



WMA BEST PRACTICE GUIDELINE & SPECIFICATION

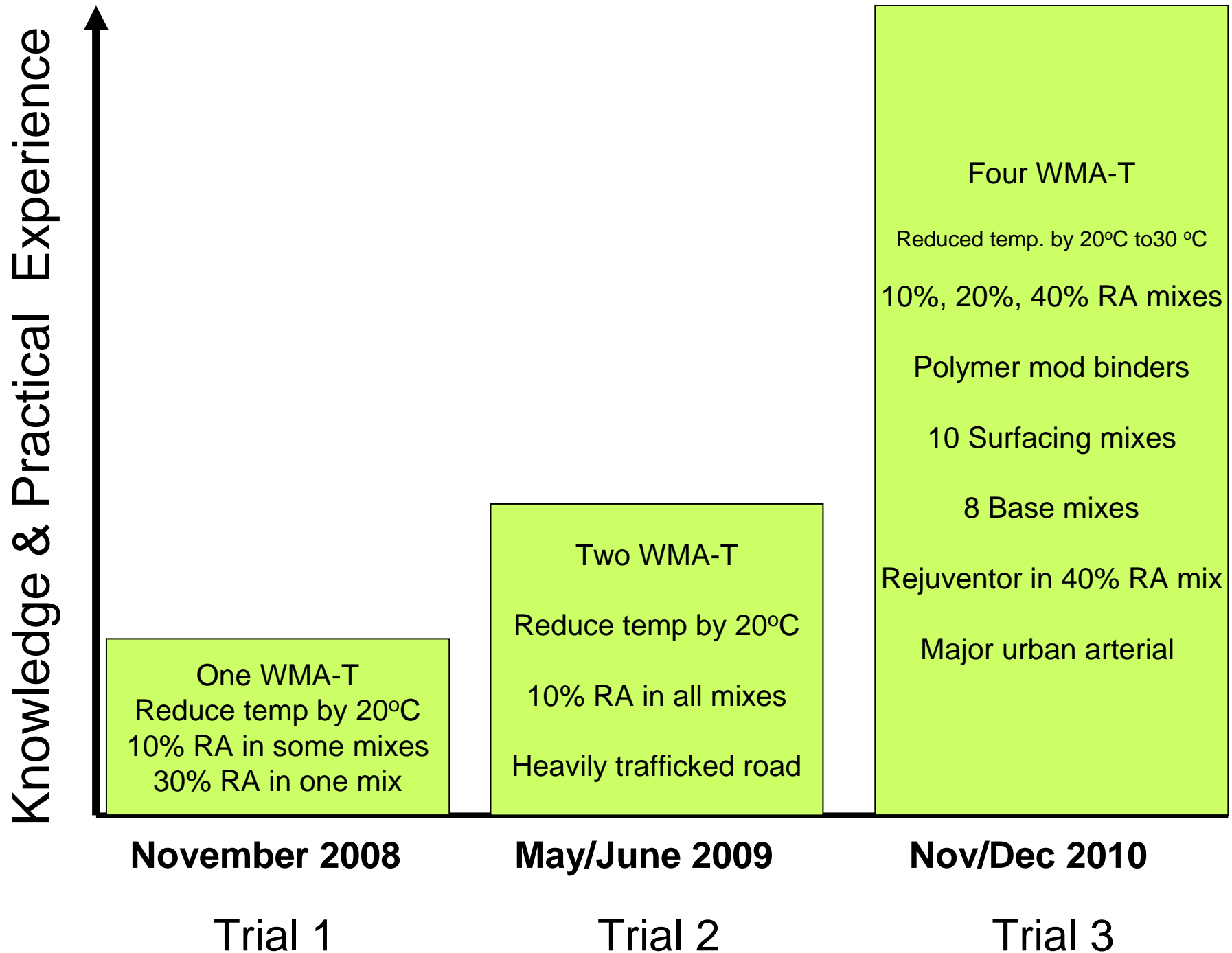
Road Pavement Forum

11 May 2011

THIRD TRIAL OBJECTIVES

- Reduce mixing and paving temperatures by a further 10°C
- Include:
 - polymer modified binders in the “warm” mixes
 - at least 10% RA in all the mixes, some up to 40%
 - base as well as surfacing mixes

Gather sufficient information to compile a South African WMA Guideline & Specification



