






**Layman's Guide  
to Kansas'  
Water  
Terminology  
&  
Acronyms**

**Created through the  
Kansas Environmental Leadership Program,  
Class Five, 2004.**

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We hope that you find this a helpful resource  
in learning and refreshing your knowledge  
of Kansas' water issues.

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who contributed time and efforts to complete this booklet .



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Improving water quality in Kansas  
is the responsibility of all Kansas citizens.

Not everyone has been trained to understand the complex language of  
water resource management. This book was produced to help those  
working to improve water quality as volunteers, educators, natural  
resource managers, and laborers to better communicate amongst  
ourselves and our communities about the increasingly complex issues  
of water quality in Kansas.

You can download a copy of this booklet or find links to the booklet at  
the following websites:  
<http://www.kwo.org>  
<http://www.hwqp.org>  
<http://www.kdhe.state.ks.us>  
<http://www.kacee.org>

# Acronyms

<b>319</b>	Section 319 in the Clean Water Act
<b>303d Listed Waters</b>	Water that doesn't meet EPA water quality standards.
<b>501c3</b>	Non-Profit Status and Tax Exempt
<b>AFO</b>	Animal Feeding Operation
<b>BAC</b>	Basin Advisory Committee
<b>BAT</b>	Best Available Technology
<b>BER</b>	Bureau of Environmental Remediation <i>KDHE</i>
<b>BMP</b>	Best Management Practice
<b>BOD</b>	Biochemical Oxygen Demand
<b>BOW</b>	Bureau of Water <i>KDHE</i>
<b>BWM</b>	Bureau of Waste Management <i>KDHE</i>
<b>CAFO</b>	Confined Animal Feeding Operation
<b>CCD</b>	County Conservation District
<b>CCRP</b>	Continuous Conservation Reserve Program
<b>CERCLA</b>	Comprehensive Environmental Response, Compensation and Liability Act <i>Super Fund</i>
<b>CFS</b>	Cubic Feet per Second
<b>CNMP</b>	Certified Nutrient Management Plan
<b>CRP</b>	Conservation Reserve Program
<b>CWA</b>	Clean Water Act <i>EPA</i>
<b>CWN</b>	Clean Water Neighbor
<b>DBP</b>	Disinfection By Products
<b>DO</b>	Dissolved Oxygen
<b>DOE</b>	Division of Environment
<b>DWR</b>	Division of Water Resources <i>KS Dept. of Agriculture</i>
<b>EE</b>	Environmental Education
<b>EPA</b>	United States Environmental Protection Agency
<b>EQIP</b>	Environmental Quality Incentive Program
<b>ET</b>	Evapotranspiration
<b>FWP</b>	Federal Wildlife Program
<b>GPM</b>	Gallons Per Minute
<b>GMD</b>	Ground Water Management District
<b>GWA</b>	Ground Water Association
<b>HDPE</b>	High Density Polyethylene

<b>HUC</b>	Hydrologic Unit Code
<b>IGUCA</b>	Intensive Groundwater Use Control Area
<b>KACEE</b>	Kansas Association of Conservation and Environmental Education
<b>KANSCHED</b>	Kansas Schedule
<b>KAWS</b>	Kansas Alliance of Wetlands and Streams
<b>KBS</b>	Kansas Biological Survey
<b>KCW</b>	Kansas Clean Waters
<b>KDA</b>	Kansas Department of Agriculture
<b>KDHE</b>	Kansas Department of Health and Environment
<b>KDWP</b>	Kansas Department of Wildlife and Parks
<b>KRWA</b>	Kansas Rural Water Association
<b>KEHA</b>	Kansas Environmental Health Association
<b>KELP</b>	Kansas Environmental Leadership Program
<b>KFS</b>	Kansas Forest Service
<b>KGS</b>	Kansas Geological Survey
<b>KLA</b>	Kansas Livestock Association
<b>KLES</b>	Kansas Livestock Environmental Stewardship
<b>KVHA</b>	Kaw Valley Heritage Alliance
<b>KWA</b>	Kansas Water Authority
<b>KWO</b>	Kansas Water Office
<b>LEPP</b>	Local Environmental Protection Program
<b>MAP</b>	Midwest Assistance Program
<b>MCL</b>	Maximum Contaminant Level
<b>MCLG</b>	Maximum Contaminant Level Goal
<b>MDS</b>	Minimum Desirable Streamflow
<b>NIPDWR</b>	National Interim Primary Drinking Water Regulation
<b>NPDES</b>	National Pollutant Discharge Elimination System
<b>NPL</b>	National Priorities List <i>Super Fund</i>
<b>NPS</b>	Non Point Source <i>pollution</i>
<b>NRCS</b>	Natural Resources Conservation Service
<b>NSA</b>	National Statistical Assessment <i>rural water conditions</i>
<b>NTU</b>	Nephelometric Turbidity Unit
<b>NWRI</b>	National Water Research Institute
<b>NWSIA</b>	National Water Supply Improvement Association
<b>O&amp;M</b>	Operations and Maintenance

<b>OM&amp;R</b>	Operation, Maintenance and Repair
<b>OSW</b>	Office of Saline Water <i>Federal– abolished in 1974</i>
<b>OTA</b>	Office of Technology Assessment <i>Federal– abolished in 1995</i>
<b>PET</b>	Polyethylene Terephthalate
<b>pH</b>	A measure of acidity and alkalinity of a solution that is a number on a scale on which a value of 7 represents neutrality, lower numbers indicate increasing acidity. Each unit of change represent a tenfold change in acidity or alkalinity and is the negative logarithm of the effective hydrogen-ion concentration or hydrogen-ion activity in gram equivalents per liter of the solution.
<b>PIP</b>	Project Implementation Plan
<b>POU</b>	Point of Use (water treatment for home use)
<b>PLHIP</b>	Playa Lakes Habitat Improvement Program
<b>PWS</b>	Public Water Supply
<b>R&amp;D</b>	Research and Development
<b>RC&amp;D</b>	Resource Conservation and Development
<b>RCRA</b>	Resource Conservation and Recovery Act <i>Federal</i>
<b>RO</b>	Reverse Osmosis
<b>SCC</b>	State Conservation Commission
<b>SDWA</b>	Safe Drinking Water Act
<b>STORET</b>	Storage and Retrieval of Water Quality Data (EPA)
<b>TCE</b>	Tri-chloro-ethylene
<b>TDS</b>	Total Dissolved Solids
<b>THM</b>	Trihalomethanes
<b>TMDL</b>	Total Maximum Daily Load
<b>TSS</b>	Total Suspended Solids
<b>USDA</b>	United States Department of Agriculture
<b>USGS</b>	United States Geological Survey
<b>VOC</b>	Volatile Organic Compounds <i>found in water</i>
<b>WER</b>	Water Effect Ratio
<b>WHIP</b>	Wildlife Habitat Incentive Program
<b>WIG</b>	Watershed Initiative Grant
<b>WISP</b>	Water Issue Strategy Plan
<b>WIST</b>	Water Issues Strategy Team
<b>WRAPS</b>	Watershed Restoration And Protection Strategy
<b>WRP</b>	Wetlands Reserve Program



