

Human Health Risk Assessment of Artificial Turf Fields Based Upon Results from Five Fields in Connecticut



Gary Ginsberg and Brian Toal
Connecticut Dept Public Health

May 10, 2012

Background

- Previous air investigations
 - Norway – 3 indoor fields – active play
 - USEPA – 4 outdoor fields – some play
 - NYC/NYS – 2 outdoor fields – some play
- Ingestion studies
 - California OEHHA
 - Norway
- CT study
 - Increasing the database
 - Personal monitoring
 - Indoor field
 - Acute risks
 - Benzothiazole risk assessment

Outline of Connecticut Air Study

July 2009

Summa cans, Personal Monitors, Stationary Monitors, Meterology, Soccer balls

4 Outdoor Fields

VOCs, SVOCs,
Rubber SVOCs,
Nitrosamines,
PM10, Lead

Air Concs, Lead in Infill/Grass

HHRA Child & Adult

1 Indoor Field

VOCs, SVOCs,
Rubber SVOCs,
Nitrosamines,
PM10, Lead

Air Concs, Lead in Infill/Grass

HHRA Child & Adult

Sample Type	VOCs	SVOCs	Rubber SVOCs	Nitrosamines	PM₁₀
Personal monitor	yes	no	yes	yes	no
Stationary on-field 6 inch	yes	no	yes	yes	no
Stationary on field 3 feet	yes	yes	yes	yes	yes
Stationary upwind	yes	yes	yes	yes	yes
Community	yes	yes	yes	yes	yes



Figure 1. Personal sampling for VOCs.



Figure 2. VOC sampling on turf field.

COPCs for RA

- Higher detect than off the field
- Not just in the personal monitors
- 27 COPCs at both the indoor and outdoor fields
 - 14 VOCs
 - 11 PAHs
 - 1-2 targeted SVOCs
 - Miscellaneous SVOCs

**Figure 7. Benzene Detects at Artificial Turf Fields
(no detects at Field D)**

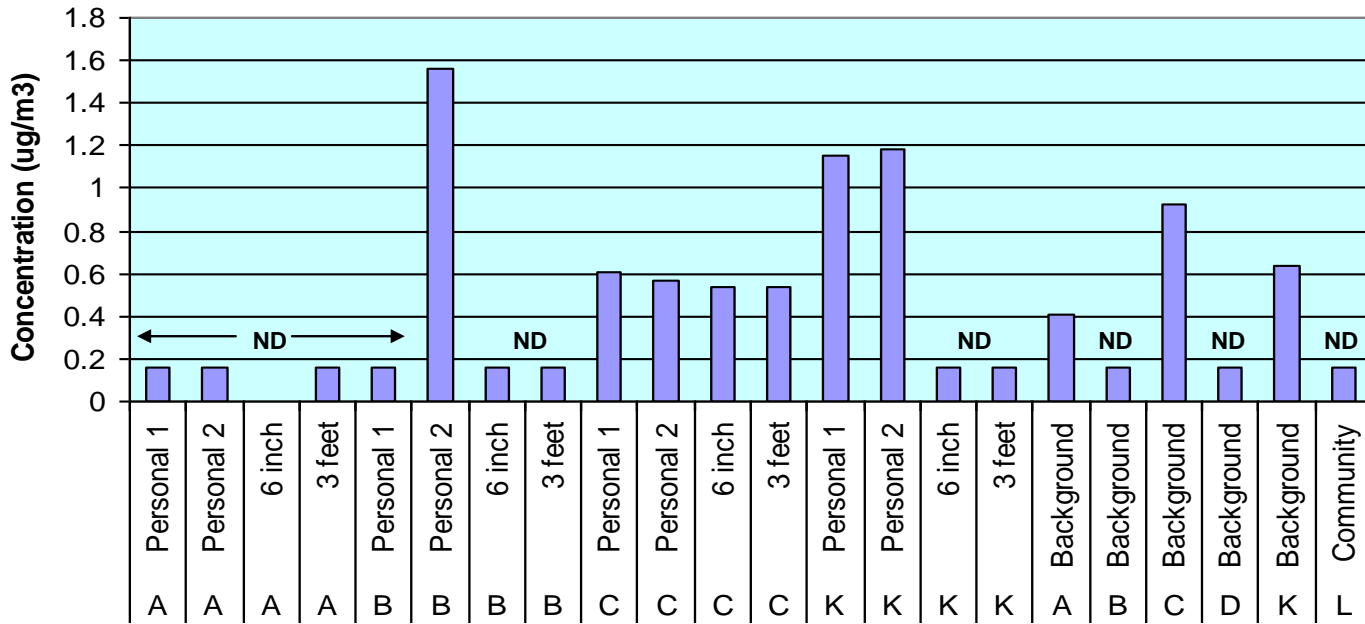
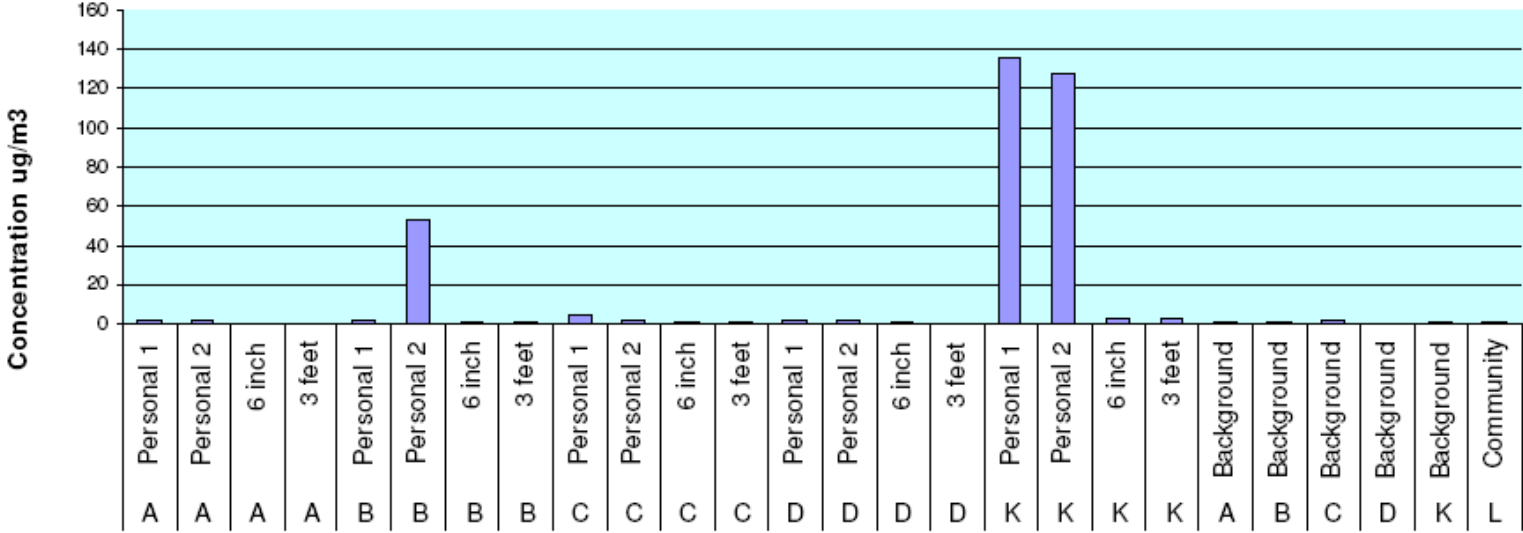


