JBPHH JP-5 Exposure Assessment and Technical Basis of Hawaii Department of Health TPH Tapwater Action Levels

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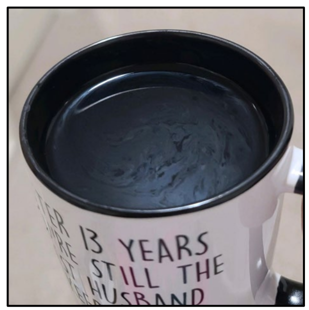
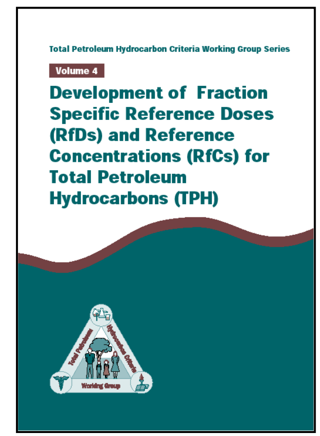
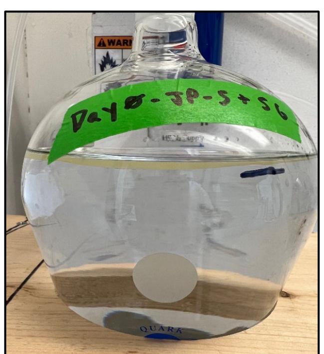
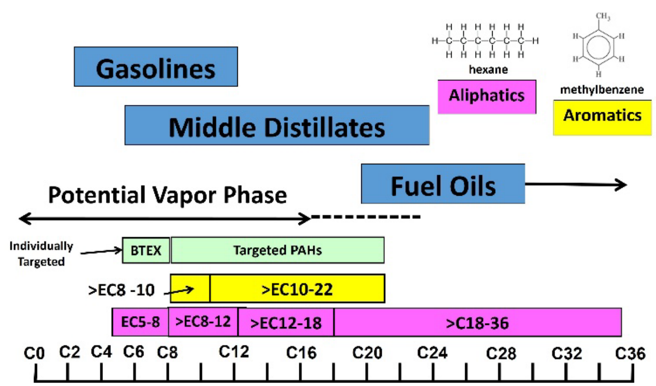
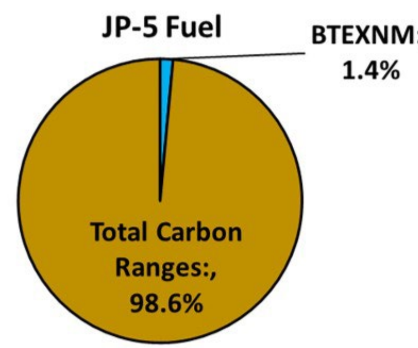
NASEM September 8, 2025











Outline

- **Terminology;**
- **Migration of JP-5 into and through the JBPHH drinking water system;**
- **Categories of tapwater contamination;**
- **Chemistry and toxicity of contaminated tapwater;**
- **Estimates of "Reasonable Maximum Exposure (RME)";**
- **Use of Total Petroleum Hydrocarbons data to assess health risk.**

Terminology

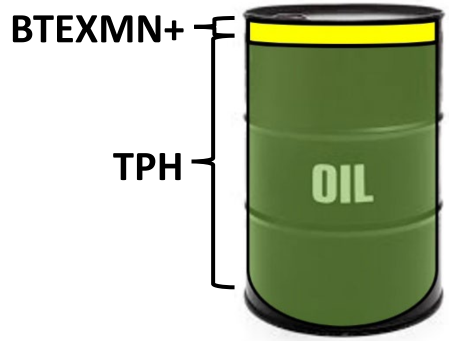
TPH: Total Petroleum Hydrocarbon

- Complex mixture of hundreds of hydrocarbon compounds; and degradation compounds (“metabolites”);
- Comprises the dominant fraction of petroleum fuels;
- Normally drives health and environmental risk over BTEXMN.

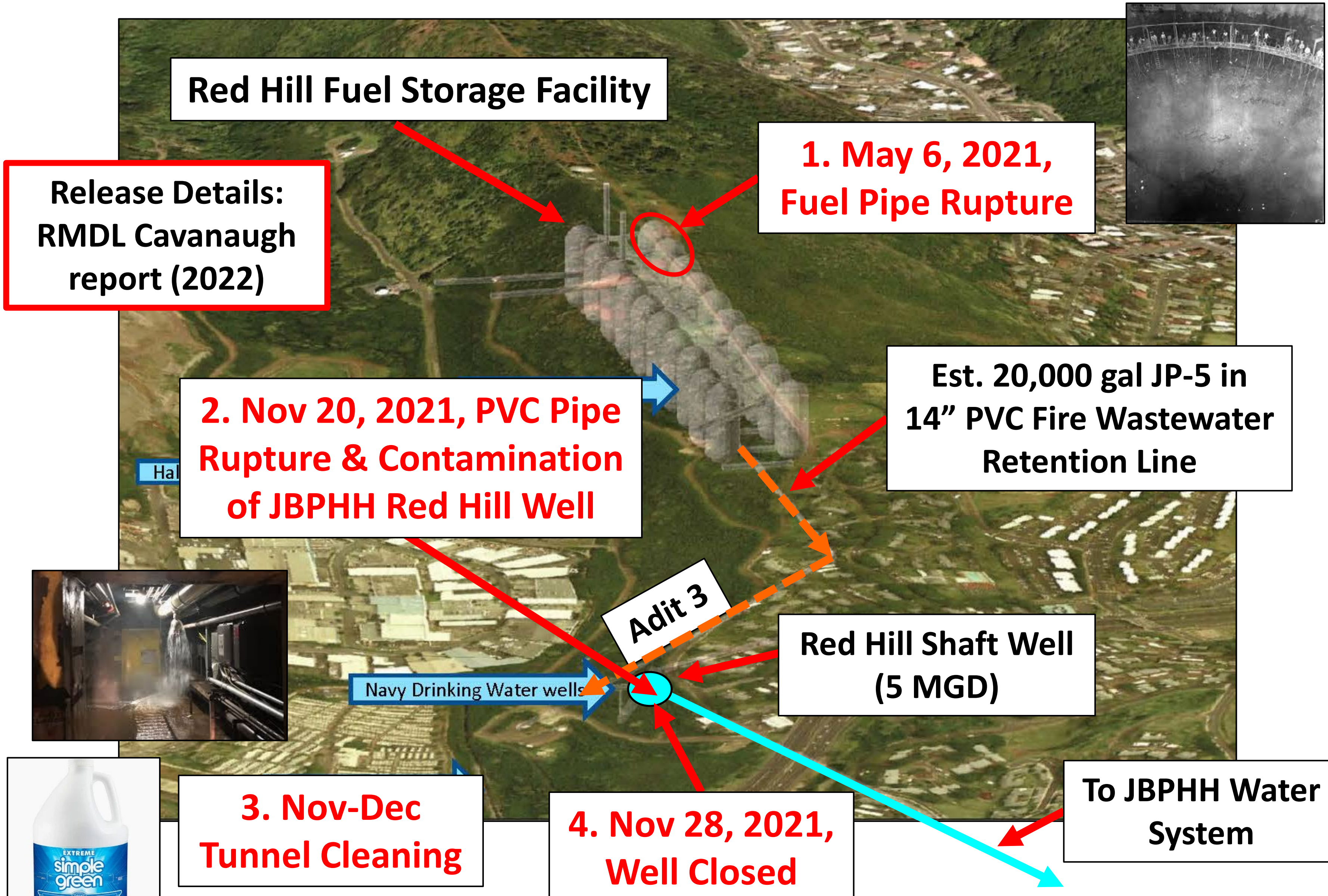
BTEXNM: Benzene, Toluene, Ethylbenzene, Xylenes, Naphthalene, Methylnaphthalenes (individual compounds found in fuels).

FSII: Fuel System Icing Inhibitor (prevents ice from forming in fuel at high altitudes).

DiEGME: Diethylene Glycol Monomethyl Ether (FSII; aka: 2-(2-Methoxyethoxy) ethanol, Methyl Carbitol).



2021 Red Hill Fuel Storage JP-5 Release Timeline



Original graphic from HIDOH presentation on 2014 fuel tank release by Deputy Director Gary Gill.

Red Hill JP-5 Release Exposure Assessment Report

Exposure Assessment

- Where did the fuel go?
- How were residents exposed?
- What were they expose to?
- How long were they exposed?
- Expertise: Risk Assessment
- Lead: Hawaii Dept Health

→

Health Assessment

- How did it affect the residents' health?
- Are the effects transient or long-term?
- Expertise: Toxicology, Epidemiology, etc.
- Lead: US Dept Health (ATSDR+)

References:

USDN, 2022, *Command Investigation into the 6 May 2021 and 20 November 2021 Incidents at Red Hill Bulk Fuel Storage Facility*: United States Department of the Navy, memorandum from Vice Chief of Naval Operations to File, June 13, 2022, Ser N09/22U100552.

HIDOH, 2023, *Exposure Assessment: November 2021 Release of JP-5 Jet Fuel into the Joint Base Pearl Harbor Hickam Drinking Water System*: Hawaii Department of Health, Hazard Evaluation and Emergency Response, June 2023 (File # 2023-054-RB, and updates).

