

**SE 416TH STREET OVERLAY:
SHINGLES IN PAVING DEMONSTRATION**

**Post-Construction Pavement Condition
SEPTEMBER 2010**

Prepared By:



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September 23, 2010

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VIA: Alan D. Corwin, P.E., Materials Engineer, Materials Laboratory,
Engineering Services Section, Road Services Division, KCDOT

FM: Kevin L. Kelsey, Senior Engineer, Materials Laboratory,
Engineering Services Section, Road Services Division, KCDOT

SE 416th Street Overlay: Shingles in Paving Demonstration Post-Construction Pavement Condition - September 2010

Ref: *Technical Support Document for SE 416th Street Overlay:
Shingles in Paving Demonstration*, King County Materials Laboratory,
January 2010

As requested, we have completed post-construction testing and analysis for 2010 in support of the SE 416th Street Overlay: Shingles in Paving Demonstration project. The King County Materials Laboratory previously provided technical support during design and construction in 2009. A summary of our work and participation was submitted in the above referenced report. Current pavement conditions are documented in this report.

The Materials Laboratory is committed to closely monitor the structural performance of the roadway through 2012. Following the monitoring period, we will submit a supplemental report summarizing our findings and provide recommendations for the continued use of recycled asphalt shingles (RAS) on public roadways in King County.

We trust this information meets your current request. If you have any questions or require clarification, please call me at 296-7712 or Alan Corwin at 296-7711.

cc: Paulette Norman, P.E., County Road Engineer,
Road Services Division, KCDOT

Lydia Reynolds-Jones, Managing Engineer, Project Support Services,
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TABLE OF CONTENTS

1.0 INTRODUCTION.....	1
1.1 Purpose	1
1.2 Background	1
1.2.1 Test Section Layout.....	2
2.0 PAVEMENT CONDITION SURVEYS	2
2.1 Pavement Condition Survey Methods	2
2.2 Pre-construction Pavement Rating Comparisons	4
2.3 Post-construction Pavement Rating Comparisons	4
2.4 Rutting and Roughness	5
2.4.1 Pavement Rutting Condition.....	5
2.4.2 International Roughness Index.....	5
3.0 ADDITIONAL OBSERVATIONS.....	6
4.0 SUMMARY OF FINDINGS	7
4.1 Pavement Condition Surveys	7
4.2 Pavement Rutting Condition	8
4.3 International Roughness Index.....	8
4.4 Additional Observations.....	8
5.0 CONTINUING TESTING AND ANALYSIS	8
6.0 CONCLUSION	9
7.0 REFERENCES.....	10

List of Tables (Included in Text)

Table 1, Test Section Layout - page 2

Table 2, PCI Rating Ranges - page 3

Table 3, Comparison of KCML and WSDOT Pavement Rating Conditions - page 4

Table 4, Post Construction Pavement Condition Surveys - page 4

Table 5, WSDOT Pavement Rutting Condition Surveys - page 5

Table 6, International Roughness Scale - page 6

Table 7, WSDOT International Roughness Index Surveys - page 6

List of Figures (Following Text)

Figure 1: Vicinity Map

Figure 2: Test Section Layout

SE 416th Street Overlay: Shingles in Paving Demonstration

Post-Construction Pavement Condition

King County Materials Laboratory - September 2010

1.0 INTRODUCTION

1.1 PURPOSE

This report summarizes post-construction pavement conditions on SE 416th Street following approximately one year of traffic use. In September 2009 the roadway was overlaid with a 2-inch thick layer of Hot Mix Asphalt (HMA) incorporating both Recycled Asphalt Pavement (RAP) and Recycled Asphalt Shingles (RAS) in designated test sections.

The King County Materials Laboratory (KCML) performed pavement condition surveys by walking the site and documenting distressed areas. Additional pavement condition surveys were conducted by the Washington State Department of Transportation (WSDOT) using a distress data collection van.

1.2 BACKGROUND

The Road Services Division of the King County Department of Transportation, in partnership with the Solid Waste Division of the King County Department of Natural Resources and Parks, and the WSDOT Materials Laboratory conducted an overlay demonstration project in September 2009 on SE 416th Street to evaluate the use of post-consumer RAS in combination with RAP in HMA.

