

Classifications of Air Pollution

A tall, cylindrical industrial smokestack, likely made of brick or concrete, stands vertically against a dramatic sky. The smokestack has a dark metal ladder or access structure wrapped around its middle. At the top, a plume of white smoke or steam rises into the air. The sky is filled with large, dark, heavy clouds, with some lighter patches where the sun might be breaking through. The overall mood is industrial and somewhat somber due to the dark clouds.

City of Albuquerque
Env. Health Dept
Air Quality Division
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Gases	Particulate Matter
<ul style="list-style-type: none">•Carbon Monoxide (CO)•Nitrogen Dioxide (NO₂)•Sulfur dioxide (SO₂)•Ozone (O₃)•Nitrogen Oxide (NO)•VOCs/HAPs (Volatile Organic Compounds/ Hazardous Air Pollutants)	<ul style="list-style-type: none">•PM_{2.5} (2.5 microns or less)•PM₁₀ (10 microns or less)•Lead•TSP (Total Suspended Particulate)•VOCs/HAPs/metals (Polycyclic Aromatic Hydrocarbons, cadmium, mercury, chromium, etc.)

Ambient standards (gaseous)

Pollutant	Time Average	EPA	NM
CO	1-hr	35.0 ppm	13.1 ppm
	8-hr	9.0 ppm	8.7 ppm
NO ₂	24-hr	--	100 ppb
	Annual	53 ppb	53 ppb
SO ₂	3-hr	500 ppb	--
	24-hr	140 ppb	100 ppb
	Annual	30 ppb	20 ppb

Carbon Monoxide

- Vehicles, woodburning, generators, and PNM Reeves Generating Station
- Hydroxyl radicals convert CO to CO₂.

Nitrogen oxides

- Combustion processes emit NO.
e.g. smokestacks, engines, generators
- Free radicals & O_3 convert NO to NO_2 .
- Nitric & sulfurous emissions → acid rain.

Sulfur dioxide

- Smokestacks
 1. Coal-fired power plants
 2. Refineries
 3. Smelters
- Largest source in Bernalillo County:
GCC Rio Grande Portland Cement Plant
- Fate: dry deposition/gravitational settling;
conversion to sulfates

Ozone

- Direct O₃ emissions are rare.
- Formation: photochemical reactions among precursor pollutants.
- High ozone levels occur during afternoons June, July, and August.

More on ozone

- Light winds, plentiful sunshine favor O₃
- On such days, O₃ levels limited by levels of precursor pollutants.

Ozone formation/destruction

- NO/NO₂ & Volatile Organic Compounds
- Hundreds of VOCs
- After sunset, NO destroys ozone

VOC Reactivity

- Some highly-reactive VOCs:
 - ethylene
 - propylene
 - 1,3-butadiene
 - Benzene
 - Toluene
- Perc: low reactivity, removed from list.

More on precursors

- Sources of Volatile Organic Compounds
 1. Gasoline, diesel, ethanol, etc.
 2. Paints, solvents, dry cleaning, etc.
 3. Cigarettes, forest fires, etc.
- VOCs are not criteria pollutants

Stratosphere and ground-level

- Stratospheric O₃ – protective shield.
- Ground-level ozone - harmful pollutant.
- Stratospheric ozone can descend to ground-level behind springtime cold fronts.

Particulates

- Interchangeable terms:
 - Aerosol,
 - Particle,
 - Particulate (matter).
- Smoke and dust are the most common aerosols in Bernalillo County.

Primary PM

- Emitted directly to the atmosphere
 1. Geologic material
 2. Organic carbon
 3. Elemental carbon (a.k.a., soot)
 4. Metals released into air from combustion

Elemental/black carbon (soot)



