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How Safe is "Safe?"

Challenges in Risk Characterization and Communication with Publicly Available Information in Disaster Response

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In any disaster…

*"…there are **known knowns**; there are things we know we know. We also know there are **known unknowns**; that is to say we know there are some things we do not know. But there are also **unknown unknowns**…"*

Secretary of Defense Donald H. Rumsfeld briefs reporters at the Pentagon on the latest developments in the war on terrorism on Feb. 21, 2002. Rumsfeld and Chairman of the Joint Chiefs of Staff Gen. Richard B. Myers, U.S. Air Force, provided details of the January 23, 2002, U.S. ground assault on two buildings in the Afghan village of Hazar Qadam. https://en.wikipedia.org/wiki/There_are_unknown_unknowns

East Palestine

https://www.cleveland19.com/2023/02/14/ntsb-announces-preliminary-malfunction-that-caused-east-palestine-train-derailment/

POLYPROPYLENE
POLYETHYLENE
Residue lube oil
VINYL CHLORIDE, STABILIZED
DIPROPYLENE GLYCOL
PROPYLENE GLYCOL
DIETHYLENE GLYCOL
COMBUSTIBLE LIQ., NOS (ETHYLENE GLYCOL MONOBUTYL ETHER)
SEMOLINA
COMBUSTIBLE LIQ., NOS (ETHYLHEXYL ACRYLATE)
POLYVINYL
PETROLEUM LUBE OIL
POLYPROPYL GLYCOL
ISOBUTYLENE
BUTYL ACRYLATES, STABILIZED
PETRO OIL, NEC
ADDITIVES, FUEL
BALLS,CTN,MEDCL
SHEET STEEL
VEGTABLE, FROZEN
BENZENE
PARAFFIN WAX
FLAKES, POWDER
HYDRAULIC CEMENT
AUTOS PASSENGER
MALT LIQUORS

Known health hazards with known "safe" levels:

- Vinyl Chloride
- EGBE
- Benzene

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Known health hazards but unknown "safe" levels*:

- DEG
- Acrylates
- Isbutylene

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*Although occupational limits exist, no toxicity values meant for the general public were available from EPA, ATSDR, CalEPA

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East Palestine

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Unknown unknowns

- Combustion products from "controlled burn" and their toxicity

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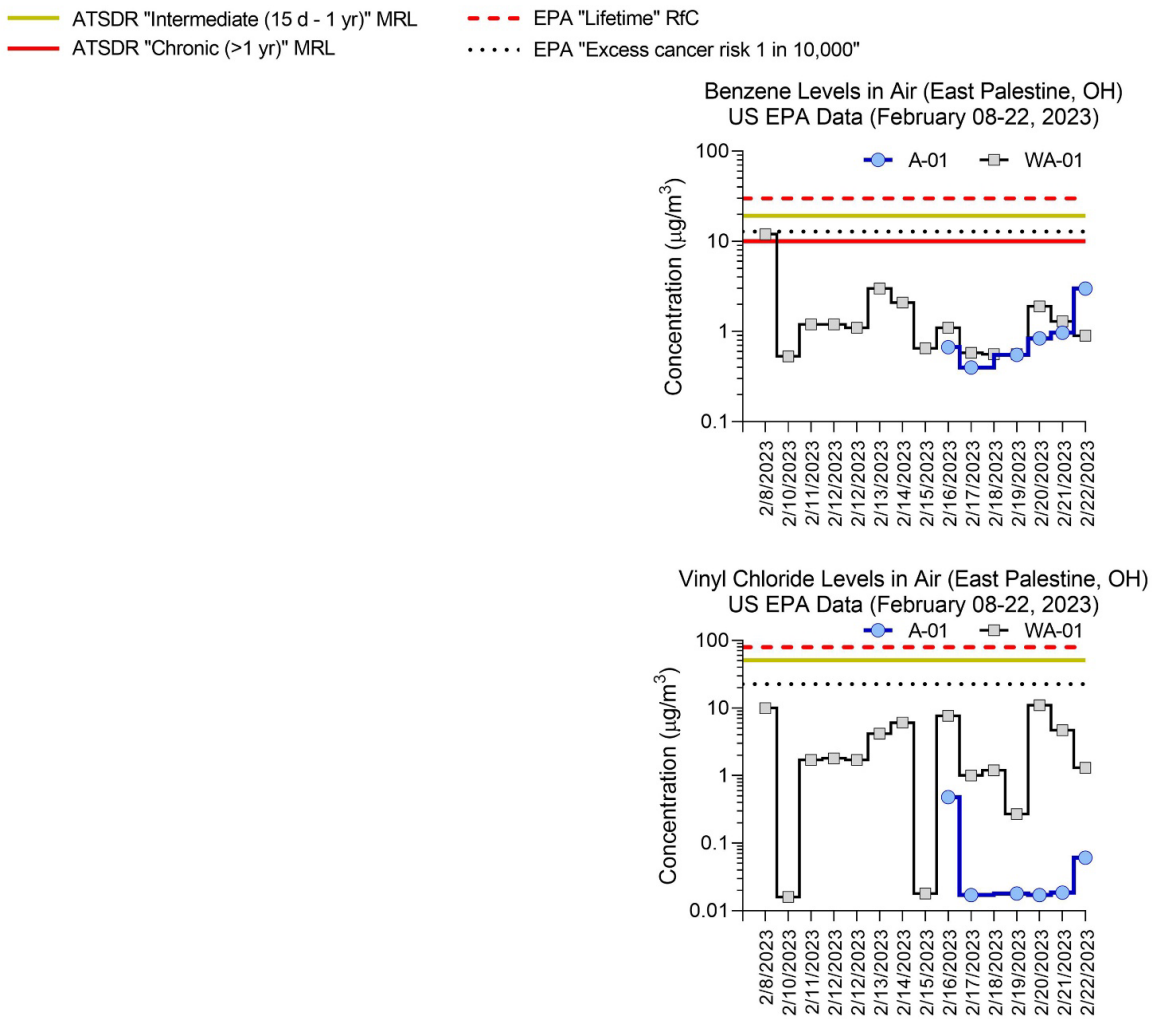
- **Challenge #1:** Communicating risk or safety in the face of “known unknowns” and “unknown unknowns.”

