Oregon Wellhead Protection Program Guidance Manual

Part 3

(The original document has been divided into three sections to keep file sizes small.)

This document was originally developed in 1996 by OHS–Drinking Water Services (then a part of Oregon Health Division) and Oregon Department of Environmental Quality. It continues to serve as a valuable resource today.

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4

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* These are only intended to be optional sources of information. Inclusion in this list does not constitute a recommendation or an endoursement by DEQ for all material provided in each document. You are encouraged to review and familiarize yourself with many different approaches before selecting "tools" to help protect your groundwater.

5

WELLHEAD PROTECTION GLOSSARY

***Abandonment, Permanent of A Well <WRD, OAR 690>*:** Means to remove a well from service by completely filling it in such a manner that vertical movement of water within the wellbore and within the annular space surrounding the well casing is effectively and permanently prevented.

***Abandonment, Temporary of A Well <WRD, OAR 690>*:** Means to remove a drilling machine from a well site prior to putting the well into service or returning it to service or subsequent to completing or altering a well, or to remove a well from service with the intent of using it in the future.

***Advection (OHD)*:** Contaminant transport by the movement of groundwater at pore water velocity along streamlines of groundwater flow.

***Alluvium*:** Unconsolidated sediments of gravel, sand, silt and clay, that were deposited in stream channels and floodplains of rivers and streams.

***Altering a Well <WRD, OAR 690>*:** Means the deepening, reaming, casing, re-casing, perforating, re-perforating, installation of line pipe, packers, seals, and any other material change in the design or construction of a well.

***Annular Space <WRD, OAR 690>*:** The cylindrical space between the drillhole wall and the outer well casing.

***Aquifer <OHD 33-61-020>*:** Means a water saturated and permeable geological formation, group of formations, or part of a formation that is capable of transmitting water in sufficient quantity to supply wells or springs.

***Aquifer <WRD, OAR 690-200>*:** Means a geological formation, group of formations, or part of a formation that contains saturated and permeable material capable of transmitting water in sufficient quantity to supply wells or springs; the terms water bearing zone or water bearing stratum are synonymous with the term aquifer.

***Aquifer <DEQ, 340>*:** Means an underground stratum holding water which is capable of yielding a significant amount of water to a well or spring.

***Aquifer Parameter*:** Means a characteristic of an aquifer, such as thickness, porosity or hydraulic conductivity.

***Aquifer Test*:** Means pumping a well in a manner that will provide information regarding the hydraulic characteristics of the aquifer.

***Aquitard*:** A geologic unit with low hydraulic conductivity, capable of transmitting water at low rates, but not at rates sufficient for production wells.

Artesian Aquifer <WRD, OAR

690>: Means an aquifer in which groundwater is under sufficient head (pressure) to rise above the level at which it was first encountered whether or not the water flows at land surface. If the water level stands above land surface, the well is a flowing artesian well.

Artificial Groundwater Recharge <WRD, OAR 690>: The intentional addition of water to a groundwater reservoir by diversion from another source.

Average Groundwater Velocity: Means the average velocity at which groundwater moves through the aquifer as a function of hydraulic gradient, hydraulic conductivity and porosity.

Background Level: In groundwater monitoring, the sampling and analysis of the water for the determination of drinking water characteristics, water quality and the concentration of contamination indicator parameters. Generally performed on wells upgradient to areas of concern.

Background Water Quality <DEQ, OAR 340>: The quality of water immediately upgradient from a current of potential source of pollution that is unaffected by the source.

Basin <WRD, OAR 690>: Any one of the major drainage areas identified by the Water Resources Commission for program planning and management purposes. Basin boundaries are identified on WRD maps.

Bedrock: A general term for the consolidated (solid) rock that underlies soils or other unconsolidated surficial material.

Beneficial Purposes <DEQ, OAR 340>: Means a purpose where the resource values of the reclaimed waters, such as but not limited to its nutrients or moisture value, are utilized for enhanced productivity or water conservation by the user.

Beneficial Use <DEQ, OAR 340 and WRD, OAR 690>: The reasonably efficient use of water without waste for a purpose consistent with the laws, rules, and best interests of the people of the state.

Best Management Practice (BMPs): Operational or maintenance measures that are determined to be the most effective, practical means of preventing or reducing pollution inputs from nonpoint or point sources of contamination.

Biochemical or Biological Oxygen Demand (BOD): A measure of the amount of oxygen consumed in the biological processes that break down organic matter in water. The greater the BOD, the greater the degree of pollution.

Calculated Fixed Radius: Means a technique to delineate a wellhead protection area, based on the determination of the volume of the aquifer needed to supply groundwater to a well over a given length of time.

Carcinogen <DEQ, OAR 340>: A compound which the EPA has classified as Group A or Group B under the carcinogenic classification procedures described in 51 Fed. Reg. 33992.

Casing <WRD, OAR 690>: Means the outer tubing, pipe, or conduit, welded or screw coupled, and installed in the borehole during or after drilling to support the sides of the wall and prevent caving, to shut off water, gas, or contaminated fluids from entering the hole, and to prevent waste of groundwater. Casing does not include slotted or perforated pipe, well screens, or liner pipe.

Casing Seal <WRD, OAR 690>: Means the watertight seal established in the wellbore between the well casing and the drillhole wall to prevent the inflow and movement of surface water or shallow groundwater in the well annulus, or to prevent the outflow or movement of water under artesian or hydrostatic pressures.

Cement-Bentonite Grout (Slurry): A mixture of cement, bentonite, and water generally used as an annular sealant.

Chemical Analysis (Groundwater): The determination of the concentration of dissolved inorganic and organic constituents, the values of chemical state parameters (e.g., pH, Eh, and temperature), and the physical properties (e.g., turbidity). The minimum chemical properties that are usually determined are: T, pH, hardness, specific conductance, dissolved solids, chloride, bicarbonate, iron, fluoride, and nitrate.

Cleanup <DEQ, OAR 340>: Includes, but is not limited to, the containment, collection, removal, treatment or disposal of oil or hazardous material; site restoration; and any investigations, monitoring, surveys, testing, and other information gathering required or conducted by DEQ.

Coliform — Fecal Coliform: Microorganisms found in the intestinal tract of humans and animals. Their presence in water indicates fecal pollution and potentially dangerous bacterial contamination by disease-causing microorganisms.

Compliance Point <DEQ, OAR 340>: The point or points where groundwater quality parameters must be at or below the permit specific concentration limits or the concentration limit variance.

***Community Well* <WRD, OAR 690>**: Means a well, whether publicly or privately owned, which serves or is intended to serve more than 15 connections for the purpose of supplying water for drinking, culinary, or household uses.

***Community Water System* <OHD, OAR 333>**: Public supply which serves at least 15 service connections used by year-round residents or regularly serves at least 25 year-round residents. Community public supply wells may be owned by a municipality or community, a water district, a corporation, a private individual or by a local, state, or federal government agency.

***Concentration Limit* <DEQ, OAR 340>**: The maximum acceptable concentration of a contaminant allowed in groundwater at a DEQ specified compliance point.

Conductivity (Chemical Analysis): The ability of water to transmit an electrical current. Conductivity is directly related to the abundance of ions in the water.

Cone of Depression: The depression of heads around a pumping well caused by the withdrawal of water.

***Confined Animal Feeding or Holding Area* <WRD, OAR 690>**: The concentrated confined feeding or holding of animals or poultry, including but not limited to horse, cattle, sheep, swine feeding, dairy confinementareas, slaughterhouse, or shipping terminal holding pens where the animal waste is allowed to build up on the ground, and where the concentration of animals has destroyed the vegetative cover. Areas where animals and animal waste is confined in buildings are exempt.

***Confining Formation* <WRD, OAR 690>**: Means the impermeable stratum immediately overlying an artesian (confined) well. A layer of rock having very low hydraulic conductivity that hampers the movement of water into and out of an aquifer.

***Confirmed or Confirmation* <DEQ, OAR 340>**: Means that a second laboratory quantitatively detects the presence of the contaminant or substance of concern in groundwater by an established analytical technique.

***Consolidated Formation* <WRD, OAR 690>**: Means materials that have become firm through natural rock forming processes. It includes material such as basalt, sandstone, hard claystone, conglomerate, and granite.

***Contaminant* <OHD, OAR 333>**: Any physical, chemical, biological, or radiological substance or matter in water which may render the water nonpotable.

***Contaminant (Groundwater)* <DEQ, HB 3515 and WRD, OAR 690>**: Any chemical, ion, radionuclide, synthetic organic compound, microorganism, waste, or other substance that does not occur naturally in groundwater or that occurs naturally but at a lower concentration. (The introduction into the natural groundwater environment of any chemical, organic material, live organism(s), wastes, radioactive, or other material that lessens the quality of the water, renders it unfit, and/or affects the intended use of the water.)

***Contamination* <WRD, OAR 690>**: An impairment of water quality by chemicals, radionuclides, biologic organisms, or other extraneous matter whether or not it affects the potential or intended beneficial use of water.

Contaminant Plume: The two-dimensional (map view) or three-dimensional form of contaminated groundwater in an aquifer. The shape of the plume is controlled by groundwater flow and by the transportation processes involved.

***Contingency Plan* <DEQ, OAR 340>**: A document setting out an organized, planned, and coordinated course of action to be followed in case of a fire, explosion, or release of hazardous waste or hazardous waste constituents which could threaten human health or the environment and is prepared pursuant to 40 CFR part 264.

***Corrective Action* <DEQ, OAR 340>**: Remedial action taken to protect the present or future public health, safety, welfare, or the environment from a release of a regulated substance.

***Critical Groundwater Area Boundary* <WRD, OAR 690>**: A line established in a critical groundwater area order on a map that surrounds an area in which one or more of the statutory criteria for critical area declaration are met and which is located either:

- Physically by coincidence with natural features such as groundwater reservoir boundaries, hydrologic barriers, or recharge or discharge boundaries, or
- Administratively by surrounding an affected area when that area does not coincide with an area bounded by natural features.

Datum Plane: An arbitrary elevation to which others are compared, e.g., sea level.

***Decommission* <*DEQ, OAR 340*>**: To remove from operation an underground storage tank, including temporary or permanent removal from operation, abandonment in place, or removal from the ground.

Delineation: Means the determination of the extent, orientation, and boundaries of a wellhead protection area using factors such as geology, aquifer characteristics, well pumping rates, and time of travel

***Detect, Detectable, Detection or Detected* <*DEQ, OAR 340*>**: To measure a contaminant by an established analytical technique in a laboratory using established quality assurance and quality control procedures such as 40 CFR 136.

Discharge: Means the volume rate of loss of groundwater from the aquifer through wells, springs, or to surface water.

Dispersion: Spreading out of a contaminant in groundwater by diffusion and mixing.

***Disposal System* <*DEQ, ORS 468*>**: A system for disposing of wastes, either by surface or underground methods and includes municipal sewerage systems, domestic sewerage systems, treatment works, disposal wells, and other systems.

***Downgradient Detection Monitoring Point* <*DEQ, OAR 340*>**: The point or points at which groundwater quality is monitored to immediately determine whether a pollutant has been discharged to groundwater. The detection monitoring point is not necessarily the same as the compliance point.

***Domestic Well* <*WRD, OAR 690*>**: A well used to serve no more than three residences for the purpose of supplying water for drinking, culinary, or household uses, and which is not used as a public water supply. (A water well used exclusively to supply the household needs of the owner/ lessee and family. Uses may include drinking, cooking, washing, sanitary purposes, lawn and garden watering, and caring for pets.)

Downgradient Well: A groundwater monitoring well which has been constructed at a point of lesser static head (downgradient) of an area of environmental concern for the purpose of detecting the migration of contaminants from this area.

Drawdown: Means the difference, measured vertically, between the static water level in the well and the water level during pumping.

Dump: A land site where solid waste is disposed of in a manner that harms the environment. Dumping is the indiscriminate disposal of solid waste.

Effective Porosity: Means the ratio of the volume of interconnected voids (openings) in a geological formation to the overall volume of the material.

Effluent: Sewage water, or other liquid, raw or partly treated flowing into a reservoir, basin, or treatment plant.

Element: Means one of seven components considered by the U.S. Environmental Protection Agency as the minimum required components in any state wellhead protection program:

- Specification of duties;
- Delineation of the wellhead protection area;
- Inventory of potential contaminant sources.
- Specification of management approaches;
- Development of contingency plans;
- Addressing new (future) wells and springs; and
- Ensuring public participation.

Emergency: Means a condition resulting from an unusual calamity such as a flood storm, earthquake, drought, civil disorder, volcanic eruption, an accidental spill of hazardous material, or other occurrence which disrupts water service at a public water system or endangers the quality of water produced by a public water system.

***Environment* <*DEQ, OAR 340*>**: The air, water and land, and the interrelationship which exists among and between water, air, and land and all living organisms.

Equipotential Line: A line on a map or cross section along which total heads are the same.

***Federal Standard* <*SDWA, DEQ, HB 3515*>**: A maximum contaminant level, a national primary drinking water regulation, or an interim drinking water regulation adopted by the EPA under the *Safe Drinking Water Act*.

Flow Line: The idealized path followed by particles of water.

Flow Net: The grid pattern formed by a network of flow lines and equipotential lines.

Formation: A mappable geologic unit or units with definite lithologic characteristics.

Future Groundwater Sources: Means wells and/or springs that may be required by the public water system in the future to meet the needs of the system.

Generator <DEQ, OAR 340>: The person who, by virtue of ownership, management or control, is responsible for causing or allowing to be caused the creation of hazardous waste.

Governmental Entity: Means any local, state, Indian tribe, or federal organization or agency which may own or manage lands or activities within a Wellhead Protection Area.

Gravel Pack (Filter Pack): The term applied to the inert, usually siliceous, material placed in and around the annular space between the borehole and a perforated casing or well screen to prevent the movement of finer material into the well.

Groundwater <WRD, ORS 537>: Any water, except capillary moisture, beneath the land surface or beneath the bed of any stream, lake, reservoir, or other body of surface water within the boundaries of this state, whatever may be the geological formation or structure in which such water stands, flows, percolates, or otherwise moves.

Groundwater <DEQ, OAR340>: Water that occurs beneath the land surface in the zone(s) of saturation.

Groundwater Management Area <DEQ, HB 3515>: An area in which contaminants in the groundwater have exceeded the levels established under this act (Section 24) and the affected area is subject to a declaration (Section 36).

Groundwater Monitoring Program (Detection Monitoring): A monitoring well system capable of yielding groundwater samples for analysis. Upgradient well(s) are installed to obtain representative samples of the background (unaffected) groundwater. Downgradient wells are generally placed immediately adjacent to the area of concern to detect any constituents migrating into the groundwater environment.

Groundwater Velocity: The rate of movement of groundwater through an aquifer. Groundwater velocity may vary considerably within a given aquifer. The average groundwater velocity in the aquifer is defined as:

$$v = (\text{hydraulic conductivity} \times \text{gradient})/\text{porosity}$$

Half-Life (T 1/2): Time required to reduce the initial concentration of the component by one half. The component's concentration will be reduced to 50 percent after one half-life, 25 percent after two half-lifes, and 12.5 percent after three half-lifes, etc.

Hazardous Material <SFM, OAR 437 and DEQ, OAR 453>: Any substance known to present a physical or health hazard to people under normal conditions of use and/ or during emergency use. Any chemical or material which is required to have a Material Safety Data Sheet under OAR 437 and ORS 453, or designated as such by the SFM.

Hazardous Substance <DEQ, OAR 340>: Any substance intended for use which may also be identified as hazardous.

Hazardous Waste <DEQ, ORS 340/466/469>: Means a substance defined by ORS Chapter 466.005 and or ORS 469.300. Storage or collection, the containment of hazardous wastes either on a temporary basis or for a period of years, in a manner that does not constitute disposal of the hazardous waste.

Hazardous Waste Disposal Site <WRD, OAR 690>: Refers to a geographical site in which or upon which hazardous waste is disposed.

Hazardous Waste Storage Site <WRD, OAR 690>: The geographical area site upon which hazardous waste is stored.

Hazardous Waste Generators <EPA>: Generators of greater than 1,000 kg/month of hazardous waste (large quantity generators); generators between 100 and 1,000 kg/month hazardous waste (small quantity generators); and generators of less than 100 kg/month of hazardous waste (conditionally exempt small quantity generators or very small quantity generators).

Head: The energy possessed by the water mass at a given point, related to the height above a datum plane that water will rise in a well drilled to that point. In a groundwater system, it is composed of elevation head and pressure head.

Health Hazard <WRD, OAR 690>: A condition where there are sufficient concentrations of biological, chemical, or physical contaminants in the water that are likely to cause human illness, disorders, or disability. This includes naturally occurring substances, pathogenic viruses, bacteria, parasites, toxic chemicals, and radioactive isotopes. Sufficient concentrations of a contaminant include but are not limited to contaminant levels set by the DEQ and ODH.

Health Threat <WRD, OAR690>: A condition where there is an impending health hazard. The threat may be posed by, but not limited to: a conduit for contamination, or a well affecting migration of a contaminate plume, or the use of contaminated water. A well in which the well construction is not verified by a water well report or a geophysical techniques may be considered a conduit for contamination in certain circumstances. Those circumstances include, but are not limited to: an unused and neglected well, a well that is permanently out of service, or a well for which no surface seal was required. A well in which the casing seal, sanitary seal, or watertight cap has failed, or was in adequately installed may be considered a conduit for contamination.

Hydraulic Conductivity (K): A parameter related to the ability of the aquifer to transmit water. Formally defined as the rate at which a unit volume of water at the prevailing viscosity will flow through a unit cross section of the aquifer under a unit hydraulic gradient in a unit of time.

Hydraulic Connection <WRD, OAR 690>: Water that can move between a surface water source and an adjacent aquifer.

Hydraulic Gradient: Change in head per unit of distance measured in the direction of the steepest change.

Hydraulic Head: Means the energy possessed by the water mass at a given point, related to the height above the datum plane that water resides in a well drilled to that point. In a groundwater system, the hydraulic head is composed of elevation head and pressure head.

Hydrolysis: The reaction of an organic molecule with water or a component of water. Important in that hydrolysis may affect the molecule's solubility or susceptibility to biodegradation.

Hydrogeologic Boundary: Means physical features that bound and control direction of groundwater flow in a groundwater system. Boundaries may be in the form of a constant head, e.g., streams, or represent barriers to flow, e.g., groundwater divides and impermeable geologic barriers.

Hydrogeologic Mapping: Means characterizing hydrogeologic features (e.g. hydrogeologic units, hydrogeologic boundaries, etc.) within an area and determining their location, areal extent and relationship to one another.

Hydrogeologic Unit: Means a geologic formation, group of formations, or part of a formation that has consistent and definable hydraulic properties.

Interfering Wells: Means wells, that because of their proximity and pumping characteristics, and as a result of the aquifer's hydraulic properties, produce drawdown cones that overlap during simultaneous pumping. The result is a lowering of the pumping level in each well below what it would be if that well were pumping by itself.

Ion: A chemical species that carries a charge. Ions may consist of one or more elements and may be either positive (cations) or negative (anions).

Impermeable <WRD, OAR 690>: Means a material that limits the passage of water.

Inactive Well: A well is considered to be inactive if it is not presently operating but is maintained in such a manner that it can be placed back into operation with a minimum of effort.

Indicator Parameters: Specific biological, chemical and/or physical properties analyzed for the determination of groundwater quality (e.g., coliform bacteria, pH, total organic halogens, etc.).

Industrial Wastewater <DEQ, OAR 340>: means any liquid, gaseous, radioactive, or solid waste substance, or a combination thereof resulting from any process of industry, manufacturing, trade or business, or from the development or recovery of any natural resources.

Industrial Well: A well used to supply water for plants that manufacture, process, or fabricate a product. The water may or may not be used to cool machinery, to provide sanitary facilities for employees, to air condition the plant, and to water grounds at the plant.

Infiltration: The downward movement of water of surface origin into the soil or rock formations.

Injection Well: A well into which fluids are injected for the purpose of waste disposal or to recharge Aquifer pressure.

Irrigation Well: A well used for irrigating cultivated plants, for watering stock, farming, and similar agriculture activities.

Joint: A fracture in a rock along which no relative movement has taken place (e.g., columnar joints in basalts).

Landfill <DEQ, OAR 340>: A facility for the disposal of solid waste involving the placement of solid waste on or beneath the land surface.

Leachate <EPA>: Water that has percolated through solid waste or another medium and has extracted materials by dissolving them or carrying them in suspension. If leachate contaminates groundwater, it is difficult and expensive to clean up, and it may take decades for the contaminants to be flushed naturally.

Leachate <DEQ, OAR 340>: Liquid that has come into direct contact with solid waste and contains dissolved and/or suspended contaminants as a result of such contact.

Leakage <WRD, OAR 690>: Means leakage of surface and/or subsurface water around the well casing or within the well bore from one aquifer to another.

Local Emergency Planning Committee (LEPC) <OEM>: Part of the local emergency planning districts, focal point for SARA Title III community activities.

Local Government <DLCD, ORS 190>: A city, county, special district, or other public corporation, commission, authority or entity organized under state statute or city or county charter.

Material Safety Data Sheet <SFM, OAR 837>: Written or printed material concerning a hazardous chemical which is prepared pursuant to rules OAR 437 of the Oregon OSHA.

Maximum Contaminant Level (MCL) <SDWA/ODH OAR 333>: Refers to the maximum possible level of a contaminant in water at which no known or anticipated adverse effect on health of persons would occur and which allows an adequate margin of safety. Defined as the maximum allowable level of a contaminant in water, which will not cause a public health risk when the water is delivered to the users of a public water system, except in the case of turbidity where the maximum allowable level is measured at the point of entry to the distribution system. Contaminants occurring in the water resulting from circumstances controlled by the water user except those resulting from corrosion of piping and plumbing caused by water quality are excluded from this definition.

Maximum Measurable Level (MML) <DEQ, HB3515>: The maximum allowable concentration of a contaminant or substance of concern that is established by the EQC in accord with these rules. Adopted MMLs are to be used by DEQ to initiate the process of designating groundwater management areas within the state of Oregon were necessary to preserve groundwater quality.

Mineralized Water <WRD, OAR 690>: Means any naturally occurring groundwater containing an amount of dissolved chemicals limiting the beneficial uses to which the water may be applied.

Mitigation <WRD, OAR 690>: Avoiding or minimizing losses of resource values by implementing structural or operational measures within the project area.

Modified Spill Prevention Control and Countermeasure (SPCC) Plan <DEQ, OAR 340>: The plan to prevent the spill of oil from a non-transportation related facility that has been modified to include those hazardous substances and hazardous wastes handled at the facility.

Monitoring Well <WRD, OAR 690>: Any hole, however constructed, in naturally existing or artificially emplaced earth materials through which groundwater is accessed to make judgments, determinations, observations, or measurements of water quality.

Municipal or Quasi-Municipal Well <WRD, OAR 690>: A well owned by a municipality or non-profit corporation that may be used as a community or public water supply.

Municipality <DEQ, OAR 340>: Any county, city, special service district, other governmental entity having authority to dispose of sewage, industrial waste, or other wastes, any indian tribe or authorized tribal organization, or any combination of two or more of the foregoing.

Natural Water Quality <DEQ, OAR 340>: Water quality that would exist as a result of conditions unaffected by human caused pollution.

New Groundwater Sources: Means additional or modified wells and/or springs owned by the Public Water System.

Non-Aqueous Phase Liquid (NAPL): A liquid that is immiscible with water. May be more or less dense than water.

Noncommunity Public Supply Well <EPA>: A public supply water well which serves either fewer than 15 service connections or fewer than 25 year-round residents or no year-round residents. Examples of the former case are small public water supplies for mobile home parks, subdivisions, etc., which fall below the 15 connections/25 persons criteria for community water supplies. The latter case includes water supplies which serve no year-round residents, such as lunges, motels, camps, office buildings, restaurants, rest stops, schools, etc.

Noncommunity Public Water Supply Well (NCWS) <OHD>: Those systems providing water to at least 10 people, 60 days per year. May be transient or nontransient.

Nonpoint Source <DEQ, OAR 340>: Diffuse or unconfined sources of pollution where contaminants can enter into or be conveyed by the movement of water into public water.

Nontransient Noncommunity Water System (NTNCWS)<OHD/EPA>: Means a public water system that is not a Community Water System and that regularly serves 25 or more of the same people for more than six months out of the year, e.g., schools, factories, and small residential systems.

Open Interval: Means in a cased well, the sum of the length(s) of the screened or perforated zone(s) and in an uncased (open-hole) well, the sum of the thickness(es) of the water-bearing zones or, if permeable, 10 percent of the length of the open hole.

Other Hole <WRD, OAR 690>: A hole other than a water well or monitoring well, however constructed, in naturally occurring or artificially emplaced earth materials through which groundwater can become contaminated.

Perched Groundwater <WRD, OAR 690>: Means groundwater held above the regional or main water table by a less permeable underlying earth or rock material.

Permeability <WRD, OAR 690>: The ability of material to transmit fluid, usually described in units of feet per day or gallons per day per square foot of cross-section area.

pH: A mathematical expression of the hydrogen-ion activity. A measure of the acidity (pH $<$ 7.0) or alkalinity (pH $>$ 7.0) of a material.

Pesticide <SFM, OAR 837, DEQ, OAR 340, and ODA, ORS 634>: Means any substance or mixture of substances (including fungicides, herbicides, insecticides, nematocides, and rodenticides), intended for preventing, destroying, repelling, or mitigating any pest and any substance or mixture of substances indented for use as a plant regulator, defoliant, or desiccant.

Plan: Means a specific local Wellhead Protection Plan.

Point Source <DEQ, OAR 340>: Any confined or discrete source of pollution where contaminants can enter into or be conveyed by the movement of water into the public waters.

Pollution (Water) <DEQ, ORS 340/468>: Alteration of the physical, chemical, or biologic properties of any waters of the state, including change in temperatures, taste, color, turbidity, silt or odor of the waters, or such discharge of any liquid, gaseous, solid, radioactive or other substance into waters of the state, which will or tends to, either by itself or in connection with any other substance, create a public nuisance or which will or tends to render such waters harmful, detrimental or injurious to public health, safety or welfare, or to domestic, commercial, industrial, agricultural, recreational or other legitimate beneficial uses or to livestock, wildlife, fish or other aquatic life, or the habitat thereof.

