FIELD VERIFICATION PROCESS FOR OPEN-GRADED HMAC MIXES

Final Report

SPR 304-051

Oregon Department of Transportation

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by

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OREGON DEPARTMENT OF TRANSPORTATION
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16. Abstract

The State of Oregon uses significant amounts of open-graded HMAC mixes as primary wearing courses on state highways. The primary materials design system for these mixes relies heavily on laboratory draindown to select the design asphalt content. Subsequent adjustments in the field rely heavily on the visual draindown characteristics as well. Draindown is a limiting characteristic in terms of constructability of open-graded mixes, but adjustments made to mitigate draindown may reduce the long-term performance of the wearing surface.

This research looked at the viability of using conventional film thickness measurements as a means of field verifying the quality of the open-graded mixtures being produced. The findings were that conventional film thickness measurements were too sensitive to the material passing the 75 μm sieve and were therefore not a practical tool.

The authors proposed a simple alternative involving measuring the volume change that occurs when asphalt cement is added to uncoated aggregate. This measurement tool uses readily available field laboratory equipment and provides a simple means of measuring a fundamental mixture property.

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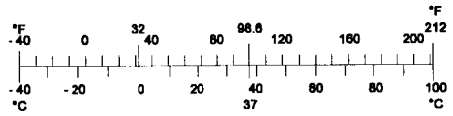
SI* (MODERN METRIC) CONVERSION FACTORS

APPROXIMATE CONVERSIONS TO SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
In	Inches	25.4	Millimeters	Mm
Ft	Feet	0.305	Meters	M
Yd	Yards	0.914	Meters	M
Mi	Miles	1.61	Kilometers	Km
		AREA		
in^2	Square inches	645.2	millimeters	mm^2
ft^2	Square feet	0.093	meters squared	M^2
yd^2	Square yards	0.836	meters squared	M^2
Ac	Acres	0.405	Hectares	Ha
mi^2	Square miles	2.59	kilometers squared	Km^2
		VOLUME		
fl oz	Fluid ounces	29.57	Milliliters	ML
Gal	Gallons	3.785	Liters	L
ft^3	Cubic feet	0.028	meters cubed	m^3
yd^3	Cubic yards	0.765	meters cubed	m^3
NOTE: Volumes greater than 1000 L shall be shown in m^3.				
		MASS		
Oz	Ounces	28.35	Grams	G
Lb	Pounds	0.454	Kilograms	Kg
T	Short tons (2000 lb)	0.907	Megagrams	Mg
		TEMPERATURE (exact)		
°F	Fahrenheit temperature	5(F-32)/9	Celsius temperature	°C

APPROXIMATE CONVERSIONS FROM SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
mm	Millimeters	0.039	inches	in
m	Meters	3.28	feet	ft
m	Meters	1.09	yards	yd
km	Kilometers	0.621	miles	mi
		AREA		
mm^2	millimeters squared	0.0016	square inches	in^2
m^2	meters squared	10.764	square feet	ft^2
ha	Hectares	2.47	acres	ac
km^2	kilometers squared	0.386	square miles	mi^2
		VOLUME		
mL	Milliliters	0.034	fluid ounces	fl oz
L	Liters	0.264	gallons	gal
m^3	meters cubed	35.315	cubic feet	ft^3
m^3	meters cubed	1.308	cubic yards	yd^3
		MASS		
g	Grams	0.035	ounces	oz
kg	Kilograms	2.205	pounds	lb
Mg	Megagrams	1.102	short tons (2000 lb)	T
		TEMPERATURE (exact)		
°C	Celsius temperature	1.8C + 32	Fahrenheit	°F



* SI is the symbol for the International System of Measurement

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DISCLAIMER

FIELD VERIFICATION PROCESS FOR OPEN-GRADED HMAC MIXES FINAL REPORT

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1.0 INTRODUCTION

1.1 PROBLEM STATEMENT

In recent years the Oregon Department of Transportation (ODOT) has moved toward contractors being responsible for developing their own Hot Mix Asphalt Concrete (HMAC) mix designs. These mix designs are developed under the general guidelines established by ODOT, but do allow designs to fit within a set of broad parameters. For dense-graded mixes ODOT has instituted a field mix design verification process to assure the produced mix will meet ODOT design criteria. No such verification is performed for open-graded mixes. Although the open-graded mixes are generally more forgiving than dense-graded mix, there may be differences between the mix design and field conditions affecting mix properties. ODOT needs an objective verification process that will assure open-graded HMAC mixes are receiving adequate liquid asphalt to optimize performance.

1.2 BACKGROUND

Since 1990 open-graded HMAC mixes (12.5 mm and 19.0 mm nominal maximum size aggregate) have played an important role as the primary wearing surface used on many of Oregon's highways. Approximately 2,900 centerline kilometers of open-graded HMAC mixes have been placed on the state highway system for use by all levels of traffic. The significant "splash and spray" reduction as well as improved resistance to rutting has made open-grades an attractive alternative as a primary wearing course material for use in Oregon's wet climate.

While overall performance has generally been quite good, the forgiving nature of open-graded mixes has allowed mixes to be produced with effective asphalt contents (P_{be}) ranging from the lower 3% range to those exceeding 6%. Effective asphalt is the "non-absorbed" asphalt (i.e. the asphalt not absorbed into the aggregate) that is free to bind the aggregate structure together. This range of allowable P_{be} is primarily due to the high Voids in Mineral Aggregate (VMA) contents of these mixtures and the significant draindown problems encountered when designing these mixes.

The high VMA (20-25%) creates a large "surge reservoir" in the aggregate structure that allows a high P_{be} without major negative impacts to the stability of the mix. At the other extreme, the strong aggregate structure appears to allow mixes to be constructed with relatively low P_{be} and still perform adequately, at least initially.

The original laboratory design philosophy was to put as much asphalt into the mix as possible until significant draindown appeared in the laboratory-fabricated samples. Lower viscosity asphalts would inherently have lower design asphalt contents because the asphalt tended to run off the aggregate more readily. Higher viscosity asphalts led to laboratory designs that had significantly higher asphalt contents. In some instances these high asphalt content designs led to

significant draindown problems during construction or resulted in mixes with greatly reduced permeability.

Once designed in the laboratory it was still essential to have an expert at the construction site to adjust the asphalt content based on any draindown issues encountered in the field. During mix production and placement, draindown was usually dealt with by lowering plant temperature, by lowering asphalt content or both. While this strategy may have mitigated the constructability issue of draindown, it also may have sacrificed long-term durability. The experts were more apt to lower the asphalt content if a draindown problem existed than to raise the asphalt content if no draindown problem existed.

In the mid 1990's a volumetric criteria was placed on Voids Filled with Asphalt (VFA) to try to modulate the extremes in design asphalt contents for open-graded mixes. The 40 to 50% VFA criteria significantly reduced the occurrence of draindown problems during construction and helped to reduce the range of P_{be} to approximately 4 to 5%. However, this 4 to 5% range of P_{be} can still be considered significant and heuristically most designers would expect a 5% P_{be} to outperform the same aggregate gradation with a 4% P_{be}. Because the vast majority of the open-graded mixes in Oregon have not reached the end of their design lives, the nuances of their failure mechanisms are not fully understood. Therefore, the "more is better" design philosophy, within the VFA limits, is the current state of the practice. With greater training, the field experts are also now more willing to consider increasing the asphalt content if draindown is not an issue in construction.

In an attempt to refine the process, an initial reaction might be to tighten the VFA range. However, VFA is a linear function of VMA and a "one size fits all" approach to VFA would lead to different P_{be} as VMA varied. A better tool would be to identify the optimum volume of asphalt needed to bind a given volume of aggregate together, then assure that the design has adequate VMA to accommodate both the volume of asphalt and the volume of void space desired for permeability.

If a simple field measure of asphalt volume were available, it could be used as a tool by the field decision maker to assure that the optimum mix is being produced. One potential tool is to utilize existing techniques to determine average film thickness of asphalt on aggregates and then apply an average film thickness criteria to both mix design and field production. Another technique, as proposed by the authors, utilizes a measure of the aggregate volume and effective asphalt cement volume as a means of quantifying a fundamental volumetric ratio of the mix, the Volume Increase Ratio (VIR). This method can also lead to establishing objective criteria for mix design and production. This project tests the viability of using these two techniques for field verification of open-graded HMAC mixes. The results are reported in the following chapters.

1.3 OBJECTIVES

The overall objective of the research was to prove or disprove the hypotheses that film thickness or P_{be} can be used to make field adjustments for open-graded HMAC mixes. Specific tasks included:

1. Review literature for information on film thickness related to open-graded HMAC mixes.

2. Select actual to-be-constructed projects for data collection and evaluation. (Approximately 6 projects in fiscal year 2001).

3. Evaluate existing as-constructed open-graded HMAC projects for effective asphalt content, both mix designs and construction quality control data.

4. Collect field samples from previous open-graded HMAC projects if available.

5. Perform laboratory testing including maximum specific gravity of mixes and aggregate specific gravities of cold feed materials to calculate film thickness and volume increase ratio.

6. Determine and analyze film thickness data for all new and existing projects to determine relevance to field control of open-graded HMAC mixes. Evaluate use of film thickness method and proposed VIR method.

7. Develop recommendations for implementation.

This literature review is contained in Chapter 2. Chapter 3 contains the evaluation of 19 existing projects as reported by Dunn et.al. (*1998*) and development of the VIR. Chapter 4 includes an evaluation of the data gathered during the 2001 construction season and Chapter 5 contains the conclusions and recommendations.

2.0 LITERATURE REVIEW

A review was conducted of the literature relating to studies of film thickness in porous asphalt pavements. In general, several studies acknowledge the importance of film thickness, however, there was little in the way of specific studies on quantifying or specifying film thicknesses for open-graded mixtures. A review was also made of studies of film thickness related to dense-graded asphalt mixtures. Because of the higher porosity of open-graded mixtures, it would be anticipated that film thicknesses should not be lower than those generally specified for dense-graded mixtures. There is a significant body of work on film thickness as it relates to quantifying and specifying film thickness for dense-graded mixtures.

2.1 FILM THICKNESS RELATED TO OPEN-GRADED MIXES

Increased film thickness or increased asphalt content are mentioned in several studies as providing greater resistance to aging and or raveling in porous pavements. This general belief that "more is better" is then tempered with discussions on asphalt draindown, which becomes the limiting factor during actual construction of the pavement.

2.1.1 Relationship of Film Thickness to Pavement Performance

Increased asphalt contents (i.e. increased film thicknesses) will improve resistance to aging, but is limited by draindown (*Younger et al 1994*). Excess asphalt (i.e. high film thicknesses) and/or fine mixes contribute to fat spots and rutting (*Dunn et al 1998*). Open-graded mixtures typically fail by raveling due to asphalt binder aging and subsequent embrittlement (*Huber 2000*). Oxidation and hardening of the asphalt cement due to thin film thickness and air and water movement through the voids has caused early failure of the surface by raveling (*Smith 1992*). For open mixtures, resistance to hardening can be achieved by increasing the thickness of the asphalt coating on the aggregate pieces (*Kumar and Goetz 1977*).

2.1.2 Film Thickness Design Requirements

An Open Graded Friction Course (OGFC), another name for open-graded HMAC, has a higher asphalt content than a dense-graded mix and uses an equal or harder grade of asphalt. An OGFC requires a 8 – 11 micron average film thickness (*FHWA 1990*). ODOT is the only U.S. agency that has a volumetric requirement in its design process and specifies voids filled with asphalt (VFA) of 40 to 50% (*Huber 2000*).

2.2 FILM THICKNESS RELATED TO DENSE-GRADED MIXES

Various studies dating back to the 1950's have attempted to establish appropriate film thicknesses for dense-graded mixes. Conclusions of the studies include:

- An average film thickness of 6 – 8 microns is recommended for dense mixtures (*Campen et al 1959*).
- A more recent study involving the Strategic Highway Research Project short and long-term aging process has led to a recommendation of 8 microns for mixtures with 4 – 5% air voids (*Kandhal et al 1998*).
- A dense-graded mixture requires a 4 – 6 micron average film thickness (*FHWA 1990*).

Film thicknesses are typically calculated based on P_{be} and the surface area of aggregates as determined from the aggregate gradation and surface area factors (*Asphalt Institute 1993*). Table 2.1 provides the surface area factors for the various sieve sizes.

Table 2.1: Surface Area Factors

Sieve	Surface Area Factor
4.75 mm	0.41
2.36 mm	0.82
1.18 mm	1.64
600 µm	2.87
300 µm	6.14
150 µm	12.29
75 µm	32.77

3.0 EVALUATION OF EXISTING PROJECTS

This chapter contains an evaluation of the volumetric data of 19 projects listed in ODOT Research Report, "Establishment of QC/QA Procedures For Open-Graded Mixes", as reported by Dunn et.al. (*1998*). The evaluation was based on the mix designs, statistical acceptance reports and field coring data contained in that report and/or obtained from ODOT. Also included is a discussion and evaluation of potential relationships between volumetric properties and performance for the 19 projects.

3.1 DETERMINATION OF MATERIAL PROPERTIES

Film thickness calculations are based on two inputs; the volume of effective asphalt and an estimate of surface area of the aggregate. ODOT did not routinely measure effective asphalt contents during mix production, therefore production effective asphalt contents were estimated for this study based on the mix design properties.

Additionally, while actual mean values for the gradations of each project were available from the statistical acceptance reports, ODOT does not specify the same sieve series as is used in the most common form of the film thickness calculation. For this analysis, estimates were made as to the percent passing on the various intermediate sieves that are required for the surface area calculations.

Maximum specific gravity (G_{mm} or Rice) testing and asphalt content testing were performed on the cored materials. The cores were not randomly sampled and often times represented distressed areas of unknown severity. The gradation results from cored materials were consistently finer than both the mix design and the production quality control tests. This finer gradation had a significant impact on the surface area of the aggregates and subsequent calculations of film thickness.

While some breakdown of the aggregate is expected in the drum, the gradation changes observed in the cores greatly exceeded what would normally be attributed to the action of the drum. Other sources of the gradation change may be migration of fines due to draindown, external debris that has entered the interconnected void system of the mix, raveling and breakdown of the surface due to the action of studded tires, or generation of fines during coring and subsequent transport into the mix by the cooling water of the coring apparatus.

In several instances, comparisons of the mix design effective specific gravity of the aggregate (G_{se}) and the G_{se} obtained from cored samples indicated significant differences. These may be attributed to either differences in the maximum specific gravity testing or the asphalt content testing. In either case, differences in G_{se} have a significant impact on the calculation of P_{be} and subsequent calculations on film thickness.

3.2 ESTIMATING EFFECTIVE ASPHALT CONTENTS

P_{be} are a function of G_{se}, which in turn is a function of G_{mm}. G_{se} is a particularly powerful tool because it is essentially independent of asphalt content. Hence, once G_{se} is established for a mixture then P_{be} can be reasonably estimated for in-place material based on the total mean asphalt content (P_b) as reported in the statistical acceptance data for a project.

The development of an open-graded mix design generally entails fabricating samples at three to five different known asphalt contents. Historically, G_{mm} and bulk specific gravities (G_{mb}) are measured at each of the different asphalt contents and reported on the mix design.

Also required are the aggregate specific gravity (G_{sb}) for the design gradation and the liquid asphalt specific gravity (G_b), however, these values were not routinely reported on the mix design until the mid 1990's. Fortunately for those designs that lacked the necessary information, G_{sb} could be obtained from ODOT's central laboratory databases. Because the calculations are relatively insensitive to G_b, an assumed value of 1.020 was used in cases where it was not otherwise available.

The first step in this process was to establish a reasonable value for G_{se}. G_{se} was calculated for each known asphalt content and G_{mm} reported in the mix design. While in theory they should be the same, in most cases they varied to some degree due to minor testing errors or round off of significant digits. There was a particularly noticeable change in G_{se} at the higher asphalt contents. Most likely this can be attributed to the draindown and subsequent loss of oil from the test specimen when preparing the G_{mm} sample.

The resultant G_{se} were evaluated and those that appeared to be representative of the mixture were averaged to come up with a final mix design value of G_{se}. In addition, because G_{mm} data was not available from actual mix production, the same design G_{se} was also used in calculating P_{be} for in-place material.

Having established a design G_{se}, the next step is to adjust the mix design volumetrics to the design G_{se}. This is a standard practice now used in the ODOT mix design process. It involves using G_{se} to calculate a new G_{mm} for each design point and computing the volumetrics based on these adjusted G_{mm}. The same process was applied to the in-place material using the mean value asphalt content as reported in the statistical acceptance data. The result was that P_{be} could now be calculated for both the adjusted mix design and for the in-place material.

3.3 ESTIMATING AGGREGATE GRADATIONS

Standard surface area sieves versus historical ODOT mix design sieves are listed in Table 3.1.

Table 3.1: Surface Area Sieves vs. ODOT Sieves

Sieves w/Surface Area Factors	Sieves Used by ODOT for Mix Design
Maximum	25 mm
-	19 mm
-	12.5 mm
-	9.5 mm
-	6.3 mm
4.75 mm	-
2.36 mm	-
-	2.0 mm
1.18 mm	-
600 μm	-
-	425 μm
300 μm	-
150 μm	-
75 μm	75 μm

The inconsistency between the two sieve sets necessitated providing either an estimate of surface area for the ODOT sieves or an estimate of percent passing for the Surface Area sieves. The latter alternative was chosen and determined by applying a 0.45 power gradation chart. The 0.45 power gradation chart is an accepted standard graph used in HMAC analysis for plotting and evaluating aggregate gradations. The percent passing for each of the ODOT sieves was plotted on the graph. The percent passing for the sieves necessary to calculate the surface area were then interpolated from each graph generated from the ODOT sieves. All estimates were made to the nearest whole number.

3.4 ESTIMATED FILM THICKNESS ON EXISTING PROJECTS

Using the estimates of P_{be} and aggregate gradation, film thicknesses were calculated according to accepted procedures (*Asphalt Institute 1993*) for each of the projects:

Table 3.2: Film Thickness on Existing Projects

Hwy No.	Name	Year	Asphalt Grade	Design Film Thickness, μm	In-Place Film Thickness, μm
001	Hayesville- Battle Creek	1990	AC-30(tbl II)	13.95	14.41
001	W. Marquam – N. Tigard	1990	AC-30(tbl II)	13.44	12.90
004	Forge Rd. Lobert Rd.	1990	AC-20R	14.66	15.26
001	Jumpoff Joe – N. Grants Pass	1991	PBA-5	13.03	13.67
002	Corbett – Multnomah Falls	1991	PBA-5	16.61	17.57
002	Rufus – Arlington (E. Unit)	1991	PBA-5	13.06	12.62
004	Williamson Riv. – Modoc Pt.	1991	AC-20R	14.55	16.80
006	Baldock Slough – S. Baker	1991	AC-20R	18.16	15.92
006	E. Pendleton – Emigrant Hill	1992	PBA-6	21.23	25.34
002	Rufus – Arlington (W. Unit)	1993	PBA-6	23.60	24.77
002	Umatilla – McNary	1993	PBA-6	21.85	23.59
047	Wolf Cr. – W. Fk. Dairy Cr.	1993	PBA-5	20.31	20.90
001	Azalea – Jumpoff Joe	1994	PBA-6	17.49	18.90
001	Halsey – Lane Co. Line (SB)	1994	PBA-6	18.00	17.67
001	Halsey – Lane Co. Line (NB)	1994	PBA-6	16.66	17.43
144	Sunset Hwy – Pacific Hwy	1994	PBA-6	21.18	19.29
004	Willowdale – Qualle Rd.	1995	PBA-6	19.93	16.99
026	Mt. Hood – Long Prairie	1995	PBA-6	22.74	23.08
041	Prineville – Powell Butte	1995	PBA-6	19.09	20.99

Standard specifications for asphalt materials are included in Appendix A. Detailed film thickness calculations are included in Appendix B.

Using average film thickness to evaluate typical Oregon open-graded HMAC has two major shortcomings. The first is that "Surface Area Factors" are universal and do not account for variation in particle shape. That is to say, the same surface area factor is used for round particles as well as flat or elongated particles. On a mass percent passing basis, these different shapes may have significantly different surface areas.

The other shortcoming of this procedure is that the largest surface area factors are applied to the finest sieves with the largest contribution to surface area (approximately 40% of the surface area) coming from the material passing the 75 μm sieve (P75 μm). Oregon's open-graded mixes have low targets for P75 μm, typically in the 2 to 5% range. Allowable production ranges for P75 μm are of a similar order of magnitude. Therefore, normal variations in P75 μm cause wide swings in average film thickness due to its large surface area factor.

3.5 VOLUME INCREASE RATIO

A different way to look at film thickness is to recognize that as asphalt coating increases, so should the volume per unit mass of the mixture. If this volume change can be accurately quantified then a less subjective measure of film thickness may be obtained.

Such a measure can be calculated using currently established test methods; the specific gravity test for bituminous materials (*AASHTO T228, 2001*), the aggregate specific gravity tests (*AASHTO T84 and T85, 2001*), and the "Rice" test (*AASHTO T209, 2001*). The aggregate specific gravity tests give us the aggregate contribution to mixture volume and the Rice test gives us the mixture volume. The difference in the two will be the "non-absorbed" asphalt contribution to mixture volume.

The relationship between the specific gravity of the mixture and the specific gravities of the constituents of the mix (effective aggregate and asphalt liquid) is given as follows[1]:

$$\frac{100}{G_{mm}} = \frac{P_s}{G_{se}} + \frac{P_b}{G_b} \qquad \textbf{(3-1)}$$

P_s is the percentage of the mix by mass that is aggregate. The first term on the right hand side of Equation 3-1 represents the effective aggregate contribution to mixture specific gravity and the second term represents the liquid asphalt contribution. What is desired is the "bulk" volume of aggregate and the "non-absorbed" volume of asphalt.

The liquid asphalt contribution is a combination of "absorbed" and "non-absorbed" materials. Only the "non-absorbed" asphalt will contribute to an increase in film thickness. The relationship between "absorbed" and "non-absorbed" asphalt is as follows[2]:

$$\frac{P_{ba}}{100} = \frac{P_b}{P_s} - \frac{P_{be}}{P_s} \qquad \textbf{(3-2)}$$

P_{ba} is the percent by mass of asphalt binder that is absorbed into the aggregate and is unavailable to bind aggregate together. The relationship between "absorbed" asphalt and aggregate specific gravity is also known and is as follows[3]:

$$\frac{P_{ba}}{100} = \frac{G_b}{G_{sb}} - \frac{G_b}{G_{se}} \qquad \textbf{(3-3)}$$

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[1] Asphalt Institute. "Manual Series No. 2 (MS-2)" Sixth Edition. Article 4.07, Eq. (3)
[2] Asphalt Institute. "Manual Series No. 2 (MS-2)" Sixth Edition. Article 4.09, Eq. (5)
[3] Asphalt Institute. "Manual Series No. 2 (MS-2)" Sixth Edition. Article 4.08, Eq. (4)

Equating Equations 3-2 and 3-3 results in the following:

$$\frac{P_b}{G_b} = \frac{P_{be}}{G_b} + \frac{P_s}{G_{sb}} - \frac{P_s}{G_{se}} \quad \textbf{(3-4)}$$

The first term on the right hand side of Equation 3-4 represents the contribution of "non-absorbed" asphalt to the liquid asphalt portion of mixture specific gravity. The second and third terms represent the "absorbed" asphalt contribution.

Substituting Equation 3-4 into Equation 3-1:

$$\frac{100}{G_{mm}} = \frac{P_s}{G_{sb}} + \frac{P_{be}}{G_b} \quad \textbf{(3-5)}$$

Equation 3-5 now establishes the desired relationship between the "bulk" volume of aggregate per unit mass and the volume of "non-absorbed" asphalt per unit mass. The Volume Increase Ratio (VIR) of these two terms represents the increase in volume of the mixture due to the "non-absorbed" asphalt coating.

$$\textit{Volume Increase Ratio (VIR)} = \frac{(P_{be}/G_b)}{(P_s/G_{sb})} \quad \textbf{(3-6)}$$

When multiplied by 100, the VIR becomes a percentage increase with the "bulk" aggregate volume as the basis.

This simple ratio gives a dimensionless measure of how the mixture volume is changing as the asphalt liquid is added to the uncoated aggregate. The measure is determined from known laboratory measurements and not from "assumed" surface area factors. It does not require gradation inputs and therefore is insensitive to minor swings in the P75 μm.

3.6 VOLUME INCREASE RATIO (VIR) ON EXISTING PROJECTS

Using the estimates of P_s and P_{be} and design values for G_b and G_{sb} from the mix designs, the VIR were calculated for each of the projects:

Table 3.3: Volume Increase Ratio on Existing Projects

Hwy No.	Name	Year	Asphalt Grade	Design Volume Increase, %	In-Place Volume Increase, %
001	Hayesville- Battle Creek	1990	AC-30(tbl II)	12.78	12.78
001	W. Marquam – N. Tigard	1990	AC-30(tbl II)	11.59	11.77
004	Forge Rd. Lobert Rd.	1990	AC-20R	12.82	12.42
001	Jumpoff Joe – N. Grants Pass	1991	PBA-5	10.93	10.78
002	Corbett – Multnomah Falls	1991	PBA-5	11.78	11.55
002	Rufus – Arlington (E. Unit)	1991	PBA-5	9.58	9.58
004	Williamson Riv. – Modoc Pt.	1991	AC-20R	11.89	11.63
006	Baldock Slough – S. Baker	1991	AC-20R	12.59	12.45
006	E. Pendleton – Emigrant Hill	1992	PBA-6	15.93	17.32
002	Rufus – Arlington (W. Unit)	1993	PBA-6	15.67	15.60
002	Umatilla - McNary	1993	PBA-6	16.66	16.94
047	Wolf Cr. – W. Fk. Dairy Cr.	1993	PBA-5	14.69	14.69
001	Azalea – Jumpoff Joe	1994	PBA-6	14.92	14.79
001	Halsey – Lane Co. Line (SB)	1994	PBA-6	15.46	15.46
001	Halsey – Lane Co. Line (NB)	1994	PBA-6	14.31	14.31
144	Sunset Hwy – Pacific Hwy	1994	PBA-6	14.65	13.47
004	Willowdale – Qualle Rd.	1995	PBA-6	13.71	12.90
026	Mt. Hood – Long Prairie	1995	PBA-6	14.82	14.73
041	Prineville – Powell Butte	1995	PBA-6	13.38	13.38

Detailed volume increase results are contained in Appendix C.

3.7 POTENTIAL RELATIONSHIPS TO PERFORMANCE

The ODOT Pavement Management database was queried to obtain performance data for the 19 projects. A detailed distress survey of ODOT highways designated on the National Highway System (NHS) is completed every two years. Indexes for fatigue cracking, rutting, patching, longitudinal cracking, transverse cracking, block cracking, raveling, and bleeding are calculated and reported for each section of highway. The index for each distress type quantifies the amount and severity of the distress. An "Overall Condition Index" combining all distress factors is calculated and reported for each section of highway. This index is reported on a scale of 0 to 100, with 100 representing a pavement in excellent condition, and other ratings as defined in Table 3.4. The rating system includes the same evaluation processes and condition definitions for open-graded and dense-graded HMAC.

Table 3.4: Condition Index Descriptions

Overall Condition Index	Description
98.1 – 100.0	Very Good
75.1 – 98.0	Good
45.1 – 75.0	Fair
10.1 – 45.0	Poor
0.0 – 10.0	Very Poor

Table 3.5 indicates the project age, condition index in 2001, and the condition index for each project at 6 years of age. Using six-year performance data allowed a common comparison point for all 19 projects. Attempts were made to correlate individual indexes to performance, but the results were no better than comparing the overall condition indexes.

Table 3.5: Pavement Condition

Hwy#	Project Name	Quality Control (QC)			Binder Grade	Age (2001)	Overall Condition Index (2001)	Overall Condition Index @ Age 6
		P_b	Film Thkn	VIR				
1	Hayesville - Battle Creek	5.50	14.41	12.78	AC-30(Tbl II)	11	61.9	73.2
1	W. Marquam - N. Tigard	5.26	12.90	11.77	AC-30(Tbl II)	11	49.8	61.5
4	Forge Rd. - Lobert Rd.	5.86	15.26	12.42	AC-20R	11	80.3	83.1
1	Jumpoff Joe - N. Grants Pass	4.95	13.67	10.78	PBA-5	10	87.9	85.2
2	Corbett Intch. - Multnomah Falls	5.42	17.57	11.55	PBA-5	10	54.2	81.2
2	Rufus - Arlington(E. Unit)	5.30	12.62	9.58	PBA-5	10	76.6	89.0
4	Williamson River - Modoc Point	5.11	16.80	11.63	AC-20R	10	70.0	75.1
6	Baldock Slough - S. Baker Intch.	5.45	15.92	12.45	AC-20R	10	90.6	84.4
6	E. Pendleton - Emigrant Hill	6.46	25.34	17.32	PBA-6	9	80.8	81.8
2	Rufus - Arlington(W. Unit)	5.78	24.77	15.60	PBA-6	8	94.8	94.8
2	Umatilla - McNary	6.29	23.59	16.94	PBA-6	8	85.5	85.5
47	Wolf Cr. - W. Fk. Dairy Cr.	6.00	20.90	14.69	PBA-5	8	91.6	91.6
1	Azalea - Jumpoff Joe	5.56	18.90	14.79	PBA-6	7	92.7	92.7
1	Halsey Intch. - Lane Co. Ln.(SB)	6.00	17.67	15.46	PBA-6	7	87.0	87.0
1	Halsey Intch. - Lane Co. Ln.(NB)	5.80	17.43	14.31	PBA-6	7	94.6	94.6
144	Sunset Hwy - Pacific Hwy	5.20	19.29	13.47	PBA-6	7	73.4	73.4
4	Willowdale - Qualle Rd.	5.22	16.99	12.90	PBA-6	6	97.9	97.9
26	Mt. Hood - Long Prairie	5.97	23.08	14.73	PBA-6	6	80.1	80.1
41	Prineville Airport - Powell Butte	5.20	20.99	13.38	PBA-6	6	95.1	95.1

Plots of overall condition index at age 6 and film thickness and VIR respectively were generated in an effort to establish if a correlation existed between either mix property and performance at the same baseline age. The plots, including a best fit curve and corresponding R^2 value are presented in Figures 3.1 and 3.2.

