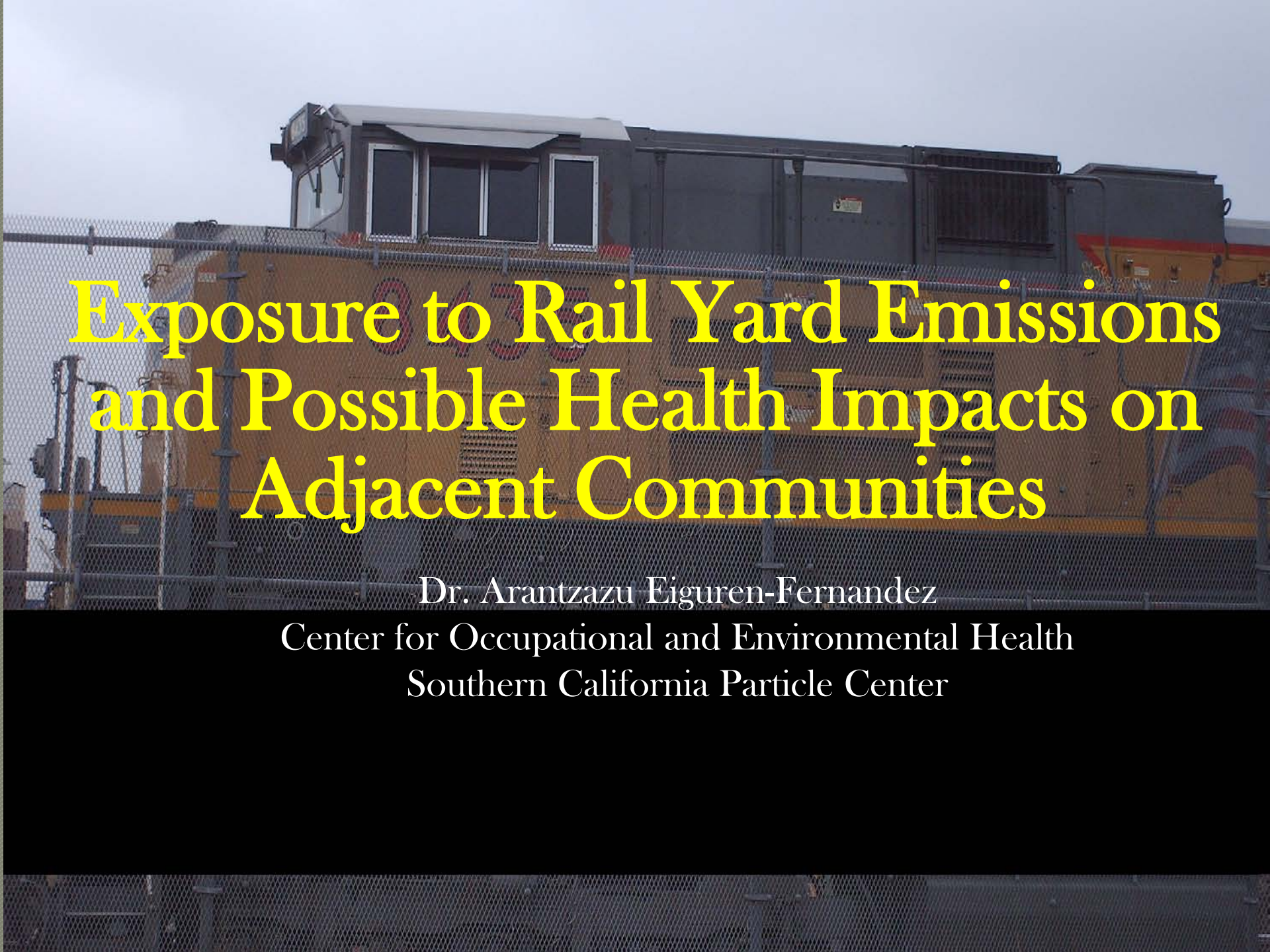

Exposure to Rail Yard Emissions and Possible Health Impacts on Adjacent Communities

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Why this study?

The “Smokestacks on Rails” report (2006) conducted by the Environmental Defense Fund, estimated that locomotive emissions would be responsible for more than 3,000 premature deaths, more than 4,000 non-fatal heart attacks, more than 60,000 cases of acute bronchitis and exacerbated asthma in children nationwide.