ASPHALT SURFACING	TYPE	
Mix D (60/70 pen bitumen)	Control	Conventional HMA temperatures
10% RA MIXES		
MIX D Sasobit® + 10% RA	WMA	Temperatures reduced by 30°C
MIX D Foamtec +10% RA	WMA	Temperatures reduced by 30°C
MIX D Rediset + 10% RA	WMA	Temperatures reduced by 30°C
20% RA MIXES		
Mix D AE2 (Sasolwax Flex™) + 20% RA	WMA	Temperatures reduced by 20°C
Mix D AE2 + 20% RA	Control	Conventional HMA temperatures
Mix D AP1 + Rediset + 20% RA	WMA	Temperatures reduced by 20°C
Mix D AP1+ 20% RA	Control	Conventional HMA temperatures

ASPHALT BASE	TYPE	
Mix B (40/50 pen bitumen)	Control	Conventional HMA temperatures
10% RA MIXES		
Mix B AE2 (Sasolwax Flex™) + 10% RA	WMA	Temperatures reduced by 20°C
Mix B AE2 + 10% RA	Control	Conventional HMA temperatures
Mix B AP1 + Rediset + 10% RA	WMA	Temperatures reduced by 20°C
Mix B AP1 + 10% RA	Control	Conventional HMA temperatures
Mix B AP1 Foamtec + 10% RA	WMA	Temperatures reduced by 20°C
40% RA MIXES		
Mix B AE2 (Sasolwax Flex™) + 40% RA	WMA	Temperatures reduced by 20°C
Mix B AE2 + 40% RA	Control	Conventional HMA temperatures
Mix B AP1 + Rediset + 40% RA	WMA	Temperatures reduced by 20°C
Mix B AP1 + 40% RA	Control	Conventional HMA temperatures

