Comments on Safer Products for Washington: Identifying Priority Chemicals Cycle 2 Phase 1

The June 2023 Draft Identification of Priority Chemicals Report to the Legislature (referred hereafter as the Priority Chemicals Report) identifies the priority chemicals for Cycle 2 Phase 1. While I strongly support the well-grounded and justified selection of all these chemicals, I will limit my comments in this letter specifically to lead.

Lead is a 'toxic champion' that makes any 'top X list' of toxic chemicals, typically near the top, no matter the government or organization. For example, lead is currently ranked 2nd among the major toxic substances in the United States by the Agency for Toxic Substances and Disease Registry (ATSDR) [1]. The dangers of heavy metals in general are epitomized by the ATSDR ranking as number 1 is arsenic, number 3 is mercury, and number 7 is cadmium. WHO has also identified lead as one of the top 10 chemicals of major concern for public health. It follows that selecting lead as a priority chemical in the next round (chemicals number 6 through 10 for Washington state) would be consistent with many other agencies and governing bodies.

The aim of my note is not to repeat all the excellent reasons why lead should be in the next group of priority chemicals – the Draft Priority Chemicals Report noted above already makes a very strong case. However, I hope I can add some additional information that strongly supports the selection of lead as a priority chemical along with the numerous uses of lead products requiring regulation.

Sincerely,
David Krizan

A) Selecting Lead as Priority Chemical – Additional Considerations

A. 1) There is no safe level of lead, period.

For many decades now, and arguably centuries, scientists have revealed and refined the know dangers of lead. The trend has been entirely in one direction; 'safe levels' of lead have been lowered time after time again, until a broad scientific consensus has formed that, as the WHO states, '*there is no level of exposure to lead that is known to be without harmful effects*' [2]. Very recent news from the EPA (this week) also uses the same language [3].

While it is always rightly noted that children are the most susceptible and sensitive to lead poisoning, it is often overlooked or minimized that there is no safe level of lead in adults either. There needs to be a focus on children of course, but the communication of lead reduction strategies for children can give an erroneous impression that lead is safe for adults.

A peer-reviewed 2018 paper published in the Lancet [4] states that 412, 000 people die from lead-induced cardiovascular disease annually in the United States. They further state that '*Low-level environmental lead exposure is an important, but largely overlooked, risk factor for cardiovascular disease mortality in the USA. A comprehensive strategy to prevent deaths from cardiovascular disease should include efforts to reduce lead exposure*.'

Peer-reviewed work from outside the United States support this conclusion. For example, in [5] they state that the risk of death due to cardiovascular disease increases with long-term lead exposure and supports the findings that risk of coronary stenosis increases 1.25-fold with every 1 µg/dL increase in blood lead levels. This is a large increase in risk for what has, until recently, been generally considered a low and insignificant change in blood lead levels in adults.

Further reducing lead exposure will be difficult to achieve unless all stakeholders (from government to the public) understand this point. I've asked a lot of otherwise educated people about this and they know that lead is dangerous to children, but they haven't yet caught up to the science of no safe level of lead for anyone. And I'm sure you've come across comments that trivialize and minimize lead exposure, that go something like '*sure lead is bad for you, but only if you eat a lot of it every day. So don't eat your fishing sinker*'. I can't count the number of times I've seen/heard comments like that and it's not then surprising when the same people don't understand why the sum of very small amounts of lead from numerous products are a hazard to their health.

I would strongly urge you to emphasize the point that there is no safe level of lead, for *anyone*, in any communications or public education materials. It's not just a matter of

education but also establishing the proper baseline for understanding any future lead regulations.

A. 2) The natural level of lead in the environment is overstated.

Many reports on lead mention some natural level of lead in the environment. By normalizing lead in this way, it makes any effort to reduce lead poisoning very difficult. While technically true there is some natural level of lead, what is becoming increasingly clear is that the actual natural level is vanishingly small. Human activity has displaced lead from the Earth's crust for several thousand years, with a very steep increase since the beginning of the Industrial Age a couple hundred years ago. Until recently, there was consensus that the average levels of lead prior to the industrial age were the natural levels. This innovative study from a peer-reviewed journal in [6], discussed in article [7], calls this into serious question. From [6]:

"*During the Black Death pandemic, demographic and economic collapse interrupted metal production and atmospheric lead dropped to undetectable levels. This finding challenges current government and industry understanding of preindustrial lead pollution and its potential implications for human health of children and adults worldwide*".

It is well known that lead serves no useful purpose in the human body (or any other known living organism). If there were some higher natural levels in the environment one would think that evolution would have found a use for lead, as it did with other notably toxic elements, such as oxygen - although we associate oxygen with life, it was very poisonous to early lifeforms on Earth. From the standpoint of humans and animals, lead is as foreign a substance as PCBs.

I've seen various estimates (before the study in [6]) that the levels of lead we have in soil throughout the world are 1000-2000 times greater than natural. This number will likely go up based on the work noted above. However, even at *only* 1000-2000 times natural levels, we are already living in a very lead-contaminated world. This is an important point to communicate as we need to de-normalize lead contamination. Globally, approximately 5 million tons of lead are mined, and 11 million tons are used for new products annually, with the difference made up by recycled lead. It's vital to emphasize that every pound of lead that is mined is an additional pound of toxin - with no safe level in humans – that needs to be managed forever. Lead can react to form different compounds that have varying toxicity profiles, and break down and disperse over time, but at its core lead is a stable element and is thus forever. All you can do is move it from one place to another.

