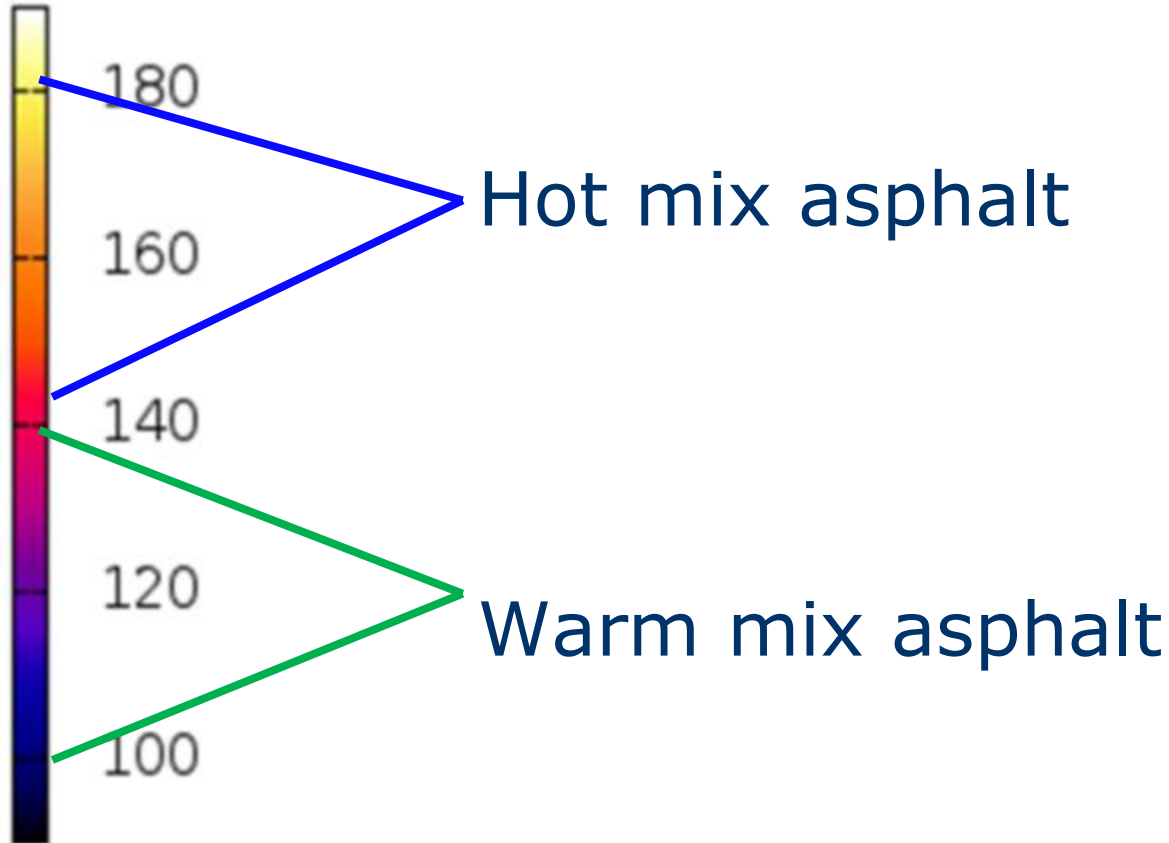




WHAT IS WARM MIX ASPHALT AND WHY SHOULD WE USE IT?

What is warm mix asphalt

T°C



Why WMA?

- By decreasing the temperature you will achieve
 - Better conditions for the workers – less fume exposure
 - Less emission of greenhouse gases and hydrocarbons
- Saving energy
 - Positive for the environment

By lowering the temperature with 10° C, the emission of asphalt fumes will be reduced with 50 %

The history of WMA in Norway

- WAM-Foam was developed by Kolo Veidekke and Shell in 1995-1998 to reduce CO₂ emissions
- >100.000 m² was paved for Statens Vegvesen in 2001, but the product «died» after while and after 2006 nothing was produced
- 2006 - «European Study Tour»
American road authorities and contractors went to Europe to learn from Norway, Germany and the UK.
- In 2011, 40% of the production in the US was WMA, (in Norway, 0,4%)

The Project LTA 2011

- The project regarding WMA started with focus from:
 - Norwegian asphalt and road contracting association (EBA)
 - Public Road Administration in Norway (Statens Vegvesen)
 - The Norwegian labour inspection authorities on health and safety (Arbeidstilsynet og STAMI)

Also involved:

- Suppliers of chemicals and bitumen.