# Vocabulary

<b>Acre-Foot</b>	The amount of water needed to cover one acre of land with one foot of water. Used for water appropriation applications. = 325,829 gallons.
<b>Adjudication</b>	A hearing and settlement by judicial procedure: in the case of water rights, the action of settling claims relating to use of water on a particular stream system or groundwater basin.
<b>Aerobic</b>	Living or occurring only in the presence of oxygen; aerobic bacteria.
<b>Aeration</b>	A water treatment process that mixes water with air. A chamber or tower filled with packing material disperses the water as it flows.
<b>Air Gap Separation</b>	A physical separation between the free flowing discharge end of a potable water supply pipeline and the overflow rim of an open or non pressure receiving vessel, used to prevent backflow in a water distribution system.
<b>Algae</b>	Refers to several groups of simple photosynthetic plants, mostly microscopic, lacking roots, stems and leaves. Many species exist as single cells; others exist in colonies such as seaweed.
<b>Algae Bloom</b>	Rapid growth of algae on lakes, streams or ponds; stimulated by nutrient enrichment. Frequently causes taste and odor problems in the water when the organisms die.
<b>Allocation</b>	To set apart for a particular purpose.
<b>Alkaline</b>	The presence of alkalis in water or soil in the amounts sufficient to raise the pH value above 7.0.
<b>Alluvial</b>	Pertaining to, contained in, or composed of, alluvium; relating to the deposits made by flowing water; washed away from one place and deposited in another; as alluvial soil, mud, accumulations, and deposits.

<b>Alum</b>	Common name for commercial grade Aluminum Sulfate Al <sub>2</sub> (SO <sub>4</sub> ) <sub>3</sub> used in water purification to form floc.
<b>Aluminum</b>	Aluminum is a lightweight, silver-white, metallic element that makes up approximately 7 percent of the Earth's crust.
<b>Anabaena</b>	A species of blue-green algae which is common in lakes and reservoirs with enhanced nutrient concentrations. The presence of Anabaena in a water body often contributes to poor water quality because it can impart noxious odors and disagreeable tastes to the water.
<b>Anaerobic</b>	Living or occurring where there is no air or free oxygen.
<b>Annular Spaces</b>	Opening between the bore hole and casing of a well.
<b>Aphanizomenon</b>	A species of blue-green algae which is often a nuisance in water supplies. It resembles lawn mower clippings and floats in dense mats at the surface of the water.
<b>Appropriate</b>	Authorization of use for a specific quantity of water to an individual, municipality, or industry. Authorization is granted through the Division of Water Resources.
<b>Appropriation</b>	The right to use water for a beneficial use or the acquisition of such a right gained through the process of diverting surface or ground water and putting it to a beneficial use.
<b>Aquifer</b>	A permeable under ground geological formation capable of yielding quantities of ground water to wells and springs.
<b>Aquifer Recharge</b>	The refilling of an underground bed or layer yielding ground water for wells and springs, etc.
<b>Artesian</b>	Rising to the surface under internal hydrostatic pressure; "an artesian well;" "artesian pressure."

<b>Atmospheric Vacuum Breaker</b>	A type of device used to prevent backflow in a water distribution system that allows air to enter the water line when the line pressure is reduced to a gauge pressure of zero or below.
<b>Backflow</b>	Water of questionable quality that flows back to the distribution system. It is sometimes caused by a water system pressure loss .
<b>Bacteria</b>	Prokaryotic unicellular round, spiral or rod-shaped single-celled microorganisms that are often aggregated into colonies that live in soil, water, organic matter, or plants' and animals' bodies .
<b>Bailer</b>	A section of pipe with a check valve at the bottom, used to remove water and crushed soil material accumulated during the process of drilling a well using the cable tool method.
<b>Base flow</b>	Stream flow coming from groundwater seepage into a stream.
<b>Basin</b>	A physiographic region bounded by a drainage divide; consists of a drainage system comprised of streams and often natural or man-made lakes. <i>Also called drainage basin or watershed. Kansas has 12 basins.</i>
<b>Basin Advisory Committee</b>	Citizen or watershed professionals who provide advice or water resources in their basin to the Kansas Water Office and others.
<b>Best Available Technology (BAT)</b>	The current technology available to detect and treat the contaminant of concern.
<b>Benthic Organism</b>	Organisms which live on the bottom of a lake, river, stream, or ocean, such as clams or caddis fly larvae.
<b>Bioaccumulation</b>	The accumulation in animals tissues of non-biodegradable by nature substances and are magnified or accumulated with each level of the food chain.
<b>Biochemical Oxygen Demand (BOD)</b>	A measure of the amount of oxygen removed from aquatic environments by aerobic microorganisms for their metabolic requirements. BOD measurements are used to determine a stream or lake the organic pollution level.

<b>Biodegradable</b>	A product which can be broken down in the environment by microorganisms.
<b>Biological Characteristics</b>	A characteristic of water defined by the levels of bacteria, viruses, and microscopic animals present.
<b>Biota</b>	All the plant and animal life of a particular region.
<b>Black Water</b>	Wastewater from toilets containing high levels of human fecal matter or urine.
<b>Blue Stone</b>	<i>See Copper Sulfate.</i>
<b>Blow-Off Hydrant</b>	A hydrant used to flush the water main. <i>Also called flushing hydrants.</i>
<b>Bore Hole</b>	A hole drilled in the ground usually in search of water or oil.
<b>Bowl Assemblies</b>	Found in vertical turbine well pumps, used to house the impellers, which spin to push water to the surface through the well column.
<b>Carbon Filtering</b>	An organic treatment technology used to remove VOCs in water.
<b>Casing</b>	Lengths of pipe welded or coupled together in a well to form a continuous casing from the surface to the aquifer.
<b>Check Valve</b>	Device that allows liquids to flow in only one direction in a pipe. In sewer pipes and chemical injection systems on irrigation systems it prevents a reverse flow. It is one of a water line backflow preventer.
<b>Chemical Characteristics</b>	A characteristic of water defined by the amounts of organic or inorganic compounds present.
<b>Chlorine</b>	A yellow-green halogen gas added to water to destroy or de-activate disease-causing microorganisms. Mostly widely used disinfectant in United States.
<b>Chlorination</b>	A method of disinfecting water where gaseous, liquid or dissolved chlorine is added to a water supply system.
<b>Chlorine Demand</b>	The minimum amount of chlorine needed to react with organic matter present in a treatment plant.