MONITORING TEAM



HIGGINSON HIGHWAY







MIX NUMBER	S6	S2	S3	S7	S5	S4	S8	S9	SPECIFICATION TYPED	B9	B4	B3	B1	B2	B10	B5	B8	B7	B6	SPECIFICATION TYPE B			
ASPHALT MIX DESCRIPTION	TYPE D	TYPE D	TYPE D	TYPE D	TYPE D	TYPE D	TYPE D	TYPE D		TYPE B	TYPE B	TYPE B	TYPE B	TYPE B	TYPE B	TYPE B	TYPE B	TYPE B	TYPE B		TYPE B		
NATIONAL SAMPLE NUMBER	10/4243	10/3993	10/4020	10/4288	10/4194	10/4143	10/4303	10/4246		104267	10/3827	10/3767	10/3640	10/3698	10/4273	10/4041	10/4207	10/4169	10/4093				
NATIONAL LOT NUMBER	1369	1306	1316	1385	1360	1348	1388	1395		1374	1265	1244	1215	1229	1381	1323	1361	1355	1330				
SRT SAMPLE NUMBER	B10976	B10756	B10784	B11010	B10911	B10900	B11009	B11043		B10984	B10651	B10620	B10500	B10519	B10989	B10805	B10928	B10907	B10827				
BINDER TYPE	60/70	60/70	60/70	60/70	A-E2	A-P1	A-E2	A-P1		40/50	A-P1	A-E2	A-E2	A-P1	A-P1	A-P1	A-P1	A-E2	A-P1		A-E2		
RA CONTENT	10%	10%	10%	10%	20%	20%	20%	20%		0%	10%	10%	10%	10%	10%	40%	40%	40%	40%				
WARM MIX TECHNOLOGY	Control	Sasobit	Rediset	NA FoamTec™	Control Bituguard	Control COLAS	SasoLwax Flex	EVA/R Set		Control	Control COLAS	Control Bituguard	SasoLwax Flex	EVA/R Set	NA FoamTec™	Control COLAS	Control Bituguard	EVA/R Set	SasoLwax Flex				
% WARM MIX TECHNOLOGY ADDED	-	1.5%	1.0%	-	4.2%	5.0%	4.2%	5% + 1.5%		0.0%	5.0%	4.2%	4.2%	5.0% + 1.5%	5.0%	5.0%	4.2%	5.0% + 1.5%	4.2%				
MANUFACTURED TEMPERATURE	156 - 166	125 - 128	122 - 129	122 - 130	160 - 166	163 - 168	137 - 140	136 - 144		160 - 162	161 - 163	158 - 164	132 - 142	136 - 140	140 - 141	155 - 159	156 - 164	132 - 142	129 - 142				
DATE MANUFACTURED	1-Dec	16-Nov	18-Nov	5-Dec	28-Nov	25-Nov	6-Dec	8-Dec	MIN	MAX	2-Dec	07 / 08 Nov	02 / 03 Nov	25 / 26 Oct	27 / 29 Oct	4-Dec	19 / 20 Nov	29 / 30 Nov	26 / 27 Nov	22 / 23 Nov	MIN	MAX	
	26.50	100	100	100	100	100	100	100	100.0		100	100	100	100	100	100	100	100	100	100	100	100	100.0
	19.00	100	100	100	100	100	100	100	100.0		95	94	96	94	94	97	98	94	95	98	98	80 - 100	
	13.20	100	100	99	99	100	99	98	92 - 100		75	76	80	78	82	81	81	73	81	87	87	60 - 80	
	9.50	90	85	86	86	86	82	88	74 - 90		58	60	65	64	67	59	67	58	67	71	71	51 - 71	
SIEVE	6.70	74	68	65	69	65	64	68	-		45	48	49	53	52	46	53	46	53	57	57	44 - 64	
ANALYSIS	4.75	64	58	56	58	55	55	59	52 - 68		38	41	42	44	46	39	47	41	45	50	50	36 - 56	
	2.36	44	39	38	38	39	39	42	36 - 52		27	29	31	30	31	27	35	29	33	36	36	28 - 44	
