Health Element

Clark County Comprehensive Growth Management Plan

Growing Healthier

Pathways from the built environment to health:

Environmental Quality

Introduction

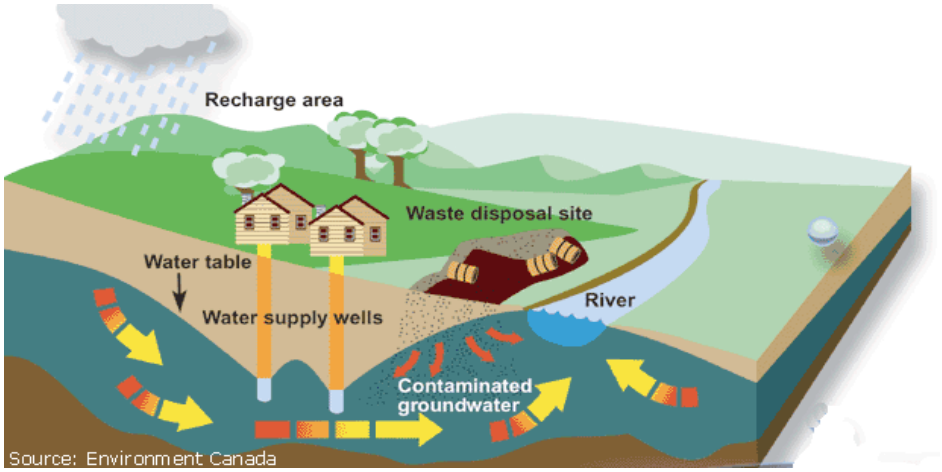
A healthy community is one in which the natural resources essential to human life are of a quality and quantity sufficient to protect and sustain the population. The focus of this literature review is to examine the primary challenges to a community's ability to meet this condition: the presence of toxic contaminants and the depletion of critical resources.

A community's survival is dependent on a local environment that provides the natural resources essential for life: food, air and water. When those resources become toxic, rates of morbidity and mortality increase. When those resources become depleted, the environment may no longer be able to support the community at all. Toxic and depleted resources are described by the key concepts of point source pollution, nonpoint source pollution, and resource depletion.

Point Source Pollution

Point source pollution refers to events that originate from a single site, such as chemical spills, leaking storage tanks, or illegal dumping of toxic chemicals. Figure 8.1 illustrates the pollutants' primary route of dispersal, as they travel into and contaminate ground water.[1]

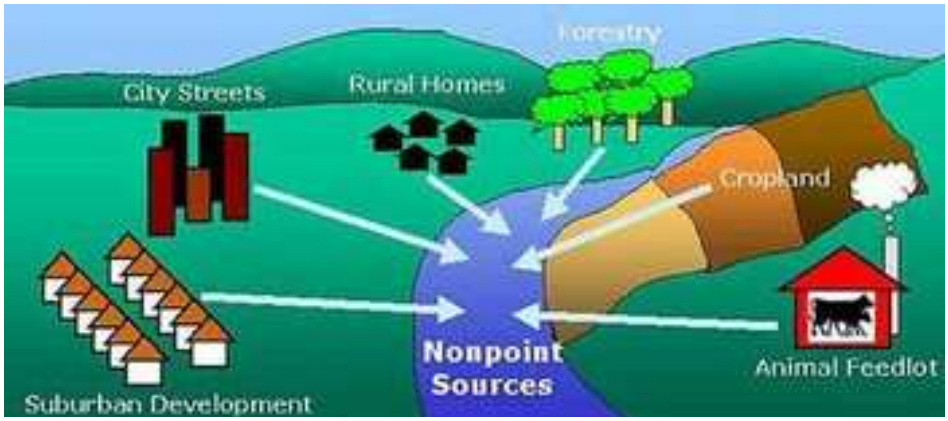
Figure 8.1. Point Source Pollution



Nonpoint Source Pollution

Nonpoint source pollution refers to toxins from multiple sites (e.g., emissions from factories, fertilizers from agricultural lands, grease and oil from city streets) being widely dispersed throughout the community by runoff from precipitation. Water carries and deposits these chemicals across the landscape, creating multiple paths to human and environmental exposure and ultimately degrading surface and groundwater quality (Figure 8.2).[2]

Figure 8.2. Nonpoint Source Pollution



Resource Depletion

Resource depletion is a term that describes a reduction in number or quantity of a resource so as to threaten the ability of a community to function. In the United States and around the globe, the health and viability of many communities are threatened not only by degradation of water quality, but also by the depletion of water resources.[3]

This paper presents research on threats to the health of the environment that we depend on to survive and thrive. Human exposures to toxins can be categorized into industrial pollutants, outdoor air pollutants, and indoor air pollutants. Water quality and quantity are vital to a healthy community. The impacts of water quality and quantity on human health can be described as water contamination and depletion.

Human Exposures to Toxins

- Industrial pollutants
- Outdoor air pollutants
- Indoor air pollutants

Water Quality & Quantity

- Contamination
- Depletion

Human Exposures to Toxins

Environmental toxins have a negative impact on human health. In the United States, there are over 80,000 naturally occurring or manufactured chemicals used by industry and commerce, very few of which have been tested for health impacts on animals or humans.[4] A 2004 literature review examined research on the relationship between

> Around 1950, approximately one in four Americans could expect a cancer diagnosis at some point during his or lifetimes. Today, nearly one in two men and more than one in three women can someday expect to hear, 'you have cancer'.
>
> - *American Cancer Society, 2005*

chemical contaminants and 180 different diseases or conditions. The review found "strong" evidence that chemicals were associated with 127 different diseases, including cancers, respiratory illness, and birth defects.[5] A 2006 literature review focusing on 30 years of cancer research presented strong evidence that chemical exposures elevated the rate of adult and childhood cancers.[6] The American Cancer Society concluded that environmental chemicals are not only linked to chronic disease, but also explain the increase in the most commonly diagnosed cancers and the rapidly increasing adult and child diagnoses of melanoma, lymphomas, testicular, brain and bone marrow cancers (none of which are related to tobacco use).[7] The American Cancer Society also reported that the incidence of cancer increased by 85% between 1950 and 2001.

> The Agency for Toxic Substances and Disease Registry (ATSDR) is a federal public health agency operated by the US Department of Health and Social Services. Their "Toxic Substance Portal" has an extensive list of substances that are documented as toxic to humans, which can be searched by name or by type of impact (such as toxins that are carcinogenic, or that damage a specific

For example, medical and epidemiological studies demonstrate the connection between childhood leukemia and living near benzene emitting sources such as gas stations.[8] Documented associations between malignancies in children (e.g. leukemia, neuroblastoma, non-Hodgkin's lymphoma, cancers of the brain) and pesticide exposures have also been reported.[9,10,11]

Industrial Pollutants

Exposure to harmful industrial pollutants can have adverse impacts on human health. The first step in evaluating the impact of man-made and naturally occurring chemicals used in industrial processes is to determine which lead to human exposures, at what frequency, and at

what level. This is the question addressed by biomonitoring studies carried out by the Centers for Disease Control and Prevention (CDC) over the past decade.[12] Testing is so complex that they have only been able to assess a miniscule proportion of the 80,000 chemicals used in industry or commerce. CDC has tested for the presence of 300 chemicals by analyzing blood, urine, saliva, hair or breast milk of random sub-samples of 2500 people across the country. The CDC has found that 219 (73%) were present at some level in the bodies of a significant number of subjects, indicating that a high percentage of contaminants are widely dispersed in the environment and absorbed into people's bodies.[13] For example, almost all subjects were found to have traces of polybrominated diphenyl ethers (BDE-47) used in fire retardants, Bisphenol A (BPA) used in epoxy resins and production of plastics, and perfluorooctanoic acid (PFOA) used in coatings on non-stick pans.[14] The human health effects of these chemicals at low environmental doses or at biomonitored levels from low environmental exposures are unknown. However, animal studies have indicated adverse health impacts of these chemicals (e.g., fetal development, neurodevelopment, and thyroid function).[15]

Exposures to Point Source Pollution

Point source industrial pollution increases the likelihood of exposure to chemicals that can adversely impact human health, but clean-up efforts can reduce risk. Despite regulatory oversight, industrial chemicals may enter the environment because of accidental spills, leaks from deteriorating infrastructure, or illegal dumping. Exposure to these harmful substances in the environment increases the risk of experiencing negative health effects. The Comprehensive Environmental Response, Compensation, and Liability Act (known as Superfund or CERCLA)

provides federal funding to clean up uncontrolled or abandoned hazardous-waste sites as well as accidents, spills, and other emergency releases of pollutants and contaminants into the environment.[16] In Washington, the Department of Ecology is responsible for assessing known toxic sites and prioritizing available funding for clean up based on the toxicity of the chemicals and the likelihood that they will adversely impact human health.[17] Both the Environmental Protection Agency (EPA), the Washington Department of Ecology, and the Washington Department of Community Trade and Economic Development have dedicated considerable resources to restoring "brownfields", properties abandoned due to known or suspected contamination by chemicals. Environmental cleanups of these sites might reduce the risk of exposure to harmful substances. Some of these chemicals include petroleum releases (primarily from leaking underground storage tanks), chlorinated solvents, pesticides and other organic and inorganic chemicals.[18,19] Clean up and re-use of these neglected properties protects the public's health and creates opportunities for economic development and other community improvements.[20,21] Another source of environmental contamination are landfills, which received 54% of consumer waste in 2008.[22] In that same year, 82 percent of surveyed landfill cells had leaks, and 41 percent had a leak larger than 1 square foot.[23]

Exposures to Nonpoint Source Pollution

Humans are regularly exposed to harmful nonpoint source industrial pollutants that can have serious health effects. Nonpoint source pollution is a more far-reaching problem due to the sheer volume of industrial chemicals, the lack of information about their toxicity, and the challenges of safe production and disposal. The EPA has identified 187 toxic air pollutants

(chemicals known or suspected to cause cancer or other serious health effects, such as reproductive effects or birth defects, or adverse environmental effects) released to the environment through industrial, commercial and vehicular emissions.[24] In February 2011 stronger emission standards were issued for commercial and industrial solid waste incinerators in an effort to decrease the health risks presented by their releases of toxins such as mercury, lead, and cadmium and their contribution to ozone and particulate matter.[25] Toxic exposures may also occur through product use by consumers. For example, people come into daily contact with products made from petrochemicals, many of which are toxic and can enter the human body through skin contact, inhalation or ingestion (Box 8.1).[26]

Box 8.1. Common products made from petrochemicals

Plastics	Paints	Synthetic fibers
Soaps	Drugs	Rubbers
Detergents	Fertilizer	Flooring and insulating materials
Solvents	Pesticides	

Outdoor Air Pollutants

Outdoor air pollutants are harmful to human health. Transportation emissions from cars, trucks, marine vessels and air travel (known collectively as mobile sources) are the largest single source of air pollution In the United States,[27] which is why the Clean Air Act required the EPA to establish National Ambient Air Quality Standards in 1999.[28] Despite some measure of success in reducing emission levels subsequent to this law, in 2008 40% of Americans (127 million people) lived in counties that failed to meet the clean air standards.[29] Ozone and particulate matter are the two outdoor air pollutants that present the greatest threat to human health.[30]

Ground Level Ozone

Ground level ozone results in serious risks to human health. Ground level ozone is created by chemical reactions between oxides of nitrogen (NOx) and volatile organic compounds (VOC) when exposed to heat or sunlight. The major sources of NOx and VOC are emissions are from industrial facilities and electric utilities, motor vehicle exhaust, gasoline vapors, and chemical solvents.[31] Ozone creates serious human health risks, including increased suspectibility to pneumonia and bronchitis, inflammation and scarring of the lung, exacerbation of asthma and respiratory diseases, and increased mortality.[32]

