VERMONT AGENCY OF TRANSPORTATION
RESEARCH SECTION
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Progress Report 2020-05

Recycled Asphalt Shingles (RAS) in Town Gravel Roads-Progress Report

1. INTRODUCTION

Together, VTrans and VTANR-DEC are working to determine any benefits of Recycled Asphalt Shingles (RAS) as an aggregate additive to gravel roads. The idea for this project stemmed from a 2002 pilot of a RAP/RAS/Gravel used by Vermont towns in 2002 [1]. Available literature from Minnesota DOT (2014) and Iowa DOT (1997) show the beneficial use of RAS in gravel roads, providing reduced maintenance needs and decreased dust [2][3].

Vermont generates an estimated 25,000 tons of waste shingles a year [4]. Act 175 of the Vermont Legislature will increase shingle recycling and create a supply of RAS in the state. Vermont statute 10 V.S.A. § 6605m requires recycling of shingles generated within 20 miles of a recycling facility, and by July 1, 2021, all of Vermont is to have shingle recycling programs. To utilize this supply of RAS, VTrans and VTANR-DEC are testing the use of RAS in conjunction with towns road departments in their gravel roads (20% RAS, 80% typical gravel aggregate). The proposed projects targeted using RAS that meets AASHTO MP-23, which calls for material 3/8" minus (100% of material passing a 3/8" sieve), with limited debris.

Due to the previous projects and their benefits VTrans and VTANR-DEC began working with towns in 2018 to install pilot projects [5] to determine their feasibility in Vermont.

2. TEST SITE SUMMARIES

This section describes the three demonstration projects installed in Summer 2020. With the previous projects installed in 2018 (Pownal, Shaftsbury) and 2019 (Panton), the funds set aside for demonstrating RAS in Town Gravel Roads have been expended.

2.1. Cornwall/Shoreham

The towns of Cornwall and Shoreham, in central Vermont, acquired 271 tons of RAS from Myers Recycling in Colchester. The town of Cornwall mixed the RAS and gravel from Acker Excavating at their town garage using a front-end loader and a ratio of 4 bucketsful of gravel to 1 bucketful of RAS, resulting in a 20% mix by volume. This mix was used to resurface 1450 ft of roadway on Wooster Rd in Shoreham and 4900 ft of adjoining roadway on Wooster Rd in Cornwall, (TH 5), location shown in Figure 1. The roadway has a varying width of 20-21 ft, 5-6% crown, and a slope between 0-10%.

Figure 1: Location of Cornwall/Shoreham Test Section, Wooster Rd.

The RAS used in the Cornwall/Shoreham test section had a few small agglomerations, some as large as 4" in diameter. Photos of the material are available in Figure 2.

Cornwall Gravel Pile

Cornwall RAS Pile

Cornwall 80/20 Gravel/RAS

RAS Clump

Figure 2: Cornwall/Shoreham Materials to be used in test section

Gravel was mixed with RAS at the town of Cornwall garage, trucked to the site and deposited onsite using town of Cornwall and Shoreham dump trucks. Construction of the road followed typical procedures used by the Town. The town of Shoreham grader with an attached roller was used to grade and compact the road surface. Construction took place on June 15, 2020 and June 16, 2020. After the first day of construction approximately 1,200 gallons of calcium chloride were applied to the road surface. On the morning of June 16, 2020 approximately 4,500 gallons of water was applied to the roadway. After construction had concluded another 2,400 gallons of calcium chloride was applied. The day after construction had finished another 4,500 gallons of water was applied. The resurfacing process can be seen in Figure 3.

Truck dumped material

Grader spreading and rolling

Figure 3: Test Section Construction

The town of Cornwall has been pleased with the performance of the RAS/gravel test section. Typically, the Town has to grade the road five or six times per year; however, the RAS/gravel may necessitate grading only three or four times per year. The Towns have graded once and added 1,000 gallons of calcium chloride since the installation of the test section. As Cornwall is pleased with the performance of the test section, they plan to install the RAS/gravel on two other town roads. The Town would consider a higher ratio of RAS to gravel in future, suggesting a ratio of 1:3 RAS/gravel or even a 1:1 mix. During a site visit on July 14, 2020 Wooster Road seemed to be in good working order. However, some larger gravel had worked its way to the surface and off to the shoulders, and there was corrugation at the intersection with Buttolph Rd. All in all, the town of Cornwall is satisfied with the RAS/gravel mix and the performance of the road. Photos of the roadway are shown in Figure 4.

