BOHS
The Chartered Society for Worker Health Protection

Practical Application of Human Human Health Risk Assessment for the IH/OH

Vapor Intrusion at an Elementary School

Presented by:
Megan Canright, MPH, CIH
Director of Scientific Operations
Forensic Analytical Consulting Services

FACS
Forensic Analytical Consulting Services

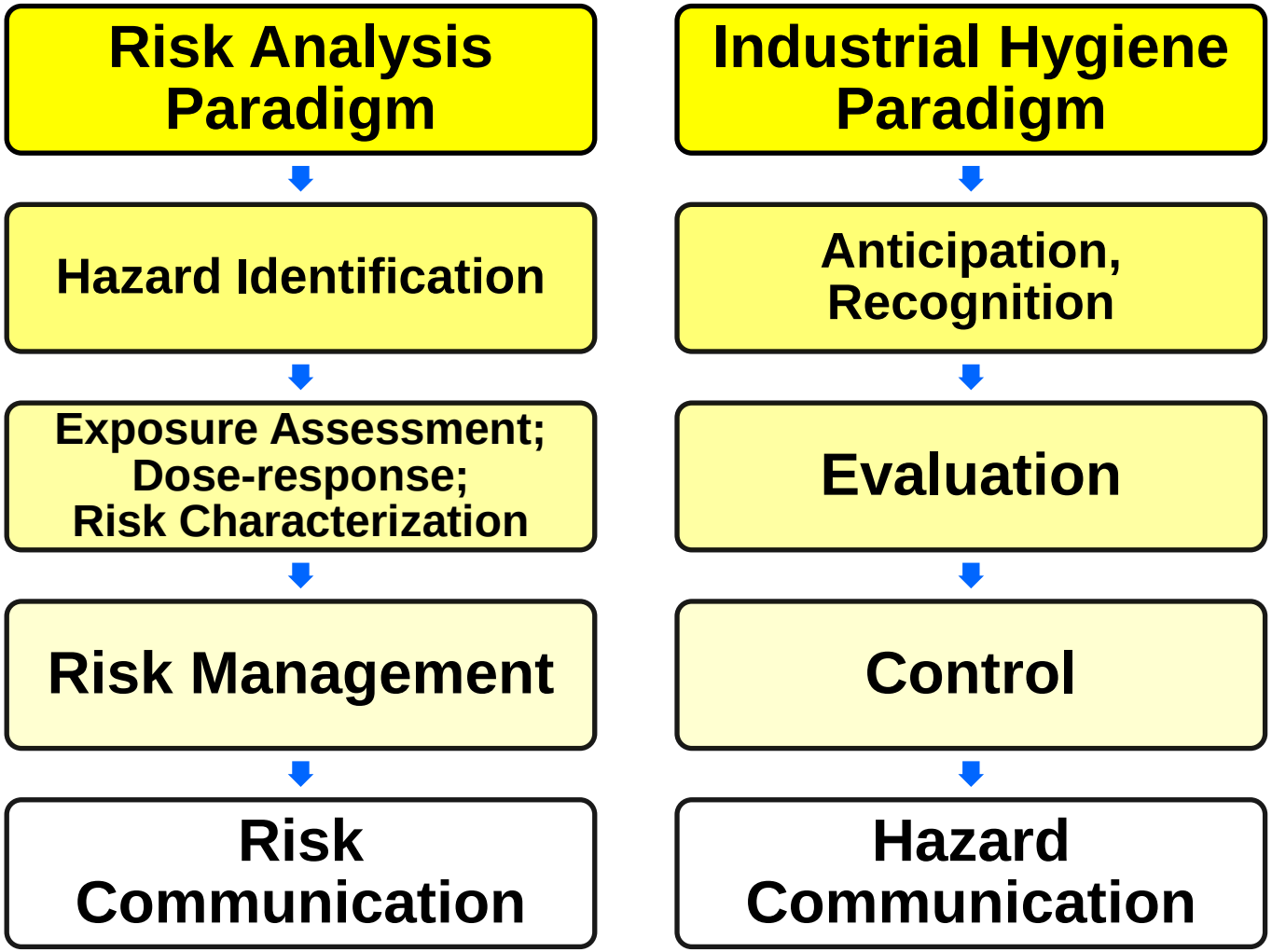
Human Health Risk Assessment

The Chartered Society for Worker Health Protection

- **Hazard Identification**
  - *Generation of a Conceptual Site Model (CSM)*
  - *Selection of Chemicals of Potential Concern (COPCs)*
- **Dose Response**
  - *Cancer or non-cancer endpoints*
  - *Selection of toxicological criteria*
- **Exposure Assessment**
  - *Estimation of lifetime exposure/dose*
- **Risk Characterization**
  - *Calculation of risk and selection of acceptance criteria*

