OS-600 (10-08)

pennsylvania
DEPARTMENT OF TRANSPORTATION
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MEMO

DATE: September 16th, 2016

SUBJECT: Biannual Memorandum of Understanding Status Report

TO: Lawrence Holley, Chief
Division of Waste Minimization and Planning
DEP Bureau of Land Recycling and Waste Management

FROM: Winnie Okello, SRP Manager
SEMP Section - Maintenance Tech. Leadership Division
Bureau of Maintenance & Operations

The Memorandum of Understanding (MOU) Status Report Number 41 is attached, and it summarizes the current status of the Pennsylvania Department of Transportation Strategic Recycling Program efforts as established under the FY 2015 MOU (executed to date) with the Department of Environmental Protection - **(SAP # 4000018553)**. If you have any questions or comments regarding this Status Report, please contact Winnie Okello (SRP Manager) at 717-214-8788.

Thank you.

Winnie Okello, P.E.
SRP Manager

Attachments:
N/A

cc: Rich, Heineman, Civil Engineer Supervisor, CKB6
File Copy

Status Report Number: 41
Reporting Period: January 1 to June 30, 2016
Report Date: August 10, 2016

Introduction

This status report summarizes the Pennsylvania Department of Transportation's (Penndot) Strategic Recycling Program (SRP) efforts as established under FY 2015 Memorandum of Understanding (MOU) (ME # 4000018553 and SAP # 1058200612) with the Pennsylvania Department of Environmental Protection (PADEP). Activities for this report cover the January 1, 2016 to June 30, 2016 period and includes all research**,** specification development, projects, outreach, and contracting the SRP has done. Penndot's Strategic Environmental Management Program (SEMP) Section administers the SRP's contract, with consultant support available as needed.

Implementation of the Strategic Recycling Plan

Implementation of Penndot's SRP is ongoing, with action items anticipated for FY 2016/2017. Internal Penndot distribution serves as an outreach mechanism to heighten District awareness of recycling projects and, encourage exchanges of information. We now look to increase external awareness to the general public and industry professionals and potential vendors/manufacturers through partnerships with the; Recycling Markets Center (RMC), Recycled Materials Resource Center (RMRC), Recycling Fund Advisory Committee (RFAC), our DEP partners, and our commonwealth webpage found here: http://www.penndot.gov/ProjectAndPrograms/RoadDesignEnvironment/Environment/PollutionPrevention/

History

Penndot initially developed the SRP in June 2000 as a tool to systematically identify, evaluate and implement recycling opportunities throughout the Commonwealth. The ultimate objective of the SRP is to realize economic savings and environmental enhancement to Penndot and the Commonwealth through the continued development of pollution prevention, recycling, and sound environmental management practices.

Focus Areas

Five key focus areas are emphasized in the SRP to achieve and sustain Penndot's mission to increase utilization of recycled materials in transportation engineering applications. The five key focus areas are continuously reviewed and revised to reflect Penndot's ongoing efforts to implement sound environmental management practices. Action items are systematically implemented as resources (e.g., staffing, time, funding) permit in each of the key focus areas of the SRP. The five key focus areas include: *Research, Specifications, Projects, Outreach, and Contracting.*

Current Status of MOU Items

1.1 Research

- During this reporting period, the SEMP Section has continued communications with the project managers overseeing the funded demonstration projects implementing Hot In-Place Recycling (HIPR) of pavement, Recycled Asphalt Pavement (RAP) # 8 aggregate, as well as post-consumer asphalt shingles specification updates. The HIPR projects were approved for funding and are anticipated for construction in the 2016construction season.

- The SRP is a partner in the pooled fund studies and research conducted through the RMRC at University of Wisconsin, Madison. A new five-year agreement term begins in the2016/17 Fiscal Year for the fourth generation (4G) projects and the research topics will cover key areas relevant to transportation applications combined with outreach programs that provide the educational and technical resources needed to maximize the rate at which recycled materials and industrial byproducts are used in transportation applications focused specifically on issues of direct relevance to the contributing state DOTs. The Executive Board has recognized that past efforts to share RMRC research findings by conducting outreach presentations, webinars or workshops have been of great benefit to DOTs, state departments of environmental quality, the EPA and consulting engineers/contractors in industry. The RMRC-4G staff will submit quarterly progress reports that will include all research and outreach/technology transfer activities. Some examples of research efforts that could carry over (from RMRC-3G) or be incorporated into RMRC-4G may include:
    - Phase II for Recycled Materials as Back Fill for Mechanically Stabilized Earth Walls – installations and field testing
    - Recycled Material Web Map Network: Connecting Consumers with Producers – full scale launch
        - This is a nationwide mapping of recycled materials providers and users. Material producers can request access to add and modify facility data to the map. The mapping tool will be linked to the SRP website for outreach and education to source producers and material users
        - Recycled materials web map can be located at http://rmwm.caps.ua.edu/
    - Value of Using Recycled Materials via Life cycle Analysis/Life Cycle Cost Analysis (LCA/LCCA) - State-Wide Life Cycle Benefits of Recycled Materials, documentation and presentations to DOTs
    - Further development of LCA and LCCA methodologies for transportation infrastructure
        - Life cycle analyses of the reported recycled materials was used to better evaluate associated environmental impacts and cost savings. Associated Cost quantification is currently underway to better correlate with DOTs budget flexibility
    - Issues associated with high pH leachate from RCA and some fly ashes – pH and Alkalinity of RCA as base course
    - Enhanced friction and surface treatments using alternative materials (e.g., taconite tailings)
    - Regulatory and other impediments to wider use of quarry fines
    - Detailed information on the RMRC-4G can be found in Attachment 1 of this report.
- The SRP in partnership with the NPI team, continues to research applications of proposed reusable materials in the DOT's construction and maintenance activities.

1.2 Specifications

- The SEMP Section is collaborating with the Lab personnel, and RMC partners to evaluate revisions and updates/additions to current specifications and review relevant applications for recycled materials implementation in Penndot listed materials and vendors (bulletin 14&15), and projects.
- During this reporting period, we received significant interest in the consideration of a post-consumer asphalt shingles specification, and in response, Penndot currently has a work order (for consultant assistance) underway to evaluate the effects of post-consumer recycled asphalt shingles on asphalt pavement performance for Pennsylvania roads. Detailed work order objectives are included in Attachment 2 of this report.

1.3 Projects

- The SEMP Section received funding approval for Hot in place recycling projects, two in district 10 (Armstrong and Indiana), and one in District 11(Allegheny). These projects are underway this construction season (summer 2016). Hot-in-Place recycling is an in-situ process which helps rejuvenate the pavement in preparation for the surface wearing coat placement. HIPR roads require a surface wearing course for most effective outcomes, and increased longevity. The Indiana county project is approximately 5.5 miles along SR0085, covering 102,058 square yards of area. The Armstrong county project is approximately 1.7 miles along SR1038, with a seal coat covering an estimated area of 2800 square yards. The Allegheny county project is approximately 3.7 miles locate along SR1019, recycling the top 1.54 inches of in-situ asphalt pavement and overlay materials.

  A significant amount of planning, pre-construction sampling and lab testing was required to execute the associated work orders so as to ensure covering with a wearing surface prior to the fall season. Hot-in-place asphalt recycling needs a longer than aver-age lead time from concept to completion to ensure all the necessary parts of the projects are in place prior to bidding and commencement of construction.

  The NPI team conducted field views of both sites prior to construction to observe the “before” conditions. It was noted that there are a few areas of significant rutting. The HIP process requires a structurally sound roadway. HIP can fix block cracking, weathering, and other age related distresses; but it is not a structural repair.

- The SRP manager will follow up with the project managers/NPI partners for Post-construction follow-up reports; continued monitoring will be facilitated by the Lab team. The project work plans are included in Attachment 3 of this report.

1.3.1 Non-SRP Funded Projects/Initiatives

- Over the last fiscal year numerous district funded projects have implemented recycled materials in civil engineering applications. The SRP is currently working on means of tracking statewide projects that use recycled materials; this effort will implement the use of automated tracking and reporting tools to make annual reporting more accurate and efficient. The SRP continues to offer support to our internal research units to promote the use of recycled materials; currently, mulch/compost and RAP/RAS Recycling projects are underway.

Waste Tire Recycling

- Penndot encourage the recycling of waste tires produced both internally, as well as those gathered through the roadside cleanup programs. An annual waste tire hauler authorization permit from DEP is required for proper disposal and recycling of waste tires. Approximately 1500Tons of waste tire were recycled by Penndot in CY2015 in comparison to the previous year’s 225 tons of recorded data. The chart below shows recycling rates over last two years; increased data availability is reflective of better documentation and reporting requirements.

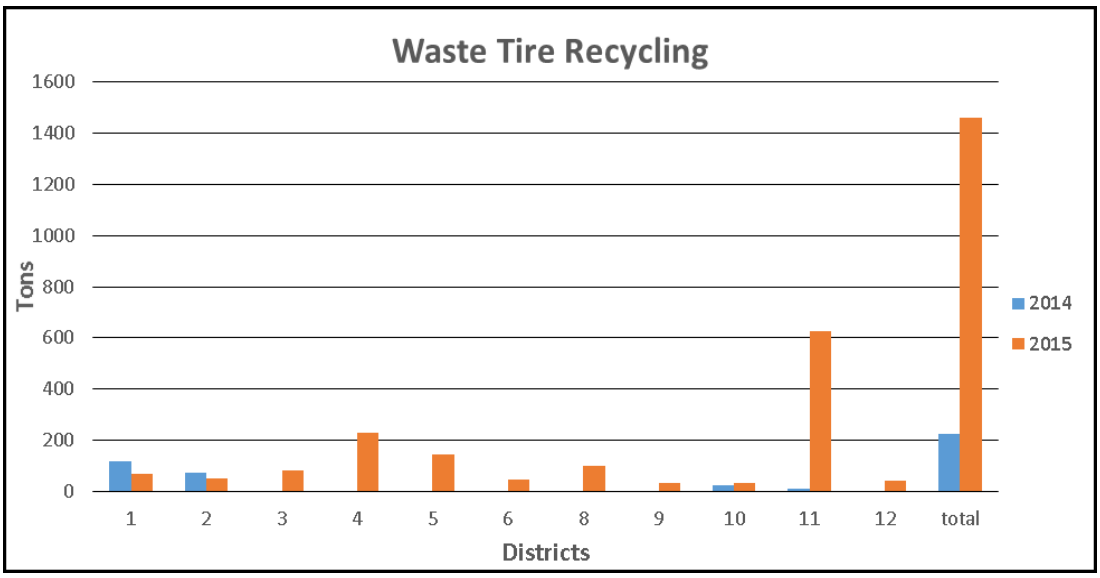

Figure 1. Waste Tire Recycling Rates

RAP/RCA: Pavement material recycling

- Penndot produces RAP annually as part of the construction/roadway maintenance operation, and approximately 2 Million tons of RAP was produced; 80% of the RAP was given to contractors for reuse while Penndot retained the remaining 20% of the material. Recycled Concrete Aggregate (RCA) is produced and shipped statewide for project use as needed. Approximately 53,800 tons of RCA was shipped to project sites for the 2015 construction season; primarily by Districts 6 and 12.

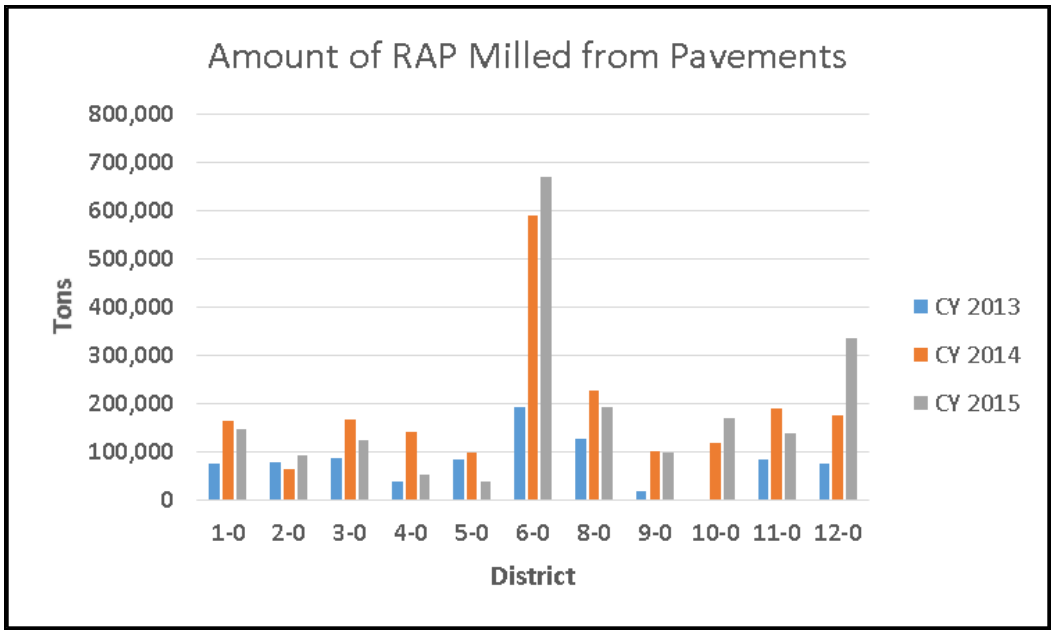

Figure 2. Statewide RAP Millings

Waste Material Recycling Reimbursements through DGS

- The SRP Continues to encourage recycling, especially when reimbursement funds area available. Penndot continues to seek areas where innovative solutions can aid in the recycling efforts, and fund necessary operations. The districts/counties use the STD497 form to ensure reimbursement for aluminum, scrap metal, and waste oil. Penndot anticipates increased participation as more districts adopt diligent documentation and reporting practices of the recycled quantities. Table 1 below shows the statewide reimbursements rates over the last three fiscal years.

