Using Science to Protect Your Community from the Waste They Make.

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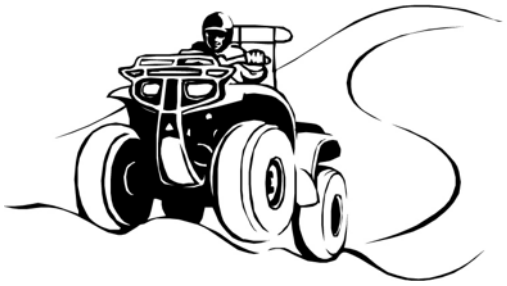
Why are we all here?

According to a study on Alaska village disposal sites, people who visit their dump are **2 to almost 4 times more likely** to experience faintness, fever, vomiting, stomach pain, ear and eye irritation, headache, and/or numbness.

The more often people visit the dump, the more likely they were to experience the symptoms.



People who smell dump smoke or simply smelled dump odor are about **2 to 6 times more likely** to experience these symptoms.

BIRTH OUTCOMES STUDY

- A study was performed using birth records from 1997 – 2001 from mothers who resided in 197 Villages, together with dumpsite rankings.
- **Babies weighed on average 55 grams less** when born to mothers from the villages with high site exposure potential
- On average, **pregnancies lasted 1.2 days less** in mothers from high site hazard content Villages.

- ✓ Infants born to mothers from Villages with high hazard dumpsite contents were **4.3 times more likely to have "other defects"** than other infants.

- ✓ The results indicated that all **other categories of birth defects *might* be associated with high hazard dumpsites.** Without a larger population to look at, or greater exposure detail, we can't know.

Studies have shown that waste pickers experience situations which place them at high risk of …**external and internal injuries e.g., … fires; explosions; being injured by glass, contaminated needles, medical waste and also death**. They can also develop **respiratory diseases, eye infections, stomach problems, typhoid fever, diarrhea, musculoskeletal disorders and carcinogenic effects**. …. It's is common to find a high prevalence of **falls, accidents, [illegible] problems …. diseases.**

Being exposed to open dumpsites has been associated with numerous illnesses, injuries, and medical conditions, from cancers and respiratory problems to cuts and rashes.

One study …evidences that waste pickers working with recyclable materials are exposed to **cuts, maiming, fatal accidents, contamination by heavy metals and dangerous wastes and are at risk of developing pulmonary diseases, HIV and hepatitis C as a result of contact with sharp items and hazardous health wastes**. A study … reinforced these hazards highlighting **the lack …of protective equipment …** According to the South Sudanese Development Organization, the risks to the health and safety of waste pickers around the world in order of prevalence rate are**: joint pain; injuries / cuts; respiratory problems; gastrointestinal disorders; fatigue; skin infection; infectious ..**

…From the 57 studies …the authors showed sufficient evidence to associate exposure [with] …various types of acute symptoms, such as **neurological, otorhinolaryngological, respiratory, digestive and dermatological.** The evidence is limited, however, there is information in relation to **cancer of the liver, bladder, breasts and testicles; non-Hodgkin lymphoma; asthma; congenital anomalies in general; anomalies of the neural tube and urogenital, connective and musculoskeletal systems; low birth weight; and preterm birth.**

Excerpts from *Health conditions and occupational risks in a novel group: waste pickers in the largest open garbage dump in Latin America*¸ Cruvinel et al 2019.

What do we know?

Do we know 100% that **your community** is experiencing ill health from the dumpsite? **No.**

Do we know that the current site conditions and community practices could cause ill health? **Probably, but we'll talk about it.**

Do we know some things that can make it way less likely? **Yes.**

Communities need to weigh the health risks that they observe to be reasonably present.

And make decisions about whether to act, how to act, and what to act on first.

Science can help make those decisions.

Science (from the Latin word *scientia*, meaning "knowledge")[1] builds and organizes knowledge in the form of testable explanations and predictions.

Every person in this room is now, or can be, a scientist.

By organizing knowledge to explain and predict the health risks from your dump – you are acting in your role as a environmental scientist for your community.

Using Science to Organize Health Risk Observations

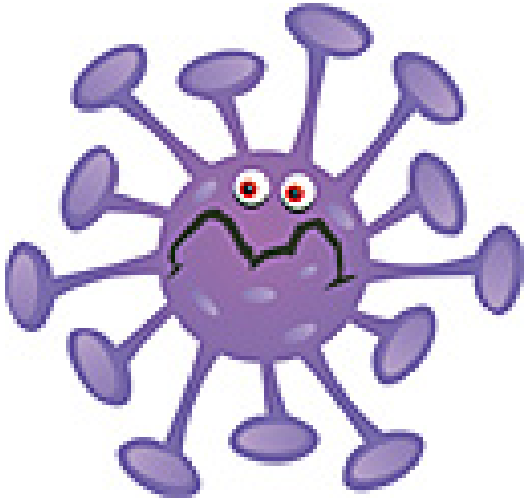
Toxicity/Impact (Is it bad for you?)

X

Exposure/Likelihood (Are you in danger?)

=

Health risk



Toxcitiy/Impact

Exposure

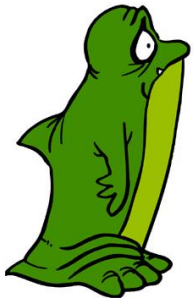
Health Risk

We make decisions about risks every day.

Risk = Likelihood X Impact

How big of an ***impact*** would be a Martian attack? Very High!

But what is the ***likelihood*** of a Martian attack?
Very, very, very low. Like zero (?).



So even though a martian attack would be pretty bad, the risk of an attack is:
Attack Risk = 1 million x 0 = **Zero.**

Phew! We're safe.

Think of Your Dump as Mars

- Lots of Martians living there ready to attack. They are disguised as toxic chemicals and disease organism called pathogens.
- You are your community's defender.
- Your community might not know that and think you're crazy for running around warning them about the dump.
- Don't give up – Just fall back on Science and facts!!

