

**DEPARTMENT OF LAND USE AND TRANSPORTATION  
OPERATIONS AND MAINTENANCE DIVISION**

**Interoffice Memorandum**

**DATE:** December 15, 2009  
**TO:** Dave Schamp, Division Manager  
**FROM:** Greg Clemmons, Operations Engineer  
**RE:** CHIP SEAL REVIEW – 2009 PROGRAM

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Attached is the summary review for this past summer's chip seal program. The work was completed entirely by Washington County personnel, with rock furnished by Baker Rock of Beaverton, OR and oil provided by Albina Fuel of Vancouver, WA. The work was programmed and performed during July and August under good conditions.

While the overall quality of the work is quite high and Washington County's processes continue to be a showcase program, there are opportunities for improvement. Proper preparation of widened areas in our gravel road upgrades and Local Improvement Districts can be better addressed. Closer attention to sampling and testing of material before, during, and after construction, should be performed more diligently and other miscellaneous items are addressed in the report. These items all point toward a more significant finding. An Inspection Technician needs to be assigned to oversee the chip seal program throughout the work.

The attachment does not include the hard copies of the test results which I will retain in a binder along with this memo and report. They are available for review.

Attachments

c: Todd Watkins  
Keith Lewis  
Marv Vanaken  
c/file

Washington County  
Department of Land Use and Transportation  
Operations and Maintenance Division



Chip Seal Program Review  
Summer 2009

Prepared by: Greg Clemmons  
Operations Engineer  
December 10, 2009

## **Chip Seal Program Review – Summer 2009**

This report summarizes the results of a review of the chip seal work performed by Washington County for the summer of 2009. It also reviews past work to assess the overall quality of the chip seal program. The report consists of six sections:

- Background
- Cost
- Quality
- Performance
- Summary and Conclusions

### **Background**

Washington County applies chip seals to satisfy two distinct goals:

- Provide a wearing surface for a gravel road upgrade
- Preventive maintenance for a paved road

As is typical with most localities, contractors interested in chip seal work are few in the Portland area. Most counties throughout the United States rely on their own crews to perform the work. Consequently, Washington County does its own chip seals through an annually adopted program of work approved by the Board of County Commissioners.

The county has periodically reviewed its chip seal work to assess quality and cost effectiveness of its work when compared to contractors and other agencies. This has included contract work in the year 2000, with inspection by an independent consultant who also inspected concurrent county work. The county has also retained another independent consultant to assess the overall practices and quality of work performed by the county (Gerry Douglas, 2006). The results of this work will be provided in the cost and performance sections of this report.

Washington County applies a single shot chip seal over paved roads as a preventive maintenance measure. Indicators leading to the selection of this work include raveling and oxidized asphalt. The single shot chip seal consists of an application of emulsified asphalt and a layer of fine aggregate. The asphalt is a high float emulsion (HFE 100S) applied at a target rate of 0.45 gallons per square yard and the aggregate is a crushed rock sized from 3/8” to no. 10 size. This is commonly referred to as “3/8-10”, where the “10” represents a size of the screen used in the quarrying process that has 10 openings per inch. The target application rate for the rock is 28 pounds per square yard. Finally, Washington County applies a fog seal consisting of an emulsified asphalt (901-S diluted) shot at a fine mist (0.08 to 0.14 gal/sq. yd.) and a very fine dusting of sand.

Gravel road upgrades (GRUs) may be done as part of an adopted program identified by the County’s Rural Roads Operations and Maintenance Advisory Committee (RRROMAC). They may also be done as Local Improvement Districts (LIDs), Co-op projects, which are funded prior to the work by the interested property owners, or by

grant funding (rare). These are cost effective treatments that have applicability to low volume local roads where no other funding is available.

Washington County uses three shot chip seals to upgrade its gravel roads. This past year, because of rising asphalt costs and environmental concerns, Washington County deviated slightly from its past practice of using a cutback asphalt product (MC-250) for the first oil shot or prime coat of a GRU and went to an emulsified asphalt product (High Float Medium Set - HFMS). This offered a number of advantages. First, MC-250 costs about \$850 per ton (2008) while the HFMS costs \$600 per ton (2009) and their application rates are the same at 0.50 gallons per square yard for the first shot. Secondly, the MC-250 and first rock application required about a week to cure before the second shot should be applied. With HFMS, all three shots can be applied on the same day, if the project is appropriately sized. This eliminates the need for re-mobilizing to a site a week later, thus saving cost. Third, while the environmental drawbacks (volatiles emitted to the atmosphere) are minimal, the week long exposure while the product cured has been eliminated.