Entreprenørforeningen - Bygg og Anlegg

Background for the LTA 2011

- International Agency for Research on Cancer (IARC) have recommended the asphalt producers to reduce the exposure from asphalt fumes for the workers
- Authorities for inspection of health and safety for workers in Norway have focused on the asphalt industry through different projects
- The contractors (EBA) wanted to see what possibilities we have to make better conditions for the workers.

Goals

Part 1a: Chemical working conditions

Part 1b: Mechanical workload, comparing paving of WMA and ordinary hot mix asphalt

Part 2: Comparing asphalt quality, WMA vs hot mix, assuming that WMA production will not affect the quality

The Project LTA 2011

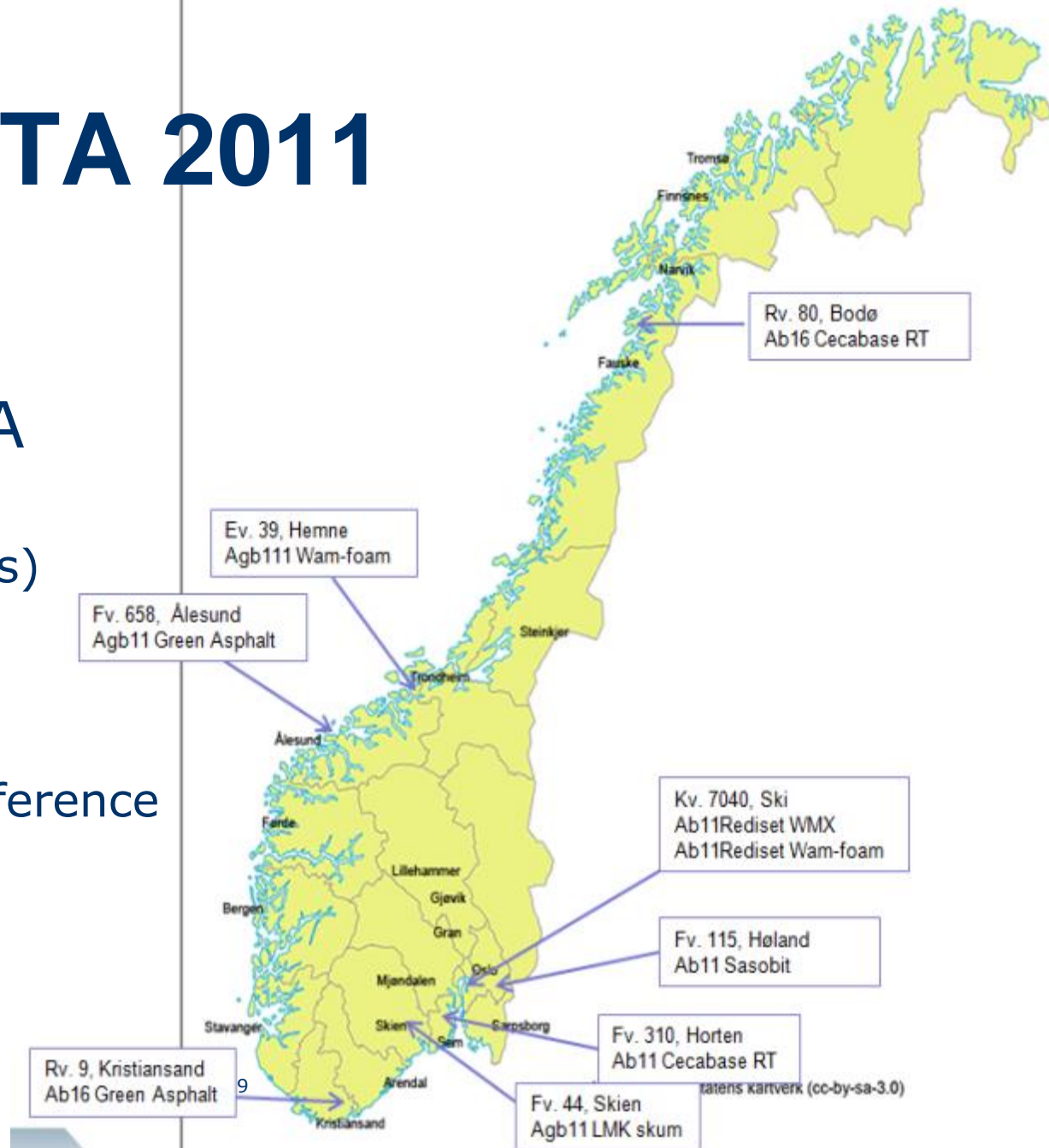
- Different production methods were tested. Both foaming technic and different chemicals
- Emission of asphalt fumes and ergonomic workload for the workers were measured.