<b>Chlorophyll</b>	A pigment found in algae and other aquatic plants that is used in photosynthesis. The most common chlorophyll pigments are chlorophyll "a" and chlorophyll "b." The amount of chlorophyll a in a water sample is often used to assess the amount of algae present in a water body.
<b>Classified Surface Water</b>	A stream, lake, wetland or pond that is subject to water quality regulations.
<b>Coliform Bacteria</b>	A group of organisms usually found in animal and human intestine and colons. The presence of coliform bacteria in water is an indicator of possible fecal material pollution.
<b>Column</b>	The vertical pillar of water formed by water being pumped out of a well.
<b>Combined Chlorine Residual</b>	The by-products of chlorine and organics provide longer lasting disinfection used in distribution lines.
<b>Community Water Supply</b>	Public water supply system with at least 10 connections or that regularly serves at least 25 year-round residents. [KS 15 28-15-11(b)]
<b>Composting</b>	The natural decomposition or breakdown of organic material by bacteria and other soil organisms to produce humus.
<b>Compound Meter</b>	A water meter used in places with high fluctuations in water usage; includes a positive displacement meter and a turbine meter.
<b>Condensation</b>	The conversion of water from the vapor state to a liquid state usually initiated by a reduction in temperature of the vapor.
<b>Conditional Waiver</b>	An exemption given by the State to a water system if an Maximum Contaminant Level (MCL) cannot be met; given that certain conditions are met by the water system.
<b>Confined Aquifer</b>	An aquifer sealed on all sides and under an impermeable layer such as rock or clay.
<b>Cone of Depression</b>	A depression of groundwater levels around a well in response to groundwater withdrawal.
<b>Confluence</b>	The place where two or more streams come together.

<b>Conservation</b>	Conservation is the wise use of natural resources (nutrients, minerals, water, plants, animals, etc.). Planned action or non-action to preserve or protect living and non-living resources.
<b>Consumer Confidence Report</b>	A report that community water systems must provide or make available to their customers annually; designed to inform the customers of the quality of the water they are drinking.
<b>Consumptive Use</b>	A use that makes water unavailable for other uses, usually by permanently removing it from local surface or groundwater storage as the result of evaporation or transpiration.
<b>Copper Sulfate (also called Blue Stone)</b>	A water soluble copper salt which is toxic to algae and other aquatic organisms. It is often used to control algae in swimming pools, but its use in natural waters may not be practical, successful, or legal.
<b>Corrosion Control</b>	A technology used to keep lead and copper out of water systems.
<b>Cross Connections</b>	A direct, unprotected connection between water to a potable water supply; mixing can occur due to backflow.
<b>Cryptosporidium</b>	A microscopic parasite found in the feces of mammals which can be transmitted through water. Ingestion of Cryptosporidium causes cryptosporidiosis, a disease characterized by nausea, diarrhea, and cramps.
<b>Cultural Eutrophication</b>	The process whereby human activities increase the amounts of nutrients entering surface waters thus allowing increased algae and other aquatic plant population growths.
<b>Cubic Feet Per Second (CFS)</b>	A rate of flow in a river, creek or stream. Indicates the volume of water (1-foot high, 1-foot wide and 1-foot long.) [ICFS=XGPM] that passes a given point in one second.

<b>Denitrification</b>	Anaerobic process in the nitrogen cycle that converts nitrates (NO <sub>3</sub> ) to nitrogen gas (NO <sub>2</sub> ).
<b>Deposition</b>	The laying, placing, or throwing down of any material.
<b>Designated Use</b>	To indicate or specify a certain use for a classified surface water.
<b>Direct-Read</b>	A type of water meter read by looking at the numbers on the top of the meter dial or on a remote registering head.
<b>Discharge</b>	The outflow of water, originating from either a pipe or stream, into a larger body of water.
<b>Dissolved Oxygen (DO)</b>	The amount of oxygen dissolved in water. Generally, proportionately higher amounts of oxygen can be dissolved in colder water than in warmer water. Minimum levels of dissolved oxygen are required to sustain aquatic life.
<b>Dissolved Solids</b>	Substances found in solution in water due to break down of the materials when put into water.
<b>Distribution System</b>	Consists of treated water vessels and pipes that convey potable water to consumers.
<b>Dosage</b>	The amount of compound per gallon, or other unit measurement, found in a water treatment system.
<b>Domestic Water Use</b>	Water used for household purposes such as drinking, bathing, washing clothes and watering lawns and gardens.
<b>Drawdown</b>	The difference between the static water level and the pumping water level in a well, determined by the ability of the aquifer to replace the amount of water that is being pumped.
<b>Drip Irrigation System</b>	An irrigation method where pipes or tubes filled with water slowly drip onto or underneath crops. A low pressure system that reduces water lost to evaporation.
<b>Dry-Barrel Hydrant</b>	A freeze-proof hydrant with the operating valve located at the bottom of the barrel that keeps the water below the frost line.