HIDOH, 2024, *Evaluation of Environmental Hazards at Sites with Contaminated Soil and Groundwater* (and updates): Hawai'i Department of Health, Office of Hazard Evaluation and Emergency Response.

HIDOH, 2024, *Comparison of HIDOH Total Petroleum Hydrocarbon (TPH) Action Levels to Data for Water Samples* (June 2024): Hawai'i Department of Health, Office of Hazard Evaluation and Emergency Response.

HDOH Recorded Webinars: https://health.hawaii.gov/heer/guidance/heer-webinars/

Specific Exposure Assessment Questions

1. How did JP-5 jet fuel get into and move through the JBPHH drinking water system?
2. Which specific chemicals were in the tapwater and at what concentrations?
3. How long were residents exposed?
4. How did exposure change over time?
5. Was exposure high enough to affect to my patient’s health?
6. Were they exposed to contaminants in the tapwater prior to the November 20, 2021, release?

Resident Exposure

Nov 25, 2021: JBPHH water system residents notice fuel odor in tapwater (media interview);

Nov 27, 2021: Widespread reports of fuel odors, sheens, foam, high chlorine, etc., in tapwater beginning with residents closest to the Red Hill Facility;

Nov 28, 2021: Red Hill Shaft well shut down;

Nov 29, 2021: HIDOH issues JBPHH drinking water advisory;
Flushing of JBPHH water system initiated;
System impacts initially thought to be isolated and not spreading;

December 2021: Residents in some areas continue using water until at least Dec 10th and become ill.

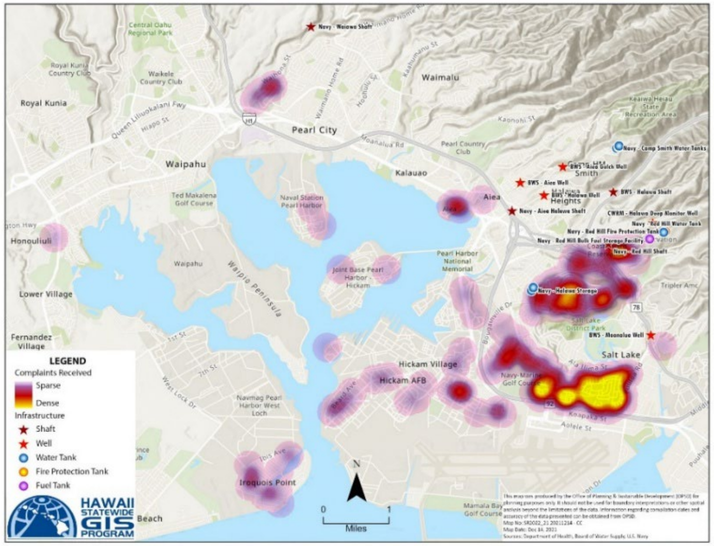
Subsequent Weeks and Months:

- Residents seek medical help;
- ATSDR and other organization initiate assessment of health effects.

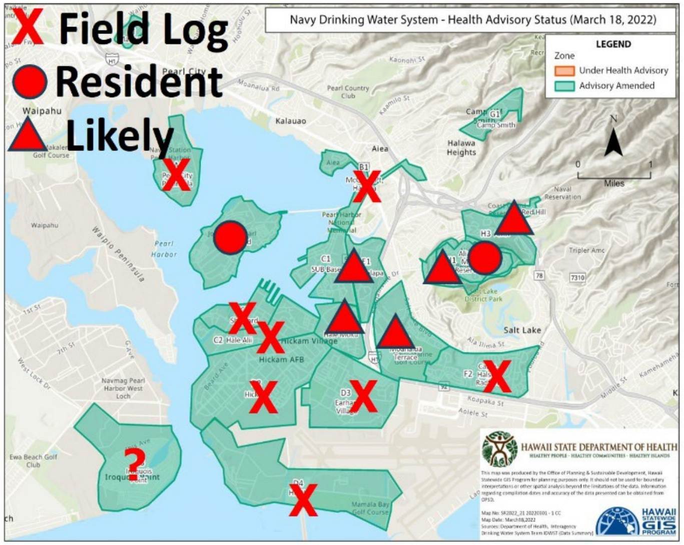
Refer to photos and videos in referenced Hawaii News Now and Vice News reports

Affected Areas and Primary Exposure Period
(related to November 20, 2021, release)

Early Call-In Reports Of Fuel Odors & Sheens (Nov 27 – Early Dec 2021)



Flushing Log Reports, etc. of Fuel Odors +/- Sheens (Nov 2021 to Jan 2022)

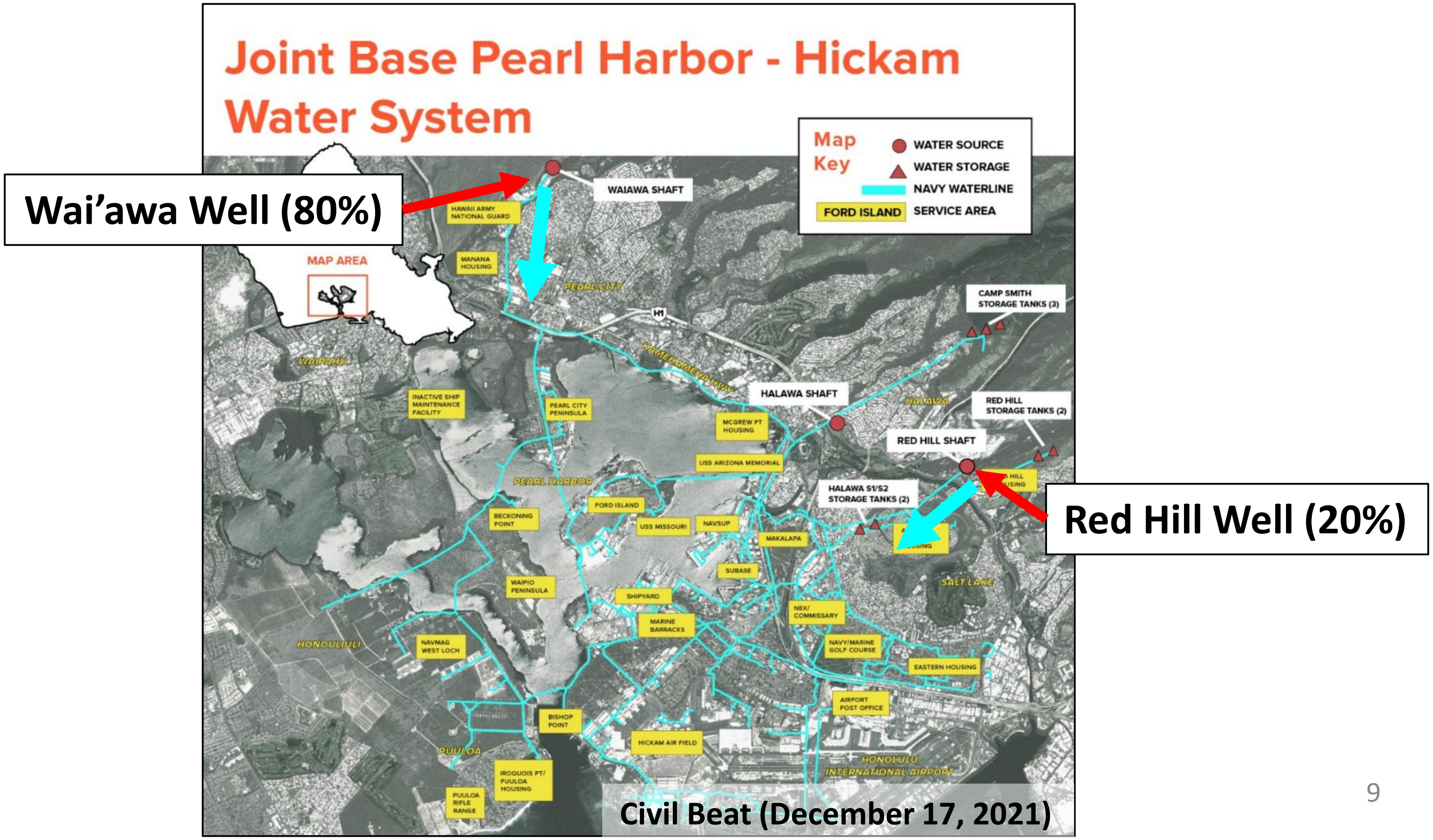


Combined + Other Reports (news, residents, etc.):

