

The Relationship between Solid Waste Management and Source Water Quality in Alaska Villages: Potential Impacts and Prevention



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What is Solid Waste?











- There are exact federal definitions under the Resource Conservation and Recovery Act – “RCRA”

*“Any garbage, refuse, sludge..., and any other discarded material, including:
solid, liquid, semisolid or contained gaseous material, resulting from industrial, commercial, mining, and agricultural operations and from community activities...”*

- *Solid Waste Regulations under State are in Chapter 60. The State has delegated authority for solid waste.*

Typical Solid Wastes in Alaska Villages

- ❑ Food scraps 
- ❑ Paper, cardboard, textiles 
- ❑ Rubbish (what you sweep off your floor)
- ❑ Metals (cans, old toys, pots, etc.) 
- ❑ Plastics 
- ❑ Yards Wastes, Wood 
- ❑ Household hazardous wastes: paints, cleaners, oils, batteries, etc. (commercial and household) 
- ❑ Electronic Wastes 
- ❑ Used oil, used antifreeze
- ❑ Demolition and Construction (wide variety of wastes, including some hazardous wastes) 

What is Hazardous Waste?



Hazardous waste is defined as solid waste that contains properties that are dangerous or potentially harmful to human health or the environment.

Under RCRA, hazardous waste is treated differently to ensure “cradle to grave”, and non-residential hazardous wastes are considered differently than household sources. There are a gazillion regulations on handling, treatment, and disposal of solid and hazardous wastes.

- *But when it comes to how solid wastes are treated and disposed in villages, you can throw typical solid waste notions out the door (preferably into a garbage can).*

Alaska's RCRA Exemption

- Alaska Villages of about 1,000 people or less are under a RCRA exemption– the only U.S. communities to have one. Even the hubs are under an exemption – but their exemption is not as broad.
- The exemption applies to the landfills – it allows them to be unlined, with no runoff treatment, or other safeguards or monitoring. And the State also allows contained waste burning without emission control or treatment.
- Without the exemption, it would be financially infeasible for a community to pay for a permitted landfill. And there are a lot of other reasons and issues related to this exemption –not part of this talk.
- Actually, most rural landfills are unpermitted even with this exemption. Like the other public utilities (water and wastewater, electricity), it is **extremely difficult for communities of this small size to self-pay** for the construction, operation, and maintenance of the infrastructure.

So what else is new?



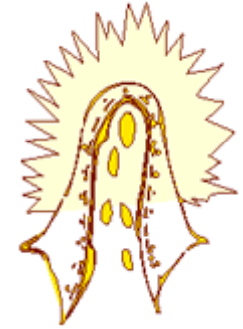
- The difference with solid waste is **that anyone can just discard their trash where-ever they want.** Their lifestyle doesn't change much if the waste system is "broken" – not like Electricity and plumbing. So it is even harder to get households to pay.
- So in villages, you have the unlined landfill (or "dump"), you may also have wastes indiscriminately dumped or littered in town, waterways ("boat dumps"), and other areas, such as subsistence camps. You have ash from open burning. **You can run into wastes nearly everywhere.** The rural nature of communities means no-one to police the dumpers.
- And to top this off, **nearly all wastes from households, businesses, and institutions (schools, utilities, tribal and city offices, etc) are discarded here.** This includes a household battery to a piece of heavy equipment. It includes a harmless piece of paper to a drum of used oil.

Again, solid wastes aren't solid.