A. 3) Broad action is needed to prohibit lead in a wide array of products

I can't emphasize this point enough – trying to choose the highest priority consumer products in a highly selective manner will lead to difficult-to-understand regulations that will frustrate and confuse the public and allow broad loopholes for lead sellers to exploit in existing and new products.

If we can follow the science that there are no safe levels in lead in the human body, then the direction is clear - prohibit the use of lead in as many products as possible and 'de-lead the economy. Whether a product exposes people or the environment to 'a lot' of lead, or 'just a little' lead, it clears the bar of no safe levels of lead and confuses the public with complicated and conflicting information on what is supposed to be safe or not.

A. 4) Consumers are often unaware of products which contain lead.

For some of these items I describe further on, the buyer wouldn't likely even know there is lead in the product. Everyone I have casually spoken to about this (who are often very well educated in general) incorrectly assumed that everyone knows lead is dangerous and so it's obviously not used in product X.

There is an erroneous 'mission accomplished' aspect to reducing lead exposure since it was banned in (most, see later in this report) gasoline. And review of lead usage worldwide will show this toxic industry is still growing.

There are just too many and often hidden uses of lead in products and it's basically impossible for the consumer to be aware of it all, particularly since companies don't need to disclose in many cases what's in their products. And when companies do give information on materials, they frequently stop at the incredibly broad categories of metal, plastic, and wood. It would be like having label on food packing that only had the categories of hard, medium and soft ingredients.

A. 5) Companies are often unaware of their own products containing lead.

Even employees at companies selling these products aren't necessarily aware or forthcoming and that's for US-based companies. Many of the products I listed can be purchase on online marketplaces by resellers and importers. From my experience, they have a woeful understanding of the products they are selling. It's exceedingly difficult and frustrating to get material information from them on their products - if you can even reach them in the first place. And if you do, they often reply that they essentially have no idea as

a manufacturer, often overseas, makes these and they just buy them and have no way to get this information from the manufacturer. Or, more typical of US companies, they state that they don't reveal their materials for competitive reasons. This too is entirely unacceptable as any competitor can easily identify these materials in any number of material labs. Clearly, companies don't want consumers to know this information. I hope that as part of these regulations there is a mechanism for companies to 'know their own products and be transparent with consumers what's in them'.

A. 6) The lifecycle impact of large sources of solid lead

I can't find unbiased and peer reviewed papers that quantify how much lead is spread over time from solid lead when used in real world settings where lead wears over, or rubs against another object, is handled, and or exposed to sweat and water, or and so on. Any research I have found always considers some ideal lab-like situation or other highly controlled setting.

But considering the allowable amount of daily lead ingestion is measured in micrograms per day (µg/day) and these sources are in many cases kilograms (a billion µg) it takes only the very tiniest fraction of lead from such a major point source to cause significant contamination. Since lead is not hard diamond, it's difficult to argue this contamination isn't occurring. Using the 'precautionary principle' it should be the responsibility of sellers of these products to demonstrate they are safe to use in real-world uses.

Of course, we know that is never going to happen (and realistically, there are so many products that realistically testing them all would be difficult) so the best course of action is to simply ban the use of solid lead, particularly where it's used in the most primitive of functions as a weight. It seems ridiculous to use toxic materials in the 21st century in such a basic way. Further on I give a number of unnecessary uses of solid lead, and in all cases, there are multiple material alternatives.

Also, even in cases where solid lead could be demonstrated to be less hazardous to use than other forms of lead (and again, this would require financially unbiased and peer-reviewed research), you must still consider the entire lifecycle of the lead, from mining to manufacturing, and recycling and all the people, often underprivilege people in foreign countries, who must do that work. Every additional pound of lead usage means another pound of lead for that cycle and another pound of lead that must be handle and moved from place to place, essentially forever, as it is an element.

B) Priority Products Containing Lead - Additional Considerations

B. 1) Pull-out kitchen faucet hose counterweights

- **Description**: These are the 3-5 lb. weights that attach to a faucet water hose to help the faucet head retract after it is pulled it out. One made entirely of lead (confirmed by the manufacturer) is shown in my photo below:

- It's not clear how many models are sold with these lead weights, but I've so far come across at least 3 companies who've admitted to selling them. When contacted, I've received a wide range of response from faucet manufacturers: along the lines of "*yes it's lead, no we don't use any lead, we don't answer any questions on materials in our products, we don't know as we're not the manufacturer and have no way to get this information from overseas, to no answer at all"*. There is a dizzying number of faucet makers at stores such as Home Depot, Lowes, and Amazon, and many more.