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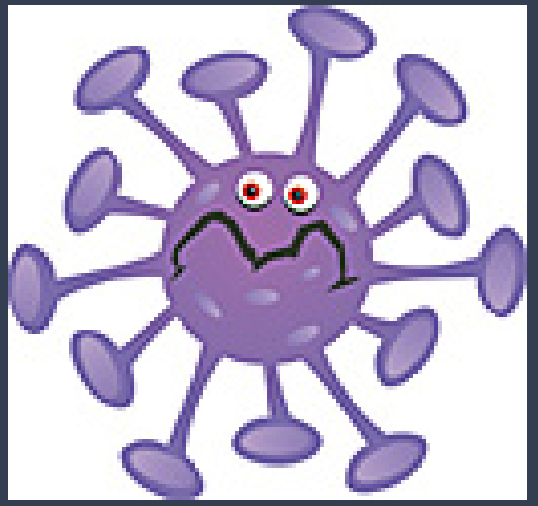

Toxcitiy/Impact

Exposure

Health Risk

Martian Impact (Toxicity or Hazard, sort of…)

Are martians harmful?
Are they all harmful?

Is a chemical or pathogen or other ***stressor*** able to harm?

How bad is the harm they can cause?

Rash or birth defects?

Are there conditions/times when Martians don't cause harm? What are they? Are they present? (Think buried plastic instead of burned plastic)

THERE ARE A LOT OF TOXIC CHEMICALS IN DUMP SMOKE

	Methylenechloride	17.00
	o-Xylene	16.25
	Styrene	527.50
	Toluene	372.00
SVOCs (1)	2,4,6-Trichlorophenol	0.19
	2,4-Dichlorophenol[a]	0.24
	2,4-Dimethylphenol[a]	17.58
	2,6-Dichlorophenol[a]	0.04
	2-Chlorophenol[a]	0.95
	2-Methylnaphthalene[a]	8.53
	2-Cresol	24.59
	3- or 4-Cresol	44.18
	Acetophenone	4.69
	Benzylalcohol[a]	4.46
	Bis(2-ethylhexyl) phthalate	23.79
	Di-*n*-butylphthalate	3.45
	Dibenzofuran	[illegible]
	Isophorone	9.25
	Pentachloro nitrobenzene	0.01
	Phenol	112.66
Chlorobenzenes (1)	1,3-Dichlorobenzene	0.08
	1,4-Dichlorobenzene	0.03
	1,2-Dichlorobenzene[a]	0.16
	1,3,5-Trichlorobenzene[a]	0.01
	1,2,4-Trichlorobenzene	0.10
	1,2,3-Trichlorobenzene[a]	0.11
	1,2,3,5-Tetrachloro benzene[a]	0.03
	1,2,4,5-Tetrachloro benzene[a]	0.02
	1,2,3,4-Tetrachloro benzene[a]	0.08
	1,2,3,4,5-Pentachloro benzene[a]	0.08
	Hexachlorobenzene	0.04
PAHs (1)	Acenaphthene	0.64

	Isovaleraldehyde[a]	10.20
	p-Tolualdehyde[a]	5.85
	Propionaldehyde	112.60
PCDDs/Fs and PCBs (2)	Total PCDDs/Fs	5.80×10^{-3}
	TEQ PCDDs/Fs	7.68×10^{-5}
	Total PCBs	1.26×10^{-1}
	TEQ PCBs	1.34×10^{-6}

Source. (1) Ref. [34]. (2) Ref. [37].
[a] Compound of interest not on HAP list.

processes, such as cement kilns and utility boilers [80–82]. Another potentially attractive option is the use of ground tire material as a supplement to asphalt paving materials. The Intermodal Surface Transportation Efficiency Act [83] mandates that up to 20% of all federally funded roads in the US include as much as 20 lb (9 kg) of rubber derived from scrap tires per ton (907 kg) of asphalt by 1997. Lutes et al. [84] measured the air emissions from adding tire rubber to asphalt. In spite of these efforts, less than 25% of the total amount of discarded tires are reused or reprocessed, and the remaining 175 million scrap tires are discarded in landfills, above-ground stockpiles, or illegal dumps. In addition,

Table 10
Emissions from burning dumps and landfill fires (ng/m^3)

Class	Compound	Controlled landfill fire	Uncontrolled landfill fire
PAHs	Acenaphthylene	90	60
	Acenaphthene	50	30
	Fluoranthene	100	50
	Phenanthrene	520	30
	Anthracene	160	85

Compound	Range (μg/l)	References[d]
Aromatic hydrocarbons		
Benzene	1–1630	a,b,d,f,h,i,k,l,m,n,o,p,q
Toluene	1–12300	a,b,d,f,h,i,k,l,m,n,o,p,q
Xylenes	4–3500	a,b,d,f,h,i,k,l,m,n,o,p,q
Ethylbenzene	1–1280	a,b,d,f,m,n,o,p,q
Trimethylbenzenes	4–250	b,f,o,p
Naphthalene	0.1–260	c,d,f,m,n,o,p
Halogenated hydrocarbons		
Chlorobenzene	0.1–110	a,d,f,m,o
1,2-Dichlorobenzene	0.1–32	a,c,d,f,o
1,4-Dichlorobenzene	0.1–16	a,c,d,f,m
1,1,1-Trichloroethane	0.1–3810	a,b,d,f,m,o,p,q
Trichloroethylene	0.7–750	a,b,d,f,l,m,n,o,p
Tetrachloroethylene	0.1–250	a,b,d,f,l,m,n,o,p,q
Methylene chloride	1.0–64	a,b,d,k,m
Chloroform	1.0–70	a,b,d,f,l,m,n,o,p,q
Phenols		
Phenol	1–1200	c,f,g,k,m,n
Cresols	1–2100	c,g,j,k,l,m,n
Pesticides		
Mecoprop[a]	2.0–90	c,e,l, n
Miscellaneous		
Acetone	6–4400	a,i,k,o
Diethylphthalate	10–660	c,g,j,m
Di-*n*-butylphthalate	5.0–15	c,g,i,j,m
Tetrahydrofuran	9–430	a,i,k,o
Tri-*n*-butylphosphate	1.2–360	c,f,j,l,m
Camphor[b]	I[c]	c,f,j,n