The prescription for Washington County’s three shot chip seals are shown in Table 1:

<b><u>Layer</u></b>	<b><u>Oil</u></b>	<b><u>Rock</u></b>
1	HFMS @ 0.50 gal/sq. yd.	1/2” to 1/4” @ 35 lb/sq. yd.
2	HFMS @ 0.55 gal/sq. yd.	3/8”-10 @ 35 lb/sq.yd.
3	HFMS @ 0.45 gal/sq. yd.	3/8”-10 @ 28 lb/sq. yd.

Table 1

A summary of the testing results, actual spread rates and costs will be provided in the remainder of this report.

**Cost**

In the year 2000, Washington County advertised half of its preventive maintenance chip seal work (single shot) as a contract. As a result, approximately 10.2 miles of county roads were chip sealed by Central Oregon Paving for a total contract cost of \$128,436.18, or about \$12,640 per mile. At the same time, Washington County’s crews chip sealed 11.8 miles of road for \$82,175.95, or about \$7,000 per mile (\$0.73 per sq. yd.). Since that time, chip seal costs have risen dramatically. The average cost for a single shot chip seal in 2009 was approximately \$2.37 per sq. yd., or a growth factor of 3.25.

Most of this cost increase is due to inflation and a dramatic increase in oil product and energy costs, with a small part of it attributed to the additional cost of the fog seal which is applied over the single shot chip seal. The county only started applying the fog seal in 2002, so that cost is not reflected in the costs from the year 2000. The fog seal ties the loose rock, minimizing “whip off” and damaged windshield claims. It also provides a better appearance, mimicking an overlay and it may improve the ride quality and tire noise. At approximately \$0.50 per sq. yd., it is believed to be worth the expense.

These single shot chip seal cost increases are displayed in Figure 1, which shows that the single largest component contributing to the overall annual cost increase of 12.5% is the cost for material at 15%. The annual percentage increase for equipment is 1% and labor is 2%.

