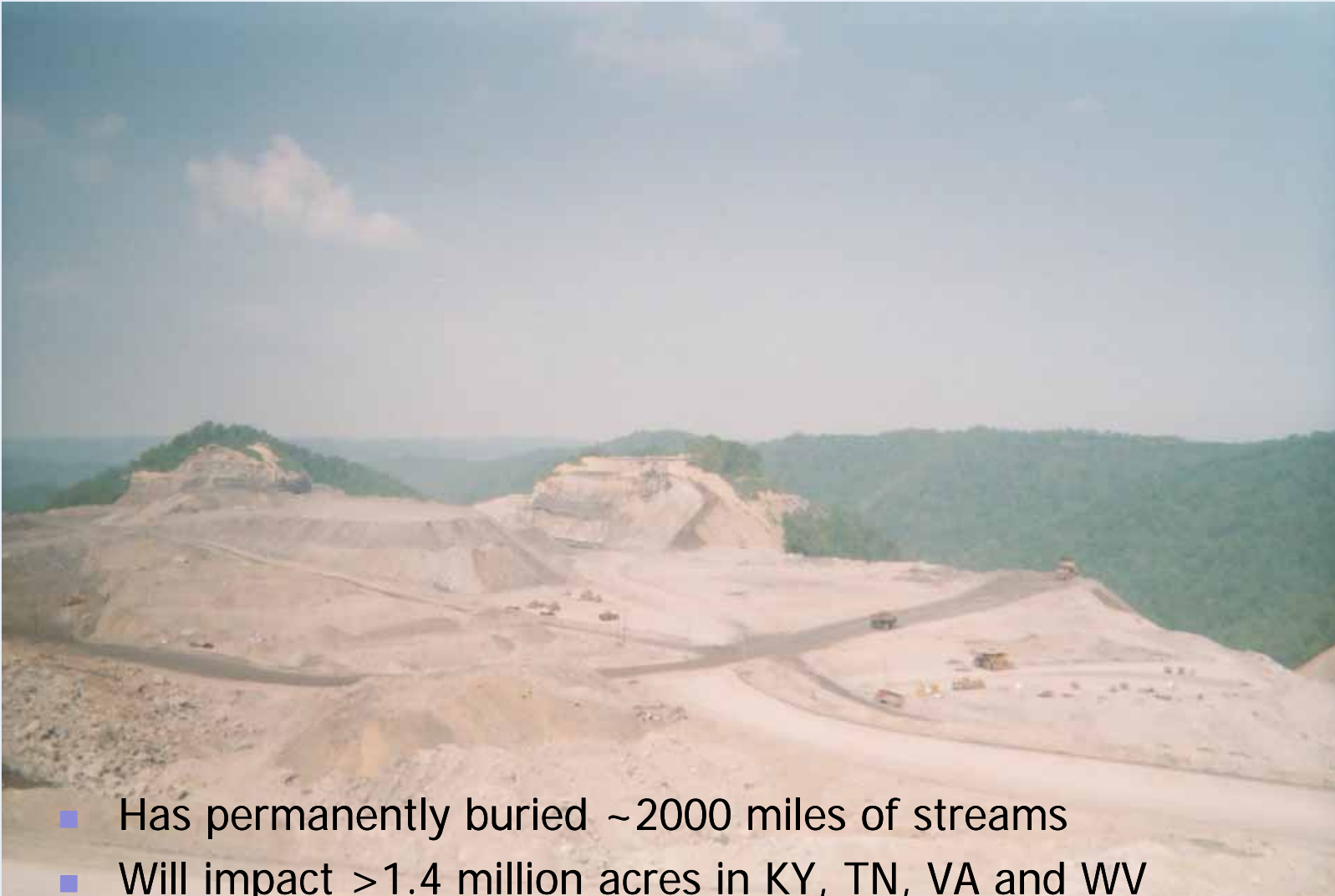


Public Health Disparities in Appalachian Coal Mining Communities

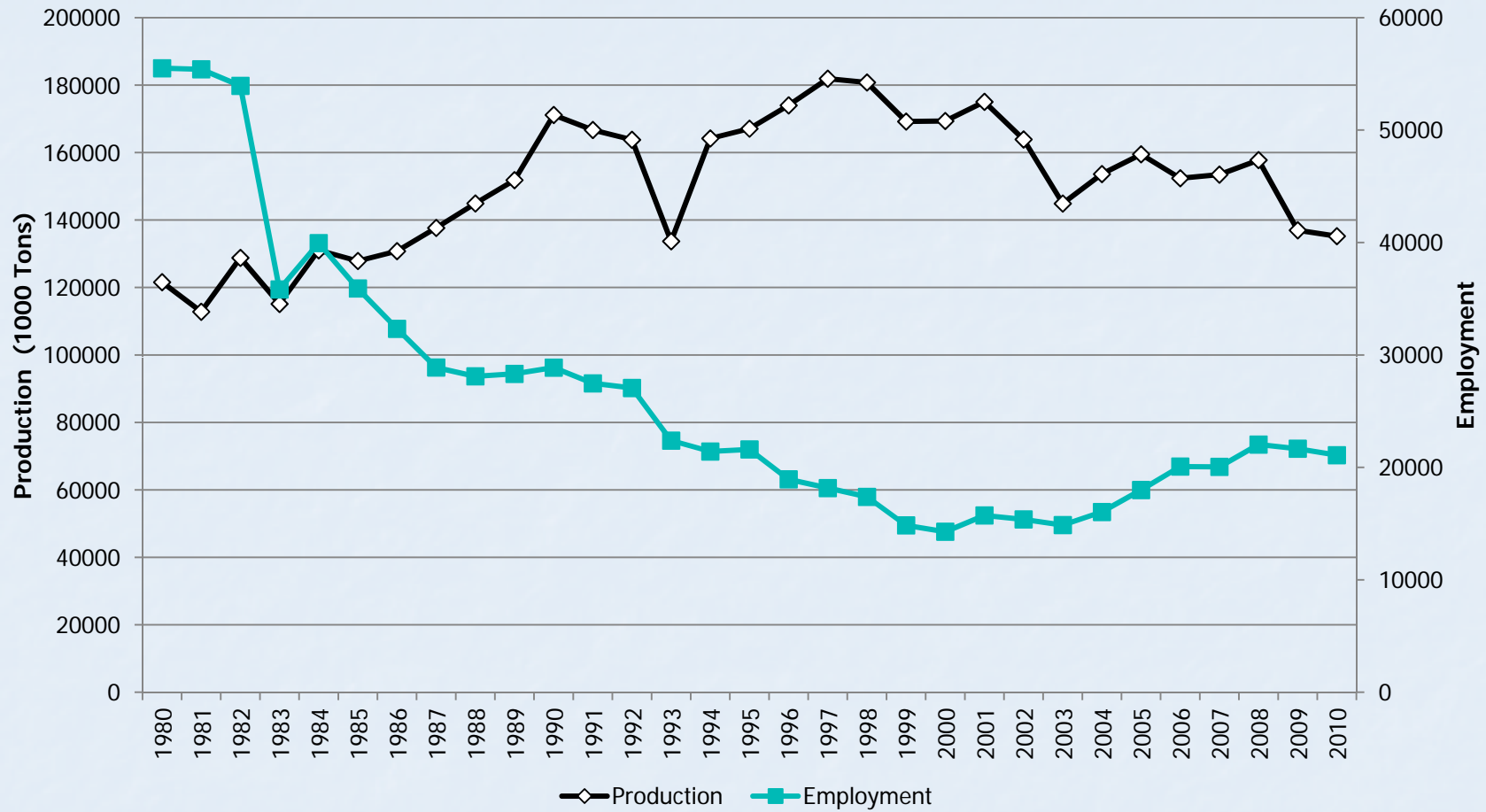


Mountaintop Mining



- Has permanently buried ~2000 miles of streams
- Will impact >1.4 million acres in KY, TN, VA and WV