TABLE 2 - SUMMARY OF PHARMACEUTICA

	Hatch Hill Landfill, Augu		
	Primexpand III		
Parameter Name	Conc. [ng/L]	LQ	RL
10-hydroxy-amitriptyline		U	0.15
2-Hydroxy-ibuprofen	19400	D/EMPC	1460
Acetaminophen	117000		2840
Albuterol	604		2.08
Amitriptyline	6.36		3.95
Amphetamine	419		9.15
Androstenedione		U	14.7
Atenolol	195		4.7
Azithromycin	502		16.4
Benzoylecgonine	1260		2.76
Bisphenol A		UD	7520
Caffeine	8460		146
Carbamazepine	371		27.2
Cimetidine	24.8		3.68
Ciprofloxacin	269		165
Clarithromycin	131		7.69
Cocaine	57.1		0.625
Cotinine	11000		89.6

THERE ARE A LOT OF TOXIC CHEMICALS IN THE LEACHATE

Benzene
Benzene dichloro-
Benzene, butyl-
Benzene, propyl-
Benzene, 1-chloro-2-methy
Chloroform
1,1,1-Trichloroethane
1,2-Dibromoethane
1,1,2,2-Tetrachloethane
2-Bromo1,3,5 trichlorobenzene
Ethylbenzene
Bromodichloromethane
Carbon tetrachloride
Propane, 1,2-dichloro-
Xylenes
Tetrachloroethylene
Toluene
Trichloroethylene

THERE ARE A LOT OF TOXIC CHEMICALS IN THE AMBIENT AIR AT THE DUMP

Xylenes
Tetrachloroethylene
Toluene
Trichloroethylene
Formaldehyde
Acetaldehyde
Acetone
Acrolein
Propanal
Butanal
Crotonaldehyde
Benzaldehyde
Isovalaraldehyde
Valaraldehyde
o-Tolualdehyde
m,p-Tolualdehyde
Hexanal
2,5-Dimethylbenzaldehyde

Notes: Highlighted data indicate significant di

Table 3: Physicochemical analysis of the landfill soil of A.E.H. compared with previous studies.

Study site (Landfill)	Strata	pH	EC (µS·cm^{-1})	Total limestone (%)	Organic matter (%)	Heavy metals (mg·kg^{-1})						Reference
						Cd	Pb	Ni	Zn	Cr	Cu	
Algeria (Ain-El-Hammam)	0	7.4	2.0	4.8	1.7	0.5	7.3	20.0	43.0	76.0	18.8	Current study
	1	7.3	2.1	4.7	1.6	1.2	55.5	40.7	88.8	94.2	76.3	
	2	7.2	2.3	4.6	3.4	1.5	58.4	41.6	91.0	96.6	78.7	
	3	7.0	2.8	4.4	4.5	1.6	60.4	42.2	92.8	98.9	80.1	
Czech Republic (Pilsen)	—	—	—	—	—	0.3	5.4	11.1	52.0	86.7	51.2	[34]
Ghana (Accra)	—	—	—	—	—	0.9	59.2	5.1	297.1	17.9	27.0	[35]
Tunisia (Tunis)	—	—	—	—	—	1.1	55.2	28.6	92.1	32.4	48.2	[36]
Italy (Malagrotta)	—	—	—	—	—	0.1	53.6	10.3	25.6	16.8	6.3	[37]
Poland (Lubna)	—	—	—	—	—	0.3	21.0	2.1	11.0	4.5	2.7	[38]
Spain (Getafe-Madrid)	—	—	—	—	—	—	16.9	6.4	73.9	1.5	13.5	[39]
Morocco (Ahfir-Saidia)	—	—	—	—	—	—	61.8	47.2	68.1	51.5	—	[40]
Nigeria (Port Harcourt)	—	—	—	—	—	1.3	12.4	—	84.2	—	46.2	[41]

There are a lot of toxic chemicals in the soil.

Toxicity/Impact – The less the better.

- Your dump will contain toxins, no matter what you do.
- **But how do you reduce toxicity of the individual wastes at your dump?**
- Unlike batteries, not all household hazardous products need to be toxic !
- Safer Products. *Safer Choice.* https://www.epa.gov/saferchoice
- Make your own cleaners, etc.

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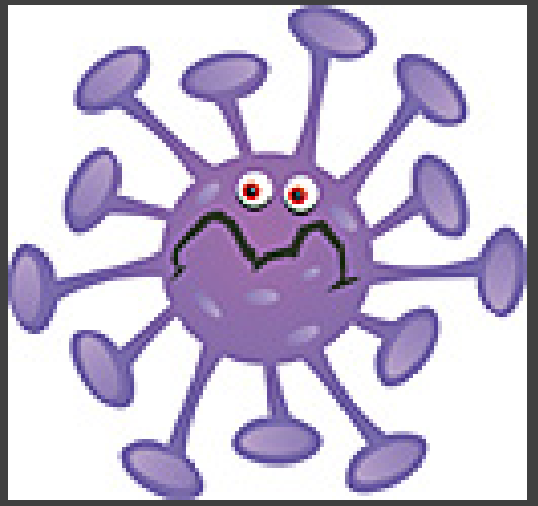