Figure 8. Toluene Detects at Artificial Turf Fields



**Figure 9. Methylene Chloride Detects at Artificial Turf Fields
(no detects at Fields A or D)**

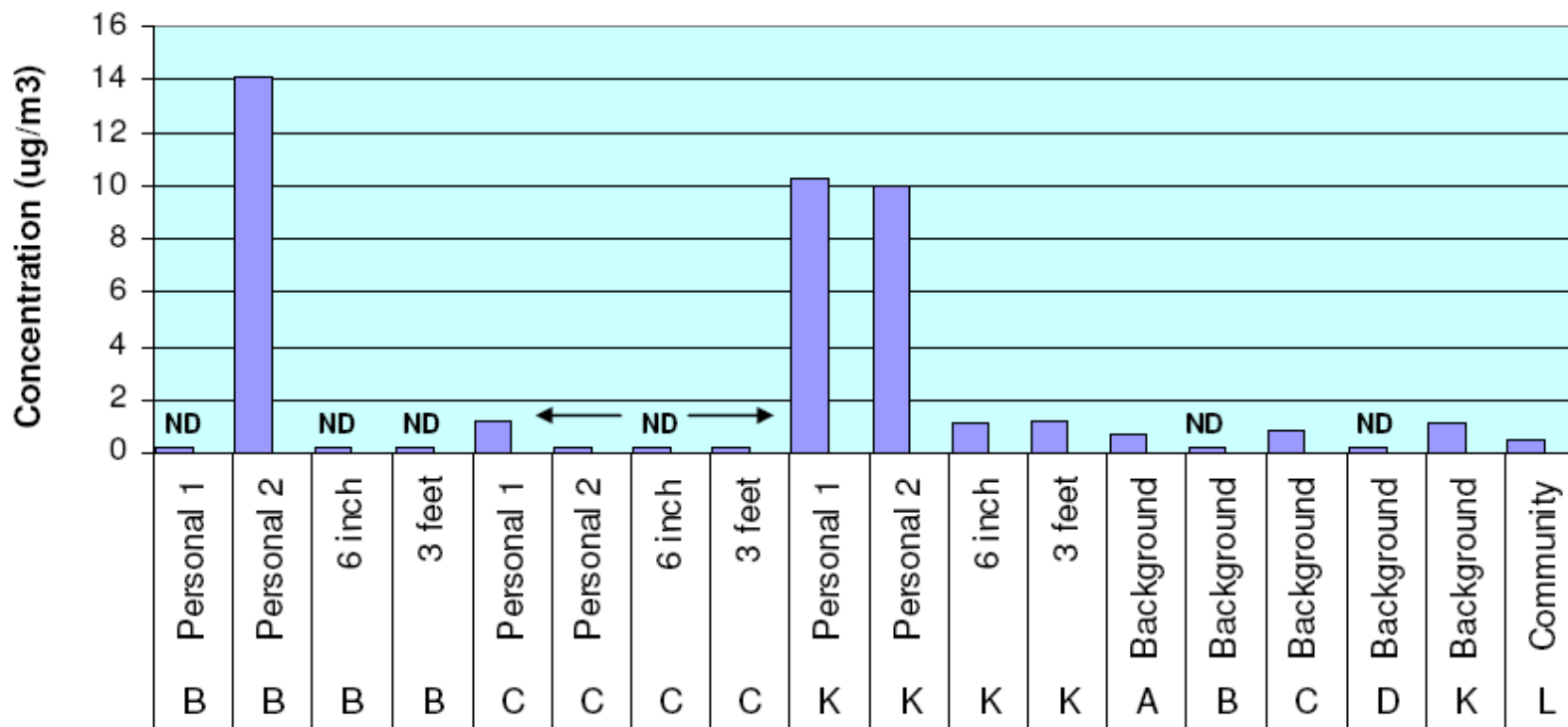


Figure 5. PAHs that were Detected Above Background Concentration

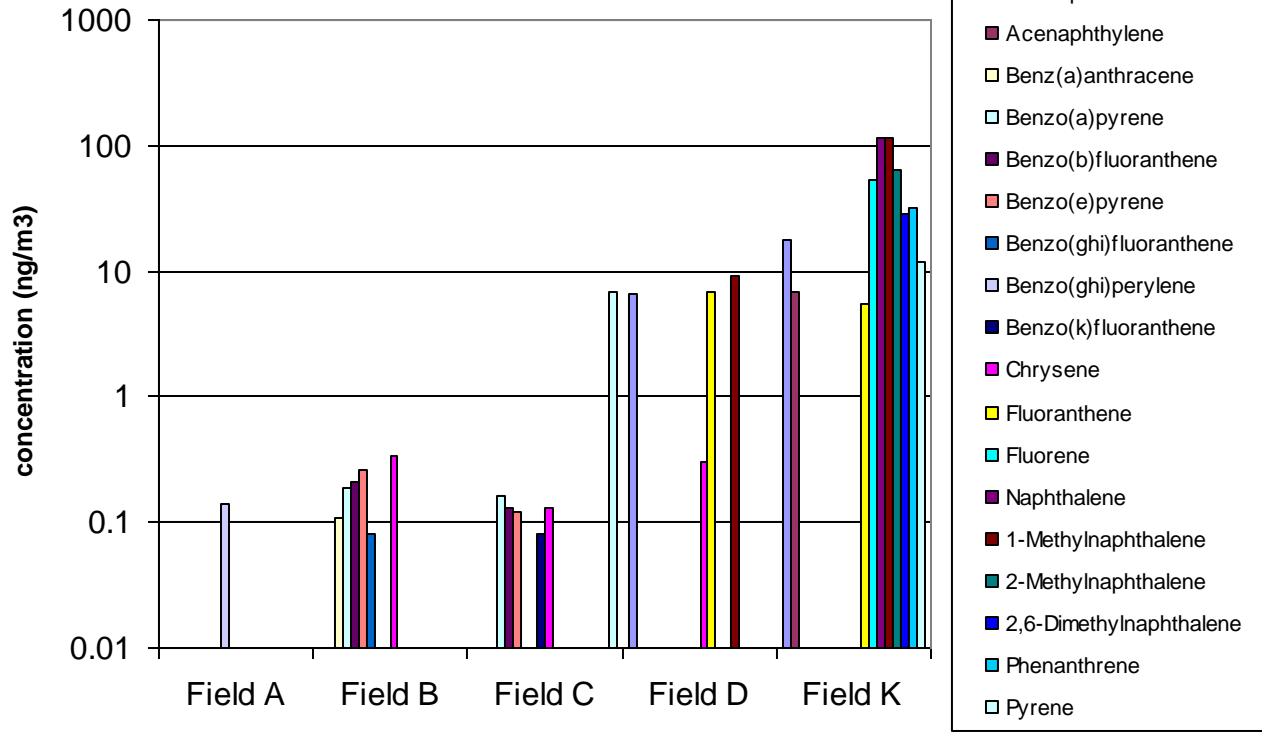


Figure 2. Benzo(a)pyrene Results Across Fields and Comparison with Background

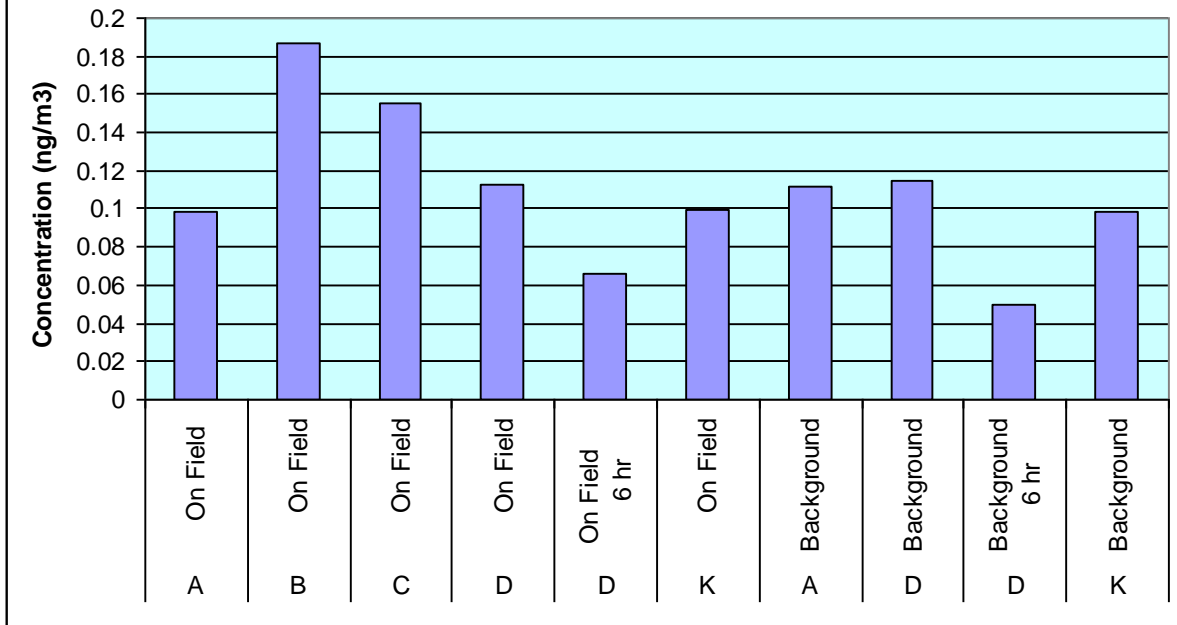


Figure 4. Naphthalene Results Across Fields and Comparison to Background

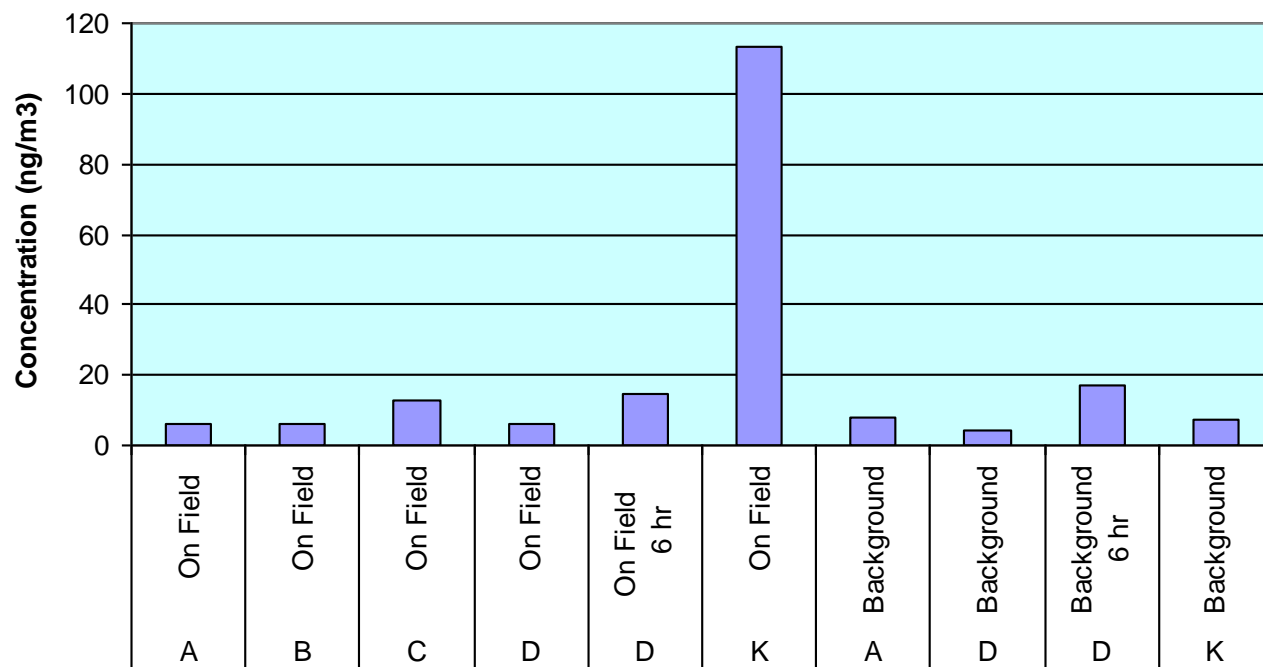


Figure 11. Benzothiazole Results Across Fields Not Including Indoor Field

