

We Are What We Build: A New Paradigm for Sustainable Healthy buildings

Elia Sterling

President , Theodor Sterling Associates

1-877-993-9933

elia@sterlingiaq.com

www.sterlingiaq.com



Elia Sterling

- President of Theodor Sterling Associates Ltd. (Canada) and Director of Green Building Services Ltd. (Hong Kong)
- Member of the Development Committees for ANSI/ASHRAE Standards 62 and 55
- Chair of the Energy and Environmental Committee of the Building Owners and Managers Association of Canada
- Founding Member of the Canada Green Building Council (CaGBC)
- Founding member of the Indoor Air Quality Association of Canada and the Canadian Healthy Indoors Partnership
- Chair of the Canadian Advisory Committee to the ISO Technical Committee on IAQ
- Appointed as the expert on IAQ for the National Building Code of Canada





Theodor Sterling Associates

- Established in 1973
- Integral role in the development of international, national and local standards, regulations, and building codes
- Industry leader in IAQ services worldwide
- Providing proactive IAQ Management services in the US, UK, Hong Kong, Mainland China and Macau
- Over 600 commercial buildings on proactive program



Agenda

- Overview of green buildings and IEQ
- Are green buildings healthy?
- A new paradigm to achieve sustainable healthy buildings



Previous ‘Green’ Building Practices

- In the 1970s and 80s, building and energy management policies and practices introduced throughout North America and Western Europe caused serious IEQ challenges
- The result was an era of “Sick Buildings”
- *“An energy declaration without a declaration to the indoor environment makes no sense” **

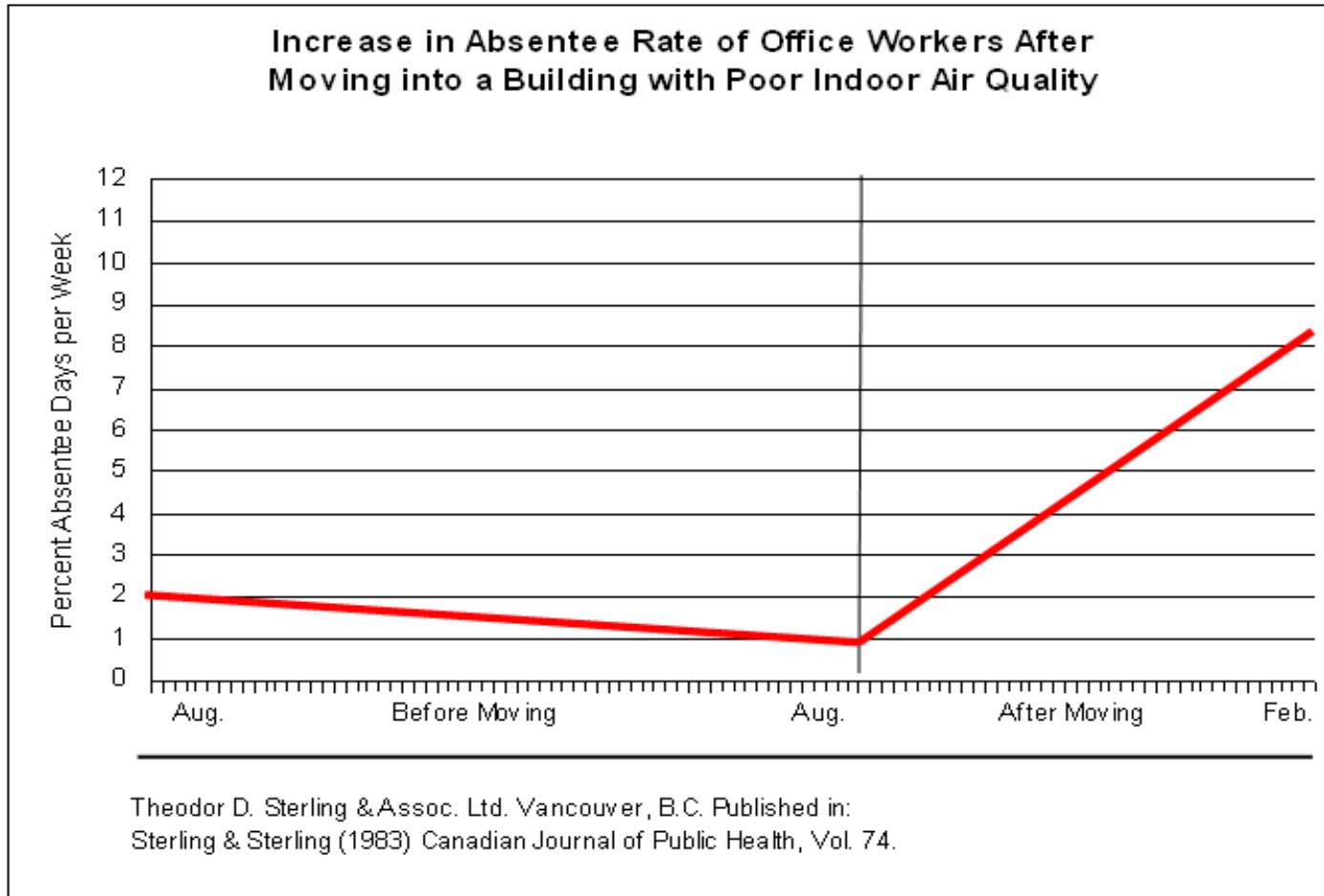
*Indoor environmental input parameters for design and assessment of energy performance of buildings addressing indoor air quality, thermal environment, lighting and acoustics – BSI Standard EN15251:2007



Scope of IAQ Challenges

- Poor IAQ affects 20-30% of commercial and institutional buildings worldwide
 - World Health Organization (WHO), Health Canada, U.S. Environmental Protection Agency (EPA), Building Research Establishment (UK), U.S. Occupational Safety & Health Administration (OSHA)
- According to the International Facilities Management Association, poor IAQ is the top complaint heard by facilities operators
- In developed countries, people spend an estimated 90% of their time indoors
- According to The World Health Report 2002 - indoor air pollution is responsible for 2.7% of the global burden of disease.

Scope of IAQ Challenges



Poor IEQ Health Outcomes

“Recent studies have shown that costs of poor indoor environment for the employer, building owner and society as a whole are often considerably higher than the cost of the energy used in the same building”

– BSI EN15251:2007





Cost of IEQ Challenges in the U.S.

- Respiratory Disease (US\$6-14 billion)
- Asthma and Allergies (US\$2-4 billion)
- Sick Building Syndrome (US\$10-30 billion)
- Reduced worker performance unrelated to health (US\$20-160 billion)



Estimated Annual Tenant Expenses

■ \$ Maintenance	1%
■ \$ Utilities	1%
■ \$ Taxes	1%
■ \$ Rent	9%
■ \$ Salaries	88%

If a business pays US\$20 million per year in salaries, a 1% decrease in productivity due to poor IAQ is worth **US\$200,000 per year**

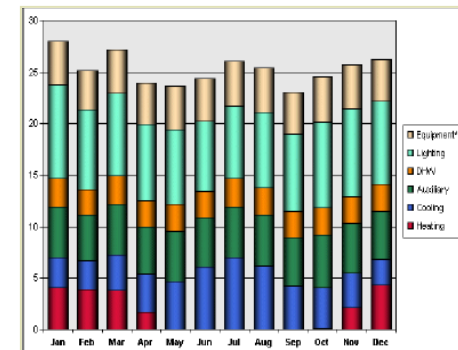
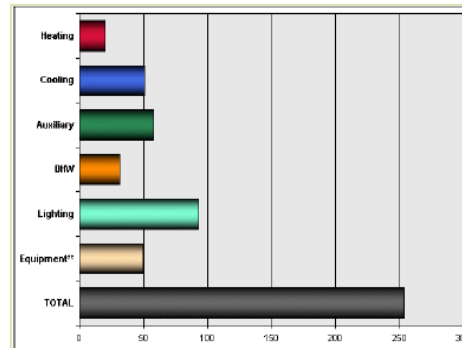


The Paradox: Green Buildings and IEQ

- Building management perceive improved energy performance as the most valuable benefit of going green
- However, the most valuable benefit of Green Buildings perceived by tenants and the public is **improved comfort and IEQ**
 - Green Buildings today are promoted as Healthy Buildings
 - Market transformation to Green Buildings has largely been achieved by convincing the public that Green Buildings improve IEQ and are healthy
 - ***But not all Green Buildings have good IEQ!***

What's New in IAQ? 'Green' Buildings

The *REAL CHALLENGE* for sustainable buildings is to **optimize** the balance between an indoor environment that promotes occupant health and well-being and the use of energy and emission of greenhouse gases associated with maintaining that environment





Factors affecting IAQ

- HVAC system design, operation and maintenance
- Materials and product off-gassing
- Indoor (tenant) activities (printing, forklifts, industrial processes etc)
- Ambient air & sub-surface soil contamination
- Recent convergence of IAQ-related mould and/or moisture problems with building envelope and HVAC system failures

Causes of IAQ-related problems

<u>Frequency</u>	
Ventilation	36%
Thermal Control	19%
Ventilation Infiltration	10%
Cross-contamination	11%
Indoor Sources	9%
Microbial Contamination	7%
Site Infiltration	2%
Undetermined Cause	6%

* Source: IAQ Investigations conducted since 1981 by Theodor Sterling Associates Ltd.



IAQ for The Living Building Challenge - Prerequisites

- Three IAQ prerequisites:
 - A Civilized Environment: Every occupiable space must have operable windows that provide access to fresh air and daylight.
 - Source control: Comply with SCAQMD 2007/2008 and Cal Standard 01350.
 - Ventilation: The building must be designed to deliver air change rates in compliance with California Title 24 requirements.



Living Building Challenge: Indoor Quality Healthy Air

- As comfort decreases, environmental impact often increases, as people find inefficient and wasteful solutions to improve their physical environment.
- Further, it is difficult to insure optimal conditions due to the unpredictable nature of how people operate and maintain a building.



IAQ In Green Buildings

- A 2009 New York Department Of Health Study of 142 buildings found that LEED certified buildings remain susceptible to poor IAQ from particulates.
- The researchers studied both new buildings seeking LEED certification and occupied LEED schools, apartments and offices.
- The team found that particulate levels increased well beyond the LEED limit when people were inside doing normal activities.

IAQ in Five Buildings Tested for LEED™ Certification

Building	CO ppm	PM10 µg/m ³	Form. ppb	TVOC µg/m ³	4-PCH µg/m ³
Guideline	9	50	50	500	6.5
New Office building	<1	2-22	0-10	0-262	--
Existing tower (test 1)	<1	38-97	60	2540	<0.2
Existing tower (test 2)	<1	1-5	1-30	1-200	<0.2
1 office suite in existing building	<1	13-18	20	400	<2.0
Condo building	<1	43-74	0-40	1100-4100	<2.0
Hotel/Casino Las Vegas	<1	14-574	--	0-3820	<0.03



A New Paradigm for Green and Healthy Buildings

A new paradigm is required to achieve green and healthy buildings. That paradigm must be based on IAQ commissioning and proactive management.



What is IAQ Commissioning?

IAQ Commissioning is ...

Verifying and documenting that all the systems and assemblies in a building are designed, installed, tested, operated and maintained to provide exceptional IAQ.



What is Proactive IAQ Management ?

