


Chapter 4.2
Water Management

BACKGROUND

Mines can affect water quality in many ways, including: the discharge of mine water to the environment, seepage through mine wastes to groundwater and surface water, breaches or failures of tailings and water storage facilities, chemical spills and the release of uncontrolled stormwater.

Remediation of mining-caused pollution can be extremely costly. Consequently, the design of systems to prevent surface and groundwater contamination should be a primary goal of the mining operation. Responsible mining operators can minimize water pollution by using a variety of source control approaches including: limiting infiltration of air and water to acid-generating/metal leaching waste and mined materials, collecting mine-influenced water as close to the source as possible, and carefully controlling the discharge of stormwater and treated water to the environment.

TERMS USED IN THIS CHAPTER

Acid Rock Drainage (ARD) ■ Adaptive Management ■ Affected Community ■ Background ■ Baseline ■ Basin/Catchment/Watershed ■ Collaboration ■ Competent Professionals ■ Conceptual Flow Model (CFM) ■ Conceptual Site Model (CSM) ■ Consultation ■ Dewatering ■ Ecosystem Services ■ Host Country Law ■ Metals Leaching (ML) ■ Mine Closure ■ Mining Project ■ Mitigation ■ Mitigation Hierarchy ■ Mixing Zone ■ Natural Seep/Spring ■ Offsetting ■ Operating Company ■ Pit Lake ■ Point of Compliance ■ Post-Closure ■ Practicable ■ Stakeholder ■ Stormwater ■ Tailings ■ Waste Rock ■ Water Balance ■ Water Quality Criteria ■ Whole Effluent Toxicity ■

These terms appear in the text with a dashed underline. For definitions see the Glossary of Terms at the end of the document.

Mines are often a large water user for their locale, even if not over a large region. The impacts of water used by a mining project are highly location-specific, depending on the local climate as well as on competition for water for uses other than mining. In arid regions water scarcity may be a critical concern, whereas in high rainfall regions or areas where the water table is above the level of the mine challenges arise from the need to divert water in order to develop a mine. The depletion of groundwater, surface water and springs from mine dewatering operations and general water usage by mine facilities can take decades to replenish after mining ceases, and in some instances, groundwater levels and flow directions can be altered indefinitely.

Responsible mining operators can protect water resources by using water efficiently, ensuring that total withdrawals maintain environmental flows in streams, springs and other surface waters, minimizing groundwater drawdown, and treating mine-influenced water and discharging it in ways that minimize harm to surrounding water users and environmental resources. Responsible mining operations can also clean up previously impacted water to make it usable, and in some cases provide a water supply from an alternative source.

Increasingly, responsible mining operators are aware of their operating context, and pay attention not only to their impacts but to their dependencies and opportunities as well. They are participating in collective actions to address shared water challenges and opportunities among diverse stakeholders, and are adopting approaches that lead to positive water governance outcomes at the local and regional levels. Such proactive and collaborative identification of potential water quality and quantity issues and the development of suitable management strategies adapted throughout the life cycle of a mine can help prevent or minimize surface water and groundwater contamination and impacts on water quantity.

OBJECTIVES/INTENT OF THIS CHAPTER

To manage water resources in a manner that strives to protect current and future uses of water.

SCOPE OF APPLICATION

RELEVANCE: This chapter is applicable to all mines.

NEW VS. EXISTING MINES: In 4.2.2.1, it is expected that new mines will collect baseline water quality data. Existing mines that did not collect baseline data prior to commencement of mining operations will need to demonstrate that background water quality data have been collected.

Water Management Requirements

4.2.1. Water Management Context and Collaboration at the Local and Regional Level

4.2.1.1. The operating company shall identify water users, water rights holders and other stakeholders that may potentially affect or be affected by its mine water management practices.

4.2.1.2. The operating company shall conduct its own research and collaborate with relevant stakeholders to identify current and potential future uses of water at the local and regional level that may be affected by the mine's water management practices.[215]

4.2.1.3. The operating company shall conduct its own research and collaborate with relevant stakeholders to identify and address shared water challenges and opportunities at the local and regional levels, and shall take steps to contribute positively to local and regional water stewardship outcomes.

4.2.2. Site Characterization and Prediction of Potential Impacts

4.2.2.1. The operating company shall gather baseline or background data to reliably determine:[216]

a. The seasonal and temporal variability in:
    i. The physical, chemical and biological conditions of surface waters, natural seeps/springs and groundwaters that may be affected by the mining project;
    ii. Water quantity (i.e., flows and levels of surface waters, natural seeps/springs and groundwaters) that may be affected by the mining project;[217] and

[215] "relevant stakeholders" should include water users, water rights holders, downstream communities (or communities that may be affected by groundwater withdrawals or contamination), government regulators, others engaged in work related to water management at the local or regional level, and others who may affect, be affected by or have an interest in the mine's management of water.

"local and regional level" is meant to encompass the areas that may be affected by a mine site's water use or water management practices. For IRMA purposes, the "local" area should be considered to be the particular basin/catchment/watershed where the site is located, whereas "regional" encompasses areas beyond the immediate basin/catchment/watershed.

Water-related ecosystem services are important uses to consider. (See, e.g., Grizzetti et al., 2016. "Assessing water ecosystem services for water resource management," Environmental Science and Policy. 61:194-203. https://www.sciencedirect.com/science/article/pii/S1462901116300892) They may be discussed in 4.2.1.2, but are otherwise required to be scoped, assessed and mitigated as per Chapter 4.6.

[216] New mines are expected to collect baseline data. Existing mines that did not collect baseline data prior to commencement of mining operations will need to demonstrate that background water quality data have been collected.

[217] For IRMA purposes, water quantity refers generally to the amount of water present or passing a certain location in water bodies that exist on the earth's surface, such as lakes, ponds, rivers, streams, etc., (i.e., referred to as surface waters) and water present in water bodies that exist underground (i.e., groundwaters). It also includes the amount of water that originates underground but expresses itself at the surface (e.g., natural springs or seeps). Water quantity measurements may be expressed as volumes, however, for IRMA's purposes measurements for rivers, streams and natural springs/seeps maybe expressed as a flow (in ft3/sec or m3/sec), while measurements for lakes and groundwater may be expressed as a level or elevation (e.g., feet or meters above a reference point such as sea level).

b. Sources of contamination and changes in water quantity or quality that are unrelated to the mining project.

4.2.2.2. The operating company shall carry out a scoping process that includes collaboration with relevant stakeholders to identify potentially significant impacts that the mining project may have on water quantity and quality, and current and potential future water uses. The scoping process shall include evaluation of:

a. The mining-related chemicals, wastes, facilities and activities that may pose a risk to water quality;[218] and
b. The mine's use of water, and any mining activities that may affect water quantity.