Human Health Risk Assessment

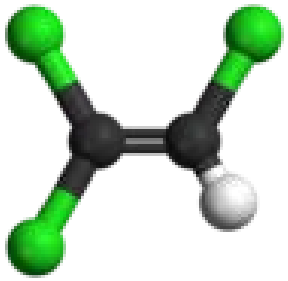
The Chartered Society for Worker Health Protection

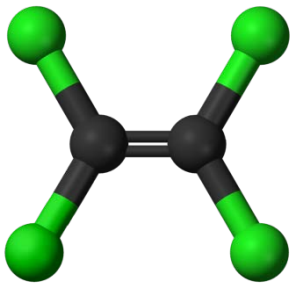


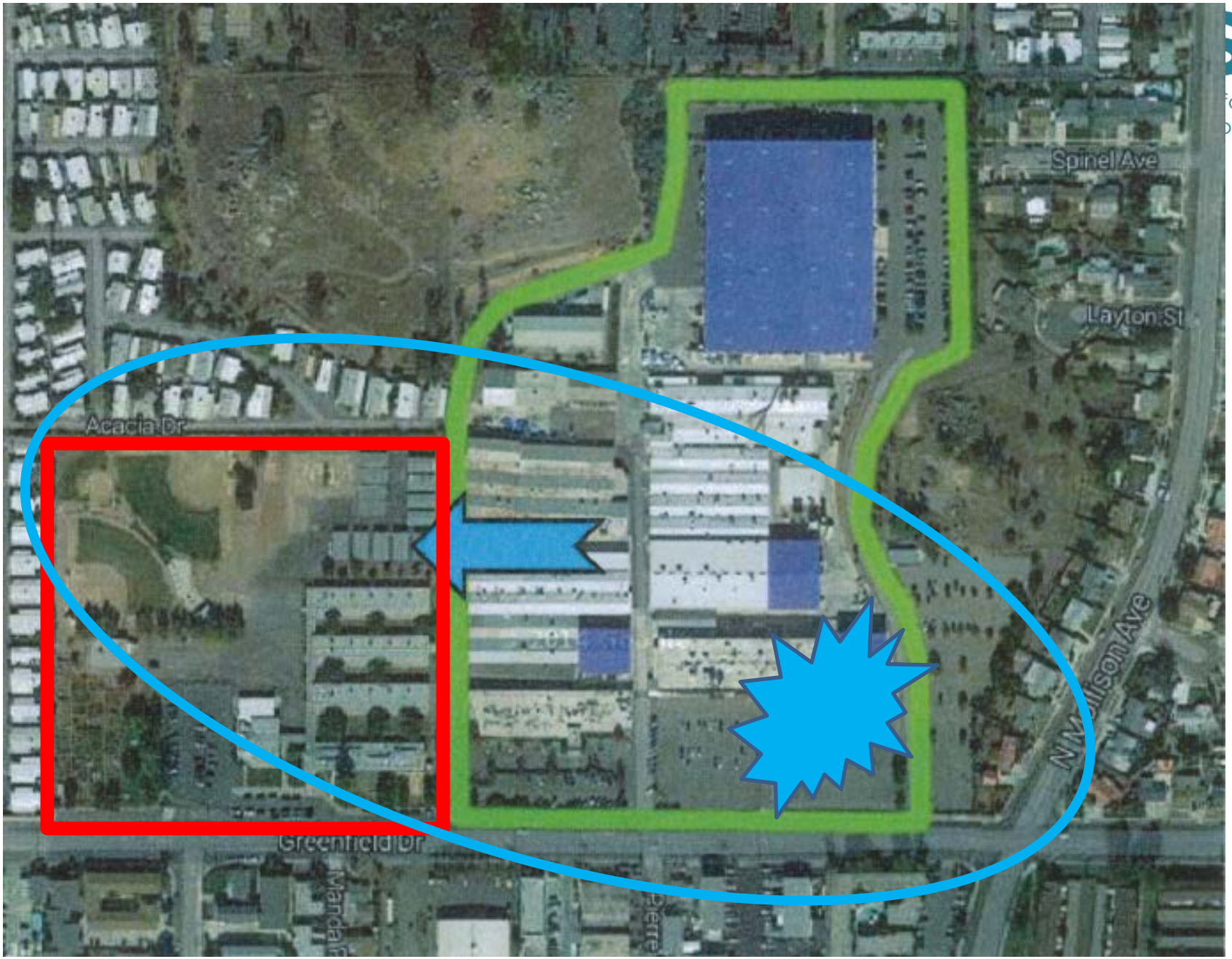
Project Background

The Chartered Society for Worker Health Protection

- Aerospace parts manufacturing facility
- Operated through the 1950s
- Heavy use of chlorinated solvents
- Adjacent elementary school built in 1952
- Groundwater contamination plume identified in 1987; regular monitoring at former site