The R^2 values are very low, indicating poor correlation of either property with the overall condition index as calculated by the ODOT Pavement Management System. Analysis of the correlation to performance data is inconclusive.

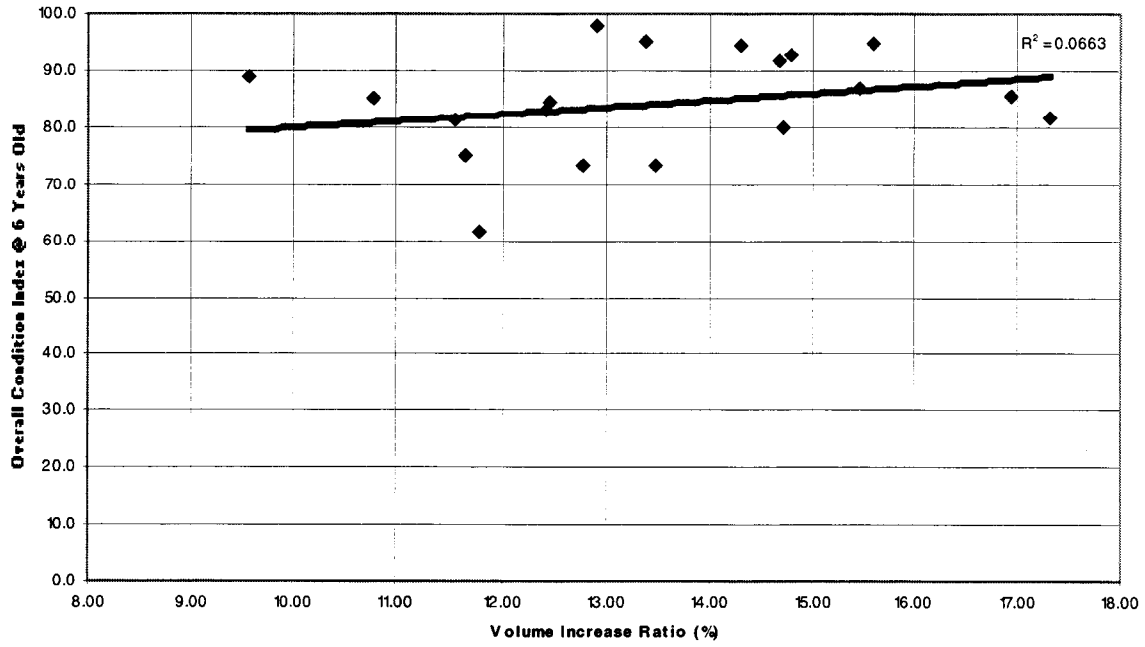

Figure 3.1: Overall Condition Index @ 6 Years Old vs. Volume Increase Ratio

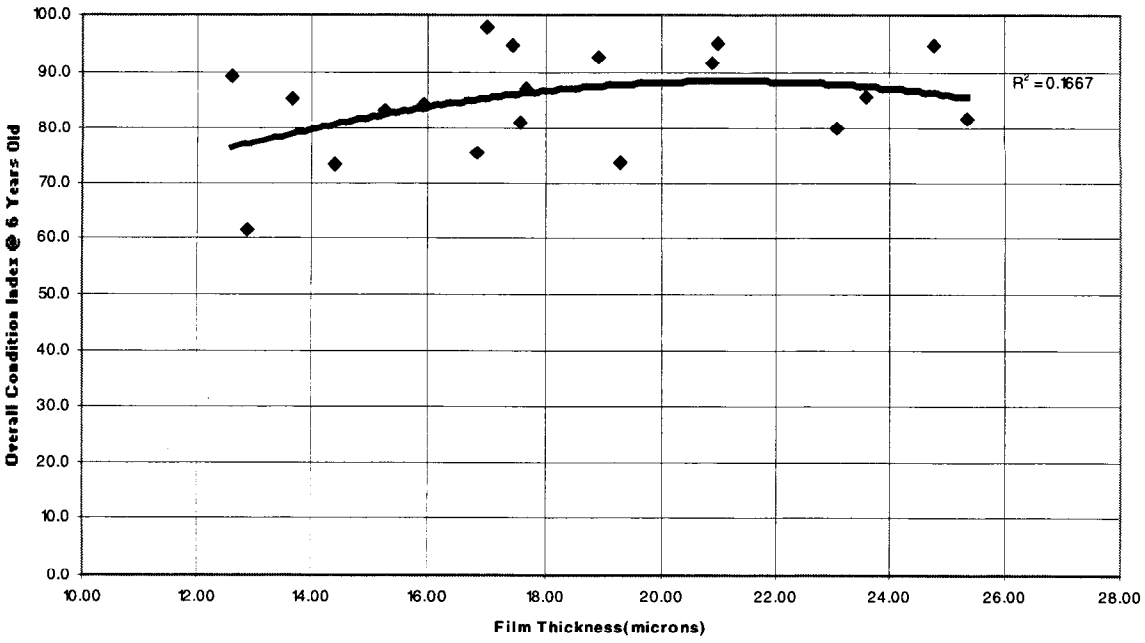

Figure 3.2: Overall Condition Index @ 6 Years Old vs. Film Thickness

Review of the data in Table 3.5 also suggests that there may be some relationship between binder grade and film thickness and VIR. A summary is presented in Table 3.6.

Table 3.6: Binder Grade, Film Thickness and VIR Relationship

Binder	VIR (%)		Film Thickness (μm)	
	Average	Standard Deviation	Average	Standard Deviation
PBA-6	14.9	1.5	20.8	3.2
PBA-5	11.7	2.2	16.2	3.8
AC-30(tbl II)	12.3	0.7	13.7	1.1
AC-20R	12.2	0.5	16.0	0.8

Table 3.6 shows that PBA-6 provides substantially better VIR and film thickness relative to the other binders. PBA-6 is typically polymer modified and is generally more viscous at higher temperatures than the other grades, thus it is more likely to result in thicker films and less likely to draindown during production than the non-modified binders. A change in open-graded HMAC mix design methodology occurred in 1992 that resulted in higher recommended binder contents relative to mixes designed prior to 1992. All of the projects with PBA-6 occurred on or after 1992, and all but one of the projects with other binders occurred prior to 1992. The changes in mix design methodology may have also contributed to the higher VIR noted for projects with PBA-6.

3.8 SELECTION OF TRIAL VIR CRITERIA

The available project data did not identify a specification criteria for volume increase. In a general sense, the poorest performing open-graded surfaced pavements (Overall Condition Index @ Year 6 ≤ 75.1) all occurred at VIR less than 13.5%. None of the projects with a VIR greater than 14% had an Overall Condition Index less than 80. This data suggests that a minimum VIR of 14% may be a reasonable starting point for future evaluations.

One way to develop a VIR criteria is to compare VIR values with current mix design criteria for projects using PBA-6 binder. The PBA-6 binder seems to provide a better VIR and film thickness relative to the non-modified binders as discussed above. The only current volumetric criteria for open-graded HMAC in Oregon is 40 to 50% Voids Filled with Asphalt (VFA), which is based on having a Voids in Mineral Aggregates measure typically in the 20 - 25% range. This range of VFA attempts to achieve a minimum asphalt content on the low end, but preclude localized "fat spots" at the high end.

Six of the ten projects incorporating PBA-6 generally met the current criteria for 40 to 50% VFA. Three of the remaining four PBA-6 projects exceeded the 50% VFA criteria and one didn't meet the minimum 40% VFA criteria.

The six projects that met the VFA criteria had an average design P_b of 5.6% and an average VIR of 14.3%. This data along with the general trends from performance data discussed above suggest a minimum VIR criteria of 14.0% is appropriate. The three projects that exceeded the

VFA criteria all were in excess of 15.5% VIR, suggesting this value to be an appropriate maximum VIR criteria. The authors recognize the proposed minimum and maximum VIR criteria are based on very limited mixture and performance data, but feel they are appropriate initial values to consider for future work with the VIR concept.

4.0 TESTING OF FIELD MIXES

4.1 FIELD SAMPLES

Field samples of construction materials were obtained from two projects during the 2001 construction season. The purpose of the field testing was to evaluate the sensitivity of film thickness and VIR to changes in mix constituents and to evaluate the practicality of performing the required testing in a field environment.

The samples included coldfeed aggregate samples and HMAC mixture samples. These materials were tested at the ODOT Central Laboratory in Salem. The projects were as follows:

- C12322 – Shogren – Rowena, Phase 2 & W. Mayer State Park – Rowena
- C12511 – Nesika Beach – Rogue River

4.2 LABORATORY TESTING

An incinerator calibration factor was determined for each mixture using the calibration procedure in ODOT TM 323 (*2001*). A portion of each HMAC mixture was then incinerated per AASHTO T 308 (*2001*) and the residue was graded per AASHTO T 30 (*2001*). A separate portion of each mixture was tested per AASHTO T 209 (*2001*) to determine the maximum specific gravity of the mix.

The results were combined with the mix design values for asphalt specific gravity, G_b and combined aggregate bulk specific gravity, G_{sb} to determine the necessary volumetrics.

4.2.1 Shogren – Rowena, C12322

This project involved construction of a 19.0 mm open-graded mix with lime and a PBA-6 binder. The job mix formula (JMF) and project quality control (QC) statistics are included in Appendix D. The JMF and QC results produced the following:

Table 4.1: Shogren – Rowena, C12322 – JMF and QC Results

	JMF	QC
Asphalt Content, P_b	5.30	5.35
% Passing 75 μm Sieve	3.40	3.14
Film Thickness, μm	17.89	18.72
Volume Increase Ratio, %	13.08	13.23

It should be noted that the in-place results are based on the calculated G_{mm} value given the design G_{se} and the mean asphalt content percentage from project data.

Material samples from the project were tested at the ODOT Central Laboratory with the following results:

Table 4.2: Shogren – Rowena, C12322 – Individual Sample Results

	QC 1-2	QC 1-12	QC 1-23
Asphalt Content, P_b	5.34	4.93	5.57
% Passing 75 µm Sieve	3.6	3.0	3.9
Film Thickness, µm	14.84	14.96	15.69
Volume Increase Ratio, %	13.00	11.89	14.29

Details of the film thickness calculations are included in Appendix E and volume increase calculations are included in Appendix F.

4.2.2 Nesika Beach – Rogue River, C12511

This project involved construction of a 19.0 mm open-graded mix with a PG64-22 binder. The project JMF and QC results are included in Appendix D. The JMF and QC results produced the following:

Table 4.3: Nesika Beach – Rogue River, C12511 – JMF and QC Results

	JMF	QC
Asphalt Content, P_b	5.80	5.80
% Passing 75 µm Sieve	2.60	2.13
Film Thickness, µm	17.89	18.72
Volume Increase Ratio, %	13.67	13.67

It should be noted that the in-place results are based on the calculated G_{mm} value given the design G_{se} and the statspec mean asphalt content percentage.

Material samples from the project were tested at the ODOT Central Laboratory with the following results:

Table 4.4: Nesika Beach – Rogue River, C12511 – Individual Sample Results

	QC 1-8	QC 1-13	QC 1-14
Asphalt Content, P_b	6.58	5.60	5.53
% Passing 75 µm Sieve	2.2	1.8	1.7
Film Thickness, µm	20.04	21.63	22.16
Volume Increase Ratio, %	15.01	12.21	12.37

Details of the film thickness calculations are included in Appendix E and volume increase calculations are included in Appendix F.

4.3 ANALYSIS OF FIELD RESULTS

4.3.1 Evaluation of Film Thickness

The field results for both projects show an excessive sensitivity to the P75 μm in the film thickness calculation. In both projects relatively minor changes in P75 μm had a greater impact on the average film thickness than relatively large variations in asphalt content.

As an example, on the Nesika Beach project there was essentially a 1% drop in asphalt content between QC 1-8 and QC 1-13. This is double the normal production tolerance of ±0.5% and would be considered a significant change in asphalt content. Intuitively, it would have been expected that the film thickness for the mix would also have dropped precipitously. In fact the average film thickness went up from 20.04 μm to 21.63 μm. This increase was primarily due to what would be considered an almost insignificant change in P75 μm from 2.2% to 1.8%.

This excessive sensitivity to a non-critical constituent of the mix precludes the use of average film thickness as a practical tool for field control of open-graded mixes.

4.3.2 Evaluation of Volume Increase Ratio (VIR)

In general, volume increase ratios did a much better job of quantifying changes to the mix that could be intuitively tied to changes in the critical constituents, particularly asphalt content. The same change in asphalt content on the Nesika Beach project as noted above resulted in a drop in VIR from 15.01% to 12.21%. This change in VIR is consistent with what would be expected under these circumstances.

The VIR measurement was also able to discern other changes in the mixture beyond change in total asphalt content. Again referring to the Nesika Beach project, the total asphalt content dropped slightly from 5.60% to 5.53% between QC 1-13 and QC 1-14. At first glance, it might be expected that VIR should also have dropped, but in fact, VIR went up slightly from 12.21% to 12.37%. On closer examination of the QC data it is noted that the gradation became measurably coarser on the upper sieves on sublot QC 1-14. As the gradation becomes coarser it would be reasonable to expect the absorption to decrease. However, overall absorption dropped by 0.13% (meaning P_{be} increased and more free oil was available to coat the aggregate). The change in absorption offset any drop in total asphalt and resulted in the slight increase in VIR between QC 1-13 and QC 1-14.

VIR is also a function of G_{sb} and therefore, will be sensitive to changes in aggregate specific gravity. While no changes in aggregate specific gravity were observed on these two projects, it is anticipated that when such a change does occur the resulting VIR will change accordingly.

The ability of VIR to correctly track changes in total asphalt content as well as detect changes in absorption and/or aggregate specific gravity makes it a practical tool for controlling the quality of open-graded mixes.

The authors note that the mix design for neither project fell within the VIR criteria suggested in Section 3.8 and only one of the three field samples from each project met the criteria. The VIR concept was developed after the project mix designs and field testing was completed, so no attempt was made to adjust either mixture to meet the proposed VIR criteria.

4.4 FIELD TESTING CONSIDERATIONS

All of the test procedures to be used for VIR analysis are readily applicable to field testing. All contractor QC and ODOT quality assurance (QA) laboratories and technicians are currently equipped and certified to perform tests required for VIR analysis, including:

- AASHTO T 85 (*2001*) (Specific Gravity of Coarse Aggregates)
- ODOT TM 323 (*2001*) (Determination of Calibration Factors for the Ignition Method)
- AASHTO T 308 (*2001*) (Determining Binder Content of HMA by the Ignition Method)
- AASHTO T 30 (*2001*) (Sieve Analysis of Extracted Aggregates)
- AASHTO T 209 (*2001*) (Maximum Specific Gravity of HMA Mixtures)

No new or special equipment would be required, which makes VIR very attractive as a QC/QA tool for open-graded HMAC.

The biggest obstacle to using VIR as a quality control or assurance tool is obtaining representative and consistent samples. ODOT typically obtains HMAC samples at the discharge of the plant with a mechanical sampling device. The material is transferred via cardboard boxes or stainless steel bowls to a laboratory for splitting and testing. Open-graded mixtures can have a substantial amount of draindown of binder during the transfer of the mix from the plant to the splitting tray. The binder may soak into the cardboard box or coat the steel bowls and not end up in the tested sample. In some cases, the technician may scrape most of the binder from the bowls, but it ends up as globs on top of the sample, and is difficult to evenly distribute through the sample. These difficulties can lead to substantial variability in binder content and maximum specific gravity test results, and ultimately, VIR.

The bulk of the variability in binder content noted in Tables 4.2 and 4.4 can likely be attributed to sampling and splitting issues. Any future work with VIR will need to address procedures for minimizing variability from sampling and splitting of test samples.

5.0 CONCLUSIONS AND RECOMMENDATIONS

5.1 CONCLUSIONS

This research looked at the viability of using film thickness as a field measure of mixture quality for open-graded mixes in Oregon. The results of this research lead to the following conclusions:

1. Due to the low amount of material passing the 75 μm sieve in Oregon's open-graded mixtures and the high sensitivity of the film thickness calculation to material passing the 75 μm sieve, conventional film thickness calculations do not provide a practical tool for field management of open-graded mixtures.

2. An alternative procedure developed by the authors involving Volume Increase Ratio (VIR) measurements offers a practical measure of mixture properties for open-graded mixtures. This procedure is simple and uses readily available testing equipment in field laboratories.

3. There is no strong correlation between either VIR or film thickness and performance of open-graded HMAC based on overall condition index from the ODOT Pavement Management System.

4. PBA-6 provided significantly higher VIR and thicker films than the other binders used on the 18 projects evaluated in this study.

5.2 RECOMMENDATIONS

The findings of this research lead to the following recommendations:

1. The Volume Increase Ratio (VIR) measurements should be incorporated into a field mixture verification process for open-graded mixes on a trial basis.

2. A proposed range for the Volume Increase Ratio (VIR) of 14.0% to 15.5%, for both mix design and production, should be used as the initial criteria.

3. The above proposed criteria for both mix design and production should be reviewed periodically as additional long term pavement performance data becomes available for open-graded mixtures in Oregon.

4. ODOT should explore requiring a modified binder (i.e. PG equivalent of PBA-6) for all open-graded mixtures as a means to consistently meet the recommended minimum VIR.

5. Procedures for minimizing variability in test results due to sampling and splitting problems with open-graded HMAC should be investigated and established to improve confidence and repeatability in VIR determination.

6.0 REFERENCES

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APPENDIX A

STANDARD SPECIFICATIONS
FOR
ASPHALT MATERIALS

ASPHALT CEMENTS

PERFORMANCE BASED ASPHALT GRADES

	Moderate Climate	Cold Climate	Very Cold Climate	Hot Climate	Hot/Cold Climate	Hot/Very Cold Climate
Climatic Guidelines for Selecting the PBA Grade: Lowest recorded air temperature Highest mean monthly air temperature	Above -12°C Below 32°C	above -29°C below 32°C	below -29°C below 32°C	above -23°C above 32°C	above -23°C above 32°C	below -29°C above 32°C

Asphalt Binder Performance Issue	Asphalt Binder Test Method	AASHTO Test Method	PBA-1	PBA-2	PBA-3	PBA-4	PBA-5	PBA-6
Low temperature thermal cracking.	Penetration (4°C), 200g, 60s), dmm RTFO Aged Residue (Note 1)	T-49	---	15+	30+	---	15+	30+
	Penetration (25°C), 100g, 5s), dmm RTFO Aged Residue (Note 1)	T-49	25+	---	---	20+	---	---
	Ductility (7.2°C), 1 cm/min), cm RTFO Aged Residue (Note 2)	T-51	---	10+	---	---	---	---
High ambient temperature mix stability (tenderness, rutting).	Absolute Viscosity (60°C), P (Note 3) Original Binder RTFO Aged Residue	 T-202 T-202	 800+ 2500-5000	 1100+ 2500-6000	 1100+ 3000+	 2800+ 14000-	 2000+ 4000+	 2000+ 5000+
Consistency during construction: - Pumpability, handling - Mix tenderness	Kinematic Viscosity (135°C), cSt Original Binder RTFO Aged Residue	 T-201 T-201	 --- 275+	 --- 275+	 2000- 275+	 --- 350+	 2000- 400+	 2000- 275+
Hardening during the hot mix paving process.	Absolute Viscosity Ratio (60°C) RTFO Viscosity/Original Viscosity		4.0-	4.0-	4.0-	4.0-	4.0-	4.0-
Safe Handling.	Flash Point, Cleveland Open Cup, C Original Binder	T-48	232+	232+	232+	232+	232+	232+
Asphalt Binder Purity.	Solubility in Trichloroethylene, % Original Binder	T-44	99.0+	99.0+	---	99.0+	99.0+ (Note 4)	---
Asphalt Cement Internal Compatibility.	Ductility (25°C, 5 cm/min), cm RTFO Aged Residue	T-51	75+	75+	75+	50+	50+	60+

Note 1. "RTFO Aged Residue" means the asphalt residue obtained using the Rolling Thin Film Oven Test , AASHTO T 240 or ASTM D2872. If material leaves jar during test, the front of the oven may be elevated so that the glass container, when in position in the carriage, is tilted 1.06° (approximately 1 cm rise in 54 cm).

Note 2. Use AASHTO T-51 as modified by Washington DOT (using a special mold release agent and a special method of applying the release agent).

Note 3. The Absolute Viscosity (60°C) of PBA-3, PBA-5 and PBA-6 will be determined at 1 sec^{-1} using ODOT TM 430 (similar to ASTM P159 using Asphalt Institute Vacuum Capillary viscometers).

Note 4. May be waived if polymer modification interferes with test accuracy.

ASPHALT SPECIFICATIONS COMPARISON CHART

		AASHTO TABLE I AC 2.5	AASHTO TABLE II AC 2.5	AR 1000	AASHTO TABLE I AC 5	AASHTO TABLE II AC 5	PBA 1	AASHTO TABLE I AC 10	AASHTO TABLE II AC 10	AR 2000	AR 2000W	PBA 2	AR 4000	AR 4000W
ORIGINAL PROPERTIES														
VIS @ 140 DEGREES F	MIN	200	200		400	400	800	800	800			1100		
VIS @ 140 DEGREES F	MAX	300	300		600	600		1200	1200					
VIS @ 275 DEGREES F	MIN	80	125		110	175		150	250					
PEN @ 39.2 DEGREES F	MIN													
PEN @ 77.0 DEGREES F	MIN	200	220		120	140		70	80					
FLASH (COC)	MIN	325	325		350	350	450	425	425		425	450		440
DUCTILITY @ 77 DEGREES F	MIN													
SOLUBILITY %	MIN	99	99		99	99	99	99	99		99	99		99
AGED RESIDUE PROPERTIES														
VIS @ 140 DEGREES F	MIN			750			2500			1500	1500	2500	3000	2500
VIS @ 140 DEGREES F	MAX	1000	1000	1250	2000	2000	5000	4000	4000	2500	2500	6000	5000	5000
VIS @ 275 DEGREES F	MIN			140			275			200	200	275	275	275
VIS RATIO	MAX						4					4		
PEN @ 39.2 DEGREES F	MIN											15		
PEN @ 77 DEGREES F	MIN			65			25			40	50		25	40
PEN RATIO (% ORIGINAL)	MIN									40	40		45	45
FLASH (PMCT)	MIN			400						425			440	
DUCT @ 45 DEGREES F	MIN										20	10		10
DUCT @ 77 DEGREES F	MIN	100	100	100	100	100	75	50	75	100		75	75	
SOLUBILITY %	MIN			99						99			99	
SPOT TEST		OPT	OPT		OPT	OPT		OPT	OPT					

		AASHTO TABLE I AC 15 (OREGON)	PBA 5	AASHTO TABLE I AC 20	AASHTO TABLE II AC 20	AR 8000	AR 8000W	PBA 4	AASHTO TABLE II AC 30	AASHTO TABLE I AC 40	AASHTO TABLE II AC 40	AR 16000	POLYMER MODIFIED PBA 3	POLYMER MODIFIED PBA 6
ORIGINAL PROPERTIES														
VIS @ 140 DEGREES F	MIN	1200	2000	1600	1600			2800	2400	3200	3200		1100	2000
VIS @ 140 DEGREES F	MAX	1800		2400	2400				3600	4800	4800			
VIS @ 275 DEGREES F	MIN	175	2000 MAX	210	300				350	300	400		2000 MAX	2000 MAX
PEN @ 39.2 DEGREES F	MIN	25												
PEN @ 77.0 DEGREES F	MIN	55		40	60				50	20	40			
FLASH (COC)	MIN	435	450	450	450		450	450	450	450	450		450	450
DUCTILITY @ 77 DEGREES F	MIN													
SOLUBILITY %	MIN	99	99	99	99		99	99	99	99	99			
AGED RESIDUE PROPERTIES														
VIS @ 140 DEGREES F	MIN		4000			6000	6000					12000	3000	5000
VIS @ 140 DEGREES F	MAX	6000		8000	8000	10000	10000	14000	12000	16000	16000	20000		
VIS @ 275 DEGREES F	MIN		400			400	400	350				550	275	275
VIS RATIO	MAX		4					4					4	4
PEN @ 39.2 DEGREES F	MIN		15										30	30
PEN @ 77 DEGREES F	MIN					20	30	20				20		
PEN RATIO (% ORIGINAL)	MIN					50	50					52		
FLASH (PMCT)	MIN					450						460		
DUCT @ 45 DEGREES F	MIN													
DUCT @ 77 DEGREES F	MIN	75	50	20	50	75	75	50	40	10	25	75	75	60
SOLUBILITY %	MIN					99						99		
SPOT TEST				OPT	OPT				OPT	OPT	OPT			

OCT 1991

FHWA SPECIFICATION

G-2

SECTION 702.—BITUMINOUS MATERIALS

702.01 Asphalt Cements. Delete the text under this subsection and substitute the following:

Asphalt cement shall be viscosity Grade AC-20(R) meeting the requirements for rubberized asphalt cement, viscosity graded at 140 F. The rubber additive shall be added at the refinery.

Property	AASHTO No.	Specification MIN.	MAX.
Viscosity @ 140°F., Poises	T-202	1600	2400
Viscosity @ 275°F., CS	T-201	325	
Flash Point, F., COC	T-48	450	
Duct. @ 77°F. (5 cm/min.) cm	T-51	100	
duct. @ 39°F. (5 cm/min.) cm	T-51	50	
Toughness, Inch-Pounds	*	110	
Tenacity, Inch-Pounds	*	75	
Spot Test	T-102	Negative**	
Tests on Residue			
Viscosity @ 140°F., Poises	T-202		8000
Duct. @ 77°F. (5 cm/min.) cm.	T-51	100	
Duct. @ 39.2°F. (5 cm/min.) cm	T-51	25	

* Benson Method of Toughness and Tenacity: Scott tester, inch pounds @ 77°F., 20 inches per minute pull. Tension head seven-eights inch diameter.