California Air Resources Board (CARB) conducted in 2005 a Health Risk Assessments on 18 rail facilities in California

The study sought to identify cancer risks and non-cancer risks for residents living in proximity to these facilities

Results focused on calculating the cancer risk associated with diesel emissions from yard activities based in a 70-year exposure duration

The study did not evaluate the risk of non-carcinogenic diseases due to uncertainties and difficulties in identifying the different factors involved in these diseases

Among the 18 facilities, 4 yards were found to be the highest polluting facilities:

1. BNSF Railway in San Bernardino, with a point of maximum impact (PMI) of 3,300 chances in a million

2. BNSF Hobart Yard in Commerce, with a PMI of 3,000 chances in a million

3. Union Pacific in Commerce with a PMI of 650 chances in a million

4. Union Pacific Intermodal Container Transfer Facility in West Long Beach/Carson, with a PMI of 1,200 chances in a million

General practice allows for 25 in 1 million cancer risk as "acceptable"!!!!!!

EPA passed in 2008 a rule that mandates: cleaner fuel starting in 2012 and cleaner-burning engines starting 2015

Emissions (g/gal)

Large Line-hauler	PM10	PM2.5	HC	NOx	CO	VOC
Uncontrolled	6.66	6.46	9.98	270	26.6	10.5
Tier 0 (<2001)	6.66	6.46	9.98	178	26.6	10.5
Tier 1 (2002-2005)	6.66	6.46	9.78	139	26.6	10.3
Tier 2 (>2005)	3.74	3.63	5.41	103	26.6	5.69
Tier 2 + 3	1.66	1.61	2.70	103	26.6	2.85
Tier 4 (>2015)	0.31	0.30	0.83	20.8	26.6	0.88

Switching	PM10	PM2.5	HC	NOx	CO	VOC
Uncontrolled	6.69	6.49	15.4	264	27.8	16.2
Tier 0	6.69	6.49	15.4	192	27.8	16.2
Tier 1	6.54	6.34	15.4	150	27.8	16.2
Tier 2	2.89	2.80	7.75	111	27.8	8.16
Tier 3	1.22	1.18	3.95	68.4	27.8	4.16
Tier 4	0.23	0.22	1.22	15.2	27.8	1.28

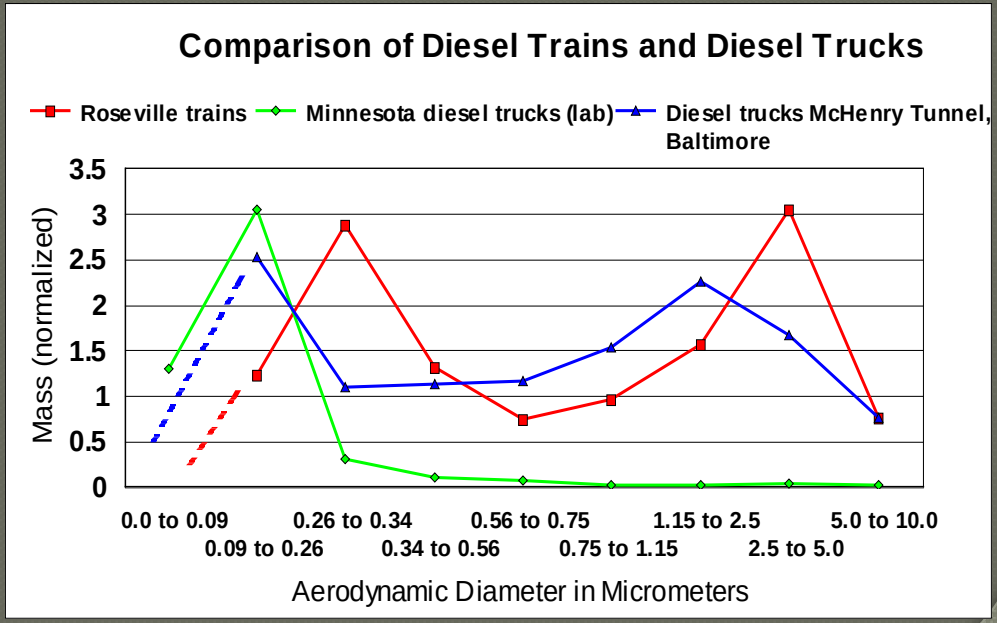
EPA420-F-09-025

The highest locomotive emissions occurred during switching activities and idling periods