Porosity <WRD, OAR 690>: Means the ratio of the volume of voids (openings) in a geological formation being drilled to the overall volume of the material without regard to size, shape, interconnection, or arrangement of openings.

Porous Media Assumption: Means the assumption that groundwater moves in the aquifer as of the aquifer were granular in character; i.e., moves directly down-gradient, and the velocity of the groundwater can be described by Darcy's Law.

Potable Water <WRD, OAR 690>: Water which is sufficiently free from biological, chemical, physical, or radiological impurities so that users thereof will not be exposed to or threatened with exposure to disease or harmful physiological effects. (Water whose bacteriological, physical, and chemical properties make it suitable for human consumption.)

Potable Water Supply System <DEQ, OAR 340>: A water supply system used to provide water for human consumption.

Potential Contaminant Source: Means any activity which has the potential to release contaminants to the groundwater.

Potential Contaminant Source Inventory: Means the determination of the location within the wellhead protection area of activities known to use or produce materials that can contaminate groundwater.

Potentiometric Surface: Means a surface that denotes the variation of hydraulic head in the given aquifer across an area.

Potentiometric Surface (Piezometric Surface) <WRD, ORS 690>: The level to which water will rise in tightly cased wells.

Protect Public Health and the Environment <DEQ, OAR 340>: To keep humans and the environment from unreasonable adverse risk, effect or harm, excluding economic concerns.

Provisional Delineation: Means approximating the wellhead protection area for a well by using the wellhead protection area from another well in the same hydrogeologic setting or by using generalized values for the aquifer characteristics to generate an approximate wellhead protection area of the well. Used only for the purpose of evaluating potential siting of new or future groundwater sources. Not an acceptable way to formally delineate a wellhead protection area.

Public Health Hazard <WRD, OAR 690>: A condition whereby there are sufficient types and amounts of biological, chemical, or physical, including radiological agents relating to water which are likely to cause human illness, disorders, or disability. These include, but are not limited to pathogenic viruses, bacteria, parasites, toxic chemicals, and radioactive isotopes.

Public Health Hazard <OHD, OAR 333>: Defines as a condition, device or practice which is conductive to the introduction of waterborne disease organisms or harmful chemical, physical or radioactive substances into a public water system, and which presents an unreasonable risk to health.

Public Water System: Means a system for the provision to the public of piped water for human consumption, if such system has more than 3 service connections or supplies water to a public or commercial establishment which operates a total of at least 60 days per year, and which is used by 10 or more individuals per day or is a facility licensed by the Division. A public water system is either a "Community water system", a "Transient Non-Community water system", a "Non-Transient Non-Community water system" or a "State regulated water system".

Pump Test <WRD, OAR 690>: Means the procedure involving pumping water for a specified period of time to determine the yield characteristics of an aquifer.

Recharge: Means the process by which water is added to a zone of saturation, usually by downward infiltration from the surface.

Recharge Area: Means a land area in which water percolates to the zone of saturation through infiltration from the surface.

Reclaimed Water <DEQ, OAR 340>: Means treated effluent from a sewage treatment system which, as a result of treatment, is suitable for direct beneficial purpose or a controlled use that could not otherwise occur.

Recovery: Means the rise in water level in a well from the pumping level towards the original static water level after pumping has been discontinued.

Redox Potential (Eh): An indication of the environment's tendency to cause oxidizing-reducing reactions. These reactions are important in controlling solubilities of minerals and transport of contaminants. Eh is also an important control in biodegradation processes that reduce contaminant concentrations.

Registered Well: An inventoried well that has been assigned an identification number by state agencies and whose records are available.

Release <DEQ, OAR 340>: The discharge, deposit, injection, dumping, spilling, emitting, leaking, or placing of a regulated substance from an underground storage tank into the air or into or on land or the waters of the State, other than authorized by a permit issued under State or Federal law.

Remedial Action <DEQ, ORS 466>: Those actions consistent with a permanent remedial action taken instead of or in addition to, removal actions in the event of a release or threatened release of a hazardous substance into the environment, to prevent or minimize the release of a hazardous substance so that they does not migrate to cause substantial danger to present or future public health, safety, welfare, or the environment.

Reportable Quantity <DEQ, OAR 340>: An amount of oil or hazardous material which if spilled, released, or threatens to spill or release, in quantities equal to or greater than those specified in OAR 340 which would trigger CERCLA and SARA Title III emergency release reporting requirements.

Responsible Management Authority: Means the Public Water System whose water supply is being protected and any governmental entity with management, rule or ordinance making authority to implement wellhead protection management strategies within a Wellhead Protection Area. Responsible Management Authorities are responsible for implementation of the Wellhead Protection Plan; includes cities, counties, special districts, Indian tribes, state/federal government entities as well as Public Water Systems.

Retardation: The movement of a contaminant at a velocity less than that of the water in the aquifer as a result of chemical or biological reactions.

Rock: Any naturally formed, consolidated or unconsolidated material (but not soil) consisting of two or more minerals.

Sanitary Survey <EPA>: An on-site review of the water source, facilities, equipment, operation, and maintenance of a public water system for the purpose of evaluating the adequacy of such source, facilities, equipment, operation, and maintenance for production and distributing safe drinking water.

Saturated Zone: The subsurface zone in which all opening are full of water.

Screened Interval: A depth interval in a cased well that is slotted or perforated and serves as the intake portion for water from the aquifer.

Sewage <DEQ, OAR 340>: Means water-carried human wastes, including kitchen, bath, and laundry waste from residences, buildings, industrial and commercial establishments, or other places, together with such groundwater infiltration, surface waters, or industrial wastewater as may be present.

Sewage Treatment System <DEQ, OAR 340>: Any facility or equipment used to alter the quality of sewage by physical, chemical or biological means or a combination thereof such that the tendency of said wastewater to degradation in water quality or other environmental conditions is reduced.

Significant Adverse Impact <WRD, OAR 690>: Any impact resulting in degradation of an important resource, that is unacceptable because it cannot be mitigated or because of unacceptable conflicts in management of use of the impacted resource.

Signatory: Means any Responsible Management Authority in the Wellhead Protection Area who signs the Wellhead Protection Plan. Signing the Plan indicates the Responsible Management Authority will implement the actions outlined for their jurisdiction in the Plan.

Significant Hazard to Public Health <SDWA>: Any level of contaminant which causes or may cause the aquifer to exceed any maximum contaminant level set forth in any promulgated Nation Primary Drinking Water Standard at any point where the water may be used for drinking purposes or which may otherwise adversely affect the health of persons or which may require a public water system to install additional treatment to prevent such adverse effect.

Stakeholder(s): Means person(s) and/or governmental entity(ies) who could or will be affected by activities or requirements that may be required within a local wellhead protection area.

State Emergency Response Commission (SERC)<OEM>: Appointed by each state to ensure that SARA Title III emergency planning and implementation is developed.

Soil: The layer of material at the land surface that supports plant growth.

Solubility: The mass of a specific material, either solid, liquid or gas, that can be dissolved under specific conditions. Usually expressed as milligrams per liter.

Specific Capacity: The yield of a well per unit of drawdown.

Specific Retention: The ratio of the volume of water retained in a rock after gravity drainage to the volume of the rock.

Specific Yield: The ratio of the volume of water that will drain under the influence of gravity to the volume of saturated rock.

Spill or Release <DEQ, ORS 454/459/466/468/469>: The discharge, deposit, injection, dumping, spilling, emitting, releasing, leaking, or placing of any oil or hazardous material in the air or into, or on any land or waters of the state, except as authorized by a permit.

Sorption: The attaching of a component to the surface of a solid — either a mineral or organic particles.

Static Water Level <WRD, OAR 690>: The stabilized level or elevation of the water surface in a well which is not being pumped.

Storage Coefficient: The volume of water released (or gained) from storage in the aquifer per unit area of aquifer per unit change in hydraulic head.

Stratification: Large scale layered structure in rocks, e.g., sedimentary rocks or lava flows.

Substance of Concern <DEQ, OAR 340>: A contaminant confirmed to exist in groundwater in Oregon as a result of actual or suspected nonpoint source activities.

Sump <WRD, OAR 690>: A hole dug to a depth of 10 feet or less with a diameter greater then 10 feet in which water is encountered.

Team: Means the local Wellhead Protection Team, which includes representatives from the Responsible Management Authorities and various interests and stateholders potentially affected by the Wellhead Protection Plan.

Threat To Drinking Water <DEQ, ORS 454>: The existence in any area of any three of the following conditions:

- More than 50 percent of the affected area consists of rapidly draining soils;
- The groundwater underlying the affected area is used or can be used for drinking water;
- More than 50 percent of the sewage in the affected area is discharged into cesspools, septic tanks or seepage pits and the sewage contains biological, chemical, physical or radiological agents that can make water unfit for human consumption; and
- Analysis of samples of groundwater from wells producing water that may be used for human consumption in the affected area contains levels of one or more biological, chemical, physical or radiological contaminants which, if allowed to increase at historical rates, would produce a risk to human health as determined by the local health officer. Such contaminant levels must be in excess of 50 percent of the maximum allowable limits set in accordance with the federal *Safe Drinking Water Act*.

Time-of-Travel (TOT): Means the amount of time it takes groundwater to flow to a given well. The criterion that effectively determines the radius in the calculated fixed radius method and the up-gradient distance to be used for the analytical and numerical models during delineation of the wellhead protection area.

Transient Noncommunity Water System <OHD>: Noncommunity systems that serve a transient population, e.g., motels, restaurants, and campgrounds.

Transmissivity: The rate at which water of the prevailing kinetic viscosity is transmitted through a unit width of an aquifer under a unit hydraulic gradient. It equals the hydraulic conductivity multiplied by the aquifer thickness.

Treatment Works <DEQ, OAR 340>: Any facility for the purpose of treating, neutralizing or stabilizing sewage of industrial wastes of a liquid nature, including treatment or disposal plants, the necessary intercepting, outfall and outlet sewers, pumping stations integral to such plants or sewers, equipment and furnishings, thereof, and their appurtenances.

Turbidity: A cloudy condition in water due to suspended silt or organic matter.

Unconfined Aquifer (Water Table) <WRD, OAR 690>: An aquifer in which the water table is the upper boundary. There is no confining layer between the aquifer and the surface and the pressure at the water table is atmospheric. Water level in an unconfined aquifer may move up and down in response to local recharge or discharge.

Unconsolidated Formation <WRD, OAR 690>: Means naturally occurring, loosely cemented, or poorly indurated materials including clay, sand, silt, and gravel.

Underground Storage Tank <DEQ, OAR 340>: Any one or a combination of tanks and underground pipes connected to the tank, used to contain an accumulation of a regulated substance, and the volume of which, including the volume of the underground pipes connected to the tank, is 10 percent or more beneath the surface of the ground (e.g., excludes farm and residential tanks, heating oil tanks, septic tanks).

Unsaturated Zone: The subsurface zone, usually starting at the land surface, that contains both water and air.

Upgradient Well: One or more wells which are placed hydraulically upgradient of an area of concern and are capable of yielding groundwater samples that are representative of the regional conditions andare not influenced by the monitored area.

Violation <WRD, OAR 690>: An infraction of any statute, rule, standard, order, license, compliance schedule, or any part thereof, and includes both acts and omissions.

Volatile: The tendency to transform from the liquid or solid state to the gaseous state.

Wastes <DEQ, ORS 468>: Sewage, industrial wastes, and all other liquid, gaseous, solid, radioactive, or other substances which will or may because pollution or tend to cause pollution of any waters of the state.

Wasteful Use <WRD, OAR 690>: Any artificial discharge or withdrawal of groundwater from an aquifer that is not put to a beneficial use, including leakage from one aquifer to another within the well bore.

Water (of the state) <DEQ, OAR 340/468 and WRD OAR 690>: Includes lakes, bays, ponds, impounding reservoirs, springs, wells, rivers, streams, creeks, estuaries, marshes, inlets, canals, the Pacific Ocean within the territorial limits of the State of Oregon and all other bodies of surface or underground waters, natural or artificial, inland, or coastal, fresh or salt, public or private (except those private waters which do not combine or effect a junction with natural surface or underground waters), which are wholly or partially within or bordering the state or within its jurisdiction.

Water-Bearing Zone: Means that part or parts of the aquifer encountered during drilling that yield(s) water to a well.

Water Table: The upper surface of an unconfined water body, the surface of which is at atmospheric pressure and fluctuates seasonally. The water table is defined by the levels at which water stands in wells that penetrate the water body.

Well <WRD, OAR 690 and OHD, OAR 333>: Any artificial opening or altered natural opening, however made, by which groundwater is sought or through which groundwater flows under natural pressure, or is artificially withdrawn or injected. This definition shall not include a natural spring, or wells drilled for the purpose of exploration or production of oil and gas. Prospecting or exploring for geothermal resources as defined in ORS 522 or production of geothermal resources derived from a depth greater than 2,000 feet or greater than 250 degrees Fahrenheit as defined in ORS 522 is regulated by DOGAMI.

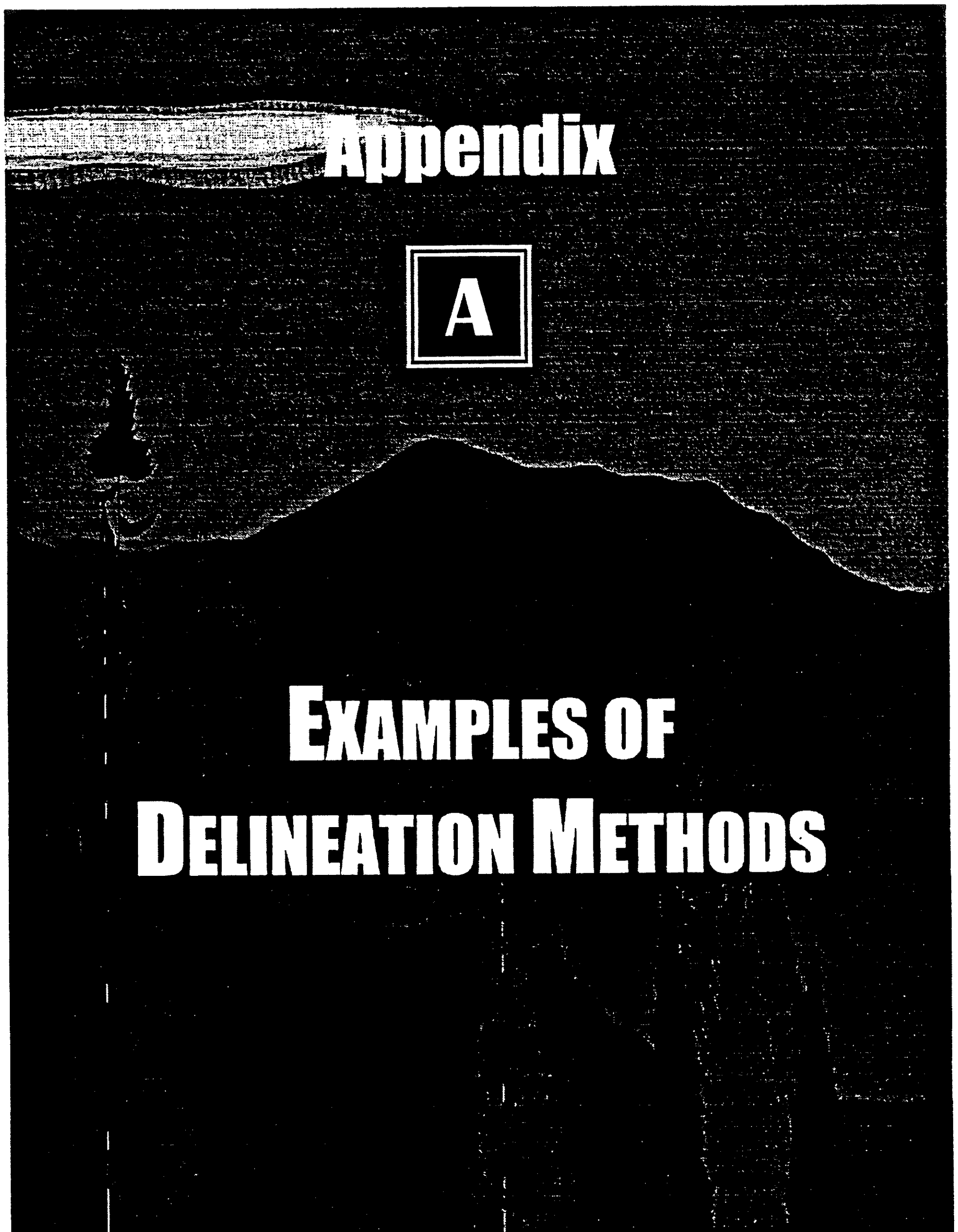
Wellhead Protection: Means implementing strategies within a wellhead protection area to minimize the potential impact of contaminant sources on the quality of groundwater used a drinking water source by a Public Water System.

Wellhead Protection Area: Means the surface and subsurface area surrounding a water well, spring or wellfield, supplying a public water system, through which contaminants are reasonably likely to move toward and reach that water well, spring, or wellfield.

Wellhead Protection Plan: Refers to a Department certified plan which identifies the actions to be taken at the local level to protect a specific defined Wellhead Protection Area. The Plan is developed by the local Responsible Management Authority(ies) and/or team and includes a written description of each element, public participation efforts, and an implementation schedule.

Zone of Contribution (ZOC) <OHD>: Area surrounding a pumping well that includes all regions which supply groundwater to the well. In other words, groundwater within the ZOC boundaries will ultimately move to the well.

Zone of Influence (ZOI)<OHD>: The area surrounding a pumping well where the hydraulic head has been modified by the pumping.


Appendix
A
EXAMPLES OF
DELINEATION METHODS

APPENDIX

A

Examples of Delineation Methods

SAFE YIELD CALCULATION

The safe yield calculation is designed to determine the maximum pump rate that can be sustained without lowering the water level in the well bore to the screened or perforated interval (assuming the pump intake is not placed at a shallower level).

• Specific Capacity

The first step in the process is to determine the specific capacity of the well. This calculation yields the relationship between pump rate and drawdown. To determine specific capacity, the well is pumped at a constant rate at a discharge approximately 50 percent of pump capacity. Pumping continues until the drawdown has stabilized. From a practical perspective, drawdown can be considered stabilized if the amount of change in pumping level between measurements (1 hour interval) is less than 5 percent of the total drawdown to that point. The minimum duration of the pumping interval should be 4 hours; specific capacity can best be determined in conjunction with an aquifer test (see Section Aquifer Tests).

After drawdown has stabilized, the specific capacity (SC) can be determined as follows:

$$SC = Q/s$$

Where "Q" is the pump rate in gallons per minute and "s" is the drawdown in feet. SC then has units of gpm/ft. As an example, assume that a pump rate of 250 gpm produces a drawdown of 18 feet. The specific capacity then equals 250 gpm/18 feet = 13.9 gpm/ft drawdown. This implies that for every 13.9 gpm of pump rate, the drawdown produced will be one foot.

In the diagram below, a well is illustrated showing the static water level (SWL), screened or perforated interval, or water-bearing zone in an uncased well (SI), and depth to the top of the screens (SD).

In calculating the safe yield, we first determine the available water (AW) in the well as follows:

$$AW = SD - SWL$$

The available water is the distance that the water level can be lowered without encountering the screened- or water-bearing interval. Note that in many areas, the SWL varies seasonally as a function of recharge to the aquifer and demand. Water systems should base their safe yield on the lowest SWL of the year and continue to monitor that level to make certain that the resource is not in a state of decline. In addition, systems may want to build in a safety factor by multiplying AW by some value less than one, e.g., 0.90, to prevent accidentally lowering the pumping level below the screens.

As an example, if the seasonally lowest SWL for the system was 23 feet and the depth to the water-bearing zone or the screened interval was 51 feet, the AW would be calculated as follows, using a 90 percent safety factor:

$$AW = (51-23) \times 0.9 = 25.2 \textit{ feet}$$

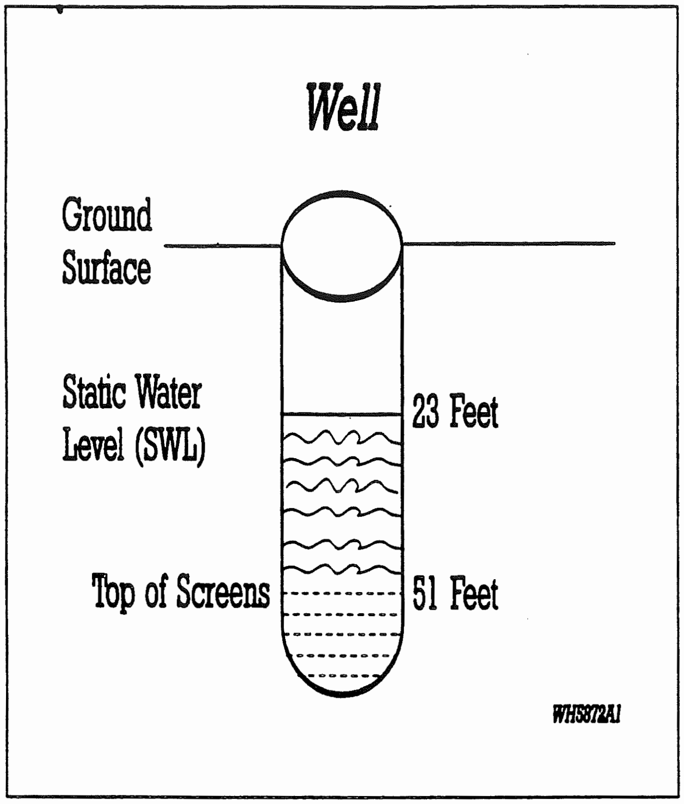


Figure A-1: Example Well Characteristics

The safe yield (SY) for the well is obtained by multiplying the available water (AW) times the specific capacity (SC). Figure A-1 illustrates this example calculation of the safe yield.

$$SY = AW \times SC$$

$$SY = \frac{25.2\ feet \times 13.9\ gpm}{foot} = 350.2\ gpm$$

This calculation indicates that the well could be pumped at 350 gpm without lowering the pumping level to the screens. It should be noted that depending upon other use in the area, the aquifer may not be able to sustain that pump rate. Static water levels in the aquifer should be monitored to ensure that long-term decline of water levels in the aquifer are not indicated.

CALCULATED FIXED RADIUS EXAMPLE

The Calculated Fixed Radius (CFR) method for wellhead delineation determines the volume of the aquifer that will be required to supply water to the well for a period of time equivalent to the time-of-travel (TOT) criteria established by the state. In Oregon, the TOT applied to the CFR technique is 15 years. The CFR technique assumes a uniform aquifer and a flat water table, i.e., negligible groundwater flow. As a result, the volume calculated is a cylinder and the wellhead protection area is a circle (see Figure 3-3, Section 3.3). The radius (R) of the circle depends on the TOT, the adjusted pump rate (Q_a; see text), the effective porosity (n_e) and the screened/perforated or water-bearing interval (I). The appropriate equation is as follows:

$$r(feet) = [\frac{Q_a \times TOT}{(3.14 \times n_e \times I)}]^{1/2}$$

Where:

r = The radius of circle (actually the cylinder);

Q_a = Cubic feet/year (= gpm × 70267);

TOT = Years (15);

n_e = A dimensionless number between 0 and 1.0 (see Table 3-1, Section 3.3).

I = Feet.

- **Example 1 – The Calculation**

A community of 400 has an average daily water use of 140,000 gallons. The water is derived from two separate wells both of which produce equally[1]. The average daily use of each well, therefore, is:

140,000 gpd per 2 Wells = 70,000 gpd per Well

70,000 gpd per 1,440 min/day = 49 gpm per Well

Q_a = *49 gpm × 1.25 = 61 gpm =*

61 gpm × 70,267 = 4,286,287 ft^3 */ year*

From the well report:

I = 22 feet (-33 to -55 feet);

n_e = 0.2 (Table A-1 - for sand and gravel);

TOT = 15 years (pop. <500, Figure 3-1, Section 3.3)

[1] If data were available that indicated differing pump rates for the two wells, the total usage would be divided between the wells in a manner consistent with those pump rates.

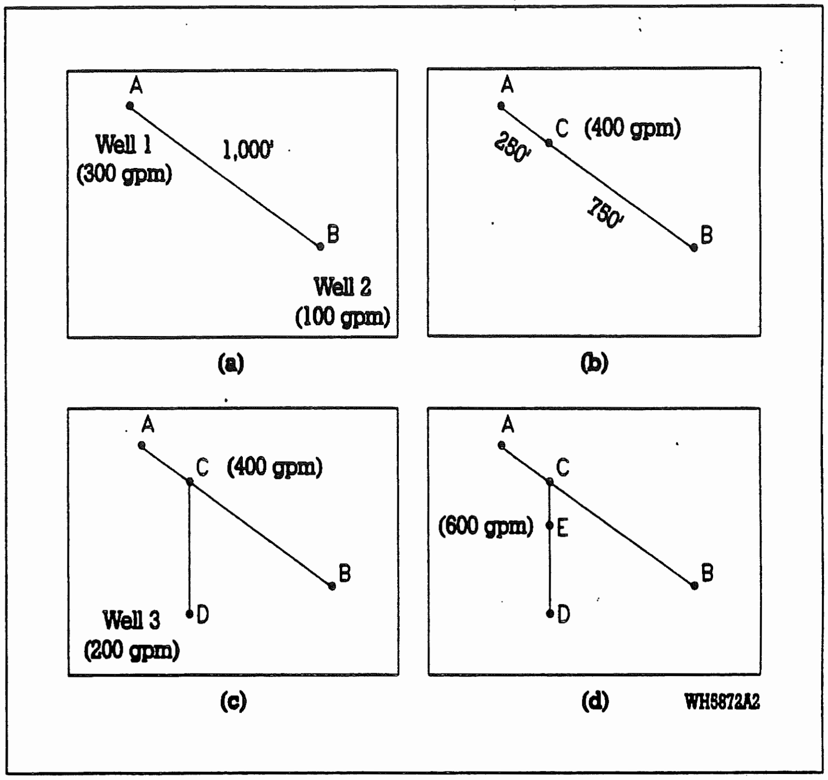
Substituting into the above equation yields:

$$r = [\frac{(4{,}286{,}287 ft^3) per yr. \times 15 yrs.}{(3.14 \times 0.3 \times 22\ feet)}]^{1/2}$$

$$r = 1{,}761\ feet.$$

The wellhead protection area for this well, therefore, is constructed by drawing a circle of radius 1,761 feet around the wellhead. Internal delineations can be constructed by substituting different values of TOT in the equation. For example, the radius corresponding to a 6-month TOT would be 322 feet.