Particulate Matter (PM)

Particulate matter causes morbidity and mortality. Particulate Matter (PM) consists of chemicals carried in particles and liquid droplets that can be suspended in the air for long periods of time. PM can vary by particle size and is commonly categorized by diameter, such as PM_{10} (smaller than 10 micrometers) and $PM_{2.5}$ (smaller than 2.5 micrometers). PM also varies in composition, from relatively benign dust to harmful asbestos or heavy metals.[33] Being exposed to any kind of particulate matter may increase breathing and heart problems, worsen asthma symptoms, lead to adverse birth outcomes, lung cancer, decreased lung growth in children, and early death. $PM_{2.5}$ is particularly dangerous because the particles are so small that they stay in the air longer (days to weeks), travel farther (hundreds of miles), and can pass through smaller airways to lodge deep in the lungs and even enter the bloodstream.[34] In terms of particle composition, a study of sources of daily mortality in six US cities found that an

increase in $PM_{2.5}$ from mobile emissions, compared to an increase due to dust, accounted for a 3.4% increase in daily mortality.[35]

Indoor Air Pollutants

Exposure to indoor air pollutants can have adverse impacts on human health. There are many sources of indoor air pollution, including gases and particulates from the combustion of oil, gas or wood for heating or cooking; asbestos fibers from insulation, off-gassing of chemicals in pressed wood products, household cleaning chemicals, and the penetration and concentration of fumes and gasses from outdoor air. Among these, three relatively common pollutants are highly carcinogenic: second hand smoke, radon and benzene.[36]

Second Hand Smoke

Exposure to secondhand smoke causes cancer, heart disease, Sudden Infant Death Syndrome (SIDS), and asthma. Secondhand smoke contains more than 700 chemicals, hundreds of which are toxic and 70 which are known carcinogens. The CDC states that there is no risk-free level of exposure to secondhand smoke.[37] One out of every six cancer deaths in the US are due to tobacco, and exposure to the toxins in second hand smoke, particularly indoors, increases tobacco-related morbidity and mortality among adults and children.[38] Compared to those without exposure, nonsmokers exposed to secondhand smoke at home or work have a 20-30% higher risk of developing lung cancer.[39] Secondhand smoke causes an estimated 46,000 premature deaths from heart disease in the US each year among non-smokers.[40] In addition, secondhand smoke causes serious health problems in children, such as asthma, pneumonia and

ear infections.[41] Infants exposed to secondhand smoke after birth are also at greater risk for SIDS.[42]

Radon

Radon causes lung cancer. Radon is an odorless and tasteless gas that is formed from the natural process of radioactive decay of small amounts of uranium found in rocks and soil.[43] The second leading cause of lung cancer in the United States next to smoking, radon is estimated to be present in nearly 1 out of 15 homes in the US. Due to its relationship to geological features, it is more prevalent in some parts of the country than others.[44] Radon is responsible for more than 200,000 lung cancer deaths each year.[45]

Benzene

Benzene causes cancer. In the top 20 of chemicals for production volume and an ingredient in gasoline, glues, paints, furniture wax, and detergents, benzene is generally found in higher concentrations in indoor than outdoor air.[46] A known carcinogen, individuals exposed to high levels of benzene may develop and die from leukemia within five to fifteen years.[47] Exposures occur at occupational sites where benzene is used, among smokers (benzene is an ingredient in tobacco), and from environmental proximity. For instance, children who live near freeways or in dwellings next to gas stations or fuel storage sites show high rates of exposure and increased rates of leukemia.[48]

Water Quality and Quantity

Contamination

Humans can be exposed to toxins through polluted water. Persistent toxins from point source pollution may leach into groundwater; toxins from nonpoint sources are transported across the landscape by precipitation and snowmelt, may be concentrated in plants and aquatic species, are discharged surface water bodies such as streams, lakes and estuaries and may penetrate aquifers as well.

Quality of Private Well Water

Many private well systems are at risk of contamination. A 2008 U.S. Geological Survey (USGS) study sampled wells across 48 states and 30 regional aquifers and found that 23% had one or more contaminants at a concentration greater than the human health benchmark.[49] Health threats were mainly due to microbial contamination, and to a lesser extent to inorganic chemicals including radon, arsenic, uranium, nitrate and fluoride. Among the inorganic chemicals, the most frequent threat was from high levels of nitrates (found in 4.4% of sampled wells and attributed to run off from fertilizers, livestock and septic systems). Nitrates deprive red blood cells of oxygen and may cause mortality in infants and miscarriages in pregnant women or birth defects in their offspring.[50] As approximately 15% of the population relies on private wells for drinking water, the health threat is considerable. It is also worth noting that 60% of the wells tested positive for traces of man-made organic compounds including herbicides, insecticides, solvents, gasoline byproducts, and other chemicals. The study concludes that the widespread presence of so many contaminants is evidence of the role aquifers in concentrating and transporting chemicals.[51]

Quality of public water

Public water systems are generally safe, but are susceptible to contamination. According to the CDC, US drinking water is among the safest in the world, but not invulnerable to contamination from runoff, industrial pollution, and water-borne microorganisms. The largest such systems are called Community Water Systems (CWS's) serve about 292 million people in the US. Although these systems are regulated by the EPA, they rely on states to monitor and report violations. Based on such reports, the EPA warns that public water systems are at increasing risk of contamination due to aging infrastructure and pollution from human activities.[52] A 2003 study of public drinking water in 19 US cities found water quality to be uneven, and also pointed to crumbling infrastructure and nonpoint source pollution as the routes by which lead, bacteria, pesticides, and other contaminants enter municipal water systems.[53] In 1993 only 79% of systems nationwide met health standards, peaking in 2002 when 94% did so. In 2009, 92% met standards.[54] In Washington State, agriculture has had a substantial effect on water quality, especially east of the Cascades, due largely to the effects of nonpoint source contamination on ground and surface waters. Nitrate is the most prevalent drinking water quality concern in Washington, but there are also quality issues due to pesticide contamination of water supplies, point-source contamination from industrial and commercial activities, and urban runoff. Water-quality related to the Hanford Nuclear Reservation is also a concern.[55]

Recreational waters

Contamination makes many waterways unsafe for recreation. Consistent with other findings presented in this paper, a 2007 study by the EPA that assessed the quality of 30% of US freshwater bodies found quality to be significantly impaired, primarily due to nonpoint source pollution.[56] Specifically, they reported that about 45% of assessed stream miles, 47% of assessed lake acres, and 32% of assessed bay and estuarine square miles were not clean enough to support uses such as fishing and swimming. The leading causes of water quality issues included excess levels of nutrients, metals (primarily mercury), sediment and oxygen depletion due to organic contaminants.[57] High nutrient levels are associated with fecal contamination accumulation of microorganisms can pose an infection hazard for recreational water users. Chemicals can be ingested with water, breathed, or absorbed through contact with skin, potentially resulting in exposure to irritants or carcinogens.[58]

Water Depletion

Public access to safe, healthy drinking water is threatened not just by water pollution, but also by the risk of aquifer or reservoir depletion. While many regions of the world have ample freshwater supplies, four out of every 10 people live in river basins which are experiencing water scarcity. By 2025, at least 3.5 billion people or nearly 50 percent of the world's population will face water scarcity.[59] Ground water depletion is occurring in many states in the US as a result of continued pumping to meet population growth and agricultural demands. Major drops in water tables are occurring in many parts of the US, including the Pacific Northwest (Columbia River Basin and Snake River Plain aquifer in Idaho).[60] Glacial melt as well

as over-pumping challenge glacially fed river basins or water reservoirs that were historically replenished by snowmelt. The Columbia River traverses 1,243 miles, along which glaciers are melting and the timing of supply and demand is changing as a result of warmer, dryer summers. Consequently, there is a greater scarcity of water resources in summer and warmer, wetter winters with more rapid runoff and decreased recharge.[61]

Disparities

While everyone is at risk from environmental toxins, some groups face higher levels of exposure depending on the location of their homes or work. Greater health impacts are experienced by people with physical vulnerabilities related to age or pre-existing health conditions. Disparities in water quality and quantity are largely geographic.

Socioeconomic Status (SES)

Low-income populations are at risk for higher exposures to poor quality indoor air, outdoor air, and industrial pollutants. Because the presence of manufacturing industries or location along trafficked roads or freeways makes housing prices decrease, persons with limited income and limited choice more often live in areas where industrial chemicals make soil or water contamination more likely, and where outdoor air quality is more polluted due to mobile emissions.[62, 63, 64]

Age

In general, children and older adults face the most severe health consequences from degraded environments. Infants and children are at increased risk due to developmental vulnerabilities.[65] Infants are at highest risk for death after exposure to high levels of nitrates in

drinking water, particulate matter is more damaging to children whose lungs are still developing, and lead exposure has more adverse and lasting cognitive impacts since children's brain and nervous systems are not fully developed.[66, 67, 68] The other age group disproportionately impacted is older adults. [69] Older adults have high rates of pre-existing conditions such as asthma, chronic bronchitis, emphysema and cardiac problems. Consequently, they face more serious health effects at lower levels of exposure than the general population.

Race and Ethnicity

Greater exposure to some toxins has been observed in racial and ethnic minorities. The CDC's 2007-2008 biomonitoring studies indicated that 9% of the total population showed exposure to Benzene. The rate was appreciably higher for non-Hispanic blacks (27.4%) and Mexican Americans (22.3%).[70] This is likely a result of occupational and residential exposures associated with poverty. Disparities in exposures to nitrates were found in small drinking water systems in agricultural areas in California (where fertilizer runoff contributes to this problem). Higher levels of nitrates were detected in systems serving Latinos and renters compared to those serving whites or homeowners.[71] Subsistence fishing is another source of toxic exposure that is more common among racial/ethnic minorities. This creates greater risk of exposure to persistent toxins such methyl mercury that causes neurological damage to fetuses and children.[72]

Geography

The risk of exposure to environmental toxins varies by geography. Although there is nowhere in the United States that people do not experience toxic exposures, risks do vary somewhat by

geography, such as increased residential exposures from proximity to current or past sources of pollution, or occupational exposures in areas with mining or petrochemical industries. At this time, the risk of water depletion is more geographically specific, but rapidly increasing across the US and worldwide.[73]

Conditions Needed to Thrive

To thrive, communities need to be able to breathe air, eat food, and drink water that is not contaminated by toxic pollutants. While the number of toxins already in our environment means the total elimination of threat is unrealistic, every action taken to prevent further emission of toxins, clean up existing pollutants, protect residents from avoidable exposures, and ensure the availability of essential natural resources, is an action that will promote a healthier community.

