NOTICES OF FINAL RULEMAKING

The Administrative Procedure Act requires the publication of the final rules of the state's agencies. Final rules are those which have appeared in the *Register* first as proposed rules and have been through the formal rulemaking process including approval by the Governor's Regulatory Review Council. The Secretary of State shall publish the notice along with the Preamble and the full text in the next available issue of the *Register* after the final rules have been submitted for filing and publication.

NOTICE OF FINAL RULEMAKING

TITLE 12. NATURAL RESOURCES

CHAPTER 4. GAME AND FISH COMMISSION

PREAMBLE

1. Sections Affected **Rulemaking Action**

R12-4-108 Amend

2. The specific authority for the rulemaking, including both the authorizing statute (general) and the statutes the rules are implementing (specific):

Authorizing statutes: A.R.S. §§ 17-231(A)(1)(2), and (3) for all rules

Implementing statute: A.R.S. § 17-245 for R12-4-108

3. The effective date of the rules:

The effective date for the rule will be July 1, 2001. The effective date was changed from January 1, 2000, because the yearlong hunt season begins on July 1 and runs through June 30. An effective date of July 1, 2001, will allow for the boundary unit changes to appear in the Fall Hunt Regulations (published in May 2001). This will provide notice of the changes to the public prior to the start of the hunt season.

4. A list of all previous notices appearing in the Register addressing the final rule:

Notice of Rulemaking Docket Opening: 6 A.A.R. 715, February 18, 2000

Notice of Final Rulemaking: 6 A.A.R. 1146, March 31, 2000

Notice of Proposed Rulemaking: 6 A.A.R. 1711, May 12, 2000

5. The name and address of agency personnel with whom persons may communicate regarding the rulemaking:

Name: Mark E. Naugle
Manager, Rules & Risk Management

Address: Arizona Game and Fish Department DORR
2221 West Greenway Road
Phoenix, AZ 85023-4399

Telephone: (602) 789-3289

Fax: (602) 789-3677

E-mail: mnaugle@gf.state.az.us

6. An explanation of the rule, including the agency's reasons for initiating the rule:

R12-4-108. Management Unit Boundaries establishes Management Unit Boundaries for the principal purpose of wildlife management, particularly game species. Generally, management will be for all species, or at least more than one particular species. Management Unit Boundaries are also established for use by the public. They are used by hunters as a familiar point of reference in planning present and future hunting expeditions, and for knowing "where they are" in the field. Management Unit Boundaries are also established when there are administrative or legal reasons for separate management. The boundaries do not change annually. Retaining permanent Management Units, whose unit numbers do not change, minimizes confusion and creates fixed points of reference that can be depended upon. Although statute requires the Commission to prescribe game management units "by order," the Administrative Procedure Act supersedes much of the language in Title 17 that refers to "Commission order." Unless the Act specifically grants an exemption from rulemaking requirements, the word "order" in Title 17 has to be read as "rule." This is according to past research by legal counsel. Therefore, Management Unit Boundaries are properly prescribed by rule instead of order.

It should be noted that during the previous reviews of this rule, the Publications Editor of the Secretary of State's office was contacted regarding the rule's structure, since the rule does not follow the usual numbering sequence. The Editor agreed that numbering these paragraphs would be confusing to the reader, and the variation is therefore allowed just as it is allowed in some other agencies' rules for the same reason.

This proposed rule amendment will extend the northern boundary of Metropolitan Management Unit 42M to include the communities of Cave Creek, Desert Hills, and portions of the City of Peoria. Since these areas are currently within the adjacent Management Units 20B and 21, the boundaries of these units will also be revised. This change is being proposed by the Arizona Game and Fish Department's Region VI/Mesa to address the recent urban expansions and city annexations in the north valley. Tracts of land that were traditionally hunted in Units 21 and 20B now have minimal opportunities for rifled firearms hunting. The communities of Cave Creek, Desert Hills, and Peoria have experienced significant growth, and as a direct result, conflicts between landowners and hunters have increased dramatically. Due to the cumulative factors listed, the Region feels it is appropriate and timely to expand the Unit 42M boundary northward. The proposed boundary change will allow the Department to more consistently manage the above referenced communities under the urban program narrative. Department funds and personnel resources can be more closely aligned with mandated activities. If this change is not implemented, the Department's ability to address public concerns and designate a clear and concise management boundary will be more difficult.

The proposed rule amendment also identifies that sovereign tribal lands exist within, but are not a part of Management Unit 42M. This is intended to clarify that sovereign tribal lands located within management unit boundaries are not under the jurisdiction of the Arizona Game and Fish Commission or the Arizona Game and Fish Department.

7. A reference to any study that the agency relies on in its evaluation of or justification for the final rule and where the public may obtain or review the study, all data underlying each study, any analysis of the study and other supporting material:

Not applicable

8. A showing of good cause why the rule is necessary to promote a statewide interest if the rule will diminish a previous grant of authority of a political subdivision of this state:

Not applicable

9. The summary of the economic, small business, and consumer impact:

There are no new costs to the Department or to any person resulting from this proposed rulemaking. The extension of the northern boundary of existing metropolitan Management Unit 42M will directly affect hunters, residents, landowners, and non-hunting recreationists in the metropolitan areas of Cave Creek, Desert Hills, and Peoria. The reduction in firearm hunts and the better management of conflicting land uses will benefit hunters who use primitive methods of take (such as archery gear), residents, landowners, and non-hunting recreationists by reducing conflicts between outdoor recreationists and landowners. However, hunters unable to hunt with firearms in these areas may incur travel costs if they chose to hunt in other areas. It may also result in some local residents purchasing posted signs for property.

The proposed rulemaking will also benefit the public and the sovereign tribes in Arizona by clarifying that sovereign tribal lands are not part of management units and that sovereign tribal lands located within management unit boundaries are not managed by the Arizona Game and Fish Department.

10. A description of the changes between the proposed rules, including supplemental notices, and final rules (if applicable):

There were no substantive changes between the text of the rule contained in the Notice of Proposed Rulemaking filed with the Secretary of State on May 12, 2000, and the text of the rule as finally adopted by the Arizona Game and Fish Commission on September 25, 2000. The following nonsubstantive changes in rule text were made by the Department at the request of GRRC staff:

1. The exit number for the junction of I-17 and New River Road was corrected to read "232" for consistency within the rule.

2. The subsection governing the effective date of the rule was clarified for consistency within the rule.

11. A summary of the principal comments and the agency response to them:

This summary statement addresses oral and written comments and arguments received regarding the rulemaking. Comments both pro and con were numbered in the order received or evaluated.

1. Argument: There was 1 comment in support of the Arizona Game and Fish Commission proposed rulemaking. The comment supported the proposed amendment that will extend the northern boundary of Metropolitan Management Unit 42M to include the communities of Cave Creek, Desert Hills, and portions of City of Peoria.

Evaluation: The agency agrees. The proposed boundary change will allow the Department to more consistently manage the above referenced communities under the urban program narrative. Department funds and personnel resources can be more closely aligned with mandated activities.

12. Any other matters prescribed by statute that are applicable to the specific agency or to any specific rule or class of rules:
Not applicable

13. Incorporations by reference and their location in the rules:
None

14. Was this rule previously adopted as an emergency rule?
No

15. The full text of the rules follows:

TITLE 12. NATURAL RESOURCES

CHAPTER 4. GAME AND FISH COMMISSION

ARTICLE 1. DEFINITIONS AND GENERAL PROVISIONS

R12-4-108. Management Unit Boundaries

ARTICLE 1. DEFINITIONS AND GENERAL PROVISIONS

R12-4-108. Management Unit Boundaries

A. No change
1. No change.
2. No change.
3. No change.
4. No change.

B. No change.

C. No change.
Unit 1 -- No change.
Unit 2A – No change.
Unit 2B -- No change.
Unit 2C – No change.
Unit 3A -- No change.
Unit 3B -- No change.
Unit 3C -- No change.
Unit 4A -- No change.
Unit 4B -- No change.
Unit 5A -- No change.
Unit 5B -- No change.
Unit 6A -- No change.
Unit 6B -- No change.
Unit 7 -- No change.
Unit 7M -- No change.
Unit 8 -- No change.
Unit 9 -- No change.
Unit 10 -- No change.
Unit 12A -- No change.
Unit 12B -- No change.
Unit 13A -- No change.
Unit 13B -- No change.
Unit 15A -- No change.
Unit 15B -- No change.
Unit 15C -- No change.
Unit 15D -- No change.
Unit 16A -- No change.
Unit 16B -- No change.
Unit 17A -- No change.
Unit 17B -- No change.
Unit 18A -- No change.
Unit 18B – No change.
Unit 19A -- No change.

Unit 19B -- No change.
Unit 20A -- No change.
Unit 20B -- Beginning at the Hassayampa River and U.S. Hwy 93 (in Wickenburg); northeasterly along the Hassayampa River to the Kirkland Junction-Wagoner-Crown King-Cordes road (at Walnut Grove); southerly and northeasterly along this road to I-17 (Exit 259); south on the southbound lane of I-17 to the New River Road (Exit 232); west on the New River Road to State Highway 74; west on AZ Hwy 74 to the Junction of AZ Hwy 74 and U.S. Hwy 93; ~~Carefree Hwy (Exit 223); west on the Carefree Hwy to the Lake Pleasant road; southerly on the Lake Pleasant road to the Central Arizona Project (CAP) Canal; westerly on the CAP Canal to the Beardsley Canal; southerly along Beardsley Canal to U.S. Hwy 93;~~ northwesterly on U.S. Hwy 93 to the Hassayampa River.
Unit 20C -- No change.
Unit 21 -- Beginning on I-17 at the Verde River; southerly on the southbound lane of I-17 to the New River Road (Exit 232); east on New River Road to Fig Springs Road; northeasterly on Fig Springs Road ~~Carefree Hwy (Exit 223); east on the Carefree Hwy to Cave Creek Road; northeasterly on Cave Creek Road~~ to the Tonto National Forest boundary; southeasterly along this boundary to the Verde River; north along the Verde River to I-17.
Unit 22 -- No change.
Unit 23 -- No change.
Unit 24A -- No change.
Unit 24B -- No change.
Unit 27 -- No change.
Unit 28 -- No change.
Unit 29 -- No change.
Unit 30A – No change.
Unit 30B -- No change.
Unit 31 -- No change.
Unit 32 -- No change.
Unit 33 -- No change.
Unit 34A -- No change.
Unit 34B -- No change.
Unit 35A -- No change.
Unit 35B -- No change.
Unit 36A -- No change.
Unit 36B -- No change.
Unit 36C -- No change.
Unit 37A -- No change.
Unit 37B -- No change.
Unit 37M -- No change.
Unit 39 -- No change.
Unit 39M -- No change.
Unit 40A -- No change.
Unit 40B -- No change.
Unit 41 -- No change.
Unit 42 -- No change.
Unit 42M -- Beginning at the junction of I-17 and the New River Road (Exit 232); west on New River Road to AZ Hwy 74; west on AZ Hwy 74 to the junction with U.S. Hwy 93; southeasterly on U.S. Hwy 93 ~~Carefree Hwy (Exit 223); west on the Carefree Hwy to the Lake Pleasant Road; southerly on the Lake Pleasant Road to the Central Arizona Project (CAP) Canal; westerly on the CAP Canal~~ to the Beardsley Canal; southwesterly along the Beardsley Canal to Indian School road; west on Indian School road to Jackrabbit Trail; south on Jackrabbit Trail to I-10 (Exit 121); west on I-10 to Oglesby Road (Exit 112); south on Oglesby road to AZ Hwy 85; south on AZ Hwy 85 to the Gila River; east along the Gila River to the Salt River; east along the Salt River to I-10; easterly on I-10 to U.S. Hwy 60; east on U.S. Hwy 60 to the Usery Pass road (Ellsworth Road); north on the Usery Pass road to Bush Hwy; easterly on Bush Hwy to the Salt River at the Blue Point Bridge; westerly along the Salt River to the Verde River; northerly along the Verde River to the Tonto National Forest boundary; northwesterly along this boundary to the Fig Springs; southwesterly on Figs Spring Road; west on New River Road to I-17 (Exit 232). ~~Cave Creek Road; southwesterly on Cave Creek Road to the Carefree Hwy; west on the Carefree Hwy to I-17 (Exit 223).~~ ; except those portions that are sovereign tribal lands of the Salt River Pima-Maricopa Indian Community and the Fort McDowell Mohave-Apache Community.
Unit 43A -- No change.
Unit 43B -- No change.
Unit 44A -- No change.
Unit 44B -- No change.

Unit 45A -- No change.
Unit 45B -- No change.
Unit 45C -- No change.
Unit 46A -- No change.
Unit 46B -- No change.

D. This rule is effective July 1, 2000, for all Units except Units 20B, 21, and 42M. The subsections governing Units 20B, 21, and 42M are effective July 1, 2001.

NOTICE OF FINAL RULEMAKING

TITLE 17. TRANSPORTATION

CHAPTER 4. DEPARTMENT OF TRANSPORTATION - MOTOR VEHICLE DIVISION

PREAMBLE

1. Sections Affected **Rulemaking Action**
R17-4-242 Repeal

2. The specific authority for the rulemaking, including both the authorizing statute (general) and the statutes the rules are implementing (specific):
Authorizing statute: A.R.S. § 28-366

Implementing statute: A.R.S. § 28-4302

3. The effective date of the rules:
January 22, 2001

4. A list of all previous notices appearing in the Register addressing the final rule:
Notice of Rulemaking Docket Opening: 5 A.A.R. 4007, October 22, 1999

Notice of Proposed Rulemaking: 6 A.A.R. 3643, September 22, 2000

5. The name and address of agency personnel with whom persons may communicate regarding the rulemaking:

Name:	Ellen Damron Rules Analyst
Address:	Arizona Department of Transportation Administrative Rules Unit, Mail Drop 507M 3737 North Seventh Street, Suite 160 Phoenix, Arizona 85014-5017
Telephone:	(602) 712-6722
Fax:	(602) 241-1624
E-mail:	edamron@dot.state.us.az

6. An explanation of the rule, including the agency's reasons for initiating the rule:
R17-4-242 does not reflect the current underlying statute A.R.S. § 28-4302. The current statute's language provides specific information about the pricing for various motor vehicle dealer and recycler licenses required for such business activities in Arizona.

7. A reference to any study that the agency relied on its evaluation or justification for the rule, and where the public may obtain or review the study, all data underlying each study, any analysis of the study and other supporting material:
None

8. A showing of good cause why the rule is necessary to promote a statewide interest if the rule will diminish a previous grant of authority of a political subdivision of this state:
Not applicable

9. The summary of the economic, small business, and consumer impact:
This final rulemaking repeals R17-4-242. A.R.S. § 41-1055(D) exempts this action from the economic impact statement requirement.

10. A description of the changes between the proposed rules, including supplemental notices, and final rules (if applicable):
None

11. A summary of the principal comments and the agency response to them:
The Division received no comments in this rulemaking process.

12. Any other matters prescribed by statute that are applicable to the specific agency or to any specific rule or class of rules:
None

13. Incorporations by reference and their location in the rules:
None

14. Was this rule previously adopted as an emergency rule?
No

15. The full text of the rules follows:

TITLE 17. TRANSPORTATION

CHAPTER 4. DEPARTMENT OF TRANSPORTATION - MOTOR VEHICLE DIVISION

ARTICLE 2. TITLES AND REGISTRATION

R17-4-242. ~~Dealer license – changing location, branch outlet, etc~~. Repealed

ARTICLE 2. TITLES AND REGISTRATION

R17-4-242. ~~Dealer license – changing location, branch outlet, etc~~. Repealed

~~A.~~ ~~For the purpose of determining when a dealer or wrecker may legally change his place of business, open a branch lot, or move a branch lot, application must be made to the Motor Vehicle Division and the $10.00 fee therefore must be paid.~~

~~B.~~ ~~No dealer or wrecker shall offer for sale or sell a motor vehicle unless or until he has obtained a duly authorized license issued pursuant to application made by him and approved by the Motor Vehicle Division.~~

NOTICE OF FINAL RULEMAKING

TITLE 18. ENVIRONMENTAL QUALITY

CHAPTER 11. DEPARTMENT OF ENVIRONMENTAL QUALITY
WATER QUALITY STANDARDS

PREAMBLE

1. Sections Affected	**Rulemaking Action**
Article 3	New Article
R18-11-301	New Section
R18-11-302	New Section
R18-11-303	New Section
R18-11-304	New Section
R18-11-305	New Section
R18-11-306	New Section
R18-11-307	New Section
R18-11-308	New Section
R18-11-309	New Section
Appendix A	New Appendix

2. The specific authority for the rulemaking, including both the authorizing statute (general) and the statutes that the rules are implementing (specific):
General statutory authority: A.R.S. § 49-203(A)(1)

Specific statutory authority: A.R.S. § 49-221(E)

3. Effective date of the rule:
January 22, 2001

4. A list of all previous notices appearing in the Register addressing the proposed rule:
Notice of Rulemaking Docket Opening: 6 A.A.R. 1443, April 14, 2000

Notice of Proposed Rulemaking: 6 A.A.R. 1637, May 5, 2000

5. The name and address of agency personnel with whom persons may communicate regarding the rule:

Name: Mr. Steven Pawlowski

Address: Arizona Department of Environmental Quality
3033 North Central Avenue
Phoenix, Arizona 85012

Telephone: (602) 207-4219

Fax: (602) 207-4528

E-mail: pawlowski.steven@ev.state.az.us

6. An explanation of the rule, including the agency's reasons for initiating the rule:

Statutory authority

A.R.S. § 49-221(E) provides the Arizona Department of Environmental Quality (ADEQ) with the authority to adopt, by rule, water quality standards for the direct reuse of reclaimed water. A.R.S. § 49-221(E) states:

> The director may adopt by rule water quality standards for the direct reuse of reclaimed water. In establishing these standards the director shall consider the following:
>
> 1. The protection of public health and the environment.
> 2. The uses that are being made or may be made of reclaimed water.
> 3. The degree to which standards for the direct reuse of reclaimed water may cause violations of water quality standards for other hydrologically connected water categories.

Applicability

The proposed reclaimed water quality standards apply to *the direct reuse of reclaimed water.* What is "reclaimed water" and what does "direct reuse" mean?

"Reclaimed water" is defined by A.R.S. § 49-201(31). § 49-201(31) defines "reclaimed water" as "water that has been treated or processed by a wastewater treatment plant or an on-site wastewater treatment facility." In layman's terms, reclaimed water is the wastewater that is flushed down toilets or goes down the sink, bathtub, shower, and laundry drains in our homes and businesses, is collected in a sewer system, and is transported to a wastewater treatment plant where it is treated adequately so it can be reused.

"Direct reuse" is defined by A.R.S. § 49-201(10). § 49-201(10) defines "direct reuse" as "the beneficial use of reclaimed water for specific purposes authorized pursuant to § 49-203, subsection A, paragraph 6." "Direct reuse" means that a direct connection exists between a wastewater treatment plant, a reclaimed water distribution system or a conveyance, and a site where reclaimed water is intentionally reused for agricultural or landscape irrigation, in impoundments, or for industrial or other purposes. In "direct reuse," wastewater is treated at a wastewater treatment plant and the reclaimed water is transported in a pipeline or a canal from the wastewater treatment plant directly to one or more sites where it is reused. Direct reuse means that there is no intervening discharge of the reclaimed water to a surface water (for example, a river, stream, or lake) or to an aquifer. By contrast, "indirect reuse" means either: 1) the treated wastewater is used to recharge groundwater or is stored underground, recovered, and used, or 2) a wastewater treatment plant discharges treated wastewater to a surface water and the water is subsequently diverted and beneficially used.

The reclaimed water quality standards in this Article apply to direct reuse, not to indirect reuse. Discharges of treated wastewater to a surface water are regulated under the surface water quality standards and the National Pollutant Discharge Elimination System (NPDES) permit programs. The discharge of treated wastewater to groundwater through injection wells or infiltration basins is regulated under the aquifer water quality standards and the Aquifer Protection Permit (APP) programs.

Existing reclaimed water quality standards

Arizona has existing rules that regulate the reuse of reclaimed water. The current reclaimed water quality standards are codified in Title 18, Chapter 9, Article 7 of the *Arizona Administrative Code* [*See* R18-9-701 through R18-9-707]. The current reclaimed water quality standards have not been revised since their effective date, May 24, 1985. A.A.C. R18-9-703 and Tables I - IV in the current rules prescribe numeric reclaimed water quality criteria and monitoring requirements for the reuse of reclaimed water. In general, the current rules prescribe allowable limits for pH, fecal coliform, turbidity, enteric viruses, and certain parasites in reclaimed water for different types of reuse [*See* Table I below].

The current rules establish allowable limits for concentrations of bacteria, viruses, and parasites in reclaimed water to protect human health. In general, the stringency of the reclaimed water quality criteria depends on the type of reuse and the expected degree of human exposure to the reclaimed water. The current rules use the concentration of fecal

coliform organisms as an indicator of the microbiological quality of the reclaimed water. The fecal coliform criteria are expressed as 5-sample geometric means and as single sample maximum concentrations. Geometric mean concentrations range from 2.2 cfu /100 ml. to 1000 cfu / 100 ml depending on the type of reuse. Single sample maximum concentrations range from 25 cfu / 100 ml to 4000 cfu / 100 ml. Very stringent fecal coliform criteria (2.2 cfu / 100 ml) apply to the reuse of reclaimed water where the risk of ingestion of pathogens in the reclaimed water is considered to be high such as irrigation of food crops that are consumed raw. Stringent fecal coliform criteria (25 cfu / 100 ml) apply to the reuse of reclaimed water for open access landscape irrigation where there is a greater risk of human exposure to the reclaimed water by accidental ingestion, exposure to reclaimed water aerosols, and potential exposure of vulnerable populations (for example, children, the elderly, and persons with compromised immune systems). Relatively stringent fecal coliform criteria apply to the reuse of reclaimed water in impoundments where full-body contact recreation is intended (200 cfu / 100 ml). The current fecal coliform criteria are established at concentrations that, at the time of their adoption in 1985, were equivalent to the existing surface water quality standards for full-body contact recreation. Less stringent criteria (1000 cfu / 100 ml) apply to reuse applications where the risk of human exposure to pathogens is considered to be low (for example, non-food crop irrigation and livestock watering).

The current rules include reclaimed water quality criteria for turbidity for some reuse applications. The current turbidity criteria apply only to reclaimed water that is reused for open access landscape irrigation, irrigation of food crops that are consumed raw, and recreational impoundments. The turbidity criterion that applies to the reuse of reclaimed water for full-body contact recreational impoundments and irrigation of food crops that are consumed raw is very stringent: 1 nephelometric turbidity unit, or 1 NTU. This turbidity criterion is equivalent to the turbidity criterion that applies to finished drinking water after filtration. The turbidity criterion for reclaimed water that is reused for open access landscape irrigation and recreational impoundments where partial-body contact recreation may take place is somewhat less stringent: 5 NTUs. However, both the 1 and 5 NTU turbidity criteria are technology-forcing parameters that can be achieved only if wastewater undergoes treatment that includes filtration. In fact, it has been reported to ADEQ that it is difficult for a wastewater treatment plant to achieve consistent compliance with a 1 NTU turbidity standard even when coagulation and filtration treatments are provided. The 1 NTU turbidity standard in the current rules may operate as a regulatory barrier to the reuse applications where it applies. Currently, there are no reuse permits for the irrigation of food crops that are consumed raw or for impoundments of reclaimed water where full-body contact recreation is an intended use of reclaimed water.

The current wastewater reuse rules prescribe reclaimed water quality criteria for enteric viruses. Stringent enteric virus criteria apply to the reuse of reclaimed water for irrigation of food crops that are consumed raw and for impoundments where full-body contact recreation takes place. The applicable enteric virus standard for these reuse applications is 1 plaque forming unit, a most probable number of 1, or 1 immunoflourescent foci per 40 liters. Like the 1 NTU turbidity standard, the stringency of this enteric virus criterion may operate as a regulatory barrier to the reuse applications where it applies. Less stringent enteric virus criteria apply to the reuse of reclaimed water for open access landscape irrigation and for recreational impoundments where partial-body contact recreation may take place [125 enteric virus units per 40 liters]. While the current reuse rules prescribe enteric virus standards, the rules do not require reuse permittees to monitor routinely for viruses [*See* R18-9-703(B)].

The current rules prescribe reclaimed water quality criteria for parasites, including *Entamoeba histolytica, Giardia lamblia, Ascaris lumbricoides*, and the common large tapeworm. The applicable criterion for each of these parasites is "none detectable." Reclaimed water quality criteria for parasites apply to the reuse of reclaimed water for recreational impoundments, irrigation of food crops that are consumed raw, irrigation of pastures, livestock watering, and open access landscape irrigation [*See* Table I below]. Again, the current rules prescribe reclaimed water quality standards for parasites, but they do not require routine monitoring for parasites [*See* R18-9-703(B)].

Finally, the current rules prescribe that reclaimed water that is used for agricultural irrigation, livestock watering, and in recreational impoundments must comply with surface water quality standards for trace substances, organic chemicals, toxic substances, and radiochemicals [*See* R18-9-703(A)]. Like the monitoring requirements for viruses and parasites, the current rules state that reuse permittees are not required to conduct routine monitoring for the presence of trace substances, organic chemicals, toxic substances, or radiochemicals in reclaimed water [*See* R18-9-703(B)].

Table I. Allowable Permit Limits for Specific Reuses in Current Wastewater Reuse Rules

Parameter	Orchards	Fiber, Seed & Forage	Pastures	Livestock Watering	Processed Food	Restricted Access Landscape Irrigation	Open Access Landscape Irrigation	Food Consumed Raw	Partial Body Contact	Full Body Contact
pH	4.5 - 9	4.5 - 9	4.5 - 9	6.5 - 9	4.5 - 9	4.5 - 9	4.5 - 9	4.5 - 9	6.5 - 9	6.5 - 9
Fecal coliform 5-sample geometric mean	1000	1000	1000	1000	1000	200	25	2.2	1000	200 cfu / 100 ml
Single sample maximum	4000	4000	4000	4000	2500	1000	75	25	4000	800 cfu / 100 ml
Turbidity [NTUs]							5	1	5	1
Enteric Viruses							125 / 40 L	1 / 40 L	125 / 40 L	1 / 40 L
Entamoeba Histolytica								None Detectable		None Detectable
Giardia Lamblia								None Detectable		None Detectable
Ascaris Lumbricoides							None Detectable	None Detectable	None Detectable	None Detectable
Common Large Tapeworm			None Detectable	None Detectable						

The reuse of effluent from on-site wastewater treatment plants

The current wastewater reuse rules include reclaimed water quality standards and monitoring requirements for surface irrigation with on-site wastewater treatment plant effluent and gray water [*See* Table II below and R18-9-703(C)(5) and (6)]. The current microbiological water quality standards for the reuse of on-site wastewater treatment plant effluent are expressed as fecal coliform concentrations and as chlorine residual requirements. The monitoring requirements in the current rules are minimal. A permittee must take a series of five samples of reclaimed water in one calendar month at least once a year and have the samples analyzed for fecal coliform. The current rules also require monitoring for chlorine residual at least once a month.

Table II. Allowable Limits and Monitoring Requirements for Surface Irrigation With On-Site Wastewater Treatment Plant Effluent and Gray Water in Current Wastewater Reuse Rules

Parameter	Allowable Limits	Samples Required
Fecal Coliform [geometric mean]	25 cfu / 100 ml	Series of 5 in one calendar month; 1 series / year
Fecal Coliform [Single sample maximum]	75 cfu / 100 ml	Series of 5 in one calendar month; 1 series / year
Chlorine Residual	2.0 mg / L	1 / month

The reuse of reclaimed water in constructed wetlands

The current wastewater reuse rules prescribe water quality criteria for reclaimed water that is released to a manmade wetlands marsh [*See* Table III below]. R18-9-703(C)(7) states that the formation of a wetlands marsh is "an allowable reuse." Table III prescribes criteria for fecal coliform, pH, maximum daily pH change, dissolved oxygen, and temperature. Under the current rules, reclaimed water that is released to a manmade wetlands marsh must comply with surface water quality standards for trace substances to protect aquatic life and wildlife, but reuse permittees are not required to monitor routinely for trace substances.