Table 1. Penndot Recycling Reimbursements (Form STD-197)

FY	13/14	14/15	15/16
Aluminum	$ 143,541.54	$ 196,810.82	$ 182,149.59
Scrap Metal	$ 11,089.57	$ 21,128.75	$ 14,439.89
waste oil	$ 6,957.40	$ 154.50	$ 69.75
total	**$ 161,588.51**	**$ 218,094.07**	**$ 196,659.23**

1.4 Outreach

- During this reporting period the SEMP Section continued collaborations with the RMRC through conducting research and outreach on environmental and material properties of recycled materials. SRP focused webinars were conducted between January and May for internal Penndot employees as well as current and potential contractors/vendors. The Internal employees' webinars "An introduction to the Penndot Strategic Recycling Program" were conducted January 11th, and March 17th, with a combined attendance of 16 people. The external webinar "Doing Business with Penndot -An Introduction to the Penndot "New Product" Evaluation Procedure" was conducted on May 25th, and received attendance by 23 people. These webinars were hosted by the RMC and were purposed to increase awareness to both internal and external parties on the benefits/potential assistance available through the SRP and the RMC.
- The SRP provided a speaker for the Professional Recyclers of Pennsylvania (PROP) conference in Harrisburg: July 27-29 to present on Penndot's potential implementation and reservations regarding post-consumer recycled asphalt shingles in highway projects.
- The SRP manager will be presenting at the TRB ADC60 summer workshop in Asheville NC on the progress of Penndot's implementation of recycled materials in highway construction and maintenance activities over the years, since the inception of the SRP: July 25-29
- The SRP in partnership with the RMC plans to visit with a few of the district office to encourage office waste recycling and promote awareness of research and demonstration projects assistance for new and innovative recycled materials and processes implementation in our highway projects/maintenance activities.

1.5 Contract Bidding

The SEMP Section continues to assist Districts on various contract bidding issues pertaining to the use of recycled materials, especially, with SRP funded projects. The HIPR projects required extended time commitments in the contracting/bidding process as negotiation and consideration from the contractors; based on project location and specifications clarifications, were implemented in revisions. The projects in District 10 got off to a slow start when no bidders submitted for the first advertisement. One of the issues was that the contract consisted of three specialty items which none of the specialty contractors could bid the entire job solely. The scope of the work was then revised, and the job was let again, and the contract was successfully awarded.

2. Evaluation of Recycling Opportunities and Technologies

Evaluation of recycling opportunities and technologies is an on-going process that occurs in each SRP focus area (See Section 1). The SRP plans to focus more on cost savings and quantification of the benefits of recycled materials implementation is versus traditional construction materials.
The SRP manager reviews and prepares the annual waste tire hauler authorization permits; which allow the DOT to responsibly dispose of waste tires for reuse opportunities to authorized receiving facilities.
The SRP also followed-up with DGS to track reimbursements from recyclables form Penndot disposals of Aluminum, scrap metal, and waste oil. Penndot continues to evaluate means to save and recoup costs through recycling/material-reuse.

3. Development of Specifications that Include Recycled Materials or Products

We currently do not have any SRP initiated specification updates; however, a post-consumer asphalt shingles research is underway, led by the NPI team, and a specification would follow based on findings from the conducted research.

4. Performance of Laboratory and Field Testing on Recycled Materials

The SEMP Section in collaboration with the Lab team continues to conduct a number of laboratory and field tests on recycled materials for project implementation.

5. Review of Policies and Procedures

Policies and procedures are continually addressed through Penndot's development of the SRP, and identification of environmental objectives and targets under the SEMP Section. Beginning January 2015, the SRP had been tasked with informing/educating upper management and district personnel on the Recycling, Waste Reduction, and Procurement of Environmentally Preferable Products Management Directive dated September 19, 2014. This management directive is a DGS/DEP compliance requirement for all commonwealth agencies.

In efforts to comply with the Recycling Management Directive, Penndot created a tracking tool to better document recycled materials produced, and reused by the districts, both in civil engineering projects as well as municipal applications. The waste tracking tool and training was disseminated on May 19th, 2016 and districts/counties were directed to submit quarterly updates to the online survey monkey form via the DGS portal. The SRP continues to offer webinars which include updates to the department regarding applicable recycling regulatory requirements.

6. *Implement the Penndot Strategic Recycling Program*

The SEMP Section uses funds provided by this MOU to implement the SRP at its Central, District, and County offices. The SRP will continue using appropriated funds to fulfill activities within the five key focus areas.

7. Submission of Status Reports

The SEMP Section will continue submitting biannual MOU status reports. This status report covers the reporting period of January 1st to June 30th, 2016.

8. Use of Money provided by the MOU

As previously agreed, all SRP funds expenditures require DEP approval, and all unspent/unencumbered funds must be returned to the restricted account. Table 1 shows currently available SRP funds, expenses

incurred within this reporting period and anticipated projects funds appropriations.

TABLE 2. SRP Funds Balances

ITEM	AMT ($)
Beginning balance in restricted account	**$ 700,000.00**
Anticipated FY 16-17deposit form DEP	**$ 450,000.00**
Current Balance	**$ 1,150,000.00**
Pending Expenses (FY 16-17)	**AMT($)**
D 10-1 Armstrong Co. (2017/18)	*$ 137,000.00*
D10-4 Indiana Co.	$ 500,000.00
D11-1 Allegheny Co.	$ 420,000.00
Pooled Fund Study (4G)	$ 40,000.00
Outreach/ Annual Conferences	$ 3,000.00
Total	**$ 1,060,000.00**

9. Transfer of MOU Funding

Penndot and DEP entered into a new MOU agreement starting July 1, 2014 to June 30, 2019. The five-year agreement term has $2,250,000.00 appropriated within DEP funds, allocating $450,000.00 for each FY. Henceforth, Penndot will aim to invoice DEP within approximately 60 days of each New Fiscal Year, unless directed otherwise by DEP.

Attachment 1
RMRC- 4G Solicitation
(Pooled Funds Studies)

POOLED FUND PROPOSAL:
RECYCLED MATERIALS RESOURCE CENTER (RMRC) – 4TH GENERATION

Background

For more than 30 years, State DOTs have made significant progress incorporating recycled materials and industrial byproducts in transportation infrastructure. Recycled materials can add economic value, enhance service life and promote sustainability by reducing emission of greenhouse gases and consumption of energy and natural resources during construction. Despite these benefits, many recycled materials remain underutilized due to technical and institutional barriers. The Recycled Materials Resource Center (RMRC) was created to assist State DOTs and FHWA in breaking down these barriers through research and outreach activities focused on the wise and safe use of recycled materials.

The initial RMRC was founded in 1998 at the University of New Hampshire through an agreement with FHWA based on a stipulation in TEA-21. From 2007-2012, the RMRC was renewed as RMRC-2 as a joint venture between the University of New Hampshire (UNH) and the University of Wisconsin-Madison. RMRC-2 was awarded competitively and funded by FHWA and by a state pooled fund, TPF5(199), supported by Alabama, Colorado, Georgia, Indiana, North Carolina, New Hampshire, New York and Wisconsin. In the summer of 2012, the RMRC was renewed as RMRC-3G as a single venture at the University of Wisconsin-Madison (UW-Madison) and funded by a pooled fund, TPF-5(270), supported by Colorado, Georgia, Illinois, Minnesota, Pennsylvania, Virginia and Wisconsin. The contract for RMRC-3G ends on September 30, 2016, and a new fourth generation RMRC (RMRC-4G) is being proposed by the Wisconsin Department of Transportation (WisDOT) building upon past strengths of the RMRC.

State DOTs have developed considerable interest in using recycled materials in transportation construction and are seeking technical information regarding appropriate uses and best practices for existing and forthcoming recycled materials. With past research and known use of recycled materials, DOTs are seeking to understand the highest and best use of recycled materials. Thus, to maintain momentum regarding the use of recycled materials in transportation infrastructure, with emphasis on enhancing sustainability, service life and cost savings, WisDOT proposes to take the lead the next generation of the RMRC.

Study Objectives

The goal of the proposed RMRC-4G is to provide the resources and activities needed to break down barriers and increase utilization of recycled materials and industrial byproducts. This will be done through carefully integrated and orchestrated activities that include applied research in key areas relevant to transportation applications combined with outreach programs that provide the educational and technical resources needed to maximize the rate at which recycled materials and industrial byproducts are used in transportation applications. RMRC-4G would be supported by a new pooled fund and focus specifically on issues of direct relevance to the contributing state DOTs. The governance structure would include a pooled fund Technical Advisory Committee (the Executive Board) comprised of representatives of participating State DOTs as well as an ex-officio member as the study liaison assigned by the Federal Highway Administration. The Executive Board will have direct input on the activities and priorities of RMRC-4G through a balloting process.

Through research projects, workshops and outreach efforts, the RMRC-4G expects to achieve its goal via the accomplishment of the following objectives to:

- Define, conduct and manage critical recycled materials research that will support and improve the sustainability of transportation systems construction
- Collect and share information between state agencies that will improve the understanding of recycled materials and the appropriate applications
- Define a system of regionally significant recycled materials and establish performance expectations for those materials in various applications that will guide and enhance their use and management
- Evaluate and recommend effective technologies from a recycled materials perspective and in a manner that supports the reliable, efficient, safe and sustainable use of construction materials

- Reach out to and share ideas with private sector producers of recycled materials on approaches to making their availability, quality control and efficient delivery possible
- Identify issues or bottlenecks that prevent the widespread use of recycled materials
- Actively contribute to the development of specifications and guidelines through AASHTO
- Coordinate along the lines of the agreement that has been established between AASHTO and ASTM
- Organize webinars and workshops on the highest and best use of recycled materials
- Maintain and continually enhance RMRC website as an up-to-date resource
- Deploy innovative solutions that enhance RMRC's availability as a resource to the highway materials and construction community on recycled materials

Organizational Structure

Success of the proposed RMRC-4G will hinge directly on the ability of its Executive Board to define and tackle the most pressing barriers affecting the use of recycled materials in transportation infrastructure. The leadership team will comprise the DOT Executive Board (representatives of the states supporting the RMRC), the ex-officio FHWA representative, friends of the committee and the administrative personnel. Executive Board voting privileges will be at the discretion of each member. The collective wisdom and experience of this team will define the most important technical issues, and the best methods to address these issues. The staff of the RMRC will manage day-to-day operations of the Center and this proposed Transportation Pooled Fund, including coordinating communications, fiscal management and additional support to each of the committees as needed. This organizational structure served well in previous generations of the RMRC.

RMRC-4G will also allow non-DOT parties who express interest to become *Associate Members of the RMRC (Associates)*. Becoming an Associate Member affords an opportunity to get involved in the RMRC's activities. Associates enjoy networking opportunities with other experts in their field and are free to become actively engaged in the work of the Executive Board. They are not eligible to vote on research ideas, but are encourage to submit them to the Executive Board for consideration. Associates would be encouraged to:

- **Contact** RMRC staff representative to learn of current activities in which they may wish to participate
- **Volunteer** to submit research ideas, to serve as a reviewer of research papers, to work on a committee project, or to give a presentation or preside at a session of the annual meeting or a specialty conference
- **Participate** in RMRC Executive Board and research meetings, which generally are open to anyone who wishes to attend. Friends must introduce themselves to the chair and other meeting members.

Both the Executive Board and the Associate Members will maintain an unbiased research base.

Responsibilities of Involved Parties

Lead State (WisDOT):

- Is the agency proposing the pooled fund
- Is responsible for soliciting interest from other states.
- Will act as the sponsoring agency and will contract with the University of Wisconsin-Madison to manage the pooled fund
- Will receive invoices from the University of Wisconsin-Madison for expenses generated through the accomplishment of pooled fund tasks

Participating Members will:

- Propose research and outreach topics to be developed as proposals by the RMRC-4G staff
- Review, comment on and recommend for approval all project proposals generated by RMRC-4G staff through their participation on pooled fund Technical Advisory Committee (Executive Board)
- Through their involvement with the Executive Board, make final decisions of the approval of any project proposal recommended to them by the RMRC-4G staff and oversee the projects as needed
- Have one vote on the Executive Board

University of Wisconsin-Madison (staff of RMRC-4G) will:

- Plan, coordinate and facilitate meetings of the Executive Board using teleconferencing and other available technologies as well as through face-to-face meetings
- Prepare draft proposals (including work plans and budgets) to be presented to the Executive Board for their review, comment and approval. RMRC-4G staff may propose research projects to the Executive Board in addition to those submitted by the participating states
- Prepare quarterly progress reports to be submitted to the Executive Board and the WisDOT Research and Library Services unit for posting on the TPF website and provide other interim deliverables as determined through the development of the project's work plans
- Manage the research process, including the generation of research topics, assist in the writing of research statements, soliciting proposals, contracting of external research projects, monitoring progress of projects, and coordinating review and approval of draft final reports.
- Write research summaries for each completed research project.
- Prepare invoices to be sent to WisDOT for research and administrative activities

FHWA will provide a technical liaison for technology deployment and research sharing. FHWA will also provide research project ideas and potential funding.

Scope of Work

The RMRC-4G will have two main programs to advance the highest and best use of recycled materials:

(1) Research and Development
(2) Outreach and Technology Transfer

The RMRC-4G pooled fund will focus on recycled bound materials (e.g., asphalt and Portland cement concrete), unbound materials (e.g., base, sub-base, structural fill), the highest and best use of these materials in transportation infrastructure, stabilization of materials using industrial byproducts (e.g. fly ash, lime, other binders) and other related research projects. Factors that affect long-term physical and environmental performance of recycled materials will be evaluated using scientific principles and applied research. Additionally, a database for life cycle assessment (i.e., environmental benefits in terms of greenhouse gas emissions and energy consumption) associated with practices that use recycled materials and industrial byproducts will be updated as necessary and validated to allow for rational evaluation of material and construction options in the context of life cycle cost and sustainability.

In terms of outreach and technology transfer, the RMRC-4G staff will present RMRC research findings and continue outreach at appropriate national events per the Executive Board. RMRC-4G staff will participate in the development of new specifications, guidelines and standards related to recycled materials in AASHTO-Subcommittee on Materials (-SOM)and the ASTM Committee D18.14 in semi-annual meetings, host quarterly (or more as needed) Executive Board meetings and an annual meeting generally held at TRB in January. The team will continually update and enhance RMRC website and organize webinars or workshops as requested by the Executive Board. The Executive Board has recognized that past efforts to share RMRC research findings by conducting outreach presentations, webinars or workshops have been of great benefit to DOTs, state departments of environmental quality, the EPA and consulting engineers/contractors in industry. They will respond to any and all queries received through the website, emails, phone calls or other contacts. RMRC-4G staff will submit quarterly progress reports that will include all research and outreach/technology transfer activities.