KCML specifically assisted in selecting the project roadway section, documented the existing condition of the selected roadway, provided limited preliminary testing of the materials used, conducted quality control testing during construction, and coordinated post-construction testing. The initial findings were summarized in our report entitled "Technical Support Document for SE 416th Street Overlay: Shingles in Paving Demonstration", dated January 2010.

SE 416th Street, within the project limits, is located in south King County, near the City of Enumclaw. The roadway runs east-west and serves as a 2-lane paved rural arterial with 2-foot wide paved shoulders. The project extended approximately 2 miles, beginning at the intersection of 212th Avenue SE (Station 10+20) and ending at 244th Avenue SE (Station 116+00). The general location is shown on the attached Vicinity Map, Figure 1.

1.2.1 Test Section Layout

The roadway was divided into four separate test sections, each approximately 1/2 mile in length. The division allowed for one test section each of RAP with HMA and RAP/RAS with HMA to be sited on both the western and eastern portion of the roadway. Each test section required about 1000 tons of HMA to provide for a 2-inch thick overlay. The test section layout for this project is shown in Table 1.

TABLE 1				
Se 416TH Street Overlay				
Test Section Layout				
Lane Description	Test Section #1	Test Section #2	Test Section #3	Test Section #4
Stationing	10+20 to 36+50	36+50 to 63+10	63+10 to 89+66	89+66 to 116+00
Lane 1 (eastbound)	HMA Mix with 15% RAP	HMA Mix with 3% RAS and 15% RAP	HMA Mix with 3% RAS and 15% RAP	HMA Mix with 15% RAP
Lane 2 (westbound)	HMA Mix with 15% RAP	HMA Mix with 3% RAS and 15% RAP	HMA Mix with 3% RAS and 15% RAP	HMA Mix with 15% RAP

A graphical depiction of the test section layout is attached as Figure 2.

2.0 PAVEMENT CONDITION SURVEYS

2.1 PAVEMENT CONDITION SURVEY METHODS

Pavement condition surveys were conducted by both KCML and WSDOT. For this project, KCML performed walking surveys using methodologies generally prescribed by ASTM D-6433-03 (ASTM) and the Northwest Pavement Management Association. WSDOT conducted drive-through surveys using laser and other sensing devices mounted to a distress data collection van.

Pavement distresses observed during the surveys were categorized and quantified for the purpose of developing a Pavement Condition Index (PCI) for each test section and the overall roadway.

The general intent of the surveys is to provide a method of measuring and documenting the current condition of the pavement for comparison with past and future evaluations. These measurements assist in determining the rate of deterioration.

PCI is a numerical indicator that rates the present condition of the pavement surface based upon the type, quantity, and distress levels observed. A newly constructed pavement would have a PCI of 100 and a roadway that has failed would have a rating near 0.

The ASTM survey method includes up to 19 different categories of distress. KCML recorded five distress categories including alligator cracking, longitudinal cracking, transverse cracking, rutting, and patching for flexible pavements. Each category of distress is qualitatively classified as having a Low, Medium, or High level of severity. An initial uncorrected deduct value is then determined for each distress category and severity level as a function of the distress density (percent of total area or length).

The final deduct value was determined based upon the total sum of initial deduct values and number of different distress categories within a sample lot or section of roadway. The total corrected deduct value is subtracted from 100 to determine the overall PCI. ASTM suggests using terminology shown in Table 2 to describe the condition of pavements based upon various PCI rating ranges.

TABLE 2	
SE 416TH Street Overlay	
PCI Rating Ranges	
PCI Rating	Condition Description
85 to 100	Excellent
70 to 85	Very Good
55 to 70	Good
40 to 55	Fair
25 to 40	Poor
10 to 25	Very Poor
0 to 10	Failed

WSDOT designates a Pavement Condition Index (PCI) as a Pavement Structural Condition (PSC), documenting the forms and severity levels of distress including alligator cracking, longitudinal cracking, transverse cracking, and patching for flexible pavements.