<b>Escherichia coli (E. coli)</b>	Bacteria normally found in gastrointestinal tracts of animals that exists as numerous strains, some strains are responsible for diarrheal diseases.
<b>Easement</b>	A legal instrument enabling the giving, selling of certain land or water rights without transfer of title, such as for passage of utility lines.
<b>Ecosystem</b>	A group of plants or animals together with that part of the physical environment with which they interact.
<b>Ecozone</b>	Large areas of land with similar geographic features such as soil, land forms, water courses, vegetation and climate.
<b>Effluent</b>	The liquid waste discharged from sewage or industrial processing.
<b>Electrical Conductivity</b>	A physical characteristic of water used to indicate the level of Total Dissolved Solids in water; the level of electrical conductivity is proportional to the amount of dissolved solids found in the water.
<b>Electrolysis</b>	The producing of chemical changes by passage of an electric current between two metallic surfaces; can cause corrosion in pipes.
<b>Elevated Tank</b>	A pressure vessel storing water above ground monitoring a water supply system distribution .
<b>Emergent Plant</b>	Aquatic plants found in shallow waters that extend above the water surface and have relatively rigid stems, e.g., cattails.
<b>Ephemeral Stream</b>	A markedly short-lived stream. Ephemeral streams only flow after precipitation events.
<b>Erosion</b>	The gradual wearing away and destruction of land surfaces due to wind, water, or wave action.
<b>Estuary</b>	An area where fresh and salt water mix, such as a bay, salt marsh or where a stream enters the ocean.

<b>Eutrophic Lake</b>	A lake with a high concentration of nutrients. Eutrophic lakes are often shallow and exhibit periods of oxygen deficiency.
<b>Eutrophication</b>	An excess of mineral and organic nutrients that promote a proliferation of plant life, especially algae, in lakes or ponds. Eutrophication reduces the dissolved oxygen content and may limit animal production in the system.
<b>Evaporation</b>	The process of water changing phases from a liquid state to a vapor.
<b>Evapotranspiration (E.T.)</b>	The process by which plants take in water through roots, and give it off through the leaves as a by product of respiration. (2) The loss of water to the atmosphere from the earths surface by evaporation and by transpiration through plants.
<b>Exotic species</b>	A species which is accidentally or intentionally introduced into habitats where it is not naturally found.
<b>Fauna</b>	The collection of animal species in a particular ecosystem.
<b>Fecal Coliform Bacteria</b>	Bacteria that originate in the intestines of all warm-blooded animals, including humans and livestock. The presence of these bacteria in water often indicates contamination by human or animal feces. (See E. Coli)
<b>Fertilizer</b>	Nutrients essential for plant life containing nitrogen, phosphates; used to enhance crop production.
<b>Filtration</b>	A treatment technology used to remove inorganic compounds from water. During filtration, water passes through layers of sand, coal or other granular material.
<b>First Draw</b>	A water sampling method for lead and copper, whereby the water is allowed to remain motionless in the plumbing for a minimum of six hours before collecting the sample.

<b>Floating Plants</b>	Aquatic plants, rooted in the sediments or free-floating, with leaves that float on the surface of the water. Their stems lack rigidity and the plants rely on the water for support.
<b>Floc</b>	Clumps of suspended solids; commonly generated by alum. As floc settles particles are removed
<b>Flora</b>	The collection of plant species in a particular ecosystem.
<b>Flood Plain</b>	The area covered by water during a major flood or past major floods.
<b>Flow</b>	The rate of water discharged from a source expressed in volume with respect to time.
<b>Flushing Hydrant</b>	A hydrant used to flush the water main. <i>Also called blow-off hydrants.</i>
<b>Free Chlorine Residual</b>	The amount of chlorine remaining in a water purification system after the chlorine demand; used as a monitoring measurement by system operators.
<b>Gastroenteritis</b>	Stomach upset caused by bacteria or enteric viruses leading to mild fever, vomiting, diarrhea, and stomach cramps.
<b>Giardia</b>	A microscopic intestinal parasite of humans and aquatic mammals which can be transmitted through water. Ingestion of giardia causes giardiasis, or Beaver Fever, an intestinal disorder characterized by nausea, diarrhea, and fatigue.
<b>Granulated Activated Carbon (GAC)</b>	A treatment technology used to remove dissolved organic compounds from water, whereby water is passed through beds of activated carbon to absorb organic contaminants.
<b>Greywater</b>	Used kitchen, shower and bath water, excluding toilet water.
<b>Ground Storage</b>	A below ground tank for storing water.
<b>Groundwater</b>	Water that flows or seeps downward and saturates soil or rock forming pockets of stored water.

<b>Grout</b>	A cement used to fill the annular spaces between a well casing and bore hole.
<b>Hard Water</b>	Water that contains high amounts of dissolved minerals, specifically calcium and magnesium. Measured in grains per gallon or mg/L; 1 grain= 17 mg/L.
<b>Head Loss</b>	Energy loss due to friction of flowing liquid.
<b>Heavy Metals</b>	Metals such as mercury, lead, zinc, copper, etc.; that when present in high concentrations, can possibly be toxic to living organisms and may bioaccumulate in the food chain.
<b>Herbicide</b>	Chemical agent that kills or inhibits plant growth.
<b>Holding Pond</b>	Pond or reservoir, usually made of earth, built to store polluted runoff.
<b>Household Hazardous Waste (HHW)</b>	Product that is discarded from a home or a similar source that is either ignitable, corrosive, reactive, or toxic (e.g. used motor oil, oil-based paint, auto batteries, gasoline, pesticides, etc.).
<b>Hydrant</b>	Device used to access water directly from the supply.
<b>Hydrologic Cycle (or Water Cycle)</b>	Complete cycle through which water moves from the oceans, through the atmosphere, to the land and back to the oceans.
<b>Hydrological Considerations</b>	Considerations which deal with the occurrence, circulation, distribution, and properties of water and its reaction with the environment.
<b>Hydrology</b>	Study of water and its properties, circulation, principles and distribution.
<b>Impellor</b>	Rotors found in well pumps that are used to move water to the surface through the well column.
<b>Impermeable</b>	Geologic formations that resist water percolating through them.
<b>Infiltration</b>	Process of water moving into and through soil.
<b>Injection Well</b>	A well constructed for the purpose of injecting water or hazardous material into the ground.
<b>Inorganic Material</b>	Chemical substances of mineral origin; not containing carbon to carbon bonds.

