



Draft Revisions to the 2008 PM10 Windblown Dust Inventory for the Maricopa County Nonattainment Area

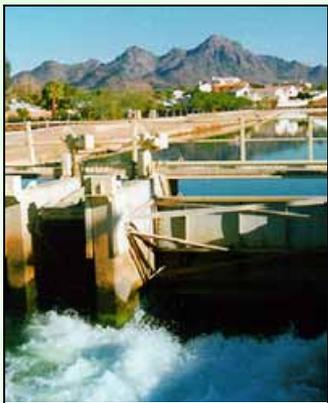
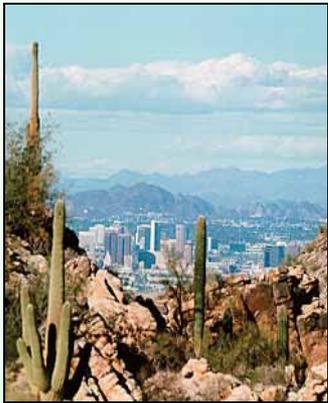
MAG Air Quality Technical Advisory Committee

February 24, 2011

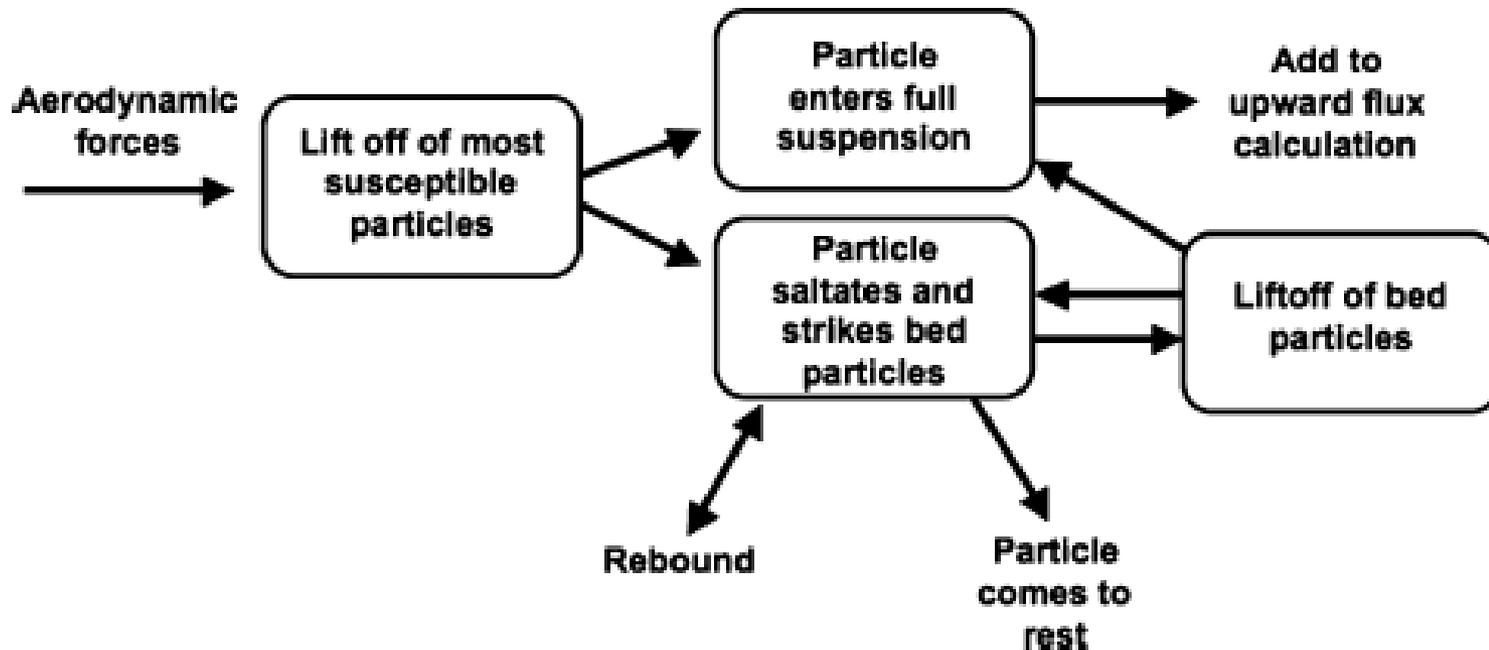
Conceptual Framework for Revisions

n Macpherson et al., 2008 article:

- | Critical importance of supply-limited environments
- | *"Results indicate that for these supply-limited environments, PM10 emissions are primarily driven by the aerodynamic resuspension of loose surface materials as opposed to dynamic entrainment mechanisms associated with saltating grains."*
- | PM10 emissions from supply-limited soils are produced at wind speeds 50-75% of the threshold values required for saltation (Roney & White, 2004)
- | Wind tunnel studies performed in the Macpherson article, along with recent Clark County tests indicate PM10 emission thresholds in 11-14 mph range for both disturbed and undisturbed soils
- | Disturbance of soil has the primary effect of generating more PM10 emissions than undisturbed soils under similar wind speeds and does not necessarily lower the threshold wind speed upon which PM10 emissions are initiated



Windblown Dust Generation Process

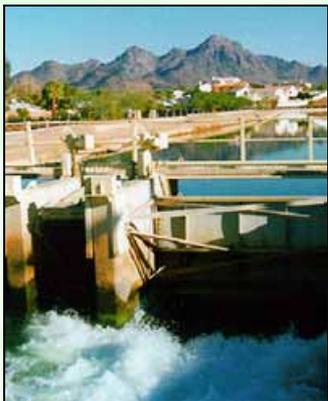
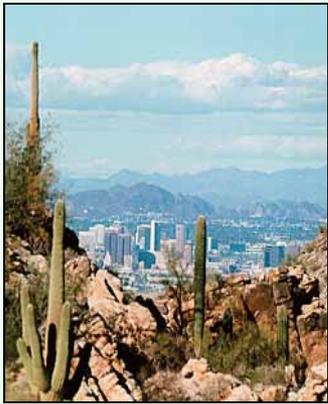


Harris et al., 2009. *A Monte Carlo Model for Soil Particle Resuspension Including Saltation and Turbulent Fluctuations*. Aerosol Science and Technology.



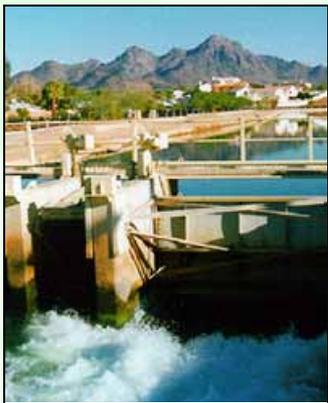
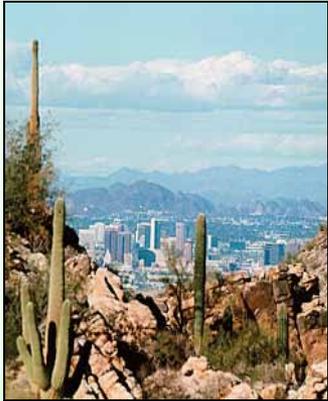
Changes to Current (June 2010) Windblown Dust Inventory

- n Lowered the threshold wind speed necessary for PM10 entrainment to 12 mph (5-minute average) at 10-meters for all soils and land uses (except active ag fields)
- n Developed unique PM10 vertical emissions fluxes for disturbed and undisturbed soils
- n Applied new inspection data to determine percentage of disturbed and undisturbed soils by land use
- n Scaled windblown PM10 emissions to match observed annual monitor concentrations (sensitivity analysis)



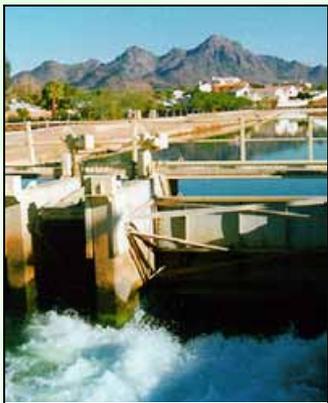
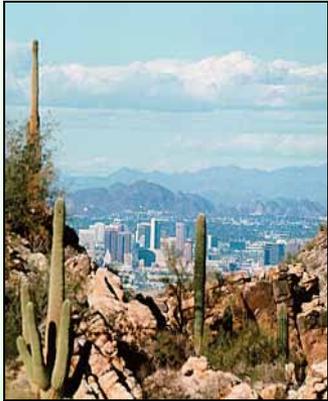
Lowered Threshold Wind Speeds to 12mph (5-minute average) at 10 meters