The PSC is a scoring of the pavement structure based on a compilation of visible surface distresses. This score ranges from 100 being a new surface absent of any distress to 0 representing total pavement failure. The ratings are similar to those presented in Table 2 (PCI Rating Ranges).

The WSDOT Materials Laboratory conducted PSC surveys using laser equipment mounted to a distress data collection van. For calculation of the PSC, the van is driven along the test section collecting laser images while travelling near the posted speed limit. The images are evaluated with other pertinent roadway information, such as length and area. An operator then views the images in a frame by frame progression and, using the "WSDOT Pavement Surface Condition Rating Manual", records pavement distresses as they appear.

2.2 PRE-CONSTRUCTION PAVEMENT RATING COMPARISONS

The recorded pre-construction pavement condition of the roadway surface varied significantly when comparing data obtained from KCML and WSDOT. A comparison of the ratings is presented in Table 3.

TABLE 3		
SE 416th Street Overlay		
Comparison of KCML and WSDOT Pavement Rating Conditions		
Pre-Construction (Summer 2009)		
Test Section	KCML Ratings (PCI)	WSDOT Ratings (PSC)
Test Section 1	78	43
Test Section 2	72	25
Test Section 3	44	27
Test Section 4	70	30
Overall Rating	66	31

Note: Test results are rounded to whole numbers.

Discrepancies found in the above recorded values were most likely due to subjective and qualitative interpretation for the rated severity of observed distressed areas.

KCML interpreted the majority of longitudinal cracking as low severity, while WSDOT generally measured these distresses as moderately severe. In addition, KCML designated the majority of asphalt patching as low severity. WSDOT documented patching as medium severity.

2.3 POST-CONSTRUCTION PAVEMENT RATING COMPARISONS

In December 2009, the WSDOT Materials Laboratory conducted a post-construction pavement condition survey using the distress data collection van. In August 2010, both WSDOT and KCML conducted separate surveys. Post-construction pavement condition surveys are summarized below in Table 4.

TABLE 4			
SE 416th Street Overlay			
Post Construction Pavement Condition Surveys			
Test Section	WSDOT December 2009	WSDOT August 2010	KCML August 2010
Test Section 1	100	100	100
Test Section 2	100	100	100
Test Section 3	100	100	100
Test Section 4	100	100	100
Overall Rating	100	100	100

Note: Test results are rounded to whole numbers.

The surveys revealed, the roadway surface in all test sections continued to appear in excellent condition, following nearly one year of service post-construction.

2.4 RUTTING AND ROUGHNESS

In addition to PSC testing, the WSDOT distress data collection van is capable of documenting pavement rutting condition (PRC) and roughness based on the International Roughness Index (IRI). Test results for rutting and roughness are presented below.

2.4.1 Pavement Rutting Condition (PRC)

PRC is a score representing the extent of rutting present in the rated lane. This is accomplished by using a Laser Rut Measurement System (LRMS) mounted on the distress data collection van. Two of these collection devices are mounted on the back of the collection van, one for each half of the lane width. The devices collect laser images every 5 feet through the length of the site.

The rating scale for the PRC ranges from 100 (no rutting) to 0 (deep rutting dependent on the length). Typically, a roadway would be considered for rehabilitation when the PRC rating is 50 or below. Pre-existing and post-construction PRC test results from the WSDOT pavement condition surveys are summarized in Table 5.

TABLE 5			
SE 416th Street Overlay			
WSDOT Pavement Rutting Condition Surveys (PRC)			
Test Section	Pre-existing July 2009	Post construction December 2009	Post-construction August 2010
Test Section 1	80	96	95
Test Section 2	77	98	96
Test Section 3	77	95	95
Test Section 4	79	96	94
Overall Rating	79	96	95

Note: Test results rounded to whole numbers.

The August 2010 pavement rutting condition survey revealed a slight increase in rutting in all test sections when compared to the post-construction survey conducted in December 2009. Minimal rutting within the roadway is occurring in all test sections.