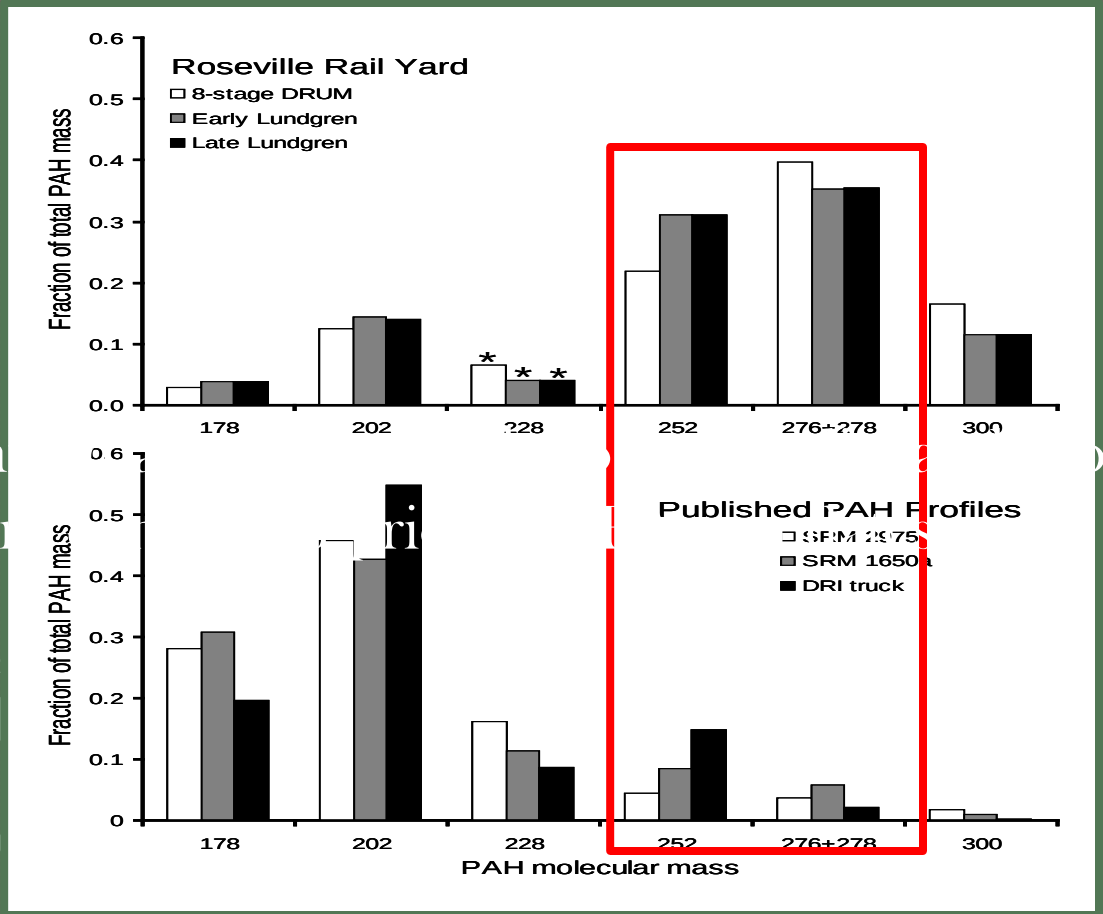
The activities / sources and emissions in the rail yards are diverse

Diesel exhaust emitted by activities conducted at the Roseville railyards differ from truck diesel engines (Cahill et al., HETF, 2007)

a) Peaks for mass and sulfur are about 3 times higher, but similar to size distributions of idling diesel engines



b) Locomotive emissions are 5.5 times richer in the most carcinogenic PAHs (>252)



Limited in … ost of the studies we…

In general … d do not include ot…

Need to b… gical properties of emissions from the newer engines and other activities

OBJECTIVES

1. Determine community exposure to emissions from rail yard activities: characterization of chemical and toxicological properties and associated adverse outcomes

2. Engage community members in the research

3. Present results on community forums and prepare reports for organizing groups explaining the possible adverse health effects

Rail Yard emission sources

Communities neighboring rail yards get constant and large doses of diesel emissions due to the diverse activities occurring in the yard

Locomotives Lifts Cranes Trucks

Comparison of Diesel PM Emissions from several railyards (tons per year)

Railyard	Locomotive	Cargo Handling Equipment	On-road Trucks	Others	Total
BNSF Commerce Eastern	0.6	0.4	1.1	1.0	3.1
BNSF Sheila	2.2	N/A	N/A	0.4	2.7
UP Mira Loma	4.4	N/A	0.2	0.2	4.9
UP Stockton	6.5	N/A	0.2	0.2	6.9

ARB report, HRA for UP Railroad Commerce, 2007

In general, locomotives are the major contributors to DEP

Locomotive Engines

Locomotives are designed to operate at relatively low speed for high efficiency and long life

Almost all locomotives are powered by medium-speed engines (max. 900-1000 rpm)

The locomotive engine is operated at a series of fixed settings (throttle notches), which determine the locomotive speed

There are 2 basic engines represented in US

1. a two-stroke cycle engine (70% of locomotives)
2. a four-stroke engine

BNSF locomotives move as much freight as 280 trucks, carrying a ton of freight 423 miles on just one gallon of fuel ➔ locomotives have the smallest percentage of emissions (Lyndersen K., 2010)

Study Design

Aim 1

Characterize community exposure to rail yard emissions (spatial and seasonal variability) and assess its impact in public health

1. Collection of vapors and $PM_{2.5}$ (winter and summer)
2. Chemistry: PAHs and carbonyls
3. Chemical reactivity: DTT, DHBA, GAPDH
4. Cell toxicity