Table III. Allowable Limits and Monitoring Requirements for Reclaimed Wastewater Released to Wetlands Marshes in Current Wastewater Reuse Rules

Parameter	Allowable Limit	Samples Required
Fecal Coliform [30-day geometric mean] [Single sample maximum]	 1000 cfu / 100 ml 4000 cfu / 100 ml	5 / month if flow is < 1 million gallons per day (MGD) 10 / month if flow is greater than or equal to 1 MGD
pH	6.5 - 8.6	1 / week
pH change	0.5	Monitoring frequency not prescribed
Dissolved oxygen	6 mg/L	2 / week
Temperature	Shall not interfere with aquatic life and wildlife	2 / week
Trace Substances	Per Aquatic &Wildlife criteria in A.A.C. Title 18, Chapter 11	Monitoring frequency not prescribed

Why does ADEQ propose to change the existing reclaimed water quality standards?

ADEQ proposes to change the current reclaimed water quality standards for the following reasons:

1. The current fecal coliform criteria that are prescribed for some direct reuse applications are less stringent than the fecal coliform criteria for the same types of direct reuse recommended in the U.S. Environmental Protection Agency (EPA) Guidelines for Water Reuse and that are required by other states with wastewater reuse regulations.

2. ADEQ proposes to conform the pH values that are prescribed in the current wastewater reuse rules to pH values that are required under federal secondary treatment regulations for wastewater treatment plants. The range of pH values in the current rules (4.5 to 9.0 standard units) is inconsistent with the range of effluent values for pH that must be maintained under the federal secondary treatment regulations (6.0 to 9.0 standard units).

3. ADEQ questions whether it is technically or economically feasible for a wastewater treatment plant to achieve compliance with the 1 NTU turbidity criterion that applies to the reuse of reclaimed water for the irrigation of food crops that are consumed raw and for recreational impoundments where full-body contact recreation is an intended use. It is unnecessary to require this high a level of clarification before reclaimed water can be safely reused for food crop irrigation or in recreational impoundments.

4. ADEQ questions whether the current enteric virus criteria for reclaimed water can be practically implemented. There are significant problems with monitoring compliance with enteric virus criteria. The routine examination of reclaimed water for enteric viruses is not recommended in Standard Methods for the Examination of Water and Wastewater, 20th Edition, American Public Health Association, 1015 Fifteenth Street, NW, Washington, D.C. (1998) (p. 9-116) because of the need for highly specialized laboratories and trained virologists to conduct the viral assays. There are problems with: 1) a lack of laboratory capacity, 2) significant limitations of the available analytical methodologies, 3) the lack of timeliness of the results of viral assays, and 4) a lack of consensus among public health experts regarding the health significance of enteric virus concentrations in reclaimed water.

5. ADEQ questions the current reclaimed water quality standards for parasites. Again, laboratory capacity and a lack of reliable analytical methods for the identification of *Entamoeba histolytica, Giardia lamblia, Ascaris lumbricoides* and the common large tapeworm are problems. Also, ADEQ believes that analyses for specific parasites are unnecessary if minimum treatment requirements and required analyses for a microbiological indicator parameter are included in the reclaimed water quality standards rules.

6. ADEQ believes that the current reclaimed water quality standards can be revised to be more clear, concise, and understandable. The reclaimed water quality standards can be written to provide more regulatory certainty to the operators of water reclamation plants. Clearer design or performance standards will provide more regulatory certainty and an incentive for water reclamation. The encouragement of water reclamation through the development of clear, concise, and understandable reclaimed water quality standards is an important objective of this rulemaking.

7. The numeric, criteria-based approach to establishing reclaimed water quality standards reflected in Arizona's current rules is not clear because of uncertainty regarding how many reclaimed water quality standards should be established or for which parameters.

8. The implementation of a numeric, criteria-based approach relies upon extensive end-of-process monitoring. Critics of this approach point out that not all criteria that have been established are capable of being adequately analyzed [for example, enteric viruses and parasites]. It is argued that the required monitoring often involves complex, time-consuming, and expensive analytical procedures and that few operators of wastewater treatment plants employ the personnel or have the equipment necessary to perform the necessary analyses. Provisions in the current wastewater reuse rules that establish standards for enteric viruses, parasites, and chemical pollutants but which also state that reuse permittees are not required to conduct routine compliance monitoring lend support to this criticism. It has been argued that better protection of the public health and the environment is provided by an approach that requires that wastewater undergo a prescribed set of minimum treatment processes and meet a limited number of reclaimed water quality criteria that give reasonable assurance that a water reclamation plant is operating properly and that the reclaimed water can be reused safely.

9. The reclaimed water quality standards should be revised to recognize new types of wastewater reuse.

10. The reclaimed water quality standards should be revised to be more consistent with EPA recommendations for wastewater reuse.

In 1992, The U.S. Environmental Protection Agency [EPA] published a guidance document containing recommended guidelines for wastewater reuse [*See* Guidelines for Water Reuse, U.S. Environmental Protection Agency, EPA/ 625 / R-92 / 004, September, 1992]. The EPA guidelines include recommended reclaimed water quality standards that are expressed as a combination of minimum treatment process requirements and reclaimed water quality criteria. EPA's recommendations are based upon an extensive review of water reclamation practice in the United States; research and pilot plant or demonstration study data; a review of the literature on wastewater reuse; various state reuse regulations, policies or guidelines; current engineering practice; and technical feasibility. In the Guidelines for Water Reuse, EPA explained that its recommendations for wastewater reuse were expressed as a combination of recommended treatment processes and reclaimed water quality limits for the following reasons:

1. Specific reclaimed water quality criteria that employ the use of surrogate parameters may not adequately characterize reclaimed water quality,

2. A combination of required treatment processes and reclaimed water quality requirements known to produce reclaimed water of acceptable quality obviates the need to monitor reclaimed water for many pollutants, and

3. Expensive, time-consuming, and, in some cases, questionable monitoring for pathogenic organisms, such as viruses, is eliminated without compromising public health protection.
[*See* EPA Guidelines for Water Reuse, p. 139]

In this rulemaking, ADEQ adopted reclaimed water quality standards following the regulatory approach outlined in the EPA Guidelines for Water Reuse. ADEQ intends to establish 5 reclaimed water quality categories that specify minimum levels of treatment. ADEQ also adopted a limited number of numeric reclaimed water quality criteria. Together, these requirements provide reasonable assurance that reclaimed water can be used safely without adversely affecting public health or the environment. Wastewater treatment plants will be required to monitor for compliance with reclaimed water quality standards either in the plant (for example, turbidity) or at a point where reclaimed water leaves the wastewater treatment plant and enters a canal or a pipeline distribution system. Monitoring requirements will be established in individual or general permits for the wastewater treatment plant to provide timely data on whether required treatment processes are operating correctly. For example, ADEQ proposes to establish reclaimed water quality criteria for turbidity, total nitrogen, and fecal coliform bacteria. Compliance with required secondary treatment requirements will be determined by monitoring compliance with certain conventional pollutants such as pH, total suspended solids, and 5-day biochemical oxygen demand.

ADEQ's revisions of the reclaimed water quality standards are based, in part, on other states' approaches to wastewater reuse regulation, particularly the states of California and Florida. California has established statewide reclamation criteria based upon prescribed wastewater treatment processes. Descriptive terms for required treatment processes are used rather than numeric criteria for specific pollutants. For example, the California regulations require that wastewater be "oxidized, clarified, coagulated, filtered, and disinfected" before it can be used for open access landscape irrigation. To ensure that reclaimed water can be expected to be free of pollutants and pathogens, required treatment processes, monitoring requirements, operation and maintenance procedures, and treatment reliability requirements are prescribed. The California regulations also prescribe a limited number of numeric reclaimed water quality criteria such as disinfection requirements expressed as maximum allowable total coliform concentrations, turbidity, and pH. Many western states, including Colorado, Idaho, Montana, and Oregon have followed the California model. The California approach provides regulatory flexibility by recognizing that methods of treatment other than the specific treatment processes prescribed in the California reclamation criteria may be used. The California rules state that an alternative method of treatment is acceptable if it can be demonstrated to the satisfaction of the regulatory agency that the alternative method of treatment and its reliability features are equivalent to the treatment processes and reliability features prescribed in the statewide reclamation criteria [*See* Title 22, California Administrative Code, Wastewater Reclamation Criteria, Article 5.5, § 60320.5. Other Methods of Treatment].

Florida uses a similar approach to regulating the reuse of reclaimed water. The Florida Department of Environmental Protection has written rules governing the reuse of reclaimed water to ensure that communities and wastewater utilities that practice reclamation provide enough treatment and disinfection so that continuous and reliable supplies of high quality reclaimed water are produced. Chapter 62-600 of the Florida Administrative Code prescribes requirements for domestic wastewater management facilities, including minimum treatment and disinfection requirements. Secondary treatment is a minimum treatment standard for wastewater treatment plants in Florida. Chapter 62-610 specifically addresses the reuse of reclaimed water. Florida prescribes basic, intermediate, and high-level disinfection requirements depending upon the type of reuse. Disinfection requirements consist of minimum chlorine residual requirements and fecal coliform limits. Florida's reuse regulations are generally consistent with EPA recommendations in the Guidelines for Water Reuse.

Why does Arizona need reclaimed water quality standards?

Water reclamation is an important strategy for conserving and augmenting Arizona's drinking water supply. Source substitution, or the reuse of reclaimed water to replace potable water that currently is used for nonpotable purposes, conserves higher quality sources of water for human consumption and domestic purposes. Many urban, commercial, industrial, and agricultural water demands can be satisfied with reclaimed water. For example, it is not necessary to use drinking water for landscape irrigation, agricultural irrigation, industrial processing, cooling water, or toilet flushing. Reclaimed water can be reused safely for these uses. Every gallon of reclaimed water that is reused for a nonpotable purpose conserves a gallon of drinking water.

Reclaimed water can be reused safely in many beneficial ways [*See* Appendix A of the rules]. For example, reclaimed water can be reused for agricultural irrigation including the irrigation of food crops. Reclaimed water can be reused to irrigate orchards, vineyards, pastures, sod farms, plant nurseries, and tree farms. Reclaimed water may be used for livestock watering. Reclaimed water can be reused for landscape irrigation including irrigation of golf courses, parks, highway landscapes, cemeteries, greenbelts, common areas, and large turf areas. If adequately treated, reclaimed water can be reused safely to irrigate school grounds, playgrounds, and residential lawns. Reclaimed water can be reused in industrial facilities for cooling water, stack scrubbing, or process water. Reclaimed water can be used in separate distribution systems for flushing toilets and urinals and priming drain traps in industrial, commercial, and residential buildings. Reclaimed water can be reused to create artificial lakes, lagoons, ponds, and other recreational and landscape water features. Reclaimed water can be reused in various urban and construction applications, including soil compaction, dust control, street washing, equipment and vehicle washdown, materials washing and sieving, and for making concrete. In some states, reclaimed water is being used for stream augmentation, snowmaking, aquaculture, and to recharge groundwater that is a source of drinking water.

How does ADEQ propose to change the standards for reclaimed water?

The rules establish 5 classes of reclaimed water. The 5 classes of reclaimed water are expressed as a combination of minimum treatment requirements and a limited set of numeric reclaimed water quality criteria. For reuse applications where there is a relatively high risk of human exposure to the reclaimed water, Class A reclaimed water is required. Where the potential risk to public health is lower, Class B and Class C reclaimed water are acceptable. ADEQ proposes to require a minimum of secondary treatment for all 5 classes of reclaimed water.

The proposed rules include Class A+ and Class B+ reclaimed water. The two "+" categories of reclaimed water include nitrogen removal treatment requirements. Both "+" categories require treatment to produce a reclaimed water with a total nitrogen concentration of less than 10 mg / L. ADEQ's purpose in establishing the "+" categories is to create two categories of reclaimed water whose reuse minimizes the risk of nitrate contamination of groundwater that may lie below reuse application sites. ADEQ would like to emphasize that the rules do *not* require the reuse of the "+" categories of reclaimed water. However, ADEQ hopes to encourage the production and reuse of the "+" categories of reclaimed water by providing regulatory incentives in the rulemaking to revise the reuse permit program rules.

Class A+ reclaimed water

Class A+ reclaimed water is a wastewater that has undergone a minimum of secondary treatment, filtration, nitrogen removal treatment, and high level disinfection. A wastewater treatment plant that produces Class A+ reclaimed water must have chemical addition facilities so it has the capability of adding coagulants or polymers if they are necessary to achieve consistent compliance with the Class A+ reclaimed water quality criteria. However, chemical addition facilities may remain idle if the turbidity criteria for filtered effluent prior to disinfection can be met without chemical addition. Class A+ reclaimed water may be safely reused for any reuse application that is listed in Appendix A of the rules. However, Class A+ reclaimed water is *not* required for any reuse application. Wastewater treatment plant operators may choose to produce Class A+ reclaimed water, but nothing in the rules requires a wastewater treatment plant to provide Class A+ treatment. ADEQ hopes to encourage the production and reuse of Class A+ reclaimed water by making it easier to reuse Class A+ reclaimed water. ADEQ will encourage the reuse of Class A+ reclaimed water by reducing the regulatory burden on persons who directly reuse it. For example, water balance requirements that are typically written into wastewater reuse permits now to ensure consumptive use of reclaimed water and to prevent nitrate contamination of groundwater will not be necessary in individual and general reuse permits for the reuse of Class A+ reclaimed water because the total nitrogen concentration of Class A+ reclaimed water will be less than 10 mg / L. Class A+ reclaimed water already complies with the applicable aquifer water quality standard for nitrate at the point of use.

Class A+ Reclaimed Water

Secondary treatment + nitrogen removal treatment + chemical feed facilities [1] + filtration + disinfection
No detectable fecal coliform organisms (7-sample median)[2]
23 / 100 ml (single sample maximum) [3]
Filtered effluent turbidity prior to disinfection: 2 NTU (24-hour average); not to exceed 5 NTU at any time
Total nitrogen: <10 mg / L (5-sample geometric mean)

[1] Coagulation or polymer addition may be required if filtered effluent prior to disinfection does not meet turbidity criteria.

[2] The fecal coliform limit is a median value determined from the bacteriological results of the last 7 days for which analyses have been completed. 4 out of the last 7 samples must have no detectable fecal coliform organisms.

[3] Either the membrane filter technique or multiple-tube fermentation technique may be used for bacteriological analysis. Results may be expressed in cfus or MPN. Cfu means colony forming units and MPN means most probable number.

Class A reclaimed water

Class A reclaimed water is Class A+ reclaimed water without the nitrogen removal requirement. Class A reclaimed water is a wastewater that undergoes a minimum of secondary treatment, filtration, and high level disinfection. Chemical addition facilities and the capability of adding coagulants or polymers are required to ensure treatment reliability and compliance with Class A reclaimed water quality criteria. The chemical addition facilities may remain idle if the turbidity criteria for filtered effluent prior to disinfection can be met without chemical addition. Class A reclaimed water may be safely used for any reuse application listed in Appendix A of the rules. ADEQ requires the use of Class A reclaimed water for irrigation of food crops that are consumed raw, spray irrigation of orchards and vineyards, open access landscape irrigation, recreational impoundments where fishing and boating may take place, reuse in fire protection systems, vehicle washing, commercial air conditioning, snow-making, and toilet flushing.

Class A Reclaimed Water

Secondary treatment + chemical feed facilities [1] + filtration + disinfection
No detectable fecal coliform organisms (7-sample median)[2]
23 / 100 ml (single sample maximum)
Filtered effluent turbidity prior to disinfection: 2 NTU (24-hour average); not to exceed 5 NTU at any time

[1] Coagulation or polymer addition may be required if filtered effluent prior to disinfection does not meet turbidity criteria.

[2] Fecal coliform limit is a median value determined from the bacteriological results of the last 7 days for which analyses have been completed. 4 of the last 7 samples must have no detectable fecal coliform organisms.

[3] Either the membrane filter technique or multiple-tube fermentation technique may be used for bacteriological analysis. Results may be expressed in cfus or MPN. Cfu means colony forming units and MPN means most probable number

In these rules, ADEQ proposes to adopt an alternative methods rule for Class A+ and Class A reclaimed water. Under the proposed alternative methods rule, ADEQ may allow a water reclamation plant to use alternative treatment processes or to operate at average turbidities higher than 2 NTUs prior to disinfection provided: 1) the wastewater treatment plant complies with all of the disinfection criteria for Class A reclaimed water, 2) the wastewater treatment plant operator demonstrates that the alternative wastewater treatment processes achieve a four log removal of enteric virus (99.99%), and 3) the wastewater treatment plant conducts routine monitoring for enteric viruses to demonstrate that the water reclamation plant reliably produces an essentially pathogen-free reclaimed water using alternative methods of treatment.

There are existing water reclamation systems currently in operation in Arizona that produce essentially pathogen-free reclaimed water using a combination of wastewater treatment processes and blending but which operate at average turbidities that are greater than the average operating turbidity of 2 NTUs for Class A reclaimed water. For example, the Tucson Water reclamation system treats secondarily-treated effluent using a combination of filtration, blending of groundwater from the Sweetwater Underground Storage and Recovery facility, and disinfection. Tucson Water has submitted reclaimed water quality data to ADEQ indicating that the average turbidity of the reclaimed water provided to their reclaimed water distribution system from 1995-1999 was less than 5 NTUs. During this time period, daily samples were taken for fecal coliform analysis. 65 samples tested positive for fecal coliform and 7 samples exceeded the proposed single sample maximum concentration of 23 cfu / 100 ml. for Class A reclaimed water. Tucson Water also conducted virus monitoring during this time period and no enteric viruses were detected in samples taken over the 5-year period. The operating experience and the water quality data from the Tucson Water reclamation system demonstrate that it is possible to use alternative methods of treatment, operate at higher average turbidities than 2 NTUs, and still produce a Class A reclaimed water. For this reason, ADEQ included a provision in the Class A reclaimed water quality standard rule that permits alternative methods of treatment and operation with average operating turbidities greater than 2 NTUs provided the reclaimed water provider demonstrates that the alternative treatment methods reliably produce a reclaimed water that is equivalent to Class A reclaimed water.

Class B+ reclaimed water

Class B+ reclaimed water is a wastewater that has undergone a minimum of secondary treatment, nitrogen removal treatment, and disinfection. The disinfection requirements for Class B+ reclaimed water are equivalent to those recommended in the EPA Guidelines for Water Reuse for wastewater treatment plants that provide secondary treatment and disinfection. The Class B+ category includes pH, 5-day biochemical oxygen demand (BOD_5), and total suspended solids (TSS) criteria for Class B+ reclaimed water that are based upon federal secondary treatment regulations [*See* 40 CFR §133.105]. ADEQ does not require Class B+ reclaimed water for any reuse application in these rules. However, a water reclamation plant operator may choose voluntarily to produce denitrified Class B+ reclaimed water to reduce the regulatory burden on customers who reuse Class B+ reclaimed water under individual or general reuse permits. Class B+ reclaimed water may be used for any reuse application where Class B or Class C reclaimed water is acceptable.

Class B+ Reclaimed Water

Secondary treatment + nitrogen removal treatment + disinfection
Fecal coliform: < 200 / 100 ml (7-sample median)
800 / 100 ml (single sample maximum)
Total nitrogen: < 10 mg/L (5-sample geometric mean)

Class B reclaimed water

Class B reclaimed water is a wastewater that has undergone a minimum of secondary treatment and disinfection. The definition of "secondary treatment" in Class B reclaimed water is based on the federal definition of secondary treatment in 40 CFR §133.105. The disinfection requirements for Class B reclaimed water are expressed as fecal coliform concentrations. The fecal coliform criteria for Class B reclaimed water are the same as the bacteriological water quality criteria recommended by EPA in the Guidelines for Water Reuse when secondary treatment and disinfection are provided. The recommended fecal coliform criteria are median values determined from the bacteriological results of the last 7 daily samples for which analyses have been completed. Either the membrane filter or fermentation tube technique may be used for fecal coliform analyses.

Class B reclaimed water may be reused safely for irrigation of nonfood crops and pastures, surface irrigation of orchards and vineyards, irrigation of food crops that are commercially processed to destroy pathogens, restricted access landscape irrigation, golf course irrigation, landscape impoundments, livestock watering, construction applications [for example, soil compaction, materials washing and sieving, and making concrete], dust control, and street washing. Class B reclaimed water also may be used for any reuse application where Class C reclaimed water is acceptable such as irrigation of pasture for non-milking animals, livestock watering (non-dairy animals), sod farm irrigation, silviculture, and irrigation of fiber, seed, forage, and other nonfood crops.

Class B Reclaimed Water

Secondary treatment + disinfection
Fecal coliform:< 200 / 100 ml (7-sample median)
800 / 100 ml (single sample maximum)

Class C reclaimed water

Class C reclaimed water is a wastewater that has been treated in wastewater stabilization ponds or in a lagoon system. Wastewater stabilization ponds require relatively large land areas and they are commonly used by smaller, rural communities with available land. Wastewater stabilization ponds are often arranged in a series of anaerobic, facultative, and aerobic maturation ponds with an overall detention time of 20 - 180 days, depending upon the climate and the effluent quality required. Wastewater stabilization ponds are considered to be a low-rate secondary treatment process. Most organic matter removal occurs in anaerobic and facultative ponds. Maturation ponds, which are largely aerobic, are designed primarily to remove pathogenic microorganisms following biological oxidation processes. A well-designed wastewater stabilization pond system is capable of reducing biochemical oxygen demand to 15 - 30 mg/ L and total suspended solids to 15 - 40 mg / L. They are capable of achieving a 6-log reduction of bacteria, a 3-log reduction of helminths, and a 4-log reduction of viruses and cysts [*See* EPA Guidelines for Water Reuse, p. 31]. Pathogen removals by wastewater stabilization pond systems can be erratic, but systems having long hydraulic retention times can effectively reduce pathogen concentrations to low levels.

Disinfection of Class C reclaimed water is not required under the adopted rules. A wastewater stabilization pond system may be able to meet the fecal coliform criteria for Class C reclaimed water without disinfection through adequate detention time in the system. Because Class C reclaimed water may not be disinfected, its reuse is restricted to uses where public access to the reuse site and the risk of human exposure to pathogens in the reclaimed water are limited [for example, irrigation of nonfood crops such as cotton].

Class C Reclaimed Water

Secondary treatment by wastewater stablilization ponds with multiple cells, including aeration
Minimum total retention time: 20 days
Fecal coliform: <1000 cfu or MPN / 100 ml (7-sample median)
4000 / 100 ml (single sample maximum)

The purposes of reclaimed water quality standards

The protection of the public health is the primary objective of the proposed reclaimed water quality standards. The public health may be protected by: 1) reducing concentrations of pathogenic bacteria, parasites, and viruses in reclaimed water through appropriate wastewater treatment; and 2) limiting human exposure to reclaimed water at sites where reclaimed water is reused. Where human exposure to reclaimed water is likely, reclaimed water should be highly treated prior to its reuse to minimize the risk to public health. Conversely, where public access to a reuse site can be restricted so that human exposure to the reclaimed water is unlikely, a lower level of treatment is acceptable provided worker safety is not compromised. Other reclaimed water quality objectives include prevention of groundwater contamination, avoiding the creation of nuisance conditions, producing an aesthetically acceptable reclaimed water, and meeting the specific water quality requirements of reusers.

What reuse applications are recognized in the current rules and does ADEQ propose to amend or eliminate any of them in this rulemaking?

Existing reuse applications allowed by the current rules include the use of reclaimed water for the irrigation of orchards, pastures, fiber, seed and forage crops; and food crops that are eaten raw and food crops that undergo additional processing; livestock watering; landscape irrigation (open access and restricted access); creation of artificial wetlands; industrial reuse applications and the creation of impoundments where full body contact and incidental human contact may occur [*See* Table I above].

ADEQ proposes to retain most of the reuse applications listed in the previous paragraph. ADEQ intends to prohibit full-body contact recreation [for example, swimming] in impoundments of reclaimed water. While advanced wastewater treatment can substantially reduce the risk of human exposure to pathogenic microorganisms in reclaimed water, ADEQ believes that the risk of human exposure to disease-causing organisms from swimming in impoundments of reclaimed water is unnecessary and avoidable. Even with advanced wastewater treatment, there is no guarantee that even Class A+ or Class A reclaimed water is completely pathogen-free. As noted above, the public health can be protected by requiring appropriate wastewater treatment *and by limiting human exposure to reclaimed water at reuse sites*. A prohibition on swimming in impoundments of reclaimed water is a reasonable limitation on human exposure to any pathogens that may be in reclaimed water and it provides an additional margin of safety that will protect public health. It also is consistent with ADEQ regulations for effluent dependent waters and rules that prohibit the use of treated wastewater as make-up water in swimming pools and spas.

The current wastewater reuse rules prohibit direct potable reuse of reclaimed water [*See* R18-9-702(M)]. ADEQ proposes to retain the current prohibition against direct potable reuse. By “direct potable reuse,” ADEQ means the piping of reclaimed water from a wastewater treatment plant directly into a drinking water distribution system.

ADEQ recognizes that there has been promising research conducted nationally on the feasibility of using advanced wastewater treatment systems to produce reclaimed water that can be reused in direct potable reuse systems. One of the most well-known direct potable reuse demonstration projects is the Denver Potable Reuse Demonstration Plant located in Colorado. The Denver Potable Reuse Demonstration Plant is a 1 MGD wastewater treatment plant that produces reclaimed water for testing and analysis using alternative treatment processes. The reclaimed water produced by the plant is suitable for direct use as drinking water. The Denver Potable Reuse Demonstration Plant can treat secondary effluent using chemical coagulation, recarbonation, multimedia filtration, ion exchange, ultraviolet disinfection, two-stage carbon adsorption, ultrafiltration, reverse osmosis, air stripping, ozonation, and chlorination. Tests of the reclaimed water show that the quality of the reclaimed water produced by the plant is comparable to the quality of other surface and ground water sources of drinking water for the City of Denver. The Denver Potable Reuse Demonstration Plant also shows that it is technologically feasible to use multiple barriers to treat wastewater so that it is suitable for direct potable use. Notwithstanding the research being conducted at the Denver Potable Reuse Demonstration Plant, ADEQ believes that the current prohibition against direct potable reuse should be retained for the following reasons:

1. At the present time, there is not a demonstrated need for direct potable reuse systems in Arizona. Instead, the reuse rules should encourage the reuse of reclaimed water for nonpotable uses as a way of augmenting the potable water supply.

2. ADEQ does not believe that the public is ready to accept direct potable reuse.

3. The level of treatment reliability needed for a direct potable reuse system needs to be better understood.

4. Additional research on the public health effects of using reclaimed water in direct potable reuse systems needs to be done, especially on the fate of trace organic chemicals in reclaimed water as it recycles through a closed loop system.

5. While various indirect potable reuse projects have been implemented in the United States, currently there are no direct potable reuse systems in operation in the United States.

ADEQ proposes to recognize several new reuse applications for reclaimed water. These include the reuse of reclaimed water for construction purposes such as materials washing and sieving, concrete and cement mixing, soil compaction, and dust control. ADEQ also intends to recognize the use of reclaimed water for toilet and urinal flushing. Other new urban reuse applications include using reclaimed water for street washing, fire protection systems, and in air conditioning systems.

The adopted rules also will allow the reuse of Class A reclaimed water for snow-making. ADEQ did not include snow-making as a type of direct reuse when ADEQ originally proposed the reclaimed water quality standards rules. ADEQ received several public comments requesting that ADEQ consider allowing snow-making as a type of direct reuse. It was pointed out that several states currently allow the use of reclaimed water for snowmaking, including California, Maine, Pennsylvania, and New Hampshire. California's proposed revisions to its Title 22 reclamation criteria in September, 1999 specifically allow the use of disinfected, tertiary recycled water for artificial snowmaking for commercial outdoor uses. California's disinfected, tertiary recycled water is equivalent to Class A reclaimed water that is proposed by ADEQ.

