Risk Impact Statement

Phase II Revisions to Chapter 62-610, F.A.C.

Docket No. 95-08R

Florida Department of Environmental Protection

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I. Background

Reuse in Florida

Sections 373.250 and 403.064, Florida Statutes (F.S.), establish the encouragement and promotion of reuse of reclaimed water as state objectives. In response to these objectives, the Department of Environmental Protection (DEP), the water management districts, and other state agencies have implemented a comprehensive reuse program. In addition, an important partnership between the DEP and the Florida Department of Health has been formed in support of reuse in Florida. A key component of Florida's reuse program is Chapter 62-610, Florida Administrative Code (F.A.C.), ***Reuse of Reclaimed water and Land Application***, which contains detailed, comprehensive rules governing reuse.

During the last decade, Florida has become a national leader in the reuse arena. In 1997, there were about 450 domestic wastewater treatment facilities that provide reclaimed water for one or more beneficial purpose (1). Florida's reuse systems have a total permitted capacity of about 880 mgd (about 40 percent of all permitted domestic wastewater capacity). In 1997, about 440 mgd was reused for beneficial purposes.

The rulemaking evaluated in this risk impact statement (RIS) is designed to facilitate permitting of viable reuse projects and to expand opportunities for reuse in Florida. This rulemaking largely focuses on reuse activities that involve ground water recharge and indirect potable reuse. As always, the underlying objectives of rulemaking are to ensure that Florida's rules protect environmental quality and public health.

Need for Risk Assessment

Section 120.81(6), F.S., requires the following:

> Effective October 1, 1995, the Department of Environmental Protection shall prepare a risk impact statement for any rule that is proposed for approval by the Environmental Regulation Commission (ERC) and that establishes or changes standards or criteria based on impacts to or effects upon human health.

This RIS has been prepared in response to this statutory directive. The October 31, 1997 Draft RIS was subjected to a peer review, as described in Appendix D. Feedback from the peer review panel has been incorporated into this RIS.

This RIS also summarizes existing information about risk assessment related to human pathogens and reuse activities.

Guidelines for Risk Impact Statements

The 1995 legislation dealing with risk assessment in rulemaking, established the Florida Risk-Based Priority Council. This council published ***Guidelines for Risk Analyses Undertaken in Conjunction With Rule-Making*** (2). These guidelines are rather generic in nature and focus on the assessment of risks associated with chemical agents. There is no mention of risk assessment for human pathogens. These guidelines have been consulted during preparation of this RIS for the proposed revisions to Chapter 62-610, F.A.C. The suggested format of the RIS has been modified to accommodate the range of reuse activities addressed in this rulemaking and to address risks associated with human pathogens. The fact that this rulemaking activity involves refinements to existing rule requirements has also been factored into the preparation of this RIS.

The Ground Rules

As discussed in Chapter III, quantitative risk assessment methodologies are not sufficiently developed to enable their use in this RIS. As a result, the RIS relies primarily on qualitative assessment of risks.

Existing rules have been developed based on the best available scientific data and have been adopted by the ERC. Rulemaking for these existing rules featured significant opportunities for public input into the rule making process. In general, existing rules have been regarded as being fully protective of public health and environmental quality.

Therefore, this RIS focuses on an assessment of the changes in levels of risk associated with the proposed revisions to the reuse rules. Reflecting the focus of this rulemaking, the RIS concentrates on ground water recharge and indirect potable reuse activities.

As described in the following section, Florida's reuse rules require compliance with ground water quality standards (for the most part, are the drinking water standards) and surface water quality standards, including the minimum criteria. Toxicity, carcinogenicity, mutagenicity, and terotogenicity issues are addressed in the ground water and surface water quality standards.

Reflecting growing interest in human pathogens, this RIS includes discussion of the human pathogens and risk assessment methodologies related to microorganisms.

Hierarchy of Rules Related to Ground Water Recharge and Indirect Potable Reuse

Drinking Water: Drinking water standards have been established by the U.S. Environmental Protection Agency (EPA) under authorization of the federal Safe Drinking Water Act. These standards are for finished (treated) drinking water and are designed to protect public health.

Florida has, in turn, adopted drinking water standards, which are contained in Chapter 62-550, F.A.C., ***Drinking Water Standards, Monitoring and Reporting***. Florida's drinking water standards include both "primary" and "secondary" standards. The primary standards have been established for materials that have human health implications. The state primary drinking water standards include the federal drinking water standards (will be referred to as the "federal primary standards") along with state primary standards for sodium and lead. Florida also has adopted state secondary drinking water standards. The secondary standards are not "health-based," but are designed to ensure that finished drinking water is aesthetically pleasing. The state secondary drinking water standards regulate materials that may cause taste, odors, staining of fixtures or laundry, or other aesthetic problems. There are no federal secondary drinking water standards. Florida's drinking water standards have been adopted by the ERC.