	1.18	33	28	28	28	29	29	32	24 - 40		21	21	23	21	22	20	27	23	25	27	27	20 - 34	
	0.600	25	21	21	21	23	23	24	18 - 28		17	16	17	16	17	15	22	18	20	22	22	15 - 27	
	0.300	17	15	15	14	16	16	17	10 - 20		13	12	13	12	12	11	16	14	15	16	16	10 - 20	
	0.150	11	9	9	9	10	9	10	6 - 12		9	8	9	9	8	8	10	9	10	10	10	6 - 12	
	0.075	7.1	5.5	5.4	5.8	6.0	5.5	6.2	4 - 8		4.8	5.5	6.3	6.1	6.2	5.2	6.6	5.8	6.8	6.3	6.3	2 - 6	
FILLER / BIT. RATIO	(-)	1.218	1.040	1.000	1.100	1.188	1.104	1.135	1.212	1.0 - 1.5	1.122	1.262	1.463	1.349	1.364	1.282	1.575	1.400	1.585	1.364	1.364	1.0 - 1.5	
MOISTURE CONTENT D&S	(%)	0.1	0.1	0.2	0.2	0.1	0.2	0.1	0.3	0.5 Max	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.1	0.2	0.1	0.1	< 0.5	
RICES S.G. (Max theo dens.)	(kg / m³)	2.457	2.481	2.477	2.475	2.488	2.482	2.473	2.473	-	2.497	2.483	2.493	2.490	2.499	2.500	2.490	2.495	2.503	2.486	2.486	-	
BULK R.D.	(kg / m³)	2.384	2.362	2.358	2.372	2.379	2.371	2.382	2.383	-	2.390	2.379	2.396	2.374	2.386	2.369	2.380	2.385	2.387	2.374	2.374	-	
BITUMEN CONTENT	(%)	5.5	5.0	5.1	5.0	4.8	4.8	5.2	5.2	5.0 - 5.6	4.1	4.2	4.1	4.3	4.4	3.9	4.0	4.0	4.1	4.4	4.4	4.2 - 4.8	
FILM THICKNESS	(µm)	7.5	7.9	8.2	8.0	7.1	7.6	7.4	7.2	5.0 Min	7.5	8.1	7.0	7.5	7.2	7.7	6.2	6.9	6.0	6.7	5.0 Min	5.0 Min	
BINDER ABSORPTION	(%)	0.4	0.5	0.5	0.4	0.5	0.4	0.5	0.5	0.5 Max	0.3	0.1	0.2	0.3	0.5	0.2	0.1	0.2	0.4	0.3	0.3	0.5 Max	
MARSHALL VOIDS	(%)	2.9	4.8	4.8	4.2	4.4	4.5	3.7	3.7	3.0 - 6.0	4.4	4.2	3.9	4.8	4.5	5.3	4.4	4.4	4.7	4.5	4.5	3.0 - 6.0	
V.M.A.	(%)	14.8	15.2	15.4	14.8	14.4	14.7	14.6	14.6	15.0 Min	13.2	13.7	13.0	14.0	13.6	13.8	13.4	13.2	13.3	14.0	14.0	14 Min	
V.F.B	(%)	80.1	68.3	68.8	71.9	69.3	69.2	74.8	74.9	65 - 75	67.0	69.2	69.9	66.1	66.8	61.8	67.3	66.8	64.8	67.7	67.7	65 - 75	
MODIFIED LOTTMAN	(%)	0.84	0.81	0.74	0.78	0.88	0.84	0.85	0.92	80 Min	0.81	0.87	0.84	0.92	0.90	0.80	0.89	0.89	0.92	0.83	0.83	70 Min	
ITS	(kPa)	1,365	1,032	1,143	1,030	1,423	1,322	1,547	1,168	800 Min	1,157	1,575	1,289	1,167	1,261	1,727	1,990	1,830	1,454	1,586	1,586	1000 Min	
GYRATORY VOIDS / 300	(%)	2.5	4.5	2.7	3.5	2.3	3.5	2.0	1.3	2.0 Min	0.8	2.5	2.1	2.6	2.0	5.9	1.2	1.0	2.0	1.5	1.5	2.0 Min	
AIR PERM		0.80	1.05	2.05	1.40	1.57	1.20	2.85	0.86	1.0x10⁴ Max	0.73	0.04	2.80	1.24	0.36	0.74	0.85	2.08	2.20	0.32	0.32	1.0x10⁴ Max	
Dynamic Creep Modules	(Mpa)	36.2	33.6	27.3	36.9	31.7	51.1	54.0	50.5	20.0 Min	42.4	47.9	38.2	42.0	54.3	49.0	49.2	36.8	43.2	41.0	41.0	20.0 Min	