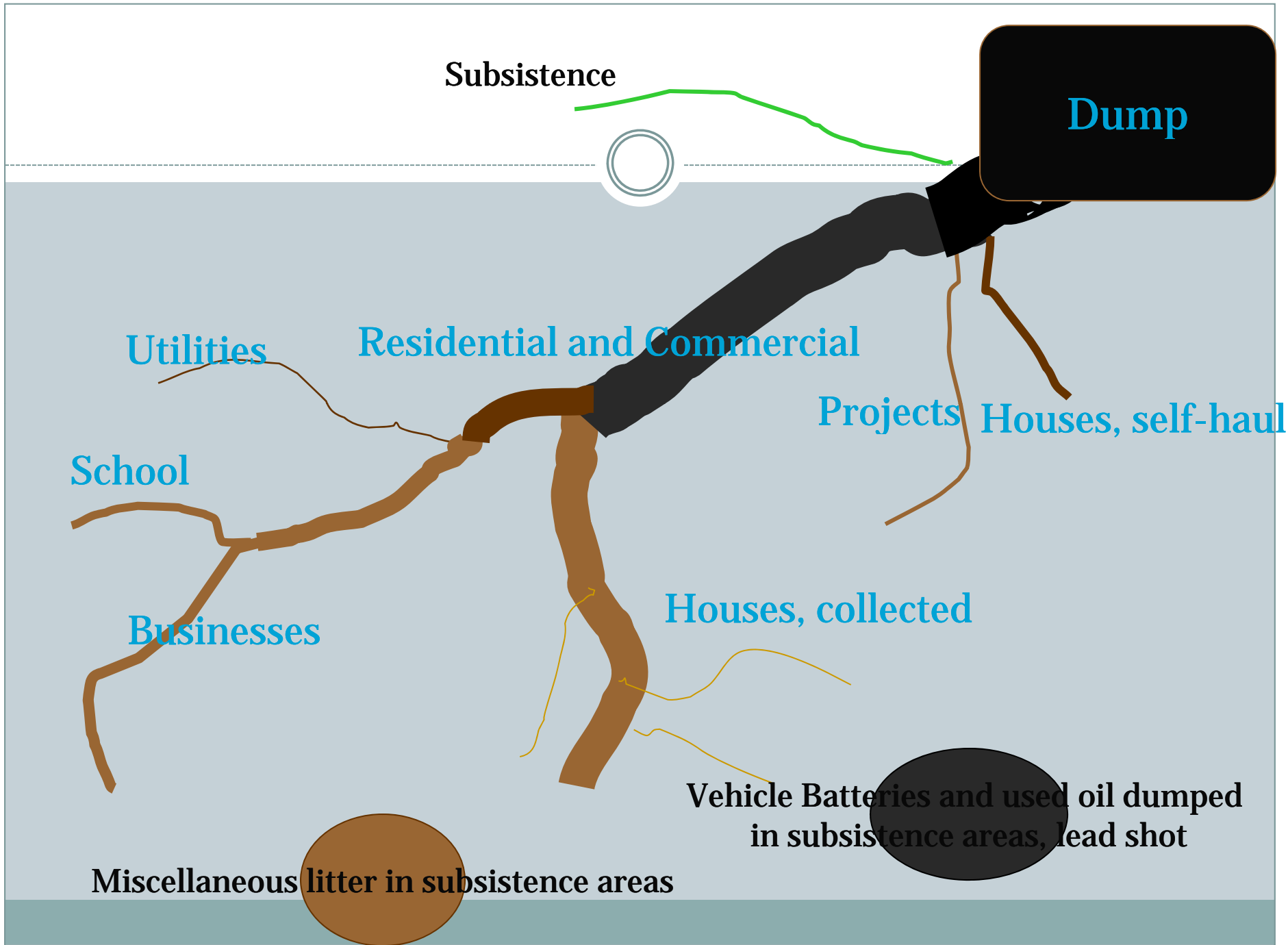
- We already know from the RCRA definition that some solid wastes actually start out as liquids. But even the most solid of wastes eventually breakdown into a form that can contaminate water because of exposure to water (dissolution), sun (photo-oxidation), chemical processes (e.g. oxidation), biological processes (little soil and water organisms eating). And burning transforms wastes to tiny flyable particles and contaminants.
- Wastes therefore can contaminate water-- it isn't a matter of sifting out garbage from the water line.
- And that is why village source water managers need to be involved with solid waste management and planning.

What is a Wastestream?



A **wastestream** is like a **water** stream, but made up of **wastes**, instead of **water**.

- ❖ The wastes go in one direction only.
- ❖ Each waste starts from one place.
- ❖ By the time the wastes arrive at the dump, they are with lots of other wastes – just like a river, it can get bigger and bigger when the small streams join together.