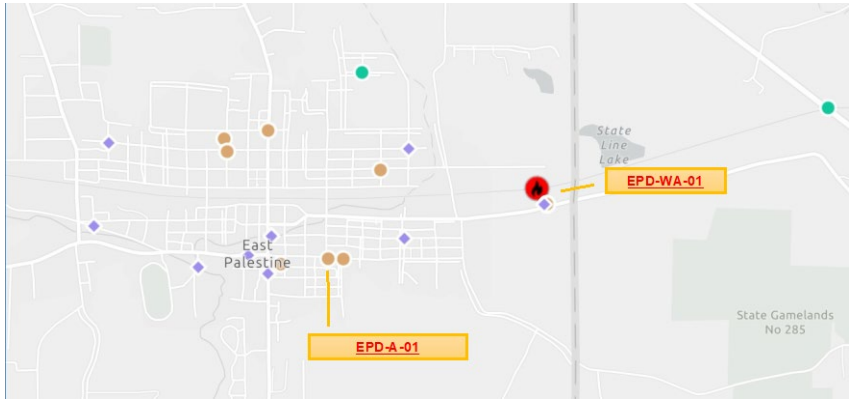
Easiest case: characterizing and communicating “safety” for “known knowns”



For example, for Benzene and Vinyl Chloride

- EPA measurements in East Palestine are **below “safe” levels** available from ATSDR and EPA.

Data mostly from only two locations.
Is it still “safe” everywhere else?



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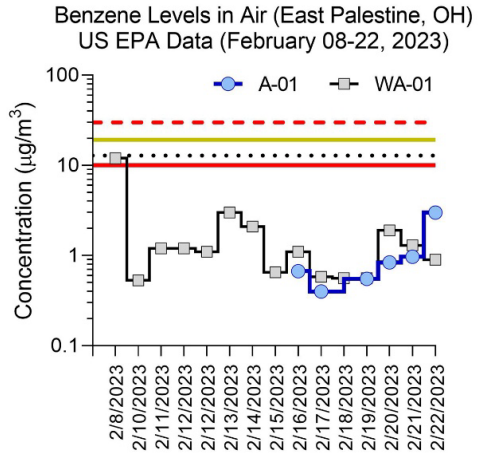
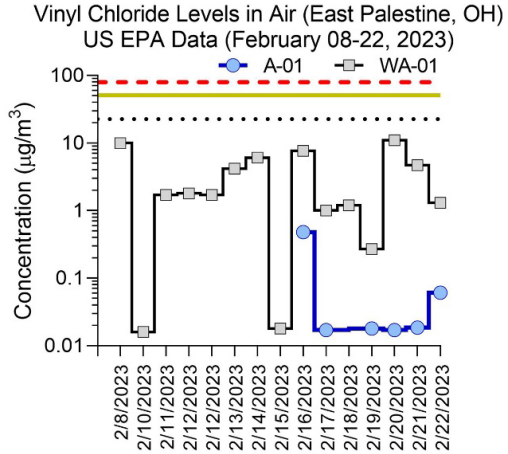
Easiest case: characterizing and communicating “safety” for “known knowns”

ATSDR "Intermediate (15 d - 1 yr)" MRL
ATSDR "Chronic (>1 yr)" MRL
EPA "Lifetime" RfC
EPA "Excess cancer risk 1 in 10,000"

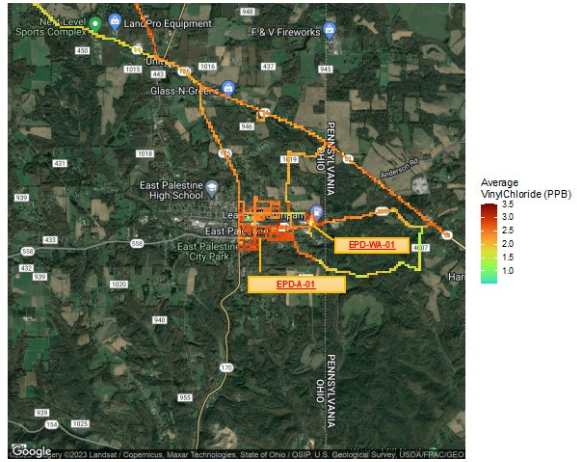




For example, for Benzene and Vinyl Chloride

- EPA measurements in East Palestine are **below “safe” levels** available from ATSDR and EPA.