Selected locations

Railyards identified by ARB as the highest polluting facilities

1. BNSF Railway in San Bernardino
2. UP Intermodal Container Transfer Facility in West Long Beach/Carson
3. UP / BNSF Hobart Yard in Commerce

San Bernardino Railyard

Section A

Build and configure trains

Section B

Unloading of automobiles onto trucks for local delivery

Several surrounding residential areas are within 200 feet

Activities at this railyard include:

1. receiving inbound trains
2. switching rail cars
3. building and configuring trains
4. loading and unloading intermodal trains
5. truck loading
6. unloading automobiles (B yard)

Emission sources:

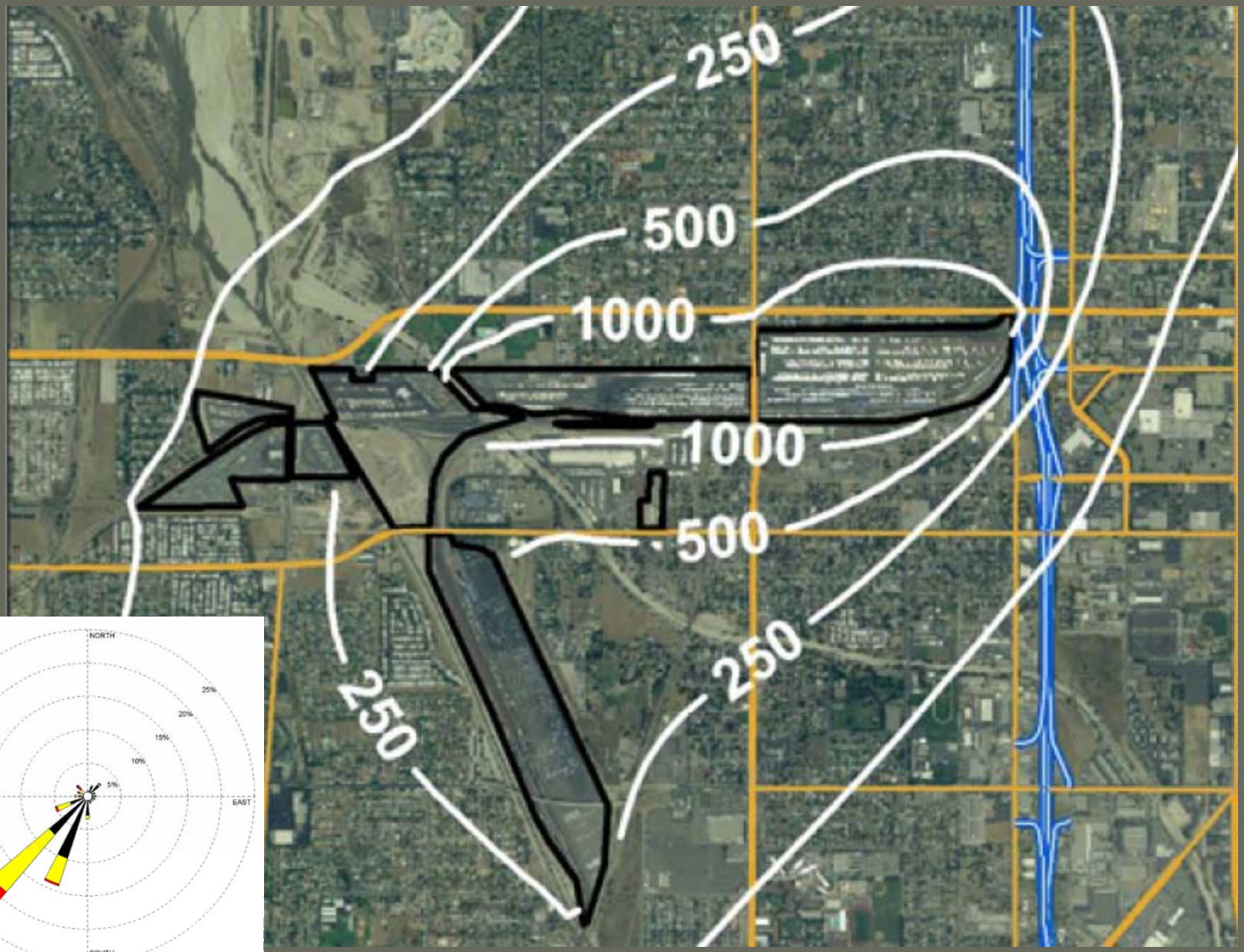
1. locomotives
2. on-road diesel trucks
3. cargo handling equipment (cranes, yard hostlers, etc)
4. heavy equipment
5. transport refrigeration units (TRUs) and refrigerated rail cars