4.2.2.3. Where potential significant impacts on water quantity or quality, or current and future water uses have been identified, the operating company shall carry out the following additional analyses to further predict and quantify the potential impacts:

a. Development of a conceptual site model (CSM) to estimate the potential for mine-related contamination to affect water resources;
b. Development of a numeric mine site water balance model to predict impacts that might occur at different surface water flow/groundwater level conditions (e.g., low, average and high flows/levels);
c. If relevant, development of other numerical models (e.g., hydrogeochemical/hydrogeological) to further predict or quantify potential mining-related impacts on water resources; and
d. Prediction of whether water treatment will be required to mitigate impacts on water quality during operations and mine closure/post-closure.

4.2.2.4. Use of predictive tools and models shall be consistent with current industry best practices, and shall be continually revised and updated over the life of the mine as operational monitoring and other relevant data are collected.

4.2.3. Prevention and Mitigation of Impacts to Water

4.2.3.1. The operating company, in collaboration with relevant stakeholders, shall evaluate options to mitigate predicted significant adverse impacts on water quantity, water quality and current and potential future water uses that may be affected by the mine's water management practices. Options shall be evaluated in a manner that aligns with the mitigation hierarchy.

4.2.3.2. If a surface water or groundwater mixing zone is proposed as a mitigation strategy:

a. A risk assessment shall be carried out to identify, evaluate and document risks to human health, local economies and aquatic life from use of the proposed mixing zone, including, for surface water mixing zones, an evaluation of whether there are specific contaminants in point source discharges, such as certain metals, that could accumulate in sediment and affect aquatic life; and
b. If any significant risks are identified, the operating company shall develop mitigation measures to protect human health, aquatic life and local economies including, at minimum:
    i. Surface water or groundwater mixing zones are as small as practicable;
    ii. Water in a surface water mixing zone is not lethal to aquatic life;
    iii. A surface water mixing zone does not interfere with the passage of migratory fish;
    iv. Surface water or groundwater mixing zones do not interfere with a pre-mine use of water for irrigation, livestock or drinking water, unless that use can be adequately provided for by the

[218] Some of this information will have been gathered as per Chapter 4.1- Mine Waste and Materials Management, criterion 4.1.2 Source Characterization and Prediction.

operating company through another source of similar or better quality and volume, and the substitution is agreed to by all potentially affected water users; and

v. Point source discharges into a surface water mixing zone match the local hydrograph for surface water flows to the extent practicable.[219]

4.2.3.3. Waters affected by the mining project shall be maintained at a quality that enables safe use for current purposes and for the potential future uses identified in collaboration with relevant stakeholders (see 4.2.1.2). In particular, the operating company shall demonstrate that contaminants measured at points of compliance are:

a. Being maintained at baseline or background levels; or

b. Being maintained at levels that are protective of the identified uses of those waters (see IRMA Water Quality Criteria by End Use Tables 4.2.a to 4.2.h, which correspond to particular end uses).

[flag] **4.2.3.3 Issue in brief:** During IRMA's Launch Phase a mine site may request an exception to 4.2.3.3 if it believes there are site-specific factors that prevent it from meeting the requirement. Sites will still be expected to demonstrate that water quality is protective of identified current and future uses of water. IRMA's Technical Water Committee will review requests for exceptions (see Notes at the end of the chapter).

Additionally, IRMA is seeking input, in particular, on the proposed criteria for cyanide in IRMA Water Quality Criteria Table 4.2.a. – Aquatic Organisms - Fresh Water Quality Criteria. (For further information, see Table 4.2.a)

4.2.3.4. Unless agreed by potentially affected stakeholders, water resources affected by mining activities shall be maintained at quantities that enable continued use of those resources for current purposes and for the potential future uses identified in collaboration with relevant stakeholders (see 4.2.1.2).

4.2.4. Monitoring and Adaptive Management

4.2.4.1. The operating company shall develop and document a program to monitor changes in water quantity and quality.[220] As part of the program the operating company shall:

a. Establish a sufficient number of monitoring locations at appropriate sites to provide reliable data on changes to water quantity and the physical, chemical and biological conditions of surface waters, natural springs/seeps and groundwater (hereafter referred to as water characteristics);

b. Sample on a frequent enough basis to account for seasonal fluctuations, storm events and extreme events that may cause changes in water characteristics;

c. Establish trigger levels and/or other indicators to provide early warning of negative changes in water characteristics;

d. Sample the quality and record the quantity of mine-affected waters destined for re-use by non-mining entities;

e. Use credible methods and appropriate equipment to reliably detect changes in water characteristics; and

[219] A hydrograph is a graph or plot that shows the rate of water flow in relation to time, given a specific point or cross section.

[220] See also IRMA Chapter 4.1, criteria 4.1.4, as water monitoring that occurs here is likely to have relevance to waste management (e.g., one indicator of the effectiveness of waste management practices may be whether or not water quality is being maintained at required levels).

f. Use accredited laboratories capable of detecting contaminants at levels below the values in the IRMA Water Quality Criteria by End-Use Tables.

4.2.4.2. Samples shall be analyzed for all parameters that have a reasonable potential to adversely affect identified current and future water uses. Where baseline or background monitoring, source characterization,[221] modeling, and other site-specific information indicate no reasonable potential for a parameter to exceed the baseline/background values or numeric criteria in the IRMA Water Quality Criteria by End-Use Tables (depending on the approach used in 4.2.3.3), those parameters need not be measured on a regular basis.[222]

4.2.4.3. The operating company shall actively solicit stakeholders from affected communities to participate in water monitoring and to review and provide feedback on the water monitoring program:

a. Participation may involve the use of independent experts selected by the community; and
b. If requested by community stakeholders, costs related to participation in monitoring and review of the monitoring program shall be covered in full or in part by the company, and a mutually acceptable agreement for covering costs shall be developed.

4.2.4.4. The operating company shall develop and implement an adaptive management plan for water that:

a. Outlines planned actions to mitigate predicted impacts on current and future uses of water and natural resources from changes in surface water and groundwater quality and quantity related to the mining project; and
b. Specifies adaptive management actions that will occur if certain outcomes (e.g., specific impacts), indicators, thresholds or trigger levels are reached, and timelines for their completion.

4.2.4.5. Annually or more frequently if necessary (e.g., due to changes in operational or environmental factors) the operating company shall review and evaluate the effectiveness of adaptive management actions, and, as necessary, revise the plan to improve water management outcomes.