RAS Test Section

Figure 4: RAS Test Section during 7-14-20 Site Visit

Sieve analysis of the Cornwall/Shoreham RAS/gravel mix can be seen in Table 1 and the distribution in Figure 5. The samples of the RAS and gravel mix used in reconstruction were found to be above the 3/8” minus targeted for the project, as shown in Table 1, where 8% of the material is retained on the 3/8 sieve with 28% being greater than 3/8”. This resulted in a mix light on fines. Normally, the No. 200 fines should be between 12-15% and the combined No. 100 and No. 200 fines should be over 30%. This this mix has 0% No. 200 fines and 8% combined No. 100 and 200 fines.

Table 1: Cornwall/Shoreham Sieve Analysis

Sieve Size (mm)	Sieve Size (in)	Sieve Size (#)	% Passing (by mass) Gravel with RAS
75	1		100
37.5	3/4		95
19	1/2		80
9.5	3/8		72
4.75	0.187	No.4	53
2	0.0787	No.10	39
0.84	0.0331	No.20	25
0.425	0.0165	No.40	17
0.25	0.0098	No.60	12
0.15	0.0059	No.100	8
0.075	0.0029	No.200	0

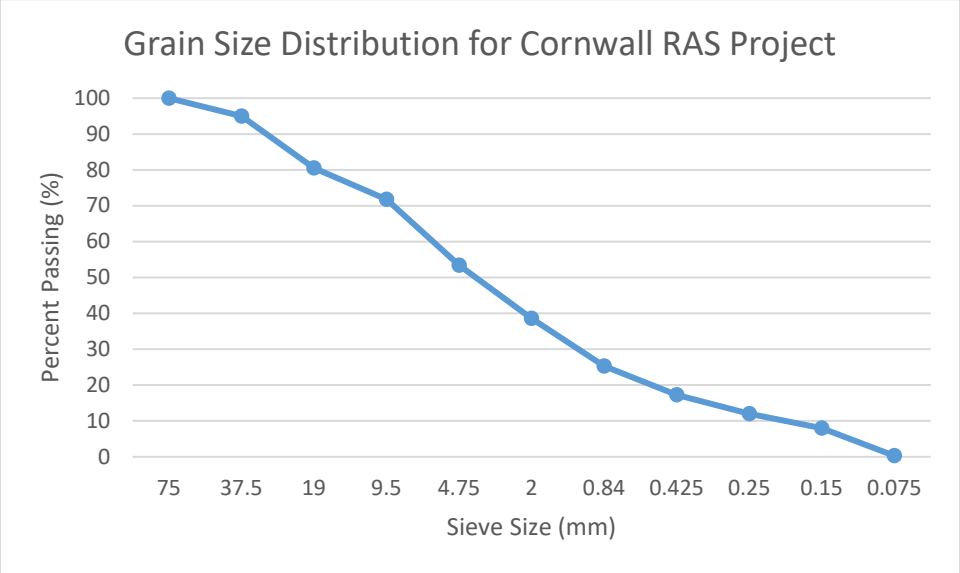

Figure 5: Cornwall/Shoreham Grain Size Distribution

2.2. Waterbury

The Town of Waterbury, in central Vermont, acquired 30 CY of RAS from Myers Recycling in Colchester. The Town mixed the RAS with 200 tons of gravel from Varens Gravel of Bolton resulting in an approximate 15% mix by volume, a lower percentage than recommended. This mix was used to resurface 900 ft of roadway on Little River Rd, (TH 7), location shown in Figure 6. The roadway has a uniform width of 24 ft, 5-6% crown, and a slope consistently between 0-3%. After the road was graded, approximately 150 gallons of calcium chloride was applied to the road surface.