San Bernardino Railyard Diesel Emissions in 2005

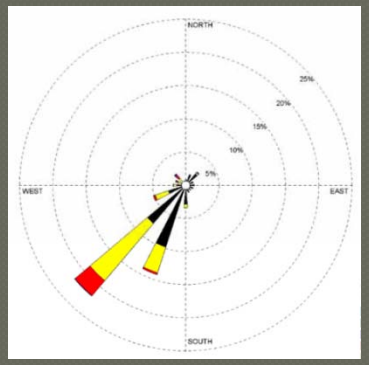
	tons / year	percentage
LOCOMOTIVES	**10.6**	**48%**
- Line Haul locomotives	6.1	28%
- Switch locomotives	4.1	18%
- Refueling	0.4	2%
CARGO HANDLING EQUIPMENT	**3.7**	**17%**
ON-ROAD TRUCKS	**4.4**	**20%**
Off road vehicles and equipment	**0.4**	**3%**

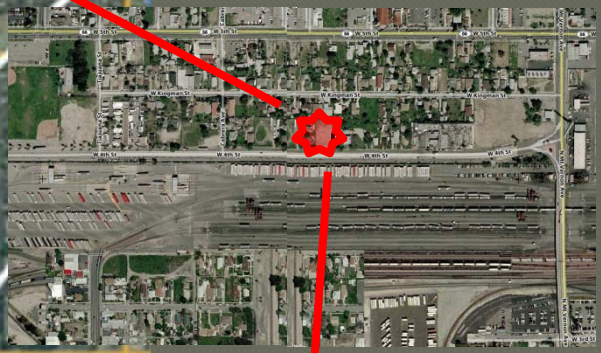
Locomotive, CHE, and diesel trucks contribute to 97% of the total on-site emissions

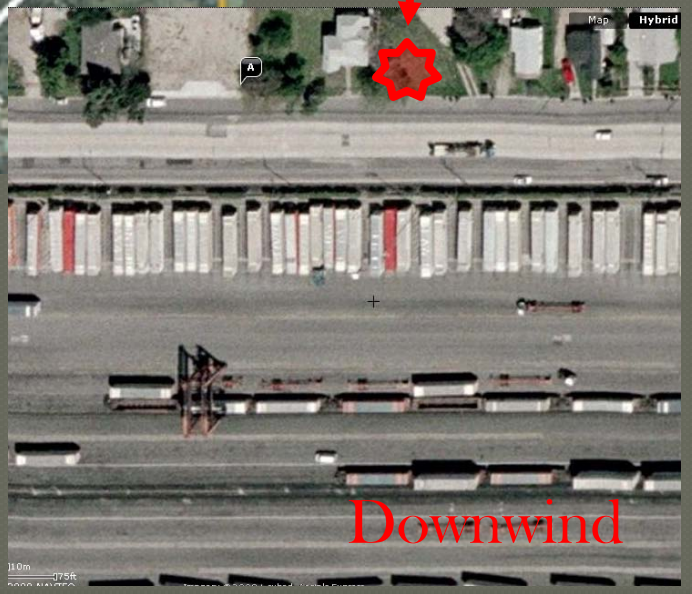
Estimated Cancer Risk (chances per million)