** Using 10 percent Xylene.

APPENDIX B

FILM THICKNESS CALCULATIONS FOR EXISTING PROJECTS

		Hayesville - Battle Creek			F-Mix				
		Pile #1	Pile #2	Pile #3	Pile #4	AC	Fly Ash	Total	
% Comb.		80	9	10	0	5.5	1	100	
Sp. Gr.		2.650	2.560	2.560	1.000	1.020	2.270		
							JMF	Adj Gse	QC
Gsb								2.628	
Pb		4.5	5.0	5.5	6.0	6.5	5.5	5.5	5.50
Gmm		2.495	2.483	2.469	2.443	2.440	2.469	2.466	2.466
Gse		2.677	2.686	2.692	2.682	2.701	2.692	2.688	2.688
Gmb		2.132	2.124	2.148	2.077	2.102	2.148	2.148	2.148
VMA		22.5	23.2	22.8	25.7	25.2	22.8	22.8	22.8
Va		14.5	14.5	13.0	15.0	13.9	13.0	12.9	12.9
Pba		0.72	0.83	0.92	0.78	1.05	0.92	0.86	0.86
Pbe		3.82	4.21	4.63	5.27	5.51	4.63	4.69	4.69
VFA		35.4	37.7	42.9	41.7	45.1	42.9	43.3	43.3
		Adj JMF				QC			
Sieves	%Passing	Factor	S. Area		%Passing	Factor	S. Area		
1"	100	0.41	0.41		99.94	0.41	0.41		
3/4"	93	0	0.00		94.43	0	0.00		
1/2"	68	0	0.00		64.72	0	0.00		
3/8"	47	0	0.00		44.00	0	0.00		
1/4"	26	0	0.00		24.96	0	0.00		
#4	22	0.41	0.09		21.00	0.41	0.09		
#8	14	0.82	0.11		14.00	0.82	0.11		
#16	9	1.64	0.15		9.00	1.64	0.15		
#30	7	2.87	0.20		7.00	2.87	0.20		
#50	6	6.14	0.37		6.00	6.14	0.37		
#100	5	12.29	0.61		5.00	12.29	0.61		
#200	4.6	32.77	1.51		4.28	32.77	1.40		
		Area =	3.45			Area =	3.34		
		Vbe =	0.0987			Vbe =	0.0987		
		Wbe =	100.64			Wbe =	100.64		
		Ws =	2047.36			Ws =	2047.36		
		Avg Film =	13.95			Avg Film =	14.41		

		W.Marquam - N. Tigard			F-Mix				
		Pile #1	Pile #2	Pile #3	Pile #4	AC	Fly Ash	Total	
% Comb.		78	9	12	0	5.5	1	100	
Sp. Gr.		2.690	2.600	2.600	1.000	1.020	2.270		
							JMF	Adj Gse	QC
Gsb								2.666	
Pb		4.5	5.0	5.5	6.0	6.5	5.2	5.2	5.26
Gmm		2.541	2.541	2.513	2.493	2.470	2.530	2.530	2.518
Gse		2.733	2.757	2.747	2.746	2.741	2.754	2.741	2.742
Gmb		2.340	2.360	2.340	2.350	2.350	2.350	2.350	2.350
VMA		16.2	15.9	17.0	17.1	17.6	16.4	16.4	16.5
Va		7.9	7.1	6.9	5.7	4.9	7.1	7.1	6.7
Pba		0.94	1.27	1.13	1.12	1.05	1.22	1.05	1.06
Pbe		3.60	3.79	4.43	4.95	5.52	4.04	4.20	4.26
VFA		51.1	55.2	59.6	66.5	72.4	56.7	56.7	59.5
		Adj JMF				QC			
Sieves	%Passing	Factor	S. Area		%Passing	Factor	S. Area		
1"	100	0.41	0.41		99.90	0.41	0.41		
3/4"	94	0	0.00		92.08	0	0.00		
1/2"	65	0	0.00		65.14	0	0.00		
3/8"	46	0	0.00		46.00	0	0.00		
1/4"	27	0	0.00		23.43	0	0.00		
#4	22	0.41	0.09		19.00	0.41	0.08		
#8	15	0.82	0.12		13.00	0.82	0.11		
#16	9	1.64	0.15		8.00	1.64	0.13		
#30	7	2.87	0.20		7.00	2.87	0.20		
#50	6	6.14	0.37		6.00	6.14	0.37		
#100	5	12.29	0.61		5.00	12.29	0.61		
#200	3.8	32.77	1.25		4.49	32.77	1.47		
		Area =	3.20			Area =	3.38		
		Vbe =	0.0968			Vbe =	0.0981		
		Wbe =	98.78			Wbe =	100.04		
		Ws =	2251.22			Ws =	2249.96		
		Avg Film =	13.44			Avg Film =	12.90		

		Sunset Hwy - Pacific Hwy			F-Mix + Lime				
		Pile #1	Pile #2	Pile #3	Pile #4	AC	Lime/RAP	Total	
% Comb.		39	44	16	0	5.8	1	100	
Sp. Gr.		2.690	2.680	2.610	2.520	1.011	2.270		
							JMF	Adj Gse	QC
Gsb								2.668	
Pb		4.0	4.5	5.0	5.5	6.0	5.6	5.6	5.20
Gmm		2.506	1.000	2.488	1.000	2.449	2.465	2.465	2.480
Gse		2.671	0.999	2.695	0.999	2.694	2.695	2.695	2.695
Gmb		1.000	1.000	2.099	1.000	1.000	2.109	2.109	2.109
VMA		64.0	64.2	25.2	64.6	64.8	25.37	25.37	25.05
Va		60.1	0.0	15.6	0.0	59.2	14.44	14.44	14.96
Pba		0.04	-63.25	0.39	-63.26	0.36	0.38	0.38	0.38
Pbe		3.96	64.91	4.63	65.29	5.66	5.24	5.24	4.84
VFA		6.1	100.0	38.1	100.0	8.6	43.1	43.1	40.3
		Adj JMF				QC			
Sieves	%Passing	Factor	S. Area		%Passing	Factor	S. Area		
1"	100	0.41	0.41		99.93	0.41	0.41		
3/4"	90	0	0.00		92.14	0	0.00		
1/2"	63	0	0.00		69.66	0	0.00		
3/8"	46	0	0.00		47.00	0	0.00		
1/4"	23	0	0.00		22.76	0	0.00		
#4	15	0.41	0.06		15.00	0.41	0.06		
#8	11	0.82	0.09		9.00	0.82	0.07		
#16	10	1.64	0.16		8.00	1.64	0.13		
#30	6	2.87	0.17		6.00	2.87	0.17		
#50	5	6.14	0.31		5.00	6.14	0.31		
#100	4	12.29	0.49		4.00	12.29	0.49		
#200	2.7	32.77	0.88		2.93	32.77	0.96		
		Area =	2.58			Area =	2.61		
		Vbe =	0.1093			Vbe =	0.1009		
		Wbe =	110.46			Wbe =	102.03		
		Ws =	1998.54			Ws =	2006.97		
		Avg Film =	21.18			Avg Film =	19.29		

		Wolf Cr. - W. Fk. Dairy Cr.			F-Mix (SD)				
		Pile #1	Pile #2	Pile #3	Pile #4	AC	Lime/RAP	Total	
% Comb.		34	44	10	12	6.0	0	100	
Sp. Gr.		2.650	2.660	2.620	2.620	1.030	2.270		
							JMF	Adj Gse	QC
Gsb								2.648	
Pb		4.5	5.0	5.5	6.0	6.5	6.0	6.0	6.00
Gmm		2.511	2.493	2.474	2.456	2.438	2.456	2.456	2.456
Gse		2.693	2.694	2.694	2.694	2.694	2.694	2.694	2.694
Gmb		2.190	2.210	2.230	2.240	2.240	2.240	2.240	2.240
VMA		21.0	20.7	20.4	20.5	20.9	20.5	20.5	20.5
Va		12.8	11.4	9.9	8.8	8.1	8.8	8.8	8.8
Pba		0.66	0.67	0.67	0.67	0.67	0.67	0.67	0.67
Pbe		3.87	4.36	4.87	5.37	5.87	5.37	5.37	5.37
VFA		39.2	45.2	51.7	57.0	61.1	57.0	57.0	57.0
		Adj JMF				QC			
Sieves	%Passing	Factor	S. Area		%Passing	Factor	S. Area		
1"	100	0.41	0.41		99.98	0.41	0.41		
3/4"	90	0	0.00		90.86	0	0.00		
1/2"	65	0	0.00		66.32	0	0.00		
3/8"	41	0	0.00		45.00	0	0.00		
1/4"	24	0	0.00		24.95	0	0.00		
#4	21	0.41	0.09		22.00	0.41	0.09		
#8	14	0.82	0.11		15.00	0.82	0.12		
#16	9	1.64	0.15		9.00	1.64	0.15		
#30	6	2.87	0.17		6.00	2.87	0.17		
#50	5	6.14	0.31		5.00	6.14	0.31		
#100	4	12.29	0.49		4.00	12.29	0.49		
#200	3.0	32.77	0.98		2.73	32.77	0.89		
		Area =	2.71			Area =	2.64		
		Vbe =	0.1168			Vbe =	0.1168		
		Wbe =	120.30			Wbe =	120.30		
		Ws =	2119.70			Ws =	2119.70		
		Avg Film =	20.31			Avg Film =	20.90		

	Core 1B		Core 2B		Core 3B		Core 4B	
Pb	5.9		7.4		5.4		6.1	
Gmm	2.444		2.408		2.461		2.432	
Gse	2.674		2.696		2.673		2.668	
Gmb	2.301		2.242		2.122		2.140	
VMA	18.2		21.6		24.2		24.1	
Va	5.9		6.9		13.8		12.0	
Pba	0.39		0.70		0.37		0.29	
Pbe	5.54		6.75		5.05		5.82	
VFA	67.9		68.1		43.0		50.2	
Vol Pbe	0.1258		0.1534		0.1148		0.1323	
Sieves	%Passing	S. Area	%Passing	S. Area	%Passing	S. Area	%Passing	S. Area
1"	100	0.41	100	0.41	100	0.41	100	0.41
3/4"	93	0.00	92	0.00	95	0.00	97	0.00
1/2"	74	0.00	72	0.00	75	0.00	85	0.00
3/8"	56	0.00	53	0.00	59	0.00	69	0.00
1/4"	33	0.00	32	0.00	32	0.00	35	0.00
#4	28	0.11	29	0.12	26	0.11	28	0.11
#8	18	0.15	20	0.16	18	0.15	19	0.16
#16	12	0.20	15	0.25	13	0.21	14	0.23
#30	8	0.23	12	0.34	10	0.29	11	0.32
#50	7	0.43	9	0.55	7	0.43	8	0.49
#100	6	0.74	7	0.86	6	0.74	7	0.86
#200	4.9	1.61	6.1	2.00	4.9	1.61	5.4	1.77
	Area =	3.87	Area =	4.70	Area =	3.94	Area =	4.35
	Vbe =	0.1237	Vbe =	0.1470	Vbe =	0.1041	Vbe =	0.1210
	Wbe =	127.42	Wbe =	151.36	Wbe =	107.20	Wbe =	124.62
	Ws =	2173.58	Ws =	2090.64	Ws =	2014.80	Ws =	2015.38
	Avg Film =	14.70	Avg Film =	14.97	Avg Film =	13.12	Avg Film =	13.81

Core 5B		Core 6B		Core 7B		Core 8B		Core 9B
6.1		13.1		5.1		6.6		7.3
2.437		2.467		2.482		2.420		2.457
2.674		3.124		2.685		2.675		2.758
2.163		2.182		2.119		2.197		2.219
23.3		28.4		24.1		22.5		22.3
11.2		11.6		14.6		9.2		9.7
0.39		5.93		0.55		0.40		1.55
5.74		7.95		4.58		6.23		5.86
51.7		59.3		39.2		59.0		56.6
0.1303		0.1805		0.1041		0.1415		0.1331
%Passing	S. Area	%Passing	S. Area	%Passing	S. Area	%Passing	S. Area	%Passing
100	0.41	100	0.41	100	0.41	100	0.41	100
96	0.00	96	0.00	89	0.00	94	0.00	94
76	0.00	79	0.00	71	0.00	82	0.00	78
55	0.00	57	0.00	54	0.00	64	0.00	58
30	0.00	31	0.00	31	0.00	39	0.00	33
26	0.11	27	0.11	26	0.11	33	0.14	28
19	0.16	20	0.16	20	0.16	22	0.18	21
15	0.25	15	0.25	14	0.23	17	0.28	16
11	0.32	11	0.32	11	0.32	12	0.34	12
8	0.49	7	0.43	7	0.43	8	0.49	8
7	0.86	6	0.74	6	0.74	7	0.86	7
5.3	1.74	4.9	1.61	4.8	1.57	4.8	1.57	5.6
Area =	4.32	Area =	4.02	Area =	3.97	Area =	4.27	Area =
Vbe =	0.1205	Vbe =	0.1683	Vbe =	0.0942	Vbe =	0.1328	Vbe =
Wbe =	124.08	Wbe =	173.37	Wbe =	97.08	Wbe =	136.83	Wbe =
Ws =	2038.92	Ws =	2008.63	Ws =	2021.92	Ws =	2060.17	Ws =
Avg Film =	13.67	Avg Film =	20.85	Avg Film =	11.75	Avg Film =	15.09	Avg Film =

	Core 10B		Core 11B		Core 12B	
	6.2		7.2		5.9	
	2.421		2.438		2.469	
	2.658		2.727		2.706	
	2.257		2.309		2.163	
	20.0		19.1		23.1	
	6.8		5.3		12.4	
	0.15		1.13		0.84	
	6.05		6.15		5.11	
	66.2		72.3		46.4	
	0.1375		0.1396		0.1161	
S. Area	%Passing	S. Area	%Passing	S. Area	%Passing	S. Area
0.41	100	0.41	100	0.41	100	0.41
0.00	98	0.00	94	0.00	94	0.00
0.00	84	0.00	82	0.00	74	0.00
0.00	68	0.00	61	0.00	55	0.00
0.00	45	0.00	32	0.00	31	0.00
0.11	39	0.16	27	0.11	27	0.11
0.17	26	0.21	20	0.16	20	0.16
0.26	20	0.33	15	0.25	15	0.25
0.34	14	0.40	12	0.34	12	0.34
0.49	9	0.55	7	0.43	8	0.49
0.86	8	0.98	6	0.74	7	0.86
1.84	6.1	2.00	4.8	1.57	5.2	1.70
4.49	Area =	5.05	Area =	4.02	Area =	4.33
0.1262	Vbe =	0.1327	Vbe =	0.1378	Vbe =	0.1073
130.02	Wbe =	136.66	Wbe =	141.94	Wbe =	110.55
2088.98	Ws =	2120.34	Ws =	2167.06	Ws =	2052.45
13.46	Avg Film =	12.40	Avg Film =	15.84	Avg Film =	12.08

		Corbett - Multnomah Falls			F-Mix + Lime				
		Pile #1	Pile #2	Pile #3	Pile #4	AC	Lime/RAP	Total	
% Comb.		81	7	11	0	5.8	1	100	
Sp. Gr.		2.660	2.580	2.580	2.520	1.020	2.270		
							JMF	Adj Gse	QC
Gsb								2.641	
Pb		4.5	5.0	5.5	6.0	6.5	5.5	5.5	5.42
Gmm		2.537	2.512	2.506	2.486	2.462	2.506	2.500	2.503
Gse		2.728	2.722	2.738	2.737	2.730	2.738	2.731	2.731
Gmb		2.320	2.340	2.360	2.370	2.370	2.360	2.360	2.360
VMA		16.1	15.8	15.5	15.6	16.1	15.55	15.55	15.47
Va		8.6	6.8	5.8	4.7	3.7	5.83	5.60	5.71
Pba		1.24	1.15	1.37	1.36	1.27	1.37	1.27	1.27
Pbe		3.32	3.91	4.20	4.72	5.31	4.20	4.30	4.22
VFA		46.9	56.7	62.5	70.2	76.8	62.5	64.0	63.1
		Adj JMF				QC			
Sieves	%Passing	Factor	S. Area		%Passing	Factor	S. Area		
1"	100	0.41	0.41		100.00	0.41	0.41		
3/4"	95	0	0.00		95.03	0	0.00		
1/2"	68	0	0.00		67.72	0	0.00		
3/8"	48	0	0.00		47.00	0	0.00		
1/4"	27	0	0.00		24.03	0	0.00		
#4	20	0.41	0.08		18.00	0.41	0.07		
#8	13	0.82	0.11		12.00	0.82	0.10		
#16	10	1.64	0.16		9.00	1.64	0.15		
#30	6	2.87	0.17		6.00	2.87	0.17		
#50	5	6.14	0.31		5.00	6.14	0.31		
#100	4	12.29	0.49		4.00	12.29	0.49		
#200	2.8	32.77	0.92		2.31	32.77	0.76		
		Area =	2.65			Area =	2.46		
		Vbe =	0.0995			Vbe =	0.0976		
		Wbe =	101.45			Wbe =	99.56		
		Ws =	2258.55			Ws =	2260.44		
		Avg Film =	16.61			Avg Film =	17.57		

		Mt Hood - Long Prairie			F-Mix + Lime				
		Pile #1	Pile #2	Pile #3	Pile #4	AC	Lime/RAP	Total	
% Comb.		25	62	5	7	6.0	1	100	
Sp. Gr.		2.760	2.630	2.560	2.560	1.021	2.270		
							JMF	Adj Gse	QC
Gsb								2.648	
Pb		4.5	5.0	5.5	6.0	6.5	6.0	6.0	5.97
Gmm		2.502	1.000	2.482	2.456	2.429	2.456	2.454	2.455
Gse		2.686	0.999	2.707	2.698	2.687	2.698	2.695	2.695
Gmb		1.000	1.000	1.000	2.137	1.000	2.137	2.137	2.137
VMA		63.9	64.1	64.3	24.1	64.7	24.15	24.15	24.12
Va		60.0	0.0	59.7	13.0	58.8	12.99	12.92	12.95
Pba		0.53	-63.66	0.84	0.71	0.55	0.71	0.67	0.67
Pbe		3.99	65.47	4.70	5.33	5.99	5.33	5.37	5.34
VFA		6.1	100.0	7.2	46.2	9.1	46.2	46.5	46.3
		Adj JMF				QC			
Sieves	%Passing	Factor	S. Area		%Passing	Factor	S. Area		
1"	100	0.41	0.41		100.00	0.41	0.41		
3/4"	93	0	0.00		92.55	0	0.00		
1/2"	64	0	0.00		62.27	0	0.00		
3/8"	43	0	0.00		44.00	0	0.00		
1/4"	24	0	0.00		28.00	0	0.00		
#4	16	0.41	0.07		19.00	0.41	0.08		
#8	10	0.82	0.08		13.00	0.82	0.11		
#16	7	1.64	0.11		9.00	1.64	0.15		
#30	6	2.87	0.17		7.00	2.87	0.20		
#50	4	6.14	0.25		4.00	6.14	0.25		
#100	3	12.29	0.37		3.00	12.29	0.37		
#200	3.0	32.77	0.98		2.55	32.77	0.84		
		Area =	2.44			Area =	2.39		
		Vbe =	0.1123			Vbe =	0.1117		
		Wbe =	114.66			Wbe =	114.05		
		Ws =	2022.34			Ws =	2022.95		
		Avg Film =	22.74			Avg Film =	23.08		

		Rufus - Arlington (W. Unit)			F-Mix (HD) + Lime				
		Pile #1	Pile #2	Pile #3	Pile #4	AC	Lime/RAP	Total	
% Comb.		84	5	10	0	6.0	1	100	
Sp. Gr.		2.860	2.840	2.840	2.560	1.020	2.270		
							JMF	Adj Gse	QC
Gsb								2.850	
Pb		5.0	5.5	6.0	6.5	7.0	5.8	5.8	5.78
Gmm		2.651	1.000	2.607	1.000	2.564	2.615	2.615	2.616
Gse		2.895	0.999	2.894	0.999	2.894	2.894	2.894	2.894
Gmb		2.340	1.000	2.360	1.000	2.380	2.356	2.356	2.355
VMA		22.0	66.8	22.2	67.2	22.3	22.12	22.12	22.13
Va		11.7	0.0	9.5	0.0	7.2	9.90	9.90	9.98
Pba		0.56	-66.32	0.55	-66.34	0.55	0.54	0.54	0.55
Pbe		4.47	68.17	5.48	68.53	6.49	5.29	5.29	5.27
VFA		46.6	100.0	57.2	100.0	67.9	55.2	55.2	54.9
		Adj JMF				QC			
Sieves	%Passing	Factor	S. Area		%Passing	Factor	S. Area		
1"	100	0.41	0.41		99.97	0.41	0.41		
3/4"	93	0	0.00		91.67	0	0.00		
1/2"	65	0	0.00		64.83	0	0.00		
3/8"	41	0	0.00		41.00	0	0.00		
1/4"	25	0	0.00		24.53	0	0.00		
#4	18	0.41	0.07		18.00	0.41	0.07		
#8	10	0.82	0.08		11.00	0.82	0.09		
#16	7	1.64	0.11		7.00	1.64	0.11		
#30	6	2.87	0.17		6.00	2.87	0.17		
#50	4	6.14	0.25		4.00	6.14	0.25		
#100	3	12.29	0.37		3.00	12.29	0.37		
#200	2.6	32.77	0.85		2.21	32.77	0.72		
		Area =	2.32			Area =	2.20		
		Vbe =	0.1221			Vbe =	0.1216		
		Wbe =	124.56			Wbe =	123.99		
		Ws =	2231.44			Ws =	2231.01		
		Avg Film =	23.60			Avg Film =	24.77		

		Rufus - Arlington (E. Unit)			F-Mix				
		Pile #1	Pile #2	Pile #3	Pile #4	AC	Lime/RAP	Total	
% Comb.		80	9	10	0	5.3	1	100	
Sp. Gr.		2.638	2.638	2.638	1.000	1.020	2.270		
							JMF	Adj Gse	QC
Gsb								2.634	
Pb		4.0	4.5	5.0	5.5	6.0	5.3	5.3	5.3
Gmm		2.591	2.580	2.549	2.523	2.540	2.538	2.538	2.538
Gse		2.769	2.780	2.767	2.760	2.807	2.769	2.769	2.769
Gmb		2.220	2.242	2.220	2.192	2.235	2.203	2.203	2.203
VMA		19.1	18.7	19.9	21.3	20.2	20.8	20.8	20.8
Va		14.3	13.1	12.9	13.1	12.0	13.2	13.2	13.2
Pba		1.89	2.04	1.87	1.77	2.39	1.89	1.89	1.89
Pbe		2.19	2.55	3.22	3.83	3.75	3.51	3.51	3.51
VFA		25.0	30.0	35.2	38.6	40.6	36.5	36.5	36.5
		Adj JMF				QC			
Sieves	%Passing	Factor	S. Area		%Passing	Factor	S. Area		
1"	100	0.41	0.41		100.00	0.41	0.41		
3/4"	95	0	0.00		94.69	0	0.00		
1/2"	65	0	0.00		66.99	0	0.00		
3/8"	45	0	0.00		46.00	0	0.00		
1/4"	25	0	0.00		25.87	0	0.00		
#4	21	0.41	0.09		22.00	0.41	0.09		
#8	13	0.82	0.11		15.00	0.82	0.12		
#16	9	1.64	0.15		11.00	1.64	0.18		
#30	7	2.87	0.20		8.00	2.87	0.23		
#50	5	6.14	0.31		5.00	6.14	0.31		
#100	4	12.29	0.49		4.00	12.29	0.49		
#200	3.0	32.77	0.98		3.04	32.77	1.00		
		Area =	2.73			Area =	2.83		
		Vbe =	0.0759			Vbe =	0.0759		
		Wbe =	77.40			Wbe =	77.40		
		Ws =	2125.60			Ws =	2125.60		
		Avg Film =	13.06			Avg Film =	12.62		

		Umatilla - McNary			F-Mix (SD) + Lime				
		Pile #1	Pile #2	Pile #3	Pile #4	AC	Lime/RAP	Total	
% Comb.		86	13	0	0	6.2	1	100	
Sp. Gr.		2.800	2.640	2.580	2.520	1.020	2.270		
							JMF	Adj Gse	QC
Gsb								2.772	
Pb		5.0	5.5	6.0	6.5	7.0	6.2	6.2	6.29
Gmm		1.000	1.000	2.541	1.000	1.000	2.533	2.533	2.529
Gse		0.999	0.999	2.808	0.999	0.999	2.808	2.808	2.808
Gmb		2.290	1.000	2.300	1.000	2.340	2.310	2.310	2.313
VMA		21.5	65.9	22.0	66.3	21.5	21.82	21.82	21.80
Va		-129.0	0.0	9.5	0.0	-134.0	8.80	8.80	8.54
Pba		-65.30	-65.32	0.48	-65.34	-65.35	0.48	0.48	0.47
Pbe		67.04	67.22	5.55	67.59	67.78	5.75	5.75	5.85
VFA		699.7	100.0	56.9	100.0	723.7	59.7	59.7	60.8
		Adj JMF				QC			
Sieves	%Passing	Factor	S. Area		%Passing	Factor	S. Area		
1"	100	0.41	0.41		100.00	0.41	0.41		
3/4"	92	0	0.00		92.95	0	0.00		
1/2"	64	0	0.00		63.11	0	0.00		
3/8"	48	0	0.00		47.00	0	0.00		
1/4"	24	0	0.00		26.68	0	0.00		
#4	18	0.41	0.07		19.00	0.41	0.08		
#8	15	0.82	0.12		15.00	0.82	0.12		
#16	11	1.64	0.18		11.00	1.64	0.18		
#30	7	2.87	0.20		7.00	2.87	0.20		
#50	5	6.14	0.31		5.00	6.14	0.31		
#100	4	12.29	0.49		4.00	12.29	0.49		
#200	2.9	32.77	0.95		2.41	32.77	0.79		
		Area =	2.74			Area =	2.58		
		Vbe =	0.1302			Vbe =	0.1326		
		Wbe =	132.81			Wbe =	135.22		
		Ws =	2177.19			Ws =	2177.78		
		Avg Film =	21.85			Avg Film =	23.59		

		E. Pendleton - Emigrant Hill			F-Mix + Lime				
		Pile #1	Pile #2	Pile #3	Pile #4	AC	Lime/RAP	Total	
% Comb.		81	11	7	0	6.2	1	100	
Sp. Gr.		2.720	2.710	2.680	2.560	1.020	2.270		
							JMF	Adj Gse	QC
Gsb								2.711	
Pb		4.0	4.5	5.0	5.5	6.0	6.0	6.0	6.46
Gmm		2.553	2.543	2.527	2.517	2.493	2.493	2.488	2.470
Gse		2.724	2.735	2.740	2.752	2.746	2.746	2.740	2.739
Gmb		2.290	1.000	2.300	1.000	2.340	2.310	2.310	2.314
VMA		18.9	64.8	19.4	65.1	18.9	19.90	19.90	20.15
Va		10.3	60.7	9.0	60.3	6.1	7.34	7.15	6.32
Pba		0.18	0.34	0.40	0.57	0.49	0.49	0.40	0.39
Pbe		3.83	4.17	4.62	4.97	5.54	5.54	5.63	6.10
VFA		45.5	6.3	53.7	7.5	67.5	63.1	64.0	68.7
		Adj JMF				QC			
Sieves	%Passing	Factor	S. Area		%Passing	Factor	S. Area		
1"	100	0.41	0.41		100.00	0.41	0.41		
3/4"	94	0	0.00		96.50	0	0.00		
1/2"	65	0	0.00		67.33	0	0.00		
3/8"	42	0	0.00		44.00	0	0.00		
1/4"	25	0	0.00		28.17	0	0.00		
#4	18	0.41	0.07		20.00	0.41	0.08		
#8	13	0.82	0.11		13.00	0.82	0.11		
#16	9	1.64	0.15		9.00	1.64	0.15		
#30	7	2.87	0.20		7.00	2.87	0.20		
#50	5	6.14	0.31		5.00	6.14	0.31		
#100	4	12.29	0.49		4.00	12.29	0.49		
#200	3.1	32.77	1.02		2.34	32.77	0.77		
		Area =	2.75			Area =	2.51		
		Vbe =	0.1274			Vbe =	0.1383		
		Wbe =	129.96			Wbe =	141.10		
		Ws =	2180.04			Ws =	2172.90		
		Avg Film =	21.23			Avg Film =	25.34		

		Baldock Slough - S. Baker			F-Mix				
		Pile #1	Pile #2	Pile #3	Pile #4	AC	Lime/RAP	Total	
% Comb.		82	9	8	0	5.5	1	100	
Sp. Gr.		2.631	2.631	2.631	1.000	1.020	2.270		
							JMF	Adj Gse	QC
Gsb								2.627	
Pb		4.5	5.0	5.5	6.0	6.5	5.5	5.5	5.45
Gmm		2.508	2.482	2.465	2.457	2.434	2.465	2.469	2.471
Gse		2.693	2.685	2.687	2.700	2.694	2.687	2.692	2.692
Gmb		2.132	2.124	2.148	2.077	2.102	2.148	2.148	2.145
VMA		22.5	23.2	22.7	25.7	25.2	22.7	22.7	22.8
Va		15.0	14.4	12.9	15.5	13.6	12.9	13.0	13.2
Pba		0.96	0.83	0.86	1.05	0.96	0.86	0.93	0.94
Pbe		3.59	4.21	4.68	5.01	5.60	4.68	4.62	4.56
VFA		33.3	37.8	43.4	39.8	45.8	43.4	42.8	42.1
		Adj JMF				QC			
Sieves	%Passing	Factor	S. Area		%Passing	Factor	S. Area		
1"	100	0.41	0.41		99.98	0.41	0.41		
3/4"	93	0	0.00		92.76	0	0.00		
1/2"	64	0	0.00		66.86	0	0.00		
3/8"	43	0	0.00		43.00	0	0.00		
1/4"	26	0	0.00		29.21	0	0.00		
#4	22	0.41	0.09		25.00	0.41	0.10		
#8	14	0.82	0.11		17.00	0.82	0.14		
#16	9	1.64	0.15		11.00	1.64	0.18		
#30	7	2.87	0.20		8.00	2.87	0.23		
#50	5	6.14	0.31		6.00	6.14	0.37		
#100	4	12.29	0.49		5.00	12.29	0.61		
#200	2.6	32.77	0.85		2.75	32.77	0.90		
		Area =	2.61			Area =	2.95		
		Vbe =	0.0972			Vbe =	0.0960		
		Wbe =	99.19			Wbe =	97.92		
		Ws =	2048.81			Ws =	2047.08		
		Avg Film =	18.16			Avg Film =	15.92		

		Powell Butte - Prineville			F-Mix (SD) + Lime				
		Pile #1	Pile #2	Pile #3	Pile #4	AC	Lime/RAP	Total	
% Comb.		86	5	8	0	5.2	1	100	
Sp. Gr.		2.650	2.640	2.640	2.520	1.015	2.270		
							JMF	Adj Gse	QC
Gsb								2.644	
Pb		4.5	5.0	5.5	6.0	6.5	5.2	5.2	5.20
Gmm		2.468	1.000	2.456	1.000	2.421	2.459	2.460	2.460
Gse		2.647	0.999	2.677	0.999	2.679	2.667	2.668	2.668
Gmb		2.096	1.000	1.000	1.000	1.000	2.106	2.106	2.106
VMA		24.3	64.1	64.3	64.5	64.6	24.50	24.50	24.50
Va		15.1	0.0	59.3	0.0	58.7	14.36	14.39	14.39
Pba		0.03	-63.19	0.47	-63.21	0.50	0.33	0.35	0.35
Pbe		4.47	65.03	5.05	65.42	6.03	4.89	4.87	4.87
VFA		38.0	100.0	7.7	100.0	9.2	41.4	41.3	41.3
		Adj JMF				QC			
Sieves	%Passing	Factor	S. Area		%Passing	Factor	S. Area		
1"	100	0.41	0.41		100.00	0.41	0.41		
3/4"	93	0	0.00		92.60	0	0.00		
1/2"	63	0	0.00		63.55	0	0.00		
3/8"	42	0	0.00		42.00	0	0.00		
1/4"	23	0	0.00		23.05	0	0.00		
#4	18	0.41	0.07		18.00	0.41	0.07		
#8	11	0.82	0.09		11.00	0.82	0.09		
#16	9	1.64	0.15		9.00	1.64	0.15		
#30	6	2.87	0.17		6.00	2.87	0.17		
#50	5	6.14	0.31		5.00	6.14	0.31		
#100	4	12.29	0.49		4.00	12.29	0.49		
#200	2.9	32.77	0.95		2.17	32.77	0.71		
		Area =	2.64			Area =	2.40		
		Vbe =	0.1011			Vbe =	0.1011		
		Wbe =	102.59			Wbe =	102.59		
		Ws =	2003.41			Ws =	2003.41		
		Avg Film =	19.09			Avg Film =	20.99		