RMRC-4G will begin with a collaborative effort to develop ideas and define a clear vision of the most important issues affecting the use of recycled materials today and in the future. This effort will be followed by development and implementation of an integrated strategic research and outreach plan focused on developing and providing the technical information and educational resources necessary to resolve the issues. Work plans will then be developed under the auspices of the Executive Board with the ultimate objective to increase the safe and wise use of recycled materials in roadway construction and maintenance. Some examples of research efforts that could carry over (from RMRC-3G) or be incorporated into RMRC-4G may include:

- Phase II for Recycled Materials as Back Fill for Mechanically Stabilized Earth Walls – installations and field testing
- Recycled Material Web Map Network: Connecting Consumers with Producers – full scale launch
- Value of Using Recycled Materials via LCA/LCCA - State-Wide Life Cycle Benefits of Recycled Materials, documentation and presentations to DOTs
- Further development of LCA and LCCA methodologies for transportation infrastructure
- Issues associated with high pH leachate from RCA and some fly ashes – pH and Alkalinity of RCA as base course
- Enhanced friction and surface treatments using alternative materials (e.g., taconite tailings)
- Regulatory and other impediments to wider use of quarry fines

In determining the final scope and priorities and in developing work plans, tasks and timelines over the five-year life of the pooled fund, RMRC-4G staff and the Executive Board will work together to:

- Determine appropriate interim deliverables for work plans (as necessary in addition to quarterly and final reports); these may include white papers, technical briefs, specifications or guidelines, fact sheets and annual progress reports or presentations
- Ensure timely results on RMRC research projects through communication products that emphasize lessons learned and implementation
- Identify appropriate mechanisms to promote and facilitate technology transfer and the deployment and implementation of pooled fund results

Budget

The budget for RMRC-4G would be based on commitments of $40,000 per year per partner state. Future obligations during the five-year period may occur to fund further activities as decided by the Executive Board. We request the initial $40,000 commitment for FY2016 or FY2017 (if partner state funding is no longer available for FY2016). Staff of WisDOT will provide management of the overall program while the University of Wisconsin-Madison will provide direction and management on a project level. Contributions less than $40,000 will be considered by the Executive Board on a case by case basis.

Commitment

- **Sponsoring Agency:** WisDOT
- **Lead State Agency:** WisDOT
- **Commitments Required:** $600,000
- **Minimum State Commitment:** $40,000 per year
- **Commitment Start Year:** FFY2016 or FFY2017
- **Commitment End Year:** FFY2020 or FFY2021
- **Duration:** 5 Years

Attachment 2

PCRAS-ECMS Advertisement

Project ID: E03723

ADVERTISEMENT - OPEN END - RESEARCHING AND EVALUATING THE EFFECT OF POST-CONSUMER RECYCLED ASPHALT SHINGLE USE ON ASPHALT PAVEMENT PERFORMANCE FOR PENNSYLVANIA ROADWAYS.

Special Comments

The SOI due date for this advertisement has been extended to 6/16/16.

The anticipated date of selection for this agreement is 7/13/16 with a NTP on the first work order anticipated for 8/29/16.

General

Initiating Organization: Bureau of Planning and Research **Status:** Published

Agreement Type: Open End

Open End Sub-Type: Non Project Specific

100% State Funded: No

Services Requested: Design and Misc Services

Selection Process: Modified

SOI Deadline: 06/16/2016

Agreements: E03723 Office of Planning Assistance Agreement

*** This advertisement was created from Agreement E03723**

Services

The Department of Transportation will retain a consultant firm for (1) open-end agreement for the services indicated below on various projects. Statewide Project. The Agreement will be for a period of 3 years. with projects assigned on an as-needed basis. The maximum amount of the Open-end Agreement will be 200,000 dollars.

Selection Criteria

The Department will establish an order of ranking of a minimum of (3) firms for the purpose of negotiating an agreement based on the Department's evaluation of the statements of interest received in response to this solicitation. The final ranking will be established directly from the statements of interest. Technical proposals will not be requested prior to the establishment of the final ranking.

The following factors, listed in order of importance, will be considered by the Department during the evaluation of the business partners submitting statements of interest:

Criteria Description	Weight
Relevant experience and expertise of personnel, sufficiency of appropriate staffing and ability to provide a range of services that maybe required and deliverables are timely and meet high quality standards.	30%
Demonstrated work experience with preparing PennDOT policies, plans, analytical tools and specifications.	25%
How did the management team perform on past PennDOT projects?	15%
How will management team work with PennDOT to meet the tasks and deliverables of the project?	15%
Firm's commitment to a quality control and quality assurance process as demonstrated in the	10%

firm's Statement of Interest and the firm's QA/QC Plan on file in ECMS with PennDOT.	
Availability of staffing for this assignment, the ability to provide prompt response to meet the Department's needs in the event of unforeseen circumstances.	5%
Weight Total:	100%

Work Task

See attachment for tasks.

Requirements

The goal for Disadvantaged Business Enterprise (DBE) participation in this agreement shall be 10 % of the total agreement cost. Cost included in a DBE firm's price proposal as direct cost of work and services by others shall not count as DBE participation in this agreement, unless completed by a DBE firm. Additional information concerning DBE participation in this agreement is contained in the General Requirements and Information Section referenced below.

The engineering services and environmental studies identified above are the general work activities that can be expected under this Open-end Contract. A more specific and project-related Scope of Work will be outlined for each individual Work Order developed under this Open-end Contract.

Additional information regarding this Agreement/Advertisement and Statement of Interest requirements are contained in the **General Requirements** document.

Attachment

5-13-16 PCRAS Advertisement.pdf

Questions and Responses

No records found.

Contact Information

Name	Email	Phone	Fax	Org
Heather A. Heslop	hheslop@pa.gov	(717) 214-9508		5100

History

Published	SOI Deadline	Revised Description
06/06/2016	06/16/2016	
05/16/2016	05/26/2016	revised SOI due date

You are currently logged in as **Winnie A. Okello**.

Release: 44.0
Session size: 0.1k

Mon Aug 08 15:20:18 EDT 2016
Official ECMS Date/Time

This is an open-end arrangement with direction provided through work orders from the Pennsylvania Department of Transportation. This agreement will be utilized for work associated with researching and evaluating the effect of Post-Consumer Recycled Asphalt Shingle use on asphalt pavement performance for Pennsylvania roadways. Some of the issues and expertise may include:

- Determine if Pennsylvania can use Post-Consumer Recycled Asphalt Shingles in asphalt pavements without affecting quality and if so, to what level can this be done.

- Gather information on completed research related to the development or the start of the development of performance testing and specification limits for Post-Consumer Recycled Asphalt Shingle use in asphalt pavements.

- Present at least three (3) cost effective alternatives for an experimental plan that would determine performance testing limits, while maintaining acceptable quality, for the effective use of Post-Consumer Recycled Asphalt Shingles in Pennsylvania's asphalt mixtures.

- Gather Pennsylvania aggregate, asphalt binder, asphalt additives, RAP, manufactured waste shingles and post-consumer shingles, as needed, to facilitate the fabrication of test specimens required for development of and/or validation of testing limits associated with recommended performance tests.

- Test the proposed experimental plan by performing testing of materials, as required, to establish and validate the experimental limits proposed for the use of Post-Consumer Recycled Asphalt Shingles in asphalt mixtures.

- Develop any necessary changes and additional specifications as needed to Pennsylvania's specifications to facilitate the implementation of the findings of completed research and the experimental plan.

- Develop minimum quality control and quality assurance specifications required to ensure that the quality of the Post-Consumer Recycled Asphalt Shingles are introduced into the asphalt mixtures and the needed quality control measures are established to ensure the finished asphalt mixture quality.

- Develop minimum quality control and quality assurance specification requirements to ensure that the processing sources of Post-Consumer Recycled Asphalt Shingles produce processed Post-Consumer Recycled Asphalt Shingles that achieves the desired result in the asphalt mixture and are within established limits for asbestos and other environmentally hazardous materials.

- Present a summary of all findings provided throughout the course of the project, in addition, present recommendations (based on the project findings) that will enable PennDOT to consider/determine if Post-Consumer Recycled Asphalt Shingles are a viable option for

Pennsylvania's asphalt mixtures. Provide one (1) presentation to PennDOT management, and one (1) presentation to the Joint PennDOT and Industry Committee, attend and participate in up to three (3) meetings as requested by PennDOT and present one (1) webinar training session.

Attachment 3

HIPR Projects

(Counties: Allegheny, Indiana)

Research Project

Evaluation of Hot in Place Asphalt Recycling
District 11 – Allegheny County

Work Plan

November 2015

Prepared by:

Sheri Little

Conducted by:
Evaluations and Research Unit
New Products and Innovations Section
Innovation and Support Services Division
Bureau of Project Delivery

pennsylvania
DEPARTMENT OF TRANSPORTATION

I. INTRODUCTION

There are limited material resources to repair the many miles of pavement in Pennsylvania. Hot-In-Place Asphalt Recycling (HIP) is an on-site, in place pavement rehabilitation method. This system consists of heating, scarifying, adding a rejuvenating agent, mixing, placing, and compacting the recycled bituminous pavement. The benefits of using HIP include using the existing asphalt pavement rejuvenated to remove surface distresses, less pollution and less fuels consumed transporting materials. Fewer resources are used than under normal asphalt recycling, which includes milling the surface, trucking the millings to a plant to be heated and rejuvenated, and trucking the material back to the site to place as a recycled bituminous pavement.

The HIP process consists of a train of either two or three heater trucks that use propane heated firebrick to indirectly heat the pavement to approximately 375°F via radiant heat. The last heater truck also: scarifies the material to a depth of 1.5", adds a predetermined amount of rejuvenating oil, mixes the oil and material, and spreads the rejuvenated material using a heated paving screed. Typically, a new wearing course is placed on top of the recycled bituminous materials. Alternatively, several different surface treatments such as chip seals, micro surfacing, and slurry seals may be used to seal the surface of the HIP pavement depending on the ADT of the highway.

HIP provides an interim layer to fix imperfections prior to placing an overlay. It will correct minor rutting and surface cracking, and restore some flexibility to the old pavement.

II. SCOPE OF WORK

The research project is located in Allegheny County, SR 1019. The project section will be a 2-lane highway 3.75 miles long located between Segment/Offset 0100/0000 to Segment/Offset 0170/0864. The average annual daily traffic (AADT) varies from 670 vehicles with 9 % trucks to 2,890 vehicles with 4% trucks. The roadway width is approximately 20' over the length of the project with four foot shoulders on both sides. The project will be completed across the entire mainline and shoulder (out to out). Attachment C has the pavement history of the project section. After the HIP process is completed, a surface treatment will be applied being a sealcoat completed by Allegheny County Department Forces.

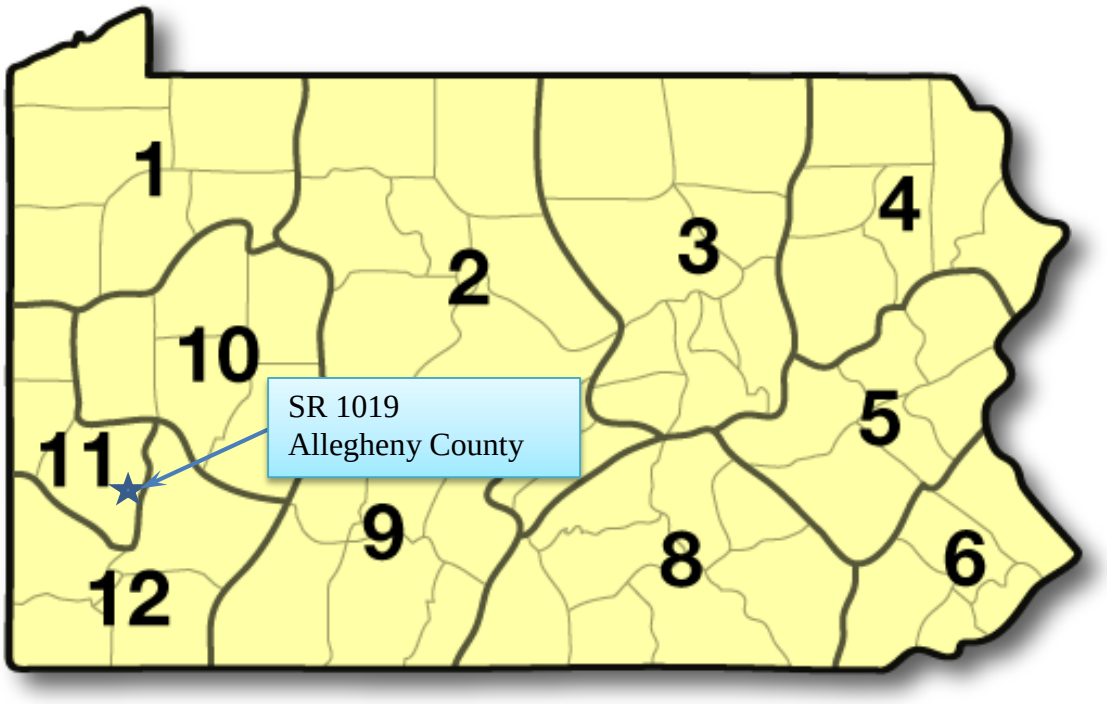

Figure 1, General Project Location

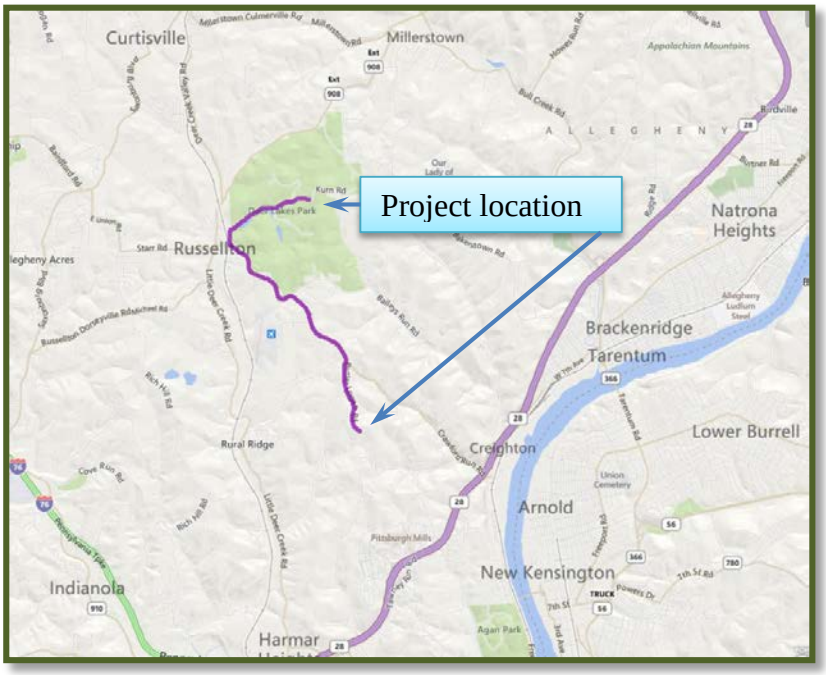

Figure 2, Project Location

III. PLAN OF STUDY

The site was compared to the HIP project guidelines listed in Attachment A. The site was considered suitable; the work will be constructed and evaluated for up to three years after placement of the product. The New Products and Innovation Section (NPI) will document the construction procedures and any problems encountered. Revisions will be made to the proposed specification as warranted to reflect any lessons learned from the construction and field performance.