Regular testing of air quality parameters (particles & gases) and the inspection of a Building's vital components that may affect the indoor air quality

Proactive

“acting in anticipation of future, needs, changes, challenges and opportunities”



What Parameters should be tested

- Carbon dioxide (CO₂)
- Carbon monoxide (CO)
- Temperature and relative humidity
- Respirable suspended particulate (RSP)
- Total volatile organic compounds (TVOC)



IAQ Parameters:

■ Carbon dioxide (CO₂)

- Exhaled by occupants
- Not considered a 'toxic' contaminant
- Considered an indicator of ventilation system effectiveness
 - 600 ppm inside = 42 cfm/person
 - 800 ppm inside – 24 cfm/person
 - 1000 ppm inside = 16 cfm/person

(Based on 350 ppm outside)



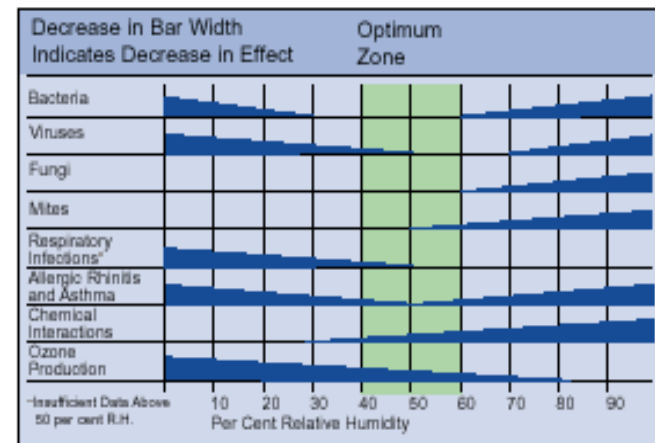
IAQ Parameters

■ Carbon monoxide

- Combustion by-product
- Colourless, odourless
- Heat exchangers, parkades, boiler exhaust, etc.
- Stack effect

IAQ Parameters

- Temperature and Relative Humidity
 - Comfort parameters
 - Elevated temperature can lead to complaints of ‘poor air quality’
 - Low RH can lead to complaints
 - High RH can lead to other issues (mould, dust mites, etc.)



by Sterling et al in ASHRAE Transactions 1985 Vol. 91 Part 1



IAQ Parameters

■ Particulate

- Respirable (RSP)
- Ultra fine particulate (0.3 μm)
- Assesses level of filtration afforded by ventilation system
- Determines if there are indoor sources of particulate
- Assesses general cleanliness of space
- Construction/renovation activities can affect adjacent spaces.



IAQ Parameters

- Volatile organic compounds (VOCs)
 - Measures potential off-gassing of building materials, furniture, paints, adhesives.
 - Can measure individual VOCs but total (TVOCs) is generally used for IAQ
 - Drycleaners, shoe repair, nail salons, hair salons, leather stores, printing operations.

IAQ Parameters

■ Other parameters

- Ozone
- Formaldehyde
- Mould
- Asbestos
- Tobacco smoke



HVAC Inspections





Conclusion

- Market is rapidly transforming 'Green' buildings to become the new norm
- Key assumed benefits of 'Green' building are reduced carbon footprint and improved IEQ, health and productivity
- Rumor has it ... 'Green' buildings are healthier than typical buildings ... but are they?
- 'Green' buildings can be healthy and energy efficient by taking a proactive approach to IEQ
- A new Healthy Building Paradigm is achieved by commissioning new buildings and ongoing IEQ data management and reporting.

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Green Buildings and Toxins



Dennis Kunkel Microscopy, Inc.

Living Future '09 Conference
William Lambert, PhD
lambertw@ohsu.edu

The “Red List” and “Chemicals of Concern”

- 1,2-dibromoethane
- 1,3-Butadiene
- Acetaldehyde
- Acrylonitrile
- Arsenic
- Antimony
- Cadmium
- CFCs or Hydro-CFCs
- Chlorinated Polyethylene
- Chlorosulfonated Polyethylene
- Cobalt
- Copper
- Creosote
- Ethylbenzene
- Added Formaldehyde
- Halogenated Flame Retardants
- Hexavalent Chromium
- Lead
- Mercury
- Organotins
- PAHs
- Pentachlorophenol
- Perfluorochemicals (PFCs)
- Phenol
- Phthalates
- Polychloroprene (Neoprene)
- Polyurethane
- PVC or Chlorinated PVC
- Trichloroethylene
- Xylenes

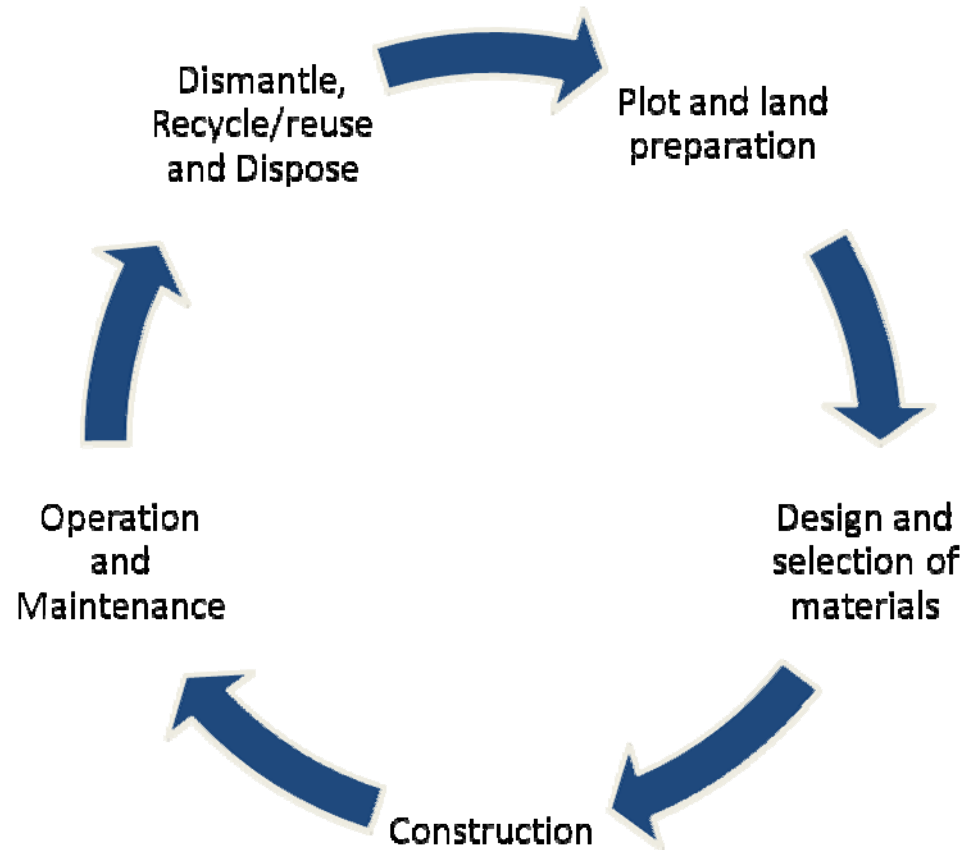
Rationale for inclusion on the Red List

- The ultimate goal: environmentally sound and healthy buildings

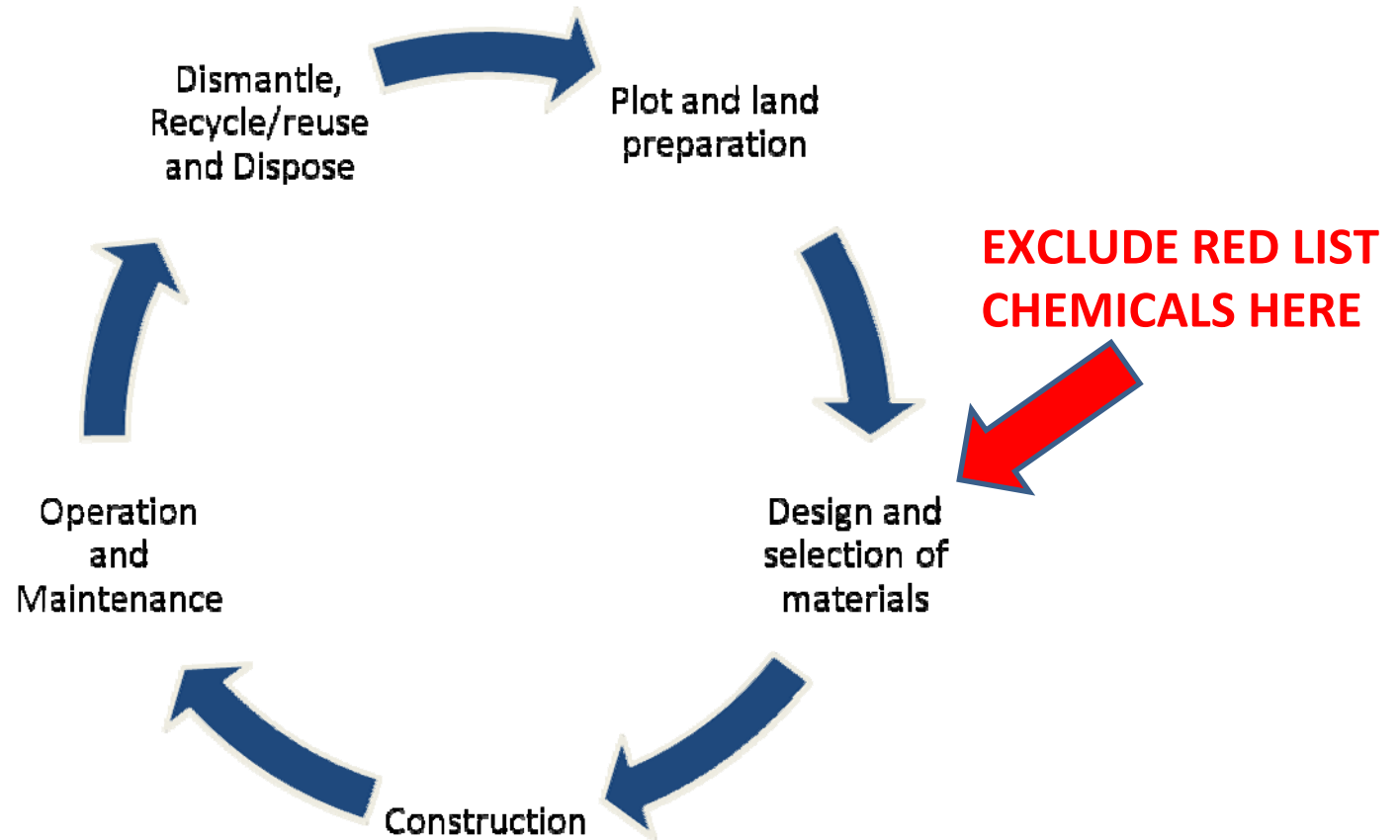
Rationale for inclusion on the Red List

- The ultimate goal: environmentally sound and healthy buildings
- The assumption: by excluding materials we protect building occupants, we protect producers and the environment, *and* we reduce market demand and help to force the change to safer alternatives.

