# SE 416TH STREET OVERLAY: SHINGLES IN PAVING DEMONSTRATION

## Post-Construction Pavement Conditions
## Interim Report - 2011
JANUARY 2012

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January 13, 2012

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VIA: Alan D. Corwin, P.E., Materials Engineer, Materials Laboratory, Project Support Services, ESS/RSD/KCDOT

FM: Kevin L. Kelsey, Senior Engineer, Materials Laboratory, Project Support Services, ESS/RSD/KCDOT

**SE 416th Street Overlay: Shingles in Paving Demonstration Post-Construction Pavement Conditions, Interim Report - 2011**

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

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

As requested, we have completed post-construction testing and analysis for 2011 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 and post-construction testing in 2010. A summary of our past work and participation was submitted in the above referenced reports. 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 final 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., Division Director, County Road Engineer, Road Services Division, KCDOT

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# SE 416th Street Overlay: Shingles in Paving Demonstration

**Post-Construction Pavement Conditions**
**Interim Report - 2011**
**King County Materials Laboratory**

## 1.0 INTRODUCTION

### 1.1 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 Washington State Department of Transportation (WSDOT) Materials Laboratory conducted an overlay demonstration project 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 purpose of the demonstration project is to evaluate the use of post-consumer RAS in combination with RAP in HMA. Following our evaluation of the roadway in 2012, a final report will be prepared containing our conclusions and recommendations for future use of RAS in HMA on County-wide paving projects.

Since construction, the King County Materials Laboratory (KCML) has conducted pavement condition surveys on a yearly basis by walking the site and documenting distressed areas. Additional pavement condition surveys have been conducted by WSDOT using a distress data collection van.

This interim report summarizes recorded pavement conditions observed and measured during the Fall of 2011, following two years of post-construction traffic. Previous surveys and related documentation are available on the King County Solid Waste website "Linkup" at http://your.kingcounty.gov/solidwaste/linkup/shingles/paving-project.asp.

### 1.2 TEST SECTION

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 limits extend 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.

The roadway was divided into four separate test sections, each approximately ½ mile in length. Each test section required about 1000 tons of HMA to provide 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 The American Society for Testing and Materials (ASTM) test method D-6433-03 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. KCML recorded five distress categories for the PCI rating including alligator cracking, longitudinal cracking, transverse cracking, rutting, and patching for flexible pavements.

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. 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). 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 records pavement distresses as they appear.

## 2.2 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 2010 and 2011, both WSDOT and KCML conducted separate surveys. Post-construction pavement condition surveys are summarized below in Table 3.

| TABLE 3 | | | | | |
|---|---|---|---|---|---|
| SE 416th Street Overlay | | | | | |
| Post Construction Pavement Condition Surveys | | | | | |
| **Test Section** | **WSDOT December 2009** | **WSDOT 2010** | **WSDOT 2011** | **KCML 2010** | **KCML 2011** |
| Test Section 1 | 100 | 100 | 100 | 100 | 100 |
| Test Section 2 | 100 | 100 | 99 | 100 | 100 |
| Test Section 3 | 100 | 100 | 99 | 100 | 99 |
| Test Section 4 | 100 | 100 | 99 | 100 | 100 |
| Overall Rating | 100 | 100 | 99 | 100 | 100 |

**Note:** Test results are rounded to whole numbers. Ratings are based on the combined average of both lanes in each test section.

The roadway surface in all test sections continues to appear in excellent condition following two years of post-construction service. KCML did note one 15-foot long low severity longitudinal crack in the westbound lane of Test Section 3. The cracking appears to follow along

the edge of a roller mark and may be mostly related to poor construction techniques. Pre-construction records indicate a low severity longitudinal crack existed at this location, prior to paving.

## 2.3 PAVEMENT RUTTING CONDITION (PRC)

The WSDOT distress data collection van also documented the pavement rutting condition (PRC) 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.

PRC is a score representing the extent of rutting present in the rated lane. 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. Post-construction PRC test results from the WSDOT pavement condition surveys are summarized in Table 4.

| TABLE 4 | | | |
|---|---|---|---|
| SE 416th Street Overlay | | | |
| WSDOT Pavement Rutting Condition Surveys - Post Construction (PRC) | | | |
| **Test Section** | **December 2009** | **August 2010** | **November 2011** |
| Test Section 1 | 96 | 95 | 96 |
| Test Section 2 | 98 | 96 | 96 |
| Test Section 3 | 95 | 95 | 96 |
| Test Section 4 | 96 | 94 | 94 |
| Overall Rating | 96 | 95 | 96 |

**Note**: Test results are rounded to whole numbers. Ratings are based on the combined average of both lanes in each test section.

All roadway test sections continue to exhibit only minimal rutting following two years of service.