- **Exposure & Sensitive Populations** – These are very large potential single point sources of lead, in the range of 1 kg to 2 kg. Since lead exposure is measured in micro-grams, it is useful to think of it in terms of 1 billion to 2 billion micro-grams. The lead weight is subject to movement and impact against neighboring objects (plumbing fixtures and objects stored under the sink) every time the faucet head is pulled out and then retracted. I've observed some people are abrupt in the way they pull out and retract theses faucet heads, only adding more force to any lead weight impact below the sink. You can see from my picture on the previous page that this quite new lead weight, about 3 years old when I took the photo, was already showing noticeable signs of contact and abrasion. This removed lead would have transferred onto neighboring objects. Recall again how much lead is in the weight and how little must be abraded to cause a concern. And keep in mind the mantra 'there is no safe level of lead'.

  This particular lead faucet weight was present in a home of someone I know with four small children. The area under the sink was used on a very regular basis as it contained small bins for trash and recycling, as well as storage of paper products such as bags, and other often used items. Ironically, no household cleaning chemicals were stored there in order to prevent any accidental exposure to the young children. In fact, they were 'training' the children on how to use the trash and recycling bins so it's very possible they ended up rummaging around whatever else was under the sink (Again, the parents stored no cleaning products there for precisely that reason). The parents had no idea they had several pounds of pure lead toxin located there as it was not labeled and they reasonably assumed that lead was no longer allowed in plumbing products.

  How much of the lead that was abraded ended up on objects handled by the adults, or even worse, the children? It seems very likely that this happened through normal activities.

  I've looked at research to see if there are any peer reviewed studies that quantify how much lead material would be rubbed off this soft weight in the often cramped environment under a sink. I couldn't find a precise study but looking at some research I came up with a back-of-the-envelope calculation in the 10,000s µg per year. Keeping in my 1 cubic millimeter of lead is 11,600 µg, this isn't a whole lot of volume. But it could vastly exceed even the current (and soon to be lowered) limits of acceptable lead dust from the EPA of 10 µg of lead in dust per square foot (ft^2) for floor dust and 100 $\mu g/ft^2$ for window-sill dust.

  Besides occupants in these home, plumbers and construction workers would also be exposed to lead from these lead weights as well as the people who manufacture them (often overseas) and the workers in stores that sell them.

- **Disposal** – Literally no one I spoke to outside the faucet companies considered that these weights could possibly be lead. They assumed that since all faucets now are 'lead-free' (which is also not entirely true for kitchen faucets and not true at all for bathroom faucets) that it would be forbidden for a company to brazenly sell several pounds of lead along with the faucet. So, when these items are discarded it's quite likely they aren't always sent to a hazardous waste site.

- **Safer Alternatives** – Some companies that did give information regarding the weight stated they use iron, steel, zinc alloy, high density thermoplastics, or iron sand. These are feasible and available. There is also a clever solution from a company called Sustainable Solutions (no financial interest) that uses a spring on the faucet hose and eliminates the weight entirely (https://www.sustainablesolutions.com/): There are also increasingly popular 'commercial pre-rinse' kitchen faucets that don't pull out at all but have a flexible curved hose encased in a spring, as shown in the example below (again, no financial interest):

Example of Commercial pre-rinse kitchen faucet: Kraus Oletto Touchless Sensor Commercial Pull-Down Single Handle Kitchen Faucet. Source: https://www.homedepot.com

- **Requested Regulatory Action** – Plumbing fixtures are federally regulated by the NSF/ANSI 61 standard, but this only applies to surfaces that come into contact with drinking water. So, there is a large loophole that allows lead to be used in faucet weights. Simplify the rule so lead is banned on the sale or import of any plumbing fixtures and accessories.

B. 2) Other plumbing components

I would like to also highlight that it no longer makes no sense to limit NSF/ANSI 61 only to plumbing components that come into contact with drinking water. Referring again to 'there is no safe level of lead', then all plumbing components need to be lead-free, in order to protect plumbers, home renovators, and workers in manufacturing plants. Even outdoor water faucets need to be lead-free. I'm still amazed how many leaded outdoor faucets (and plastic hoses containing lead) are sold and then used by people to water their gardens

A common criticism in the past has been that brass without lead is difficult to machine, but newer brass alloys with bismuth or silicon machine just as well and have the same corrosion resistance as lead brass alloys, according to peer-reviewed research out of Virginia Tech [8].

There is no good reason to continue allowing the sale of leaded plumbing fixtures of any kind.

B. 3) Lead tape

- **Description** – Typically a ¼" or ½" wide tape made of solid lead with an adhesive backing. Used to balance tennis, racquetball, squash, and other racquets as well as golf clubs. Lead tape has also been traditionally used in electroplating (often in wider widths). Sellers of lead tape have wasted no time in picking up on the recent popularity of pickleball and now sell the same lead tape but labelled as 'pickleball' lead tape!

Source: https://www.tennisexpress.com/gamma-lead-tape-36-yards-2731

- **Exposure & Sensitive Populations** – When used on tennis (or other) racquets for example, the tape is used on the exterior frame of the racquet head or under the grip tape on the handle. Some players believe this added weight helps their swing and as an extension their game. The real-world use of this tape means it is eventually subject to sweat from the tennis player, water from spilled water bottles, and rain when used in

outdoor courts. Furthermore, the tape particularly on the head is fully exposed to abrasion from striking a tennis ball or if the racquet falls to the ground or is stored where it can rub against another material, such as a tennis bag or backpack while it's carried, a locker, a closet full of items, and much more. I've even seen people carry on these racquets onto an airplane and store them in an overhead compartment where they get jostled around with all the other luggage during turbulence, landing, and luggage handling. It doesn't seem to be that sensible when you think about it.