2.4.2 International Roughness Index (IRI)

IRI is a measurement for roughness of the pavement surface. The collection van is outfitted with two accelerometers, one for each wheel path. As the van travels over the test site these accelerometers measure the movement of the van. For this rating, the scoring ranges from low to high and is measured in inches per mile. The higher the score, the rougher the roadway section, with zero considered equivalent to a smooth glass surface.

WSDOT uses the following rankings, shown in Table 6, when rating the IRI:

TABLE 6	
SE 416th Street Overlay	
International Roughness Index Scale	
IRI (inches/mile)	Pavement Rating
Below 95	Very Good
95-170	Good
170-220	Fair
220-320	Poor
Above 320	Very Poor

Pre-existing and post-construction IRI test results from the WSDOT pavement condition surveys are summarized in Table 7:

TABLE 7			
SE 416th Street Overlay			
WSDOT International Roughness Index Surveys (IRI)			
Test Section	Pre-existing July 2009	Post construction December 2009	Post-construction August 2010
Test Section 1	83	68	60
Test Section 2	94	60	64
Test Section 3	185	88	91
Test Section 4	132	78	82
Overall Rating	124	74	74

Note: Test results are rounded to whole numbers.

The roughness (IRI) of the roadway continues to be measured below a rating of 95 in all test sections indicating a relatively smooth surface since placement of the overlay.

3.0 ADDITIONAL OBSERVATIONS

In addition to pavement conditions observed and rated above, minor imperfections were also observed and recorded by KCML. These imperfections included localized and intermittent microcracking visible in Test Sections 1 and 2.

There are many potential causes of microcracking, or sometimes called checking, including under-compaction due to deflection of the underlying subgrade, over-compaction of the asphalt mat, especially when compacting an excessively cool mat, mix tenderness, and excessive tacking of the underlying asphalt roadway.

Microcracking is generally considered a minor factor affecting the overall long term performance of the roadway, but could assist in reduced fatigue life. The observed imperfection is not inherently related to the addition of RAS in HMA.

We also observed minor extraneous materials slightly imbedded in the asphalt mat in all test sections, but mostly observed in Test Sections 2 and 3. These materials included small

fragments of narrow gauge wire in Test Sections 1 and 4. Materials in Test Sections 2 and 3 consisted of mastic-like fragments (rubbery texture) and were likely byproducts from RAS processing.

In addition to extraneous materials, we noted what appeared to be periodic surface voids typically about 1 inch in diameter and generally less than ¼ inch in depth in Test Sections 2 and 3. These shallow depressions are sometimes called “pop-outs”, due to the belief that material originally filled the voids and “popped out” from vehicle use. We surmise that extraneous materials, most likely in the form of mastic or other rubber-like fragments, had popped out after vehicle use. The amount of materials and pop-outs were minimal and periodic.

A summary of imperfections found in each test section is listed below:

Test Section 1 (HMA and RAP Only)

- Localized intermittent microcracking, low severity
- Three 3” to 4” long fragments of narrow gauge wire

Test Section 2 (HMA with RAP and RAS)

- Localized intermittent microcracking, low severity
- Ten typically one-inch diameter pop-outs
- Three rubber-like fragments
- One 4” long fragment of narrow gauge wire

Test Section 3 (HMA with RAP and RAS)

- One 1-inch diameter pop-out
- Four rubber-like fragments
- One 4” long fragment of narrow gauge wire

Test Section 4 (HMA and RAP Only)

- Four 2” to 4” long fragments of narrow gauge wire

4.0 SUMMARY OF FINDINGS

4.1 PAVEMENT CONDITION SURVEYS

Separate pre-construction pavement condition ratings conducted by KCML and WSDOT varied significantly when comparing pavement condition indexes (PCI). KCML documented an overall PCI rating of 66 as compared to an overall rating of 31 recorded by WSDOT. This is likely due to the subjective and qualitative interpretation for the rated severity of observed distressed areas.

Both KCML and WSDOT post construction surveys revealed a PCI rating of 100 for the entire roadway and each test section. The entire roadway within the project limits is considered to be in excellent condition.

4.2 PAVEMENT RUTTING CONDITION (PRC)

Current PRC survey test results revealed a slight increase in rutting in all test sections when compared to rut testing conducted in December 2009. Rutting values were similar in all test sections. Minimal but expected rutting within the roadway has occurred in all test sections.