## 2.4 INTERNATIONAL ROUGHNESS INDEX (IRI)

WSDOT also recorded surface roughness based on the International Roughness Index (IRI). 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 5, when rating the IRI:

| TABLE 5 | |
|---|---|
| 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 |

Post-construction IRI test results from the WSDOT pavement condition surveys are summarized in Table 6:

| TABLE 6 | | | |
|---|---|---|---|
| SE 416th Street Overlay | | | |
| WSDOT International Roughness Index Surveys - Post Construction (IRI) | | | |
| Test Section | December 2009 | August 2010 | November 2011 |
| Test Section 1 | 68 | 60 | 67 |
| Test Section 2 | 60 | 64 | 60 |
| Test Section 3 | 88 | 91 | 92 |
| Test Section 4 | 78 | 82 | 88 |
| Overall Rating | 74 | 74 | 77 |

**Note:** Test results are rounded to whole numbers. Ratings are based on the combined average of both lanes in each test section.

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

### 3.1 MICROCRACKING

Localized and intermittent microcracking was observed in Test Sections 1 and 2 during the 2010 pavement reconnaissance. The extent of cracking observed this year are comparable to last year and does not appear to be impacting the structural integrity of the pavement section.

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.

### 3.2 EXTRANEOUS MATERIALS AND POP-OUTS

We also recorded extraneous materials imbedded in the asphalt mat in all test sections. These materials were most noted in Test Sections 2 and 3. Materials in Test Sections 2 and 3 consisted mostly of mastic-like fragments (rubbery texture) and were likely byproducts from RAS processing. Small wood fragments were typically found in Test Sections 1 and 4.

In addition to extraneous materials, we observed periodic surface voids typically about 1 inch in diameter and generally less than ¼ inch in depth. These shallow depressions are sometimes called "pop-outs", due to the belief that material originally filled the voids and was then forced or "popped" out from repeated traffic loading.

The pop-outs are visible only during a careful walk-through inspection of the pavement surface. The amount of materials and pop-outs as compared to the overall surface area of the pavement is considered minimal and periodic.

In 2010, following a cursory survey of these imperfections, a summary of the number of areas consisting of extraneous materials was noted. In 2011, a more carefully observed survey was taken recording the type, size, and number. A summary of the number of imperfections found in 2011 are listed in Table 7.

| Table 7 | | |
|---|---|---|
| SE 416th Street Overlay | | |
| Extraneous Materials and Pop-outs Summary - 2011 | | |
| Test Section | Extraneous Materials | Pop-outs |
| 1 | 6 | 7 |
| 2 | 28 | 21 |
| 3 | 15 | 12 |
| 4 | 10 | 14 |

Although observed in all test sections, extraneous materials and pop-outs were mostly found in Test Sections 2 and 3 and appear to be related to byproducts of RAS processing.

## 4.0 SUMMARY OF FINDINGS

### 4.1 PAVEMENT CONDITION SURVEYS

Both KCML and WSDOT post construction surveys revealed a PCI rating of or nearly 100 for 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 relatively no change in the degree of rutting in all

test sections. 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 recorded in 2009 and 2010, 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 has marginally increased since construction.

### 4.4 ADDITIONAL OBSERVATIONS

Minor localized microcracking observed in Test Sections 1 and 2 during the 2010 survey has not increased. Minimal extraneous materials and periodic surface voids were observed on the pavement surface in all test sections, however, they were predominantly found in Test Sections 2 and 3.

## 5.0 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 continue to indicate using RAS as part of the HMA mix has had no significant effect, favorable or detrimental, on pavement performance.

## 6.0 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 pavement condition survey in the Fall of 2012 by walking the site and documenting distressed areas.
- Conduct a pavement condition survey in the Fall of 2012 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 final report summarizing

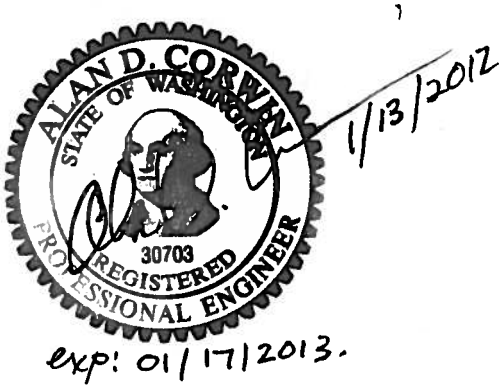
the findings.

- Provide recommendations in the final report for the continued use of RAS on public roadways in King County.

We trust this interim report sufficiently summarizes the current condition of the roadway to date. Please call us, should you have questions, concerns, or would like further information.