References

1 Environment Canada. (2010). Groundwater contamination. Retrieved at http://www.ec.gc.ca/eau-water/default.asp?lang=En&n=6A7FB7B2-1

2 National Oceanic and Atmospheric Administration. (2008). Ocean service education. Nonpoint source pollution. Retrieved from http://oceanservice.noaa.gov/education/kits/pollution/03pointsource.html

3 US Geological Survey. (2003). Fact Sheet 103-03. Groundwater depletion across the nation. Retrieved from http://pubs.usgs.gov/fs/fs-103-03/

4 Centers for Disease Control and Prevention. (2011). National report on human exposure to environmental chemicals. Frequently asked questions. Retrieved from http://www.cdc.gov/exposurereport/faq.html

5 Janssen S, Solomon G, Schettler T. (2004) Chemical contaminants and human disease: A summary of evidence. Collaborative on health and the environment. Retrieved from http://www.healthandenvironment.org/

6 Clapp RW, Howe GK, Jacobs M. (2006). Environmental and occupational causes of cancer re-visited. *Journal of Public Health Policy*. 297:61-76. Available from http://www.palgrave-journals.com/jphp/journal/v27/n1/abs/3200055a.html

7 American Cancer Society. (2005). Cancer facts & figures. Retrieved from http://www.cancer.org/Research/CancerFactsFigures/CancerFactsFigures/cancer-facts-figures-2005

8 Steffen C, Auclerc MF, Auvrignon A, et al. (2004). Acute childhood leukemia and environmental exposure to potential sources of benzene and other hydrocarbons; a case-control study. *Occupational and Environmental Medicine.* 61:773-778 Retrieved from http://droitcitoyen.ca/doc/posteessence/etudeInserm.pdf.

9 Daniels JL, Olshan AF, Savitz DA. (1997). Pesticides and childhood cancers. *Environmental Health Perspectives*. October 1997;105 (10): 1068-1077. Available from http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1470375/

10 Zahm SH, Ward MH. (1998). Pesticides and Childhood Cancer. *Environmental Health Perspectives*. 1998;106 (3) 893-908. Retrieved from http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1533072/

11 Menegaux F, Baruchel A, Bertrand Y, et al. (2006). Household exposure to pesticides and risk of childhood acute leukemia. *Occupational and Environmental Medicine*. 2006; 63:131-134. Retrieved from http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2078075/

12 Centers for Disease Control and Prevention. (2010). National Biomonitering Program. About the program. Retrieved from http://www.cdc.gov/biomonitoring/about.html

13 Centers for Disease Control and Prevention. (2011). National report on human exposure to environmental chemicals. Frequently asked questions. Retrieved from http://www.cdc.gov/exposurereport/faq.html

14 Centers for Disease Control and Prevention. (2011). Fourth national report on human exposure to environmental chemicals 2009 and updated tables, February 2011. Executive summary. Retrieved from http://www.cdc.gov/exposurereport/

15 Centers for Disease Control and Prevention. (2011). Fourth national report on human exposure to environmental chemicals 2009 and updated tables, February 2011. Executive summary. Retrieved from http://www.cdc.gov/exposurereport/

16 US Environmental Protection Agency. (2011). Summary of the comprehensive environmental response, compensation, and liability act (superfund). Retrieved from http://www.epa.gov/lawsregs/laws/cercla.html

17 Washington Department of Ecology. (2001). Hazardous sites list, February 2001. Retrieved from http://www.ecy.wa.gov/programs/tcp/mtca_gen/hs010227.pdf

18 US Environmental Protection Agency. (2011). Region 4: Land revitalization and re-use. Retrieved from http://www.epa.gov/region4/landrevitalization/program/brownfieldsites.html

19 US Environmental Protection Agency. (2011). Ecosystems research. Brownfields. Retrieved from http://www.epa.gov/athens/research/regsupport/brownfields.html

20 US Environmental Protection Agency. (2011). Brownfields and land revitalization. Retrieved from http://epa.gov/brownfields/index.html

21 Washington Department of Ecology. (2011). Summary of brownfields funding in Washington State. Retrieved from www.ecy.wa.gov/programs/tcp/brownfields/State%20Funding%20Overview.pdf

22 US Environmental Protection Agency. (2009). Municipal solid waste generation, recycling, and disposal in the United States: Facts and figures for 2008. Retrieved from http://www.epa.gov/epawaste/nonhaz/municipal/pubs/msw2008rpt.pdf

23 Zero Waste America. (1988-2008). Waste and recycling: Data, maps, & graphs. Retrieved from http://zerowasteamerica.org/Statistics.htm

24 US Environmental Protection Agency. (2010). Technology transfer network. Air toxics website. Retrieved from http://www.epa.gov/ttn/atw/allabout.html

25 US Environmental Protection Agency. Emissions standards for boilers and process heaters and commercial / industrial solid waste incinerators. Regulatory actions. Retrieved from http://www.epa.gov/airquality/combustion/actions.html

26 National Petrochemical and Refiners Association. (2011). Petrochemical facts. Retrieved from http://www.npra.org/ourIndustry/petrochemicalFacts/

27 Union of Concerned Scientists. (2008). The impacts of gasoline and diesel fuels. Cars, trucks and air pollution. Retrieved from http://www.ucsusa.org/clean_vehicles/vehicle_impacts/cars_pickups_and_suvs/cars-trucks-air-pollution.html

28 US Environmental Protection Agency. (2011). Technology transfer network, national ambient air quality standards (NAAQS). Retrieved from http://www.epa.gov/ttn/naaqs/

29 US Environmental Protection Agency. (2010). Office of air quality planning and standards. Our nation's air: status and trends through 2008. Retrieved from http://www.epa.gov/airtrends/2010/

30 US Environmental Project Agency. (2010). Air now. Air quality index-A guide to air quality and your health. Retrieved from http://airnow.gov/index.cfm?action=aqibasics.aqi

31 US Environmental Protection Agency. (2011). Ground Level Ozone. Retrieved from http://earth1.epa.gov/air/ozonepollution/

32 World Health Organization. (2011). Air quality and health. Retrieved from http://www.who.int/mediacentre/factsheets/fs313/en/index.html

33 US Environmental Protection Agency. (2010). Basic concepts in environmental sciences. Module 3-characteristics of particles-particle size categories. Retrieved from http://www.epa.gov/apti/bces/module3/category/category.htm

34 Center for Disease Control and Prevention. (2011). National environmental health tracking network. Outdoor air. Air contaminants. Retrieved from http://ephtracking.cdc.gov/showAirContaminants.action#pm

35 Laden N, Neas LM, Dockery DW, Schwartz J. (2000). Association of fine particulate matter from different sources with daily mortality in six cities. *Environmental Health Perspectives*. 108 (10); 941-947. Retrieved from http://ehp03.niehs.nih.gov/article/info%3Adoi%2F10.1289%2Fehp.00108941

36 US Environmental Protection Agency. (2010). An introduction to indoor air quality. Retrieved from http://www.epa.gov/iaq/ia-intro.html

37 Centers for Disease Control and Prevention. (2011). Smoking and tobacco use. Health effects of secondhand smoke. Retrieved from http://www.cdc.gov/tobacco/data_statistics/fact_sheets/secondhand_smoke/health_effects/index.htm

38 Center for Disease Control and Prevention. (2011). CDC features: Lung cancer prevention. Retrieved from http://www.cdc.gov/features/lungcancer/

39 U.S. Department of Health and Human Services. (2006). The health consequences of involuntary exposure to tobacco smoke: A report of the surgeon general. Retrieved from http://www.cdc.gov/tobacco/data_statistics/sgr/2006/index.htm

40 Centers for Disease Control and Prevention. (2008). Smoking-attributable mortality, years of potential life lost, and productivity losses—United States, 2000–2004. *Morbidity and Mortality Weekly Report 2008*;57(45):1226–8. Retrieved from http://www.cdc.gov/mmwr/preview/mmwrhtml/mm5745a3.htm

41 US Department of Health and Human Services. (2006). The Health consequences of involuntary exposure to tobacco smoke: A report of the surgeon general: Secondhand smoke: What it means to you.

42 U.S. Department of Health and Human Services.(2006). The health consequences of involuntary exposure to tobacco smoke: A report of the surgeon general. Retrieved from http://www.cdc.gov/tobacco/data_statistics/sgr/2006/index.htm

43 CDC Agency for Toxic Substances and Disease Registry. (2008). Toxic substances portal-Radon. Public health statement for radon. Retrieved from http://www.atsdr.cdc.gov/PHS/PHS.asp?id=405&tid=71

44 Washington Radon Information. (2011). General radon information. Retrieved from http://wa-radon.info/WA_general.html.

45 US Environmental Protection Agency. (2011). Radon health risks. Retrieved from http://www.epa.gov/radon/healthrisks.html

46 Center for Disease Control and Prevention. (2006). Emergency preparedness and response. Facts about benzene. Retrieved from http://www.bt.cdc.gov/agent/benzene/basics/facts.asp

47 US Department of Labor. (2010). Occupational health and safety administration. Safety and health topics. Benzene. Retrieved from http://www.osha.gov/SLTC/benzene/

48 Steffen C, Auclerc MF, Auvrignon A, Baruchel A, et al. (2004). Acute childhood leukemia and environmental exposure to potential sources of benzene and other hydrocarbons; a case-control study. *Occupational and Environmental Medicine.* 2004;61:773-778 Retrieved from http://droitcitoyen.ca/doc/posteessence/etudeInserm.pdf.

49 DeSimone, LA, Hamilton, PA, Gilliom, RJ. (2009) Quality of water from domestic wells in principal aquifers of the United States, 1991–2004—Overview of major findings: US Geological Survey Circular 1332, 48 p. Retrieved from http://pubs.usgs.gov/circ/circ1332/

50 Washington State Department of Health Office of Drinking Water. (2010). Q&A : Nitrates in drinking water. Retrieved from http://www.doh.wa.gov/ehp/dw/Programs/nitrate.htm

51 DeSimone, LA, Hamilton, PA, Gilliom, RJ. (2009) Quality of water from domestic wells in principal aquifers of the United States, 1991–2004—Overview of major findings: US Geological Survey Circular 1332, 48 p. Retrieved from http://pubs.usgs.gov/circ/circ1332/

52 US Environmental Protection Agency. (2010). Water on tap: What you need to know. Retrieved from http://water.epa.gov/drink/guide/index.cfm

53 Natural Resource Defense Council. (2011). What's on tap? Grading drinking water in US cities. Retrieved from http://www.nrdc.org/water/drinking/uscities/execsum.asp

54 US Environmental Protection Agency. (2010) Population served by community water systems with no reported violations of health-based standards. Retrieved from http://cfpub.epa.gov/eroe/index.cfm?fuseaction=detail.viewInd&lv=list.listbyalpha&r=216626&subtop=203

55 US Geological Survey, Washington Science Center. (2008). Water Quality. Retrieved from http://wa.water.usgs.gov/water_issues/qual.htm

56 US Environmental Protection Agency. (2007). The national water quality inventory: Report to congress for the 2002 reporting cycle – A profile. Fact Sheet No. EPA 841-F-07-003. Retrieved from http://www.epa.gov/owow/305b/2002report/factsheet2002305b.pdf

57 US Environmental Protection Agency. (2007). The national water quality inventory: Report to congress for the 2002 reporting cycle – A profile. Fact sheet No. EPA 841-F-07-003. Retrieved from http://www.epa.gov/owow/305b/2002report/factsheet2002305b.pdf

58 World Health Organization. (2006). Guidelines for safe recreational waters. Retrieved from http://www.who.int/water_sanitation_health/bathing/bathing2/en/

59 United Nations Development Programme, United Nations Environment Programme, World Bank, World Resources Institute. 2000. World resources 2000-2001: People and ecosystems: The fraying web of life. Retrieved from http://www.wri.org/publication/world-resources-2000-2001-people-and-ecosystems-fraying-web-life

60 US Geological Survey. (2003). Ground-water depletion across the nation. Retrieved from http://pubs.usgs.gov/fs/fs-103-03/#pdf

61 Washington Department of Ecology. (2007). Preparing for the impacts of climate change in Washington: Draft recommendations of the preparation and adaption working groups. Retrieved from http://www.ecy.wa.gov/climatechange/cat_pawg_wr.htm

62 Bell J, Cohen L.The Transportation Prescription: Bold Ideas for Healthy, Equitable Transportation Reform in America Malekafzali S (ed). Available from www.preventioninstitute.org/documents/transportationRX_final.pdf

63 Northridge ME, Freeman L. Urban Planning and Health Equity. Journal of Urban Health. 2011; 88(3):582-97.

64 Steffen C, Auclerc MF, Auvrignon A, et al. (2004). Acute childhood leukemia and environmental exposure to potential sources of benzene and other hydrocarbons; a case-control study. *Occupational and Environmental Medicine*. 61:773-778 Retrieved from http://droitcitoyen.ca/doc/posteessence/etudeInserm.pdf.