4.2.4.6. Community stakeholders shall be provided with the opportunity to review adaptive management plans and participate in revising the plans.

4.2.5. Data Sharing, Communications and Reporting on Water Management Performance

4.2.5.1. The operating company shall publish baseline or background data on water quantity and quality, and the following water data shall be published annually, or at a frequency agreed by stakeholders from affected communities:[223]

a. Monitoring data for surface water and groundwater points of compliance; and
b. Monitoring data for water quantity (i.e., flows and levels of surface waters, springs/seeps and groundwater), and the volume of water discharged and extracted/pumped for mining operations.

4.2.5.2. The operating company shall develop and implement effective procedures for rapidly communicating with relevant stakeholders in the event that there are changes in water quantity or quality that pose an imminent threat to human health or safety, or commercial or natural resources.

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[221] See also IRMA Chapter 4.1, criterion 4.1.2 on Source Characterization and Prediction.

[222] The comprehensive suite of parameters in IRMA Water Quality Tables should be analyzed periodically during operations, such as every five years, to ensure that no unanticipated contaminants have appeared, e.g., due to changes in ore or waste characteristics as mining progresses.

[223] Additionally, as per Chapter 1.2—Community and Stakeholder Engagement, requirement 1.2.4.3: "Communications shall be carried out and information shall be provided to stakeholders in a timely manner, and shall be in formats and languages that are culturally appropriate and accessible to affected communities and stakeholders."

4.2.5.3. The operating company shall discuss water management strategies, performance and adaptive management issues with relevant stakeholders on an annual basis or more frequently if requested by stakeholders.

NOTES

IRMA is establishing a multi-stakeholder technical water committee that will operate, at minimum, during IRMA's Launch Phase. The committee will serve two primary purposes:

- The committee will evaluate the exceptions to the numeric water quality criteria requested by mines being independently audited during the Launch Phase and determine whether or not mine site's rationale can be viewed as credibly protecting water uses/aquatic ecosystems (see 4.2.3.3); and
- Based on learning gained through evaluations of launch-phase information and stakeholder feedback, the technical water committee will help develop language for a revised water management chapter that will be included in the post-Launch phase IRMA Standard (estimated to be released in mid-to-late 2019).

CROSS REFERENCES TO OTHER CHAPTERS

CHAPTER	ISSUES
1.1—Legal Compliance	As per Chapter 1.1, if there are host country laws that pertain specifically to the topics addressed in any IRMA chapter the operating company is required to abide by those laws. If IRMA requirements are more stringent than host country law, the company is required to also meet the IRMA requirement, as long as complying with it would not require the operating company to break the host country law. E.g., if host country water quality criteria are more protective of human health or the environment than IRMA requirements, the host country requirements supersede IRMA requirements.
1.2—Community and Stakeholder Engagement	The requirements to consult or collaborate with stakeholders regarding mine water management (in 4.2.1.2, 4.2.1.3, 4.2.4.1) shall conform with IRMA stakeholder engagement requirements in Chapter 1.2. This includes determining if the stakeholders have the capacity to effectively participate in discussions, and provision for access to independent experts if necessary to ensure meaningful engagement in water monitoring (requirement 4.2.5.3). Similarly, communications with stakeholders (e.g., in 4.2.1.2, 4.2.1.3, 4.2.4.1 and 4.2.6) shall conform with requirements in 1.2.4, which require that communications and information are in culturally appropriate formats and languages that are accessible and understandable to affected stakeholders, and are provided in a timely manner, and requirement 1.2.2.2 requires dialogue and meaningful engagement that includes providing stakeholders with feedback on how their input has been taken into account.
1.3—Human Rights Due Diligence	In 2010, the United Nations recognized the right to safe and clean drinking water and sanitation as a human right that is essential for the full enjoyment of life and all human rights. The potential for the mining project to infringe on this right should be evaluated as part of human rights due diligence in Chapter 1.3.
1.4—Complaints and Grievance Mechanism and Access to Remedy	If not resolved by other means, issues related to mining-related water impacts may be discussed and resolved through the mine's operational-level grievance mechanism (see IRMA Chapter 1.4).
2.1-Environmental and Social Impact Assessment and Management	Scoping of impacts related to water may have been done as part of the Environmental, and Social Impact Assessment process (See 2.1.3). If potential impacts were identified during scoping, they should have been further assessed as per 4.2.2.

CROSS REFERENCES TO OTHER CHAPTERS	
2.6—Planning and Financing Reclamation and Closure	The need for long-term water treatment (i.e., post-closure) should have been evaluated in Chapter 4.2, requirement 4.2.2.3.d. If it is predicted to be necessary, Chapter 2.6 includes additional requirements for a risk assessment prior to long-term water treatment (see 2.6.6.1), and provision of financial assurance to cover the cost of long-term water treatment (see 2.6.7.2). Also, the conceptual site model, site water balance and numerical hydrogeochemical or hydrogeological models mentioned in 4.2.2.3, if used, can and should inform reclamation and closure planning (e.g., areas requiring soil remediation, whether wet or dry closure will be possible, the potential future impacts of climate change on the site, the water quality and quantity at closure, and potential to avoid long-term water treatment).
4.1—Waste and Materials Management	Mine waste management has potential implications for water management. As a result, Chapter 4.2, similar to 4.1, addresses characterization of wastes, water balance, chemical modeling and Conceptual Site Models (see 4.2.2), prevention of water contamination through management of mine wastes (see 4.2.3), and mitigation and monitoring of waters that may be contaminated by mine wastes (see 4.2.3 and 4.2.4, respectively).
4.3—Air Quality	The conceptual site model may provide information that will be useful to air quality assessment, as air is one pathway for contaminants to travel.
4.6—Biodiversity, Ecosystem Services and Protected Areas	Mining-related impacts on water and mine water management practices may affect biodiversity (e.g., affect habitat or water supply for threatened and endangered species), ecosystem services (e.g., reduce flood regulation, availability of drinking water), or mining may affect waters located in protected areas. Potential impacts related to biodiversity, ecosystem services or protected areas should have been scoped either during the Biodiversity, Ecosystem Services and Protected Areas screening process (see criteria 4.6.2) or as per Site Characterization and Prediction of Potential Impacts in Chapter 4.2 (see 4.2.2). If potential impacts are identified in either case, the significance of the potential impacts should be further assessed (as per 4.6.3), and mitigation developed accordingly to 4.6.4.
4.7—Cyanide Management	If cyanide is transported to, stored or used on site, monitoring of cyanide in surface water and groundwaters is required in Chapter 4.7 (see 4.7.4). Monitoring of cyanide in water may be incorporated into the water management program in Chapter 4.2 (see criteria 4.2.4).
4.8—Mercury Management	Monitoring of mercury released to water may be required as part of the mercury monitoring plan (See 4.8.3). Mercury monitoring in water may be incorporated into the water management program in Chapter 4.2 (see criteria 4.2.4).