The proposed reclaimed water quality standards do not establish criteria for specific industrial applications. ADEQ recognizes that industrial use represents a significant potential market for reclaimed water. Reclaimed water may be used by many industries for processes that do not require water of potable quality. Industrial uses of reclaimed water may include cooling water, boiler-feed water, and process water. However, reclaimed water quality requirements may vary considerably depending upon the type of industrial use. For example, reclaimed water used for once-through cooling may have few reclaimed water quality restrictions and little treatment may be necessary. On the other hand, the reclaimed water quality requirements for recirculating cooling systems that employ cooling towers may be much more restrictive. Advanced wastewater treatment may be necessary in recirculating systems to avoid cooling water quality problems such as scaling, corrosion, biological growth, fouling, and foaming. ADEQ recognizes that the reuse of reclaimed water for industrial purposes is already a reality in Arizona. For example, the Palo Verde Nuclear Generating Station (PVNGS) located outside of Phoenix reuses reclaimed water for cooling purposes. PVGNS uses reclaimed water from two wastewater treatment plants (WWTP), the 91st Avenue WWTP and the Tolleson WWTP. The two WWTPs provide secondarily-treated effluent to PVGNS. A 90-mgd tertiary wastewater reclamation facility at PVGNS provides additional treatment of the reclaimed water to meet the specific water quality requirements for the recirculating cooling system at PVGNS. Additional treatment processes at PVGNS include trickling filtration, lime / soda ash softening, and gravity filtration.

Another potential industrial reuse of reclaimed water is as boiler feed water. However, the use of reclaimed water as boiler feed water requires extensive additional treatment to prevent scaling, corrosion, and foaming. The water quality requirements for boiler-feed water are dependent upon the pressure at which a boiler is operated. Generally, the higher the boiler pressure, the higher the quality of reclaimed water required. Very high pressure boilers require make-up water of almost distilled water quality. If reclaimed water is used for boiler feed makeup, it must be treated to reduce hardness to close to zero. The removal of calcium and magnesium salts and the control of silica and aluminum are required to prevent scale build-up in boilers. Depending upon the characteristics of the reclaimed water, lime treatment (including flocculation, sedimentation, and recarbonation) followed by filtration, carbon adsorption, and nitrogen removal may be necessary. High purity boiler feed water for high pressure boilers may require additional treatment by reverse osmosis or ion exchange. Even Class A or Class A+ reclaimed water would require additional treatment before it could be used as boiler feed water for high pressure boilers.

The suitability of reclaimed water for use as industrial process water depends upon the particular industrial process. For example, the electronics industry may require water of almost distilled quality for washing circuit boards and other electronic components. On the other hand, the mining, textile, pulp and paper, and metal fabricating industries may be able to use reclaimed water of lower quality in some of their industrial processes. Reclaimed water quality standards for industrial reuse are determined primarily by the specific water quality requirements of the industries that want to reuse the reclaimed water. For this reason, ADEQ did not propose general categories of reclaimed water for industrial reuse. Instead, ADEQ proposed R18-11-308. R18-11-308 states that reclaimed water quality requirements for industrial reuse applications are industry-specific and must be determined on a case-by-case basis.

Finally, ADEQ recognizes that new and creative ways to reuse reclaimed water may be developed in the future that are not addressed in the proposed rules. To address this issue, ADEQ proposes to adopt R18-11-309. This rule gives ADEQ the flexibility of prescribing reclaimed water quality requirements on a case-by-case basis for a new type of direct reuse that is not contemplated in the proposed rules.

What microbiological quality standards does ADEQ propose for reclaimed water?

ADEQ proposes the establishment of 5 classes of reclaimed water. Class A+ and Class A reclaimed waters undergo advanced wastewater treatment and high level disinfection so they are essentially free of pathogenic bacteria, viruses, and parasites. Basically, ADEQ proposes a "no detectable" fecal coliform standard for Class A+ and Class A reclaimed water. The operator of a wastewater treatment plant that produces Class A+ or Class A reclaimed water will be required to take daily samples of reclaimed water and have the samples analyzed for the presence of fecal coliform organisms. The proposed "no detectable" fecal coliform criterion is expressed as a 7-day median value. This means that 4 of the last 7 daily samples for which fecal coliform analyses are completed must have "no detectable" fecal coliforms per 100 ml [that is, less than < 2 cfu or MPN / 100 ml]. Also, no single daily sample of Class A reclaimed water may exceed 23 cfu or MPN / 100 ml. A wastewater treatment plant that produces Class A+ or Class A reclaimed water must comply with a 24-hour average turbidity standard of 2 NTUs prior to disinfection. This turbidity criterion is established to ensure the production of a highly clarified reclaimed water that will result in a high level of disinfection.

A water reclamation plant that consistently meets the minimum treatment requirements, fecal coliform, and turbidity criteria for Class A+ and Class A reclaimed water should reliably produce essentially pathogen-free reclaimed water that may be reused safely for all of the reuse applications listed in Appendix A of the rules. The rules require the use of Class A reclaimed water where there is a relatively high risk of public exposure to reclaimed water or where there is a risk of food contamination. ADEQ proposes to require Class A reclaimed water for surface or spray landscape irrigation where public access to a reuse site is unrestricted. For example, Class A reclaimed water is required for irrigation of schoolyards, playgrounds, and parks. Class A reclaimed water is required for surface or spray irrigation of food crops that are eaten raw. Class A reclaimed water is required for use in recreational impoundments where fishing and boating may take place, but no swimming. Finally, ADEQ proposes to require Class A reclaimed water for toilet and urinal flushing, fire protection systems, vehicle washing, snow-making, and air conditioning systems.

Class B reclaimed water is a wastewater that has undergone secondary treatment and disinfection. ADEQ proposes to establish disinfection criteria for Class B+ and Class B reclaimed water that are equivalent to the criteria that EPA recommends for reclaimed water that has undergone secondary treatment and disinfection. Class B reclaimed water are expressed as fecal coliform bacteria concentrations. The maximum 7-sample median fecal coliform bacteria concentration for Class B+ and Class B reclaimed water is < 200 cfu or MPN / 100 ml. and the single sample maximum concentration is 800 cfu or MPN / 100 ml. ADEQ believes that Class B+ and Class B reclaimed water may be reused safely for the reuse applications where it is required because there is only a small risk of ingestion of the reclaimed water and the risk of human exposure to potential pathogens in the reclaimed water is less than the risk of exposure to pathogens that may be encountered during full body contact recreation in a surface water. ADEQ proposes to require the use of Class B reclaimed water for golf course irrigation, landscape irrigation where public access is restricted, and landscape impoundments where swimming, boating, and fishing are prohibited. Class B reclaimed water also may be used safely for the irrigation of fiber, seed, and forage crops; irrigation of food crops that are commercially processed to destroy pathogens; surface irrigation of orchards and vineyards, irrigation of pastures used by dairy animals; livestock watering; dust control; street cleaning, soil compaction, concrete and cement mixing, and materials washing and sieving.

Class C reclaimed water is a wastewater that has undergone secondary treatment in wastewater stabilization ponds. Class C reclaimed water may be reused without disinfection provided minimum detention times in the lagoon system and fecal coliform criteria are met. The minimum detention time in the wastewater stabilization pond system is 20 days. ADEQ proposes to establish a maximum 7-sample median fecal coliform concentration for Class C reclaimed water of < 1000 cfu or MPN / 100 ml and a single sample maximum concentration of 4000 cfu or MPN / 100 ml. These fecal coliform criteria are equivalent to the fecal coliform criteria in the current rules that apply to the reuse of treated wastewater for irrigation of nonfood crops. Class C reclaimed water may be reused safely for silviculture, sod farm irrigation, irrigation of nonfood crops, livestock watering of non-dairy animals, and irrigation of pastures used by non-dairy animals.

Why are microbiological water quality standards for wastewater reuse necessary?

Wastewater is known to have pathogenic microorganisms in it. The presence of pathogens in wastewater creates a potential for disease transmission and other adverse public health effects if persons come into contact with reclaimed water. Persons may contact, ingest, or inhale bacteria, parasites, and viruses that may be present in reclaimed water. The table below lists some of the pathogenic microorganisms that may be present in raw wastewater and the diseases they cause.

Pathogenic Microorganisms in Raw Wastewater

Bacteria	Disease
Shigella	Shigellosis [dysentery]
Salmonella typhi	Typhoid fever
Salmonella [over 1700 serotypes]	Salmonellosis
Vibrio cholerae	Cholera
Escherichia coli [enteropathogenic]	Gastroenteritis
Legionella	Legionnaire's disease

Protozoa	Disease
Giardia lamblia	Giardiasis
Cryptosporidium	Cryptosporidiosis
Entamoeba histolytica	Amoebic dysentary

Helminths	Disease
Ascaris lumbricoides [roundworm]	Ascariasis
Ancylostoma duodenale [hookworm]	Ancylostomiasis
Necator americanus [hookworm]	Necatoriasis
Ancylostoma [hookworm]	Cutaneous larva migrams
Strongloides stercoralis [threadworm]	Strongyloidiasis
Trichuris trichiura [whipworm]	Trichuriasis
Taenia [spp.] [tapeworm]	Taeniasis
Enterobius vermicularis [pinworm]	Enterobiasis
Echinococcus granulosus [tapeworm]	Hydatidosis

Viruses	Disease
Enteroviruses [72 types] [polio, echo, coxsackie, new enteroviruses]	Gastroenteritis, heart anomalies, meningitis
Heptatitis A virus	Infectious hepatitis
Adenovirus [47 types]	Respiratory disease, eye infections
Rotavirus [4 types]	Gastroenteritis
Parvovirus [3 types]	Gastroenteritis
Norwalk agent	Diarrhea, vomiting, fever

[Source: EPA Guidelines for Water Reuse, p. 20]

One of the most common pathogens found in wastewater are bacteria of the genus *Salmonella*. Over 1,700 different serotypes of *Salmonella* have been identified. This group of bacteria contains a wide variety of species that can cause disease in humans. *Salmonella* species cause three distinct forms of salmonellosis: enteric fevers, septicemias, and acute gastroenteritis. The most severe form of salmonellosis is typhoid fever, caused by *Salmonella typhi* and the most common form of salmonellosis is acute gastroenteritis.

A less common genus of bacteria that has been isolated from wastewater is *Shigella*, which produces an intestinal disease known as shigellosis or bacillary dysentery. Waterborne outbreaks of shigellosis have been reported where wastewater has contaminated drinking water wells. *Shigella* also has been identified as a cause of waterborne disease outbreaks in lakes and rivers.

There are a variety of other pathogenic bacteria that have been isolated from wastewater. These include *Vibrio*, *Mycobacterium*, *Clostridum*, *Leptospira*, and *Yersinia* species. While these pathogens may be present in wastewater, their concentrations are usually too low to initiate disease outbreaks. *Vibrio cholerae* is the disease agent for cholera, which is not common in the United States but is common in many parts of the world. The most frequent mode of transmission of cholera is through contaminated water. Waterborne gastroenteritis of unknown cause is frequently reported and the suspected etiologic agent is often bacterial, such as certain gram-negative bacteria. These include enteropathogenic *Escherichia coli* [*E. coli*] and certain strains of *Pseudonomas*. Waterborne enteropathogenic *E. coli* have been implicated in gastrointestinal disease outbreaks. *Campylobacter coli* has been identified as the cause of diarrheal disease and it has been implicated as the etiologic agent in other waterborne disease outbreaks.

There are a number of protozoans that are pathogenic to humans and that occur in wastewater. Waterborne disease outbreaks have been linked to the protozoans, *Giardia lamblia* and *Cryptosporidium*. *Giardia lamblia* is the cause of giardiasis, which is characterized by severe gastrointestinal disturbance and diarrhea. Infection is caused by the ingestion of *Giardia lamblia* cysts. *Cryptosporidium* also causes diarrheal disease and infection is caused by ingestion of *Cryptosporidium* oocysts. *Cryptosporidium* in drinking water was the agent implicated in a major waterborne outbreak of cryptosporidiosis in Milwaukee in 1993 where an estimated 400,000 people became sick and 40 - 50 people died. It should be noted that there are no documented outbreaks of giardiasis or cryptosporidiosis related to wastewater reuse practices reported in the literature on wastewater reclamation.

There are a number of parasitic worms that occur in wastewater. The most important of these are intestinal worms, including the roundworm, *Ascaris lumbricoides*; the tapeworms, *Taenia saginata* and *Taenia solium*; the whipworm, *Trichuris trichirar*; the hookworms, *Ancylostoma duodenia* and *Necator americanus*, and the threadworm, *Strongyloides stercoralis*. Parasitic worms can have complex life cycles. For some parasitic worms, the infective stage is either the adult organism or the larvae. In other worms, the eggs, or ova, are the infective stage. In general, the eggs and larvae are resistant to environmental stresses and they may survive typical wastewater disinfection. However, eggs and larvae are readily removed by commonly used wastewater treatment processes such as sedimentation, filtration, or wastewater stabilization ponds.

There are over 120 different enteric viruses that are capable of producing disease in humans. Viruses can cause a wide variety of diseases, such as diarrhea, meningitis, paralysis, myocarditis, conjunctivitis, and hepatitis. The most important human enteric viruses found in wastewater are the enteroviruses [polio, echo, and coxsackie], rotaviruses, reoviruses, parvoviruses, adenoviruses, Norwalk-type viruses, and the Hepatitis A virus. Hepatitis A, the virus causing infectious hepatitis, is a virus that is frequently reported to be transmitted by water. It should be noted that there is no evidence that human immunodeficiency virus [HIV], the pathogen that causes acquired immunodeficiency syndrome [AIDS], is transmitted through water.

While viruses are known to occur in wastewater, little is known about the occurrence of waterborne viral disease. There has been little study of low level occurrence of waterborne viral disease for several reasons:

1. Current virus detection methods are not sufficiently sensitive to accurately detect low concentrations of viruses in water;

2. Enteric virus infections are often not apparent, thus making it difficult to establish the endemicity of viral infections;

3. The mild nature of most enteric virus infections precludes reliable reporting by patients or physicians;

4. Current epidemiological techniques are not sufficiently sensitive to detect low level transmission of waterborne viral diseases;

5. Illness due to enteric virus infections may not become obvious for several months or years;

6. Once introduced into a population, person-to-person contact becomes a major mode of transmission of enteric viral disease, thereby obscuring the role of water in its transmission.

There is epidemiological evidence of disease transmission from the reuse of raw or minimally treated wastewater. Epidemiological investigations directed at wastewater-contaminated drinking water supplies, the use of raw or minimally-treated wastewater for food crop irrigation, health effects to farmworkers who routinely contact poorly treated wastewater used for irrigation, and the health effects of wastewater aerosols emanating from spray irrigation sites using undisinfected wastewater have provided evidence of the transmission of disease from such practices.

Conversely, there is no epidemiological evidence of disease transmission from the reuse of wastewater that has received a minimum of secondary treatment and disinfection. ADEQ is not aware of any epidemiological studies of populations who have been exposed to reclaimed water that has been treated to such relatively high levels. However, this may be due to the fact that epidemiological studies have not been done because of the small size and mobility of study populations, the difficulty in determining actual levels of human exposure, and the inability of current epidemiological techniques to detect low level or endemic disease transmission. What can be said is that wastewater reclamation practices in the United States have not been implicated as the cause of any infectious disease outbreaks.

Diseases may be transmitted to humans either by the ingestion, inhalation, or conjunctival exposure to disease agents in reclaimed water. However, in order for a person to get sick, the following circumstances must occur. First, persons in the community from which the wastewater comes must be infected with a disease for a disease agent to be present in the wastewater and therefore present in the reclaimed water. Second, the disease agent must survive the treatment processes that the wastewater undergoes. Third, the person must be exposed to the reclaimed water. Finally, the disease agent must be present in sufficient numbers in the reclaimed water to cause infection at the time of exposure.

Whether illness occurs depends on a series of complex relationships between the person who is exposed and the disease agent. Variables include the number of disease agents in the reclaimed water at the time of exposure or the dose; the number of organisms necessary to initiate infection or the infectious dose; and the vulnerability of the person who is exposed to the disease agent to infection. A person's susceptibility to disease is highly variable and dependent upon his or her general health and the virulence of the specific pathogen in question. For example, infants, the elderly, persons with AIDS or who have compromised immune systems, and persons who are already ill may be more susceptible to disease than healthy adults.

Ideally, microbiological water quality standards for reclaimed water would be based upon epidemiological evidence that demonstrates a quantifiable cause / effect relationship between the concentration of a pathogenic organism in reclaimed water and human disease. Such data can be used to determine minimum or no-risk concentrations of the pathogenic organism. Unfortunately, there is not enough epidemiological evidence to support the development of risk-based standards. There is little data on the concentrations of specific pathogens in reclaimed water. Also, data on minimum infectious doses are not available for many pathogenic microorganisms because of the high cost of conducting clinical studies and the uncertainty inherent in extrapolating dose-response curves to low exposure levels.

Infectious dose studies with a variety of pathogenic microorganisms have been conducted over the past 30 years with human volunteers. The clinical studies that have been done indicate that there is a wide range of infectious doses for pathogenic microorganisms. The widest dose range required to produce illness has been found with bacteria. For example, some *Salmonella* species require doses of up to 10^8 cells to produce a 50% illness rate in the study population. In contrast, some species of *Shigella* produce a significant percentage of illness in subjects dosed with as few as 10 cells. Giardiasis has been produced in subjects who were dosed with gelatin capsules containing as few as 1-10 *Giardia lamblia* cysts. Enteric viruses also have produced infection at low dosage levels via oral ingestion, inhalation, and conjunctival exposure. These studies have shown that certain pathogenic microorganisms from all three categories [for example, bacteria, parasites, and viruses] can produce infections at relatively low exposure levels. The following table presents estimated infectious doses for some selected pathogens:

Infectious Doses of Selected Pathogens

Organisms	Infectious Dose
Escherichia coli	10^6 to 10^{10}
Salmonella typhi	10^4 to 10^{10}
Vibrio cholerae	10^3 to 10^7
Entamoeba histolytica	20
Shigella dysentariae	10
Giardia lamblia	<10
Viruses	1 to 10
Ascaris lumbricoides	1 to 10

[Source: EPA Guidelines for Water Reuse, p. 22]

The concentration of pathogenic microorganisms in raw wastewater

The occurrence and concentration of pathogenic microorganisms in raw wastewater is variable. This variability makes it difficult to predict the microbiological water quality characteristics of any particular wastewater. Important variables that affect the occurrence and concentration of pathogenic microorganisms in raw wastewater include the wastewater sources in the community, seasonal and diurnal variations in microbiological water quality, and the general health of persons in the community. Notwithstanding these variables, there is general consensus that there may be high concentrations of pathogenic microorganisms in raw or minimally-treated wastewater. The potential presence of high concentrations of pathogenic microorganisms in raw or minimally-treated wastewater precludes any consideration of the safe reuse of such wastewater. This conclusion is supported by epidemiological evidence of human disease transmission associated with the reuse of raw wastewater or minimally-treated wastewater. The table below presents some typical ranges of concentrations of indicator organisms and pathogenic microorganisms in raw wastewater:

Microorganism Concentrations in Raw Wastewater

Organisms	Concentration [#/100 ml]
Total coliforms	10^7 to 10^8
Fecal coliforms	10^4 to 10^9
Salmonella	400 to 8000
Helminth ova	1 to 800
Enteric virus	100 to 50,000
Giardia lamblia cysts	50 to 10^4

[Source: EPA Guidelines for Water Reuse, p. 22]

It has been estimated that raw wastewater typically contains 10^6 to 10^7 fecal coliform organisms per 100 ml [Hubley, D., et al., "Risk Assessment of Wastewater Disinfection," EPA-600/2-85/037, NTIS No. PB85-188845, U.S. Environmental Protection Agency, Cincinnati, OH, 1985]. Fecal coliform organisms are often used as indicators of the microbiological quality of water. The basic idea of the indicator organism concept is that an indicator organism functions as a surrogate parameter that indicates the presence of other pathogenic microorganisms in wastewater. If one accepts the basic premise that other pathogenic microorganisms are present in some proportion to the concentration of the indicator organism, and one considers: 1) the low infectious doses for certain bacteria, viruses, and parasites; 2) the possible presence of a sensitive or vulnerable population that may be exposed to reclaimed water when it is reused; and 3) the available epidemiological evidence, then one cannot escape the conclusion that raw or minimally treated wastewater, which may have *millions* of fecal coliform organisms per 100 ml, cannot be reused safely.

The reduction of pathogenic microorganisms in wastewater through treatment

While everyone may agree that raw or minimally treated wastewater cannot be reused safely, finding consensus on what level of treatment should be required before the treated wastewater can be reused is more difficult. The concentration of pathogenic microorganisms in raw wastewater can be substantially reduced through treatment. Levels of wastewater treatment are generally classified as primary, secondary, and advanced (or tertiary) wastewater treatment.

Preliminary treatment of wastewater generally consists of physical treatment processes of screening, comminution, and grit removal. Coarse screening is typically the first treatment step to remove large solids and trash that may interfere with downstream treatment processes. Comminution devices are used to cut up the solids in the wastewater into smaller solids of more uniform size. Grit chambers are used to remove sand, gravel, cinders, and other heavy solids from the wastewater. Other preliminary treatment processes may include flocculation, pre-aeration, and odor control.

The primary treatment of wastewater consists of physical treatment processes that remove settleable organic and inorganic solids by sedimentation and floating materials by skimming. Primary treatment removes some nitrogen, phosphorus, and heavy metals from wastewater but it does little to remove colloidal or dissolved pollutants. Primary treatment has little effect on the removal of pathogenic microorganisms in wastewater. Some parasitic ova or cysts may settle out during primary treatment. Primary treatment also may remove some bacterial pathogens that are associated with particulates. However, percent removals of pathogenic microorganisms by primary treatment are typically less than 50%. Also, primary treatment does not effectively reduce the levels of enteric viruses in wastewater. Because of the low removal of pathogenic microorganisms and the potential threat to public health, ADEQ proposes to prohibit the reuse of wastewater that has only undergone preliminary or primary treatment. ADEQ intends to require a minimum of secondary treatment before reclaimed water may be reused.

Typical Percent Removal Efficiencies for Primary Treatment

Constituent	Percent Removal
BOD	42
COD	38
TSS	53
Fecal coliform	<10
Salmonella	0-15
Shigella	15
Entamoeba histolytica	0-50
Helminth ova	50-98
Enteric viruses	Limited

[Source: EPA Guidelines for Water Reuse, p. 30]

Secondary treatment utilizes aerobic biological treatment processes to remove organic matter from wastewater. Aerobic biological treatment occurs in the presence of oxygen whereby microorganisms oxidize the organic matter in the wastewater. Several types of aerobic biological treatment are used in secondary treatment. These may include low-rate processes such as wastewater stabilization ponds and aerated lagoons or high-rate processes such as activated sludge, trickling filters, or rotating biological contactors. Conventional secondary treatment processes reduce the concentration of pathogenic microorganisms by predation or adsorption to particulates that are subsequently removed by sedimentation. It is estimated that conventional secondary treatment processes are capable of removing over 90% of the bacteria and viruses found in raw wastewater. Hubley, et. al assessed the concentration ranges of certain organisms in domestic wastewater, the reductions achievable through secondary treatment, and the estimated secondary treated effluent concentrations. The results of this assessment are summarized in the tables below:

Microorganism Reductions by Secondary Treatment

Constituent	Percent Removal
Total coliforms	90-99
Fecal coliforms	90-99
Shigella sp.	91-99
Salmonella sp.	96-99
Escherichia coli	90-99
Virus	76-99

Secondary Effluent Ranges for Pathogenic and Indicator Organisms Prior to Disinfection

	Number / 100 ml	
Organisms	Minimum	Maximum
Total coliforms	45,000	2,020,000
Fecal coliforms	11,000	1,590,000
Viruses	0.5	1,000

Source: Design Manual: Municipal Wastewater Disinfection, EPA 625/1-86/021, U.S Environmental Protection Agency, Office of Research and Development, Water Engineering Research Laboratory, Cincinnati, OH [October, 1986], p. 6-7.

Estimated reductions in pathogenic microorganisms of 90% or more by secondary treatment support the establishment of secondary treatment as a minimum level of treatment for wastewater reuse. However, the secondary effluent ranges for viruses and indicator organisms cited above suggest that conventional secondary treatment alone, without disinfection, may be inadequate to prevent disease transmission when reclaimed water is reused. Given the low infectious doses of some bacterial and viral pathogens, the secondary effluent ranges for viruses and indicator organisms without disinfection are unacceptably high. For this reason, ADEQ proposes (with the exception of Class C) to require a minimum of secondary treatment with disinfection for all reuse applications.

In ADEQ's view, the most important wastewater treatment process for the prevention of waterborne disease transmission is disinfection. ADEQ proposes that reclaimed water, except for Class C, be disinfected before it is reused. Chlorination is the most widely used method for disinfection of wastewater in the United States. Ozonation and ultraviolet light disinfection are other important disinfection technologies that are used in wastewater treatment plants. ADEQ does not propose that any specific disinfection technology be utilized before reclaimed water may be reused. As many as 25 disinfection alternatives could be considered and have been previously identified from the literature [*See* "Design Manual: Municipal Wastewater Disinfection," U.S. Environmental Protection Agency, Office of Research and Development, EPA/625/1-86/021, October 1986, p. 11]. Major factors that must be considered when evaluating disinfection alternatives include disinfection effectiveness, treatment reliability, wastewater treatment plant size and design flow, capital costs, operation and maintenance costs, safety requirements, formation of hazardous by-products such as trihalomethanes, potential adverse effects on the environment, and practicality [for example, the complexity of the disinfection technology, operator competence and expertise, and the ease of transport and storage of disinfectants]. ADEQ proposes to require disinfection and will propose certain numeric disinfection criteria. However, ADEQ will leave the selection of the most appropriate disinfection technology to achieve compliance with the disinfection criteria to the owners and operators of reclamation facilities.

ADEQ proposes to require advanced wastewater treatment, including filtration, for Class A reclaimed water. Filtration is a common treatment process used to remove particulate matter in wastewater prior to disinfection. Filtration involves passing wastewater through a bed of granular media which filters out particulates. Typical filter media include sand or anthracite. The pollutant removal efficiency of filtration can be enhanced through the addition of coagulants or polymers. Coagulation or polymer addition may be necessary to achieve consistent compliance with the reclaimed water quality criteria that are proposed for Class A reclaimed water, especially the proposed turbidity criterion.

The removal of suspended solids or turbidity from secondary effluent by filtration is important because it affects the efficiency of the disinfection process. It is known that many pathogens are associated with particulates that can shield bacteria and viruses from the action of disinfectants. Also, the organic matter in wastewater consumes chlorine, making less chlorine available for disinfection. There is general agreement that particulate matter in wastewater should be reduced to low levels prior to disinfection to ensure the reliable destruction of pathogenic microorganisms during the disinfection process.