Resilient Modules	(Mpa)	4,747	3,772	2,590	3,820	4,428	5,020	4,855	4,774	-	4,651	7,744	7,744	5,010	4,713	3,875	8,602	8,684	6,566	6,101	6,101	-	
MMLS RUTTING	(kg / m³)	2.11	1.56	1.79	1.50	1.24	0.69	1.58	1.01	2.0 Max	2.00	1.10	1.00	1.76	1.39	0.98	0.87	1.34	0.86	1.36	1.36	2.0 Max	
BINDER GRADE		60 / 70	60 / 70	60 / 70	60 / 70	80 / 100	80 / 100	80 / 100	80 / 100	A-P1	A-E2	40 / 50	60 / 70	60 / 70	60 / 70	60 / 70	80 / 100	80 / 100	80 / 100	80 / 100	80 / 100	A-P1	A-E2
SOFTENING POINT	(°C)	48.8	58.0	55.0	48.8	73.0	65.0	80.0	62.0	63 - 73	65 - 85	58.0	68.6	72.0	87.8	66.0	66.0	66.0	67.0	88.0	88.0	63 - 73	65 - 85
ELASTIC RECOVERY @ 15	(%)	-	-	-	-	76.0	52.3	74.0	37.5	> 30	> 60	-	40.0	72.3	74.8	43.3	38.8	57.3	75.0	40.8	71.8	> 30	> 60
STORAGE STABILITY	(°C)	2.8	0.0	0.0	2.8	4.4	0.5	0.1	0.6	≤ 5	-2 to +8	0.6	0.0	0.6	0.0	0.2	0.2	4.4	0.0	0.2	0.2	≤ 5	-2 to +8
PG Grading			70-22			70-22	64-16	76-22	76-16	-	-		70-16	76-22	76-28	70-22		70-22		70-22		-	-
RECOVERED SOFTENING POINT	(°C)	57.6	64.0	55.0	58.0	64.0	64.0	71.0	62.0	63 - 73	65 - 85	55.4	68.0	62.6	73.0	63.0	62.0	66.0	69.0	67.2	70.2	63 - 73	65 - 85
RECOVERED BINDER PEN		29	26	44	30	30	20	28	24	-	-	42	16	33	18	25	22	18	17	18	20	-	-
-8mm RA Recovered Pen		5.0	5.0	5.0	5.0	6.0	5.0	5.0	5.0	-	-	-	5.0	4.0	4.0	5.0	3.0	5.0	5.0	6.0	6.0	-	-
-8mm RA Recovered S / P		90.0	85.0	83.3	82.3	83.3	84.8	84.0	89.3	63 - 73	65 - 85	-	87.3	83.3	83.3	88.0	84.0	80.0	86.0	87.0	82.3	63 - 73	65 - 85
-8mm RA Binder Content		4.9	5.8	5.3	5.5	5.2	4.9	6.1	4.9	-	-	-	5.7	6.1	6.1	6.2	5.5	6.2	4.9	5.8	5.8	-	-
-16mm RA Recovered Pen		6.0	11.0	5.0	5.0	6.0	6.0	6.0	4.0	-	-	-	4.0	5.0	5.0	6.0	5.0	6.0	5.0	6.0	6.0	-	-
-16mm RA Recovered S / P		82.0	79.6	85.3	88.0	84.0	82.3	84.3	90.0	63 - 73	65 - 85	-	88.3	82.3	82.3	80.0	83.3	77.8	85.0	87.8	80.4	63 - 73	65 - 85
-16mm RA Binder Content		4.5	4.4	4.5	4.2	4.3	3.8	4.0	3.8	-	-	-	4.5	4.7	4.7	4.9	4.5	4.3	4.5	4.8	4.8	-	-
Layer Thickness	(mm)	54.7	57.3	58.0	61.2	60.7	56.7	56.7	56.5	50mm	81.8	74.0	75.8	76.8	85.0	84.0	83.0	79.7	77.3	82.7	82.7	80mm	
FIELD VOIDS	(%)	5.1	4.8	6.4	6.6	5.6	6.3	5.0	5.2	8.0 Max	3.5	2.7	3.1	3.9	4.3	5.0	3.2	5.1	4.5	4.0	4.0	8.0 Max	
AVERAGE COMPACTION	(%)	94.9	95.2	93.6	93.4	94.4	93.7	95.0	94.8	92.0 Min	96.6	97.3	96.9	96.1	95.7	94.4	96.8	94.9	95.5	96.0	96.0	92.0 Min	