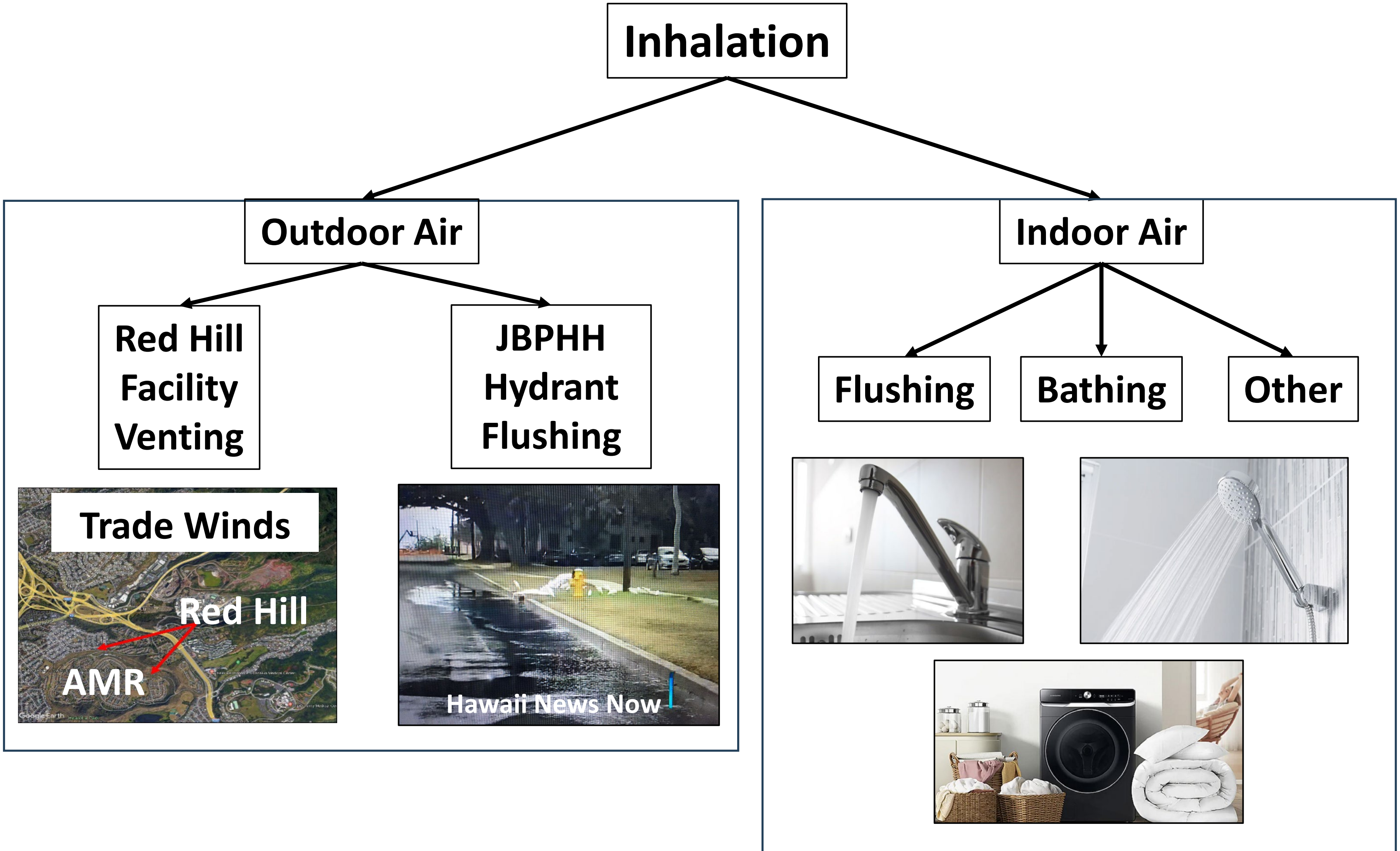
- **Observations of odors, sheens, etc. (resident calls, DoD staff field logs, media, etc.);**
- **Reasonable to assume tapwater had sheens & emulsion in all areas of JBPHH and connected water systems at some point in time.**

Isolated Slugs and Flushing of the Drinking Water System

- Contaminated water likely moving through system as ***isolated slugs***;
- Complicated flushing operations;
- Drinking water system flushed using water from Navy’s Wai’awa well (20 million gallons/day for 100 days);
- Drinking water system declared safe for use in March 2021.



Exposure Pathways: JP-5 Vapors



Exposure Pathways: Contaminated Tapwater

Ingestion

Tapwater

Drinking | **Cooking**

Dermal

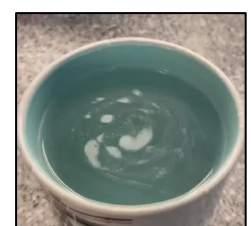
Tapwater

Bathing

Categories Of Tapwater Contamination

1. Dissolved

2. Dissolved + Sheen



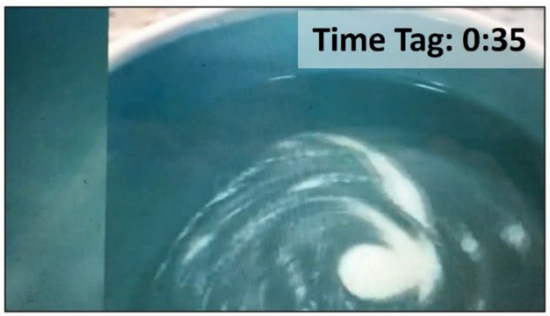
3. Dissolved + Sheen + Emulsion

Documentation of Contaminated Tapwater (media reports)

[1]Petroleum Sheen (aliphatics)

[2]FSII (DiEGME) Emulsion?

[1]Emulsion and/or Surfactant?

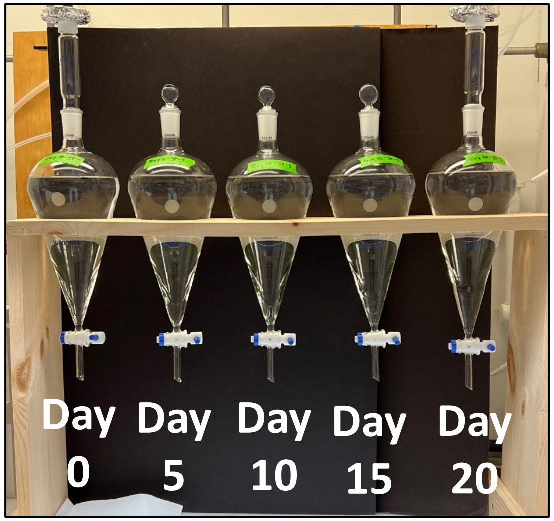


[2]Flammable Water (JP-5 or DiEGME)

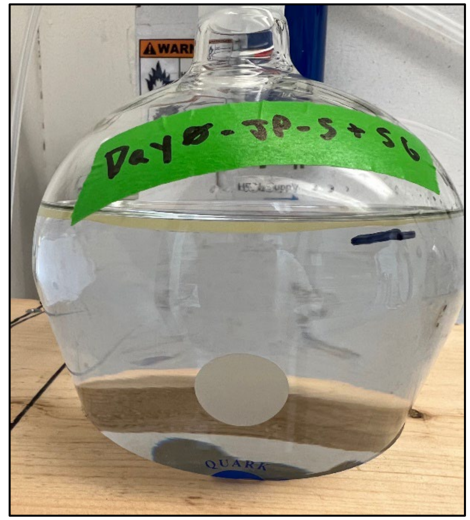
- *Poor field and laboratory documentation* of nature of contamination within drinking water system *during exposure (primarily media reports)*;
- Rapid *Total Organic Carbon* testing of samples used to identify presence of fuel in tapwater but ultimately unreliable (TPH & BTEXMN analysis can take days/weeks);
- Detailed testing for TPH & BTEXMN only carried out *after flushing* to confirm that residual contamination was below risk-based action levels;
- *Available tapwater sample data are not representative* of exposure conditions and observed acute to subchronic health effects.

Laboratory Simulation of Tapwater Contamination
(Newfields & Alpha Laboratory)

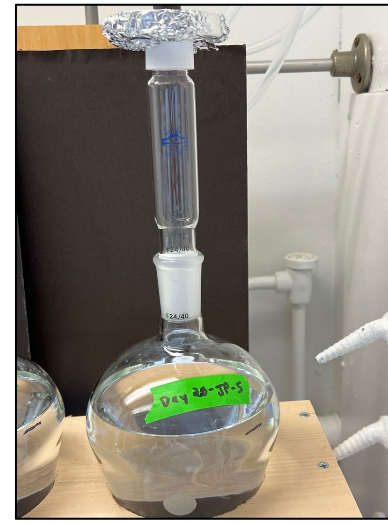
Setup



Fuel on Water



Vapor Sample

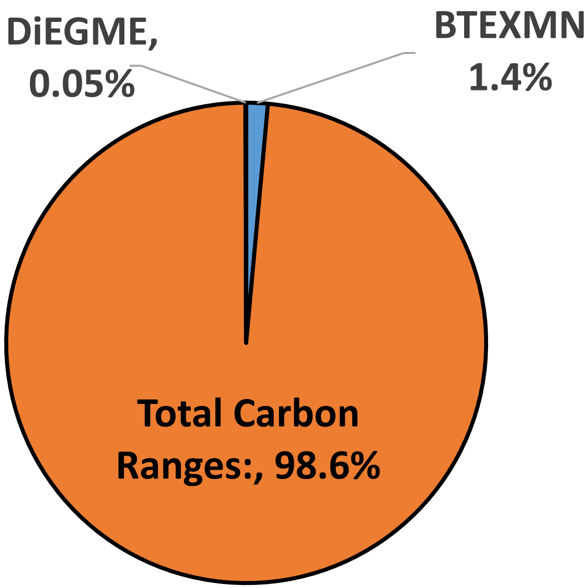


- **Sample of *JP-5 fuel from Red Hill Fuel Storage Facility* provided by Navy;**
- ***Layer of fuel placed on water* and allowed to equilibrate over 20 days;**
- ***Simple Green* solution sprayed onto second set of experiments (no significant effect on dissolution of fuel into water);**
- **Water samples collected on Days 0, 5, 10, 15 and 20;**
- **Tested for TPH aliphatic and aromatic carbon ranges, BTEXMN, DiEGME, 1-butoxy-2-propanol (Simple Green);**
- **Vapor samples also collected.**