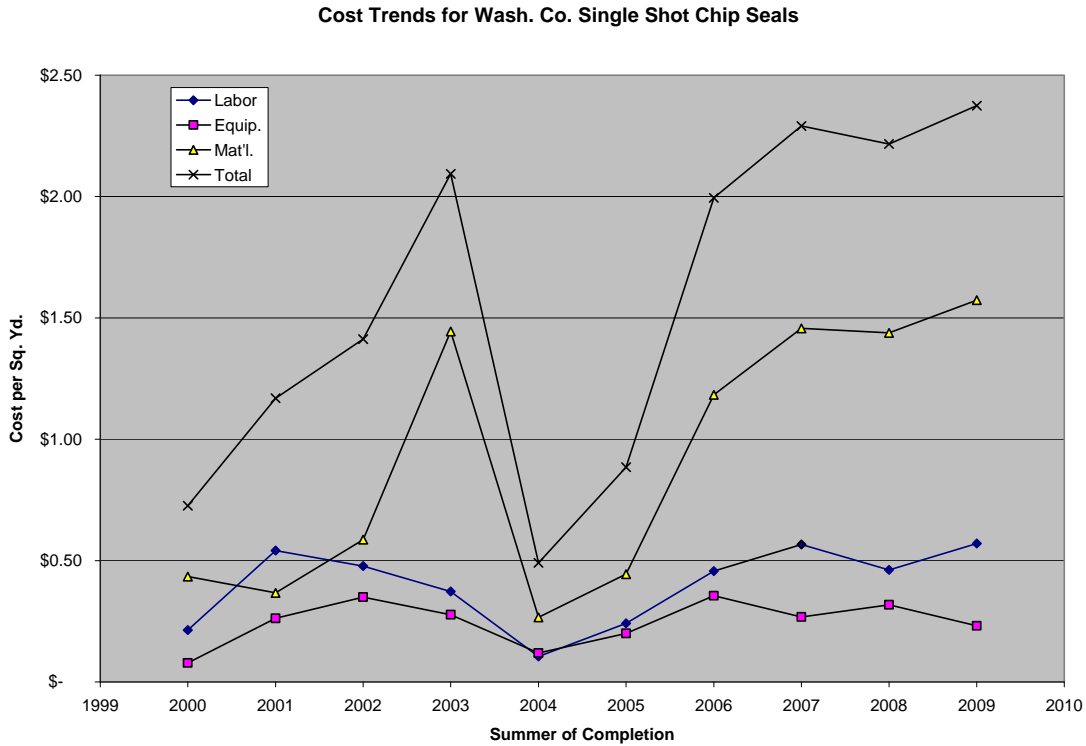


Figure 1

The second aspect of the county's chip seal program is the three shot chip seal program used for upgrading gravel roads. During the period from the year 2000 through 2003 there were no upgrades. In the year 2004, the Division embarked on the Gravel Road Upgrade Program, utilizing approximately 10% of the receipts realized from HB 2041. This has resulted in about \$150,000 annually for the program. There has been a substantially larger increase in the costs for the three shot chip seals used in the Gravel Road Upgrade program and Local Improvement Districts as shown in Figure 2. However, they are cause for concern when future upgrades are considered. This graph shows a cost increase multiplier of 4.5 for the five year period and an annual inflation rate of 35%.

Cost Trends for Wash. Co. Triple Shot Chip Seals

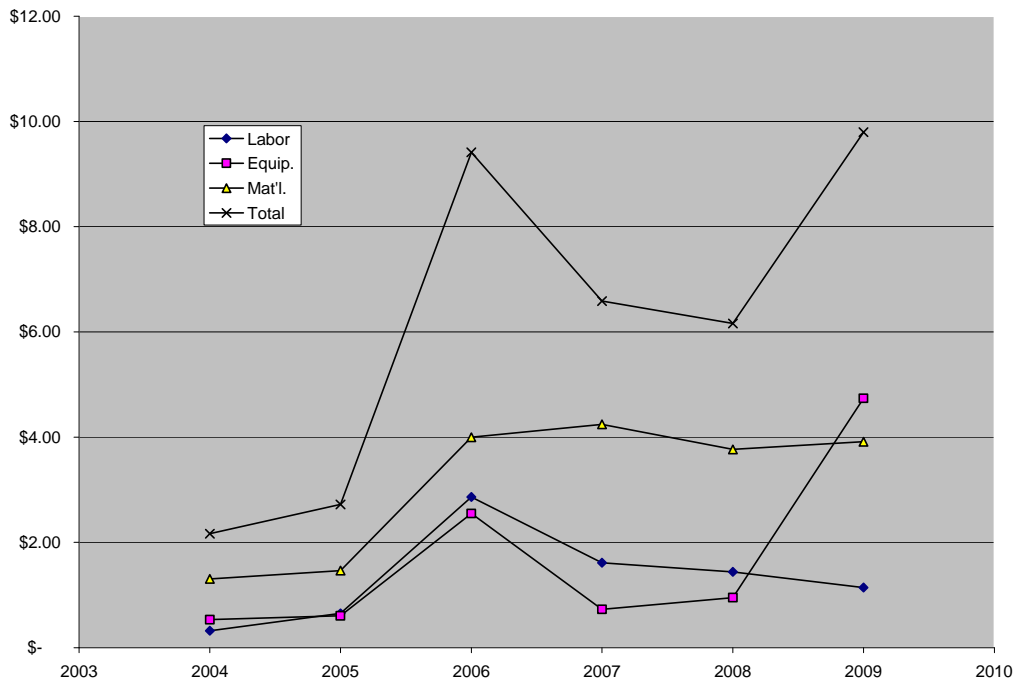


Figure 2

### Quality

Application rates, lab tests, visual inspections and long-term performance are the primary measures of the quality assurance program associated with chip seals. This section of the report documents the findings of program analysis, tests and inspections of the 2009 program. It also reviews a few of the past chip seals completed through Washington County's work program.

One of the measures of quality of a chip seal program is an assessment of the application rates. Aggregate and oil quality are also critical components of any chip seal program. The spread of both the oil and aggregate should be even and uniform. Ideally, a chip seal should have the aggregate in a layer of oil embedded approximately 2/3 of its height. Additionally, the type and quality of the asphalt component and aggregate must be considered in the initial design of the program. Aggregate should be crushed, of uniform size, clean and durable. It should be resistant to both mechanical degradation (traffic) and chemical degradation (weathering). Also, the oil and rock should be compatible. Normally, an anionic rock is matched with a cationic oil, to take advantage of the opposite charges inherent in each.