If the second well, with the same production rate and in the same aquifer, was perforated through 15 feet instead of 22 feet, a value of 15 would be used for "I" in the equation. The resulting value of "r" for the second well using a 15-year TOT would be 2,133 feet. Because a smaller aquifer thickness is being used by the second well (15 versus 22 feet), a larger radius is required to supply the same amount of water.



NOTE: Determination of location of single hypothetical well to replace actual wells in the case where individual CFR circles overlap. One circle is drawn with hypothetical well as center point having discharge equal to sum of all individual wells.
(See text for explanation.)

Figure A-2: Determination of Location of Single Hypothetical Well

- ## Example 2 – Overlapping Wells

The city in the example above noted that after drawing the appropriate circles around wells 1 and 2 that the areas overlapped. The city correctly reasoned that because the wells were drawing from the same interval, the wells could not each draw the same water from the overlapping area. To compensate for the overlapping area, the city chose to represent the two smaller wells as a single well whose production rate was equal to the sum of the two individual wells (140,000 gpd). The hypothetical well was located exactly half way along a line between the two active wells. If the production rate of the two wells differed, then the placement of the hypothetical well would be closer to the higher producing well.

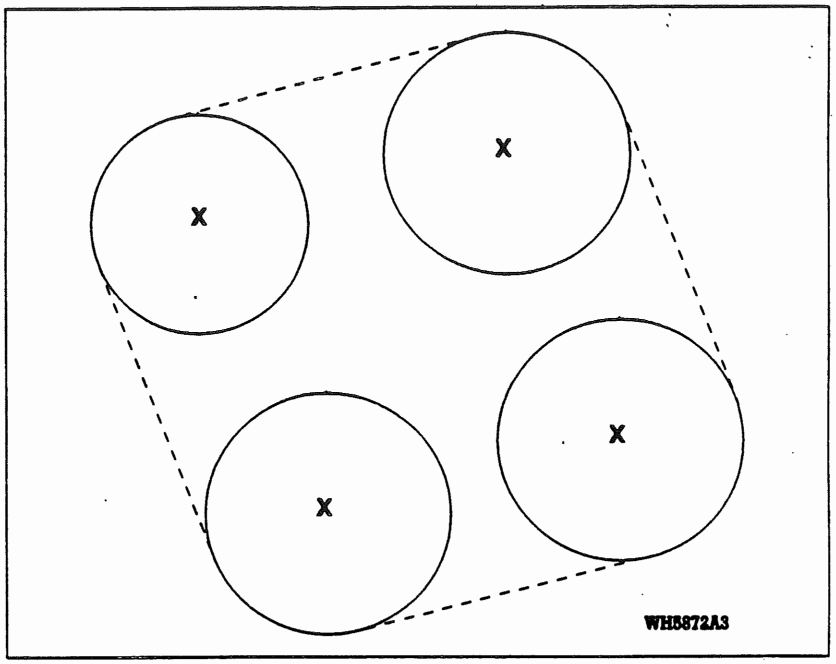
Figure A-2a illustrates this case. Two wells are separated by 1,000 feet. Well 1 (point A) pumps at 300 gallons per minute, while well 2 (point B) pumps at 100 gallons per minute. The location of the hypothetical well (producing 400 gallons per minute) would clearly be closer to "A" (well 1) than "B" (well 2). Well A pumps at 0.75 of the total discharge (300 gpm/ - 300 gpm + 100 gpm); therefore, the location of the hypothetical well would be 75 percent (i.e., 750 feet) of the way from "B" to "A" (point C in Figure A-2b). The radius of the hypothetical well would be calculated based on the 400 gpm figure and drawn from point C.

If three wells, all with overlapping circles, had been involved in this case, the hypothetical well, with a discharge equal to the sum of the three individual wells, would be located along the line segment "C–D" in Figure A-2c. If the pump rate of well 3 (point D) was 200 gpm, than the hypothetical well would be placed 0.33 (i.e., 200 gpm/(200 gpm + 400 gpm)) of the distance towards "D" along segment "C–D". In calculating the radius for the three wells, the discharge would be 600 gpm and the radius would be drawn from point E in Figure A-2d.

If the wells have different intervals, use an average thickness in the calculation, not the sum.

This process of drawing line segments can be continued to include additional wells as necessary. Further, the final placement of the hypothetical well is independent of the order in which the segments are drawn as long as the appropriate pump rates are used in the calculation. For example (Figure A-2d), the point E would have been the same if we would have started with segment "B–D" and then went to segment "A–B". This method should not be construed as a necessarily accurate way of compensating for the overlap. Rather, it represents an approximate solution to the problem.

If proximal wells are drawing from separate aquifers, it is permissible for the circles to overlap at the surface.



NOTE: Because of uncertainty associated with the calculated fixed radius method, a singleline (dashed in figure) is drawn to encompass all the individual circles. The area enclosed by the dashed line should be considered as the wellhead protection area for the wellfield. (Shown individually as "x".)

Figure A-3: Calculated Fixed Radius Method Applied to Four Distinct Wells

• Example 3 – Delineation of A Wellfield

In cases where nonoverlapping CFRs are drawn around individual wells in a wellfield, it is reasonable to delineate a wellfield protection area comprising all of the individual CFRs. For example, Figure A-3 shows a case where the WHPAs for four wells within a wellfield have been delineated using the CFR technique. As can be seen in the figure, the individual circles are separated from one another by small areas that according to the CFR technique, overlie portions of the aquifer that do not contribute to the well.

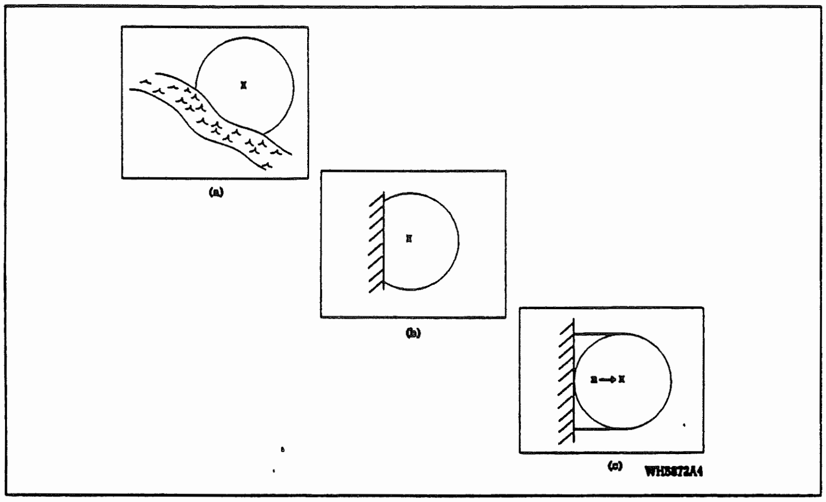
Given the uncertainty of the CFR technique, however, it would be prudent to include those inner areas within the wellfield protection area. Accordingly, it is recommended that in such situations, all of the CFRs be enclosed in a smooth curve (dashed line in Figure A-3) to provide a conservative approach to protection.

• Example 4 – Well Near A Boundary

1. ***Stream Boundary*** — In those cases where the CFR of a well intersects a perennial stream, the CFR can simply be truncated at the stream (Figure A-4a).

2. ***No-Flow Boundary*** — If the CFR intersects a no-flow hydrogeologic boundary, e.g., impermeable bedrock valley wall, adjustments to the position of the circle should be made (Figure A-4b). This can be accomplished by shifting the CFR relative to the boundary. The shift should be perpendicular to the general trend of the boundary. The CFR should be moved until the circle is tangential to the boundary. The area between the circle and the boundary should be included in the delineated WHPA (Figure A-4c).

The adjustments above should not be regarded as technically defensible methods of correcting for the presence of the boundary. Rather they reflect an attempt to improve the estimate of the area involved in supplying water to the well.



NOTE:

(a) For wells where the circle delineated by the CFR method intersects a perennial stream, the circle should be truncated at the stream.

(b) CFR method applied to a well adjacent to a no-flow boundary, except valley alluvial sediments against the bedrock valley wall.

(c) The circle drawn in (b) should be moved directly away (perpendicular) from the boundary (see arrow) until the circle is tangential to the boundary. The area within the circle and the area between the circle and the boundary should be included in the WHPA.

Figure A-4: Calculated Fixed Radius (CFR) Method in Proximity to A Hydrogeologic Boundary

CONCEPTUAL MODEL DEVELOPMENT

As indicated in Figure 3-3 (Step 3 - Flowchart), public water systems having a population >500 must develop a conceptual model as a framework for the delineation of the WHPA. If the population is between 500 and 3,300 the conceptual model can be constructed from regional data. For larger populations site-specific data must be incorporated.

The various components of the conceptual model are listed below. The requirements below represent what the State views as the minimum data needed for a framework to construct the conceptual model. They may, of course, be modified based on best professional judgment.

• Components of The Regional Conceptual Model (Population 500–3,300)

1. ***Compilation of Regional Studies*** — A literature search should be conducted to locate any existing geological/hydrogeological publications or reports that have included the area of concern in their study. This literature search can be greatly facilitated by contacting local and state agencies that deal with water issues: Watermaster's Office, Water Resources Department, Regional office of the Department of Environmental Quality, Groundwater Section of the DEQ, U. S. Geological Survey, Drinking Water Program of the Oregon Health Division, the Department of Geology and Mineral Industries (DOGAMI), Geology Departments at area colleges and universities.

2. ***Development of A Well-Log Inventory*** — Experience from the Demonstration Projects indicates that this task can be most efficiently accomplished by the water system because of its familiarity with the local area. Well reports for wells within the area should be obtained from the local watermaster's office or the Salem office of the Water Resources Department. It is recommended that the well reports from the section within which the well of concern occurs and the eight (8) surrounding sections should be obtained. Wells should be located on appropriate 7.5 minute quadrangle maps. Depending on available information and the pump rate, however, well reports from fewer sections may be sufficient. Other features of interest, e.g., springs, surface waterbodies, high-production wells, etc., should also be noted at this time.

3. ***Fence Diagram*** — The well-log inventory should be utilized to identify the hydrologic units within the area. Data allowing, spatial variation of the units should be identified through the use of a fence diagram, constructed from a minimum of two mutually perpendicular sets of three cross sections. Ideally, these should be oriented so that one set is approximately parallel to the direction of groundwater flow.

4. ***Field Visit*** — A field visit to the area provides a valuable perspective in developing the conceptual model. It should be

used to ground check the well log inventory and to determine if the fence diagram is consistent with surface exposures.

5. ***Recharge to The Aquifer*** — The GPTRAC semi-analytical model allows for input of the amount of recharge to the aquifer. In Oregon, the most common sources recharge to the aquifer are rainfall and irrigation. Rainfall amounts can be derived from local records or from the Oregon Precipitation Map (Oregon Climate Service, Oregon State University). Irrigation application can be arrived at by local records or from estimates based on crop requirements (Consumptive Use Requirements, Soil Conservation Service; see Hydraulic Surplus Determination, OHD's Guidance Document for Monitoring Reduction through Use, and Susceptibility Waivers). Infiltration coefficients depend highly on the nature of the surface (e.g., residential, industrial, agricultural, etc.), the extent of the vegetation, character of the rainfall, and, in the case of irrigation, the irrigation method (e.g., flood, sprinkler, drip, etc). Published recharge rate estimates are available for some areas. Where they are not available, an estimate of one-third to one-half of the precipitation rate is probably reasonable for natural recharge.

6. ***Other Wells*** — Well reports from the area, supplemented by a local area review, should be evaluated to identify any large production wells (e.g., irrigation or industrial) that might exist in the area. Wells used specifically for recharge should also be located. These include dry wells utilized for disposal of storm water or other wastewaters.

7. ***Hydrogeologic Characteristics*** — Parameters utilized directly in the delineation of the wellhead protection area include the hydraulic gradient, hydraulic characteristics of the hydrogeologic units and the presence of hydrogeologic boundaries.

   - **Hydraulic Gradient**. The gradient is obtained from regional studies or from static water level measurements on a minimum of three appropriately selected wells. Wells selected must be within the same hydrogeologic unit as the production well and be spaced appropriately to provide a solution to a "3-point problem". Separation should be as great as possible within the constructs of the conceptual model.

   - **Hydraulic Characteristics**. The average thickness of the aquifer (b) should be determined based on the well reports and other available data. If the aquifer has more than one water-bearing zone, their thicknesses and relative continuities should be noted. Hydraulic conductivity (K) and effective porosity (n_e) should be derived from regional studies, specific capacity data (from pump tests ≥ 4 hours in duration) or from the well reports in conjunction with Table A-1. If specific capacity data are utilized it is recommended that the geometric mean (e.g., $K_{gm} = [K_1 \times K_2 \times \ldots K_n]^{1/n}$) be utilized rather than the arithmetic mean to avoid undue influence by "outliers" in the data set.

   - **Hydrologic Boundaries**. Streams, lithologic contacts, groundwater divides, etc., identified in the development of the conceptual model must be utilized in the delineation to constrain the boundaries of the wellhead protection area as appropriate.

• Components of the Site-Specific Conceptual Model (Population 3,300 and greater)

1-6. ***Components 1 through 6*** — Conduct components 1 through 6 of the Regional Conceptual Model as described above.

7. ***Hydrogeologic Characteristics*** — Parameters utilized directly in the delineation of the wellhead protection area include the hydraulic gradient, hydraulic characteristics of the hydrogeologic units and the presence of hydrogeologic boundaries.

   - **Hydraulic Gradient:** The hydraulic gradient should be determined by mapping the potentiometric surface in the area. Mapping will be accomplished by measuring static water levels in adequately constructed wells open to the aquifer of concern only. The number of measurements required depend on variability of head elevation in the area but should at a minimum include one well per quarter section where possible. Emplacement of monitoring wells may be necessary.

   Systems may wish to consider determining the direction and magnitude of the gradient on a quarterly basis (see above) in order to determine seasonal fluctuations in these

Table A-1: Approximate Values of Porosity and Hydraulic Conductivity for Various Aquifer Materials

Material	Hydraulic Conductivity* (Feet/Day)	Porosity**
Sediments		
Gravel	86 – 8,600	0.24 – 0.38
Coarse Sand	0.25 – 1,725	0.31 – 0.46
Fine Sand	0.26 – 50	0.26 – 0.53
Silt	2.6×10^{-4} – 17	0.34 – 0.61
Clay	2.6×10^{-6} – 4.0×10^{-3}	0.34 – 0.60
Loess	1.3×10^{-2} – 0.5	0.30 – 0.50
Sedimentary Rocks		
Sandstone	8.6×10^{-5} – 1.7	0.05 – 0.40
Siltstone	2.6×10^{-6} – 4.3×10^{-3}	0.20 – 0.40
Shale	2.6×10^{-8} – 5.2×10^{-4}	–
Limestone	3×10^{-5} – 70	0.05 – 0.50
Igneous/Metamorphic Rocks		
Basalt (dense)	5.0×10^{-6} – 0.1	<0.01 – 0.05
Basalt (fractured)	0.1 – 5,180	0.05 – 0.35
Unfractured Igneous/Metamorphic Rocks	1.0×10^{-8} – 5.2×10^{-5}	<0.01 – 0.05
Fractured Igneous/Metamorphic Rocks	2.1×10^{-3} – 85	<0.05 – 0.50

* **Hydraulic Conductivity:**

- Increased by — Presence of sand or gravel, increase in sorting, stratification, unconsolidated character, and high secondary porosity.
- Decreased by — Presence of clay, poor sorting, unstratified character, cementation, or compaction.

** **Porosity:**

- Increased by — Increase in sorting, rounded grains, small particle size, unconsolidated character, and high secondary porosity.
- Decreased by — Poor sorting, irregular shaped particles, unstratified, large particle size, cementation/compaction.

Source:

Domenico and Schwarz, 1990; EPA, 1994

parameters and minimize the area to be protected.

- **Aquifer Characteristics:** Values of transmissivity (T) and the storage coefficient (S) or specific yield (S_y) as appropriate should be obtained through aquifer tests (see Appendix A, "Aquifer Tests"), using well-accepted techniques for solution. Evaluation of potential boundaries and "leaky" conditions should be part of the analysis.

- **Spatial Variability of Aquifer Characteristics:** The variation of the hydraulic characteristics of the aquifer should be mapped. This should be accomplished using the conceptual model, supplemented by specific capacity data. As above, the specific capacity should be used only when it is derived from a pump test with a minimum of a 4-hour duration. Values of "K" and saturated thickness should be displayed in map form, contoured if appropriate. Aquifer inhomogeneity will be incorporated in the delineation techniques as appropriate.

- **Hydrologic Boundaries**: Streams, lithologic boundaries, groundwater divides, etc., must be identified based on hydrogeologic mapping (well reports, conceptual model and field mapping).

POROUS MEDIA ASSUMPTION

Of concern here is the relation between groundwater flow direction and the gradient. In a homogeneous isotropic aquifer, groundwater will flow perpendicular to head contours. It is, therefore, predictable through the use of simple analytical expressions and groundwater velocity can be determined through Darcy's Law. If the aquifer is fractured, groundwater flow direction may be significantly different than the gradient direction (Bradbury et al., 1991; Bradbury and Muldoon, 1994). Further, Darcy's Law, which assumes laminar flow, cannot be applied to groundwater flow through discrete fractures (EPA, 1994). Heterogeneities within the aquifer, manifest as large hydraulic conductivity contrasts, may also result in groundwater flow that departs from the general down-gradient direction (EPA, 1994).

• Recognizing Fractured Aquifers

The first step in determining whether the aquifer that is supplying the well of concern is fractured or porous is to evaluate the geologic province that the aquifer falls within. Wells producing from aquifers within alluvial basins are unlikely to be producing from a fractured aquifer, whereas those producing from any bedrock area outside or below the alluvial basins may be. A review of the well logs may provide useful information. If the producing zone is described as a sediment, e.g., sand, gravel or silt, it is justifiable to assume that the aquifer is porous. If on the other hand, the aquifer is described as bedrock, e.g., basalt, granite, sandstone, etc., further evaluation is necessary. Geologic maps and/or aerial photographs may be useful in a preliminary evaluation. Geologic maps will show the location and orientation of fractures (joints and faults) within an area. Aerial photographs may indicate the presence of fractures by linear features on the image.

• Evaluation of The Porous Media Assumption

The EPA recommends the following "subjective criteria" for determining whether a fractured-rock aquifer can be regarded as a porous medium for purpose of application of analytical models discussed below (Bradbury et al., 1991).

1. ***Pumping Test Responses*** — A porous medium should respond as follows:

   - Drawdown in observation wells during step tests should increase linearly with increased discharge.

   - Time-drawdown curves from observation wells located in two or more different directions from the production well should be similar in shape and not show any sharp inflections.

   - A contoured drawdown cone, from multiple wells, should be circular or slightly elliptical. A Linear or highly irregular cone may indicate fractures.

   Note that it is the drawdown that is contoured, not the hydraulic head. A symmetrical drawdown imposed on a regional gradient may yield an elliptical head pattern around the well.

2. ***Fracture Scale to WHPA Scale*** - The observed fractures should be numerous and small (size and spacing) relative to the delineated area. The EPA offers as a general rule that if the WHPA dimensions are at least 100 times that of the fracture spacing, the porous media assumption may be justified. The

scale of fractures may be estimated from geologic maps, from borehole geophysical studies, including down-hole camera, and field investigations.

3. *Distribution of Hydraulic Conductivity (K)* — In an aquifer that conforms to the porous media assumption, the distribution of "K" should be relatively uniform or conform to a log-normal distribution. In a fractured terrain, the distribution of "K" may yield a bimodal distribution, showing two dominant "K" values, one corresponding to the conductivity along the fractures and the other to the conductivity normal to the fractures.

4. ***Variations in Groundwater Chemistry*** — The EPA (1991) provides several criteria related to groundwater composition that may indicate flow along fracture surfaces. These include: (1) significant variations in composition in space and time, and (2) low total dissolved solids and mineral saturation indices. It should be noted that there are alternative explanations for the above observations and groundwater chemistry is most useful if the data from a number of similarly constructed wells are compared simultaneously.

   Even though a given fractured aquifer meets all criteria to be considered as behaving as a porous medium, there is still a consideration to be made in the application of traditional analytical tools. Bradbury and Muldoon (1994) Note that even under such situations, the actual capture zone of the well is invariably larger than that calculated through the use of the analytical methods.

• Heterogeneities Within The Aquifer

If large hydraulic conductivity contrasts occur within the aquifer, either as a result of depositional or deformational histories, groundwater flow direction will change as groundwater crosses from one material into another. In general, the groundwater flow paths will be "refracted" into the medium having the higher value of "K" and will exhibit preferential flow within that medium even though that path may not be perpendicular to the regional groundwater gradient. A method of transforming the direction of flow to accommodate aquifer heterogeneities is given in EPA (1994) and references cited therein.

AQUIFER TESTS

An aquifer test consists of a carefully planned interval of pumping and water level monitoring. We use the term "aquifer test" instead of "pump test" for two reasons. First of all, the objective is not just to test the pump, rather it is to better characterize the aquifer. Secondly, an aquifer test is a multi-phase effort that includes a number of steps in addition to just pumping the well.

The determination of aquifer properties in the site-specific conceptual model requires an aquifer test. This test should be at a constant rate for a minimum of 24 hours for a confined aquifer and 72 hours for an unconfined aquifer. Recovery should be allowed to occur over the same time period as drawdown. Pump rate should be consistent with normal production levels. In some cases, the well yields may be too small to allow for prolonged pumping at normal production levels. In those cases, alternate methods, e.g., slug tests (see below) may have to be used. Ideally, at least two observation wells should be monitored during the test. If the aquifer has confined characteristics, a third shallow observation well placed to explore leakance should be utilized.

The drop in the water levels (i.e., the drawdown, in the production well and in nearby monitoring wells as a function of time) are monitored throughout the test. The drawdown-time data is critical to the proper determination of aquifer properties. Therefore, the monitoring is done according to a rigorous schedule in order to ensure that the data obtained is useful.

• How Are Aquifer Test Results Used?

There is a direct relationship between the aquifer's characteristics and the amount of drawdown relative to both the time since pumping began and the distance a monitoring well is from the production well. For example, if we know the aquifer's transmissivity (equal to the hydraulic conductivity multiplied by the aquifer's thickness) and storativity (the amount of water the aquifer releases), we can predict what the drawdown will be for a given pump rate after a certain time and at a certain distance from the well.

It follows, then, that we can use those same equations in reverse to calculate transmissivity and storativity if we know the drawdown, time and distance. Generally, the solutions are graphical; i.e., we plot the data and compare the graph to theoretical solutions. There are many different types of solutions, depending on the hydrogeologic setting.

• Designing The Aquifer Test

Aquifer tests can be expensive and

time consuming. Therefore, it is important that the data be collected in a manner that will yield useful results in terms of aquifer characteristics. We recommend that you consult with a professional early on in the planning of the aquifer test so that the data collected will meet your needs and expectations. The Drinking OHD Water Program (503-731-4010) will provide technical assistance to help get you started.

Importantly, there is no "off-the-shelf" aquifer test plan that is available. Critical questions of what pump rate, what test duration, what additional wells should be involved and at what distance, what hydrogeologic boundaries may affect the results, and what corrections need to be applied to the drawdown data, all need to be addressed on a site by site basis. As discussed above, there are several solution methods that are applied to aquifer test results depending on the hydrogeologic setting and well construction characteristics. For the solutions to be valid, certain criteria must be met with regard to how the test is performed. Clearly these criteria have to be identified prior to running the test itself.

A conceptual model of the hydrogeologic setting based on well reports and other data available should be prepared prior to the test. From this information, a simulation of the aquifer test can be run prior to the actual test in order to identify potential problems and critical data to be collected. This allows the test to be designed to fit your specific setting and helps to ensure that the data collected will in fact represent your part of the aquifer and groundwater flow system.

• Common Mistakes

1. ***Inadequate Planning*** — The most common mistake is not planning the test adequately beforehand. As a result the data is only marginally useful and any use of it is open to some question.

2. ***Too Short of Test*** — Pump test data of limited duration (i.e., 1 to 4 hours) may be useful to evaluate the specific capacity of the well or to monitor the groundwater resource regionally, but is generally inadequate to define aquifer characteristics. The purpose of the test is to obtain **representative** values for those parameters that influence groundwater movement in the aquifer. The longer the duration of the test, the larger volume of aquifer involved; therefore, the more representative is the data of the aquifer.

   In some instances, the early water derived from the well may be supplied wholely by thin highly permeable beds. With further pumping, other less permeable zones may be involved. If the pump test had been of limited duration, the resulting aquifer characteristics might have reflected the thin beds only. Applying their characteristics to the entire aquifer during delineation modeling would have led to erroneous results.

   In unconfined aquifers, a test of limited duration may not capture the delayed yield of the aquifer. In such cases, the results might indicate an artifically low transmissivity or be mistaken for the impact of a nearby boundary.

   The potential impact of hydrogeologic boundaries is an important issue to recognize in aquifer tests. These boundaries (e.g., streams, geologic contacts, groundwater divides, etc.) may significantly affect groundwater flow in the area. There presence can be recognized in a longer test, but may be completely missed in a test of limited duration.

3. ***Inadequate Recovery*** — As has already been discussed, the important data that is collected is the amount of drawdown as a function of time in the given well. If the pump has been on just prior to the test and the water level in the well has not fully recovered (i.e., returned to its pre-pumping level), the drawdown recorded subsequently will not accurately reflect the pumping conditions during the test. As a result, the aquifer characteristics determined will be in error. The well should be idle for a minimum of 16 hours prior to the aquifer test.