CMU sampled independently using mobile van



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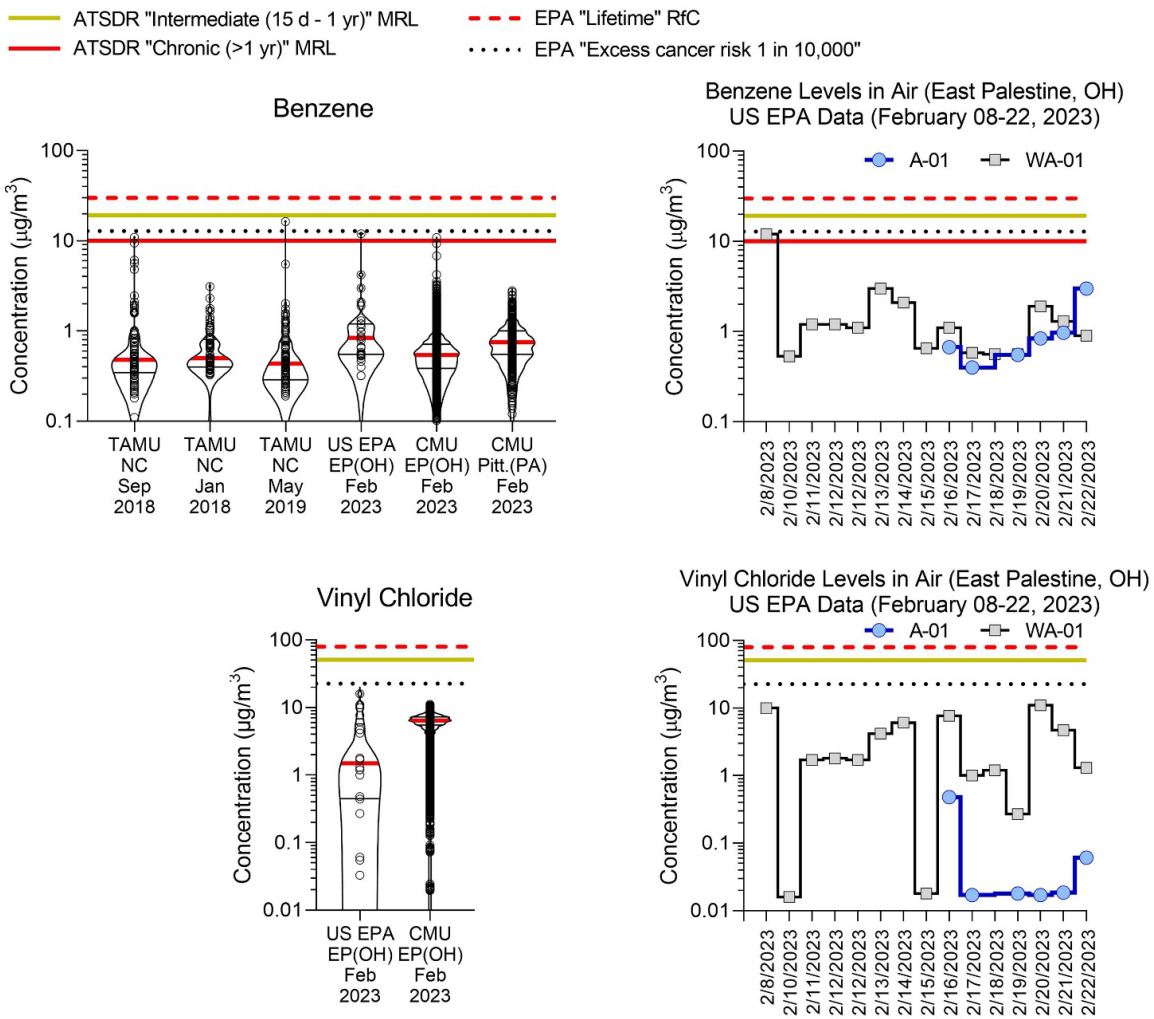
Easiest case: characterizing and communicating “safety” for “known knowns”



For example, for Benzene and Vinyl Chloride

- EPA measurements in East Palestine are **below “safe” levels** available from ATSDR and EPA.
- EPA stationary and CMU mobile measurements in East Palestine are **consistent**
- EPA measurements **similar to “typical” levels** at various locations outside East Palestine

- **Challenge #1:** Communicating risk or safety in the face of “known unknowns” and “unknown unknowns.”

- **Challenge #2:** Appropriate acknowledgement of geographic and temporal variability in exposure concentrations.