SUMMARY OF FINDINGS

We have been successful in:

- Reducing mixing and paving temperatures by 25°C to 30°C below those of conventional mixes
- Including polymer modified binders in the “warm” mixes
 - Adding up to 40% RA
 - Using base as well as surfacing mixes

The quality of the WMA is shown to be at least as good as that of the HMA control mixes

Sufficient information is now available from these trials, supplemented with overseas information, to compile a South African WMA Guideline & Specification

WMA GUIDELINE & SPECIFICATION

Panel Members:

A Lewis (TLC) (scribe)
K Naidoo (WAM National Co-ordinator)
E Lathlieff (eThekweni Municipality)
I McDonald (City of Cape Town)
W Nortjè (National Asphalt)
H Marais (Much Asphalt)
R Archibald (Vela VKE)
D Needham (Akzo Nobel)
S Strydom (Sasol Wax South Africa)

Review Panel:

P Myburgh
D Rossmann
K Jenkins
S Solomons

What are the benefits of WMA in terms of the environment, working conditions and costs?

Environmental – reduced fossil fuel consumption, less GHG emissions

Health – improved conditions for workers

Engineering & Economic:

compaction,

workability for handwork,

paving at night,

paving in cold weather

What technologies are used to reduce the asphalt temperature while still enabling a high level of compaction to be achieved?

Overview of WMA Technologies (WMA-T):

Water Technologies

Chemical additives

Rheological modifiers

How are WMA Technologies classified?

More detailed descriptions of:

Water Technologies

- Mechanical binder foam systems
(NA Foamtec, Aztec Double Drum)
- Zeolites (Aspha-min)
- Moist fine aggregate addition systems (LEA, EBE)

Chemical additives

- Surfactant types (**Rediset WMX**, Evotherm)

Rheological modifiers

- Reduce binder viscosity at high temperatures
FT waxes (**Sasobit**, Thiopave)

Polymer –rheology modified hybrids

- Cc-modified technologies (**Sasobit Flex**,
Rediset combined with EVA)

Are any additional or less stringent measures required regarding HSE when manufacturing and paving WMA?