65 Bearer CF. (1995). Environmental health hazards: How children are different from adults. *The Future of Children*. 5(2): 11-26

66 US Environmental Protection Agency. (2007). Nitrates and nitrites TEACH chemical summary. Retrieved from www.epa.gov/teach/chem_summ/Nitrates_summary.pdf

67 US Department of Health and Human Services. (2005). Health consultation: Mary McLeod Bethune School and South Phoenix air monitoring. Retrieved from

http://www.atsdr.cdc.gov/HAC/pha/MaryMcLeodBethuneSchool111605/MaryMcLeodBethuneSchoolHC111605.pdf

68 US Environmental Protection Agency. (2010). Lead in paint, dust, and soil. Retrieved from http://www.epa.gov/lead/pubs/leadinfo.htm#health

69 Dominici F, Peng RD, Bell ML, Pham L, McDermott A, Zeger SL, & Samet JM. (2006). Fine particulate air pollution and hospital admission for cardiovascular and respiratory diseases. *Journal of the American Medical Association*. 295(10):1127-1134

70 Centers for Disease Control and Prevention. (2009). Fourth national report on human exposures to environmental chemicals. Retrieved from http://www.cdc.gov/exposurereport/index.html

71 Balazs C, Morello-Frosch R, Hubbard A, Ray I. (2011). Social disparities in nitrate-contaminated drinking water in California's San Joaquin Valley. *Environmental Health Perspectives*. 119:1272–1278. Retrieved from http://dx.doi.org/10.1289/ehp.1002878

72 Payne-Sturges D, Geeb G. (2006). National environmental health measures for minority and low-income populations: Tracking social disparities in environmental health. *Environmental Research* 102 154–171. Retrieved from http://yosemite.epa.gov/ochp/ochpweb.nsf/content/Disparities2.htm/$file/Disparities2.pdf

73 Wada Y, van Beek PH, van Kempen CM, Reckman J, Vasak S, Bierkens M. (2010). Global depletion of groundwater resources. *Geophysical Research Letters* 37 (20). Retrieved from http://tenaya.ucsd.edu/~tdas/data/review_iitkgp/2010GL044571.pdf

Health Element

Clark County Comprehensive Growth Management Plan

Growing Healthier

Current Conditions:

Environmental Quality

Health Data

Local data is not available for all forms of morbidity and mortality related to toxin exposures. We summarize available county data on asthma and cancer, and report results of statewide testing for persistent bioaccumulative toxins and health impacts of particulate matter.

Asthma

In 2009, the Clark County age-adjusted hospitalization rate for asthma was 76.3 per 100,000, about the same as the statewide rate of 77.7.[1]

Cancer

Cancer is the leading cause of death and years of potential life lost in Clark County and in Washington State. In 2008, cancer accounted for about 30% of all deaths in Clark County, followed by heart disease, and chronic lung disease.[2] Clark County has overall rates of cancer similar to those of Washington State.

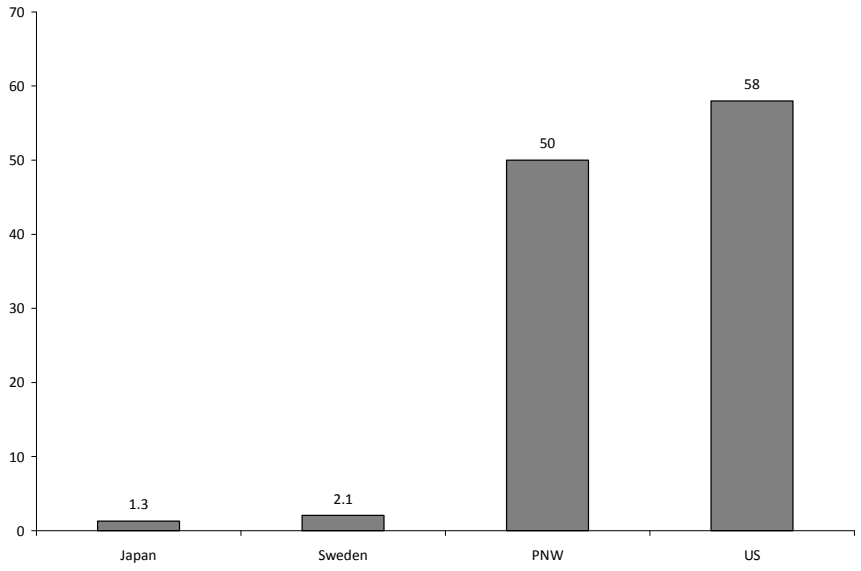
Presence of Bioaccumulative Toxins

The Sightline Institute analyzed data from subjects throughout the Northwest testing for the presence of two toxins, polychlorinated biphenyl (PCB) and polybrominated diphenyl ethers (PBDE).[3] PCBs and PBDEs were formerly used in many industrial and household products, such as furniture, electronics, and flame retardant. These toxins were chosen as indicators of pollution because of their characteristics that reflect long-term and widespread exposure. Specifically, they are harmful to organisms, break down slowly, and accumulate in tissues over time. Both pollutants interfere with hormones in humans, and can result in developmental or fertility problems. PCBs can result in skin rashes, liver

problems, and dermal or ocular lesions.[4] The EPA has determined that PCBs affect the neurological, reproductive, and immune systems, and are probably carcinogenic to humans.[5]

PCBs and PBDEs were banned in the United States in the 1970s pursuant to an international treaty on persistent organic pollutants. However, they continue be present in humans and in other animals. The Sightline study found that in Washington, test results showed the average PCB contamination level of 300 parts per billion, whereas the lowest level found in the Northwest was 51. A 2005-2006 Washington Department of Ecology study of Vancouver Lake found PCB levels exceeding the EPA's National Toxics Rule criterion.[6] Sightline documented PBDE contamination levels in Washington of 88 parts per billion, compared to 1.3 parts in Japan and 2.1 parts in Sweden, two populations referenced as models (Chart 8.1). The analysis shows that there is some evidence of increasing accumulation over time, and that the Northwest has slightly lower contamination than the US as a whole.

Chart 8.1. Median PBDE levels (Parts per Billion in Breast milk)



Morbidity and Mortality from Particulate Matter

In 2009, the Washington State Department of Ecology estimated that the cost of disease related to PM2.5 (mostly from diesel fuel) amounted to $190 million annually.[7] Their study found that, statewide, PM2.5 contributed to:

- 1,500 nonfatal heart attacks
- 450 incidents of different heart diseases not resulting in heart attacks
- 1,900 incidents of acute bronchitis
- 100 cases of chronic lung disease
- 250 incidents of pneumonia
- 400 emergency room visits for asthma, and
- Thousands of incidents of worsened asthma.

Current Conditions

Industrial Pollutants

Point Source Industrial Pollutants in Clark County

The 2010 Toxics Release Inventory identifies 24 facilities in Clark County reporting disposal of toxic chemicals through air emissions, recycling, treatment, energy recovery, or other means (Map 8.1). Collectively, these facilities released about 340,000 pounds of 32 different toxic chemicals through point source air emissions in 2010. Total on-site disposal or release of toxic chemicals from these facilities is estimated at about 400,000 pounds in 2010, placing the county in the middle third of emitters among Washington's 39 counties. Large amounts of toxic chemicals are also disposed of or released in nearby counties. Cowlitz and Lewis Counties are home to some of the state's largest managers of toxic chemicals, with 1.6 and 3.6 million pounds disposed of or released in 2010,

respectively. Facilities in Multnomah County disposed of or released an additional million pounds.[8]

There are relatively few point source facilities in Clark County polluting the air. An analysis of EPA data led by news media and a non-profit group shows that there are seventeen sites in Clark County emitting hazardous chemicals into the air, and none are currently classified as high-priority violators.[9] Using the EPA's Risk Screening Environmental Risk Indicators tool, analysts scored the facilities based on the potential harm to human health from toxins released from 2003 through 2009. Although the risk screening tool is not intended to assess risk from specific facilities, it can help characterize risk in the county as a whole. The analysis shows three high-risk facilities in Clark County.[10]

Table 8.1. Cleanup Sites in Clark County

Site	City	Status
Alcoa*	Vancouver	Cleanup started
BNSF Railway Co.	Vancouver	Cleanup started
Boomsnub Airco*	Vancouver	Cleanup started
Burlington Environmental	Washougal	Cleanup started
Chevron Bulk Plan	Vancouver	Cleanup started
Frontier Hardchrome*	Vancouver	Cleanup started
Nustar Energy	Vancouver	Cleanup started
Pacific Wood Treating	Ridgefield	Cleanup started
RJ Frank Property	Ridgefield	Cleanup started
Time Oil Handy Andy 8	Vancouver	Cleanup complete - monitoring
Camp Bonneville	North Clark Co.	Cleanup started
Vancouver City Blanford Station 4*	Vancouver	Cleanup started

** Indicates EPA Superfund site*

There are approximately 50 hazardous sites in Clark County identified by the Washington Department of Ecology.[11] These may be closed or abandoned, but pose a contamination concern. The department ranks these sites according to their threat to public health and the environment. Those with the highest possible ratings are listed in table 8.1.