Harder case even for “known knowns”: measured levels exceeding “safe” levels

	EPA Reported Concentrations		Calculated Hazard Quotient (HQ)		HQ due to “Normal” Levels in Counties across USA, Counties in Ohio, and in Columbiana County, OH				
Chemicals (CAS#)	Median (mg/m3) in East Palestine (OH) Feb 2023	Highest (mg/m3) in East Palestine (OH) Feb 2023	HQ for median in East Palestine (OH) Feb 2023	HQ for highest in East Palestine (OH) Feb 2023	HQ for median county in USA (EPA NATA 2014)	HQ for highest county in USA (EPA NATA 2014)	HQ for median county in Ohio (EPA NATA 2014)	HQ for highest county in Ohio (EPA NATA 2014)	HQ for Columbiana County, Ohio (EPA NATA 2014)
1,1,2-Trichloroethane (79-00-5)	0.00007	0.00145	0.35	0.73	0.00	0.02	0.00	0.00	0.00
1,3-Butadiene (106-99-0)	0.000084	0.00053	0.04	0.27	0.01	0.08	0.01	0.02	0.01
Acrolein (107-02-8)	0.00014	0.0008	7.0	40	0.89	6.1	0.88	1.56	0.83
Benzene (71-43-2)	0.00084	0.012	0.03	0.40	0.01	0.03	0.01	0.02	0.01
m,p-Xylenes (179601-23-1)	0.00078	0.0098	0.01	0.10	0.00	0.01	0.00	0.01	0.00
Naphthalene (91-20-3)	0.00007	0.0014	0.02	0.47	0.01	0.04	0.01	0.02	0.01
o-Xylene (95-47-6)	0.00029	0.021	0.00	0.21	0.00	0.01	0.00	0.01	0.00
Trichloroethylene (79-01-6)	0.000018	0.00053	0.01	0.27	0.00	0.17	0.01	0.03	0.01
Vinyl Chloride (75-01-4)	0.00026	0.016	0.00	0.20	0.00	0.00	0.00	0.00	0.00

Harder case even for “known knowns”: measured levels exceeding “safe” levels

	EPA Reported Concentrations		Calculated Hazard Quotient (HQ)	
Chemicals (CAS#)	Median (mg/m3) in East Palestine (OH) Feb 2023	Highest (mg/m3) in East Palestine (OH) Feb 2023	HQ for median in East Palestine (OH) Feb 2023	HQ for highest in East Palestine (OH) Feb 2023
1,1,2-Trichloroethane (79-00-5)	0.00007	0.00145	0.35	0.73
1,3-Butadiene (106-99-0)	0.000084	0.00053	0.04	0.27
Acrolein (107-02-8)	0.00014	0.0008	7.0	40
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Vinyl Chloride (75-01-4)	0.00026	0.016	0.00	0.20

- Concentrations for nine of the ~50 chemicals EPA reported are higher than “normal” average levels
- If they **continue** at these levels, some (e.g., Acrolein) may be of health concern
- **What do these numbers actually mean?**

Hazard Quotient (HQ)

HQ = Concentration ÷ Reference Value

Generally smaller HQ is “safe” and large HQ is “unsafe”

