Protecting homes from outdoor pollutants

For the stakeholder meeting for Reducing Outdoor Contaminants in Indoor Spaces

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What's the problem?

- Indoor air quality in homes is usually blamed on indoor pollutant sources
- Outdoor air is the "clean" air used for ventilation
  - It flushes out contaminants from the house
- What if the outdoor air carries a high pollutant load?
  - How do we deal with that?

Why is this an issue now?

- There are traditional outdoor pollutant sources that vary over time and by location
  - e.g. traffic-related pollutants, forest fires, wood stoves, power plant emissions
- There are new outdoor pollutant risks
  - Fracking
  - Heat spells or flooding induced by changing climate

Structure of the presentation

- What are the pollutants of concern?
- How are they getting into the house (and its occupants)?
- How can that be stopped?
- What more do we need to know?

Pollutants of concern

- Mostly airborne pollutants
  - Some come in with track-in dust or in water
- Usually cause respiratory problems but also risks of cancer, neurological effects, etc.
- Noise pollution and electromagnetic fields (EMF) are beyond the scope of this project
- Full list of pollutants available in White Paper

Pollutants of concern (cont.)

- Respirable particles (aka PM_{10}, $PM_{2.5}$, ultrafines) from vehicle emissions, woodsmoke, industry, agriculture, chemical reactions in the atmosphere

Airborne particles

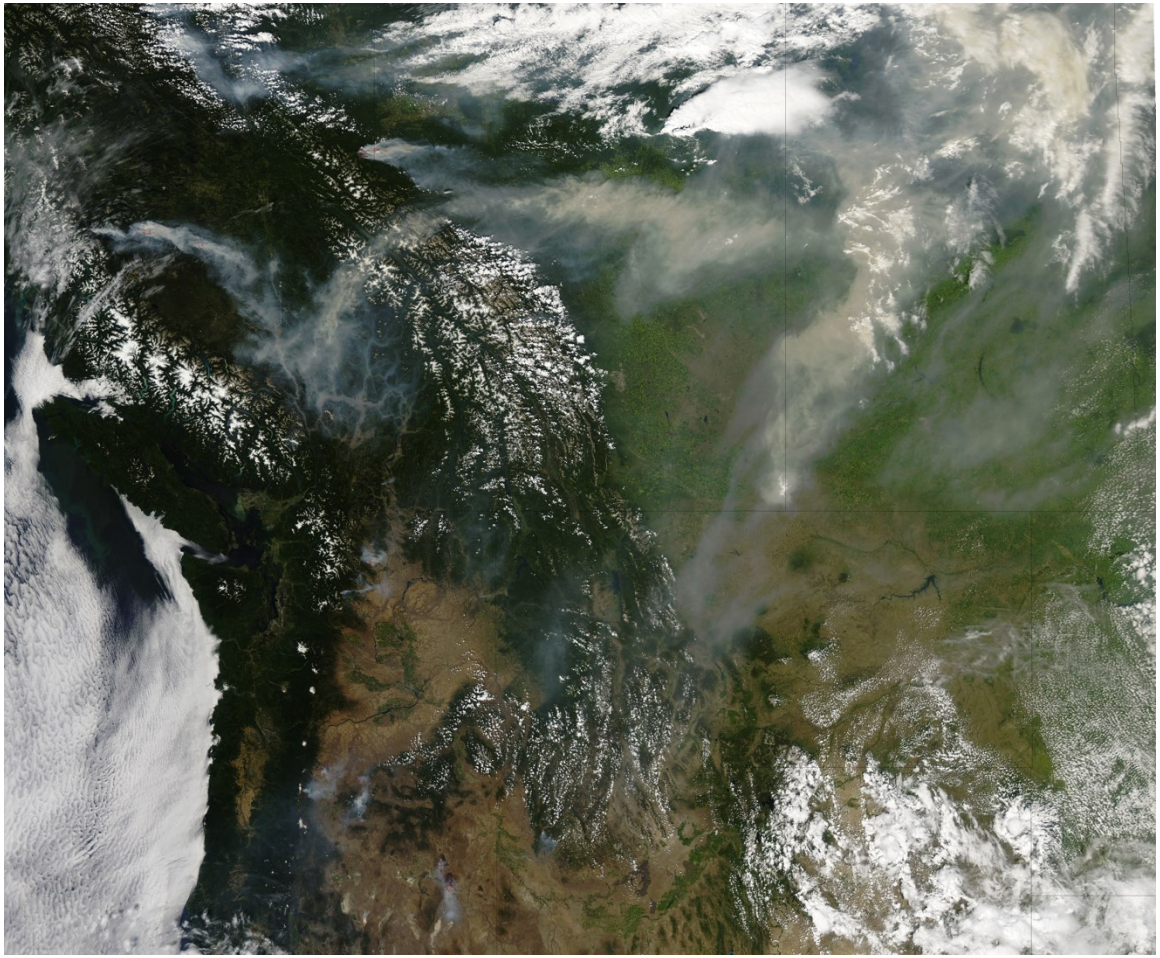
Diesel emissions

Source: Scienceguy.org

Woodsmoke

Source: Yukon government

Current forest fire smoke movement



Fracking site

Source: NY Times Site: Montrose, PA

Pollutants of concern (cont.)

