

Recycled Asphalt Pavement Toolkit

Best Practices Checklist for RAP Projects

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Introduction

The National Zero Waste Council, an initiative of Metro Vancouver, is leading Canada's transition to a circular economy by bringing together governments, businesses and NGOs to advance a waste prevention agenda that maximizes economic opportunities for the benefit of all Canadians. One of the initiatives established by its Construction, Renovation & Demolition Working Group in 2018 was to develop a recycled asphalt pavement (RAP) pilot project.

The goal of the document is to share best practices for asphalt plants and processors which can allow users to drive sustainability goals by increasing the use of RAP while having certainty about quality and life cycle guarantees.

Four phases of project planning were defined to develop the pilot:

Stage 1: Stakeholder Engagement and Scoping Study

Stage 2: Development of Technical Assessment Framework and Procurement Tool

Stage 3: Application of RAP Pilot on Richmond Road

Stage 4: Long-term Assessment and Validation

Note that the pilot focuses on roads and pavement applications, rather than structural uses in the building construction industry. The term “recycled materials” means “RAP” moving forward.

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Methodology to the Procurement Tool for RAP Projects

The prioritized topics are derived from a summation of the best practices in the asphalt and concrete recycling industry based on research findings from site visits, interviews, literature reviews, and standards and specifications. The topics take into account both internal and external considerations, with the focus on improving quality and increasing industry involvement.



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Procurement Best Practices Checklist

1. Operational Excellence
 - 1.1 Receiving
 - 1.2 Crushing and Sorting
 - 1.3 Moisture
 - 1.4 Traceability of Inventory
 - 1.5 Equipment Maintenance
 - 1.6 Process Flow
2. Quality Control/Quality Assurance
 - 2.1 Mix design criteria/standard requirements/specifications
 - 2.2 Sampling plan and procedures
 - 2.3 Testing
 - 2.4 Labs (in-house and 3rd party)
 - 2.5 Monitoring programs for customer applications
 - 2.6 Management record keeping
 - 2.7 Investigation plan/program for failures and non-conformities
 - 2.8 Audit Records
3. Sustainability and Environmental Management
 - 3.1 Waste reduction management
 - 3.2 Greenhouse gas emissions (GHGe) targets and reduction plan (baseline and monitoring program)
 - 3.3 Demonstrate greenhouse gas reductions through reduced use of virgin materials
 - 3.4 Demonstrate greenhouse gas reductions through improved production performance in plant operations
 - 3.5 Demonstrate greenhouse gas reductions through the guarantee of product life cycle
4. Staff Development (internal/corporate)

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- 4.1 Operational training
- 4.2 Quality control training
- 4.3 Innovation in training and awareness
- 5. Customer and Stakeholder Management
 - 5.1 Communication plan
 - 5.2 Stakeholder engagement
 - 5.3 Marketing materials
 - 5.4 Reporting
 - 5.5 Participation in technical groups/associations/etc.
- 6. Innovation and Leadership (Recommended)
 - 6.1 Other certifications (ISO, LEED, CCIL, etc.)
 - 6.2 Investments/technology advancement
 - 6.3 Research and development (R&D) program
 - 6.4 Pilot projects (plan)
 - 6.5 Training
 - 6.6 Knowledge sharing
 - 6.7 Define/Prove innovation
- 7. RAP in Product Mix Designs
 - 7.1 10% by binder content
 - 7.2 20% by binder content
 - 7.3 30% by binder content

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1. Operational Excellence

1.1 Receiving

Incoming loads shall be visually inspected to ensure that the materials are suitable to be recycled. To guarantee that the recycled product is of high quality, loads shall be free from contaminants, such as dirt, rubbish, vegetation, or other waste, from the beginning of the recycling process. The product is inspected at the receiving stage and there shall be a process to remove any contaminants. Should traces of contaminants be found but are considered negligible, the contaminated materials shall be separated and stockpiled in a different area for disposal.¹

Evidence:

- I. Procedure for receiving material or equivalent
- II. Track slips or equivalent (relating to the material would be used in the mix design for the RAP 40%)

1.2 Crushing and Sorting

The key to achieving homogeneous recycled materials from multiple sources or a “composite” pile is to crush the materials. Recycled materials shall be crushed together and classified into different sizes. Each stockpile lot shall not exceed 1,000 tonnes and shall contain up to 5% of P200.²

Evidence:

- I. Field visit
- II. Procedure
- III. Lab report

1.3 Moisture

Due to the environmental conditions and nature of local materials, impacts from increased moisture can be a special concern for most mixes. Moisture control in the recycled materials stockpile is crucial to assure the quality of the final product. To

¹ Observed in all the facilities during site visits. This practice is recommended by National Asphalt Pavement Association and the Federal Highway Administration in several papers cited in the Appendix A.