4. ***Inadequate Corrections to Drawdown*** — A number of factors other than pumping can influence the water level in the well during the test. These include long-term changes in the aquifer due to regional pumping or recharge effects, changes in barometric pressure (especially for confined aquifers), changes in surface water stage (especially for unconfined aquifers) and interference from nearby pumping wells. If these features are identified and monitored before and during the test, corrections can be made to the data.

5. ***Poor Monitoring Practices*** — We have seen aquifer test data in which the water levels have been measured too infrequently or too imprecisely. Careful monitoring is critical to the utility of the data. We provide recommendations for frequency of monitoring water levels below. With respect to field mea-

surements, it is recommended that the pump rate be monitored on a 2-hour basis and the rate be maintained within 10 percent of its starting value. Significant variations in the pump rate pose large problems in interpreting the data.

Water level measurements should be determined to the nearest 0.01 feet. Tapes marked in tenths/hundredths of feet should be used as opposed to inches/feet. Time determinations should be made to the nearest minute, and if more than one observer is involved, the measurements should be synchronous to within 1 percent of the time since pumping began.

6. ***Improper Conveyance of Pumped Water*** — The water brought to the surface during the pump test must be piped sufficiently far away from the production and monitoring wells so that it will not seep back into the ground and artificially recharge the aquifer in the vicinity of the well. This is particularly important for aquifer tests involving unconfined aquifers.

7. ***Well Interference*** — During the pre-pumping, pumping, and recovery phases, the presence of any other pumping wells within 1500 feet should be noted. The pre-test simulation may help to better define the distance from the well another well can be before interfering with the pumping level in the production or monitoring wells.

• Data Collection

Below are recommendations regarding the collection of data during the aquifer test's pre-pumping, pumping, and recovery phases.

NOTE: These are general recommendations only; modifications may be necessary as dictated by the conceptual model and simulation results.

1. ***Duration*** — The pumping phase should be at a constant rate for a minimum of 24 hours for a confined aquifer and 72 hours for an unconfined aquifer.

2. ***Pump Rate*** — The pump rate should be at normal operating levels, but care must be taken to avoid the possibility of excessive drawdown, i.e., lowering the water level to the perforations or screens, during the test. It may be necessary to calculate the safe yield of the well and set the constant rate at 75 percent of that value.

3. ***Observation Wells*** — If other wells, e.g., domestic or irrigation (open to the same aquifer as the test well), are available in the vicinity (e.g., within 1000 feet), they should be identified as possible observation (monitoring) wells. The use of observation wells greatly enhances the ability to obtain representative data during the test. The conceptual model and simulation will provide information as to which wells can be used as a function of their depth and distance. If these observation wells are screened over different portions of the aquifer, corrections to the drawdown will probably be necessary. If the aquifer being evaluated is confined, it may be useful to select an observation well completed within the overlying unconfined aquifer to determine if there is any leakage from the overlying aquifer into the confined system.

4. ***Stream Stage*** — If there is a stream near the well being tested, and the conceptual model or simulation suggests a potential connection, it may be useful to periodically monitor the stage (depth and width) of that stream during the test. In areas near the coast, tidal fluctuations should be considered

5. ***Pre-Pumping Phase*** — The well to be tested should remain idle for at least 16 hours prior to the test. During that time, water level measurements should be made at 16, 12, 3, 2 and 1 hours prior to initiating pumping. Within the hour immediately proceeding pumping, water level measurements should be taken at 20 minute intervals. The purpose of this exercise is to establish any long term trends in water level changes that may be occurring. Barometric measurements of atmospheric pressure (inches of mercury) should be made as well. Confined aquifers may show significant responses, e.g., 0.5 to 1 foot, to large changes (e.g., 1 inch of mercury) in atmospheric pressure. These measurements will allow the determination of the barometric efficiency of the aquifer so that corrections can be applied to the drawdown data.

6. ***Pumping Phase*** — After initiation of the pumping, drawdown measurements in the production and observation wells should be made according to Table A-2. The most critical period of measurements are within the first 100 minutes, when the water levels are changing rapidly.

7. ***Recovery Phase*** — Water level measurements made during the recovery of those water levels after the pump has been shut down should be taken at the

Table A-2: Drawdown Measurement

Time Intervals	Time After Pumping Started
0 – 1 Minute	As Frequent as Practical
1 – 10 Minutes	1 Minute
10 – 100 Minutes	10 Minutes
100 – 300 Minutes	30 Minutes
300 – 1,000 Minutes	1 Hour
1,000 – 5,000 Minutes	4 Hours
5,000 – End	1 Day

same frequency as the drawdown measurements during the pumping phase. As in the drawdown phase, the most important information is obtained during the first 100 minutes. Measurements should continue for the same duration as in the pumping phase, or until the water levels have reached 95 percent recovery.

8. ***Measurement Devices*** — Water level and flow rate measurement methods should be in accordance to Water Resource Department requirements (see "Pump Test Requirements for Ground Water Right Holders" distributed by the Department).

• What About Low Yield Wells?

Instances occur for low demand wells where the well's yield will not permit long-term pumping. In other words, the aquifer cannot supply water to the well bore at the same rate as the pump extracts it. As a result, the pumping level drops below the perforations or pump intake and no water is produced. This is most common in areas where the aquifer has a low hydraulic conductivity, e.g., has a high proportion of fines or is characterized by low-density fractures.

In these instances, the aquifer test may be designed using a lower pump rate, or may involve the use of slug tests. A slug test involves introducing an object or volume of water into the well and recording how long it takes the water to return to its initial level. This should not be necessary for a water supply well equipped with a pump.

As an example, a cylinder of solid PVC or aluminum, or a capped, sand-filled PVC pipe, is lowered into the well. Its volume displaces the water to a higher level. Over time, that water level will return to the initial level. Water levels versus time are recorded during this "falling head" portion of the test. After the water levels have returned to the original level, the cylinder can be withdrawn. This will result in a dropping of the water level in the well. The time versus water level data collected during this "rising head" portion of the test will yield a second independent estimate of the hydraulic conductivity from the falling head portion.

There are a number of disadvantages to using slug test results for estimating hydraulic conductivity. Perhaps the most limiting is the fact that the volume of aquifer involved in the test is very small and therefore the results are not very representative. A second problem is the fact that there is always borehole damage that occurs when the well is drilled that changes the hydraulic conductivity of the aquifer at the bore hole-water interface.

Finally, if the casing is not perforated, the water must enter and leave from the bottom of the casing. This results in the data reflecting the vertical hydraulic conductivity rather than the horizontal conductivity.

• Who Can Perform Aquifer Tests?

Aquifer tests should be performed by qualified individuals. The conceptual model/simulation phase should be performed by registered geologists, engineering geologists or professional engineers, providing they have hydrogeological experience. The actual test itself can be conducted by experienced individuals in the above professional groups as well as licensed well drillers and certified water rights examiners.

• References

1. **Bradbury, K.R., Muldoon, M.A., Zaporozec, A. and Levy, J.** 1991. *Delineation of Wellhead Protection Areas in Fractured Rocks.* U.S. Environmental Protection Agency, EPA 570/9-91-009.

2. **Bradbury, K.R., Muldoon, M.A.** 1994. *Effects of Fracture Density and Anisotropy on Delineation of Wellhead Protection Areas in Fracture-Rock Aquifers.* Applied Hydrogeology, 2: 17–23.

3. **Domenico, P.A. and Schwarz, F.W.** 1990. *Physical and Chemical Hydrogeology.* John Wiley & Sons, New York, 824 p.

4. **EPA.** 1994. *Ground Water and Wellhead Protection.* U.S. Environmental Protection Agency Handbook, EPA625/R-904/001.

Appendix B

Agency Resources List

APPENDIX

B

AGENCY RESOURCES LIST

Oregon Department of Environmental Quality (DEQ)
811 SW 6th, Portland, OR 97204

WATER PERMITS ①

①	DEQ — WATER QUALITY DIVISION (NPDES, WPCF, General)
Contact:	**Peg Brady**, Data Administrator — Portland Office, 503-229-5788.
Software:	Oracle DBMS.
Format:	Includes company name; location; hydro code type; facility ID; start date, expiration date; renewal date and modifications; permit (NPDES, WPCF, General); type (industry, domestic, agriculture); category (cooling water, filter backwash, fish hatchery, log pond, boiler blow down, placer mine, suction dredge, CAFO, seafood processor, gravel mine, sewer and pump station, oily stormwater runoff, seasonal food processors and wineries, and petroleum hydrocarbon clean up).
Availablity:	Sorts can be done by permit, type, facility category, street address, county/city, zip code, SIC, facility expiration date, region, and stream code (hydrocode).
Limitations:	Some data is in GIS format; in the process of acquiring all site data in a GIS format from 1990-1993.
Comments:	Does not list violations.

• National Pollutant Discharge Elimination System (NPDES) Permits

For discharge of waste water to surface water. Facility plans need to be reviewed prior to construction and includes land use compatibility statement. Depending upon the site specifics, a water quality impact evaluation may have been required.

Facility Types — Commercial, industrial, municipal sewage treatment plants, confined animal feeding lots and mining operations.

• Water Pollution Control Facility (WPCF) Permit

For discharge of all wastewater disposed on land or injected into the ground with no direct discharge to surface waters.

Facility Types — Land irrigation, evapo-transpiration lagoons, industrial seepage pits, confined animal feeding operations, and surface sewage disposal systems for flows over 5,000 gpd. Sometimes a WPCF type discharge is covered in a NPDES permit.

Agriculture related plans are also reviewed by the Oregon Department of Agriculture (ODA), and manual files are kept with additional data.

- **General Permit for Several Categories of Minor Discharges**

Facility Types — Confined animal feeding operations (CAFO), portable gold dredges, log ponds, and fish hatcheries. Agricultural related plans are also reviewed by ODA and are in a manual file system.

EPA VULNERABILITY STUDY ②

Compiled to predict groundwater vulnerability on a statewide basis and includes data used to develop groundwater management areas. The major data components being collected are geological, soils and contamination data. Includes data from DEQ sampling sites, OHD Public Water System well locations, and EPA data on major NPDES facilities, along with data collected on the groundwater management areas. Data compilation in progress.

Facility Type — Wells, some permitted sites.

② **DEQ — WATER QUALITY DIVISION — GROUNDWATER SECTION**

Contact:	**Amy Clark**, GIS Coordinator — Portland, 503-229-5370.
Software:	ARC-Info (GIS system).
Format:	Call for status update.
Availability:	Sorts can be done by zip code, SIC, city and county.
Limitations:	On-going project collecting data in a GIS format as compiled. Limited by staffing and funding.
Comments:	When compiled, it will include facility locations for all sources of contamination, wells statewide, geology, and soils. Proposed to capture Wellhead Protection area data.

UNDERGROUND INJECTION CONTROL (UIC) ③

Covers five classes of underground injection systems; only Class II and Class V are allowed in Oregon.

③ **DEQ — WATER QUALITY DIVISION — INDUSTRIAL & ON-SITE WASTE**

Contact:	**Rene Dulay**, UIC Program (Portland, 503-229-5374), or **Peg Brady**, Data Administrator (Portland, 503-229-5788).
Software:	Oracle.
Format:	Facility name, ID and UIC number, address, city, county, zip code, township and range, well classification, number of wells, operations status, sites with permits, well casing, well abandonment, compliance/violations, contamination, and inspection log.
Availability:	Most data for the Bend/Sisters area and Multnomah County. Call and inquire.
Limitations:	Data collected by EPA, may be incomplete.

Class II covers the disposal of drilling or mineral pollutants. Class V deals with storm water runoff, geothermal re-injection or aquifer recharge, commercial and industrial non-hazardous waste disposal (drywells, cesspools), and septic systems. Class V wells are being inventoried and assessed for threats to groundwater. Permitted sites are covered under NPDES or WPCF permits. Allowable wells (Class V) are not permitted.

Facility Types — City, county facilities, commercial and industrial, residential, and mining.

POINT AND NONPOINT SOURCE GROUNDWATER FILE INDEX ④

Compiled internally to track projects reviewed related to groundwater concerns. Projects of concern are sent in from the districts and other Divisions of DEQ for review.

Groundwater section was established in 1990, so files are not all inclusive.

Facilities Types — Municipalities, food processors, agriculture chemical companies, RV parks, metal processing, ports, nurseries, storm water, wetlands, lagoons, landfills, sanitary sewers, PWS, schools, golf courses, state parks, food processors, mining, etc.

HAZARDOUS WASTE GENERATORS⑤

For generators of toxic, corrosive, ignitable, reactive, or "listed" hazardous wastes. Includes generators, storage, waste collection, disposal, and treatment. Hazardous waste generators must meet specific federal and state regulations. Hazardous waste disposal sites must be permitted.

Facility Types — Forest products, agriculture experimental stations, airports/rail yards, metals fabrication/manufacturing, pipelines and meter stations, gas stations, military bases, mining, agriculture/chemi-

④ DEQ — WATER QUALITY DIVISION — GROUNDWATER SECTION	
Contact:	**WQ - Main Reception** — Portland, 503-229-5279.
Software:	Lotus 1,2,3.
Format:	Facility name, county, point or nonpoint project, and alternate names.
Availability:	List available by facility or county.
Limitations:	Limited to DEQ regulated point and nonpoint source sites of concern associated with other DEQ permits.
Comments:	Useful to identify where a file might be kept on known potential contaminant sources (PCS).

⑤ DEQ — WASTE MANAGEMENT AND CLEANUP DIVISION	
Contact:	**Scott Latham**, Data Management — Portland, 503-229-5082.
Software:	Oracle DBMS.
Format:	Business identification number; generator status; generator type (fully regulated, small quantity, and conditionally exempt); waste stream by EPA codes (RCRA); and SIC codes.
Availability:	Large and small quantity generator list can be generated by organization, region, individual facility, SIC code, zip code, county, or city. Transporters can only be listed by organization.
Limitations:	Not in a GIS format — no data on violations or spills.
Comments:	SIC codes are currently being added for each facility in the database.

cals, transportation maintenance/ machine shops, electrical and farm co-op, power substation and other utilities, computer related industry, drug enforcement operations, etc.

SOLID WASTE PERMITS ⑥

For solid waste disposal operations where garbage, demolition waste, industrial waste, land clearing debris or sludge is stored, received, processed, or land filled. Permit required prior to operation to justify need and establish land use compatibility. Engineering and site plan requirements may apply.

Facility Types — Landfills, military bases, dumps, industrial waste piles, and municipal sewage operations.

⑥ DEQ — WASTE MANAGEMENT AND CLEANUP DIVISION	
Contact:	**Kelly Scharbrough**, Permits — Portland, 503-229-6299; **Northwest/ Western Regions** — Salem, 503-378-8240; **Eastern Region** — Bend, 541-298-7255.
Software:	Oracle.
Format:	Facility ID; common name; township and range; DEQ region; county; facility type (landfill, transfer, wood, pulp/paper, demolition, incineration, septage lagoon, sludge, recovery, composting, tire storage, and other); permit number; permit type (regular, closure); date issued/expires; owner; operator; and permittee.
Availability:	List available by region, city, facility, facility types, or organization.
Limitations:	Does not list violations; not in a GIS format; does not give street address, facility age, information on use of liners, or groundwater monitoring.
Comments:	Known problem facilities would appear on the ECSI data base.

UNDERGROUND STORAGE TANK PERMITS ⑦

Statewide listing of facilities which have voluntarily complied with regulations to acquire a permit for their underground storage tanks. DEQ regulates tanks which contain petroleum or listed chemical products, USTs with 10 percent or more of their total volume beneath the ground (including piping), farm or residential motor fuel tanks larger than 1,100 gallons, and regulated substances. Covers existing, decommissioned, retro-fitted, test, and new tanks. Tank servicing and decommissioning requires a license.

Facility Types — Gas stations, fleet operations, markets, garages, airports, railroad yards, nursery, farms, parks, oil distributors, automotive industry, schools, fire district operations, restaurants, marine yards, state police, car wash, food processing, department store, sanitary service, construction, mining, residential, wood industry facilities, etc. (unlimited).

LEAKING UNDERGROUND STORAGE TANKS (LUST) AND CLEANUP LIST ⑧

A list of regulated tanks (regulated and non-regulated) with known releases. Problems are usually identified when the tanks are decommissioned or upgraded. Contamina-

⑦ **DEQ — WASTE MANAGEMENT AND CLEANUP DIVISION**

Contact: **Steve Paiko**, Permit Data — Portland, 503-229-5733.

Software: Oracle.

Format: Facility number, facility name, address, city, zip code, phone number, permittee name, number of tanks, number of permits, tank age, tank contents, number of active, and decommissioned tanks.

Availability: List available by site, owner, city/county, and zip codes.

Limitations: Only lists known owners of tanks; does not list violations, or SIC codes. Limited to regulated tanks. Excludes farm or residential tanks holding less than 1,100 gallons that are used for noncommercial purposes, heating oil tanks, septic tanks, pipeline facilities, bulk facilities, surface impoundments, stormwater or water collection systems, liquid traps, above ground tanks, tanks above the surface in an underground area, machinery tanks, and tanks under 110 gallons — abandoned tanks. Not available in a GIS format.

Comments: Does include data on activity with associated chemical.

⑧ **DEQ — WASTE MANAGEMENT AND CLEANUP DIVISION**

Contact: **Marcie Murphy** — Portland, 503-229-5790.

Software: Oracle.

Format: Site name, address, city, zip code, date spill was reported, clean up start and end dates, and region.

Availability: List available by region, city, facility, and zip codes.

Limitations: Does not list violations; no SIC codes; not in a GIS format; does not include non-regulated tanks until they leak.

Comments: Does include limited data on activity with associated chemical. Sites designated as soil only or unknown may have impacts to groundwater. DEQ encourages file review at the nearest regional office.

tion of the groundwater and/or soils can occur. A secondary list of LUST with groundwater contamination problems can be asked for. A third list is available that contains information on above ground leaking tanks (i.e., heating oil tanks). When an above ground tank leaks, it then comes under DEQ regulation for clean up. Information is also available on known LUST sites which have since been cleaned up to state and federal standards.

Facility Types — Car wash, gas station, bulk plant, school district bus center, general store, residential, armory, airport, ranger station, city fleet operations, BLM operations, post office, ski operation, yacht club, farms, tire and auto center, city shop, irrigation district, railroad yard, food processor, wood treatment facility, flour mill, water/sewage treatment plant, grocery store distribution facility, trucking operation, swimming pool operation, tire center, logging facility, construction facility, industrial tool facility, tavern, nursery, drilling supply, car rental, garage, feed store, park, heating oil distributor, job core center, pulp and paper mill, car dealer, etc.

ENVIRONMENTAL CLEAN-UP SITE INFORMATION SYSTEM (ECSI) ⑨

Compiled internally at DEQ for the Waste Management and Cleanup Division (WMC); this list includes all suspected and confirmed release sites statewide. Federal EPA National Priority (NPL) and CERCLA sites have been included, as well as state sites. EPA, NPL, and CERCLA sites compose one-third of total list. A separate list for groundwater contamination can be requested.

Facility Types — Any type of facility or site.

AIR CONTAMINANT DISCHARGE PERMIT ⑩

For facilities emitting over 10 tons a year, or a significant source of toxic air pollution. Requires a "Notice of Intent"; might be subject to a source review, and other strictures are located in a non-attainment area.

⑨ **DEQ — WASTE MANAGEMENT AND CLEANUP DIVISION**

Contact: **Daniel Crouse**, Data Management — Portland, 503-229-6821; **Northwest Region (Janelle Dean)** — Portland, 503-229-5741; **Western Region (Dena Burian)** — Eugene, 541-686-7838 (Ext. 231); **Eastern Region (Dan Duso)** — Pendleton, 541-278-4612.

Software: Oracle.

Format: Data on site name and alias, site address, region, and EPA identification number.

Availability: List available by site name, county, SIC code, and substance.

Limitations: Has most SIC codes and CAS. EPA sites (320-CERCLIS and 8-NPL) are included. Not available in GIS format.

Comments: Data from this list can be used to obtain detailed information on cleanup status, funding, violations, contaminant media affected, and contaminant levels.

⑩ **DEQ — AIR QUALITY DIVISION**

Contact:	**Spence Erickson**, Technical Services — Portland, 503-229-6458.
Software:	Oracle (with some files) only available in hard copy.
Format:	Facility ID, and address.
Availability:	By SIC code, city/county.
Limitations:	Not available in a GIS format.
Comments:	None.

Oregon Water Resources Department (WRD)
158 Twelfth St. NE, Salem, OR 97310-0210

WATER RIGHTS ①

For the use of surface or groundwater site withdrawal for beneficial uses. Format includes location, nearest stream, basin area, owners name, quantity limits, and reservoirs.

STATEWIDE OBSERVATION WELLS ①

Statewide wells used to monitor water levels. Format includes location, dates sampled, analytical results, pump rate, depth to water, etc. GIS data available for Harney, Malheur, Marion, and Clackamas counties.

WELL INVENTORY ②

Partial well inventory data set including abandoned and deepened wells by location. Format includes well location, owner, driller, depth to water, depth of well, age, type (PWS), etc.

① **WRD — WATER RESOURCES — INFORMATION SERVICES**

Contact:	**Bob Devyldere** — Salem, 503-378-8455 (Ext. 325).
Software:	ARC-INFO (GIS system).
Format:	Varies by data base. All have location to nearest quarter section, township, and range.
Availability:	Data available by location, most in GIS format
Limitations:	Not all data in a GIS Format yet; older well logs may lack desired data; does not list construction or water quality concerns.
Comments:	In the middle of a 3-year process to have all the data up on a GIS system.

② **WRD — WELL INVENTORIES**

Contact:	**Lisa Jewell** — Salem, 503-378-8455 (Ext. 304); **Mary Riggins** — Salem, 503-378-8455 (Ext. 260).
Software:	ARC-INFO (GIS system).
Format:	Varies by data base. All have location to nearest quarter section, township, and range.
Availability:	Data available by location, most in GIS format
Limitations:	Not all data in a GIS Format yet; older well logs may lack desired data; does not list construction or water quality concerns.
Comments:	None.

Oregon State Fire Marshal (SFM)
4760 Portland Rd., Salem, OR 97305

TOXIC RELEASE INVENTORY (TRI) UNDER SARA TITLE 313 ①

Federally mandated inventory of sites associated with potentially hazardous and toxic substances which would need specialized attention should the facility have a fire or spill.

Data is also available from EPA Region 10 in Seattle from Bill Boyne at (206) 553-1676.

Facility Type — Chemical suppliers, handlers, and users.

①

SFM — TRI DATA

Contact: **Bill Brauer**, Hazardous Materials — Salem, 503-378-3473 (Ext. 233).

Software: Microsoft Windows and Superbase 4.

Format: Company name, substance and its trade name, quantity of substances, storage type, storage location, and hazardous ingredient in the highest quantity.

Availability: Filed by company name, SIC codes, Mailing address, zip code, city, and county.

Limitations: Chemical reporting threshold is 55 gallons of a liquid substance, 500 pounds of a dry or solid substance, or 200 cubic feet of a compressed or liquified gas.

MSDS DATA FILES UNDER SARA TITLE III ②

Updated yearly through inspections and based upon chemical thresholds.

Facility Types — All.

②

SFM — SARA TITLE III DATA

Contact: **Bill Brauer**, Hazardous Materials — Salem, 503-378-3473 (Ext. 233).

Software: None.

Format: Chemical substance, amount of chemical, facility, SIC code.

Availability: Pulled manually by facility name.

Limitations: Threshold reporting quantities (same as above)

Comments: Not yet on a data base — being compiled. Local fire department may also have MSDS records

INDIVIDUAL COMPANY REPORTING UNDER SARA TITLE 312 ③

Facility Type — All.

③

SFM — SARA TITLE 312 DATA

Contact: **Bill Brauer**, Hazardous Materials — Salem, 503-387-3473 (Ext. 233).

Software: None.

Format: Facility name, address, substances, trade names, quantities, storage type and location of storage areas, SIC code, and hazard class.

Availability: Manually pulled.

Limitations: Threshold reporting may be too low for WHP.

Comments: None.

Oregon Emergency Management (OEM)
595 Cottage St. NE, Salem, OR 97310

RELEASE LIST ①

For discarded pesticides, and substances that are toxic, corrosive ignitable or reactive. May apply to generators, handlers, and those who treat hazardous and solid waste (HSW).

①	OEM — TOXIC RELEASE DATA
Contact:	**Larry Raaf**, OERS Coordinator — Salem, 503-378-2911 (Ext. 241).
Software:	None.
Format:	None.
Availability:	County, city, type of event, date.
Limitations:	None.
Comments:	Updated weekly.

Oregon Health Division (OHD)
800 NE Oregon, Ste. 611, Portland, OR 97232

PUBLIC WATER SYSTEM (PWS) ①

Statewide list of known PWS who are monitored by OHD for drinking water potability. Available by type (community, noncommunity, non-transient/non-community, and state regulated. Can be sorted by county area.

CONTAMINANT DETECTION ①

List of PWSs sites which show contamination detections beginning in late 1989. Verification of contamination requires a second set of tests. Once confirmed, OHD can opt to deal with the situation on their own or relay it to DEQ for enforcement. Usually if the PWS is "abandoned" or lacking financial capability to mitigate the situation, the project is sent to DEQ. Available by county or PWS. Use PWS classifications to determine what is monitored for.

①	OHD — DRINKING WATER SECTION
Contact:	**Patrick Meyer** — Portland, 503-731-4821 (Ext. 753).
Software:	None.
Format:	PWS name, size of population served, contaminant, county, if the contaminant is over the MCL, and the confirmation date.
Availability:	Hard copy available of most recent print out. System addresses, wells associated with the system, classification of PWS available.
Limitations:	No SIC codes. Some detections have not been confirmed.
Comments:	PWS locations are being digitized into a GIS format at DEQ in the Groundwater Section as part of the Vulnerability Study.