Sampling locations

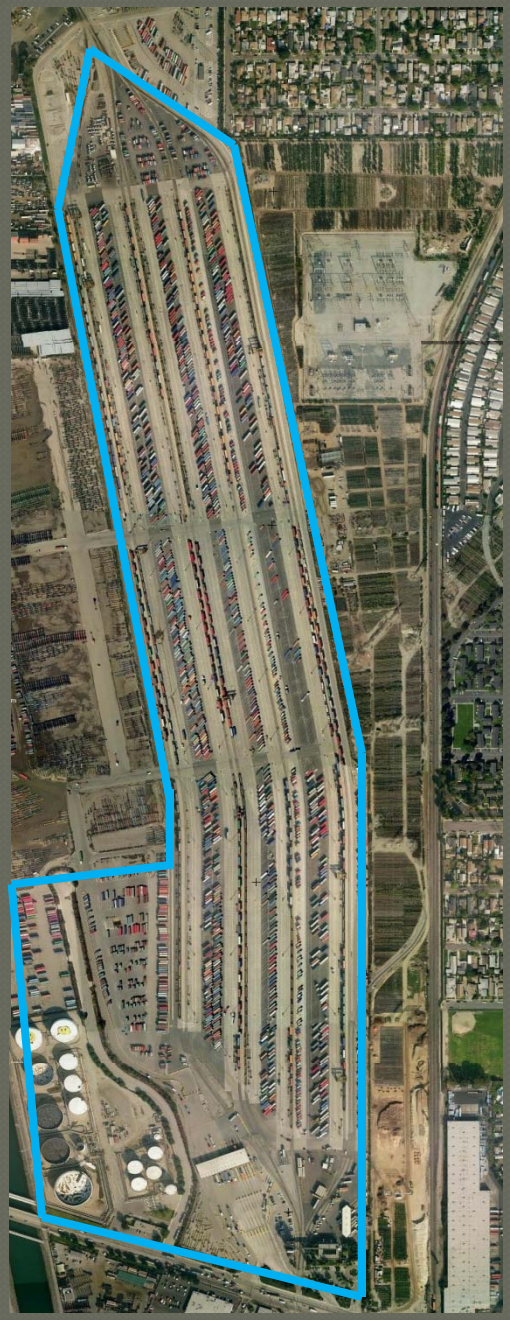






Upwind

Downwind



UP – Intermodal Container Transfer Facility (ICTF)

~ 4 miles north of the Port of Long Beach and operates 24/7

The facility has two railyards:

- the ICTF intermodal yard (east)
- Dolores switching and servicing yard

This facility handles over 750,000 containers a year

Activities include:

1. receiving inbound trains
2. loading and unloading intermodal trains
3. storing intermodal containers and chassis
4. building and departing outbound trains
5. switching, refueling and servicing

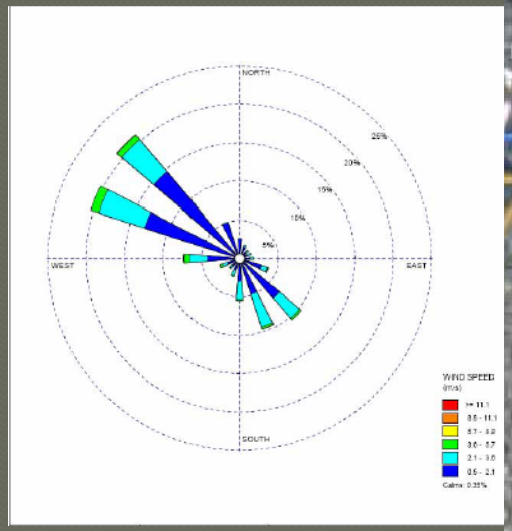
Long Beach Railyard Diesel Emissions in 2005

	tons / year	percentage
LOCOMOTIVES	**9.8**	**42%**
- Line Haul locomotives	3.0	13%
- Switch locomotives	5.6	24%
- Refueling	1.2	5%
CARGO HANDLING EQUIPMENT	**4.4**	**18%**
ON-ROAD TRUCKS	**7.5**	**32%**
Off road vehicles and equipment	**1.9**	**8%**

The locomotive diesel PM emissions are primarily due to switching operations

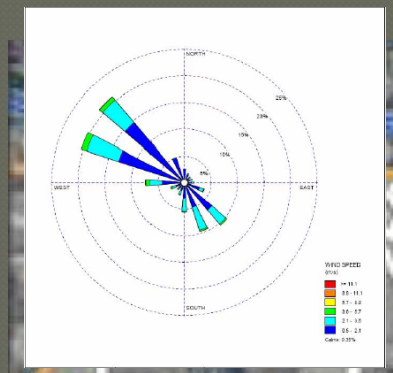
Higher heavy diesel truck contribution to the total DEP emissions than San Bernardino railyard

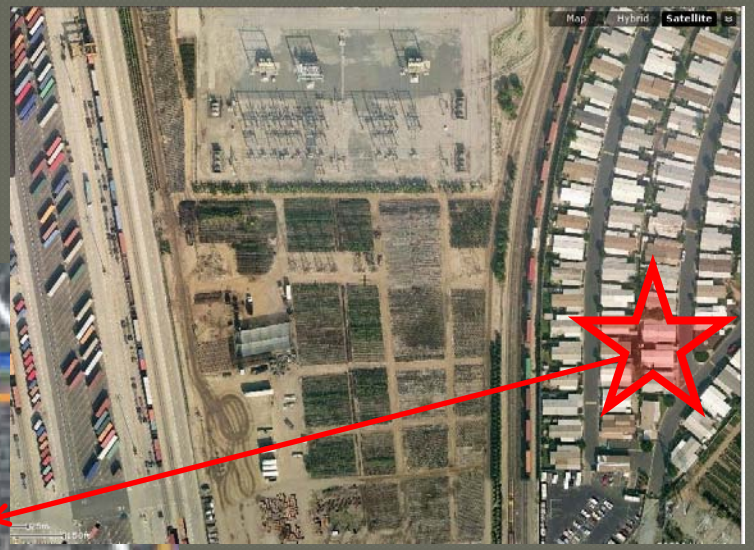
Estimated Cancer Risk (chances per million)