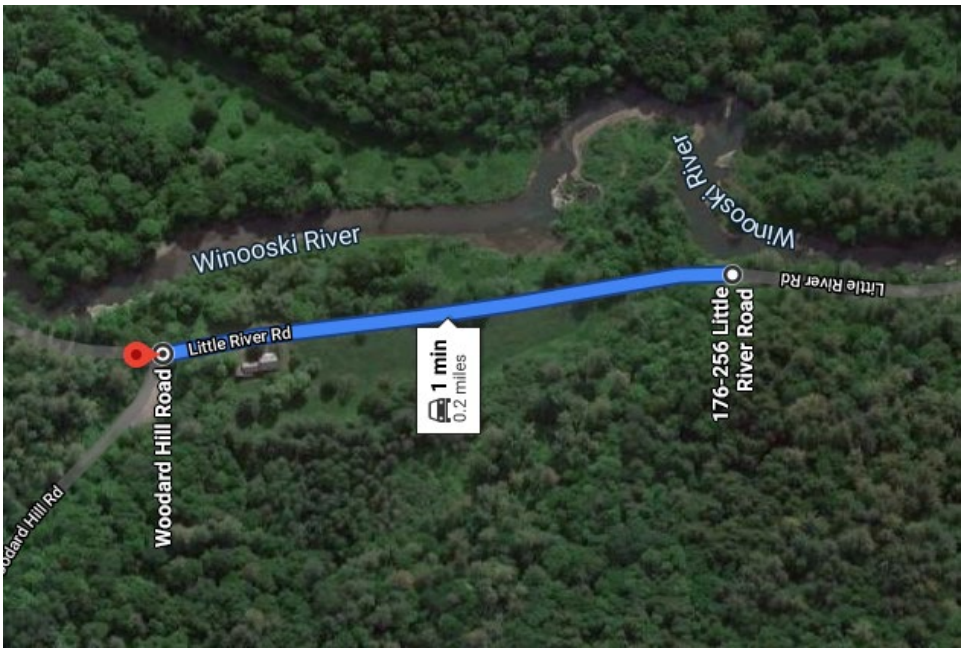

Figure 6: Location of Waterbury Test Section, Little River Rd.

The RAS used in the Waterbury test section had a few small agglomerations, some as large as 3” in diameter. Additionally, the gravel the Town’s gravel source had some larger stones, mostly smooth river rocks along with a large quantity of fines. Photos of the material are available in Figure 7.

Waterbury 85/15 Gravel/RAS

RAS/Gravel mix

Figure 7: Waterbury Materials to be used in test section

Resurfacing of the road followed standard procedures used by the Town. Gravel was mixed with RAS onsite near the parking lot on Woodard Hill Rd and deposited on the road with a dump truck. A Town grader was used to spread and grade the RAS/gravel with a crown, but no roller was used for compaction. Construction took place on June 30, 2020. The resurfacing process can be seen in Figure 8.

Grader shaping of existing roadway materials

Grader spreading

Chloride application

Figure 8: Test Section Construction

Historically the Town has had drainage, washboarding, and potholing problems with Little River Riad. Initially, the installation of RAS/gravel did not lessen any of those problems, potentially because of the low percentage of RAS in the mix. After installation and several rain events the RAS/gravel section of the road is very loose with many stones rose to the surface. There are the beginnings of washboarding and there was a lot of airborne dust when traffic went past. Photos of the roadway during a site visits on July 14, 2020 and July 24, 2020, respectively, are shown in Figure 9. However, by early August the Town regraded the RAS/gravel section and reported a more homogeneous and cohesive surface.

Potholing on 7-14-20

Washboarding on 7-14-20

Washboarding on 7-24-20

Loose Gravel on Surface on 7-24-20

RAS Test Section

Gravel vs. RAS section on 7-24-20

Gravel Control Section

Figure 9: Failure of the RAS Test Section compared to the All-Gravel Control Section

Sieve analysis of the RAS and gravel mix can be seen in Table 2, and the grain size distribution in Figure 10. The samples of the RAS and gravel mix used in reconstruction were found to be above the 3/8" minus targeted for the project, as shown in Table 2, where 4% of the material is retained on the 3/8 sieve and 28% of the RAS and gravel mix was larger than 3/8". This mix is also light on fines, with No. 200 fines of 4%, which is below the target of 12%. The combined No. 100 and 200 fines of 13%, which is less than half of the 30% it should be.

Table 2: Waterbury Sieve Analysis

Sieve Size (mm)	Sieve Size (in)	Sieve Size (#)	% Passing (by mass) Gravel with RAS
75	1		95
37.5	3/4		86
19	1/2		76
9.5	3/8		72
4.75	0.187	No.4	62
2	0.0787	No.10	51
0.84	0.0331	No.20	37
0.425	0.0165	No.40	25
0.25	0.0098	No.60	15
0.15	0.0059	No.100	9
0.075	0.0029	No.200	4