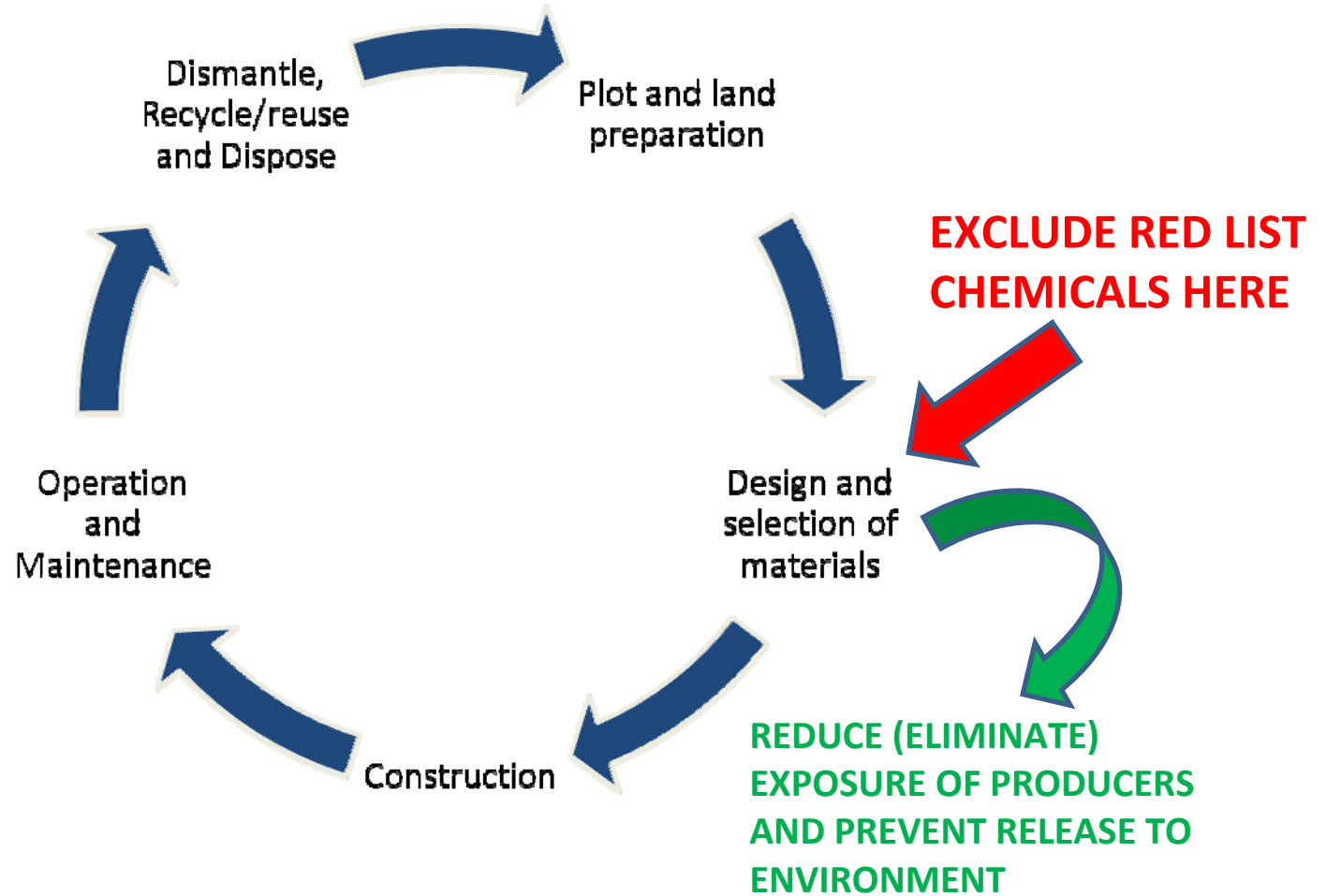
Life cycle of a building



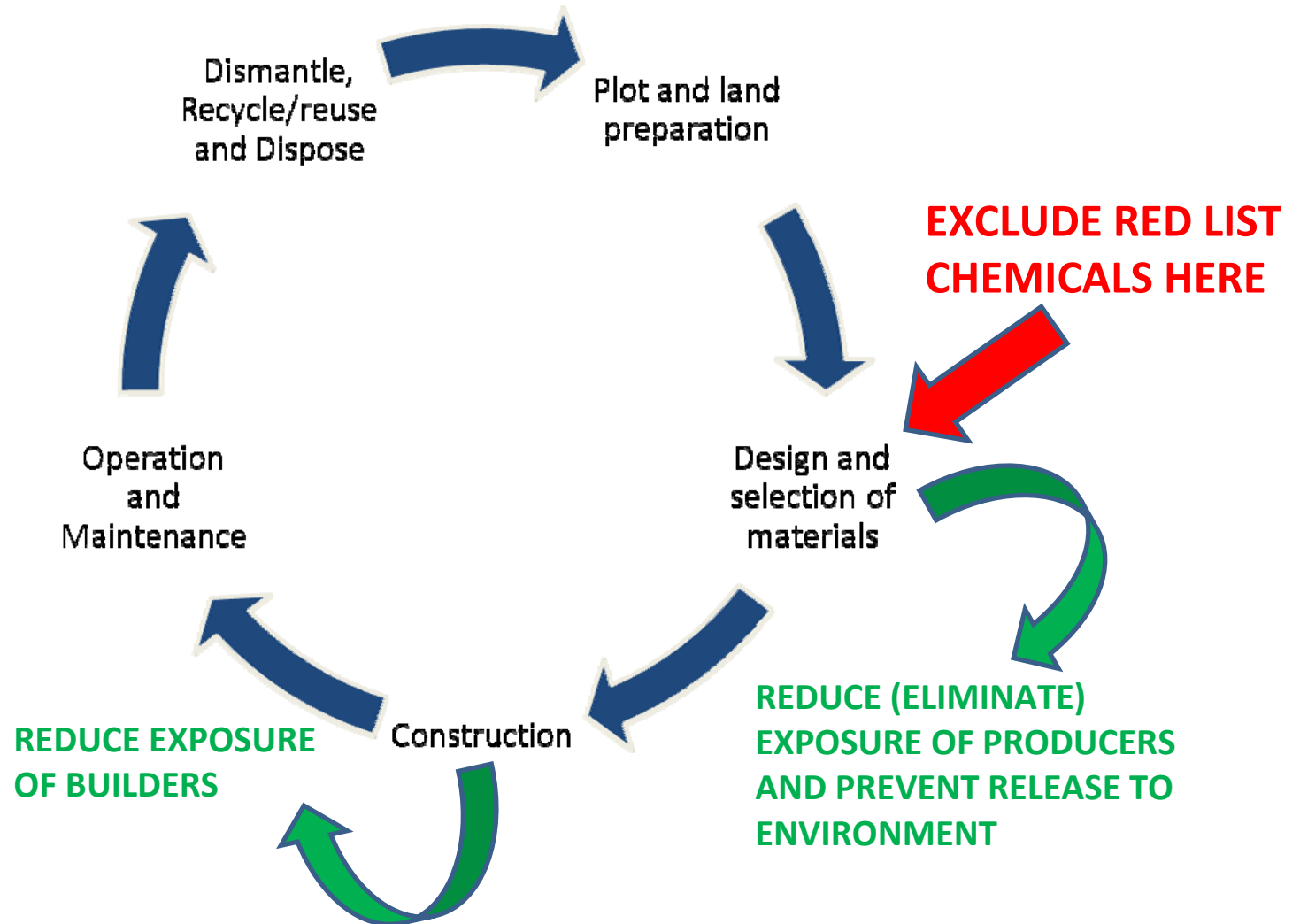
Life cycle of a building



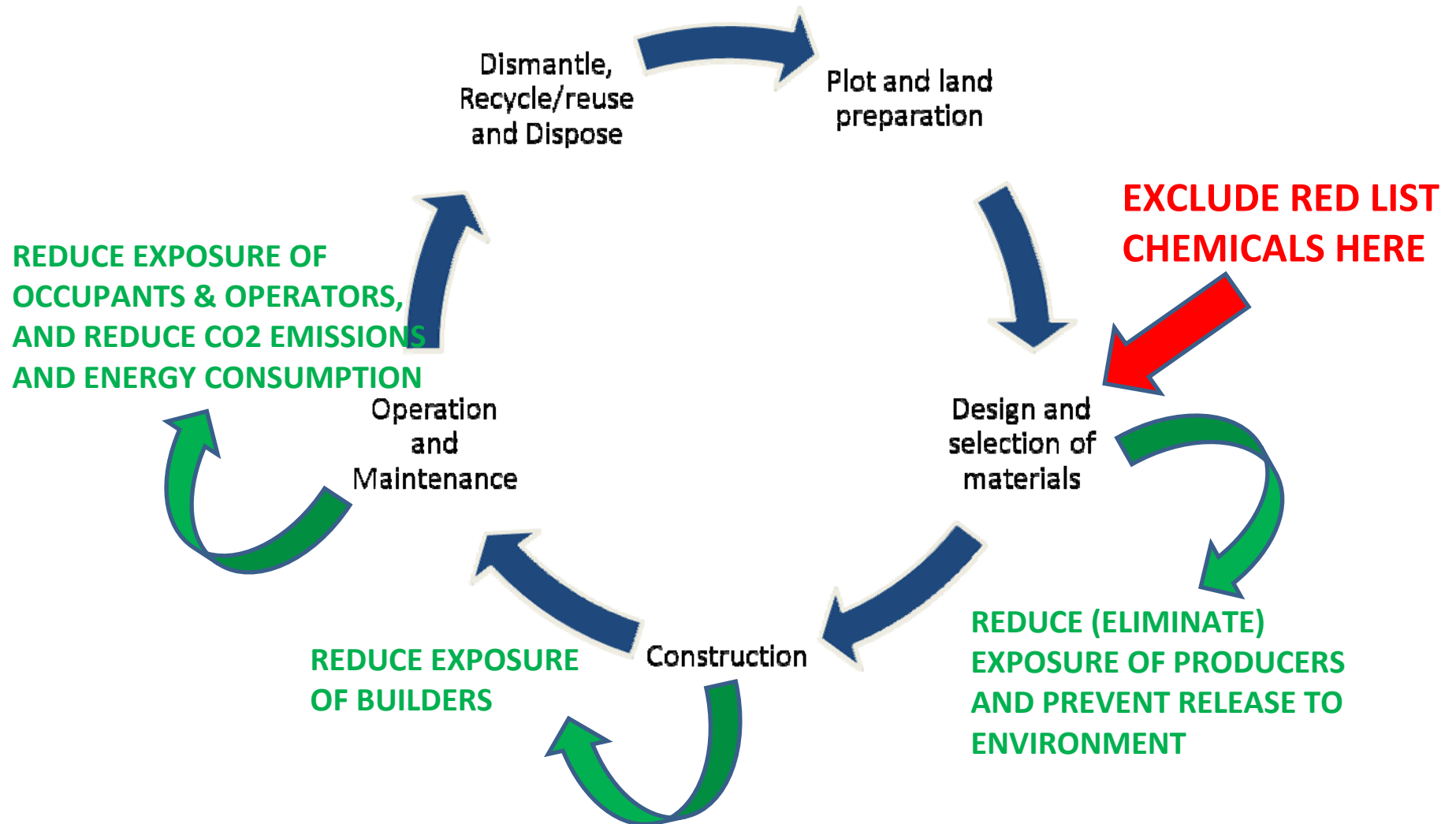
Life cycle of a building



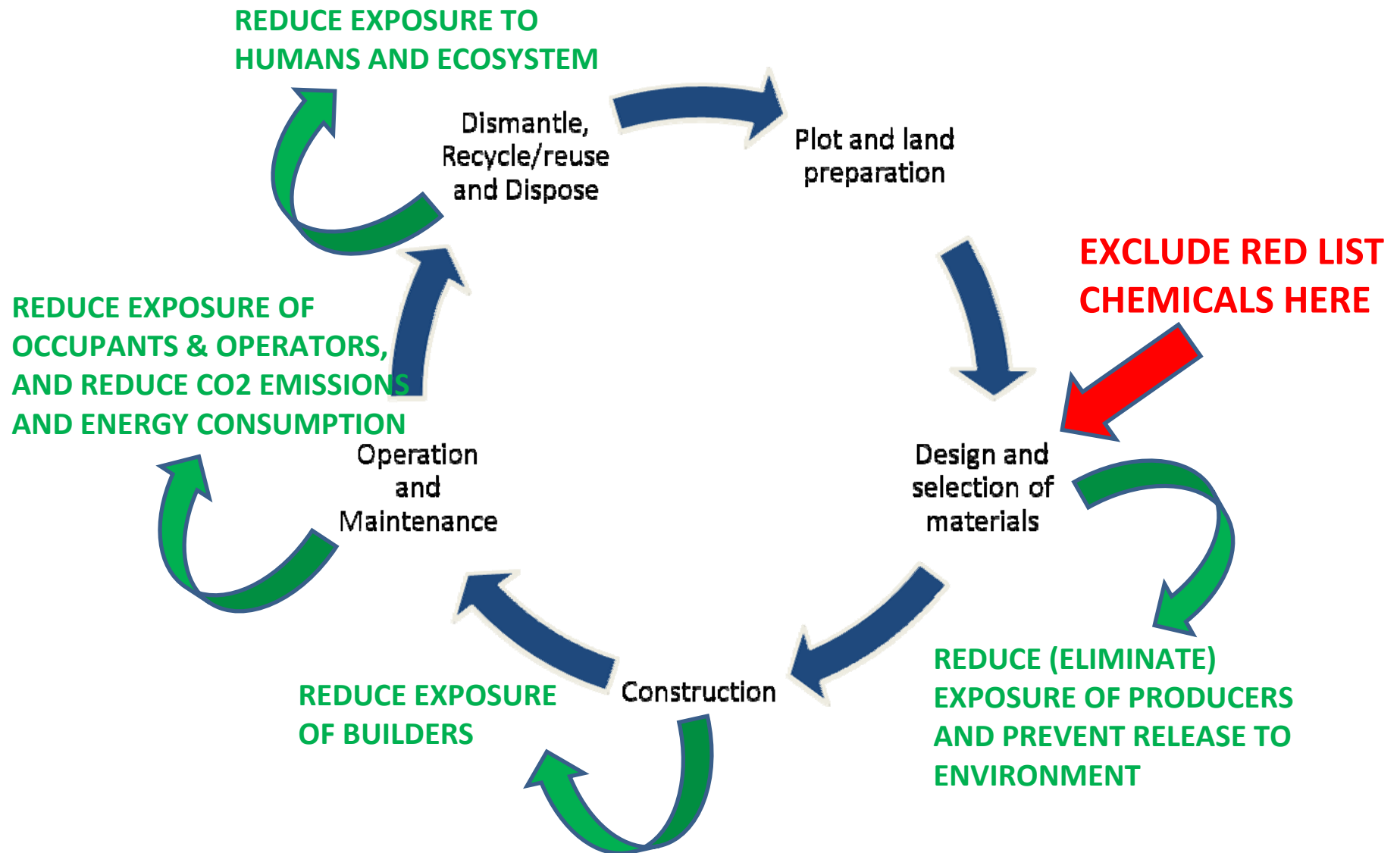
Life cycle of a building



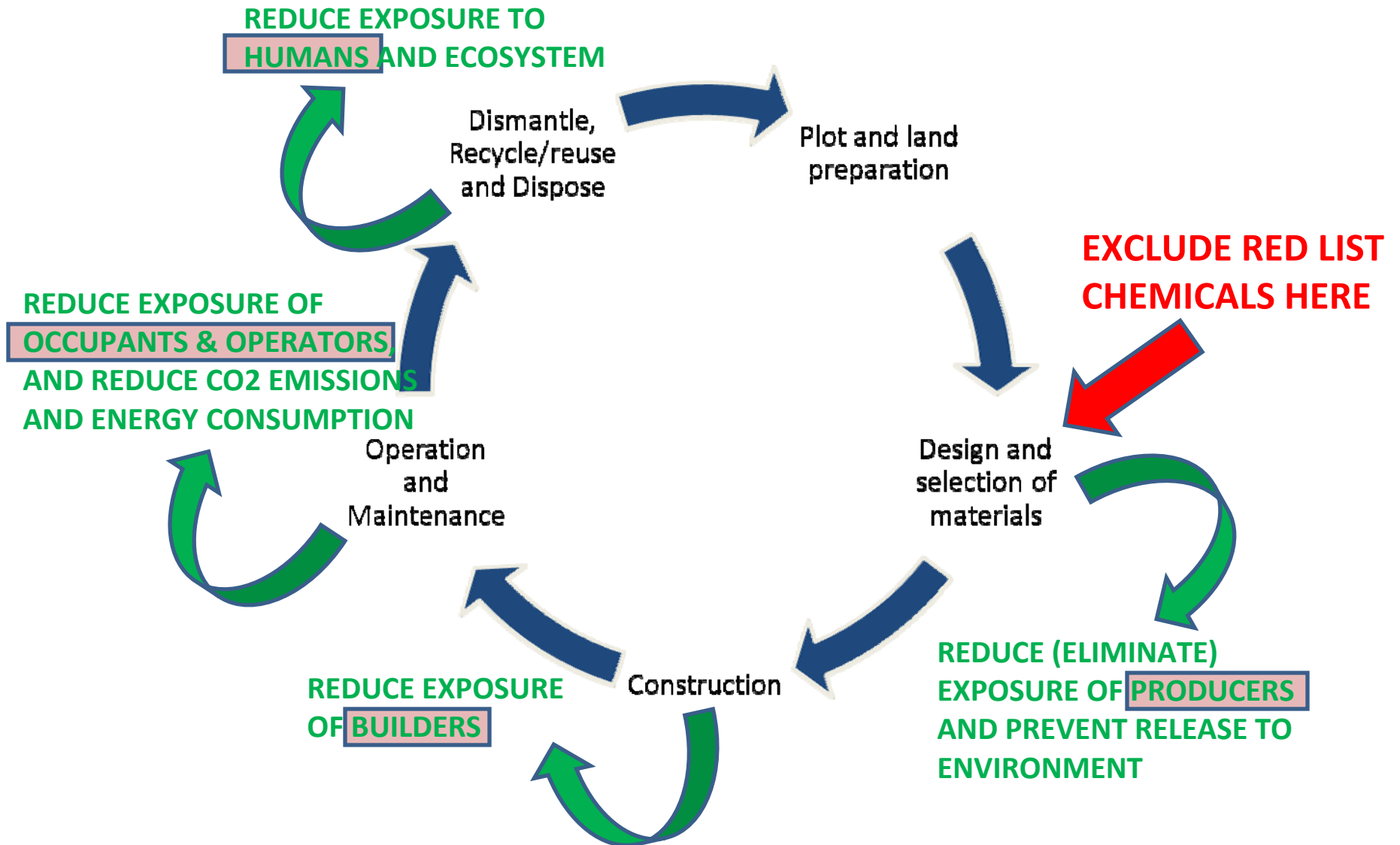
Life cycle of a building



Life cycle of a building



Life cycle of a building



Formaldehyde



- On the Red List
- Eye, skin, and respiratory tract irritant
- Chronic low-level inhalation causes inflammation and eventually scarring and narrowing of the bronchi – nasal and throat irritation most commonly reported
- Nervous system effects: malaise, headache, sleeping disturbances, irritability, and impairment of cognition
- Children may be more vulnerable than adults because of increased minute ventilation and smaller diameter of airways
- Potent sensitizer
- Probable human carcinogen – genotoxic properties, nasal tumors and nasal cancers in rat studies
- March 2009 IARC – carcinogenicity questioned in wood dust case-control studies meta-analysis

Arsenic



- On the Red List
- Inhalation is the primary route of exposure in industries such as nonferrous smelting and wood preservation, glass manufacturing, and electronics
- Non-occupational exposure is primarily through food (except in drinking water in Bangladesh, Taiwan, India)
- Inhalation and ingestion suggest an association with cancer of lung, skin, and urinary bladder
- March 2009 IARC classified arsenic as “carcinogenic to humans” (Group 1)
- Organic arsenicals used in some herbicides was classified as “possibly carcinogenic to humans” (Group 2B)

Mercury



- On the Red List
- Methyl mercury and metallic mercury vapors are more harmful than other forms, because it can be transported to the brain
- Nervous system is very sensitive to all forms of mercury
- Fetus is most sensitive (mental retardation, development)