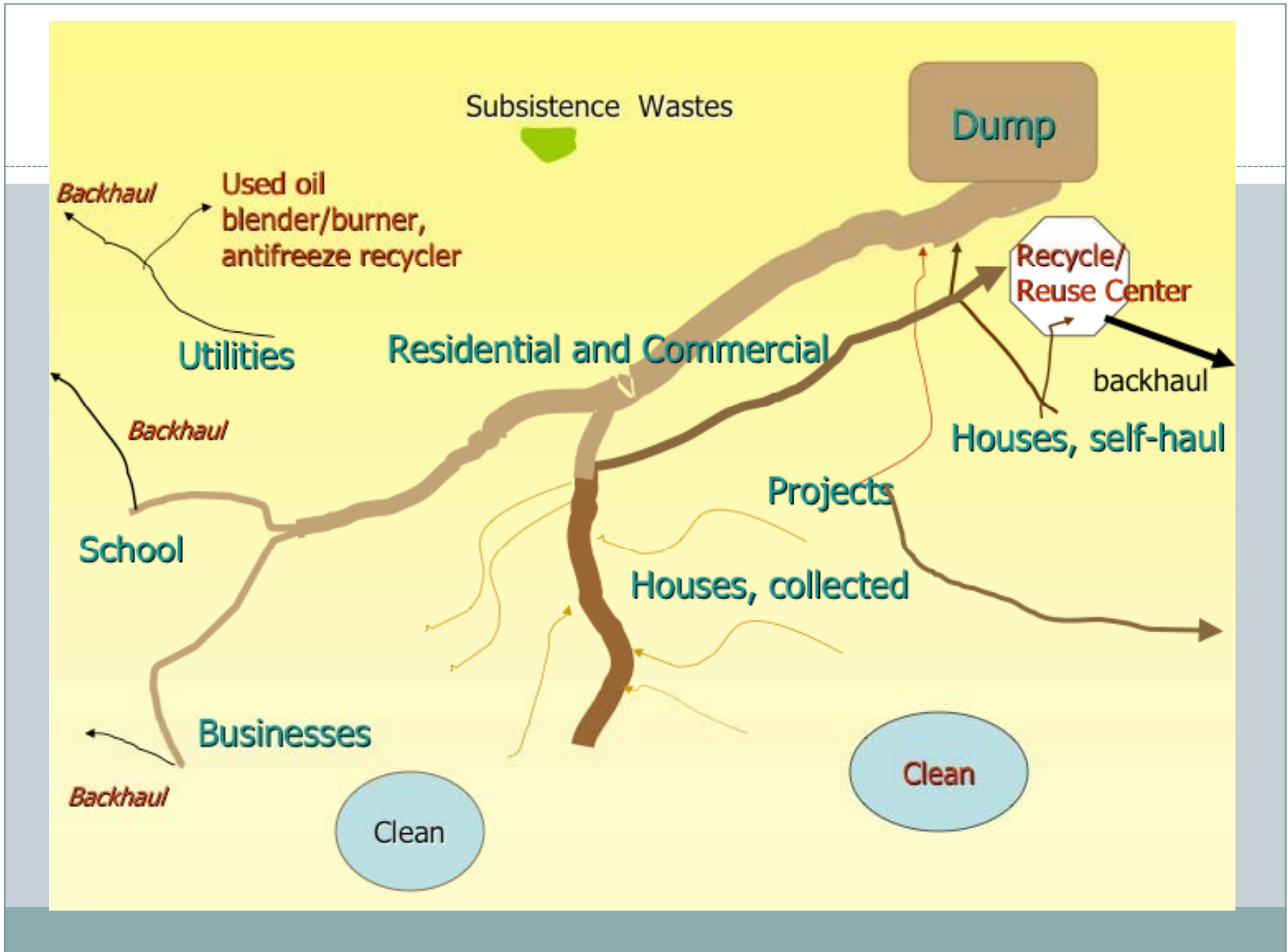


Wastestream: Just like the waterways and trails, your wastestream must be learned well to live well.



How much of each kind of waste do you have? Where does it start? What wastestreams are most important to work on? Which wastestream can be made smaller or less hazardous?

Learning your wastestream is called a “**wastestream analysis**”. Some people say “**waste assessment**” or “**waste characterization**”.



How can waste contaminants get into source water?



- Waste dumped directly into source water.
- Waste dumped at dump or elsewhere on ground:
 - Leaches out from dumpsites wastes or other litter sites (think coffee grinds and water) and flows underground to water body. This is called leachate.
 - Flushes out overland (or overland and underground) due to flooding
 - Overland flow from rain, snowmelt
 - Settles out or rains out from burning emissions
 - Transported via vectors (humans, animals, boats, atvs, birds that have contacted the waste).
 - In plumbed villages, hazardous wastes such as medicines, cleaners, paints, etc. might be dumped/rinsed down the sink (point source).
 - Other??