IV. Surface Evaluation

Prior to construction, a pavement distress survey will be performed by NPI to document the existing site conditions and to establish a baseline for monitoring the project during the evaluation period. Distresses appearing within the project will be reviewed to determine if there is any correlation with previously noted distresses.

Laser Crack Survey will be completed by the Pavement Testing and Asset Management Section prior to placing the material and after placement. The Laser Crack Survey will be completed at least yearly after placement for three years.

Field views will be conducted by NPI (and/or District 11-0) at least once per year during the three year evaluation period. The frequency of field views may be increased at any time at the discretion of the project team. Reasons for increasing the frequency of field views include rapid degradation, rutting, cracking, etc.

Field views are primarily visual inspections documented with selected site photographs. Inspection assistance may be required from the District by NPI on an as-needed basis. NPI will coordinate with the District to ensure that the project team is meeting all appropriate safety requirements during field views.

Material Testing

Prior to construction, the district representative will select four core locations on the existing pavement for every lane-mile. Two cores will be drilled at each location for the first mile and the core locations will be clearly mark off the side of the roadway for taking companion loose box samples during construction. The companion core from each location will be sent to NPI for verification testing. The contractor will record descriptive notes of the locations for each core, along with the associated test results showing percent of recovered asphalt content, aggregate gradation, and original penetration value for each sample.

The recycling agent shall be tested in accordance with requirements in Table 1.

Table 1 – Recycling Agent Requirements

Test Requirements	Test Method	Minimum	Maximum
Tests of Residue from Distillation: Viscosity, 140F, cSt Flash Point, CSC, F	 T 201 T 48	 901 215	 4500 -
Tests on Residue from RTFO, 325F: Viscosity Ratio Weight Change, ±, %	T 240	 - -	 3 4
Specific Gravity	T 228	Report	
Saybolt Furol Viscosity @ 77F, s	T 59(1)	15	85
Storage Stability, 24 hrs, %		-	1.0
Sieve, %		-	0.1
Cement Mixing, %		-	2.0
Asphalt Content by Evaporation, %		65.0	

1. This testing requirement is only for ERA25

On the first day of construction and prior to compaction, take two loose box samples near each of the pre-construction baseline core locations. Samples should be taken either behind the screed or from any place after the spraying and milling / mixing units. All samples should be identified by their locations at the project site. The contractor will test one box sample from each set for penetration and the other box sample will be provided to NPI to verify the Contractor's test results. Samples or cores should not be taken within the first 500 feet of the day's production.

The loose mix samples taken will be tested for recycling agent application rate such that the minimum average penetration value of the recovered asphalt binder during construction is at least 30% higher than the average penetration value of the recovered asphalt binder from the existing pavement cores. The penetration testing will be performed on all samples in accordance with AASHTO T 49, Penetration of Bituminous Materials. The final penetration value shall not exceed 100.

V. STAFF

Staffing for this project will be as follows:

Project Manager
Daniel E. Clark, P.E.
Bureau of Project Delivery
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Principal Investigator
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BOMO Representative
Larry Ligon
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District 11-0 Representative
William Dipner
District 11-0
45 Thoms Run Road
Bridgeville, PA 15017
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e-mail: wdipner@pa.gov

VI. REPORTING

Construction Report

A construction report detailing the placement of the Hot in Place Asphalt Recycling will be prepared by the NPI Division after the construction is completed.

Field Views

Field reviews will be performed for the first three years after placement to review the performance of pavement. A field report will be completed within fifteen (15) days after each field review.

Final Report

A single final report, detailing the performance of the test sections and any recommendations, will be prepared by the NPI Division at the end of the three year evaluation period.

VII. SCHEDULE

Table 1, Research Project Schedule

	Year	2016				2017				2018				2019			
Activity	Quarter	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Construction/Placement			■														
Collect Material Samples			■														
Testing			■	■	■												
Construction Report					■												
Annual Field View							■				■				■		
Closeout Recommendations																■	

VIII. REFERENCES

http://www.hotinplacerecycling.com/

http://highwayrehab.com/

ATTACHMENT A

Guidelines for Selecting Hot in Place Recycling Projects

The following pavement conditions should be considered in determining the suitability of Hot in Place (HIP) Recycling projects.

Distresses should be limited to the surface of the pavement. The pavement should not have load distresses or problems with the base. Pavements should be evaluated according to the following Pub. 336 criteria:

- Rutting Severity should be < 3.0 inches.
- Transverse and Miscellaneous Cracking should be < 1.0 inches deep. The average crack width should not exceed the Medium Rating of ≤ 0.5 inches.
- Raveling/Weathering should not exceed the Medium Rating. The surface may be rough and pitted, and may have loose particles.

Other pavement conditions to consider for acceptable Hot in Place Recycling projects.

- The pavement can have minor corrugations, shoving, and slippage with an average depth <1.0 inches.
- Minor bleeding and low friction numbers are acceptable
- HIP working depth is typically 1 to 1.5 inches with a maximum of 2 inches.
- HIP can be used to increase traffic loading above current capacity if the base has capability for more loading. Adding a wearing course will provide a driving surface for increased traffic loading.
- HIP should not be considered for roadways that need widening
- HIP can work around tight turns, manholes, catch basins, etc.
- HIP does not work well with pavements with high water tables or susceptible to flooding.
- Bituminous pavement thickness needs to be at least 1-½ inches more than the HIP milling.
- The pavement aggregate size should be < ¾ inch.
- If paving fabric has been used on the proposed project site, then the paving fabric must be at least 1-½ inches below the HIP milled surface.
- HIP can accommodate most pavement mixes and surface treatments. Cores will be taken from the proposed project pavement to design the amount of rejuvenator required. Examples of acceptable pavement and surface treatments:
    - Specialty mixes, for example: stone matrix asphalt, open graded friction courses, and open graded drainage layers.
    - Surface treatments, for example: seal coats, crack seals, crumb rubber in pavement, patching.
    - Pavements with mix designs outside the acceptable tolerance limit can be brought into tolerance by adding aggregate or rejuvenator.
- HIP can be used with any AADT and truck traffic; it will require a wearing course for the higher traffic roadways. Determination of the wearing surface will depend on the AADT and truck traffic. A seal coat will require at least two weeks of traffic before placement. The seal coat will be performed before the end of the current paving season.

ATTACHMENT B

Provision Name: a11201 HOT SURFACE RECYCLING OF BITUMINOUS PAVEMENT

Header

HOT SURFACE RECYCLING OF BITUMINOUS PAVEMENT

Provision Body

I. DESCRIPTION

This work consists of heating, scarifying, rejuvenating, milling, mixing, leveling, and compacting the existing bituminous surface material to a depth of at least one inch or as specified. The final wearing surface, such as hot mix overlay, microsurfacing, seal coat, or slurry seal, will be specified and paid for separately.

II. MATERIAL

Use a recycling agent meeting the requirements of ASTM D 4552 grades RA25 or ERA25 (an emulsified RA25) petroleum-based recycling agent specifically designed as a rejuvenator meeting the requirements outlined in Table 1. At the start of, and during, production provide certified test results and documented quantities to the Representative for each shipment of recycling agent. Acceptance of this material is based on a signed Manufacturer's Certification stating conformance to this specification. The use of any other grade of recycling agent requires prior approval from the Representative. Submit the test data and analysis, and obtain the approval of the recycling agent type, grade and amount from the Laboratory Testing Section (LTS) prior to commencing the work.

Table 1 – Recycling Agent Requirements

Test Requirements	Test Method	Minimum	Maximum
Tests of Residue from Distillation: Viscosity, 140°F, cSt Flash Point, CSC, F	T 201 T 48	901 215	4500 -
Tests on Residue from RTFO, 325°F: Viscosity Ratio Weight Change, ±, %	T 240	- -	3 4
Specific Gravity	T 228	Report	
Saybolt Furol Viscosity @ 77°F, s	T 59[(i)]	15	85
Storage Stability, 24 hrs, %		-	1.0
Sieve, %		-	0.1
Cement Mixing, %		-	2.0
Asphalt Content by Evaporation, %		65.0	

i.This testing requirement is only for ERA25.

III. CONSTRUCTION

(a) General.

1. Weather Limitations. Do not undertake hot surface recycling between October 31 and April 1, unless otherwise permitted in writing by the District Executive. Do not start when surfaces are wet or when the existing surface and air temperature are less than 45°F measured in the shade.

2. Conditioning Existing Surface. Prior to commencing heater scarifying operations, clean the existing pavement of all extraneous material. Supplement power brooming when necessary with hand brooming and such other tools to bring the surface to a clean, suitable condition, free of deleterious material.

(b) Equipment.

Provide equipment configured for a continuous single pass, multi-step operation capable of drying and heating the upper layers of the existing pavement such that scarifying to the prescribed depth can be accomplished without excessively damaging aggregate; uniformly adding a metered amount of recycling agent to the scarified material based on the job mix design; thoroughly mixing and evenly distributing the recycled material across the entire paving width; and leveling and spreading the material prior to compaction. Use conventional asphalt paving rollers to compact the material behind the paver. Use equipment capable of processing the existing pavement to a maximum depth of 2 inches. Use a burner assembly adjustable to a width of between 8 and 14 feet. The equipment must be sufficiently articulated to treat the entire project roadway, including curves, corners, and cul-de-sacs. Provide a competent operating crew. Equipment must meet the following requirements:

1. **Heating Unit(s).** The heating units shall be self-contained self-propelled, and able to remove excess moisture and soften the asphalt pavement to the specified depth without burning or charring the asphalt binder or producing undesirable pollutants. Operate the heating unit at speeds of ten feet to twenty-five feet per minute while uniformly heating the surface of the asphalt. Enclose or shield the heating unit so that it does not damage adjacent materials. The heating unit shall not subject the pavement surface to open flame. Comply with all applicable Federal, State and Local Air Pollution Control regulations.

   Raise or lower the entire burner assembly with a single control. Equip each unit with a fire suppression system. Place hand-held hoses with adjustable nozzles on each unit to allow for pre-wetting of specific plants or objects.

2. **Scarifying Unit(s).** The scarifying units consist of no less than two rows of spring-loaded tines to ensure penetration of the teeth and to prevent damage to utility structures. Space the tines approximately 1 inch apart and configure the tines to conform to the pavement contour and to cover entire paving width.

3. **Spraying Unit.** The spraying units shall uniformly apply a recycling agent at the specified rate to the newly loosened materials prior to mixing and placing. The recycling agent must be added after scarification. Use a thermostatically controlled heater to uniformly maintain

the recycling agent in the recycling agent tank within the temperature range of minimum 160°F and maximum 170°. Equip the spraying unit with an electronic digital measuring system capable of maintaining the required application rate of the recycling agent with a tolerance of ±5% for the mix design. Continuously verify and display the application rate of the recycling agent and cumulative total with respect to the volume of treated material for the road surface. Calibrate the sprayer to show gallons used to the nearest tenth. Calibrate the electronic digital measuring system in the presence of the Representative or designee. Satisfactory calibrations are required for each project. Work shall not progress until the calibration has been completed and verified to be accurate.

4. **Milling/Mixing Unit.** The milling/mixing unit shall be capable of thoroughly blending the loosened material and recycling agent to a point that the material exiting the paving screed has a uniform appearance across the entire paving width. Immediately following the application of the recycling agent, use a dual-drum enclosed milling machine to thoroughly mix the recycling agent with the scarified and milled material. This milling/mixing unit shall be an integral part of the scarifying machine and shall be located between the spraying system, which applies the recycling agent, and the screed. Use a milling /mixing unit capable of treating a width of 8 to 14 feet. Use an articulated unit to allow for quarter point and crown control.

5. **Paver.** Use an approved paving machine equipped with a heated tamping or vibratory screed to distribute and level the treated material. Obtain prior approval from the Representative if another type of screed is used.

6. **Compacter.** Use steel-wheel, pneumatic-tire, vibratory, or oscillating rollers as specified or allowed in Section 108.05(c)3 or 4. Operate rollers according to manufacturer's recommendations.

(c) Procedure

1. **Pre-construction sampling, testing, and mix design.** Prior to construction, take a series of cores for mix design and to establish baselines for subsequent verification testing. The Representative will select four core locations on the existing pavement for every lane-mile or fraction thereof if production is less than one mile. The locations are intended to be representative of the entire project. Drill two cores at each location for the first mile and clearly mark the core locations off the side of the roadway for taking companion loose box samples during construction. Provide sample to contractor for testing for mix design and the companion core from each location to the Representative for verification testing. Contractor shall provide descriptive notes of the locations for each core, along with the associated test results showing percent of recovered asphalt content, aggregate gradation, and original penetration value (AASHTO T49) for each sample. Perform testing using an AMRL Accredited Laboratory.

   The Contractor may request to take supplemental cores from the existing bituminous pavement to help determine / verify the mix design. If supplemental cores are desired, submit the request to the Representative at least 2 weeks prior to coring.

Determine the recycling agent application rate such that the minimum average penetration value of the recovered asphalt binder from the loose mix samples taken during construction is at least 30% higher than the average penetration value of the recovered asphalt binder from the existing pavement cores or 90, whichever is less. The final penetration value shall not exceed 100. Perform penetration testing of all samples in accordance with AASHTO T 49, Penetration of Bituminous Materials. After a test strip has been completed, or as the work progresses, the Representative may make adjustments to the mix design if needed.

2. **Construction.** Operate the heating unit in a manner to minimize damage to adjacent property and vegetation. Repair all heat-damaged areas immediately, and at no additional cost to the Department.

   Use an adequate number of heater units to ensure that the temperature of the heated material directly behind the paver is greater than 200ºF and the required production rates will be achieved without burning the pavement. Control the equipment so that the temperature of the scarified material, after mixing, should be at least 230ºF and no more than 300ºF. The surface temperature of the pavement should at no point exceed 375ºF

   Add recycling agent uniformly to the scarified pavement at the predetermined application rate to produce a homogenous recycled mix.

   Construct the pavement to the width and depth specified. Control the width of each pass to provide proper placement of longitudinal joints including a 3-inch overlap onto adjacent lane passes. Measure the depth of the loose mix after the screed prior to rolling. Adjust the mat thickness if the loose mix depth does not meet the project requirements. Do not cause the aggregates to be pulverized, spalled or broken.

   Control the speed of the equipment to ensure that the pavement is properly milled, mixed, and uniformly redistributed to the proper thickness, slope, and crown shown on the Contract plans. Take extra care in controlling the equipment to prevent segregation of the recycled material at the start and end of paving production as well as any points where the paving train needs to stop and restart.