Oregon Department of Agriculture (ODA)
635 Capitol St. NE, Salem, OR 97310-0110

FERTILIZER RECORDS ①

Manufacturers, registrants, sellers or other persons importing fertilizers, agricultural minerals must submit reports to ODA quarterly, on the type and tonnage sold, or delivered in Oregon. Not public records.

PESTICIDE RECORDS ①

Licensed pesticide operators, public applicators and some commercial applicators are required by Oregon law to prepare records of specific information of pesticide applications. Pesticide dealers are required to keep records of all transactions involving restricted use pesticide products. All records are to be maintained for 3 years. Private pesticide applicators (growers, producers, etc.) must also keep records of any restricted use pesticide applicaitons per USDA regulations for 2 years. All records are open to inspection.

① **ODA — PLANT DIVISION**

Information: Salem, 503-986-4635.

Oregon Department of Geology & Mineral Industries (DOGAMI)
800 NE Oregon, Suite 965, Portland, OR 97232

STATEWIDE GEOLOGIC INFORMATION ①

Statewide geologic information including geologic maps, thesis and dissertations, and various other geologic information throughout Oregon. Resident geologists in Portland, Baker City, and Grants Pass with geologic data. A complete geologic library is located at the Portland office, as is the Nature of the Northwest Information Center for geologic and topographic maps by the USGS, DOGAMI, and other sources of geologic maps and geologic information such as geologic land uses including mining and oil, gas, and geothermal well drilling activities.

OIL, GAS, AND GEOTHERMAL WELL LOCATIONS AND DATABASE ①

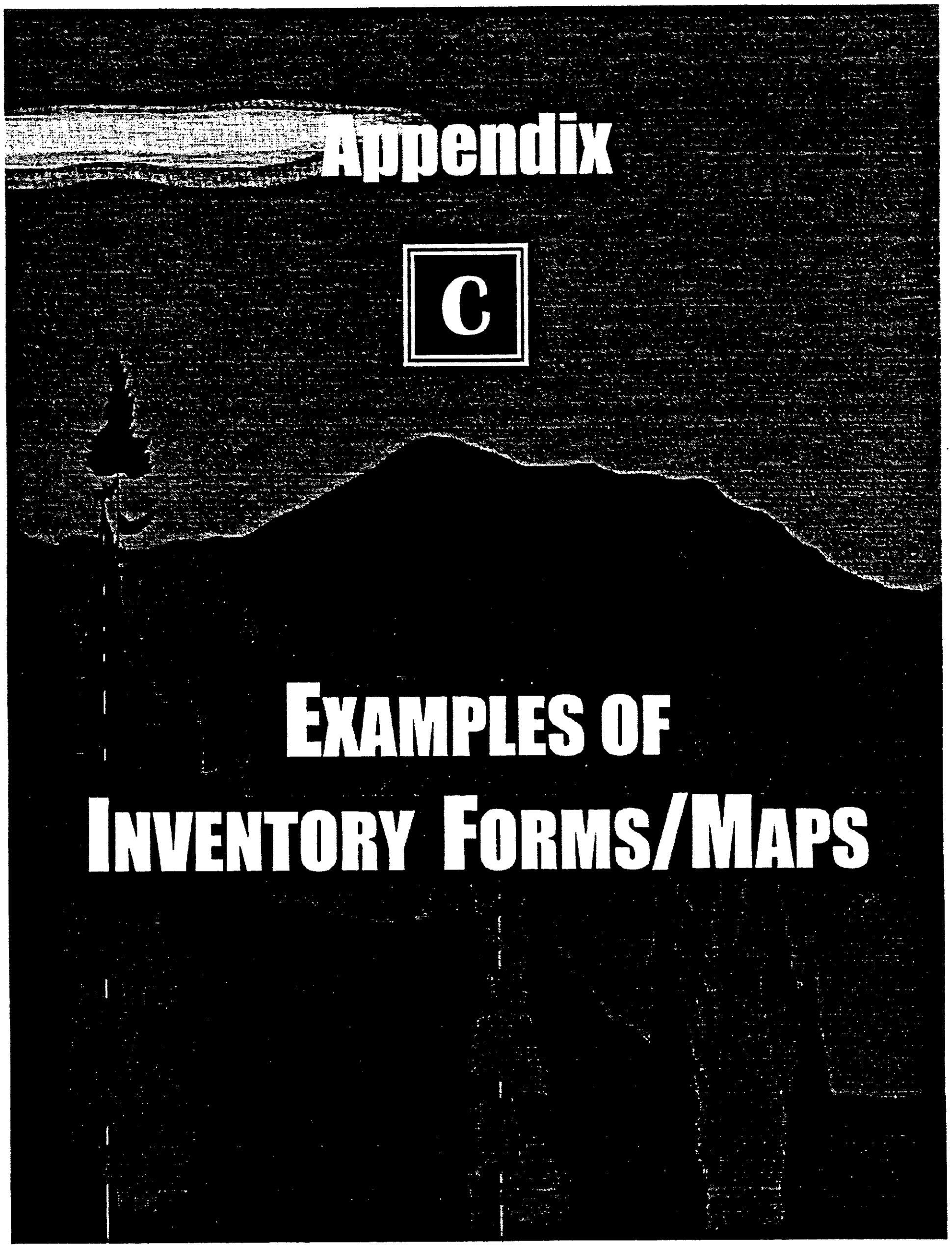
List of location, depth, date drilled, and other data pertaining to all oil, gas, and geothermal wells drilled in Oregon. Also locations and data of active wells, including production figures and other data for producing natural gas wells, and locations of wells permitted to be drilled. The geothermal wells are those drilled for high temperature resources for the purpose of electrical generation.

STATEWIDE LOCATIONS OF MINING SITES AND DATABASE ①

A complete database, the Mineral Information Layer for Oregon

(MILO), listing the historical locations for mining activities including commodities, years of operation, and other data. Also the location of active mines in the state and permits for future mining locations. A Mined Lands Reclamation Office is located in Albany with statewide mining information.

①	**DOGAMI — GEOLOGIC DATA**
Contact:	***Regional Geology*** — **George Priest**, Regional Geologist — Portland, 503-731-4100; **Mark Ferns**, Regional Geologist — Baker City, 541-523-3133; **Tom Wiley**, Regional Geologist — Grants Pass, 541—476-2496; **Klaus Neuendorf**, Geological Librarian — Portland, 503-731-4100; **Don Haines**, Nature of the Northwest — 503-872-2750.
	Oil, Gas, and Geothermal Data — **Dan Wermiel**, Geologist — Portland, 503—731-4100.
	Mining Data — **Gary Lynch**, MLR Supervisor — Albany, 503-976-2039; **Ron Geitgey**, Minerals Geologist — Portland, 503-731-4100.
Software:	Microsoft Windows, Dbase, Lotus, Map-Info.
Format:	Call for information.
Availability:	Statewide — Will provide data in format desired by user.
Limitations:	Not available in GIS Format; oil and gas database under development.
Comments:	None.



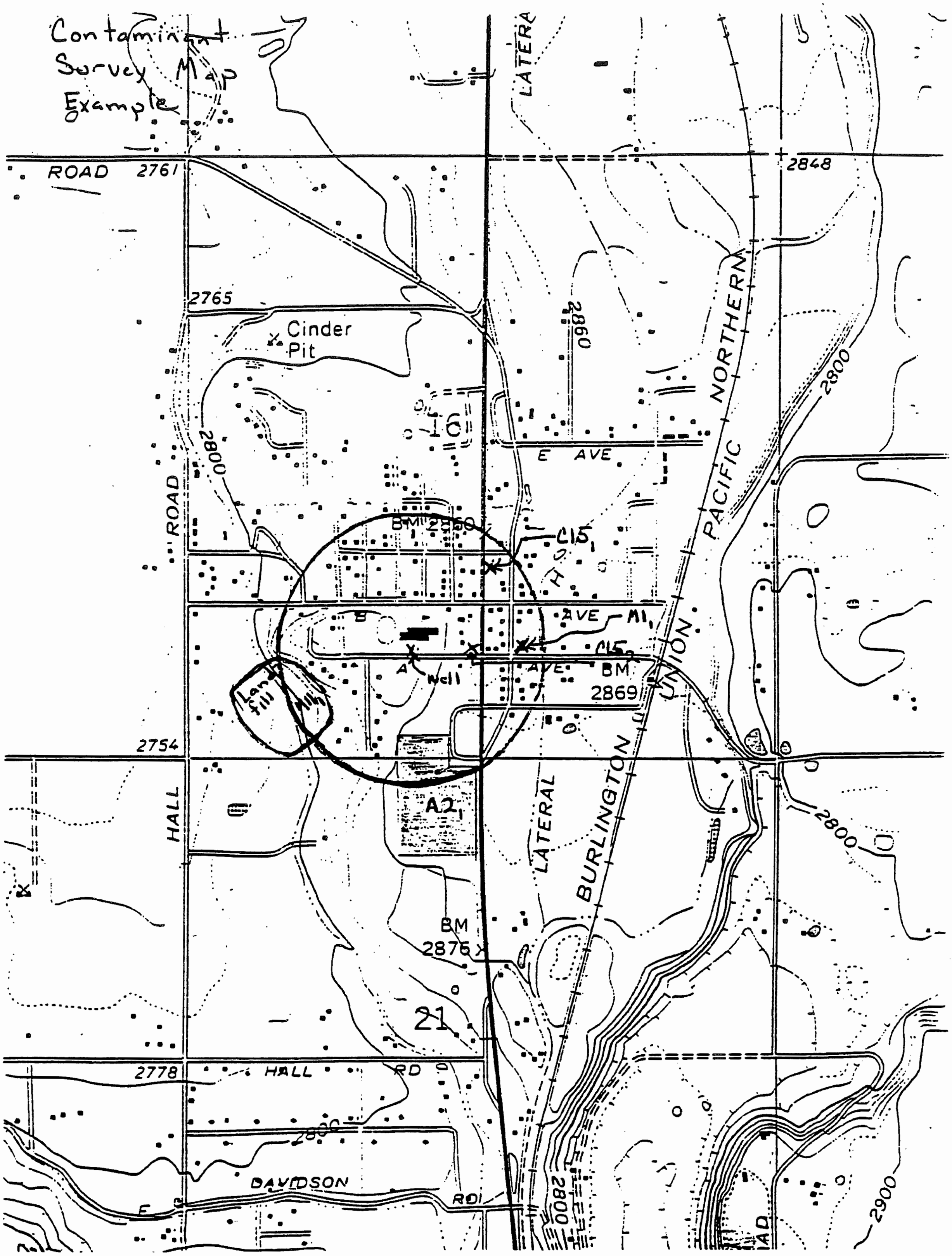
Appendix C

Examples of Inventory Forms/Maps

The following example potential contaminant survey and well log inventory comes from the work of the Oregon Association of Water Utilities (OAWU). Groundwater program grants were awarded from EPA to OAWU through its parent organization, the National Rural Water Association, to help small water systems develop wellhead protection plans. OAWU has been actively involved in delineating and inventorying over 65 small water systems in Oregon for the past two years. OAWU can be reached at (503) 873-8353. Mr. Tom Pattee is OAWU's Groundwater Technician and coordinator here in Oregon.

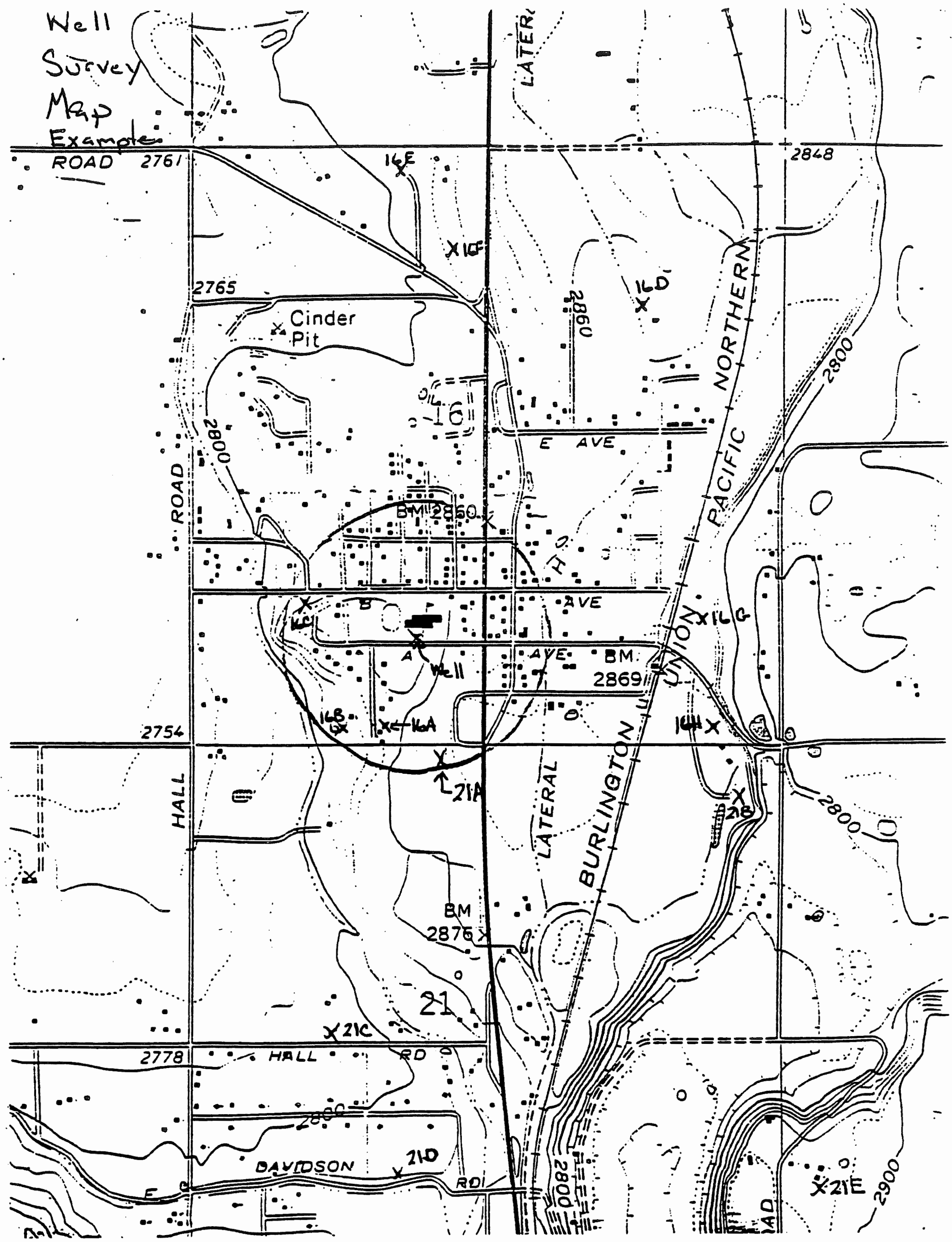
Example Sheet

CONTAMINANT	CODE	LOCATION	NOTES/COMMENTS
Manure Spreading	$A2_1$	3647 Hwy 84	Manure Applied 2 times a year, once in Fall & once in Spring
Gas Service Station	$C15_1$	3000 Hwy 84, John Doe Quick Serve	2 500,000 gal. tanks
Gas Service Station	$C15_2$	3193 Hwy 84, Quick Serve Gas Mart	1 250,000 gal. tank - diesel 2 500,000 gal. tank - gas.
Land fill	$M11_1$	See Map	Abandond, 1970. (Unsanitary)
City Shops	$M1_1$	1325 A Avenue	Solvents, pesticides, oil, gas

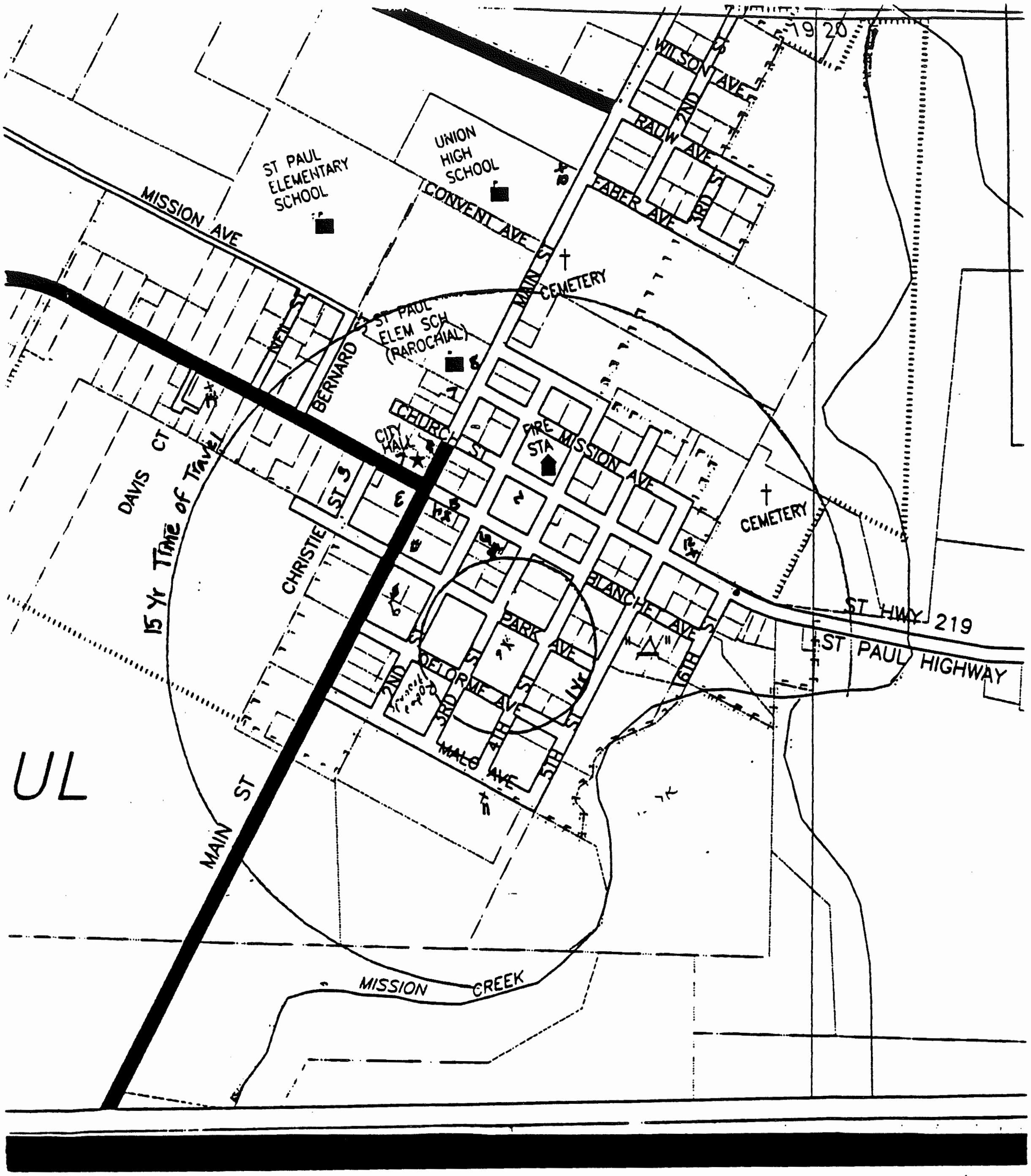


Contaminant Survey Map Example
ROAD 2761
2848
2765
Cinder Pit
NORTHERN
2860
2800
16
E AVE
PACIFIC
ROAD
BM 2860
C15
AVE
M1
C15
BM 2869
A Well
Land fill
UNION
2754
A2
LATERAL
BURLINGTON
HALL
BM 2876
21
2778
HALL RD
DAVIDSON RD
2900

C-3


Well
Survey
Map
Example
ROAD 2761
2848
16E
16F
2765
Cinder
Pit
16D
2860
NORTHERN
2800
16
E AVE
ROAD
PACIFIC
BM 2860
AVE
16C
16G
A
Well
AVE
BM
2869
UNION
16B
16A
2754
16H
21A
HALL
LATERAL
BURLINGTON
21B
2800
BM
2875
21
21C
2778
HALL
RD
2800
DAVIDSON
21D
RD
21E
2900

The following example wellhead protection survey form and map comes from the work of the Mid-Willamette Valley Council of Governments (MWVCOG). MWVCOG was awarded an EPA grant in 1994 to develop a prioritization system for multiple public water systems and assist all public water systems in Marion and Yamhill Counties by delineating the wellhead protection areas and conducting a potential contaminant source inventory. Ms. Jeanne Fromm served as the Wellhead Protection Specialist for MWVCOG and the Project Manager in Mr. Skip Wendoloski. MWVCOG staff can be reached at (503) 588-6177.


ST PAUL ELEMENTARY SCHOOL
UNION HIGH SCHOOL
MISSION AVE
CONVENT AVE
WILSON AVE
RAUW AVE
FABER AVE
MAIN ST
CEMETERY
ST PAUL ELEM SCH (PAROCHIAL)
BERNARD
CHURCH ST
CITY HALL
FIRE STA
MISSION AVE
DAVIS CT
15 Yr Time of Travel
CHRISTIE
ST
CEMETERY
BLANCHET AVE
PARK AVE
DELORME AVE
MALO AVE
2ND
3RD ST
4TH ST
5TH
6TH
ST HWY 219
ST PAUL HIGHWAY
UL
MAIN ST
MISSION CREEK
19 20

Map is 1" = 800'

WELLHEAD PROTECTION SURVEY FORM

Water System Name: St Paul, City of	Survey Date: Dec 27, 1994
Population Served: 345	Suvey By: D. Jasse & K. Stellman
Connection Numbers: ~~[illegible]~~ 123	Soil Types: Woodburn silt loam 0-3% slopes 3-12%
USGS Topo Sheet: St Paul	
Well Names and Ave. Pumping Rate: #2 @ 47 GPM	

COMMERCIAL/INDUSTRIAL		TOTAL
Automobile		
Gas Stations (Ca)	||	2
Car Washes (Cb)		
Dealers/Mechanics (Cc)		
Fleet/Trucking Companies (Cd)	|	1
Salvage Yards (Ce)		
Dry Cleaners (Cf)		
Photo Processing (Cg)		
Funeral Homes/Cemetaries (Ch)	||	2
Hardware/Lumber Stores (Ci)	|	1
Large Parking Lots/Malls (Cj)		
Medical/Vet/Lab Offices (Ck)		
Electronical Manfacturing (Ia)		
Cement/Concrete Plants (Ib)		
Food Processing (Ic)		
Metal/Machine Shops (Id)	|	1
Metal Finishing/Electroplating (Ie)		
Paper Mills (If)		
Wood Processing/Mills (Ig)		
Furniture–Home Manufacturing (Ih)		
Other		
Home Fuel Tank	|	1

RESIDENTIAL/MUNICIPAL		TOTAL
Housing Density (H,M,L)(Ra)		M
Waste Systems		
Septic Systems (Rb)		
Sewers (Rc)		✓
Golf Courses (Rd)		
Parks (Re)		
Schools (Rf)	|	1
Fire Stations (Rg)		1
Campgrounds/RV Parks (Rh)		
Transportation		
Airports (Ma)		
Railroad (mi) (Mb)		
Freeways/State Highways (mi) (Mc)	2/19	0.50 mile
Motor Pools (Md)		
Waste Handling		
Landfills/Dumps (Me)		
Recycling Centers (Mf)	|	1
Transfer Stations (Mg)		
Waste Water Treatment Plants (Mh)		
Other		

AGRICULTURAL		TOTAL
Fertilizer/Chemical Wholesaler (Aa)	|	1
Fert/Chem Application Service (Ab)		
Machinery Dealer/Repair (Ac)		
Livestock		
Chicken/Turkeys (Ad)		
Dairies (Ae)		
Feedlots (Af)		
Auction Lots (Ag)		
Nurseries (Ah)		
Farmsteads		
Fuel Storage (Ai)		
Chemical Storage (Aj)		
Machine Shops (Ak)		
Sewage Lagoons (Al)		
Crop Types		
Long-Term		
Orchard (Am)		
Hops (An)		
Berries/Vineyard (Ao)		
Christmas Trees (Ap)		
Pasture (Aq)		
Short Term		
Grains (Ar)		
Vegetables (As)		
Other Grain Storage	|	1

OTHER SOURCES		TOTAL
Forests (Oa)		
Mines/Gravel Pits (Ob)		
Underground Storage Tanks (Oc)	||	2
Leaking Underground Storage Tanks (Oc*)	|	1
Above Ground Storage Tanks (Od)	|	1
Other wells	|||	3

PAST USES		TOTAL
Dumps/Landfills (Pa)		
Gas Stations (Pb)		
Chemical Storage (Pc)		
Underground Storage Tanks		
Removed (Pd)		
Not Removed (Pd*)		
Wells		
Properly Abandoned (Pe)		
Improperly Abandoned (Pe*)		
Other		

St Paul

Ca	1	Wilco Farm Gas Station 3 UST
Grain Storage	2	Grain storage
Aa, Ca, Ci, Od	3	Ernist Hardware / Jon Deer Tractor
Oc*	4	P.O.
Mf, Cd	5	Phillips Garbage Service / Recycling depot
Fuel tank	6	home fuel tank
Oc, Id	7	Western Industrial
Oc, Kf	8	St Paul School Dist
not counted	9	City well currently being pumped
OUT	10	High school + grade school well - irrigation only
well	11	Community well - drinking + irrigation
well	12	Cemetery well irrigation only
well	13	City well - not used for public purposes anymore
OUT	14	Ernst well - generally not used for public purposes (back-up well)
	15	St Paul Feed + Supply
	16	
	17	