Nonpoint Source Industrial Pollutants in Clark County

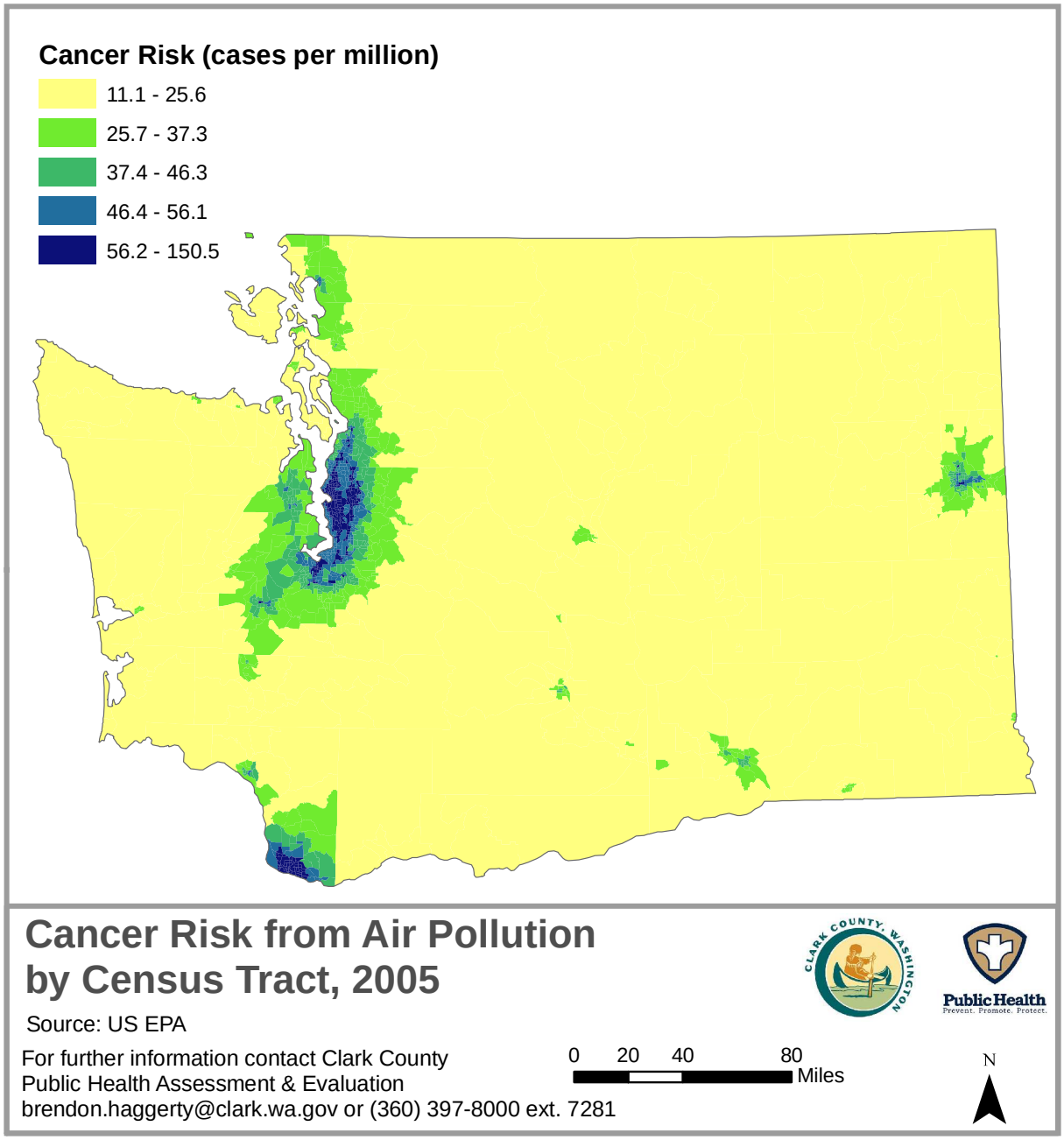
Clark County is vulnerable to many of the same nonpoint source pollutants that are found elsewhere in the country. The EPA has created models that provide estimated county-level risks for cancer, neurological disorders, and respiratory disease based on air toxins. Based on air pollution alone, these risks levels are described in table 8.2, which includes point source as well as nonpoint source pollutants. Statewide cancer risk from air pollution is displayed in map 8.2, in which higher estimated cancer risk is represented in darker colors.

Table 8.2. Cancer Risk from Air Toxins in Clark County, 2005 (cases per million people)

	Point Source Risk	**Nonpoint Source Risk**	**On road Risk**	**Non Road Risk**	**Background Risk**	**Secondary Risk**	**Total Risk**
Clark County	0.0786	4.43	0.916	0.969	6.90	8.63	21.9
Washington	0.0476	0.919	0.743	0.303	0.859	1.44	4.31

Clark County faces higher cancer risks from air toxins than the state as a whole.

Map 8.2. Cancer Risk from Air Toxins by Census Tract, 2005



These risks are from air pollution only. Clark County residents face additional risks similar to those throughout North America. As discussed above, persistent bioaccumulative toxins contribute to cancer risk and are transmitted through food.

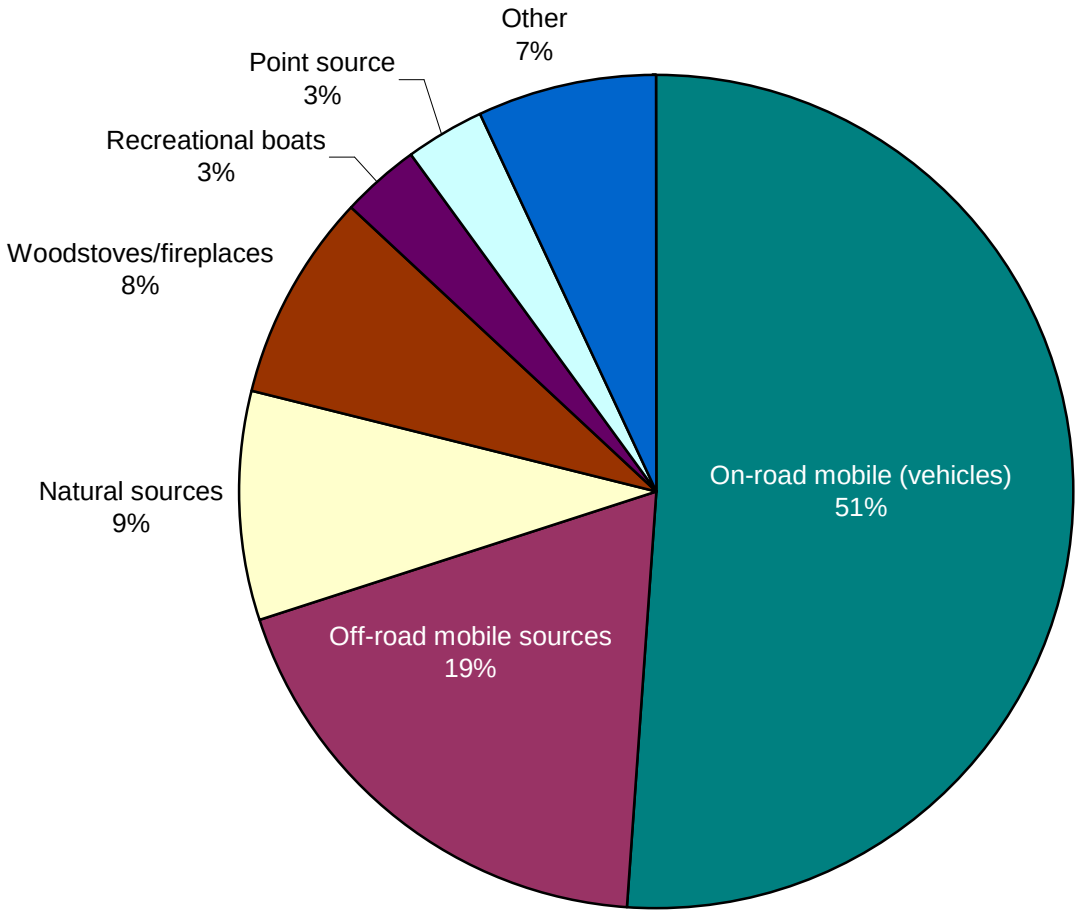
Outdoor Air Pollutants

Sources of Outdoor Air Pollution in Clark County

The Washington State Department of Ecology conducts periodic inventories of emissions for **criteria air pollutants**.[12] The dominant sources of air pollution in Clark County are on and off-road vehicles. In terms of tons of emissions per year, on-road vehicles account for over half of emissions, and combined with off-road vehicles (not including rail or marine), total 70 percent of emissions in Clark County. Cars, trucks, and off-road sources such as construction equipment are the largest contributors to air pollution. The next largest source of air pollutants is natural emissions (9%), followed by woodstoves and fire places (8%). Chart 8.2 displays the contribution of primary sources to total tons of air pollution. Note that ozone is not directly emitted, but formed by precursors such as nitrogen oxides and Volatile Organic Chemicals (VOCs).

Criteria air pollutants are regulated by the EPA under the Clean Air Act. They include ozone, particulate matter, carbon monoxide, nitrogen oxides, sulfur dioxide, and lead.

Chart 8.2. Clark County Air Pollution by Source, 2005 (percent of total tonnage)



Vehicles are the dominant source of air pollution in Clark County. Source: Washington Department of Ecology. Pollutants include PM10, PM2.5, DPM2.5, NOx, SO2, CO, NH3, and VOC.

Exposure to Ozone

Ground level ozone is a criteria air pollutant under the Clean Air Act, and it is monitored in Clark County by the Southwest Washington Clean Air Agency and the EPA. In 1990, the EPA designated the Vancouver area as a nonattainment area for ozone because ozone levels exceeded the National Ambient Air Quality Standard. Following this designation, Washington and Oregon submitted maintenance plans to control ozone emissions from on-road vehicles, non-road vehicles, household products, and industry.[13] Data from the EPA show that, with the exception of 1996, ground level ozone in Clark County has been

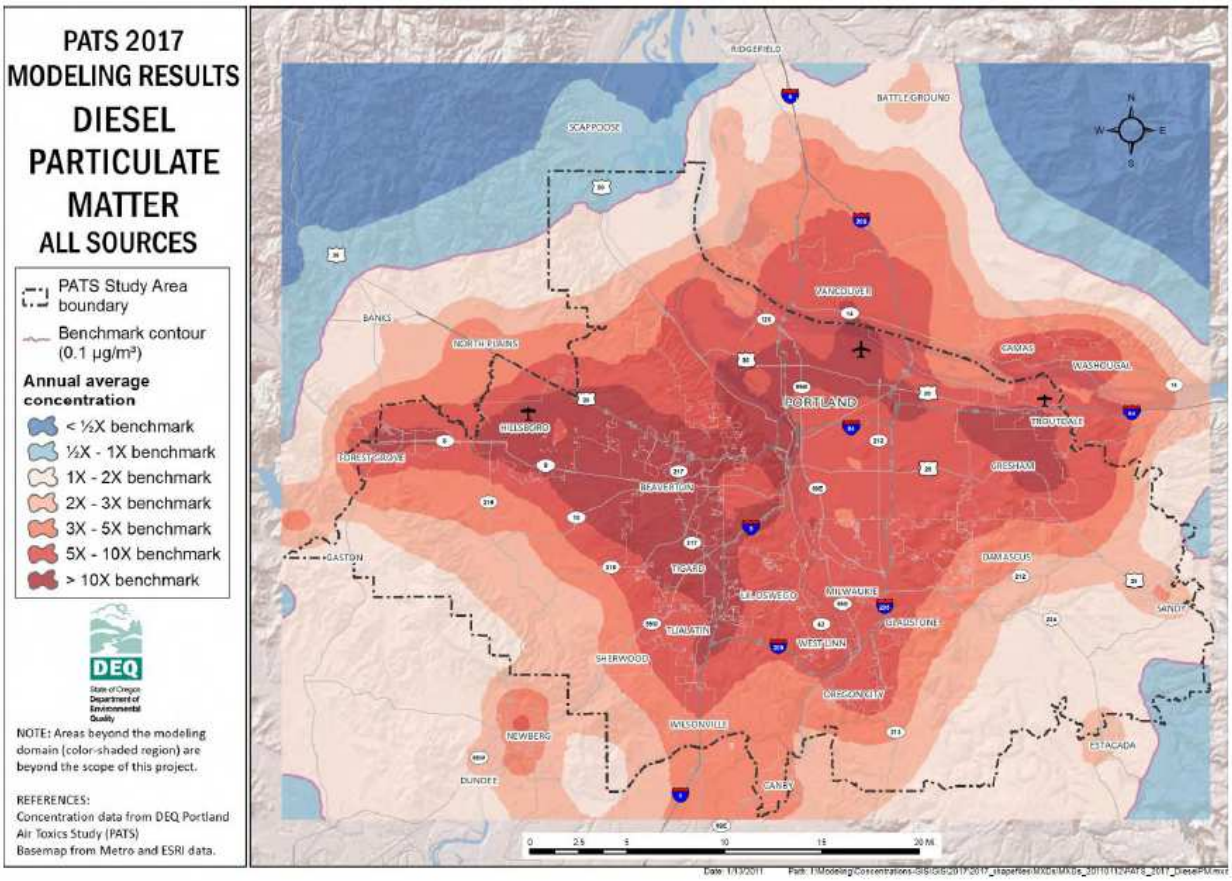
consistently below the National Ambient Air Quality Standard since 1990. Other monitoring stations in the region have shown a similar trend, and there has been a 21% national decrease in ozone levels since 1990.[14]

Exposure to Particulate Matter

Clark County shares an air shed with the Portland Metropolitan Area, and our assessment benefits from analysis conducted by the State of Oregon Department of Environmental Quality, the Portland Air Toxics Solutions study. Their analysis, also used in studies by the Southwest Washington Clean Air Agency, shows that by 2017, nearly all of the urbanized area of Clark County is projected to have diesel particulate matter values above the benchmark for healthy air established by Oregon DEQ. [15]

The benchmark value is the concentration of PM that that would cause one cancer case out of one million people exposed constantly over 70 years. The study models show that much of Clark County will have concentrations more than five times the benchmark value in 2017 (Map 8.3).[16]

Map 8.3. Diesel Particulate Matter in the Portland Metropolitan Region



Data from the Washington Department of Ecology show the sources of PM10, PM2.5, and DPM 2.5 (from diesel combustion). The largest sources of each are listed in table 8.2.