		Willowdale - Qualle Rd			F-Mix (SD) + Lime				
		Pile #1	Pile #2	Pile #3	Pile #4	AC	Lime/RAP	Total	
% Comb.		87	5	7	0	5.5	1	100	
Sp. Gr.		2.640	2.630	2.630	2.520	1.019	2.270		
							JMF	Adj Gse	QC
Gsb								2.635	
Pb		4.5	5.0	5.5	6.0	6.5	5.5	5.5	5.22
Gmm		2.484	1.000	2.441	1.000	2.432	2.441	2.452	2.463
Gse		2.665	0.999	2.657	0.999	2.691	2.657	2.671	2.671
Gmb		2.079	1.000	2.107	1.000	2.135	2.107	2.107	2.099
VMA		24.6	63.9	24.4	64.3	24.2	24.42	24.42	24.49
Va		16.3	0.0	13.7	0.0	12.2	13.68	14.07	14.78
Pba		0.44	-63.32	0.32	-63.34	0.82	0.32	0.52	0.54
Pbe		4.08	65.15	5.19	65.54	5.73	5.19	5.01	4.71
VFA		33.8	100.0	44.0	100.0	49.6	44.0	42.4	39.6
		Adj JMF				QC			
Sieves	%Passing	Factor	S. Area		%Passing	Factor	S. Area		
1"	100	0.41	0.41		100.00	0.41	0.41		
3/4"	95	0	0.00		93.93	0	0.00		
1/2"	63	0	0.00		64.50	0	0.00		
3/8"	47	0	0.00		49.00	0	0.00		
1/4"	23	0	0.00		25.71	0	0.00		
#4	16	0.41	0.07		17.00	0.41	0.07		
#8	10	0.82	0.08		12.00	0.82	0.10		
#16	8	1.64	0.13		9.00	1.64	0.15		
#30	6	2.87	0.17		6.00	2.87	0.17		
#50	5	6.14	0.31		5.00	6.14	0.31		
#100	4	12.29	0.49		4.00	12.29	0.49		
#200	3.1	32.77	1.02		3.54	32.77	1.16		
		Area =	2.68			Area =	2.86		
		Vbe =	0.1035			Vbe =	0.0971		
		Wbe =	105.48			Wbe =	98.91		
		Ws =	2001.52			Ws =	2000.09		
		Avg Film =	19.33			Avg Film =	16.99		

		Forge Rd - Lobert (S. Unit)			F-Mix				
		Pile #1	Pile #2	Pile #3	Pile #4	AC	Lime/RAP	Total	
% Comb.		88	0	11	0	6.0	1	100	
Sp. Gr.		2.629	1.000	2.629	1.000	1.020	2.270		
							JMF	Adj Gse	QC
Gsb								2.625	
Pb		5.0	5.5	6.0	6.5	7.0	6.0	6.0	5.86
Gmm		2.492	2.485	2.488	2.475	2.435	2.488	2.475	2.480
Gse		2.697	2.712	2.740	2.747	2.719	2.740	2.723	2.723
Gmb		2.250	2.270	2.270	2.250	2.290	2.270	2.270	2.203
VMA		18.6	18.3	18.7	19.9	18.9	18.7	18.7	21.0
Va		9.7	8.7	8.8	9.1	6.0	8.8	8.3	11.2
Pba		1.04	1.24	1.63	1.73	1.34	1.63	1.40	1.39
Pbe		4.01	4.32	4.47	4.88	5.75	4.47	4.68	4.55
VFA		47.7	52.7	53.2	54.2	68.4	53.2	55.7	46.8
		Adj JMF				QC			
Sieves	%Passing	Factor	S. Area		%Passing	Factor	S. Area		
1"	100	0.41	0.41		99.94	0.41	0.41		
3/4"	93	0	0.00		92.29	0	0.00		
1/2"	66	0	0.00		61.53	0	0.00		
3/8"	47	0	0.00		44.00	0	0.00		
1/4"	25	0	0.00		26.94	0	0.00		
#4	22	0.41	0.09		24.00	0.41	0.10		
#8	15	0.82	0.12		14.00	0.82	0.11		
#16	11	1.64	0.18		11.00	1.64	0.18		
#30	9	2.87	0.26		9.00	2.87	0.26		
#50	7	6.14	0.43		7.00	6.14	0.43		
#100	5	12.29	0.61		5.00	12.29	0.61		
#200	3.6	32.77	1.18		2.91	32.77	0.95		
		Area =	3.29			Area =	3.06		
		Vbe =	0.1042			Vbe =	0.0982		
		Wbe =	106.33			Wbe =	100.17		
		Ws =	2163.67			Ws =	2102.83		
		Avg Film =	14.66			Avg Film =	15.26		

	Core 1C		Core 2C		Core 3C		Core 4C	
	4.8		4.7		4.9		4.9	
	2.522		2.525		2.521		2.513	
	2.724		2.723		2.728		2.718	
	2.201		2.135		2.143		2.079	
	20.2		22.5		22.4		24.7	
	12.7		15.4		15.0		17.3	
	1.42		1.40		1.47		1.33	
	3.45		3.36		3.50		3.63	
	36.9		31.3		32.9		30.0	
Vol Pbe	0.0744		0.0704		0.0736		0.0741	
Sieves	%Passing	S. Area	%Passing	S. Area	%Passing	S. Area	%Passing	S. Area
1"	100	0.41	100	0.41	100	0.41	100	0.41
3/4"	93	0.00	93	0.00	93	0.00	94	0.00
1/2"	65	0.00	70	0.00	65	0.00	67	0.00
3/8"	48	0.00	49	0.00	48	0.00	48	0.00
1/4"	31	0.00	32	0.00	31	0.00	30	0.00
#4	26	0.11	27	0.11	26	0.11	26	0.11
#8	20	0.16	21	0.17	20	0.16	21	0.17
#16	15	0.25	16	0.26	15	0.25	16	0.26
#30	12	0.34	12	0.34	12	0.34	12	0.34
#50	8	0.49	8	0.49	8	0.49	8	0.49
#100	7	0.86	7	0.86	7	0.86	7	0.86
#200	5.1	1.67	5.6	1.84	5.1	1.67	5.1	1.67
	Area =	4.29	Area =	4.49	Area =	4.29	Area =	4.32
	Vbe =	0.0744	Vbe =	0.0704	Vbe =	0.0736	Vbe =	0.0741
	Wbe =	75.93	Wbe =	71.80	Wbe =	75.11	Wbe =	75.54
	Ws =	2125.07	Ws =	2063.20	Ws =	2067.89	Ws =	2003.46
	Avg Film =	8.16	Avg Film =	7.61	Avg Film =	8.29	Avg Film =	8.56

Core 5C		Core 6C	
5.0		5.8	
2.513		2.471	
2.723		2.708	
2.164		2.215	
21.7		20.5	
13.9		10.4	
1.40		1.20	
3.67		4.67	
35.9		49.5	
0.0779		0.1015	
%Passing	S. Area	%Passing	S. Area
100	0.41	100	0.41
97	0.00	94	0.00
73	0.00	77	0.00
50	0.00	57	0.00
30	0.00	38	0.00
25	0.10	30	0.12
21	0.17	20	0.16
16	0.26	15	0.25
12	0.34	12	0.34
8	0.49	8	0.49
7	0.86	7	0.86
5.2	1.70	5.6	1.84
Area =	4.35	Area =	4.47
Vbe =	0.0779	Vbe =	0.1015
Wbe =	79.47	Wbe =	103.51
Ws =	2084.53	Ws =	2111.49
Avg Film =	8.60	Avg Film =	10.74

		Williamson Riv. - Modoc Pt.			F-Mix + Lime				
		Pile #1	Pile #2	Pile #3	Pile #4	AC	Lime/RAP	Total	
% Comb.		37	42	20	0	5.2	1	100	
Sp. Gr.		2.700	2.690	2.680	2.520	1.020	2.270		
							JMF	Adj Gse	QC
Gsb								2.687	
Pb		4.0	4.5	5.0	5.5	6.0	5.2	5.2	5.11
Gmm		2.583	2.559	2.539	2.524	2.525	2.533	2.533	2.536
Gse		2.759	2.755	2.755	2.761	2.788	2.757	2.757	2.757
Gmb		2.350	2.320	2.360	2.360	2.350	2.320	2.320	2.320
VMA		16.0	17.5	16.6	17.0	17.8	18.14	18.14	18.06
Va		9.0	9.3	7.1	6.5	6.9	8.41	8.41	8.52
Pba		1.00	0.94	0.94	1.02	1.37	0.97	0.97	0.96
Pbe		3.04	3.60	4.11	4.54	4.71	4.28	4.28	4.20
VFA		43.7	46.7	57.4	61.8	61.0	53.6	53.6	52.8
		Adj JMF				QC			
Sieves	%Passing	Factor	S. Area		%Passing	Factor	S. Area		
1"	100	0.41	0.41		100.00	0.41	0.41		
3/4"	92	0	0.00		93.91	0	0.00		
1/2"	66	0	0.00		68.91	0	0.00		
3/8"	43	0	0.00		44.00	0	0.00		
1/4"	25	0	0.00		26.00	0	0.00		
#4	16	0.41	0.07		17.00	0.41	0.07		
#8	13	0.82	0.11		13.00	0.82	0.11		
#16	9	1.64	0.15		9.00	1.64	0.15		
#30	6	2.87	0.17		6.00	2.87	0.17		
#50	5	6.14	0.31		5.00	6.14	0.31		
#100	4	12.29	0.49		4.00	12.29	0.49		
#200	4.0	32.77	1.31		2.60	32.77	0.85		
		Area =	3.01			Area =	2.56		
		Vbe =	0.0973			Vbe =	0.0954		
		Wbe =	99.25			Wbe =	97.35		
		Ws =	2220.75			Ws =	2222.65		
		Avg Film =	14.55			Avg Film =	16.80		

		Jumpoff Joe Cr. - N. Grants Pass			F-Mix + Lime				
		Pile #1	Pile #2	Pile #3	Pile #4	AC	Lime/RAP	Total	
% Comb.		80	9	10	0	5.2	1	100	
Sp. Gr.		2.790	2.770	2.760	2.520	1.020	2.270		
							JMF	Adj Gse	QC
Gsb								2.779	
Pb		4.0	4.5	5.0	5.5	6.0	5.0	5.0	4.95
Gmm		2.687	2.650	2.635	2.620	2.624	2.635	2.637	2.639
Gse		2.883	2.866	2.875	2.883	2.917	2.875	2.877	2.877
Gmb		2.480	2.460	2.460	2.470	2.450	2.460	2.460	2.460
VMA		14.3	15.5	15.9	16.0	17.1	15.90	15.90	15.85
Va		7.7	7.2	6.6	5.7	6.6	6.64	6.71	6.78
Pba		1.33	1.11	1.22	1.33	1.74	1.22	1.25	1.25
Pbe		2.72	3.44	3.84	4.24	4.37	3.84	3.81	3.76
VFA		46.2	53.6	58.2	64.2	61.3	58.2	57.8	57.2
		Adj JMF				QC			
Sieves	%Passing	Factor	S. Area		%Passing	Factor	S. Area		
1"	100	0.41	0.41		100.00	0.41	0.41		
3/4"	94	0	0.00		93.12	0	0.00		
1/2"	66	0	0.00		65.41	0	0.00		
3/8"	39	0	0.00		40.00	0	0.00		
1/4"	24	0	0.00		24.77	0	0.00		
#4	16	0.41	0.07		17.00	0.41	0.07		
#8	13	0.82	0.11		13.00	0.82	0.11		
#16	9	1.64	0.15		9.00	1.64	0.15		
#30	6	2.87	0.17		6.00	2.87	0.17		
#50	5	6.14	0.31		5.00	6.14	0.31		
#100	4	12.29	0.49		4.00	12.29	0.49		
#200	3.9	32.77	1.28		3.35	32.77	1.10		
		Area =	2.98			Area =	2.80		
		Vbe =	0.0919			Vbe =	0.0907		
		Wbe =	93.71			Wbe =	92.54		
		Ws =	2366.29			Ws =	2367.46		
		Avg Film =	13.03			Avg Film =	13.67		

		Azalea - Jumpoff Joe (SB)			F-Mix + Lime				
		Pile #1	Pile #2	Pile #3	Pile #4	AC	Lime/RAP	Total	
% Comb.		37	43	7	12	5.6	1	100	
Sp. Gr.		2.920	2.910	2.870	2.870	1.020	2.270		
							JMF	Adj Gse	QC
Gsb								2.898	
Pb		4.5	5.0	5.5	6.0	6.5	5.6	5.6	5.56
Gmm		2.725	1.000	2.672	1.000	2.652	2.670	2.671	2.673
Gse		2.958	0.999	2.950	0.999	2.984	2.953	2.955	2.955
Gmb		1.000	1.000	2.333	1.000	1.000	2.340	2.340	2.337
VMA		67.0	67.2	23.9	67.6	67.7	23.77	23.77	23.84
Va		63.3	0.0	12.7	0.0	62.3	12.36	12.39	12.57
Pba		0.72	-66.91	0.62	-66.93	1.02	0.66	0.68	0.68
Pbe		3.82	68.56	4.91	68.91	5.55	4.97	4.96	4.92
VFA		5.6	100.0	47.0	100.0	8.0	48.0	47.9	47.3
		Adj JMF				QC			
Sieves	%Passing	Factor	S. Area		%Passing	Factor	S. Area		
1"	100	0.41	0.41		100.00	0.41	0.41		
3/4"	93	0	0.00		94.10	0	0.00		
1/2"	65	0	0.00		62.58	0	0.00		
3/8"	49	0	0.00		50.00	0	0.00		
1/4"	23	0	0.00		25.41	0	0.00		
#4	19	0.41	0.08		19.00	0.41	0.08		
#8	13	0.82	0.11		13.00	0.82	0.11		
#16	10	1.64	0.16		10.00	1.64	0.16		
#30	7	2.87	0.20		7.00	2.87	0.20		
#50	6	6.14	0.37		6.00	6.14	0.37		
#100	5	12.29	0.61		5.00	12.29	0.61		
#200	3.0	32.77	0.98		2.26	32.77	0.74		
		Area =	2.93			Area =	2.68		
		Vbe =	0.1138			Vbe =	0.1127		
		Wbe =	116.07			Wbe =	114.93		
		Ws =	2223.93			Ws =	2222.07		
		Avg Film =	17.49			Avg Film =	18.90		

		Halsey Int. - Lane Co. Line SB			F-Mix (SD)				
		Pile #1	Pile #2	Pile #3	Pile #4	AC	Lime/RAP	Total	
% Comb.		33	49	17	0	6.0	1	100	
Sp. Gr.		2.620	2.650	2.620	2.620	1.020	2.270		
							JMF	Adj Gse	QC
Gsb								2.631	
Pb		5.0	5.5	6.0	6.5	7.0	6.0	6.0	6.0
Gmm		2.453	2.449	2.426	1.000	2.389	2.426	2.424	2.424
Gse		2.649	2.666	2.660	0.999	2.657	2.660	2.657	2.657
Gmb		2.150	2.155	2.160	2.180	2.200	2.160	2.160	2.160
VMA		22.4	22.6	22.8	22.5	22.2	22.8	22.8	22.8
Va		12.4	12.0	11.0	-118.0	7.9	11.0	10.9	10.9
Pba		0.27	0.52	0.43	-63.36	0.39	0.43	0.39	0.39
Pbe		4.75	5.01	5.60	65.75	6.63	5.60	5.63	5.63
VFA		44.7	46.8	51.9	624.1	64.4	51.9	52.3	52.3
		Adj JMF				QC			
Sieves	%Passing	Factor	S. Area		%Passing	Factor	S. Area		
1"	100	0.41	0.41		100.00	0.41	0.41		
3/4"	93	0	0.00		91.08	0	0.00		
1/2"	66	0	0.00		64.75	0	0.00		
3/8"	49	0	0.00		45.00	0	0.00		
1/4"	24	0	0.00		25.46	0	0.00		
#4	18	0.41	0.07		19.00	0.41	0.08		
#8	13	0.82	0.11		14.00	0.82	0.11		
#16	10	1.64	0.16		11.00	1.64	0.18		
#30	7	2.87	0.20		7.00	2.87	0.20		
#50	6	6.14	0.37		6.00	6.14	0.37		
#100	5	12.29	0.61		5.00	12.29	0.61		
#200	4.0	32.77	1.31		4.10	32.77	1.34		
		Area =	3.25			Area =	3.31		
		Vbe =	0.1192			Vbe =	0.1192		
		Wbe =	121.62			Wbe =	121.62		
		Ws =	2038.38			Ws =	2038.38		
		Avg Film =	18.00			Avg Film =	17.67		

		Halsey Int. - Lane Co. Line NB			F-Mix (SD)				
		Pile #1	Pile #2	Pile #3	Pile #4	AC	Lime/RAP	Total	
% Comb.		33	49	17	0	5.8	1	100	
Sp. Gr.		2.620	2.650	2.620	2.620	1.044	2.270		
							JMF	Adj Gse	QC
Gsb								2.631	
Pb		5.0	5.5	6.0	6.5	7.0	5.8	5.8	5.8
Gmm		2.471	1.000	2.436	1.000	2.402	2.443	2.443	2.443
Gse		2.663	0.998	2.663	0.997	2.663	2.663	2.663	2.663
Gmb		2.110	1.000	2.120	1.000	2.160	2.110	2.110	2.110
VMA		23.8	64.1	24.2	64.5	23.6	24.4	24.4	24.4
Va		14.6	0.0	13.0	0.0	10.1	13.6	13.6	13.6
Pba		0.48	-64.97	0.48	-65.02	0.48	0.48	0.48	0.48
Pbe		4.55	66.90	5.55	67.29	6.55	5.35	5.35	5.35
VFA		38.6	100.0	46.5	100.0	57.4	44.2	44.2	44.2
		Adj JMF				QC			
Sieves	%Passing	Factor	S. Area		%Passing	Factor	S. Area		
1"	100	0.41	0.41		100.00	0.41	0.41		
3/4"	93	0	0.00		90.92	0	0.00		
1/2"	66	0	0.00		64.21	0	0.00		
3/8"	49	0	0.00		44.00	0	0.00		
1/4"	24	0	0.00		24.01	0	0.00		
#4	18	0.41	0.07		18.00	0.41	0.07		
#8	13	0.82	0.11		13.00	0.82	0.11		
#16	10	1.64	0.16		10.00	1.64	0.16		
#30	7	2.87	0.20		7.00	2.87	0.20		
#50	6	6.14	0.37		6.00	6.14	0.37		
#100	5	12.29	0.61		5.00	12.29	0.61		
#200	4.0	32.77	1.31		3.56	32.77	1.17		
		Area =	3.25			Area =	3.10		
		Vbe =	0.1081			Vbe =	0.1081		
		Wbe =	112.85			Wbe =	112.85		
		Ws =	1997.15			Ws =	1997.15		
		Avg Film =	16.66			Avg Film =	17.43		

APPENDIX C

VOLUME INCREASE RATIO (VIR) CALCULATIONS FOR EXISTING PROJECTS

Volume Ratio

Project: Hayesville - Battle Creek
Contract No.: C10941

Adj Gse =	2.688						
Gsb =	2.628						
Gb =	1.02						
Pba =	0.86						
						Adj JMF	QC
Pb:	4.50	5.00	5.50	6.00	6.50	5.50	5.50
Pbe:	3.68	4.18	4.69	5.19	5.70	4.69	4.69
Pbe/100Gb:	0.036066	0.041010	0.045954	0.050898	0.055842	0.045954	0.045954
Ps/100Gsb:	0.363394	0.361492	0.359589	0.357686	0.355784	0.359589	0.359589
1/Gmm:	0.399460	0.402501	0.405543	0.408584	0.411626	0.405543	0.405543
Volume Ratio:	9.924673	11.344607	12.779567	14.229792	15.695528	12.779567	12.779567

Volume Ratio

Project: W. Marquam - N. Tigard
Contract No.: C10952

Gse =	2.741
Gsb =	2.666
Gb =	1.02
Pba =	1.05

						JMF	QC
Pb:	4.50	5.00	5.50	6.00	6.50	5.20	5.26
Pbe:	3.50	4.00	4.51	5.01	5.52	4.20	4.27
Pbe/100Gb:	0.034287	0.039240	0.044194	0.049147	0.054100	0.041222	0.041816
Ps/100Gsb:	0.358215	0.356339	0.354464	0.352588	0.350713	0.355589	0.355364
1/Gmm:	0.392501	0.395579	0.398657	0.401735	0.404813	0.396810	0.397180
Volume Ratio:	9.571572	11.012038	12.467747	13.938942	15.425872	11.592479	11.767089

Volume Ratio

Project: Sunset Hwy - Pacific Hwy
Contract No.: C11468

Gse =	2.695
Gsb =	2.668
Gb =	1.011
Pba =	0.38

						Adj JMF	QC
Pb:	4.00	4.50	5.00	5.50	6.00	5.60	5.20
Pbe:	3.64	4.14	4.64	5.14	5.64	5.24	4.84
Pbe/100Gb:	0.035956	0.040921	0.045885	0.050850	0.055814	0.051843	0.047871
Ps/100Gsb:	0.359820	0.357946	0.356072	0.354198	0.352324	0.353823	0.355322
1/Gmm:	0.395777	0.398867	0.401957	0.405048	0.408138	0.405666	0.403193
Volume Ratio:	9.992905	11.43213	12.88651	14.35628	15.84169	14.65211	13.47256

Volume Ratio

Project: Wolf Cr. - W.Fk. Dairy Cr.
Contract No.: C11229

Gse =	2.694						
Gsb =	2.648						
Gb =	1.03						
Pba =	0.67						
						Adj JMF	QC
Pb:	4.50	5.00	5.50	6.00	6.50	6.00	6.00
Pbe:	3.86	4.36	4.87	5.37	5.87	5.37	5.37
Pbe/100Gb:	0.037477	0.042364	0.047251	0.052138	0.057025	0.052138	0.052138
Ps/100Gsb:	0.360650	0.358761	0.356873	0.354985	0.353097	0.354985	0.354985
1/Gmm:	0.398127	0.401125	0.404124	0.407123	0.410121	0.407123	0.407123
Volume Ratio:	10.39158	11.80843	13.24027	14.68735	16.1499	14.68735	14.68735

Volume Ratio

Project: Corbett - Multnomah Falls
Contract No.: C10939

Gse =	731
Gsb =	2.641
Gb =	1.02
Pba =	1.27

						Adj JMF	QC
Pb:	4.50	5.00	5.50	6.00	6.50	5.50	5.42
Pbe:	3.29	3.79	4.30	4.81	5.31	4.30	4.22
Pbe/100Gb:	0.032227	0.037191	0.042155	0.047120	0.052084	0.042155	0.041361
Ps/100Gsb:	0.361605	0.359712	0.357819	0.355926	0.354033	0.357819	0.358122
1/Gmm:	0.393832	0.396903	0.399974	0.403045	0.406116	0.399974	0.399483
Volume Ratio:	8.912189	10.33915	11.78121	13.2386	14.71159	11.78121	11.54945

Volume Ratio

Project: Mt Hood - Long Prairie
Contract No.: C11400

Gse =	2.695						
Gsb =	2.648						
Gb =	1.021						
Pba =	0.67						
						Adj JMF	QC
Pb:	4.50	5.00	5.50	6.00	6.50	6.00	5.97
Pbe:	3.86	4.36	4.87	5.37	5.87	5.37	5.34
Pbe/100Gb:	0.037808	0.042738	0.047667	0.052597	0.057527	0.052597	0.052302
Ps/100Gsb:	0.360650	0.358761	0.356873	0.354985	0.353097	0.354985	0.355098
1/Gmm:	0.398457	0.401499	0.404541	0.407582	0.410624	0.407582	0.407400
Volume Ratio:	10.48318	11.91252	13.35698	14.81681	16.29226	14.81681	14.72879

Volume Ratio

Project: Rufus - Arlington (W. Unit)
Contract No.: C11256

Gse =	2.894
Gsb =	2.850
Gb =	1.02
Pba =	0.55

						Adj JMF	QC
Pb:	5.00	5.50	6.00	6.50	7.00	5.80	5.78
Pbe:	4.48	4.98	5.48	5.99	6.49	5.28	5.26
Pbe/100Gb:	0.043897	0.048826	0.053755	0.058684	0.063613	0.051783	0.051586
Ps/100Gsb:	0.333333	0.331579	0.329825	0.328070	0.326316	0.330526	0.330596
1/Gmm:	0.377230	0.380405	0.383579	0.386754	0.389929	0.382310	0.382183
Volume Ratio:	13.16912	14.7253	16.29803	17.88758	19.49423	15.66693	15.60397

Volume Ratio

Project: Rufus - Arlington (E. Unit)
Contract No.: C10949

Gse =	2.769
Gsb =	2.634
Gb =	1.02
Pba =	1.89

						Adj JMF	QC
Pb:	4.50	5.00	5.50	6.00	6.50	5.30	5.30
Pbe:	2.70	3.20	3.71	4.22	4.73	3.51	3.51
Pbe/100Gb:	0.026422	0.031417	0.036411	0.041406	0.046400	0.034413	0.034413
Ps/100Gsb:	0.362566	0.360668	0.358770	0.356872	0.354973	0.359529	0.359529
1/Gmm:	0.388988	0.392085	0.395181	0.398278	0.401374	0.393943	0.393943
Volume Ratio:	7.287508	8.710684	10.14892	11.60246	13.07154	9.571803	9.571803

Volume Ratio

Project: Umatilla - McNary
Contract No.: C11245

Gse =	2.808
Gsb =	2.772
Gb =	1.02
Pba =	0.48

						Adj JMF	QC
Pb:	5.00	5.50	6.00	6.50	7.00	6.20	6.29
Pbe:	4.54	5.05	5.55	6.05	6.55	5.75	5.84
Pbe/100Gb:	0.044549	0.049475	0.054400	0.059325	0.064251	0.056370	0.057257
Ps/100Gsb:	0.342713	0.340909	0.339105	0.337302	0.335498	0.338384	0.338059
1/Gmm:	0.387262	0.390384	0.393505	0.396627	0.399749	0.394754	0.395316
Volume Ratio:	12.99893	14.51252	16.04221	17.58826	19.15094	16.65865	16.93691

Volume Ratio

Project: E. Pendleton - Emigrant Hill
Contract No.: C11119

Gse =	2.739
Gsb =	2.711
Gb =	1.02
Pba =	0.39

						Adj JMF	QC
Pb:	4.00	4.50	5.00	5.50	6.00	6.00	6.46
Pbe:	3.63	4.13	4.63	5.13	5.63	5.63	6.10
Pbe/100Gb:	0.035545	0.040466	0.045387	0.050308	0.055229	0.055229	0.059757
Ps/100Gsb:	0.354113	0.352269	0.350424	0.348580	0.346736	0.346736	0.345039
1/Gmm:	0.389658	0.392735	0.395811	0.398888	0.401965	0.401965	0.404796
Volume Ratio:	10.03779	11.48731	12.95209	14.43237	15.9284	15.9284	17.31887

Volume Ratio

Project: Baldock Slough - S. Baker
Contract No.: C10930

Gse =	2.692
Gsb =	2.627
Gb =	1.02
Pba =	0.93

						Adj JMF	QC
Pb:	4.50	5.00	5.50	6.00	6.50	5.50	5.45
Pbe:	3.61	4.12	4.62	5.13	5.63	4.62	4.57
Pbe/100Gb:	0.035410	0.040358	0.045305	0.050253	0.055200	0.045305	0.044811
Ps/100Gsb:	0.363533	0.361629	0.359726	0.357823	0.355919	0.359726	0.359916
1/Gmm:	0.398943	0.401987	0.405031	0.408076	0.411120	0.405031	0.404727
Volume Ratio:	9.740612	11.16001	12.59442	14.04409	15.50927	12.59442	12.4503

Volume Ratio

Project: Powell Butte - Prineville
Contract No.: C11573

Gse =	2.668						
Gsb =	2.644						
Gb =	1.015						
Pba =	0.35						
						Adj JMF	QC
Pb:	4.50	5.00	5.50	6.00	6.50	5.20	5.20
Pbe:	4.17	4.67	5.17	5.67	6.17	4.87	4.87
Pbe/100Gb:	0.041042	0.045985	0.050929	0.055872	0.060815	0.047963	0.047963
Ps/100Gsb:	0.361195	0.359304	0.357413	0.355522	0.353631	0.358548	0.358548
1/Gmm:	0.402237	0.405289	0.408342	0.411394	0.414446	0.406510	0.406510
Volume Ratio:	11.3628	12.79841	14.24922	15.71546	17.19739	13.3769	13.3769

Volume Ratio

Project: Willowdale - Qualle Rd
Contract No.: C11572

Gse =	2.671
Gsb =	2.635
Gb =	1.019
Pba =	0.52

						Adj JMF	QC
Pb:	4.50	5.00	5.50	6.00	6.50	5.50	5.22
Pbe:	4.00	4.51	5.01	5.51	6.01	5.01	4.73
Pbe/100Gb:	0.039288	0.044220	0.049152	0.054084	0.059017	0.049152	0.046390
Ps/100Gsb:	0.362429	0.360531	0.358634	0.356736	0.354839	0.358634	0.359696
1/Gmm:	0.401716	0.404751	0.407786	0.410821	0.413855	0.407786	0.406086
Volume Ratio:	10.84007	12.26518	13.70538	15.16089	16.63197	13.70538	12.897

Volume Ratio

Project: Forge Road - Lobert
Contract No.: C10874

Gse =	2.723						
Gsb =	2.625						
Gb =	1.02						
Pba =	1.4						
						Adj JMF	QC
Pb:	4.50	5.00	5.50	6.00	6.50	6.00	5.86
Pbe:	3.16	3.67	4.18	4.68	5.19	4.68	4.54
Ps:	95.50	95.00	94.50	94.00	93.50	94.00	94.14
Mass Ratios:							
Pbe/Ps*100:	3.3120	3.8632	4.4201	4.9830	5.5519	4.9830	4.8248
Ps/Pbe*100:	3019.2855	2588.5559	2262.3893	2006.8318	1801.1944	2006.8318	2072.6370
Unit Volumes:							
A:Pbe/100Gb:	0.0310	0.0360	0.0410	0.0459	0.0509	0.0459	0.0445
B:Ps/100Gsb:	0.3638	0.3619	0.3600	0.3581	0.3562	0.3581	0.3586
C:1/Gmm:	0.3948	0.3979	0.4010	0.4040	0.4071	0.4040	0.4032
Volume Ratios:							
A/B*100:	8.5236	9.9420	11.3753	12.8238	14.2879	12.8238	12.4167
A/C*100:	7.8542	9.0429	10.2135	11.3663	12.5017	11.3663	11.0452
B/A*100:	1173.2081	1005.8388	879.0998	779.7975	699.8927	779.7975	805.3675
B/C*100:	92.1458	90.9571	89.7865	88.6337	87.4983	88.6337	88.9548
(C-B)/C*100:	7.8542	9.0429	10.2135	11.3663	12.5017	11.3663	11.0452
(C-A)/C*100:	92.1458	90.9571	89.7865	88.6337	87.4983	88.6337	88.9548