Different Reference Values have different definitions

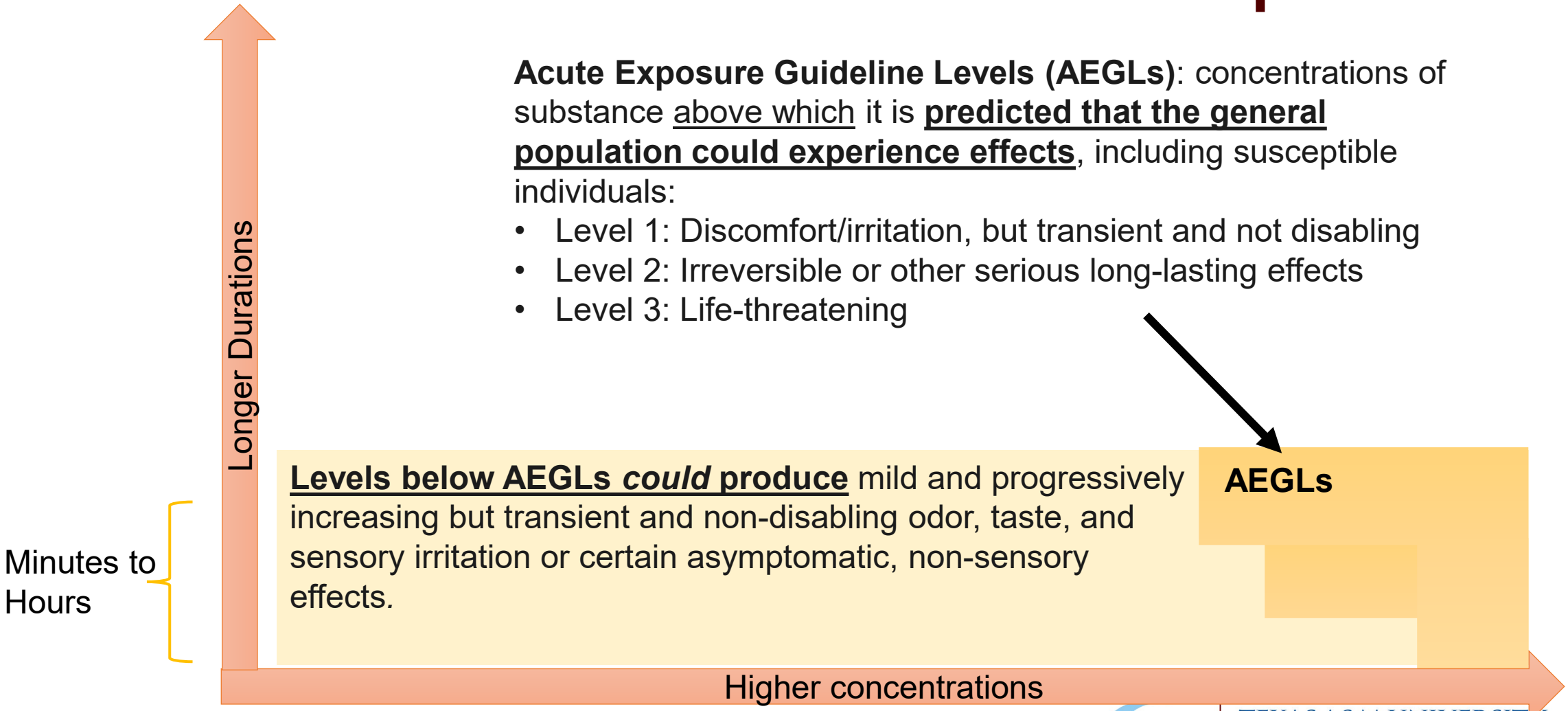
Therefore…

Different HQs have different interpretations

Communication is challenging due to how "safe" levels are derived and interpreted

Acute Exposure Guideline Levels (AEGLs): concentrations of substance above which it is **predicted that the general population could experience effects**, including susceptible individuals:

- Level 1: Discomfort/irritation, but transient and not disabling
- Level 2: Irreversible or other serious long-lasting effects
- Level 3: Life-threatening



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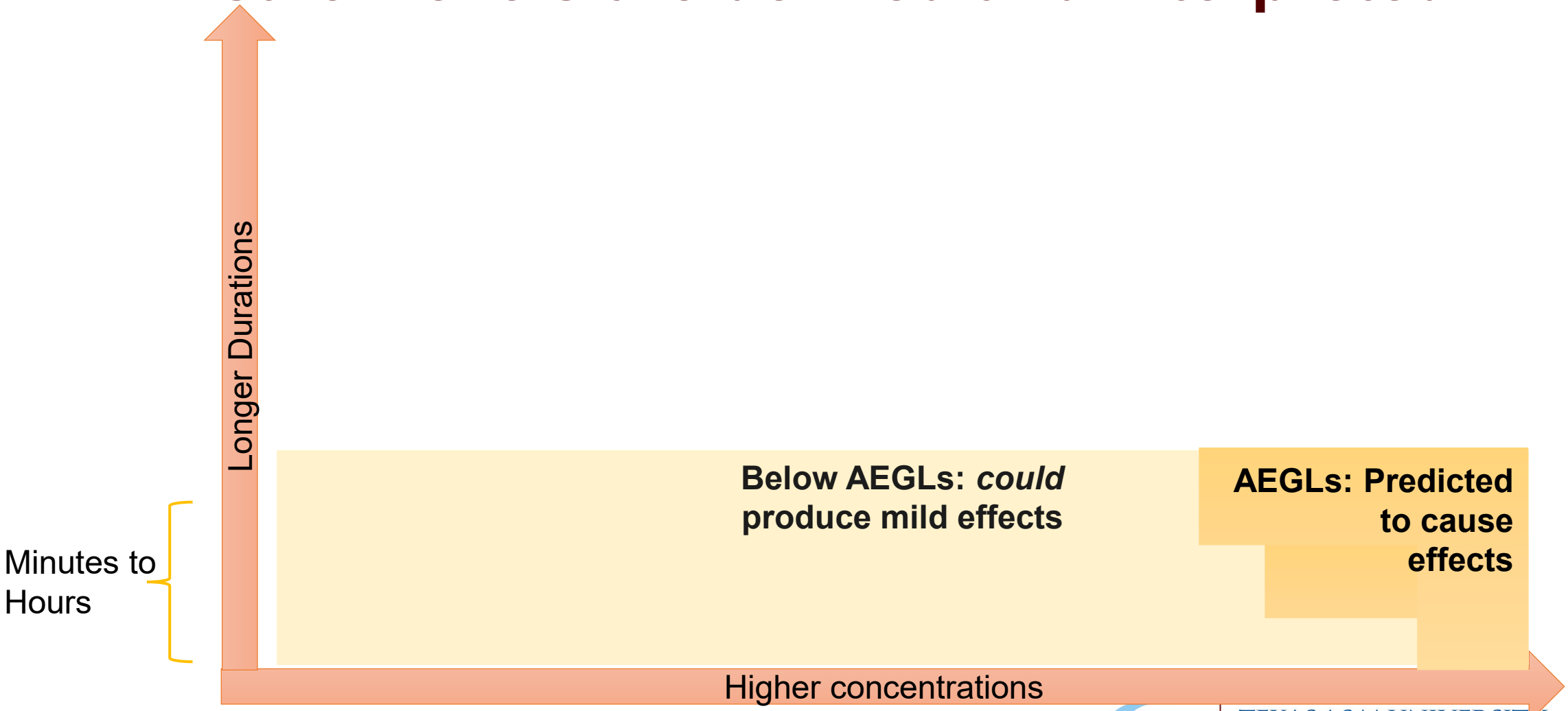