Toxcity/Impact

Exposure

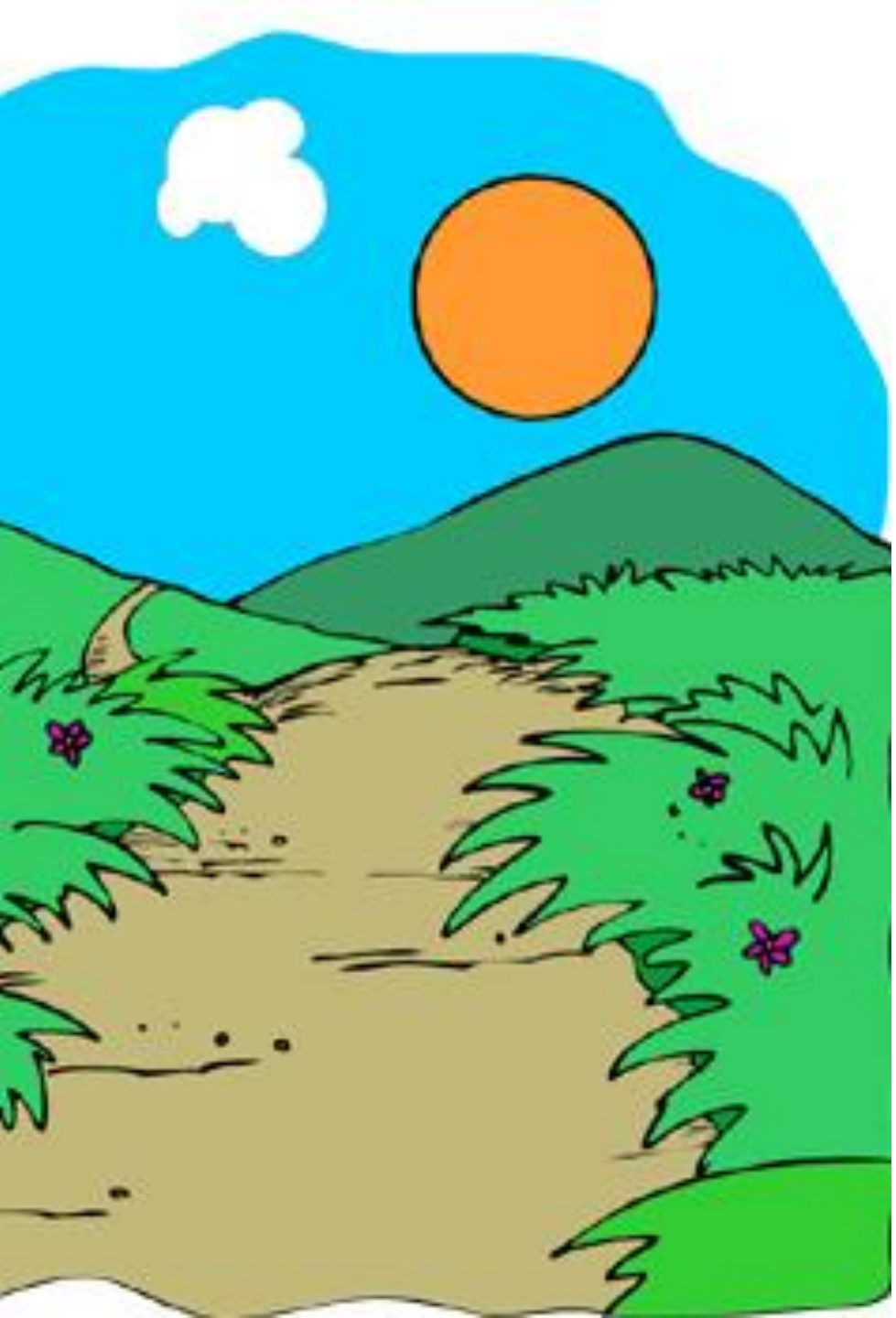
Health Risk

Likelihood = **Exposure**

To be harmed, people/wildlife need to be exposed.

The more they are exposed, the more likely they are to be harmed.

With populations, you are looking at the likelihood of exposure and you are interested in the portion and profiles of people that might be exposed.



Exposure Pathway

- Think the Martians' line of attack. A way for the stressor/chemical/pathogen to make its way from the source to its contact with people and wildlife. Think leachate traveling to drinking water, or smoke traveling into town.

Is your exposure pathway complete?

A **complete exposure pathway** = evidence that people/wildlife are exposed to the chemical.

Toxicity X Exposure = Risk. If there is exposure there is risk. If there more exposure there is more risk.

Example: When a battery is burned, we know that some of the lead goes off in smoke.

Does the smoke travel all the way to where people are? This is called "contact". **How can you tell?**

Just because the Martian made contact, how do you **know** the stressor can enter the body?

Exposure Route = **The way the chemical/stressor can enter the body.**

A chemical/stressor can be in-taken by:

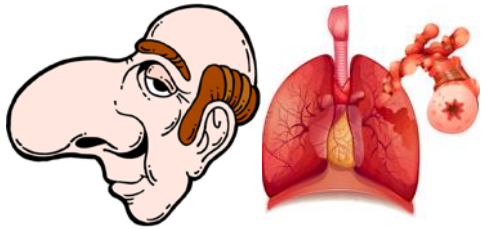
1. **Eating & Drinking**
2. **Breathing**

Or up-taken through the skin or body cavity such as open sore, eye, nose:

3. **Skin contact** or
4. **Injection** (e.g. nail puncture).

These routes are considered differently because the stressor starts out in a different body system and will generally route into or through different organs.

The different body route makes the potential impact on different



Inhalation

Touching

If you eat it, breathe it, touch it…
You are at risk.

Puncture/injection

Eating & drinking

Forget Martians for a while and think your doctor.

Exposure = Dose x Time

Exposure to a substance equals the Amount of chemical multiplied by the Time you are in contact with it...

Your doctor prescribes you **2 pills** each day for **10 days**.
Your exposure is **2 pills** per day x **10** days =**20 pills**.

For eating, drinking, breathing.

$$D_{pot} = \bar{C} \cdot \bar{IR} \cdot ED$$

Dose = Amount of chemical in the soil, air, water, food (i.e. the Concentration)

***times the* Intake Rate** (how fast we breathe, eat, drink)

***times* the Duration of time** we breathe/eat/drink.

Simplification Note

To be harmful it must be **biologically available** to get to the particular organ/cell that it does its harm. Think swallowing soil contaminated lead versus breathing soil contaminated dust:

- Potential dose -How much reached a body?
- Delivered dose- How much reached the organ/cells where it can do harm?