- Respirable particles of biological origin (pollen, mold spores, decay)
- Heavy metals (lead, arsenic, mercury, etc.) usually from industry but can be natural

Heavy metals

Source: CBC

Pollutants of concern (cont.)

- Volatile organic compounds (VOC) are the chemical emissions likely to become airborne
  - Hundreds of different compounds
  - Many sources: traffic, industry, construction, oil and gas fields, etc.
- Semi-volatile organic compounds (SVOC), such as phthalates, somewhat less mobile
  - Pesticides, plasticizers, flame retardants, contaminated sites, industry

Pollutants of concern (cont.)

- Odors
- Explosive gases (e.g. methane)
- Ozone and oxides of nitrogen (usually traffic-related smog)
- Radioactive gases (e.g. radon)

How do you know that these pollutants are getting in?

Sometimes it’s obvious

How do you know that these pollutants are getting in?

- Other times you have to measure
- Some pollutants (like CO) have consumer-level detection devices available
- More are in development
- Some require expensive test equipment and trained personnel

Carbon monoxide detector

Source: Nighthawk

How do pollutants get into houses?

- Unintentional air infiltration through house envelope
- Air infiltration through adjacent spaces (garages, crawl spaces, attics)
- Soil gases
- Intentional air exchange by window opening or mechanical ventilation
- Track-in dust
- Water

Air infiltration

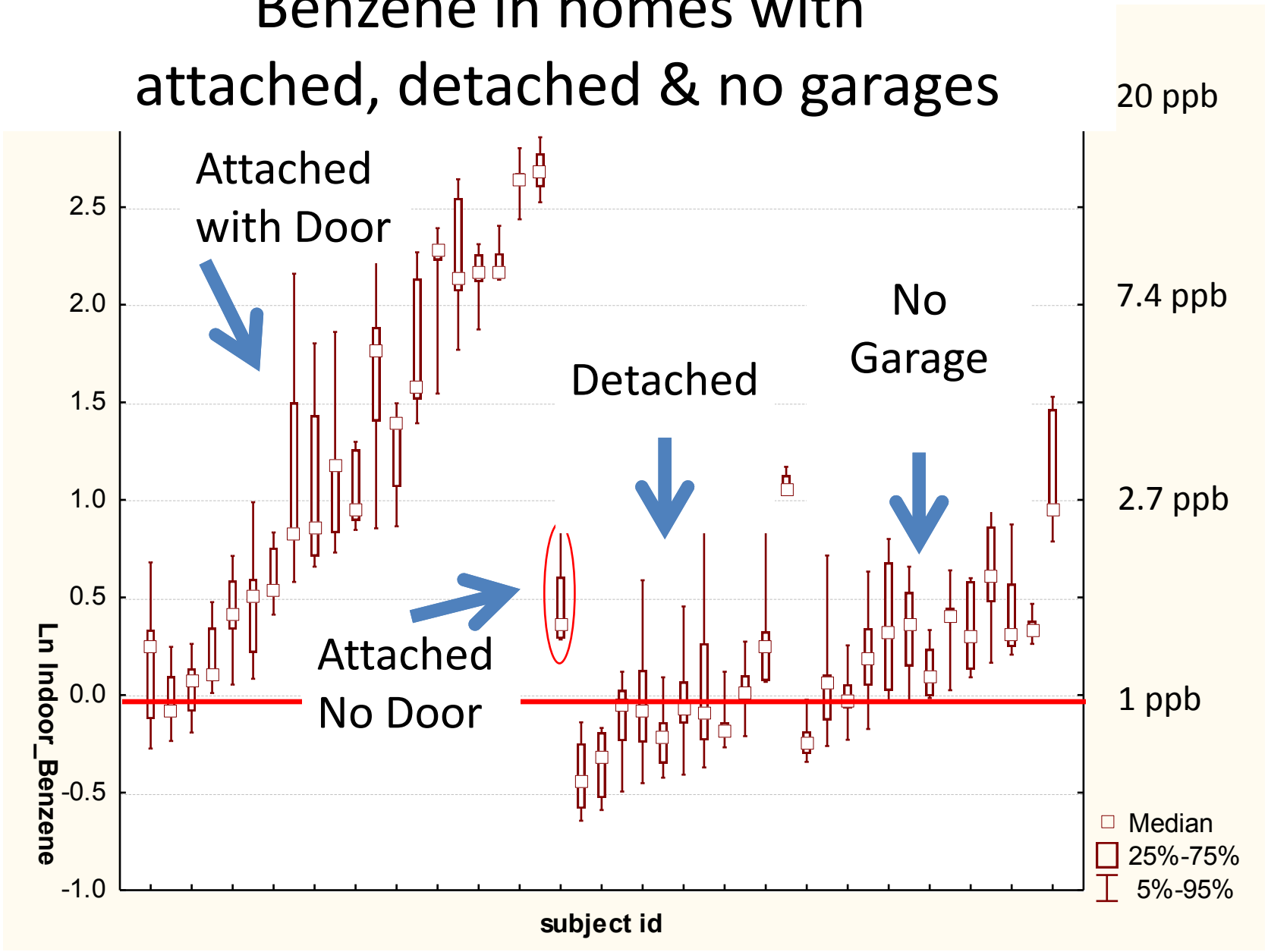
- All houses have air leakage
  - Size of leaks vary greatly from house to house
- Houses have pressure differences across the envelope
  - Wind pressures
  - Stack pressures
  - HVAC-induced pressures (fans, chimneys, etc.)
- Holes plus pressure means air movement