- Non-occupational exposure is primarily through eating fish and shellfish contaminated with methyl mercury
- Industry releases and exposures include spills, incineration, and coal burning
- Long-range transport well documented
- Reduction of use and collection of mercury from dental practices
- Natural sources

PBDEs - Flame retardants



- On the Red List
- Polybrominated diphenylethers
- Plastics, textiles, and polyurethane foams
- Very limited scientific evidence of toxicity in humans (or ecosystems)
- Introduced in 1980s
- Rapid movement through food web to keystone predators and human breastmilk
- Similar to PCBs in chemical structure – but is their biologic activity the same?
- Endocrine disruption – low-level toxicity – interference with hormone signalling
- Thyroid function and cancer
- Action now being taken under the precautionary principle

Asbestos



- Not on the Red List
- Epidemiological evidence has increasingly shown an association with all forms of asbestos
- Chrysotile, crocidolite, amosite, tremolite, actinolite, and anthophyllite
- Increased risk of lung cancer and mesothelioma
- New and sufficient evidence for cancer of larynx and ovary
- While dimensions are debated, the fundamental conclusion is that all forms of asbestos are “Carcinogenic to humans” (IARC – Group 1)
- Mineral substances (eg., talc or vermiculite) that contain asbestos should also be regarded as “carcinogenic to humans”

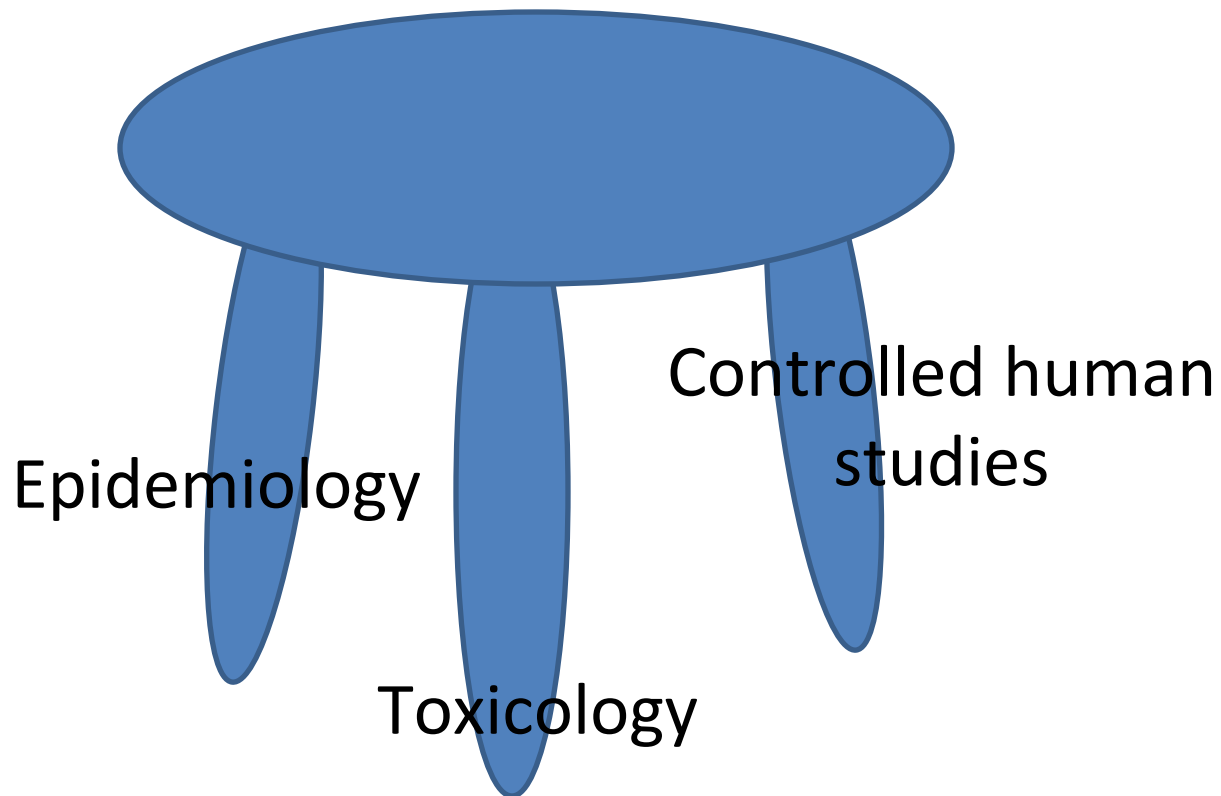
(Some) Drywall



- Emerging concern
- Rotten eggs smell
- Corrosion of copper coils and wiring
- Reports of respiratory problems, headaches, and dry raspy throats
- Sulfur-based gas emissions?
- Linked to a single manufacturer in China
- Imported as early as 2004 (through 2007)
- In response to building boom in aftermath of hurricanes Wilma and Katrina (domestic supplies were depleted)
- State agencies investigating in Florida

Evaluating the Evidence for Risk

“Three-legged Stool”