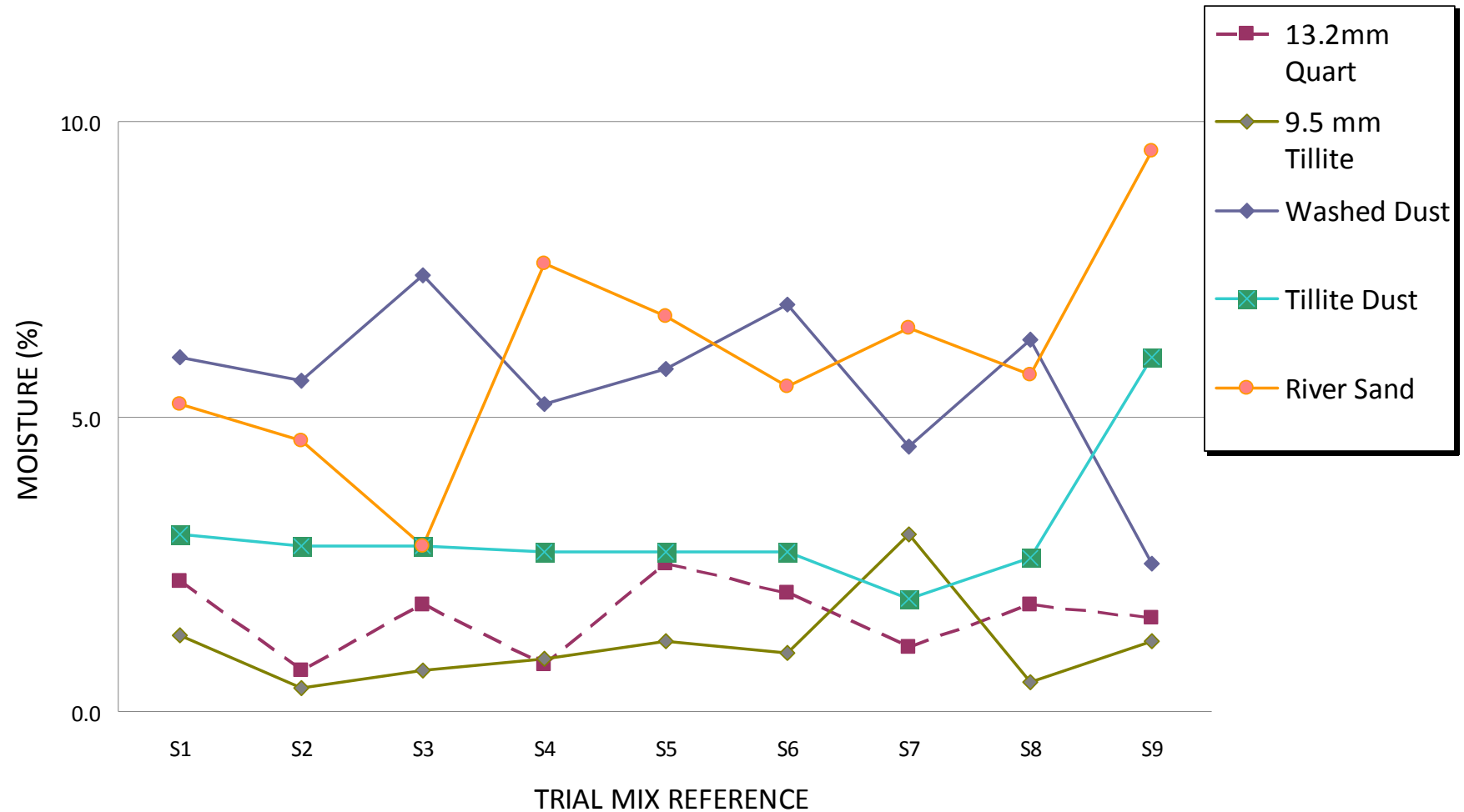
Apply same best practice as for HMA

UTILISE Sabita Manual 25

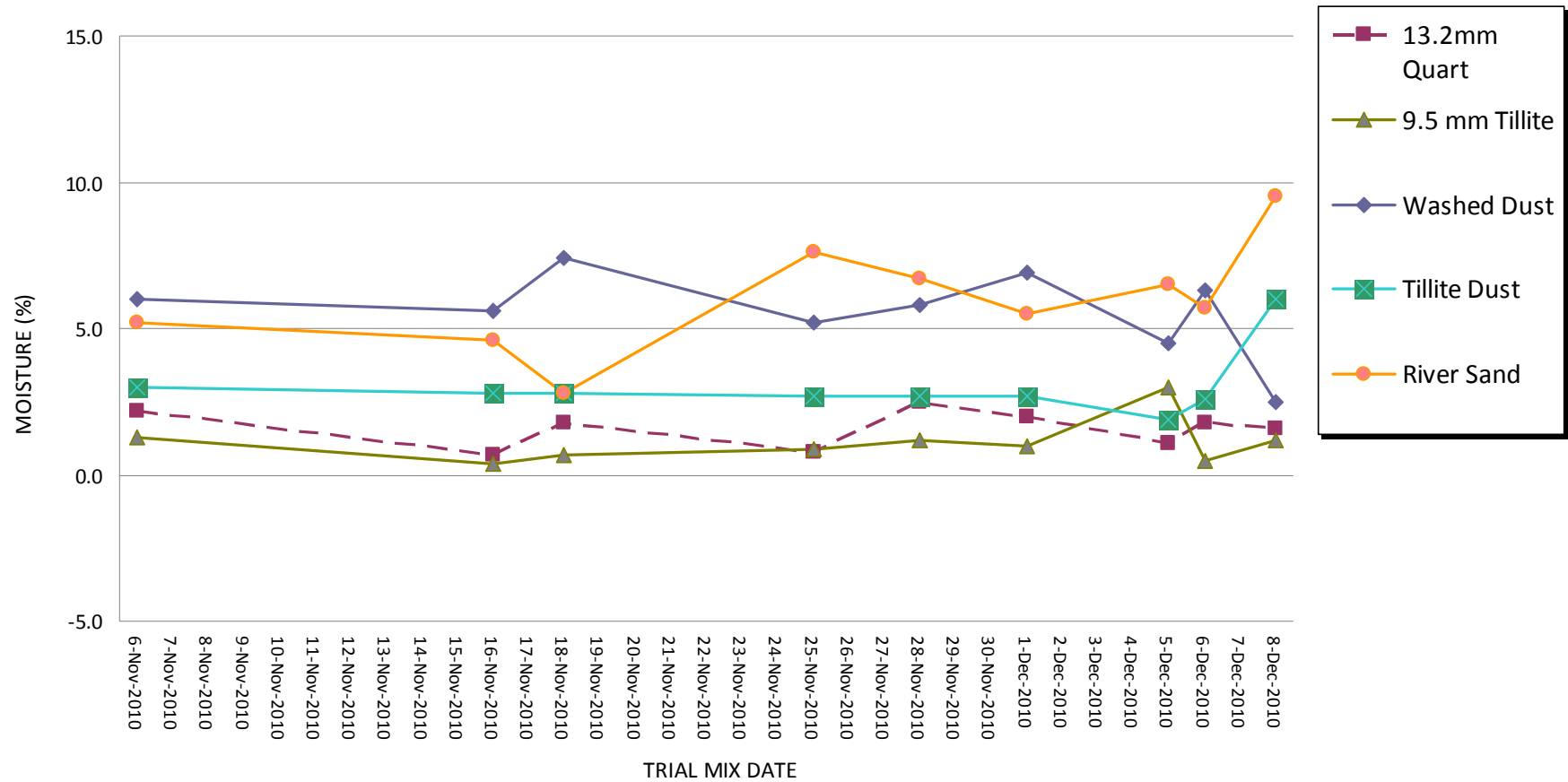
How should the various components that are used to make up WMA be handled?

- New aggregates
- Reclaimed asphalt (RA) – milling, stockpiling, processing by crushing & screening – moisture content
- Binders
- WMA Technologies – information required by supplier

