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Glossary

Alert Level (AL): A numeric value that expresses the concentration, or physical or chemical properties, of selected groundwater constituents. With the exception of field parameters and common ions which will not be assigned ALs, ALs are established for Level 1 and Level 2 analytes using methods approved by the Director, including the methods for establishing ALs in the April 26, 2000 amendments to the UIC Permit.

Analyte: A constituent, or a chemical or physical property of a constituent, that is analyzed or measured by chemical or physical means.

Anion: A negatively charged ion (as a hydroxide, chloride, or acetate ion).

Annulus: The space between the casing of a well and the well bore. Also, the space between the tubing and casing of a well. The annulus may be referred to as the "annular space."

Aquifer: A geologic unit that contains sufficient saturated permeable material to yield usable quantities of water to a well or spring Arizona Revised Statutes ([A.R.S.] § 49-201.2). The Aquifer Boundary and Protected Use Classification Rules (Arizona Administrative Code [A.A.C.] R18-11-501.4) have defined "usable quantities" at 5 gallons per day (gpd).

Aquifer is defined (40 Code of Federal Regulations [CFR] 144.3) as a geological formation, group of formations, or part of a formation that is capable of yielding a significant amount of water to a well or spring.

Aquifer Exemption: Term relating to the act of designating an underground source of drinking water as an exempted aquifer. Term is also used to refer to documents designating exempted aquifers and to the three-dimensional space underground that encloses the exempted aquifer.

Aquifer Quality Limit (AQL): AQLs shall be established for parameters with primary maximum contaminant levels (MCLs) established pursuant to 40 CFR 141. If the calculated AL is less than the MCL, then the AQL shall be set equal to the MCL. If the calculated AL is greater than the MCL, then the AQL shall be set equal to the AL.

Aquifer Water Quality Standards (AWQS): AWQS means a standard established under A.R.S. §§ 49-221 and 49.223. Narrative AWQS are set forth in A.A.C. R18-11-405 and numeric AWQS are set forth in A.A.C. R18-11-406.

Area of Review: Area around an injection well or, in case of area permit, the project area plus a circumscribing area the width of which is either ¼ of a mile or a number calculated according to the criteria set forth in 40 CFR 146.6.

Best Available Demonstrated Control Technology (BADCT): The best available demonstrated control technology, process, operating method, or other alternative to achieve the greatest degree of discharge reduction determined for a facility by the ADEQ Director under A.R.S. § 49-243 and A.A.C. R18-9-101.7.

Calibration:	The process of refining a model representation of the hydrogeologic framework, hydraulic properties and boundary conditions to achieve a desired degree of correspondence between the model simulations and observations of the groundwater flow system.
Cation:	A positively charged ion (as a hydrogen, calcium, or ammonium ion).
Director:	The Regional Administrator of Region 9, United States Environmental Protection Agency (USEPA), or the Director of the Region 9 Water Division acting on behalf of the Regional Administrator.
Discharge:	The addition of a pollutant from a facility either directly to an aquifer or to the land surface or the vadose zone in such a manner that there is a reasonable probability that the pollutant will reach an aquifer (A.R.S. § 49-201.12).
Discharge Impact Area (DIA):	The "potential areal extent of pollutant migration, as projected on the land surface, as the result of a discharge from a facility" (A.R.S. § 49-201.13).
Enrichment:	The supergene processes of mineral deposition, including near-surface oxidation, downward migration, and precipitation (e.g. sulfide enrichment).
Florence Copper Project (FCP):	The land and related facilities owned and operated by Florence Copper Inc. for the production of copper using in-situ copper recovery (ISCR) technologies.
Fracture Gradient:	The fracture gradient is a measure of how the pressure required to fracture rock in the earth changes with depth. It is usually measured in units of "pounds per square inch per foot" (psi/ft) and varies with the type of rock and the stress history of the rock.
Formation:	A body of consolidated or unconsolidated rock characterized by a degree of lithologic homogeneity which is prevailingly, but not necessarily, tabular and is mappable on the earth's surface or traceable in the subsurface
Formation Fluid:	A fluid present in a formation under natural conditions, as opposed to introduced fluids, such as drilling mud.
Granodiorite:	A group of coarse-grained plutonic rocks intermediate in composition between quartz diorite and quartz monzonite, containing quartz, plagioclase (oligoclase or andesine), and potassium feldspar, with biotite, hornblende, or more rarely, pyroxene, as the mafic components. The ratio of plagioclase to total feldspar is at least 2 to 1 but less than 9 to 10. With less alkali feldspar it grades into quartz diorite, and with more alkali feldspar, into granite or quartz monzonite.
Hydraulic Conductivity:	Hydraulic conductivity describes the ease with which water can pass through an aquifer. The hydraulic conductivity multiplied by the thickness of the aquifer is equal to the transmissivity.
Hydraulic Control:	Inward hydraulic gradient that prevents in-situ solutions from migrating beyond the portion of the oxide zone where injection and recovery of in-situ solutions is occurring.