Table 8.2. Largest Sources of Particulate Matter in Clark County (percent of total tonnage), 2005

PM10	PM2.5	DPM2.5
Wood stoves & fireplaces (29%) Road dust (26%) Point sources (16%)	Wood stoves & fireplaces (47%) Point sources (18%) Residential outdoor burning (11%)	On-road mobile (30%) Non-road mobile (46%) Ships (12%)

Research shows that particulates emitted from roadways impact health for a considerable distance. About 15% of County residents live within 500 feet of a highway, and about 40%

within 500 feet of a major roadway. Some studies suggest a wider buffer to estimate impact, and CCPH estimates that about 25% live within 1500 feet of a highway.

Protective and Mitigating Factors

Over the past several years, many efforts have been undertaken to control emissions and improve air quality. Following designation as an air quality maintenance area, the region implemented mitigating measures such as vehicle emissions testing and wood stove certification that have contributed to reduced emissions of criteria pollutants and ozone precursors.

Indoor Air Pollutants

Sources of Indoor Air Pollutants in Clark County

Clark County residents face indoor air pollution risks similar to those faced by other jurisdictions. The Washington State Department of Health notes many indoor air pollutants present in Washington, including asbestos, carbon monoxide, mold, radon, formaldehyde, and second-hand smoke from tobacco.[17]

Map 8.4. Radon risk in Washington

Radon

According to the EPA, Clark County has among the highest predicted levels of radon, the second leading cause of lung cancer. The average radon

level in Clark County is 3.1 pCi/L (a measure of radioactivity), compared to a national average of 1.3 pCi/L. The EPA recommends mitigating action when levels are at or above 4 pCi/L. Despite the Clark County average being within established limits, one of the largest radon testing companies in Clark County found that 21% of homes have levels at or above 4 pCi/L.[18] Map 8.4 displays predicted radon risk in Washington, with red representing the highest risk.[19]

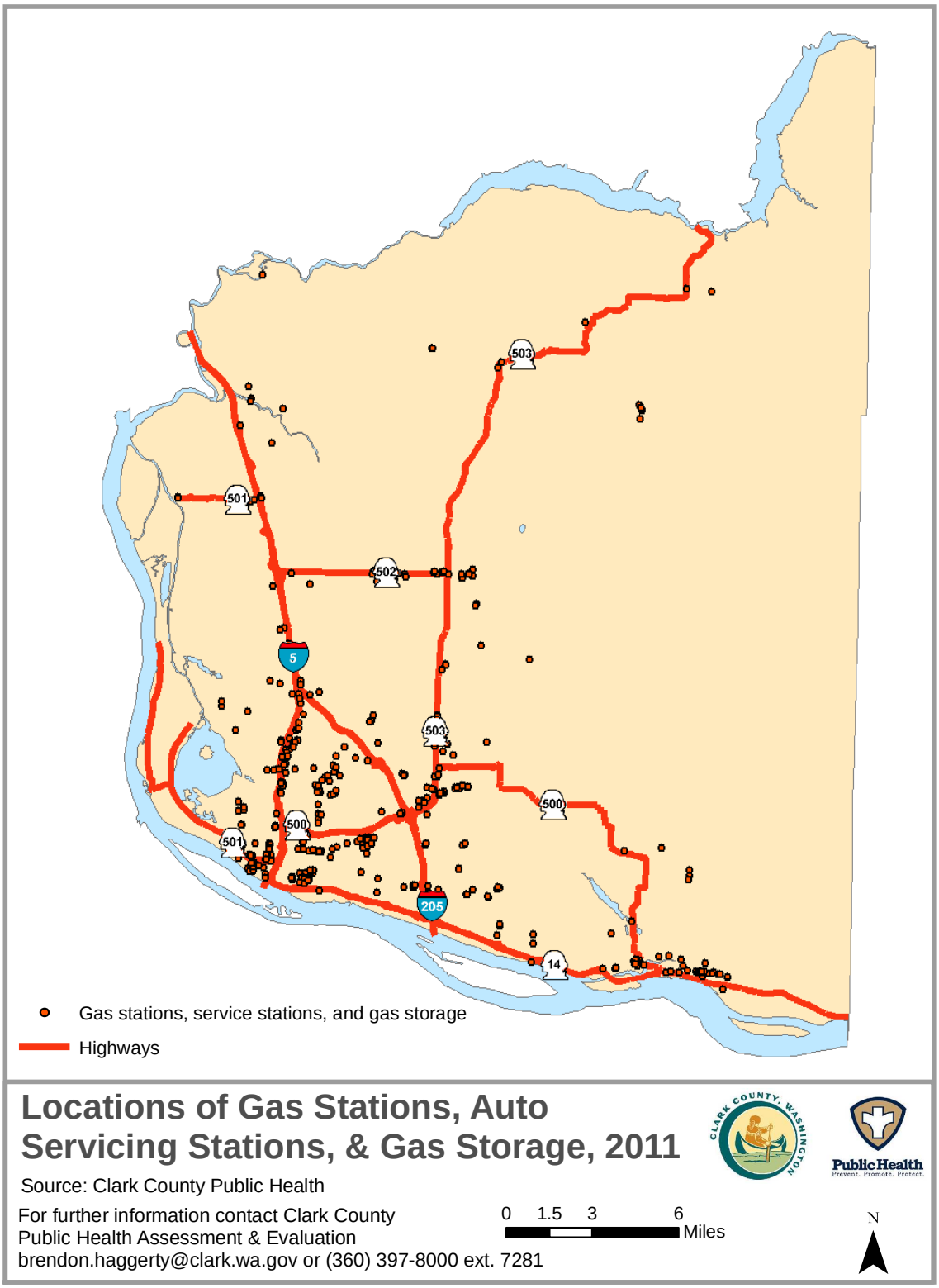
Benzene

Benzene is nearly ubiquitous in our built environments, especially indoors. Paints, detergents, and other household objects emit benzene in homes and businesses. The CDC has found that gas stations, underground storage tanks, and heavily trafficked roads can be significant sources.[20] Map 8.5 displays the location of gas stations, auto servicing facilities, and highways in Clark County. As would be expected, gas stations are clustered along major traffic corridors.

Second Hand Smoke

The CDC identifies tobacco smoke as a major cause of benzene exposure.[21] In Clark County, 90% of households do not allow smoking inside their homes.[22] In addition, some large housing providers, such as Vancouver Housing Authority, prohibit smoking in many or all of their buildings.

Map 8.5. Gas Stations, Auto Service Stations, and Gas Storage, 2011



Water Quality

Drinking Water

There are three types of water delivery systems in Washington State. Group A systems have 15 or more connections and include public water providers such as municipalities, Clark Public Utilities, and a number of privately operated systems. Group B systems are privately operated public water systems with 2-14 connections. Private water sources are the third type of system, consisting of a well or in rare instances a spring and typically serving a single residence. About 75% of residents are served by Group A systems, 24% by private wells, and 1% by Group B systems.[23]

Group A Community Water Systems

Monitoring and reporting are required for community water systems, which serve about 330,000 people in Clark County.[24] Providers are required to produce annual consumer confidence reports on the levels of various water contaminants.[25] In addition to reporting on regulated contaminants, many providers voluntarily test for unregulated contaminants.[26] Recent reports on water quality testing from all public water providers in Clark County indicate they are providing very good water quality, showing that all primary contaminants regulated by the EPA are at safe levels.[27, 28, 29, 30, 31, 32] Community water systems often employ sophisticated water treatment processes to ensure that both health and esthetic quality standards are achieved.

Group B and Private Water Systems

There are no requirements for regular monitoring and reporting on water quality in private well systems. These systems are monitored only if problems arise or through temporary programs. As there are no reliable data to determine the quality of the drinking water, Group B and private wells are at higher risk of undetected contamination. A characteristic specific to Group B water systems is that they are more likely to be used by people unaware of the lack of monitoring and associated risks. Of 2830 total documented connections to Group B systems, about 2650 are residential.[33] The total number of users of non-residential systems is unknown, and these users are likely unaware of risks associated with Group B systems.

In the recent past, some private wells and Group B systems within Clark County have experienced contamination from multiple sources, including coliforms, arsenic, and nitrates. Clark County Public Health recommends testing for each of these, suggesting tests every year for coliform bacteria, every three years for nitrates, and once for arsenic.

Coliform bacteria are naturally occurring and are found in the feces of many animals, including humans. The presence of coliform bacteria is indicative of the possibility of harmful pathogens such as *E. coli.* Voluntary tests from 2,300 private wells in Clark County found unsatisfactory levels of coliforms in 30% of wells tested in the late 1990s.[34]