Lead and your landfill

- People living near open disposal sites can be exposed to lead and chemicals that contain lead by breathing air, drinking water, eating food, or swallowing dust or dirt (from burning or waste degradation) that contains lead.
- Families can be exposed to higher levels of lead when lead dust is brought home on their work clothes.
- When lead is ***breathed***, it ***travels fast*** from your lungs ***through blood*** to other parts of your body.
- Dust and soil that contain lead may get on your skin, but only a small portion of the lead will pass through healthy skin and enter your blood if it is not washed off.
- The only kinds of lead compounds that easily penetrate the skin are the additives in leaded gasoline.

- Particles that are too large to get into your lungs can be coughed up and then *swallowed*. You can also *swallow lead* by eating/drinking food and liquids that contain it.
- Most lead entering the body is from swallowing, but how much gets into your body from the stomach depends on age and when you last ate.
- For adults who just ate, only about 6% of the of lead enters the blood. If they fast for a day, about 60%–80% enters their blood.
- More lead enters the blood of children – they absorb about 50% of the lead they eat.
- Shortly after lead gets into your body, it travels in the blood to the soft tissues and organs (such as the liver, kidneys, lungs, brain, spleen, muscles, and heart).

- After several weeks, most of the lead moves into your bones and teeth. In adults, about 94% of lead in the body is contained in the bones and teeth.
- About 73% of lead in children's bodies is stored in their bones.
- Some lead can stay in your bones for decades; however, some lead can leave your bones and reenter your blood and organs under certain circumstances (during pregnancy and periods of breast feeding, after a bone is broken, and during advancing age.
- About 99% of lead taken into the body of an adult leaves in the waste within a couple of weeks, but in children, only about 32% of the lead leaves in the waste.

We’re simplifying but…the level of dose can make the exposure.

Exposure = Dose x Contact time.

Low Dose x short contact = *Low* Exposure

Low Dose x long contact = *Medium* Exposure

High Dose x short contact= *Medium* Exposure

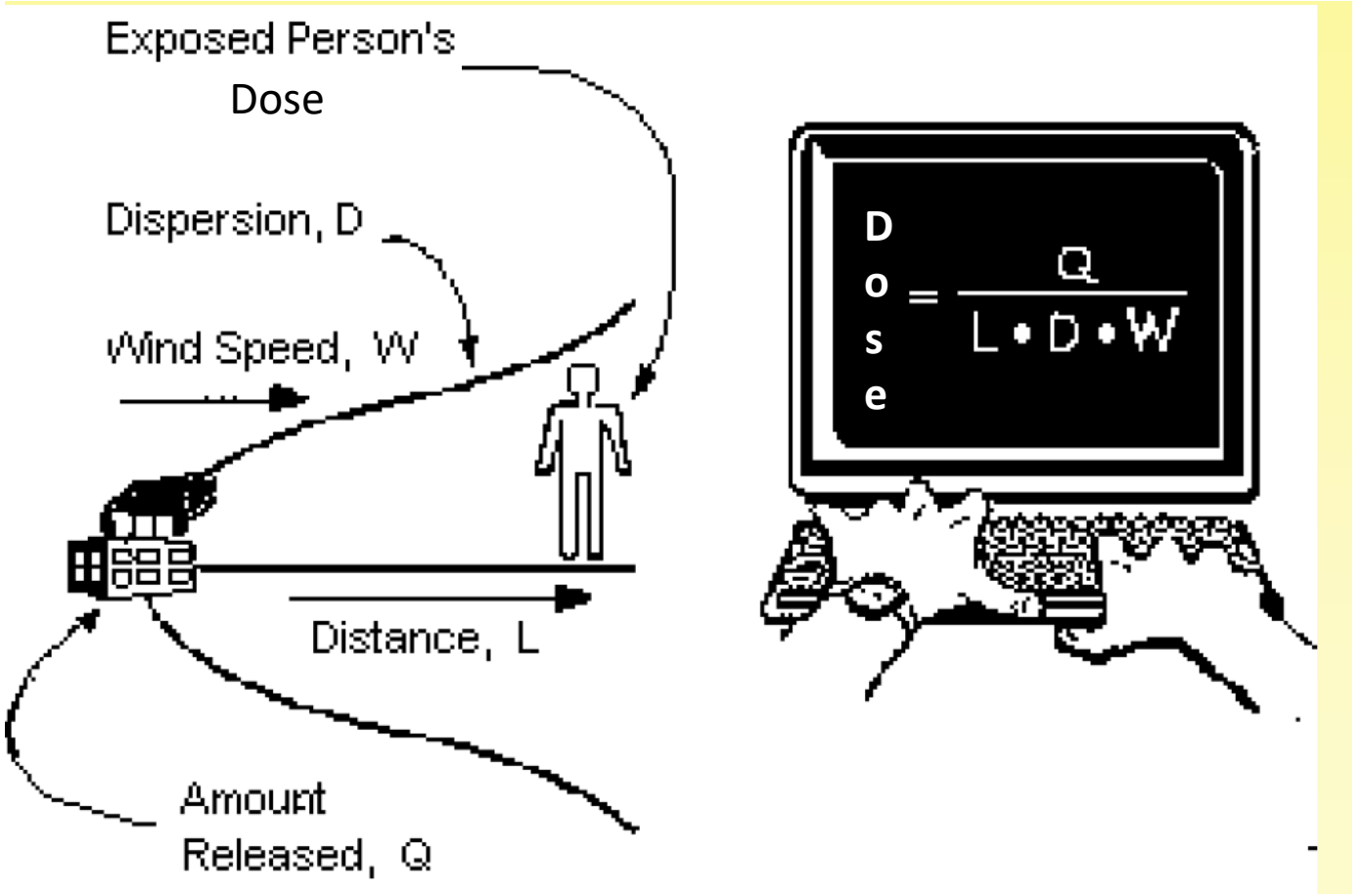
High Dose x long contact = *High* Exposure

Low dose is important to get low exposure and low risk.