Hydraulic Gradient:	(a) In an aquifer, the rate of change of pressure head per unit of distance of flow at a given point and in a given direction. (b) In a stream, the slope of the hydraulic grade line.
Hydraulic Head:	(a) The height of the free surface of a body of water above a given subsurface point. (b) The water level at a point upstream from a given point downstream. (c) The elevation of the hydraulic grade line at a given point above a given point of a pressure pipe.
Injection Well:	A well through which injectate is injected into the oxide zone under applied pressure or gravity flow.
In-Situ Copper Recovery (ISCR) Area:	The portion of the FCP in which the installation and operation of injection and recovery wells was authorized by the USEPA in Underground Injection Control (UIC) Permit No. AZ 396000001 (UIC Permit) issued May 1, 1997. ISCR area is within the area for which USEPA issued an aquifer exemption in conjunction with the UIC Permit. The ISCR area was referred to as the "mine area" in the APP and in the UIC Permit issued in 1997.
In-Situ Copper Recovery (ISCR) Process:	Process involving (1) the injection of an injectate solution or lixiviant into the oxide zone for the purpose of dissolving copper and (2) pumping the resulting copper-bearing solution (pregnant leach solution or PLS) to the surface for the recovery of the copper in an SX/EW plant.
In-Situ Copper Recovery (ISCR) Solutions:	Also referred to as in-situ solutions and includes any injectate, raffinate, PLS, pre-stacked PLS, rinse water, solutions containing neutralization agents, or HCS.
Leak Collection and Removal System (LCRS):	An engineered assembly of components installed between the upper and lower liner of a double liner system that is designed to drain and remove liquids that may pass through the upper liner.
Level 1 Water Quality Parameters:	Parameters are based on Level 1 analytes, which include constituents of ISCR solutions that are monitored to provide an early indication of groundwater effects associated with the operation of the SX/EW plant and the ISCR facilities. Level 1 analytes are shown in Table 1 of the UIC Permit and are to be sampled at least once quarterly from each point of compliance (POC) well in accordance with the schedule described in Part II.F.4 of the UIC Permit.
Level 2 Water Quality Parameters:	Parameters are based on Level 2 analytes, which include conservative constituents most likely to be present in ISCR solutions and for which primary MCLs have been established pursuant to 40 CFR 141 and other relatively conservative constituents which are likely to appear in greater concentrations in ISCR-affected groundwater than in non-affected groundwater. Level 2 analytes are shown in Table 2 of the UIC Permit and are to be sampled at least once every two years from each POC well in accordance with the schedule described in Part II.F.4 of the UIC Permit.