How much lead is rubbed off and contaminates hands and surrounding objects like tennis bags and backpacks (which often also hold someone's lunch or snack). A ½" wide tape typically weighs 0.5 grams / inch or 500,000 µg / inch. Again, an exceedingly small percentage of the material rubbing off results in a high level of lead contamination and lead is a soft metal so prone to rubbing off. And any moisture that gets on the tape increases the amount of lead available for abrasion due to leeching of the lead.

Similar tape is use on the clubhead of golf clubs.

I spoke with a tech at a tennis pro shop in Seattle and he indicated he really doesn't like working with lead tape, as it needs to be cut and handled extensively when installing. But he said that people ask for it and it's his job, so he does it. However, he would prefer that only non-lead tape was available as it works well and is safer for him to use. Of course, who wouldn't want to work daily with safer materials?

Besides workers in these pro shops, and adult golfers, some children are likely exposed to this as well through either using the lead tape themselves, working in these pro shops, tennis courts, or golf courses, working as golf caddies, or working in sporting goods stores (like Dick's, as one example, who sells this tape). Additionally, children of avid tennis and golf players or workers that make this tape can be exposed as well.

- **Disposal** – If someone buys 'lead tape' then hopefully they will discard it as hazardous material. But it's a good bet that compliance is far from 100% - does anyone really believe this tape is brought to a hazardous waste facility when it needs to be discarded? Additionally, some people may not install the tape personally, but have it done at a pro shop, which may or may not inform them it's lead. So, it's reasonable to expect a significant amount of this lead tape ends up improperly disposed.

- **Safer Alternatives** – Tungsten and copper tape are effective and available. They are a bit less dense but the slight increase in thickness isn't a problem in these applications. Some tennis players even use standard electrical tape – it might not be pretty but it gets the job done for them. There's no need to use lead tape.

Additionally, a company called Ecomass (no financial interest) has developed an innovative dense compound that can be used to replace lead in many applications, including for weight and balancing: https://www.ecomass.com/weighting-and-balancing-2/.

As for lead tape used in electroplating, there are various options but widely available aluminum tape is a good option when electroplating with harsher chemicals. Again, there is no need to use lead tape.

Requested Regulatory Action – Ban the sale or import of lead tape.

B. 4) Diving weights

- **Description** – Diving weights are typically made of lead shot or solid lead. They are used to balance the buoyancy of the diver (and also for submersibles).

Source: https://www.walmart.com/ip/Scuba-Choice-Diving-Soft-Mesh-Lead-Shot-Weight-5lb-Made-in-USA/453677883

Source : https://www.houseofscuba.com/collections/weights/products/wbelt74

- **Exposure & Sensitive Populations** – Lead shot has a very high surface area to volume ratio. The soft bag that contains the lead shot conforms to the shape of the diver's equipment and body and whenever they move, there is some contact between the faying surfaces of the pellets of lead. Divers report seeing visible clouds of lead dust from this lead shot when they enter the water or wash their equipment. There is logically then dust present whenever the weights are moved when they are dry, contaminating wherever they are stored and transported. The solid weights have less surface area and likely pose less risk to the diver compared to the lead shot but certainly lead particles wash off every time they dive, whether in fresh or saltwater. Also, due to their weight and because they are typically uncovered, they are prone to scratching, which would release a significant amount of small lead particles.

  I have often come across erroneous beliefs that lead doesn't break down– of course, lead is not diamond but a soft metal that is subject to oxidation and breakdown in both air and water. And it's difficult to picture the minute quantities of lead that can contaminate water – for example, a single dissolved bullet fully dissolved is enough to bring a full day's supply of drinking water to a city of 200,000 people above EPA lead limits. It really doesn't take much.

  There aren't many studies I could find that reliably quantify lead exposure in divers. A pilot study in 2014 [9] was conducted but the sample size of 20 was not representative

of divers in general and more concerningly, the blood samples were taken an average of 4.8 weeks after the last dive (with a range of 1-18 weeks). Since lead has a half-life of 30 days in blood, this is a significant source of error. But if you only consider the average BLL (Blood Lead Level) of 2.65 µg/dL after 4.8 weeks, that is still well above the average BLL of adults in 2015-16 of 0.92 µg/dL, according to the CDC. And as previously noted, the risk of coronary stenosis increases 1.25-fold with every 1 µg/dL increase in blood lead levels [4].

- **Safer Alternatives** – Bismuth, stainless steel, and tungsten are feasible and available alternatives. Tungsten is a bit more expensive than lead, but it is quite a bit denser (19.28 g/cm^3 compared to 11.29 g/cm^3 for lead) and is more durable. It is possible to coat the solid lead in plastic, but then plastic is itself prone to wear and break over time. But if the plastic containment is the route, then steel can be coated too to give it better corrosion protection.

  Note that a typical diver needs about 10% of their bodyweight in these weights (depending on their weight, equipment they are wearing, fresh/saltwater diving, etc.) so the total cost of any of the materials above is very small compared to the total cost of diving equipment, which can range from $1,000-$5,000 or more depending on the quality of gear and type of diving intended), and the additional cost of diving activities and often travel.