LTA 2011

11 sites

Different WMA
technics
(foam and additives)

Every site has a reference
with Hot mix.



LTA 2011- trials

- Production temperature (avg):

AC s	Ref. 160 ° C	WMA. 132 ° C
AC bin	Ref. 160 ° C	WMA. 128 ° C

- Paving temperature (avg):

AC s	Ref. 158 ° C	WMA. 130 ° C
AC bin	Ref. 151 ° C	WMA. 124 ° C

1 a: Measurements of chemical exposure

Asphalt fumes

Organic carbons

Amines and polyamminer
(additives)

Dust



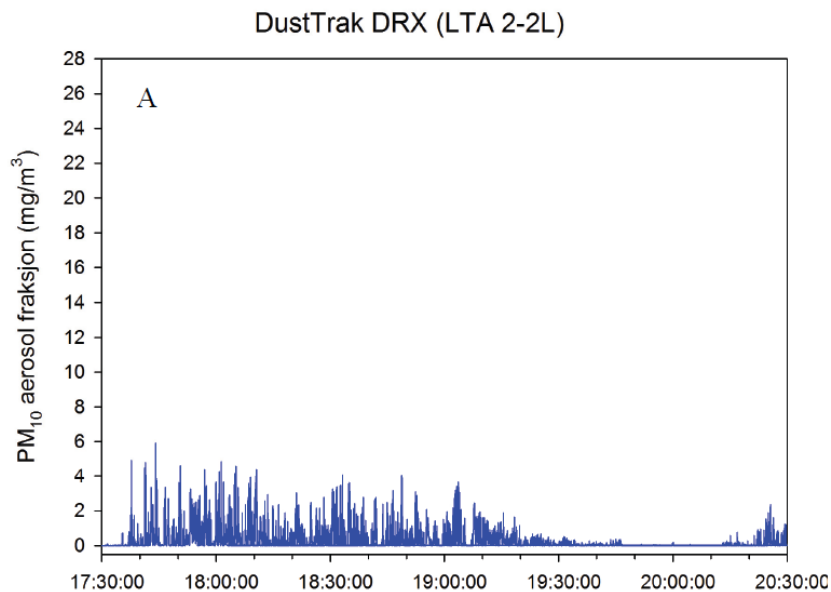
Results Part 1a

In these measurements we found that there is a significant difference between exposure from paving of WMA and Hot mix asphalt when it comes to:

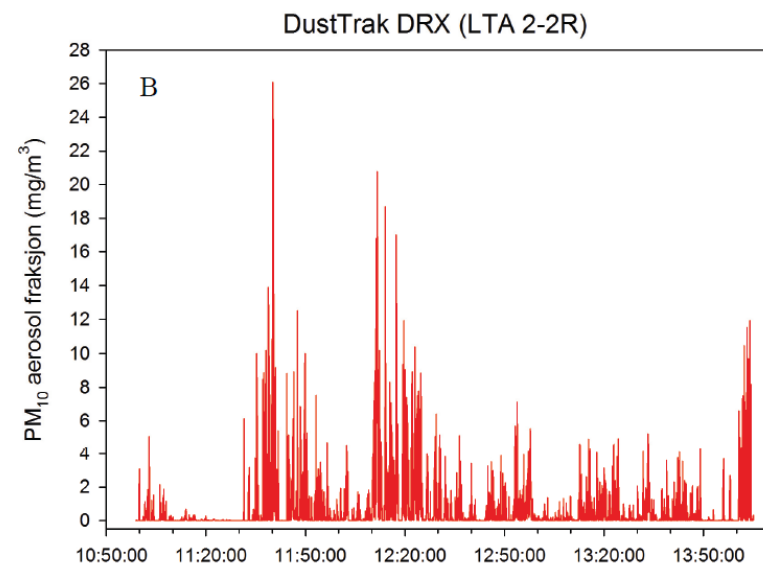
asphalt fumes
organic carbon

Measurements of asphalt fumes

DustTrack DRX



WMA



Ref

Reduction of 67 %



Entreprenørforeningen – Bygg og Anlegg

WMA

Paving of WMA and Reference

Ref



Visible difference.
No smoke in the WMA

EBA

Entreprenørforeningen – Bygg og Anlegg

1 b: Ergonomic workload

Tests while performing
handwork:

Heart frequency

Workload on tools



EBA

renørforeningen – Bygg og Anlegg

1 b: Ergonomic measurements

- Load: Part of the time with loads of; less than 5 kg, 5-10 kg, 10-15 kg, 15-20 kg og mer enn 20 kg
- Heart frequency: Measured every 5 sec. Average for a period of 20 min.

Also controled by video. Parts of the time when the tools were not in use , were excluded from the measurements

1 b: Results

- Mechanical measurements show no significant difference in loads on tools used by paving WMA or reference.
- There could not be measured any difference in heart frequency.

Part 2: Quality

The project has assumed that:

- WMA and reference has the same formulation regarding aggregates and bitumen

And that:

- The pavements will meet the same requirements and have the same life time, if they are paved under equal conditions and have achieved the same values of voids.

Quality control



Quality, paving results

Production and paving temperature

	Reference	WMA	Difference
Stated production temperature, °C	161	130	31
Stated paving temperature, °C	156	127	29

Average void content

	Laboratory mixed samples		Cores from the road	
	Reference	WMA	Reference	WMA
Average void content [%]	2.7	2.6	3.6	3.3

Conclusions

WMA has been produced and paved with a reduced temperature of about 30 ° C.

No special problems detected during production or paving.

Measurements shows a significant reduction in exposure of asphalt fumes during paving

Measurements could not show higher workloads connected to WMA

Bonus from the Public Road Administration

- The Public Road Administration and The Norwegian labour inspection authorities on health and safety see the advantages of using WMA.
- The Public Road Administration have decided to give a bonus to the contactors that produces WMA, using the foaming technic.
 - A bonus of 30 NOK is given for every ton produced WMA.
 - The temperature has to be lowered with 25 ° C compared to «normal» production temperature .

Continuing in 2013

For how long will this «lubrication effect» last with the foaming technic?

Trials connected to storage and transportation.

WMA stored in silo overnight:

No problems in paving (even handwork) the following day

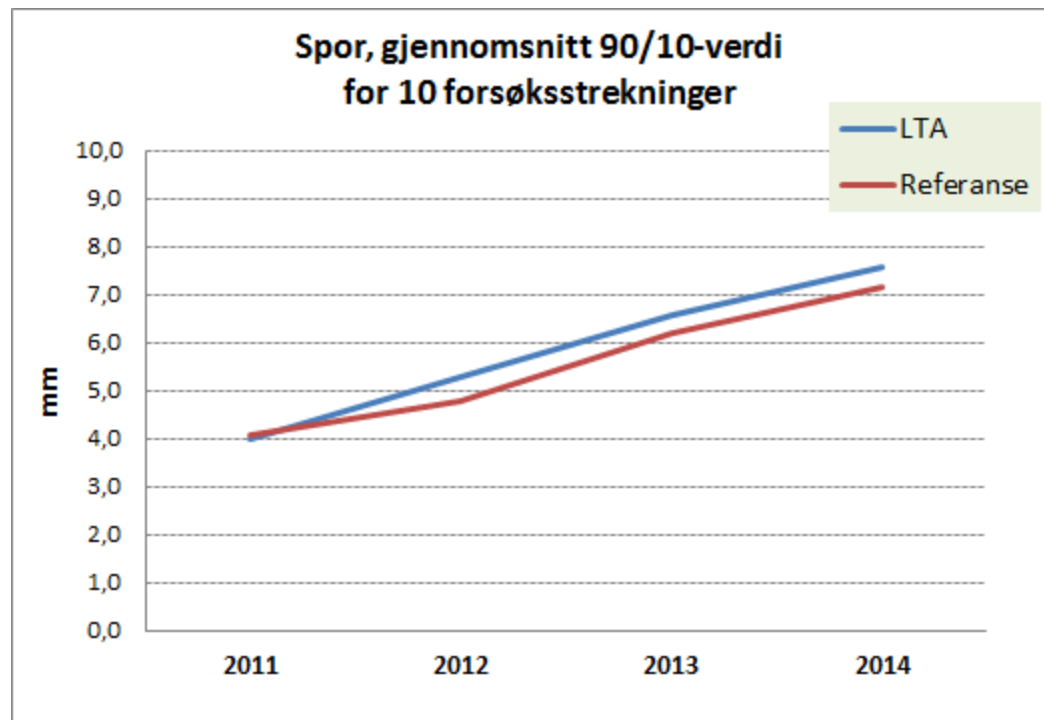
WMA transported in boat:

Transport and storage from one day to the next.

No problems in paving (even handwork)



Following up, Rutting



Following up

- The Norwegian Road Administration will follow up these roads with measurements on rutting and evenness every year.
- So far, there are no signs that indicates big differences in WMA and hot mix asphalt.

Production af asphalt in Norway 2014

PRODUSERT ASFALT I NORGE 31.12.14

	ASFALT PRODUKSJON x 1.000 tonn			
Produsent	Total	Lavtemperaturasfalt		Total
	31.12.2014	LTA	LTA	31.12.2013
		31.12.2014	31.12.2013	
	2 451	188	96	2 224
	1 504	197	105	1 305
	1 178	142	134	1069
	366	3	3	377
	304			414
	277			220
	211	9		201
	180			193
	145			138
	87			71
	80			
	76			42
	57			43
	55			53
	25			25
	20			
	20			16
	0			50
				30
Sum tonn:	7 025	539	338	6 471



Lemminkäinen Norge

WMA

Lemminkäinen



WMA in Lemminkäinen Norway

- It was decided from the Leaders group in Lemminkäinen Norway to really go for WMA production
- It was decided to make investments on several locations
- The background for these investments was the thought of being more environmentally friendly, make better conditions for the workers and also reduce emissions.
- Another issue was the bonus from the Road Administration and also to save energy.



Further trials with Pmb

- The work done in 2011 was successful. We decided to go further with the foaming technic.
- All jobs so far were done with ordinary penetration grade bitumen. The next season we wanted to try Pmb.
- As far as we know, Lemminkäinen was the only company in Norway trying WMA with Pmb at that time.



Further trials with Pmb

- In 2012, Lemminkäinen Norway made 2 trials with pmb
 - Both of them with reference works
 - Night work with quite low air temp. - about 9 °C
 - One trial in tunnel
- Foaming technic was used
- Asphalt fumes were measured



WMA in tunnel

- AC s 11 with Pmb
- Temperatures:

	Ref	WMA
In paver	170 - 180	130 - 145
Behind screed	160 - 170	125 - 135

- Temperature is reduced by about 30 °C
- There were no problems paving or compacting.