It has been demonstrated that conventional filtration, or coagulation, sedimentation, and filtration, without disinfection, can remove more than 2 logs [99%] of seeded poliovirus [Source: EPA Guidelines for Water Reuse, p. 35]. Conventional filtration reduces the turbidity of the effluent to low levels and enhances the efficiency of the subsequent disinfection process. Direct filtration, or coagulation and filtration without sedimentation, without disinfection, also has been shown to remove up to 2 logs of seeded poliovirus. Virus removal studies have demonstrated that chemical coagulation and conventional filtration followed by chlorine disinfection to very low total coliform levels can remove or inactivate 5 logs [99.999%] of seeded poliovirus. This treatment chain can produce a reclaimed water that is essentially free of measurable levels of pathogenic microorganisms. Equivalent 5-log virus removals have been achieved using direct filtration and high level disinfection if certain design and operational controls are provided. For example, the State of California developed a policy that describes the design and operational controls for direct filtration facilities that are necessary to produce an essentially pathogen-free reclaimed water:

1. Coagulant addition unless secondary effluent turbidity is less than 5 NTU;

2. Maximum filtration rate of 12 m/h [5 gpm/ft^2];

3. Average filter effluent turbidity of 2 NTU or less;

4. High-energy rapid mix of chlorine;

5. Theoretical chlorine contact time of at least 2 hours with an actual modal contact time of at least 90 minutes;

6. Minimum chlorine residual of 5 mg/L after the required contact time;

7. Chlorine contact chamber length to width or depth ratio of at least 40:1; and

8. Seven-day median number of total coliform organisms in the effluent of 2.2 / 100 ml or less, not to exceed 23 / 100 ml in any single sample.

Chemical addition and filtration requirements for Class A reclaimed water are supported by research conducted by Professors Charles P. Gerba and Joan B. Rose [*See* "Assessing Potential Health Risks From Viruses and Parasites in Reclaimed Water in Arizona and Florida," Water Sci. Tech., V. 23, pp. 2091-2098 (1991)]. Professors Gerba and Rose evaluated virus and parasite monitoring data from 24 wastewater plants in Arizona and Florida and concluded that filtration was necessary to achieve an effluent quality suitable for unrestricted irrigation. Professors Gerba and Rose noted that previous studies had demonstrated that sand filtration was efficient for virus removal only when preceded by coagulation. Their monitoring data demonstrated that filtration decreased the concentration of *Giardia lamblia* cysts and *Cryptosporidium* oocysts in reclaimed water. However, without the use of coagulation, *Giardia lamblia* cyst and virus breakthrough was greater. For example, monitoring data from a wastewater treatment facility utilizing coagulants with filtration showed that no *Giardia lamblia* cysts were detected in the reclaimed water. At a wastewater treatment facility utilizing sand filtration alone, 27% of the samples tested positive for *Giardia lamblia*. Monitoring data from a wastewater treatment plant utilizing coagulants with filtration showed that only 8% of the samples contained viruses at levels greater than 1 pfu / 40 L. At a wastewater treatment facility utilizing sand filtration alone, 16% of the effluent samples contained viruses.

Using a probability of infection risk assessment model, Drs. Gerba and Rose reported that the risk of infection from accidental ingestion of 100 milliliters of treated wastewater ranges from approximately 2×10^{-3} to 2×10^{-4} for the levels of viruses typically found in chlorinated secondary effluent. Drs. Gerba and Rose estimated that the risk of infection was reduced to 2×10^{-4} to 2×10^{-6} with filtration and disinfection following secondary treatment. The authors concluded:

> [D]epending on the type of reuse (i.e. irrigation of highway medians versus school playgrounds) one may want to achieve equal to or greater than 10^{-6} risk on a routine basis to provide an extra margin of safety. Thus reliable treatment must be maintained to eliminate the pathogens equal to or below 0.1 organisms / 100 ml routinely.....In order to achieve an effluent quality for unrestricted irrigation, filtration is needed in addition to secondary treatment [p. 2097].

Coagulation and filtration requirements for Class A reclaimed water are supported by wastewater reclamation experience and research conducted in Florida. In 1977, the City of St. Petersburg, Florida initiated a dual distribution system to deliver reclaimed water for landscape irrigation. The water reclamation system in St. Petersburg is one of the largest of its kind in the world. The city operates 4 water reclamation plants. Each reclamation plant treats wastewater using activated sludge biological treatment, secondary clarification, coagulant addition, filtration, and disinfection. The 4 water reclamation plants deliver approximately 21 MGD of reclaimed water to more than 7000 customers through more than 250 miles of pipelines. 40% of the reclaimed water is reused by system customers to irrigate parks, golf courses, school grounds, common areas, and residential neighborhoods.

In 1987, in response to the absence of definitive water reclamation criteria, the City of St. Petersburg commissioned a panel of engineering and public health experts to develop recommendations for reclaimed water quality criteria. The panel prepared a white paper entitled, "Urban Water Reuse in the City of St. Petersburg: Water Quality and Public Health Considerations." The panel concluded that there was no evidence of disease transmission associated with reclamation in urban areas when reclaimed water had undergone secondary treatment, coagulation, filtration, and disinfection. The panel recommended that water reclamation facilities be designed as secondary treatment facilities with provision for chemical addition before filtration. The panel recommended that reclamation facilities comply with a 24-hour average turbidity standard of 2.0 NTUs. The panel also recommended that the standard for disinfection of the reclaimed water be 2.2 fecal coliform organisms / 100 ml [30-day average] with an upper limit of 23 / 100 ml in not more than 10% of the samples. Finally, the panel recommended the maintenance of a 4.0 mg/ L chlorine residual in the reclaimed water.

The water reclamation plants in St. Petersburg currently comply with these recommendations and there have not been any reported cases of disease or illness resulting from the reuse of reclaimed water. This finding is significant because many St. Petersburg residents who are served by the city's dual distribution system are elderly who may be considered to be more vulnerable to disease than the general population. For example, data from 1980 to 1985 were reported to the Centers for Disease Control for two enteric viruses, aseptic meningitis and hepatitis A, which are historically associated with waterborne disease transmission. The data gave no indication that the use of reclaimed water in St. Petersburg altered the expected epidemiological patterns of these diseases. The reported incidence rate of aseptic meningitis for the county in which St. Petersburg is located was not significantly different from the national rate for the same period of time and the incidence rate of hepatitis A was lower than the national rate.

The epidemiological data is supported by virus monitoring results of reclaimed water produced by the St. Petersburg reclamation plants between 1981 and 1988. The virus monitoring data from over 200 samples of reclaimed water indicated that reclaimed water that had undergone secondary treatment, coagulation, filtration, and disinfection was essentially virus-free. While detectable levels of viruses were occasionally detected, the few samples that were virus-positive contained less than 1 enteric virus / 100 L.

ADEQ believes that chemical addition, filtration, and high level disinfection should be required before reclaimed water is reused in urban settings where there is a high probability of public exposure to the reclaimed water or where there is a potential risk of food contamination. Wastewater treatment plants should have the capability to add coagulants or polymers prior to filtration to ensure consistent compliance with the proposed reclaimed water quality criteria for fecal coliform and turbidity. The research on virus removal cited in this section supports the proposal of advanced wastewater treatment requirements for Class A reclaimed water. Finally, ADEQ believes that the proposed filtration and disinfection treatment requirements for Class A reclaimed water are both technically and economically feasible.

How do the proposed disinfection criteria compare to disinfection criteria for the reuse of reclaimed water in other states?

All states that have established reclaimed water quality standards prescribe disinfection criteria. In general, the disinfection criteria are commonly expressed as either total or fecal coliform concentrations. Average total coliform or fecal coliform limits that have been established by the states differ depending upon the type of reuse. Arizona and Hawaii are the only states that have established disinfection criteria for enteric viruses and specific parasites.

Disinfection criteria for open access landscape irrigation

For unrestricted urban reuse applications where public exposure to reclaimed water is likely such as irrigation of parks, playgrounds, and common areas, states have adopted disinfection criteria with average total or fecal coliform limits which range from the nondetectable level to 200 fecal coliform organisms / 100 ml. For example, California, Colorado, Hawaii, Idaho, Montana, and Oregon require that wastewater be oxidized, coagulated, clarified, filtered, and disinfected before it can be reused for unrestricted urban reuse applications. These states require compliance with a total or fecal coliform criterion of < 2.2 coliform organisms per 100 ml [mean or median concentration] and 23 coliform organisms per 100 ml [single sample maximum concentration]. Hawaii also prescribed an enteric virus criterion of 1 PFU / 40 L for unrestricted urban reuse applications. Utah requires advanced wastewater treatment and compliance with a single sample maximum total coliform concentration of 3 coliform organisms / 100 ml for unrestricted urban reuse.

Florida requires that wastewater be treated by secondary treatment, chemical feed facilities, filtration, and high level disinfection before reclaimed water can be reused for unrestricted urban reuse applications. Florida's disinfection criteria are expressed as concentrations of fecal coliform organisms. Florida requires that 75% of the samples of reclaimed water taken in a 30-day period have no detectable fecal coliforms. Florida also requires compliance with a single sample maximum concentration of 25 fecal coliform per 100 ml. South Carolina has similar treatment requirements and disinfection criteria. Illinois and Kansas require secondary treatment, filtration, and disinfection before reclaimed water may be reused for unrestricted urban reuse applications.

There are several states that require secondary treatment and disinfection only before the reclaimed water can be reused for unrestricted urban reuse applications. These states include Arkansas, Delaware, Georgia, Nevada, South Dakota, Tennessee and Washington. Maximum allowable disinfection criteria in these states range from < 2.2 fecal coliforms / 100 ml to < 200 fecal coliforms / 100 ml. Arizona's current rules do not prescribe minimum treatment requirements. Arizona currently requires compliance with an average fecal coliform concentration of < 25 fecal coliform organisms / 100 ml with no single sample exceeding 75 fecal coliform organisms / 100 ml for open access landscape irrigation. The new rules require Class A reclaimed water for open access landscape irrigation. The proposed Class A disinfection criteria are more stringent than the current criteria. ADEQ proposes a 7-sample median fecal coliform limit of no detectable fecal coliform organisms / 100 ml [that is, < 2 cfu or MPN / 100 ml] and a single sample maximum concentration of < 23 cfu or MPN / 100 ml. This means that 4 of the last 7 daily samples of reclaimed water must have no detectable fecal coliform organisms. That is, the most probable number (MPN) or the number of colony forming units (cfu) must be less than 2. If a sample is fecal coliform positive, the concentration of fecal coliform organisms cannot exceed 23 cfu or MPN / 100 ml.

Disinfection criteria for restricted access landscape irrigation

Restricted urban reuse applications generally involve the reuse of reclaimed water for irrigation of areas where public access to the reuse site is limited or controlled such as irrigation of highway medians, cemeteries, and golf courses. Many states do not recognize restricted urban reuse as a separate reuse category and do not prescribe less stringent disinfection criteria for it. For example, the states of Florida, Delaware, Georgia, Illinois, South Carolina and Utah require that all landscape irrigation meet the reclaimed water quality standards that apply to unrestricted urban reuse applications.

Where states recognize restricted access landscape irrigation as a separate reuse category, there is wide variation in the applicable disinfection criteria. Most states require secondary treatment and disinfection as a minimum level of treatment before reclaimed water may be reused for restricted access landscape irrigation. The states have adopted disinfection criteria that are expressed as fecal coliform or total coliform concentrations. There is a wide range of maximum allowable concentrations from the nondetectable level in Florida to < 1,000 / 100 ml in New Mexico. Many western states, including Colorado, Nevada, and Oregon, have adopted the California reclamation criteria for restricted access landscape irrigation. These states generally require secondary treatment and disinfection as a minimum level of treatment. The states that have adopted the California reclamation criteria prescribe a disinfection criterion of < 23 total coliform organisms / 100 ml as a median value and 240 / 100 ml as a single sample maximum concentration.

Several states prescribe disinfection criteria for restricted urban reuse applications that are less stringent than the California reclamation criteria. For example, the states of Idaho, Missouri, Montana, New Mexico, South Dakota, Tennessee, and Wyoming require secondary treatment and disinfection, but have disinfection criteria that range from < 200 fecal coliforms / 100 ml to < 1000 fecal coliforms / 100 ml. These disinfection criteria are similar to Arizona's current disinfection criteria for restricted access landscape irrigation. In Arizona, the current wastewater reuse standards for restricted access landscape irrigation are an average fecal coliform concentration of < 200 cfu or MPN / 100 ml with no single sample exceeding 1000 cfu or MPN / 100 ml.

ADEQ proposes to require the use of Class B reclaimed water for restricted access landscape irrigation. The proposed minimum treatment requirements are secondary treatment and disinfection. The disinfection criteria for Class B reclaimed water quality criteria are expressed as fecal coliform concentrations. The disinfection criteria are established as concentrations that are equivalent to the level of water quality protection recommended in the EPA Guidelines for Water Reuse for restricted access area landscape irrigation where public access is either prohibited, restricted, or infrequent. The new rules require a 7-sample median value of < 200 cfu or MPN / 100 ml and a single sample maximum concentration of 800 cfu or MPN / 100 ml.

Disinfection criteria for food crop irrigation

Many states prohibit irrigation of food crops with reclaimed water or they permit it only if a food crop is to be commercially processed to destroy pathogens. Other states have established minimum treatment requirements and disinfection criteria for reclaimed water that is reused for food crop irrigation. Reclaimed water quality criteria for food crop irrigation vary depending upon the type of food crop [for example, orchards, vineyards, root crops, raw vegetables] and the type of irrigation [for example, surface or spray irrigation]. The average fecal or total coliform limits prescribed by the states that allow irrigation of food crops with reclaimed water range from the nondetectable level in Florida to < 2,000 cfu or MPN / 100 ml in Utah. Most states that allow food crop irrigation with reclaimed water require advanced wastewater treatment and they prescribe very stringent disinfection criteria.

For example, Florida requires that reclaimed water undergo secondary treatment with chemical feed facilities, filtration, and high level disinfection before reclaimed water can be reused for irrigation of food crops. Florida's disinfection criteria require that 75% of the samples of reclaimed water over a 30-day period have no detectable fecal coliform organisms. Florida prescribes a single sample maximum concentration for fecal coliform of 25 cfu / 100 ml.

California requires that wastewater be oxidized, coagulated, clarified, filtered, and disinfected before it can be reused for spray irrigation of food crops. The California disinfection criteria are expressed in terms of concentrations of total coliform organisms. California requires compliance with a disinfection criterion of < 2.2 total coliform organisms / 100 ml [as a median value] and a single sample maximum concentration of 25 total coliform organisms / 100 ml. These treatment requirements and disinfection criteria have been adopted by the states of Colorado, Hawaii, Idaho, Montana, Oregon, and Washington.

Arizona current wastewater reuse criteria for irrigation of food crops that are eaten raw are similar to California's disinfection criteria for food crop irrigation. However, Arizona's disinfection criteria are expressed in terms of fecal coliform organisms instead of total coliforms. Arizona currently requires compliance with an average fecal coliform concentration of < 2.2 fecal coliforms / 100 ml with no single sample exceeding 25 fecal coliforms / 100 ml.

Arizona and Hawaii are the only states that have established reclaimed water quality standards for viruses or specific pathogenic organisms for irrigation of food crops. Arizona has established limits for enteric viruses, *Entamoeba histolytica*, *Giardia lamblia*, and *Ascaris lumbricoides*. The allowable limit for each of these, except enteric viruses, is nondetectable. The allowable limit for enteric viruses is 1 pfu / 100 ml. Hawaii also has established limits on enteric viruses, *Entamoeba histolytica*, *Giardia lamblia*, and *Cryptosporidium*. ADEQ proposes to repeal the current virus and parasite criteria for food crop irrigation. The new rules require Class A reclaimed water for irrigation of food crops. The disinfection criteria in the proposed rules are: 1) a 7-day median fecal coliform limit of no detectable fecal coliform organisms / 100 ml, and 2) a single sample maximum concentration of < 23 cfu or MPN / 100 ml.

A few states permit surface irrigation of food crops with reclaimed water that has undergone secondary treatment and disinfection [for example, California, Colorado, Hawaii, New Mexico, Utah, Washington, and West Virginia]. Disinfection criteria for surface irrigation of food crops range from <2.2 fecal or total coliform organisms to < 2000 fecal or total coliform organisms / 100 ml. A few states, including Arizona, have adopted separate reclaimed water quality standards for the irrigation of food crops that are commercially processed to destroy pathogens. In general, the reclaimed water quality standards for food crops that receive commercial processing are less stringent than the standards that apply to irrigation of food crops that are consumed raw. For example, Colorado and Oregon require a minimum of secondary treatment and disinfection and compliance with a limit of < 23 total coliforms / 100 ml [median value] for irrigation of food crops that are commercially processed. Idaho allows the reuse of disinfected primary effluent and compliance with a median total coliform limit of < 230 / 100 ml.

Arizona currently requires compliance with an average fecal coliform limit of < 1000 / 100 ml and a single sample maximum concentration of 2500 / 100 ml. ADEQ proposes to require the use of Class B reclaimed water for irrigation of food crops that are commercially processed. The disinfection criteria for Class B reclaimed water are more stringent than the current reclaimed water quality criteria for this type of direct reuse.

Disinfection criteria for irrigation of orchards and vineyards

A few states have adopted disinfection criteria for reclaimed water that is reused for surface and spray irrigation of orchards and vineyards. In general, more stringent disinfection criteria apply to spray irrigation than to surface irrigation of orchards and vineyards. For example, Colorado requires that wastewater be oxidized, coagulated, clarified, filtered and disinfected and comply with a total coliform limit of < 2.2 per 100 ml [median value] before it can be reused for spray irrigation of orchards. On the other hand, Colorado allows the use of wastewater that has been oxidized and disinfected and which complies with a total coliform limit of < 23 / 100 ml [median value] for surface irrigation of orchards. Nevada permits irrigation of fruit and nut bearing trees with reclaimed water that has undergone secondary treatment and disinfection. Similarly, the state of New Mexico allows the use of "adequately treated" and disinfected reclaimed water for surface irrigation on food crops provided there is no contact between the reclaimed water and the edible portion of the food crop. California and Idaho allow the reuse of disinfected primary effluent for surface irrigation of orchards and vineyards.

Arizona currently requires compliance with the following disinfection criteria for irrigation of orchards: < 1000 cfu / 100 ml [5-sample geometric mean] and 4000 cfu / 100 ml [single sample maximum]. The new rules require that Class A reclaimed water be used for spray irrigation of orchards and vineyards and Class B reclaimed water for surface irrigation of orchards and vineyards.

Disinfection criteria for irrigation of non-food crops and pastures

Most states that regulate wastewater reuse allow the reuse of reclaimed water for the irrigation of nonfood crops. In general, the treatment and reclaimed water quality requirements are less stringent than those that apply to irrigation of food crops. Most states require a minimum of secondary treatment and disinfection, although some states allow the reuse of primary effluent for irrigation of non-food crops. Average fecal and total coliform limits range from 2.2 coliform organisms / 100 ml to 2,000 coliforms / 100 ml depending on the type of irrigation [that is, surface or spray irrigation] and whether there are any buffer zone requirements.

Arizona currently requires an average fecal coliform concentration of < 1000 / 100 ml and a single sample maximum concentration of 4000 / 100 ml for irrigation of pastures and fiber, seed and forage crops. The adopted rules require Class C reclaimed water for these reuse applications. The proposed Class C disinfection criteria prescribe the same fecal coliform criteria found in the current wastewater reuse standards for irrigation of nonfood crops.

Disinfection criteria for recreational and landscape impoundments

Arizona, California, Colorado, Nevada, and Oregon have established reclaimed water quality criteria for impoundments where "unrestricted" recreation may take place. Unrestricted recreational reuse means that full-body contact with the reclaimed water such as swimming is allowed. California, Oregon, and Colorado require that wastewater be disinfected, oxidized, coagulated, clarified, and filtered and comply with a median total coliform count of < 2.2 cfu / 100 ml, with no single sample exceeding 23 cfu / 100 ml. Nevada requires secondary treatment and disinfection and compliance with a median fecal coliform count < 2.2 cfu / 100 ml with no single sample exceeding 23 cfu / 100 ml.

Of the five states that allow the reuse of reclaimed water in recreational impoundments, Arizona has the least stringent fecal coliform criteria. Arizona does not prescribe minimum treatment processes and currently requires that the reclaimed water meet a median fecal coliform concentration < 200 cfu / 100 ml with no single sample exceeding 800 cfu / 100 ml. However, Arizona also adopted stringent enteric virus and turbidity standards for unrestricted recreational reuse. The allowable limit for enteric virus in reclaimed water that is reused in an impoundment where full-body contact recreation may take place is 1 pfu / 100 ml and the applicable turbidity standard is 1 NTU. Arizona also established limits for *Entamoeba histolytica, Giardia lamblia*, and *Ascaris lumbricoides* for unrestricted recreational reuse [the current standard is "none detectable"]. These enteric virus and turbidity standards are technology-forcing parameters. They can be achieved only through the use of advanced wastewater treatment. Consequently, no reuse permits have been issued in Arizona for impoundments that are intended for full body contact recreation.

Seven states, including Arizona, have established disinfection criteria for reclaimed water that is reused in "restricted" recreational impoundments. A restricted recreational impoundment means an impoundment where partial-body contact recreational activities such as boating or fishing are allowed. California, Colorado, Hawaii, Nevada, and Oregon require secondary treatment and disinfection as a minimum level of treatment for reclaimed water that is used in restricted recreational impoundments. In addition, California, Oregon and Colorado require compliance with a median total coliform count of < 2.2 cfu / 100 ml. Nevada requires compliance with a median fecal coliform count of < 2.2 cfu / 100 ml with no single sample that exceeds 23 cfu / 100 ml. Hawaii requires compliance with a mean total coliform count not to exceed 23 cfu / 100 ml with no two consecutive samples exceeding 240 cfu / 100 ml. Texas prescribes stringent criteria for biochemical oxygen demand [10 mg/L] and turbidity [3 NTUs]. Texas also requires compliance with a fecal coliform count not to exceed 75 cfu / 100 ml.

Again, Arizona currently has the least stringent reclaimed water quality standards for impoundments where partial-body contact with reclaimed water is allowed. Arizona does not prescribe treatment requirements and requires compliance with a median fecal coliform count of 1,000 cfu / 100 ml with no single sample exceeding 4,000 cfu / 100 ml. However, Arizona is the only state that has standards for specific pathogens for this reuse application, including enteric viruses and *Ascaris lumbricoides*. The allowable limit for enteric viruses is 125 pfu / 100 ml and the limit for *Ascaris lumbricoides* is "none detectable." ADEQ also requires compliance with a 5 NTU turbidity standard. The new rules require the use of Class A reclaimed water in recreational impoundments. The proposed fecal coliform limit would be no detectable fecal coliform organisms / 100 ml (7-sample median) and a single sample maximum concentration of 23 cfu or MPN / 100 ml.

How do the proposed disinfection criteria compare to EPA's suggested guidelines for water reuse?

ADEQ proposes to adopt most of EPA's recommended guidelines for water reuse. The recommended reuse standards in EPA's Guidelines for Water Reuse are expressed as a combination of minimum treatment unit processes and reclaimed water quality limits. For reuse applications where there is a high probability of human exposure such as urban reuse applications, irrigation of food crops, and recreational impoundments, EPA recommends a minimum of secondary treatment, filtration, and disinfection. The EPA guidelines also state that chemical coagulant or polymer addition prior to filtration may be necessary to meet the recommended reclaimed water quality limits for turbidity and fecal coliform.

EPA recommends compliance with a microbiological quality guideline of no detectable fecal coliforms per 100 ml for reuse applications where there is a high probability of human exposure. This recommended criterion is a median value that is determined from the bacteriological results of the last seven days for which analyses have been completed using either the membrane filter technique or the multiple tube fermentation technique. The EPA-recommended single sample maximum concentration is 14 fecal coliform organisms / 100 ml. ADEQ adopted EPA's recommended minimum treatment requirements and the "no detectable" fecal coliform criterion [7-day median value] for Class A reclaimed water. However, ADEQ adopted a different single sample maximum concentration of < 23 fecal coliform / 100 ml for Class A reclaimed water. ADEQ adopted a different single sample maximum concentration because ADEQ believes that EPA's recommended single sample maximum criterion of 14 cfu / 100 ml is unnecessarily stringent. Reclamation experience in Arizona, California, and other states demonstrates that a single sample maximum criterion of < 23 cfu / 100 ml is adequately protective.

For reuse applications where human exposure is less likely such as restricted access landscape irrigation, surface irrigation of orchards and vineyards, irrigation of nonfood crops and pastures, landscape impoundments, and construction uses, EPA recommends secondary treatment and disinfection as a minimum level of treatment. EPA recommends compliance with a microbiological quality criterion of < 200 fecal coliforms / 100 ml as a median value and < 800 fecal coliforms / 100 ml as a single sample maximum concentration. ADEQ adopted EPA's recommended minimum treatment requirements of secondary treatment and disinfection and EPA's recommended fecal coliform criteria for Class B reclaimed water.

EPA's recommended microbiological water quality limits for reclaimed water are expressed as fecal coliform concentrations. EPA selected fecal coliforms as the indicator organism because EPA thought that they were better indicators of fecal contamination than total coliforms. EPA's Guidelines for Water Reuse do not recommend virus or parasite standards. EPA did not recommend parasite standards because parasites have not been shown to be a problem at wastewater reuse operations in the United States when the suggested minimum treatment and reclaimed water quality limits are met. EPA did not recommend virus standards for the following reasons:

1. Virus criteria are unnecessary if the treatment process approach and fecal coliform disinfection criteria are adopted. Compliance with the prescribed treatment processes and recommended fecal coliform criteria will result in effective removal of viruses from reclaimed water.
2. Virus monitoring is expensive and complex, recovery rates are low, and the laboratory procedures to determine the presence of viruses and identify them can take up to a month.
3. There are a limited number of laboratories with the personnel and equipment that can perform viral assays.
4. There is no consensus among public health official regarding the public health significance of low levels of virus in reclaimed water.
5. There are no documented cases of viral disease resulting from the reuse of reclaimed water in the United States.

ADEQ also selected fecal coliform organisms as the indicator organism to be used for the disinfection criteria for Class A, B, and C reclaimed water. ADEQ repealed the current enteric virus and parasite reclaimed water quality standards and will rely on microbiological reclaimed water quality standards that are expressed in terms of the selected indicator organism.

How do the proposed disinfection criteria compare to surface water quality standards that have been established by other states to protect recreational waters?

Most of the current disinfection criteria for reclaimed water that have been adopted by other states appear to be based upon California's Title 22 reclamation criteria or they are appear to be derivations of the EPA water quality criteria for bacteria that have been recommended to protect marine and fresh recreational waters.

The two most commonly used microbiological water quality standards for marine and fresh recreational waters in the United States are the total coliform limit of 1000 cfu / 100 ml and the fecal coliform limit of 200 cfu / 100 ml. The total coliform limit of 1000 cfu / 100 ml was based on a series of studies of bathing waters conducted by the U. S. Public Health Service in the late 1940's and 1950's. The fecal coliform limit of 200 cfu / 100 ml was developed in 1968 by the National Technical Advisory Committee (NTAC) to the Federal Water Pollution Control Administration. The fecal coliform limit of 200 cfu / 100 ml was derived from the original total coliform limit established by the U.S. Public Health Service. The fecal coliform limit was based upon a total coliform to fecal coliform correlation study which found that in the original bathing water studies about 18%, or approximately 1/5 of the total coliforms, were fecal coliforms. The NTAC applied this ratio to the original total coliform limit to come up with a fecal coliform limit of 200 / 100 ml. The NTAC recommended the use of a fecal coliform limit because it was thought to be more fecal-specific than total coliforms and therefore represented a more realistic measure of the potential health hazard associated with swimming in sewage-contaminated waters. In 1976, the fecal coliform limits for recreational waters developed by NTAC were recommended by U.S. Environmental Protection Agency in the national criteria document for bacteria. EPA recommended fecal coliform criteria to protect human health even though the criteria had been criticized for the poor quality of the data base and deficiencies in the study design that were used in their development. By 1979, many states had adopted the EPA-recommended fecal coliform criteria to protect the microbiological water quality of recreational waters. The fecal coliform limit of 200 cfu / 100 ml is frequently seen in states' reuse regulations and it appears to be the basis for the some of the recommendations in EPA's Guidelines for Water Reuse.