  Tungsten is denser than lead but even if steel is used, there would be a negligible increase in volume when compared to total volume of equipment already worn by the diver. So, this shouldn't be an acceptable excuse to adopting a safer material.

  Finally, for divers who really want to use weights with smaller volumes, besides tungsten there is another option - high density thermoplastics (up to 11 g/cm^3) from Ecomass. And with greater demand with banning the lead diving weights, surely more options will be developed by industry.

- **Requested Regulatory Action** – Ban sale or import of lead diving weights. Extend this to weights generally used to submerse in water, whether for divers or small submersible craft. There are safer alternatives in all cases.

B. 5) Curtain / Drape Hem weights

- **Description** – are sewn or taped in the hem of a curtain or drape to make drapes, curtains, and shower curtains hang straighter.

Source: https://www.joann.com/fabric-cov-drapery-lead-weights-12ct/10702173.html

- **Exposure & Sensitive Populations** – Putting the weights in a perforated pouch just means the pouch is rubbing against the weight when it is handled or when the curtain or drape is moved, particularly abruptly, resulting in the bottom of the curtain or drape contacting an adjacent wall or window. The perforations in the pouch allow any generated lead dust to come out. Worse, if these weights are in the bottom of long curtains or drapes that hand to the floor, they are within easy reach of small children and dogs and cats who may handle or chew them (of course, they 'shouldn't' but any pet owner knows these things can happen, especially when they're young). And how many parents know if these are lead weights? I'm guessing not many, particularly since many of these weights are unhelpfully described with the broad term 'metal' in product descriptions.

  Additionally, people working in sewing and alteration jobs would be exposed to lead when handling these weights, as well as the people who manufacture and sell these weights.

- **Disposal** – As noted above, many consumers would not even be aware if these weights are lead since the companies currently don't have to disclose this. I've reached out to some pretty large shower curtain brands and they also had a difficult time tracking down this information – or didn't provide it at all – since they typically purchase them from overseas apparently don't know and more than what is on the package. So once again, disposal of these weights is likely not going to be to hazardous waste sites.

- **Safer Alternatives** – Zinc, steel, and ceramic are feasible and available. Even wood or plastic can work, depending on the style of drape or curtain.

- **Requested Regulatory Action** – Ban sale or import of lead curtain/drape hem weights.

B. 6) Other Lead Weights

I've already details three preceding products where leads are used simply as weights. There are certainly more:

- **Weighted vests and ankle and hand weights,** typically used for exercise:
  I purchased a weighted vest from a seller on Amazon and wanted to know if there was lead in the weights of the vest. The seller refused to provide any information so I had it tested with XRF and the filling came back as 0.81% lead. This was concerning as the seller, although not willing to look into this by contacting their manufacturer in China, assured me their vest was 'safe and *did not contain chemicals'*. The vest comes into versions from 6 to 20 lb and so 0.81% of that weight is a significant quantity of lead. These vests can be used by a wide variety of people, including children. Any wearing or damage to the vest will release lead as part of the filling as well as any residual lead on it from manufacturing under unknown safety protocols. Sensitive populations also would include the foreign workers who assemble these products, typically overseas. There's no good reason that lead weights should be every be used for any sporting product when the whole point of physical activity is to become healthier!
- **Piano key weights** – lead weights are used to "*control the inertia of the keys. A technician can add, remove, or change lead weights in the keys to change how light or heavy the keys feel to the playe*r" [10]. Again, as with other weights, there's no good reason different options can't be used such as brass, which are available. Piano tuners nor their families should not be exposed to these lead weights in a routine manner. Numerous studies of various lead occupations seems to typically point to additional lead being brought home by the worker on clothing, shoes, personal articles etc. Lead piano key weights need to be banned for sale or import while existing lead key weights should be replaced with lead-free versions when they need to be replaced during regular tuning.
- **Ballast for boats**: Various forms of lead such as lead shot, sheet lead, and lead ingots have been used as ballast in boats. Significant quantities of weight can be required, depending on the boat, and so they can come in 50 lb or larger versions. This is an enormous source of lead and should also be banned (recall the points made in Sec A.6 regarding the lifecycle of lead and reducing aggregate lead demand). Various forms of steel and concrete are alternatives. Other materials such as tungsten or even the previously material from Ecomass could also be considered and would equal or exceed the density of lead.

There appears to be no end to the ways in which lead are used for weights. To *prevent regrettable new applications of lead*, there needs to be a blanket ban on the sale or import of using lead as a weight. In every application that I can think of, there is an alternative that is safer. We shouldn't use lead weights in the 21st century.

B. 7) Lead Came for Stained Glass

- **Description** – Typically straight pieces of H or U shape lead that hold together and surround the glass panels in stained glass windows. They are typically soldered together with 50/50 or 60/40 lead/tin solder. So the metal around a typical stained glass window, which itself may contain lead in the glass crystal, is almost entirely a smorgasbord of lead.