Type of function	Year	Location	Source	Weight
Algebra	1911-12	Algebra (part of the ...)	1	1
Geometry	1911	Geometry (part of the ...)	1	1
Calculus	1911	Calculus (part of the ...)	1	1
Statistics	1911	Statistics (part of the ...)	1	1
Physics	1911	Physics (part of the ...)	1	1
Chemistry	1911	Chemistry (part of the ...)	1	1
Biology	1911	Biology (part of the ...)	1	1
History	1911	History (part of the ...)	1	1
Political Science	1911	Political Science (part of the ...)	1	1
Economics	1911	Economics (part of the ...)	1	1
Law	1911	Law (part of the ...)	1	1
Medicine	1911	Medicine (part of the ...)	1	1
Engineering	1911	Engineering (part of the ...)	1	1
Architecture	1911	Architecture (part of the ...)	1	1
Art	1911	Art (part of the ...)	1	1
Music	1911	Music (part of the ...)	1	1
Physical Education	1911	Physical Education (part of the ...)	1	1
Language	1911	Language (part of the ...)	1	1
Foreign Languages	1911	Foreign Languages (part of the ...)	1	1
Mathematics	1911	Mathematics (part of the ...)	1	1
Science	1911	Science (part of the ...)	1	1
Humanities	1911	Humanities (part of the ...)	1	1
Business	1911	Business (part of the ...)	1	1
Education	1911	Education (part of the ...)	1	1
Health	1911	Health (part of the ...)	1	1
Environmental Studies	1911	Environmental Studies (part of the ...)	1	1
Interdisciplinary Studies	1911	Interdisciplinary Studies (part of the ...)	1	1

Table 1.1.1. Name of the last function of each type. The table shows the last function of each type of function. The table is organized by type of function. The table is organized by type of function. The table is organized by type of function.

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Types of chemicals from burning of regular trash at **1400F** in a burn barrel with well-designed puncture holes and wire mesh on top, with good draft properties. Numbers given equivalent to Village of 400 people.

Compound
benzene
acetone
styrene
total VOCs (tentative)
naphthalene
phenol
dichlorobenzenes
trichlorobenzenes
tetrachlorobenzenes
pentachlorobenzene
hexachlorobenzene

Compound
acenaphthylene
naphthalenec
phenanthrene
aldehydes & ketones
total dioxins
total furans
total PCBs
PM10
PM2.5
HCl
HCN

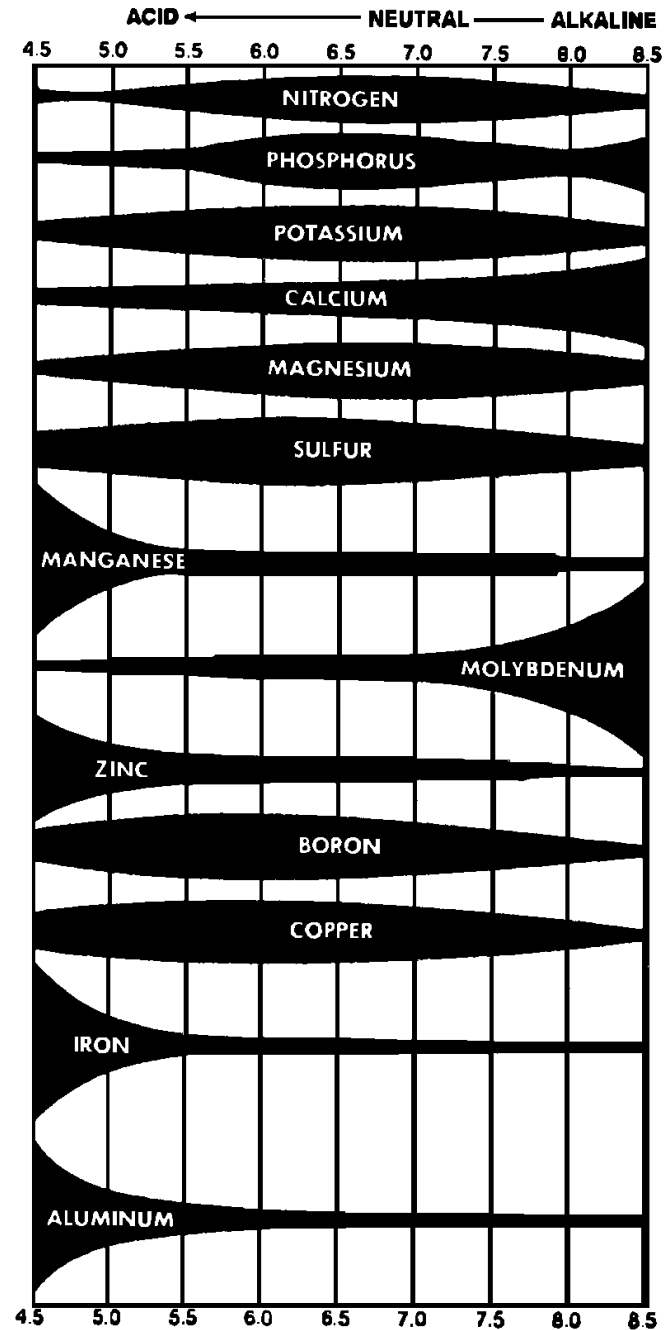
Different chemicals move differently in the environment