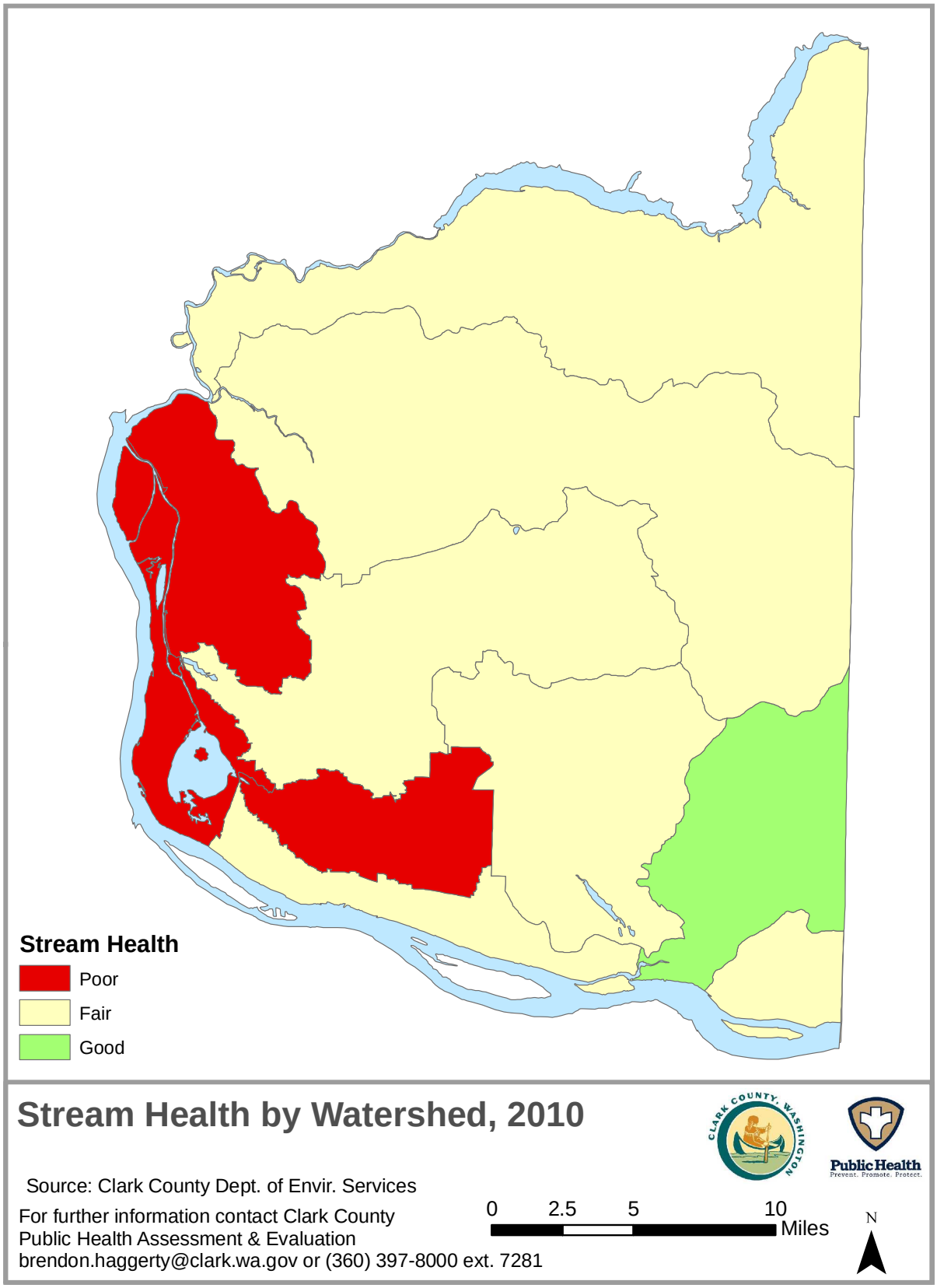
Arsenic is a naturally occurring but poisonous chemical sometimes found in well water in Clark County. There have been intermittent detections of arsenic levels far above the safe contamination level (10 ug/L) established by the EPA. In 2004 Clark County Public Health launched an effort to test wells, following previous test results indicating the presence of arsenic. Using 1,200 testing results, CCPH identified contaminated drinking water and modeled the probability of arsenic contamination throughout the county. The study found that areas of northwest Clark County are at higher risk of contamination from arsenic.

Nitrate is a chemical that comes from fertilizers, manure, and septic system discharge.[35] Whereas public water systems are required to treat water to remove nitrates, private wells are not regulated. Recently, nitrate levels were found to be increasing in some wells in north Clark County, likely due to increasingly concentrated development and human activity in the area.[36]

Surface Water

The Clark County Department of Environmental Services (DES) monitors surface water and manages stormwater through the Clean Water Program. Surface water is indicative of overall water health and of the risks associated with recreational water use. The department monitors Clark County's ten watersheds and assesses stream health. In 2010, they found one watershed in good health, three in poor health, with the rest in fair health. Map 8.6 displays stream health by watershed.

Map 8.6. Stream Health by Water Shed, 2010



DES also reports on lake health, which has been problematic in Clark County. Both Vancouver and Lacamas lakes have unhealthy levels of nutrients, which lead to algae blooms, low levels of dissolved oxygen, and damaged fish habitat. CCPH monitors E. Coli and bluegreen algae in Vancouver Lake, and the Washington Department of Ecology monitors Battle Ground Lake. In some cases there are threats to human health when algae levels exceed safety thresholds set by the World Health Organization. Algae and E. coli have led to occasional closures of Vancouver Lake swimming beaches, listed in table 8.3.[37]

Table 8.3. Vancouver Lake Closures 2003 - Present

Year	Reason
2003	Cyanobacteria
2004	Cyanobacteria
2004	Cyanobacteria
2006	Cyanobacteria
2007	Cyanobacteria
2007	Cyanobacteria
2007	E. Coli
2009	Cyanobacteria
2009	E. Coli

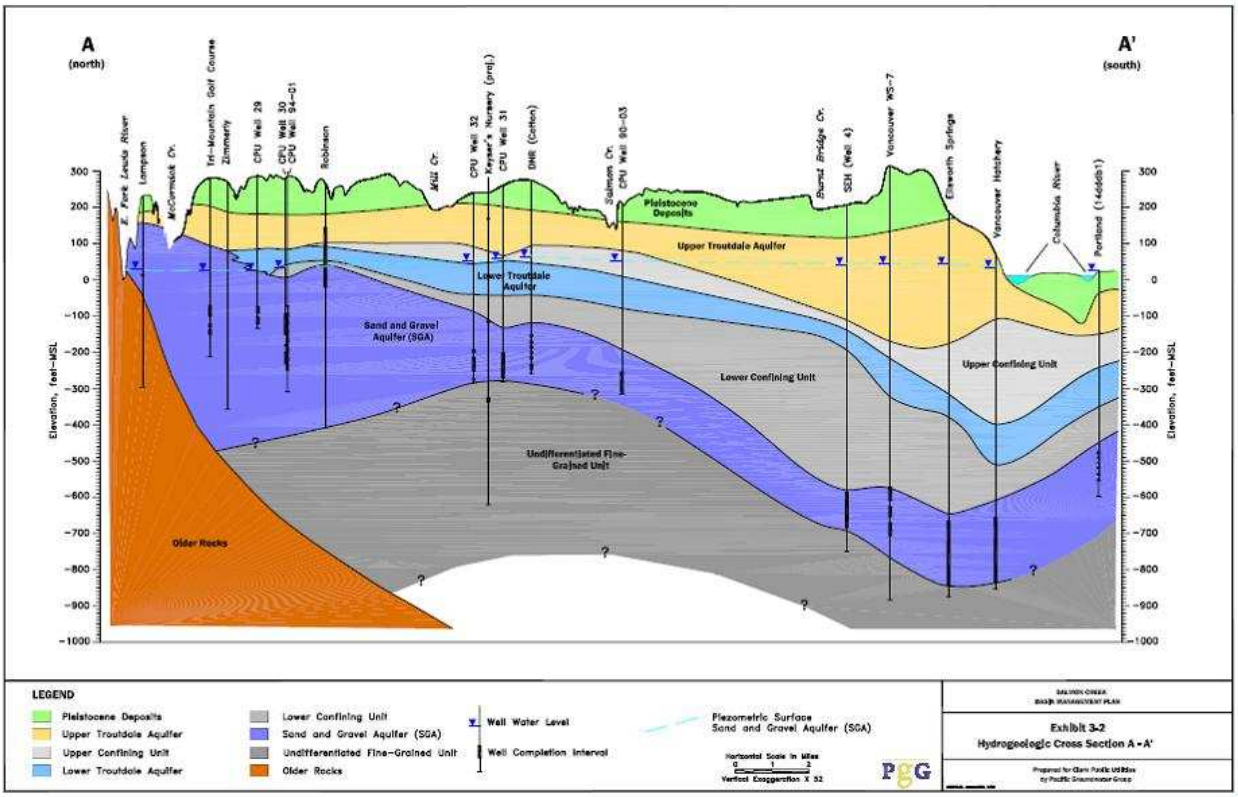
Water Quantity

Status of Water Resources in Clark County

Ground water is the main source of drinking water in Clark County. Most private wells draw from underground sources in the Troutdale Aquifer system. A cross section of water sources and wells is displayed in figure 8.3. The Salmon-Washougal watershed serves most of Clark County. In 2011, the Washington Department of Ecology found that:

"This watershed is one of the most intensely populated basins in western Washington, and as a result much of the water in this watershed has already been spoken for. There is limited water available for new uses, especially given that river and stream levels need to be maintained to ensure adequate water quality and fish migration. Increased demands from population growth, declining summer and early fall stream flow levels, and impacts from climate change add to the challenge of finding new water supplies in [the Salmon-Washougal watershed]."[38]

Figure 8.3. Cross Section of Hydro-Geologic Structures in Clark County



New well fields under development near the southern area of Vancouver Lake and the confluences of the East and North Forks of the Lewis River are anticipated to increase water supplies for several decades.

Threats to Water Resources in Clark County

There are two principle issues regarding the quantity of water resources in Clark County. First, the Troutdale Aquifer has been designated as a sole-source aquifer, meaning that it supplies more than 50% of the drinking water for an area and there are no other adequate sources that can be legally or feasibly accessed.[39] Any contamination of this aquifer could potentially harm hundreds of thousands of people or leave them without

drinking water. As of 2006, the Washington Department of Ecology listed 12 super fund sites in the aquifer area where contamination has occurred but is part of an EPA clean up.

A second threat to water quantity is that increasing population coupled with climate change could result in a diminishing supply of water. The EPA's sole source finding cites data indicating that stress on the aquifer had decreased water levels by ten feet or more by 2005.[40] This could pose water availability issues for those with uphill or shallow wells, especially during dry summer months when there is less recharge, also a time when the Portland Water Bureau may draw from the aquifer to compensate for low water levels in Bull Run. The Northwest is expected to experience less snowpack and drier summers as a result of climate change, exacerbating quantity problems. University of Washington scientists estimate that in the Portland metropolitan region, water providers will have to secure 50% more water resources because of climate change, over and above those needed to accommodate population growth.[41]

Disparities

Socioeconomic Status (SES)

Using data from the EPA National Air Toxins Assessment (Map 8.X, above), CCPH examined cancer risk by census tract within Clark County. We found that there is a moderate positive correlation between the percent of census tract populations living in poverty and the cancer risk from air toxins (0.53, $p<.01$). The risk of cancer from ambient air toxins increases somewhat as the percent of population in poverty increases, meaning

that people living in census tracts with high poverty also tend to have increased risk of cancer caused by air pollution. Statewide patterns of cancer risk suggest a strong association with density, and the denser census tracts in Clark County tend to have higher poverty levels and a greater density of roads and auto traffic. These coincident factors may explain variation in risk more than poverty itself.

The risk of disproportionate exposure to drinking water contaminants faced by lower SES populations is low in Clark County. Low SES populations are concentrated in urbanized areas, and are therefore less likely to depend on private wells vulnerable to contamination. All Clark County census tracts with high poverty rates (≥20%) are served by Group A water systems, which are subject to regular monitoring, reporting, and treatment.

Race and Ethnicity

In our analysis of cancer risk from air toxins, CCPH found that there is a moderate positive correlation between cancer risk and the percent of census tract population that is non-White (0.49, $p<.01$). Like low SES populations, racial and ethnic minorities make up a larger share of the population in densely populated areas of Clark County, which tend to have higher cancer risk.

Racial and ethnic minorities have a low risk of disproportionate exposure to drinking water contaminants. As a result of their concentration in urban areas, there is a higher likelihood that their drinking water comes from a safer Group A water system.

Age

Youth can be disproportionately impacted by some pollutants, as their stage of physical and neurological development makes them more susceptible. For example, children are especially vulnerable to exposure to lead, and infants are susceptible to "blue baby syndrome" which results from nitrate contamination in drinking water. CCPH did not find evidence of disproportionate impacts on youth in Clark County. In fact, we found a moderate negative correlation between the percent of census tract populations under age 20 and the risk of cancer from air toxins (-0.51, $p<.01$). The correlation between risk of cancer from air toxins and the percent of adults aged 65 or older was low (0.25, $p<.05$). In Washington, youth under age 20 and adults age 65 or older have higher hospitalization rates for asthma. However, the Clark County youth hospitalization rate for asthma is 75.4 per 100,000, significantly below the statewide rate of 102.3.[42] Whereas older adults in Clark County face a higher risk of hospitalization due to asthma, there does not appear to be a disproportionate risk to youth.