4.3 INTERNATIONAL ROUGHNESS INDEX (IRI)

The roughness (IRI) of the roadway continues to be measured below 95 in all test sections indicating a relatively smooth surface since placement of the overlay. As previously observed during December 2009 testing, Test Sections 3 and 4 rated about 20 points higher than Test Sections 1 and 2. This may be due to traveling over the existing Newaukum Creek Bridge located in Test Section 3 and/or accelerating or decelerating during testing. The severity of roughness was essentially unchanged from measurements recorded in December 2009.

4.4 ADDITIONAL OBSERVATIONS

Minor localized microcracking was observed in Test Sections 1 and 2. Minimal extraneous materials were observed on the pavement surface in all test sections. Periodic surface voids, typically in the form of shallow one-inch diameter depressions, were noted in Test Sections 2 and 3.

5.0 CONTINUING TESTING AND ANALYSIS

KCML will continue to coordinate and conduct post-construction testing and analysis in support of the demonstration project through 2012. Further monitoring and analysis of the retrieved data will include the following procedures:

- Conduct a yearly pavement condition survey by walking the site and documenting distressed areas.
- Conduct a yearly pavement condition survey using the WSDOT distress data collection van.
- Conduct skid testing in 2012 for both dry and wet conditions.
- Perform analysis of the above retrieved data and submit a yearly supplemental report summarizing the findings.

- Provide recommendations for the continued use of RAS on public roadways in King County following 3 years of pavement performance (2012).

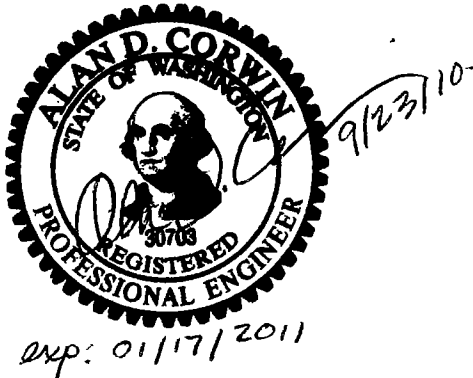
6.0 CONCLUSION

Pavement condition surveys verified the entire surface of the roadway is in near perfect condition. Slight rutting has occurred within the roadway and is relatively uniform across all test sections. The road surface is considered to be smooth with minimal measured roughness. Minor imperfections included localized microcracking, periodic shallow surface depressions, and few extraneous materials imbedded in the asphalt mat.

Current observations and test results indicate that using RAS as part of the HMA mix has had no significant effect, favorable or detrimental, on pavement performance.

Respectfully Submitted,

King County Materials Laboratory



Alan D. Corwin, P.E.
Materials Engineer

Kevin L. Kelsey
Senior Engineer

7.0 REFERENCES

ASTM Standards, Volume 04.03, *ASTM D 6433-07 Standard Practice for Roads and Parking Lots Pavement Condition Index Surveys*, 2009.

Northwest Pavement Management Association, *Pavement Surface Condition Field Rating Manual for Asphalt Pavement, Second Edition*, undated