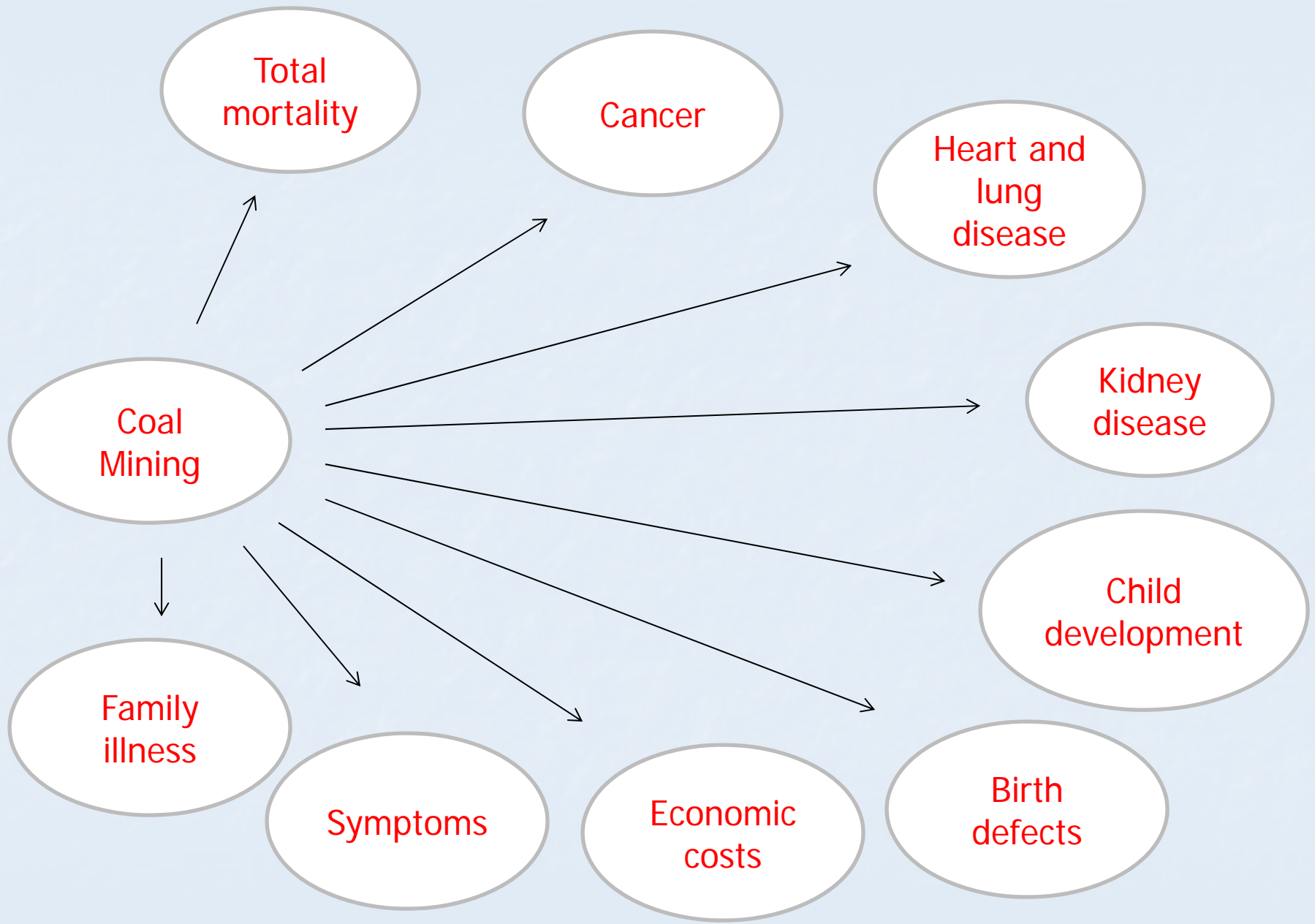
West Virginia Coal Production and Employment 1980 - 2010