What factors affect the stressor dose your community is getting?

- Distance (L)
- Amount at Dumpsite (Q)
- Wind Speed & Direction (W)
- Dispersion (D)

Very simplified equation for dose.



DISTANCE

The longer the distance the lower the dose.

Keep people away from the dumpsite

Site new landfills or waste areas farther

Keep waste and burning out of town

Stop tracking chemicals and poop back to town.

If present, longer (twisty) water channels.

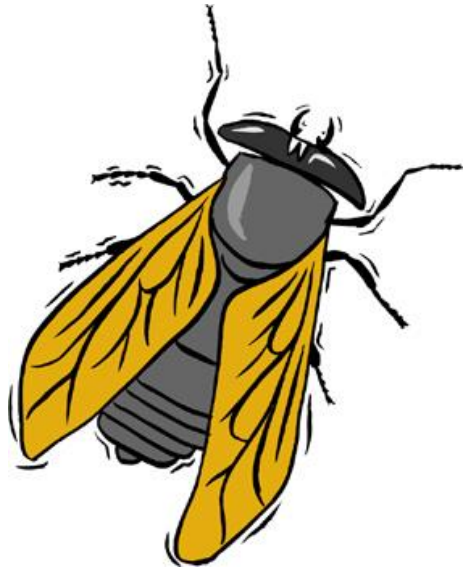
High stack versus no stack

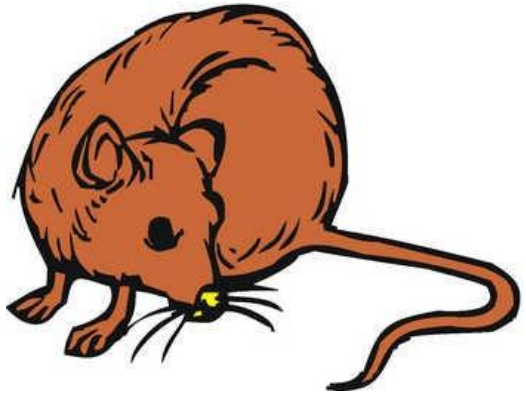
Vertical distance counts too.

And during inversions, smoke will always be closer to the ground and nearer face level.

Distance & Zoonotic Vectors

- Think mosquitos, flies, rats, fleas, ticks, mice, birds, foxes.
- What do these all have in common? They look at the dump as food.
- Where does a smart animalstay? Where their food is.
- A home range distance is the furthest distance that an animal will go from their home range.





- Culex pipiens (An Alaskan mosquito that can carry West Nile) = **½ to 1.5 miles**

- Norway Rat – home range – 200 to 330 ft, **max range is 2 – 3 miles.**

- Birds – Note FAA regs – the bulk range about **1 to 2 miles**.
- Flies – max **1 to 2 miles max**

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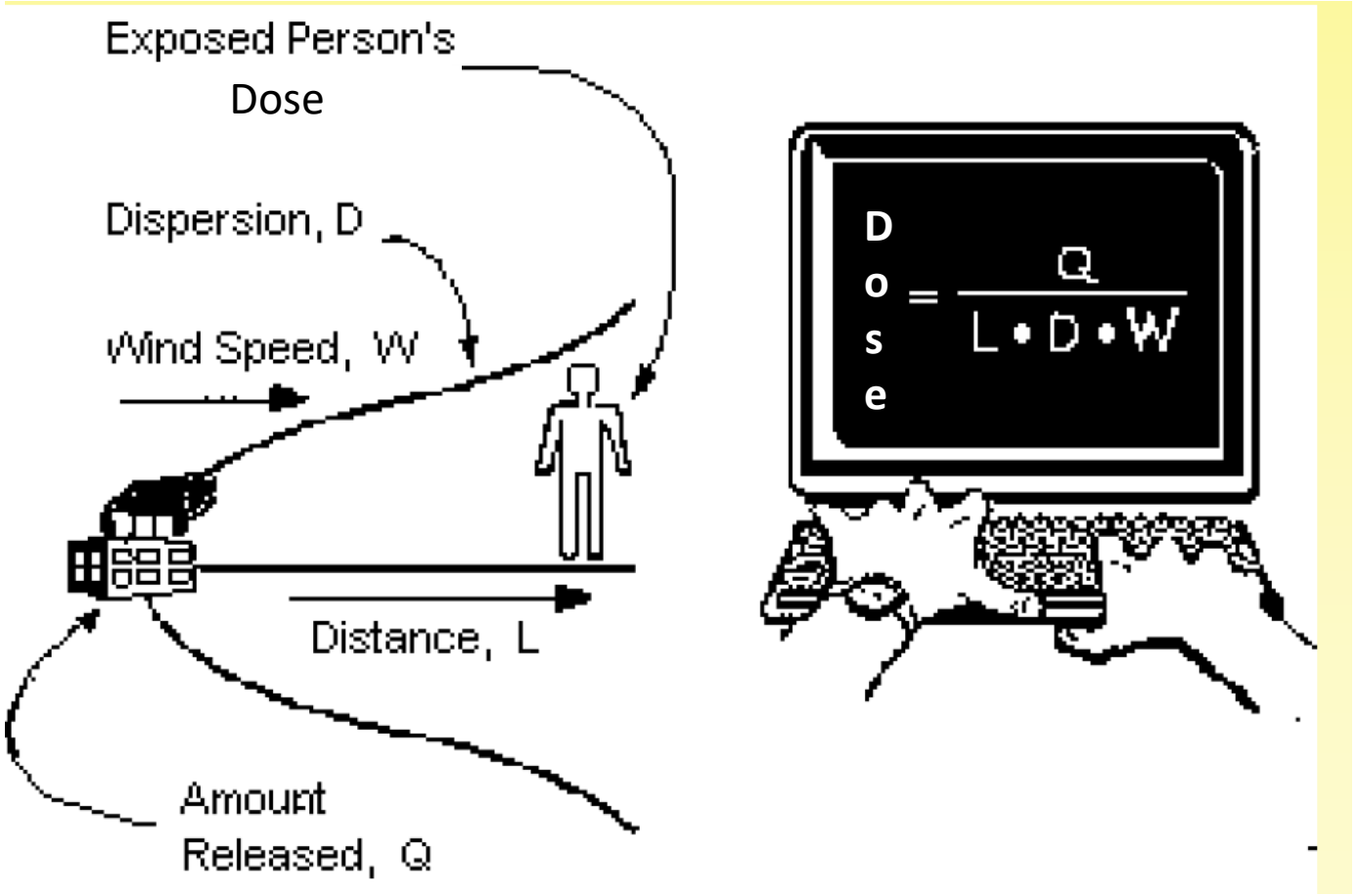