Surface Water: Florida's standards for surface waters are contained in Chapter 62-302, F.A.C., ***Surface Water Quality Standards***. This chapter defines several classes of waters, based on intended uses. Class I waters are defined as surface waters used for public water supply. In some instances, water quality standards for Class I waters are more stringent than standards for Class II shellfishing waters or for Class III recreation waters.

Chapter 62-302, F.A.C., also includes standards for Class IV agricultural waters. These standards are designed to ensure that these water sources are of a quality suitable for agricultural purposes, including irrigation of edible food crops.

Ground Water: Florida's ground water standards are contained in Chapter 62-520, F.A.C., ***Ground Water Classes, Standards, and Exemptions***. Five classes of ground water are defined based on the intended use and the total dissolved solids (TDS) content of the ground water. Table 1 lists the five classes of ground water.

Table 1. Classes of Ground Water

Class	TDS Range	Designated Uses
F-I	< 3,000 mg/L	Potable water use, single source aquifer
G-I	< 3,000 mg/L	Potable water use, single source aquifer
G-II	< 10,000 mg/L	Potable water use
G-III	> 10,000 mg/L	Nonpotable water use, unconfined aquifer
G-IV	> 10,000 mg/L	Nonpotable water use, confined aquifer

Of most interest in this rulemaking are Class F-I, G-I, and G-II ground waters, since these are designated as being suitable for potable purposes. It should be noted that there are individuals that drink ground water in these classes that is not treated or disinfected. As a result, ground water standards have been established to ensure protection of individuals that consume this water without treatment or disinfection. Florida's primary and secondary drinking water standards have been adopted as the ground water standards for Class F-I, G-I, and G-II ground water. There are two exceptions. The primary drinking water standards for bacteriological quality and asbestos do not apply as ground water standards. In place of the drinking water bacteriological standards, Rule 62-520.420(1), F.A.C., establishes a total coliform limitation of 4 per 100 mL as the ground water standard for G-I and G-II ground water. In addition, the minimum criteria (the so called "free froms") established in Rule 62-520.400, F.A.C., apply at all times and at all places within all classes of ground water (except for G-IV). The minimum criteria essentially require that ground water be free from substances that are carcinogenic, teratogenic, mutagenic, or toxic. These types of substances are regulated using the existing minimum criteria regulations.

Some individuals argue that ground water standards (based on drinking water standards) may not adequately reflect concerns related to discharge of treated reclaimed water and effluent to the ground water. These individuals argue that wastewater contains a wide range of chemical constituents, many of which may not be present in “natural” waters. These individuals also note that drinking water standards are generally based on the presumption of use of the highest available water source.

There is a long history of wastewater and reclaimed water discharges to ground water in Florida, as well as elsewhere. Florida has over 3,000 permitted domestic wastewater treatment facilities, and over two thirds of them involve some form of land application or other discharge to ground water. About 25 percent of Florida’s population is served by on-site wastewater systems (mostly septic tanks). There are an estimated 1.6 million septic tanks in Florida. These septic tanks contribute on the order of 160 mgd to ground water. Collectively, they exceed the discharge from Florida’s largest domestic wastewater treatment plant (located in Dade County). Approximately 1,100 industrial wastewater facilities discharge to ground water in Florida. In addition, the state has about 2,500 stormwater drainage and lake level control wells designed to rapidly move stormwater and surface water off of the land’s surface and into the ground water.

When considering the significance of discharges to ground water in Florida, it is difficult to conclude that ground water standards have somehow been created in a vacuum that ignores the potential concerns for stormwater, septic tank effluent, and treated wastewater inputs. Within the Department of Environmental Protection, the reuse, domestic wastewater, ground water, surface water, and drinking water programs all reside within the Division of Water Facilities. These programs interact on a continuing basis and all participate in rulemaking activities in these subject areas. For example, significant revisions were made to Florida’s ground water standards in Chapter 62-520, F.A.C., in 1994 and the wellhead protection rule was adopted in 1995. These programs were actively involved in these rulemaking activities, and the significance of the interactions of the programs was considered. The fact that there were significant numbers of reuse, domestic wastewater, industrial wastewater, septic tank, storm water, and other inputs to ground water was known by the individuals and programs involved in these rulemaking activities.