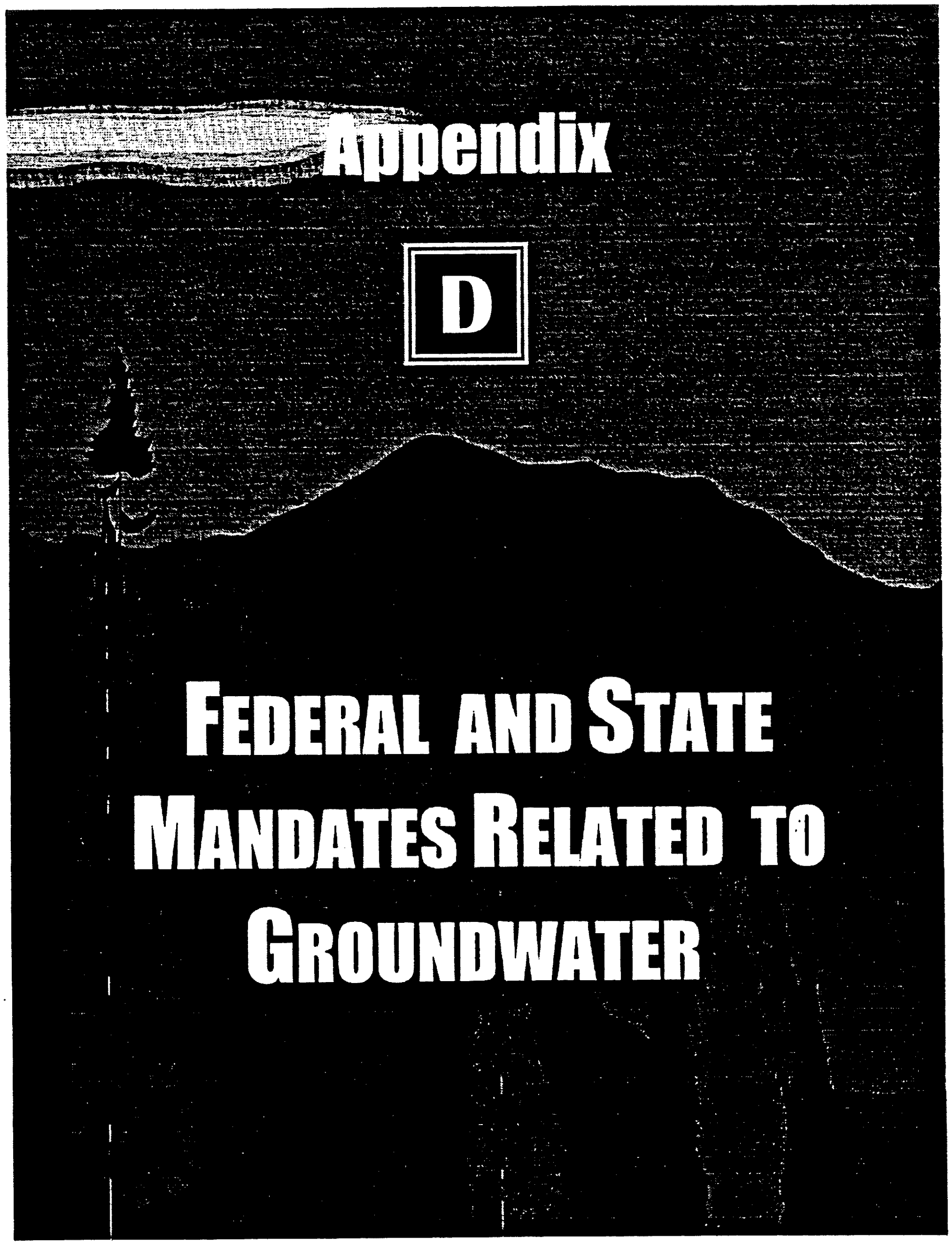

Appendix
D
FEDERAL AND STATE
MANDATES RELATED TO
GROUNDWATER

Table D-1: Federal and State Mandates Related to Groundwater

Program/Agency	Federal Law/Regulations	State Law/Rules
Drinking Water/OHD	*Safe Drinking Water Act* (SDWA) 42 USC 1417 40 CFR 141, 142, 143	ORS 448.273 ORS 448.277 ORS 285.757 OAR 333
Coliform Monitoring/OHD	40 CFR 141.21, 141.63	OAR 333-61-032 OAR 333-61-036
Disinfection/OHD	40 CFR 141.72	OAR 333-61-032
IOCs/OHD	40 CFR 141.11, 141.23, 141.62	OAR 333-61-030 OAR 333-61-036
SOCs/OHD	40 CFR 141.12,131.24, 141.61	OAR 333-61-030 OAR 333-61-036
VOCs/OHD	40 CFR 141.24, 141.61, 141.62	OAR 333-61-030 OAR 333-61-036
Surface Water/OHD	40 CFR 141.71(b)	OAR 333-61-032
Fluorides/OHD	40 CFR 141.11, 141.23, 141.62, 143.3	OAR 333-61-030 OAR 333-61-036
Lead Material Ban/OHD	SDWA 1417(a)(1) & (2), 42 USC 1417(a)(1) & (2)	OAR 333-61-034(5) OAR 333-61-036
Pb & Cu Rules/OHD	–	OAR 333-61-034
Radionuclides/OHD	40 CFR 141.16, 141.23, 141.62	OAR 333-61-036
Asbestos/OHD	40 CFR 141.23(b), 141.62(b)(2), OSHA 29 CFR 1910 & 1926	OAR 333-61-030 OAR 333-61-036
Public Notification/OHD	40 CFR 141, 142, & 143	OAR 333-61-025 OAR 333-61-042
Operator Certification/OHD	–	ORS 448.405-470 OAR 333-61-065
Plan Review/OHD	–	ORS 448.131 OAR 333-61-060
PWS Permits/OHD	–	ORS 448.140 & .145 OAR 333-61-046
PWS Construction Standards/OHD	–	ORS 448.131 OAR 333-61-050
Area of Groundwater Concern/OHD	–	ORS 448.268 OAR 333-61-032
Water Quality Standards/DEQ	*Federal Water Pollution Control Act* of 1972 – Renamed the *Clean Water Act* (CWA) – and Amendments; 33 USC 1251 through 1376	ORS 468B ORS 454 OAR 340-41 OAR 340-48
Injection Wells/DEQ	CWA	ORS 468B.005-035 OAR 340-44-005
Septic Systems/DEQ	CWA	ORS 454.010-805 OAR 340-71-100

Table D-1: Federal and State Mandates Related to Groundwater (Continued)

Program/Agency	Federal Law/Regulations	State Law/Rules
National Pollutant Discharge Elimination System (NPDES) Permitting/DEQ	40 CFR 122, 123, 123, 125, 129–131	ORS 466B.050 OAR 340-14 OAR 340-45
Groundwater Quality Protection/DEQ	–	ORS 568.900–933 OAR 603-90
Hazardous Waste Storage, Treatment, Disposal DEQ	*Resource Consevation and Recovery Act* of 1976 (RCRA) 40 CFR 260–272	ORS 465 ORS 466 OAR 340-100
Solid Waste – Treatment Disposal/DEQ	RCRA	ORS 459 OAR 340-61 OAR 340-64 (tires) OAR 340-102
Underground Storage Tanks (USTs) Permitting & Cleanup/DEQ	RCRA 40 CFR 280 (FR 2-18-93)	OAR 340-122 OAR 340-150
Hazardous Waste Cleanup/EPA & DEQ	*Comprehensive Environmental Response Compensation and Liability Act* (CERCLA); *Superfund Amendments and Reauthorization Act* (SARA); *Emergency Planning and Community Right-to-Know Act* (Title III)	ORS 485 OAR 340-122
Manufactures Chemicals – Regulations/DEQ	Toxic Substances Control Act (TSCA)	ORS 465 OAR 340-135
Pesticides – Regulations/ODA & DEQ	*Federal Insecticide, Fungicide, and Roenticide Act* (FIFRA)	ORS 634 ORS 466.005(7) OAR 340-109
Spill Reporting and Response/DEQ	–	ORS 466.605 OAR 340-108-001
Enforcement and Civil Penalties/DEQ	–	ORS 468.090-140 OAR 340-12-026
Pollution Prevention Requirements/EPA & DEQ	*Federal Pollution Prevention Act* of 1990 (Implemented through Toxic Release Inventory Reporting Requirements)	–
Toxic Use Reduction and Hazardous Waste Reduction/DEQ	–	ORS 466.003 OAR 340-135

LEGEND:

USC — United States Code
CFR — Code of Federal Regulations
PWS — Public Water System
OHD — Oregon Health Division
DEQ — Department of Environmental Quality
ODA — Oregon Department of Agriculture
DLCO — Department of Land Conservation and Development
ORS — Oregon Revised Statutes
OAR — Oregon Administrative Rules

Appendix E

EXAMPLE ORDINANCE FOR CREATING A WELLHEAD PROTECTION AREA DISTRICT

APPENDIX

E

WELLHEAD PROTECTION AREA DISTRICT

Appendix E contains an example ordinance. An ordinance is just one of the many zoning tools available to the local government. Your community can identify the wellhead protection area by the use of zoning or an "overlay" zone, which is a planning tool commonly used by many local governments. Then, by using the current zoning permit process that is already in place at the local government, an overlay zone or district can be applied to the wellhead protection area. This includes establishing an area for special review of proposed land uses that may contaminate the drinking water supply.

The following is intended to be a model or example ordinance only. To meet the needs and objectives of the local community, each local ordinance should be written in a way that works best for the community.

The information gathered in developing a local wellhead protection plan will also provide you with the information needed to develop a local ordinance. Delineation establishes: (1) appropriate zoning boundaries that best reflect the drinking water resource, and (2) any other interior boundaries or areas, e.g., 6 month time-of-travel boundary, wherein you may want to provide more protection. Information gathered on potential sources of contaminants (by use of local zoning maps) will help you identify any particular areas that require special attention. The existing local zoning tells you the uses in your wellhead protection area that are permitted outright, as a conditional use, or not allowed without rezoning. The local "Team" provides feedback and consensus on the best approach to use and how to establish a planning process that meets the needs of the local community in protecting the wellhead protection area.

For further information, refer to Statewide Planning Goal 1, Citizen Involvement, Goal 2, Part 1, Planning, and local government's enabling authorities under ORS Chapter 97 (for cities), and ORS Chapter 215 (for counties). EPA has compiled an extensive set of groundwater protection ordinances from around the country. Information about the "Compendium of Local Wellhead Protection Ordinances" can be obtained by contacting Doug White or Diana Butts at DLCD in Salem (503-373-0083).

Wellhead Protection Area District

COUNTY/CITY OF ________

PURPOSE AND INTENT

The ________ (City, County) Commission recognizes: (a) that residents of ________ rely exclusively on groundwater for a safe drinking water supply, and (b) that certain land uses in ________ can contaminate groundwater particularly in shallow/surficial aquifers.

The purpose of the Wellhead Protection Area District is to protect public health and safety by minimizing contamination of the shallow/surficial aquifers of ________. It is the intent to accomplish this, as much as possible, by public education and securing public cooperation.

Appropriate land use regulations may be imposed, however, which are in addition to these imposed in the underlying zoning districts or in other county regulations.

• Section 1.0 – Definitions

1. **AQUIFER**. A geological formation, group of formations or part of a formation capable of storing and yielding groundwater to wells and springs.

2. **BEST MANAGEMENT PRACTICES (BMPs)**. Measures, either managerial or structural, that are determined to be the most effective, practical means of preventing or reducing pollution inputs from point sources or nonpoint sources of water bodies.

3. **CONFINED ANIMAL FEEDING OPERATION (CAFO)**. The concentrated confined feeding or holding of animals or poultry, including, but not limited to horse, cattle, sheep or swine feeding areas, dairy confinement areas, slaughterhouse or shipping terminal holding pens, poultry and egg production facilities and fur farms, in buildings or in pens or lots where the surface has been prepared with concrete, rock or fibrous material to support animals in wet weather or which have waste water treatment works.

4. **CONTAMINATION**. An impairment of water quality by chemicals, radionuclides, biologic organisms, or other extraneous matter whether or not it affects the potential or intended beneficial use of water.

5. **DEVELOPMENT**. The carrying out of any construction, reconstruction, alteration of surface or structure or change of land use or intensity of use.

6. **FACILITY**. Something that is built, installed, or established for a particular purpose.

7. **FARM PRACTICES**. A mode of operation that is common to farms of a similar nature, reasonable and prudent for the operation of such farms to obtain a profit in money, is or may become a generally accepted method in conjunction with farm use, complies with applicable laws, and is done in a reasonable and prudent manner.

8. **GREY WATER**. All domestic wastewater except toilet discharge water.

9. **HAZARDOUS MATERIAL**. A material which

is defined in one or more of the following categories:

- **Ignitable**: A gas, liquid or solid which may cause fires through friction, absorption of moisture, or which has low flash points. Examples: white phosphorous and gasoline.

- **Carcinogenic**: A gas, liquid, or solid which is normally considered to be cancer causing or mutagenic. Examples: PCB's in some waste oils.

- **Explosive**: A reactive gas, liquid or solid which will vigorously and energetically react uncontrollably if exposed to heat, shock, pressure or combinations thereof. Examples: dynamite, organic peroxides and ammonium nitrate.

- **Highly Toxic**: A gas, liquid, or solid so dangerous to man as to afford an unusual hazard to life. Example: chlorine gas.

- **Moderately Toxic**: A gas, liquid or solid which through repeated exposure or in a single large dose can be hazardous to man.

- **Corrosive**: Any material, whether acid or alkaline, which will cause severe damage to human tissue, or in case of leakage might damage or destroy other containers of hazardous materials and cause the release of their contents. Examples: battery acid and phosphoric acid.

10. **PRIMARY CONTAINMENT FACILITY**. A tank, pit, container, pipe or vessel of first containment of a liquid or chemical.

11. **RELEASE**. Any unplanned or improper discharge, leak, or spill of a potential contaminant including a hazardous material.

12. **SECONDARY CONTAINMENT FACILITY**. A second tank, catchment pit, pipe, or vessel that limits and contains liquid or chemical leaking or leaching from a primary containment area; monitoring and recovery are required,

13. **SHALLOW/SURFICIAL AQUIFER**. An aquifer in which the permeable medial (sand and gravel) starts at the land surface or immediately below the soil profile.

14. **SPILL RESPONSE PLANS**. Detailed plans for control, recontainment, recovery, and clean up of hazardous material releases, such as during fires or equipment failures.

15. **TIME-OF-TRAVEL DISTANCE**. The distance that groundwater will travel in a specified time. This distance is generally a function of the permeability and slope of the aquifer.

16. **WELLHEAD PROTECTION AREA**. The surface and subsurface area surrounding a water well, spring or wellfield, supplying a public water system, through which contaminants are reasonably likely to move toward and reach that water well, spring or wellfield.

• Section 2.0 – Zones Within The Wellhead Protection Area

1. **ZONE A — DRINKING WATER CRITICAL IMPACT ZONE**. Zone A is the area within the 6-month time-of-travel distance mapped around the public water supply well(s).

   a. **Encouraged Uses**. Provided they meet appropriate performance standards outlined in 2.c below and are designed so as to prevent any groundwater contamination.

      (1) Parks, greenways, or publicly-owned recreational areas.

      (2) Necessary public utilities/facilities.

   b. **Special Exceptions**. The following uses are permitted only under the terms of a special exception and must conform to provisions of the underlying zoning district and meet the performance standards outlined in 2(c) below.

      (1) Expansion of existing nonconforming uses to the extent allowed by the underlying district. ***(NOTE: consult local plan for nonconforming uses.)*** The __________ Commission shall not grant approval unless it finds such expansion does not pose greater potential contamination of groundwater than the existing use.

   c. **Prohibited Uses**. The following uses are prohibited within Zone A, the 6- month time-of-travel zone. ***(NOTE: this is typically within about 1000 feet of the public water supply well.)***

- Automobile body/repair shop;
- Gas station;
- Fleet/trucking/bus terminal;
- Dry cleaner;
- Electrical/electronic manufacturing facility;
- Machine shop;
- Metal plating/finishing/fabricating facility;
- Chemical processing/storage facility;
- Wood preserving/treating facility;
- Junk/scrap/salvage yard;
- Mines/gravel pit *(unless zoned EFU and permitted under ORS 215.248)*;
- Irrigated nursery/greenhouse stock *(unless zoned EFU)*;
- Confined animal feeding operations *(unless zoned EFU)*;
- Land divisions resulting in high density (> 1/acre) septic systems;
- Equipment maintenance/fueling areas;
- Injection wells/dry wells/sumps;
- Underground storage tanks, (except those with spill, overfill, and corrosion protection requirements in place;
- All other facilities involving the collection, handling, manufacture, use, storage, transfer or disposal of any solid or liquid material or waste having potentially harmful impact on groundwater quality;
- All uses not permitted or not permitted as special exceptions.

2. **ZONE B**. Zone B is established as the remainder of the wellhead protection area not included in Zone A.

   a. **Permitted Uses**: All uses permitted in the underlying zoning districts provided that they can meet the Performance Standards as outlined for the Wellhead Protection Area District.

   b. **Special Exceptions**: All special exceptions allowed in underlying districts may be approved by the _________ Commission provided they can meet performance standards outlined for the Wellhead Protection Area District.

   c. **Performance Standards**: The following standards shall apply to uses in Zones A and B of the Wellhead Protection Area District:

      (1) Any facility involving the collection, handling, manufacture, use, storage, transfer or disposal of any solid or liquid material or wastes, except those facilities associated with Farm Practices as defined in ORS 30.930 in an Exclusive Farm Use Zone and to the extent prohibited by SB 3486 (pesticide use and sale) and CAFOs, in excess of 1,000 pounds and/or 100 gallons which has the potential to contaminate groundwater must have a secondary containment system which are easily inspected and whose purpose is to intercept any leak or release from the primary containment vessel or structure. Underground tanks or buried pipes carrying such materials must have double walls and inspectable sumps.

      (2) Open liquid waste ponds containing materials referred to in item (1) above will not be permitted without a secondary containment system.

      (3) Storage of petroleum products in quantities exceeding fifty-five (55) gallons at one locality in one tank or series of tanks must be in elevated tanks; such tanks must have a secondary containment system noted in item (1) above where it is deemed necessary by ______ _________.

      (4) All permitted facilities must adhere to appropriate federal and state standards for storage, handling and disposal of any hazardous waste materials.

      (5) An acceptable contingency plan for all

permitted facilities must be prepared for preventing hazardous materials from contaminating the shallow/surficial aquifer should floods, fire, or other natural catastrophes, equipment failure, or releases occur:

(a) For flood control, all underground facilities shall include but not be limited to a monitoring system and secondary standpipe above the 100 year flood control level, for monitoring and recovery. For above ground facilities, an impervious dike, above the 100 year flood level and capable of containing 100 percent of the largest volume of storage, will be provided with an overflow recovery catchment area (sump).

(b) For fire control, plans shall include but not be limited to a safe fire fighting procedure, a fire retarding system, effective containment of any liquid runoff, and provide for dealing safely with any other health and technical hazards that may be encountered by disaster control personnel in combating fire. Hazards to be considered are pipes, liquids, chemicals, or open flames in the immediate vicinity.

(c) For equipment failures, plans shall include but not be limited to:

- Below ground level, removal and replacement of leaking parts, a leak detection system with monitoring, and an overfill protection system.

- Above ground level, liquid and leaching monitoring of primary containment systems, their replacement or repair and cleanup and/or repair of the impervious surface.

(d) For any other release occurring, the owner and/or operator shall report all incidents involving liquid or chemical material to the designated wellhead protection spill coordinator at the _________ office.

(6) Since it is known that improperly abandoned wells can become a direct conduit for contamination of groundwater by surface water, all abandoned wells should be properly plugged according to Oregon Water Resources Department regulations.

Section 3.0 – City/County Liability

1. Nothing in this ordinance shall be construed to imply that the (city/county) __________ has accepted any of an owner/developer's liability if a permitted facility or use contaminates groundwater in any aquifer.

Section 4.0 – Enforcement

1. **CIVIL ENFORCEMENT:**

a. Any person may submit to this jurisdiction a verbal or written complaint alleging a violation of this ordinance.

b. Upon receipt of a complaint, the jurisdiction shall conduct a brief investigation of the substances of the complaint, including a meeting with the landowner involved.

c. Based upon the determination that there is a violation of this ordinance, the jurisdiction shall conduct an informal reconciliation with the violator. As part of such informal reconciliation, the jurisdiction shall:

(1) Notify the violator by mail of the violation of this ordinance and a desire of the jurisdiction to correct the violation through informal reconciliation. The statement shall also indicate that should the violator refuse to allow the recommended corrective actions within the time set forth by the jurisdiction, action may be taken to correct the violation and the violator will be billed for the cost of taking the corrective action.

(2) Make a good faith effort to meet the violator and resolve/correct the violation.

d. If after taking the steps above and after a period of ninety (90) days following the mailing of the notice of the violation, the jurisdiction in good faith determines that the violator is unwilling to participate in informal reconciliation and take the corrective actions prescribed, the jurisdiction shall notify the violator by mail of the termination of the informal reconciliation.

e. The jurisdiction may take the corrective action prescribed above following thirty (30) days after notifying violator by mail of the notice of termination of the informal reconciliation, and bill the violator for the reasonable cost of such action.

2. **CRIMINAL ENFORCEMENT:** In lieu of proceeding under Section 4.0, a person who is alleged to have violated this ordinance may be prosecuted for the commission of a crime. Violation of this ordinance is a misdemeanor and may be punished by imprisonment of not more than ninety (90) days or imposition of a fine of not more than $500.00 or both.

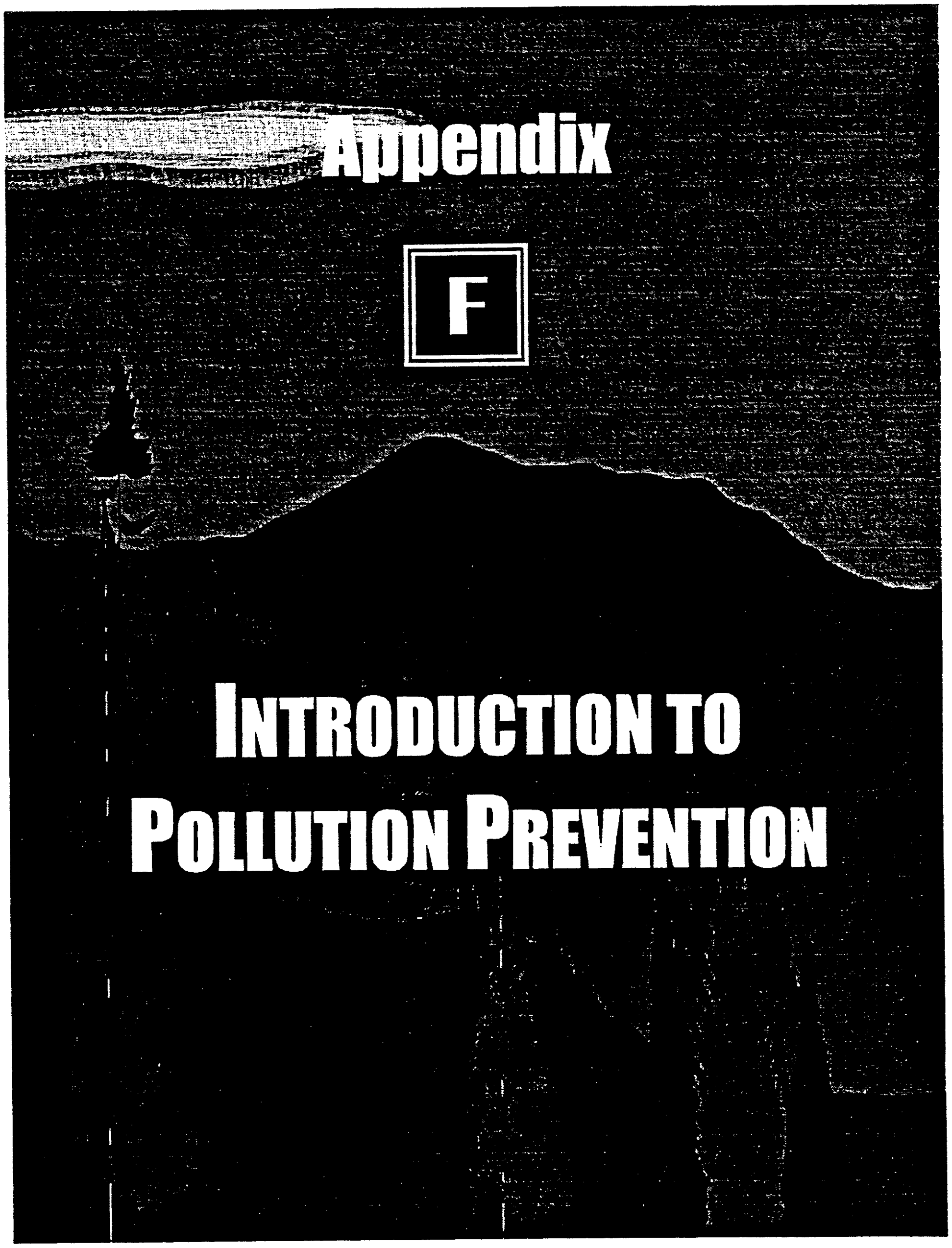
Section 5.0 – Saving Clause

1. Should any section or provision of this ordinance be declared invalid, such decision shall not affect the validity of the ordinance as a whole or any other part thereof.