Biologic Impact Pathway

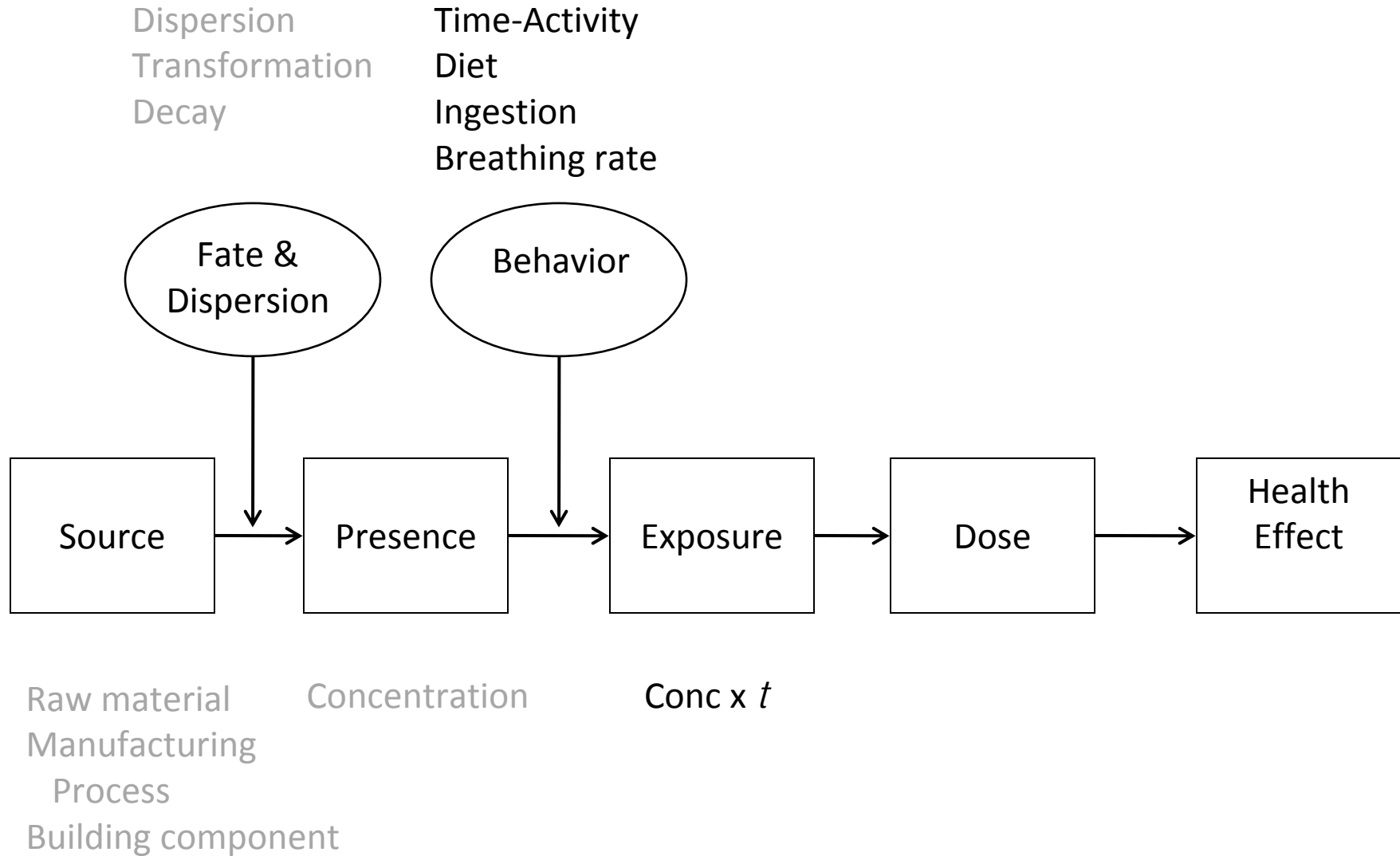
Dispersion
Transformation
Decay



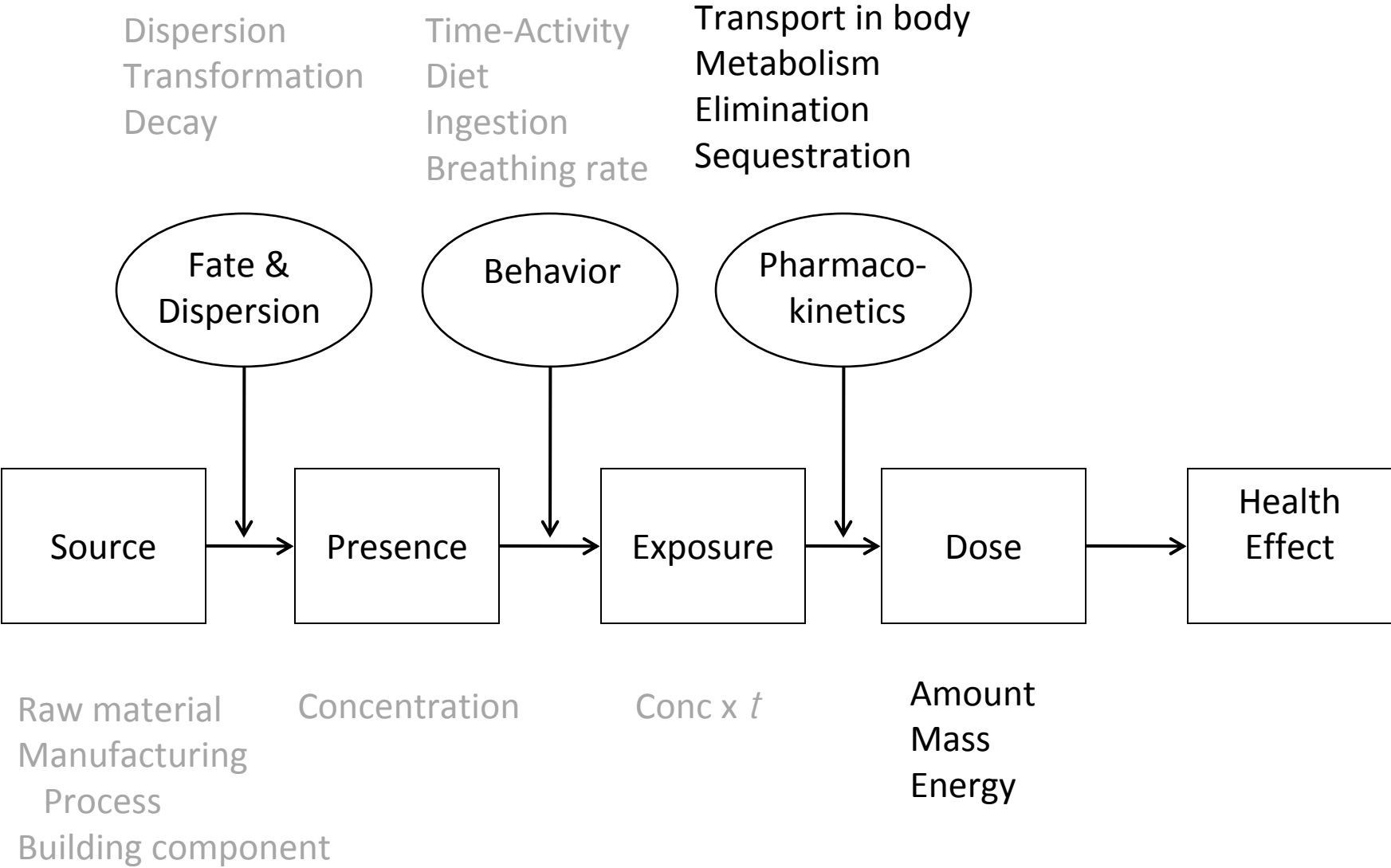
Raw material
Manufacturing
Process
Building component