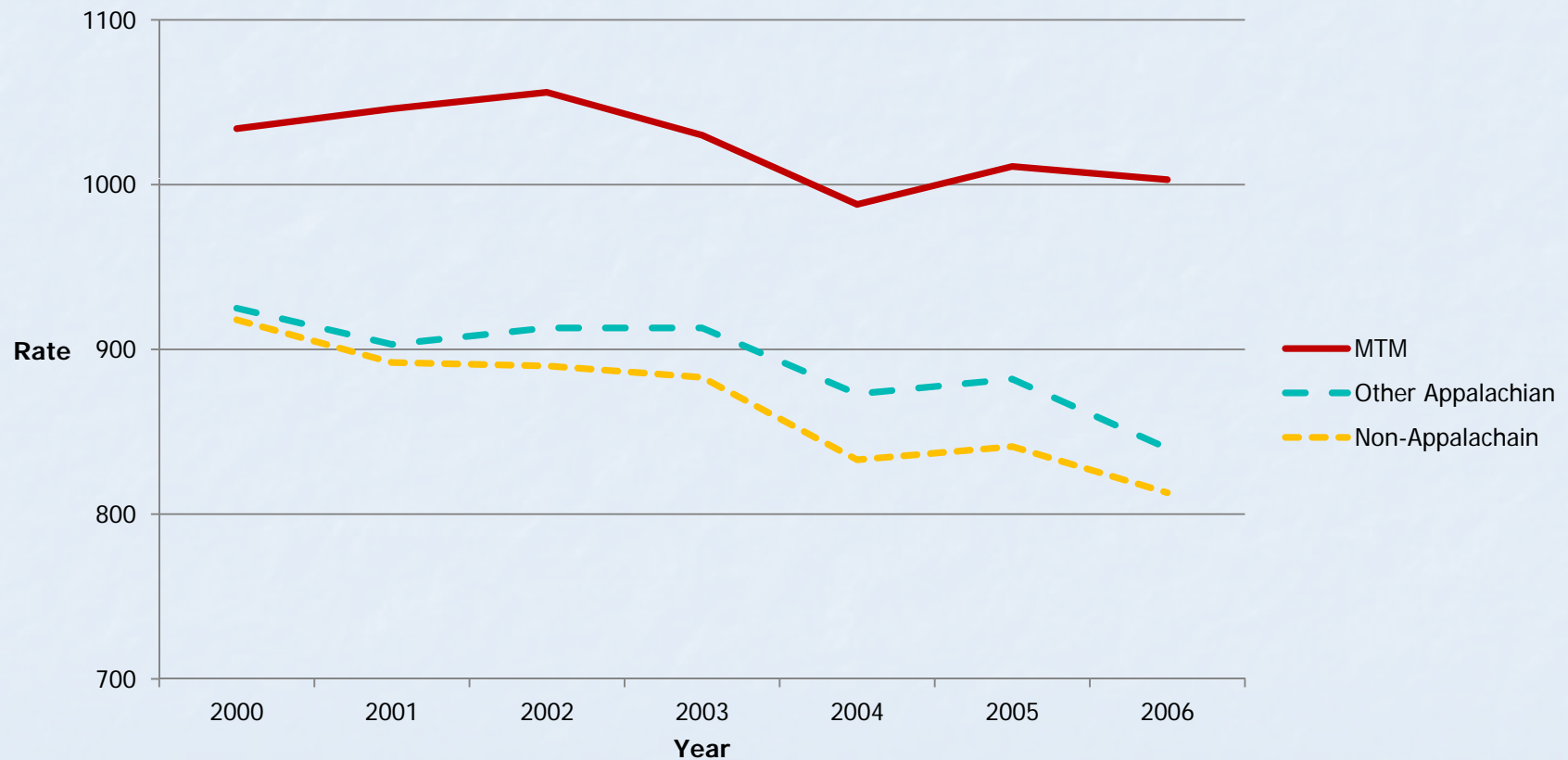
Sources: Energy Information Administration and West Virginia Coal Association