² Best Practices for RAP and RAS Management - Quality Improvement Series 129 - National Asphalt Pavement Association – 2015

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minimize moisture in the recycled materials, the stockpile shall be stored in an “open-sided shelter” or similar to maintain dryness.³

Evidence:

- I. Field visit
- II. Infrastructure description or equivalent
- III. Procedures to control and measure moisture

1.4 Traceability of Inventory

Poor management of recycled material stockpiles is commonly cited as a reason why municipalities, contractors, and consultants are hesitant to increase the use of recycled materials in local projects. Inventory management best practices are oftentimes integrated as part of the quality control program for production. Inventory management addresses⁴:

- Components in the recycled materials, such as special classes of aggregate, steel slag, or asphalt rubber, that warrant handling the materials separately from other sources;
- Whether or not the customer requires captive stockpiles or allows continuous replenishment of stockpiles;
- Whether the customer allows recycled materials from other sources in mixes produced for its projects specifications;
- The space available at the site for recycled materials processing and stockpiling;
- The percentages of recycled materials in the asphalt mixes to be produced; and
- The quantity of recycled materials that come from a single project.

Evidence:

- I. Spreadsheet of the recycled material inventory/database or equivalent
- II. Quality control report relating to the inventory data or equivalent

³ Observed in all the facilities during site visits. Best Practices for RAP and RAS Management - Quality Improvement Series 129 -

National Asphalt Pavement Association – 12/2015. Reclaimed Asphalt Pavement in Asphalt Mixes: State of the Practice, US Department of Transportation, FHWA, 2011. This practice is also recommended in several papers cited in the Appendix A

⁴ 2016 Standard Specification for Highway Construction, BC MoTI, 2016. High RAP Asphalt Pavements, Japan Practice - Lessons

Learned, Information Series 139, National Asphalt Pavement Association, 2015. This practice is also recommended in several papers cited in the Appendix A

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1.5 Equipment Maintenance

Predictive and/or preventative maintenance helps to eliminate production losses caused by equipment breakdowns and is an integral part of quality control. The general objective is to maintain the equipment at sound condition to produce the maximum quantity with the expected quality without unprogrammed stoppages.⁵

Evidence:

- I. Preventative Maintenance Program and checklist or equivalent

1.6 Process Flow

Process flow identifies and records all the operational activities, including:

- Efficiency in the interaction of the operations,
- Time management,
- Strategies,
- Improvement in the process flow,
- Plan for implementing improvements.

Evidence:

- I. Process flow diagram with all the information described above

2. Quality Control/Quality Assurance

2.1 Mix design criteria/standard requirements/specifications

Standards and specifications for designing mixes according to client criteria are critical in determining efficient and effective processes and high-quality final product. A concern with recycled materials is keeping the design specifications within the mix design parameters due to content variability. The objective is to meet the standard mix design criteria using recycled materials.⁶

⁵ Observed in some of the facilities during site visits.

⁶ Observed in one of the facilities during site visits. Application of Reclaimed Asphalt Pavement and Recycled Asphalt Shingles in Hot-Mix Asphalt - National and International Perspectives on Current Practice – Transportation Research Board of the National Academies, US, 2014. High RAP Asphalt Pavements, Japan Practice - Lessons Learned, Information Series 139, National Asphalt Pavement Association, 2015. Reclaimed Asphalt Pavement in Asphalt Mixes: State of the Practice, U.S. Department of Transportation, The Federal Highway Administration (FHWA), 2011.

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Evidence:

- I. Procedure to prepare product specification based on the buyer's requirement and internal correspondence. (i.e. The buyer requests the mix design with X% RAP content. The supplier's production team should provide evidence (i.e. the calculation and work behind the mix design) to match the buyer's request)

2.2 Sampling plan and procedures

Sampling at least one set of tests per 1,000 tons of recycled materials is a best practice. This is generally more frequent than is required for virgin aggregates but is considered appropriate for a component that will comprise a large portion of an asphalt mix. A minimum of 10 samples should be performed on a recycled materials stockpile to yield adequate statistics for consistent analysis. Standard sampling procedures normally used for virgin aggregates may be used to sample recycled materials and are provided in Section X1.2 of AASHTO T 2, Sampling of Aggregates or ASTM D75-03.⁷

Evidence:

- I. Procedure
- II. Spreadsheet

2.3 Testing

Production testing programs should be implemented to verify mix design assumptions, including the asphalt binder blend properties. This is especially important for mixes with high recycled materials. Evaluating the performance of the designed mixes containing recycled materials, especially high content, is recommended.