[flag] **Issue in brief:** IRMA is seeking input on the proposed criteria for cyanide in IRMA Water Quality Criteria by End-Use Table 4.2.a. Aquatic Organisms - Fresh Water Quality Criteria.

The International Cyanide Management Code ("the Cyanide Code") was developed through a multi-stakeholder process as an effort to improve the management of cyanide at gold, and in 2017 also silver mines. The Cyanide Code's Implementation Guidance states that: "Discharges to surface waters should not exceed 0.5 mg/l WAD cyanide nor result in a concentration of free cyanide in excess of 0.022 mg/l within the receiving surface water body, and downstream of any mixing zone approved by the applicable jurisdiction. The 0.022 mg/l guideline is from the United States Environmental Protection Agency's National Water Quality Criteria for Cyanide, and represents a concentration to which a freshwater aquatic community can be briefly exposed without resulting in an unacceptable effect." (Guidance for Standard of Practice 4.5. https://www.cyanidecode.org/become-signatory/implementation-guidance)

There is concern among some stakeholder groups, however, that a lower value may be necessary, as some aquatic species are more sensitive to cyanide's effects, and several regulatory jurisdictions have a set a cyanide limit between 0.004 and 0.007 mg/L for the protection of aquatic life. As per IRMA Chapter 1.1, if there are lower limits set by a host country, mines in those jurisdictions are expected to meet those limits.

Although it is not as stringent a standard as found in some countries, it is hoped that the 0.022 mg/l limit in the Launch Phase version of the IRMA Standard will begin to spur improvements in cyanide management at mining operations located in countries that do not have strong regulatory programs.

During IRMA's Launch Phase, we will be gathering data to better understand what levels of cyanide are achievable in surface waters at existing mines, and whether aquatic impacts related to cyanide are being experienced at sites that are meeting the 0.022 mg/l guidelines set by the Cyanide Code. Depending on the outcomes, IRMA may revise its cyanide criteria to provide greater protections for aquatic organisms.

IRMA Water Quality Criteria by End-Use Tables

4.2.a—Aquatic Organisms - Fresh Water Quality Criteria

4.2.b—Aquatic Organisms - Salt Water Quality Criteria

4.2.c—Drinking Water and Human Health Quality Criteria

4.2.d—Agriculture - Irrigation Water Quality Criteria

4.2.e—Agriculture - Irrigation Water Quality Criteria

4.2.f—Aquaculture Water Quality Criteria

4.2.g—Recreational Water Quality Criteria

4.2.h—Industrial Water Quality Criteria

Abbreviations

Bq/L = Becquerel per Liter
$CaCO_3$ = calcium carbonate
degC = degrees centigrade
mg/L = milligrams per Liter
s.u. = standard units
Tot. = Total
µg/L = micrograms per Liter
WAD = weak acid dissociable

Note: Data and rationale for IRMA and end-use criteria values are available upon request.

TABLE 4.2.a. – Aquatic Organisms - Fresh Water Quality Criteria										
Metals / Metalloids[1]	**Units**		**Criteria**	**Source**		**Non-Metals / Anions[1]**	**Units**		**Criteria**	**Source**
Aluminum	µg/L		55	AUS-NZ		Alkalinity (as CaCO3)	mg/L		measure	
Antimony	µg/L		-			Ammonia (Tot)	mg/L		X**	USA
Arsenic	µg/L		24	AUS-NZ		Chlorine	µg/L		3	AUS-NZ
Barium	µg/L		-	PER, CHI		Chloride	mg/L		230	USA
Boron	µg/L		750	PHI						
Beryllium	µg/L		-			Cyanide (Free/*WAD*)	µg/L		22	Cyanide Code
Cadmium	µg/L		X*	USA						
Calcium	mg/L		measure			Dissolved Organic Carbon	mg/L		measure	
Chromium (Tot)	µg/L		-			Dissolved Oxygen	mg/L		measure	
Chromium (III)	µg/L		X*	USA		Fluoride	mg/L		1	PHI
Chromium (VI)	µg/L		11	USA, PE		Hardness	mg/L		measure	
Cobalt	µg/L		-			Hydrogen Sulfide	mg/L		****	
Copper	µg/L		X*	USA, CAN		Nitrate & Nitrite	mg/L		-	
Iron	µg/L		1000	USA		Nitrate (as NO_3^-)	mg/L		13	CAN, PER
Lead	µg/L		X*	USA, CAN		Nitrite (as NO_2^-)	mg/L		-	
Magnesium	mg/L		measure			Nitrogen, tot. as N	mg/L		measure	
Manganese	µg/L		370	SAF		pH	s.u.		6.5 - 9.0	US, CAN
Mercury	µg/L		0.1	PER, EU, SAF		Sulfate	mg/L		-	
Molybdenum	µg/L		73	CAN		Temperature	degC		<3 diff	IFC
Nickel	µg/L		X*	USA		Total Dissolved Solids	mg/L		-	
Potassium	mg/L		measure			Total Suspended Solids	mg/L		40	Between CAN and IFC ***
Radium 226/228	Bq/L		-							
Selenium	µg/L		5	USA, SAF, AUS-NZ						
Silver	µg/L		0.25	CAN						
Sodium	mg/L		measure							
Thallium	µg/L		0.8	CAN, PER						
Uranium	µg/L		-							
Vanadium			-							
Zinc	µg/L		X*	USA						

Notes: * Use USEPA Hardness-based or Biotic Ligand Model (BLM) calculations for metals; ** and Temperature and pH-based calculations for Ammonia. *** Baseline /background likely to be higher at many sites. See 4.2.3.3.a. **** A limit for Hydrogen Sulfide is not included because the methods available for analyses are presently well below the Method Reporting Limit (The lowest amount of an analyte in a sample that can be quantitatively determined with stated, acceptable precision and accuracy under stated analytical conditions, i.e. the lower limit of quantitation). However, if there is some reason to believe that sulfide is present, then it should be measured.

Abbreviations for Sources/ Standards: AUS-NZ = Australia and New Zealand; CAN = Canada; CHI = China; EU = European Union; IFC = International Finance Corporation; PER =Peru, PHI =Philippines; SAF = South Africa; USA = United States. (References listed at end of tables).