Downtown Whitesville, WV

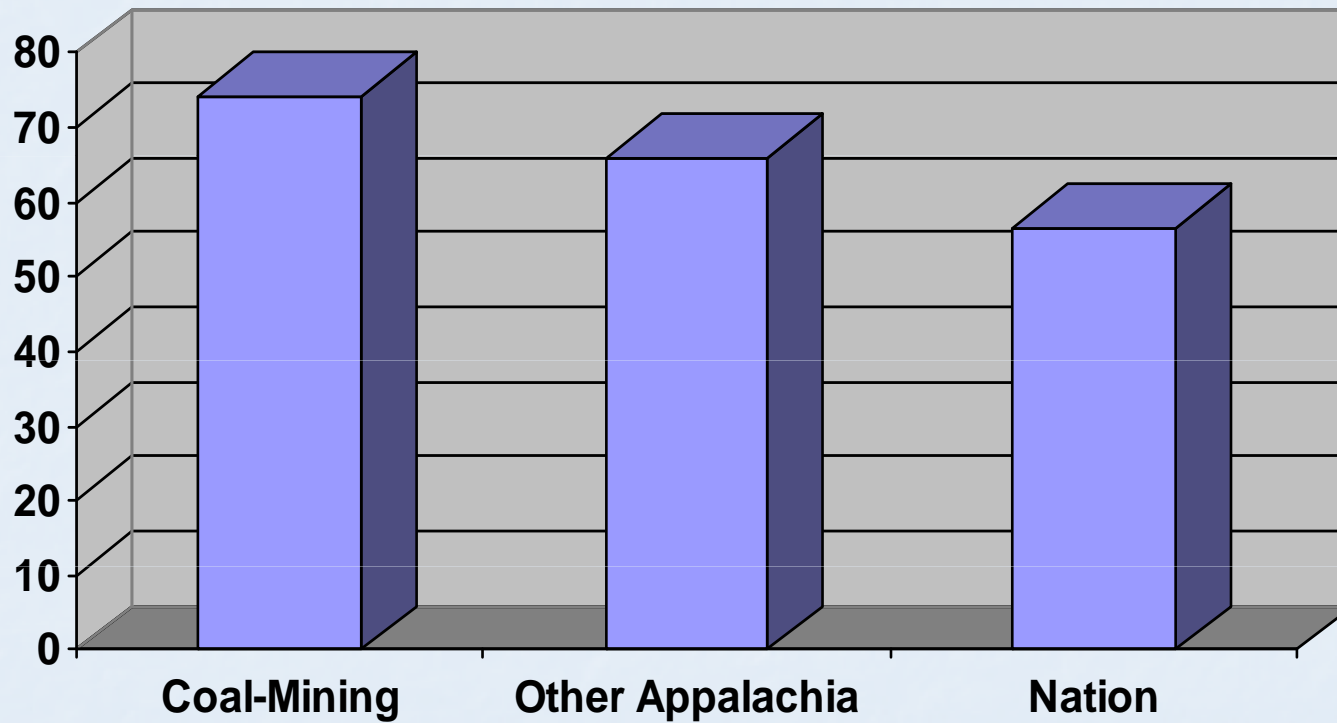




Age-adjusted total mortality per 100,000 by MTM status



Age-Adjusted Lung Cancer Mortality per 100,000, years 2000-2004

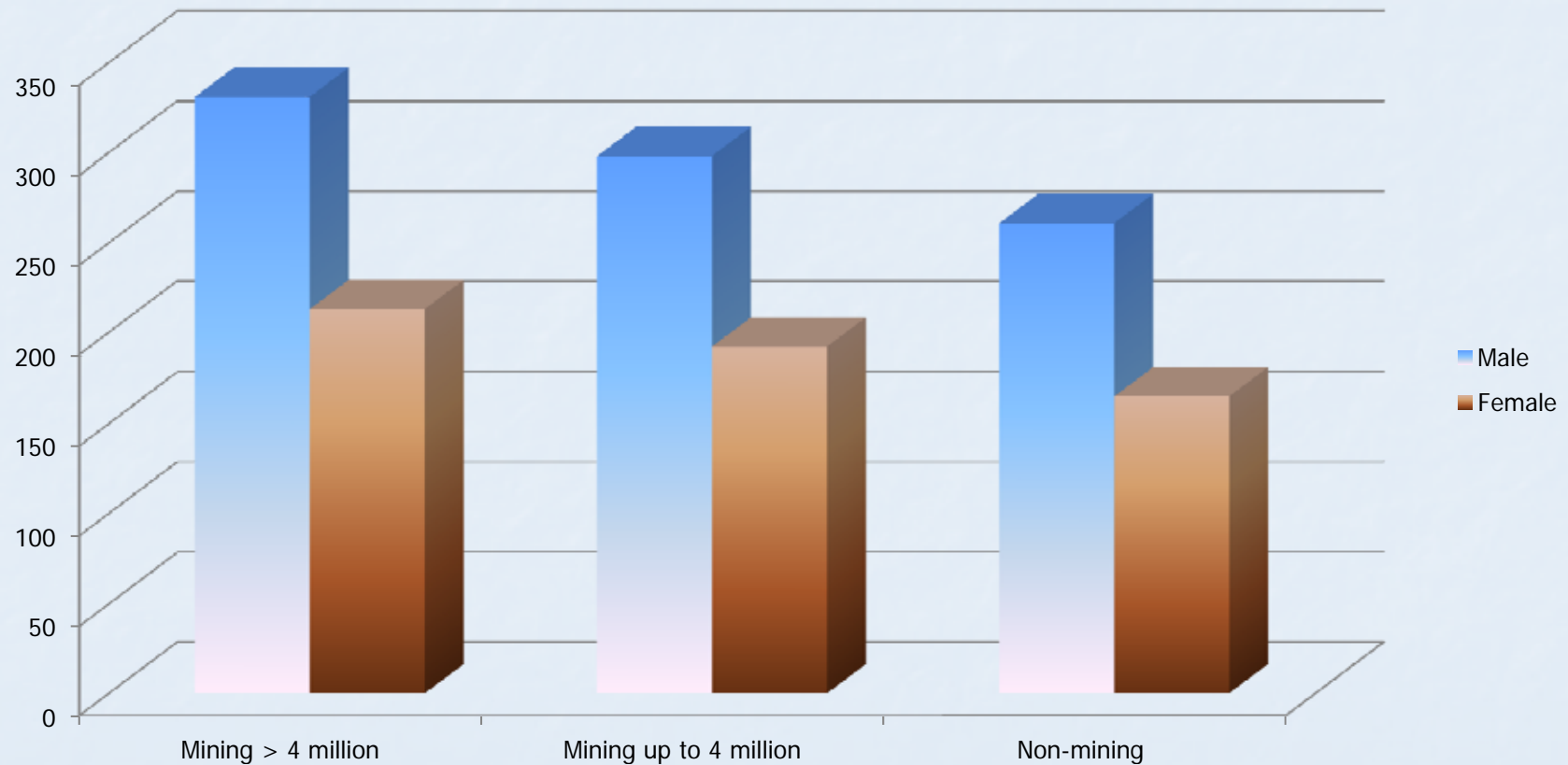


Hendryx et al. Lung Cancer 2008

Heart, Lung and Kidney Disease Mortality

- Adjusted chronic heart, lung, & kidney disease mortality rates are higher in coal mining areas than the rest of Appalachia or the nation
 - Hendryx, IAOEH, 2009
- Results are concentrated in MTM areas
 - Esch and Hendryx, JRH, 2011

2000-2004 Total Heart Disease Mortality per 100,000



Heart, Lung and Kidney Disease Morbidity

- Greater coal mining is associated with higher rates of chronic cardiovascular, respiratory, and kidney disease
 - Hendryx et al., AJPH, 2008
- National BRFSS data show higher rates of heart attack and coronary heart disease
 - Hendryx & Zullig, Prev Med, 2009

Academic Performance

- Students in mining counties of WV are significantly more likely to fail standardized tests
 - Grades 3 through 10
 - Controlling for low income, county high school education rate, class size, teacher quality, school size
 - Approximately 1,600 excess fails per year
 - Cain & Hendryx, EJ, 2010

Health-Related Quality of Life

- People in Appalachian mining areas report more adjusted days of poor health and activity limitations
 - Men and women, young and old
 - Effects are concentrated in MTM areas
 - Zullig & Hendryx Prev. Med. 2010; AJPB 2011

Birth Defects in MTM Areas

	MTM	Other Mining
Age-adjusted only PRR	1.63 (1.54, 1.72)	1.27 (1.20, 1.35)
Adjusted PRR	1.26 (1.21, 1.32)	1.10 (1.05, 1.16)