Source: https://grandvictorian.co.uk/how-do-you-clean-leaded-windows/

- **Exposure & Sensitive Populations** – The most sensitive populations are likely people who work with lead came glass and home hobbyists. Sawing the came and soldering release very large quantities of lead dust and significant measure need to be taken to removed lead dust from contaminated surfaces and to remove lead dust from the air. This is not a trivial undertaking even for workers and hobbyists that take this threat seriously. Additional exposure would be to retail employees handling this lead came. And of course, the family members of all the above could be exposed as well by lead brought home on clothing, shoes, etc or by stained glass work done in the home.

Stained glass used indoors in homes and public buildings is another exposure route. I've seen kitchens with a dozen cabinet doors, all made from stained glass and lead came. The owners used them as if they weren't lead and didn't seem to be aware that repeated touching and moving of the cabinet doors would lead to lead dust on their hands as well as countertops. And it didn't occur to them to wash their hands after the touching the lead cabinet doors and then eating - they had become acclimatized to having it in the kitchen. If this situation results in no lead exposure, there should be real world studies to support this. Basic logic however suggests there is lead exposure. I've also observed people casually throwing jackets and purses on and adjacent to lead stained glass windows in public windows that open – to let in cooler air during the warmer months. Again, they were unaware that the area under the stained glass window would certainly have lead dust and throwing objects in around the stained glass would further disrupt and release more lead dust.

As stated previously, lead is not inert and will certainly oxidize. Many people do not like the patina formed from this oxidation and will periodically clean their leaded windows (or other lead stain glass). Scraping off the surface, which is comprised of various lead compounds (whose composition depends on the local atmosphere make-up) seems more likely than not to lead to contamination of areas under the stained glass along with the person doing the work. It would take a lot of care and skill to do this without releasing a significant quantity of lead dust and any video I've seen on the topic displaying how to do this would lead to a lot of lead contamination.

Source: https://americanglassguild.com/forum6/40.html

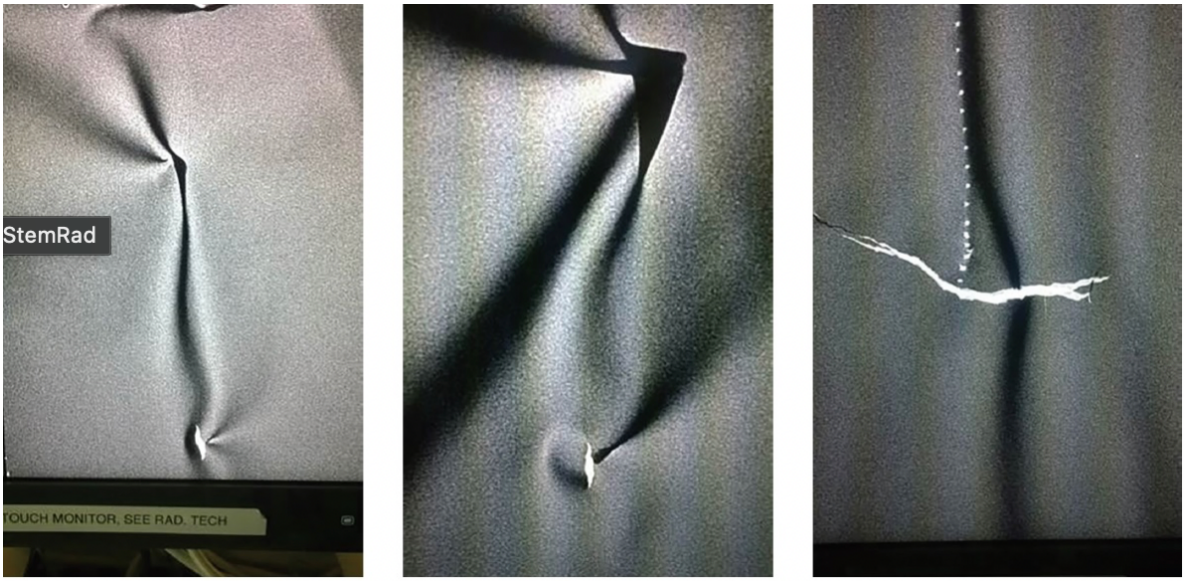
Finally, lead exposed to the outside elements will create a constant amount of lead runoff through leeching from rainwater and snow. I haven't seen a study on this specifically, but a reasonable starting point is to look at the lead runoff from ancient churches that have lead roofs. In [11] they estimate 11 kg of lead runs off 1 square meter of lead plated roof in 800 years. If you assume this is linear it works out to 1375 µg/cm^2 per year. Assuming either ¼ in or ½ in wide lead came, and the fact that a stained-glass installation can contain a large total surface area of lead came, then a considerable amount of lead will run off the windows every year and contaminate the surfaces and ground below. If it is drained, then it will find its way into our wastewater system. If there are surfaces that the runoff lead can adhere o, such as a sitting area under a stained glass window, then this can transfer to people's clothing. And if there is soil below, the lead will tend to stay in the top surfaces of the soil, where lead dust will accumulate over time and impact people, especially children. It depends on many factors, but the large amount of lead in the stained glass came and solder can easily contaminate the area around it.

- **Disposal** – One would hope any stained glass that was to be discarded would be brought to a hazardous waste facility. Of course, even in that case there is still the major problem of workers and surrounding neighborhoods being contaminated with lead when the lead is recycled. Safer materials would eliminate or at least greatly reduce that risk. Less lead means fewer problems in the lifecycle of the product (referring to Sec. A.6).