In 1986, EPA recommended new water quality criteria to maintain and protect water quality in surface waters that are used for recreation. EPA recommended that states adopt either enterococci or *E. coli* water quality criteria. EPA made this recommendation because EPA's fresh water health effects studies confirmed that there was a strong correlation between *E. coli* densities and swimming-related gastrointestinal illness and that *E. coli* was a better indicator of swimming-associated gastrointestinal illness than fecal coliform [*See* Dufour, Alfred, Health Effects Criteria for Fresh Recreational Waters, EPA 600 / 1-84-004, Health Effects Research Laboratory, Office of Research and Development, U.S. Environmental Protection Agency, Research Triangle Park, North Carolina (August, 1984)]. EPA recommended that the 30-day geometric mean concentration of *E. coli* in fresh water (5-sample minimum) should not exceed 126 cfu / 100 ml. EPA also recommended single sample maximum concentrations of *E. coli* that were calculated depending upon anticipated levels of use. The recommended single sample maximum concentrations were:

- Designated bathing beach: 235 cfu / 100 ml.
- Moderate use for bathing: 276 cfu / 100 ml.
- Light use for bathing: 298 cfu / 100 ml.
- Infrequent use for bathing: 576 cfu / 100 ml.

These *E. coli* criteria were published in "Quality Criteria for Water, 1986," EPA 440 / 5-86-001, U. S. Environmental Protection Agency, Office of Water Regulations and Standards, Washington D.C. 20460 (May 1, 1986). ADEQ originally proposed to adopt the recommended *E. coli* water quality criteria as disinfection requirements for Class B reclaimed water. ADEQ argued in the proposed rules that reclaimed water that complies with the recommended *E. coli* criteria for discharge to a lake or river that is protected for full body contact recreation (FBC) also may be safely reused for the types of direct reuse where Class B reclaimed water is required. In effect, ADEQ proposed to adopt full-body contact recreation water quality standards for Class B reclaimed water. While this approach may make sense at an intuitive level, the health effects studies that were conducted by EPA to support the recommended *E. coli* criteria showed only that there is a correlation between swimming-related gastrointestinal illness and the *E. coli* concentration in a surface water. The health effects studies for the recommended *E. coli* criteria do not support the use of *E.coli* as an indicator of microbiological water quality for different types of direct reuse. ADEQ changed the Class B indicator of microbiological quality from *E. coli* to fecal coliform in the adopted rule to be consistent with EPA recommendations in the Guidelines for Water Reuse and to make the indicator of microbiological quality consistent across the different classes of reclaimed water.

Some states have adopted even more stringent disinfection criteria for reclaimed water. For example, microbiological water quality criteria to protect shellfish waters were developed by the National Shellfish Sanitation Program. The National Shellfish Sanitation Program was established by the U.S. Public Health Service in the aftermath of a 1924-1925 typhoid epidemic caused by consumption of sewage-contaminated shellfish. In 1964, a National Shellfish Sanitation Workshop established a limit of 70 total coliform organisms / 100 ml as the microbiological water quality criterion to protect shellfish waters. In 1977, EPA recommended a limit of 14 fecal coliform organisms / 100 ml to protect shellfish waters. This fecal coliform limit was derived from the total coliform limit of 70 / 100 ml, using the same 5:1 total coliform to fecal coliform ratio that had been used to develop fecal coliform criteria for recreational waters. The criterion of 14 fecal coliform organisms / 100 ml also appears as a recommended single sample maximum concentration for various reuse applications in EPA's Guidelines for Water Reuse.

Some states have adopted even more stringent disinfection requirements for some reuse applications. For example, the California State Department of Health "Uniform Guidelines for Sewage Disinfection" include total coliform limits for different discharge situations. The guideline for nonrestricted recreational uses of wastewater and for shallow ocean discharges in close proximity to shellfish areas specifies a 7-day median total coliform value of < 2.2 cfu / 100 ml. This total coliform limit also appears in California's Title 22 reclamation criteria as the applicable limit for recreational impoundments, irrigation of food crops, and for landscape irrigation. The single sample maximum concentration of total coliforms is < 23 / 100 ml. These total coliform criteria frequently appear in other states' reclamation criteria for reuse applications where a high quality reclaimed water is deemed necessary.

It should be noted that the < 2 / 100 ml and the < 23 / 100 ml values are based on the standard method for estimating bacterial densities prescribed in Standard Methods for the Examination of Water and Wastewater, 20th Edition, Section 9221(C) at p. 9-116. The <2 / 100 ml value is the Most Probable Number (MPN) index number when there are no total or fecal coliform-positive tubes using the 5-tube multiple fermentation technique for bacteriological analysis. The 23 / 100 ml value is the MPN Index Number when 5 tubes are fecal or total coliform-positive using the 5-tube multiple fermentation technique for bacteriological analysis.

In these rules, ADEQ proposes to adopt disinfection criteria for Class B reclaimed water that are equivalent to the fecal coliform criteria recommended by EPA for reclaimed water that has undergone secondary treatment and disinfection as the reclaimed water quality standards for landscape impoundments. That is, a 7-sample median value of < 200 cfu or MPN / 100 ml and a single sample maximum concentration of 800 cfu or MPN / 100 ml. For recreational impoundments, ADEQ proposes to require Class A reclaimed water. The disinfection criteria for Class A reclaimed water are more stringent than surface water quality standards that have been established for recreational surface waters. Considering the source of reclaimed water, ADEQ proposes to require the use of Class A reclaimed water in recreational impoundments to provide a greater margin of safety and public health protection. The Class A requirement is based upon the assumption that a high level of disinfection is necessary to ensure essentially pathogen-free reclaimed water in recreational impoundments.

What indicator of microbiological quality of reclaimed water should be used?

It has been common practice in the wastewater treatment industry to analyze for an indicator organism to determine microbiological water quality because it is impractical to analyze for all of the bacteria, parasites, and viruses that may be present in wastewater. This practice raises the question of what is the best indicator organism to determine the microbiological quality of reclaimed water?

A water quality criterion that is developed using an indicator organism has been defined as a quantifiable relationship between the density of the indicator in water and the potential human health risks involved in that water's use [*See* V.J Cabelli, et. al, "A Marine Recreational Water Quality Criterion Consistent With Indicator Concepts and Risk Analysis," Journal of the Water Pollution Control Federation, V. 55, No. 10, p. 1309]. Under this definition, a reclaimed water quality standard that is expressed as a concentration of an indicator organism would represent the upper limit for the density of that indicator organism that is positively correlated with unacceptable health risks associated with each reuse of reclaimed water.

An ideal indicator organism for reclaimed water would have the following characteristics:

1. There would be clear epidemiological evidence of illness or disease transmission which positively correlates with the density of the indicator organism for each reuse application;

2. The upper limit for the density of an indicator organism would be at a concentration that is quantifiable;

3. The indicator organism would have similar survival characteristics to the pathogenic microorganisms of concern in reclaimed water; and

4. The indicator organism would be easily and accurately detected using simple and inexpensive analytical methods.

Unfortunately, no indicator organism for the microbiological quality of reclaimed water meets all of the criteria described above. First, there is no epidemiological evidence of disease transmission associated with the reuse of reclaimed water that can be used to support the use of any indicator organism. ADEQ is not aware of any epidemiological studies that positively correlate disease transmission with the density of an indicator organism in reclaimed water for each type of wastewater reuse. Also, since the upper limits for the density of potential indicator organisms for various reuse applications are unknown, it is not possible to determine whether limits are quantifiable.

It should be noted that California's reclamation criteria, which use total coliform as an indicator of the microbiological quality of reclaimed water, were not developed using epidemiological data or quantitative risk analysis. At the time the California reclamation criteria were adopted in 1978, the California Department of Health Services concluded that it was not possible to develop reclamation criteria based upon quantitative risk assessment. Rather, the total coliform limits were based on best professional judgments regarding the technical feasibility of well-designed reclamation plants to achieve compliance, the experience of existing reclamation facilities, an evaluation of the available health effects data, and the implementation of a conservative regulatory approach to protect public health. Also, the adoption of the total coliform limit of 2.2 cfu / 100 ml was predicated on studies that had been conducted in California to determine the virus removal capability of advanced wastewater treatment systems.

It also should be noted that, given the limited amount of risk assessment information and epidemiological data currently available, the determination of health risks associated with the reuse of reclaimed water is uncertain. While risk assessment models have been used to assess the relative health risks from pathogens in reclaimed water [*See* T. Asano and R. Sakaji, "Virus Risk Analysis in Wastewater Reclamation and Reuse," in *Chemical Water and Wastewater Treatment*, pp. 483-496, 1990; Joan B. Rose and Charles P. Gerba, "Assessing Potential Health Risks From Viruses and Parasites in Reclaimed Water in Arizona and Florida, USA," Water Sci. Tech., V. 23, pp. 2091-2098, 1991], these risk analyses require numerous assumptions regarding infectious doses, the typical concentrations of pathogens in reclaimed water, amounts of human exposure, and the probability of infection. To ADEQ's knowledge, no state has adopted reclaimed water quality standards using an indicator organism that is based upon quantitative risk assessment.

Third, no single indicator organism has survival characteristics that are similar to all of the pathogenic microorganisms of concern in reclaimed water. For example, fecal or coliform organisms have survival characteristics that are similar to other bacterial agents. However, pathogenic protozoans and viruses may be more resistant to wastewater treatment processes than fecal or total coliform organisms. ADEQ acknowledges that some pathogens of public health significance such as *Giardia lamblia* cysts are more resistant to disinfection than total or fecal coliform organisms. It is possible that the disinfection of wastewater could kill or inactivate total or fecal coliform organisms, but not kill or inactivate *Giardia lamblia* cysts.

Finally, not all potential indicator organisms can be detected using simple and inexpensive analytical methods. While total coliform, fecal coliform, and *E. coli* analyses are relatively simple and inexpensive, most virus and parasite monitoring involves complex and expensive analytical procedures. No single procedure is available that can be used to isolate and identify all pathogens. Furthermore, negative findings for specific pathogens are provisional because state-of-the-art analytical methods are often not sufficiently sensitive to detect low levels of pathogens. For example, *Salmonella* bacteria are common in wastewater, but isolation techniques for them involve relatively complicated analytical procedures that exceed the capabilities of most laboratories. The routine examination of wastewater for specific pathogens is limited by factors such as lack of laboratory facilities, lack of adequately trained personnel, insufficient laboratory time, high costs, and inadequate analytical methods.

Also, the routine examination of wastewater for enteric viruses is not recommended in Standard Methods [See Standard Methods of Examination of Water and Wastewater, 20th ed., p. 9-116]. There are several significant analytical problems with virus monitoring. First, the identification and enumeration of viruses in wastewater is limited by low virus recovery rates. Because virus concentrations in wastewater are typically low, viruses in the wastewater must be concentrated. The available methodologies for concentrating viruses from wastewater are limited and the efficiency of the concentration method may vary depending upon water quality. Most virus concentration methods have achieved adequate virus recovery rates with wastewater samples that have been contaminated experimentally with known quantities of a few specific enteric viruses. While the concentration method may adequately recover the known virus, it is difficult to evaluate the effectiveness of the concentration method in recovering "naturally occurring" viruses in wastewater. Second, the methods used to identify viruses are complex procedures that are beyond the capability of most laboratories. Viral assays can be done only by trained virologists working in specially equipped laboratories. Particular problems associated with the detection of enteric viruses include: 1) the small size of enteric virus particles, 2) the typically low virus concentrations in wastewater, 3) the variability in the amounts and types of enteric viruses that may be present, 4) the various dissolved and suspended materials in wastewater that interfere with enteric virus detection procedures, and 5) the present limitations of virus estimation and identification methods. Third, the laboratory culturing procedure to determine the presence or absence of viruses takes about 14 days and another 14 days are required for identification. This length of time does not provide adequate real-time process control. Finally, none of the available virus detection methods have been tested adequately with representatives from all of the virus groups of public health significance. Because of these significant virus monitoring problems, ADEQ proposes to eliminate virus criteria for reuse.

ADEQ proposes to eliminate the criteria for pathogenic protozoa for similar reasons. The analytical methods for the detection of pathogenic protozoa are not well-standardized. Standard Methods states that the available methods should be considered research procedures and not methods that can be used for the routine examination of wastewater. For example, while methods for detecting *Giardia lamblia* cysts in water have been available since 1975, no comparative studies of method efficiency, precision, or sensitivity have been reported with a variety of waters under different conditions. Also, the identification of *Giardia lamblia* cysts requires analysis by an individual with demonstrated proficiency for recognizing and differentiating protozoa. Finally, practical methods for determining the viability of cysts in water samples are not available. Thus, the identification of *Giardia lamblia* cysts in a reclaimed water sample does not provide any information as to whether the cysts are viable and present a health risk.

Most states express the disinfection criteria for reclaimed water in terms of traditional indicator organisms, as total or fecal coliform concentrations. Coliform organisms have been used as indicators of microbiological water quality because they are positively correlated with fecal contamination of water, they typically occur in wastewater in higher concentrations than other pathogenic microorganisms, they are easily detectable using widely available laboratory methods, and they respond similarly to environmental conditions and treatment processes as many bacterial pathogens.

ADEQ acknowledges that there are limitations associated with using fecal coliform organisms as indicators of the microbiological quality of reclaimed water. The determination of the concentration of fecal coliform organisms does not predict the presence or absence of enteric viruses or parasites. For example, the absence of fecal coliform organisms in a sample of reclaimed water does not necessarily mean that the reclaimed water is free of significant concentrations of enteric viruses. Notwithstanding the limitations of the traditional indicators, ADEQ proposes to express disinfection requirements for reclaimed water in terms of maximum allowable fecal coliform concentrations. ADEQ believes that the fecal coliform bacteria group represents the best available indicator organism currently available to measure the microbiological quality of reclaimed water. ADEQ proposes to use the fecal coliform bacteria group as an indicator of the microbiological quality of reclaimed water rather than attempt to establish reclaimed water quality criteria for specific pathogens. It is impractical to monitor reclaimed water for the hundreds of bacteria, viruses, and parasites that may be present in wastewater. The fecal coliform group of bacteria have been used extensively as indicators of the microbiological quality of treated wastewater. They are a traditional and well-understood indicator of disinfection effectiveness and sanitary water quality. In general, they are present in reclaimed water in greater numbers than other bacterial pathogens. Fecal coliforms generally are more resistant to disinfection than many, but not all, pathogens. The analytical test for fecal coliforms is simple and inexpensive which will permit more frequent monitoring of the microbiological quality of reclaimed water. Most importantly, the use of fecal coliform organisms as an indicator of disinfection effectiveness in combination with technology-based requirements which prescribe minimum treatment processes has been shown to provide effective removal of viruses, bacteria, and parasites.

The current rules prescribe reclaimed water quality criteria for fecal coliform, viruses, and parasites. ADEQ proposes to repeal the numeric criteria and monitoring requirements for enteric viruses, *Giardia lamblia*, *Entamoeba histolytica, Ascaris lumbricoides*, and tapeworm. Instead, ADEQ proposes to rely on fecal coliform concentrations as the indicators of the microbiological quality of reclaimed water.

Are the proposed microbiological criteria overly conservative?

The approach taken by ADEQ in proposing microbiological water quality criteria for reclaimed water is admittedly conservative. However, in the absence of definitive risk assessment information on the health hazards associated with human exposure to reclaimed water through various reuse applications, ADEQ believes that prudent public health policy requires the establishment of reclamation criteria that err on the side of protecting human health. This caution is reflected in the proposed requirement that Class A reclaimed water be essentially pathogen-free.

The literature on the reuse of reclaimed water indicates that wastewater that has undergone advanced treatment [that is, secondary treatment + filtration + disinfection to meet a total or fecal coliform limit of < 2.2 cfu / 100 ml] is essentially pathogen-free. It has been demonstrated through virus removal studies that the prescribed treatment processes and compliance with the proposed disinfection criteria result in the production of a reclaimed water that is essentially free of bacteria, parasites, and viruses. Moreover, there are reclamation facilities currently in operation that produce essentially pathogen-free reclaimed water through this level of advanced wastewater treatment. The successful operation of reclamation facilities in California, Florida, and Arizona demonstrates that it is both economically and technologically feasible to achieve compliance with the proposed reclaimed water quality standards.

There is no consensus on a minimum level of wastewater treatment that adequately protects human health when reclaimed water is reused. There is general agreement among public health experts that untreated or minimally treated wastewater presents an unacceptable risk of disease transmission. There are documented cases of waterborne transmission of disease from the reuse of untreated or minimally treated wastewater for agricultural irrigation. For example, epidemiological studies have been conducted on kibbutzes in Israel where minimally-treated wastewater after short-term retention of the wastewater in oxidation ponds was used for agricultural irrigation. Researchers in Israel found that there was a statistically significant increase in the risk of disease in young children associated with the reuse of such minimally treated wastewater for agricultural irrigation.

The available epidemiological data support the establishment of secondary treatment and disinfection as a minimum level of wastewater treatment before reclaimed water is reused. However, there is uncertainty with regard to the amount of risk that is associated with the reuse of reclaimed water that has received a minimum of secondary treatment and disinfection. It is not clear whether additional treatment beyond secondary treatment and disinfection, if any, is necessary to protect public health. There is general agreement by public health experts that advanced wastewater treatment which includes coagulation, filtration and disinfection can produce an essentially pathogen-free effluent that will protect public health when it is reused. However, some scientists criticize such advanced wastewater treatment requirements as being overly protective and unnecessarily restrictive [*See* Health Guidelines for the Use of Wastewater in Agriculture and Aquaculture [Technical Report Series #778, World Health Organization, Geneva, Switzerland, 1989].

While ADEQ recognizes that the conservative approach reflected in the proposed reclamation criteria has been criticized as overly protective from some quarters, there is little epidemiological evidence or risk assessment information to support standards that are based upon lower levels of treatment. ADEQ therefore proposes to adopt the EPA recommendations for wastewater reuse for the following reasons:

1. In the face of uncertainty and an inability to develop reuse criteria based upon definitive risk assessments, sound public health policy dictates a conservative approach, especially for reuse applications where the risk of human exposure to reclaimed water is high. ADEQ is confident that the proposed reclamation criteria will protect public health.

2. Compliance with the prescribed Class A treatment requirements and disinfection criteria will provide effective control of bacteria, parasites, and viruses in reclaimed water.

3. The adoption of less stringent microbiological criteria might be justifiable if reuse site controls and worker protection provisions are fully implemented. However, such precautions are not always fully implemented by operators of reuse sites. The adoption of the proposed technology-based requirements and disinfection criteria, especially for Class A reclaimed water, will provide a margin of safety.

Should ADEQ prescribe turbidity standards for reclaimed water?

Yes. ADEQ intends to prescribe turbidity criteria for Class A reclaimed water. Turbidity is a key parameter for reclaimed water. Continuous monitoring of turbidity provides real time process control and an instantaneous measure of reclaimed water quality. Requiring compliance with prescribed turbidity criteria helps to ensure adequate process control. Also, compliance with the proposed turbidity standard for Class A reclaimed water relates to achieving compliance with the proposed disinfection criteria for reclaimed water. Turbidity or total suspended solids standards are necessary to ensure high level disinfection of reclaimed water. Many pathogenic organisms are associated with suspended solids. The suspended solids in reclaimed water can shield bacteria and viruses from the action of disinfectants. Also, the organic matter in wastewater consumes chlorine, making less chlorine available for disinfection. To ensure the reliable destruction of pathogens, suspended solids in wastewater must be reduced to low levels prior to disinfection.

ADEQ adopted California's reclamation criteria for turbidity. California requires that reclaimed water meet a standard of 2 NTUs before it can be used for irrigation of food crops and for use in recreational impoundments where swimming is allowed. The California reclamation criterion states that turbidity may not "exceed an average operating turbidity of 2 turbidity units and does not exceed 5 turbidity units more than 5 percent of the time during any 24-hour period." This criterion is based on the professional judgment that compliance with a 2 NTU standard results in the production of an adequately clarified reclaimed water that is suitable for high level disinfection. Also, it is has been demonstrated in California that it is technically feasible to comply with a 2 NTU standard. Reclamation experience in California has shown that a 2 NTU turbidity level is achievable by well-operated wastewater treatment plants employing chemical coagulation and filtration treatment processes.

An alternative approach would be to establish criteria for total suspended solids (TSS). The state of Florida uses this approach and has established TSS criteria for irrigation with reclaimed water. Florida requires reclamation facilities to collect a 24-hour composite TSS sample. No daily sample may exceed 5 mg/L TSS. The results of the analysis on a composite sample represent a daily average TSS value. Florida apparently adopted a daily average TSS standard because of the ease of sample collection and analysis. However, Florida also has established an operating protocol for reclamation facilities under which turbidity is monitored continuously. A "set point" is established for turbidity in the range of 2.0 - 2.5 NTU. If turbidity exceeds this set point for a predetermined time, Florida requires that wastewater be routed to a holding facility or to alternative disposal until the treatment problem is fixed. The Florida TSS standard is equivalent to the California average operating turbidity standard of 2 NTU because each NTU translates into approximately 2.3 - 2.4 mg/L of TSS. Thus, an "average operating turbidity" of 2 NTU is equivalent to a daily average of less than 5 mg/L of TSS.

In Guidelines for Water Reuse, EPA recommends a 24-hour average turbidity standard of _ 2 NTU, not to exceed 5 NTUs at any time for reclaimed water which undergoes secondary treatment, filtration, and disinfection. The EPA-recommended turbidity limits must be met prior to disinfection. The EPA guidelines also state that if suspended solids criteria are to be used in lieu of turbidity, the average TSS concentration should not exceed 5 mg/L.

A turbidity standard which requires continuous monitoring is superior to a daily average TSS standard. A daily average TSS value does not provide the same level of treatment reliability that the filtration and disinfection systems are operating properly. In these rules, ADEQ proposes a 24-hour average turbidity standard of < 2 NTU, not to exceed 5 NTU at any time for Class A reclaimed water.

Should ADEQ adopt total nitrogen standards for reclaimed water?

ADEQ adopted total nitrogen criteria for Class A+ and Class B+ reclaimed water only. However, ADEQ will not require the use of Class A+ or Class B+ reclaimed water for any reuse application. The total nitrogen limit of 10 mg/L for Class A+ and B+ reclaimed water is based upon Best Available Demonstrated Control Technology (BADCT) requirements that apply to wastewater treatment plants under the Aquifer Protection Permit program. The BADCT guidance document for wastewater treatment plants states that the optimum range for the reduction of total nitrogen is 1.0 mg/L to 10.0 mg/L. The BADCT requirement means that a wastewater treatment plant is required to provide treatment to reduce total nitrogen to less than 10 mg/L unless it can be shown that site-specific characteristics are available to control the discharge of total nitrogen to ground water.

Nitrogen is an essential plant nutrient that is necessary for the production of food, fiber, seed, and forage crops. Nitrogen and other nutrients are present in reclaimed water and they provide important fertilizer benefits for crops and landscape plants. However, in some cases, the total nitrogen concentrations in reclaimed water may be in excess of crop plant needs. Excessively high total nitrogen concentrations can cause excessive vegetative growth at the expense of fruit production, delay crop maturity, or reduce crop quality. Also, excessively high total nitrogen concentrations in reclaimed water may result in nitrate contamination of ground water. Total nitrogen that is not taken up by crop or landscape plants may leach to ground water as nitrate.

The fate and transport of nitrogen in the soil is complex. There are a number of chemical, physical, and biological processes that affect the fate of nitrogen in the soil after the application of reclaimed wastewater for irrigation. These processes include nitrogen fixing, NH^{+4} adsorption and retention, nitrogen transformations in the soil such as mineralization, nitrification, and denitrification, volatilization of ammonia, and plant uptake. Total nitrogen that is not removed by these processes may move through the soil profile to ground water as nitrate. The amount of nitrate that is leached to ground water depends upon the processes described above, the quantity of reclaimed water that is applied, evapotranspiration rates, nitrogen utilization, fertilizer applications, and soil profile characteristics.

The nitrate contamination of ground water is a public health concern. The primary public health concern arising from nitrate contamination of drinking water is the risk of methomoglobinemia, or "blue baby disease." High concentrations of nitrate in drinking water may interfere with the oxygen-carrying capacity of the blood of infants. EPA has established a National Primary Drinking Water Maximum Contaminant Level (MCL) for nitrate of 10 mg / L to protect infants from this disease. This MCL has been adopted as an aquifer water quality standard in Arizona.

ADEQ could regulate total nitrogen concentrations in reclaimed water in several ways to prevent nitrate contamination of ground water. ADEQ could:

1. Require a nitrogen budget for reuse sites in an individual reuse permit. Under this method, total nitrogen loading is managed through irrigation water management and an allowable annual hydraulic loading rate is calculated so the average concentration in percolate will comply with a nitrate limit of 10 mg / L [*See* G. Pettygrove and T. Asano, Irrigation with Reclaimed Municipal Wastewater, A Guidance Manual, Chapter 8, Irrigation System Design, p. 8-1 through 8-16].

2. Require nitrogen removal at the wastewater treatment plant to reduce the total nitrogen concentration in the reclaimed water. Under this method, ADEQ would require a wastewater treatment plant to meet a 10 mg / L total nitrogen limit unless it can be demonstrated that reuse site characteristics permit the release of reclaimed water with higher total nitrogen concentrations.

3. Issue general permits and rely on best management practices developed for reuse sites to control the discharge of nitrate to groundwater.

ADEQ does not believe that total nitrogen concentrations in reclaimed water can be regulated through the development of nitrogen budgets in reuse permits. ADEQ believes that nitrogen budgeting is unrealistic for several reasons. First, a nitrogen budget would have to be prescribed in a reuse permit for each reuse site. Nitrogen budgets in individual or general reuse permits are impractical because hydraulic loading requirements will vary over time and from reuse site to reuse site depending upon nitrogen uptake by crops, the total nitrogen concentration of the reclaimed water, precipitation, evapotranspiration rates, nitrogen removal due to site characteristics, and fertilizer applications. Second, even if a nitrogen budget could be prescribed for each reuse site in a permit, a wastewater treatment plant that provides reclaimed water cannot tailor the total nitrogen concentration of the reclaimed water to meet individual nitrogen loading requirements at each reuse site. Finally, it is unlikely that ADEQ can effectively develop or administer individual or general reuse permits with nitrogen budgets because of agency resource constraints. Even if ADEQ could prescribe nitrogen budgets in reuse permits, ADEQ would not have enough field staff to adequately monitor compliance with nitrogen loading requirements.

ADEQ decided not to regulate the discharge of total nitrogen from reclamation plants through the reclaimed water quality standards program. Instead, ADEQ will rely on the Unified Water Quality Permit program and BADCT requirements to control the discharge of nitrogen from wastewater treatment plants. The BADCT guidance document for domestic and municipal wastewater treatment plants defines the optimum reduction of nitrogen through the application of best available demonstrated control technology as less than 10.0 mg / L. Attainment of this level requires the application of nitrogen removal technology at the wastewater treatment plant. The BADCT guidance document states:

> Denitrification technology is well developed at full-scale. Wastewater treatment plants with a sufficient economic base, skilled operators, and reliably controlled pH, temperature, loading, and chemical feed can achieve nitrogen effluent concentrations as low as 1 mg / L total nitrogen. Small package treatment plants can readily achieve treatment levels between 5 and 10 mg / L total nitrogen.

The BADCT guidance document states that site characteristics may be available to meet nitrogen removal requirements [*See* Draft BADCT Guidance Document for Domestic and Municipal Wastewater Treatment Plants, pp. 16-19]. The operator of a wastewater treatment plant may be able to demonstrate, on a case-by-case basis, that reuse site characteristics can be used to attain optimum reductions of total nitrogen, in lieu of engineered nitrogen removal technologies at the wastewater treatment plant.

ADEQ proposes to rely on BADCT requirements which require nitrogen removal at a source wastewater treatment plant to less than 10 mg / L unless it can be demonstrated that reuse site characteristics permit the delivery of reclaimed water with higher concentrations of total nitrogen. Nitrogen removal at source wastewater treatment plants will be required by the Unified Water Quality Permit program unless it is demonstrated that individual reuse site characteristics are available to control the discharge of nitrate to ground water. ADEQ decided not to establish regulatory requirements in the reclaimed water quality standards rules that require nitrogen removal treatment. Instead, ADEQ will try to encourage the production of denitrified reclaimed water that complies with a total nitrogen limit of 10 mg / L through the establishment of the "+" categories of reclaimed water.