- Regular monitoring at school since 1994



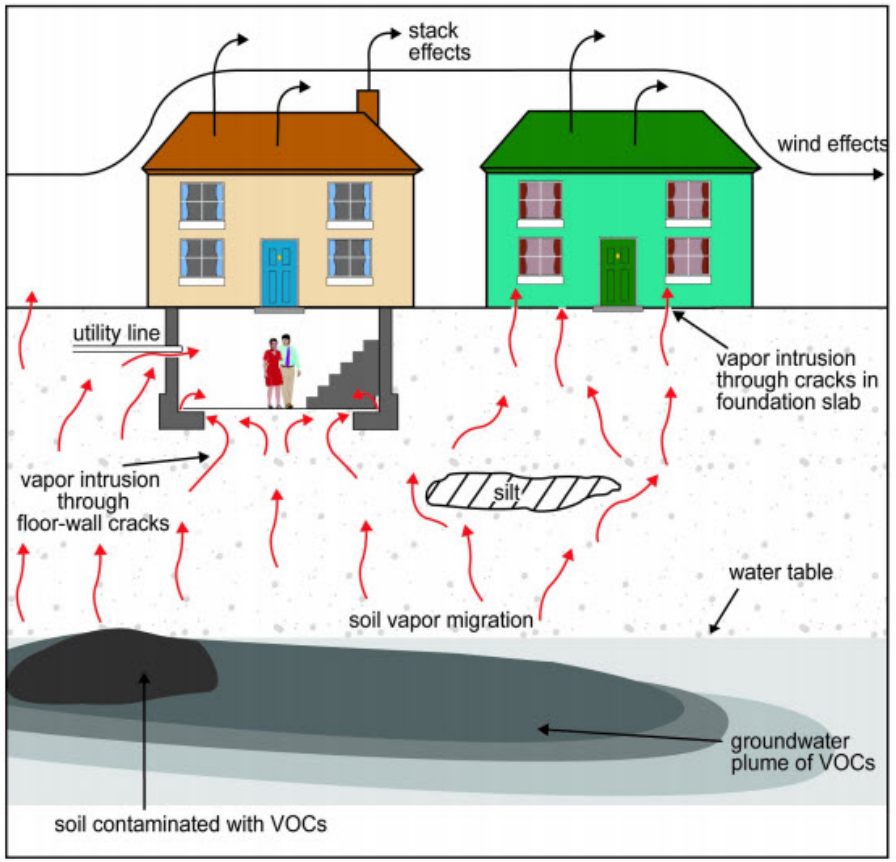



Spinel Ave
Layton St
Acacia Dr
Greenfield Dr
NW Allison Ave

Hazard Identification

- COPCs
  - Perchloroethylene (PCE)
  - Trichloroethylene (TCE)
  - Chloroform
  - Breakdown products
- Indoor air contaminants "match" plume contaminants
- PCE = 8.31 µg/m^3

  (95th percentile)



Dose Response, Cancer

The Chartered Society for Worker Health Protection

Inhalation Unit Risk (IUR)