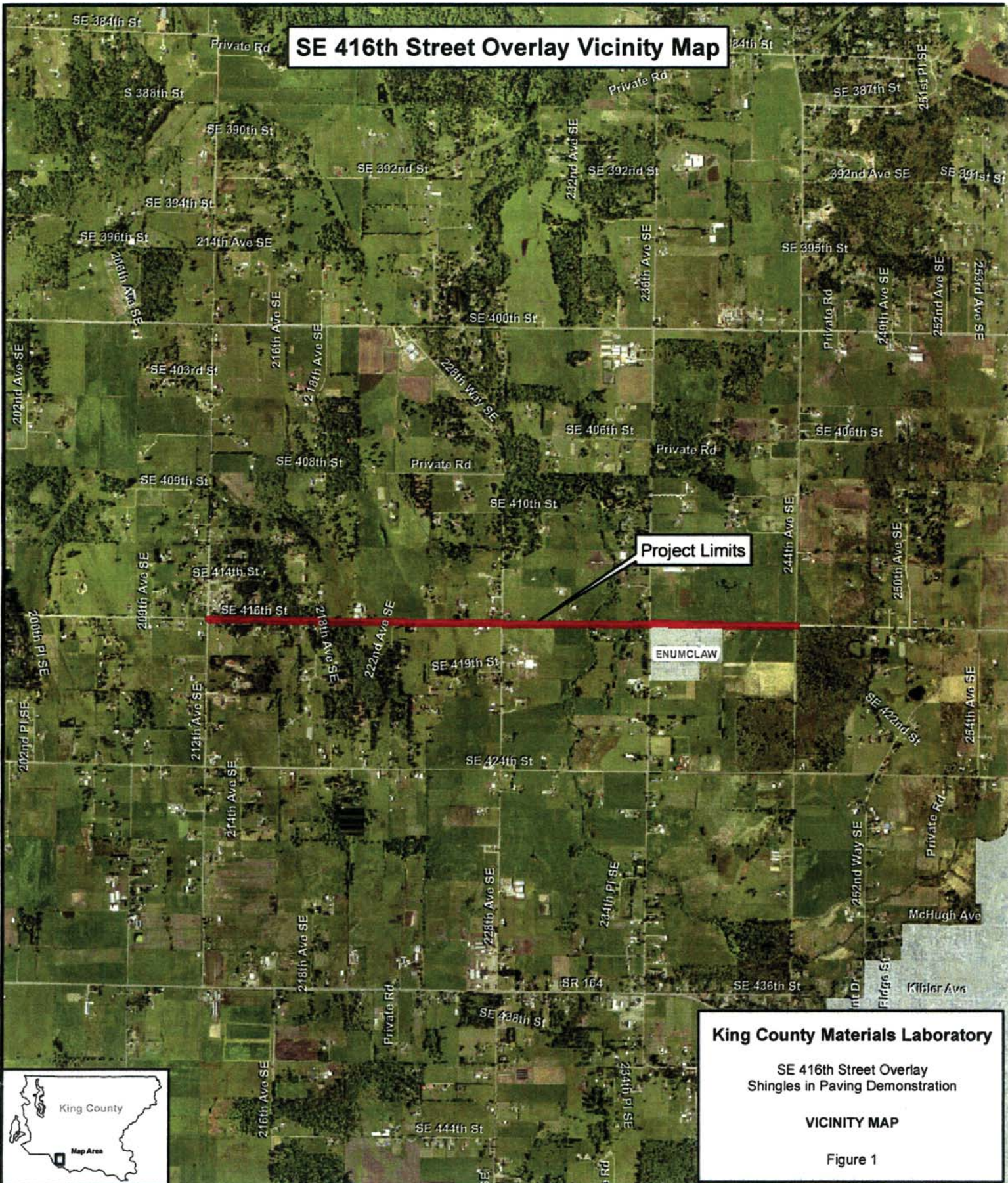
WSDOT Materials Manual website:

<http://www.wsdot.wa.gov/publications/manuals/fulltext/M46-01/Materials.pdf>, 2009 Edition

King County Materials laboratory, *Technical Support Document for SE 416th Street Overlay: Shingles in Paving Demonstration*, dated January 2010



SE 416th Street Overlay Vicinity Map



King County Materials Laboratory
 SE 416th Street Overlay
 Shingles in Paving Demonstration
VICINITY MAP
 Figure 1