TABLE 4.2.b. – Aquatic Organisms - Salt Water Quality Criteria

Metals / Metalloids[1]	Units	Criteria	Source		Non-Metals / Anions	Units	Criteria	Source
Aluminum	µg/L	-			Alkalinity (as CaCO3)	mg/L	-	
Antimony	µg/L	-			Ammonia (Total)	mg/L	X *	AUS-NZ
Arsenic	µg/L	12.5	CAN		Chlorine	µg/L	0.5	CAN
Barium	µg/L	-			Chloride	mg/L	-	
Beryllium	µg/L	-			Cyanide (Chronic - Free / *WAD*)	µg/L	4	AUS-NZ, PER
Cadmium	µg/L	4	SAF		Fluoride	mg/L	-	
Calcium	mg/L	-			Hardness	mg/L	-	
Chromium (Total)	µg/L	-			Hydrogen Sulfide	mg/L	***	US, PER
Chromium (III)	µg/L	27.4	AUS-NZ		Nitrate & Nitrite	mg/L	-	
Chromium (VI)	µg/L	4.4	AUS-NZ		Nitrate (NO_3^-)	mg/L	13 **	AUS
Cobalt	µg/L	-			Nitrite (NO_2^-)	mg/L	-	
Copper	µg/L	3.1	US		Nitrogen, total (as N)	mg/L	-	
Iron	µg/L	-			pH (standard units)	s.u.	6.5- 8.7	US, CAN
Lead	µg/L	8.1	US, PER		Sulfate	mg/L	-	
Magnesium	mg/L	-			Temperature	degC	-	
Manganese	µg/L	-			Total Dissolved Solids	mg/L	-	
Mercury	µg/L	0.4	AUS-NZ		Total Suspended Solids	mg/L	-	
Molybdenum	µg/L	-						
Nickel	µg/L	70	PHI					
Potassium	mg/L	-						
Radium 226/228	Bq/L	-						
Selenium	µg/L	71	US, PER					
Silver	µg/L	1.4	US, AUS-NZ					
Sodium	mg/L	-						
Thallium	µg/L	-						
Uranium	µg/L	-						
Vanadium	µg/L	100	AUS-NZ					
Zinc	µg/L	15	AUS-NZ					

Notes: * Calculated value based on temperature and pH. ** From Vol. 2, Chapter 8 of AUS-NZ (2000). Guidelines for Fresh and Marine Water Quality, p. 8-3-169. (See references at end of tables). *** A limit for Hydrogen Sulfide is not included because the methods available for analyses are presently well below the Method Reporting Limit (The lowest amount of an analyte in a sample that can be quantitatively determined with stated, acceptable precision and accuracy under stated analytical conditions, i.e. the lower limit of quantitation). However, if there is some reason to believe that sulfide is present, then it should be measured.

Abbreviations for Sources/ Standards: AUS-NZ = Australia and New Zealand; CAN = Canada; PER =Peru, PHI =Philippines; SAF = South Africa; USA = United States. (References listed at end of tables).

TABLE 4.2.c. –Drinking Water and Human Health Quality Criteria			
Metals / Metalloids	**Units**	**Criteria**	**Source**
Aluminum	µg/L	100	CAN, WHO
Antimony	µg/L	6	USA, CAN
Arsenic	µg/L	10	USA, CAN, AUS, EU, SAF, WHO
Barium	µg/L	1000	CAN, PER
Beryllium	µg/L	60	AUS
Cadmium	µg/L	5	USA, CAN, EU, SAF, CHI, PER
Chromium (Total)	µg/L	50	CAN, AUS, EU, WHO, SAF, CHI, PER
Copper	µg/L	1000	USA, CAN, AUS
Iron	µg/L	300	USA, CAN, AUS, SAF, CHI
Lead	µg/L	10	CAN, AUS, EU, SA, WHO, CHI, PER
Manganese	µg/L	50	USA, CAN, EU, SAF
Mercury	µg/L	1	CAN, AUS, EU, SAF, PER, PHI
Molybdenum	µg/L	50	AUS
Nickel	µg/L	20	AUS, EU, CHI, PHI
Radium 226/228	Bq/L	13.5	CAN, AUS
Selenium	µg/L	40	WHO, PER
Silver	µg/L	100	USA, AUS
Thallium	µg/L	2	USA
Uranium	µg/L	30	USA, WHO
Zinc	µg/L	3000	AUS, SAF, PER
Non-Metals / Ions	**Units**	**Criteria**	**Source**
Alkalinity (as CaCO3)	mg/L	-	
Ammonia	mg/L	0.5	AUS, EU, PER
Chlorine	mg/L	5	AUS, WHO
Chloride	mg/L	250	AUS, USA, CAN
Cyanide (Free or WAD)	µg/L	80	AUS
Fluoride	mg/L	1.5	CAN, AUS, EU, WHO, PER
Hydrogen Sulfide (as S^{2-})	mg/L	*	
Nitrate (as NO_3^-)	mg/L	45	CAN, USA, CHI
Nitrite (as NO_2^-)	mg/L	3.3	CAN, USA, CHI
pH (standard units)	s.u.	6.5 - 8.5	USA, CAN, AUS, CHI, PHI
Sulfate	mg/L	400	Value between CAN, PER and USA, WHO, CHI
Total Dissolved Solids	mg/L	500	USA, CAN

Notes: * A limit for Hydrogen Sulfide is not included because the methods available for analyses are presently well below the Method Reporting Limit (The lowest amount of an analyte in a sample that can be quantitatively determined with stated, acceptable precision and accuracy under stated analytical conditions, i.e. the lower limit of quantitation). However, if there is some reason to believe that sulfide is present, then it should be measured.

Abbreviations for Sources/ Standards: AUS = Australia; CAN = Canada; CHI = China; EU = European Union; IFC = International Finance Corporation; PER =Peru, PHI =Philippines; SAF = South Africa; USA = United States; WHO = World Health Organization of the United Nations;. (References listed at end of tables).