Blower door

Air movement through adjacent spaces

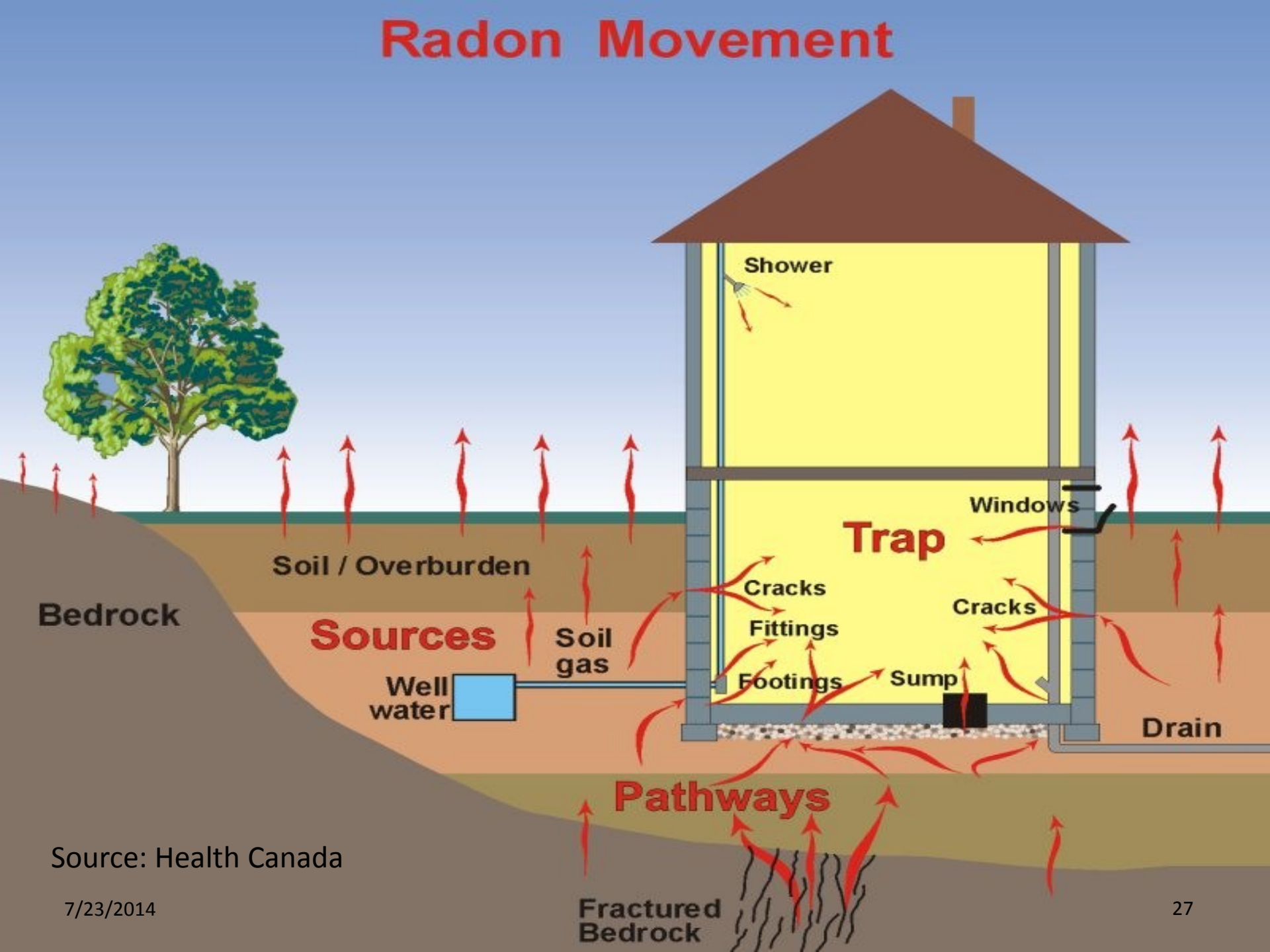
- Seems like outdoor air but it passes through a structure on the way, picking up pollutants
  - Garages (car emissions, VOCs, herbicides, etc.)
  - Vented crawl spaces (who knows what is there)
  - Attics (loose insulation, bat poop, etc.)
- Minimize these entry points

Benzene in homes with attached, detached & no garages



Soil gases

- Soil gases are outside air that comes in through the soil, via cracks in the foundation, open sumps
- Main pollutants are radon, high humidity
  - Other possible pollutants include VOCs from contaminated soils, pesticides, methane, etc.