7. A reference to any study that the agency relied on in its evaluation of or justification for the rule and where the public may obtain or review the study, all data underlying each study, any analysis of the study, or other supporting material:

Not applicable

8. A showing of good cause why the rule is necessary to promote a statewide interest if the rule will diminish a previous grant of authority of a political subdivision of this state:

Not applicable

9. The summary of the economic, small business, and consumer impact:

ADEQ believes that the reclaimed water quality standards rules will have few economic, small business, or consumer impacts. The establishment of the Class A+ and Class B+ categories of reclaimed water will have no direct economic impact because neither of the "+" categories of reclaimed water impose regulatory requirements. Compliance with the proposed Class A+ or Class B+ reclaimed water quality standards is voluntary. No water reclamation plant is required to meet the minimum treatment requirements or the reclaimed water quality criteria that are proposed in the "+" categories and no person who wants to reuse reclaimed water will be required to obtain Class A+ or Class B+ reclaimed water.

The establishment of the proposed Class A category of reclaimed water may result in the need for upgrades at some existing wastewater treatment plants that are engaged in wastewater reclamation. The minimum treatment requirements for Class A reclaimed water are secondary treatment, chemical feed facilities, filtration, and high-level disinfection. If the proposed Class A reclaimed water quality standards are adopted, this level of advanced wastewater treatment will be required for wastewater treatment plants that provide reclaimed water for irrigation of food crops, recreational impoundments, open access landscape irrigation, toilet and urinal flushing, fire protection systems, spray irrigation of orchards and vineyards, commercial air conditioning, vehicle and equipment washing, and snow-making.

ADEQ does not believe that the treatment requirements for Class A reclaimed water impose new regulatory burdens or will require treatment upgrades at reclamation facilities that provide reclaimed water for irrigation of food crops that are consumed raw. While the current wastewater reuse rules do not prescribe minimum treatment requirements, the allowable permit limits for irrigation of food crops prescribed in the current wastewater reuse rules are so stringent that they probably cannot be achieved without providing a level of treatment that is equivalent to that proposed for Class A reclaimed water. For example, the current wastewater reuse rules prescribe a turbidity criterion of 1 NTU, an enteric virus criterion of 1, and a 5-sample fecal coliform criterion of < 2.2 cfu / 100 ml. for reclaimed water that is reused for irrigation of food crops that are consumed raw. The 1 NTU criterion in the current rules is more stringent than the 2 NTU criterion that ADEQ proposes for Class A reclaimed water. The current fecal coliform criteria are equivalent to the fecal coliform criteria that ADEQ proposes for Class A reclaimed water. ADEQ proposes to repeal the current enteric virus criteria that apply to reclaimed water that is used for irrigation of food crops that are consumed raw. It is unlikely that the turbidity, enteric virus, and fecal coliform criteria in the current wastewater reuse rules can be achieved without undergoing the minimum treatment processes of secondary treatment, chemical addition, filtration, and high level disinfection that ADEQ proposes for Class A reclaimed water. Finally, to ADEQ's knowledge, there are no existing wastewater reclamation facilities that provide reclaimed water for food crop irrigation.

The proposed Class A reclaimed water standards may require treatment upgrades at existing wastewater treatment plants that provide reclaimed water for open access landscape irrigation. The current wastewater reuse rules prescribe a turbidity criterion of 5 NTUs, an enteric virus criterion of < 125 / 40 L, and a 5-sample geometric mean fecal coliform criterion of < 200 cfu / 100 ml. for reclaimed water that is used for open access landscape irrigation. Secondary treatment and disinfection are minimum treatment requirements to meet the allowable permit limits for open access landscape irrigation under the current wastewater reuse rules. The current turbidity criterion of 5 NTUs probably requires wastewater treatment plants to provide filtration. Thus, the current wastewater reuse rules and the proposed Class A reclaimed water quality standards both require secondary treatment, filtration, and disinfection. However, the allowable permit limits for open access landscape irrigation in the current wastewater reuse rules may be achievable without chemical addition facilities that are required under the proposed Class A reclaimed water quality standards. Consequently, the final rules may require treatment plant upgrades to provide chemical addition facilities at existing wastewater treatment plants if they provide reclaimed water for open access landscape irrigation.

The Class A reclaimed water standards may require treatment upgrades at existing wastewater treatment plants that provide reclaimed water for impoundments where partial body contact recreation takes place. The current wastewater reuse rules prescribe a turbidity criterion of 5 NTUs, an enteric virus criterion of < 125 / 40 L, and a 5-sample geometric mean fecal coliform criterion of < 1000 cfu / 100 ml. for reclaimed water that is reused for reclaimed water impoundments for partial body contact recreation. Under the adopted rules, ADEQ proposes to define such impoundments as recreational impoundments and require Class A reclaimed water. Secondary treatment and disinfection are minimum treatment requirements that are needed to consistently achieve compliance with the allowable permit limits under the current wastewater reuse rules. Again, the current turbidity criterion of 5 NTUs requires that wastewater treatment plants provide filtration. Thus, both the current wastewater reuse rules for partial body contact recreation and the Class A reclaimed water quality standards for recreational impoundments require secondary treatment, filtration, and disinfection. However, the current permit limits for impoundments of reclaimed water where partial body contact recreation takes place may be achievable without chemical addition facilities that are required for Class A reclaimed water. Consequently, the adopted rules may require treatment plant upgrades to provide chemical addition facilities at existing wastewater treatment plants if they provide reclaimed water for impoundments that are used for partial body contact recreation. ADEQ solicited public comments from wastewater utilities that provide reclaimed water for impoundments that are used for partial body contact recreation as to whether the proposed Class A reclaimed water standards would require treatment upgrades at existing wastewater treatment plants.

ADEQ received one public comment from a wastewater utility indicating that they may need to upgrade treatment to meet the Class A reclaimed water quality requirements. ADEQ did not receive any economic data that could be used to estimate the economic impact of this treatment upgrade.

ADEQ proposes to require Class A reclaimed water for *spray* irrigation of orchards and vineyards. The proposed Class A reclaimed water quality criteria are more stringent than the criteria for orchard irrigation in the current wastewater reuse rules. The current rules require that reclaimed water used for orchard irrigation comply with a 5-sample geometric mean fecal coliform criterion of < 1000 cfu / 100 ml and a single sample maximum fecal coliform concentration of < 4000 cfu / 100 ml. The current wastewater reuse rules do not distinguish between surface and spray irrigation of orchards as the adopted rules do. The fecal coliform criteria for orchard irrigation in the current rules probably can be met by wastewater treatment plants that provide secondary treatment and disinfection (Class B) and even by wastewater stabilization pond systems (Class C). The proposed Class A rules will require that wastewater treatment plants provide secondary treatment, chemical addition facilities, filtration, and disinfection for spray irrigation of vineyards and orchards. Consequently, the adopted rules will require treatment plant upgrades at wastewater treatment plants that provide reclaimed water for *spray* irrigation of orchards. Wastewater treatment plants probably will have to be upgraded to provide both chemical addition facilities and filtration. It is not known how many wastewater treatment plants in the state currently provide reclaimed water for spray irrigation of orchards and vineyards. It is estimated that less than 10 reclamation plants provide reclaimed water for orchard irrigation in the state. ADEQ estimates that the proposed Class A reclaimed water quality standards for spray irrigation of orchards will have little or no impact because most, if not all, of the estimated 10 wastewater treatment facilities provide reclaimed water for *surface* irrigation of orchards.

ADEQ proposes to require Class A reclaimed water for toilet and urinal flushing, fire protection systems, commercial air conditioning, snow-making, and vehicle and equipment washing. These types of wastewater reuse are not specifically recognized in the current rules. The proposal of Class A reclaimed water quality standards for these types of direct reuse impose no costs on existing facilities. The proposed Class A requirements for these types of direct reuse will not require wastewater treatment plant upgrades. Instead, they provide additional options for the reuse of reclaimed water.

The proposed Class B reclaimed water quality standards should not impose additional costs on existing wastewater treatment plants that provide reclaimed water for direct reuse. ADEQ believes that most wastewater treatment plants that are engaged in wastewater reclamation already comply with the proposed secondary treatment and disinfection requirements for Class B reclaimed water. While the proposed fecal coliform criteria for Class B reclaimed water are more stringent than the current fecal coliform criteria for some types of wastewater reuse, ADEQ believes that the proposed criteria can be achieved without major wastewater treatment upgrades at existing facilities.

The proposed Class C reclaimed water quality standards should not impose additional costs for wastewater stabilization pond systems engaged in reclamation. The proposed reclaimed water quality criteria are equivalent to the criteria that are prescribed in the current wastewater reuse rules.

State law requires agencies to reduce the impact of a rule on small businesses by using certain methods when they are legal and feasible in meeting the statutory objectives for the rule making. ADEQ considered each of the methods prescribed in A.R.S. §§ 41-1035 and 41-1055(B)(5)(c) for reducing the impact on small businesses. Methods that may be used include the following: (1) Exempt them from any or all rule requirements, (2) Establish performance standards which would replace any design or operational standards, or (3) Institute reduced compliance or reporting requirements. An agency may accomplish the 3rd method by establishing less stringent requirements, consolidating or simplifying them, or setting less stringent schedules or deadlines. ADEQ has been unable to incorporate these specific methods to reduce the impact on small businesses. The proposed reclaimed water quality standards are intended to protect public health. Small businesses cannot be exempted from the requirements of the reclaimed water quality standards without compromising public health protection. For the same reason, different performance standards for small wastewater treatment plants engaged in wastewater reclamation cannot be allowed. The proposed rules do not contain any reporting requirements, schedules, or deadlines. Small wastewater treatment plants engaged in reclamation are expected to benefit from the proposed streamlining of the current rules and the simplified monitoring requirements contained in the reclaimed water quality standards. The proposed reclaimed water quality standards provide clear design standards for owners of wastewater treatment plants who may be interested in providing reclaimed water for direct reuse in the future.

10. A description of the changes between the proposed rules, including supplemental notices, and final rules, if applicable:

ADEQ made several changes between the proposed rules and the final rules:

1. ADEQ added definitions of “landscape impoundment,” “recreational impoundment,” and “sewage” and deleted the definition of “sanitary wastewater.”
2. ADEQ deleted R18-11-302(B) from the proposed rule because it is unnecessary and unrelated to the subject matter of the rule. R18-11-302(B) did not relate to the applicability of the reclaimed water quality standards.
3. ADEQ deleted the phrase “prior to direct reuse” in R18-11-303(C), R18-11-303(E), R18-11-304(C), R18-11-304(D), R18-11-305(B) and R18-11-306(B) and replaced it with the phrase “before discharge to a reclaimed

water distribution system" to clarify where the point of compliance is for disinfection and total nitrogen criteria that are prescribed in the different classes of reclaimed water.

4. ADEQ changed the microbiological indicator organism and disinfection criteria for Class B+ reclaimed water in R18-11-305 and Class B reclaimed water in R18-11-306. The proposed rule used *E. coli* as the indicator of microbiological quality of reclaimed water. The rule submitted to the Governor's Regulatory Review Council uses fecal coliform organisms as the indicator of microbiological water quality.
5. ADEQ deleted R18-11-308(C). This subsection in the proposed rule merely states ADEQ's intention with regard to establishing the 5 classes of reclaimed water. The subsection has no regulatory effect and is unnecessary.
6. ADEQ deleted R18-11-309(B). The subsection authorizes the use of Class A+ and Class A reclaimed water for any new type of direct reuse that may be developed in the future other than direct potable reuse and for use in swimming pools and spas. Subsection (A) is inconsistent with R18-11-309(A) which states that reclaimed water quality requirements for a direct reuse that is not listed in Appendix A shall be determined on a case-by-case basis using best professional judgment.
7. ADEQ revised Appendix A to include snow-making and livestock watering of dairy animals as authorized uses of reclaimed water.
8. ADEQ made other minor editorial changes to the rules. Grammatical and organizational changes recommended by the staff of the Governor's Regulatory Review Council were made. The rules are reproduced on the following pages. All of the changes made to the rule text from the Notice of Proposed Rulemaking to the rules as submitted to the Governor's Regulatory Review Council are indicated. Language that was deleted is indicated by strike-outs. Language that was added is indicated by underlining.

TITLE 18. ENVIRONMENTAL QUALITY

CHAPTER 11. DEPARTMENT OF ENVIRONMENTAL QUALITY WATER QUALITY STANDARDS

ARTICLE 3. RECLAIMED WATER QUALITY STANDARDS

R18-11-301. Definitions
R18-11-302. Applicability
R18-11-303. Class A+ Reclaimed Water
R18-11-304. Class A Reclaimed Water
R18-11-305. Class B+ Reclaimed Water
R18-11-306. Class B Reclaimed Water
R18-11-307. Class C Reclaimed Water
R18-11-308. Industrial Reuse
R18-11-309. Reclaimed Water Quality Standards for An Unlisted Type of Direct Reuse
Appendix A. Minimum Reclaimed Water Quality Requirements for Direct Reuse ~~Applications~~

R18-11-301. Definitions

The terms in this Article have the following meanings:

"Direct reuse" ~~means the beneficial use of reclaimed water for a purpose allowed by 18 A.A.C. 9, Article 7 including industrial wastewater used for the production or processing of any crops used as a human or animal food. The following do not constitute direct reuse of reclaimed water:~~

~~Use of water subsequent to its release under the conditions of a National Pollutant Discharge Elimination System permit,~~

~~Use of water subsequent to discharge under the conditions of an Aquifer Protection Permit issued under 18 A.A. C. 9, Articles 1 through 4, or~~

~~Use of industrial wastewater or reclaimed water, or both, in a workplace that is subject to federal programs that protect workers from workplace exposures.~~ has the meaning prescribed in R18-9-701(1).

"Disinfection" means a treatment process that ~~kills or inactivates pathogenic organisms in wastewater by oxidants, ultraviolet light, or other agents~~ uses oxidants, ultraviolet light, or other agents to kill or inactivate pathogenic organisms in wastewater.

"Filtration" means a treatment process ~~for removing~~ that removes particulate matter from wastewater by passage through porous media.

"~~Graywater~~ Gray water" means wastewater, ~~separately~~ collected separately from a sewage ~~flows~~ flow, that originates from ~~clothes washers, bathtubs, showers, and sinks~~ a clothes washer, bathtub, shower, or sink, but ~~it~~ does not include wastewater from ~~kitchen sinks, dishwashers, or toilets~~ a kitchen sink, dishwasher, or a toilet.

"Industrial wastewater" means ~~water~~ wastewater generated from an industrial process.

"Landscape impoundment" means a manmade lake, pond, or impoundment of reclaimed water where swimming, wading, boating, fishing, and other water-based recreational activities are prohibited. A landscape impoundment is created for storage, landscaping, or for aesthetic purposes only.

"NTU" means nepholometric turbidity unit.

"On-site wastewater treatment facility" has the meaning prescribed in A.R.S. § 49-201(24).

"Open access" means that access to reclaimed water by the general public is uncontrolled.

"Reclaimed water" has the meaning prescribed in A.R.S. § 49-201(31) ~~and includes gray water and industrial wastewater with a component of sanitary wastewater~~.

"Recreational impoundment" means a manmade lake, pond, or impoundment of reclaimed water where boating or fishing is an intended use of the impoundment. Swimming and other full-body recreation activities [for example, water-skiing] are prohibited in a recreational impoundment.

"Restricted access" means that access to reclaimed water by the general public is controlled.

~~"Sanitary wastewater" means wastewater originating from toilets, baths, sinks, lavatories, laundries, and other plumbing fixtures in places of human habitation, employment, or recreation.~~

"Secondary treatment" means a biological treatment process that achieves the minimum level of effluent quality defined by the federal secondary treatment regulation at 40 CFR §133.102.

"Sewage" means untreated wastes from toilets, baths, sinks, lavatories, laundries, and other plumbing fixtures in places of human habitation, employment, or recreation.

R18-11-302. Applicability

~~A.~~ This Article applies to the direct reuse of reclaimed water, except for ~~the~~:

1. The direct reuse of ~~graywater~~ gray water, or
2. The direct reuse of reclaimed water from an onsite wastewater treatment facility regulated by a general Aquifer Protection Permit under 18 A.A.C. 9, Article ~~4~~ 3.

~~**B.** A direct reuse of reclaimed water shall comply with applicable standards established in this Article and reclaimed water permitting requirements established in 18 A.A.C. 9, Article 7.~~

R18-11-303. Class A+ Reclaimed Water

A. ~~*Treatment requirements:*~~ Class A+ reclaimed water is ~~a~~ wastewater that has undergone secondary treatment, filtration, nitrogen removal treatment, and disinfection. Chemical feed facilities to add coagulants or polymers are required to ensure that filtered effluent ~~prior to~~ before disinfection complies with the 24-hour average turbidity criterion prescribed in subsection (B)(1). Chemical feed facilities may remain idle if the 24-hour average turbidity criterion in (B)(1) is achieved without chemical addition.

~~**C.** *Turbidity:* The turbidity of reclaimed water at a point in the wastewater treatment process after filtration and immediately prior to disinfection shall comply with the following criteria.~~

~~1. The 24-hour average turbidity of filtered effluent shall be 2 NTUs or less.~~

~~2. The turbidity of filtered effluent shall not exceed 5 NTUs at any time.~~

~~**C.** *Disinfection criteria:* Class A+ reclaimed water shall meet the following criteria after disinfection and prior to direct reuse:~~

~~1. There shall be no detectable fecal coliforms in 4 of the last 7 reclaimed water samples taken.~~

~~2. The single sample maximum concentration of fecal coliform shall be less than 23 colony forming units per / 100 ml.~~

~~3. If a reclaimed water provider operates under an alternative treatment method or turbidity criterion under subsection (E), there shall be no detectable enteric virus in 4 of the last 7 monthly reclaimed water samples taken.~~

~~**D.** *Nitrogen removal:* The 5-sample geometric mean concentration of total nitrogen shall be less than 10 mg / L.~~

~~**E.** *Alternative methods:* Treatment methods or turbidity criteria other than those described in subsections (A) or (B) or blending reclaimed water with other water may be used to produce Class A+ reclaimed water provided the reclaimed water provider demonstrates through pilot plant testing, existing reclaimed water quality data, or other means that the alternative method or turbidity criteria reliably produce a reclaimed water that meets the disinfection criteria in~~

D. An owner of a facility shall ensure that:

1. The turbidity of Class A+ reclaimed water at a point in the wastewater treatment process after filtration and immediately before disinfection complies with the following:
   a. The 24-hour average turbidity of filtered effluent is 2 NTUs or less, and
   b. The turbidity of filtered effluent does not exceed 5 NTUs at any time.
2. Class A+ reclaimed water meets the following criteria after disinfection treatment and before discharge to a reclaimed water distribution system:
   a. There are no detectable fecal coliform organisms in 4 of the last 7 daily reclaimed water samples taken, and
   b. The single sample maximum concentration of fecal coliform organisms in a reclaimed water sample is less than 23 / 100 ml.

c. If alternative treatment processes or alternative turbidity criteria are used or reclaimed water is blended with other water to produce Class A+ reclaimed water under subsection (C), that there are no detectable enteric virus in 4 of the last 7 monthly reclaimed water samples taken.

3. The 5-sample geometric mean concentration of total nitrogen in a reclaimed water sample is less than 10 mg / L.

E. An owner of a facility may use alternative treatment methods other than those required by subsection (A), or comply with alternative turbidity criteria other than those required by subsection (B)(1), or blend reclaimed water with other water to produce Class A+ reclaimed water provided the owner demonstrates through pilot plant testing, existing water quality data, or other means that the alternative treatment methods, alternative turbidity criteria, or blending reliably produces a reclaimed water that meets the disinfection criteria in subsection (B)(2) and the total nitrogen criteria in subsection (B)(3) before discharge to a reclaimed water distribution system.

~~F~~**D.** *Reuse applications:* Class A+ reclaimed water is not required for any ~~reuse application~~ type of direct reuse. ~~Class A+ reclaimed water may be reused for any reuse application~~ A person may use Class A+ reclaimed water for any type of direct reuse listed in Appendix A ~~of this Article~~.

R18-11-304. Class A Reclaimed Water

A. *Treatment requirements:* Class A reclaimed water is ~~a~~ wastewater that has undergone secondary treatment, filtration, and disinfection. Chemical feed facilities to add coagulants or polymers are required to ensure that filtered effluent ~~prior to~~ before disinfection complies with the 24-hour average turbidity criterion ~~prescribed~~ in subsection (B)(1). Chemical feed facilities may remain idle if the 24-hour average turbidity criterion in subsection (B)(1) is achieved without chemical addition.

~~**B.** *Turbidity:* The turbidity of Class A reclaimed water at a point in the wastewater treatment process after filtration and immediately prior to disinfection shall comply with the following:~~

~~1. The 24-hour average turbidity of filtered effluent shall be 2 NTUs or less.~~

~~2. The turbidity of filtered effluent shall not exceed 5 NTUs at any time.~~

~~**C.** *Disinfection criteria:* Class A reclaimed water shall meet the following criteria after disinfection treatment and prior to direct reuse:~~

~~1. There shall be no detectable fecal coliforms in 4 of the last 7 reclaimed water samples taken.~~

~~2. The single sample maximum concentration of fecal coliform shall be less than 23 colony forming units per 100 ml.~~

~~3. If a reclaimed water provider operates under an alternative method or turbidity criterion under subsection (D), there shall be no detectable enteric virus in 4 of the last 7 reclaimed water samples taken.~~

~~**D.** *Alternative methods:* Treatment methods and turbidity criteria other than those described in subsections (A) or (B) or blending reclaimed water with other sources of water may be used to produce Class A reclaimed water provided the reclaimed water provider demonstrates through pilot plant testing, existing reclaimed water quality data, or other means that the alternative method or turbidity criteria reliably produce a reclaimed water that meets the disinfection criteria in subsection (C) prior to direct reuse.~~

B. An owner of a facility shall ensure that:

1. The turbidity of Class A reclaimed water at a point in the wastewater treatment process after filtration and immediately before disinfection complies with the following:
   a. The 24-hour average turbidity of filtered effluent is 2 NTUs or less, and
   b. The turbidity of filtered effluent does not exceed 5 NTUs at any time.
2. Class A reclaimed water meets the following criteria after disinfection treatment and before discharge to a reclaimed water distribution system:
   a. There are no detectable fecal coliform organisms in 4 of the last 7 daily reclaimed water samples taken, and
   b. The single sample maximum concentration of fecal coliform organisms in a reclaimed water sample is less than 23 / 100 ml.
   c. If alternative treatment processes or alternative turbidity criteria are used, or reclaimed water is blended with other water to produce Class A reclaimed water under subsection (C), there are no detectable enteric virus in 4 of the last 7 monthly reclaimed water samples taken.

C. An owner of a facility may use alternative treatment methods other than those required by subsection (A), or comply with alternative turbidity criteria other than those required by subsection (B)(1), or blend reclaimed water with other water to produce Class A reclaimed water provided the owner demonstrates through pilot plant testing, existing water quality data, or other means that the alternative treatment methods, alternative turbidity criteria, or blending reliably produces a reclaimed water that meets the disinfection criteria in subsection (B)(2) before discharge to a reclaimed water distribution system.

~~E~~**D.** *Reuse applications:* ~~Class A reclaimed water shall be used for the specific reuse applications designated Class A in Appendix A. Class A reclaimed water may be used for any reuse application where Class B+, Class B, or Class C reclaimed water is allowed~~. A person shall use Class A reclaimed water for a type of direct reuse listed as Class A in Appendix A. A person may use Class A reclaimed water for a type of direct reuse listed as Class B or Class C in Appendix A.

R18-11-305. Class B+ Reclaimed Water

A. ~~*Treatment requirements:*~~ Class B+ reclaimed water is ~~a~~ wastewater that has undergone secondary treatment, nitrogen removal treatment, and disinfection.

~~**B.** *Disinfection criteria:* Class B+ reclaimed water shall meet the following E. coli criteria after disinfection and prior to direct reuse:~~

~~1. The concentration of E. coli in 4 of the last 7 samples shall be less than 126 cfu / 100 ml.~~

~~2. The single sample maximum concentration of E. coli shall be less than 576 cfu / 100 ml.~~

~~**C.** *Nitrogen removal:* The 5-sample geometric mean concentration of total nitrogen shall be less than 10 mg / L.~~

B. An owner of a facility shall ensure that:

1. Class B+ reclaimed water meets the following criteria after disinfection treatment and before discharge to a reclaimed water distribution system:
   a. The concentration of fecal coliform organisms in 4 of the last 7 daily reclaimed water samples is less than 200 / 100 ml.
   b. The single sample maximum concentration of fecal coliform organisms in a reclaimed water sample is less than 800 / 100 ml.
2. The 5-sample geometric mean concentration of total nitrogen in a reclaimed water sample is less than 10 mg / L.

~~**D**~~**C.** ~~*Reuse applications*: Class B+ reclaimed water is not required for any reuse application. Class B+ reclaimed water may be used for any reuse application where Class B or Class C reclaimed water is allowed. The reuse of Class B+ reclaimed water for a reuse application that requires Class A reclaimed water is prohibited.~~ A person may use Class B+ reclaimed water for a type of direct reuse listed as Class B or Class C in Appendix A. A person shall not use Class B+ reclaimed water for a type of direct reuse listed as Class A in Appendix A.

R18-11-306. Class B Reclaimed Water

A. ~~*Treatment requirements:*~~ Class B reclaimed water is ~~a~~ wastewater that has undergone secondary treatment and disinfection.

~~**B.** *Disinfection criteria:* Class B reclaimed water shall meet the following E. coli criteria after disinfection and prior to direct reuse:~~

~~1. The concentration of *E. coli* in 4 of the last 7 samples shall be less than 126 cfu / 100 ml.~~

~~2. The single sample maximum concentration of *E. coli* shall be less than 576 cfu / 100 ml.~~

B. An owner of a facility shall ensure that:

1. Class B reclaimed water meets the following criteria after disinfection treatment and before discharge to a reclaimed water distribution system:
   a. The concentration of fecal coliform organisms in 4 of the last 7 daily reclaimed water samples is less than 200 / 100 ml.
   b. The single sample maximum concentration of fecal coliform organisms in a reclaimed water sample is less than 800 / 100 ml.

C. ~~*Reuse applications*: The use of Class B reclaimed water for reuse applications where Class A reclaimed water is required is prohibited. Class B reclaimed water may be used for any reuse application where Class C reclaimed water is permitted. A minimum of Class B reclaimed water is required for the specific reuse applications designated Class B in Appendix A.~~ A person shall use a minimum of Class B reclaimed water for a type of direct reuse listed as Class B in Appendix A. A person may use Class B reclaimed water for a type of direct reuse listed as Class C in Appendix A. A person shall not use Class B reclaimed water for a type of direct reuse listed as Class A in Appendix A.

R18-11-307. Class C Reclaimed Water

A. ~~*Treatment requirements:*~~ Class C reclaimed water is ~~a~~ wastewater that has undergone secondary treatment in a series of wastewater stabilization ponds, including aeration, with or without disinfection.

~~**B.** *Total retention time:* The total retention time in wastewater stabilization ponds shall be at least 30 days.~~

~~**C.** *Fecal coliform criteria:* Class C reclaimed water shall meet the following fecal coliform criteria:~~

~~1. The concentration of fecal coliform organisms in 4 of the last 7 reclaimed water samples taken shall be less than 1000 cfu / 100 ml.~~

~~2. The single sample maximum concentration of fecal coliform shall be less than 4000 cfu / 100 ml.~~

B. The owner of a facility shall ensure that:

1. The total retention time of Class C reclaimed water in wastewater stabilization ponds is at least 20 days.
2. Class C reclaimed water meets the following criteria after treatment and before discharge to a reclaimed water distribution system:
   a. The concentration of fecal coliform organisms in 4 of the last 7 reclaimed water samples taken is less than 1000 / 100 ml.
   b. The single sample maximum concentration of fecal coliform organisms in a reclaimed water sample is less than 4000 / 100 ml.