Approved by: ______________________________

______________________ (Auditor/Attorney)

______________________ (Authority)


Appendix
F
INTRODUCTION TO
POLLUTION PREVENTION

Pollution
Prevention Resources for Business

TECHNICAL ASSISTANCE

Organization	Services Offered	Contact Person	Phone
Oregon State University Extension Service	Manufacturing efficiency audits (water, energy, raw materials, for SIC codes 20–39)	Greg Wheeler, Director Oregon State University Industrial Assessment Center	(541) 737-2515
USDOE Pollution Prevention Information Resource Center	Free on-site P2 & waste min. technical assistance for small businesses, personnel exchanges, laboratory assistance	Gary Spanner, NPL	(509) 372-4296
Oregon Environmental Technology Association	Network of environmental service providers	David Welsh Executive Director	(503) 227-6361
Oregon Economic Development Dept	Manufacturing extension program technical assistance	Peter Schmid	(503) 986-0192
Oregon Dept. of Energy (ODOE)	Energy efficiency audits for businesses	Mark Kendall	(503) 378-8444
Oregon DEQ: Hazardous Waste Program	Haz waste technical & compliance assistance	DEQ staff	(800) 452-4011
Oregon DEQ: Toxics Use Reduction Program	Technical assistance (pollution prevention & planning)	DEQ staff	(800) 452-4011

INFORMATION

Organization	Services Offered	Phone/Electronic Address
USDOE Pollution Prevention Information Resource Center	24-hour P2 Info Hotline & electronic bulletin board	(509) 3P2-INFO
Pollution Prevention Info. Clearinghouse (PPIC)	Electronic database & library of P2 information, reports, policy, programs, document, research	(202) 260-1023
Pacific Northwest Pollution Prevention Research Center (PPRC)	Electronic database of P2 research projects, P2 library	(206) 223-1151 gopher://Gopher.pnl.gov:2070/1/.pprc
Internet Databases: EPA Envirosene	P2 information, documents, expert systems for solvent substitution, etc.	http://wastenot.inel.gov:80/envirsense/

POTENTIAL FUNDING

Organization	Services Offered	Contact Person	Phone
Cascadia Revolving Fund	Environmental loans for minority- & women-owned businesses	Patty Grossman Executive Director	(206) 447-9226
DEQ	Tax credits for pollution control facilities and some P2 investments	Claudia Taylor	(503) 229-6484 (800) 452-4011
Dept of Energy	Energy tax credits	Mark Kendall	(503) 378-8444

Oregon Department of Environmental Quality
POLLUTION PREVENTION PRINCIPLES

VISION: DEQ will incorporate the principles of pollution prevention into Agency internal and external activities at every available opportunity.

DEFINITION: "Pollution Prevention" applies to environmental degradation caused by human activities. Pollution prevention can be achieved by:

- Protection of natural resources[1] by conservation and improved management practices.
- Increased efficiency in the use of raw materials, energy, water, or other resources; or
- Source reduction[2] and other practices that reduce or eliminate the creation of pollutants;

STRATEGIES

Internal: DEQ management/staff	External: Industry/government/public
Build Agency communication network	Build outreach/communication network
Demonstrate upper management support	Select target projects
Provide job specific mgmt/staff training	Provide training/education
Identify opportunities/barriers	Identify opportunities/barriers
Incorporate P2 into Agency activities	Align P2 incentives across programs
Establish measure of success/baseline	Develop partnerships
	Establish measure of success/baseline

MEASUREMENT OF SUCCESS[3]

Indicator	Measure	Internal Examples	External Examples
Inputs	$, time	Effort/funding outlay	Effort/capital outlay
Activities	Total #	P2 Tools developed	Assessments implemented
Involvement	Total #	Staff/contacts trained	Businesses participating
Reactions	Scale	Staff rating of efforts	Contact rating of efforts
KASA[4] change	Total #	Staff using concepts	Contacts using P2 tools
Practices	Total #	Permits w/P2 section	Processes changed
End results	Pounds		Pollution avoided

1. "Natural resources" include ecosystems and the raw materials extracted from them.
2. "Source reduction" means any practice which:
   - Eliminates or reduces the amount or use of hazardous substances, pollutants, or contaminants that enter a wastestream or are released into the environment prior to any recycling, treatment, or disposal; and thereby,
   - Reduces adverse public health and environmental affects associated with their release.
3. Various combinations of indicators will be measured (project dependent) to evaluate the success of each strategy.
4. "KASA change" refers to changes in Knowledge, Attitudes, Skills, and/or Aspirations of target audience.

Pollution Prevention Group, Office of the Director (503) 229-5630

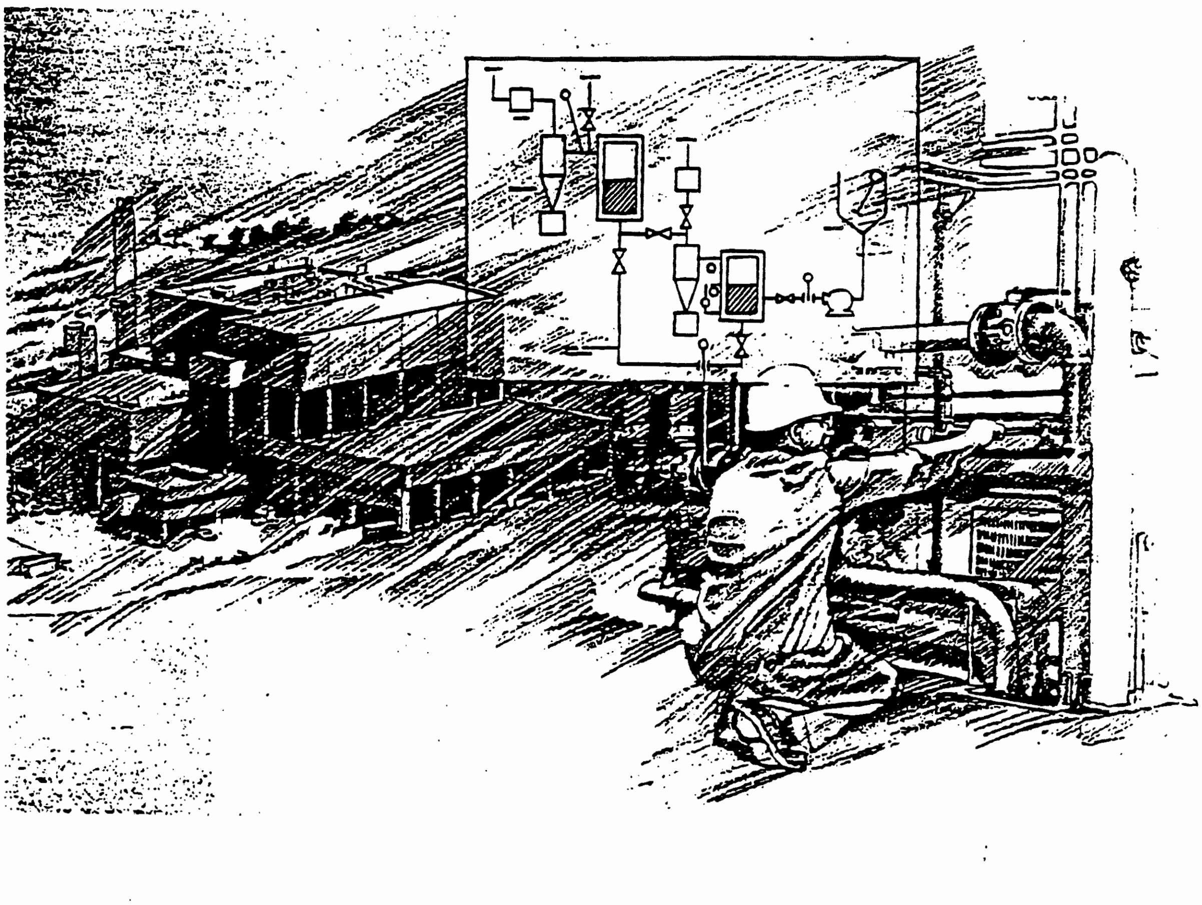
United States
Environmental Protection
Agency

Office of Research and
Development
Washington, DC 20460

EPA/600/R-92/088
May 1992

EPA

Facility Pollution Prevention Guide



Chapter 1
Deciding On Pollution Prevention

Pollution prevention is the use of materials, processes, or practices that reduce or eliminate the creation of pollutants or wastes at the source. It includes practices that reduce the use of hazardous and nonhazardous materials, energy, water, or other resources as well as those that protect natural resources through conservation or more efficient use.

A pollution prevention program addresses all types of waste.

A pollution prevention program is an ongoing, comprehensive examination of the operations at a facility with the goal of minimizing all types of waste products. An effective pollution prevention program will:

- reduce risk of criminal and civil liability
- reduce operating costs
- improve employee morale and participation
- enhance company's image in the community
- protect public health and the environment.

Those companies "struggling to maintain compliance today may not be around by the end of the '90s. Those toeing the compliance line will survive. But those viewing the environment as a strategic issue will be leaders."

— Richard W. MacLean, chief of environmental programs at Arizona Public Service Co., as quoted in Environmental Business Journal, December, 1991.

This *Guide* is intended to assist you in developing a pollution prevention program for your business. It will help you decide which aspects of your operation you should assess and how detailed this assessment should be.

This chapter provides background information on pollution prevention. Specifically, it

- Summarizes the benefits you can obtain from a company-wide pollution prevention program that integrates raw materials, supplies, chemicals, energy, and water use.
- Describes the U.S. EPA's Environmental Management Hierarchy.
- Explains what pollution prevention is and what it is not.
- Provides an overview of federal and state legislation on pollution control.

BENEFITS OF A POLLUTION PREVENTION PROGRAM

In the case of pollution prevention, national environmental goals coincide with industry's economic interests. Businesses have strong incentives to reduce the toxicity and sheer volume of the waste they generate. A company with an effective, ongoing pollution prevention plan may well be the lowest-cost producer and have a significant competitive edge. The cost per unit produced will decrease as pollution prevention measures lower liability risk and operating costs. The company's public image will also be enhanced.

Reduced Risk of Liability

You will decrease your risk of both civil and criminal liability by reducing the volume and the potential toxicity of the vapor, liquid, and solid discharges you generate. You should look at all types of waste, not just those that are currently defined as hazardous. Since toxicity definitions and regulations change, reducing the volume of wastes in all categories is a sound long-term management policy.

"Above all, companies want to pin down risk... Because the costs can be so enormous, risk must now be taken into account across a wide range of business decisions."

— Bill Schwalm, senior manager for environmental programs and manufacturing at Polaroid, in an interview with Environmental Business Journal, December, 1991.

Environmental regulations at the federal and state levels require that facilities document the pollution prevention and recycling measures they employ for wastes defined as hazardous. Companies that produce excessive waste risk heavy fines, and their managers may be subject to fines and imprisonment if potential pollutants are mismanaged.

Civil liability is increased by generating hazardous waste and other potential pollutants. Waste handling affects public health and property values in the communities surrounding production and disposal sites. Even materials not currently covered by hazardous waste regulations may present a risk of civil litigation in the future.

Workers' compensation costs and risks are directly related to the volume of hazardous materials produced. Again, it is unwise to confine your attention to those materials specifically defined as hazardous.

Look beyond the wastes currently defined as hazardous.

Reduced Operating Costs

An effective pollution prevention program can yield cost savings that will more than offset program development and implementation costs. Cost reductions may be immediate savings that appear directly on the balance sheet or anticipated savings based on avoiding potential future costs. Cost savings are particularly noticeable when the costs resulting from the treatment, storage, or disposal of wastes are allocated to the production unit, product, or service that produces the waste. Refer to Chapter 6 for more information on allocating costs.

A comprehensive pollution prevention program can reduce current and future operating costs.

Materials costs can be reduced by adopting production and packaging procedures that consume fewer resources, thereby creating less waste. As wastes are reduced, the percentage of raw materials converted to finished products increases, with a proportional decrease in materials costs.

Waste management and disposal costs are an obvious and readily measured potential savings to be realized from pollution prevention. Federal and state regulations mandate special in-plant handling procedures and specific treatment and disposal methods for toxic wastes. The costs of complying with these requirements and reporting on waste disposition are direct costs to businesses. There are also indirect costs, such as higher taxes for such public services as landfill management. The current trend is for these costs to continue to increase at the same or higher rates. Some of these cost savings are summarized in Box 1.

Waste management costs will decrease as pollution prevention measures are implemented:

- Reduced manpower and equipment requirements for on-site pollution control and treatment
- Less waste storage space, freeing more space for production
- Less pretreatment and packaging prior to disposal
- Smaller quantities treated, with possible shift from treatment, storage, and disposal (TSD) facility to non-TSD status
- Less need to transport for disposal
- Lower waste production taxes
- Reduced paperwork and record-keeping requirements, e.g., less Toxic Release Inventory (TRI) reporting when TRI-listed chemicals are eliminated or reduced.

Box 1

Optimizing processes and energy use reduces waste and controls production costs.

Production costs can be reduced through a pollution prevention assessment. When a multi-disciplinary group examines production processes from a fresh perspective, opportunities for increasing efficiency are likely to surface that might not otherwise have been noticed. Production scheduling, material handling, inventory control, and equipment maintenance are all areas that can be optimized to reduce the production of waste of all types and also control the costs of production.

Energy costs will decrease as pollution prevention measures are implemented in various production lines. In addition, energy used to operate the overall facility can be reduced by doing a thorough assessment of how various operations interact. Chapter 8 discusses energy conservation.

Facility cleanup costs may result from a need to comply with future regulations or to prepare a production facility or off-site waste storage or disposal site for sale. These future costs can be minimized by acting now to reduce the amount of wastes of all types that you generate.

Improved Company Image

Corporate image is enhanced by a demonstrated commitment to pollution prevention.

As the quality of the environment becomes an issue of greater importance to society, your company's policy and practices for controlling waste increasingly influence the attitudes of your employees and of the community at large.

Employees are likely to feel more positive toward their company when they believe that management is committed to providing a safe work environment and is acting as a responsible member of the community. By participating in pollution prevention activities, employees can interact positively with each other and with management. Helping to implement and maintain a pollution prevention program should increase their sense of identity with company goals. This positive atmosphere helps to retain a competitive workforce and to attract high-quality new employees.

Community attitudes will be more positive toward companies that operate and publicize a thorough pollution prevention program. Most communities actively resist the siting of new waste disposal facilities in their areas. In addition, they are becoming more conscious of the monetary costs of treatment and disposal. Creating environmentally compatible products and avoiding excessive consumption and discharge of material and energy resources, rather than concentrating solely on treatment and disposal, will greatly enhance your company's image within your community and with potential customers.

"We regard the environment as a long-term strategic set of issues. To have a strong, viable company, the environment has to be taken into account... by planning for [consumer demand for more environmental quality] we will be more competitive in the marketplace."

— Bill Riley, director of Environment—Marketing at Clorox, as quoted in Environmental Business Journal, December, 1991.

Public Health and Environmental Benefits

Reducing production wastes provides upstream benefits because it reduces ecological damage due to raw material extraction and refining operations. Subsequent benefits are the reduced risk of emissions during the production process and during recycling, treatment, and disposal operations.

THE ENVIRONMENTAL MANAGEMENT HIERARCHY

Source reduction and reuse prevent pollution.

The Pollution Prevention Act of 1990 reinforces the U.S. EPA's Environmental Management Options Hierarchy, which is illustrated in Figure 1. The highest priorities are assigned to preventing pollution through source reduction and reuse, or closed-loop recycling.

Preventing or recycling at the source eliminates the need for off-site recycling or treatment and disposal. Elimination of pollutants at or near the source is typically less expensive than collecting, treating, and disposing of wastes. It also presents much less risk to your workers, the community, and the environment.

WHAT IS POLLUTION PREVENTION?

Change products and production processes to reduce pollution at the source.

Pollution prevention is the maximum feasible reduction of all wastes generated at production sites. It involves the judicious use of resources through source reduction, energy efficiency, reuse of input materials during production, and reduced water consumption. There are two general methods of source reduction that can be used in a pollution prevention program: product changes and process changes. They reduce the volume and toxicity of production wastes and of end-products during their life-cycle and at disposal. Figure 2 provides some examples.

Product changes in the composition or use of the intermediate or end products are performed by the manufacturer with the purpose of reducing waste from manufacture, use, or ultimate disposal of the products. Chapter 7 in this *Guide* provides information on designing products and packaging that have minimal environmental impact.

Redesign products to minimize their environmental impact.

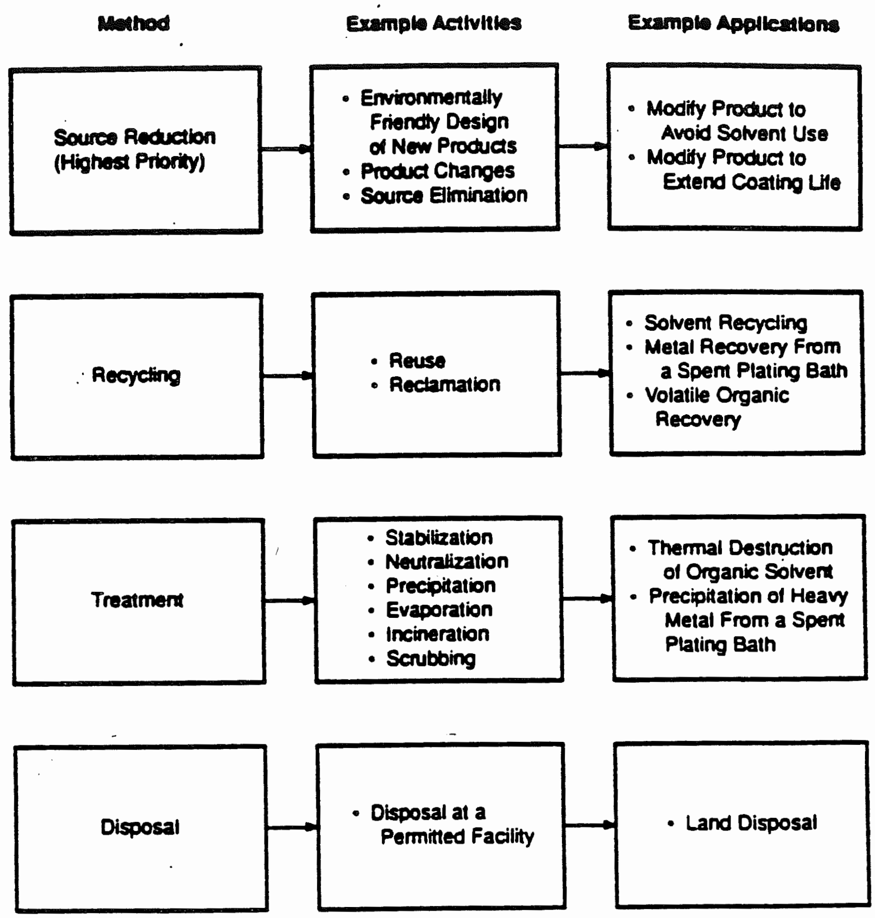


Figure 1: Environmental Management Options Hierarchy

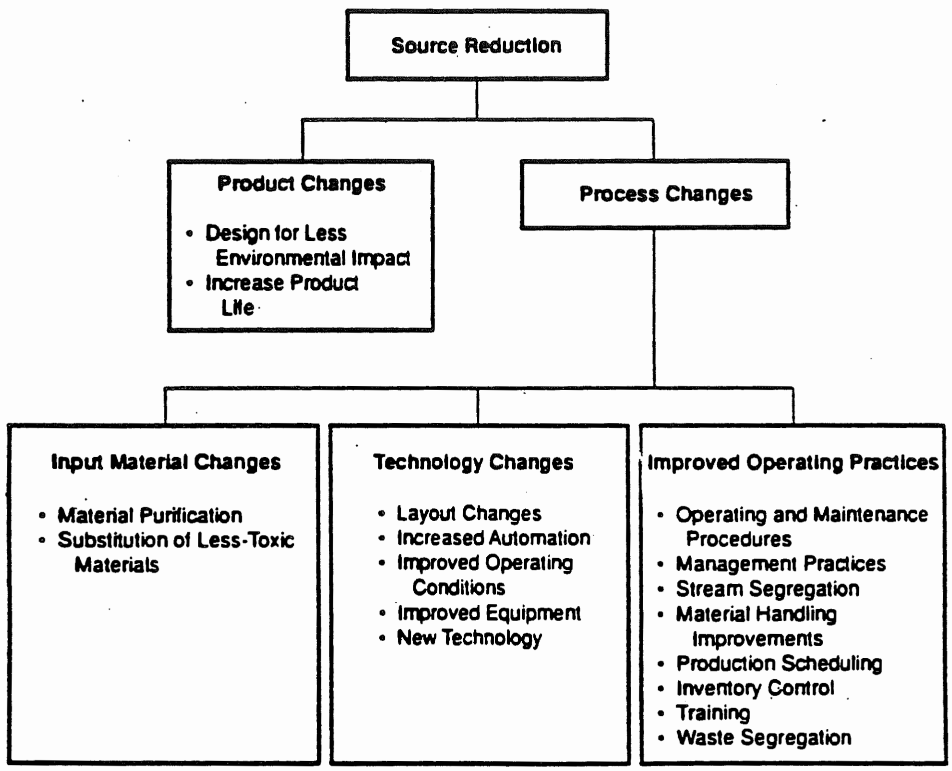


Figure 2. Source Reduction Methods

Process changes are concerned with how the product is made. They include input material changes, technology changes, and improved operating practices. All such changes reduce worker exposure to pollutants during the manufacturing process. Typically, improved operating practices can be implemented more quickly and at less expense than input material and technology changes. Box 2 provides examples of process changes.

Process changes may be implemented more quickly than product changes.

The following process changes are pollution prevention measures because they reduce the amount of waste created during production.

Examples of input material changes:

- Stop using heavy metal pigment.
- Use a less hazardous or toxic solvent for cleaning or as coating.
- Purchase raw materials that are free of trace quantities of hazardous or toxic impurities.

Examples of technology changes:

- Redesign equipment and piping to reduce the volume of material contained, cutting losses during batch or color changes or when equipment is drained for maintenance or cleaning.
- Change to mechanical stripping/cleaning devices to avoid solvent use.
- Change to a powder-coating system.
- Install a hard-piped vapor recovery system to capture and return vaporous emissions.
- Use more efficient motors.
- Install speed control on pump motors to reduce energy consumption.

Examples of improved operating practices:

- Train operators.
- Cover solvent tanks when not in use.
- Segregate waste streams to avoid cross-contaminating hazardous and nonhazardous materials.
- Improve control of operating conditions (e.g., flow rate, temperature, pressure, residence time, stoichiometry).
- Improve maintenance scheduling, record keeping, or procedures to increase efficiency.
- Optimize purchasing and inventory maintenance methods for input materials. Purchasing in quantity can reduce costs and packaging material if care is taken to ensure that materials do not exceed their shelf life. Reevaluate shelf life characteristics to avoid unnecessary disposal of stable items.
- Stop leaks, drips, and spills.
- Turn off electrical equipment such as lights and copiers when not in use.
- Place equipment so as to minimize spills and losses during transport of parts or materials.
- Use drip pans and splash guards.

Box 2

Appendix

G

Sample Letter to Property Owners/Operators & Examples

Re: ________________ WELLHEAD PROTECTION PLAN

Dear Property Owner/Operator:

The community(ies) of ________________ has(have) taken a proactive approach to protecting our valuable drinking water supply by establishing a local wellhead protection plan. A wellhead protection plan is developed by delineating the geographic area where the water supplies originate and protecting that area through our own selected methods. Our local wellhead protection Team worked to develop this plan with involvement from as many local citizens and property owners as possible. We hope you were involved and/or informed of this effort.

The purpose of this letter is to tell you that your property is within the wellhead protection area which contributes groundwater to our drinking water supply. One element of our local wellhead protection plan involves creating more awareness of the need to take precautions to prevent groundwater contamination in this area. We are asking for your commitment to join us in this effort.

> OPTIONAL: An ordinance has been adopted for this wellhead protection area which requires all property owners to employ best management practices.

Or...

> OPTIONAL: We will be relying on voluntary implementation of pollution prevention activities, including the incorporation of best management practices.

We are committed to helping you obtain free information on what can be incorporated into your day-to-day operations to reduce your risk of release of any potential groundwater contaminant. Businesses within our wellhead protection area can begin by reviewing the attached handout (use Table 3-5) which summarizes best management practices that are applicable to most operations. These are basically common sense approaches that are already employed by many businesses in order to reduce their liabilities.

The second attachment to this letter contains some resources available to help you with your pollution prevention efforts (use info from Appendix F). We have also enclosed some information on Oregon DEQ's Waste Reduction Assistance Program, where you can obtain on-site technical assistance, free training workshops, and access to an information clearinghouse on waste reduction. We encourage all property owners within our wellhead protection area to contact one or more of these resources to get more information on best management practices specific to your type of operation.

If you have any questions about wellhead protection, please feel free to call ____________________. Thank you in advance for your participation in this important community effort. It is critical to the protection of our drinking water supply.

Sincerely,

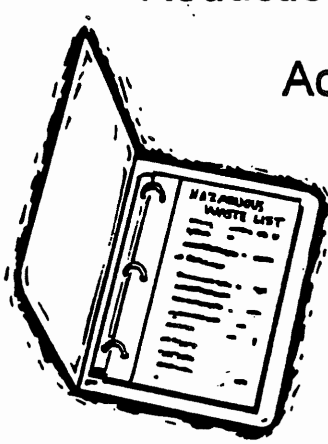
________________________________ (list of Team members)

Oregon Waste Reduction Assistance Program

FOR TOXIC SUBSTANCES AND HAZARDOUS WASTES

F A C T S H E E T

Oregon's Toxics Use Reduction & Hazardous Waste Reduction Act



A Broader View

Oregon's landmark Toxics Use Reduction and Hazardous Waste Reduction Act of 1989 contained in *Oregon Revised Statutes* (ORS 465-003 through 037), was one of the first laws in the nation to mandate pollution prevention planning. The Act takes a comprehensive approach addressing chemical usage from start to finish. The law was designed to achieve facility-wide changes that reduce, avoid or eliminate the use of toxic substances and generation of hazardous wastes by requiring affected parties to develop reduction plans and to monitor their progress on an ongoing basis. Long-term implementation of the law is expected to lower industrial costs and liabilities, and to benefit public health, safety, and the environment.

Who Is Affected?

Three groups of toxics users are affected by this Act:

- *Large users* – users of toxic chemicals who are required to report under SARA Title III, Section 313 (the Federal Community Right-to-Know program);
- *Large quantity hazardous waste generators*–persons who generate more than 2,200 pounds of hazardous waste per month, or more than 2.2 pounds of acutely hazardous waste per month; and
- *Small quantity hazardous waste generators*–persons who generate between 220 and 2,200 pounds of hazardous waste per month.

Conditionally-exempt generators of hazardous waste (persons who generate less than 220 pounds of hazardous waste per month or less than 2.2 pounds of acutely hazardous waste) are not required to develop reduction plans, although they may obtain technical assistance from DEQ.

Department of Environmental Quality • 811 S.W. 6th Avenue • Portland, Oregon 97204 • (503) 229-5913

What Is Required?