II.C. QUANTITATIVE ESTIMATE OF CARCINOGENIC RISK FROM INHALATION EXPOSURE

II.C.1. SUMMARY OF RISK ESTIMATES

II.C.1.1. Inhalation Unit Risk: 1.8×10^{-3} per ppm, or 2.6×10^{-7} per $\mu g/m^3$ (2×10^{-3} per ppm, or 3×10^{-7} per $\mu g/m^3$, rounded to one significant figure)

The inhalation unit risk is derived from the $BMCL_{10}$, the 95% lower bound on the exposure associated with a 10% extra cancer risk, by dividing the risk (as a fraction) by the $BMCL_{10}$, and represents an upper bound, continuous lifetime exposure risk estimate:

$BMCL_{10}$, lower 95% bound on exposure at 10% extra risk – 57 ppm, or 3.9×10^5 $\mu g/m^3$.
BMC_{10}, central estimate of exposure at 10% extra risk – 80 ppm, or 5.4×10^5 $\mu g/m^3$.

*** Tox data obtained from US EPA Integrated Risk Information System (IRIS)*

$IUR = 2.6 \times 10^{-7}\ (\mu g/m^3)^{-1}$

Dose Response, Non-Cancer

BOHS
The Chartered Society for Worker Health Protection

Reference Concentration (RfC)

I.B.1. CHRONIC INHALATION RfC SUMMARY

Principal Study / Critical Effect	POD (mg/m^3)	UFs	Candidate RfDs (mg/m^3)	RfC (mg/m^3)*
Echeverria et al. (1995): neurotoxicity (reaction time, cognitive effects) in occupationally-exposed adults	LOAEL = 56	1,000	0.056	0.04

*** Tox data obtained from US EPA Integrated Risk Information System (IRIS)*

RfC = 0.04 mg/m^3 = 40 $\mu g/m^3$

Exposure Assessment

The Chartered Society for Worker Health Protection

Screening Calculation, Lifetime Exposure:

$$\mathbf{EC = \frac{CA \times ET \times EF \times ED}{AT}}$$

Where:

EC = Exposure Concentration, ($\mu g/m^3$)

CA = Concentration in Air, ($\mu g/m^3$) – sample concentration

ET = Exposure Time, (hours/day) – 8.5 hours/day

EF = Exposure Frequency, (days/year) – 250 days/year

ED = Exposure Duration, (years) – 25 years

AT = Averaging Time, (hours)

- cancer = 613,200 hours (70 years in hours)
- non-cancer = same as ED, 219,000 hours (25 years in hours)

Exposure Concentration, EC

BOHS
The Chartered Society for Worker Health Protection

EC, Cancer

$$EC_{(PCE)} = \frac{(8.31\ \mu g/m^3)(8.5\ hrs/day)(250\ days/yr)(25\ yrs)}{613{,}200\ hours}$$

$EC_{(PCE)} = 0.72\ \mu g/m^3$

EC, Non-cancer

$$EC_{(PCE)} = \frac{(8.31\ \mu g/m^3)(8.5\ hrs/day)(250\ days/yr)(25\ yrs)}{219{,}000\ hours}$$

$EC_{(PCE)} = 2.02\ \mu g/m^3$

Lifetime Risk, Cancer

The Chartered Society for Worker Health Protection

Risk = EC x IUR

Where:
Risk = Upper bound of lifetime cancer risk estimate, unitless
EC = Exposure Concentration, ($\mu g/m^3$)
IUR = Inhalation Unit Risk, $(\mu g/m^3)^{-1}$

$EC_{(PCE)} = 0.72\ \mu g/m^3$ (cancer)
$IUR_{(PCE)} = 2.6 \times 10^{-7}\ (\mu g/m^3)^{-1}$

$$Risk_{(PCE)} = (0.72\ \mu g/m^3) \times (2.6 \times 10^{-6}\ \mu g/m^3)^{-1}$$

$Risk_{(PCE)} = 1.9 \times 10^{-6}$ or 1.9 in 1,000,000

Hazard Quotient, Non-cancer

The Chartered Society for Worker Health Protection

$$\mathbf{HQ = EC / RfC}$$

Where:
HQ = Hazard Quotient (ratio), unitless
EC = Exposure Concentration, ($\mu g/m^3$)
RfC = Reference Concentration - Inhalation, ($\mu g/m^3$)