TABLE 4.2.d. – Agriculture - Irrigation Water Quality Criteria			
Metals / Metalloids	**Units**	**Criteria**	**Source**
Aluminum	µg/L	5000	CAN, USA, AUS-NZ, SAF, FAO, PER
Antimony	µg/L	-	
Arsenic	µg/L	100	USA, AUS-NZ, SAF, FAO, PER
Barium	µg/L	-	
Beryllium	µg/L	100	USA, CAN, AUS-NZ, SAF, FAO, PER
Boron	µg/L	750	PHI
Cadmium	µg/L	10	USA, AUS-NZ, SAF, FAO, PER
Chromium (Total)	µg/L	100	USA, AUS-NZ, FAO, SAF, PER
Cobalt	µg/L	50	USA, AUS-NZ, CCME, FAO, SAF, PER
Copper	µg/L	200	USA, AUS-NZ, CCME, FAO, SAF
Iron	µg/L	5000	USA, CAN, FAO, SAF, PER
Lead	µg/L	200	CAN, SAF
Manganese	µg/L	200	CAN, AUS-NZ, FAO, PER, PHI
Mercury	µg/L	2	AUS-NZ , PHI
Molybdenum	µg/L	10	USA, CAN, AUS-NZ, SAF, FAO
Nickel	µg/L	200	USA, CAN, AUS-NZ, SAF, FAO, PER, PHI
Radium 228	Bq/L	-	
Selenium	µg/L	20	USA, CAN, AUS-NZ, SAF, PER, PHI
Silver	µg/L	-	
Thallium	µg/L	-	
Uranium	µg/L	100	AUS-NZ
Vanadium	µg/L	100	USA, CAN, AUS-NZ, FAO
Zinc	µg/L	2000	USA, FAO, PER, PHI
Non-Metals / Anions	**Units**	**Criteria**	**Source**
Alkalinity (as CaCO3)	mg/L	-	
Chlorine	mg/L	175	CAN
Chloride	mg/L	100	CAN, SAF
Cyanide (Free or WAD)	µg/L	-	
Fluoride	mg/L	1	USA, CAN, FAO, PER
Nitrate & Nitrite	mg/L	-	
Nitrate	mg/L	-	
Nitrite	mg/L	-	
pH (standard units)	s.u.	6.5 - 8.4	USA, SAF, FAO
Sulfate	mg/L	1000	AUS-NZ, PER
Total Dissolved Solids	mg/L	500 – 3500*	CAN
Total Suspended Solids	mg/L	-	

Notes: * 500 mg/L for berries, stone fruit, and some vegetables; 3500 mg/L for asparagus, some grains and other vegetables (see Canadian Council of Ministers of the Environment for more information. http://st-ts.ccme.ca/en/index.html?lang=en&factsheet=215)

Abbreviations for Sources/ Standards: AUS-NZ = Australia and New Zealand; CAN = Canada; FAO = Food and Agriculture Organization of the United Nations; PER =Peru, PHI =Philippines; SAF = South Africa; USA = United States. (References listed at end of tables).

TABLE 4.2.e. – Agriculture - Livestock Water Quality Criteria			
Metals / Metalloids	**Units**	**Criteria**	**Source**
Aluminum	µg/L	5000	USA, CAN, AUS-NZ, SAF, FAO, PER
Antimony	µg/L	-	
Arsenic	µg/L	200	USA, PER
Barium	µg/L	-	
Beryllium	µg/L	100	CAN, PER
Boron	µg/L	5000	CAN, AUS-NZ, PER
Cadmium	µg/L	50	USA, PER
Chromium (Total)	µg/L	1000	USA, AUS-NZ, SAF, PER
Cobalt	µg/L	1000	USA, CAN, AUS-NZ, SAF, PER
Copper	µg/L	500	USA, CAN, AUS-NZ, SAF, PER
Iron	µg/L	10000	SAF
Lead	µg/L	100	USA, CAN, AUS-NZ, SAF
Manganese	µg/L	200	AUS-NZ, PER, PHI
Mercury	µg/L	3	CAN
Molybdenum	µg/L	300	USA
Nickel	µg/L	1000	CAN, AUS-NZ, SAF, PER, PHI
Radium 228	Bq/L	-	
Selenium	µg/L	50	USA, CAN, SAF, PER
Silver	µg/L	-	
Thallium	µg/L	-	
Uranium	µg/L	200	CAN, AUS-NZ
Vanadium	µg/L	100	USA, CAN
Zinc	µg/L	24000	USA, PER
Non-Metals / Anions	**Units**	**Criteria**	**Source**
Alkalinity (as CaCO3)	mg/L	-	
Chlorine	mg/L	-	
Chloride	mg/L	-	CAN, SAF
Cyanide (Free or WAD)	µg/L	-	
Fluoride	mg/L	2	USA, CAN, AUS-NZ, PER
Nitrate & Nitrite (NO_3-N + NO_2-N)	mg/L	100	CAN, AUS-NZ
Nitrate (as NO_3-N)	mg/L	-	
Nitrite (as NO_2-N)	mg/L	10	USA, CAN, PER
pH (standard units)	s.u.	6.5 - 8.4	PER
Sulfate	mg/L	1000	AUS-NZ, PER
Total Dissolved Solids	mg/L	3000	CAN
Total Suspended Solids	mg/L	-	

Abbreviations for Sources/ Standards: AUS-NZ = Australia and New Zealand; CAN = Canada; FAO = Food and Agriculture Organization of the United Nations; PER =Peru, PHI =Philippines; SAF = South Africa; USA = United States. (References listed at end of tables).

TABLE 4.2.f. – Aquaculture Water Quality Criteria				
Metals / Metalloids	**Units**	**Fresh Criteria**	**Marine Criteria**	**Source**
Aluminum	µg/L	30	10	AUS, SAF
Antimony	µg/L	-	-	
Arsenic	µg/L	50	30	AUS, PER, SAF
Barium	µg/L	-	-	
Beryllium	µg/L	-	-	
Cadmium	µg/L	X *	X *	AUS, SAF
Chromium (VI)	µg/L	100	50	PER, PHI
Cobalt	µg/L	-	-	
Copper	µg/L	X *	X *	AUS
Iron	µg/L	10	10	AUS, SAF
Lead	µg/L	X *	X *	AUS
Manganese	µg/L	10	10	AUS
Mercury	µg/L	1	1	AUS, SAF
Molybdenum	µg/L	-	-	
Nickel	µg/L	100	100	AUS
Radium 226/228	Bq/L	-	-	
Selenium	µg/L	10	10	AUS, PHI
Thallium	µg/L	-	-	
Uranium	µg/L	-	-	
Zinc	µg/L	5	5	AUS
Non-Metals / Anions	**Units**	**Fresh Criteria**	**Marine Criteria**	**Source**
Alkalinity (as CaCO3)	mg/L	-	-	
Ammonia (Total)	µg/L	20	100	AUS
Chlorine	µg/L	-	-	
Chloride	mg/L	-	-	
Cyanide (Free or WAD)	µg/L	5	5	AUS, PER
Fluoride	mg/L	20	5	AUS, SAF
Hydrogen Sulfide	mg/L	**	**	
Nitrate & Nitrite	mg/L	-	-	
Nitrate (as NO_3^-)	mg/L	50	100	AUS
Nitrite (as NO_2^-)	mg/L	0.1	0.1	AUS
pH (standard units)	s.u.	6.5 - 9.0	6.0 - 9.0	AUS, WHO
Sulfate	mg/L	-	-	
Temperature	degC	<2 diff	<2 diff	AUS
Total Dissolved Solids	mg/L	-	-	
Total Suspended Solids	mg/L	40	40	AUS, PER

Notes: * Hardness dependent. ** A limit for Hydrogen Sulfide is not included because the methods available for analyses are presently well below the Method Reporting Limit (The lowest amount of an analyte in a sample that can be quantitatively determined with stated, acceptable precision and accuracy under stated analytical conditions, i.e. the lower limit of quantitation). However, if there is some reason to believe that sulfide is present, then it should be measured.