To assess the spreadrates applied to the roads, the county's cost accounting system contained within IRIS (Integrated Road Inventory System) was examined for the summer's work. The results are shown in Table 2. A few observations can be made regarding the data in this table.

<b>Chip Seal Spread Rates, Summer 2009</b>					
	Actual Values				
	Rock Spread Rates		Oil Spread Rate		
	3/8-10	1/2-1/4	HFMS	901-s	100-s
Road Name	lb/sy	lb/sy	gal/sy	gal/sy	gal/sy
150th AV	18.1				0.31
BANKS RD	22.1				0.33
ELSNER RD	25.6				0.36
GORDON RD	28.5				0.40
HORNECKER RD	28.2				0.39
JACKSON SCHOOL RD	28.8				0.39
SCOTCH CHURCH RD	30.3				0.36
SELLERS RD	30.3				0.35
UNGER RD	27.0				0.39
WREN RD	26.7				0.39
HARRINGTON RD	30.0	108.2	1.60		
PARMELE RD	28.2	29.7	1.00	0.42	
REILING RD	30.3	57.7	0.86	0.66	
WHITMORE RD	30.7	32.5	0.49	1.09	0.00
	Average Values				
	3/8-10	1/2-1/4	HFMS	901-s	100-s
	lb/sy	lb/sy	gal/sy	gal/sy	gal/sy
Single Shot Average	26.7				0.37
Three Shot Average	30.1	56.6	1.53		
	Target Values				
	3/8-10	1/2-1/4	HFMS	901-s	100-s
	lb/sy	lb/sy	gal/sy	gal/sy	gal/sy
Single Shot Target	28.0				0.45
Three Shot Target	28.0	70.0	1.50		

Table 2

1. The oil application rates for the single shot chip seal are consistently below the target value by about 18%.
2. The 3/8-10 rock application rate is, on average, very close to the target value, however, 150<sup>th</sup> Ave. and Banks Road are lower than expected.
3. Generally speaking, the overall values are close to the target values.

Aggregate quality, measured as gradation and cleanness values (CV) were tested by the supplier's certified lab prior to the work and after the work by an independent lab. These test results are provided in Appendix A. While all test results prior to the work were acceptable, most of the cleanness values for the post construction runs were below acceptable. There could be a number of reasons for this. First, a few independent checks should have been performed to verify the results from the supplier's lab. This will be done with next year's program of work. Secondly, the samples were stored in plastic bags and could have been contaminated with dust during sampling and storage. Finally, the aggregate can degrade over time, resulting in a small amount of dust, resulting in the failing tests. This is a common occurrence on many rock sources in the region. Basalt (the parent rock source) is known to exhibit this behavior.

The consequences of the failing CV readings will be a possible premature loss of aggregate, especially in areas of high lateral loading such as on curves. While this rock source (Baker Rock Products) has been used on several of our past chip seals, failures of this type have not been observed. An examination of these chip seals for occurrence of this potential problem will be performed in the fall of 2010 to see if it appears to be a problem.

Finally, each chip sealed road, both single shot and triple shot, has been visually inspected. While in general, the work appears to be of excellent quality, there are a few observations made that would lead to a better end-product if corrected with next year's program.

Overall, there appeared to be an excess of rock that was lost over the shoulder and in the ditch. It is possible that this is just a fact of life and one of the "expenses" associated with chip seals (see photo). Excess rock is often placed to protect the new chip seal during the curing process and when hot weather is expected. Without it, traffic could quickly wear away the top course of aggregate on the fresh chip seal.



**Excess Rock**

Excess chip seal aggregate left on side of Wilkesboro Road. Problem is common on most chip seals performed in 2009.

Another defect observed was an occasional transverse joint that was not completed satisfactorily (see photo). These were very rare with the south bound lane, near the north end of 150<sup>th</sup> Avenue the only other identified location showing this defect.

Another identified defect was an occasional area left untreated. These were typically on areas such as curve widened sections of road or a small area (less than 20 feet long) that did not receive the fog seal. These areas are very inconsequential and should have very little overall affect on the quality and long-term performance of the product.





Transverse Joint  
improperly constructed.

Overall, however, Washington County's chip seal program is an example of quality chip seals that provide a valuable preventive maintenance treatment, saving the public money over the life of our pavement system. It is often used as a demonstration for other agencies that are doing chip seals.