   In areas such as catch basins or manholes not accessible to the recycle paving train, the Representative will determine the treatment required. Pavement surfaces that the Representative determines to be in good condition and are less than one square yard in size may be exempted. Treat areas with cracks or spalls that are larger than one square yard in size as approved by the Representative at no additional cost to the Department.

3. **Verification testing.** On the first day of construction and prior to compaction, take two loose box samples near each of the pre-construction baseline core locations. These samples will be considered representative of the day's production. Take samples either after the screed or from any place after the spraying and milling / mixing units. Identify all samples by their locations at the project site. Test two box samples from each set for penetration and bulk specific gravity (PTM 715). Provide the other box samples to the Representative for evaluation by the LTS to verify the Contractor's test results. Do not take samples or cores within the first 500 feet of the day's production.

Submit verification test results to the Representative by the end of the next day's production. If test results are not provided, the Representative may shutdown the paving operation until the results are submitted. The average penetration value of the loose mix samples must be at least 30% higher than the average penetration of the baseline core samples or 90, whichever is less.

Take loose box samples as described above every day of production for quality control and quality assurance purposes.

If the loose box samples fail to meet the minimum 30% higher average penetration requirement, adjust the recycling agent application rate and submit the new application rate to the Representative. Repeat the sampling and testing procedure described above until the average penetration values meet the minimum 30% higher requirement.

If, at any time, the average penetration value of the loose mix samples fails to meet the minimum 30% higher average penetration requirement or is greater than 90, the Representative may evaluate the pavement section and request the treated pavement be removed and replaced at no additional cost to the Department. The evaluation may include, but is not limited to, penetration testing of the core samples, assessing the location of the samples / section, etc. If the treated pavement is not satisfactory to the Representative, additional tests may be required on the existing samples at no additional cost to the Department. If additional samples are required, take and submit the test results to the Department at no additional cost to the Department.

4. **Compaction.** Unless a thin hot mix overlay 1 inch or less is placed as the final monolithic wearing surface, roll the treated material immediately following placement. If a thin hot mix overlay is placed as the final monolithic wearing surface, spread the new hot bituminous plant mix uniformly over the treated mix immediately following placement and compaction. Keep the temperature of the recycled mix above 175°F at the time the new hot bituminous plant mix is placed over it. Do not allow the new mix to become a homogenous mixture with the recycled material. Commence rolling of the final surface immediately after the laydown of the new mix. Accomplish rolling in accordance with Section 409.3(h).

   Do not allow the temperature of the material to drop below 200°F prior to the commencement of rolling.

   Accept density of recycled material based on an optimum-rolling pattern developed as specified in Section 409.3(j)3. The relative compacted density must be as specified by the department. If no density is specified, use 92% of the maximum specific gravity as the minimum.

   If the hot mix overlay is not placed as a monolithic wearing course, and the treated surface is opened to traffic in the interim, apply a bituminous tack coat over the treated surface prior to placing the overlay in accordance with Section 460 if required by the Representative.

5. **Opening to traffic.** Ensure that, prior to opening the roadway to traffic; the surface temperature of the HIR-treated pavement is 150°F or less as required by contract documents.

IV. MEASUREMENT AND PAYMENT

(a) Hot Surface Recycling. Square Yard.

(b) Recycling Agent. Gallon.

ATTACHMENT C

Pavement History

Layer Code / Year of Placement	FULL LAYER DESCRIPTION	Seg/Off Begin 0100/0000 End 0104/1466	Seg/Off Begin 0110/0000 End 0110/2238	Seg/Off Begin 0120/0000 End 0120/2893	Seg/Off Begin 0130/0000 End 0140/2046	Seg/Off Begin 0150/0000 End 0160/3480	Seg/Off Begin 0170/0000 End 0170/0760	Seg/Off Begin 0170/0760 End 0170/0864
		Layer Depth	Layer Depth	Layer Depth	Layer Depth	Layer Depth	Layer Depth	Layer Depth
NSTR1 2012	SURFACE TREATMENT - SEALCOAT	.25	.25	.25	.25	.25	.25	.25
NSTR1 2008	SURFACE TREATMENT - SEALCOAT	.25	.25	.25	.25	.25	.25	
NSTR1 2007	SURFACE TREATMENT - SEALCOAT				.25			
NSTR1 2004	SURFACE TREATMENT - SEALCOAT	.25	.25	.25	.25	.25		
NSTR1 2002	SURFACE TREATMENT - SEALCOAT				.25			
NSTR1 2001	SURFACE TREATMENT - SEALCOAT		.25	.25				
NSTR1 1999	SURFACE TREATMENT - SEALCOAT	.25						
NSTR4 1996	SURFACE TREATMENT – SLURRY SEAL		1.00	1.00	1.00	1.00	1.00	1.00
ID2U0 1994	BITUMINOUS WEARING COURSE ID-2	2.50	2.50	2.50	2.50	2.50	2.50	2.50
MILL0 1994	MILLING			-1.50	-1.50	-1.50	-1.50	-1.50
NSTR1 1988	SURFACE TREATMENT - SEALCOAT	.25	.25	.25				
FB2B0 1988	BITUMINOUS BINDER COURSE FB-2	2.00	2.00	3.00				
FB1U0 1987	BITUMINOUS WEARING COURSE FB-1				3.00	3.00	3.00	3.00

Layer Code / Year of Placement	FULL LAYER DESCRIPTION	Seg/Off Begin 0100/0000 End 0104/1466	Seg/Off Begin 0110/0000 End 0110/2238	Seg/Off Begin 0120/0000 End 0120/2893	Seg/Off Begin 0130/0000 End 0140/2046	Seg/Off Begin 0150/0000 End 0160/3480	Seg/Off Begin 0170/0000 End 0170/0760	Seg/Off Begin 0170/0760 End 0170/0864
		Layer Depth	Layer Depth	Layer Depth	Layer Depth	Layer Depth	Layer Depth	Layer Depth
CABC0 1965	CRUSHED AGGREGATE BASE COURSE	8.00	8.00	8.00				
NSTR1 1940	SURFACE TREATMENT - SEALCOAT	.25	.25	.25				
NSB00 1940	NATIVE STONE (GRANULAR) SUBB	8.00	8.00	8.00				
NSTR1 1900	SURFACE TREATMENT - SEALCOAT				.25	.25	.25	.25
NSB00 1900	NATIVE STONE (GRANULAR) SUBB				8.00			
STONE 1900	STONE BASE COURSE					8.00	8.00	8.00
CABC0 1900	CRUSHED AGGREGATE BASE COURSE					10.00	10.00	10.00

Research Project

Evaluation of Hot in Place Asphalt Recycling
District 10 – Armstrong County

Work Plan

November 2015

Prepared by:

Sheri Little

Conducted by:
Evaluations and Research Unit
New Products and Innovations Section
Innovation and Support Services Division
Bureau of Project Delivery

pennsylvania
DEPARTMENT OF TRANSPORTATION

I. INTRODUCTION

There are limited material resources to repair the many miles of pavement in Pennsylvania. Hot-In-Place Asphalt Recycling (HIP) is an on-site, in place pavement rehabilitation method. This system consists of heating, scarifying, adding a rejuvenating agent, mixing, placing, and compacting the recycled bituminous pavement. The benefits of using HIP include using the existing asphalt pavement rejuvenated to remove surface distresses, less pollution and less fuels consumed transporting materials. Fewer resources are used than under normal asphalt recycling, which includes milling the surface, trucking the millings to a plant to be heated and rejuvenated, and trucking the material back to the site to place as a recycled bituminous pavement.

The HIP process consists of a train of either two or three heater trucks that use propane heated firebrick to indirectly heat the pavement to approximately 375°F via radiant heat. The last heater truck also: scarifies the material to a depth of 1.5", adds a predetermined amount of rejuvenating oil, mixes the oil and material, and spreads the rejuvenated material using a heated paving screed. Typically, a new wearing course is placed on top of the recycled bituminous materials. Alternatively, several different surface treatments such as chip seals, micro surfacing, and slurry seals may be used to seal the surface of the HIP pavement depending on the ADT of the highway.

HIP provides an interim layer to fix imperfections prior to placing an overlay. It will correct minor rutting and surface cracking, and restore some flexibility to the old pavement.

II. SCOPE OF WORK

The research project is located in Armstrong County, SR 1038. The project section will be a 2-lane highway 1.79 miles long located between Segment/Offset 0090/0000 to Segment/Offset 0130/0847. The average annual daily traffic (AADT) is 2,788 vehicles with 2% trucks. The predominate roadway width is 20' over the length of the project with two foot shoulders on both sides. The project will be completed across the entire mainline and shoulder (out to out). Attachment C has the pavement history of the project section. After the HIP process is completed, a sealcoat will be applied by Armstrong County Department Forces.

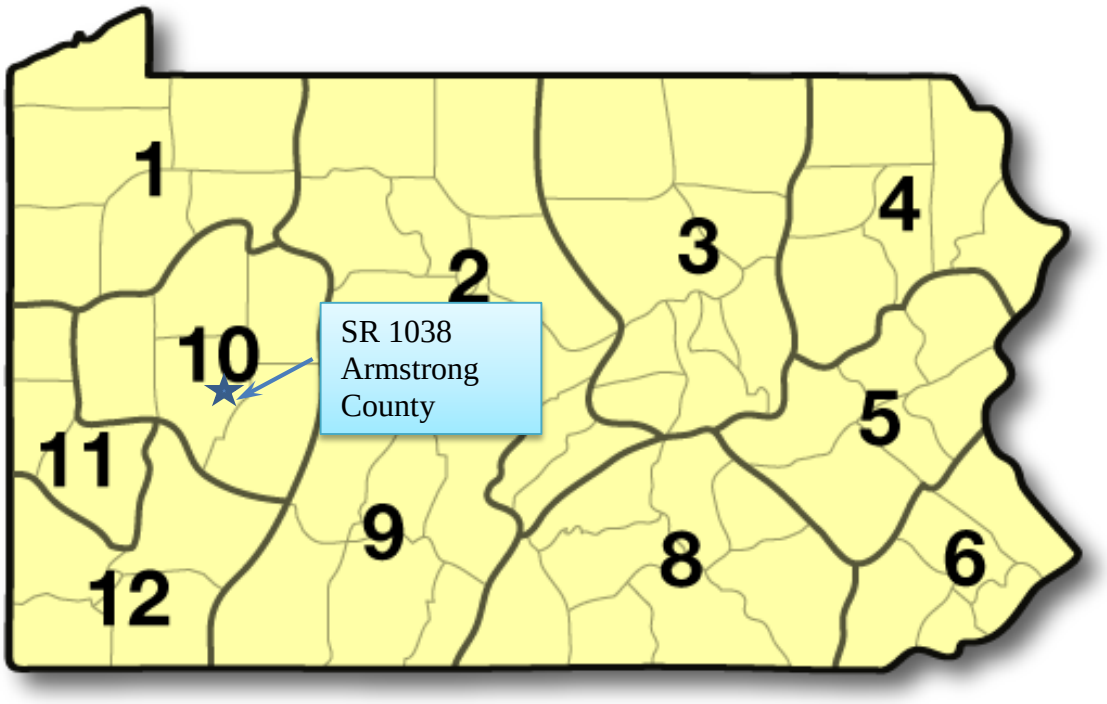

Figure 1, General Project Location

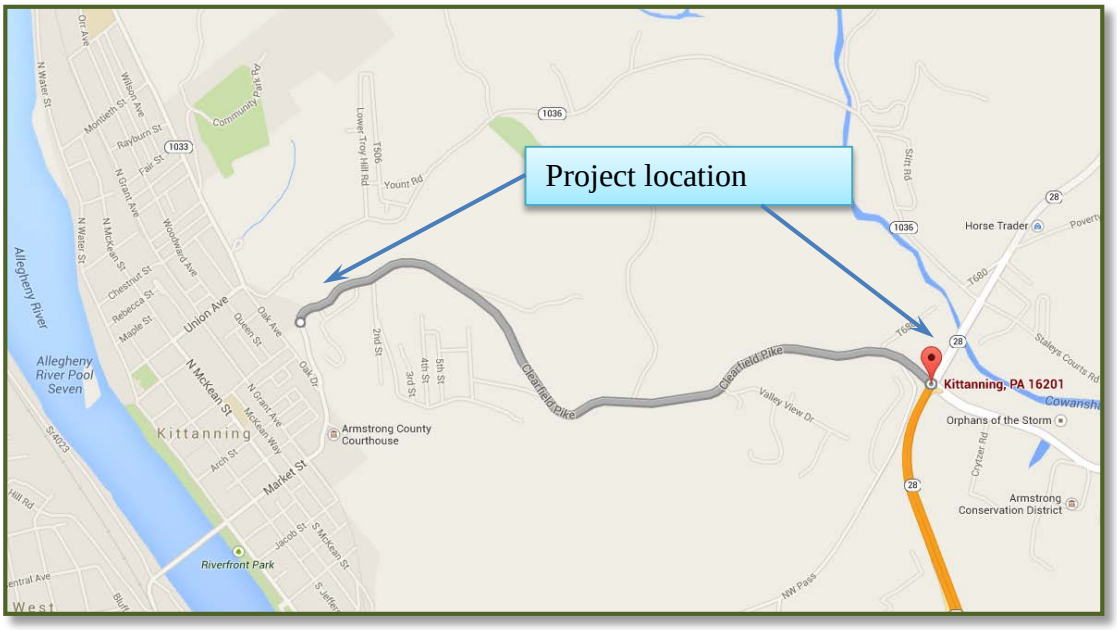

Figure 2, Project Location

III. PLAN OF STUDY

The site was compared to the HIP project guidelines listed in Attachment A. The site was considered suitable; the work will be constructed and evaluated for up to three years after placement of the product. The New Products and Innovation Section (NPI) will document the construction procedures and any problems encountered. Revisions will be made to the proposed specification as warranted to reflect any lessons learned from the construction and field performance.

Surface Evaluation

Prior to construction, a pavement distress survey will be performed by NPI to document the existing site conditions and to establish a baseline for monitoring the project during the evaluation period. Distresses appearing within the project will be reviewed to determine if there is any correlation with previously noted distresses.

Laser Crack Survey will be completed by the Pavement Testing and Asset Management Section prior to placing the material and after placement. The Laser Crack Survey will be completed at least yearly after placement for three years.

Field views will be conducted by NPI (and/or District 10-0) at least once per year during the three year evaluation period. The frequency of field views may be increased at any time at the discretion of the project team. Reasons for increasing the frequency of field views include rapid degradation, rutting, cracking, etc.