Amount –

The less volume of waste the better.

Reduce your toxic waste stream.

Reuse, repair, and regift materials

Recycle (backhaul)

Separate and store it someplace safe.

Treat it – hard to do here, but not impossible….

Low dose is important to get low exposure and low risk.

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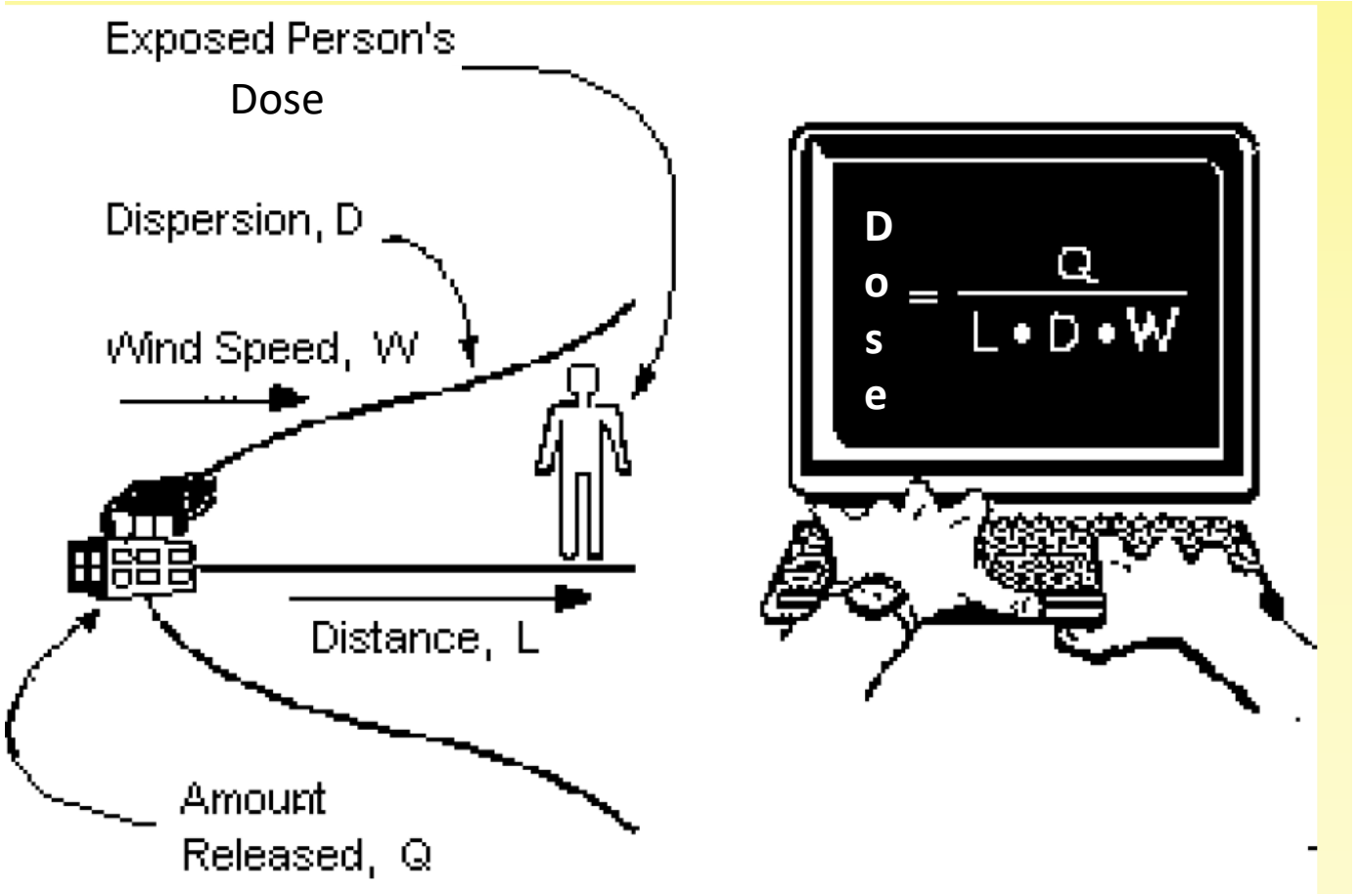


Dispersion – The more the better.

In air & burnboxes– high mixing – turbulent winds. (remember to not burn upwind and think about fire danger)

Runoff through plants and soil and tundra diffuses the toxins!

Create an attenuation buffer

Leachate can be treated by designed land application or designed treatment ponds. Chemicals lessen (attenuate) the further they are.

The land and ponds act as a buffer zone between the dump and areas of concern – like homes or berry grounds.

Contaminants travel and get filtered, treated, degraded, uptaken, immobilized. The further from the source, the lower the concentration.

Organic soil (lots of plant material), clay soil, low acidic soil, many types of reeds and grasses are all very helpful.

How do we maximize our natural buffer capacity – so that is doesn't need to be as wide?