Source: Health Canada

Intentional air exchange

- Turning on kitchen or bathroom fans vented to the outside
- Heat recovery ventilators (HRV)
- Dryers, central vacuums vented to outside
- Opening windows (some do, some don’t)
- Mechanical ventilation will only cause air exchange when it is used (some do, some don’t)

Track-in dust

- Settled dust in houses in often mostly skin flakes, hair, and clothing fibers but some of it is outside dirt
- Soil can contain old automotive emissions (lead), pesticides, herbicides, exterior lead paint, etc.
- High lead in indoor dust often due to shoe traffic

Track-in dirt

Source: Godfreyhirst

Water

- Huh? How does water bring in air?
- Dissolved pollutants in water (radon in well water, organochlorines from water treatment) are released during water usage (e.g. showers)
- Overland flooding, if that occurs, brings in many assorted contaminants

Stopping pollutant entry

- Those are the entry points
- How do we prevent that entry or mitigate it?

Stopping pollutant entry - airtightness

- A completely airtight house, with closed windows, would have no air leakage
  - It doesn't exist
- Houses can be built or retrofitted to be close to airtight, at some expense
  - Very good pollutant defense
  - Will need mechanical ventilation and filtration of intake air for occupants

Envelope sealing

Source: Homeenergyteam.com

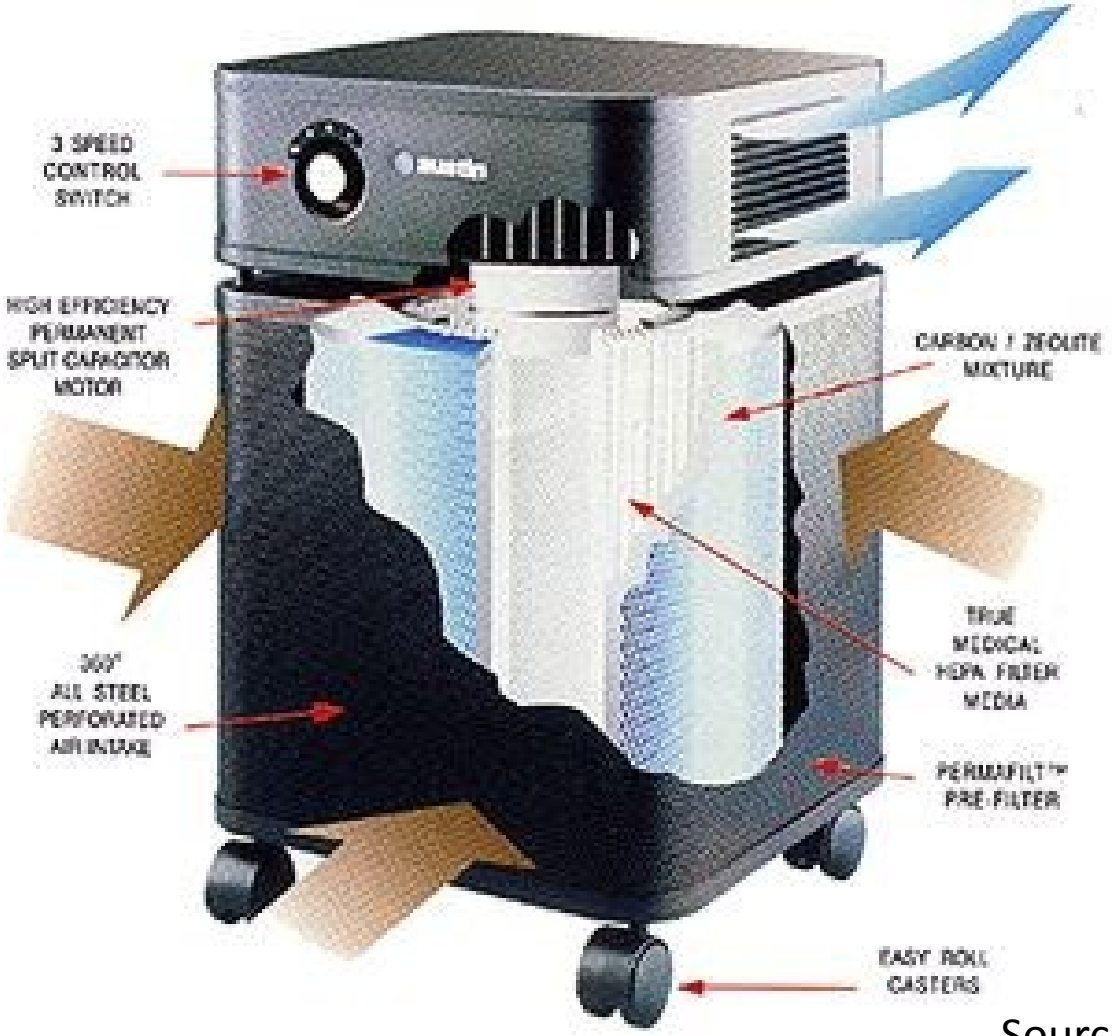
Stopping pollutant entry – preventing air movement from adjacent spaces