Volume Ratio

Project: Williamson Riv. - Modoc Pt.
Contract No.: C11015

Gse =	2.757
Gsb =	2.687
Gb =	1.02
Pba =	0.97

						Adj JMF	QC
Pb:	4.00	4.50	5.00	5.50	6.00	5.20	5.11
Pbe:	3.07	3.57	4.08	4.58	5.09	4.28	4.19
Pbe/100Gb:	0.030086	0.035036	0.039985	0.044935	0.049884	0.041965	0.041074
Ps/100Gsb:	0.357276	0.355415	0.353554	0.351693	0.349833	0.352810	0.353145
1/Gmm:	0.387362	0.390451	0.393539	0.396628	0.399717	0.394775	0.394219
Volume Ratio:	8.421023	9.857712	11.30952	12.7767	14.25948	11.89454	11.63098

Volume Ratio

Project: Jumpoff Joe - N. Grants Pass
Contract No.: C11065

Gse =	2.877						
Gsb =	2.779						
Gb =	1.02						
Pba =	1.25						
						Adj JMF	QC
Pb:	4.00	4.50	5.00	5.50	6.00	5.00	4.95
Pbe:	2.80	3.31	3.81	4.32	4.83	3.81	3.76
Pbe/100Gb:	0.027451	0.032414	0.037377	0.042341	0.047304	0.037377	0.036881
Ps/100Gsb:	0.345448	0.343649	0.341850	0.340050	0.338251	0.341850	0.342030
1/Gmm:	0.372899	0.376063	0.379227	0.382391	0.385555	0.379227	0.378911
Volume Ratio:	7.946487	9.432367	10.93389	12.4513	13.98485	10.93389	10.78303

Volume Ratio

Project: Azalea - Jumpoff Joe SB
Contract No.: C11334

Gse =	2.955
Gsb =	2.898
Gb =	1.02
Pba =	0.68

						Adj JMF	QC
Pb:	4.50	5.00	5.50	6.00	6.50	5.60	5.56
Pbe:	3.85	4.35	4.86	5.36	5.86	4.96	4.92
Pbe/100Gb:	0.037751	0.042686	0.047622	0.052557	0.057492	0.048609	0.048214
Ps/100Gsb:	0.329538	0.327812	0.326087	0.324362	0.322636	0.325742	0.325880
1/Gmm:	0.367289	0.370499	0.373709	0.376918	0.380128	0.374351	0.374094
Volume Ratio:	11.45574	13.02156	14.60395	16.20317	17.81949	14.92244	14.79496

Volume Ratio

Project: Halsey Int. - Lane Co. Line SB
Contract No.: C11294

Gse =	2.657						
Gsb =	2.631						
Gb =	1.02						
Pba =	0.39						
						Adj JMF	QC
Pb:	4.50	5.00	5.50	6.00	6.50	6.00	6.00
Pbe:	4.13	4.63	5.13	5.63	6.14	5.63	5.63
Pbe/100Gb:	0.040466	0.045387	0.050308	0.055229	0.060150	0.055229	0.055229
Ps/100Gsb:	0.362980	0.361079	0.359179	0.357279	0.355378	0.357279	0.357279
1/Gmm:	0.403446	0.406467	0.409487	0.412508	0.415529	0.412508	0.412508
Volume Ratio:	11.14833	12.56988	14.00648	15.45836	16.92577	15.45836	15.45836

Volume Ratio

Project: Halsey Int. - Lane Co. Line NB
Contract No.: C11294

Gse =	2.663
Gsb =	2.631
Gb =	1.044
Pba =	0.48

						Adj JMF	QC
Pb:	4.50	5.00	5.50	6.00	6.50	5.80	5.80
Pbe:	4.04	4.54	5.05	5.55	6.05	5.35	5.35
Pbe/100Gb:	0.038713	0.043525	0.048337	0.053149	0.057962	0.051225	0.051225
Ps/100Gsb:	0.362980	0.361079	0.359179	0.357279	0.355378	0.358039	0.358039
1/Gmm:	0.401692	0.404604	0.407516	0.410428	0.413340	0.409263	0.409263
Volume Ratio:	10.66523	12.05411	13.45768	14.87618	16.30986	14.30698	14.30698

APPENDIX D

JOB MIX FORMULAS AND PROJECT QUALITY CONTROL STATISTICS FOR 2001 CONSTRUCTION PROJECTS

** COPY ** OREGON DEPARTMENT OF TRANSPORTATION ** COPY **
MATERIALS LABORATORY
800 AIRPORT RD. SE SALEM, OR 97301-4798
(503) 986-3100
FAX (503) 986-3096

Contract No.: C12322 **EA No.: CON01427** **Lab No.: 00-001439**
Project: SHOGREN - ROWENA, PHASE 2 & W. MAYER STATE PARK - ROWENA
Highway: COLUMBIA RIVER County: WASCO **Data Sheet No.: NONE**
Contractor: ROSS BROS. & CO. FA No.: NH-BRO-STP-S002(26)
Project Manager: CARL MICKELSON Org Unit: 4821 Bid Item No.: NONE
Material Source: 33-079-4 SUN ROCK QUARRY Qty Represented: T
Sampled At: N/A Sampled By: N/A Witnessed By: N/A
DATE-Sampled: N/A Received: Tested: 00/ 5/16 Reported:
Type of Test: Contr. Open Graded Design **Use: LEVEL 4 19MM OPEN MIX w/Lime**

CONTRACTOR BITUMINOUS MIX DESIGN REVIEW

Mix Design Lab : Chris Hardwick & Assoc. CMD Technician : Chris Hardwick
HMAC Supplier : RL Houck
Asphalt Brand : MCCALL Asphalt Grade : PBA-6 **Original Mix Design No. : 00-01439**

If excess free asphalt is observed pooling in the windrow or mat, reduce the asphalt in 0.2% increments until no excess asphalt is observed, or contact Mike Remily, Pavement Quality Engineer for recommendations.

THE RECOMMENDED ASPHALT CONTENT FOR WEARING COURSE DRAIN MATERIAL (WCDM) IS 3.5%. GRADATION SHOULD BE MAINTAINED WITHIN THE SPECIFICATION FOR 19.0-6.3 MM AGGREGATE.

STOCKPILE PERCENTS

Aggregate Size :	19-12.5	12.5-6.3	6.3-0	LIME
Percent Comb. :	35	41	23	1

JOB MIX FORMULA

Sieve	% Pass
31.5 mm	100
25.0	100
19.0	91
12.5	64
9.5	42
4.75	20
2.36	13
600 µm	7
75	3.4

Paving Course	% Asphalt by Wt. of Mixture (Pb)	Max. Specific Gravity (Gmm)
Wearing Course	5.3	2.556

Mixing Temperature : 133-138 °C
Placement Temperature : 123-128 °C

Tensile Strength Ratio : 100
Combined Aggregate Gravity (Gsb) : 2.772

Approved: Brian M. Patterson 5-19-00

TM 301 =$ 0.
$

REMARKS:

Mix design **DOES** comply with mix design criteria.
*

TOTAL LAB CHARGES: $ 0.00

: FILES ; FHWA ; PROJ MGR: CARL MICKELSON ; RAS 4 ; ROSS BROS. & CO. ; D. DOMINICK - PAVEMENTS BITUMINOUS ; REG 4 Q.A. COORDINATOR

P O Box 25250
Portland, OR 97298
Phone (503) 590-8378
Fax (503) 590-2741

Chris Hardwick and Associates

To:	DICK DOMINICK	Fax:	(541) 986-3096
From:	Chris Hardwick	Date:	5/15/00
Re:	JMF – SHOGREN ROWENA – F mix	Pages:	8 with cover
CC:	ROSS BROTHERS AND COMPANY		

Note: WITH LIME

JMF F MIX - ROSS
SHOGREN C 12,322

CHRIS HARDWICK AND ASSOCIATES

POST OFFICE BOX 25250
PORTLAND, OREGON 97298
(503) 590 8378 FAX 590 2741

00-01439

May 15, 2000

ASPHALTIC CONCRETE JOB MIX FORMULA FOR AN OREGON DEPARTMENT OF TRANSPORTATION 19 mm OPEN GRADED HOT MIX ASPHALT CONCRETE WITH PBA-6 LIQUID ASPHALT FROM THE MCCALL OIL COMPANY PREPARED FOR: ROSS BROTHERS AND COMPANY

This report covers the laboratory test results for an asphaltic concrete hot mix using crushed aggregate from the Sun Rock Quarry (Source #33-079-04) and was treated with 1.0% lime. The bituminous mixture was tested using procedures contained in the Asphalt Institute's MS-2 Manual and the current "Oregon Department of Transportation (ODOT) Contractor Hot Mix Asphaltic Concrete Design Guidelines". The final blended aggregate gradation was within the grading bands for an Oregon Department of Transportation 19.0 mm Open Graded asphaltic concrete. PBA-6 liquid asphalt from McCall Oil Company was used to prepare this job mix formula. A Tensile Strength Ratio Test was conducted on eight samples of Class "B" mix at a bitumen content of 5.3% with 1.0% lime and the TSR test value was over 100% which is above the 80% minimum required by ODOT.

I appreciate this opportunity to be of service.

Sincerely,

Chris Hardwick
ODOT Certified Mix
Design Technician

ROSS BROTHERS AND COMPANY
MAY 15, 2000
PAGE 1 - ODOT CLASS 'F' HOT-MIX

SHOGREN-ROWENA - PHASE II
ODOT CONTRACT NO. C 12,322
PBA-6 - MCCALL OIL COMPANY

TEST RESULTS
AASHTO T 166 AND T 209

VOLUME OF COMPACTED SAMPLE, AIR VOIDS AND VOIDS IN MINERAL AGGREGATE

The ODOT Job Mix Formula for open graded mixes is based on the above tests. The air voids for this formula were computed based on the Rice Method (ASTM D2041 / AASHTO T209). The specimens were mixed at 138 degrees C (800 ± 100 cSt) and compacted at 128 degrees C (1400 ± 200 cSt) in accordance with the current ODOT Guideline for the test procedure.

MARSHALL TEST RESULTS

BITUMEN CONTENT	DRAIN DOWN	VOIDS FILLED	TOTAL AIR VOIDS	Bulk Specific Gravity	Max. Specific Gravity
4.5%	70%	35	16.3%	2.168	2.591
5.5%	80%	45	13.9%	2.194	2.547
6.5%	99%	54	11.9%	2.208	2.505
Maximum	80%	50%	16.0%		
Minimum	70%	40%	13.5%		

SIEVE SIZE	MIX FORMULA	ODOT GRADING BAND
25.0 mm	**100%**	99% TO 100%
19.0 mm	**91%**	85% TO 96%
12.5 mm	**64%**	55% TO 71%
9.5 mm	**42%**	
4.75 mm	**20%**	10% TO 24%
2.36 mm	**13%**	6% TO 16%
600 um	**7%**	
75 um	**3.4%**	1.0% TO 6.0%
BITUMEN CONTENT	**5.3%**	

ROSS BROTHERS AND COMPANY
MAY 15, 2000
PAGE 2 - ODOT CLASS 'F' HOT-MIX

SHOGREN-ROWENA - PHASE II
ODOT CONTRACT NO. C 12,322
PBA-6 - MCCALL OIL COMPANY

BLEND OF AGGREGATE AT THE COLD FEED

19 - 12.5 mm	12.5 - 6.3 mm	6.3 - 0 mm	LIME	BLEND	SIEVE SIZE
35	41	23	1	100	
75	100	100	100	91%	19 mm - 3/4"
9	91	100	100	64%	12.5 mm - 1/2"
3	42	100	100	42%	9.5 mm - 3/8"
2	1	77	100	20%	4.75 mm - #4
2	1	49	100	13%	2.36 mm - #8
1	1	21	100	7%	600 um - #30
1.1	0.8	7.4	100.0	3.4%	75 um - #200

HOT MIX PROPERTIES AT BITUMEN TARGET VALUE

VOIDS IN MINERAL AGGREGATE	25.5	VMA
PERCENT AIR VOIDS (RANGE 13.5% TO 16.0%)	14.4%	AIR VOIDS
TENSILE STRENGTH RATIO (80% MIN.) ON B MIX	100%	TSR (1.0% LIME)
BITUMEN CONTENT AT 75% DRAIN DOWN	5.30%	BITUMEN CONTENT
MAXIMUM SPECIFIC GRAVITY AT TARGET VALUE	2.556	SPECIFIC GRAVITY
UNIT WEIGHT IN POUNDS PER CUBIC FOOT	159.5	POUNDS/CUBIC FOOT
BULK SPECIFIC GRAVITY AT TARGET VALUE	2.189	SPECIFIC GRAVITY
UNIT WEIGHT IN POUNDS PER CUBIC FOOT	136.6	POUNDS/CUBIC FOOT
VOIDS FILLED WITH ASPHALT	42%	VOIDS FILLED
COMBINED AGGREGATE SPECIFIC GRAVITY	2.772	GSB

ROSS BROTHERS AND COMPANY
MAY 15, 2000
PAGE 3 - ODOT CLASS 'F' HOT-MIX

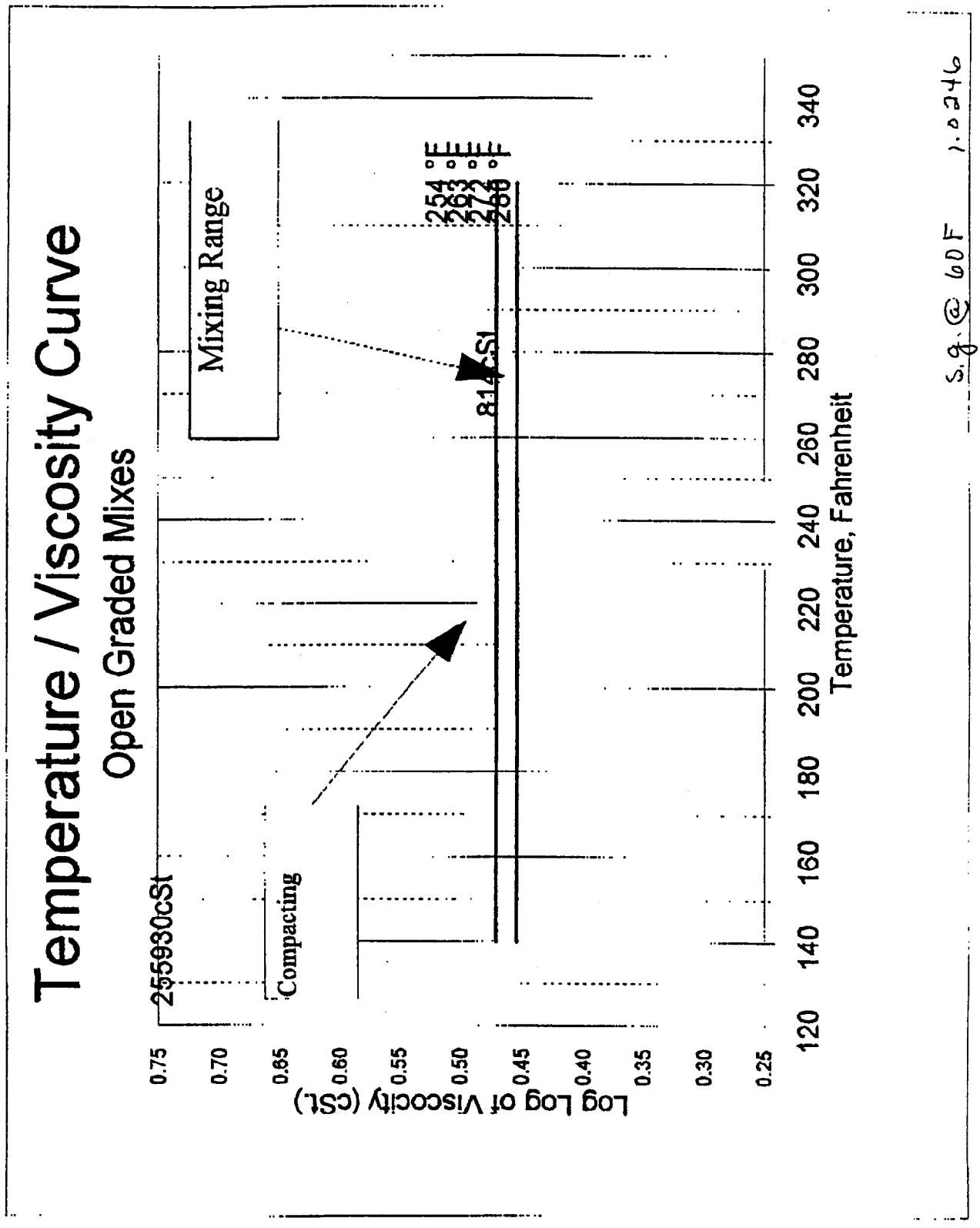
SHOGREN-ROWENA - PHASE II
ODOT CONTRACT NO. C 12,322
PBA-6 - MCCALL OIL COMPANY

#1 - AASHTO T84 & T85 Specific Gravity - 19 mm to 12.5 mm				35	2.792
#2 - AASHTO T84 & T85 Specific Gravity - 12.5 mm to 6.3 mm				41	2.775
#3 - AASHTO T84 & T85 Specific Gravity - 6.3 mm to 0				24	2.738
LIQUID ASPHALT SPECIFIC GRAVITY					1.025
TOTAL BITUMEN	4.5%	5.5%	6.5%		
% Total Aggregate	95.5%	94.5%	93.5%		
% Aggregate #1	33.4%	33.1%	32.7%		
% Aggregate #2	39.2%	38.7%	38.3%		
% Aggregate #3	22.9%	22.7%	22.4%		
Combined = Gsb	2.772	2.772	2.772		
Max. Sp Gr = Gmm	2.591	2.547	2.505		
Bulk Sp Gr = Gmb	2.168	2.194	2.208		
EFF SP GR	2.792	2.788	2.785		
% ABSORBED	0.3%	0.2%	0.2%		
% EFFECTIVE	4.2%	5.3%	6.3%		
VMA	25.3	25.2	25.5		
% AIR VOIDS	16.3%	13.9%	11.9%		
AC VOLUME	9.5	11.8	14.0		
VOL AB AC	0.5	0.4	0.3		
VOL AGG	74.7	74.8	74.5		
VOIDS FILLED	35.5	45.0	53.5		
MAX LBS	161.7	158.9	156.3		
BULK LBS	135.3	136.9	137.8		
DRAIN DOWN	70%	80%	99%		
TSR (on B mix)		97%			

Project:	Shogren - Rowena - phase II		Mix Class	19 Mm Open Graded
Contract No.	C 12,322		Duty	HEAVY DUTY
Contractor	ROSS BROTHERS AND COMPANY		ODOT Manager	CARL MICKELSON
Material	19 - 12.5 mm	12.5 - 6.3 mm	6.3 - 0 mm	LIME
Percentages	35	41	23	1%
Source	33-079-04	33-079-04	33-079-04	
Soundness Loss	0%	0%	0%	
Abrasion Loss	17.1% (B)	17.1% (B)	na	
Degrade / mm	5 mm	5 mm	7 mm	
Degrade P/#20	13.4%	13.4%	12.8%	
Fractured faces	100.0%	100.0%	100.0%	
Lightweight %	0	0	na	
Wood Particles	0	0	na	
Dust/Clay %	0	0	na	
Bulk Sp Gr Gsb	2.792	2.775	2.738	
Absorption %	1.9%	2.0%	2.4%	

Mix at Design Asphalt Content	
Max Sp Gr Gmm	2.556
Bulk Sp Gr Gmb	2.189
% Air Voids Va	14.4%
VMA %	25.5%
VFA %	42%
Effective AC %	5.09%
Dust/Oil Ratio	na
Kg/cu M - Rice	25560
Total Rock Gsb	2.772
Tensile Strength	100%
TSR Blows	48
Gmm Dry Back	
Hammer Factor	
Hammer No.	H-CHA-771
Drain Down F mix	5.30%
Date:	MAY 15, 2000
By:	Chris Hardwick

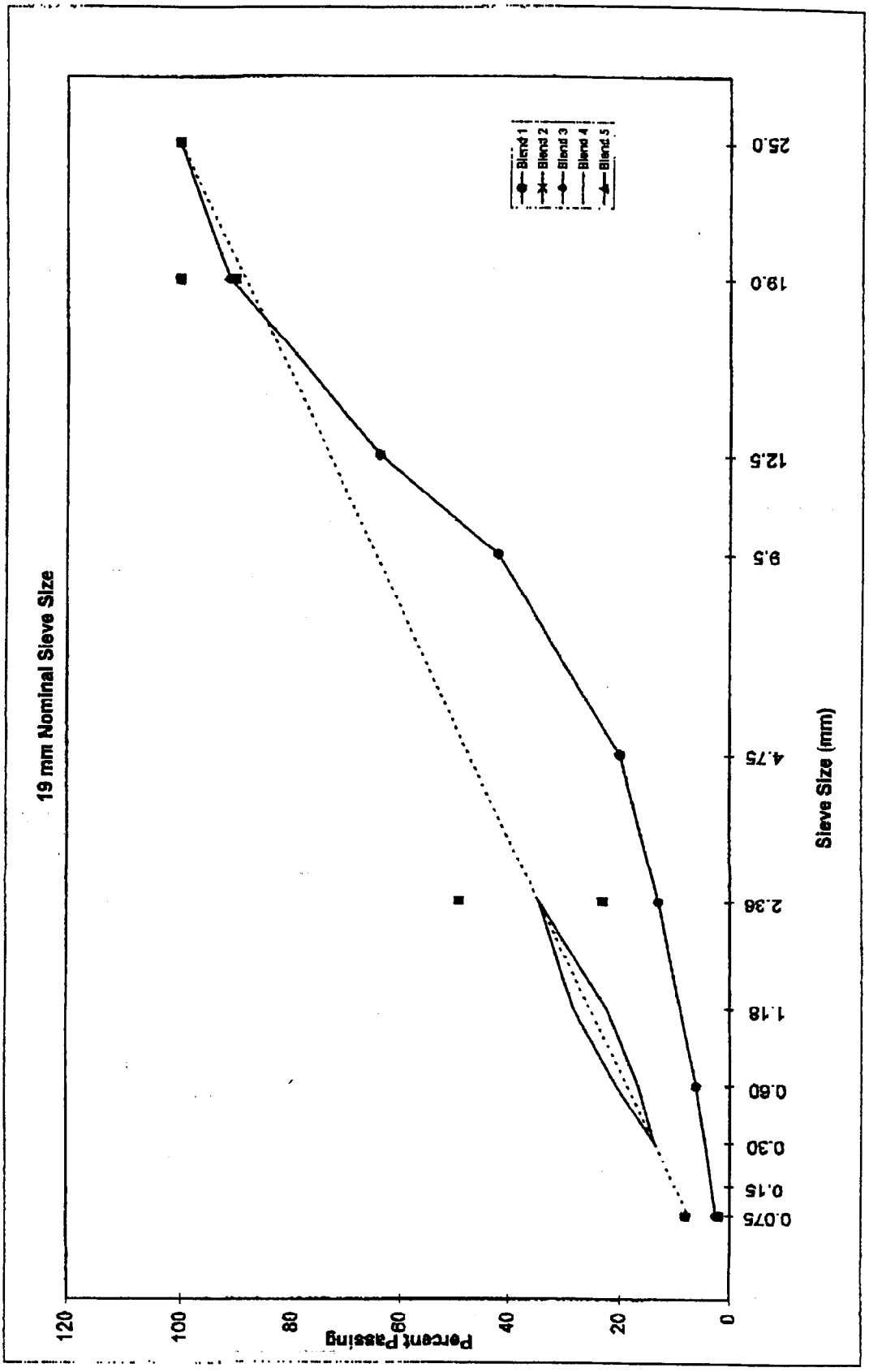
Job Mix Formula Aggregate Gradation and Bitumen Targer Values	
37.5 mm	100%
25.0 mm	100%
19.0 mm	91%
12.5 mm	64%
9.5 mm	42%
4.75 mm	20%
2.36 mm	13%
600 um	7%
75 um	3.4%
Asphalt Content	5.30%
Anti strip %	1.0% lime
Asphalt Brand	McCall Oil Company
Asphalt Grade	PBA-6
Mixing Temperature	133 - 138 C (272 - 280 F)
Compaction Temperature	123 - 128 C (254 - 263)
Asphalt SP GR (25/25 C) Gb	1.020
Asphalt SP GR (15.6/15.6 C) Gb	1.025


McCall Oil Company - Portland, Oregon
Temperature / Viscosity Curve
Open Graded Mixes
Mixing Range
Compacting
255930cSt
814 cSt
254 °F
263 °F
272 °F
280 °F
Log Log of Viscosity (cSt.)
0.75
0.70
0.65
0.60
0.55
0.50
0.45
0.40
0.35
0.30
0.25
120
140
160
180
200
220
240
260
280
300
320
340
Temperature, Fahrenheit
S.g. @ 60F 1.0246

19.0 mm OPEN GRADED HOT MIX

Project Name: SHOGREN - ROWENA - PHASE II
Technician: CHRIS HARDWICK
Date: 5/10/00

Filename: Pine1901
Description: OPEN GRADED CLASS F MIX
Nominal Sieve Size: 19 mm



OPEN GRADED MIX DATA SHEET

Gb: 2.772
Gsb: 1.020

PROJECT:	Shoptau-Rowena
Contract No. :	C12322
Source:	Sun Rock Quarry (33-079-4)
Mix Class:	F (4-4) w/ lime
Mix No. :	00-91 Date: 051900

Asphalt Lab No. :		
Brand of Asphalt:		McCall
Apshalt Grade / PBA:		PBA-6
Mixing Temp:		133-138
Comp Temp:		123-128
Additives:	X	X
Percent:		

Add Lime

STOCKPILE SPLITS

Stockpile:	19-12.5	Stockpile:	12.5-6.3	Stockpile:	6.3-0	Stockpile	Lime
@ Percent:	35	@ Percent:	41	@ Percent:	23	@ Percent:	1

DRAIN DOWN AND RICE GRAVITY

AGGREGATE WT. OF SAMPLE= 1003.2 gm. TOTAL WT. OF SAMPLE= gm.

PERCENT ASPHALT		4.5		5.5			6.5
gm OF ASPHALT		47.3		58.4			69.7
COMPACTION TEMPERATURE		135					
ASPHALT FILM THICKNESS		Suf		Suf/Thk			Thk
DRAIN DOWN		20		75			95
MAXIMUM SP. GR. (T-209)		2.606		2.576			2.512
VOIDS	13.6	13.1		11.8	12.0	10.5	9.3
Gse		2.812 ✓		2.827			2.796
Corrected Max Sp. Gr.		2.606		2.564			2.524
VMA		22.4		23.1			23.8
VFA		39.4		48			56

2.8

RECOMMENDED ASPHALT CONTENT: 5.4

VA = 12.2
VFA = 47
DD = 70

Same

Sample #	1	Agg. Wt. :	5010.5	Asphalt Wt. :	236.1	Total Wt:	1750
Asphalt %	Ht of Brick	Wt. Of Brick	Sp. Gr. 2.268				
4.5	3.72	1738.5	2.276				
Sample #	2	Agg. Wt. :		Asphalt Wt. :		Total Wt:	
Ashpalt %	Ht of Brick	Wt. Of Brick	Sp. Gr. 2.244		2.264		
4.5	3.76	1738.3	2.252				2.25
Sample #	3	Agg. Wt.		Asphalt Wt. :	348.3	Total Wt:	2.2
% Asphalt	Ht of Brick	Wt. Of Brick	Sp. Gr. 2.291				
6.5	3.66	1726.8	2.298				
Sample #	4	Agg. Wt.		Asphalt Wt. :		Total Wt:	
%Asphalt	Ht of Brick	Wt. Of Brick	Sp. Gr. 2.253		2.279		
6.5	3.73	1731.1	2.260				

CONTRACTOR ASPHALT CONTENT: 5.3

DRAINDOWN VALUE: 76

OREGON DEPARTMENT OF TRANSPORTATION
MATERIALS LABORATORY
800 AIRPORT RD. SE SALEM, OR 97301-4798

(503)986-3100
FAX(503)986-3096

Contract No.: C12322 **EA No.: CON01427** **Lab No.: 00-000964**
Project: SHOGREN - ROWENA, PHASE 2 & W. MAYER STATE PARK - ROWENA
Highway: COLUMBIA RIVER County: WASCO **Data Sheet No.: F1367 004**
Contractor: ROSS BROS. & CO. FA No.: NH-BRO-STP-S002(26)
Project Manager: CARL MICKELSON Org Unit: 4821 Bid Item No.: 750 & 760
Submitted By: ELDON SAMPLEY Org Unit: Sample No.: 1
Material Source: 33-079-4 SUN ROCK QUARRY Qty Represented: MIX DESIGN & 0-5
Sampled At: FINAL BELT Sampled By: Witnessed By:
DATE-Sampled: 00/ 3/21 Received: 00/ 3/22 Tested: 00/ 4/24 Date Reported: 4-25-00
Class/Type: COMPLIANCE MIX DESIGN **Use: COARSE AC AGGR**

Q or G: QUARRY

AGGREGATE LABORATORY REPORT - CACAG

Size: 19.5mm-12.5mm

Test	Lab
TM101 S.E.	
TM102 L.L.	
TM103 P.I.	
TM213 Ttl Frac.	
TM226 Dust/Clay	
TM227 Cleanness	
TM229 Elong pcs	2.4 %
TM234 Uncomp. Voids	
TM201 unit Wt.	
TM311 Moisture	

TM 204/205 Sieve	204 Passing	205 Passing
63 mm		
50		
37.5		
25.0	100 %	100 %
19.0	72 %	73 %
12.5	9 %	9 %
9.5	3 %	3 %
6.3	1 %	1 %
4.75	1 %	1 %
2.36	1 %	1 %
2.00		
1.18		
600 µm	1 %	1 %
425		
300		
150		
75	0.4 %	0.5 %

TM 202 F. Grav.
Bulk:
S.S.D.:
Appar.:
Absorp.:

TM 203 C. Grav.
Bulk: 2.788
S.S.D.: 2.843
Appar.: 2.952
Absorp.: 1.99 %

TM 206 Soundness
C A: 0% F A:
37.5-19.0: 0.1 %
19.0- 9.5: 0.2 %
9.5-4.75: 0.0 %
4.75-2.36:
2.36-1.18:
1.18-600 µm:
600 µm-300 :

TM 208 Degrade
Crse Ht: 5 mm
P20: 13.4 %
Fine Ht:
P20:

TM 211 Abrasion
17.1 %
Type B

TM 212 Impurity
Plate #:

TM 213 Fracture
DF: 19.0: 100 %
12.5: 100 %
9.5:
6.3: 100 %
SF: 4.75-2.00: 100 %

TM 221 Friables
Wt'd Avg :
37.5-19.0:
19.0-9.5 :
9.5-4.75:
4.75-1.18:

TM 222 Lightweight
Coarse: 0.0 %
Fine:

TM 225 Woodwaste
Lab:
Field:

8	233x	$
2	204	
1	205	
1	203	
2	206	
1	208a	
1	211	
1	213	
1	222	

NSM = Not Sufficient Material

TOTAL CHARGES: $ 0.00

REMARKS:
Material represented by sample **DOES** comply with specifications.