Lixiviant:	Solution specifically prepared for injection into the oxide zone for the purpose of dissolving and recovering the copper from the oxide zone. Solution is also referred to as injectate solution. Lixiviant will be prepared from raffinate once the SX/EW plant begins operations; until that time, lixiviant will be prepared from groundwater.
Maximum Contaminant Level (MCL):	The maximum permissible level of a contaminant in water which is delivered to any user of a public water system. MCLs are established by the USEPA in accordance with the Safe Drinking Water Act and 40 CFR 141.
Mechanical Integrity:	Pursuant to 40 CFR 146.8, an injection well has mechanical integrity if: • Part I tests indicate there is no significant leak in the casing, tubing or packer (internal mechanical integrity); and • Part II tests indicate there is no significant fluid movement into an underground source of drinking water through vertical channels adjacent to the injection well bore (external mechanical integrity).
MODFLOW:	The United States Geologic Survey (USGS) Modular Three-Dimensional Finite Difference Groundwater Flow Model. McDonald and Harbaugh, 1988.
MT3D:	A Modular Three-Dimensional Finite Difference Chemical Transport Model. Chunmiao Zheng (Papadopulos and Associates), 1990.
Observation Well:	Well installed and/or operated for the purpose of collecting samples and/or monitoring the hydraulic head (water level) in the immediate vicinity of an injection or recovery well.
Oxide:	A mineral compound such as cuprite, rutile, or spinel $MgAl_20_4$ that is characterized by the linkage of oxygen with metallic elements.
Oxide Exclusion Zone:	The upper 40 feet of the oxide zone in which the injection of lixiviant is prohibited unless the permittee has received written approval from the USEPA to inject less than 40 feet from the top of the oxide zone (Part II.D.5 of APP and Part II.A.2 of UIC Permit).
Oxide Zone:	An area of mineral deposits modified by surface waters (e.g. sulfides altered to oxides and carbonates) such as has occurred in the upper portion of the bedrock beneath the site of the FCP.
Parameter:	A variable, measurable property whose value is a determinant of a system.
PATH3D:	A Ground-Water Path and Travel-Time Simulator by Chunmiao Zheng (Papadopulos and Associates) 1992. A general particle tracking program for calculating groundwater paths and travel times in steady-state or transient two-or three-dimensional flow fields.
Perimeter Wells:	Wells installed along perimeter of operational unit and operated for the purpose of maintaining hydraulic control.
Plant Run-off Pond:	Lined pond located near SX/EW plant and designed to hold for short periods of time, process solutions released due to process upsets and direct precipitation that falls within the lined drainage area of the SX/EW plant.
Point of Compliance	A point or points designated by ADEQ director for identifying the point(s) at

(POC):	which compliance with aquifer water quality standards shall be determined. The POC shall be a vertical plane downgradient of the facility that extends through the uppermost aquifer(s) underlying the facility (A.R.S. § 49-244).
Point of Compliance Well:	Well installed at a POC for the purpose of collecting groundwater samples for compliance monitoring in accordance with requirements of the APP and UIC Permit.
Porosity:	The percentage of the bulk volume of rock or soil that is occupied by interstices, whether isolated or connected.
Porphyry:	An igneous rock of a composition that contains conspicuous phenocrysts in a fine-grained groundmass; a porphyritic igneous rock.
Porphyry Copper:	A copper deposit in which the copper-bearing minerals occur in disseminated grains and/or in veinlets through a large volume of rock. The term implies a large low-grade disseminated copper deposit which may be also in schist, silicated limestone, and volcanic rocks, with quartz-bearing igneous rocks always being in close association.
Pregnant Leach Solution (PLS):	A solution containing dissolved copper recovered from recovery wells during in-situ copper recovery operations for delivery to a SX/EW plant.
Public Water System:	A public water system is defined (40 CFR 142.2(k)) as a system for the provision to the public of piped water for human consumption, if such system has at least 15 service connections or regularly serves an average of at least 20 individuals daily at least 60 days out of the year.
Quartz Monzonite:	Granitic rock in which quartz comprise 10 percent to 20 percent of the felsic constituents, and in which the alkali feldspar/total feldspar ratio is between 35 percent and 65 percent; the approximate intrusive equivalent of rhyodacite. With an increase in plagioclase and femic minerals, it grades into granodiorite, and with more alkali feldspar, into a granite.
Raffinate:	PLS from which copper has been removed in a SX/EW plant. Also referred to as "barren" PLS. Raffinate is acidified to form injectate solution (lixiviant).
Recovery Well:	Well used to pump PLS to surface.
Solvent Extraction and Electowinning (SX/EW):	A two-stage process that first extracts and upgrades copper ions from low-grade leach solutions into a concentrated electrolyte, and then deposits pure copper onto cathodes using an electrolytic procedure.

Substances, Hazardous: Means:

- Any substance designated pursuant to §§ 311(b)(2)(a) and 307(a) of the Clean Water Act.
- Any element, compound, mixture, solution or substance designated pursuant to § 102 of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA).
- Any hazardous waste having the characteristics identified under or listed pursuant to § 49-922.
- Any hazardous air pollutant listed under § 112 of the Federal Clean Air Act (42 United States Code [U.S.C.] § 7412).
- Any imminently hazardous chemical substance or mixture with respect to which the administrator has taken action pursuant to § 7 of the Federal Toxic Substances Control Act (15 U.S.C. § 2606).
- Any substance which the director of the ADEQ, by rule, designates as a hazardous substance.