Abbreviations for Sources/ Standards: AUS = Australia; PER = Peru; PHI =Philippines; SAF = South Africa; WHO = World Health Organization. (References listed at end of tables).

TABLE 4.2.g. – Recreational Water Quality Criteria			
Metals / Metalloids	**Units**	**Criteria**	**Source**
Aluminum	µg/L	200	AUS-NZ, PER
Antimony	µg/L	-	
Arsenic	µg/L	10	PER, PHI
Barium	µg/L	700	PER, PHI
Beryllium	µg/L	-	
Boron	µg/L	500	PER, PHI
Cadmium	µg/L	5	AUS-NZ
Chromium (Total)	µg/L	50	AUS-NZ, PER
Cobalt	µg/L	-	
Copper	µg/L	1000	AUS-NZ
Iron	µg/L	300	AUS-NZ, PER
Lead	µg/L	10	AUS-NZ
Manganese	µg/L	100	AUS-NZ, PER
Mercury	µg/L	1	AUS-NZ, PER
Molybdenum	µg/L	-	
Nickel	µg/L	40	PHI
Radium 226/228	Bq/L	-	
Selenium	µg/L	10	AUS-NZ, PER
Silver	µg/L	50	AUS-NZ
Thallium	µg/L	-	
Uranium	µg/L	-	
Vanadium	µg/L	-	
Zinc	µg/L	3000	PER
Non-Metals / Anions	**Units**	**Criteria**	**Source**
Alkalinity (as CaCO3)	mg/L	-	
Ammonia (Total)	mg/L	-	
Chlorine	mg/L	-	
Chloride	mg/L	400	AUS-NZ
Cyanide (Free or WAD)	µg/L	100	AUS-NZ
Fluoride	mg/L	-	
Hardness	mg/L	-	
Hydrogen Sulfide	mg/L	*	
Nitrate & Nitrite	mg/L	-	
Nitrate (as NO_3-N)	mg/L	10	AUS-NZ, PER
Nitrite (as NO_2-N)	mg/L	1	AUS-NZ, PER
pH (standard units)	s.u.	6.5 - 8.5	AUS-NZ, SAF, PHI
Sulfate	mg/L	400	AUS-NZ
Total Dissolved Solids	mg/L	-	
Total Suspended Solids	mg/L	30	USA, PHI

Notes: * Hydrogen Sulfide is not included because the methods available for analyses are presently well below the Method Reporting Limit (The lowest amount of an analyte in a sample that can be quantitatively determined with stated, acceptable precision and accuracy under stated analytical conditions, i.e. the lower limit of quantitation). However, if there is some reason to believe that sulfide is present, then it should be measured.

Abbreviations for Sources/ Standards: AUS-NZ = Australia and New Zealand; PER = Peru; PHI =Philippines; SAF = South Africa; USA = United States. (References listed at end of tables).

TABLE 4.2.h. – Industrial Water Quality Criteria			
Metals / Metalloids	**Units**	**Criteria**	**Source**
Aluminum	µg/L	-	
Antimony	µg/L	-	
Arsenic	µg/L	-	
Barium	µg/L	-	
Beryllium	µg/L	-	
Cadmium	µg/L	-	
Chromium (Total)	µg/L	-	
Cobalt	µg/L	-	
Copper	µg/L	-	
Iron	µg/L	-	
Lead	µg/L	-	
Manganese	µg/L	-	
Mercury	µg/L	-	
Molybdenum	µg/L	-	
Nickel	µg/L	-	
Radium 226/228	Bq/L	-	
Selenium	µg/L	-	
Silver	µg/L	-	
Thallium	µg/L	-	
Uranium	µg/L	-	
Vanadium	µg/L	-	
Zinc	µg/L	-	
Non-Metals / Anions	**Units**	**Criteria**	**Source**
Alkalinity (as CaCO3)	mg/L	-	
Chlorine	mg/L	1	USA
Chloride	mg/L	-	
Cyanide (Free or WAD)	µg/L	-	
Fluoride	mg/L	-	
Nitrate & Nitrite	mg/L	-	
Nitrates	mg/L	-	
Nitrites	mg/L	-	
pH (standard units)	s.u.	6.0 -9.0	USA
Sulfate	mg/L	-	
Total Suspended Solids	mg/L	30	USA
Total Dissolved Solids	mg/L	-	
Abbreviations for Sources/ Standards: USA = United States. (References listed at end of tables).			

REFERENCES FOR SOURCE MATERIALS USED IN TABLES

REFERENCES FOR TABLE 4.2.A.

AUS-NZ Australian and New Zealand Environment and Conservation Council. 2000. Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Volume 1. http://www.agriculture.gov.au/SiteCollectionDocuments/water/nwqms-guidelines-4-vol1.pdf

CAN Canadian Council of Ministers of the Environment. Canadian Water Quality Guidelines for the Protection of Aquatic Life. Available at: http://ceqg-rcqe.ccme.ca/en/index.html

CHI People's Republic of China. 2002. Environmental quality standard for surface water (GB 3838-2002). English version not found. Available in: Zhao et al. 2016. "Amendment of water quality standards in China: viewpoint on strategic considerations," Environmental Quality Benchmarks for Aquatic Ecosystem Protection: Derivation and Application. https://www.usask.ca/toxicology/jgiesy/pdf/publications/JA-931-temp.pdf

EU European Union. 2013. Directive 2013/39/EU of the European Parliament and of the Council of 12 August 2013 amending Directives 2000/60/EC and 2008/105/EC as regards priority substances in the field of water policy. https://publications.europa.eu/en/publication-detail/-/publication/296e91b8-4610-11e3-ae03-01aa75ed71a1/language-en