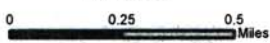
Project Limits

City

2009 King County natural color orthophoto - 0.5 GSD



January 7, 2010

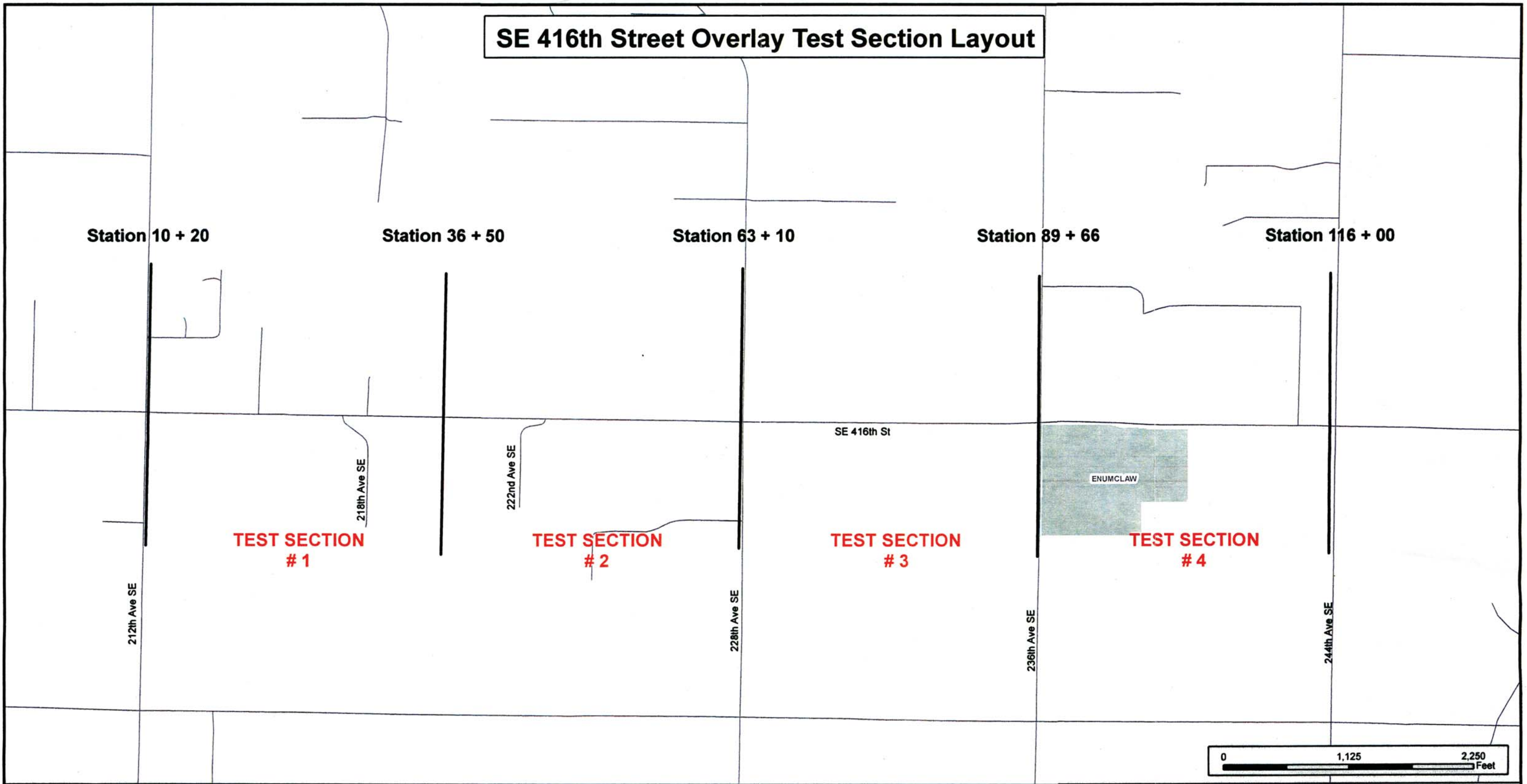


File Name: K:\TUD\development\ArcMap\ArcMapProjects\SE_416th_St_vicinity_map.mxd
 Data Sources: Standard King County datasets used include: trans_network, 2009 King County natural color orthophoto - 0.5 and 1.0 R GSD
 Roads Datasets Include: SE3146St

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SE 416th Street Overlay Test Section Layout



King County Materials Laboratory

SE 416th Street Overlay
Shingles in Paving Demonstration

TEST SECTION LAYOUT

Figure 2

-  Station Line
-  Street Network



January 7, 2010

File Name:
KG T\development\ArcMap\ArcMapProjects\SE_416th_St_test_section_map.mxd
Data Sources:
Standard King County datasets used include: trans_network
Roads Datasets include: SE416thSt_stationing

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