- Attic, crawl space sealing is done frequently
- Garage-to-house leakage is less well known; little experience in sealing techniques specific to garages
- Garages harder to seal if ducts or furnaces are in the garage (same with attics, crawl spaces)
- Sometimes a pressure solution (e.g. using an exhaust fan in the garage) can be a better choice

Stopping pollutant entry - filtration

- Putting an effective filter on a supply air duct can reduce the amount of pollutants that enter the house
  - Works for particles but also for VOCs
  - Needs proper set-up, diligent maintenance
- Having good filtration inside the house, especially distributed throughout, can reduce the pollutant exposure as well

Portable air filters

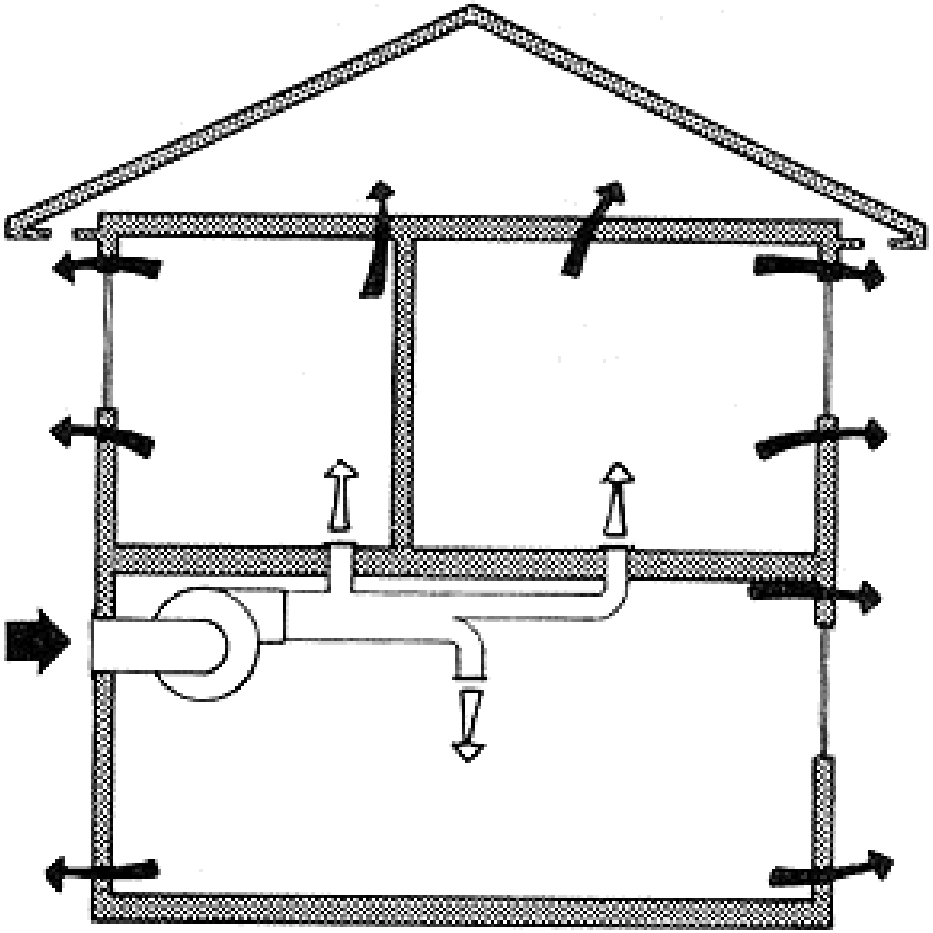


Source: Austin Air

Stopping pollutant entry – pressure solutions

- Pressurizing the house with clean, filtered air will stop most infiltration
- The holes (air leakage) are still there but the pressure is now higher inside, and the leakage goes to the outside
- Same cautions about filter specification and maintenance apply
- Some problems with pressurization in cold climates in winter