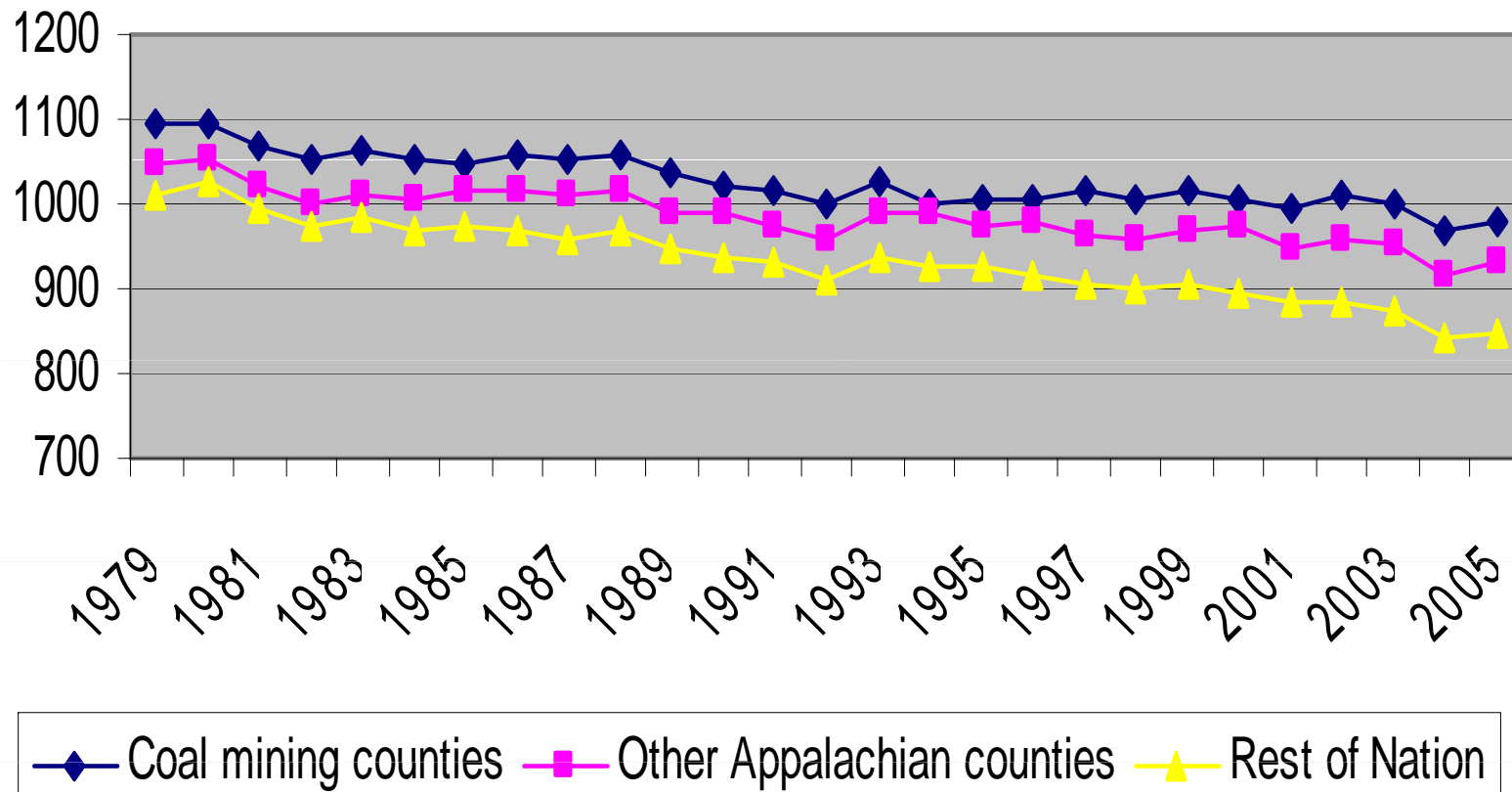
Birth Defects in MTM Areas

- Adjusted MTM PRRs by early versus late period:

	1996-1999	2000-2003
Circulatory/respiratory*	1.20 (1.03, 1.41)	2.81 (2.43, 3.25)
CNS	1.42 (1.06, 1.91)	1.30 (0.95, 1.76)
Gastrointestinal*	1.30 (0.94, 1.80)	1.53 (1.18, 1.96)
Urogenital*	1.16 (0.94, 1.42)	1.62 (1.38, 1.93)
Musculoskeletal	1.31 (1.17, 1.46)	1.30 (1.15, 1.46)
Chromosomal	1.21 (0.89, 1.64)	0.68 (0.46, 1.03)
Other*	0.99 (0.88, 1.12)	1.29 (1.15, 1.45)
Any*	1.13 (1.06, 1.21)	1.42 (1.33, 1.52)

* Higher in later period

**Figure 1. Total Age-Adjusted Mortality per 100,000
for the Years 1979-2005, by County Group**



The Human Cost of Coal Mining (versus the \$8b benefit)

	Cost estimate in billions compared to:			
VSL in millions:	Appalachia 1979-2005	Appalachia 1999-2005	Nation 1979-2005	Nation 1999- 2005
\$4.67	\$18.563	\$20.697	\$41.283	\$51.010
\$7.74	\$30.766	\$34.304	\$68.422	\$84.544
Excess annual deaths:	3,975	4,432	8,840	10,923