Neat Fuel vs Dissolved JP-5 Makeup

Red Hill JP-5 Fuel

Vapors: C8-C18 aliphatics

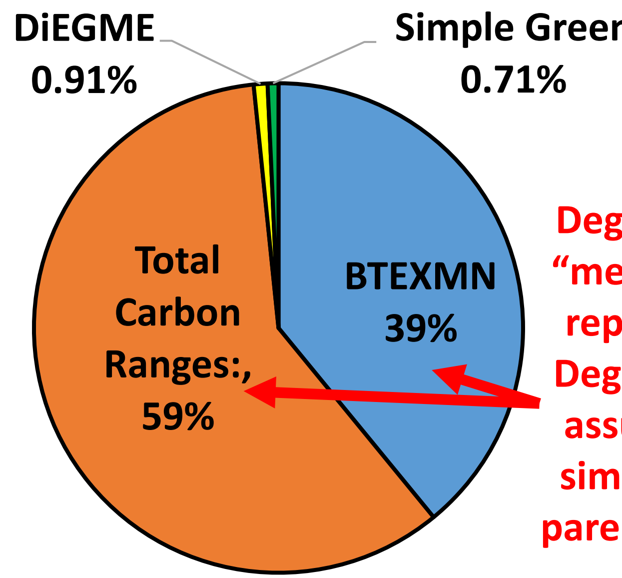


TPH: Mostly >C8-C18 aliphatics with some >C8 aromatics

BTEXMN: Mostly toluene, xylenes, naphthalene, methylnaphthalenes

FSII: DiEGME (measured = 0.05%; fuel specifications up to 0.11%)

Dissolved JP-5 in Water



Degrades to polar "metabolites" and reported as TPH. Degraded mixture assumed to have similar toxicity as parent compounds.

TPH: >C8 aromatics with trace C5-C8 aliphatics

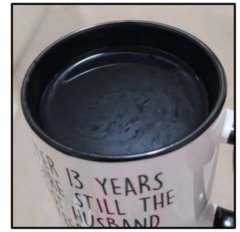
BTEXMN: Mostly toluene, xylenes, naphthalene

DiEGME: Formed emulsion on water despite miscibility

Estimation of “Reasonable Maximum Exposure (RME)”

Categories Of Tapwater Contamination

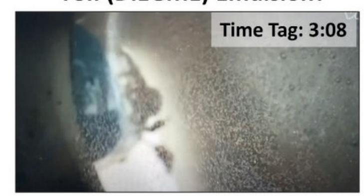
1. Dissolved



2. Dissolved + Sheen

3. Dissolved + Sheen + Emulsion

[2]FSII (DiEGME) Emulsion?



Methods:

1. Based on data from water-fuel study;
2. Assumes up to 150 mg/L TPH concentration of neat JP-5 fuel in tapwater (based on data for Red Hill Shaft soon after well shut down);
3. Assumes 0.01% DiEGME-enriched emulsion in tapwater (observations of tapwater and assumed 40% DiEGME in emulsion (see also *Investigation of “Apple Jelly” Contaminant in Military Jet Fuel*: Defense Energy Support Center, Product Technology and Standardization Division, March 2002).

"Reasonable Maximum Exposure" Concentrations versus Subchronic Tapwater Screening Levels for Rapid Health Effects

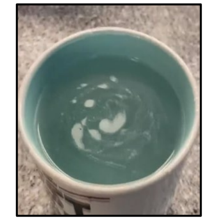
Cont.	[1,2]Tapwater Subchronic Screening Level (µg/L)	Reasonable Maximum Exposure Concentration: 1. Dissolved-Phase Contaminants Only (µg/L)	2. Dissolved Contaminants +JP-5 Sheen (µg/L)	3. Dissolved Contaminants +JP-5 Sheen +FSII Emulsion (µg/L)	[1]Predicted Subchronic Health Risk
B	150	13	16	16	No Risk
T	1,200	154	182	182	No Risk
E	650	81	123	123	No Risk
X	2,500	630	943	943	No Risk
N	36	649	1,083	1,083	High Risk
1-M	530	339	1,155	1,155	No to Low Risk
2-M	30	250	789	789	Mod to High Risk
[3]TPH	350 (270)	5,204	155,204	155,204	High to V. High Risk
DiEG ME	800	50	215	400,000	Low to V. High Risk

1.Potential health effects within days or weeks if exceeded.

2. Acute action levels for potential health effects with seconds to days not available.

3. Risk posed by dissolved-phase TPH driven by >C8 aromatics; risk posed by TPH in sheen driven by >C8-C18 aliphatics, with a less contribution from >C8 aromatics.

[1]Risk Drivers for Contaminated Air & Water

			
Exposure Route	**Dissolved Only**	**Dissolved + Sheen**	**Dissolved + Sheen + Emulsion**
[1]Inhalation	**>C8 Aromatics**	**>C8-18 Aliphatics** **>C8 Aromatics**	**>C8-18 Aliphatics** **>C8 Aromatics**
[2]Ingestion & Dermal  **Chlorine?** **Chlorine Byproducts?**	**>C8 Aromatics** **Naphthalene** **2-Methylnaph.**	**>C8-18 Aliphatics** **>C8 Aromatics** **Naphthalene** **2-Methylnaph.** **1-Methylnaph.**	**>C8-18 Aliphatics** **DiEGME** **>C8 Aromatics** **Naphthalene** **2-Methylnaph.** **1-Methylnaph.**

1. **Outdoor air contaminants similar to vapors from sheen on tapwater.**
2. **Individual aromatics will degrade and be reported with "Mid Range Organics."**

Outline

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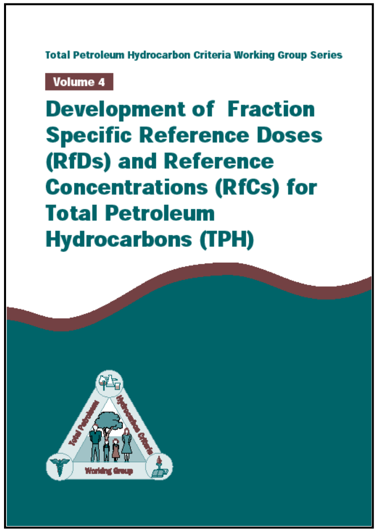
Assessment of Petroleum Exposure Health-Risk



Pre-Mid 1990s:

- Focus on short list of individual chemicals (e.g., BTEX & PAHs) but obvious heavy contamination still present when screening levels met.

Mid 1990s:

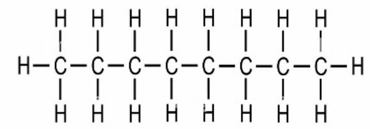
- Total Petroleum Hydrocarbon Criteria Working Group
  - Air Force (lead), Navy, States, industry, consultants;
  - Use of "Carbon Ranges" to assess TPH risk (fuel carbon range makeup, toxicity factors).
- ATSDR (toxicity factors).
- Massachusetts, Washington, Texas (toxicity factors, simplification).

2000-2020s:

- USEPA (toxicity factors);
- California (toxicity factors, metabolite chemistry & toxicity);
- Hawaii (use of "TPH" data; fuel, vapor & metabolite chemistry and toxicity, case studies, forensics);
- ITRC (use of TPH to assess risk, case studies).

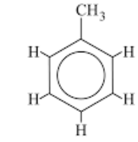
“Carbon Range” Grouping of TPH to Assess Health Risk

(6 groups of chemically similar compounds; toxicity factors assigned to each group)