Organic carbon



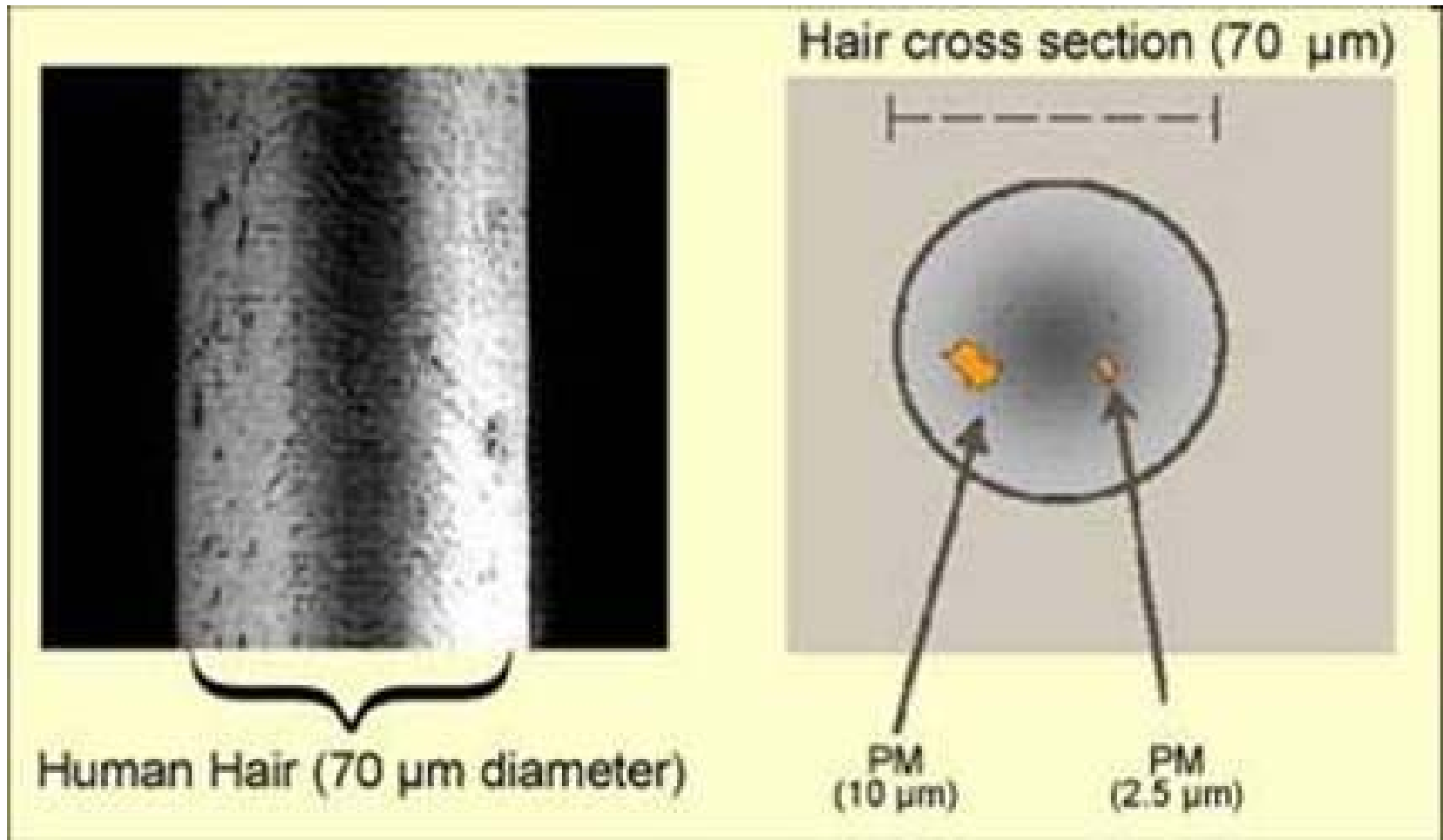
Secondary PM

- Classes of particles formed through chemical reactions:
 1. Sulfates
 2. Nitrates
 3. Ammonium compounds
 4. Organic carbon compounds

Classification according to size

- Total Suspended Particulate (TSP)
- PM_{10} – 10 microns or less
- $PM_{2.5}$ - 2.5 microns or less

Visualize PM_{10} & $PM_{2.5}$



More terms

- Fine = PM_{2.5}
- “Coarse” means between 2.5 and 10 microns
- Supercoarse is greater than 10 microns

Distinction

- $PM_{10} = \text{Coarse} + \text{Fine}$
- $TSP = \text{Supercoarse} + \text{Coarse} + \text{Fine}$
- A great deal of confusion over PM_{10} , TSP, coarse, and supercoarse.

Origin of particulates

- **Fine particulates** are produced chiefly by:
 1. Combustion processes,
 2. Chemical reactions of various gaseous pollutants (Secondary PM).
- **Coarse particles** are generally emitted directly as a result of:
 1. Mechanical processes that crush or grind larger particles,
 2. Resuspension of dusts.

Sources

- **Fine particles:** engines, residential wood burning, forest fires, tobacco smoke, big smokestacks, feedlots (precursors), etc.
- **Coarse and supercoarse:** dust from disturbed surfaces; construction, demolition, mining, crushing and screening operations; tire and brake lining materials; etc.

Particulate standards

Pollutant	Time Average	U.S. EPA	New Mexico
TSP	Annual	--	60 $\mu\text{g}/\text{m}^3$
	24-hour	--	150 $\mu\text{g}/\text{m}^3$
PM10	Annual	--	--
	24-hour	150 $\mu\text{g}/\text{m}^3$	--
PM2.5	Annual	15 $\mu\text{g}/\text{m}^3$	--
	24-hour	35 $\mu\text{g}/\text{m}^3$	--

Air Quality Index – Fine Particles

24-hr average concentrations	Category
0 – 15.4 $\mu\text{g}/\text{m}^3$ (micrograms per cubic meter)	Good 0 – 50
15.5 – 40.4 $\mu\text{g}/\text{m}^3$	Moderate 51 – 100
40.5 – 65.4 $\mu\text{g}/\text{m}^3$	Unhealthy for Sensitive Groups (101 – 150)

Air Quality Index - Ozone

8-hour average concentrations	Category
0 – 60 ppb (parts per billion)	Good 0 – 50
61 – 75 ppb	Moderate 51 – 100
76 – 95 ppb	Unhealthy for Sensitive Groups (101 – 150)

Removal of particulates

- Gravity removes coarse and supercoarse particles. Stoke's law: rate of settling is proportional to the density of the particle and the square of it's radius.
- “Fine particulates can remain suspended for weeks and can be transported thousands of kilometers.” (Federal Register)
- Developing showers and thunderstorms consume fine particles, i.e. raindrops condense around fine particles.

Particulate HAPs/VOCs

- Most of the particulate HAPs (Hazardous Air Pollutants) are metallic:
(e.g. cadmium, mercury, arsenic, lead, chromium).
- PAHs (Polycyclic Aromatic Hydrocarbons) are particulate VOCs.

More on VOCs & HAPs

- Most Volatile Organic Compounds are gases.
- Overlap with Hazardous Air Pollutants.
- Bigger problem indoors?

Indoor VOCs & HAPs

- Methylene Chloride
- Benzene
- Perc (HAP only)
- Formaldehyde

Fugitives

- Fugitive gases: evaporation from a pool of liquid
- Fugitive dust is released into the atmosphere when wind or traffic disturbs soil, piles, etc.

Seasons & Pollution events

- Mid November - January: Inversions and residential woodburning
- Spring winds & Dust storms: mostly supercoarse particles
- Wildfire smoke: spring, summer, fall
- Industrial pollution from Texas: high ozone in August '07