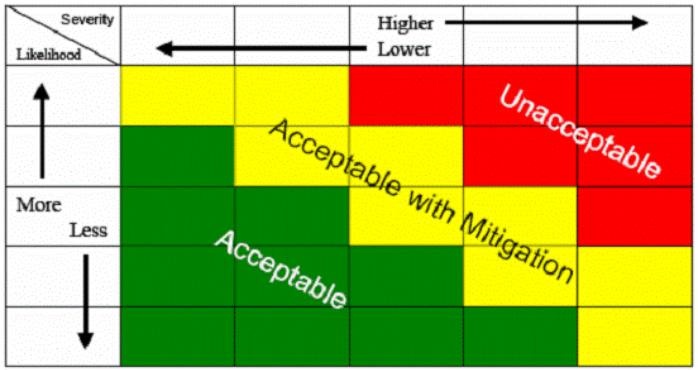
$EC_{(PCE)} = 2.02\ \mu g/m^3$ (non-cancer)
$RfC_{(PCE)} = 40\ \mu g/m^3$

$$HQ_{(PCE)} = (2.02\ \mu g/m^3) / (40\ \mu g/m^3)$$

$$\mathbf{HQ_{(PCE)} = 0.05}$$

Risk Characterization

- MANY ways to characterize and interpret risk
- What is acceptable? What is unacceptable?
- Often varies based on perception
  - Who is exposed?
  - Who are the stake holders?
  - Who is the decision maker?
  - Who is making the judgment?
  - Who is the regulatory agency?
  - What will it cost to manage/mitigate risk?