High quality chip seal  
on Gordon Road.  
Constructed in the  
summer of 2009.

## **Performance**

Over the past 20 years, Washington County has upgraded over 75 road segments, estimated at close to 100 miles, through cooperative projects (paid for upfront by the benefiting parties), Local Improvement Districts (LIDs), or through the Gravel Road Upgrade Program. Additionally, it has seal coated approximately 500 miles of paved roads throughout its system as part of its regular program of work. Overwhelmingly, the program has succeeded in its intent of preserving this valuable resource.

There are numerous examples of roads that have been upgraded through the use of the standard three shot chip seal that have far exceeded their expected life. The pavement design process that is used throughout the United States, as well as by most consultants building major capital projects in Washington County, is the AASHTO process (American Association of State Highway and Transportation Officials). When designing these pavements using this process, it would be likely that a paved section consisting of 12 inches of base rock and four inches of asphalt concrete would be recommended, as a minimum. Instead, for most roads, Washington County has found that a rock section of six inches and the three shot chip seal ( about  $\frac{3}{4}$  inch) is sufficient and has performed very satisfactorily.

This could be attributed to a number of factors, including:

- The existing subgrade is in place and has been subjected to many years of traffic, resulting in a stable platform.
- Chip seals are inherently more flexible than plant mixed asphalt concrete pavement and may result in a longer life because of this.
- Traffic loadings are typically very low and the assumptions used in the AASHTO process may not be valid.
- Maintenance expenditures may be higher for chip seals.

An excellent case study in the effectiveness of chip seals is Fern Flat Road. It was chip sealed in the early 1990's and has been subjected to very heavy logging traffic throughout its life. In the spring of 2008, a timber sale hauled approximately 11,000,000 board feet of logs across it. This is the equivalent of about 2,200 truck loads. Pavement maintenance, mostly in the form of patching, has cost about \$7,620 per mile per year. This is somewhat higher than average for county roads, but the overall cost is less than when the cost of a designed section.

There have been other cases where chip seals have not fared as well. Wren Road was chip sealed as a gravel road upgrade in the early '90s and has had to be rebuilt to support the traffic. Also, Hergert Road was upgraded with a three shot chip seal in the mid-90s through an LID. Shortly after completion, Westside Rock opened its quarry and damaged the road to the point that it required reconstruction, this time with an asphalt section that could withstand the heavy quarry traffic.

Both the gravel road upgrade and preventive maintenance chip seal programs are very cost effective tools for Washington County. In the right circumstances, they provide the public with a relatively low cost solution for upgrading a gravel road and they play a major role in maintaining our collectors and arterials in good condition.

Finally, it was mentioned earlier in this report that in the year 2000, a side-by-side comparison of county chip seals versus contractor chip seals was performed. The construction cost for the contracted roads was \$12,640 per mile while the chip seals placed by the county cost \$7,000 per mile. As a check of the work quality, a cost analysis of the pavement maintenance was performed on each road for the subsequent years. The results of this analysis show that the pavement maintenance costs for these roads were \$2,561 per mile per year for the roads that were chip sealed by Washington County and \$3,566 per mile per year for the roads chip sealed by the contractor. The roads were approximately equal in character (traffic quantities, location, original structure, etc.).

### **Summary and Conclusions**

Washington County has a very cost effective and high quality chip seal program. It has been used over the years as an effective preventive maintenance tool, keeping our major system roads, especially in the rural area, in good condition at a reasonable cost. It has also provided a means for many of the residents in the rural area to upgrade their gravel roads to a paved surface at a reasonable cost.

The visual inspection of the roads chip sealed in 2009 showed very few defects and those identified were minor, at most. There are however, a few recommendations for improvement:

1. Follow up testing of the aggregate to confirm the supplier's results from their certified lab.
2. Try to minimize the amount of aggregate lost.
3. Improve the quality of the transverse joints.
4. Observe the 2009 chip seals for aggregate retention in the fall of 2010 to assess the affects of the failing Cleanness Value tests that were performed on the aggregate following the completion of the program.
5. The Quality Assurance / Quality Control Program needs to be proactive and involved prior to and during the construction process. A post-construction review points to the issues that could have or should have been reduced or prevented. A proactive program would help bring necessary beneficial improvements.