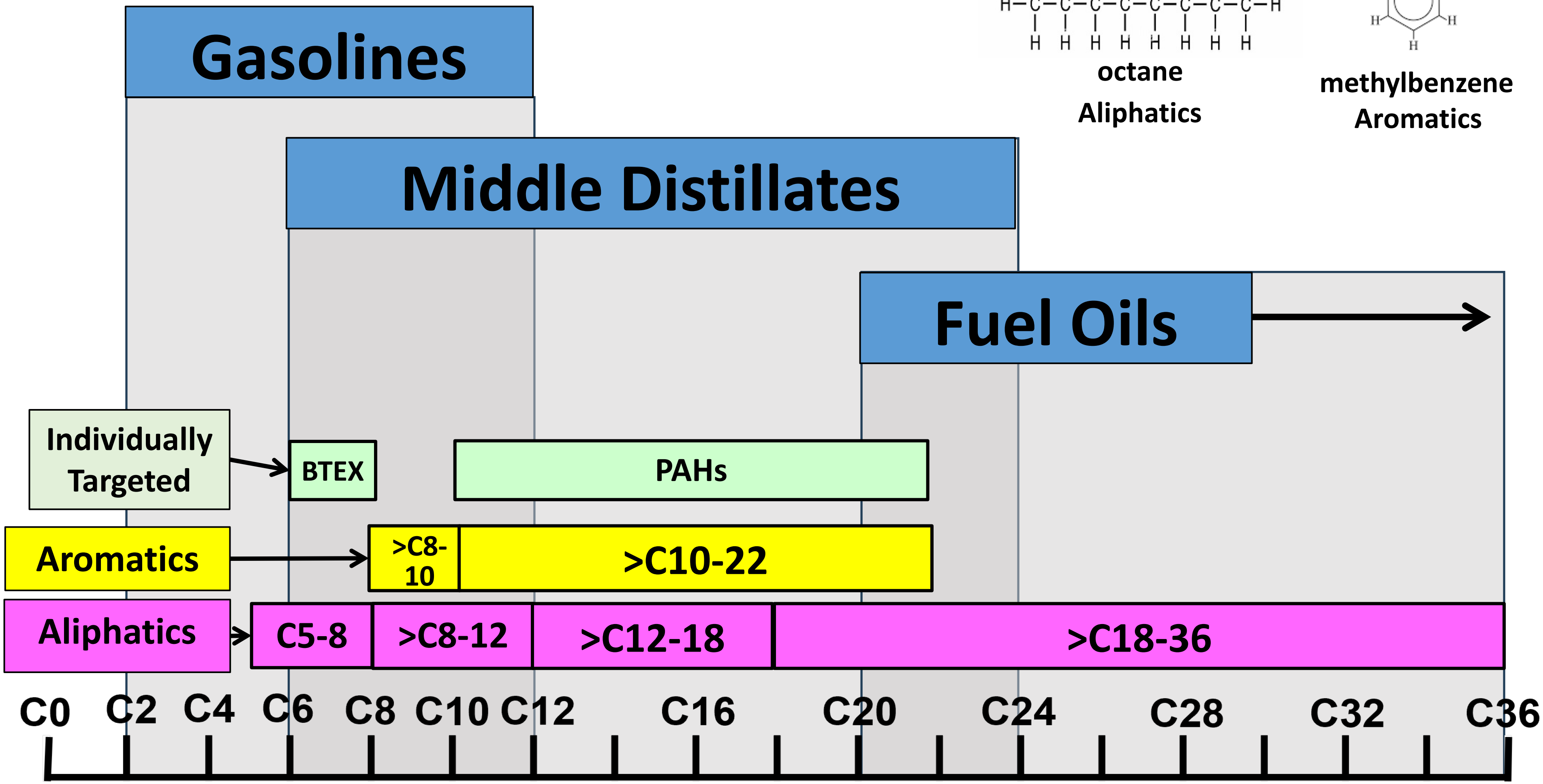
octane

Aliphatics



methylbenzene

Aromatics



TPH = Sum of Aromatics + Aliphatics + Metabolites

(excluding BTEX & PAHs)

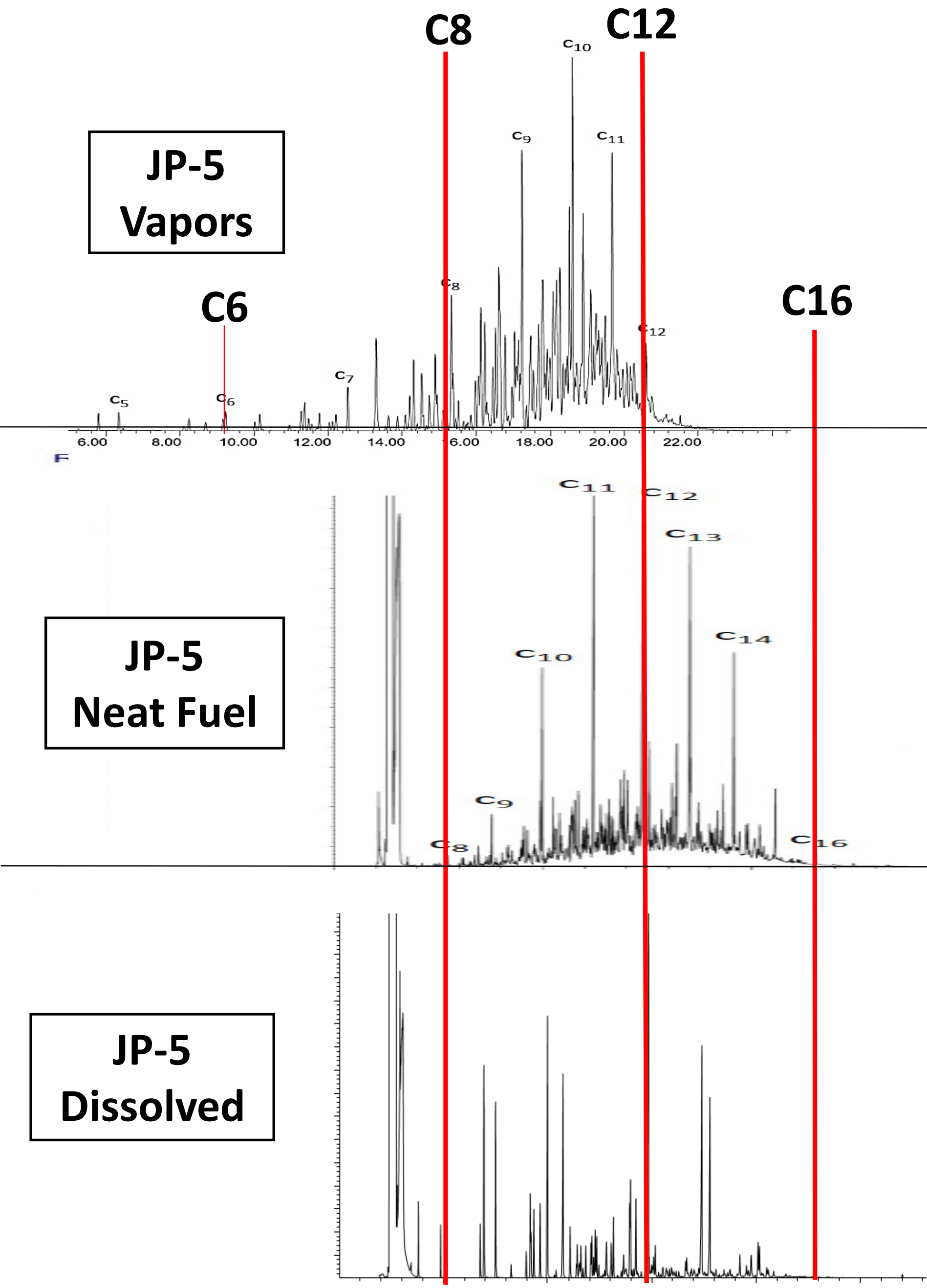
Carbon Range Chronic Toxicity Factors

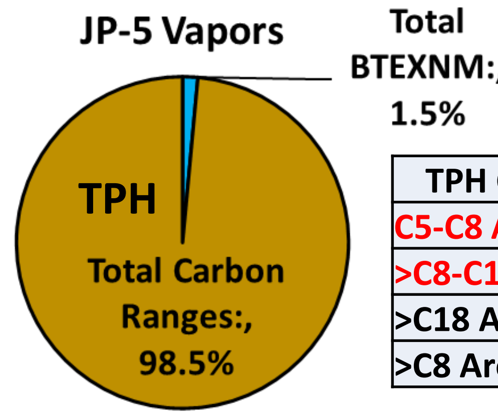
(USEPA 2022; no adverse health effects predicted after years of exposure)

Chemical/ Carbon Range	Oral/Dermal Reference Dose (µg/kg BW per day)	Inhalation Reference Concentration ($\mu g/m^3$)
C8-C8 Aliphatics	5	400
C9-C18 Aliphatics	10	100
C19+ Aliphatics	3,000	(not volatile)
C9+ Aromatics	10	60

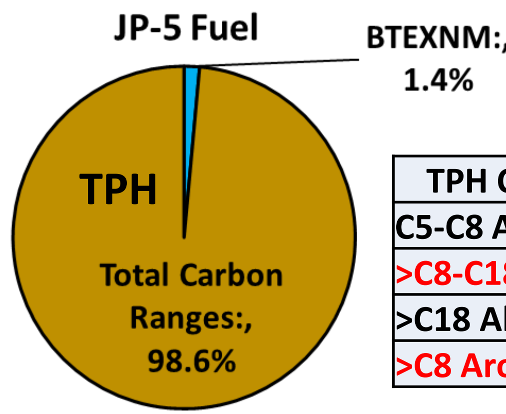
- Default *physiochemical constants* also published (e.g., average volatility and solubility);
- Allows for risk-based action levels to be calculated *in the same manner as done for BTEXMN* (assume exposure of 15 kg child);
- *Subchronic toxicity factors* also provided (potential effects after days to months of exposure)
- Problem: *Limited laboratory capability*, difficult testing procedure;
- Solution: Develop *carbon-range weighted TPH toxicity factors* based on typical carbon range makeup of neat-, dissolved- and vapor-phase fuel.