Concentration

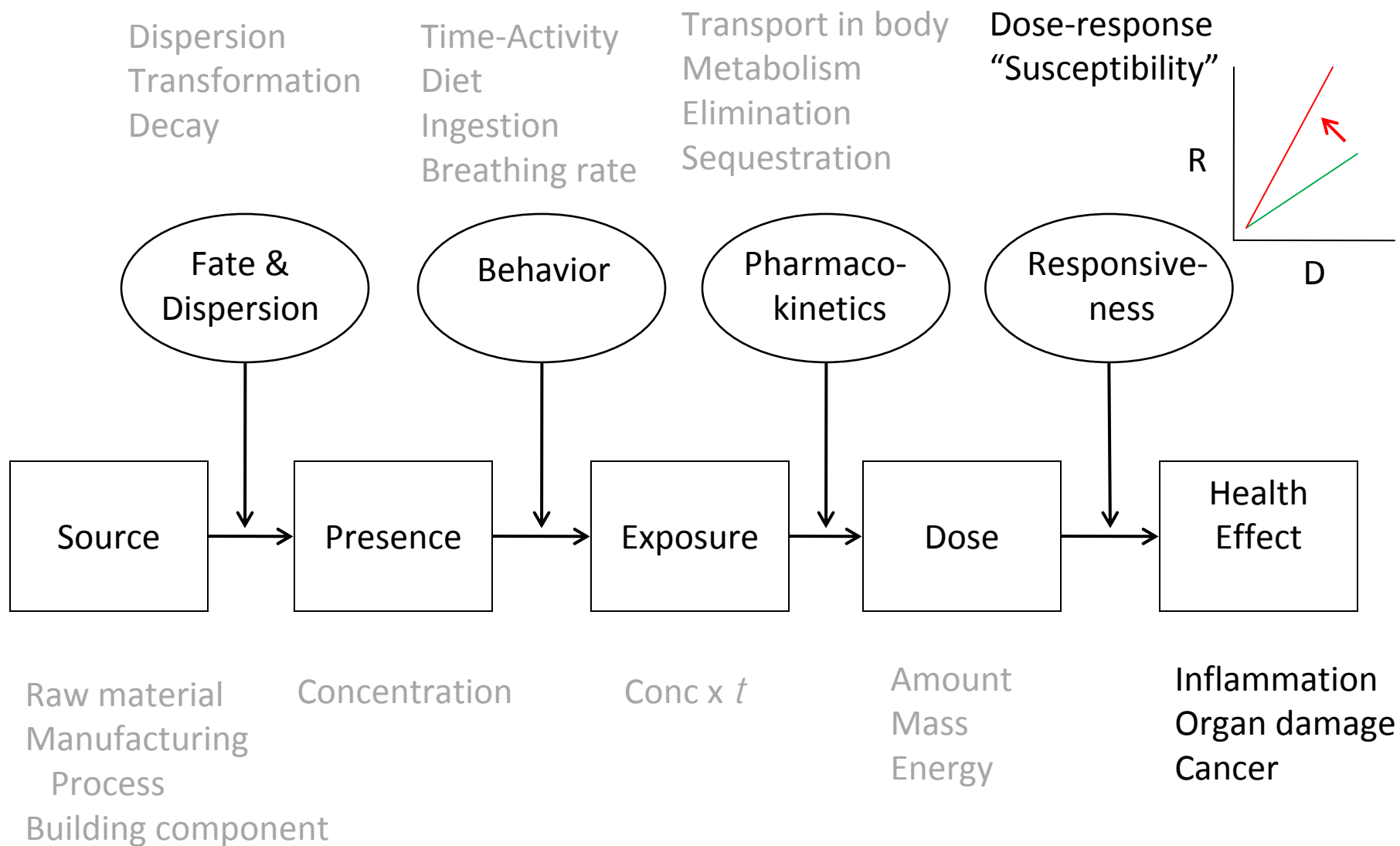
Biologic Impact Pathway



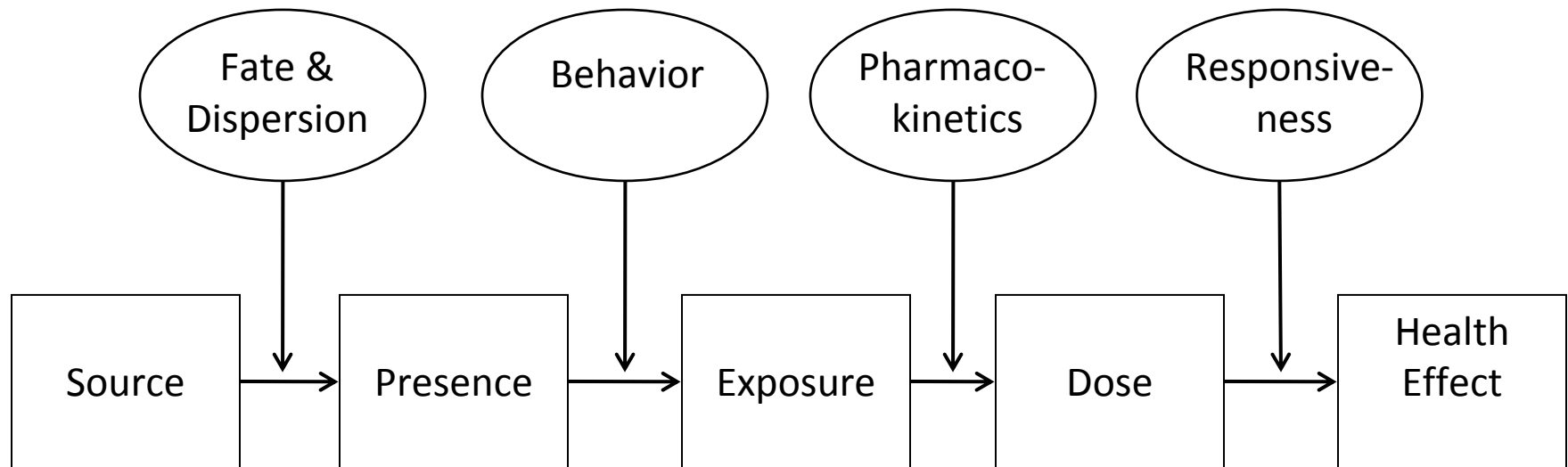
Biologic Impact Pathway



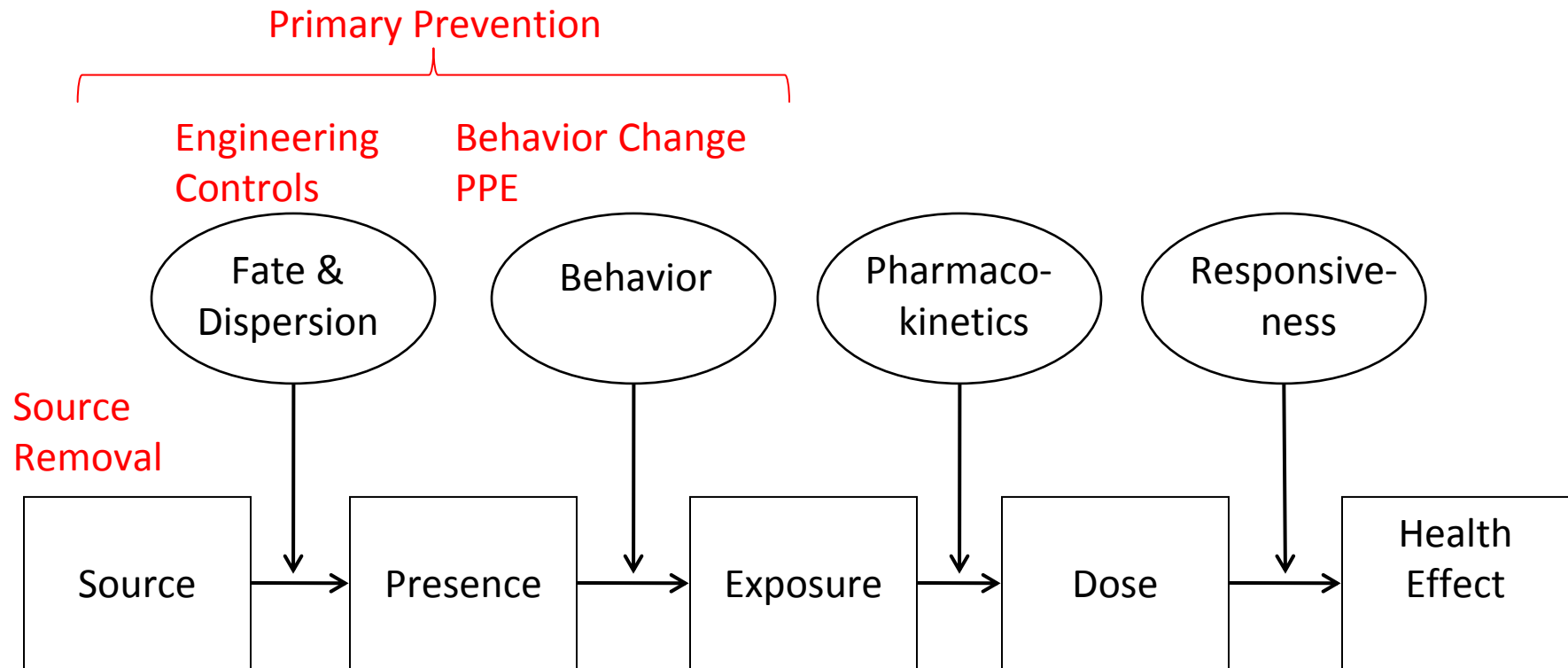
Biologic Impact Pathway



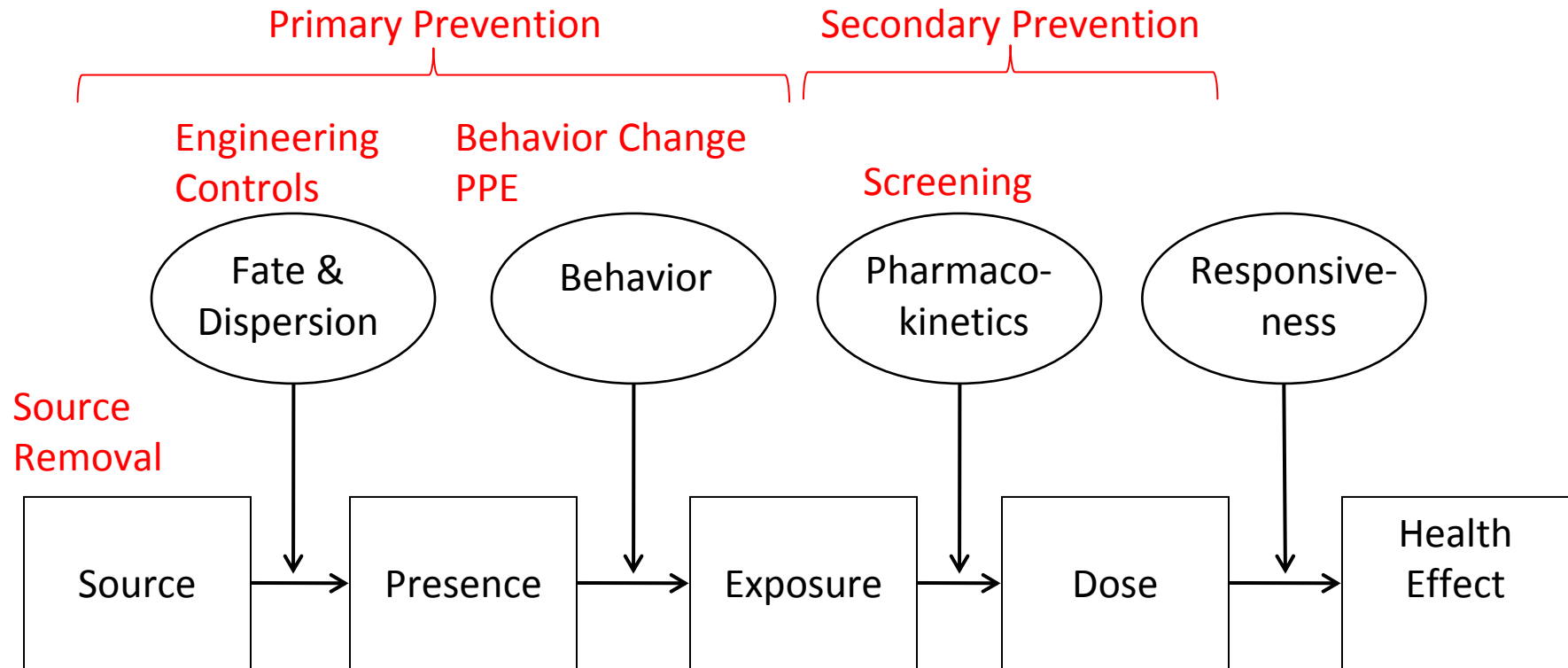
Strategies for prevention?



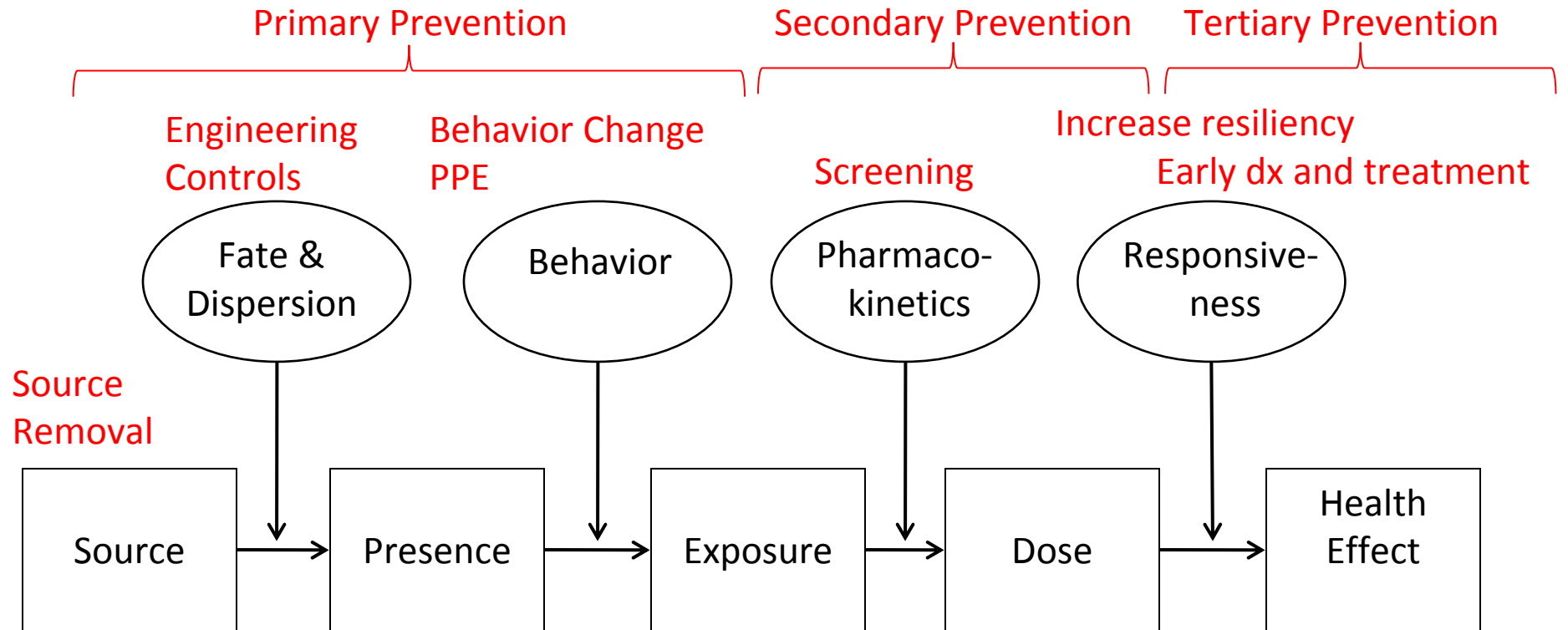
Strategies for prevention?



Strategies for prevention?



Strategies for prevention?



Risk Assessment



Conclusions

- Red List inclusion is based on reliable scientific reviews by US EPA (IRIS), the International Agency for Cancer Research (IARC), and the Agency for Toxic Substances and Disease Research (ATSDR).
- Follows Precautionary Principle
- Founded on advantages of Primary Prevention
- Challenges
 - Technically complex data
 - Knowledge is evolving
 - Need to partner with experts to conduct Risk Assessment in future maturation of Red List concept



Max Richter
Learn Before You Leap

Learn Before You Leap



Learn Before You Leap



Are Green Buildings Healthy Buildings?