The cancer risk at the PMI is estimated to be about 1200 chances per million

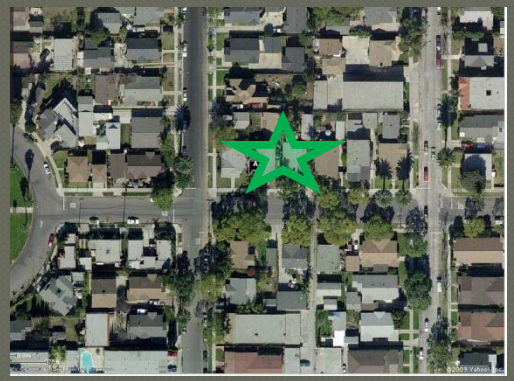
Sampling locations



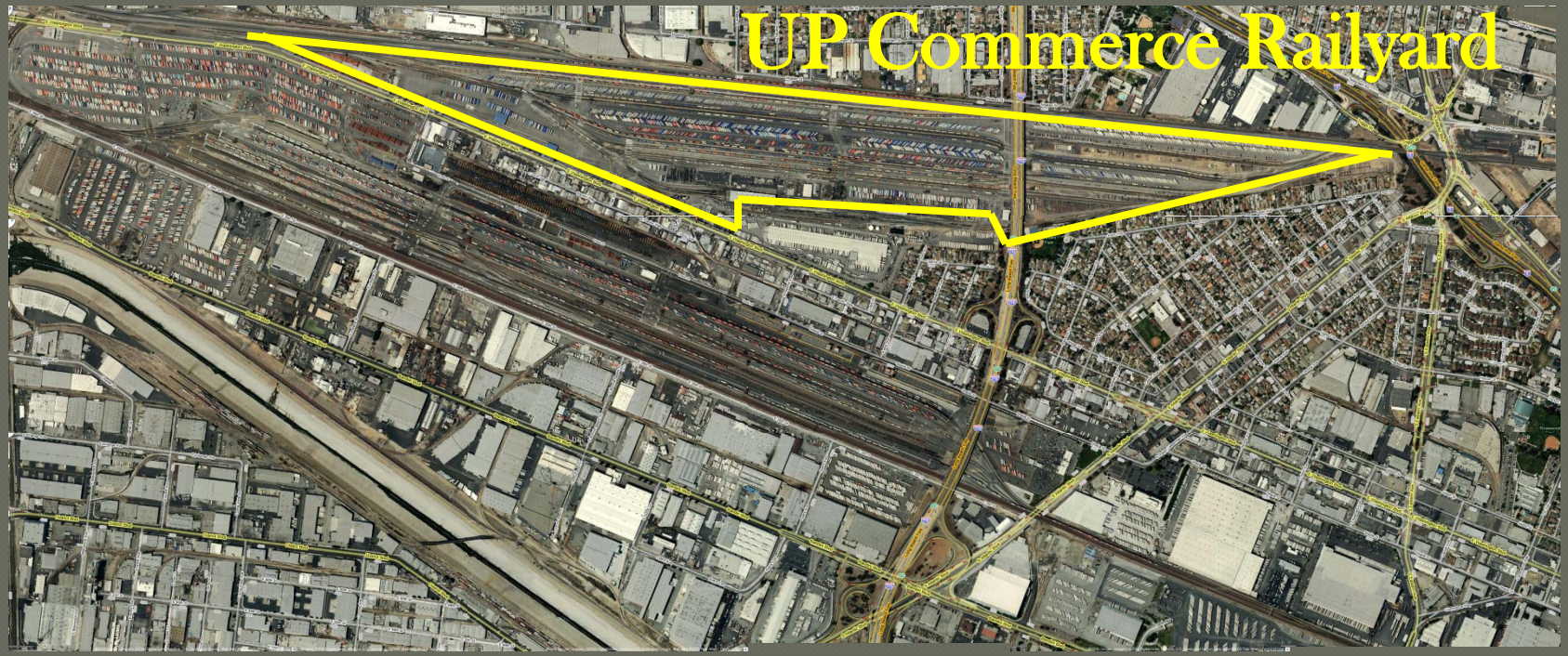


Downwind

East Long Beach



Commerce Area



Cargo handling facility
Processed more than 350,000 containers in 2005
Operate 24 hrs a day, 365 days a year
Includes a bypassing line with freight and passengers (Metrolink)

BNSF Hobart Yard

Largest intermodal railyard in the United States

25 trains a day and 1.4 million lifts a year

Adjacent mainline runs south of the railyard supporting freight trains and commuter lines for Metrolink and Amtrak