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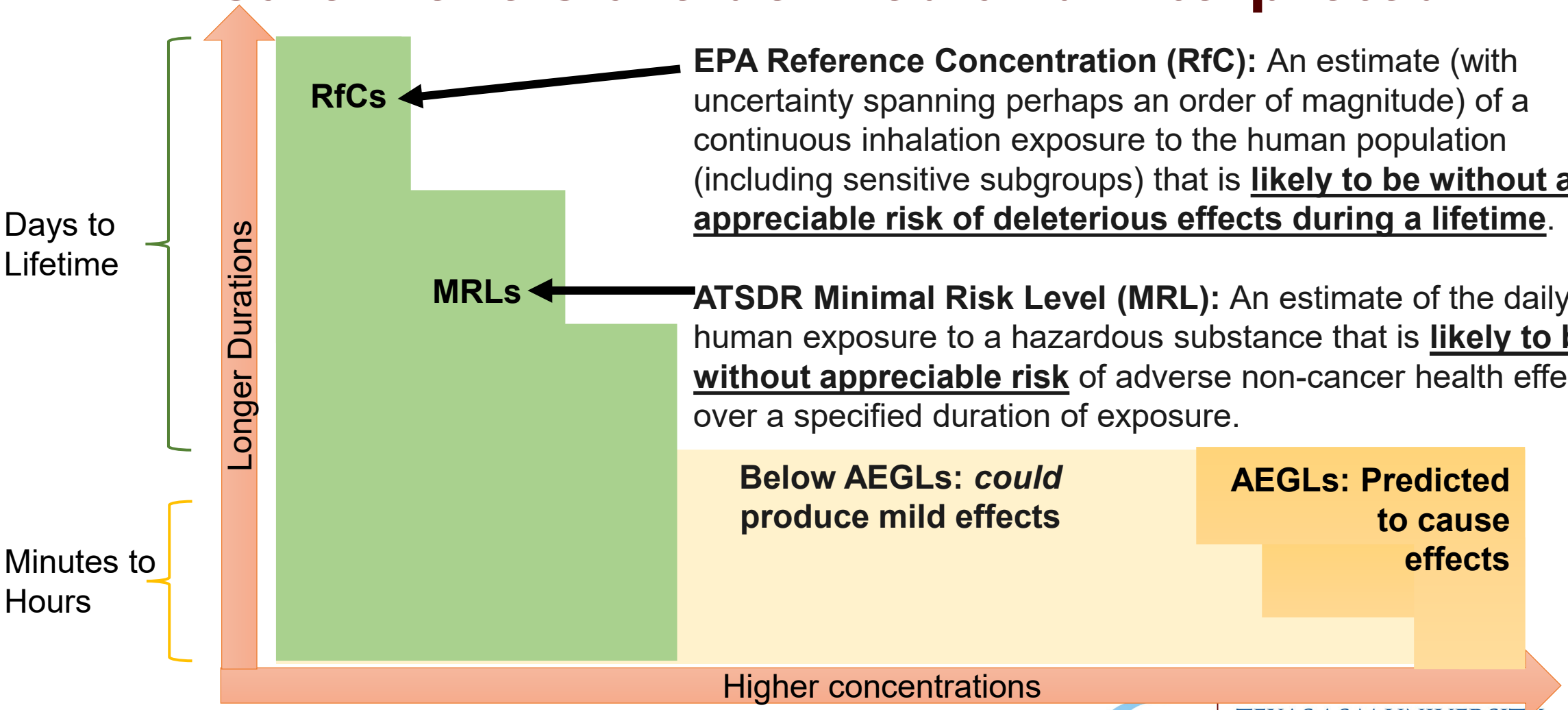
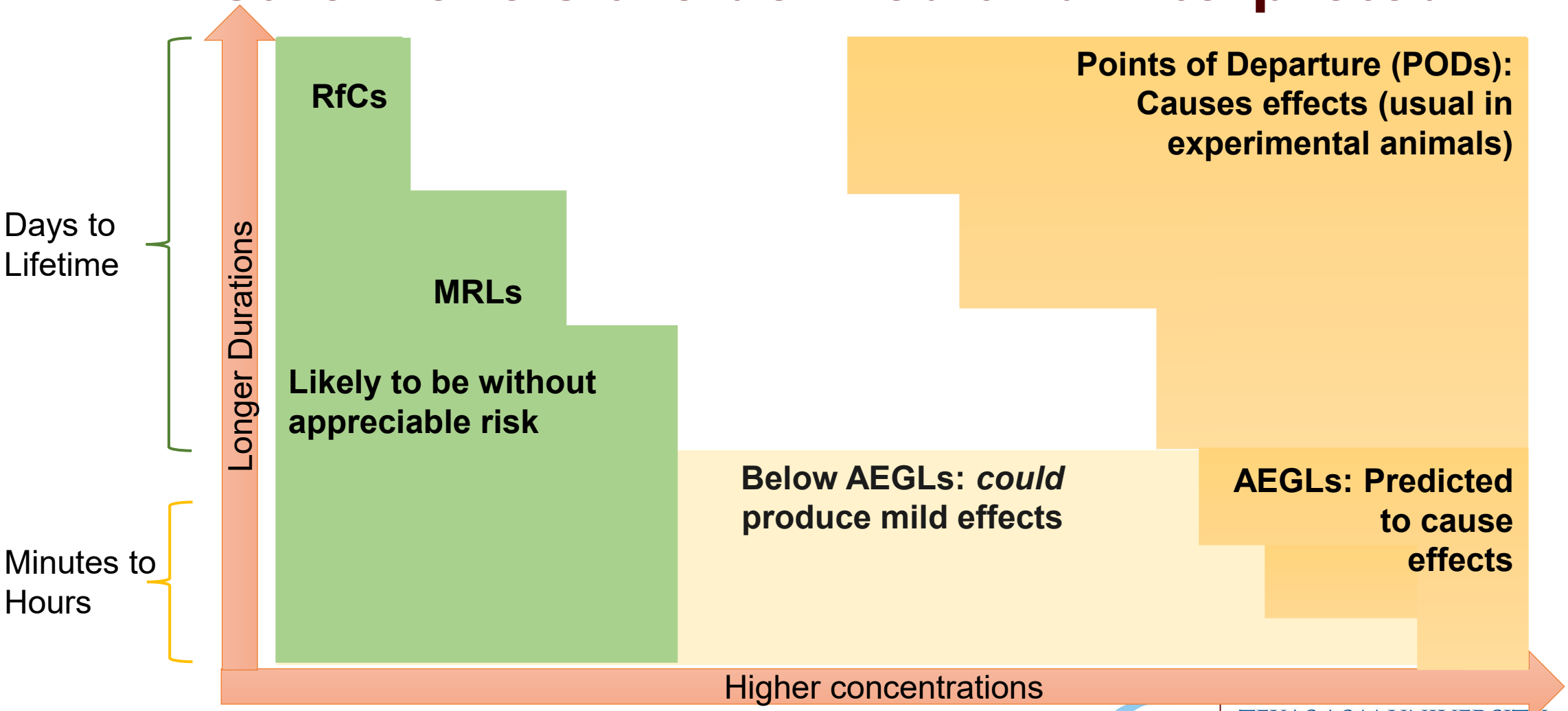