There are a variety of tests available for evaluating the probable permanent deformation, fatigue, and thermal cracking performance of compacted mixes. The results from laboratory testing on recycled materials can be used to manage discrete stockpiles from a single source or after thorough blending when originating from multiple sources. It is recommended to perform testing at regular intervals during production or if the recycled materials are derived from multiple sources. Testing

⁷ Ontario Road Builders' Association A Review of Ontario Asphalt Industry Practices Final Report, Texas A&M Transportation Institute, 2018. This practice is also recommended in several papers cited in the Appendix A

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should be performed at rates that reflect expectations of the respective binder percentage.⁸

Evidence:

- I. Lab reports/results

2.4 Labs (in-house and 3rd party)

The facility shall have an in-house lab to perform basic Quality Control tests of the production process from receiving to procuring the final product. To provide an independent assessment of lab performance, it is necessary to regularly verify the in-house outcomes with a third-party lab to ensure that the facility is carrying out processes in accordance with recognized standards.⁹

Evidence:

- I. Lab reports/results
- II. Certification(s) of the lab

2.5 Monitoring programs for customer applications

Monitoring programs can contribute to collecting the high-quality data needed to understand pavement performance with recycled materials and the variables affecting it. This information supports companies to enhance processes and to develop high-quality products in the future. Such applications should be monitored on an annual basis for 5-10 years as per an accredited standard or methodology. This will allow for long-term field data to be collected throughout the application's life cycle.¹⁰

Evidence:

- I. Monitoring program or equivalent
- II. Record of the program application (preserving confidentiality)

⁸ Expectations found during client interviews. This practice is also recommended in several papers cited in the Appendix A

⁹ Expectations found during client interviews and good practices recommended by Canadian Council of Independent Laboratories

¹⁰ Reclameid asphalt pavement optimization study, Pennsylvania Department of Transportation Bureau of Maintenance and Operations – Department of Transportation, 2018. Improved Mix Design, Evaluation, and Materials Management Practices for Hot Mix Asphalt with High Reclaimed Asphalt Pavement Content, The National Academies Press, 2013. Ontario Road Builders' Association A Review of Ontario Asphalt Industry Practices Final Report, Texas A&M Transportation Institute, 2018.

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2.6 Management record keeping

Record keeping is fundamental in any quality management process. Monitoring and recording the supplier's production activities demonstrates that all the processes and final product are meeting best practices and client expectations.¹¹

Evidence:

- I. Procedure and tools

2.7 Investigation plan/program for failures and non-conformities

The purpose of the investigation plan for failures and non-conformity management is to detect any issues and uncover the root cause to prevent further incidents. The plan should include at least the following steps:

- Detection.
- Evaluation.
- Documentation.
- Root causes treatment.
- Verification.

Evidence:

- I. Procedure

2.8 Audit Records

The suppliers shall conduct periodic audits of their operations. A report indicating preventive or corrective actions and suggestions for any improvements shall be recorded in the suppliers' system. In addition, the supplier shall provide proof of timely implementation of the actions suggested in the audit records.

Evidence:

- I. Audit records

¹¹ Expectations found during client interviews. This practice is also recommended in several papers cited in the Appendix A

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3. Sustainability and Environmental Management

3.1 Waste reduction management

Governments, communities, and businesses have long recognized the need to prioritize waste management and reduction. This has mostly been pursued through efforts to increase recycling and reduce material waste. Zero waste policies take those efforts further to keep all materials out of landfills through reuse and recycling. Future economic growth and global prosperity will not only depend on reducing waste at the end of life but also designing out the concept of waste. Metro Vancouver, which manages the region's waste, works to increase awareness around the importance of managing waste sustainably.

Evidence:

- I. [Waste reduction policy/plan or equivalent](#)

3.2 Greenhouse gas emissions (GHGe) targets and reduction plan (baseline and monitoring program)

At present, there are no standard criteria for evaluating GHGe in pavement production and application. By using a process-based life cycle assessment method, the supplier should identify GHGe savings through the entire life cycle of the pavement taking into account all benefits associated with recycled materials. The results would indicate measures to reduce GHGe from mixes and should compare recycled materials and virgin materials manufacturing. Suppliers should develop strategies and set up a monitoring program to consistently measure results to demonstrate proactiveness in reducing GHGe.