IFC International Finance Corporation. 2007. Environmental, Health and Safety Guidelines for Mining. https://www.ifc.org/wps/wcm/connect/1f4dc28048855af4879cd76a6515bb18/Final+-+Mining.pdf?MOD=AJPERES

PER Peru Ministry of Environment (MINAM). 2015. National Environmental Quality Standards for Water (2015). http://www.ana.gob.pe/sites/default/files/normatividad/files/ds-ndeg-015-2015-minam.pdf

PHI Republic of the Philippines. 2016. Water Quality Guidelines and General Effluent Standards of 2016. http://wepa-db.net/3rd/en/topic/waterstandard/Philippines_Water%20Quality%20Guideline_2016.pdf

SAF South Africa. 1996. South African Water Quality Guidelines. Volume 7: Aquatic Ecosystems, 2nd Ed. http://www.dwa.gov.za/iwqs/wq_guide/Pol_saWQguideFRESHAquaticecosystemsvol7.pdf

USA US Environmental Protection Agency. National Recommended Water Quality Criteria - Aquatic Life Criteria Table. https://www.epa.gov/wqc/national-recommended-water-quality-criteria-aquatic-life-criteria-table

REFERENCES FOR TABLE 4.2.B. (LISTED ONLY IF DIFFERENT SOURCES THAN 4.2.A)

SAF South Africa. 1995. Water Quality Guidelines for Coastal Marine Waters, Volume 1. Available at: http://www.iwa-network.org/filemanager-uploads/WQ_Compendium/Database/Future_analysis/085.pdf

REFERENCES FOR TABLE 4.2.C.

AUS Australia National Health and Medical Research Council. 2017. Australian Drinking Water Quality Guidelines 6 (2011). https://www.nhmrc.gov.au/_files_nhmrc/file/publications/nhmrc_adwg_6_version_3.4_final.pdf

CAN Health Canada. 2017. Guidelines for Canadian Drinking Water Quality: Summary Table. Available at: https://www.canada.ca/en/health-canada/services/environmental-workplace-health/reports-publications/water-quality/guidelines-canadian-drinking-water-quality-summary-table.html

CHI People's Republic of China. 2006. Standards for Drinking Water Quality. GB 5749-2006. English version available at: http://www.iwa-network.org/filemanager-uploads/WQ_Compendium/Database/Selected_guidelines/016.pdf

EU European Union. 1998. EU Council Directive 98/83/EC of 3 November 1998 on the quality of water intended for human consumption. http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:01998L0083-20151027

PER Peru Ministry of Environment (MINAM). 2015. National Environmental Quality Standards for Water (2015). http://www.ana.gob.pe/sites/default/files/normatividad/files/ds-ndeg-015-2015-minam.pdf

PHI Republic of the Philippines. 2016. Water Quality Guidelines and General Effluent Standards of 2016. http://wepa-db.net/3rd/en/topic/waterstandard/Philippines_Water%20Quality%20Guideline_2016.pdf

SAF South Africa. 1996. South African Water Quality Guidelines. Volume 1: Domestic Use. 2nd Ed. http://www.dwa.gov.za/iwqs/wq_guide/Pol_saWQguideFRESH_vol1_Domesticuse.PDF

USA US Environmental Protection Agency. 2018. Drinking Water Standards and Health Advisory Tables. https://www.epa.gov/sites/production/files/2018-03/documents/dwtable2018.pdf

WHO World Health Organization. 2011. Guidelines for Drinking Water Quality. http://www.who.int/water_sanitation_health/water-quality/guidelines/en/

REFERENCES FOR TABLE 4.2.D.

AUS-NZ Australian and New Zealand Environment and Conservation Council. 2000. Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Volume 1. http://www.agriculture.gov.au/SiteCollectionDocuments/water/nwqms-guidelines-4-vol1.pdf

CAN Canadian Council of Ministers of the Environment. Various years. Canadian Water Quality Guidelines for the Protection of Agriculture. Searched by individual factsheet. http://ceqg-rcqe.ccme.ca/en/index.html

FAO Ayers, R and Westcot, D. 1985. Water Quality for Agriculture. FAO Irrigation and Drainage Paper 29 (last updated 1994). http://www.fao.org/docrep/003/t0234e/t0234e00.HTM

PER Peru Ministry of Environment (MINAM). 2015. National Environmental Quality Standards for Water (2015). http://www.ana.gob.pe/sites/default/files/normatividad/files/ds-ndeg-015-2015-minam.pdf

PHI Republic of the Philippines. 2016. Water Quality Guidelines and General Effluent Standards of 2016. http://wepa-db.net/3rd/en/topic/waterstandard/Philippines_Water%20Quality%20Guideline_2016.pdf

SAF South Africa. 1996. South African Water Quality Guidelines. Volume 4: Agricultural Use: Irrigation. 2nd Ed. http://www.dwaf.gov.za/iwqs/wq_guide/Pol_saWQguideFRESH_vol4_Irrigation.pdf

USA US Environmental Protection Agency. 2012. Guidelines for Water Reuse. EPA/600/R-12/618. https://www3.epa.gov/region1/npdes/merrimackstation/pdfs/ar/AR-1530.pdf

REFERENCES FOR TABLE 4.2.E. (IF DIFFERENT FROM TABLE 4.2.D)

SAF South Africa. 1996. South African Water Quality Guidelines. Volume 5: Agricultural Use: Livestock Watering. 2nd Ed. http://www.dwaf.gov.za/iwqs/wq_guide/Pol_saWQguideFRESH_vol5_Livestockwatering.pdf

REFERENCES FOR TABLE 4.2.F. (IF DIFFERENT FROM TABLE 4.2.D)

SAF South Africa. 1996. South African Water Quality Guidelines. Vol. 6: Agricultural Use: Aquaculture. 2nd Ed. http://www.iwa-network.org/filemanager-uploads/WQ_Compendium/Database/Future_analysis/077.pdf

SAF South Africa. 1995. Water Quality Guidelines for Coastal Marine Waters, Vol. 4: Mariculture. Available at: http://www.iwa-network.org/filemanager-uploads/WQ_Compendium/Database/Future_analysis/084.pdf

REFERENCES FOR TABLE 4.2.G. (IF DIFFERENT FROM TABLE 4.2.D)

SAF South Africa. 1996. Water Quality Guidelines. Vol. 2: Recreational Use. Available at: http://www.iwa-network.org/filemanager-uploads/WQ_Compendium/Database/Future_analysis/084.pdf

REFERENCES FOR TABLE 4.2.H. (IF DIFFERENT FROM TABLE 4.2.D)

None.