Respectfully Submitted,

King County Materials Laboratory

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Materials Engineer

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## 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

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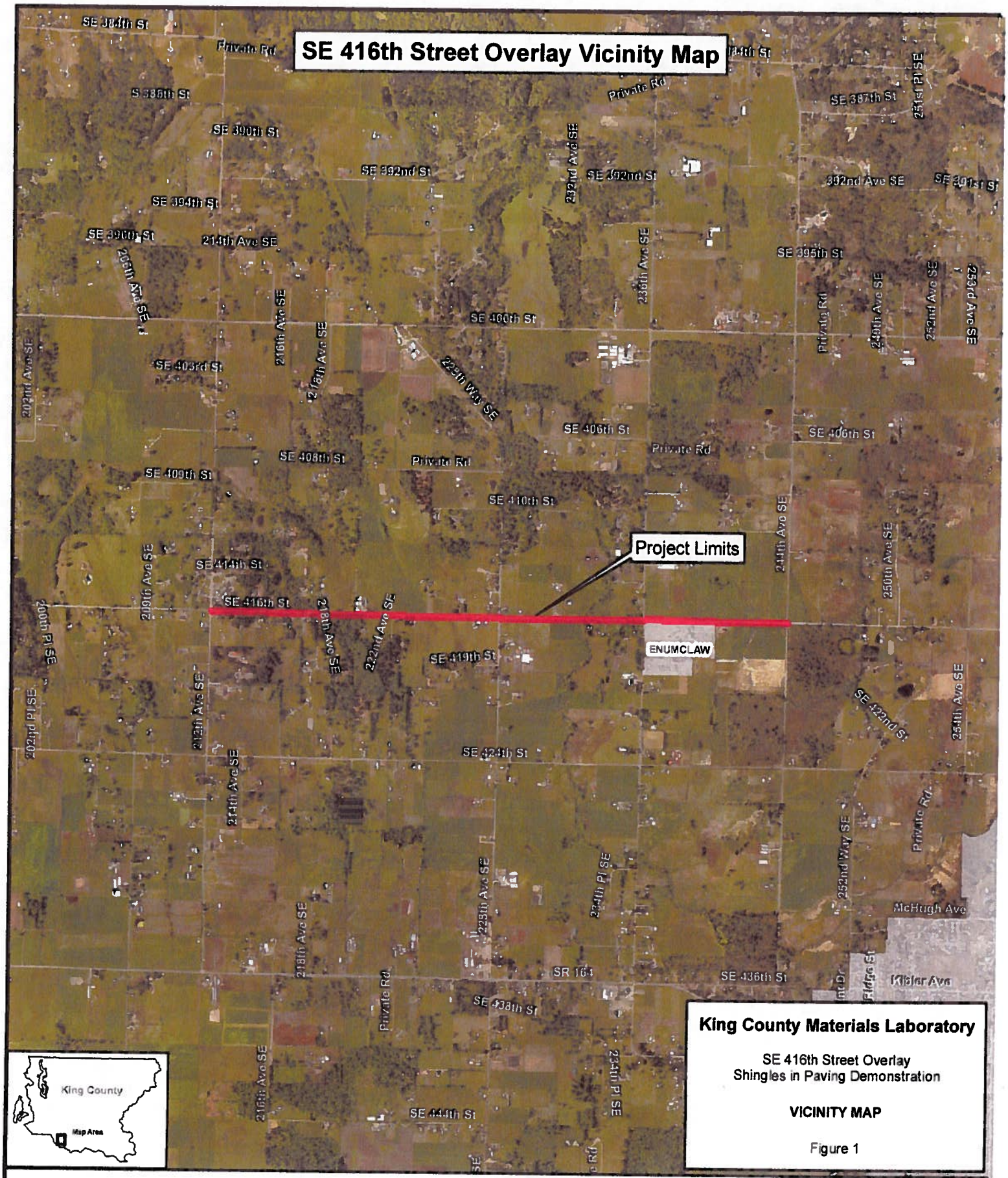
*http://www.wsdot.wa.gov/publications/manuals/fulltext/M46-01/Materials.pdf,* 2009 Edition

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

King County Materials laboratory, *SE 416th Street Overlay: Shingles in Demonstration, Post-Construction Pavement Condition*, dated September 2010

King County Department of Natural Resources and Parks, Solid Waste Division, Linkup website - http://your.kingcounty.gov/solidwaste/linkup/shingles/paving-project.asp

# 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

N

January 7, 2010

0 0.25 0.5 Miles

File Name:
KG TUdevelopment\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 ft GSD
Roads Datasets Include:SE314thSt

The information included on this map has been compiled by King County staff from a variety of sources and is subject to change without notice. King County makes no representations or warranties, express or implied, as to accuracy, completeness, timeliness, or rights to the use of such information. This document is not intended for use as a survey product. King County shall not be liable for any general, special, indirect, incidental, or consequential damages including, but not limited to, lost revenues or lost profits resulting from the use or misuse of the information contained on this map. Any sale of this map, or information on this map, is prohibited except by written permission of King County.

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