Field views are primarily visual inspections documented with selected site photographs. Inspection assistance may be required from the District by NPI on an as-needed basis. NPI will coordinate with the District to ensure that the project team is meeting all appropriate safety requirements during field views.

Material Testing

Prior to construction, the district representative will select four core locations on the existing pavement for every lane-mile. Two cores will be drilled at each location for the first mile and the core locations will be clearly mark off the side of the roadway for taking companion loose box samples during construction. The companion core from each location will be sent to NPI for verification testing. The contractor will record descriptive notes of the locations for each core, along with the associated test results showing percent of recovered asphalt content, aggregate gradation, and original penetration value for each sample.

The recycling agent shall be tested in accordance with the requirements shown in Table 1.

Table 1 – Recycling Agent Requirements

Test Requirements	Test Method	Minimum	Maximum
Tests of Residue from Distillation: Viscosity, 140F, cSt Flash Point, CSC, F	 T 201 T 48	 901 215	 4500 -
Tests on Residue from RTFO, 325F: Viscosity Ratio Weight Change, ±, %	T 240	 - -	 3 4
Specific Gravity	T 228	Report	
Saybolt Furol Viscosity @ 77F, s	T 59(1)	15	85
Storage Stability, 24 hrs, %		-	1.0
Sieve, %		-	0.1
Cement Mixing, %		-	2.0
Asphalt Content by Evaporation, %		65.0	

1. This testing requirement is only for ERA25

On the first day of construction and prior to compaction, take two loose box samples near each of the pre-construction baseline core locations. Samples should be taken either behind the screed or from any place after the spraying and milling / mixing units. All samples should be identified by their locations at the project site. The contractor will test one box sample from each set for penetration and the other box sample will be provided to NPI to verify the Contractor's test results. Samples or cores should not be taken within the first 500 feet of the day's production.

The loose mix samples taken will be tested for recycling agent application rate such that the minimum average penetration value of the recovered asphalt binder during construction is at least 30% higher than the average penetration value of the recovered asphalt binder from the existing pavement cores. The penetration testing will be performed on all samples in accordance with AASHTO T 49, Penetration of Bituminous Materials. The final penetration value shall not exceed 100.

IV. STAFF

Staffing for this project will be as follows:

Project Manager
Daniel E. Clark, P.E.
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Principal Investigator
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BOMO Representative
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400 North Street, 7th Floor
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District 10-1 Representative
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Armstrong County PennDOT Engineering District 10-1
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V. REPORTING

Construction Report

A construction report detailing the placement of the Hot in Place Asphalt Recycling will be prepared by the NPI Division after the construction is completed.

Field Views

Field reviews will be performed for the first three years after placement to review the performance of pavement. A field report will be completed within fifteen (15) days after each field review.

Final Report

A single final report, detailing the performance of the test sections and any recommendations, will be prepared by the NPI Division at the end of the three year evaluation period.

VI. SCHEDULE

Table 1, Research Project Schedule

Activity	Year	2016				2017				2018				2019			
	Quarter	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Construction/Placement			■														
Collect Material Samples			■														
Testing			■	■	■												
Construction Report					■												
Annual Field View							■				■				■		
Closeout Recommendations																■	

VII. REFERENCES

http://www.hotinplacerecycling.com/

http://highwayrehab.com/

ATTACHMENT A

Guidelines for Selecting Hot in Place Recycling Projects

The following pavement conditions should be considered in determining the suitability of Hot in Place (HIP) Recycling projects.

Distresses should be limited to the surface of the pavement. The pavement should not have load distresses or problems with the base. Pavements should be evaluated according to the following Pub. 336 criteria:

- Rutting Severity should be < 3.0 inches.
- Transverse and Miscellaneous Cracking should be < 1.0 inches deep. The average crack width should not exceed the Medium Rating of ≤ 0.5 inches.
- Raveling/Weathering should not exceed the Medium Rating. The surface may be rough and pitted, and may have loose particles.

Other pavement conditions to consider for acceptable Hot in Place Recycling projects.

- The pavement can have minor corrugations, shoving, and slippage with an average depth <1.0 inches.
- Minor bleeding and low friction numbers are acceptable
- HIP working depth is typically 1 to 1.5 inches with a maximum of 2 inches.
- HIP can be used to increase traffic loading above current capacity if the base has capability for more loading. Adding a wearing course will provide a driving surface for increased traffic loading.
- HIP should not be considered for roadways that need widening
- HIP can work around tight turns, manholes, catch basins, etc.
- HIP does not work well with pavements with high water tables or susceptible to flooding.
- Bituminous pavement thickness needs to be at least 1-½ inches more than the HIP milling.
- The pavement aggregate size should be < ¾ inch.
- If paving fabric has been used on the proposed project site, then the paving fabric must be at least 1-½ inches below the HIP milled surface.
- HIP can accommodate most pavement mixes and surface treatments. Cores will be taken from the proposed project pavement to design the amount of rejuvenator required. Examples of acceptable pavement and surface treatments:
    - Specialty mixes, for example: stone matrix asphalt, open graded friction courses, and open graded drainage layers.
    - Surface treatments, for example: seal coats, crack seals, crumb rubber in pavement, patching.
    - Pavements with mix designs outside the acceptable tolerance limit can be brought into tolerance by adding aggregate or rejuvenator.
- HIP can be used with any AADT and truck traffic; it will require a wearing course for the higher traffic roadways. Determination of the wearing surface will depend on the AADT and truck traffic. A seal coat will require at least two weeks of traffic before placement. The seal coat will be performed before the end of the current paving season.

ATTACHMENT B

Provision Name: a11201 HOT SURFACE RECYCLING OF BITUMINOUS PAVEMENT

Header

HOT SURFACE RECYCLING OF BITUMINOUS PAVEMENT

Provision Body

I. DESCRIPTION

This work consists of heating, scarifying, rejuvenating, milling, mixing, leveling, and compacting the existing bituminous surface material to a depth of at least one inch or as specified. The final wearing surface, such as hot mix overlay, microsurfacing, seal coat, or slurry seal, will be specified and paid for separately.

II. MATERIAL

Use a recycling agent meeting the requirements of ASTM D 4552 grades RA25 or ERA25 (an emulsified RA25) petroleum-based recycling agent specifically designed as a rejuvenator meeting the requirements outlined in Table 1. At the start of, and during, production provide certified test results and documented quantities to the Representative for each shipment of recycling agent. Acceptance of this material is based on a signed Manufacturer's Certification stating conformance to this specification. The use of any other grade of recycling agent requires prior approval from the Representative. Submit the test data and analysis, and obtain the approval of the recycling agent type, grade and amount from the Laboratory Testing Section (LTS) prior to commencing the work.

Table 1 – Recycling Agent Requirements

Test Requirements	Test Method	Minimum	Maximum
Tests of Residue from Distillation: Viscosity, 140°F, cSt Flash Point, CSC, F	T 201 T 48	901 215	4500 -
Tests on Residue from RTFO, 325°F: Viscosity Ratio Weight Change, ±, %	T 240	- -	3 4
Specific Gravity	T 228	Report	
Saybolt Furol Viscosity @ 77°F, s	T 59[(i)]	15	85
Storage Stability, 24 hrs, %		-	1.0
Sieve, %		-	0.1
Cement Mixing, %		-	2.0
Asphalt Content by Evaporation, %		65.0	

i.This testing requirement is only for ERA25.

III. CONSTRUCTION

(a) General.

1. Weather Limitations. Do not undertake hot surface recycling between October 31 and April 1, unless otherwise permitted in writing by the District Executive. Do not start when surfaces are wet or when the existing surface and air temperature are less than 45°F measured in the shade.

2. Conditioning Existing Surface. Prior to commencing heater scarifying operations, clean the existing pavement of all extraneous material. Supplement power brooming when necessary with hand brooming and such other tools to bring the surface to a clean, suitable condition, free of deleterious material.

(b) Equipment.

Provide equipment configured for a continuous single pass, multi-step operation capable of drying and heating the upper layers of the existing pavement such that scarifying to the prescribed depth can be accomplished without excessively damaging aggregate; uniformly adding a metered amount of recycling agent to the scarified material based on the job mix design; thoroughly mixing and evenly distributing the recycled material across the entire paving width; and leveling and spreading the material prior to compaction. Use conventional asphalt paving rollers to compact the material behind the paver. Use equipment capable of processing the existing pavement to a maximum depth of 2 inches. Use a burner assembly adjustable to a width of between 8 and 14 feet. The equipment must be sufficiently articulated to treat the entire project roadway, including curves, corners, and cul-de-sacs. Provide a competent operating crew. Equipment must meet the following requirements:

1. **Heating Unit(s).** The heating units shall be self-contained self-propelled, and able to remove excess moisture and soften the asphalt pavement to the specified depth without burning or charring the asphalt binder or producing undesirable pollutants. Operate the heating unit at speeds of ten feet to twenty-five feet per minute while uniformly heating the surface of the asphalt. Enclose or shield the heating unit so that it does not damage adjacent materials. The heating unit shall not subject the pavement surface to open flame. Comply with all applicable Federal, State and Local Air Pollution Control regulations.

   Raise or lower the entire burner assembly with a single control. Equip each unit with a fire suppression system. Place hand-held hoses with adjustable nozzles on each unit to allow for pre-wetting of specific plants or objects.

2. **Scarifying Unit(s).** The scarifying units consist of no less than two rows of spring-loaded tines to ensure penetration of the teeth and to prevent damage to utility structures. Space the tines approximately 1 inch apart and configure the tines to conform to the pavement contour and to cover entire paving width.

3. **Spraying Unit.** The spraying units shall uniformly apply a recycling agent at the specified rate to the newly loosened materials prior to mixing and placing. The recycling agent must be added after scarification. Use a thermostatically controlled heater to uniformly maintain

the recycling agent in the recycling agent tank within the temperature range of minimum 160°F and maximum 170°. Equip the spraying unit with an electronic digital measuring system capable of maintaining the required application rate of the recycling agent with a tolerance of ±5% for the mix design. Continuously verify and display the application rate of the recycling agent and cumulative total with respect to the volume of treated material for the road surface. Calibrate the sprayer to show gallons used to the nearest tenth. Calibrate the electronic digital measuring system in the presence of the Representative or designee. Satisfactory calibrations are required for each project. Work shall not progress until the calibration has been completed and verified to be accurate.

4. **Milling/Mixing Unit.** The milling/mixing unit shall be capable of thoroughly blending the loosened material and recycling agent to a point that the material exiting the paving screed has a uniform appearance across the entire paving width. Immediately following the application of the recycling agent, use a dual-drum enclosed milling machine to thoroughly mix the recycling agent with the scarified and milled material. This milling/mixing unit shall be an integral part of the scarifying machine and shall be located between the spraying system, which applies the recycling agent, and the screed. Use a milling /mixing unit capable of treating a width of 8 to 14 feet. Use an articulated unit to allow for quarter point and crown control.

5. **Paver.** Use an approved paving machine equipped with a heated tamping or vibratory screed to distribute and level the treated material. Obtain prior approval from the Representative if another type of screed is used.

6. **Compacter.** Use steel-wheel, pneumatic-tire, vibratory, or oscillating rollers as specified or allowed in Section 108.05(c)3 or 4. Operate rollers according to manufacturer's recommendations.

(c) Procedure

1. **Pre-construction sampling, testing, and mix design.** Prior to construction, take a series of cores for mix design and to establish baselines for subsequent verification testing. The Representative will select four core locations on the existing pavement for every lane-mile or fraction thereof if production is less than one mile. The locations are intended to be representative of the entire project. Drill two cores at each location for the first mile and clearly mark the core locations off the side of the roadway for taking companion loose box samples during construction. Provide sample to contractor for testing for mix design and the companion core from each location to the Representative for verification testing. Contractor shall provide descriptive notes of the locations for each core, along with the associated test results showing percent of recovered asphalt content, aggregate gradation, and original penetration value (AASHTO T49) for each sample. Perform testing using an AMRL Accredited Laboratory.

   The Contractor may request to take supplemental cores from the existing bituminous pavement to help determine / verify the mix design. If supplemental cores are desired, submit the request to the Representative at least 2 weeks prior to coring.

Determine the recycling agent application rate such that the minimum average penetration value of the recovered asphalt binder from the loose mix samples taken during construction is at least 30% higher than the average penetration value of the recovered asphalt binder from the existing pavement cores or 90, whichever is less. The final penetration value shall not exceed 100. Perform penetration testing of all samples in accordance with AASHTO T 49, Penetration of Bituminous Materials. After a test strip has been completed, or as the work progresses, the Representative may make adjustments to the mix design if needed.

2. **Construction.** Operate the heating unit in a manner to minimize damage to adjacent property and vegetation. Repair all heat-damaged areas immediately, and at no additional cost to the Department.

   Use an adequate number of heater units to ensure that the temperature of the heated material directly behind the paver is greater than 200ºF and the required production rates will be achieved without burning the pavement. Control the equipment so that the temperature of the scarified material, after mixing, should be at least 230ºF and no more than 300ºF. The surface temperature of the pavement should at no point exceed 375ºF

   Add recycling agent uniformly to the scarified pavement at the predetermined application rate to produce a homogenous recycled mix.

   Construct the pavement to the width and depth specified. Control the width of each pass to provide proper placement of longitudinal joints including a 3-inch overlap onto adjacent lane passes. Measure the depth of the loose mix after the screed prior to rolling. Adjust the mat thickness if the loose mix depth does not meet the project requirements. Do not cause the aggregates to be pulverized, spalled or broken.

   Control the speed of the equipment to ensure that the pavement is properly milled, mixed, and uniformly redistributed to the proper thickness, slope, and crown shown on the Contract plans. Take extra care in controlling the equipment to prevent segregation of the recycled material at the start and end of paving production as well as any points where the paving train needs to stop and restart.

   In areas such as catch basins or manholes not accessible to the recycle paving train, the Representative will determine the treatment required. Pavement surfaces that the Representative determines to be in good condition and are less than one square yard in size may be exempted. Treat areas with cracks or spalls that are larger than one square yard in size as approved by the Representative at no additional cost to the Department.

3. **Verification testing.** On the first day of construction and prior to compaction, take two loose box samples near each of the pre-construction baseline core locations. These samples will be considered representative of the day's production. Take samples either after the screed or from any place after the spraying and milling / mixing units. Identify all samples by their locations at the project site. Test two box samples from each set for penetration and bulk specific gravity (PTM 715). Provide the other box samples to the Representative for evaluation by the LTS to verify the Contractor's test results. Do not take samples or cores within the first 500 feet of the day's production.