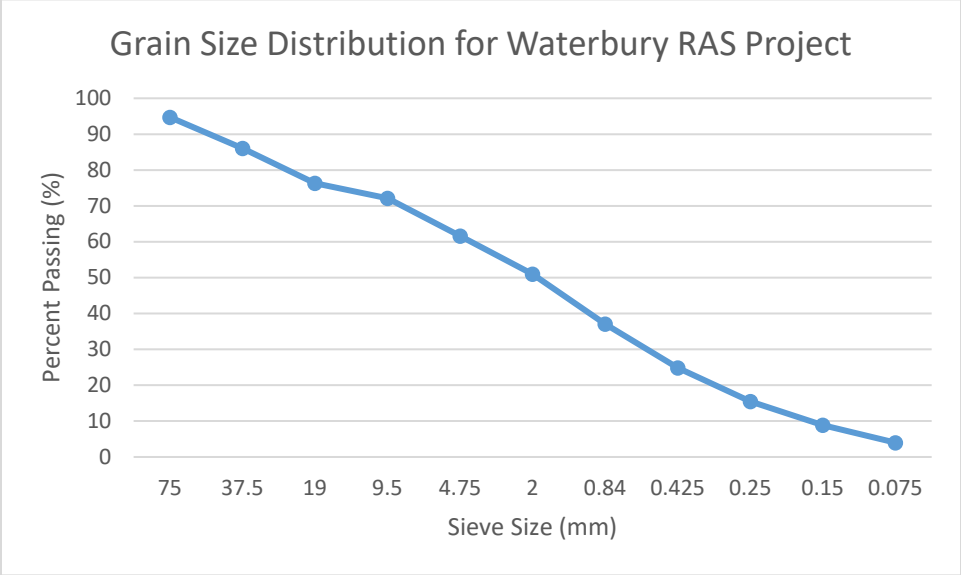

Figure 10: Waterbury Grain Size Distribution

2.3. Waltham

The Town of Waltham, in central Vermont, acquired 42 tons of RAS from Myers Recycling in Colchester. The town placed 136 tons of gravel on Burnham Rd, (TH 4), using a dump truck and deposited 42 tons of RAS with a dump truck on top of the gravel resulting in a 24% mix by weight. This mix was used to resurface 815 ft of roadway in the location shown in Figure 10. The roadway has a uniform width of 16 ft, 3-4% crown, and a slope consistently between 0-3%.

Figure 11: Location of Waltham Test Section, Burnham Rd.

The RAS used in the Waltham test section had large agglomerations, some as large as 1’ in diameter that were very difficult to break down. To break up the clumps they were driven over with a front end loader multiple times. Photos of the material are available in Figure 12.

Waltham RAS pile

RAS Clumps

Waltham 76/24 Gravel/RAS

RAS Clumps

Figure 12: Waltham Materials to be used in test section

Resurfacing of the road followed typical procedures used by the Town of Panton and suggested to the Town of Waltham's Public Works General Contractor. In early June 2020, 4-6 inches of new gravel was placed on Burnham Road, and four weeks after that the gravel was overlain by two inches of RAS. Two weeks afterwards, on July 14, 2020, the RAS and gravel were blended in situ. As the Town of Waltham possesses no equipment, the Town of Panton was on-site to mix the gravel and RAS in situ, and then grade the road. After the RAS/gravel was graded, the surface was sprayed with 600 gallons of calcium chloride. This technique was different than both the other 2020 projects. However, this technique was used for the Panton project in 2019 and was suggested by the Town of Panton to the Town of Waltham. The resurfacing process can be seen in Figure 13.

Depositing RAS over Gravel

Grader Mixing RAS and Gravel

Material Mixing and Road Grading

Road Grading

Chloride Application

Final Product

Figure 13: Test Section Construction

The Town of Waltham reports good working condition of the road surface. The Town has said that the road looks great and the surface has tightened up nicely. As of July 31, 2020 there had been no additional work done on the road surface.

Sieve analysis of the RAS and gravel mix can be seen in Table 3, and the grain size distribution in Figure 14. The samples of the RAS and gravel mix used in the resurfacing were found to be above the 3/8" minus targeted for the project, as shown in Table 2, where 10% of the material is retained on the 3/8 sieve and 20% of the RAS and gravel mix was larger than 3/8". The mix was also light on fines. The No. 200 sieve retained 5%, which is low of the targeted 12-15%. The combined No. 100 and 200 sieves retained 14%, which is less than half the 30% that the mix should attain.