<b>Intermittent Stream</b>	A stream or reach of a stream that flows only at certain times of the year.
<b>Invertebrate</b>	An animal, such as an insect or mollusk, that lacks a backbone or spinal column.
<b>Ion Exchange</b>	A method of water softening where hardness causing ions (calcium and magnesium) are exchanged with sodium ions; also effective in removing many inorganic contaminants such as nitrates, copper, and lead; and treating aesthetic water problems.
<b>Junior Water Rights</b>	Those water rights acquired since Oct. 1, 1965.
<b>Kick Net</b>	A device that is used in stream monitoring to collect macroinvertebrates and organisms within a stream.
<b>Lagoon</b>	An earthen structure for the biological treatment of liquid organic wastes. Lagoons can be aerobic, anaerobic, or facultative depending on their design and can be used in series to produce a higher quality effluent.
<b>Langelier Saturation Index</b>	A numerical index that indicates whether calcium carbonate will be deposited or dissolved in a distribution system. Generally used to indicate corrosive level of water.
<b>Laterals</b>	The pipes that carry water from the water mains to the customers, also carries waste water away.
<b>Latitude</b>	The angular distance north or south of the earth's equator, measured in degrees along a meridian, as on a map or globe.
<b>Leaching</b>	The separation of constituents from the soil by the movement of water through the ground. The soluble components are carried down by the moving water where they may enter ground-water aquifers.
<b>Levee</b>	A natural or manmade earthen barrier along the edge of a stream built for flood protection.
<b>Lime Softening</b>	A method of water softening where hydrated lime is added to water in order to precipitate out hardening agents, which are then removed by sedimentation or filtration.

<b>Longitude</b>	Angular distance on the earth's surface, measured east or west from the prime meridian at Greenwich, England, to the meridian passing through a position, expressed in degrees (or hours), minutes, and seconds.
<b>Macroinvertebrate</b>	Animal without a backbone visible to the naked eye.
<b>Macrophyte</b>	A large aquatic plant which is visible to the naked eye.
<b>Main Valves</b>	Valves installed at tees or intersect where two or more water mains , so that the mains can be isolated for emergency repair or maintenance.
<b>Maximum Contaminate Level (MCL)</b>	The level established by US EPA for various contaminants allowed in public drinking water.
<b>Microinvertebrate</b>	Animal without a backbone invisible to the naked eye and visible through a microscope.
<b>Mesotrophic Lake</b>	Clear lake with intermediate amounts of nutrients as compared to eutrophic and oligotrophic lakes.
<b>Microbe</b>	A microorganism, especially a bacterium that causes disease; a minute life form.
<b>Microcystis</b>	A species of blue-green algae which is common in lakes and reservoirs with enhanced nutrient concentrations. Microcystis often contributes to poor water quality because it can impart noxious odors and disagreeable tastes to the water and produces toxins which may be toxic to wildlife and livestock.
<b>Mouth of Stream</b>	The point of discharge of a stream into another stream, lake or sea.
<b>Municipal Water System</b>	A water system that serves at least 25 people, or has or more 15 service connections used by residents more than six months per year; governmental entity such as a city, county, town, village, sanitary district, state, or federal institution owned .
<b>NPDES Permit</b>	Required by Federal law for all point sources' discharge pipes that discharge into U.S. waters to control water pollution.

<b>Natural Flow</b>	Rate of water moves past a specific point on a natural stream. The flow comes from a drainage area in which there has been no stream diversion caused by storage, import, export, return flow, or change in consumptive use; caused by land use modifications.
<b>Natural Resources and Conservation Service</b>	United States Department of Agriculture Agency; provides financial and technical assistance to landowners for conserving soil, water and other natural resources.
<b>Nephelometric Turbidity Unit (NTU)</b>	Unit of measure for the cloudiness of water measured by a nephelometer.
<b>Nematodes (or Round Worms)</b>	Worms common in the bottom sediments of water bodies. They are most often found in oligotrophic lakes and their numbers decrease drastically in eutrophic lakes due to low oxygen concentrations.
<b>Nitrates (NO<sub>3</sub>)</b>	Final product of ammonia's biochemical oxidation. It's presence is due to the presence of nitrogenous organic matter of animal and to some extent vegetable origin. Septic tank systems may contribute nitrates to ground water if free oxygen is present. Manure and fertilizer contain large nitrate concentrations . Nitrate (NO <sub>3</sub> ) is primary source of nitrogen for plants; plants can't live without it.
<b>Nitrification</b>	The oxidation of ammonia into nitrates followed with the oxidation of these nitrites into nitrates. This is an important step in the nitrogen cycle.
<b>Nitrites (NO<sub>2</sub>)</b>	First product of the oxidation of free ammonia by biochemical activity; free oxygen must be present. (NO <sub>2</sub> ).
<b>Nitrogen (N)</b>	Colorless, tasteless element usually occurring in the gaseous state. It forms approximately 80 percent of the earth's atmosphere; essential for all living organisms.
<b>Non-Community Water Supply</b>	Public water supply system that is not a community water supply. [KSA 15.28-15-11(c)].
<b>Non-Transient Non-Community Water Supply</b>	Public water supply that is not a community water supply and regularly serves at least 25 of the same people at least six months per year. [KSA 15.28-15-11(d)].

<b>Non-Persistent Pollutant</b>	Pollutant that is degradable. Damaging effects from the pollutant can usually be reversed.
<b>Nonpoint Source Pollution</b>	Pollution discharged other than through a pipe or ditch. over a wide land area, originating from different sources, which enters water bodies through runoff or snowmelt and deposits the pollutants into ground or surface waters.
<b>Nonpotable Water</b>	Water that is not suitable for drinking.
<b>Nutrients</b>	Elements or compounds essential to life, including carbon, oxygen, nitrogen, phosphorus and many others.
<b>Oligotrophic Lake</b>	A lake low in nutrients and usually containing abundant amounts of dissolved oxygen. Oligotrophic lakes are generally deeper than eutrophic lakes.
<b>Organic</b>	Term that refers to molecules made up of two or more atoms of carbon, generally pertains to compounds formed by living organisms.
<b>Organic Material</b>	Substances containing carbon.
<b>Other Public Water Supply</b>	Public water system that services at least 25 people, or has 15 service connections used by residents more than six months per year and is owned by an entity that is not governmental, such as a manufactured housing park, subdivision, apartment complexes, or condominium association.
<b>Oxygen</b>	Colorless odorless gas that makes up about 20 percent of the air we breathe; it is essential to life because it is used for the chemical reactions that occur in the cells of the body.
<b>Oxygen Demand</b>	Oxygen amount needed to complete biological or chemical processes in water.
<b>Ozone</b>	Gaseous molecule that contains three oxygen atoms (O <sub>3</sub> ); can exist either high in the atmosphere, shielding Earth from the sun's harmful ultraviolet rays, or close to the ground, as the main component of smog. Ground-level ozone is a product of reactions involving hydrocarbons and nitrogen oxides in the presence of sunlight. It can cause lung damage and respiratory problems.