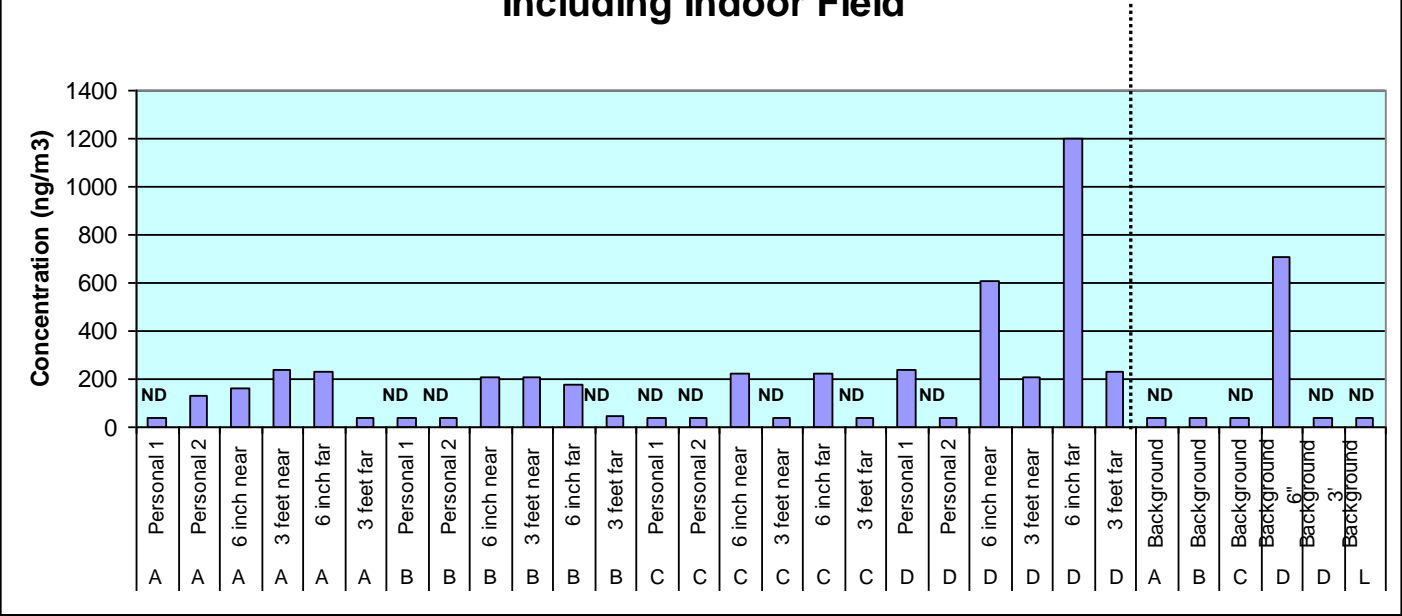
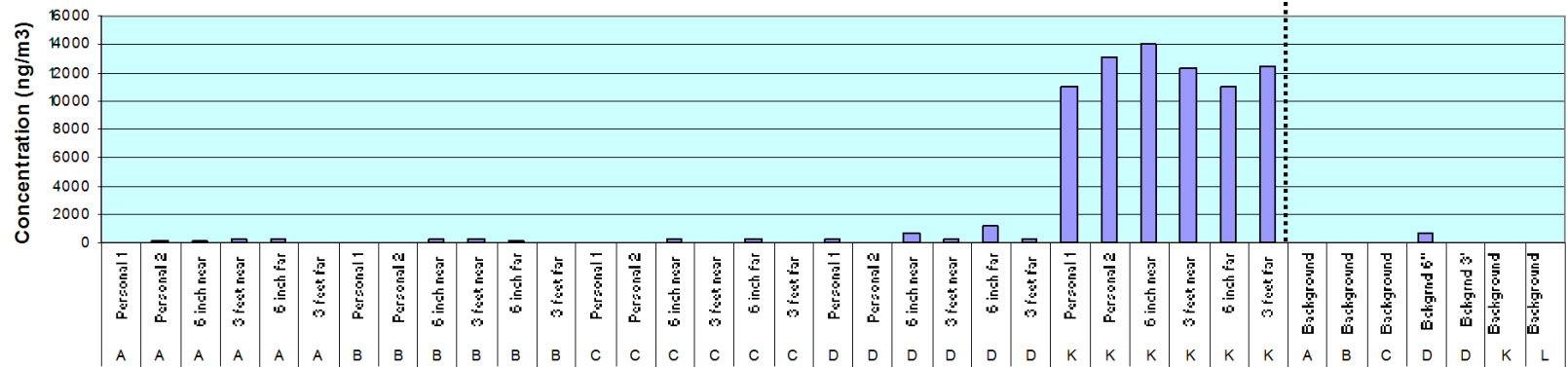


Figure 12. Benzothiazole Results Across Fields including Indoor Field



Exposure Scenarios

- Children 6-18 inhaling measured VOCs/SVOCs
- Adults 30 yrs inhaling VOCs/SVOCs
- Indoor field
- Worst case composite of outdoor field

Table 4. Exposure Parameters

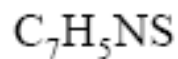
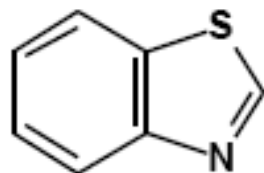
Parameter	Child	Adult	Basis
Age	12	30	Child – midpoint of 6-18 yr range
Years exposed	12	30	Child – youth to high school soccer; Adult – 90 th % residence at one location