Evidence:

- I. [Company goals, baseline, and GHGe reduction plan](#)

3.3 Demonstrate greenhouse gas reductions through reduced use of virgin materials

Recycled materials (RAP) replace virgin materials in mix designs thus decreasing the demand for and extraction of virgin materials.

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Evidence:

I. Proof of tracking and results

3.4 Demonstrate greenhouse gas reductions through improved production performance in plant operations

Improved production performance in plant operations may generate higher efficiencies, higher productivity, and also less GHGe. This may be done by installing new technologies, implementing emissions controls and measures, etc.

Evidence:

I. Proof of tracking and results

3.5 Demonstrate greenhouse gas reductions through a guarantee of the product lifecycle

Provide warranty/guarantee of the product's lifecycle (i.e. 15-year minimum). This ensures that the application will not require replacement within the specified lifecycle.

Evidence:

I. Proof of tracking and results

4. Staff Development (internal/corporate)

4.1 Operational training

Education on plant processes and procedures is critical in order for plant operators to handle recycled materials properly without compromising quality and performance. Suppliers shall invest in their staff through training and courses on the latest mix designs, best practices for plant operations, and updates on technological advancement. The appropriate use of equipment and proper application of processes are dependent on the operators and staff. A sound understanding of how recycled materials behave under different conditions (i.e. different mix designs) is also necessary for ensuring the procurement of reliable products.

Evidence:

- I. Training records (i.e. attendance)
- II. Training materials/content

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4.2 Quality control training

Performing quality control measures throughout the entire production process is critical. The recycled materials must be properly characterized for achieving different mix designs. In fact, the guarantees of high-quality high recycled material mixes can only be achieved with processing and production best practices.

Evidence:

- I. Training records (i.e. attendance)
- II. Training materials/content

4.3 Innovation in training and awareness

Suppliers shall deliver a relevant, customized training program to educate and train their employees in their own operation. The program should be competency-based training which contributes to improving the trainees' performance on their jobs.

Training shall be conducted through all the requirements applicable to the organization's activities in conjunction with existing health and safety programs.

Evidence:

- I. Training records (i.e. attendance)
- II. Training materials/content

5. Customer and Stakeholder Management

5.1 Communication plan

Develop a strategy for delivering information to the customers, whether it is regarding products or processes. A communication plan is an essential tool for delivering clear, specific messages such as measurable results. Communicating with stakeholders (i.e. clients, communities, etc.) effectively is a critical part of gaining support and engagement.

Evidence:

- I. Strategy/communication plan or equivalent

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5.2 Stakeholder engagement

Stakeholder management is the process of engaging with people who are involved and impacted by the supplier's business. This process assists in maintaining good relationships with stakeholders from many different roles, with varying levels of influence over the business. The appropriate stakeholders must be engaged when identifying concerns, analyzing issues and data, generating options and possibilities, choosing options, commenting on policies and design, and supporting implementation.¹² To promote transparency, the suppliers should include plant tours and technical workshops in their stakeholder engagement plan.

Evidence:

- I. Stakeholder engagement plan/process
- II. Records of activities/implementation

5.3 Marketing materials

Suppliers have marketing materials (i.e. a brochure, a website, etc.) to promote the products or processes. This keeps the industry up to date on the latest products and stakeholders informed of the benefits of the use of recycled materials. Suppliers may also use this avenue to demonstrate success from their products. Not only does this promote effective marketing and raises brand awareness, but it also satisfies customers when they need quick access to data and information.¹³

Evidence:

- I. Copies of marketing materials

5.4 Reporting

Annual and/or interim reporting on statistics, successes, and revenues is a way to share information on results and performance. This maintains transparency among all industry players and makes everyone accountable to the same standards, testing

¹² High RAP Asphalt Pavements Japan Practice — Lessons Learned, Information Series 139, National Asphalt Pavement Association (NAPA). 2015. This practice is also recommended in several papers cited in the Appendix A.

¹³ Practice found during client interviews.

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criteria, etc. The report may identify trends in the market, potential improvements in products as well as in operations, and highlight recent applications and projects.¹⁴

Evidence:

- I. Copies of the reports

5.5 Participation in technical groups/associations/etc.

Contribute to technical organizations which share data/information between industry stakeholders. This promotes transparency and helps expedite the implementation and increase the use of recycled materials in the local market.¹⁵

Evidence:

- I. Proof of membership and active participation

6. Innovation and Leadership (Recommended)

6.1 Certifications (ISO, LEED, CCIL, etc.)

Several suppliers are pursuing certifications to build a better reputation in the market. This is an emerging practice that goes beyond what is required from standards and specifications. Suppliers see an advantage from acquiring such certifications to provide better guarantees in the life cycle of their recycled products. In turn, customers are more confident in using the products and this could ultimately increase the use of recycled materials in local projects.