EPA Reference Concentration (RfC): An estimate (with uncertainty spanning perhaps an order of magnitude) of a continuous inhalation exposure to the human population (including sensitive subgroups) that is **likely to be without an appreciable risk of deleterious effects during a lifetime**.

ATSDR Minimal Risk Level (MRL): An estimate of the daily human exposure to a hazardous substance that is **likely to be without appreciable risk** of adverse non-cancer health effects over a specified duration of exposure.

Communication is challenging due to how "safe" levels are derived and interpreted



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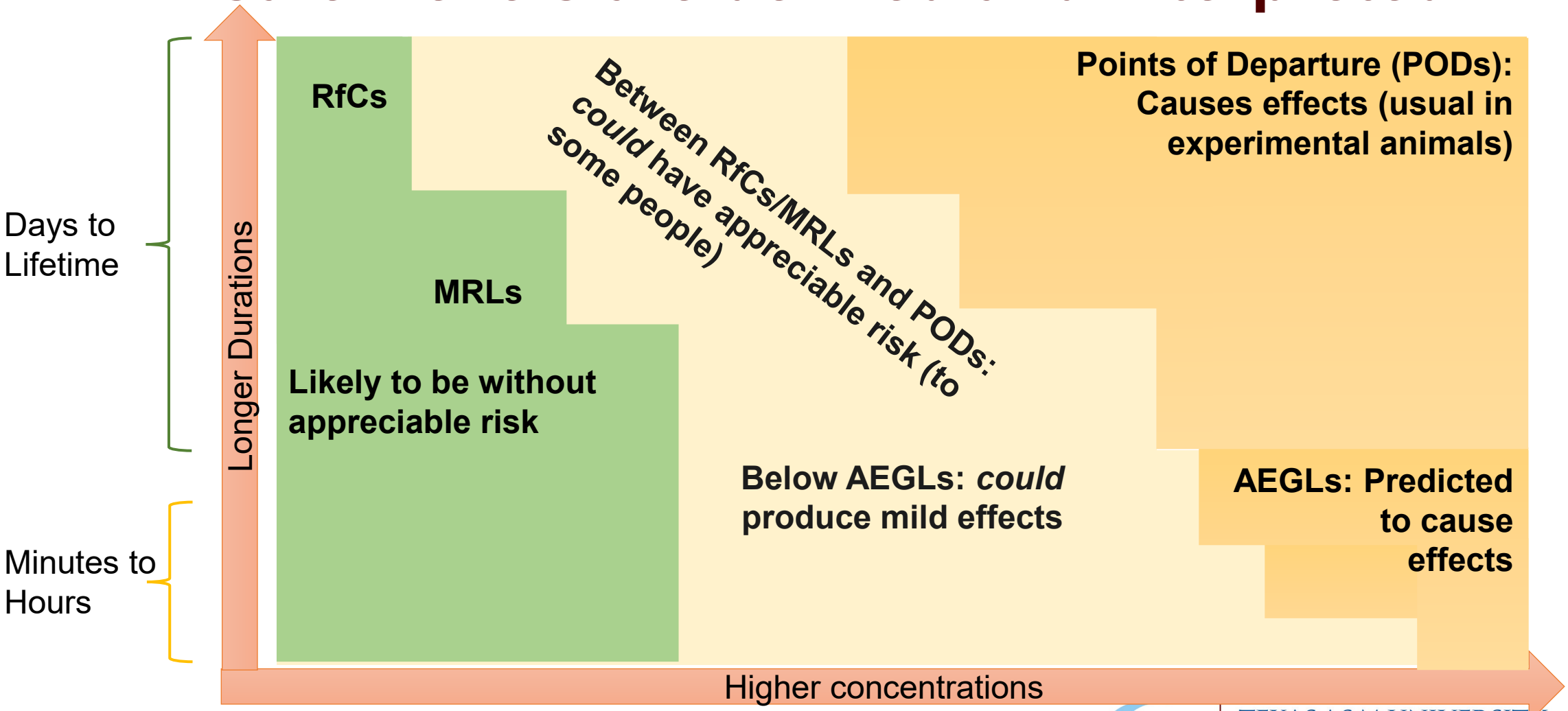