<b>Pathogen</b>	A disease-causing organism.
<b>Pathogenic</b>	Causing or capable of causing disease.
<b>Perched Aquifer</b>	Aquifer in which a groundwater body is separated from the main groundwater below it by an impermeable layer (relatively small laterally) and an unsaturated zone. Common in glacial area where lenses of clay formed in small glacial ponds, and are also common in volcanic depositional sequences where weathered ash layers of low permeability are sandwiched between highly permeable basalts. Water moving downward through the unsaturated zone will be intercepted and accumulate on top of the lens before moving laterally to the edge of the lens and seeps downward to regional water table or forms a spring on the side of a hillslope.
<b>Percolation</b>	The downward movement of water through the soil.
<b>Perfected Water Right</b>	A water right which indicates that the uses anticipated by an applicant and made under permit were made for beneficial use.
<b>Periphyton</b>	Algae and small crustaceans that live attached to surfaces projecting from the bottom of a freshwater aquatic environment.
<b>Permeable</b>	A characteristic of underground formations which have pores or openings that permit liquids to pass through.
<b>Perennial Stream</b>	A lasting or active stream that runs water throughout the year.
<b>Persistent Pollutant</b>	A pollutant which degrades very slowly and remains in the environment for years.
<b>Pesticides</b>	Toxic chemicals used to eliminate or control unwanted insects, plants, or other organisms. Pesticides include insecticides, herbicides, and fungicides.
<b>pH</b>	An expression of both acidity and alkalinity on a scale of 0 to 14, with 7 representing neutrality. Numbers less than 7 indicate increasing acidity and numbers greater than 7 indicate increasing alkalinity

<b>pH Meter</b>	An instrument that measures the alkalinity or acidity of a liquid.
<b>Photosynthesis</b>	The process by which plants manufacture their own food (simple carbohydrates) from carbon dioxide (CO <sub>2</sub> ) and water. The plant's chlorophyll-containing cells use light as an energy source and release oxygen as a by-product.
<b>Phreatophyte</b>	A deep-rooted plant that obtains water from a stream or the water table.
<b>Physical Characteristics</b>	A characteristic of water defined by the temperature turbidity, color, taste and odor of the water.
<b>Plankton</b>	The collection of small or microscopic organisms, including algae and protozoans, that float or drift in great numbers in fresh or salt water, especially at or near the surface, and serve as food for fish and other larger organisms.
<b>Playa Lake</b>	A shallow lake, generally no greater than one foot deep, found in arid and semi-arid portions of the southwest United States. These lakes are generally ephemeral and hold water seasonally.
<b>Point Source Pollution</b>	A stationary location from which pollutants are discharged. An example of point source pollution is direct, concentrated discharge such as sewage effluent discharging from a pipe or ditch into a water body. Requires a NPDES permit.
<b>Point-Of-Entry Sample</b>	A type of water sample taken from distribution after treatment and before reaching the first consumer.
<b>Pollution</b>	Contamination of air, soil, or water with harmful substances.
<b>Pollution (of Water)</b>	When the level of concentration is high enough to impair water quality to a degree that it has an adverse effect upon any beneficial use of the water.

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<b>Positive Displacement Meter</b>	A water meter used in normal and low-flow conditions.
<b>Primacy Authority</b>	The authority given by the USEPA to the states to implement and enforce the Safe Drinking Water Act, the Clean Water Act or other programs.
<b>Protozoan</b>	A member of the phylum or subkingdom Protozoa which are chiefly motile and heterotrophic unicellular protists, such as amoebas, trypanosomes, sporozoans and paramecia.
<b>Public Water Supply</b>	Federal Definition— A system providing piped water to the public; has more than or at least 15 service connections and service for more than or at least 25 inhabitants for more than or at least 60 days per year.
<b>PVC - Poly Vinyl Chloride</b>	A type of plastic used for water mains that has the properties of hardness and resistance to water and fire.
<b>Rate of Recharge</b>	The rate of inflow into a groundwater aquifer.
<b>Renewable Resource</b>	A resource that is capable of being naturally restored or replenished (e.g. trees).
<b>Reservoir</b>	A man-made body of water replenished by rain and river or stream flow that is formed after a dam is built on a river. Flood control and water supply are the two principle purposes. Reservoirs also provide wildlife habitats, recreational areas and, in some states, hydroelectric power.
<b>RCRA</b>	Federal law giving EPA control over hazardous materials from generation to disposal.

<b>Riffle</b>	A section of river or stream with rapid, turbulent flows; generally shallow.
<b>Rip Rap</b>	Crushed and broken stone of varying sizes placed to cover soil. Used for landscaping and erosion control.
<b>Riparian Zone (Riparian Area)</b>	A margin of vegetation that includes trees, shrubs, and grasses extending 30 - 50 meters away from the waterline of rivers and streams.
<b>Reverse Osmosis</b>	Reverse osmosis is the finest filtration known. The process allowing certain ions to pass through a membrane while others are rejected. Used to purify water, remove salts and other impurities to improve the color, taste or properties of a fluid. Can be used to purify fluids such as ethanol and glycol, which will pass through the reverse osmosis membrane, while rejecting other ions and contaminants from passing. Commonly used for reverse osmosis is in purifying water. It is used to produce water that meets the most demanding specifications that are currently in place. <i>Also known as hyperfiltration.</i>
<b>Runoff</b>	The amount of precipitation appearing in surface streams, rivers and lakes, defined as the depth to which a drainage area would be covered if all of the runoff for a given period of time were uniformly distributed over it.
<b>Saline Water</b>	Water that contains a significant amount (3-5 percent) of dissolved salts. Greater than 5 percent is call brine.
<b>Sanitary Surveys</b>	Periodic on-site inspections performed by Kansas Department of Health and Environment consisting of a review of a system's compliance, monitoring records and facilities. Based on a 1974 Federal law establishing public water supply standards.
<b>Saturated</b>	The state of soil when it is completely full of water and no more water can infiltrate.
<b>Sedimentation</b>	The deposition of silt, soil, clay or sand particles in locations where slow-moving water loses its ability to hold heavier particles in suspension.