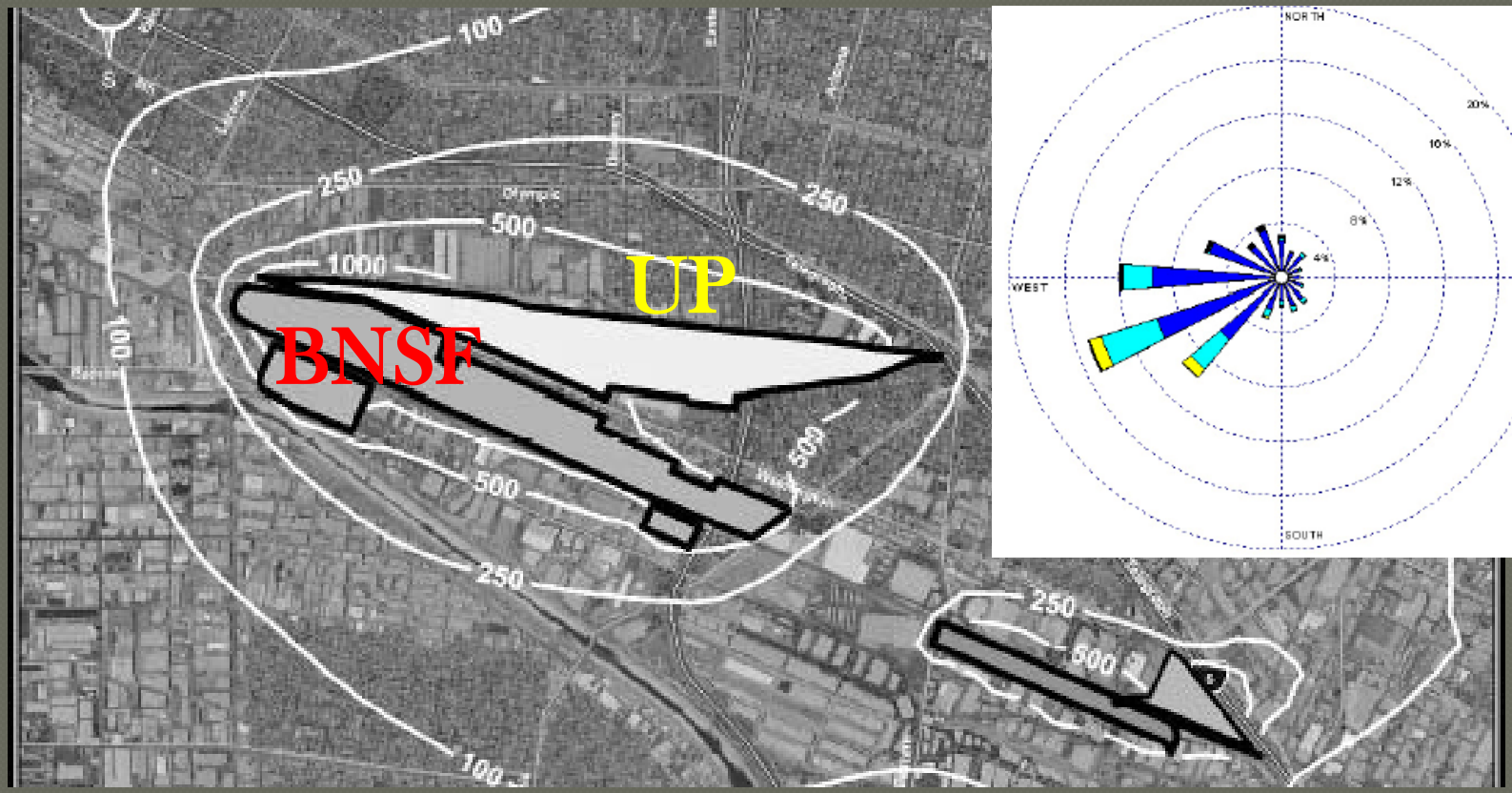
Commerce Railyards Diesel Emissions in 2005

	UP	BNSF	percentage
LOCOMOTIVES	4.9	5.9	30%
- Freight & Through trains	1.3	3.2	12%
- Switch locomotives	1.9	2.2	12%
- Service/Testing	1.7	-	5%
CARGO HANDLING EQUIPMENT	4.8	4.2	25%
ON-ROAD TRUCKS	2.0	10.1	34%
Off road vehicles and equipment	0.4	3.7	11%

UP Commerce and BNSF Hobart are estimated at about 36 tons per year (86% of total diesel PM emissions on the area)

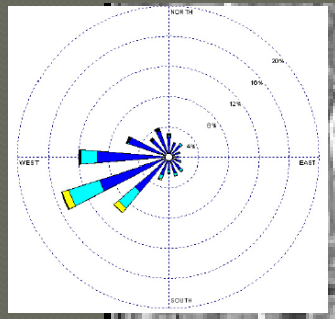
BNSF has the largest emissions of on-road trucks among the yards

Estimated Cancer Risk (chances per million)



The cancer risk at the PMI is estimated to be about 3,000 chances in a million, there is no residential areas where the risk exceeds 1,000 chances per million

Sampling locations



Upwind

Downwind