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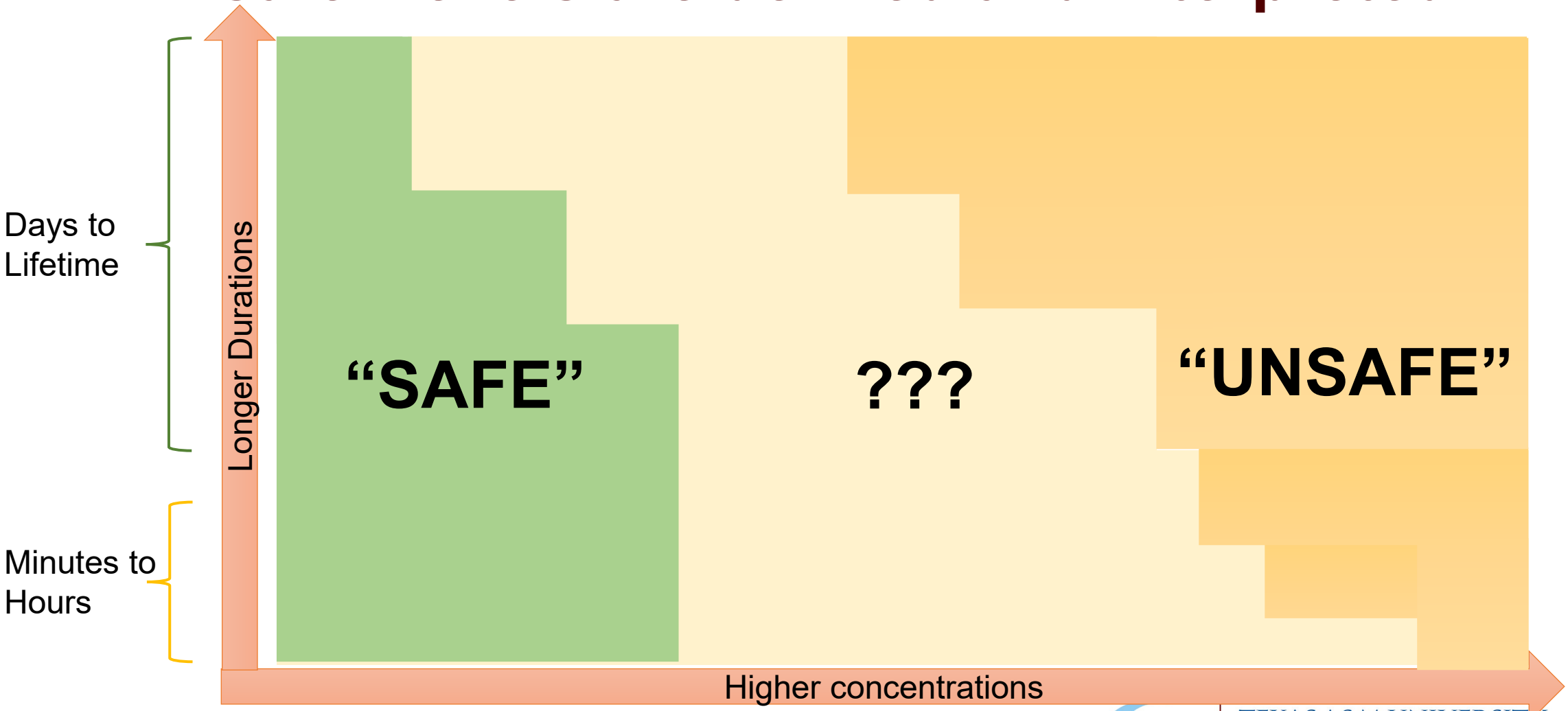

Looking forward to discussing potential solutions to these challenges!

- **Challenge #1:** Communicating risk or safety in the face of “known unknowns” and “unknown unknowns.”
- **Challenge #2:** Appropriate acknowledgement of geographic and temporal variability in exposure concentrations.
- **Challenge #3:** There is no “Bright Light” between “Safe” and “Unsafe” because risk is actually a continuum from smaller to larger likelihood, incidence and severity.
  - **Corollary:** Probabilistic methods exist to quantify risks in the “grey zone” – but communicating a continuum is challenging, especially in a disaster.