D. *Reuse applications*: ~~The use of Class C reclaimed water for reuse applications where Class A or Class B reclaimed water is required is prohibited. Class C reclaimed water may be used for the specific reuse applications designated Class C in Appendix A~~ A person shall use a minimum of Class C reclaimed water for a type of direct reuse listed as Class C in Appendix A. A person shall not use Class C reclaimed water for a type of direct reuse listed as Class A or Class B in Appendix A.

R18-11-308. Industrial Reuse

A. ~~Reclaimed~~ The reclaimed water quality requirements for the following direct reuse applications are industry-specific and shall be determined by the Department on a case-by-case basis in ~~the~~ a reclaimed water permit issued by the Department under 18 A.A.C. 9, Article 7:

1. Direct reuse of industrial wastewater containing ~~a component of sanitary wastewater~~ sewage.
2. Direct reuse of industrial wastewater for the production or processing of any ~~crops~~ crop used as human or animal food.

~~C~~**B.** The Department shall use best professional judgment ~~in determining~~ to determine the reclaimed water quality requirements needed to protect public health and the environment for ~~the direct reuse applications~~ a type of direct reuse specified in subsection (A).

~~**A.** For direct reuse of reclaimed water for an industrial use listed in Appendix A, the reclaimed water quality classes established in this Article are intended for the protection of public health and the environment and will not necessarily prevent scaling, corrosion, foaming, or biofouling of industrial process equipment.~~

R18-11-309. Reclaimed Water Quality Standards for an Unlisted Type of Direct Reuse

A. The Department may prescribe in an individual reclaimed water permit issued under 18 A.A.C. 9, Article 7, reclaimed water quality requirements for a type of direct reuse ~~that is~~ not listed in Appendix A. ~~The Department~~ Before permitting a direct reuse of reclaimed water not listed in Appendix A, the Department shall, using its best professional judgement, determine and require compliance with ~~the~~ reclaimed water quality requirements needed to protect public health and the environment ~~on a case-by-case basis using best professional judgment~~. ~~The Department may determine that an existing reclaimed water quality category is appropriate for a new type of direct reuse. The department may consider the following factors when prescribing reclaimed water quality requirements for a new type of direct reuse:~~

~~1. The risk to public health;~~
~~2. The degree of public access to the site where the reclaimed water is reused and human exposure to the reclaimed water;~~
~~3. The level of treatment necessary to ensure that the reclaimed water is aesthetically acceptable;~~
~~4. The level of treatment necessary to prevent nuisance conditions;~~
~~5. Specific water quality requirements for the intended reuse application;~~
~~6. The means of application of the reclaimed water;~~
~~7. The degree of treatment necessary to avoid a violation of surface water quality standards or aquifer water quality standards;~~
~~8. The potential for improper or unintended reuse of the reclaimed water;~~
~~9. Reuse guidelines, criteria, or standards adopted or recommended by the U.S. Environmental Protection Agency or other federal or state agencies that apply to the new reuse application;~~
~~10. Reclamation experience in the United States; and~~
~~11. An adequate margin of safety to protect public health and the environment.~~

~~**B.** Class A+ or Class A reclaimed water is allowed for a new tyoe of direct reuse except for direct potable reuse and for make up water in a swimming pool or spa. Direct potable reuse of reclaimed water and the use of reclaimed water in swimming pools or spas are prohibited.~~

B. The Department may determine that Class A+, A, B+, B, or C reclaimed water is appropriate for a new type of direct reuse.

C. The Department shall consider the following factors when prescribing reclaimed water quality requirements for a new type of direct reuse:

1. The risk to public health;
2. The degree of public access to the site where the reclaimed water is reused and human exposure to the reclaimed water;
3. The level of treatment necessary to ensure that the reclaimed water is aesthetically acceptable;
4. The level of treatment necessary to prevent nuisance conditions;
5. Specific water quality requirements for the intended type of direct reuse;
6. The means of application of the reclaimed water;
7. The degree of treatment necessary to avoid a violation of surface water quality standards or aquifer water quality standards;
8. The potential for improper or unintended use of the reclaimed water;

9. The reuse guidelines, criteria, or standards adopted or recommended by the U.S. Environmental Protection Agency or other federal or state agencies that apply to the new type of direct reuse; and
10. Similar wastewater reclamation experience of reclaimed water providers in the United States.

Appendix A.Minimum Reclaimed Water Quality Requirements for Direct Reuse ~~Applications~~

Type of Direct Reuse ~~Application~~	Minimum Class of Reclaimed Water Required
Irrigation of food crops	A
Recreational ~~and other open access~~ impoundments	A
Residential landscape irrigation	A
Schoolground landscape irrigation	A
~~Other~~ open access landscape irrigation ~~(e.g., parks, cemeteries, greenbelts, common areas)~~	A
Toilet and urinal flushing	A
Fire protection systems	A
Spray irrigation of an orchard or vineyard	A
Commercial closed loop air conditioning systems	A
Vehicle and equipment washing (does not include self-service vehicle washes)	A
Snowmaking	A
Surface irrigation of an orchard or vineyard	B
Golf course irrigation	B
Restricted access landscape irrigation ~~(e.g., irrigation of highway medians and landscapes and similar areas)~~	B
~~Restricted access~~ Landscape impoundment	B
Dust control	B
Soil compaction and similar construction activities	B
Pasture for milking animals	B
Livestock watering (dairy animals)	B
Concrete and cement mixing	B
Materials washing and sieving	B
Street cleaning	B
Pasture for non-~~milking~~ dairy animals	C
Livestock watering (non-dairy animals)	C
Irrigation of sod farms	C
Irrigation of fiber, seed, forage, and similar crops	C
Silviculture	C

Note: Nothing in this Article prevents a wastewater treatment plant from using a higher quality reclaimed water for a ~~reuse application~~ type of direct reuse than the minimum class of reclaimed water listed in Appendix A. For example, a wastewater treatment plant may provide Class A reclaimed water for a ~~reuse application~~ type of direct reuse where Class B or Class C reclaimed water is acceptable.

11. A summary of the principal comments and the agency response to them:

General comments

Comment: In general, the switch from the numeric tables under the old rules to classes of reclaimed water based on levels of treatment under the proposed rules is probably more efficient and effective.

Response: ADEQ agrees. As noted in the preamble, ADEQ recommends reclaimed water quality standards that are expressed as a combination of recommended treatment processes and reclaimed water quality limits because: 1) specific reclaimed water quality criteria that employ the use of surrogate parameters may not adequately characterize reclaimed water quality, 2) a combination of required treatment processes and reclaimed water quality requirements known to produce reclaimed water of acceptable quality obviates the need to monitor reclaimed water for many pollutants, and 3) expensive, time-consuming, and, in some cases, questionable monitoring for pathogenic organisms, such as viruses, can be eliminated without compromising public health protection.

Comment: There is a reference in the preamble that states that wastewater treatment operators will be required to monitor for compliance with reclaimed water quality criteria in the plant or at the point where reclaimed water enters a distribution system. It is a given that we will need to monitor at the plant to establish compliance with Aquifer Protection Permit (APP) requirements. It would be extremely expensive to require sampling at the point that reclaimed water enters a distribution system particularly where the reclaimed water is used by many end users. This should be clarified ....to reflect a single point of compliance. We suggest that, unless otherwise noted, the limits apply to the reclaimed water at the point of discharge from the treatment facility.

Response: ADEQ agrees. The reclaimed water quality criteria prescribed in the 5 classes of reclaimed water in the rules are intended to be met either within the wastewater treatment plant (in the case of turbidity criteria for Class A+ and Class A) or at a point where the reclaimed water is discharged from the wastewater treatment plant to a pipeline or to a canal (in the case of disinfection criteria). In general, the "point of compliance" with the reclaimed water quality criteria is the point of discharge from the wastewater treatment plant, not at a location within a reclaimed water distribution system or at the site where the reclaimed water is beneficially used.

Comment: Please confirm that the monitoring, testing, etc. (the "point of compliance") is at the wastewater treatment facility and ends at the property line of the wastewater treatment plant, not at some point downstream such as an impoundment.

Response: As noted in the answer to the previous comment, the "point of compliance" is either within the wastewater treatment plant or at the point where reclaimed water is discharged from the wastewater treatment plant to a pipeline or a canal. The turbidity criterion that is prescribed in the Class A+ and Class A reclaimed water classes is intended to be met within a wastewater treatment plant at a point in the treatment process after filtration and prior to disinfection of the reclaimed water. The disinfection criteria that are prescribed in all 5 classes of reclaimed water are intended to be met at the point of discharge from the wastewater treatment plant to a pipeline or canal that conveys the reclaimed water to the sites where it will be reused. The disinfection criteria in the 5 reclaimed water classes are intended to be performance standards for the wastewater treatment plants that produce reclaimed water. The disinfection criteria are not intended as ambient water quality criteria that have to be met at the reuse site, such as in an impoundment of reclaimed water. Compliance with the disinfection criteria is determined at the point where reclaimed water leaves the wastewater treatment plant and enters a pipeline, canal, or a reclaimed water distribution system.

Comment: R18-11-303(C) provides that Class A+ reclaimed water must meet certain criteria "after disinfection and prior to direct reuse." Prior drafts of the rule required the criteria to be met "after disinfection and prior to discharge to the reclaimed water distribution system." We suspect that the change in wording was not intended to change the intent that the point of compliance be at the point the reclaimed water leaves the treatment plant, not somewhere further down the conveyance system. However, we are concerned that the change in wording "muddies the water" as to the point of compliance. There are three possible solutions: 1) Use the old language (that is, "prior to discharge to the reclaimed water distribution system," 2) Delete the phrase "and prior to direct reuse," or 3) Include a definition of "conveyance" and revise the language to read "prior to discharge to any conveyance." Our preference is simply to return to the old language. The same issue is repeated at various places throughout the proposed rules. If ADEQ changes the language, the same changes will need to be made in the following sections: R18-11-303(C), R18-11-303(E), R18-11-304(C), R18-11-304(D), R18-11-305(B), and R18-11-306(B).

Response: ADEQ agrees. ADEQ revised the proposed rules to use the language that was previously found in informal drafts of the reclaimed water quality standards rules. The adopted rules use the phrase, "after disinfection and prior to discharge to the reclaimed water distribution system" in R18-11-303(C), R18-11-303(E), R18-11-304(C), R18-11-304(D), R18-11-305(B) and R18-11-306(B). ADEQ agrees that this language is clearer, more understandable, and preferable to the vague phrase, "prior to direct reuse."

Comment: ADEQ states in the preamble to the proposed rule that it "hopes to encourage the production and use of the "+" categories of reclaimed water by providing regulatory incentives..." Some ways to do this are: 1) NOT to create artificial limitations on use, 2) nor create the public perception that A+ quality reclaimed water may still not be desirable to use for irrigation, 3) nor otherwise discourage the use of such reclaimed water by requiring front yard signage for use of A+ reclaimed water. ADEQ acknowledges that such water is "essentially pathogen-free."

Response: ADEQ has not created artificial limitations on the use of Class A+ water. As noted at the bottom of Appendix A, Class A+ and Class A reclaimed water may be used for any of the types of reuse listed in Appendix A. Nor does ADEQ agree that the preamble or the rule can be fairly interpreted as creating a public perception that Class A+ or Class A reclaimed water is not suitable for irrigation. On the contrary, the rules specifically state that Class A reclaimed water is suitable for open access landscape irrigation, including the irrigation of residential yards, schoolyards, and playgrounds. Finally, the reclaimed water quality standards rules do not contain signage requirements. Signage requirements are found in the wastewater reuse permit rules at R18-9-701 et. al.

Definitions

Comment: A definition of "wastewater production facilities" should be added to the rule: "Wastewater production facilities" means facilities used to filter wastewater by either mechanical processes or through recharge and recovery."

Response: ADEQ disagrees. The definition of "wastewater production facilities" recommended by the commenter is inconsistent with the concept of direct reuse as explained in the preamble to the proposed reclaimed water quality standards rules. The recharge and recovery of reclaimed water is regulated under the aquifer water quality standards and Aquifer Protection Permit rules.

Comment: "Direct use" should be defined as follows: "Direct use" means reclaimed water produced by one or a combination of the following methods: 1) filtration and disinfection in a mechanical treatment plant; 2) filtration through recharge with disinfection after recovery of water."

Response: ADEQ disagrees. The definition of "direct use" recommended by the commenter includes "filtration through recharge with disinfection after recovery." Groundwater recharge and recovery of reclaimed water are not included within ADEQ's concept of direct reuse.

Comment: "Reclaimed water" is a statutorily defined term that means "water that has been treated or processed by a wastewater treatment plant or an on-site wastewater treatment plant." A.R.S. § 49-201.31. In addition, in 1999 (effective January 1, 2001), the Arizona Legislature granted ADEQ the statutory authority to adopt by rule water quality standards for the "direct reuse of reclaimed water."

A.R.S. § 49-221(A)(6). Notwithstanding the clear definition of "reclaimed water" in A.R.S. § 49-201.31, ADEQ is proposing to expand the statutory definition by providing in the proposed reclaimed water quality standards rule that the term "reclaimed water" includes "gray water and industrial wastewater with a component of sanitary wastewater." In some instances, however, neither gray water nor industrial wastewater with a component of sanitary wastewater ... will meet the statutory definition of being water that has been treated or processed by a wastewater treatment plant or on-site wastewater treatment facility. Pinnacle West therefore questions whether ADEQ has the authority to adopt water quality standards for such waters. For the foregoing reasons, Pinnacle West requests that ADEQ revise its proposed definition of "reclaimed water" as follows:

> "Reclaimed water has the meaning prescribed in A.R.S. § 49-201(31) ~~and includes gray water and industrial wastewater with a component of sanitary wastewater~~."

There is simply no need to include gray water in the proposed definition of "reclaimed water" for purposes of the reclaimed water standards rule because the rule does not attempt to establish water quality standards for gray water.

Response: ADEQ agrees that the proposed definition is more consistent with the statutory definition of reclaimed water at § 49-301(31). ADEQ also agrees that the references to gray water and industrial wastewater with a component of sanitary wastewater in the proposed rule are unnecessary. Finally, the reclaimed water quality standards are not intended to apply to gray water. ADEQ deleted the phrase from the rule as recommended in the comment.

Comment: To maintain consistency between the Aquifer Protection Permit (APP) proposed rules and the reclaimed water quality standards and permit rules, ADEQ should change the proposed term of "sanitary wastewater" (which is simply a vestige of the existing resue permit rules) to "sewage" (which is the term used in the proposed revisions to ADEQ's APP rules). A similar change has been requested by Pinnacle West for the definition of "sanitary wastewater" in the proposed reclaimed water permit rules. The definition of "sewage" in the proposed reclaimed water quality standards and permit rules should be the same as is used in the proposed revisions to ADEQ's APP rules. Accordingly, Pinnacle West respectfully requests that ADEQ amend its definition of "sanitary wastewater" in the proposed reclaimed water quality standards rules as follows:

> "~~Sanitary wastewater~~ Sewage" means ~~wastewater~~ untreated wastes originating from toilets, baths, sinks, lavatories, laundries, and other plumbing fixtures in places of human habitation, employment, or recreation.

ADEQ also should ensure that it carefully reviews its proposed reclaimed water quality standards rule in order to replace the term "sanitary wastewater" with the more appropriate term, "sewage." For example, proposed R18-11-308(1) should be revised to replace the term, "sanitary wastewater," with the more appropriate term, "sewage."

Response: ADEQ agrees that terms that are used in the reclaimed water quality standards, reuse permit, and APP rules should be consistent with each other. The APP rules use the term, "sewage," but does not use "sanitary wastewater." The term, "sanitary wastewater" is used in only one place in the reclaimed water quality standards rules at R18-11-308(1). ADEQ replaced "sanitary wastewater" with the term, "sewage." ADEQ also deleted the definition of "sanitary wastewater" and added a definition of "sewage" to be consistent with this change.

R18-11-302. Applicability

No comments.

R18-11-303. Class A+ Reclaimed Water

Comment: R18-11-303(C)(1) states that there shall be no detectable fecal coliforms in 4 of the last 7 reclaimed water samples taken. The rule should identify the timeframe over which the samples are taken.

Response: ADEQ agrees. ADEQ will clarify that daily monitoring to determine compliance with fecal coliform criteria is required. The revised rule states that there shall be no detectable fecal coliforms in 4 of the last 7 daily reclaimed water samples taken.

R18-11-304. Class A Reclaimed Water

Comment: There is no specific requirement to continuously monitor turbidity in the proposed rule or in the preamble except for one reference at p. 1664 of the *Arizona Administrative Register* stating that "....continuous monitoring of turbidity provides real time process control and an instantaneous measure of reclaimed water quality." While this is true, it should be clarified whether continuous monitoring is required (even if also referenced in the permit rules).

Response: ADEQ believes that turbidity monitoring requirements for a wastewater treatment plant that produces Class A reclaimed water is most appropriately addressed in the wastewater reuse permitting rules. While it is true that ADEQ believes that continuous monitoring of turbidity is superior to taking grab samples, the commenter is correct that there is no specific requirement in the reclaimed water quality standards rules to continuously monitor turbidity. Reuse permit writers will have the flexibility to write monitoring requirements in individual reuse permits that require either continuous monitoring or frequent grab sampling for turbidity.

Comment: The means of determining compliance with the turbidity requirement needs clarification. Continuous turbidity monitoring results in a very large amount of turbidity data that cannot be conveniently incorporated into a compliance calculation and is not necessary to assure adequate performance. We would suggest allowing the selection of a value every four hours from the continuous record, to be used in determination of compliance. For example, in a 24 hour-period, there would be six 4-hour readings selected. This is consistent with the approach used in the drinking water filtration rules [*See* R18-4-302(F)]

Response: The text of the Class A+ or Class A reclaimed water quality standards rules does not actually prescribe monitoring frequency or the type of turbidity monitoring that is required. While it is true that the preamble to the proposed rules states that turbidity is a key parameter for reclaimed water because continuous monitoring of turbidity provides real time process control and an instantaneous measure of reclaimed water quality, the actual rule text does not specifically require continuous monitoring. Because the text of the reclaimed water quality standards rules is silent with regard to continuous monitoring for turbidity, reuse permit writers have the flexibility to prescribe either continuous monitoring or grab sample monitoring requirements under the reuse permit rules. The suggestion that ADEQ follow R18-11-302(F) of the safe drinking water rules is a good one. R18-11-302(F) provides two options for water treatment plants that are conducting turbidity monitoring: 1) either take a grab sample once every four hours that the plant is operating, or 2) monitor turbidity continuously. While ADEQ agrees that the safe drinking water rules provide a useful model for establishing monitoring requirements for turbidity, ADEQ does not think it is appropriate to prescribe specific monitoring requirements in the reclaimed water quality standards rules. The appropriate place to address the type, frequency, and other monitoring requirements is in the wastewater reuse permit rules.

Comment: We believe that some wastewater treatment plants will be able to meet the turbidity requirements without the addition of chemical feed facilities. If a plant can meet the turbidity requirements, the addition of chemical feed facilities should not be required.

Response: The Class A+ and Class A rules provide for the use of alternative treatment processes or turbidity criteria. If a wastewater treatment plant can demonstrate that it reliably meets the turbidity requirements for Class A reclaimed water without chemical feed facilities, the rules allow a wastewater treatment plant to make that demonstration. However, if a reclaimed water provider chooses to operate under alternative treatment processes without chemical addition capability, then the reclaimed water provider will be required to conduct routine enteric virus monitoring to show that the wastewater treatment plant reliably produces pathogen-free reclaimed water.

Comment: The preamble to the rule states that "ADEQ intends to prohibit full body contact recreation [for example, swimming] in impoundments of A+ reclaimed water." R18-11-309(B) of the proposed rule, however, provides that Class A water "is allowed for any new type of direct use ... except for direct potable reuse and for make-up water in a pool or spa." Does ADEQ intend to differentiate between an impoundment (for example, a lake) and a pool or spa?

Response: No. ADEQ deleted R18-11-309(B) from the adopted rules which stated that Class A water is allowed for a new type of direct reuse except for direct potable reuse and for make-up water in a pool or spa. While the adopted rules authorize the use of reclaimed water in "recreational impoundments," ADEQ has tried to make it clear in the preamble to the rules and in the definition section that the use of reclaimed water in impoundments where people swim is *not* authorized by the rules. ADEQ revised the definition of "recreational impoundment" in the adopted rule to clarify that a recreational impoundment is one where boating, fishing, and other partial body contact recreation activities may take place, but swimming and other full body contact recreation activities are prohibited [*See* R18-11-301]. Also, as stated in the preamble, while Class A reclaimed water is an "essentially pathogen free" reclaimed water, there will always be a risk of human exposure to waterborne pathogens. The risk of ingestion of or exposure of sensitive organs (for example, eyes and ears) to waterborne pathogens in reclaimed water is unnecessary and avoidable. The reclaimed water quality standards protect public health by prescribing advanced treatment requirements and stringent disinfection requirements for reclaimed water and by imposing reasonable controls at reuse sites to reduce human exposure to reclaimed water. ADEQ does not differentiate between impoundments of reclaimed water for full body contact recreation, swimming pools, and spas. The adopted rules prohibit the reuse of reclaimed water in spas, swimming pools, and in impoundments that are intended to be used for full body contact recreation.

Comment: We have concerns regarding the technical merit of the requirement for Class A water for open access landscape irrigation uses.

Response: The Class A requirement for open access landscape irrigation is consistent with the EPA Guidelines for Water Reuse. The minimum treatment requirements and disinfection requirements for Class A reclaimed water also are consistent with the requirements for most states that regulate the reuse of reclaimed water for open access landscape irrigation.

Comment: ADEQ has requested comments on the direct and indirect costs and benefits of requiring Class A reclaimed water for certain uses that did not previously require this level of treatment in order to be reused. We believe that the proposed Class B water-disinfecting standards should be changed to be the same as the standard currently required for open access irrigation in the existing rule. Please note that current standards for open access are more stringent than the proposed standards for Class B and less stringent than the proposed standards for Class A. The proposed additional stringency required wherein only Class A water can be used for open access landscape irrigation, residential yard irrigation, and other uses are not justified. Given the lack of epidemiological evidence to support this position and the history of reuse of reclaimed water not consistently meeting Class A levels (over 15 years at Ocotillo) without any incident clearly does not justify the change in the standard. Please note that the quality of water produced from the Ocotillo plant is excellent (exceeds B+ but will not consistently meet A+). There is no reason to stop using reclaimed water of this quality. As the Valley continues to urbanize, the reuse of reclaimed water will be more focused on open access landscape irrigation. The water quality proposals included in the rule would have a chilling effect on such use (the reclaimed water would be more expensive and less available). This result is not consistent with the stated goal of increasing the use of reclaimed water to free up potable sources for human consumption and is not necessitated by any firm health or environmental reason. Further, if ADEQ holds that such a change of standard is warranted, reclaimed water providers and users should be given reasonable time, such as 5 years, in which to make the changes that would be necessitated by such a change in standard.

Response: ADEQ disagrees that the proposed Class B reclaimed water quality criteria should be made more stringent to allow the use of Class B reclaimed water for open access landscape irrigation, or that Class A reclaimed water (as proposed by ADEQ) should not be required for open access landscape irrigation. ADEQ believes that an essentially pathogen-free reclaimed water should be required for open access landscape irrigation such as irrigation of residential yards, schoolgrounds, and playgrounds. It is because of the lack of epidemiological evidence or definitive health risk assessment information that ADEQ takes an admittedly conservative position regarding wastewater reclamation that errs on the side of the protection of the public health, particularly for urban reuse applications such as irrigating yards and schoolgrounds with reclaimed water. While the history of wastewater reuse in the community of Ocotillo may provide anecdotal evidence that supports the use of less stringent fecal coliform criteria or lower minimum treatment levels than Class A, ADEQ is not aware of any epidemiological studies or quantitative risk assessments that have been done at Ocotillo or any other Arizona community that support continuation of the status quo or that can be relied upon to support less stringent Class A reclaimed water quality standards. Moreover, ADEQ believes that there is enough flexibility built into the Class A reclaimed water quality standards to allow the use of alternative methods of treatment provided the disinfection criteria are met. ADEQ believes it is prudent public health policy to require a reclaimed water that is essentially free of pathogenic viruses, bacteria, and parasites in urban wastewater reuse applications. ADEQ has confidence that the Class A reclaimed water quality standards, as adopted, meet that requirement. ADEQ has less confidence that the existing criteria for open access landscape irrigation, without minimum treatment requirements, are essentially pathogen-free.

ADEQ agrees that existing providers of reclaimed water need time to upgrade treatment if it is necessary to meet new Class A reclaimed water quality standards. Existing facilities that are engaged in reclamation activities that require Class A reclaimed water under the new rules and that are operating under a individual reuse permit will be permitted to continue operation for the remainder of the 5-year term of the reuse permit. Upon expiration of the permit, ADEQ expects that a treatment plant will either upgrade treatment to meet the minimum treatment requirements for Class A reclaimed water or be placed on a schedule of compliance to meet those requirements.

R18-11-305. Class B+ Reclaimed Water

No comments

R18-11-306. Class B Reclaimed Water

Comment: We suggest that ADEQ review whether fecal coliform or *E. coli* methods are comparable and select one or the other to be consistent, rather than using fecal coliform for Classes A and C and *E. coli* for Class B.

Response: ADEQ reviewed the proposed use of *E. coli* disinfection criteria for Class B+ and Class B reclaimed water. ADEQ agrees that the reclaimed water quality standards should use a consistent microbiological indicator for Classes A, B, and C. ADEQ revised R18-11-305 and R18-11-306 and changed the indicator organism from *E. coli* to fecal coliform. The use of fecal coliform as an indicator of the microbiological quality of reclaimed water is consistent with EPA recommendations in the Guidelines for Water Reuse. The use of fecal coliform as an indicator is well-accepted within the wastewater treatment community, makes the disinfection criteria in the various classes consistent with each other, and makes the standards easier to compare.

Comment: We suggest that ADEQ establish a turbidity limit for Class B water at 3 NTU daily average not to exceed 5 NTU, consistent with the existing reuse standard for open access water. There has never been any evidence of a public health incident related to reuse of Chandler's effluent. We believe that the proposed standards limiting open access to Class A water would cause wasteful, unnecessary treatment or the possible loss of current, appropriate, safe uses of reclaimed water.

Response: ADEQ disagrees that the turbidity limit should be changed from 2 NTUs to 3 NTUs as recommended by the commenter. ADEQ believes that a 2 NTU requirement is both technically and economically feasible by well-operated reclamation facilities. Furthermore, the 2 NTU turbidity standard for Class A reclaimed water is supported by virus removal studies conducted in California which demonstrate that a wastewater that undergoes the minimum treatment processes prescribed in the Class A rule and that meet the 2 NTU requirement produces an essentially pathogen-free reclaimed water. ADEQ is not aware of any literature or studies that make this demonstration at higher turbidities such as 3 NTUs. Finally, the rule for Class A reclaimed water provides a mechanism for operating under alternative turbidity limits provided the reclaimed water provider makes a demonstration through pilot plant testing, existing reclaimed water quality data, or other means that an alternative treatment processes or compliance with higher turbidity limits reliably produces a reclaimed water that meets all of the disinfection criteria prescribed in the Class A rule.

R18-11-307. Class C Reclaimed Water

Comment: We agree with including a Class C for appropriate uses that do not need higher levels of treatment. The reference to stabilization ponds should be eliminated. It may be possible to produce effluent that meet Class B or better quality criteria. Conversely, there may be treatment processes other than stabilization ponds producing effluent that would meet Class C quality criteria, and thus be suitable for Class C types of uses.