*

Richard L. Starnes
STATE CONSTRUCTION AND MATERIALS ENGINEER

C: FILES ; PROJ MGR: CARL MICKELSON ; ROSS BROS. & CO. ; RAS 4 ; D. DOMINICK - PAVEMENTS

OREGON DEPARTMENT OF TRANSPORTATION
MATERIALS LABORATORY
800 AIRPORT RD. SE SALEM, OR 97301-4798

(503)986-3100
FAX(503)986-3096

Contract No.: C12322 **EA No.: CON01427** **Lab No.: 00-000965**
Project: SHOGREN - ROWENA, PHASE 2 & W. MAYER STATE PARK - ROWENA
Highway: COLUMBIA RIVER County: WASCO **Data Sheet No.: F1367 005**
Contractor: ROSS BROS. & CO. FA No.: NH-BRO-STP-S002(26)
Project Manager: CARL MICKELSON Org Unit: 4821 Bid Item No.: 750 & 760
Submitted By: ELDON SAMPLEY Org Unit: Sample No.:
Material Source: 33-079-4 SUN ROCK QUARRY Qty Represented: MIX DESIGN
Sampled At: FINAL BELT Sampled By: Witnessed By:
DATE-Sampled: 00/ 3/21 Received: 00/ 3/22 Tested: 00/ 4/24 Date Reported: 4-25-00
Class/Type: COMPLIANCE MIX DESIGN **Use: COARSE AC AGGR**

Q or G: QUARRY **AGGREGATE LABORATORY REPORT - CACAG** **Size: 12.5mm-4.75mm**

Test	Lab
TM101 S.E.	
TM102 L.L.	
TM103 P.I.	
TM213 Ttl Frac.	
TM226 Dust/Clay	
TM227 Cleanness	
TM229 Elong pcs	4.5 %
TM234 Uncomp. Voids	
TM201 unit Wt.	
TM311 Moisture	

TM 204/205 Sieve	204 Passing	205 Passing
63 mm		
50		
37.5		
25.0		
19.0	100 %	100 %
12.5	93 %	93 %
9.5	52 %	54 %
6.3	3 %	3 %
4.75	1 %	1 %
2.36	0 %	1 %
2.00		
1.18		
600 µm	0 %	1 %
425		
300		
150		
75	0.2 %	0.5 %

TM 202 F. Grav.
Bulk:
S.S.D.:
Appar.:
Absorp.:

TM 203 C. Grav.
Bulk: 2.794
S.S.D.: 2.854
Appar.: 2.973
Absorp.: 2.16 %

TM 206 Soundness
C A: 0% F A:
37.5-19.0:
19.0- 9.5: 0.1 %
9.5-4.75: 0.3 %
4.75-2.36:
2.36-1.18:
1.18-600 µm:
600 µm-300 :

TM 208 Degrade
Crse Ht: 5 mm
P20: 13.4 %
Fine Ht:
P20:

TM 211 Abrasion
17.1 %
Type B

TM 212 Impurity
Plate #:

TM 213 Fracture
DF: 19.0:
12.5: 100 %
9.5:
6.3: 100 %
SF: 4.75-2.00: 100 %

TM 221 Friables
Wt'd Avg :
37.5-19.0:
19.0-9.5 :
9.5-4.75:
4.75-1.18:

TM 222 Lightweight
Coarse: 0.0 %
Fine:

TM 225 Woodwaste
Lab:
Field:

8	233x	$
2	204	
1	205	
1	203	
2	206	
1	208a	
1	211	
1	213	
1	222	
1	229	

NSM = Not Sufficient Material

TOTAL CHARGES: $ 0.00

REMARKS:
Material represented by sample **DOES** comply with specifications.

*

Kenneth L. Stanton
STATE CONSTRUCTION AND MATERIALS ENGINEER

C: FILES ; PROJ MGR: CARL MICKELSON ; ROSS BROS. & CO. ; RAS 4 ; D. DOMINICK - PAVEMENTS

OREGON DEPARTMENT OF TRANSPORTATION
MATERIALS LABORATORY
800 AIRPORT RD. SE SALEM, OR 97301-4798

(503)986-3100
FAX(503)986-3096

Contract No.: C12322 **EA No.: CON01427** **Lab No.: 00-000966**
Project: SHOGREN - ROWENA, PHASE 2 & W. MAYER STATE PARK - ROWENA
Highway: COLUMBIA RIVER County: WASCO **Data Sheet No.: F1367 006**
Contractor: ROSS BROS. & CO. FA No.: NH-BRO-STP-S002(26)
Project Manager: CARL MICKELSON Org Unit: 4821 Bid Item No.: 750 & 760
Submitted By: ELDON SAMPLEY Org Unit: Sample No.:
Material Source: 33-079-4 SUN ROCK QUARRY Qty Represented: MIX DESIGN
Sampled At: FINAL BELT Sampled By: Witnessed By:
DATE-Sampled: 00/ 3/21 Received: 00/ 3/22 Tested: 00/ 4/20 Date Reported: 4-21-00
Class/Type: MIX DESIGN **Use: FINE AC AGGR**

Q or G: QUARRY

AGGREGATE LABORATORY REPORT - FACAG

Size: 6.3mm-0.0mm

Test	Lab
TM101 S.E.	
TM102 L.L.	
TM103 P.I.	
TM213 Ttl Frac.	
TM226 Dust/Clay	
TM227 Cleanness	
TM229 Elong pcs	
TM234	
Uncomp. Voids	49.0 %
TM201 Unit Wt.	
TM311 Moisture	

TM 204/205	204	205
Sieve	Passing	
63 mm		
50		
37.5		
25.0		
19.0		
12.5		
9.5	100 %	100 %
6.3	96 %	96 %
4.75	84 %	84 %
2.36	58 %	59 %
2.00		
1.18		
600 µm	28 %	28 %
425		
300		
150		
75	9.8 %	10.6 %

TM 202 F. Grav.
Bulk: 2.753
S.S.D.: 2.822
Appar.: 2.957
Absorp.: 2.51 %

TM 203 C. Grav.
Bulk:
S.S.D.:
Appar.:
Absorp.:

TM 206 Soundness

C A:	F A:
37.5-19.0:	
19.0- 9.5:	
9.5-4.75:	
4.75-2.36:	
2.36-1.18:	
1.18-600 µm:	
600 µm-300 :	

TM 208 Degrade
Crse Ht:
P20:
Fine Ht:
P20:

TM 211 Abrasion

TM 212 Impurity
Plate #:

TM 213 Fracture
DF: 19.0:
12.5:
9.5:
6.3:
SF: 4.75-2.00: 100 %

TM 221 Friables
Wt'd Avg :
37.5-19.0:
19.0-9.5 :
9.5-4.75:
4.75-1.18:

TM 222 Lightweight
Coarse:
Fine:

TM 225 Woodwaste
Lab:
Field:

2	204	$
1	205	
1	202	
1	213	
1	234	
8	233x	

NSM = Not Sufficient Material

TOTAL CHARGES: $ 0.00

REMARKS:
Material represented by sample **DOES** comply with specifications.

*

STATE CONSTRUCTION AND MATERIALS ENGINEER

C: FILES ; PROJ MGR: CARL MICKELSON ; ROSS BROS. & CO. ; RAS 4 ; D. DOMINICK - PAVEMENTS

STATISTICAL TESTING INPUT DATA 3.70.022

File: 19MMOPEN.SS Date: 05/03/2001-2:55:05 PM

Section:	Shogren - Rowena			Estimate #:			Source:	33-079-4				
Contract:	12322			Mix Design:	00-001439		% Lime:	1				
Contractor:	R L Houck			Specification #:	745QA		% RAP:	0				
Proj Mgr:	Carl Mickelson			Lot #:	1		A/C Brand:	Mccall				
Bid Item #:	760			Level:	4		A/C Grade:	PBA-6				
Matl Type:	19mm open			Lift:	wearing		Plant Type:	Drum				

Constituent #	1	2	3	4	5	6	7	8	9	10	11	12
Constituent	25mm	19mm	12.5mm	4.75mm	2.36mm	.600mm	.75mm	Asph	Moist	Comp		
Weight	1	1	1	5	5	3	10	26	8	40		
USL	100	5	5	5	4	4	2	0.2	1.1			
LSL	-1	-5	-5	-5	-4	-4	-2	-0.2	0			

Target 0 = -1E+09; 100 = 1E+09; 100

Value 0 = -1E+09; 100 = 1E+09

										% Asphalt	Mg.	Test#	Date
Sublot 001	0	3	5	3	2	0	-0.3	-0.15	0.79				
Sublot 002	0	2	1	0	-1	-1	-0.6	0.08	0.51				
Sublot 003	0	2	-2	0	0	0	0.5	0	0.69				
Sublot 004	0	2	-3	-4	-4	-3	-1.4	0.05	0.75				
Sublot 005	0	3	2	3	2	0	-0.3	0	0.45				
Sublot 006	0	2	1	1	0	0	-0.1	-0.02	0.66				
Sublot 007	0	1	3	0	0	-1	-0.7	0.08	0.55				
Sublot 008	0	0	-1	3	2	0	-0.3	0.03	0.65				
Sublot 009	0	1	1	0	0	0	0.1	0.01	0.61				
Sublot 010	0	1	0	2	1	0	-0.1	-0.02	0.6				
Sublot 011	0	2	1	2	1	0	0.1	0.02	0.6				
Sublot 012	0	1	3	4	2	0	-0.3	-0.03	0.6				
Sublot 013	-1	1	4	3	2	1	0.2	0.01	0.61				
Sublot 014	0	1	-1	0	0	-1	-0.4	-0.02	0.61				
Sublot 015	0	1	1	1	0	-1	-0.6	-0.02	0.66				
Sublot 016	0	-3	-4	-2	-1	-1	-0.1	0	0.62				
Sublot 017	0	2	4	-1	-1	-1	-0.5	0.04	0.65				
Sublot 018	0	0	-1	-1	-1	-1	-0.4	-0.01	0.59				
Sublot 019	0	0	-1	-1	-1	-1	-0.1	0.05	0.63				
Sublot 020	0	1	-1	-1	-1	-1	-0.1	0.04	0.54				
Sublot 021	0	0	-2	0	0	0	0	-0.01	0.63				
Sublot 022	0	1	1	1	0	0	-0.2	0	0.66				
Sublot 023	0	-1	-3	-2	-1	-1	-0.3	0.01	0.53				
Sublot 024	✓0	✓1	✓-1	✓-1	✓0	✓-1	✓-0.3	✓-0.01	✓0.54				
Sublot 025	✓0	✓1	✓1	✓1	✓0	✓0	✓-0.2	✓-0.01	✓0.54				

Post-it™ brand fax transmittal memo 7671 # of pages ▸ 2

To MIKE REMILEY	From TRAM MCCULLEY
Co. ODOT	Co. ODOT
Dept.	Phone # 1-541-296-2800
Fax # 1-503-986-3096	Fax #

✓ Scott W. Ryan
5-4-01

STATISTICAL COMPUTATIONS				3.70.022	File:	19MMOPEN.SS			Date:	.05/03/2001-2:55:05 PM		
Section:	Shogren - Rowena				Estimate #:				Source:		33-079-4	
Contract:	12322				Mix Design:		00-001439		% Lime:		1	
Contractor:	R L Houck				Specification #:		745QA		% RAP:		0	
Proj Mgr:	Carl Mickelson				Lot #:		1		A/C Brand:		Mccall	
Bid Item #:	760				Level:		4		A/C Grade:		PBA-6	
Matl Type:	19mm open				Lift:		wearing		Plant Type:		Drum	
Constituent #	1	2	3	4	5	6	7	8	9	10	11	12
Constituent	25mm	19mm	12.5mm	4.75mm	2.36mm	.600mm	.75mm	Asph	Moist	Comp		
Weight	1	1	1	5	5	3	10	26	8	40		
Sum X	-1	25	8	11	1	-13	-6.4	0.12	15.27	0		
Sum X^2	1	63	134	93	45	21	4.72	0.048	9.4579	0		
Samples	25	25	25	25	25	25	25	25	25	0		
Mean	- 0.0400	1.0000	0.3200	0.4400	0.0400	- 0.5200	- 0.2560	0.0048	0.6108	0.0000		
Std Dev	0.2000	1.2583	2.3402	1.9166	1.3687	0.7703	0.3583	0.0445	0.0739	0.0000		
Qu	5E+09	3.18	2	2.38	2.89	5.87	6.3	4.39	6.62	1E+09		
Ql	4.8	4.77	2.27	2.84	2.95	4.52	4.87	4.61	1.354E+10	1E+09		
Pu	100	100	99	100	100	100	100	100	100	100		
Pl	100	100	100	100	100	100	100	100	100	100		
P	100	100	99	100	100	100	100	100	100	100		
Pay Factor	1.05	1.05	1.04	1.05	1.05	1.05	1.05	1.05	1.05	1.00		
Wtd. Factor	1.050	1.050	1.040	5.250	5.250	3.150	10.500	27.300	8.400	40.000		
Sum of Weight Factors:			100									
Composite Pay Factor:			1.0299									

StatSpec 3.70

** COPY ** OREGON DEPARTMENT OF TRANSPORTATION ** COPY **

MATERIALS LABORATORY (503) 986-3100
800 AIRPORT RD. SE SALEM, OR 97301-4798 FAX (503) 986-3096

Contract No.: C12511 **EA No.: CON01607** **Lab No.: 01-002156**

Project: NESIKA BEACH - ROGUE RIVER

Highway: OREGON COAST County: CURRY **Data Sheet No.: NONE**
Contractor: LTM, INC FA No.: S-NH-S009(91)
Project Manager: RAY CRANSTON Org Unit: 3811 Bid Item No.: NONE
Material Source: 08-108-3 JOHN WAHL PIT 08-070-3 Qty Represented: T
Sampled At: N/A Sampled By: N/A Witnessed By: N/A
DATE-Sampled: N/A Received: Tested: 01/ 6/22 Reported:
Type of Test: Contr. Open Graded Design **Use: LEVEL 3 19MM OPEN MIX**

CONTRACTOR BITUMINOUS MIX DESIGN REVIEW

Mix Design Lab : Carlson Testing CMD Technician : Jason Bryant
HMAC Supplier : Bracelin Yeager
Asphalt Brand : CHEVRON Asphalt Grade : PG 64-22 **Original Mix Design No. : 01-02156**

Similar mix designs on previous projects have had optimum asphalt contents at approximately 5.9%.

This mix design was developed with aggregate from two sources. The aggregate is being blended at the crusher and placed in a dedicated stockpile. The blend is 60% from 08-108-3 and 40% from 08-070-3. The two aggregates have markedly different specific gravities. If the blends are not consistently accurate, the asphalt demand will vary resulting in excess or deficient asphalt coating of the aggregate.

STOCKPILE PERCENTS

Aggregate Size :	19-4.75	6.3-2.0	2.0-0
Percent Comb. :	82	7	11

JOB MIX FORMULA

Sieve	% Pass
31.5 mm	100
25.0	100
19.0	91
12.5	64
9.5	43
4.75	16
2.36	11
600 µm	6
75	2.6

Paving Course	% Asphalt by Wt. of Mixture (Pb)	Max. Specific Gravity (Gmm)
Wearing Course	5.8	2.503

Mixing Temperature : 124-129 °C
Placement Temperature : 116-121 °C

Void Target (Va) : 14.8
Tensile Strength Ratio : 82
Combined Aggregate Gravity (Gsb) : 2.679

Approved: Bruce M. Patterson 7-05-01

TM 301 =$ 0.
$

REMARKS:

Mix design **DOES** comply with mix design criteria.

TOTAL LAB CHARGES: $ 0.00

C: FILES ; FHWA ; PROJ MGR: RAY CRANSTON ; RAS 3 ; LTM, INC ; D. DOMINICK - PAVEMENTS BITUMINOUS ; REG 3 Q.A. COORDINATOR SULLIVAN QUARRY

Carlson Testing, Inc.

Main Office
P.O. Box 23814
Tigard, Oregon 97281
Phone (503) 684-3460
FAX (503) 684-0954

Salem Office
4060 Hudson Ave., NE
Salem, OR 97301
Phone (503) 589-1252
FAX (503) 589-1309

Bend Office
P.O. Box 7918
Bend, OR 97708
Phone (541) 330-915
FAX (541) 330-9163

Project Name (Section)	Nesika Beach - Rogue River
Highway	Oregon Coast
Contract Number	C12511
Contractor	Bracelin Yeager

Mixture Class	ODOT 19.0mm Open Grade
Mixture Duty (L,S,H)	Level 3
Project Manager	Ray Cranston
CTI JMF NO. 01.25	CTI JOB NO. T0106590

No APA required 01-2156

Stockpile Sizes	19x4.75	6.3x2.00	2.00-0					
Stockpile Percentages	82%	7%	11%					

COARSE AGGREGATE:

Size		19x4.75mm	6.3x2.00mm
Source		8-108-3	8-108-3
Soundness Loss (%)		8-070-3	8-070-3
Abrasion Loss (%)			
Degradation:			
Sediment Height (mm)			
% Passing 85um sieve			
Fractured Faces (%)			
Lightweight Pieces (%)			
Wood Particles (%)			
Dust or Clay Coating (%)			
Elongated Pieces (%)			
Specific Gravity (Gsb)		2.703	2.602
Absorption (%)		1.65	2.29

FINE AGGREGATE:

Size			2.00-0mm
Source			8-108-3
Soundness Loss (%)			8-070-3
Sand Equivalent			
Degradation:			
Sediment Height (mm)			
% Passing 85um sieve			
Fractured Faces (%)			
Fine Agg. Angularity			
Specific Gravity (Gsb)			2.552
Absorption (%)			2.84

MIXTURE AT DESIGN BITUMEN CONTENT:

Maximum Specific Gravity (Gmm)	2.503
Marshall Bulk Specific Gravity (Gmb)	2.132
Total Air Voids (%) (Va)	14.8
VMA (%)	25.0
VFA (%)	40.8
Effective Bitumen Content (%) (Pbe)	4.9
P 0.075 mm / Bitumen Content ratio	0.5
P 0.075 mm / Pbe Ratio	0.4
Target maximum Density, Kg/C.M.	2503
Blended Bulk Specific Gravity (Gsb)	2.679
Tensile Strength Ratio (TSR)	82.1
TSR Compaction Blows	17
Gmm Dry Back Correction	
Compaction Apparatus (Make/Model)	Tinius Olsen/Super L
Compaction Apparatus Serial Number	105750
Draindown Percent (Open Graded)	72
CMDT Card Number	40118
Date	6/12/01
Signature	

JOB MIX FORMULA:

Aggregate Gradation:	
(Sieve Sizes)	
25mm (1")	100
19mm (3/4")	91
12.5mm (1/2")	64
9.5mm (3/8")	43
6.3mm (1/4")	
4.75mm (#4)	16
2.36mm (#8)	11
600um (#30)	6
75um (#200)	2.6
Total Bitumen Content (%)	5.8
RAP Bitumen Content @ Blend % Used	
Antistrip (%) / Brand	
Bitumen Brand	Chevron
Bitumen Grade	PG 64-22
Mixing Temperature (C)	127 124-129
Compaction Temperature (C)	118 116-121
Bitumen Specific Gravity (Gb) 25/25	1.022
Bitumen Specific Gravity (Gb)15.6/15.6	1.026

EXCEL\LAB\OSHD\BRACELINYEAGER5

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Worksheet For Analysis Of Compacted Paving Mixture (Compressive Strength Machine)

Client: Bracelin Yeager
Project: Nesika Beach
Mixture: Level 3, 19mm Open Grade

Job No.:

JMF No.: CTI.01.25
Contract No.: C12511
Bitumen: Chevron PG 64-22

Date: 6/12/01
Bid Item No.:

Composition of Paving Mixture

Constitute Material	Percentage	Specific Gravity
19mm x 4.75mm	82.00%	2.703
6.3mm x 2.00mm	7.00%	2.602
2.00mm - 0	11.00%	2.552
Asphalt Cement		1.026

Mixing Temp: 127 C
Compaction Temp: 118 C
Number of Blows: AASHTO T167

Percent AC @ Max. Unit Weight:
Percent AC @ Max. Stability:
Percent AC @ 4.0% Air Voids:
Optimum Asphalt Content: **5.80%**

	Mix Composition, % By Weight of Total Mix, P				
A. No Rap	4.5	5.5	6.5		**5.8**
1. Bulk Specific Gravity (GSB), Total Aggregate	2.679	2.679	2.679		**2.679**
2. Max. Specific Gravity (GMM), Paving Mix	2.553	2.513	2.476		**2.503**
3. Bulk Specific Gravity (GMB), Compacted Mix	2.084	2.120	2.155		**2.132**
4. Effective Specific Gravity (GSE), Total Aggregate	2.746	2.745	2.746		**2.746**
5. Absorbed Asphalt (PBA), % By Weight, Total Agg	0.92	0.91	0.93		**0.94**
6. Voids Filled with Asphalt (%)	28.6	38.0	47.7		**40.8**
7. Effective Asphalt Content (PBE)	3.6	4.6	5.6		**4.9**
8. Voids in Mineral Aggregate (VMA)	25.7	25.2	24.8		**25.0**
9. Air Voids (PA)	18.4	15.6	13.0		**14.8**
10. P200/PBE Ratio	0.6	0.5	0.4		**0.5**
11. P200/Pb Ratio	0.5	0.4	0.4		**0.4**
12. Draindown (%)	60	70	80		**73**

Aggregate Blend

Sieve	Blend Target	JMF Tolerance
25.0	100	99-100
19.0	91	85-96
12.5	64	55-71
9.5	43	
4.75	16	11-21
2.36	11	7-15
0.600	6	2-10
0.075	2.3	1.0-5.0

Aggregate Sieve	19x4.75	6.3x2.00	2.00-0		
25.0	100.0	100.0	100.0		
19.0	89.0	100.0	100.0		
12.5	56.0	100.0	100.0		
9.5	31.0	100.0	100.0		
4.75	1.0	61.0	100.0		
2.36	1.0	6.0	93.0		
0.600	1.0	2.0	43.0		
0.075	1.0	1.5	12.3		

Certified Technician and Card Number

Jason S. Bryant #40118

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Mix Design Volumetrics

Client: Bracelin Yeager
Project: Nesika Beach
Material Type: Level 3, 19mm Open Grade
Bitumen: Chevron PG 64-22

Job No.: T0106590.CTI
Project No.: C12511
Agg Source No.: 8-108-3 & 8-070-3

JMF No.: CTI.01.25
Bid Item No.:
Date: 6/12/01

Maximum Density Tests

A. Percent Asphalt Content (Pb)	4.5	5.5			
B. Pycnometer + Lid + Mix	5043.6	5057.2			
C. Pycnometer + Lid	2978.3	2983.2			
D. Mass of Dry Sample (B-C)	2065.3	2074.0			
E. Pycnometer + Lid + Water	7384.4	7381.8			
F. Pycnometer + Lid + Water + Mix	8640.3	8631.4			
G. MSG (D/D+E-F)	2.552	2.516			
H. Maximum Density (Gx1000)	2552	2516			
I. Asphalt Specific Gravity (Gb)	1.026	1.026			
J. Effective Specifc Gravity (Gse)	2.744	2.748			
K. Gse Difference	-0.004				
L. Average Gse	2.746				

Maximum Specific Gravity Determination

Pb	*Ps*	*Gse*	*Gb*	*Gmm*
4.5	95.5	2.746	1.026	2.553
5.5	94.5	2.746	1.026	2.514
6.5	93.5	2.746	1.026	2.476
5.8	94.2	2.746	1.026	2.503

Compacted HMAC

Mixing Temp: 127 C Compaction Temp: 118 C Blows/Gyrations: AASHTO T167

% AC	*Height*	*Dry Mass*	*Volume*	*Unit Wt.*	*BSG*	*Difference*	*Voids*	*Draindown*
4.5	4.135	3.913	0.03007	130.1	2.085	-0.002	18.3	
4.5	4.147	3.918	0.03016	129.9	2.082	0.002	18.7	
				Average	**2.084**		**18.4**	**60**
5.5	4.115	3.961	0.02993	132.4	2.121	-0.002	15.6	
5.5	4.117	3.957	0.02994	132.2	2.118	0.002	15.8	
				Average	**2.120**		**15.7**	**70**
6.5	4.060	3.976	0.02953	134.7	2.158	-0.003	12.8	
6.5	4.063	3.968	0.02955	134.3	2.152	0.003	13.1	
				Average	**2.155**		**13.0**	**80**

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TENSILE STRIPPING STRENGTH

Client: Bracelin Yeager Job No.: T0106590.CTI Mix Design No.: CTI.01.25
Project: Nesika Beach Contract No.: C12511 Bid Item No.:
Material Type: Level 3, 19mm Dense Grade Max. Sp. Gr. (G): 2.489
% Asphalt: 5.8% No. of Blows: 17 Sample: Mix Design Date: 6/12/01

SAMPLE NUMBER	1	2	3	4	5	6	7	8	
Diameter, In.	4.002	4.002	4.002	4.002	4.002	4.002			
Thickness, In.	2.634	2.644	2.640	2.657	2.660	2.618			
Weight in Air, g	1202.5	1203.5	1198.7	1197.9	1204.1	1198.6			
SSD Weight, g	1207.1	1208.6	1203.5	1203.6	1209.4	1203.9			
Weight in Water, g	688.1	687.2	686.2	684.1	691.1	685.6			
Volume	519.0	521.4	517.3	519.5	518.3	518.3			
Bulk Specific Gravity	2.317	2.308	2.317	2.306	2.323	2.313			Average
% Voids	6.91	7.26	6.90	7.36	6.66	7.09			7.03 ✓
Volume of Air Voids	35.9	37.9	35.7	38.2	34.5	36.7			
Test Condition Wet or Dry	D	D	D	W	W	W			

Wet Average: 7.04 Dry Average: 7.02

Desired Wt. Gain	23.3	24.6	23.2	24.8	22.4	23.9		
Target SSD Wt.	1225.8	1228.1	1221.9	1222.7	1226.5	1222.5		

SSD Wt. After Saturation				1220.8	1226.8	1222.9			
Volume of Absorbed Water				22.9	22.7	24.3			Average
% Saturation				59.9	65.7	66.1			63.9 ✓

Load for Dry Samples, Lbs.	1623	1598	1642						Average
Std.	98.1	96.2	99.0						97.8

Load for Wet Sample, Lbs.				1280	1398	1324			Average
Stm.				76.7	83.6	80.5			80.3

Tensile Strenght Ratio: 82.1 ✓
Visual Stripping, 0-5: 3

Test Performed By: Jason S. Bryant #40118

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Worksheet for Aggregate Specific Gravity

Client: Bracelin Yeager
Project: Nesika Beach
Mix Type: Level 3, 19mm Open Grade

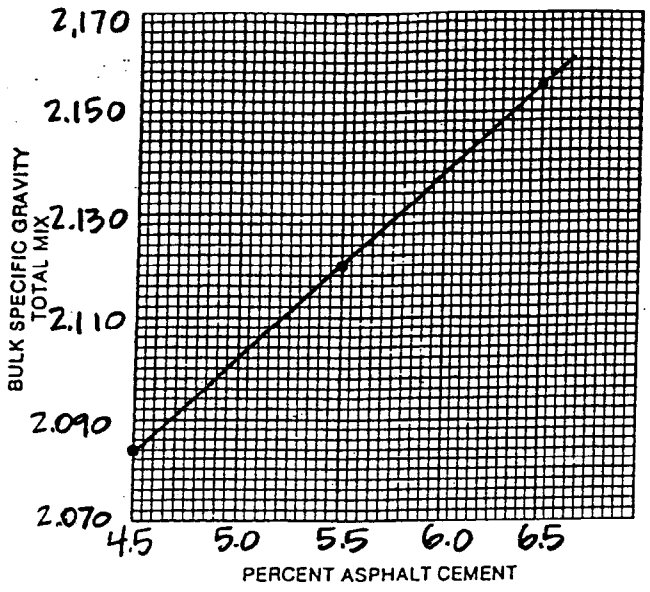
Job No.: T.CTI
Contract No.: C12511

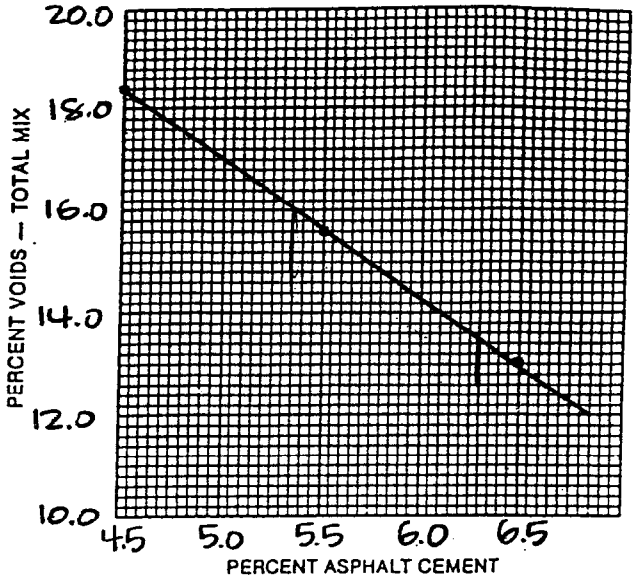
JMF No.: 01.25
Bid Item No.:

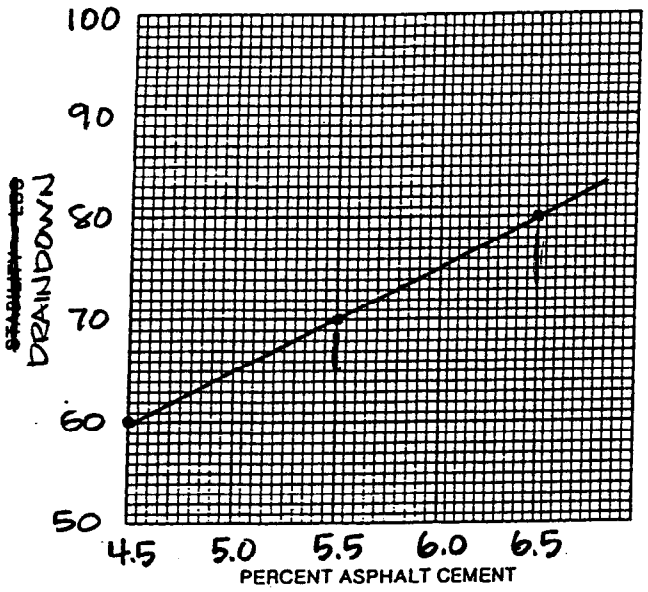
Coarse Aggregate						
Size		19 x 4.75	6.3 x 2.00			
B) Weight of SSD Sample		2960.3	2432.4			
Weight of Sample + Basket Immersed		—	—			
Weight of Basket Immersed		—	—			
C) Weight of Sample Immersed		1882.8	1518.4			
Weight of Dry Sample + Pan		—	—			
Weight of Pan		—	—			
A) Weight of Dry Sample		2912.3	2377.9			
B - C		1077.5	914.0			
A - C		1029.5	859.5			
B - A		48.0	54.5			
Bulk Specific Gravity	A / (B -C)	2.703	2.602			
Bulk Specific Gravity (SSD)	B / (B - C)	2.747	2.661			
Apparent Specific Gravity	A / (A - C)	2.829	2.767			
Absorption (%)		1.65	2.29			

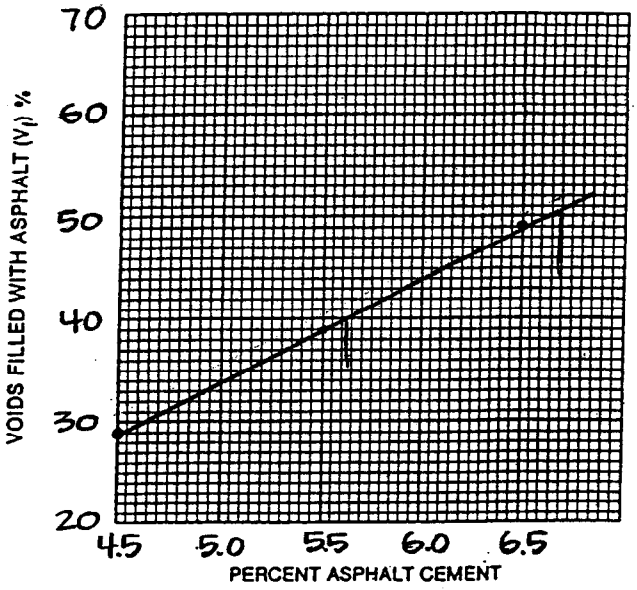
Fine Aggregate						
Size		2.00 - 0				
Weight of Flask + SSD Sample		680.6				
Weight of Flask		180.6				
B) Weight of SSD Sample		500.0				
Weight of Flask + SSD Sample + Water		990.1				
Weight of Flask + Water		680.6				
C) Weight of SSD Sample Immersed		309.5				
Weight of Dry Sample + Pan		2625.8				
Weight of Pan		2139.6				
A) Weight of Dry Sample		486.2				
B - C		190.5				
A - C		176.7				
B - A		13.8				
Bulk Specific Gravity	A / (B - C)	2.552				
Bulk Specific Gravity (SSD)	B / (B - C)	2.625				
Apparent Specific Gravity	A / (A - C)	2.752				
Absorption (%)		2.84				

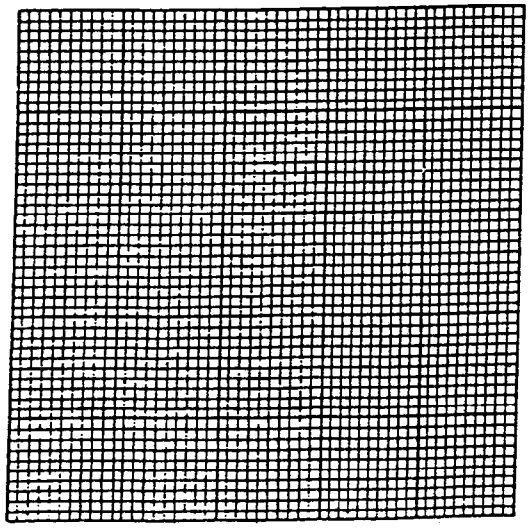
Combined Specific Gravity					
Size					
Percent Passing 4.75mm sieve					
Bulk Specific Gravity					
Bulk Specific Gravity (SSD)					
Apparent Specific Gravity					
Absorption (%)					

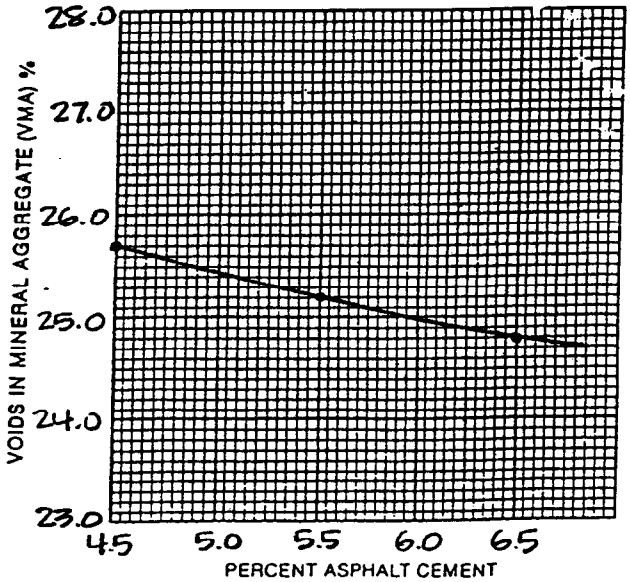

2,170
2.150
2.130
2.110
2.090
2.070
BULK SPECIFIC GRAVITY TOTAL MIX
4.5
5.0
5.5
6.0
6.5
PERCENT ASPHALT CEMENT


20.0
18.0
16.0
14.0
12.0
10.0
PERCENT VOIDS — TOTAL MIX
4.5
5.0
5.5
6.0
6.5
PERCENT ASPHALT CEMENT

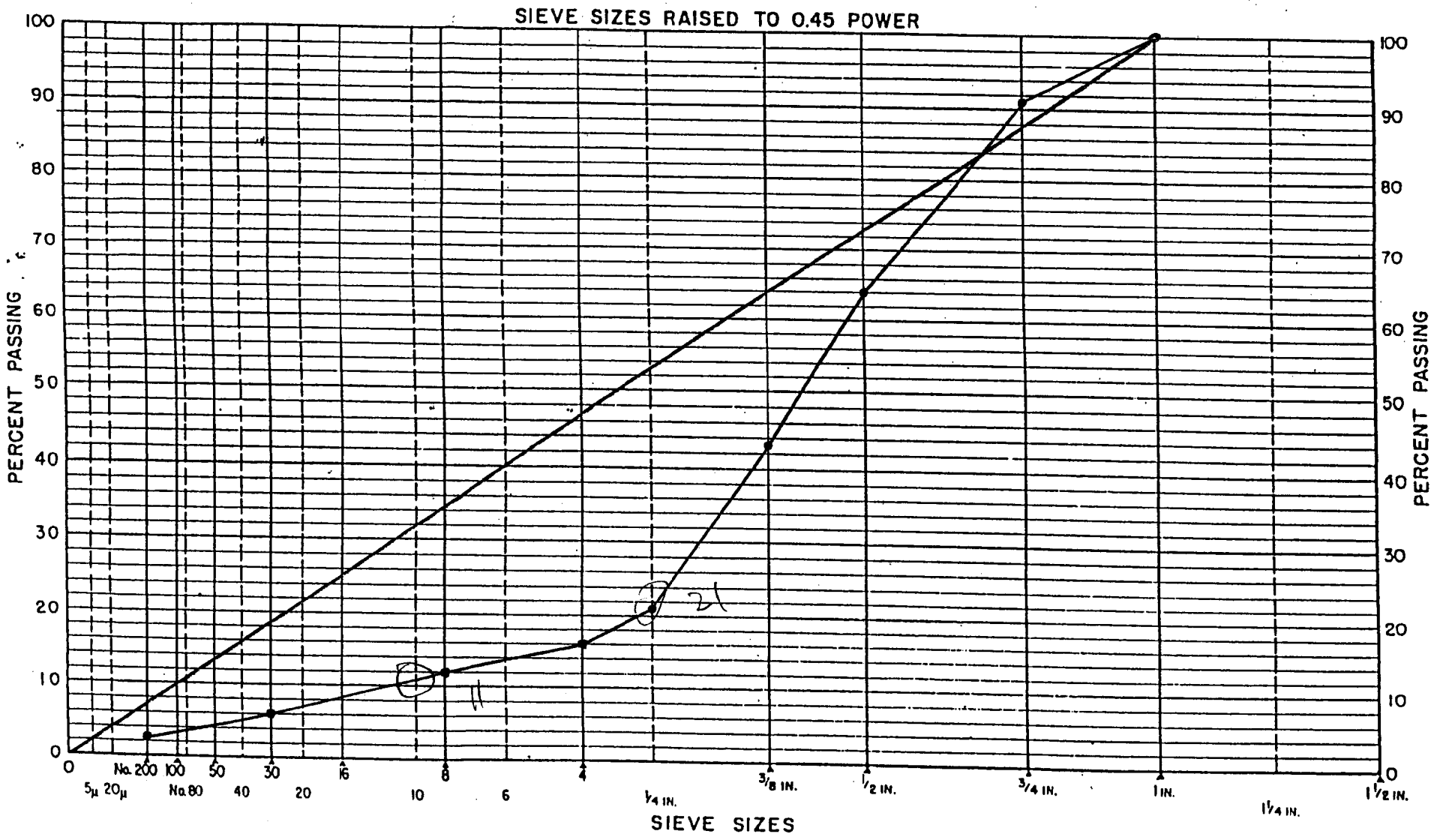

100
90
80
70
60
50
DRAINDOWN
4.5
5.0
5.5
6.0
6.5
PERCENT ASPHALT CEMENT


70
60
50
40
30
20
VOIDS FILLED WITH ASPHALT (Vf) %
4.5
5.0
5.5
6.0
6.5
PERCENT ASPHALT CEMENT


FLOW — 1/100 INCHES
PERCENT ASPHALT CEMENT


28.0
27.0
26.0
25.0
24.0
23.0
VOIDS IN MINERAL AGGREGATE (VMA) %
4.5
5.0
5.5
6.0
6.5
PERCENT ASPHALT CEMENT

UNITED STATES BUREAU OF PUBLIC ROADS 0.45 POWER GRADATION CHART



▲ THIS SYMBOL IDENTIFIES SIMPLIFIED PRACTICE AND COMPATIBLE SIEVE SIZES

Identification of gradations:
Nesika Beach - Rogue River (C12511)
Bracelin - Yeager ODOT Level 3. 19mm Open Grade HMAC

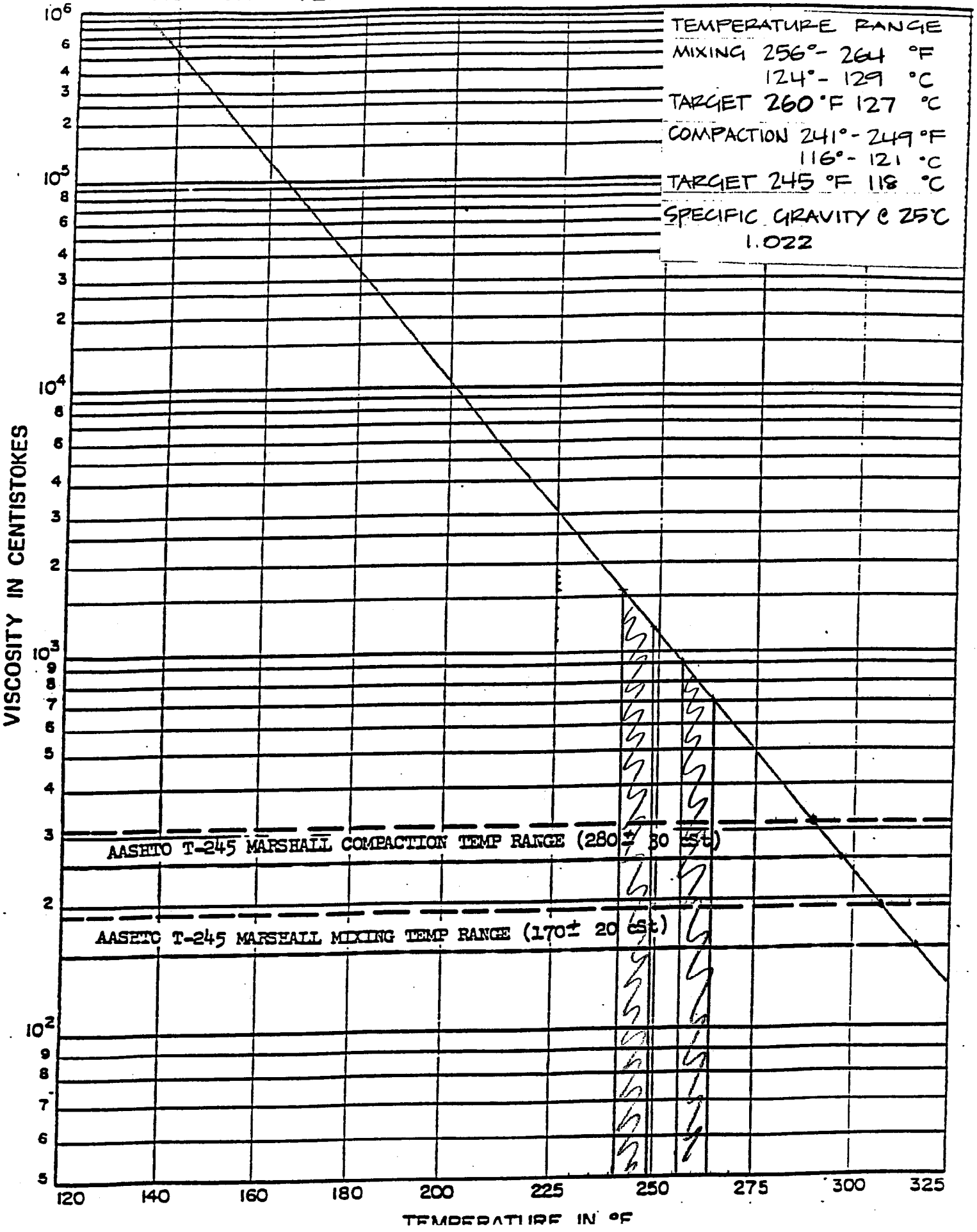
Sheet No.

Date

Form No. GC-3
THE ASPHALT INSTITUTE

CHEVRON PG64-22 / PBA-5

VISCOSITY-TEMPERATURE CHART FOR ASPHALT CEMENTS



AGGREGATE SOURCE NO. - 08-109-3 JOHN WAHL PIT

06/21/01 PART A

YR	LABNO	CON #	TT		SIZE	USE	DATE REP	ACRONYM	SE	LL	PI	UNIT WEIGHT LOOSE	UNIT WEIGHT COMPAC	% COMB	FINE BULK GRAVITY WT COMB	FINE BULK GRAVITY BULK	FINE BULK GRAVITY SSD	FINE BULK GRAVITY APAR	COARSE BULK GRAVITY % ABS	COARSE BULK GRAVITY BULK	COARSE BULK GRAVITY SSD	COARSE BULK GRAVITY APAR
01	01899		C		25.0mm-0.0mm	AGGREGATE BASE	010611	BASEAG														
01	01039		C		2.0mm-0.0mm	FINE AC AGGR	010417	FACAG		NO												
01	01038		C		6.3mm-2.0mm	FINE AC AGGR	010417	FACAG							1	2.629	2.685	2.786	2.14	19-4		
01	01037		C		19.0mm-4.75mm	COARSE AC AGGR	010413	CACAG								2.629	2.685	2.786	2.14	2.745	2.778	2.838
01	00959	12393	C	M	2.0mm-0.0mm	FINE AC AGGR	010411	FACAG		NO												
01	00958	12393	C	M	6.3mm-2.0mm	FINE AC AGGR	010413	FACAG							2	2.579	2.637	2.738	2.25			
01	00957	12393	C	M	19.0mm-4.75mm	COARSE AC AGGR	010411	CACAG								2.579	2.637	2.738	2.25			
01	00300		C		COMPLIANCE	FINE PCC AGGR	010222	FPCCAG	70							2.541	2.608	2.725	2.66	2.585	2.640	2.735
01	00299		C		COMPLIANCE	COARSE PCC AGGR	010222	CPCCAG												2.541	2.612	2.734
00	02215		C		2.0mm-0.0mm	FINE AC AGGR	000714	FACAG		NO												
00	02214		C		6.3mm-2.0mm	FINE AC AGGR	000714	FACAG							3	2.598	2.646	2.729	1.86	19-4		
00	02213		C		19.0mm-4.75mm	COARSE AC AGGR	000714	CACAG								2.598	2.646	2.729	1.86	2.590	2.643	2.726
00	01935		C		12.5mm-4.75mm	COARSE AC AGGR	000710	CACAG											12-4	2.610	2.657	2.739
00	01859		C		25.0mm-0.0mm	AGGREGATE BASE	000711	BASEAG											12-4	2.627	2.679	2.776
00	01399		C		12.5mm-4.75mm	COARSE AC AGGR	000516	CACAG														
00	00340		C		4.75mm-0.0mm	FINE PCC AGGR	000222	FPCCAG	82							2.529	2.603	2.731	2.23			
00	00339		C		19.0mm-4.75mm	COARSE PCC AGGR	000222	CPCCAG												2.553	2.614	2.727
99	03010	12250		M	19.0mm-0.0mm	BITUMINOUS MIX	990823	BIT MIX								2.508	2.457	2.743	1.89	2.441	2.491	2.750
99	03008	12250		M	12.5mm-0.0mm	BITUMINOUS MIX	990726	BIT MIX								2.520	2.504	2.722	2.94	2.584	2.636	2.727
99	02805		C		12.5mm-4.75mm	COARSE AC AGGR	990709	CACAG														
99	02804		C		19.0mm-4.75mm	COARSE AC AGGR	990709	CACAG														
99	02803		C		19.0mm-4.75mm	COARSE AC AGGR	990709	CACAG														
99	02802		C		19.0mm-4.75mm	COARSE AC AGGR	990709	CACAG														
99	02801		C		12.5mm-4.75mm	COARSE AC AGGR	990709	CACAG														
99	02800		C		19.0mm-12.5mm	COARSE AC AGGR	990709	CACAG														
99	02777	12250		M	12.5mm-0.0mm	BITUMINOUS MIX	990707	BIT MIX								2.568	2.626	2.726	2.23	2.576	2.634	2.734
99	02609		C		19.0mm-12.5mm	COARSE AC AGGR	990629	CACAG														
99	02608		C		19.0mm-12.5mm	COARSE AC AGGR	990629	CACAG														
99	02607		C		19.0mm-12.5mm	COARSE AC AGGR	990629	CACAG												5		
99	02442		C		19.0mm-12.5mm	COARSE AC AGGR	990629	CACAG											19-12	2.590	2.642	2.734
99	02358		C		19.0mm-12.5mm	COARSE AC AGGR	990617	CACAG														
99	02357		C		19.0mm-12.5mm	COARSE AC AGGR	990617	CACAG														
99	02356		C		19.0mm-12.5mm	COARSE AC AGGR	990617	CACAG														
99	02355		C		19.0mm-12.5mm	COARSE AC AGGR	990617	CACAG														
99	02354		C		19.0mm-12.5mm	COARSE AC AGGR	990617	CACAG														
99	02184	12250	C		2.0mm-0.0mm	FINE AC AGGR	990617	FACAG		NO												
99	02193	12250	C		6.3mm-2.00mm	FINE AC AGGR	990617	FACAG							4	2.575	2.634	2.736	2.27	6		
99	02192	12250	C		12.5mm-4.75mm	COARSE AC AGGR	990617	CACAG								2.575	2.634	2.736	2.27			
99	02181		C		19.0mm-4.75mm	COARSE AC AGGR	990617	CACAG											12-4	2.589	2.643	2.736
99	02102	12209	C	Q	19.0mm-0.0mm	INCINERATOR	990604	INCINER											19-4	2.597	2.646	2.732
99	01791		C		2.0mm-0.0mm	FINE AC AGGR	990529	FACAG		NO										7		
99	01790		C		6.3mm-2.0mm	FINE AC AGGR	990528	FACAG							5	2.512	2.586	2.711	2.92			
99	01789		C		19.0mm-4.75mm	COARSE AC AGGR	990614	CACAG								2.512	2.586	2.711	2.92	8		
99	01250		C		25.0mm-0.0mm	AGGREGATE BASE	990420	BASEAG														
99	00905		C		25.0mm-0.0mm	AGGREGATE BASE	990402	BASEAG														
99	00902		C		4.75mm-0.0mm	FINE PCC AGGR	990402	FPCCAG	77							2.485	2.572	2.721	2.50			
99	00323		C		6.3mm-0.0mm	FINE PCC AGGR	990223	FPCCAG	81							2.493	2.573	2.711	3.22			
99	00322		C		19.0mm-4.75mm	COARSE PCC AGGR	990223	CPCCAG												2.529	2.592	2.715
98	03196	11765	C		2.0mm-0.0mm	FINE AC AGGR	980714	FACAG		NO												

2.579 2.613

FAXED 8/17, 3 pgs.

STATISTICAL TESTING INPUT DATA				3.70.022	File:	HMAC_OPEN.SS			Date:	08/17/2001-12:50:33 PM							
Section:	Nesika Beach-Rogue River Section				Estimate #:		2156		Source:	Wahl's							
Contract:	12511				Mix Design:		~~93504~~		% Lime:								
Contractor:	Bracelin-Yeager (LTM)				Specification #:		745 SP		% RAP:								
Proj Mgr:	Ray Cranston				Lot #:		1		A/C Brand:	Chevron							
Bid Item #:	390				Level:		3		A/C Grade:	PBA5							
Matl Type:	19.0 mm Open HMAC				Lift:		Wearing		Plant Type:	Drum							
Constituent #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Constituent	25mm	19mm	12.5mm	4.75mm	2.36	.600mm	.075mm	Asph	Moist	Density							
Weight	1	1	1	5	5	3	10	26	8	40							
USL	100	96	71	5	4	4	2	0.2	1.1	N.A.							
LSL	99	85	55	-5	-4	-4	-2	-0.2	0	N.A.							
Sublot 001	100	94	65	-1	-1	-1	-0.7	0.01	0.48								
Sublot 002	100	92	67	0	0	-1	-0.4	0	0.49								
Sublot 003	100	91	65	0	0	0	-0.2	0	0.64								
Sublot 004	100	89	65	-1	0	-1	-0.5	-0.04	0.56								
Sublot 005	100	90	60	0	0	0	-0.3	-0.01	0.57								
Sublot 006	100	89	64	0	0	0	-0.4	-0.03	0.46								
Sublot 007	100	91	62	0	0	0	-0.3	-0.02	0.6								
Sublot 008	100	88	61	-1	0	0	-0.4	-0.02	0.51								
Sublot 009	100	89	67	-1	0	-1	-0.5	0.01	0.61								
Sublot 010	100	90	64	0	0	-1	-0.6	0.01	0.59								
Sublot 011	100	93	68	0	0	0	-0.5	0	0.52								
Sublot 012	100	92	70	-1	0	-1	-0.6	0.02	0.59								
Sublot 013	100	91	66	-1	-1	-1	-0.5	0.02	0.58								
Sublot 014	100 ✓	93 ✓	66 ✓	-1 ✓	-1 ✓	0 ✓	-0.4 ✓	0 ✓	0.57 ✓								
Sublot 015	100 ✓	87 ✓	61 ✓	-1 ✓	0 ✓	-1 ✓	-0.7 ✓	0.02 ✓	0.65 ✓								
Sublot 016	100 ✓	91 ✓	64 ✓	1 ✓	1 ✓	0 ✓	-0.5 ✓	0.03 ✓	0.57 ✓								

all data previously checked. 8/17

				File:	HMAC_OPEN.SS					
18	19	20	21	22	23	24				
							Target	0 = -1E+09;	100 = 1E+09;	100
							Value	0 = -1E+09;	100 = 1E+09	
							% Asphalt	Mg.	Test#	Date
							5.8	64.00	1-1	07/26/2001
							5.8	1073.00	1-2	07/31/2001
							5.8	2583.00	1-3	08/01/2001
							5.8	3116.00	1-4	08/01/2001
							5.8	4253.00	1-5	08/02/2001
							5.8	5354.00	1-6	08/03/2001
							5.8	6351.00	1-7	08/03/2001
							5.8	7543.00	1-8	08/06/2001
							5.8	8758.00	1-9	08/07/2001
							5.8	9995.00	1-10	08/07/2001
							5.8	10371.00	1-11	08/08/2001
							5.8	11424.00	1-12	08/08/2001
							5.8	12674.00	1-13	08/09/2001
							5.8	13245.00	1-14	08/14/2001
							5.8	14566.00	1-15	08/14/2001
							5.8	15298.00	1-16	08/15/2001

STATISTICAL COMPUTATIONS				3.70.022	File:	HMAC_OPEN.SS			Date:	08/17/2001-12:50:33 PM		
Section:	Nesika Beach-Rogue River Section				Estimate #:				Source:		Wahl's	
Contract:	12511				Mix Design:		93504		% Lime:			
Contractor:	Bracelin-Yeager (LTM)				Specification #:		745 SP		% RAP:			
Proj Mgr:	Ray Cranston				Lot #:		1		A/C Brand:		Chevron	
Bid Item #:	390				Level:		3		A/C Grade:		PBA5	
Matl Type:	19.0 mm Open HMAC				Lift:		Wearing		Plant Type:		Drum	
Constituent #	1	2	3	4	5	6	7	8	9	10	11	12
Constituent	25mm	19mm	12.5mm	4.75mm	2.36	.600mm	.075mm	Asph	Moist	Density		
Weight	1	1	1	5	5	3	10	26	8	40		
Sum X	1600	1450	1035	-7	-2	-8	-7.5	0	8.99	0		
Sum X^2	160000	131462	67063	9	4	8	3.81	0.0058	5.0977	0		
Samples	16	16	16	16	16	16	16	16	16	0		
Mean	100.0000	90.6250	64.6875	- 0.4375	- 0.1250	- 0.5000	- 0.4688	0.0000	0.5619	0.0000		
Std Dev	0.0000	1.9279	2.7256	0.6292	0.5000	0.5164	0.1401	0.0197	0.0556	0.0000		
Qu	1E+09	2.79	2.32	8.64	8.25	8.71	17.62	10.17	9.67	1E+09		
Ql	1E+09	2.92	3.55	7.25	7.75	6.78	10.93	10.17	1.797E+10	1E+09		
Pu	100	100	100	100	100	100	100	100	100	100		
Pl	100	100	100	100	100	100	100	100	100	100		
P	100	100	100	100	100	100	100	100	100	100		
Pay Factor	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.00		
Wtd. Factor	1.050	1.050	1.050	5.250	5.250	3.150	10.500	27.300	8.400	40.000		
Sum of Weight Factors:			100									
Composite Pay Factor:			1.0300									

StatSpec 3.70

APPENDIX E

FILM THICKNESS CALCULATIONS
FOR
2001 CONSTRUCTION PROJECTS

OREGON DEPARTMENT OF TRANSPORTATION
MATERIALS LABORATORY
800 AIRPORT RD. SE SALEM, OR 97310

(503)986-3100
FAX(503)986-3096

Contract No.: **EA No.: 02SRF304 051 P15 Lab No.:** **01-003611**

Project: RESEARCH PROJECT @ SHOGREN - ROWENA PHASE 2 & W MAYER ST

Highway: COLUMBIA County: WASCO **Data Sheet No.: F0823 108**
Contractor: ROSS BROS & CO FA No.:
Project Manager: CARL MICKELSON Org Unit: 4821 Bid Item No.:
Submitted By: MIKE REMILY Org Unit: 7827 Sample No.: 1-2
Sampled At: PLANT Sampled By: Qty Represented:
DATE-Sampled: 01/ 4/11 Received: 01/ 9/13 Tested: 01/ 9/27 Reported:
Type of Mix: 19MM OPEN MIX **Use: PAVEMENT - Wearing Course**