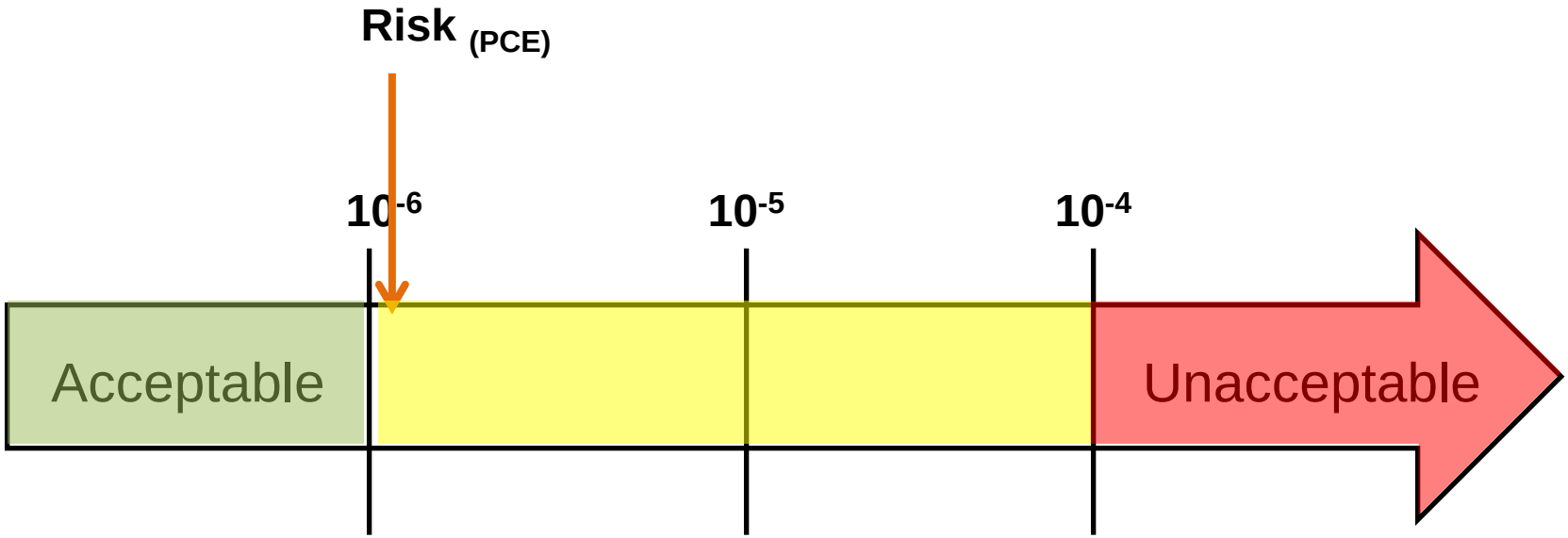
Interpreting Risk

Non-Cancer Endpoints

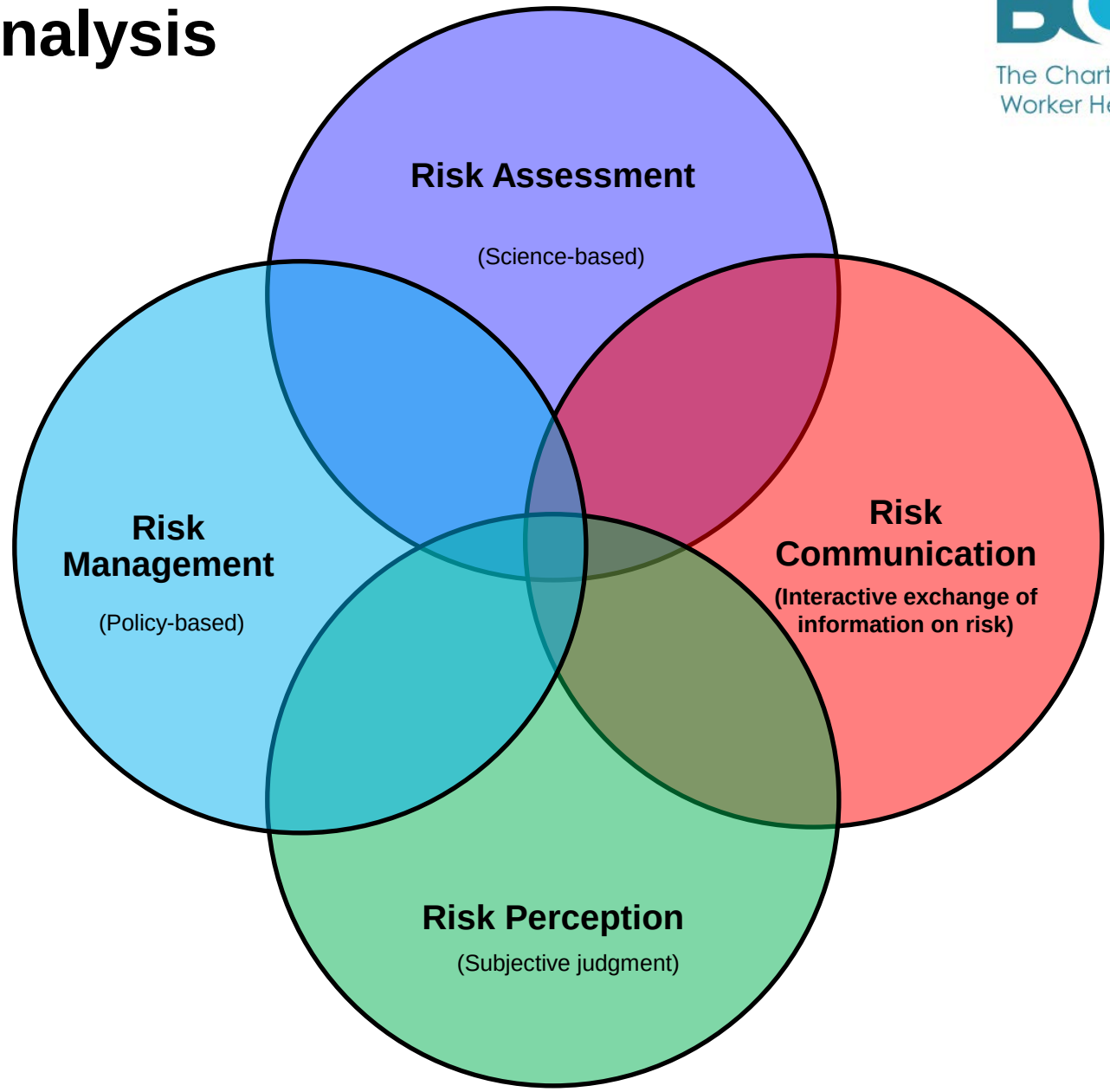
Hazard Quotient = 1 (Exposure = Reference)?

Hazard Quotient = 0.1 (Protective)?