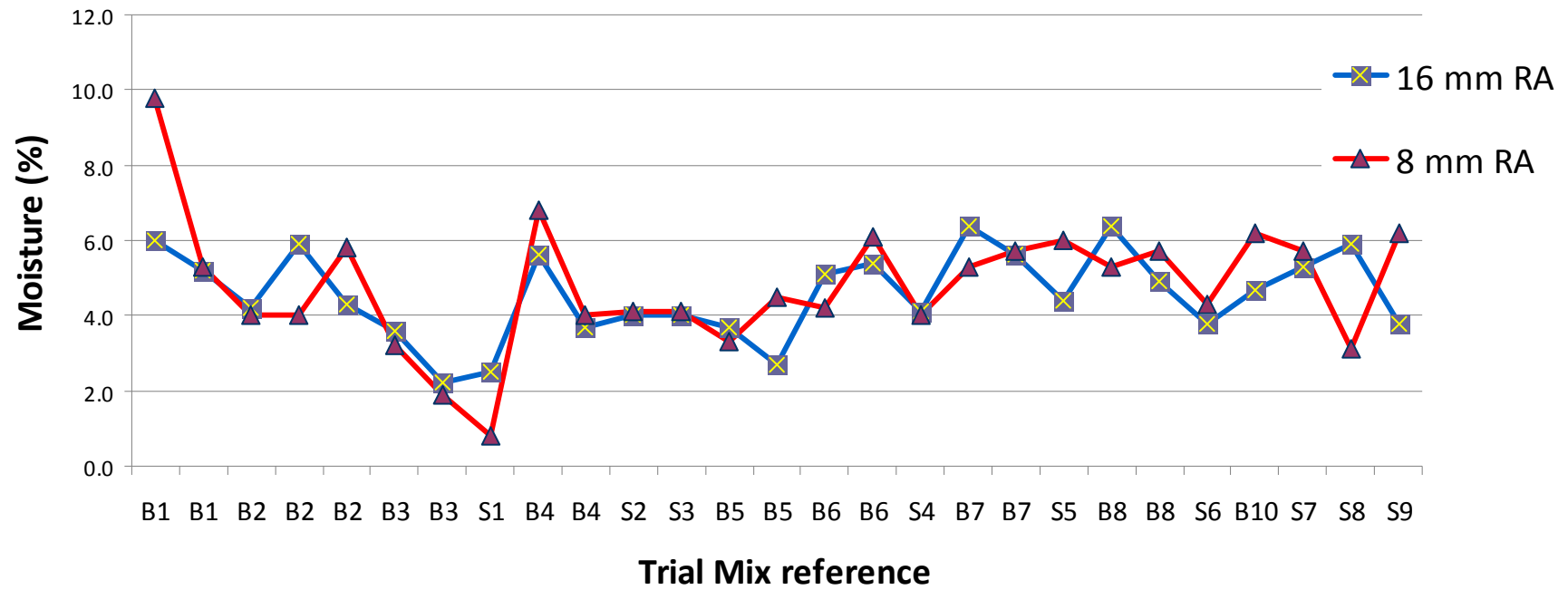
Moisture content of aggregates used in the base mixes



Moisture content of aggregates used in the surfacing mixes



Moisture content of RA fractions



Quality assurance issues

- Chapter 8 Mix components
- Chapter 11 Manufacture
- Chapter 13 Paving site

What process is used to approve the mix? What changes are there to the mix design procedures used for WMA?

Step 1	<i>Lab mix</i>
Step 2	<i>Plant mix</i>
Step 3	<i>Paving trial</i>

How is WMA manufactured; can both batch and continuous type drum mixers be used, what modifications are required, how is the plant adjusted to produce mix at a lower temperature?

- Various options for batch plants
- Various options for drum mixers
- Recommended maximum RA contents
- Cold feed requirements
- Binder storage facilities

Transportation & paving requirements?

- Preparation work
- Paving & compaction
- Opening to traffic
- Weather conditions

When new WMA Technologies are proposed, what procedure is used to introduce and approve them?

- Some WMA-T are already proven
- Phased approach for new technologies:

Phase 1	Provide information
Phase 2	Mix design approval process as in Ch 9
Phase 3	Assessment of documentation, mix approval process including results of full-scale paving trial

TIMEFRAME

Second draft currently under review

Distribute to peer reviewers: Piet Myburgh, Dennis Rossmann,
Kim Jenkins, Saied Solomons & Overseas Reviewers

Deadline for complete draft guideline end May 2011

Workshop & finalise document by end July 2011

Publish Best Practice Guideline & Spec in time for CAPSA '11

Specification

- Stand-alone specification
- Based on COLTO Section 4200
- Limited to continuously graded mixes
- Aggregate & RA moisture content limits
- Plant modifications to enable lower temperatures
- Mix approval – lab, plant mix, and trial pave

Where to now?

WMA is already being used full-scale on rehab projects











Where to now?