Submit verification test results to the Representative by the end of the next day's production. If test results are not provided, the Representative may shutdown the paving operation until the results are submitted. The average penetration value of the loose mix samples must be at least 30% higher than the average penetration of the baseline core samples or 90, whichever is less.

Take loose box samples as described above every day of production for quality control and quality assurance purposes.

If the loose box samples fail to meet the minimum 30% higher average penetration requirement, adjust the recycling agent application rate and submit the new application rate to the Representative. Repeat the sampling and testing procedure described above until the average penetration values meet the minimum 30% higher requirement.

If, at any time, the average penetration value of the loose mix samples fails to meet the minimum 30% higher average penetration requirement or is greater than 90, the Representative may evaluate the pavement section and request the treated pavement be removed and replaced at no additional cost to the Department. The evaluation may include, but is not limited to, penetration testing of the core samples, assessing the location of the samples / section, etc. If the treated pavement is not satisfactory to the Representative, additional tests may be required on the existing samples at no additional cost to the Department. If additional samples are required, take and submit the test results to the Department at no additional cost to the Department.

4. **Compaction.** Unless a thin hot mix overlay 1 inch or less is placed as the final monolithic wearing surface, roll the treated material immediately following placement. If a thin hot mix overlay is placed as the final monolithic wearing surface, spread the new hot bituminous plant mix uniformly over the treated mix immediately following placement and compaction. Keep the temperature of the recycled mix above 175°F at the time the new hot bituminous plant mix is placed over it. Do not allow the new mix to become a homogenous mixture with the recycled material. Commence rolling of the final surface immediately after the laydown of the new mix. Accomplish rolling in accordance with Section 409.3(h).

   Do not allow the temperature of the material to drop below 200°F prior to the commencement of rolling.

   Accept density of recycled material based on an optimum-rolling pattern developed as specified in Section 409.3(j)3. The relative compacted density must be as specified by the department. If no density is specified, use 92% of the maximum specific gravity as the minimum.

   If the hot mix overlay is not placed as a monolithic wearing course, and the treated surface is opened to traffic in the interim, apply a bituminous tack coat over the treated surface prior to placing the overlay in accordance with Section 460 if required by the Representative.

5. **Opening to traffic.** Ensure that, prior to opening the roadway to traffic; the surface temperature of the HIR-treated pavement is 150°F or less as required by contract documents.

IV. MEASUREMENT AND PAYMENT

(a) Hot Surface Recycling. Square Yard.

(b) Recycling Agent. Gallon.

ATTACHMENT C

Pavement History

Layer Code / Year of Placement	FULL LAYER DESCRIPTION	Seg/Off Begin 0090/0000 End 0110/0807	Seg/Off Begin 0110/0807 End 0120/1851	Seg/Off Begin 0120/1851 End 0120/1881	Seg/Off Begin 0120/1881 End 0120/2133	Seg/Off Begin 0130/0000 End 0130/0204	Seg/Off Begin 0130/0204 End 0130/0538	Seg/Off Begin 0130/0538 End 0130/0847
		Layer Depth	Layer Depth	Layer Depth	Layer Depth	Layer Depth	Layer Depth	Layer Depth
NSTR1 2011	SURFACE TREATMENT - SEALCOAT	.25	.25	.25	.25	.25	.25	.25
ID2H0 2001	BITUMINOUS WEARING COURSE ID-2				1.50	1.50	1.50	
ID2BO 2001	ID-2 BINDER COURSE				2.00	2.00	2.00	
PCC00 2001	PLAIN CEMENT CONC PAVEMENT							10.00
ATPBC 2001	ASPHALT TREATED PERMEABLE BC							4.00
BCBC0 2001	BITUM CONCRETE BASE COURSE				8.00	8.00	8.00	
SUB00 2001	2A SUBBASE				4.00	4.00	4.00	
SUB20 2001	2A SUBBASE				4.00	4.00	4.00	6.00
ID2H0 1993	BITUMINOUS WEARING CRSE ID-2					1.00	1.00	
HD2H0 1991	HEAVY DUTY BIT WAR CRSE ID2					1.50	1.50	
ID2HO 1981	BITUMINOUS WEARING CRSE ID-2	1.00	1.00	1.00	1.00			
RCC00 1959	REINFORCED CEMENT CONC PVMT						9.00	
FJ1UO 1958	BITUMINOUS WEARING CRSE FJ-1	1.00	1.00	1.00	1.00			

Layer Code / Year of Placement	FULL LAYER DESCRIPTION	Seg/Off Begin 0090/0000 End 0110/0807	Seg/Off Begin 0110/0807 End 0120/1851	Seg/Off Begin 0120/1851 End 0120/1881	Seg/Off Begin 0120/1881 End 0120/2133	Seg/Off Begin 0130/0000 End 0130/0204	Seg/Off Begin 0130/0204 End 0130/0538	Seg/Off Begin 0130/0538 End 0130/0847
		Layer Depth	Layer Depth	Layer Depth	Layer Depth	Layer Depth	Layer Depth	Layer Depth
ID2BO 1958	ID-2 BINDER COURSE				1.50			
ID2BO 1958	ID-2 BINDER COURSE	1.50	1.50	1.50				
HE100 1958	BITUMINOUS WEARING CRSE HE-1			2.00	2.00	2.00		
NSB00 1958	NATIVE STONE (GRANULAR) SUBB			8.00	8.00	8.00		
RCCOP 1900	PARABOLIC RCCP	7.00	8.00	7.50	7.50	7.50		
SSG00 1900	SPECIAL SUBBASE						6.00	

Research Project

Evaluation of Hot in Place Asphalt Recycling
District 10- Indiana County

Work Plan

November 2015

Prepared by:

Sheri Little

Conducted by:
Evaluations and Research Unit
New Products and Innovations Section
Innovation and Support Services Division
Bureau of Project Delivery

pennsylvania
DEPARTMENT OF TRANSPORTATION

I. INTRODUCTION

There are limited material resources to repair the many miles of pavement in Pennsylvania. Hot-In-Place Asphalt Recycling (HIP) is an on-site, in place pavement rehabilitation method. This system consists of heating, scarifying, adding a rejuvenating agent, mixing, placing, and compacting the recycled bituminous pavement. The benefits of using HIP include using the existing asphalt pavement rejuvenated to remove surface distresses, less pollution and less fuels consumed transporting materials. Fewer resources are used than under normal asphalt recycling, which includes milling the surface, trucking the millings to a plant to be heated and rejuvenated, and trucking the material back to the site to place as a recycled bituminous pavement.

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HIP provides an interim layer to fix imperfections prior to placing an overlay. It will correct minor rutting and surface cracking, and restore some flexibility to the old pavement.

II. SCOPE OF WORK

The research project is located in Indiana County, SR 0085. The project section will be a 2-lane highway 8 miles long located between Segment/Offset 0020/0000 to Segment/Offset 0160/2241. The average annual daily traffic (AADT) varies from 2,204 vehicles with 19% trucks to 3,683 vehicles with 9% trucks. The roadway width is approximately 22' over the length of the project. Attachment C has the pavement history of the project section. After the HIP process is completed, a surface treatment will be applied consisting of two layers of microsurfacing.

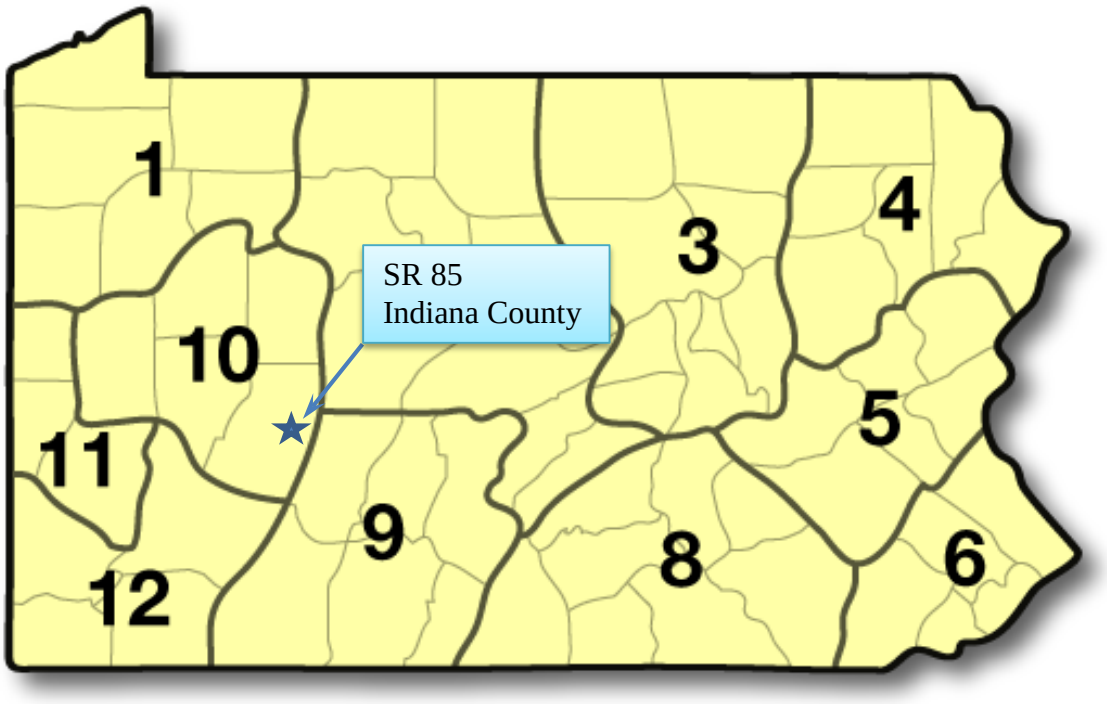

Figure 1, General Project Location

Figure 2, Project Location

III. PLAN OF STUDY

The site was compared to the HIP project guidelines listed in Attachment A. The site was considered suitable; the work will be constructed and evaluated for up to three years after placement of the product. The New Products and Innovation Section (NPI) will document the construction procedures and any problems encountered. Revisions will be made to the proposed specification as warranted to reflect any lessons learned from the construction and field performance.

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Specific Gravity	T 228	Report	
Saybolt Furol Viscosity @ 77F, s	T 59(1)	15	85
Storage Stability, 24 hrs, %		-	1.0
Sieve, %		-	0.1
Cement Mixing, %		-	2.0
Asphalt Content by Evaporation, %		65.0	

1. This testing requirement is only for ERA25

On the first day of construction and prior to compaction, take two loose box samples near each of the pre-construction baseline core locations. Samples should be taken either behind the screed or from any place after the spraying and milling / mixing units. All samples should be identified by their locations at the project site. The contractor will test one box sample from each set for penetration and the other box sample will be provided to NPI to verify the Contractor's test results. Samples or cores should not be taken within the first 500 feet of the day's production.

The loose mix samples taken will be tested for recycling agent application rate such that the minimum average penetration value of the recovered asphalt binder during construction is at least 30% higher than the average penetration value of the recovered asphalt binder from the existing pavement cores. The penetration testing will be performed on all samples in accordance with AASHTO T 49, Penetration of Bituminous Materials. The final penetration value shall not exceed 100.

IV. STAFF

Staffing for this project will be as follows:

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V. REPORTING

Construction Report

A construction report detailing the placement of the Hot in Place Asphalt Recycling will be prepared by the NPI Division after the construction is completed.

Field Views

Field reviews will be performed for the first three years after placement to review the performance of pavement. A field report will be completed within fifteen (15) days after each field review.

Final Report

A single final report, detailing the performance of the test sections and any recommendations, will be prepared by the NPI Division at the end of the three year evaluation period.

VI. SCHEDULE

Table 1, Research Project Schedule

Activity	Year	2016				2017				2018				2019			
	Quarter	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Construction/Placement			■														
Collect Material Samples			■														
Testing			■	■	■												
Construction Report					■												
Annual Field View							■				■				■		
Closeout Recommendations																■	

VII. REFERENCES

http://www.hotinplacerecycling.com/

http://highwayrehab.com/

ATTACHMENT A

Guidelines for Selecting Hot in Place Recycling Projects

The following pavement conditions should be considered in determining the suitability of Hot in Place (HIP) Recycling projects.

Distresses should be limited to the surface of the pavement. The pavement should not have load distresses or problems with the base. Pavements should be evaluated according to the following Pub. 336 criteria:

- Rutting Severity should be < 3.0 inches.
- Transverse and Miscellaneous Cracking should be < 1.0 inches deep. The average crack width should not exceed the Medium Rating of ≤ 0.5 inches.
- Raveling/Weathering should not exceed the Medium Rating. The surface may be rough and pitted, and may have loose particles.

Other pavement conditions to consider for acceptable Hot in Place Recycling projects.

- The pavement can have minor corrugations, shoving, and slippage with an average depth <1.0 inches.
- Minor bleeding and low friction numbers are acceptable
- HIP working depth is typically 1 to 1.5 inches with a maximum of 2 inches.
- HIP can be used to increase traffic loading above current capacity if the base has capability for more loading. Adding a wearing course will provide a driving surface for increased traffic loading.
- HIP should not be considered for roadways that need widening
- HIP can work around tight turns, manholes, catch basins, etc.
- HIP does not work well with pavements with high water tables or susceptible to flooding.
- Bituminous pavement thickness needs to be at least 1-½ inches more than the HIP milling.
- The pavement aggregate size should be < ¾ inch.
- If paving fabric has been used on the proposed project site, then the paving fabric must be at least 1-½ inches below the HIP milled surface.
- HIP can accommodate most pavement mixes and surface treatments. Cores will be taken from the proposed project pavement to design the amount of rejuvenator required. Examples of acceptable pavement and surface treatments:
    - Specialty mixes, for example: stone matrix asphalt, open graded friction courses, and open graded drainage layers.
    - Surface treatments, for example: seal coats, crack seals, crumb rubber in pavement, patching.
    - Pavements with mix designs outside the acceptable tolerance limit can be brought into tolerance by adding aggregate or rejuvenator.
- HIP can be used with any AADT and truck traffic; it will require a wearing course for the higher traffic roadways. Determination of the wearing surface will depend on the AADT and truck traffic. A seal coat will require at least two weeks of traffic before placement. The seal coat will be performed before the end of the current paving season.

ATTACHMENT B

Provision Name: a11201 HOT SURFACE RECYCLING OF BITUMINOUS PAVEMENT

Header

HOT SURFACE RECYCLING OF BITUMINOUS PAVEMENT

Provision Body

I. DESCRIPTION

This work consists of heating, scarifying, rejuvenating, milling, mixing, leveling, and compacting the existing bituminous surface material to a depth of at least one inch or as specified. The final wearing surface, such as hot mix overlay, microsurfacing, seal coat, or slurry seal, will be specified and paid for separately.