Cancer Endpoints



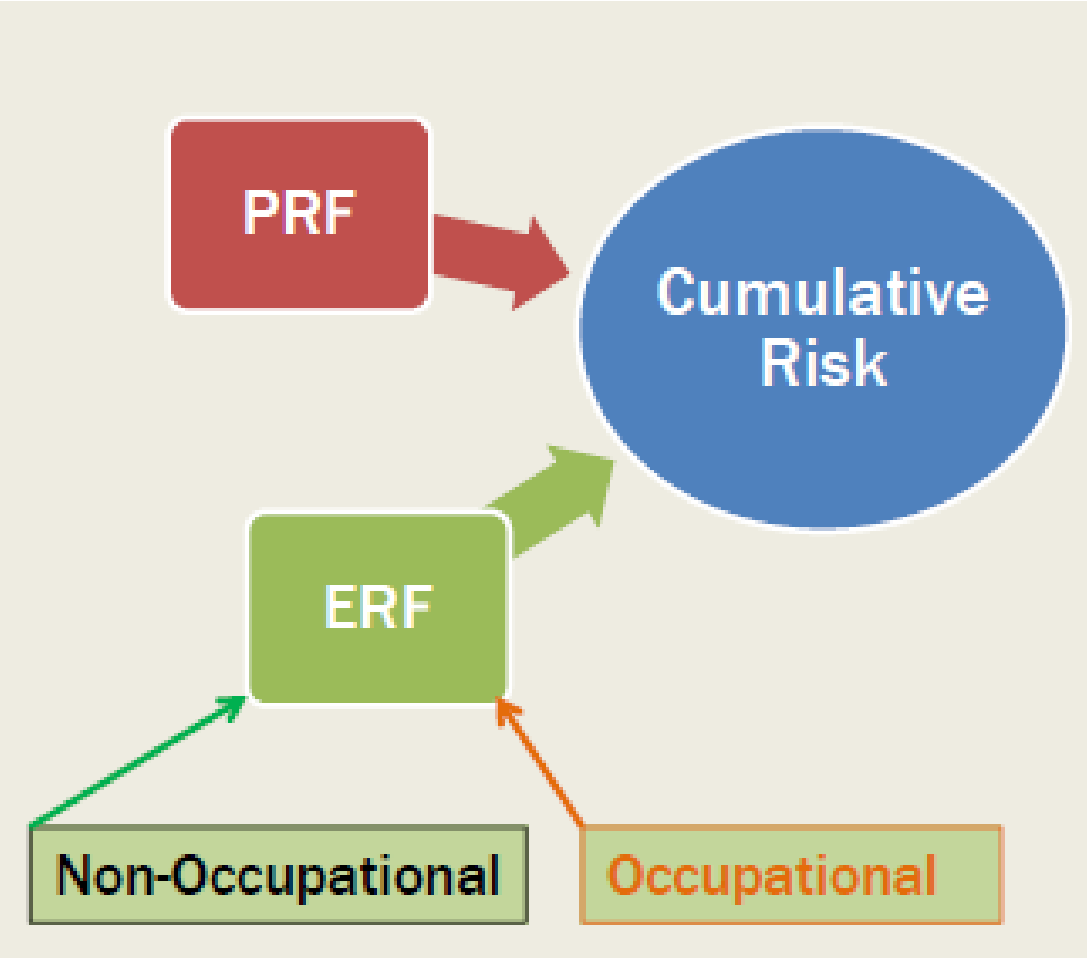
Risk Analysis



Closing Thoughts

- This is only a screening tool to assist in risk management decision making
- Narrow viewpoint, one puzzle piece
- Risk is cumulative…
  - Single chemical exposures?
  - Co-exposures to multiple chemical agents?
  - Non-chemical agents (biological, physical)?
  - Psychosocial factors or stressors?
  - Exposure outside the workplace?
  - Personal vs. environmental factors?
  - Sensitive populations?
  - Predisposition?

Cumulative Risk



Courtesy of: NIOSH CRA (G. Scott Dotson)

Questions?

Megan Canright, MPH, CIH

Director of Scientific Operations

Forensic Analytical Consulting Services, Inc.

San Diego, California

mcanright@forensicanalytical.com

+1 (858) 859 3322

Thank You!!

The Chartered Society for Worker Health Protection