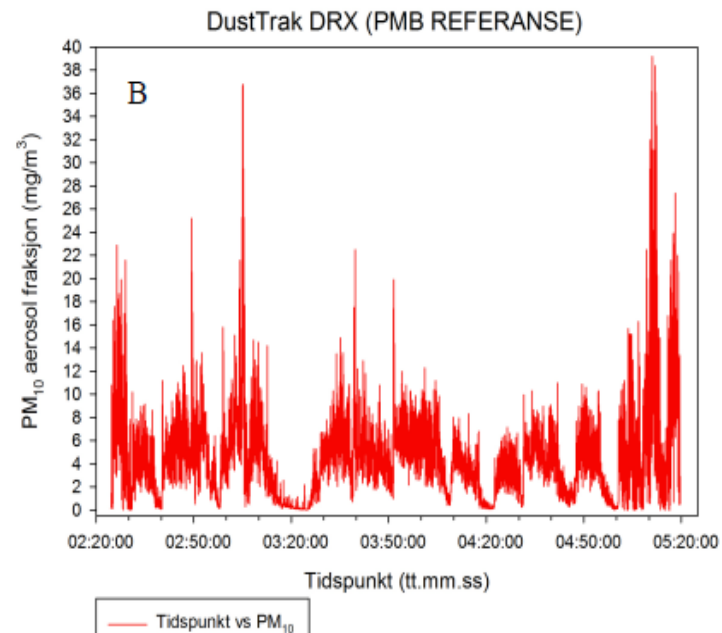
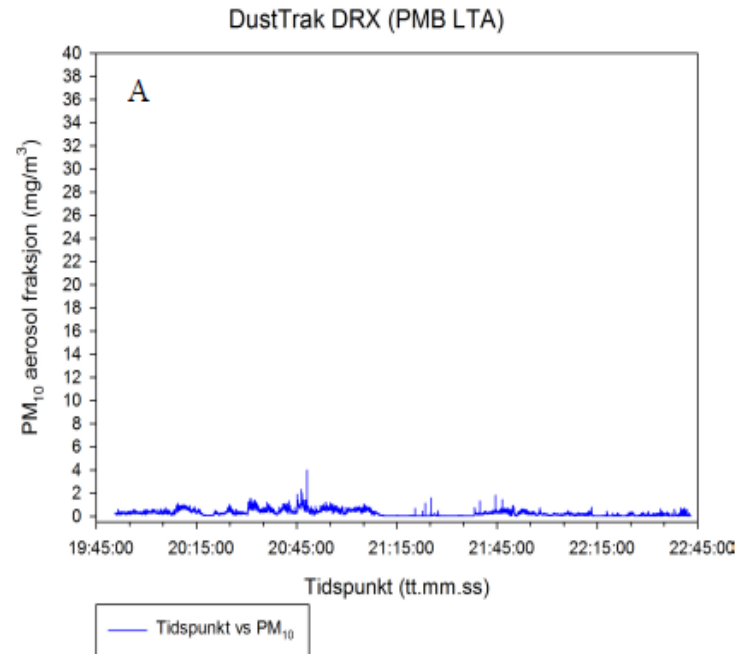
WMA – no asphalt
smoke
to see



Lots of smoke with hot mix asphalt



It was measured
a reduction in fumes of
94 %





Compaction

- To see how much compaction that was needed we made measurements after 1- 7 passings with the compactor.

Passings	Reference	WMA
	Voids %	Voids %
0	20,5	21,8
1	14	8,6
2	11	7,6
3	10	5,8
4	9,4	—
5	7,1	—
6	7	—
7	5,3	4,8



Advantages with WMA

- Better conditions for the workers
 - Less asphalt fumes. 60 – 90 % reduction has been measured

Negative: The workability could be slightly higher on handworks
- Reduced emissions





More even quality with
WMA

- Less segregation
- More even surphase
- Easy to compact



Hot mix reference
– we can see segregation



Challenges with production of WMA

- Wet aggregates
 - Reduced capacity
 - Problems with production and quality
- Fines and humidity affects the production equipment and filters





Conclusions so far

- WMA gives better conditions for the workers
- Reduced emissions and less energy used
- The quality of WMA seems just as good as conventional hot mix asphalt
- WMA gives less segregation
- Production of WMA needs dry aggregates (fines)
- We need to optimize our production equipment

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