- n **12mph was chosen for the following reasons:**
 - | Macpherson wind tunnel tests indicated PM10 emission thresholds in the low teens
 - | Clark County wind tunnel tests on a variety of soil types generated PM10 emissions at lowest available wind speeds, approximately 11mph
 - | 1989 Nickling & Gillies local wind tunnel tests observed saltation occurring at ranges of 13-30 mph, meaning PM10 emission initiation is likely 50-75% of those speeds



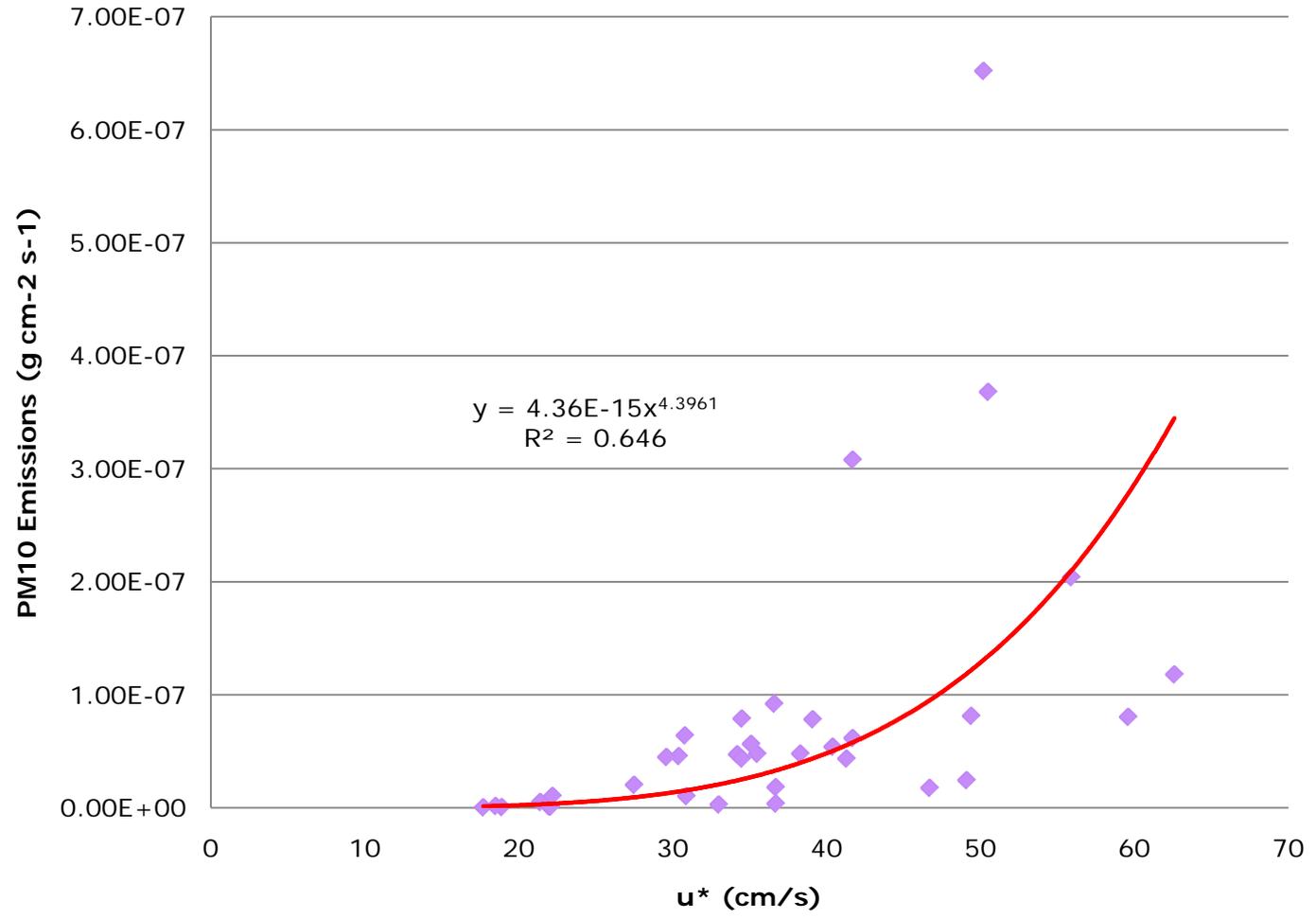
Developed Fluxes for Disturbed and Undisturbed Soils