Our Responsibility

Investigate Our Impact

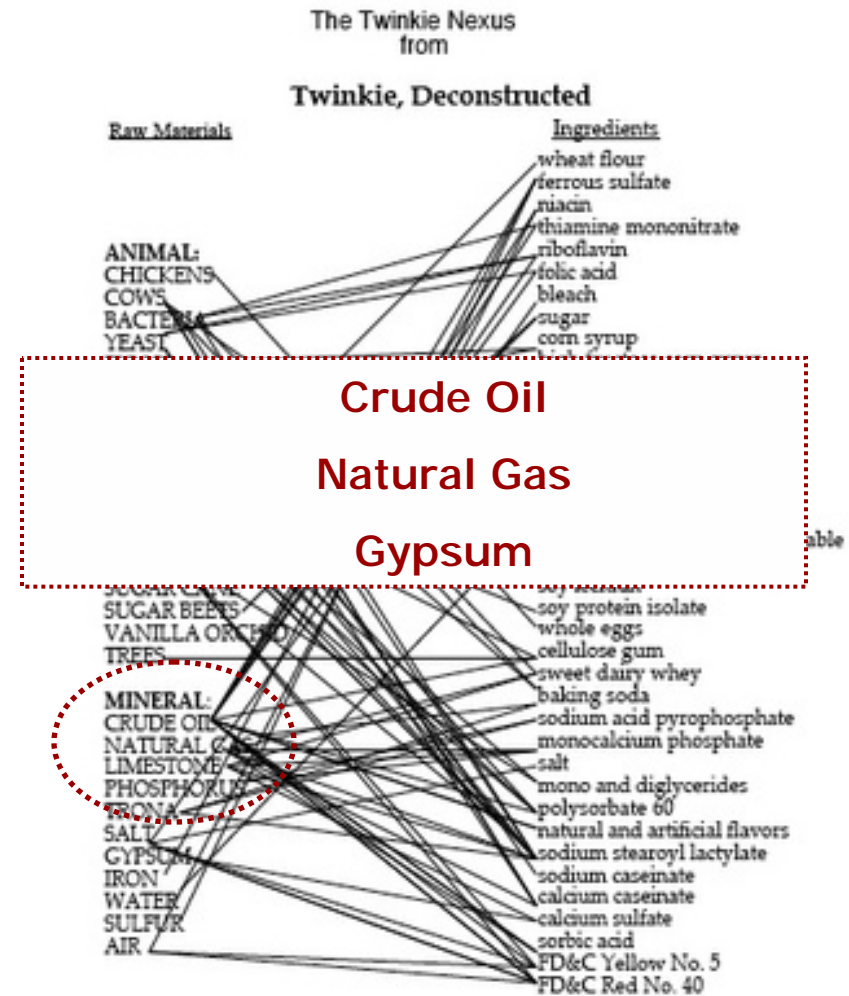
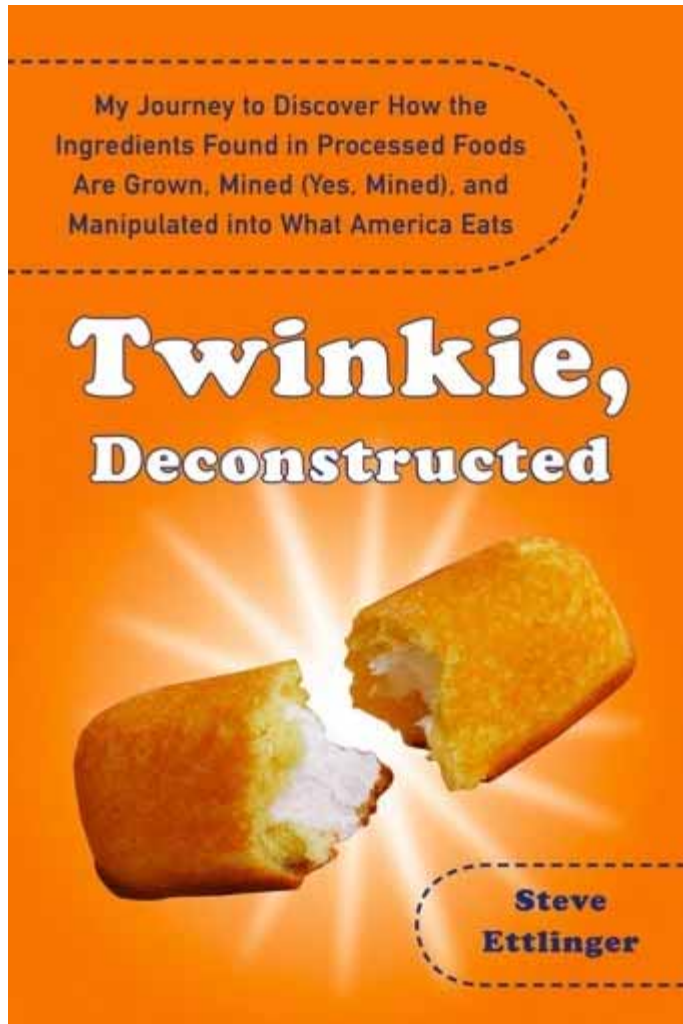
Make Changes, Where We Can

Educate Others

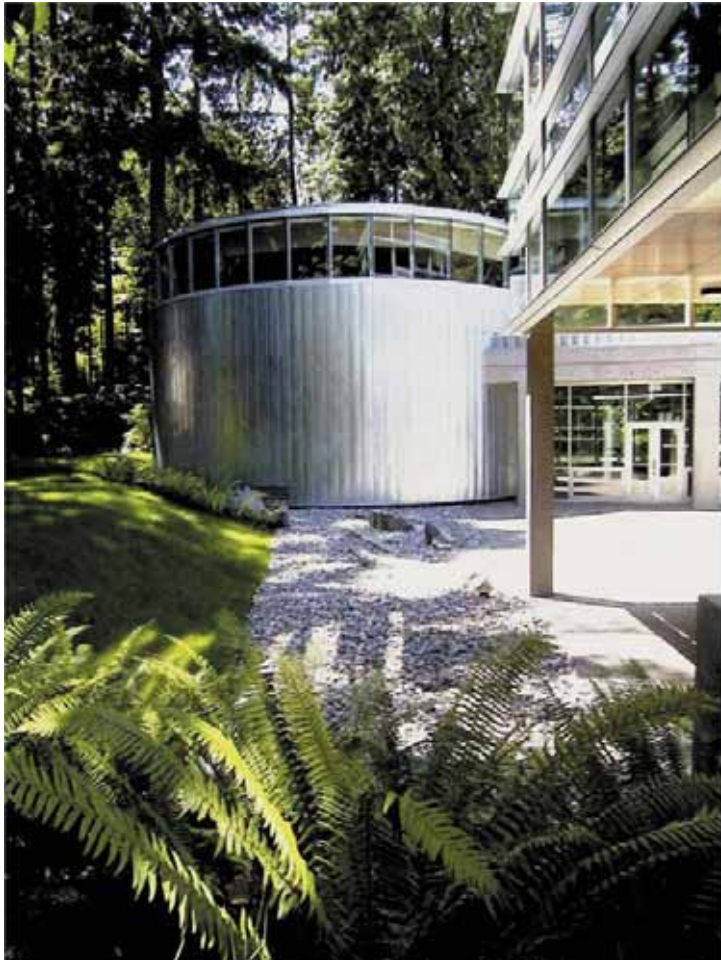
Twinkie



Toxins and Buildings



Toxins and Buildings



Cascadia's Material Red-List



Prerequisite Five

The project cannot contain any of the following red list materials or chemicals

- No added formaldehyde
- Halogenated Flame Retardants
- PVC
- Mercury
- CFCs
- HCFCs
- Neoprene (chloroprene)
- Cadmium
- Chlorinated Polyethylene and Chlorosulfonated Polyethylene
- Wood treatments containing Creosote, Arsenic or Pentachlorophenol
- Polyurethane
- Lead
- Phthalates

Every site
in every
community
needs to take
us one step
closer to true
sustainability



Toxins and Buildings



Green Buildings and Red List Materials

Lights: Mercury - Neurotoxin ¹

Power: Mercury - Neurotoxin ¹

Plywood: Formaldehyde - Carcinogen ²

Thermometers: Mercury - Neurotoxin ¹

Furniture: Brominated Flame Retardants -
Developmental Effects ³

Flooring: PVC - Dioxins - Carcinogen ⁴

Flooring: PVC - Pthalates - Birth Defects ⁵

1. "In Harm's Way: Toxic Threats to Child Development." Greater Boston Physicians for Social Responsibility. Found at: <http://psr.igc.org/ihw-project.htm>

2. Proposition 65, State of California. Found at: <http://www.oehha.ca.gov/prop65.html>

3. "Brominated Flame Retardants: Rising Levels of Concern." Health Care Without Harm. Found at: <http://www.noharm.org/details.cfm?type=document&id=1095html>

4. "Environment and Breast Cancer: Science Review. Silent Spring Institute. Found at: http://sciencereview.silentspring.org/mamm_detail.cfm?cid=75-01-4

5. "Specific Environmental Contaminants" Canadian Cancer Society. Found at: http://www.cancer.ca/ccs/internet/standard/0,3182,3172_367525__langId-en,00.html

Stantec's Chemicals of Concern



- Rebecca Hartley
- Cross listed the chemicals on the Australian National Pollutant Index & the US Agency for Toxic Substance and Disease Registry.
- Chemicals of **High Concern*** were added to the Red-List while the other were put on a Suggested Red-List.
- Chemicals of High Concern were those that had recorded negative impacts and/or incidences of contamination. They not be widely used in buildings or building materials.

Chemicals of Concern



Chemicals of Concern:

- Arsenic
- Cadmium
- CFCs & HCFCs
- Chlorinated Polyethylene
- Chlorosulfonated Polyethylene
- Copper
- Chlorinated Polyvinyl Chloride (CPVC)
- Creosote
- Dioxin
- Added Formaldehyde
- Halogenated Flame Retardants (HFRs)
- Hexavalent Chromium
- Lead
- Mercury
- Neoprene
- Organotins
- Pentachlorophenol
- Perfluorocarbons (PFCs)
- Phthalates
- Polyurethane
- Polyvinyl Chloride (PVC)

Suggested Chemicals of Concern:

- 1,2-Dibromoethane
- 1,1,1,2-Tetrachloroethane
- 1,1,2-Trichloroethane
- 1,3-Butadiene
- Acetaldehyde
- Acrylonitrile
- Antimony (and Compounds)
- Carbon Disulfide
- Cobalt
- Ethylbenzene
- Phenol
- Polycyclic Aromatic Hydrocarbons (PAHs)
- Selenium
- Styrene
- Trichloroethylene
- Xylenes

Product Questionnaire



Goal:

To create an interactive questionnaire that allows us to more fully understand the environmental and human impacts of the products specified for our buildings.

Eventually, we want to eliminate the negative impacts associated with the specification of building materials.



Product Questionnaire



1. Investigate Our Impact

- 1a. Ask suppliers to tell us what is in their products.
- 1b. Work with epidemiologists and toxicologists to better understand the impact of our material choices
- 1c. Make the information public

2. Make Changes, Where We Can

- 2a. Review your specs and designs
- 2b. Present the research to your clients to help them make well-informed decisions

3. Educate Others

- 3a. Make the information public (Cascadia site, Pharos, etc.)
- 3b. Bridge the gap between academics and consulting professionals

Initial Questionnaire



- Adapted from Sera's original concept
- Based on Cascadia's Living Building Challenge credits and the Pharos indicators
- Incorporates 30 Red-Listed Chemicals
- Interactive PDF Format
- Developed with input of 12 product manufacturers through a "Reverse" Lunch and Learn

<http://www.cascadiagbc.org/lbc/resources1/materialsresources>

Initial Questionnaire



RESET FORM



www.cascadia gbc.org/lbc

BUILDING MATERIALS QUESTIONNAIRE

--> Please Complete and Return Electronically.

Name of Manufacturer: Date:

Product or Product Line:

Representative Name:

How do you define a unit of your product? (mt, rd, linear ft, etc.)

QUESTIONS

1. What company manufactures this product?
2. Where is this product manufactured?
3. What is the intended service life of this product? years
4. Has an LCA been completed for this product? (If yes, please state the tool or company commissioned)
5. Are there any precursors, chemicals or components of the final product which are not accounted for in the answers provided for questions 1-3? (Please declare all such components below)
6. Are any precursors or components of the final product manufactured at any other locations? (If so, please list all other locations)
7. Where are the raw materials extracted and/or harvested?
8. What are the chemical constituents and raw materials in this product which occur in a percent content greater than 1% of the total final product weight?