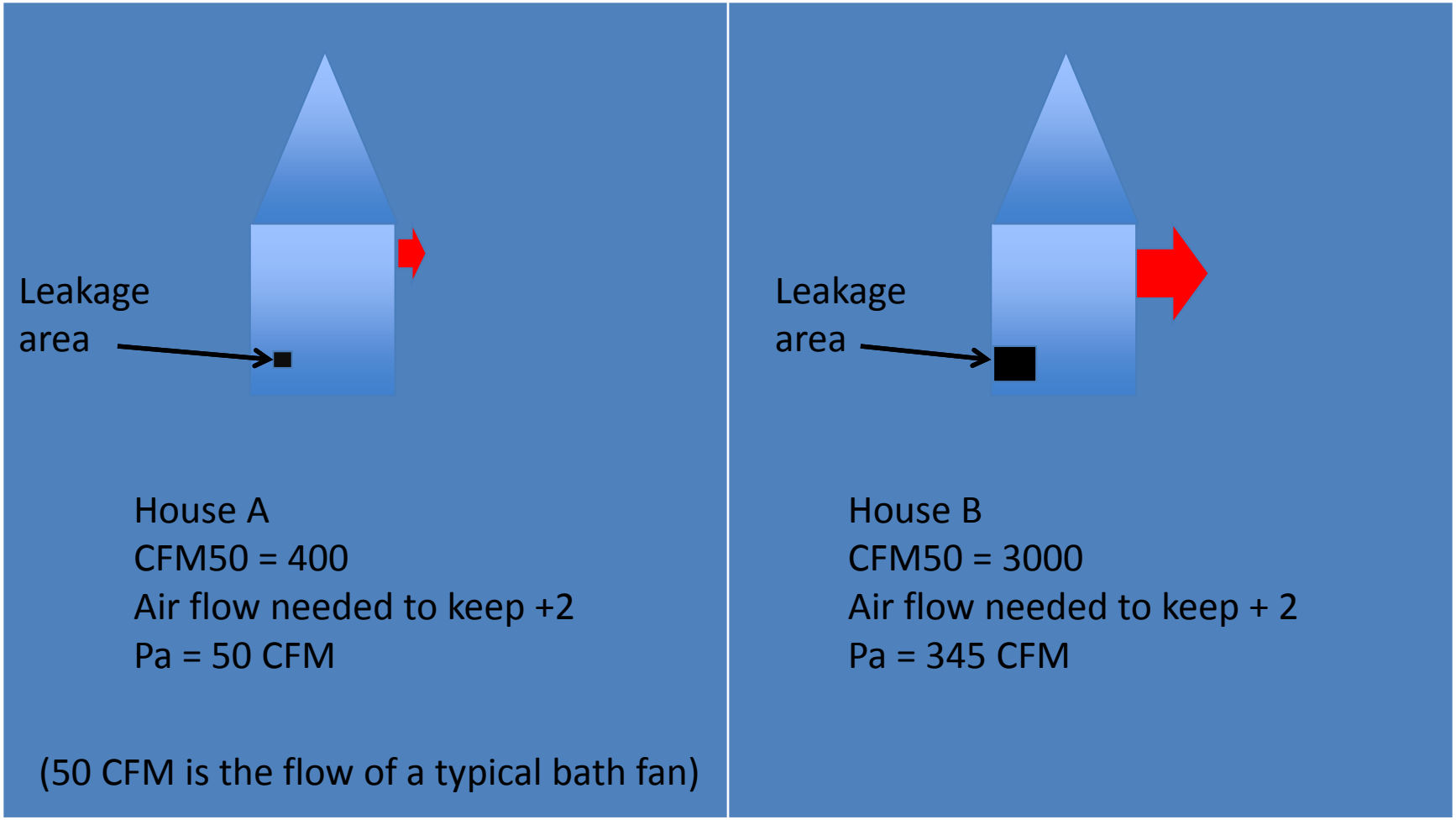
House pressurization



Effective filter at air intake

Source: NRC (Canada)

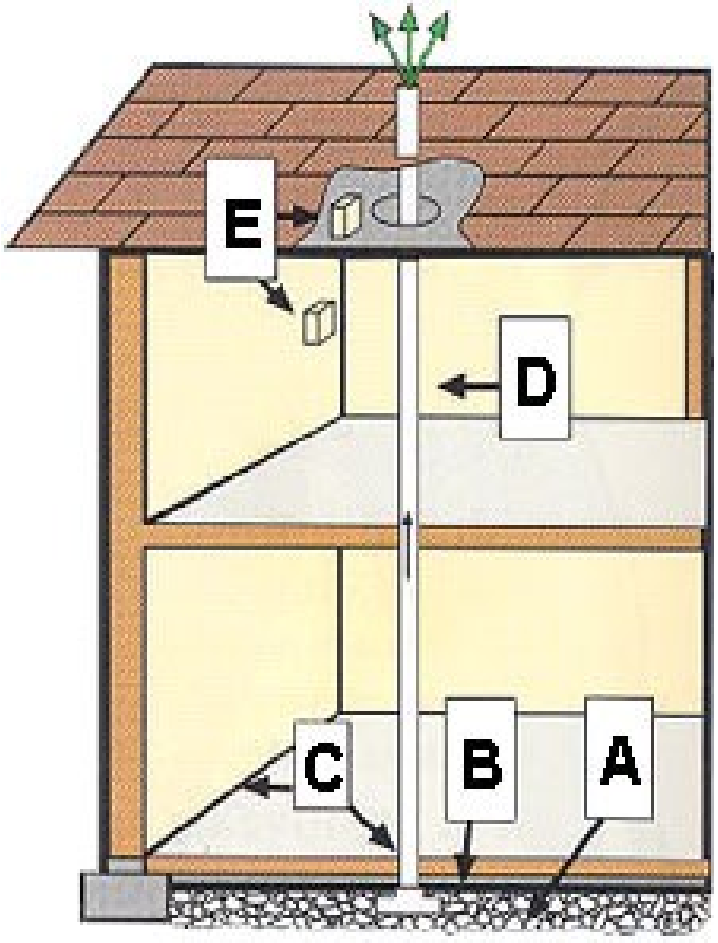
It helps to have a tight house



Stopping pollutant entry – subslab depressurization

- For soil gases such as radon, instead of pressurizing the house, you can depressurize the space under the slab
- Same effect as house pressurization but needs less power, no air filtration, minimal maintenance