<b>Septic Tank</b>	Under ground tank used to retain domestic wastewater that allows settling of solids prior to discharge to a leach field.
<b>Service Valves</b>	Valves used to isolate a single building from the water main; installed on the service line between the water main and the building, usually near the street curb, also called curb stop valves.
<b>Secchi Disk</b>	Circular plate generally 10"-12" in diameter with alternating black and white quarters used to measure water turbidity or clarity by noting the greatest depth at which it can be visually detected. Used in study of lakes.
<b>Senior Water Rights</b>	Those water rights acquired on or prior to Oct. 1, 1965. [KSA 82a-701-737]
<b>Settling Pond</b>	Open lagoon where wastewater is retained and solids are allowed to settle down to the bottom of the structure.
<b>Silt</b>	Sedimentary or soil particles smaller than sand particles, but larger than clay particles.
<b>Source Water Assessments</b>	Assessment conducted by KDHE to delineate the assessment area boundaries from which public water systems receive drinking water supplies .
<b>Species Diversity</b>	Variety of species within a region or a given area.
<b>Specific Capacity</b>	Measurement of an aquifer's ability to yield water to a well.
<b>Standpipe</b>	Equalizing water pressure to minimize the pulsations of water flowing into distribution pipes. Large vertical pipe in which a column of water rises and falls; often built inside towers; serves to store.
<b>Static Water Level</b>	The water level in a well when the pump is not running.
<b>Steel</b>	Strong, durable iron and carbon material and often other metals, to achieve different properties. Used as a component in cans and as a structural material in construction.

<b>Storm Water</b>	Rain water that is not treated and flows into a storm drain or storm ditch then into streams, rivers and lakes.
<b>Stream Bank Erosion</b>	The wearing away of stream banks by flowing water.
<b>Stream Bank Stabilization</b>	Attempts to retard the banks from eroding by use of vegetation, weirs, riprap, etc.
<b>Submergent Aquatic Plant</b>	Plants with flexible stems and leaves rooted in the sediments and completely covered by water, such as pondweed.
<b>Super Fund</b>	Federal law (CERCLA) that collects taxes from chemical and petroleum industries for cleanup of hazardous waste sites.
<b>Suspended Solids</b>	Small solid particles that resist dissolving in water or falling to the bed of the body of water. Suspended solids are one standard measure of water quality.
<b>Sustainable Development</b>	Development that meets the needs of the present without sacrificing the ability to meet future needs.
<b>Terrestrial</b>	Adapted to living on land. Not aquatic.
<b>Thermal Pollution</b>	The impairment of water quality through temperature increase. It usually occurs as a result of industrial discharges of coolant water.
<b>Topographic Map</b>	Maps with lines showing a region's relief in equal elevations; also shows natural features including hills, valley, rivers, lakes and built structures such as bridges, roads and cities.
<b>Topography</b>	The general configuration of the land surface including relief and position of natural and man-made features.
<b>Total Annual Sustainable Yield</b>	Total annual sustainable yield for ground water is that total quantity of ground water which can be extracted annually without exceeding the recharge rate.
<b>Total Chlorine Residual</b>	The total of free residual and combined residual chlorine in a water purification system; used as a monitoring measurement by system operators.

<b>Total Annual Sustainable Yield</b>	Total annual sustainable yield for ground water is that total quantity of ground water which can be extracted annually without exceeding the recharge rate.
<b>Total Chlorine Residual</b>	Total of free residual and combined residual chlorine in treated water. Used as a monitoring measurement by system operators.
<b>Total Dissolved Solids (TDS)</b>	The quantity of dissolved materials in the water. Usually measured in ppm or mg/L.
<b>Total Suspended Solids (TSS)</b>	Measure of the suspended organic and inorganic solids in water.
<b>Transpiration</b>	Process of plants absorbing water through their root system and discharging into the atmosphere through the surface of their leaves.
<b>Tributary</b>	Stream that contributes its water to another stream or body of water.
<b>Turbidity</b>	Measure of the amount of material suspended in water including clay, silt, organic and inorganic chemicals, as well as small aquatic organisms. Turbidity affects the amount of light, which is able to pass through the water column. Usually measured in the NTUs or by secchi disk.
<b>Turbine Meter</b>	Water meter that uses a propeller (turbine) to measure flow rates suitable for high-flow rates. .
<b>Ultra Violet Radiation</b>	Method of disinfecting water where water is exposed to UV light; certain wavelengths of UV light deactivate the DNA of bacteria, viruses and other pathogens and thus destroy their ability to multiply and cause disease.
<b>Ultra-Violet Rays</b>	Invisible light rays. Certain wave lengths deteriorate DNA and are used to disinfect water by destroying pathogens.
<b>Unconfined Aquifer</b>	An aquifer that is located in a permeable formation where the water table is free to rise and fall depending on factors such as the amount of rainfall.
<b>Variance</b>	An exemption given by the State to a water system if an MCL cannot be met; given that certain conditions are met by the water system.

<b>Vent</b>	A pipe installed in the well casing to allow for the displacement of air between the casing and the pump column.
<b>Vertebrate</b>	An animal having a backbone or spinal column.
<b>Vertical Turbine Pump</b>	A water pump with the motor located above ground, connected by a shaft to the pump located below the water table.
<b>Vested Water Right</b>	Water rights recognized by Kansas as belonging to people using water prior to 1945.
<b>Virgin Water</b>	Made with 100 percent new, raw materials and contains no recycled materials.
<b>Virus</b>	Any of a large group of submicroscopic infective agents that are regarded either as extremely simple microorganisms or as extremely complex molecules. They typically contain a protein coat surrounding an RNA or DNA core of genetic material, but no semi permeable membrane and are capable of growth and multiplication only in living cells. The cause of various important diseases in humans, animals and plants.
<b>Volatile Organic Compound (VOCs)</b>	Carbon-based substances that evaporate easily. Many are carcinogenic.
<b>Vulnerability Assessments</b>	An assessment performed for all community and non-transient, non-community public water systems every three years. It consists of an inventory of potential contamination sources in a delineated area; includes: well construction and pesticide susceptibility and industrial chemical use evaluations; and vulnerability to volatile organic compounds (ethylene dibromide, asbestos and coal tar).
<b>Wastewater</b>	Water that has been used in homes, industries or businesses that can be reused if adequately treated.
<b>Water (H<sub>2</sub>O)</b>	Clear, colorless, odorless and tasteless liquid, H <sub>2</sub> O essential for plant and animal life.
<b>Water Column</b>	A vertical slice of a water body.