- Some are **VOLATILE** – they go into the air
 - benzene, gasoline vapors, solvents (these dissipate quickly so if there is a transient, acute source, it might not affect water quality)
- Some **DISSOLVE IN WATER**, and move with water
 - sugar, salt (these are of more concern!)
- Some **HATE WATER**, and would rather stay in soil
 - oil, DDT, PCBs (some avoidance by intakes away from water surface and bottom sediment, and minimizing turbulence.)
- Some break down quickly in the environment; others don't (this means you might have contaminants in your water and the source is no longer there).
- It is very difficult to know what contaminants and how much of each might get into the water.

Soil and Water Source are key factors

- What your water source is affects the fate and transport of waste and its contaminants. That is partly because leachate travels **through soils and sediments (and plants)** in surface and subsurface movement, runoff and flooding.
- For soil, Ph, soil charge, organic matter content, electrical conductivity, plant type and density, and soil compaction all will affect the composition of leachate that reaches your water source. So will temperature and temperature/season fluctuations.
- For example acidic soils are more likely to leach out metals. Metals are best retained in soils that are 6.5 to 8.5. Positively charged metals (and any positively charged contaminant) are retained better by negatively charged soils. Because it is negatively charged, nitrate is very mobile in negatively charged soils, but not in positive charged soil. Southcentral soils are generally acidic (some very acidic) and Interior are more often neutral and some alkaline.
- Most soils are negatively charged. But if the contaminants are bound up in colloidal particles, it's better to have positively charged sediment. On the other hand, if the leachate travels through wetland, other mechanisms can “take the place” of a positively charged soil.
- Contact UAF ext. or USDA to see if soil types in your area have been assessed.

UAF Coop ext. illustration of effect of pH on availability of nutrients, metals. The diagram is an example of why you can't make generalizations about the effect of a certain water or soil parameter on contaminant fate and transport.



Some more miscellaneous factors

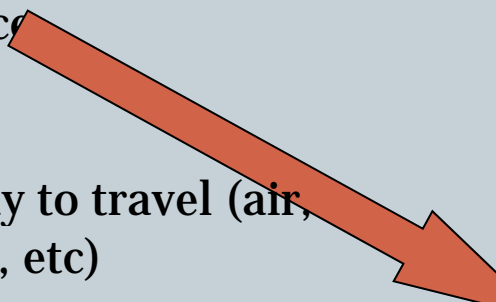
- Rain is acidic – if you have a lot of rain water flooding out the dump, you'll have a different mix of leachate than snowmelt flooding.
- Turbulence adds oxygen to the water and soils. That creates chemical reactions that release some contaminants, especially if you have a lot of sulfide in your sediment.
- If your source is a pond or lake, you'll have less flushing and dilution of waste contaminants. So you need to pay attention to both short- and long-term waste practices and circumstances. If your source is a river, some questions are whether some/all contaminants are reaching your river throughout the year, or only during flooding. And if you have contamination— is it from a transient unusual source (such as someone dumped a drum of oil), or is it from waste that is regularly dumped. If what you are seeing is from a historical waste event (such as mercury from mining, there isn't a lot to manage for wastes, and how you might want to protect or treat water for this might be different than if you know it is an ongoing event.
- Etc., etc. Hydrogeochemistry is extremely complex. Each situation will be unique.

What makes a completed exposure pathway?