Subslab depressurization



Source: EPA

EPA radon vent fan installation

Stopping pollutant entry – subslab depressurization

- Has proven successful in millions of houses with radon problems
- Can also be used to protect houses from soil-based moisture, pesticides, contaminated lands

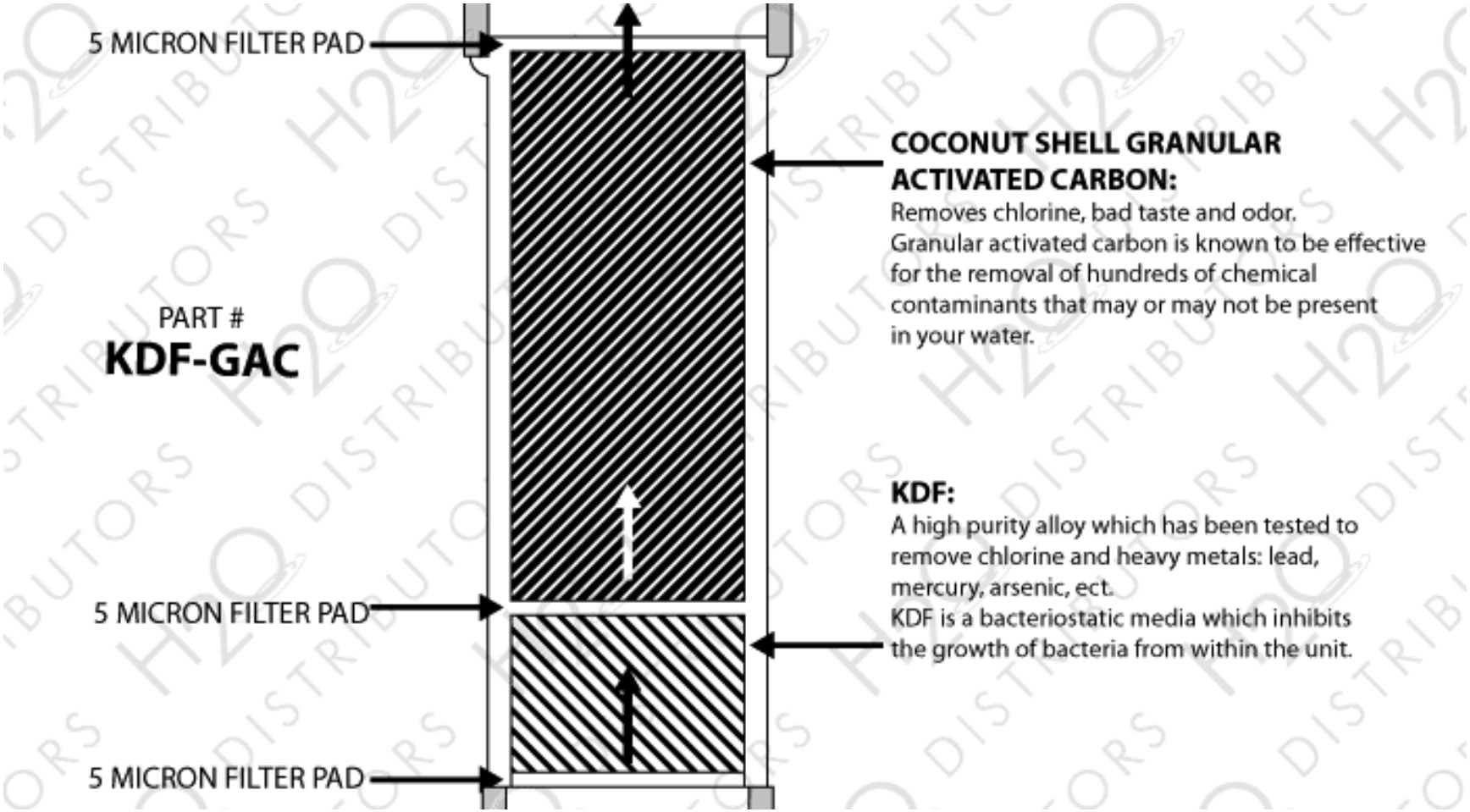
Stopping pollutant entry – track-in dust

- Good studies showing that if shoes are removed at the door, track-in dust drops by >80%
  - Maybe your mother was right after all
- "Walk-off" mats also effective