Carbon Range Makeup of JP-5 Jet Fuel (laboratory study)



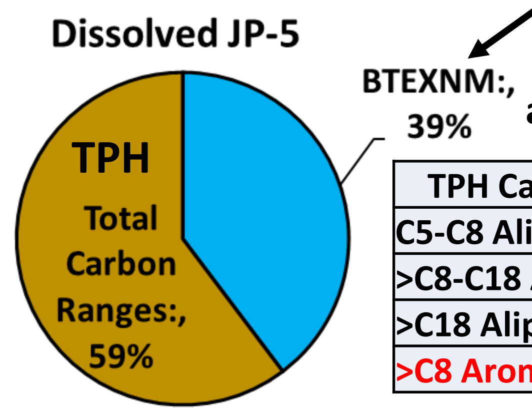


TPH Carbon Range Makeup	
C5-C8 Aliphatics	19%
>C8-C18 Aliphatics	78%
>C18 Aliphatcs	0%
>C8 Aromatics	3.2%



+Additives (e.g., FSII/DiEGME)

TPH Carbon Range Makeup	
C5-C8 Aliphatics	0.16%
>C8-C18 Aliphatics	82%
>C18 Aliphatcs	0.00%
>C8 Aromatics	18%



Partially oxidizes to complex metabolites and reported with TPH

TPH Carbon Range Makeup	
C5-C8 Aliphatics	0.17%
>C8-C18 Aliphatics	0.00%
>C18 Aliphatcs	0.00%
>C8 Aromatics	99.8%

Carbon Range-Weighted TPH Toxicity Factors for JP-5

(acute toxicity factors (effects with seconds to days) not available)

Tapwater Contamination Category	Chronic JP-5 TPH Toxicity Factors (no anticipated adverse health effects after many years of continuous exposure)		
	Oral RfD (µg/kg BW per day)	Dermal RfD (µg/kg BW-day)	Inhalation RfC ($\mu g/m^3$)
Dissolved Only	10	10	60
Dissolved + Sheen	10	10	115

Tapwater Contamination Category	Subchronic JP-5 TPH Toxicity Factors (no anticipated adverse health effects after weeks/months of continuous exposure)		
	Oral RfD (µg/kg BW per day)	Dermal RfD (µg/kg BW-day)	Inhalation RfC ($\mu g/m^3$)
Dissolved Only	40	40	200
Dissolved + Sheen	79	79	126

1 Drop of JP-5

40 mg

- Risk Assessment: Assume average 15 kg child.
- Target Organs And Health Effects: Alimentary Tract, Developmental, Hematologic, Kidney, Nervous System, Respiratory;

USEPA Tapwater Screening Level Equation

(USEPA Default: Daily use of water by average 15 kg child for 6 years)

Ingestion

- ingestion of water

$$SL_{res\text{-}wat\text{-}nc\text{-}ing\text{-}c}\,(\mu g/L) = \frac{THQ \times AT_{res\text{-}c}\left(\frac{365\ days}{year} \times ED_{res\text{-}c}\,(6\ years)\right) \times BW_{res\text{-}c}\,(15\ kg) \times \left(\frac{1000\ \mu g}{mg}\right)}{EF_{res\text{-}c}\left(\frac{350\ days}{year}\right) \times ED_{res\text{-}c}\,(6\ years) \times \frac{1}{RfD_o\left(\frac{mg}{kg\text{-}d}\right)} \times IRW_{res\text{-}c}\left(\frac{0.78\ L}{day}\right)}$$

Dermal Absorption

- dermal

FOR INORGANICS:

$$SL_{res\text{-}wat\text{-}nc\text{-}der\text{-}c}\,(\mu g/L) = \frac{DA_{event}\left(\frac{ug}{cm^2\text{-}\ event}\right) \times \left(\frac{1000\ cm^3}{L}\right)}{K_p\left(\frac{cm}{hour}\right) \times ET_{event\text{-}res\text{-}c}\left(\frac{0.54\ hours}{event}\right)}$$

FOR ORGANICS:

$$\text{IF } ET_{event\text{-}res\text{-}c}\left(\frac{0.54\ hours}{event}\right) \le t^*\ (hours), \text{then } SL_{res\text{-}wat\text{-}nc\text{-}der}\,(\mu g/L) = \frac{DA_{event}\left(\frac{ug}{cm^2\text{-}\ event}\right) \times \left(\frac{1000\ cm^3}{L}\right)}{2 \times FA \times K_p\left(\frac{cm}{hour}\right)\sqrt{\frac{6 \times \tau_{event}\left(\frac{hours}{event}\right) \times ET_{event\text{-}res\text{-}c}\left(\frac{0.54\ hours}{event}\right)}{\pi}}}$$

or,

$$\text{IF } ET_{event\text{-}res\text{-}c}\left(\frac{0.54\ hours}{event}\right) > t^*\ (hours), \text{then } SL_{res\text{-}wat\text{-}nc\text{-}der}\,(\mu g/L) = \frac{DA_{event}\left(\frac{ug}{cm^2\text{-}\ event}\right) \times \left(\frac{1000\ cm^3}{L}\right)}{FA \times K_p\left(\frac{cm}{hour}\right) \times \left[\frac{ET_{event\text{-}res\text{-}c}\left(\frac{0.54\ hours}{event}\right)}{1+B} + 2 \times \tau_{event}\left(\frac{hours}{event}\right) \times \left(\frac{1+3B+3B^2}{(1+B)^2}\right)\right]}$$

where:

$$DA_{event}\left(\frac{ug}{cm^2\text{-}\ event}\right) = \frac{THQ \times AT_{res\text{-}c}\left(\frac{365\ days}{year} \times ED_{res\text{-}c}\,(6\ years)\right) \times \left(\frac{1000\ \mu g}{mg}\right) \times BW_{res\text{-}c}\,(15\ kg)}{\left(\frac{1}{RfD_o\left(\frac{mg}{kg\text{-}day}\right) \times GIABS}\right) \times EV_{res\text{-}c}\left(\frac{1\ events}{day}\right) \times ED_{res\text{-}c}\,(6\ years) \times EF_{res\text{-}c}\left(\frac{350\ days}{year}\right) \times SA_{res\text{-}c}\left(6365\ cm^2\right)}$$

Inhalation

- inhalation of volatiles

$$SL_{res\text{-}wat\text{-}nc\text{-}inh\text{-}c}\,(\mu g/L) = \frac{THQ \times AT_{res\text{-}c}\left(\frac{365\ days}{year} \times ED_{res\text{-}c}\,(6\ years)\right) \times \left(\frac{1000\ \mu g}{mg}\right)}{EF_{res\text{-}c}\left(\frac{350\ days}{year}\right) \times ED_{res\text{-}c}\,(6\ years) \times ET_{res\text{-}c}\left(\frac{24\ hours}{day}\right) \times \left(\frac{1\ day}{24\ hours}\right) \times \frac{1}{RfC\left(mg/m^3\right)} \times K\left(\frac{0.5\ L}{m^3}\right)}$$

- Total

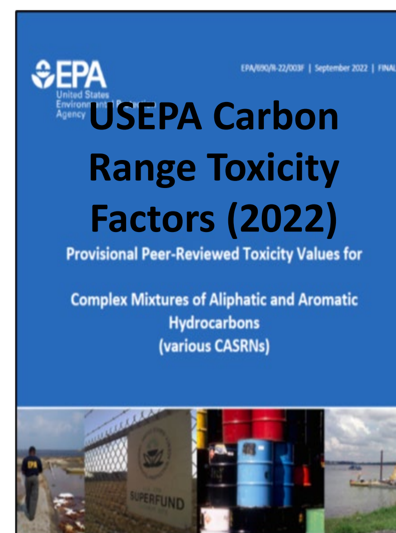
$$SL_{res\text{-}wat\text{-}nc\text{-}tot\text{-}c}\,(\mu g/L) = \frac{1}{\frac{1}{SL_{res\text{-}wat\text{-}nc\text{-}ing\text{-}c}} + \frac{1}{SL_{res\text{-}wat\text{-}nc\text{-}der\text{-}c}} + \frac{1}{SL_{res\text{-}wat\text{-}nc\text{-}inh\text{-}c}}}$$

HIDOH TPH Drinking Water Action Levels for Middle Distillate Fuels (including JP-5)

(concentration at which no adverse *chronic health effects* expected)

Year	Toxicity	Taste & Odor	Final TPH Action Level	Basis
[1]2005	400 µg/L	100 µg/L	100 µg/L	Taste & Odors
[2]2017	400 µg/L	500 µg/L	400 µg/L	Toxicity
[3]2021/2022 (Red Hill)	266 µg/L	500 µg/L	266 µg/L	Toxicity
[4]2024	91 µg/L	500 µg/L	91 µg/L	Toxicity

1. Early toxicity-based TPH action level a*ssumed degraded, non-volatile petroleum* (inhalation of vapors not considered).
2. TPH *Taste & Odor threshold* updated in 2017.
3. Toxicity-based action level for JP-5 in JBPHH drinking water system adjusted to *reflect volatility and inhalation exposure pathway*.
4. Toxicity-based action level revised to reflect updated USEPA carbon range toxicity factors.
5. Subchronic Action Levels: Dissolved (340 µg/L), Sheen (270 µg/L).