- **Safer Alternatives** – Copper foil is used for more intricate and curved stained glass, such as some 'Tiffany' lamps. Copper foil can also be readily used with lead free solder. For larger stained glass with straight edges zinc, brass, and copper came is available and feasible and can also be joined with lead-free solder. It will take a bit of re-training for artists to work with these alternative materials, but these materials and techniques are available. And of course, as more artists transition to lead-free work it can be expected there will be further innovations and material possibilities.

B. 8) Lead aprons for X-ray protection

- **Description** – lead is used to attenuate (block) radiation in a variety of protective garments sold to dentists, medical doctors, nurses, radiology technicians, researchers, and nuclear power plant workers.



Source: https://www.hmpgloballearningnetwork.com/site/cathlab/article/Your-Lead-Cracked-Radiation-Safety-Revisited

- **Exposure & Sensitive Populations** – The most at risk population is people who work around X-ray and other radioactive equipment. Over time, the protective lead clothing will wear and the lead inside will crack, which would eventually release lead if not repaired or replaced in time. Although protective garments should be checked for damage, the focus of these checks is generally on their ability to block radiation and not necessarily whether they are releasing any lead particles. An example of tearing and cracking in a lead garment can be seen in the image above. Next time you go to the dentist, have a look if their lead apron is torn.

- **Safer Alternatives** – Burlington Medical (no financial interest), who states they are the largest provider of radiation protection in the world, sells lead-free garments, based on Xenolite technology that was originally invent by DuPont [12]:

> *' A lead-free apron (LFA) is an apron made of a blend of attenuating heavy metals other than lead (Pb) and is a lightweight and non-toxic alternative to the traditional lead apron. These metals are usually some combination of aluminum, antimony, barium, bismuth, tin, titanium, or tungsten. '*

They also note in [12] that:

> '*Every year, more than 150,000 lead x-ray aprons are disposed of, adding in excess of one million pounds of toxic lead metal waste across the globe*." In [12] they note the added benefit of lighter protective garments on the health of the workers: "*According to the Mayo Clinic, a recent study shows that many radiology professionals are reporting musculoskeletal pain from the weight of lead materials. Of those surveyed, 62% of technicians, 60% of nurses and 44% of attending physicians reported job-related pain. Pain was more often reported by women, workers exposed to radiation more frequently and by those who wore a lead apron more often.*"

A quick search shows there are other lead-free apron manufactures such Barrier Technologies who use a Bismuth-based amalgamation of different alloys, including titanium, magnesium, and tungsten. [13]

A new and innovative alternative is offered by Ecomass who use "environmentally-friendly thermoplastic compounds that provide 100% lead equivalency shielding but without any toxic constituents". [14]

B. 9) Lead anchors/Fastening Systems and Lead Plugs

- **Description** – Lead anchors are typically used together with a bolt to attach structural or non-structural objects to concrete or brick. The anchors transmit loads from the bolt into the concrete or brick. A typical use for a lead plug is to install a brass tack which acts as a survey marker (municipal, commercial, residential property lines etc.).

Source: https://www.fastenal.com/product/details/50993

- **Exposure & Sensitive Populations** – The people who would come into contact with lead anchors are primarily construction workers, homeowners, workers in companies that makes these lead anchors, and retail store employees that handle them. Lead plugs for survey markers are generally considered a historical technique, but surveyors, construction workers, and homeowners will come into contact with them when removing them. And you can still find them for sale so someone is apparently still using them. Also, if the survey markers in a sidewalk are damaged (which occurs from time to time) then pedestrians can walk on them, placing weight on the plug which will abrade lead due to contact with the surrounding concrete (somewhat similar to how lead wheel balancing weights, now thankfully banned in Washington, would be worn down over time, by people or cars running them over).

  Installing and removing these anchors and plugs can take significant mechanical force, and since lead is quite soft, it can transfer to surrounding material, tools, and clothing during this process.

Additionally, installing and repeatedly reinstalling bolts into the lead anchors where they are used to temporarily fasten objects is another opportunity to displace lead and contaminate surrounding areas.

- **Disposal** – You will need to assume the workers or homeowners are aware the anchors they are removing are lead and trust that they will dispose of them in hazardous waste facilities. Further complicating this is that lead can be difficult to visually differentiate from some non-lead materials. So, it's very likely that these lead anchors, when removed or simply never used, end up in a landfill. Lead plugs removed by surveyors may be more likely recycled as these surveyors may have more experience in identifying them, and they look different then newer survey markers, but the those removed in homes or commercial establishments by homeowners or construction workers are more difficult to discern from non-lead anchors and plugs.

- **Safer Alternatives** – There is an enormous variety of fasteners using non-lead material that can be used to attach objects to any supporting material. Non-lead materials in these fasteners (some with and some without anchors) include Zamac (a family of alloys with a base metal of zinc and alloying elements of aluminum, magnesium, and copper, according to Wikipedia), zinc plated steel, stainless steel, zinc alloy, plastic, and more. Non-lead alternatives are clearly feasible and widely available. There's an effective and available non-lead fastener option for every situation so there's no reason to sell these lead anchors or any lead fastening system.