SEP 2 8 2001

BITUMINOUS MIX LABORATORY REPORT

Aggregate Source : 33-079-4 SUN ROCK QUARRY Mix Design # : 00-01439
Asphalt Brand : MCCALL Asphalt Grade : PBA-6

TM 306 Maximum Specific Gravity : 2.584

TM 324 Bituminous Incinerator
Asphalt : 5.3 % 5.34
TM 311 Moisture :
P75μm/AC Ratio : 0.7

Sieve Size	% Passing
25.0 mm	100.0 %
19.0	94.0 %
12.5	70.0 %
9.5	50.0 %
6.3	29.0 %
4.75	23.0 %
2.36	14.0 %
600 μm	7.0 %
75	3.6 %

TM324 =$ 125.
TM320X =$ 60.
$
$
$
$

REMARKS:
INFORMATION ONLY

*

TOTAL LAB CHARGES: $ 185.00

C: FILES ; PROJ MGR: CARL MICKELSON ; MIKE REMILY - PAVEMENT QUALITY
S. CHRISTENSEN - BITUMINOUS

Kenneth L Stevenson
STATE CONSTRUCTION AND MATERIALS ENGINEER

OREGON DEPARTMENT OF TRANSPORTATION
MATERIALS LABORATORY
800 AIRPORT RD. SE SALEM, OR 97310

(503)986-3100
FAX(503)986-3096

Contract No.: **EA No.: 02SRF304 051 P15 Lab No.:** **01-003612**
Project: RESEARCH PROJECT @ SHOGREN - ROWENA PHASE 2 & W MAYER ST
Highway: COLUMBIA County: WASCO **Data Sheet No.: F0823 108**
Contractor: ROSS BROS & CO FA No.:
Project Manager: CARL MICKELSON Org Unit: 4821 Bid Item No.:
Submitted By: MIKE REMILY Org Unit: 7827 Sample No.: 1-12
Sampled At: PLANT Sampled By: Qty Represented:
DATE-Sampled: 01/ 4/23 Received: 01/ 9/13 Tested: 01/ 9/27 Reported:
Type of Mix: 19MM OPEN MIX **Use: PAVEMENT - Wearing Course**

SEP 28 2001

BITUMINOUS MIX LABORATORY REPORT

Aggregate Source : 33-079-4 SUN ROCK QUARRY Mix Design # : 00-01439
Asphalt Brand : MCCALL Asphalt Grade : PBA-6

TM 306 Maximum Specific Gravity : 2.600

TM 324 Bituminous Incinerator
Asphalt : 4.9 % 4.93
TM 311 Moisture :
P75µm/AC Ratio : 0.6

Sieve Size	% Passing
25.0 mm	100.0 %
19.0	97.0 %
12.5	74.0 %
9.5	54.0 %
6.3	29.0 %
4.75	22.0 %
2.36	13.0 %
600 µm	6.0 %
75	3.0 %

TM324 =$ 125.
TM320X =$ 60.
$
$
$
$

REMARKS:
INFORMATION ONLY

*

TOTAL LAB CHARGES: $ 185.00

C: FILES ; PROJ MGR: CARL MICKELSON ; MIKE REMILY - PAVEMENT QUALITY
S. CHRISTENSEN - BITUMINOUS

Kenneth L Stevenson

OREGON DEPARTMENT OF TRANSPORTATION
MATERIALS LABORATORY
800 AIRPORT RD. SE SALEM, OR 97310

(503)986-3100
FAX(503)986-3096

Contract No.: **EA No.: 02SRF304 051 P15 Lab No.:** **01-003613**
Project: RESEARCH PROJECT @ SHOGREN - ROWENA PHASE 2 & W MAYER ST
Highway: COLUMBIA County: WASCO **Data Sheet No.: F0823 108**
Contractor: ROSS BROS & CO FA No.:
Project Manager: CARL MICKELSON Org Unit: 4821 Bid Item No.:
Submitted By: MIKE REMILY Org Unit: 7827 Sample No.: 1-23
Sampled At: PLANT Sampled By: Qty Represented:
DATE-Sampled: 01/ 5/ 1 Received: 01/ 9/13 Tested: 01/ 9/27 Reported:
Type of Mix: 19MM OPEN MIX **Use: PAVEMENT - Wearing Course**

SEP 2 8 2001

BITUMINOUS MIX LABORATORY REPORT

Aggregate Source : 33-079-4 SUN ROCK QUARRY Mix Design # : 00-01439
Asphalt Brand : MCCALL Asphalt Grade : PBA-6

TM 306 Maximum Specific Gravity : 2.563

TM 324 Bituminous Incinerator
Asphalt : 5.6 % 5.57
TM 311 Moisture :
P75µm/AC Ratio : 0.7

Sieve Size	% Passing
25.0 mm	100.0 %
19.0	92.0 %
12.5	72.0 %
9.5	52.0 %
6.3	31.0 %
4.75	24.0 %
2.36	15.0 %
600 µm	7.0 %
75	3.9 %

TM324 =$ 125.
TM320X =$ 60.
$
$
$
$

REMARKS:
INFORMATION ONLY

*

TOTAL LAB CHARGES: $ 185.00

C: FILES ; PROJ MGR: CARL MICKELSON ; MIKE REMILY - PAVEMENT QUALITY
S. CHRISTENSEN - BITUMINOUS

Kenneth L Stevenson
STATE CONSTRUCTION

OREGON DEPARTMENT OF TRANSPORTATION
MATERIALS LABORATORY
800 AIRPORT RD. SE SALEM, OR 97301-4798

(503)986-310C
FAX(503)986-309E

Contract No.: **EA No.: 02SRF304 051 P15 Lab No.:** **01-003571**
Project: RESEARCH PROJECT @ SHOGREN - ROWENA PHASE 2 & W MAYER ST
Highway: COLUMBIA County: WASCO **Data Sheet No.: F0823 107**
Contractor: ROSS BROS & CO FA No.:
Project Manager: CARL MICKELSON Org Unit: 4821 Bid Item No.:
Submitted By: MIKE REMILY Org Unit: 7827 Sample No.: 1-4 & 1-23
Material Source: 33-079-4 SUN ROCK QUARRY Qty Represented: AGG CORRECTION
Sampled At: COLD FEED/LAB BATCHED 5.3 Sampled By: Witnessed By:
DATE-Sampled: Received: 01/ 9/13 Tested: 01/ 9/25 Date Reported: SEP 26 2001
Class/Type: QUALITY CONTROL MIX DESIGN **Use: AGG CORRECTION "F" MIX RECYCLE 00-01**

Q or G: QUARRY **AGGREGATE LABORATORY REPORT - RAP** **Size: 19.0mm-0.0mm**
TM 323

SIEVE SIZE	SAMPLE #1	SAMPLE #2	SAMPLE #3	SAMPLE #4	SAMPLE AVERAGE
37.5 mm					
31.5					
25.0	100.0 %	100.0 %	100.0 %	100.0 %	100 %
19.0	88.7 %	93.6 %	96.8 %	93.1 %	93 %
12.5	66.7 %	68.1 %	72.2 %	70.5 %	69 %
9.5	47.6 %	49.2 %	51.8 %	46.6 %	49 %
6.3	28.2 %	27.8 %	28.0 %	25.4 %	27 %
4.75	22.4 %	21.7 %	21.2 %	19.2 %	21 %
2.36	14.4 %	13.1 %	12.8 %	11.6 %	13 %
2.00					
1.18					
600 µm	7.5 %	6.5 %	6.4 %	5.8 %	7 %
425					
300					
150					
75	3.6 %	3.4 %	3.2 %	3.0 %	3.3 %
% Loss :	5.61 %	5.62 %	5.76 %	5.72 %	5.68 %
Avg Corr :	5.30 %	5.30 %	5.30 %	5.30 %	5.30 %
Temp Corr:	0.13 %	0.12 %	0.12 %	0.12 %	0.12 %
% A/C :	0.18 %	0.20 %	0.34 %	0.30 %	0.26 %

Bulk Gradation : +19.0mm : 0.0 % 19.0-6.3mm : 0.0 % 6.3-2.0mm : 0.0 % 2.0-0mm : 0.0 %

1 @ TM320X =$116.00
1 @ 323 = 425.00

NSM = Not Sufficient Material

TOTAL CHARGES: $ 541.00

REMARKS:
INFORMATIONAL

% AC REPORTED ABOVE IS ACTUALLY THE CORRECTION FACTOR. THE AVERAGE CORRECTION OF 5.30% IS THE % OIL ADDED BY THE BIT CREW.
*

C: FILES ; MIKE REMILY - PAVEMENT QUALITY D. DOMINICK - PAVEMENTS

Kenneth L Stateman

		Shogren - Rowena Phase 2			Level 4 19mm Open w/Lime				
		Pile #1	Pile #2	Pile #3	Pile #4	AC	Lime/RAP	Total	
% Comb.		35	41	23	0	5.3	1	100	
Sp. Gr.		2.792	2.775	2.738	2.520	1.025	2.270		
							JMF	Adj Gse	QC
Gsb								2.766	
Pb		4.5	5.0	5.5	6.0	6.5	5.3	5.3	5.35
Gmm		2.591	1.000	2.547	1.000	2.505	2.556	2.556	2.554
Gse		2.792	0.999	2.788	0.998	2.785	2.789	2.789	2.789
Gmb		2.168	1.000	2.194	1.000	2.208	2.106	2.106	2.106
VMA		25.2	65.7	25.0	66.0	25.4	27.90	27.90	27.94
Va		16.3	0.0	13.9	0.0	11.9	17.61	17.61	17.54
Pba		0.34	-65.58	0.29	-65.60	0.24	0.31	0.31	0.31
Pbe		4.17	67.30	5.23	67.67	6.27	5.01	5.01	5.06
VFA		35.1	100.0	44.7	100.0	53.3	36.9	36.9	37.2
		Adj JMF				QC			
Sieves	%Passing	Factor	S. Area		%Passing	Factor	S. Area		
1"	100	0.41	0.41		100.00	0.41	0.41		
3/4"	91	0	0.00		92.00	0	0.00		
1/2"	64	0	0.00		64.32	0	0.00		
3/8"	42	0	0.00		42.00	0	0.00		
1/4"	23	0	0.00		23.00	0	0.00		
#4	20	0.41	0.08		20.44	0.41	0.08		
#8	13	0.82	0.11		13.04	0.82	0.11		
#16	10	1.64	0.16		10.00	1.64	0.16		
#30	7	2.87	0.20		6.48	2.87	0.19		
#50	5	6.14	0.31		5.00	6.14	0.31		
#100	4	12.29	0.49		4.00	12.29	0.49		
#200	3.4	32.77	1.11		3.14	32.77	1.03		
		Area =	2.88			Area =	2.78		
		Vbe =	0.1029			Vbe =	0.1040		
		Wbe =	105.52			Wbe =	106.57		
		Ws =	2000.48			Ws =	1999.43		
		Avg Film =	17.89			Avg Film =	18.72		

	QC 1-23		QC 1-2		QC 1-12	
	5.57		5.34		4.93	
	2.563		2.584		2.600	
	2.812		2.827		2.825	
	1.000		1.000		1.000	
	65.9		65.8		65.6	
	61.0		61.3		61.5	
	0.60		0.79		0.77	
	5.00		4.59		4.19	
	7.4		6.8		6.2	
Vol Pbe	0.0488		0.0448		0.0409	
Sieves	%Passing	S. Area	%Passing	S. Area	%Passing	S. Area
1"	100	0.41	100	0.41	100	0.41
3/4"	92	0.00	94	0.00	97	0.00
1/2"	72	0.00	70	0.00	74	0.00
3/8"	52	0.00	50	0.00	54	0.00
1/4"	31	0.00	29	0.00	29	0.00
#4	24	0.10	23	0.09	22	0.09
#8	15	0.12	14	0.11	19	0.16
#16	11	0.18	11	0.18	15	0.25
#30	7	0.20	7	0.20	6	0.17
#50	6	0.37	6	0.37	5	0.31
#100	5	0.61	5	0.61	4	0.49
#200	3.9	1.28	3.6	1.18	3.0	0.98
	Area =	3.27	Area =	3.16	Area =	2.86
	Vbe =	0.0488	Vbe =	0.0448	Vbe =	0.0409
	Wbe =	50.01	Wbe =	45.91	Wbe =	41.95
	Ws =	949.99	Ws =	954.09	Ws =	958.05
	Avg Film =	15.69	Avg Film =	14.84	Avg Film =	14.96

MATERIALS LABORATORY (503)986-3100
800 AIRPORT RD. SE SALEM, OR 97310 FAX(503)986-3096

Contract No.: EA No.: 02SRF304 051 P15 Lab No.: 01-004086
Project: RESEARCH PROJECT - NESIKA BEACH - ROGUE RVR "F" MIX
Highway: VARIOUS County: VARIOUS **Data Sheet No.: F0823 110**
Contractor: FA No.:
Project Manager: RAY CRANSTON Org Unit: Bid Item No.: NA
Submitted By: MIKE REMILY Org Unit: 7827 Sample No.: 1-8
Sampled At: PLANT Sampled By: Qty Represented:
DATE-Sampled: 01/ 8/ 6 Received: 01/10/17 Tested: 01/10/29 Reported:
Type of Mix: 19MM OPEN MIX **Use: PAVEMENT - Wearing Course**

BITUMINOUS MIX LABORATORY REPORT

Aggregate Source : 08-108-3 JOHN WAHL PIT Mix Design # : 01-02156
Aggregate Source : 08-070-3 SULLILVAN QUARRY
Asphalt Brand : CHEVRON Asphalt Grade : PG 64-22

TM 306 Maximum Specific Gravity : 2.494

TM 324 Bituminous Incinerator Asphalt : 6.6 %
TM 311 Moisture :
P75μm/AC Ratio : 0.3

Sieve Size	% Passing
25.0 mm	100.0 %
19.0	97.0 %
12.5	72.0 %
9.5	53.0 %
6.3	27.0 %
4.75	22.0 %
2.36	16.0 %
600 μm	7.0 %
75	2.2 %

TM306 =$ 60.
TM320X =$ 58.
TM324 =$ 125.
$
$
$

REMARKS:
INFORMATION ONLY
ASPHALT CORRECTION FACTOR: 1.09
*

TOTAL LAB CHARGES: $ 243.00

C: FILES ; PROJ MGR: RAY CRANSTON ; MIKE REMILY - PAVEMENT QUALITY ; MIKE REMILY - PAVEMENTS
S. CHRISTENSEN - BITUMINOUS

OREGON DEPARTMENT OF TRANSPORTATION
MATERIALS LABORATORY
800 AIRPORT RD. SE SALEM, OR 97310

(503)986-3100
FAX(503)986-3096

Contract No.: **EA No.: 02SRF304 051 P15 Lab No.:** **01-004087**
Project: RESEARCH PROJECT - NESIKA BEACH - ROGUE RVR "F" MIX
Highway: VARIOUS County: VARIOUS **Data Sheet No.: F0823 110**
Contractor: FA No.:
Project Manager: RAY CRANSTON Org Unit: Bid Item No.: NA
Submitted By: MIKE REMILY Org Unit: 7827 Sample No.: 1-13
Sampled At: PLANT Sampled By: Qty Represented:
DATE-Sampled: 01/ 8/ 9 Received: 01/10/17 Tested: 01/10/29 Reported:
Type of Mix: 19MM OPEN MIX **Use: PAVEMENT - Wearing Course**

OCT 31 2001

BITUMINOUS MIX LABORATORY REPORT

Aggregate Source : 08-108-3 JOHN WAHL PIT Mix Design # : 01-02156
Aggregate Source : 08-070-3 SULLIVAN QUARRY
Asphalt Brand : CHEVRON Asphalt Grade : PG 64-22

TM 306 Maximum Specific Gravity : 2.529

TM 324 Bituminous Incinerator Asphalt : 5.6 %
TM 311 Moisture :
P75μm/AC Ratio : 0.3

Sieve Size	% Passing
25.0 mm	100.0 %
19.0	92.0 %
12.5	69.0 %
9.5	48.0 %
6.3	23.0 %
4.75	18.0 %
2.36	12.0 %
600 μm	5.0 %
75	1.8 %

TM306 =$ 60.
TM320X =$ 58.
TM324 =$ 125.
$
$
$

TOTAL LAB CHARGES: $ 243.00

REMARKS:
INFORMATION ONLY
ASPHALT CORRECTION FACTOR: 1.09
*

C: FILES ; PROJ MGR: RAY CRANSTON ; MIKE REMILY - PAVEMENT QUALITY ; MIKE REMILY - PAVEMENTS
S. CHRISTENSEN - BITUMINOUS

K. L. Stevenson
AND MATERIALS ENGINEER

MATERIALS LABORATORY (503)986-3100
800 AIRPORT RD. SE SALEM, OR 97310 FAX(503)986-3096

Contract No.: EA No.: 02SRF304 051 P15 Lab No.: 01-004088
Project: RESEARCH PROJECT - NESIKA BEACH - ROGUE RVR "F" MIX
Highway: VARIOUS County: VARIOUS **Data Sheet No.: F0823 110**
Contractor: FA No.:
Project Manager: RAY CRANSTON Org Unit: Bid Item No.: NA
Submitted By: MIKE REMILY Org Unit: 7827 Sample No.: 1-14
Sampled At: PLANT Sampled By: Qty Represented:
DATE-Sampled: 01/ 8/14 Received: 01/10/17 Tested: 01/10/29 Reported:
Type of Mix: 19MM OPEN MIX **Use: PAVEMENT - Wearing Course**

BITUMINOUS MIX LABORATORY REPORT

Aggregate Source : 08-108-3 JOHN WAHL PIT Mix Design # : 01-02156
Aggregate Source : 08-070-3 SULLIVAN QUARRY
Asphalt Brand : CHEVRON Asphalt Grade : PG 64-22

TM 306 Maximum Specific Gravity : 2.524

TM 324 Bituminous Incinerator
Asphalt : 5.5 %
TM 311 Moisture :
P75μm/AC Ratio : 0.3

Sieve Size	% Passing
25.0 mm	100.0 %
19.0	89.0 %
12.5	64.0 %
9.5	46.0 %
6.3	23.0 %
4.75	18.0 %
2.36	13.0 %
600 μm	5.0 %
75	1.7 %

TM306 =$ 60.
TM320X =$ 58.
TM324 =$ 125.
$
$
$

TOTAL LAB CHARGES: $ 243.00

REMARKS:
INFORMATION ONLY
ASPHALT CORRECTION FACTOR: 1.09
*

: FILES ; PROJ MGR: RAY CRANSTON ; MIKE REMILY - PAVEMENT QUALITY ; MIKE REMILY - PAVEMENTS
S. CHRISTENSEN - BITUMINOUS

OREGON DEPARTMENT OF TRANSPORTATION
MATERIALS LABORATORY
800 AIRPORT RD. SE SALEM, OR 97301-4798

(503)986-310(
FAX(503)986-309(

Contract No.: **EA No.: 02SRF304 051 P15** **Lab No.: 01-004089**

Project: RESEARCH PROJECT - NESIKA BEACH - ROGUE RVR "F" MIX

Highway: VARIOUS County: VARIOUS Data Sheet No.: F0823 111
Contractor: FA No.:
Project Manager: RAY CRANSTON Org Unit: Bid Item No.:
Submitted By: MIKE REMILY Org Unit: 7827 Sample No.: 1-8, 13 & 14
Material Source: 08-108-3 JOHN WAHL PIT & 08-070-3 Qty Represented: AGG CORRECTION
Sampled At: COLD FEED/LAB BATCHED 5.8 Sampled By: Witnessed By:
DATE-Sampled: Received: 01/10/17 Tested: 01/10/24 Date Reported: OCT 25 2001
Class/Type: QUALITY CONTROL MIX DESIGN Use: BITUMINOUS MIX AGGREGATE CORRECTION

Q or G: GRAVEL **AGGREGATE LABORATORY REPORT - AGGCORR** Size: 19.0mm-0.0mm

TM 323

SIEVE SIZE	COLD FEED	BITUMINOUS MIX #1	BITUMINOUS MIX #2	BITUMINOUS MIX #3
37.5 mm				
31.5				
25.0	100 %	100 %	100 %	100 %
19.0	89 %	89 %	89 %	90 %
12.5	64 %	68 %	64 %	62 %
9.5	41 %	49 %	46 %	45 %
6.3	16 %	23 %	23 %	22 %
4.75	12 %	18 %	18 %	17 %
2.36	9 %	13 %	12 %	12 %
2.00				
1.18				
600 µm	5 %	7 %	6 %	6 %
425				
300				
150				
75	2.0 %	2.7 %	2.3 %	2.4 %
Total Loss :		7.12 %	7.09 %	6.89 %
Actual a/c :		5.80 %	5.80 %	5.80 %
Correction :		1.18 %	1.15 %	0.95 %

MIX DESIGN # : 01-02156 AVERAGE ROCK CORRECTION = 1.09 %

Type of Mix : "F" MIX Asphalt Brand : CHEVRON Grade : PG 64-22

1 @ 323 =$425.00

NSM = Not Sufficient Material

REMARKS:
INFORMATIONAL

*

TOTAL CHARGES: $ 425.00

C: FILES ; MIKE REMILY - PAVEMENT QUALITY D. DOMINICK - PAVEMENTS

Kenneth L Stauffer
STATE CONSTRUCTION AND MATERIALS ENGINEER

		Nesika Beach - Rogue River			Level 3 19mm Open w/Lime				
		Pile #1	Pile #2	Pile #3	Pile #4	AC	Lime/RAP	Total	
% Comb.		82	7	11	0	5.3	0	100	
Sp. Gr.		2.703	2.602	2.552	2.520	1.025	2.270		
							JMF	Adj Gse	QC
Gsb								2.678	
Pb		4.5	5.0	5.5	6.0	6.5	5.8	5.8	5.80
Gmm		2.553	1.000	2.513	1.000	2.476	2.503	2.503	2.503
Gse		2.746	0.999	2.745	0.998	2.746	2.747	2.747	2.747
Gmb		2.084	1.000	2.120	1.000	2.155	2.132	2.132	2.132
VMA		25.7	64.5	25.2	64.9	24.8	25.01	25.01	25.01
Va		18.4	0.0	15.6	0.0	13.0	14.82	14.82	14.82
Pba		0.94	-64.36	0.93	-64.39	0.95	0.96	0.96	0.96
Pbe		3.60	66.14	4.62	66.53	5.61	4.90	4.90	4.90
VFA		28.5	100.0	37.9	100.0	47.7	40.7	40.7	40.7
		Adj JMF				QC			
Sieves	%Passing	Factor	S. Area		%Passing	Factor	S. Area		
1"	100	0.41	0.41		100.00	0.41	0.41		
3/4"	91	0	0.00		90.63	0	0.00		
1/2"	64	0	0.00		64.69	0	0.00		
3/8"	43	0	0.00		43.00	0	0.00		
1/4"	19	0	0.00		19.00	0	0.00		
#4	16	0.41	0.07		15.56	0.41	0.06		
#8	11	0.82	0.09		10.88	0.82	0.09		
#16	9	1.64	0.15		9.00	1.64	0.15		
#30	6	2.87	0.17		5.50	2.87	0.16		
#50	5	6.14	0.31		5.00	6.14	0.31		
#100	4	12.29	0.49		4.00	12.29	0.49		
#200	2.6	32.77	0.85		2.13	32.77	0.70		
		Area =	2.54			Area =	2.37		
		Vbe =	0.1019			Vbe =	0.1019		
		Wbe =	104.47			Wbe =	104.47		
		Ws =	2027.53			Ws =	2027.53		
		Avg Film =	19.82			Avg Film =	21.25		

	QC 1-8		QC 1-13		QC 1-14	
	6.58		5.60		5.53	
	2.494		2.529		2.524	
	2.774		2.770		2.760	
	1.000		1.000		1.000	
	65.1		64.8		64.7	
	59.9		60.5		60.4	
	1.32		1.27		1.14	
	5.35		4.40		4.46	
	8.0		6.6		6.7	
Vol Pbe	0.0522		0.0429		0.0435	
Sieves	%Passing	S. Area	%Passing	S. Area	%Passing	S. Area
1"	100	0.41	100	0.41	100	0.41
3/4"	97	0.00	92	0.00	89	0.00
1/2"	72	0.00	69	0.00	64	0.00
3/8"	53	0.00	48	0.00	46	0.00
1/4"	27	0.00	23	0.00	23	0.00
#4	22	0.09	18	0.07	18	0.07
#8	16	0.13	12	0.10	13	0.11
#16	13	0.21	9	0.15	9	0.15
#30	7	0.20	5	0.14	5	0.14
#50	6	0.37	4	0.25	4	0.25
#100	5	0.61	3	0.37	3	0.37
#200	2.2	0.72	1.8	0.59	1.7	0.56
	Area =	2.75	Area =	2.08	Area =	2.05
	Vbe =	0.0522	Vbe =	0.0429	Vbe =	0.0435
	Wbe =	53.46	Wbe =	44.02	Wbe =	44.56
	Ws =	946.54	Ws =	955.98	Ws =	955.44
	Avg Film =	20.04	Avg Film =	21.63	Avg Film =	22.16

APPENDIX F

VOLUME INCREASE RATIO (VIR) CALCULATIONS FOR 2001 CONSTRUCTION PROJECTS

Volume Ratio

Project: Shogren - Rowena Phase 2
Contract No.: C12322

Gse =	2.821						
Gsb =	2.766						
Gb =	1.025						
Pba =	0.75						
						Adj JMF	QC
Pb:	4.50	5.00	5.50	6.00	6.50	5.30	5.35
Pbe:	3.78	4.29	4.79	5.30	5.80	4.59	4.64
Ps:	95.50	95.00	94.50	94.00	93.50	94.70	94.65
Mass Ratios:							
Pbe/Ps*100:	3.9620	4.5132	5.0701	5.6330	6.2019	4.8466	4.9024
Ps/Pbe*100:	2523.9511	2215.7434	1972.3454	1775.2597	1612.4165	2063.2932	2039.8157
Unit Volumes:							
A:Pbe/100Gb:	0.0369	0.0418	0.0467	0.0517	0.0566	0.0448	0.0453
B:Ps/100Gsb:	0.3453	0.3435	0.3416	0.3398	0.3380	0.3424	0.3422
C:1/Gmm:	0.3822	0.3853	0.3884	0.3915	0.3946	0.3871	0.3875
Volume Ratios:							
A/B*100:	10.6917	12.1789	13.6819	15.2008	16.7360	13.0788	13.2293
A/C*100:	9.6590	10.8567	12.0352	13.1950	14.3366	11.5661	11.6836
B/A*100:	935.3036	821.0908	730.8945	657.8601	597.5151	764.5971	755.8970
B/C*100:	90.3410	89.1433	87.9648	86.8050	85.6634	88.4339	88.3164
(C-B)/C*100:	9.6590	10.8567	12.0352	13.1950	14.3366	11.5661	11.6836
(C-A)/C*100:	90.3410	89.1433	87.9648	86.8050	85.6634	88.4339	88.3164

QC 1-2	QC 1-12	QC 1-23
5.34	4.93	5.57
4.56	4.19	5.00
94.66	95.07	94.43
4.8172	4.4073	5.2949
2075.8772	2268.9737	1888.6000
0.0445	0.0409	0.0488
0.3422	0.3437	0.3414
0.3867	0.3846	0.3902
12.9995	11.8932	14.2886
11.5040	10.6291	12.5022
769.2603	840.8164	699.8608
88.4960	89.3709	87.4978
11.5040	10.6291	12.5022
88.4960	89.3709	87.4978

Volume Ratio

Project: Nesika Beach - Rogue River
Contract No.: C12511

Gse =	2.746						
Gsb =	2.678						
Gb =	1.022						
Pba =	0.94						
						Adj JMF	QC
Pb:	4.50	5.00	5.50	6.00	6.50	5.80	5.80
Pbe:	3.60	4.11	4.61	5.12	5.62	4.91	4.91
Ps:	95.50	95.00	94.50	94.00	93.50	94.20	94.20
Mass Ratios:							
Pbe/Ps*100:	3.7720	4.3232	4.8801	5.4430	6.0119	5.2171	5.2171
Ps/Pbe*100:	2651.0840	2313.1239	2049.1359	1837.2293	1663.3755	1916.7691	1916.7691
Unit Volumes:							
A:Pbe/100Gb:	0.0352	0.0402	0.0451	0.0501	0.0550	0.0481	0.0481
B:Ps/100Gsb:	0.3566	0.3547	0.3529	0.3510	0.3491	0.3518	0.3518
C:1/Gmm:	0.3919	0.3949	0.3980	0.4011	0.4041	0.3998	0.3998
Volume Ratios:							
A/B*100:	9.8841	11.3282	12.7876	14.2625	15.7532	13.6707	13.6707
A/C*100:	8.9950	10.1755	11.3378	12.4822	13.6093	12.0266	12.0266
B/A*100:	1011.7281	882.7530	782.0078	701.1383	634.7908	731.4929	731.4929
B/C*100:	91.0050	89.8245	88.6622	87.5178	86.3907	87.9734	87.9734
(C-B)/C*100:	8.9950	10.1755	11.3378	12.4822	13.6093	12.0266	12.0266
(C-A)/C*100:	91.0050	89.8245	88.6622	87.5178	86.3907	87.9734	87.9734
(C-B)/B*100:	9.8841	11.3282	12.7876	14.2625	15.7532	13.6707	13.6707

QC 1-8	QC 1-13	QC 1-14
6.58	5.60	5.53
5.35	4.40	4.46
93.42	94.40	94.47
5.7268	4.6610	4.7211
1746.1682	2145.4545	2118.1614
0.0523	0.0431	0.0436
0.3488	0.3525	0.3528
0.4012	0.3956	0.3964
15.0063	12.2135	12.3709
13.0482	10.8842	11.0090
666.3868	818.7657	808.3499
86.9518	89.1158	88.9910
13.0482	10.8842	11.0090
86.9518	89.1158	88.9910
15.0063	12.2135	12.3709