Exposure time per event	3 hr	3 hr	Time for soccer match or practice
Days exposed per year	138	138	4 day/wk for 8 months (spring, fall soccer + 2 months in summer)
Days exposed per year VOCs	69	69	VOC offgas only in the 4 warm months for outdoor fields; no adjustment for indoor fields
Ventilation adjustment	3.96	2.64	Child – Adult factor* child factor Adult – moderate exercise
Averaging time (cancer)	25550 days	25550 days	Entire lifespan – 70 yrs
Averaging time (non-cancer)	4380 days	10950 days	Entire exposure period

Conservative Assumption –highest detect at any field represents that chemical – outdoor assessment is the combination of the high hits – worst case

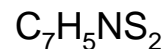
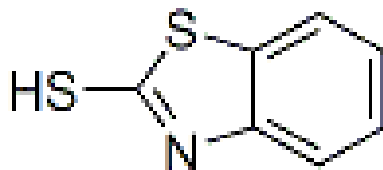
COPC Toxicity Values

- RfCs and Cancer Unit Risks
 - USEPA IRIS, CalEPA OEHHA, ATSDR
- Acute targets – 3 hr basis
 - CalEPA OEHHA, CTDPH, ATSDR
- Conservative approach
 - Use surrogate value in place of zero toxicity
 - Naphthalenes, PAHs, heptane
- Benzothiazole
 - Chronic non-cancer value – EFSA/NYS
 - Cancer – based upon 2-MBT
 - Acute – based upon formaldehyde
- Children's cancer potency 3x factor for mutagens including benzothiazole