Affected facilities in Oregon are required to develop plans to reduce toxic chemical use and hazardous waste generated. The plans must cover a five year minimum and ten year maximum period and contain:

- A written policy of management commitment;
- A written statement of plan goals, scope and objectives;
- Measurable and quantitative performance goals;
- Identification and evaluation of toxic substances and hazardous wastes;
- Identification of reduction options, associated costs and an implementation plan;
- An employee training program; and
- An ongoing reduction program.

The law also requires that facilities prepare an Annual Progress Report to update their plans, describe how their plan is being implemented and demonstrate progress towards their goals.

Recognizing that sensitive technical information is crucial to most industries, the law does not consider reduction plans or Annual Progress Reports public information. Therefore, reduction plans and Annual Progress Reports can remain at the facility (unless an organization wishes to submit one).

However, facilities required to develop plans or Annual Progress Reports must submit a Notice of Plan Completion or an Annual Progress Report Summary to the Department of Environmental Quality (DEQ), signed by the owner or senior manager. This information is public.

Important Dates

Notices of Plan Completion and Annual Progress Report Summaries are due each year on September 1.

Compliance

DEQ staff may request to review plans and progress reports. If plans or progress reports are found to be inadequate according to planning guidelines set in *Oregon Administrative Rules* (OAR 340-135-050), and the facility fails to correct identified deficiencies, staff findings will be made public. At that time, DEQ may conduct a public hearing and order that a reduction plan be developed.

Performance Goals

All toxics users must develop numeric performance goals as part of their reduction plans for toxic substances they use in the amounts listed below. In addition, large quantity hazardous waste generators must develop goals for their hazardous wastes representing 10% or more by weight of their total hazardous waste stream.

Performance Goals Required

ALL TOXICS USERS	LARGE QUANTITY GENERATORS ONLY
Each toxic substance used in quantities greater than 10,000 pounds per year.	Toxic substance requirements for all toxics users; and
Each toxic substance used in quantities greater than 1,000 pounds per year that constitutes 10 percent or more of the total toxic substances used.	Each hazardous waste representing 10 percent or more by weight of the total waste stream.

Each performance goal must be stated in percent reduction of pounds for at least a two and five year period. Some facilities additionally develop goals for a ten year period.

Reporting to the Legislature

DEQ reported on implementation of the Act to the 1991 and 1993 Legislatures. Reports included analyses of the program and recommendations for change. To date, more than 1500 facilities have reported successful completion of plans and progress reports.

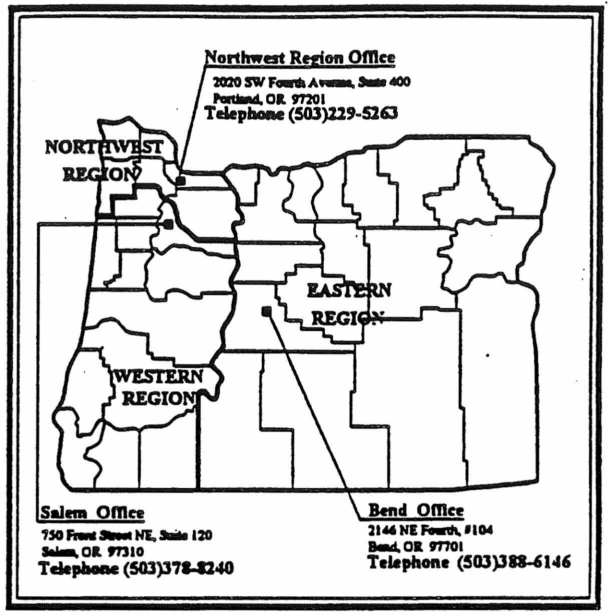
Exemptions

Some hazardous waste generating activities are exempt from Oregon's reduction planning requirements. A plan or Annual Progress Report may not be due if hazardous waste is generated solely or partially as a result of remedial activities taken in response to environmental contamination. In addition, conditionally exempt generators (who are not "Large Users") who become large or small quantity hazardous waste generators due to one time generation events, may be exempt from toxics use reduction and hazardous waste reduction planning requirements.

The guidelines describing these exemptions can be found in *Oregon Administrative Rules (OAR 340-135-040)*. To claim an exemption, please contact the Hazardous Waste Reduction Assistance Program at 811 SW Sixth, Portland OR 97204; phone (503) 229-5913.

Further Information

A planning guide "*Benefitting from Toxic Substance and Hazardous Waste Reduction: A Planning Guide for Oregon Businesses*" is available to help you. For a copy of this document, the Toxics Use Reduction and Hazardous Waste Reduction Act, administrative rules, or more information, contact your nearest DEQ regional office or the Hazardous Waste Reduction Assistance Program at 811 SW Sixth, Portland OR 97204; phone (503) 229-5913.



Oregon Waste Reduction Assistance Program

FOR TOXIC SUBSTANCES AND HAZARDOUS WASTES

Information Clearinghouse

10/94

The Oregon Department of Environmental Quality's Waste Reduction Assistance Program offers various fact sheets, brochures and guidance materials through its Information Clearinghouse.

Please check the box next to the information you wish to receive. If you would like more than one copy, write the number in the left margin next to the box.

Hazardous Waste Generators

- ☐ Small Quantity Hazardous Waste Generator Handbook, How to Reduce, Identify, Store and Dispose of Hazardous Waste in Oregon, 1993
- ☐ Hazardous Waste Determination Handbook, 1993
- ☐ Small Businesses and Hazardous Waste: What You Should Know, A Handbook for People Who Produce Small Amounts of Hazardous Waste (Conditionally Exempt Generators), 1993
- ☐ Notification of Hazardous Waste Activity (Form)
- ☐ Notification of Used Oil activity (only for transporters, collection centers, transfer facilities and processors of off specification used oil.)
- ☐ Annual Hazardous Waste Reporting Form, Forms and Instructions
- ☐ Annual Hazardous Waste Supplemental Reporting Forms
- ☐ Annual Hazardous Waste Reference Guidebook (for Reporting Forms)
- ☐ Hazardous Waste Generator Fee Factsheet, 1992
- ☐ Determining Your Hazardous Waste Generator Category, 1993
- ☐ Managing Sandblast Grit Waste with Tributyltin (TBT), 1993
- ☐ Managing Waste Pesticide Residues and Empty Pesticide Containers for Agricultural and Silvicultural Pest Control Operations. 1994
- ☐ Performance Goals for Toxics Use Reduction and Hazardous Waste Reduction Plans, 1993

Toxics Use and Hazardous Waste Reduction

- ☐ Oregon's Toxic Use Reduction and Hazardous Waste Reduction Act Factsheet, 1992
- ☐ Benefiting from Toxic Substance and Hazardous Waste Reduction: A Planning Guide for Oregon Business, 1993
- ☐ Oregon's Toxic Use Reduction and Hazardous Waste Reduction Plan Progress Report, 1992

Statutes and Regulations Pertaining to Hazardous Waste and Toxics Use Reduction

Oregon Revised Statutes

- ☐ ORS 465, Reduction of Use of Toxic Substances and Hazardous Waste Generation
- ☐ ORS 466, Storage, Treatment and Disposal of Hazardous Waste and PCBs
- ☐ ORS 468, Environmental Quality Generally
- ☐ ORS 468A, The Control of Ozone Depleting Chemicals

Oregon Administrative Rules

- ☐ Division 100 –Hazardous Waste Management System: General
- ☐ Division 101 –Identification and Listing of Hazardous Waste
- ☐ Division 102 –Standards Applicable to Generators of Hazardous Waste
- ☐ Division 103 –Standards Applicable to Transporters of Hazardous Waste by Air or Water
- ☐ Division 104 –Standards for Owners and Operators of Hazardous Waste Treatment, Storage and Disposal Facilities
- ☐ Division 105 –Management Facility Permits
- ☐ Division 106 –Permitting Procedure

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- ☐ Division 108 –Oil and Hazardous Material Spills and Releases
- ☐ Division 109 –Management of Pesticide Wastes
- ☐ Division 110 –Polychlorinated Biphenyls (PCB)
- ☐ Division 111 –Used Oil Management
- ☐ Division 120 –Additional Siting and Permitting Requirements for Hazardous Waste and PCB Treatment and Disposal Facilities
- ☐ Division 135 –Toxics Use Reduction and Hazardous Waste Reduction Regulations
- ☐ **Complete Set- Oregon Rules- Hazardous Waste Toxic Use Reduction Rules, Division 100-120, 1994**
- ☐ **Complete Set- Oregon Rules- Toxics Use Reduction, Division 135, 1994**

Vehicle Maintenance Industry

- ☐ Managing Used Antifreeze Factsheet, 1993
- ☐ Lead-Acid Battery Recycling in Oregon Factsheet, 1991
- ☐ "Model" Toxics Use Reduction Plan for Oregon Automotive Service Industries, 1992
- ☐ "Model" Toxics Use Reduction Plan for Automotive Dealers, 1992
- ☐ New Options for Auto Air Conditioner (A/C) Chlorofluorocarbon (CFC) Recycling, 1992

Used Oil

- ☐ Used Oil Generator Fact Sheet
- ☐ Used Oil Transporter and Collection Facility Factsheet (1994)
- ☐ Used Oil Management Rules (State and Federal), 1994

Other Industry Areas

- ☐ Guidelines for Waste Reduction and Recycling: Solvents, 1989
- ☐ Waste Reduction Guidebook for the Photofinishing Industry, with a Summary of Oregon Hazardous Waste Regulations, 1990
- ☐ Guidelines for Waste Reduction and Recycling: Metal Finishing, Electroplating, Printer Circuit Board Manufacturing, 1989
- ☐ Educational and Vocational Shops Factsheet, 1988
- ☐ Vehicle Maintenance and Repair Factsheet, 1988
- ☐ Laboratories Factsheet, 1988
- ☐ Proposed Federal Rules for toxics air emissions from halogenated solvent cleaning/degreasing (Final rule due November 1994.)
- ☐ Proposed Federal Rules for chromium emissions from hard and decorative chromium electroplating and chromium anodizing tanks (Final rule due November 1994.)
- ☐ Federal Regulations to Control Emissions of Perchloroethylene from Dry Cleaning Facilities, 1994
- ☐ Environmental Handbook for Oregon Construction Contractors: Regulatory Guidance, 1994
- ☐ Environmental Handbook for Oregon Construction Contractors: Best Pollution Prevention Practices. 1994
- ☐ Hazardous Waste Management for the Printing Industry, 1994

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STAMP

Waste Reduction Assistance Program
For Toxic Substances and Hazardous Waste
Information Clearinghouse
DEQ
811 SW Sixth Avenue
Portland, Oregon 97204-1390

POLLUTION PREVENTION

Pollution prevention means not creating pollution in the first place. Instead of having to control, recycle or manage pollution after it's generated, companies and their employees seek ways to avoid creating it.

What kinds of pollution can be prevented?

Pollution is created by many activities including land development, extraction of resources, manufacture and use of raw materials, transportation, energy use, commercial/industrial operations, and product use. Pollutants whose creation may be prevented include:

- Solid waste (boxes, paper, cans, etc)
- Hazardous waste
- Emissions including fugitive/evaporative losses
- Water discharges, including impacted storm or groundwater
- Spills, leaks, and releases
- Obsolete inventory and unused materials
- Scrap, offspec products, production by products
- Energy waste
- Other materials or activities that can result in environmental degradation

How can pollution be prevented?

Pollution prevention is any activity that avoids, eliminates or reduces the creation of pollutants or other environmental impacts. It is accomplished by:

- Protecting natural resources thru conservation or improved management practices.
- Increased efficiency in the use of raw materials, energy, water, or other resources.
- Any other practices that reduce or eliminate the creation of pollutants at the source including process or equipment modifications, improved housekeeping, product redesign or reformulations, raw material substitutions, etc.

BENEFITS OF PREVENTION

Pollution prevention is the most effective strategy in helping businesses meet or exceed environmental regulations, improve working conditions, eliminate burdensome paperwork and fees, reduce future liabilities, and even *increase* profits. A company can expect the following benefits if pollution prevention is an integral part of its business plan:

- **Reduced operating costs:**
  - Improved efficiency and cost savings in energy, raw material, and other resource use
  - Reduced treatment & disposal requirements
  - Less pollution control equipment needed
- **Reduced compliance costs:**
  - Less regulatory paperwork & fewer permits
  - Lower waste disposal and discharge fees
  - Lower monitoring requirements and costs
  - Fewer training & planning requirements
- **Increased productivity:**
  - Improved process efficiency & control
  - Fewer unnecessary or redundant processes
  - Improved equipment maintenance
  - Elimination of avoidable process losses
- **Reduced liability:**
  - Reduced worker/public exposure risks
  - Reduced risk of releases, spills, cleanup
  - Reduced "cradle-to-grave" liability
  - Reduced risk of criminal liability & fines
- **Improved working conditions:**
  - Reduced worker exposure to toxic materials
  - Fewer personal protection requirements
- **Improved company image:**
  - Worker satisfaction - doing the right thing
  - Reduced public and employee concern

deq Pollution Prevention Group
1-800-452-4011

COMMON P2 OPPORTUNITIES

The common, relatively simple activities listed below often result in decreased pollution or waste generation and savings in material costs.

HOUSEKEEPING

Good housekeeping practices such as keeping aisles clear, keeping containers closed while not in use, and replacing manual transfer operations with pumps or spigots can reduce spills, leaks and other causes for wasted materials.

MAINTENANCE

Properly maintaining equipment can reduce waste from leaks or equipment breakdowns during production runs. Good maintenance programs may include regular equipment inspection, changing worn out parts, regularly replacing seals and gaskets, repairing leaks as they occur, and following the manufacturer's suggested maintenance schedules.

INVENTORY CONTROL

Good purchasing practices and inventory control including elements listed below can reduce waste of unused materials. Buy only the quantity needed to reduce excess. Don't accept free samples that may not be used. Track inventory. Use older materials first to avoid outdated materials or materials with expired shelf life.

ADDITIONAL P2 OPPORTUNITIES

Additional opportunities for pollution prevention exist wherever raw materials are used or waste, emissions, or discharges are generated. These opportunities may be identified through an assessment of current operations. Once opportunities have been identified, a systematic evaluation of available options may reveal pollution prevention alternatives. Alternatives include changing processes, equipment modifications, raw material substitutions, or product reformulations.

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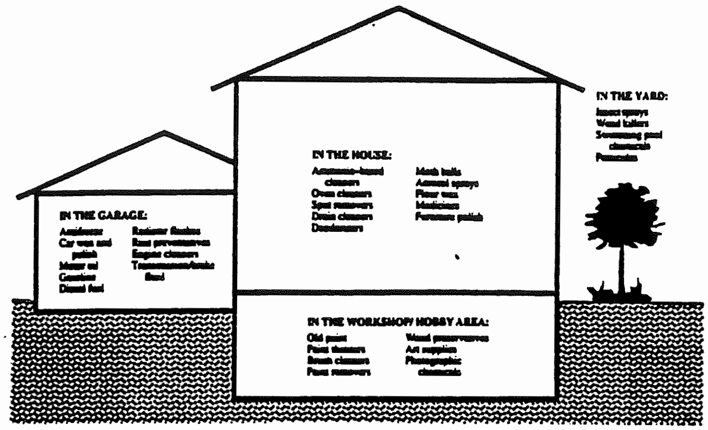
Appendix

H

Household Hazardous Waste Fact Sheet

Household Hazardous Waste



Why is it a Problem?

Many products found in your home can pose a health or environmental hazard if you don't dispose of them properly. Anything labeled as toxic, flammable, corrosive, reactive, infectious, or radioactive can threaten family health and safety.

According to national estimates, each home contains from three to eight gallons of hazardous materials in kitchens, bathrooms, garages and basements.

Throwing them in the garbage can threaten sanitation workers, who can be injured or poisoned by acids, fires, and explosions.

Hazardous wastes that reach our landfills can leach into the soil, polluting water and threatening all living things.

Substances poured into Oregon's household drains and toilets go into the sewage treatment process, eventually impacting fish and wildlife. Substances poured onto soil or street or into storm drains are carried to our streams. As little as one pint of solvent can cause measurable fish kills.

How to Minimize Hazardous Waste in Your Home

- Use safer alternatives.
- Read labels before purchasing. Watch for the words "caution," "warning," and "danger." Follow label directions.
- Buy only what you need and will use up.
- If you do have products left over, give them to friends, neighbors, or charitable institutions to use up.

Handle Hazardous Waste the Recommended Way

Watch For Household Hazardous Waste Collection Days.

Your community may be among those holding Household Hazardous Waste Collection Events, where residents can bring unused and unwanted hazardous substances to a central location for proper sorting and disposal by local officials and hazardous waste collectors.

Until then, there are things you can do:

- Keep containers upright, tightly closed, and with labels intact.
- Keep unused portions and empty containers. (Check labels to see if an empty container can be triple-rinsed and safely discarded in your household garbage.)
- Never mix substances or pour into other containers.
- Avoid burning or reusing empty containers.
- Keep out of reach of children, pets and wildlife.

What Should You Know about Hazardous Waste?

Many home and garden products contain potentially dangerous chemicals. They may cause injury to living things or damage the environment if not used and disposed of safely.

If Something Spills...

...your first concern must be for your own safety. If you have been exposed to toxic materials, call the Oregon Poison Control Center at 1-800-452-7165. (In the Portland area, call 494-8968.) For medical emergencies or large spills, call 911 or your fire department.

- Read the product label for exposure and spill information.
- Keep the area well-ventilated.
- Keep children and pets away.
- Wear gloves and protective clothing.
- Contain and cover the spill with absorbent material like cat litter, clay, or sand.
- Sweep and scoop the material into a container with a lid or doubled plastic bags. Secure well.
- Finally, wash the surface well with soap and water.

CHEMICAL HAZARDS IN THE HOME

If you use household products, there probably is hazardous waste around your home. This guide will tell you where that waste is. What it is. And how to properly use it and safely dispose of it.

One note: A quick way to identify a hazardous household product is to check the label. If the words *flammable*, *caustic*, *corrosive*, *caution*, *danger*, *warning*, or *poison* appear anywhere on the label, be careful! Read all the instructions for proper handling.

Another note: Disposal methods recommended in this brochure are for household quantities only.

	Kitchen
♦	Aluminum cleaners
♦	Ammonia-based cleaners
★	Bug sprays
♦	Drain cleaners
★	Floor care products
★	Furniture polish
★	Metal polish
★	Window cleaners
★	Oven cleaners (lye base)

	Workshop
★	Paint brush cleaners with solvent
★	Paint brush cleaners with TSP
★	Cutting oils
★	Glue (solvent base)
♦	Glue (water base)
●	Paint - without mercury or lead (dry out first)
○★	Paint - all others
★	Paint thinners and strippers
★	Paint strippers (lye base)
★	Primers
★	Rust removers
★	Turpentine
★	Varnish
★	Wood preservatives

	Bathroom
♦	Alcohol-based lotions (aftershaves, perfumes, etc.)
♦	Bathroom cleaners
♦	Depilatories
♦	Disinfectants
♦	Permanent lotions
♦	Hair relaxers
♦	Medicine (expired)
○	Nail polish
★	Nail polish remover
♦	Toilet bowl cleaners
♦	Tub and tile cleaners

	Garage
★	Antifreeze
★	Automatic transmission fluid
●	Auto body repair products
★	Battery acid (or battery)
★	Brake fluid
★	Car wax with solvent
★	Diesel fuel
★	Fuel oils
★	Gasoline
★	Kerosene
★	Metal polish with solvent
■	Motor oil
★	Other oils
♦	Windshield wiper solution

	Miscellaneous
	Ammunition (call local police or fire department)
★	Artists' paints, mediums
★	Aerosol cans
★	Fiberglass epoxy
★	Gun cleaning solvents
★	Lighter fluid
★	Mercury batteries
★	Moth balls
●	Smoke detectors
★	Photographic chemicals (unmixed)
♦	Photographic chemicals (mixed and properly diluted)
●	Shoe polish
★	Swimming pool/spa chemicals

	The Garden
★	Herbicides (weed killers)
★	Insecticides (bug killers)
★	Fungicides
★	Rodenticides (i.e., rat poison)
★	Fertilizers or "Weed & Feed"

LEGEND:

- ♦ Flush down drain with lots of water (unless you have a septic tank then follow ★).
- ● Place in trash.
- ■ Recycle
- ○ Use, or give to someone who can.
- ★ Give to household hazardous waste collection site.

For more information, call your garbage hauler, your local government solid waste department, or the Oregon Department of Environmental Quality at 229-5913 or toll-free 1-800-452-4011. If you live in the Portland area, call Metro, 224-5555. Ask for "household hazardous waste" information.

Appendix

I

EXAMPLE CONTINGENCY PLAN RESPONSE

APPENDIX

I

Example Contingency Plan Response

The Lazy Dell Community Water System

The (fictious) Lazy Dell community water system, located along the I-5 corridor in the Willamette Valley consists of two untreated supply wells, two miles of distribution, a 100,000 gallon storage tank and serves 80 residences, a grocery store, a small plant nursery and a medical clinic with a combined population of 300. Well #1 is located approximately 50 ft west of I-5, is 75 feet deep and draws water from an unconfined aquifer. Well #2 is located 200 ft east of I-5, is 210 feet deep and draws water from a confined aquifer. The two wells are joined by a common supply line that empties into the storage tank. Each well can be isolated or operated in tandem on demand by float switches located in the storage tank. Well #1 is the major producer of the two wells.

In anticipation of a contamination incident the Lazy Dell Water System had developed a contingency plan under their Wellhead Protection Plan that provided them with a reliable means to identify and respond to any real or potential disruption of water flow to their users. Since their program required them to delineate a well head protection area for each well the system knew in which locations their wells would be most vulnerable to a contamination episode.

During the development of their contingency plan, the system identified all the possible threats that might impact the flow of water to their users. Each possible threat was prioritized and scenarios developed on how they might occur and how the system would respond. As it turned out, the most likely scenario was contamination of well #1 by a highway accident that caused spilled chemicals to reach the vulnerable recharge area of this well.

Another very important component of the contingency plan was to have in place a notification protocol tied in with the local emergency response system for the county. During the development of this protocol, the water system thoroughly researched the existing local emergency notification and response network and determined how they could incorporate their vulnerable well head protection areas and personnel into it. In the county in which the water system was located, the emergency response coordinator (ERC) was a deputy with the Sheriff's office. The water system provided pertinent information in writing to the ERC regarding the location of vulnerable areas and a notification roster of key personnel designated to respond on behalf of the water system. The ERC incorporated this information into the local emergency response system. It was determined that if any reported spills were to happen along a defined area of I-5 that the water system would be notified so it could take appropriate actions. Together it was decided that the ERC would have the 911 dispatcher contact key County Health Department and Lazy Dell Water System personnel when spills were reported near the designated vulnerable areas.

Since the Lazy Dell Water System has diverse water needs, the contingency planners also prioritized the residential, commercial and emergency water needs of the system to insure that water needs could be met during a crisis. They decided that in addition to the 100,000 gallon storage tank that provides a 3 day reserve for the entire system, the medical clinic should have additional on-site storage to supplement the main water reserves and convinced the owner to add a 5,000 gallon tank to the facility.

In anticipation of short-term/long-term substitution or replacement of the water supplies, the planners investigated the logistics of purchasing and distributing bottled water, hauling water in a local dairy truck to refill their main reservoir or to fill water stations in and around the community, utilizing National Guard water haulers, tying into a nearby city water system, and the development of a new water source. For the short-term solution the planners found it most feasible to arrange with a local dairy to haul water to select water stations. With an ample water supply and the addition of a short supply line, the planners were able to make arrangements with the nearby city to tie in to their system for a long-term solution, if needed.

During the development of their Wellhead Protection Plan, the water system planners determined that some select water system improvements might be a good way to reduce or eliminate certain threats to vulnerable portions of their system, so they decided to investigate any and all financial resources available to them. The targeted improvements included creating a tie-in with the neighboring city and/or the development of a less vulnerable well. The water system planners visited the county land use planning department to learn what restrictions there might be and what support the county might provide related to these improvements. Then they investigated programs sponsored by the Oregon Economic Development Department (OEDD) including the Community Block Development Grant and Water/Wastewater Financial Programs, the Federal Rural Economic and Community Development Program (Farmer's Home) as well as the feasibility of creating special water system funds and increasing water use charges to their consumers.

The planners also learned that in order to have the support of the water system users they needed to encourage user participation in the plan development process and develop educational materials to help them understand the concepts related to the process. To that end, additional members representing varied interests in the community were recruited to the water board and a newsletter was developed for public dissemination. It was decided that the newsletter would focus on several related topics including water conservation under normal and emergency conditions, groundwater hydrogeology, groundwater contamination, cross connections and water system design and operation, to name a few. The board agreed to perform mock emergency exercises relating to the different scenarios developed under the contingency plan twice a year and to test, review and update all procedures as needed. Most importantly they made provision for continuing education and training for key personnel to make sure that everyone involved was current on contingency planning concepts, the specifics of the Lazy Dell Water System and local emergency response network in the community.

The incident occurred on a foggy morning when a southbound fuel tanker jackknifed on Interstate I-5 spilling 1,000 gallons of gasoline onto the road and adjacent agricultural land on the west side of I-5. As a result of the accident, the spilled fuel was ignited and the roadside and adjacent field were engulfed in flames. The gasoline spill flooded an area adjacent to the delineated well head protection area for Well #1.

The accident was called in by a State Patrol officer and reported to the Oregon Emergency Response System (OERS) through the county emergency response coordinator. OERS notified DEQ and the Oregon Health Division and the county 911 dispatcher notified the County Environmental Health Department and the emergency response designee for the Lazy Dell Water System. The local responding fire department was informed that the spill location was in a vulnerable well head protection area and advised not to apply water to the the fire, if possible, but to allow the gasoline to burn out or use retardant foam. The Lazy Dell Water system immediately took well #1 off line to reduce the chance of drawing the contamination toward the well. Since there were no residences or other structures in the immediate area, the fire department allowed the fire to burn out on its own in the field. The water system set up a sampling plan to monitor for gasoline components and the well was reactivated a few days later.

This scenario demonstrates how a unified and well coordinated contingency plan should operate. It should be planned, documented and tested. The contingency plan should include all the essential elements discussed in Section 3-6 of this manual.

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