Table 3: Waltham Sieve Analysis

Sieve Size (mm)	Sieve Size (in)	Sieve Size (#)	% Passing (by mass) Gravel with RAS
75	1		100
37.5	3/4		100
19	1/2		90
9.5	3/8		80
4.75	0.187	No.4	60
2	0.0787	No.10	44
0.84	0.0331	No.20	26
0.425	0.0165	No.40	17
0.25	0.0098	No.60	12
0.15	0.0059	No.100	9
0.075	0.0029	No.200	5

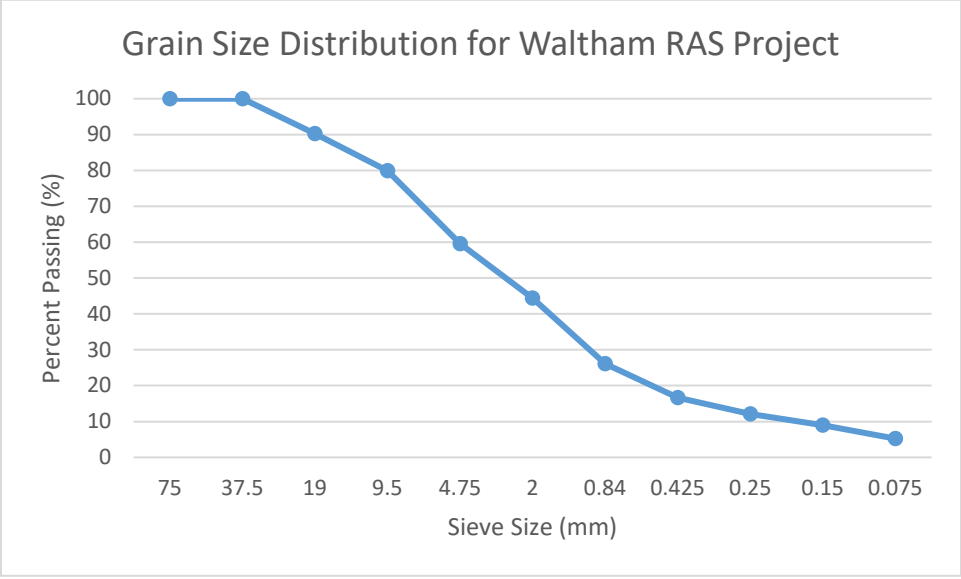

Figure 14: Waltham Grain Size Distribution

3. PREVIOUS SITE UPDATES

3.1. Pownal

The Town of Pownal, in southwestern Vermont, was sent 64 tons of RAS from Myers Recycling in Colchester in 2018. The Town mixed the RAS with their own gravel, at approximately 22-25% by volume, and used it to resurface 750 ft of Cedar Hill Rd, (TH 28), the location shown in Figure 15. The roadway has a uniform width of 19 ft, 5-6% crown, a slope consistently between 10-15%, and at the time of the project, rill erosion on the roadway edges.

Figure 15: Location of Pownal Test Section, Cedar Hill Rd.

The RAS used in the Pownal test section was not compliant with AASHTO MP-23. The RAS used had larger than 3/8" maximum aggregate size, contained a not insignificant amount of debris, and particularly worrying, 18 nails (two of them steel) were removed by hand from roadway after placement.

Resurfacing of the road followed standard procedures used by the Town, with the additional step of using a finish roller to compact the material. In addition to the 750 ft RAS test section, they resurfaced and graded the adjacent roadway section with conventional gravel. Construction took place on August 24, 2018. More information about the construction can be found in the 2019 report: *Recycled Asphalt Shingles in Town Gravel Roads*.

The Town of Pownal is pleased with the RAS/gravel mix that they placed on the relatively steep road. The Town noted that the road did not pothole as much as normal, although they noted that hills tend to pothole less than flatter roads. They have also noticed that the snow and ice melted faster as the darker soil color, from the addition of the RAS, draws more heat from the sun. The road performed well during the spring thaw and the gravel stayed in place much better than the conventional gravel sections. Originally it was difficult to get good compaction, but once it was compacted the road showed little to no "washing or chattering up during the dry season." When the RAS/gravel mix was originally installed the Town of Pownal had issues with gravel floating to the surface after rain events. The Town found that with additional compaction the gravel stayed in place better and there were fewer surface condition issues. Additionally, the road does not seem to get as desiccated and have as much airborne dust as before.

3.2. Shaftsbury

The town of Shaftsbury, in southwest Vermont, was sent 64 tons of RAS from Myers Recycling in Colchester in 2018. The RAS was mixed at 20% by mass with gravel from William E. Dailey, Inc. (Peckham Industries subsidiary). The test section (Figure 8), located on Myers Rd, (TH 7), (unrelated to Myers Recycling) is approximately 1000 ft long, with a 600 ft section of between 6-7% grade, and a flat 400 ft section. The roadway is uniformly 20 ft wide. The existing roadway had a 3-4% crown, with several sections being noticeably flatter. Location of the roadway can be seen in Figure 16.