Community-Based Studies

- Two Community Based Participatory Research studies
 - Door to door surveys in WV and KY
 - Higher cancer rates in WV MTM areas
 - Hendryx, Wolfe, Luo, Webb, JCH, 2012
 - In KY: higher COPD, hypertension, asthma, symptoms, family illness
 - MTM effects comparable to smoking and obesity
 - Hendryx, JRH

Summary of Epidemiological Study Findings:

- Effects become stronger as mining levels increase
- Present for women, men, and children
- Present across multiple data sources and health outcomes
- Become stronger in closer proximity to mining activity
- Concentrated in MTM areas
- Pattern of disease effects
- No direct environmental assessments

Explosion over the town of Dorothy





Well water in the town of Rawl, West Virginia



Photo: Antrim Casky, 2008



Photo: Nat Geographic, 2006

Tests of Surface and Groundwater

- Elevated Arsenic in ~ 1/2 of wells in central Appalachia, (Shiber)
- MTM effects last for decades (Lindberg et al.)
- Early testing by USGS: elevated conductivity, pH, ammonium, phosphate, PAHs, phenols, hydrogen sulfide



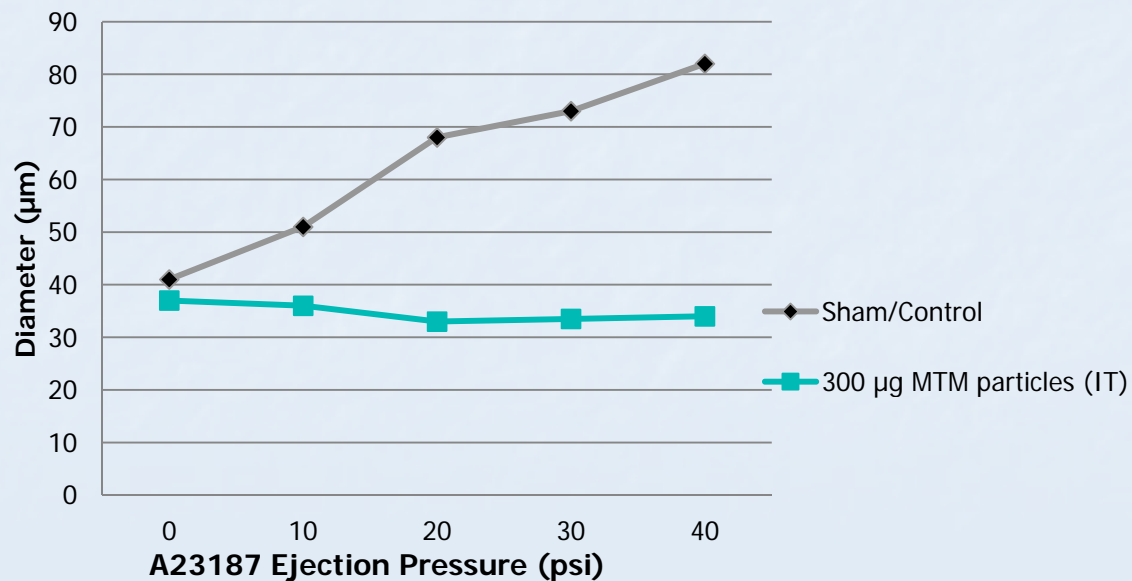
MTM Dust

- Primarily silicon and sulfur by weight
- Contains many other elements, mostly suggestive of overburden (e.g., Al, Fe, Ti)



MTM Dust

- In animal studies MTM dust:
 - Kills heart cells
 - Impairs vascular function
 - Knuckles et al. Microcirculation, 2012



Ultrafines?

- Defined as $< .1$ micron
- Large counts but little mass
- Surface to volume toxicity
- Penetrate lungs and can enter vasculature

Particle Number Concentrations per cm³

Copenhagen 1	Los Angeles 2	WV – no MTM 3	WV – MTM 3
8,116	~22,500	309,482	456,505

1. Andersen et al. Occupational and Environmental Medicine, 2008
2. Hudda et al. Atmospheric Chemistry and Physics Discussions, 2010
3. Kurth et al., under review

The Precautionary Principle

- We know that MTM environments are not healthy environments, regardless of specific causes
- Lack of knowledge regarding exact causal relationships should not preclude action
- MTM areas are where health problems are most severe, regardless of cause, and should be the focus of interventions