  There are also a wide variety of survey markers installation options from steel bolts to concrete, resin, and much more.

- **Requested Regulatory Action** – Ban sale or import of lead anchors, lead plugs, and any fastening system containing any lead parts (keep this broad so there aren't clever loopholes around banning a specific type of fastening approach). Require any lead anchors, lead plugs, or generally any fastening system containing lead parts to be replaced with non-lead fasteners if they are disturbed or removed.

B. 10) Brass Keys

- **Description** – Brass keys still typically contain up to 2.5% lead in order to make them easier to machine. For example, many house keys and almost all USPS mailbox keys are made with lead-containing brass.

Source: https://www.ebay.com

- **Exposure & Sensitive Populations** – Two groups are most at risk of, small children and locksmiths. Also, people who handle a large number of brass keys in their work, such as janitorial staff, security, and USPS carriers.

  Various organizations warn people to not let small children play with keys as they may then put their hands or the keys themselves in their mouth. Of course, who hasn't seen a small child in public do exactly this? Furthermore, there are warnings such as this one below from the Vermont Housing & Conservation Board [15]:

  - *Don't let children handle any keys or give them to children to play with*
  - *Wash your hands thoroughly after handling any key.*
  - *Avoid mixing keys with gum, candy or food products that are commonly placed in a pocket or purse.*
  - *Use plastic or rubber covers for the head of keys.*
  - *Replace keys with worn plated finishes.*

  How many people do you know who do points 2 through 5? How many people wash their hands after handling brass keys? Why don't we take the obvious and simple solution of requiring lead-free keys?

An overlooked aspect of brass keys is the locksmiths. A study in [5] states that the odds ratio of increased hypertension (high blood pressure) in locksmiths is between 1.1 and 2.3. Recall the earlier paper which discusses the serious impact of lead exposure on the cardiovascular health of adults [5].

In 2001, the state of California sued 13 key manufacturers [16]. Through testing they found that normal handling of keys twice daily deposited up to 80X the 'no significant level' of 0.5 micrograms of lead per day, with a mean of 19X. So, a mean of around 10 micrograms/day which is a very large amount of daily lead exposed to the hands, which can then find its way to the food you eat. That amount of lead ingested is not insignificant assuming 25% to 50% of lead on your hands is ingested by eating (based on which research you cite) – unless you religiously follow the advice to wash your hands between handling brass keys and eating. The settlement of the lawsuit resulted in US manufacturers agreeing to reduce the lead in their brass used for keys by 40%. Now, twenty years later, we know there is no safe level of lead and so it's time to do better and require lead-free keys.

- **Disposal** – As with most of the other examples, only knowledgeable and environmentally conscious people will go to the trouble of bringing surplus keys to a hazardous waste.

- **Safer Alternatives** – Aluminum and stainless steel are available. Additionally, lead-free brass exists and with the motivation of a ban on lead in brass keys, it would surely kickstart further demand for lead-free brass keys. As this article explains, it's a myth that lead-free brass is too difficult to machine [17].

- **Requested Regulatory Action** – Mandate that only lead-free keys are sold. A good specific place to start would be with USPS mailbox keys which are nearly always leaded brass, and it can sometimes be difficult to copy these non-leaded versions.

B. 11) Lead fishing tackle

Source : https://www.oceandefenders.org/news-and-media/toxic-lead-fishing-weights-removed-from-oahu-waters.html

It is unlawful to use lead weights or lead jigs measuring 1 1/2" or less along the longest axis in about a dozen lakes in Washington State [18]. By my count, this list includes Ferry Lake, Swan Lake, Pierre Lake, Big Meadow Lake, Yocum Lake, South Skookum Lake, Lost Lake, Blue Lake, Bonaparte Lake, Calligan Lake, Hancock Lake, Lake Hozomeen, and Long Lake.

This was a step in the right direction but it's past time to ban lead fishing tackle entirely, including lead fishing lines. ECHA (European Chemicals Agency) has proposed a rule to [19]:

1. ban on the sale and use of lead sinkers and lures (with transition periods depending on weight: ⩽ 50 g three years; > 50 g five years);
2. immediate ban on the sale and use of lead fishing wire; and
3. immediate ban on the use of lead sinkers when the sinker is deliberately released (lead 'drop off' techniques).

In [19] ECHA states that, with regards to the EU:

> *"If the current releases of lead from these activities continue, approximately 876 000 tonnes of lead would end up in the environment over the next 20 years.*
>
> *ECHA has proposed a restriction on lead use in hunting, sports shooting and in fishing. The proposed restriction could reduce lead emissions by approximately 630 000 tonnes over 20 years following its introduction. This is a reduction of 72 % compared to a situation without the proposed restriction."*

As for alternatives, they state that "*Multiple alternatives are also available to lead sinkers and lures, such as those made with tin, tungsten, glass or various alloy Multiple alternatives are also available to lead sinkers and lures, such as those made with tin, tungsten, glass or various alloys"*.

I strongly urge the reader to review [19], particularly the excellent Q & A section on lead in fishing tackle. This can serve as a very useful roadmap for work by Ecology Washington.