Benzothiazole Tox Assessment



Benzothiazole: CAS Registry Number 95-16-9



2-Mercaptobenzothiazole: CAS Registry Number 149-30-4

BZT vs 2-MBT

- Metabolism
 - BZT – ring scission - aryl amine and N-OH
 - 2-MBT – conjugation of mercapto group
- Mutagenicity
 - BZT - + in Salmonella with activation –
 - only 1 study available
 - 2-MBT – mixed results – negative in Salmonella but positive in mouse lymphoma and CHO chrom abb with metabolic activation
- Carcinogenicity
 - 2-MBT tested by NTP in rats and mice
 - Tumor increases in adrenals, kidney, pancreas, pituitary, leukemia
 - Associated with bladder cancer in two rubber worker studies
 - Whittaker 2004 calculated a slope factor from the NTP data
 - $6.34E-04/\text{mg}\cdot\text{kg}\cdot\text{d}$ based upon rat renal tumors

BZT Non-Cancer Targets

- NYS/EFSA RfD-type value
 - 1971 diet study in rats 5.1 mg/kg/d x 3 months
 - No effects found
 - NOAEL divided by 1000 = 5 ug/kg/d
 - DRE yields 18 ug/m³ for **inhalation** reference value
- BZT & 2-MBT may be skin sensitizers
 - 1931 study of BZT – 17 of 43 human subjects were sensitized

BZT Potency as Acute Respiratory Irritant

- Anecdotal reports of irritation in workers
- RD₅₀ study in mice CPSC (1996)
 - Formaldehyde RD₅₀ = 12.9 mg/m³
 - BZT RD₅₀ = 235 mg/m³
 - Acute irritant difference = 18
- Formaldehyde concern level = 50 ug/m³
 - 61.5 ug/m³
- Converting to BZT acute irritation = 1100 ug/m³
- Divided by 10 for extrapolation uncertainties
 - Acute air target = **110 ug/m³**
 - BZT treated as if only 1.8 fold less potent than formaldehyde

Figure 13. Cancer Risk Estimates for Indoor and Outdoor Turf Fields

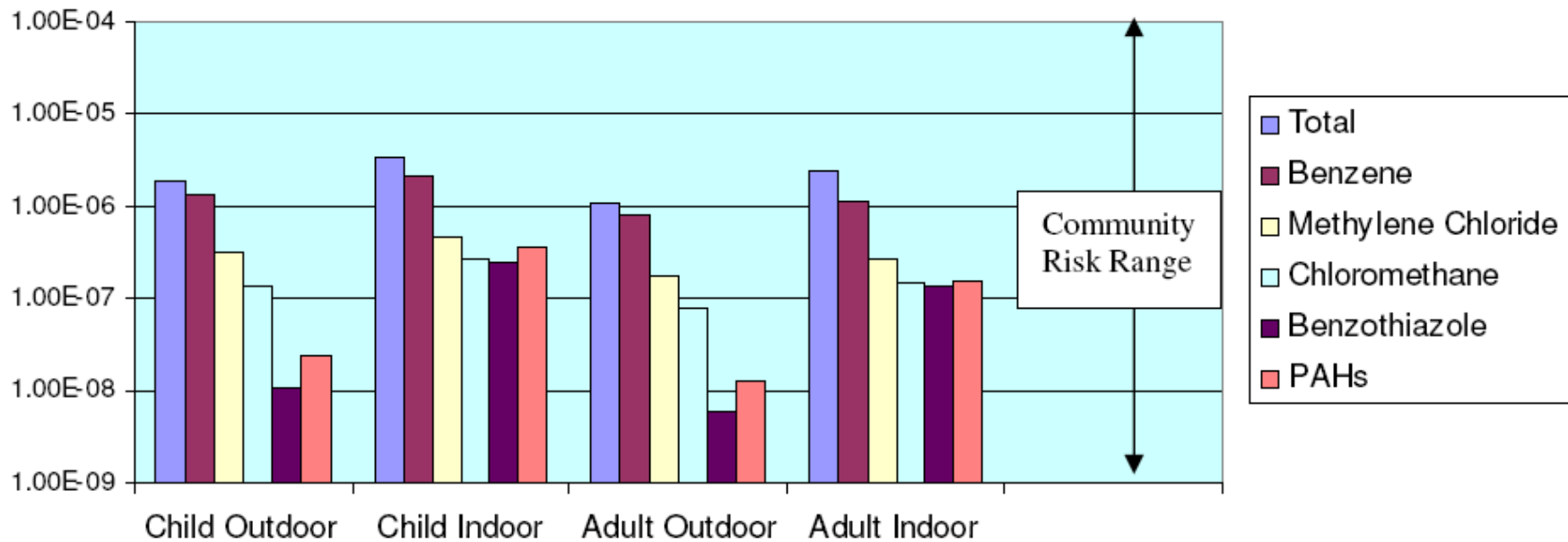


Figure 14. Hazard Indices for Non-Cancer and Acute Risk at Artificial Turf Fields