Geography

As demonstrated by the data in this report, health risks from pollutants vary throughout the county. In general, the risk of exposure to air toxins is greater in denser, urbanized areas in the southern part of the county. Conversely, vulnerability to water contamination is greater in northern parts of the county, where more of the population relies on unmonitored private wells.

Summary

Findings from the literature review compared to current conditions in Clark County are summarized below in table 8.3.

Table 8.3. Summary of Research Findings and Current Conditions

Finding	Current Condition	Level of Concern
Environmental toxins have a negative impact on human health.	Cancer is the leading cause of death and potential years of life lost.	**High**
Exposure to harmful industrial pollutants can have adverse impacts on human health.	There are high average levels of PCBs and PBDEs in Washington.	**Medium**
Point source industrial pollution increases the likelihood of exposure to chemicals that can adversely impact human health, but clean-up efforts can reduce risk.	There are 24 facilities reporting toxic releases in Clark County in 2010.	**Low**
Humans are regularly exposed to harmful nonpoint source industrial pollutants that can have serious health effects.	On-road nonpoint pollution is the largest source of air pollution in Clark County.	**High**
Outdoor air pollutants are harmful to human health.	Clark County has a cancer risk from air toxins of 21.9 cases per million, higher than the Washington risk of 4.43.	**High**
Ground level ozone results in serious risks to human health.	Ozone levels in Clark County have been consistently below dangerous levels.	**Low**
Particulate matter causes morbidity and mortality	Urbanized areas have high concentrations of PM2.5. The larges t sources of PM are woodstoves, fire places, and diesel engines.	**High**
Exposure to indoor air pollutants can have adverse impacts on human health.	Many indoor air pollutants present in Washington, including asbestos, carbon monoxide, mold, radon, formaldehyde, and tobacco smoke	**Medium**

Exposure to secondhand smoke causes cancer, heart disease, Sudden Infant Death Syndrome (SIDS), and asthma.	90% of households have rules about smoking indoors.	**Low**
Radon causes lung cancer.	Clark County has a high risk of exposure to radon.	**High**
Benzene causes cancer.	There are many indoor sources of benzene. Gas stations, auto servicing facilities, and gas storage are located along major corridors.	**Medium**
Humans can be exposed to toxins through polluted water.	Group A water systems provide high quality water. Group B systems and private wells are not monitored.	**Low**
Many private well systems are at risk of contamination.	About 24% of the Clark County population gets drinking water from private wells.	**High**
Public water systems are generally safe, but are susceptible to contamination.	All public water systems in Clark County have safe drinking water.	**Low**
Contamination makes many waterways unsafe for recreation.	Lakes in Clark County have suffered from nutrient loading and occasional beach closures have been necessary.	**Medium**
Public access to safe, healthy drinking water is threatened not just by water pollution, but also by the risk of aquifer or reservoir depletion.	The Troutdale aquifer is a sole source aquifer. Climate change and growth could strain water resources.	**Medium**
Low-income populations are at risk for higher exposures to poor quality indoor air, outdoor air, and industrial pollutants.	There is a moderate correlation between percent of population in poverty and risk of cancer from air toxins.	**Medium**
In general, children and older adults face the most severe health consequences from degraded environments.	Youth are especially susceptible to pollutants, but there is a negative correlation between percent of population under 20 and risk of cancer from air toxins.	**Medium**

Greater exposure to some toxins has been observed in racial and ethnic minorities.	There is a moderate correlation between percent non-White population and risk of cancer from air toxins.	**Medium**
The risk of exposure to environmental toxins varies by geography.	Southern areas face higher risks from air toxins. Northern areas face higher risks of water contamination.	**Medium**

References

1 Washington Department of Health. (2010). Asthma hospitalizations in Clark County. [Data files]

2 Clark County Public Health. (2010). Community Assessment, Planning and Evaluation Report. Retrieved from http://www.clark.wa.gov/public-health/reports/facts.html

3 Sightline Institute. (2009). Cascadia scorecard: Measuring what matters. Retrieved from http://scorecard.sightline.org/pollution.html

4 Aoki Y. (2001). Polychlorinated biphenyls, polychlorinated dibenzo-p-dioxins, and polychlorinated dibenzofurans as endocrine disrupters – what we have learned from Yusho disease. *Environmental* Research86(1):2-11

5 US Environmental Protection Agency. (2008). Health effects of PCBs. Retrieved from http://www.epa.gov/osw/hazard/tsd/pcbs/pubs/effects.htm

6 Coots, R. (2007). Vancouver Lake PCBs, Chlorinated Pesticide Dioxins in Fish Tissue and Sediment. Washington Department of Ecology. Retrieved from http://www.ecy.wa.gov/biblio/0703017.html

7 Washington Department of Ecology. (2009). Health effects and economic impacts of fine particle pollution in Washington. Retrieved from http://www.ecy.wa.gov/pubs/0902021.pdf

8 US Environmental Protection Agency. (2011). Toxics Release Inventory explorer, 2010 state fact sheet. Retrieved from http://iaspub.epa.gov/triexplorer/tri_statefactsheet.statefactsheet

9 National Public Radio and the Center for Public Integrity. (2011). Poisoned places. [interactive map]. Retrieved from http://www.npr.org/news/graphics/2011/10/toxic-air/#11.00/45.6591/-122.4414

10 National Public Radio and the Center for Public Integrity. (2011). Poisoned places. [interactive map]. Retrieved from http://www.npr.org/news/graphics/2011/10/toxic-air/#11.00/45.6591/-122.4414

11 Washington Department of Ecology. (2011). Hazardous Sites List August 2011. Retrieved from http://www.ecy.wa.gov/biblio/1109042b.html

12 Washington Department of Ecology. (2005). Comprehensive 3-year emissions summary. [data files]. Retrieved from http://www.ecy.wa.gov/programs/air/EmissionInventory/AirEmissionInventory.htm

13 US Environmental Protection Agency. (2011). Region 10: the Pacific Northwest. SIP – Washington Regional Air Quality Plans. Retrieved from http://yosemite.epa.gov/r10/airpage.nsf

14 US Environmental Protection Agency. (2010). Air Trends. Retrieved from http://www.epa.gov/airtrends/ozone.html

15 Southwest Washington Clean Air Agency. (2005). Vancouver 2005 Ambient Air Toxics Monitoring Review. Retrieved from http://www.swcleanair.org/pdf/Vancouver2005ToxicsMonitoringReport.pdf

16 Oregon Department of Ecology. (2011). Portland Air Toxins Solutions Study. Retrieved from http://www.deq.state.or.us/aq/toxics/pats.htm

17 Washington Department of Health. (2011). Indoor air quality. Retrieved from http://www.doh.wa.gov/ehp/ts/iaq/default.HTM

18 Air Check, Inc. (2011). Clark County Radon Information. Retrieved from http://county-radon.info/WA/Clark.html

19 U.S. Environmental Protection Agency. (2011). EPA map of radon zones. Retrieved from http://www.epa.gov/radon/zonemap.html#mapcolors

20 Centers for Disease Control and Prevention. (2006). Facts about benzene. Retrieved from http://www.bt.cdc.gov/agent/benzene/basics/facts.asp

21 Centers for Disease Control and Prevention. (2006). Facts about benzene. Retrieved from http://www.bt.cdc.gov/agent/benzene/basics/facts.asp

22 Washington State Department of Health, Center for Health Statistics. (2009). Behavioral Risk Factor Surveillance System. [data files]. Olympia, WA.

23 Clark County Public Health. (2010). Drinking water in Clark County. Retrieved from http://www.clark.wa.gov/public-health/water/documents/DrinkingWaterinClarkCounty.pdf

24 Washington State Department of Health. (2011). Setnry internet [data files]. Retrieved from https://fortress.wa.gov/doh/eh/portal/odw/si/FindWaterSystem.aspx

25 Washington State Department of Health. (2011). Consumer confidence reports. Retrieved from http://www.doh.wa.gov/ehp/dw/our_main_pages/consumer.htm

26 City of Vancouver. (2011). City of Vancouver 2010 water quality report. Retrieved from http://www.cityofvancouver.us/water.asp?menuid=10465&submenuid=17052&itemID=17060

27 City of Battle Ground. (2011). 2010 water quality report. Retrieved from http://www.cityofbg.org/docs/FINAL_WQR_2010.pdf

28 City of Camas. (2011). City of Camas 2010 water quality report. Retrieved from http://www.ci.camas.wa.us/services/forms/OP/2010waterreport.pdf

29 Clark Public Utilities. (2011). 2011 water quality report. Retrieved from http://filehost.clarkpublicutilities.com/2011waterQualityReport.pdf

30 City of Ridgefield. (2011) 2010 annual drinking water quality report. Retrieved from http://www.ci.ridgefield.wa.us/resources/documents/2010WaterQualityReportFINAL.pdf

31 City of Vancouver. (2011). City of Vancouver 2010 water quality report. Retrieved from http://www.cityofvancouver.us/water.asp?menuid=10465&submenuid=17052&itemID=17060

32 City of Washougal. (2011). Annual water quality report: Water testing performed in 2010. Retrieved from http://www.cityofwashougal.us/images/pubworks/2010%20ccr.pdf

33 Washington State Department of Health. (2011). Setnry internet [data files]. Retrieved from https://fortress.wa.gov/doh/eh/portal/odw/si/FindWaterSystem.aspx

34 Clark County Public Health. (2010). Drinking water in Clark County. Retrieved from http://www.clark.wa.gov/public-health/water/documents/DrinkingWaterinClarkCounty.pdf

35 Washington State Department of Health. (2010). Q & A: Nitrate in drinking water. Retrieved from http://www.doh.wa.gov/ehp/dw/Programs/nitrate.htm

36 Clark County Public Health. (2011). Nitrate levels in Yacolt Basin. Clark County Public Health: Vancouver, WA

37 Clark County Department of Environmental Services. (2007). Vancouver lake 2007 volunteer monitoring data summary. Retrieved from http://www.clark.wa.gov/water-resources/documents/Monitoring/VanLakeDataSummary2007.pdf

38 Washington Department of Ecology. (2011). Focus on water availability, Salmon-Washougal watershed, WRIA 28. Retrieved from http://www.ecy.wa.gov/biblio/1111032.html

39 US Environmental Protection Agency. (2006). Final support document for sole source aquifer designation of the Troutdale Aquifer System. Retrieved from http://yosemite.epa.gov/r10/water.NSF/Sole+Source+Aquifers/SSA

40 US Environmental Protection Agency. (2006). Final support document for sole source aquifer designation of the Troutdale Aquifer System. Retrieved from http://yosemite.epa.gov/r10/water.NSF/Sole+Source+Aquifers/SSA

41 Palmer RN, and Hahn MA. (2002). The impacts of climate change on Portland's water supply: An investigation of the potential hydrologic and management impacts on the Bull Run system. Report prepared for the Portland Water Bureau, University of Washington, Seattle. Retrieved from: http://cses.washington.edu/db/pubs/abstract111.shtml

42 Washington State Department of Health, Center for Health Statistics. (2009). Behavioral Risk Factor Surveillance System. [data files]. Olympia, WA