DEFINITIONS

- Biodegradable:** The capacity of a chemical or material to be decomposed and/or broken down by living organisms into simpler, more stable organic compounds.
- California Specification Section 01350:** A Special Environmental Requirements Specification developed by the State of California that addresses public health and environmental performance issues related to building materials. For more information, see <http://www.ciwm.ca.gov/greenbuilding/Specs/Section01350>
- CFs or HCFCs:** Chlorofluorocarbons or Hydrochlorofluorocarbons
- Cradle-to-gate:** A partial life cycle assessment that spans from raw material acquisition/extraction through to the final manufacturing process.
- CREL:** Chronic Reference Exposure Limit - Created by the State of California's Office on Environmental Health Hazard Assessment to address VOCs with known chronic health effects and establish a concentration level where studies found no health effects. See listed chemical exposure levels at http://www.oehha.ca.gov/air/chronic_rels/AllChrels.html
- Downcycle:** The result of material reuse that inherently reduces the quality of the material over time. It implies a loss of value for industry and/or an added dependency on chemicals to make the materials useful again.
- FSC certified:** A process created by the Forest Stewardship Council that mandates third-party certification for wood products, guaranteeing that the raw material comes from a well-managed and sustainable forest. For more information, see <http://www.fsc.org>
- HHC/VHHC:** High Hazard Chemicals/Very High Hazard Chemicals - Classification systems that aggregate chemicals that compromise human and environmental health (e.g. known and/or suspect carcinogens and mutagens). See a complete list at <http://www.pharoslens.net/framework/definitions/id/2>
- Highly acute toxicants:** Defined by OSHA as substances that may be fatal or cause damage to target organs as a result of a single exposure or exposures of short duration. See listed chemicals at http://www.bnl.gov/esh/shsd/Programs/Program_Area_Chemicals_Highly_Acute_Toxins.asp
- LCA:** Life Cycle Assessment - According to SETAC, an objective process to evaluate the environmental burdens associated with a product, process, or activity by identifying energy and materials used and wastes released to the environment, and to evaluate and implement opportunities to affect environmental improvements.
- PAHs:** Polycyclic Aromatic Hydrocarbons
- POPs:** Persistent Organic Pollutants - According to the EPA, a set of chemicals that are toxic, persist in the environment for long periods of time, and biomagnify as they move up through the food chain. For additional information, refer to the Stockholm Convention website: <http://chm.pops.int> or the EPA summary: <http://www.epa.gov/pesticides/international/pops.htm>
- Post-consumer recycled content:** Material that has completed its life cycle within a consumer item and is reused to fabricate a new product rather than be disposed of as a solid waste.
- PVC or CPVC:** Polyvinyl Chloride or Chlorinated Polyvinyl Chloride
- Rapidly renewable resources:** Bio-based materials that are grown or naturally replenished at a rate which exceeds depletion of the usable supply.
- Raw materials:** According to the Merriam Webster dictionary, a crude or unprocessed material that can be converted by manufacture, processing, or combination into a new and useful product.
- Renewable energy projects:** A source of energy not depleted by its utilization and generated through one of the following listed methods:
- Bio-diesel
 - Bio-mass
 - Geothermal
 - Low-head hydroelectric
 - Methane gas recovery
 - Renewably-derived ethanol
 - Solar photovoltaic
 - Solar thermal direct
 - Solar thermal electric
 - Tidal generation
 - Wind turbine
- Salvaged:** According to the USGBC, construction materials recovered from existing buildings or construction sites and reused in other buildings.
- SCAQMD 2006/2007 regulations:** South Coast Air Quality Management District - the air pollution control agency for Orange County and the urban portions of Los Angeles, Riverside and San Bernardino counties. See rules 1113 & 1168 at http://www.aqmd.gov/rules/reg/reg11_tofc.html
- Socially sustainable:** Actions or tangible substances that promulgate equal access for all people to the basic needs of happiness, safety, freedom, dignity and affection. Refer also to Abraham Maslow's Hierarchy of Needs: http://www.abraham-maslow.com/m_motivation/Hierarchy_of_Needs.asp
- TLV:** Threshold Limit Value - Guidelines based solely on health factors, prepared by the American Conference of Governmental Industrial Hygienists, to assist in making decisions regarding safe levels of exposure to various hazards found in the workplace. See levels at <http://www.aiha.org/1documents/Committees/WEEL-levels.xls>
- US EPA's Toxic Release Inventory Chemicals 2006:** A publicly available database created by the US Environmental Protection Agency that contains information on toxic chemical releases and waste management activities. See complete lists at <http://www.epa.gov/tri/chemical/index.htm>
- VOC:** Volatile Organic Compound - According to the EcoLogo, any organic compound which participates in atmospheric photochemical reactions to create smog and/or contributes to poor indoor air quality. For more information, see <http://www.epa.gov/iedweb00/voc.html>

Initial Questionnaire



17. What process does the manufacturer have in place for waste reduction and recycling? (Please describe)

18. How is the waste that is not re-used handled? (Please describe)

19. What percentage of the final product weight is from:

a. Post-consumer recycled content? % b. Post-industrial recycled content? %

Red List

- 19 from Red-List
- 11 from Suggested Red-List



9. Are any of the following materials and chemicals used, produced, or released at any time during the production of this product? (Check the box if the material or chemical is present during production)

- | | | |
|---|---|---|
| <input type="checkbox"/> i. 1,2-Dibromoethane | <input type="checkbox"/> xi. Cobalt | <input type="checkbox"/> xxi. PAHs |
| <input type="checkbox"/> ii. 1,3-Butadiene | <input type="checkbox"/> xii. Copper | <input type="checkbox"/> xxii. Pentachlorophenol |
| <input type="checkbox"/> iii. Acetaldehyde | <input type="checkbox"/> xiii. Creosote | <input type="checkbox"/> xxiii. Perfluorochemicals (PFC) |
| <input type="checkbox"/> iv. Acrylonitrile | <input type="checkbox"/> xiv. Ethylbenzene | <input type="checkbox"/> xxiv. Phenol |
| <input type="checkbox"/> v. Arsenic | <input type="checkbox"/> xv. Added Formaldehyde | <input type="checkbox"/> xxv. Phthalates |
| <input type="checkbox"/> vi. Antimony | <input checked="" type="checkbox"/> xvi. Halogenated Flame Retardants | <input type="checkbox"/> xxvi. Polychloroprene (Neoprene) |
| <input type="checkbox"/> vii. Cadmium | <input type="checkbox"/> xvii. Hexavalent Chromium | <input type="checkbox"/> xxvii. Polyurethane |
| <input type="checkbox"/> viii. CFCs or HCFCs | <input checked="" type="checkbox"/> xviii. Lead | <input type="checkbox"/> xxviii. PVC or CPVC |
| <input type="checkbox"/> ix. Chlorinated Polyethylene | <input type="checkbox"/> xix. Mercury | <input type="checkbox"/> xxix. Trichloroethylene |
| <input type="checkbox"/> x. Chlorosulfonated Polyethylene | <input type="checkbox"/> xx. Organotins | <input type="checkbox"/> xxx. Xylenes |

Initial Questionnaire



20. From cradle-to-gate, what are the total greenhouse gas equivalents per unit of product? Kgs of CO2 equivalent

21. What percent of the total energy consumed from cradle-to-gate comes from renewable energy projects? (See definitions for list of applicable projects) %

22. From cradle-to-gate, how much potable water is used per unit of product?

23. Does the company have a stated social equity policy? (If yes, please state in the space given below)

24. What steps has your company taken towards becoming socially and environmentally sustainable? (Please provide a description of any current or planned leadership, employee, community, or environmental management programs.)

SUBMIT BY EMAIL

PRINT FORM

Completed Questionnaires



We have named each Building Materials' Questionnaire below to reflect the Construction Specifications Institute (CSI) divisions and numbering system. Please click on the hyperlinked 'Product' name for the PDF.

MASTERFORMAT	MANUFACTURER	PRODUCT	DATE SUBMITTED
Division 3:Concrete 031500	Hycrete, Inc	Hycrete Element	2008/12/02
Division 6:Wood/Plastic.. 061600	McKillican International Distribution	Skyblend/Skyvelv	2008/07/16
066000	Roppe Corporation	Pinnacle Rubber Base	2009/03/02
067300	Trex Company Inc	Trex Wood Polymer	2008/11/18
Division 7:Thermal			
072100	Dow Chemical Co.	Styrofoam Insulation	2008/01/09
073000	Selco	Strong Seal	2009/04/03
096500	Forbo Flooring Systems	Marmoleum	2008/08/08
096500	Tarkett S.p.A.	Linoleum xt	2009/03/05
096500	Amico	Marathon Oasis Rubber Roll	2009/02/09
096800	Mohawk Industries, Inc.	Encycle Carpet Tile	2008/07/14
Division 12:Furniture			
125200	Steelcase, Inc - Seating	Leap, Think, Amia, Siento	2008/08/11
Division 22:Plumbing			
221200	Darco, Inc	Polyethylene Water Storage Tank	2009/01/29
Division 31:Earthwork 313500	Environmental Research Corps	Bio-Fence	2008/11/27



13 Submissions
Screenshot: May 4, 2009

Completed Questionnaires



Name of Manufacturer: Forbo Flooring Systems

Date: 2008/08/08

Product or Product Line: Marmoleum linoleum resilient floor covering

Representative Name: Jacco Vlaar

How do you define a unit of your product? (m2, ft2, linear ft, etc.) m2

QUESTIONS

1. What company manufactures this product? Forbo Flooring B.V.

2. Where is this product manufactured? Assendelft, the Netherlands

3. What is the intended service life of this product? [] years

4. Has an LCA been completed for this product? (If yes, please state the tool or company commissioned) []

7. Where are the raw materials extracted and/or harvested?

linseed oil: Canada (Manitoba/Saskatchewan)
Limestone: Germany
Jute: India
Woodflour: Germany & Scandinavia

8. What are the chemical constituents and raw materials in this product which occur in a percent content greater than 1% of the total final product weight?

Linseed oil: 11.7%
Rosin: 2.3%
Tall Oil: 20.7%
Wood flour: 24.2%

Completed Questionnaires



9. Are any of the following materials and chemicals used, produced, or released at any time during the production of this product? (Check the box if the material or chemical is present during production, regardless of the quantity or percentage content found in the product.)

- | | | |
|---|--|---|
| <input type="checkbox"/> i. 1,2-Dibromoethane | <input type="checkbox"/> xi. Cobalt | <input type="checkbox"/> xxi. PAHs |
| <input type="checkbox"/> ii. 1,3-Butadiene | <input type="checkbox"/> xii. Copper | <input type="checkbox"/> xxii. Pentachlorophenol |
| <input type="checkbox"/> iii. Acetaldehyde | <input type="checkbox"/> xiii. Creosote | <input type="checkbox"/> xxiii. Perfluorochemicals (PFC) |
| <input type="checkbox"/> iv. Acrylonitrile | <input type="checkbox"/> xiv. Ethylbenzene | <input type="checkbox"/> xxiv. Phenol |
| <input type="checkbox"/> v. Arsenic | <input type="checkbox"/> xv. Added Formaldehyde | <input type="checkbox"/> xxv. Phthalates |
| <input type="checkbox"/> vi. Antimony | <input type="checkbox"/> xvi. Halogenated Flame Retardants | <input type="checkbox"/> xxvi. Polychloroprene (Neoprene) |
| <input type="checkbox"/> vii. Cadmium | <input type="checkbox"/> xvii. Hexavalent Chromium | <input type="checkbox"/> xxvii. Polyurethane |
| <input type="checkbox"/> viii. CFCs or HCFCs | <input type="checkbox"/> xviii. Lead | <input type="checkbox"/> xxviii. PVC or CPVC |
| <input type="checkbox"/> ix. Chlorinated Polyethylene | <input type="checkbox"/> xix. Mercury | <input type="checkbox"/> xxix. Trichloroethylene |
| <input type="checkbox"/> x. Chlorosulfonated Polyethylene | <input type="checkbox"/> xx. Organotin | <input type="checkbox"/> xxx. Xylenes |

20. From cradle-to-gate, how much potable water is used per unit of product? Kgs of CO2 equivalent
21. What percent of the total energy consumed from cradle-to-gate comes from renewable energy projects? (See definitions for list of applicable projects) %
22. From cradle-to-gate, how much potable water is used per unit of product?

Summary



1. Investigate Our Impact

- 1a. Ask suppliers to tell us what is in their products.
- 1b. Work with epidemiologists and toxicologists to better understand the impact of our material choices
- 1c. Make the information public

2. Make Changes, Where We Can

- 2a. Review your specs and designs
- 2b. Present the research to your clients to help them make well-informed decisions

3. Educate Others

- 3a. Make the information public (Cascadia site, Pharos, etc.)
- 3b. Bridge the gap between academics and consulting professionals

Resources



1. **World Health Organization:** <http://www.who.int/en/>
2. **Health Canada:** <http://www.hc-sc.gc.ca/index-eng.php>
3. **US Department of Health and Human Services – Agency for Toxic Substances and Disease Registry:** <http://www.atsdr.cdc.gov/>
4. **US Environmental Protection Agency:** <http://www.epa.gov/>
5. **US Centers for Disease Control and Prevention – National Institute for Occupational Safety and Health:** <http://www.cdc.gov/niosh/database.html>
6. **US Department of Labour – Occupational Safety and Health:** <http://www.osha.gov/SLTC/>
7. **California Office of Environmental Health Hazard Assessment:** <http://www.oehha.ca.gov/>
8. **Healthy Building Network:** <http://www.healthybuilding.net/>
9. **Pharos Wiki:** http://www.pharosproject.net/wiki/index.php?title=Main_Page
10. **Cascadia Green Building Council:** <http://www.cascadiagbc.org/>

Thank You



<http://www.cascadiagbc.org/lbc/resources1/materialsresources>

1. Go to the Cascadia Region Green Building Council site
2. Click on Living Building Challenge (orange flower)
3. Click on Living Building Resources
4. Click on Materials

Do you feel that you know the ingredients in and impacts of The products you specify, sell, or manufacture?

For which building materials would you most like to have more detailed information?

What are your barriers to sourcing/manufacturing building products that holistically address health and pollution concerns? What are the opportunities that arise?

What are the things you can do to influence change in the materials industry and how would you integrate them into your work?