- n Through use of 1989 Nickling and Gillies local wind tunnel tests (7 sites used, ag fields and mine tailings excluded), a PM10 flux for disturbed soils can be developed
- n Developed flux compares well with fluxes observed in Macpherson article and Clark County wind tunnel tests
- n Since 1989 Nickling and Gillies local wind tunnel tests were done primarily on disturbed soils, the ratio of disturbed to undisturbed fluxes observed by Macpherson was used to create an undisturbed flux



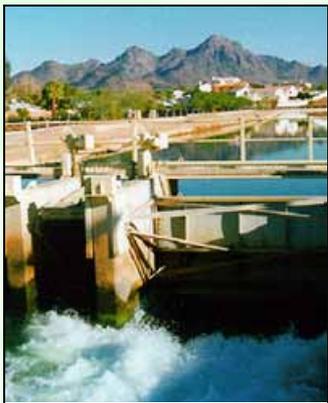
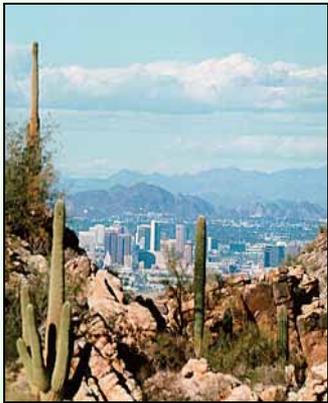


Nickling & Gillies Disturbed Flux



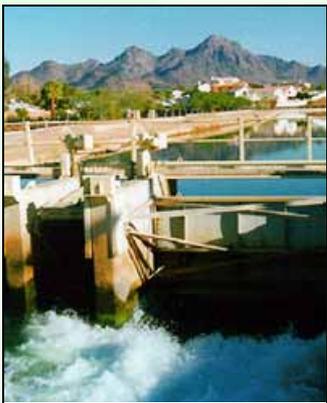
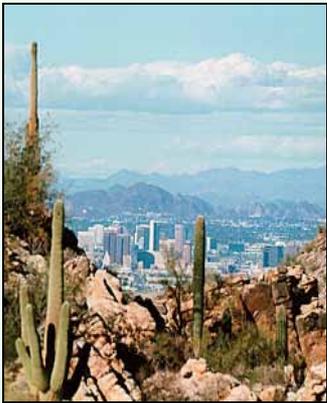
Applied New Inspection Data (July 2008 to June 2009) to Determine Disturbed vs. Undisturbed Land Uses

- n For developing land uses (Rule 310), disturbance rate was determined by the number of violations written for Section 304 of the rule which deals directly with stabilization requirements
 - | 2.62% of permits were given violations of this section
- n For sand & gravel land uses (Rule 316), disturbance rate was determined by the number of violations written for Section 306.5 of the rule which details stabilization requirements
 - | 2.21% of permits were given violations of this section
- n For all vacant, open and fallow ag land uses, disturbance rate was determined by the number of violations written for failure to pass a Rule 310.01 stabilization test
 - | 0.73% failed one of the stabilization tests
- n For comparison, Clark County reports 1.1% of their land uses as disturbed (December 2006)



Scaled Windblown PM10 Emissions to Match Monitor Concentrations

- n Windblown PM10 emissions prior to scaling are maximum potential emissions, all eligible land uses are calculated to emit at 100% of their emission flux. They do not take into account the limiting effects of differing surface roughness, vegetation of soils, moisture of soils, crusting of soils, supply reservoir, etc., because data is unavailable
- n Need a mechanism in order to properly account for these missing variables (sensitivity analysis)
- n 2009 hourly PM10 and wind speed monitor readings allow for the association of PM10 mass with hourly winds over 10mph. This provides a scaling factor with which to adjust final, annual windblown emissions



Scaled Windblown PM10 Emissions to Match Monitor Concentrations

Monitor	2009 PM-10 mass with hourly winds > 10mph ($\mu\text{g}/\text{cm}^3$)	Total 2009 PM-10 mass ($\mu\text{g}/\text{cm}^3$)	% PM-10 mass associated with hourly winds > 10mph	Monitor Rank
Buckeye	39,454	344,818	11.44%	2
Central Phoenix	26,310	306,448	8.59%	5
Durango Complex	30,157	391,086	7.71%	6
Dysart	3,795	64,262	5.90%	7
Glendale	2,735	77,387	3.53%	11
Greenwood	13,474	357,127	3.77%	10
Higley	32,828	329,713	9.96%	3
South Phoenix	19,710	389,364	5.06%	8
West Chandler	7,996	81,355	9.83%	4
West 43rd	52,949	446,491	11.86%	1
West Phoenix	14,802	318,583	4.65%	9
All Monitors	244,209	3,106,633	7.86%	NA