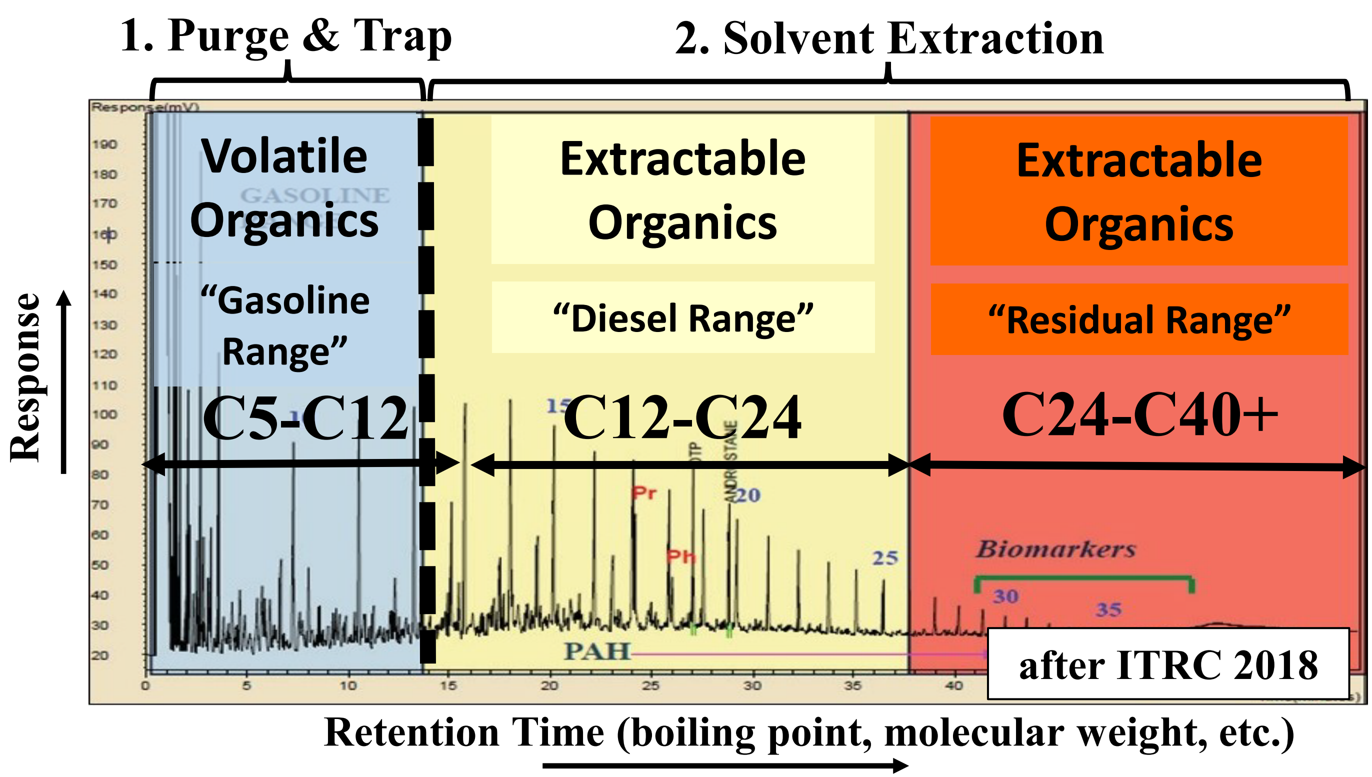


Laboratory Measurement of TPH in Water Samples

- *Two different tests* necessary to quantify the concentration of TPH in a sample:
    1. Purge and Trap: Volatile Organics;
    2. Solvent Extraction: Semi-Volatile and Nonvolatile Organics;
- Compare measured TPH to the TPH action level *specific to the fuel type best matching the chromatogram* (Gasolines, Middle Distillates, Residual Fuels);
- *Individually targeted compounds* subtracted and assessed separately;
- Misreported as separate "TPHg", "TPHd" and "TPHo" in Red Hill groundwater reports.

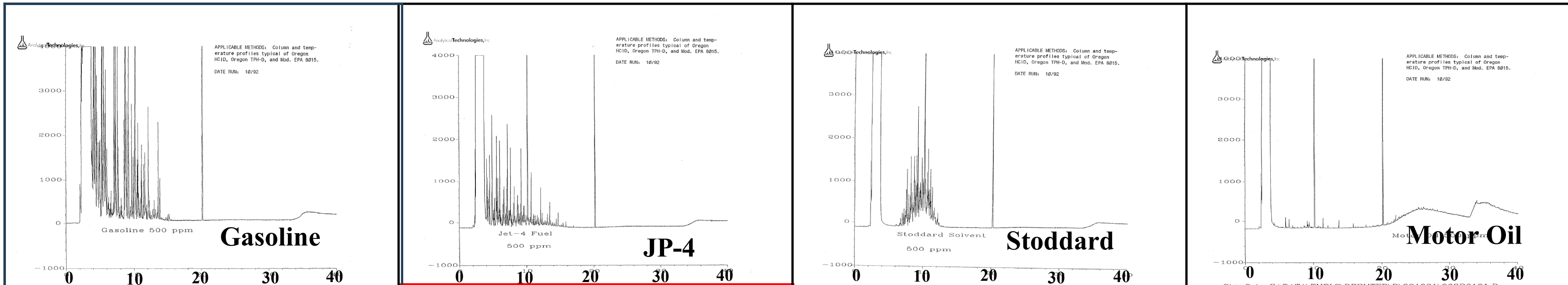
TPH = (Volatile Organics + Extractable Organics) - BTEXMN

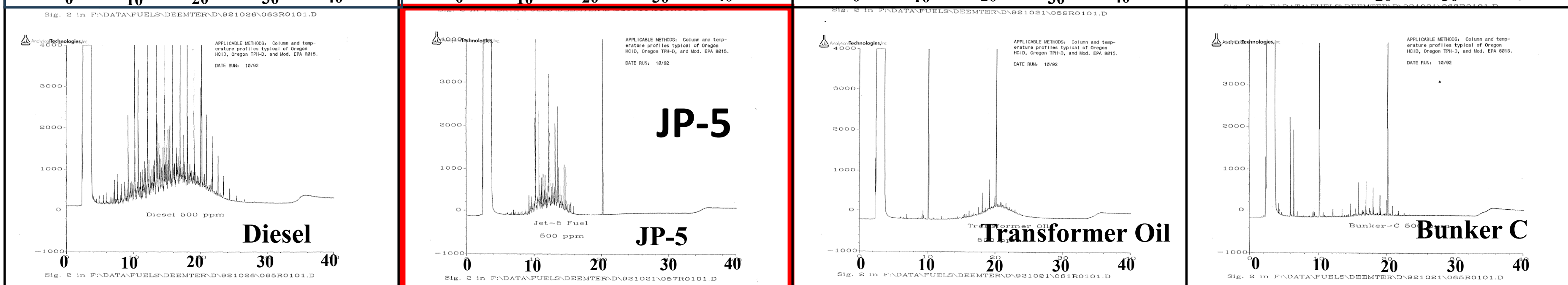
OR TPH = ("GRO" + "DRO" + "RRO") - BTEXMN

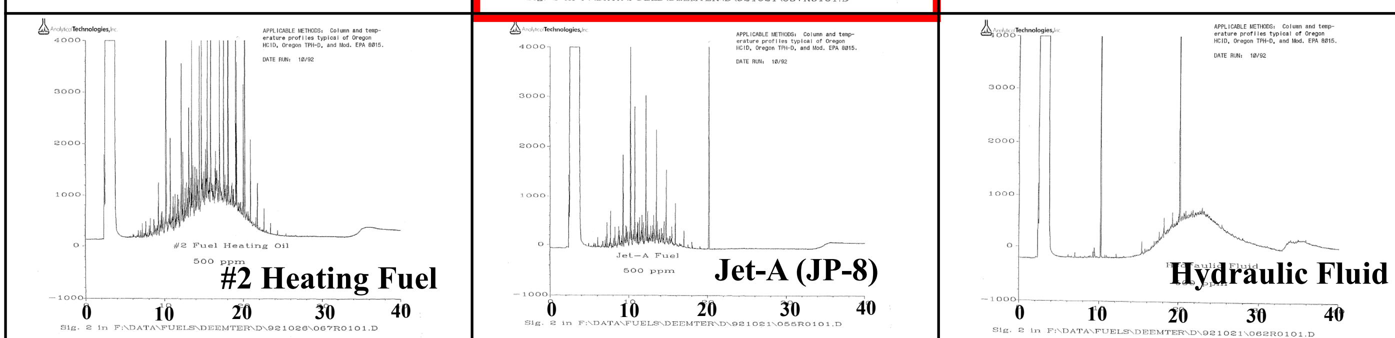


*Fuel Fingerprint Chromatograms

(used to identify fuel released and appropriate TPH Action Level for sample data)







- AVGAS is used to power piston engines; jet fuel is used to power jet engines;
- JP-4 is a mixture of gasoline and kerosene;
- JP-5 is similar to kerosene-based fuels, but with a higher flash point;
- JP-8 is a kerosene-based jet fuel (Europe);
- Jet A is similar to JP 8 but does not require corrosion or icing inhibitors.