<b>Water Cycle</b>	<i>See Hydrologic Cycle.</i>
<b>Water Flow</b>	The amount of water available in a water supply system.
<b>Water Hammer</b>	Occurs when flowing water in a system is immediately stopped due to a valve or hydrant being closed too quickly. It sends a sudden pressure wave down the water line, shocking the pipes, creating a hammer noise.
<b>Water Main</b>	A primary pipe used to carry water from the source to storage facilities and to points along the distribution system.
<b>Water Meter</b>	A device used to measure the volumetric flow of water.
<b>Water Pressure</b>	The force of the water available in a water supply system.
<b>Water Quality Criterion</b>	The numeric limit set for a pollutant that cannot be exceeded in a surface water for a specific designated use.
<b>Water Source</b>	The origin of water in a water supply system, usually a well, reservoir, or river.
<b>Water Storage Facility</b>	An area used to store water during low demand periods for distribution to customers during high demand periods in a water supply system. A water tower or stand pipe.
<b>Water Table</b>	The upper portion of the part of the ground that is completely saturated with water. The water level in a well when the pump is not running.
<b>Watershed</b>	The area which supplies water to a stream and its tributaries by direct runoff and by groundwater contribution is the drainage area or watershed for the stream.
<b>Weir</b>	Dam placed across a river or canal to raise or divert the water; fence or wattle placed in a stream to catch or retain fish.
<b>Well Abandonment</b>	Permanently closing a well. This process has certain criteria and requirements that must be followed.





# Measurements

Measurement	Explanation of Measurement
<b>K = Kelvin</b>	Basic unit of temperature
<b>ohm</b>	Unit of resistance of an electrical conductor
<b>32° Fahrenheit</b>	0° Celcius <i>Freezing Point</i>
<b>Degrees C °</b>	$5/9 (F-32°)$ ; Degrees F° = $9/5 C° + 32°$
<b>0 ° Celsius</b>	32° Fahrenheit <i>Freezing Point</i>
<b>Degrees F °</b>	Fahrenheit
<b>1 pound</b>	.45 Kilograms
<b>1 mile</b>	1.6 Kilometers
<b>1 yard</b>	0.9 Meters
<b>1 foot</b>	30 Centimeters
<b>1 inch</b>	2.5 Centimeters
<b>1 tsp</b>	5 Milliliters
<b>1mg/L</b>	1 Milligram per Liter - approx. 1 ppm
<b>1µg/L</b>	1 Microgram per Liter = approx. 1 ppb
<b>1 ml</b>	1 Milliliter
<b>1 L</b>	1 Liter
<b>1 kilogram (kg)</b>	1,000 Grams (g)
<b>cu.ft/gal.</b>	Cubic Feet per Gallon
<b>1 gal</b>	gallon = 8.345lb. = 3.785 Liters = 231 in. <sup>3</sup>
<b>Gallons Per Minute</b>	gpm = 1400 gal per day or .133 cu.ft./min
<b>1 cubic foot (ft.<sup>3</sup>)</b>	7.48 gal = 62.4 lb.
<b>ppb</b>	Parts per Billion = µg/L
<b>ppm</b>	Parts per Million = mg/L
<b>cubic yard</b>	cu. yd. X .7646 = m <sup>3</sup>
<b>cubic inch</b>	cu. in. x 16.39 = mL
<b>acre-foot</b>	ac.ft. x 1233 = m <sup>3</sup>
<b>1 acre</b>	43,560 Square Feet
<b>1 sq mile</b>	640 Acres
<b>1 inch</b>	2.54 Centimeters (cm)
<b>1 ppm</b>	1 mg per Liter = 8.34 lb per million gal.
<b>gpg</b>	Grains per Gallon

Measurement	Explanation of Measurement
<b>1 Pound Per Square Inch</b>	2.31 ft. vertical head of H <sub>2</sub> O
<b>gpm</b>	gallons per minute
<b>cfs</b>	cubic feet per second - approx. 450 gpm

**Water Conversion and Measurements**

- 1 cubic foot = 748 gallons = 62.4 pounds of water
- 1 acre-foot = 43,560 cubic feet = 325,851 gallons = 12 acre-inches
- 1 acre-inch = 27,154 gallons
- 1 acre-foot is the volume of water that would cover 1 acre of land 1 foot deep
- 1 acre-inch per hour = 450 gallons per minute (gpm)  
= 1 cubic foot per second (cfs)
- 1 cubic meter = 1,000 liters = 264 gallons
- 1 gallon = 128 ounces = 3,785 millimeters
- 1 ounce = 29.56 millimeters
- 1 liter = 1.06 quarts

<b>Irrigation Delivery Rate* per Acre (gpm/acre)</b>						
Net irrigation Application (inches/day)	System efficiency (percent)					
	50	60	70	80	90	100
	gpm/acre					
.10	3.77	3.14	2.69	2.36	2.10	1.89
.15	5.66	4.71	4.04	3.54	3.14	2.83
.20	7.54	6.29	5.39	4.71	4.19	3.77
.25	9.43	7.86	6.73	5.89	5.24	4.71
.30	11.31	9.43	8.08	7.07	6.29	5.66
.35	13.20	11.00	9.43	8.25	7.33	6.60
.40	15.09	12.57	10.78	9.43	8.38	7.54
.45	16.97	14.14	12.12	10.61	9.43	8.49
.50	18.86	15.71	13.47	11.79	10.48	9.43

**\*Field delivery rate= gpm/acre X acres irrigated**

**Area/Length/Weight/Yard**

- 1 acre = 0.405 hectare (ha) = 43,560 feet<sup>2</sup>
- 1 hectare = 2.47 acres
- 1 mile = 5,280 feet = 1.61 kilometers
- 1 foot = 0.305 meter (m) 1 meter = 3.28 feet
- 1 inch = 2.54 centimeters
- 1 pound = 454 grams
- 1 kilogram per hectare (kg/ha) = 1 metric ton/ha (MT/ha)  
= 0.0149 bushel (60 pounds) per acre

**Pressure**

- 1 pound per square inch (psi) = 2.31 feet of water = 6.9 kilopascal (kpa)  
= 0.0703 kilogram per square centimeter (kg/cm<sup>2</sup>)  
= 0.704 meters of water

A column of water 2.31 feet deep exerts a pressure of 1 psi at the bottom of the column.

Total dynamic head (TDH) = pumping lift + elevation change + friction loss + irrigation system operating pressure.

*The three above tables are excerpts from KSU's Irrigation Management Series Useful Conversions and Formulas created by Danny Rogers and Mahbub Alam.*