II. MATERIAL

Use a recycling agent meeting the requirements of ASTM D 4552 grades RA25 or ERA25 (an emulsified RA25) petroleum-based recycling agent specifically designed as a rejuvenator meeting the requirements outlined in Table 1. At the start of, and during, production provide certified test results and documented quantities to the Representative for each shipment of recycling agent. Acceptance of this material is based on a signed Manufacturer's Certification stating conformance to this specification. The use of any other grade of recycling agent requires prior approval from the Representative. Submit the test data and analysis, and obtain the approval of the recycling agent type, grade and amount from the Laboratory Testing Section (LTS) prior to commencing the work.

Table 1 – Recycling Agent Requirements

Test Requirements	Test Method	Minimum	Maximum
Tests of Residue from Distillation: Viscosity, 140°F, cSt Flash Point, CSC, F	 T 201 T 48	 901 215	 4500 -
Tests on Residue from RTFO, 325°F: Viscosity Ratio Weight Change, ±, %	 T 240	 - -	 3 4
Specific Gravity	T 228	Report	
Saybolt Furol Viscosity @ 77°F, s	T 59[(i)]	15	85
Storage Stability, 24 hrs, %		-	1.0
Sieve, %		-	0.1
Cement Mixing, %		-	2.0
Asphalt Content by Evaporation, %		65.0	

i.This testing requirement is only for ERA25.

III. CONSTRUCTION

(a) General.

1. Weather Limitations. Do not undertake hot surface recycling between October 31 and April 1, unless otherwise permitted in writing by the District Executive. Do not start when surfaces are wet or when the existing surface and air temperature are less than 45°F measured in the shade.

2. Conditioning Existing Surface. Prior to commencing heater scarifying operations, clean the existing pavement of all extraneous material. Supplement power brooming when necessary with hand brooming and such other tools to bring the surface to a clean, suitable condition, free of deleterious material.

(b) Equipment.

Provide equipment configured for a continuous single pass, multi-step operation capable of drying and heating the upper layers of the existing pavement such that scarifying to the prescribed depth can be accomplished without excessively damaging aggregate; uniformly adding a metered amount of recycling agent to the scarified material based on the job mix design; thoroughly mixing and evenly distributing the recycled material across the entire paving width; and leveling and spreading the material prior to compaction. Use conventional asphalt paving rollers to compact the material behind the paver. Use equipment capable of processing the existing pavement to a maximum depth of 2 inches. Use a burner assembly adjustable to a width of between 8 and 14 feet. The equipment must be sufficiently articulated to treat the entire project roadway, including curves, corners, and cul-de-sacs. Provide a competent operating crew. Equipment must meet the following requirements:

1. **Heating Unit(s).** The heating units shall be self-contained self-propelled, and able to remove excess moisture and soften the asphalt pavement to the specified depth without burning or charring the asphalt binder or producing undesirable pollutants. Operate the heating unit at speeds of ten feet to twenty-five feet per minute while uniformly heating the surface of the asphalt. Enclose or shield the heating unit so that it does not damage adjacent materials. The heating unit shall not subject the pavement surface to open flame. Comply with all applicable Federal, State and Local Air Pollution Control regulations.

   Raise or lower the entire burner assembly with a single control. Equip each unit with a fire suppression system. Place hand-held hoses with adjustable nozzles on each unit to allow for pre-wetting of specific plants or objects.

2. **Scarifying Unit(s).** The scarifying units consist of no less than two rows of spring-loaded tines to ensure penetration of the teeth and to prevent damage to utility structures. Space the tines approximately 1 inch apart and configure the tines to conform to the pavement contour and to cover entire paving width.

3. **Spraying Unit.** The spraying units shall uniformly apply a recycling agent at the specified rate to the newly loosened materials prior to mixing and placing. The recycling agent must be added after scarification. Use a thermostatically controlled heater to uniformly maintain the recycling agent in the recycling agent tank within the temperature range of minimum

160°F and maximum 170°. Equip the spraying unit with an electronic digital measuring system capable of maintaining the required application rate of the recycling agent with a tolerance of ±5% for the mix design. Continuously verify and display the application rate of the recycling agent and cumulative total with respect to the volume of treated material for the road surface. Calibrate the sprayer to show gallons used to the nearest tenth. Calibrate the electronic digital measuring system in the presence of the Representative or designee. Satisfactory calibrations are required for each project. Work shall not progress until the calibration has been completed and verified to be accurate.

4. **Milling/Mixing Unit.** The milling/mixing unit shall be capable of thoroughly blending the loosened material and recycling agent to a point that the material exiting the paving screed has a uniform appearance across the entire paving width. Immediately following the application of the recycling agent, use a dual-drum enclosed milling machine to thoroughly mix the recycling agent with the scarified and milled material. This milling/mixing unit shall be an integral part of the scarifying machine and shall be located between the spraying system, which applies the recycling agent, and the screed. Use a milling /mixing unit capable of treating a width of 8 to 14 feet. Use an articulated unit to allow for quarter point and crown control.

5. **Paver.** Use an approved paving machine equipped with a heated tamping or vibratory screed to distribute and level the treated material. Obtain prior approval from the Representative if another type of screed is used.

6. **Compacter.** Use steel-wheel, pneumatic-tire, vibratory, or oscillating rollers as specified or allowed in Section 108.05(c)3 or 4. Operate rollers according to manufacturer's recommendations.

(c) Procedure

1. **Pre-construction sampling, testing, and mix design.** Prior to construction, take a series of cores for mix design and to establish baselines for subsequent verification testing. The Representative will select four core locations on the existing pavement for every lane-mile or fraction thereof if production is less than one mile. The locations are intended to be representative of the entire project. Drill two cores at each location for the first mile and clearly mark the core locations off the side of the roadway for taking companion loose box samples during construction. Provide sample to contractor for testing for mix design and the companion core from each location to the Representative for verification testing. Contractor shall provide descriptive notes of the locations for each core, along with the associated test results showing percent of recovered asphalt content, aggregate gradation, and original penetration value (AASHTO T49) for each sample. Perform testing using an AMRL Accredited Laboratory.

   The Contractor may request to take supplemental cores from the existing bituminous pavement to help determine / verify the mix design. If supplemental cores are desired, submit the request to the Representative at least 2 weeks prior to coring.

   Determine the recycling agent application rate such that the minimum average penetration value of the recovered asphalt binder from the loose mix samples taken during construction is

at least 30% higher than the average penetration value of the recovered asphalt binder from the existing pavement cores or 90, whichever is less. The final penetration value shall not exceed 100. Perform penetration testing of all samples in accordance with AASHTO T 49, Penetration of Bituminous Materials. After a test strip has been completed, or as the work progresses, the Representative may make adjustments to the mix design if needed.

2. **Construction.** Operate the heating unit in a manner to minimize damage to adjacent property and vegetation. Repair all heat-damaged areas immediately, and at no additional cost to the Department.

   Use an adequate number of heater units to ensure that the temperature of the heated material directly behind the paver is greater than 200ºF and the required production rates will be achieved without burning the pavement. Control the equipment so that the temperature of the scarified material, after mixing, should be at least 230ºF and no more than 300ºF. The surface temperature of the pavement should at no point exceed 375ºF

   Add recycling agent uniformly to the scarified pavement at the predetermined application rate to produce a homogenous recycled mix.

   Construct the pavement to the width and depth specified. Control the width of each pass to provide proper placement of longitudinal joints including a 3-inch overlap onto adjacent lane passes. Measure the depth of the loose mix after the screed prior to rolling. Adjust the mat thickness if the loose mix depth does not meet the project requirements. Do not cause the aggregates to be pulverized, spalled or broken.

   Control the speed of the equipment to ensure that the pavement is properly milled, mixed, and uniformly redistributed to the proper thickness, slope, and crown shown on the Contract plans. Take extra care in controlling the equipment to prevent segregation of the recycled material at the start and end of paving production as well as any points where the paving train needs to stop and restart.

   In areas such as catch basins or manholes not accessible to the recycle paving train, the Representative will determine the treatment required. Pavement surfaces that the Representative determines to be in good condition and are less than one square yard in size may be exempted. Treat areas with cracks or spalls that are larger than one square yard in size as approved by the Representative at no additional cost to the Department.

3. **Verification testing.** On the first day of construction and prior to compaction, take two loose box samples near each of the pre-construction baseline core locations. These samples will be considered representative of the day's production. Take samples either after the screed or from any place after the spraying and milling / mixing units. Identify all samples by their locations at the project site. Test two box samples from each set for penetration and bulk specific gravity (PTM 715). Provide the other box samples to the Representative for evaluation by the LTS to verify the Contractor's test results. Do not take samples or cores within the first 500 feet of the day's production.

   Submit verification test results to the Representative by the end of the next day's production. If test results are not provided, the Representative may shutdown the paving operation until

the results are submitted. The average penetration value of the loose mix samples must be at least 30% higher than the average penetration of the baseline core samples or 90, whichever is less.

Take loose box samples as described above every day of production for quality control and quality assurance purposes.

If the loose box samples fail to meet the minimum 30% higher average penetration requirement, adjust the recycling agent application rate and submit the new application rate to the Representative. Repeat the sampling and testing procedure described above until the average penetration values meet the minimum 30% higher requirement.

If, at any time, the average penetration value of the loose mix samples fails to meet the minimum 30% higher average penetration requirement or is greater than 90, the Representative may evaluate the pavement section and request the treated pavement be removed and replaced at no additional cost to the Department. The evaluation may include, but is not limited to, penetration testing of the core samples, assessing the location of the samples / section, etc. If the treated pavement is not satisfactory to the Representative, additional tests may be required on the existing samples at no additional cost to the Department. If additional samples are required, take and submit the test results to the Department at no additional cost to the Department.

4. **Compaction.** Unless a thin hot mix overlay 1 inch or less is placed as the final monolithic wearing surface, roll the treated material immediately following placement. If a thin hot mix overlay is placed as the final monolithic wearing surface, spread the new hot bituminous plant mix uniformly over the treated mix immediately following placement and compaction. Keep the temperature of the recycled mix above 175°F at the time the new hot bituminous plant mix is placed over it. Do not allow the new mix to become a homogenous mixture with the recycled material. Commence rolling of the final surface immediately after the laydown of the new mix. Accomplish rolling in accordance with Section 409.3(h).

   Do not allow the temperature of the material to drop below 200°F prior to the commencement of rolling.

   Accept density of recycled material based on an optimum-rolling pattern developed as specified in Section 409.3(j)3. The relative compacted density must be as specified by the department. If no density is specified, use 92% of the maximum specific gravity as the minimum.

   If the hot mix overlay is not placed as a monolithic wearing course, and the treated surface is opened to traffic in the interim, apply a bituminous tack coat over the treated surface prior to placing the overlay in accordance with Section 460 if required by the Representative.

5. **Opening to traffic.** Ensure that, prior to opening the roadway to traffic; the surface temperature of the HIR-treated pavement is 150°F or less as required by contract documents.

IV. MEASUREMENT AND PAYMENT

(a) Hot Surface Recycling. Square Yard.

(b) Recycling Agent. Gallon.

ATTACHMENT C

Pavement History

Layer Code / Year of Placement	FULL LAYER DESCRIPTION	Seg/Off Begin 0020/0000 End 0020/3359	Seg/Off Begin 0030/0000 End 0070/3214	Seg/Off Begin 0080/0000 End 0110/0548	Seg/Off Begin 0110/0548 End 0110/0779	Seg/Off Begin 0110/0779 End 0120/2024	Seg/Off Begin 0120/2024 End 0120/2286	Seg/Off Begin 0120/2286 End 0160/2241
		Layer Depth	Layer Depth	Layer Depth	Layer Depth	Layer Depth	Layer Depth	Layer Depth
SPLH1 2007	SPAV,HMA WRG LVL,64-22, 9.5MM,SRL H				1.50		1.50	
SPLG1 2007	SPAV,HMA WRG LVL,64-22, 9.5MM,SRL G				0.50		0.50	
MILL0 2007	MILLING (AVERAGE DEPTH)				-2.00		-2.00	
SPWG3 2005	SPAV,HMA WRG,64-22, 9.5MM,SRL G	1.50	1.50	1.50	1.50	1.50	1.50	1.50
SPLG1 2005	SPAV,HMA WRG LVL,64-22, 9.5MM,SRL G	0.50	0.50	0.50	0.50	0.50	0.50	0.50
ID2M0 1999	BITUMINOUS WEARING COURSE / ID-2	1.00	1.00					
ID2G0 1999	BITUMINOUS WEARING COURSE / ID-2			1.00	1.00	1.00	1.00	1.00
IS2L0 1999	SCRATCH BITUM WEARING COURSE ID-2	0.50		0.50	0.50	0.50	0.50	0.50
ID2G0 1995	BITUMINOUS WEARING COURSE / ID-2	1.00	1.00	1.00				
LID2L 1995	LEVELING BITUM WEARING COURSE ID-2	0.50	0.50	0.50				
ID2G0 1987	BITUMINOUS WEARING COURSE / ID-2				1.00	1.00	1.00	1.00
ID2M0 1978	BITUMINOUS WEARING COURSE / ID-2	1.00						
ID2B0 1978	ID-2 BITUMINOUS BINDER COURSE (1) 1971	1.50	2.00 (1)					

Layer Code / Year of Placement	FULL LAYER DESCRIPTION	Seg/Off Begin 0020/0000 End 0020/3359	Seg/Off Begin 0030/0000 End 0070/3214	Seg/Off Begin 0080/0000 End 0110/0548	Seg/Off Begin 0110/0548 End 0110/0779	Seg/Off Begin 0110/0779 End 0120/2024	Seg/Off Begin 0120/2024 End 0120/2286	Seg/Off Begin 0120/2286 End 0160/2241
		Layer Depth	Layer Depth	Layer Depth	Layer Depth	Layer Depth	Layer Depth	Layer Depth
BCBC0 1978	BITUMINOUS CONCRETE BASE COURSE	7.00						
ID2U0 1970	BITUMINOUS WEARING COURSE / ID-2				1.00	1.00	1.00	1.00
FJ1U0 1962	BITUMINOUS WEARING COURSE / FJ-1	1.00						
ID2B0 1962	ID-2 BITUMINOUS BINDER COURSE	1.50						
ID2U0 1959	BITUMINOUS WEARING COURSE / ID-2			2.50	2.50	2.50	2.50	2.50
CABC0 1959	CRUSHED AGGREGATE BASE COURSE			12.00				
RCC0P 1925	PARABOLIC REINFORCED CEM CONC PVMT (2) 1926	7.00 (2)	7.00	7.00	7.00	7.00	7.00	7.00