Statistics for % PM-10 mass associated with hourly winds > 10mph

Mean	7.48%
Standard Error	0.92%
Median	7.71%
Mode	#N/A
Standard Deviation	3.06%
Sample Variance	0.09%
Kurtosis	-1.61
Skewness	0.09
Range	8.32%
Minimum	3.53%
Maximum	11.86%

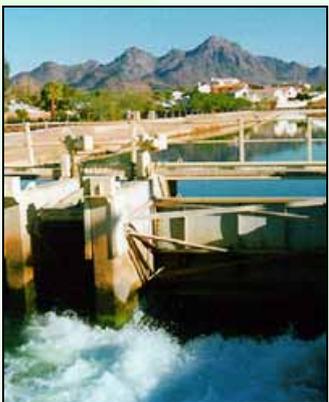
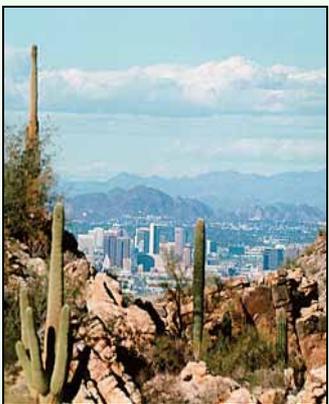
Note: 10 mph hourly average wind speed initially chosen as a cut-point for PM10 emissions generated by winds. A more detailed analysis relating the 12 mph, 5-minute average wind speed threshold with hourly wind speed data may reveal a different cut-point in the final inventory of windblown PM10 emissions.

Scaled Windblown PM10 Emissions to Match Monitor Concentrations

- n The mean PM10 mass associated with wind speeds above 10 mph is about 7.5%. To be conservative (one standard deviation), it was assumed that 10% of annual PM10 mass is associated with windblown dust
- n Given this ratio, annual windblown dust is assumed to be 10% of the total inventory
- n Current PM10 NAA emissions estimates for all sources (still under review) excluding windblown dust, total to 44,391 tons. Under the scaling scenario above, this total represents 90% of the inventory, allowing windblown dust to fill the last 10% for a windblown total of 4,932 tons ($44,391 / 0.9 * 0.1$)
- n Ratios of land uses and disturbance rates in the windblown dust categories are assumed to be constant during the scaling down process



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Scaled Windblown PM10 Emissions to Match Monitor Concentrations

LANDUSE	ANNUAL EMISSIONS (TONS)	DAILY EMISSIONS (LBS/DAY)	SCALED ANNUAL (TONS)	SCALED DAILY (LBS/DAY)
Agriculture	4,656.31	25,444.3	439.46	2,401.4
Developing	4,034.89	22,048.6	380.81	2,080.9
Vacant	19,293.31	105,427.9	1,820.90	9,950.3
Open	22,766.07	124,404.7	2,148.66	11,741.3
S&G, Mining, Landfill, Test Tracks	1,505.81	8,228.5	142.12	776.6
TOTAL:	52,256.39	285,554.0	4,931.96	26,950.6

- n **Original calculated annual PM10 emissions reduced by 90.56% in order to meet scaling factor target of 4,932 tons of PM10.**


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Comparing June 2010 Windblown PM10 Inventory to Draft February 2011 Inventory

LANDUSE	JUNE 2010		FEBRUARY 2011	
	ANNUAL EMISSIONS (TONS)	DAILY EMISSIONS (LBS/DAY)	SCALED ANNUAL (TONS)	SCALED DAILY (LBS/DAY)
Agriculture	1,083.26	5,919.5	439.46	2,401.4
Developing	2,664.48	14,560.0	380.81	2,080.9
Vacant	9,522.43	52,035.2	1,820.90	9,950.3
Open	3,762.38	20,559.5	2,148.66	11,741.3
S&G, Mining, Landfill, Test Tracks	1,435.81	7,845.9	142.12	776.6
TOTAL:	18,468.36	100,920.1	4,931.96	26,950.6



Inventory Still in Draft Form

- n **Calculations shown today are preliminary**
- n **Methodology and data inputs may change after review by participating agencies and stakeholders**



For More Information

Contact:

Matt Poppen, MAG
(602) 254-6300

www.azmag.gov