Keep plants and soil intact

Minimize windblown litter (which can block sunlight and kill plants)

Minimize the landfill footprint!! Dumping along the access route does hurt you.

Limit access to the dump to one path – even in winter!!

How can you tell if your buffer is working?

- Dead plants
- How can you tell it is not wide enough?
- Dead plants up to the areas that you care about
- Dead plant area keeps growing.

Wind Speed & Direction

- Its counter-intuitive but Wind Speed actually mixes contaminants because there tends to be more dispersion.
- And stronger wind will carry the contaminant away faster.
- On the other hand - no wind will mean usually the smoke goes up – yay!
- And no winds create less fire danger –**So don't burn on high wind days.**
- Most important for wind – is **Direction**
- **How can you ensure that the wind will blow away from people??**

- Burn hours
- Operator burning
- Contained burning
- Burnbox backups

Okay, Review what affects the potential dose that a person receives??

Distance

Dose/Concentration at Dumpsite

Wind Direction

Dispersion (Mixing, turbulence, filtration, circuitous paths)

And what needs to happen for that dose to turn into a health risk??

Exposure!!

No exposure, no risk.

And what makes exposure?

Exposure = Dose x Contact time.

Low Dose x short contact = *Low* Exposure

Low Dose x long contact = *Medium* Exposure

High Dose x short contact= *Medium* Exposure

High Dose x long contact = *High* Exposure

Contact Time – The less the better.

Hand washing

Quick, hot, contained burning (less smoke time)

Dump clothes washing

Reduced dump visits

Faster, more efficient dumpsite visits

What can make contact time = zero?

- Collection programs – keep people away
- Gate & lock
- Operator gear
- Access clear
- Cover material
- No burning
- Etc.

Using Science to Organizing Health Risk Observations

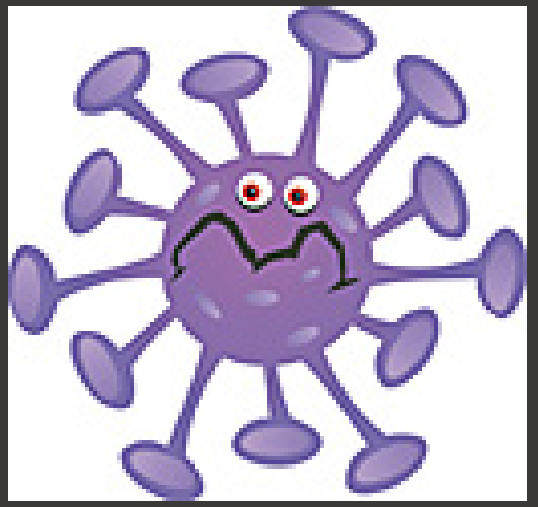
Toxicity/Impact (Is it bad for you?)

X

Exposure/Likelihood (Are you in danger?)

=

Health risk



Toxcitiy/Impact

Exposure

Health Risk

You may not be able to reduce health risk from all pathways for everybody

- Reduce contact time for the most vulnerable – sick, children, elders. They are more likely to have greater health risks than other people for the same exposure.
- Look at the exposure pathways they might have and eliminate them or teach them how to eliminate them.
- Focus on the greatest risks and that are presented for the most number of people.

Left hand, Right hand

Stand up

We will go through a bunch of scenarios

Right hand means risk is lower (good!) and your left hand the risk is greater (bad!). No hands means that is neither bad nor good , or it depends.

For multiple choice, the left hand is #1 and the right hand is #2.

Is #1 or #2 likely a higher risk situation?

1. A big pile of Aluminum cans sitting in standing water at the dump
2. Two lead acid batteries on the ground at the same dump

Why?

1. Toxicity of lead compared with Aluminum
2. Ground is safer than water for disposal

A highly toxic chemical is a big health risk.

- 1. True
- 2. False

A complete exposure to any toxic chemical is a big health risk.

1. True
2. It depends

It depends on these things.

1. Contact time, dose
2. Distance from the chemical.

Picture an open dump. What happens to the ***health risks***? Right is good, left is bad. Middle is neither/no clear effect.

- The wastes are compacted to a small footprint.
- The dump is 5 miles to town.
- The dump sits in water.
- The program has great recordkeeping.
- The dump is surrounded by tundra
- There are multiple access paths.
- There is a collection program.
- People don’t use it.
- Kids are prohibited from dumping the trash at the dump.
- There is a burnbox.
- People still burn on the ground

- There is a stack on the burnbox
- The dump is less than ½ mile.
- Mostly the whole town can smell the dump.
- Electronics and batteries are separated out.
- The dump has signage
- The only homes that are in the smoke path are adults
- Wastes are only burned 1x / month – used to be regular.
- Wastes are burned on the ground
- Plants are all around the dump
- They are dead up to the edge of the river bank.

- There is a fine for littering
- No one enforces it.
- No one litters.
- People dump their used oil on the ground in town.
- The community has a used oil burner
- People use it.
- There is a great aluminum can program
- The tribe accepts batteries
- No one knows that

A pond was used for dumping

No one goes near it.

- Someone hauls ice there.
- The dump snowmelt drains to the river.
- There are fish camps 5 miles down the river.
- People haul water 500 feet down the river for washing clothes
- People haul water for drinking 500 ft down the river
- People haul water for steam baths.
- People use rainwater.
- Birds are at the dump
- The dump is ½ mile away
- There are a ton of flies at the dump
- There are honeybuckets at the dump
- There are a lot of babies in town.
- They use disposable diapers.

What makes dose bigger?

1. Longer distance between source
2. Shorter distance

3. Bigger amount
4. Bigger exposure

A route of exposure is

1. The path the chemical takes to get to your body
2. The way the chemical gets into your body

Which are routes of exposure?

- Eating, breathing, sneezing
- Drinking, breathing, touching

What is an exposure pathway?

Traces the chemical from source to contact with the human/animal.

The path that exposure takes in making someone sick.