Response: ADEQ disagrees. The Class C category of reclaimed water was created specifically for the reuse of reclaimed water produced in wastewater stabilization ponds or in lagoon systems, with or without disinfection.

Comment: The 30-day total retention time in R18-11-307(B) is quite long. We suggest reducing it to 14 days.

Response: ADEQ agrees that the 30-day total retention time may be reduced but disagrees with a reduction of the total retention time to 14 days. Given sufficient retention time, wastewater stablilization ponds can significantly reduce the concentrations of pathogenic organisms in wastewater. There are several types of wastewater stabilization ponds, or oxidation ponds, and the retention periods for each type varies. In general, the retention periods to complete the decomposition of organic matter in a wastewater stabilization pond ranges from 1 to 4 weeks depending upon whether the wastewater stabilization pond is a facultative or aerated pond.

There are 4 types of wastewater stabilization ponds. The 4 types are: aerobic ponds, anaerobic ponds, aerated ponds, and facultative ponds. Aerobic ponds are shallow, naturally mixed ponds that depend on natural light penetration to stimulate algal growth which promotes oxygen generation. The detention time of wastewater in an aerobic pond is typically 3 to 5 days. Anaerobic ponds are deep and require relatively long detention times of 20 to 50 days. Anaerobic ponds are often the first step in a wastewater stabilization pond system for waste streams with high BOD and suspended solids loads. Facultative ponds provide both aerobic and anaerobic treatment processes. The upper layer of a facultative pond is an aerated zone, the middle layer is a facultative zone, and the bottom layer is an anaerobic zone. The detention time of facultative ponds may vary between 5 and 30 days. Aerated ponds are mechanically aerated. Aerated ponds typically have a detention time of less than 10 days. The inactivation or removal of pathogens in wastewater stabilization pond systems is controlled by a number of factors, including temperature, sunlight, pH, predation by other microorganisms, and adsorption to or entrapment of settleable solids. Indicator bacteria and pathogenic bacteria may be reduced by 90% to 99%, again depending on retention times.

The die-off of indicator bacteria in waste stablilization pond systems has been studied extensively and several models have been proposed, largely based on retention time, solar radiation, and temperature. Because these factors vary greatly by location and season, pathogen removals are expected to be site-specific. It is difficult to generalize retention times in the Class C reclaimed water standards because of the differences in climate and the various types of wastewater stabilization pond systems in the state. While a 14-day retention time may be adequate in the summer for a wastewater stabilization pond system that uses aerated ponds, is located in a desert area of the state, and experiences high summer temperatures, 14 days may not be enough retention time for a wastewater stabilization pond system that employs facultative ponds and is located at a higher elevation with a cooler climate. ADEQ agrees that the 30-day retention time may be reduced to 20 days provided the wastewater stabilization pond system includes an aerobic or aerated pond.

Comment: The Class C reclaimed water should be modified to reflect an aerobic process, increase the TSS value to the range of 15-90 mg/ L to take into account algae growth and adjust the minimum total retention time from 30 days to 20 days. The 20-day time period is consistent with the earlier narrative discussion regarding this class of water.

Response: ADEQ agrees with a reduction of the minimum retention time from 30 days to 20 days [See response to previous comment]. ADEQ did not prescribe specific total suspended solids (TSS) criteria for Class C reclaimed water in the rules. ADEQ will rely on the federal definition of secondary treatment and the special considerations that apply to wastewater stabilization ponds that are contained in 40 CFR §133.103(c) when prescribing TSS criteria for wastewater stabilization pond systems in reuse permits.

Comment: The reuse applications for Class C reclaimed water should be expanded to allow for the following three uses: 1) dust control, 2) soil compaction and similar construction activities, and 3) street cleaning.

Response: ADEQ disagrees. Class C reclaimed water may or may not be disinfected. The EPA Guidelines for Water Reuse recommend a minimum of secondary treatment and disinfection for construction uses such as soil compaction and dust control. While it is assumed that exposure of the general public to reclaimed water that is used for dust control and construction uses will be limited, workers at construction sites may have significant exposure to reclaimed water. ADEQ believes that a requirement for disinfected reclaimed water (at least Class B) is a reasonable worker safety precaution. Also, reclaimed water that is used for street cleaning in urban environments should be disinfected.

R18-11-308. Industrial Reuse

Comment: With respect to industrial wastewater with a component of sanitary wastewater, the rule simply provides in proposed R18-11-308 that ADEQ can establish water quality standards on a case-by-case basis using best professional judgment. The language in this subsection should either be deleted in its entirety or moved to the proposed reclaimed water permit rule at section R18-9-710 (the section discussing individual reclaimed water permits for certain industrial reuse activities). If the language is moved, however, ADEQ must justify its exertion of authority over such waters under the permitting program for the direct reuse of reclaimed water.

Response: ADEQ has broad authority to adopt, by rule, water quality standards for the direct reuse of reclaimed water under A.R.S. § 49-221(E), including the direct reuse of industrial wastewater with a sewage component. "Reclaimed water" is broadly defined by A.R.S. § 49-201(31) and means "water that has been treated or processed by a wastewater treatment plant or an on-site wastewater treatment facility." This definition includes a wastewater treatment plant at an industrial facility. Together, these two statutes provide ADEQ with the statutory authority to regulate the direct reuse of industrial wastewater with a sewage component on a case-by-case basis.

R18-11-309. Reclaimed Water Quality Standards for an Unlisted Type of Direct Reuse

Comment: R18-11-309(B) should be deleted. It is inconsistent to list the appropriate uses of Class A quality reclaimed water in Appendix A and then state in R18-11-309(B) that it is allowed for "any new type of direct reuse." To open the use of effluent from treated sewage to any new use that may be thought up in the future is irresponsible to the mission of ADEQ to protect public health by reducing unnecessary public exposure from poorly operated facilities, upsets, and new emerging pathogens.

Response: ADEQ agrees that R18-11-309(B) should be deleted. A blanket authorization that allows the reuse Class A reclaimed water for any new type of direct reuse is inconsistent with the approach prescribed in R18-11-309(A) which requires an evaluation of each new type of direct reuse on a case-by-case basis, considering the factors listed in the rule.

Comment: R18-11-309(A) sets forth the factors the Department will consider when a new type of reuse is proposed. However, R18-11-309(B) appears to allow any type of new reuse for Class A+ or Class A water, except potable reuse and reuse in swimming pools and spas. Does subparagraph A only apply to B+, B, and C reclaimed water?

Response: No, subparagraph A is not limited to B+, B, and C reclaimed water only. R18-11-309(A) is intended to apply to new types of direct reuse. The intent of the rule is to provide regulatory flexibility to allow consideration of new types of direct reuse that may be developed in the future that are not specifically addressed in the current rules. ADEQ recognizes that new types of direct reuse may arise in the future that are not currently anticipated. ADEQ wants to provide a mechanism in the rule that will allow consideration of new types of direct reuse on a case-by-case basis. The Department may determine, using best professional judgment, that one of the existing classes of reclaimed water (Class A+, A, B+, B, or C) is appropriate for a new type of direct reuse and will protect public health and the environment. However, depending upon the new type of reuse, ADEQ may determine that none of the existing classes of reclaimed water, including Class A+ or Class A, is adequate. The factors that are listed in subparagraph A should be considered by ADEQ when the Department makes a determination as to the minimum level of treatment and the reclaimed water quality criteria that should be established for a new type of reuse. Depending upon the proposed type of direct reuse, additional treatment requirements or new types of criteria may be necessary. R18-11-309(A) and (B) are inconsistent because R18-11-309(B) states that Class A+ and Class A reclaimed water may be used for new types of reuse without any consideration of the factors listed in R18-11-309(A). ADEQ revised the rule by deleting subsection (B).

Comment: It is unclear what an "adequate margin of safety" is in R18-11-309(A)(11).

Response: ADEQ agrees that the phrase "adequate margin of safety" in R18-11-309(A)(11) is unclear. ADEQ did not include R18-11-309(A)(11) in the adopted rules.

Comment: What type of notice and public participation is anticipated for the approval of new uses?

Response: ADEQ expects that approval of new types of direct reuse will take place within the reuse permitting context. The rule states that ADEQ may prescribe in an individual reclaimed water permit issued under 18 A.A.C. 9, Article 7, reclaimed water quality requirements for a type of direct reuse that is not listed in Appendix A. The public notice and public participation requirements that apply to the issuance of an individual reuse permit will therefore apply to the case-by-case approval of a new type of direct reuse. ADEQ expects that as new types of direct reuse are authorized in individual reuse permits, ADEQ will subsequently open a rulemaking docket to revise Appendix A of the reclaimed water quality standards to include the new type of direct reuse in Appendix A.

Appendix A: Uses of Reclaimed Water

Comment: Appendix A should appear in only one place in the reclaimed water quality standards and wastewater reuse permit rules.

Response: ADEQ agrees. The table of types of direct reuse and the minimum category of reclaimed water required is located in Appendix A of the reclaimed water quality standards rules. ADEQ deleted Appendix A from the wastewater reuse permit rules in Title 18, Chapter 9.

Comment: Arizona should include snow-making as an authorized use for recycled or treated effluent water. The Arizona Snowbowl, and other ski areas in Arizona, rely on natural snowfall for their business to be successful. The last two winters have been very dry and warm, resulting in abysmal seasons for the industry. Unfortunately, long-term forecasts are calling for a continued dry spell in the Southwest. Without predictability in the business cycle, the ski industry in Arizona will not be able to provide recreation to thousands of customers, retain hundreds of employees, or contribute to the economies of local communities. Snow-making capabilities will provide much needed assurances that the ski resorts will open and operate each year. Using reclaimed water for snow-making is a very wise and sustainable use of the treated water and preserves potable water and underground aquifers from depletion. Commercial snow-making will not pose any additional threats to the health and safety of humans compared to golfers on the course or children playing in the grass at a school or park. ADEQ should include snowmaking as an authorized use of reclaimed water.

Response: ADEQ agrees and listed snow-making as an authorized use for Class A reclaimed water.

Comment: Livestock watering for dairy animals is not listed in Appendix A. Has it been intentionally omitted?

Response: The omission of livestock watering for dairy animals was an oversight and not intentional. ADEQ added livestock watering for dairy animals as a type of direct reuse that requires Class B reclaimed water.

Comment: It is unclear why Appendix A needs to be included here and in the rule on direct reuse of reclaimed water and / or why these 2 rules should not be combined for ease of use. Given that Class A water can be used for anything other than direct potable reuse or for filling a swimming pool or spa, it would be cleaner to have the class of water listed with the list of uses available for that class of water wherein, under Class A there would be the statement "Any use other than....."

Response: ADEQ agrees that the list of uses that are found in Appendix A should not be included in the proposed reuse permit rules.

Comment: ADEQ should exclude self service vehicle washes and effluent application by hand held pressurized wands from vehicle and equipment washing in Appendix A. This exclusion is consistent with R18-9-705(E) in the proposed reuse permit rules that prohibits misting. Exposure to reclaimed water aerosols or mists is an unnecessary risk of human exposure to reclaimed water from sewage effluent.

Response: ADEQ agrees that reclaimed water should not be used in self-service vehicle washes because of the potential exposure of the general public to the reclaimed water. ADEQ clarified that "vehicle and equipment washdown" in Appendix A does not include self-service vehicle washes.

Comment: ADEQ should clarify in Appendix A that the direct use of reclaimed water in fire protection systems does not include pressurized systems. ADEQ should add "unpressurized systems only." Pressurized systems is not a significant consumptive use. Reclaimed water contains high amounts of salts or other compounds that may be corrosive or otherwise detrimental to system piping and appurtenances. Pressurized systems will often have drinking water systems as a backup and connection with potable water supplies is prohibited. Pressurized systems require flushing and no provisions for disposal of a large quantity of effluent is prescribed in the rules. Pressurized systems are frequently used in places of food preparation and consumption.

Response: ADEQ disagrees that Appendix A should clarify that the direct reuse of reclaimed water in fire protection systems should not include pressurized systems. First, separate distribution systems that deliver reclaimed water to hydrants and fire protection systems in buildings may need to be pressurized, although the pressure of a reclaimed water distribution system is typically maintained at a lower pressure than a potable water distribution system. Second, ADEQ recognizes that reclaimed water that is used in buildings for toilets and urinal flushing and for fire protection systems may present cross-connection control concerns. For this reason, ADEQ requires that an essentially pathogen-free reclaimed water (Class A) be used. Finally, under the adopted rules, Class A reclaimed water may be safely reused for urban reuse applications such as spray irrigation of parks and playgrounds. ADEQ believes that Class A reclaimed water also may be safely reused in pressurized fire protection systems inside of buildings. No change to the rules was made.

Comment: ADEQ should clarify that the direct reuse of reclaimed water for commercial air conditioning is for closed loop systems where human exposure is minimized. Humidification and evaporative cooling could be construed as air conditioning in commercial buildings, even though evaporative cooling is specifically prohibited by the proposed reuse permit rules at R18-9-705(E). Evaporative cooling towers on the tops of buildings can minimize exposure with the use of drift eliminators. Commercial air conditioning towers should not be placed in areas of human egress or ingress or on the ground.

Response: ADEQ agrees that the reference to air conditioning in Appendix A should be clarified to limit the reuse of reclaimed water in air conditioning systems to closed loop systems. Closed loop cooling systems using Class A reclaimed water present minimal public health concerns. This clarification is consistent with the prohibition against evaporative cooling systems using reclaimed water in the reuse permit rules.

Comment: ADEQ should add a 1 mg/L chlorine residual requirement to the use of reclaimed water for dust control to be consistent with EPA Guidelines for Water Reuse.

Response: ADEQ disagrees that a chlorine residual requirement should be added for the direct reuse of reclaimed water for dust control. ADEQ has not prescribed a chlorine residual regulatory requirement for any type of direct reuse of reclaimed water. It is true that EPA recommends a chlorine residual of 1 mg/L after a minimum contact time of 30 minutes for the reuse of reclaimed water for dust control and other construction applications in the EPA Guidelines for Water Reuse. However, ADEQ believes that the proposed minimum treatment requirements and disinfection criteria in the reclaimed water quality standards are conservative and adequate to protect public health. ADEQ decided not to prescribe chlorine residual requirements in the reclaimed water quality standards rules in order to preserve flexibility for water reclamation plants to use disinfection technologies other than chlorine disinfection. There are a number of effective disinfection technologies that can be used for the destruction or inactivation of pathogens in reclaimed water, including UV disinfection and ozonation. If ADEQ prescribes a chlorine residual requirement in the rules for a type of direct reuse, it will dictate the type of disinfection technology that can be used by wastewater treatment plants engaged in reclamation. ADEQ is confident that Class B reclaimed water that has undergone secondary treatment and disinfection and that meets the prescribed fecal coliform criteria can be reused safely for dust control because of the method of application and the low potential risk of human exposure or ingestion. Finally, it should be noted that the reclaimed water quality standards prescribe *minimum* treatment requirements and reclaimed water quality criteria. The rules do not prohibit the maintenance of a chlorine residual in reclaimed water. ADEQ acknowledges that the maintenance of a chlorine residual may be desirable to ensure destruction of pathogens or to control bacterial and algal growth in a reclaimed water distribution system (including tank trucks that spread Class B reclaimed water for dust control). However, ADEQ does not believe that it is necessary to include a chlorine residual as an additional regulatory requirement for Class B reclaimed water.

12. Any other matters prescribed by statute that are applicable to the specific agency or to any specific rule or class of rules:

Not applicable

13. Incorporation by reference and their location in the rules:

None

14. Was this rule previously adopted as an emergency rule?

No

15. The full text of the rules follows:

TITLE 18. ENVIRONMENTAL QUALITY

CHAPTER 11. DEPARTMENT OF ENVIRONMENTAL QUALITY
WATER QUALITY STANDARDS

ARTICLE 3. RECLAIMED WATER QUALITY STANDARDS

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Appendix A. Minimum Reclaimed Water Quality Requirements for Direct Reuse

ARTICLE 3. RECLAIMED WATER QUALITY STANDARDS

R18-11-301. Definitions

The terms in this Article have the following meanings:

"Direct reuse" has the meaning prescribed in R18-9-701(1).

"Disinfection" means a treatment process that uses oxidants, ultraviolet light, or other agents to kill or inactivate pathogenic organisms in wastewater.

"Filtration" means a treatment process that removes particulate matter from wastewater by passage through porous media.

"Gray water" means wastewater, collected separately from a sewage flow, that originates from a clothes washer, bathtub, shower, or sink, but it does not include wastewater from a kitchen sink, dishwasher, or a toilet.

"Industrial wastewater" means wastewater generated from an industrial process.

"Landscape impoundment" means a manmade lake, pond, or impoundment of reclaimed water where swimming, wading, boating, fishing, and other water-based recreational activities are prohibited. A landscape impoundment is created for storage, landscaping, or for aesthetic purposes only.

"NTU" means nepholometric turbidity unit.

"On-site wastewater treatment facility" has the meaning prescribed in A.R.S. § 49-201(24).

"Open access" means that access to reclaimed water by the general public is uncontrolled.

"Reclaimed water" has the meaning prescribed in A.R.S. § 49-201(31).

"Recreational impoundment" means a manmade lake, pond, or impoundment of reclaimed water where boating or fishing is an intended use of the impoundment. Swimming and other full-body recreation activities [for example, water-skiing] are prohibited in a recreational impoundment.

"Restricted access" means that access to reclaimed water by the general public is controlled.

"Secondary treatment" means a biological treatment process that achieves the minimum level of effluent quality defined by the federal secondary treatment regulation at 40 CFR §133.102.

"Sewage" means untreated wastes from toilets, baths, sinks, lavatories, laundries, and other plumbing fixtures in places of human habitation, employment, or recreation.

R18-11-302. Applicability

This Article applies to the direct reuse of reclaimed water, except for:

A. The direct reuse of gray water, or

B. The direct reuse of reclaimed water from an onsite wastewater treatment facility regulated by a general Aquifer Protection Permit under 18 A.A.C. 9, Article 3.

R18-11-303. Class A+ Reclaimed Water

A. Class A+ reclaimed water is wastewater that has undergone secondary treatment, filtration, nitrogen removal treatment, and disinfection. Chemical feed facilities to add coagulants or polymers are required to ensure that filtered effluent before disinfection complies with the 24-hour average turbidity criterion prescribed in subsection (B)(1). Chemical feed facilities may remain idle if the 24-hour average turbidity criterion in (B)(1) is achieved without chemical addition.

B. An owner of a facility shall ensure that:

1. The turbidity of Class A+ reclaimed water at a point in the wastewater treatment process after filtration and immediately before disinfection complies with the following:
   a. The 24-hour average turbidity of filtered effluent is 2 NTUs or less, and
   b. The turbidity of filtered effluent does not exceed 5 NTUs at any time.
2. Class A+ reclaimed water meets the following criteria after disinfection treatment and before discharge to a reclaimed water distribution system:
   a. There are no detectable fecal coliform organisms in 4 of the last 7 daily reclaimed water samples taken, and
   b. The single sample maximum concentration of fecal coliform organisms in a reclaimed water sample is less than 23 / 100 ml.
   c. If alternative treatment processes or alternative turbidity criteria are used, or reclaimed water is blended with other water to produce Class A+ reclaimed water under subsection (C), there are no detectable enteric virus in 4 of the last 7 monthly reclaimed water samples taken.
3. The 5-sample geometric mean concentration of total nitrogen in a reclaimed water sample is less than 10 mg / L.

C. An owner of a facility may use alternative treatment methods other than those required by subsection (A), or comply with alternative turbidity criteria other than those required by subsection (B)(1), or blend reclaimed water with other water to produce Class A+ reclaimed water provided the owner demonstrates through pilot plant testing, existing water quality data, or other means that the alternative treatment methods, alternative turbidity criteria, or blending reliably produces a reclaimed water that meets the disinfection criteria in subsection (B)(2) and the total nitrogen criteria in subsection (B)(3) before discharge to a reclaimed water distribution system.

D. Class A+ reclaimed water is not required for any type of direct reuse. A person may use Class A+ reclaimed water for any type of direct reuse listed in Appendix A.

R18-11-304. Class A Reclaimed Water

A. Class A reclaimed water is wastewater that has undergone secondary treatment, filtration, and disinfection. Chemical feed facilities to add coagulants or polymers are required to ensure that filtered effluent before disinfection complies with the 24-hour average turbidity criterion prescribed in subsection (B)(1). Chemical feed facilities may remain idle if the 24-hour average turbidity criterion in subsection (B)(1) is achieved without chemical addition.

B. An owner of a facility shall ensure that:

1. The turbidity of Class A reclaimed water at a point in the wastewater treatment process after filtration and immediately before disinfection complies with the following:
   a. The 24-hour average turbidity of filtered effluent is 2 NTUs or less, and
   b. The turbidity of filtered effluent does not exceed 5 NTUs at any time.
2. Class A reclaimed water meets the following criteria after disinfection treatment and before discharge to a reclaimed water distribution system:
   a. There are no detectable fecal coliform organisms in 4 of the last 7 daily reclaimed water samples taken, and
   b. The single sample maximum concentration of fecal coliform organisms in a reclaimed water sample is less than 23 / 100 ml.
   c. If alternative treatment processes or alternative turbidity criteria are used, or reclaimed water is blended with other water to produce Class A reclaimed water under subsection (C), there are no detectable enteric virus in 4 of the last 7 monthly reclaimed water samples taken.

C. An owner of a facility may use alternative treatment methods other than those required by subsection (A), or comply with alternative turbidity criteria other than those required by subsection (B)(1), or blend reclaimed water with other water to produce Class A reclaimed water provided the owner demonstrates through pilot plant testing, existing water quality data, or other means that the alternative treatment methods, alternative turbidity criteria, or blending reliably produces a reclaimed water that meets the disinfection criteria in subsection (B)(2) before discharge to a reclaimed water distribution system.

D. A person shall use Class A reclaimed water for a type of direct reuse listed as Class A in Appendix A. A person may use Class A reclaimed water for a type of direct reuse listed as Class B or Class C in Appendix A.

R18-11-305. Class B+ Reclaimed Water

A. Class B+ reclaimed water is wastewater that has undergone secondary treatment, nitrogen removal treatment, and disinfection.

B. An owner of a facility shall ensure that:

1. Class B+ reclaimed water meets the following criteria after disinfection treatment and before discharge to a reclaimed water distribution system:
   a. The concentration of fecal coliform organisms in 4 of the last 7 daily reclaimed water samples is less than 200 / 100 ml.
   b. The single sample maximum concentration of fecal coliform organisms in a reclaimed water sample is less than 800 / 100 ml.
2. The 5-sample geometric mean concentration of total nitrogen in a reclaimed water sample is less than 10 mg / L.

C. Class B+ reclaimed water is not required for a type of direct reuse. A person may use Class B+ reclaimed water for a type of direct reuse listed as Class B or Class C in Appendix A. A person shall not use Class B+ reclaimed water for a type of direct reuse listed as Class A in Appendix A.

R18-11-306. Class B Reclaimed Water

A. Class B reclaimed water is wastewater that has undergone secondary treatment and disinfection.

B. An owner of a facility shall ensure that Class B reclaimed water meets the following criteria after disinfection treatment and before discharge to a reclaimed water distribution system:

1. The concentration of fecal coliform organisms in 4 of the last 7 daily reclaimed water samples is less than 200 / 100 ml.
2. The single sample maximum concentration of fecal coliform organisms in a reclaimed water sample is less than 800 / 100 ml.

C. A person shall use a minimum of Class B reclaimed water for a type of direct reuse listed as Class B in Appendix A. A person may use Class B reclaimed water for a type of direct reuse listed as Class C in Appendix A. A person shall not use Class B reclaimed water for a type of direct reuse listed as Class A in Appendix A.

R18-11-307. Class C Reclaimed Water

A. Class C reclaimed water is wastewater that has undergone secondary treatment in a series of wastewater stabilization ponds, including aeration, with or without disinfection.

B. The owner of a facility shall ensure that:

1. The total retention time of Class C reclaimed water in wastewater stabilization ponds is at least 20 days.
2. Class C reclaimed water meets the following criteria after treatment and before discharge to a reclaimed water distribution system:

a. The concentration of fecal coliform organisms in 4 of the last 7 reclaimed water samples taken is less than 1000 / 100 ml.
b. The single sample maximum concentration of fecal coliform organisms in a reclaimed water sample is less than 4000 / 100 ml.

C. A person shall use a minimum of Class C reclaimed water for a type of direct reuse listed as Class C in Appendix A. A person shall not use Class C reclaimed water for a type of direct reuse listed as Class A or Class B in Appendix A.

R18-11-308. Industrial Reuse

A. The reclaimed water quality requirements for the following direct reuse applications are industry-specific and shall be determined by the Department on a case-by-case basis in a reclaimed water permit issued by the Department under 18 A.A.C. 9, Article 7:
1. Direct reuse of industrial wastewater containing sewage.
2. Direct reuse of industrial wastewater for the production or processing of any crop used as human or animal food.

B. The Department shall use best professional judgment to determine the reclaimed water quality requirements needed to protect public health and the environment for a type of direct reuse specified in subsection (A).

R18-11-309. Reclaimed Water Quality Standards for an Unlisted Type of Direct Reuse

A. The Department may prescribe in an individual reclaimed water permit issued under 18 A.A.C. 9, Article 7, reclaimed water quality requirements for a type of direct reuse not listed in Appendix A. Before permitting a direct reuse of reclaimed water not listed in Appendix A, the Department shall, using its best professional judgment, determine and require compliance with reclaimed water quality requirements needed to protect public health and the environment.

B. Department may determine that Class A+, A, B+, B, or C reclaimed water is appropriate for a new type of direct reuse.

C. The Department shall consider the following factors when prescribing reclaimed water quality requirements for a new type of direct reuse:
1. The risk to public health;
2. The degree of public access to the site where the reclaimed water is reused and human exposure to the reclaimed water;
3. The level of treatment necessary to ensure that the reclaimed water is aesthetically acceptable;
4. The level of treatment necessary to prevent nuisance conditions;
5. Specific water quality requirements for the intended type of direct reuse;
6. The means of application of the reclaimed water;
7. The degree of treatment necessary to avoid a violation of surface water quality standards or aquifer water quality standards;
8. The potential for improper or unintended use of the reclaimed water;
9. The reuse guidelines, criteria, or standards adopted or recommended by the U.S. Environmental Protection Agency or other federal or state agencies that apply to the new type of direct reuse; and
10. Similar wastewater reclamation experience of reclaimed water providers in the United States.

Appendix A.Minimum Reclaimed Water Quality Requirements for Direct Reuse

Type of Direct Reuse	Minimum Class of Reclaimed Water Required
Irrigation of food crops	A
Recreational impoundments	A
Residential landscape irrigation	A
Schoolground landscape irrigation	A
Open access landscape irrigation	A
Toilet and urinal flushing	A
Fire protection systems	A
Spray irrigation of an orchard or vineyard	A
Commercial closed loop air conditioning systems	A
Vehicle and equipment washing (does not include self-service vehicle washes)	A
Snowmaking	A
Surface irrigation of an orchard or vineyard	B
Golf course irrigation	B
Restricted access landscape irrigation	B
Landscape impoundment	B
Dust control	B
Soil compaction and similar construction activities	B
Pasture for milking animals	B
Livestock watering (dairy animals)	B
Concrete and cement mixing	B
Materials washing and sieving	B
Street cleaning	B
Pasture for non-dairy animals	C
Livestock watering (non-dairy animals)	C
Irrigation of sod farms	C
Irrigation of fiber, seed, forage, and similar crops	C
Silviculture	C

Note: Nothing in this Article prevents a wastewater treatment plant from using a higher quality reclaimed water for a type of direct reuse than the minimum class of reclaimed water listed in Appendix A. For example, a wastewater treatment plant may provide Class A reclaimed water for a type of direct reuse where Class B or Class C reclaimed water is acceptable.