1. Source

2. Way to travel (air, water, etc)



3. Point of contact

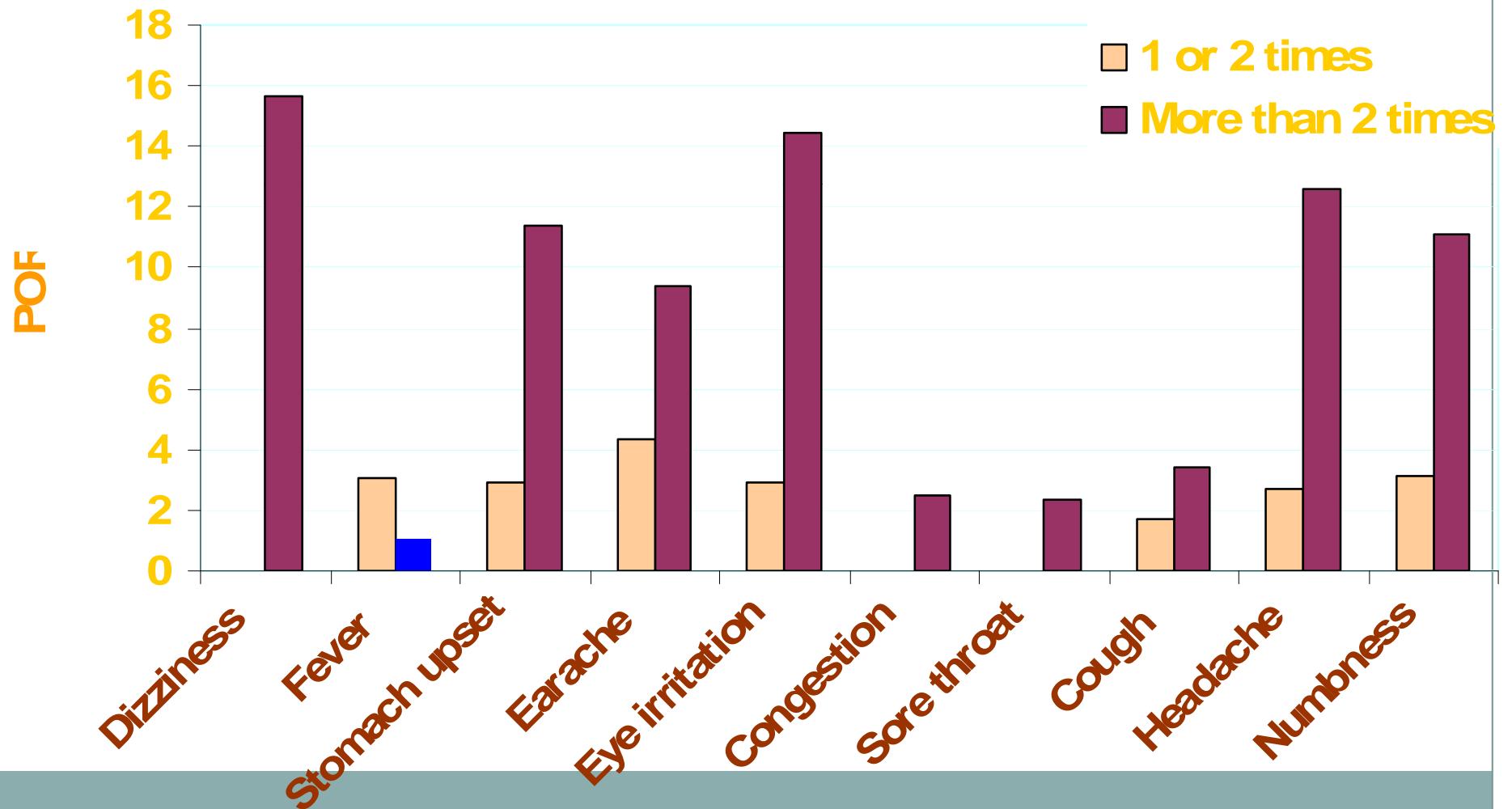


4. Route of exposure

Are wastes actually dangerous?: Relative risk of symptoms related to waste disposal factors in four Alaska Native Villages, 2001.

Symptom	% Affected	Live near dump	Dump smoke or odor concerns	Burns near home	Visits dump
Rash	7.2	-----	2.3	29.7	2.9
Faintness	3.6	4	6.3	5.4, 13.2, 17.4 frequency ↗	3.5
Fever	8.7	-----	1.7	2.3	2.0
Stomach pain	10.3	-----	2.2	-----	3.0
Vomiting	2.6	-----	1.6	-----	3.6
Diarrhea	5.2	-----	1.5	-----	-----
Ear irritation	4.4	-----	5.5	-----	2.1
Eye irritation	5.9	18.9	2.3	-----	3.7
Congestion	19.4	-----	1.8	-----	1.4
Sore throat	14.1	-----	1.8	2.0	1.6
Cough	18.4	-----	1.5	1.9	1.7
Headache	14.1	2.9	2.0	-----	3.0
Numbness	3.5	-----	2.6	4.8, 5.2, 10.1 frequency ↗	3.4

Visits to Dumpsites – Not only are our sites unhealthy, the risks support that the sites are poorly contained/managed. Source water may suffer impacts from this poor management.