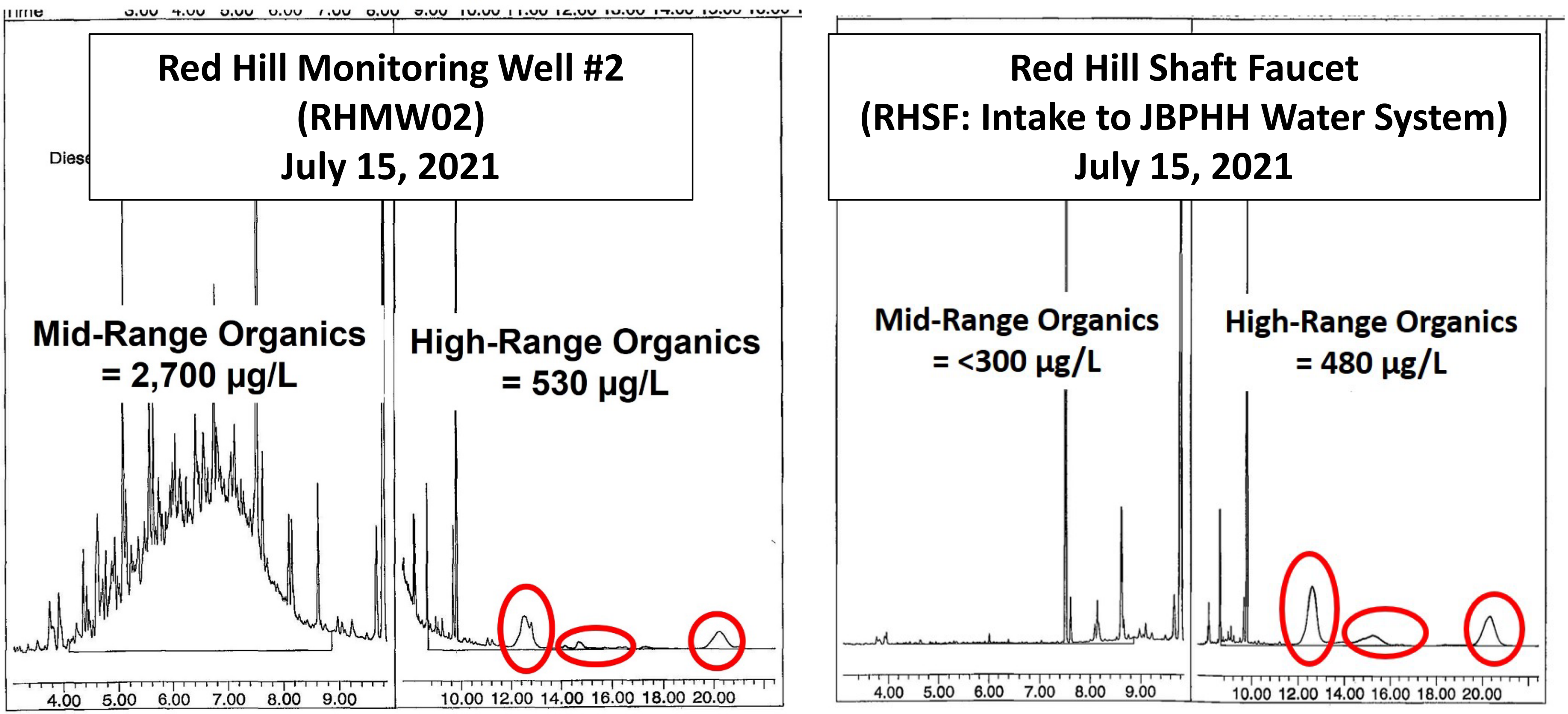
Analytical Technologies Fuels Reference Library

- *Chromatograms inadequate to identify fuel vs naturally occurring organic matter at concentrations <200 µg/L;
- More detailed forensics testing and review of sample required (HIDOH 2024).

Exposure Assessment Questions

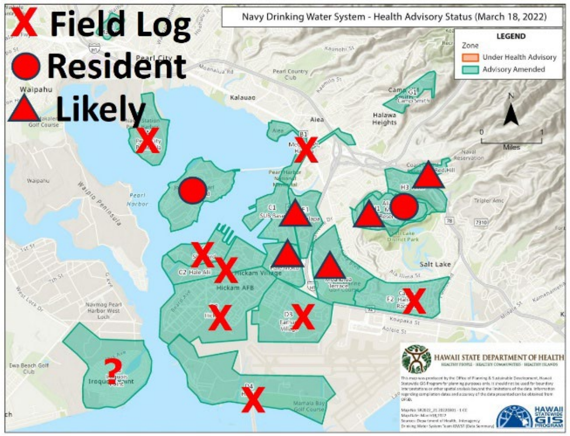
1. **How did JP-5 jet fuel get into the JBPHH drinking water system?**
2. **What was my patient exposed to and for how long?**
3. **Which specific chemicals were in the tapwater and at what concentrations?**
4. **How did exposure change over time?**
5. **Was it high enough to pose a risk to my patient's health?**
6. **Were they exposed to contaminants in the tapwater prior to the November 20, 2021, release?**

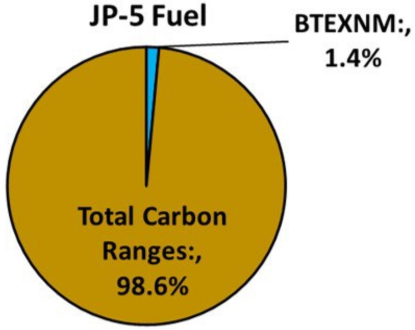
Example: "High Retention Time" (Boiling Point) Compounds in Chromatograms of Samples of Red Hill Groundwater and Water System Intake July through November 2021



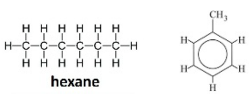
- *High Boiling Point compounds* reported as "TPH Oil" in Navy reports;
- Samples *not tested to identify specific compounds presents*;
- *Potential Sources*: Degraded Fuel (chemists: "Probably not"), Surfactants, Artifact of Laboratory Sample Processing, Algae, Something Else?

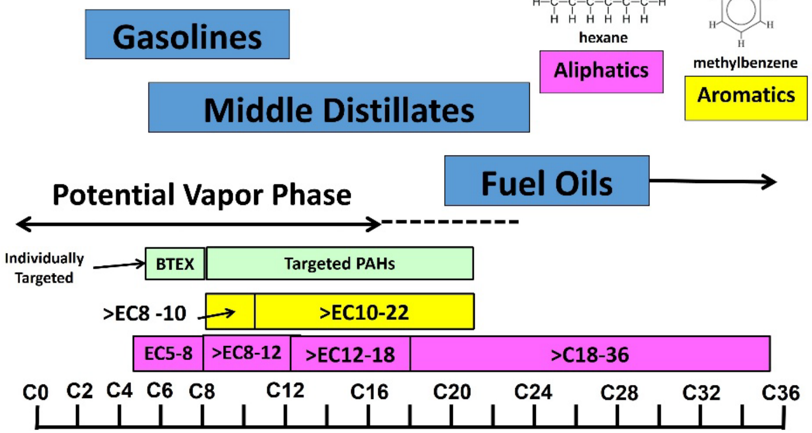
Questions? Ideas?

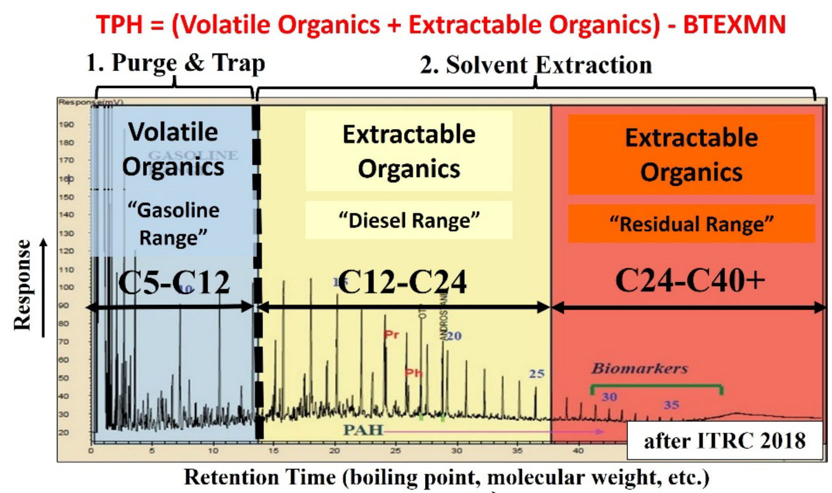




Exposure Route	 Dissolved Only	 Dissolved + Sheen	 Dissolved + Sheen + Emulsion
[1]Inhalation	>C8 Aromatics	>C8-18 Aliphatics >C8 Aromatics	>C8-18 Aliphatics >C8 Aromatics
[2]Ingestion & Dermal  ?	>C8 Aromatics Naphthalene 2-Methylnaph.	>C8-18 Aliphatics >C8 Aromatics Naphthalene 2-Methylnaph. 1-Methylnaph.	>C8-18 Aliphatics DiEGME >C8 Aromatics Naphthalene 2-Methylnaph. 1-Methylnaph.







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Additional Slides

Summary

- **Health effects associated with the November 20, 2021, release of JP-5 into the JBPHH drinking water system occurred within a matter of minutes to a few weeks following exposure (*acute to subchronic toxicity*);**
- ***Most areas* of JBPHH were affected;**
- **Exposure occurred via *inhalation of JP-5 vapors* in outdoor and indoor air and *drinking, cooking and bathing* with contaminated tapwater;**
- **The type and magnitude of water contamination *varied spatially and over time*;**
- **A *range of concentrations* of specific chemicals associated with exposure and health effects can be reasonably predicted (RMEs);**
- **The assessment supports *elevated health risk* associated with inhalation of aromatic and especially aliphatic compounds and ingestion and dermal exposure to aliphatics, aromatics and in some cases DiEGME in tapwater;**
- ***2022 USEPA updates to TPH carbon range toxicity factors* applicability to JP-5 support acute to subchronic health effects for RME exposure;**
- **An *undetermined contaminant* was present in groundwater drawn into the JBPHH drinking water system from Red Hill during at least July 2021 to November 2021.**

Method 8105 Gas Chromatography (GC) vs Gas Chromatograph + Mass Spectrometry (MS)

Review of GC chromatogram patterns sufficient to determine if detected organic compounds are associated with petroleum at concentrations ≥200 µg/L.

GC/MS required at concentrations <200 µg/L to determine if detected organic compounds are associated with petroleum.