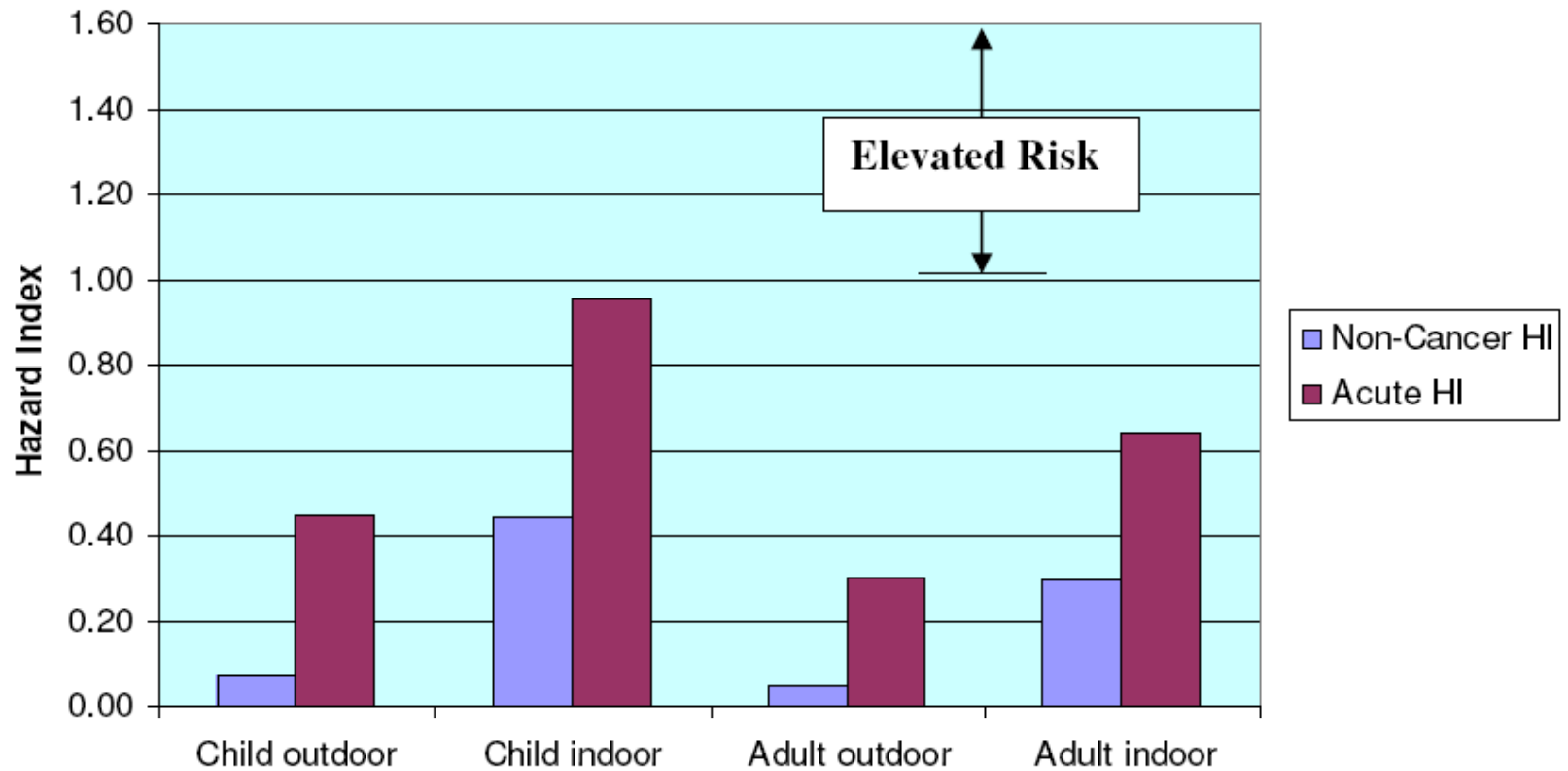


Table 6. Summary of Artificial Turf Field Risks

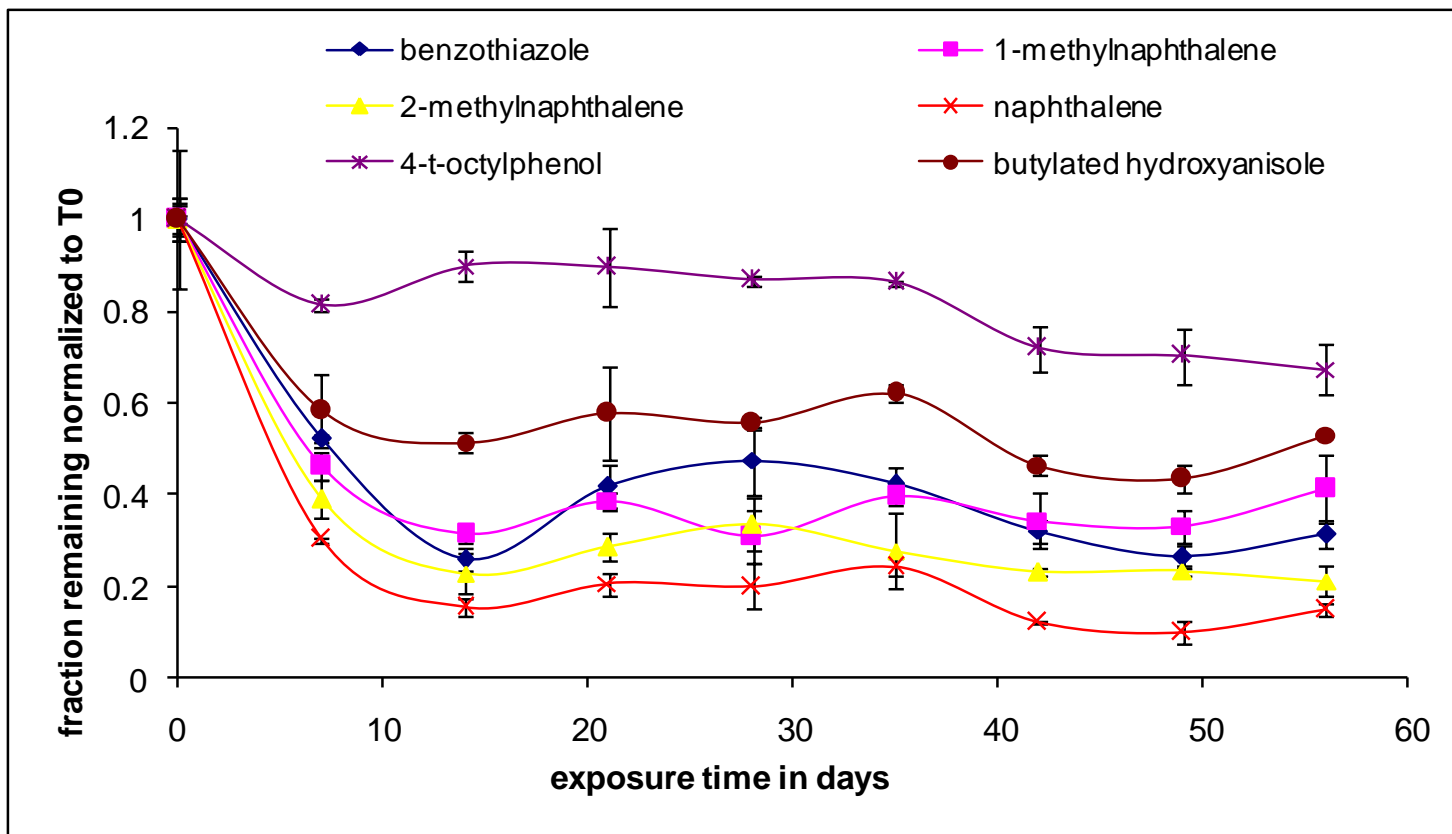
	Child Outdoor	Child Indoor	Adult Outdoor	Adult Indoor
Cancer Risk	1.9E-06	3.4E-06	1.1-06	2.3E-06
Non-Cancer	0.09	0.48	0.057	0.32
Acute	0.44	0.96	0.29	0.63
Key Analytes Cancer	Benzene 73% MethyleneCl 17% Chloro Me 7% Benzothiaz <1%	Benzene 61% MethyleneCl 14% Chloro Me 8% Benzothiaz 7%	Benzene 73% MethyleneCl 17% Chloro Me 7% Benzothiaz <1%	Benzene 51% MethyleneCl 11% Chloro Me 6% Benzothiaz 6%
Non-cancer	Toluene 19%	Toluene 18%	Toluene 19%	Toluene 18%
Acute	Benzothiaz 9.8% Benzene 16% Toluene 6.3%	Benzothiaz 54% Benzene 5.6% Toluene 7.6%	Benzothiaz 9.8% Benzene 16% Toluene 6.3%	Benzothiaz 54% Benzene 5.6% Toluene 7.6%

CASE Review

- **Are we overstating the risks?**
 - Benzene and methylene chloride not field-related??
- **Representativeness of the fields?**
 - Our results similar to other studies involving a range of conditions and fields
 - Many different crumb rubber samples tested between WOHL and CAES in offgas studies
 - Still a potentially imppt source of variability
- **Allergens**
 - Latex in natural rubber – 6% of population allergic
 - Warning signs needed?
 - Benzothiazole is a contact allergen
- **Toddler/ingestion risks**
 - California assumed 10 g crumbs ingested at once
 - Norway – assumed 1g/day over 6 months of play
 - Evaluated acute risks of phthalates and alkylphenols

Summary and Conclusions