Birth Outcomes Study

- **A study was performed using birth records from 1997 – 2001 from mothers who resided in 197 Villages, together with dumpsite rankings. Plumbing did not matter in the results.**
- ✓ **Infants weighed on average 36 grams less** when born to mothers from the high exposure group than infants in the intermediate exposure group and **55.4g less** than infants in the low exposure group.
- ✓ On average, **pregnancies lasted 1.2 days less** in mothers from high hazard potential Villages than pregnancies in the intermediate hazard ranked Villages.
- ✓ **Infants** born to mothers residing in Villages with **high hazard dumpsite contents** were **4.3 times more likely to have “other defects”** than other infants.
- ✓ Additionally, **positive odds ratios** for all congenital anomalies, central nervous system anomalies, circulatory and respiratory anomalies, urogenital anomalies, musculoskeletal and integumental anomalies, multiple anomalies were found. The estimates were similar to significant associations found in other birth defect studies on maternal populations living near open dump sites in developing countries, **indicating that associations in Alaska Villages with these birth defect categories could be significant with a higher population size or greater exposure detail.**

Ok – How do we get waste out of source water?

We don't. Or at least treatment is really a backup method to prevention. Source water is almost always better protected than treated. Chlorine and physical filtration can only remove some pathogens and only portion of contaminants, and only some types of contaminants. Bio-filtration (the bugs in the sand filtration film) can remove a larger portion of contaminants, but not all, and the same for even for carbon filters. Some types of contaminants are not removed at all. But the technologies that can remove all of the contaminants that can result from solid wastes are so expensive and complex that even big cities would have a hard time financing them (let alone test for them— given the 10,000's of unregulated chemicals). And we all know that treatment systems can fail. To fully protect against waste contamination, Villages are left **ONLY** with protecting their water in the first place.

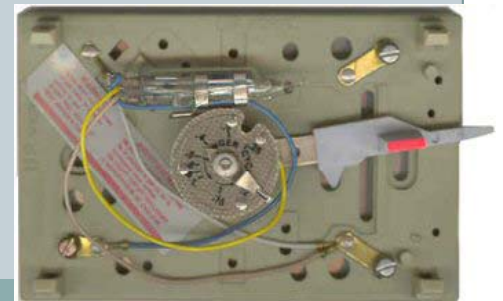
We don't know enough about the level of exposures to different leachate components. So ideally, we'd protect against all wastes, versus particular contaminants. But if you need to start with something, Lead, Mercury and Cadmium are the most common heavy metals in landfills, by far. We would expect the same to be true for Village dumps. The percent of lead in Village dumps may be higher than national averages because vehicle batteries are not recycled very much here and in Lower 48 they have over a 95% return rate. And if we remove the wastes containing Pb, Hg, and Cd, we remove a lot of other nasty contaminants.

Tonnage Estimates for 3 heavy metals disposed in US MSW Landfills, YR 2000

Metal	Tons/yr	Percent
Lead	127,108	97.6
Cadmium	2,680	2.1
Mercury	383	0.3
Total	130,171	100.0

What is mercury from and how do we get rid of it?

- Mercury is a neurotoxin, it affects nervous system development in infants, and in adults a wide range of impairments. Methylmercury is most available in acidic environments, and is the form of greatest concern to humans.
- **Appliances, thermostats, and cars:** Some freezers, stoves, thermostats, irons, dryers, and cars have **Mercury** switches or sensors. The amt is pretty high— from 1 gm to as much as 18 gms for an older wall thermostat. So one ampule contains as much as 250 to 4,500 fluorescent bulbs. This is is potentially the biggest source of mercury at the dump. You can **remove this risk by removing the switches and storing them safely**. Alternatives to mercury switches are increasingly common, and due to the lack of control at village dumps, may be something to actively advocate for in construction projects and community outreach.
- **Medical:** Also, old clinic equipment can contain a *lot* of mercury. Make sure your clinic backhauls all of its blood pressure cuffs, thermometers, batteries, etc. when they are replaced.