Stopping pollutant entry - water

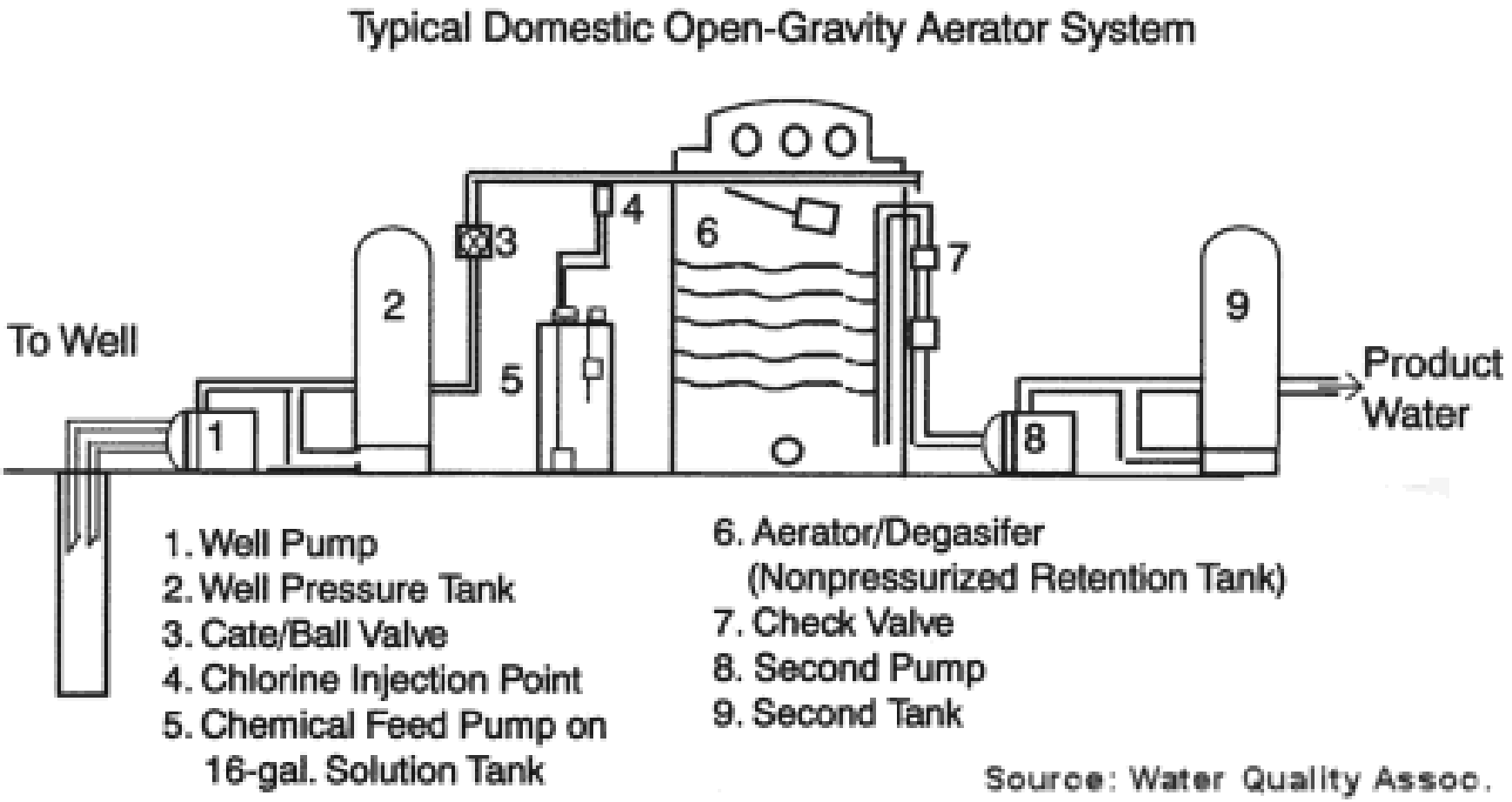
- Two main solutions for taking radon (or other contaminants) out of water:
  - Granulated activated carbon (GAC) filter
  - Water aeration
- Both work; both require electrical power and maintenance
- If high radon in water, GAC filter disposal can be a problem

GAC filter



Source: h20distributors.com

Water aeration



Summing up

- You can stop or reduce exterior pollutant entry
- You can then apply standard IAQ techniques for ensuring very clean indoor air
  - Indoor source reduction (e.g. don't smoke in house, use low emission household products)
  - Air filtration
  - House cleanliness

Challenges and opportunities?

- Many of these solutions and pollutant reductions are more theoretical than common practice
- Durability, occupant acceptance, ease of maintenance are not well established

Challenges and opportunities?

- We should be trying out and refining these solutions, especially where occupants most at risk
  - Those with respiratory illnesses
  - Those near high pollutant sources
  - Those with few resources

What would make this easier?

- Good data collection and dissemination of successes and failures would help
  - This should optimize remediation strategies and lead to eventual cost savings
  - Might avoid expensive failures and misguided advice
- Integrated community-based efforts seem appropriate

For more information

- ROCIS paper "Protecting Homes from Outdoor Pollutants" is circulating in draft
  - Has more information on each topic
  - Also references other helpful documents
- Or contact us:
  - Don Fugler – donfugler@gmail.com
  - Linda Wigington – lwigington1@outlook.com
  - Norm Anderson – andersonenvironmentalhealth@gmail.com

Companion white paper

Reducing Outdoor Pollution Intrusion Impacts on Schools & Commercial Environments

Stay tuned!

ROCIS Stakeholder Meeting

Late August - early Sept.

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Comments? Questions?