Evidence:

- I. Copies of the certificates

¹⁴ Practice found during client interviews. High RAP Asphalt Pavements Japan Practice — Lessons Learned, Information Series 139, National Asphalt Pavement Association (NAPA). 2015. This practice is also recommended in several papers cited in the Appendix A.

¹⁵ Significant findings from full-scale accelerated pavement testing – A Synthesis of Highway Practice – National Cooperative Highway Research Program . High RAP Asphalt Pavements Japan Practice — Lessons Learned, Information Series 139, National Asphalt Pavement Association (NAPA). 2015.

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6.2 Investments and technology advancement

Industries have a continuous demand for market information with regards to restructuring, upgrading, and improving. Investments and technology advancement is a crucial requirement for enhancing an industry's competitiveness and supporting growth in companies of all sizes. Investment and new technology could result in reduced costs, improved profitability and innovation in the procurement of better products.¹⁶

Evidence:

- I. Investment plan

6.3 Research and development (R&D)

Research and development are essential to future-proofing the supplier company and obtaining a higher level of performance in the production of the final product. In this context, R&D is a crucial factor to increase knowledge, improve technology, and create new products in a competitive market¹⁷.

Evidence:

- I. R&D plan

6.4 Pilot projects (plan)

A pilot project can serve as a test to collect performance data of the products with recycled materials. Pilots can help to define any improvements needed prior to large-scale applications. A pilot project is an excellent tool to predict product adoption and provide clients with real references regarding product performance and life cycle¹⁸.

Evidence:

- I. Summary of the pilot projects

¹⁶ Application of Reclaimed Asphalt Pavement and Recycled Asphalt Shingles in Hot-Mix Asphalt, Circular Number E-C188.

Transportation Research, 2014. Investigation of Binder Aging and Mix Performance in Service: Reclaimed Asphalt Pavement Mixes, Virginia Transportation Research Council, 2018.

¹⁷ High RAP Asphalt Pavements Japan Practice — Lessons Learned, Information Series 139, National Asphalt Pavement Association (NAPA). 2015. This practice is also recommended in several papers cited in the Appendix A

¹⁸ Expectations found during client interviews. Investigation of Binder Aging and Mix Performance

in Service: Reclaimed Asphalt Pavement Mixes, Virginia Transportation Research Council. 2018. Reclaimed asphalt pavement optimization study, Pennsylvania Department of Transportation Bureau of Maintenance and Operations, 2018.

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6.5 Training

Training is vital for guaranteeing quality and continuous improvement, development, and success of the company by optimizing time, capital, and resources. Training

increases the knowledge base of all employees, provides clients with better services and products as well as an understanding of the liabilities within their roles.¹⁹

Evidence:

- I. Training plan

6.6 Knowledge sharing

In a pre-competitive environment, suppliers should connect with local peers, pitch collaborations, explore opportunities, and learn about the latest regional and global insights in increasing the amount of recycled materials in high quality in the market.²⁰

Evidence:

- I. Proof of collaboration initiative or equivalent

6.7 Define and prove innovation

The supplier has clear indicators for monitoring and assessing innovation and efficiency that will help to develop new processes and products that exceed expectations or requirements. The supplier participates in innovation programs to create new opportunities for its clients and the market.

Evidence:

- I. Proof of participation in innovation programs or equivalent (i.e. collaboration with associations, universities, other organizations)

¹⁹ High RAP Asphalt Pavements Japan Practice — Lessons Learned, Information Series 139, National Asphalt Pavement Association (NAPA). 2015. This practice is also recommended in several papers cited in the Appendix A.

²⁰ One of the consultants interviewed is applying this practice with good results. High RAP Asphalt Pavements Japan Practice — Lessons Learned, Information Series 139, National Asphalt Pavement Association (NAPA). 2015. This practice is also recommended in several papers cited in the Appendix A.

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7. RAP in Product Mix Designs

7.1 10% by binder content

Supplier to incorporate at minimum 10% RAP by binder content in the product mix design, as per the client's specifications.

7.2 20% by binder content

Supplier to incorporate at minimum 20% RAP by binder content in the product mix design, as per the client's specifications.

7.3 40% by binder content

Supplier to incorporate at minimum 30% RAP by binder content in the product mix design, as per the client's specifications.