Mercury Continued



- **Batteries:** Button cell batteries, especially hearing aid batteries, contain mercury. These don't take any space to store, and are easy for folks to separate out. Help the community get in the habit of collecting them.
- **Lights:** fluorescent lights contain mercury too. These are easy to collect and eventually backhaul. EPA regulations make sending mercury –containing wastes easy so as to encourage recycling.
- One of the biggest sources of mercury in the air in the United States (35%) is from **waste burning**. And that is from mainly incinerators that treat the emissions and minimize ash. Village burning is open burning. And ash can settle. There is no reason why a community should have ANY mercury in their burnstream. Mercury is in few enough products that they can be taken out.

How to protect against lead and cadmium.

- **Lead affects ability to learn**, Poor muscle and bone development, Coordination problems, and Speech and language problems
- **Lead** comes mostly from vehicle batteries (“lead-acid batteries”). A community of 400 people can make close to 2,000 to 4,000 pounds of lead **each year** from this source. One car battery contains about 18 lbs of lead, and 1 atv battery about 8 lbs.
- Computers contain a lot of lead (about 4 lbs). “Picture tubes” in TVs also contain lead.. Batteries can be backhauled free. Stage your e-wastes covered & off the ground and look for ops to backhaul.
- **Lead-shot and lead sinkers**: We don't know how much lead is contributed by this source to our waters.
- **Cadmium affects kidneys, lungs, and bones, and**, and like many other harmful heavy metals are in computers and other electronic goods. **Computers must be stored until they are backhauled. Don't burn electronic items, including household batteries. Backhaul or recycle them.** Educate kids about electronic games. Try to reduce use. **Work with the school** so that they backhaul their computers on their charter flights and barges.

Besides advocating for household collection and waste separation, what can you do?



- Go to the dump. Find some totes or get a business/shipping company to donate an old connex. Put a sign up for e-wastes and batteries and you're in business. You don't need any precautions, other than handling old batteries s/b done with gloves, full clothing, and eyeglasses.
- Check out how the dump is expanding. Is it going towards the river/pond? Rope it off, get on the vhs, whatever you need to do to get people to dump on the other side.
- Burn only when downwind of source water. (Advocate!)
- Depending on where/how you intake, you might be able to modify where in the water column you draw from. Because some contaminants are hydrophobic – they'll be on the surface. And some precipitate out or attach to settleable solids so they'll be on the bottom. The middle draw is typically best. Your intake might be fixed – but what about folks using untreated water? Educating them can help.



- Intake – possibly close off during potential first flush events if you have control. Or you might consider testing during first flush to see if there is a difference in your heavy metal or hydrocarbon levels.
- Plant plants! Anything you can do to encourage tundra, wetland, other plants to grow around the dump and/or to not be disturbed can help. Can you rope off or barricade multiple access points? Plant cover means contaminants are uptaken by plants and soil, much much less reaches the water.
- Encourage good boating and ice fishing (chain saw) practices around your source water.
- Set up convenient waste containers for boaters– whatever will make them less likely to discard trash in the water and beach.

Educate to Collect!



- “Free” or mandatory Collection Service: This is the biggest key to keeping solid waste away from source water.
- If folks have a way to discard trash – they won’t dump it elsewhere.
- A collection service can sort out most harmful wastes.
- It keeps the dump footprint smaller, growth controlled in the right direction
- Encourages recycling
- Work with your Tribal Environmental Dept. to encourage folks to subscribe to a collection service. Or help a private hauler get started as a source water protection program.
- Lots of educational material, how to purchase village collection equipment, case studies on collection services:
<http://www.zendergroup.org/collection.html>

More to do



- The State has a program that works with contractors to properly discard project wastes. They work with the dumpsite owner and the contractor. Get involved in these discussions to make sure that source water is considered. Your expertise can help make the right decisions.
- Council and Corp development projects – keep informed of planned, potential projects. These are often planned by folks who don't realize the impact there could be on source water. There is a funded project database on the State website, and your Council(s), schools, utilities, and corps are good to ask.

The bright side!



- Recycling is increasing! Batteries, used oil, electronics, scrap metal.
- The hazardous wastes generated in villages are not nearly so bad as what is generated in cities. And because there are no roads, you don't have to worry about hazardous wastes being illegally transported and dumped.
- Wastes defined as hazardous under RCRA must be disposed at a hazardous waste facility, so the hope is that construction projects pay attention to that.