- Field investigation able to detect VOCs,SVOCs
 - Particularly BZT, naphthalenes,
- **Indoor results >> Outdoor results**
- Results consistent with previous studies
- No risks particularly elevated or novel relative to background
 - Cancer risk drivers (benzene, methylene Cl)
 - May be partially artifact
 - **Acute inhalation risk borderline at indoor field**
 - **Presents an uncertainty**
 - PM₁₀, Lead, Nitrosamines – not elevated
- **Uncertainty: hot weather, fresh rubber**
- **Uncertainty – allergenicity of the fields**
 - Latex antigen and benzothiazole dermal and inhalation exposure



[J Toxicol Environ Health A.](#) 2011;74(17):1133-49.

Synthetic turf field investigation in Connecticut.

[Simcox NJ](#), [Bracker A](#), [Ginsberg G](#), [Toal B](#), [Golembiewski B](#), [Kurland T](#), [Hedman C](#).

[J Toxicol Environ Health A.](#) 2011;74(17):1150-74.

Human health risk assessment of synthetic turf fields based upon investigation of five fields in Connecticut.

[Ginsberg G](#), [Toal B](#), [Simcox N](#), [Bracker A](#), [Golembiewski B](#), [Kurland T](#), [Hedman C](#).

[J Toxicol Environ Health A.](#) 2011;74(17):1175-83.

Benzothiazole toxicity assessment in support of synthetic turf field human health risk assessment.

Areas of Recommendation

- Ventilation of indoor fields?
- Install fields in cooler weather or have a “no play” break in period?
- Contact LHD if experience breathing difficulty or allergic skin reaction?