Sulfides: Mineral compounds such as galena, PbS, or pyrite, FeS_2, characterized by the linkage of sulfur with a metal or semi-metal

Sulfide Zone: An area of enrichment of sulfide deposits that have not yet been oxidized by near-surface waters.

Supergene: A mineral deposit or enrichment formed by descending solutions; also, refers to those solutions of that environment.

Surface Impoundment: A pit, pond or lagoon, having a surface dimension that is equal to or greater than its depth, which is used for the storage, holding, settling, treatment or discharge of liquid pollutants or pollutants containing free liquids.

Storativity/Specific Yield: Storativity and specific yield are related parameters. Storativity is defined as the amount of water released or added to storage per change in pressure due to pumping or recharge in a confined aquifer. Specific yield is the percentage of water that would drain from a unit volume of aquifer material (i.e., 1 cubic foot) in an unconfined aquifer. For coarse sands and gravel, the specific yield is roughly equal to the porosity. Storativity and specific yield control the time it will take for changes in pumping or recharge to propagate throughout an aquifer system.

Temporary Cessation: Any cessation of operation of a facility for a period of greater than 60 days but which is not intended to be permanent (A.A.C. R18-9-A209.A.1).

Transmissivity: In an aquifer, the rate at which water of the prevailing kinematic viscosity is transmitted through a unit width under a unit hydraulic gradient. Though spoken of as a property of the aquifer, it embodies also the saturated thickness and the properties of the contained liquid.

Vadose Zone: A subsurface zone containing water under pressure less than that of the atmosphere, including water held by capillarity; and containing air or gases generally under atmospheric pressure. This zone is limited above by the land surface and below by the surface of the zone of saturation, i.e. the water table.

Water Impoundment: The existing impoundment plus six proposed impoundments at the FCP that will receive neutralized ISCR solutions and associated sediments.

Well Field: Refers to the surface and subsurface area in which injection and recovery wells are, will be, or have been operating.

Zone of Endangering Influence (ZEI): Term used in one of two methods recognized in 40 CFR 146.6 for determining area of review around a well or project area. The ZEI is the lateral distance from the point of injection in which the pressures in the injection zone may cause the migration of injected or formation solutions into an underground source of drinking water.

Acronyms and Abbreviations

1996 Application	The Aquifer Protection Program Permit application submitted by BHP Copper Inc. to the Arizona Department of Environmental Quality in January 1996
A.A.C.	Arizona Administrative Code
A.R.S.	Arizona Revised Statutes
ACD	annular conductivity device
ADEQ	Arizona Department of Environmental Quality
ADWR	Arizona Department of Water Resources
AL	alert level
AOR	Area of Review
APP	Aquifer Protection Permit
AQL	aquifer quality limit
ASTM	American Society for Testing and Materials
AWQS	aquifer water quality standard
BADCT	best available demonstrated control technology
bgs	below ground surface
BHP Copper	BHP Copper Inc.
CBL	cement bond log
CFR	Code of Federal Regulations
Conoco	Continental Oil Company
CS	conductivity sensor
Florence Copper	Florence Copper Inc.
FRP	fiberglass reinforced pipe
FCP	Florence Copper Project
GIS	geographic information system
gpd	gallons per day
gpm/ft	gallons per minute per foot
gpm	gallons per minute
HDI	Hunter Dickinson Inc.
HDPE	high density polyethylene
ISCR	In-Situ Copper Recovery
LBFU	Lower Basin Fill Unit
LCRS	leak collection and removal system
MCL	maximum contaminant level
MFGU	Middle Fine-Grained Unit
mg/L	milligrams per liter
NAICS	North American Industry Classification System
pCi/L	pico Curies per liter

PLS	pregnant leach solution
POC	point of compliance
PQL	practical quantitation limit
psi/ft	pounds per square inch per foot
PTF	Production Test Facility
PVC	polyvinyl chloride
QA	quality assurance
QC	quality control
RTS	radioactive tracer study
SCIDD	San Carlos Irrigation and Drainage District
SCIP	San Carlos Irrigation Project
SIC	Standard Industrial Classification
SWS	Schlumberger Water Services
SX/EW	solvent extraction/electrowinning
UBFU	Upper Basin Fill Unit
UIC	Underground Injection Control
USDW	Underground Source of Drinking Water
USEPA	United States Environmental Protection Agency
ZEI	Zone of Endangering Influence