Figure 16: Shaftsbury Resurfacing location

Prior to regrading and adding new gravel with RAS/gravel, ditch clearing maintenance was performed. Roadway surface construction took place on October 2, 2018. Construction of the road followed typical Town procedures, with the additional step of using a roller to compact the material. The existing roadway was regraded to shape, adding crown to achieve 6-7%. Effort was made to ensure the roadway width did not creep out into the ditches and ensure that surface material was maintained on the 20 ft travel section. The gravel was dumped in successive loads onto the center of the roadway, and spread with a grader until a thickness of 2-3 inches was achieved. Large clumps of RAS were observed in the material bring spread on the roadway. These agglomerations are the result of RAS stockpiling, and self-consolidation when stored for extended periods of time. Compaction was done with a 13.75-ton smooth drum, vibratory roller, with at least two passes over each section. During construction, research staff found 10 nails in the new surface material. More information about the construction can be found in the 2019 report: *Recycled Asphalt Shingles in Town Gravel Roads*.

A follow up site visit on October 9, 2018 showed that the roadway is well consolidated, and tightly packed. Feedback from the local road foreman following the resurfacing have been positive, with no maintenance needed as of February 2019. The Town was contacted in May 2020 and have stated that most of the RAS has held up well. They did have a clay bubble work its way through the road surface, but otherwise the roadway seemed to be in good shape. The Town's opinions is that a thicker layer, up to 6" installed over a well prepared base, would be beneficial, as would an underlain geotextile. The Town sees no difference in winter maintenance between this road or any other gravel road, but that the airborne dust has declined. Based on its performance, the Town would use RAS/gravel again.

3.3. Panton

The town of Panton, in southwestern Vermont, acquired RAS in 2019 which they mixed with gravel from Acker Excavating. The Town mixed the RAS with gravel at approximately 20% by volume and used it to resurface 1,000 ft of Adams Ferry Rd, (TH 3), location shown in Figure 16. The roadway has a uniform width of 23 ft, 5-6% crown and a slope consistently between 8-12%.

Figure 17: Location of Panton Test Section, Adams Ferry Rd.

Resurfacing of the road followed typical procedures used by the Town. Of the 1,000 ft test section, RAS/gravel was installed on the western 750 ft of the test section by placing mixed RAS/gravel on the roadway surface using 14 CY dump trucks and grading afterwards. On the remaining 250 ft, an alternative installation method was employed. A 2-3-inch gravel lift was placed using "tailgating," then overlain with a thinner lift of RAS. The materials were blended by multiple grader passes until a uniform consistency was achieved. Resurfacing took place on October 30, 2019. More information about the construction can be found in the 2019 report: *Recycled Asphalt Shingles in Town Gravel Roads*.

The town of Panton has expressed satisfaction with the RAS/gravel mix that was placed on Adams Ferry Road. Panton noted that the plowed RAS/gravel section melted faster than the control section and that it did not pothole as badly. The Town also noted less dust. Panton regraded the road in May 2020 and applied an addition 1000 gallons/mile of calcium chloride. The Town is pleased with the performance and would use more RAS if the cost of the RAS was competitively priced. One alternative put forth by Panton is to run the RAS and gravel through the Town's crusher to blend it rather than mixing the materials loader bucket by loader bucket.

4. INSTALLATION CONCLUSIONS

Construction of the six RAS/gravel road test sections followed individual town conventional installation techniques and methods. The RAS content used in each of the three installations this year (2020) varied. Cornwall/Shoreham achieved the 20/80% mix that had been targeted, Waltham used approximately 24% RAS, and Waterbury used 15% RAS. In 2019 Shaftsbury and Panton both achieved approximately 20% RAS while Pownal used 22-25% RAS. Each town used gravel from a different source which contributed to the variance in the sieve analysis results.

The Waterbury site showed significant deterioration two weeks after construction, likely because the larger aggregates in the gravel were prevented from binding because of the low RAS content. Another contributing factor is the poor drainage of the road that has historically led to the road surface condition issues. The Cornwall/Shoreham site shows slight segregation of larger gravel which floated to the top of the road surface, but otherwise the road is in good condition. The Waltham road shows no significant deterioration. Further inspections will take place in early spring to determine the surface condition in Cornwall/Shoreham, Waterbury, and Waltham after one winter of exposure.

5. REFERENCES

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