In the event that Florida’s drinking water and ground water standards ever prove to be insufficient to protect public health, standards can be tightened or added to address the concerns. In addition, the minimum criteria could be employed to regulate a pollutant of concern until such time as the drinking water and ground water standards are revised. However, the general hierarchy of the drinking water standards being reflected in the ground water standards, which in turn drives the rule requirements for land application, reuse, injection, and other discharge options is sound.

Other Rules: Several other rules play roles in these types of reuse activities. Chapter 62-650, F.A.C., ***Water Quality Based Effluent Limitations***, contains the procedures used in developing discharge limits for all discharges to surface waters. These rules are designed to ensure that all discharges will result in compliance with the surface water quality standards in Chapter 62-302, F.A.C. Chapter 62-600, F.A.C., ***Domestic Wastewater Facilities***, provide more detailed requirements for surface water discharges of treated domestic wastewater. The requirements for surface water discharges contained in Chapter 62-600, F.A.C., currently are referenced in Part V of Chapter 62-610, F.A.C. Part V deals specifically with ground water recharge and indirect potable reuse. Of particular note are existing requirements for discharges to Class I surface waters (an indirect potable reuse application).

All discharges to ground water are regulated by Chapter 62-522, F.A.C., ***Ground Water Permitting and Monitoring Requirements***. This chapter includes general ground water monitoring requirements and introduces the zone of discharge concept.

Chapter 62-528, F.A.C., ***Underground Injection Control***, regulates injection projects. This chapter plays a key role in DEP's implementation of the federally-delegated underground injection control program.

Chapters 62-600 and 62-610, F.A.C., contain detailed requirements for injection of treated domestic wastewater into ground water, including injection into potable ground water. Detailed requirements currently are contained in Chapter 62-600, F.A.C., and are referenced in Part V of Chapter 62-610, F.A.C.

This rulemaking on Chapter 62-610, F.A.C., will expand and refine the provisions for ground water recharge and indirect potable reuse in Part V

Finally, Chapter 62-521, F.A.C., ***Wellhead Protection***, establishes a 500-foot setback distance surrounding public water supply wells. This setback distance figures prominently in setback distance requirements contained in Chapter 62-610, F.A.C. The wellhead protection rules specifically allow for reuse projects permitted under Part III of Chapter 62-610, F.A.C., to be located within the 500-foot wellhead protection area.

Coliform Limits

Members of the coliform group of bacteria are commonly used as indicators of disinfection effectiveness and water quality. Most rules in Title 62, F.A.C., utilize fecal coliforms. Table 2 presents a summary of key disinfection and water quality standards involving fecal coliforms. It is interesting to note that there are no bacteriological standards for Class IV agricultural waters, which include surface waters that may be used to irrigate edible crops.

National Reuse Guidelines

The U.S. Environmental Protection Agency (EPA) and the U.S. Agency for International Development (USAID) published ***Guidelines for Water Reuse*** (3) in 1992. The focus was on development for guidelines for nonpotable reuse. Significant input to the development of these guidelines was obtained from a technical advisory committee that included recognized experts in reuse, environmental engineering, and public health. Given the previous lack of federal involvement in reuse, development of the guidelines drew heavily from the leading reuse states, notably Florida and California. The guidelines were subjected to EPA's peer review process. Appendix C presents the summary table contained in these guidelines.

It must be noted that these are "guidelines." They are not standards and are in no way binding on the states. These guidelines have been considered during development of the proposed Phase II rule revisions on Florida's Chapter 62-610, F.A.C. In fact, several proposed rule revisions are based primarily on the national guidelines.

Table 2. Coliform Standards

Fecal Coliform Limit (No./100 mL)	Application	DEP Rule
No Standard	Class IV waters (agricultural/irrigation)	62-302.530
200 (a)	Basic disinfection (minimum required for surface water discharge of treated domestic wastewater and for reuse projects permitted under Parts II, IV, and VII of Chapter 62-610, F.A.C.)	62-600.440(4)
200 (b)	Standard for Class I waters (drinking water supplies)	62-302.530
200 (b)	Standard for Class III waters (recreation waters)	62-302.530
200	Bathing beach standard	Regulated by the Dept. of Health
14 (a)	Intermediate disinfection (required for discharge to tributaries of Class II shellfish waters	62-600.440(6)
14 (b)	Standard for Class II shellfish waters	62-302.530
4 (c)	Ground water standard	62-520.420(1)
< Detection (d)	High-level disinfection requirement for reuse systems permitted under Part III of Chapter 62-610, F.A.C.	62-600.440(5)
< Detection (e)	Drinking water standard	62-550.310(3)

Notes:
(a) Annual and monthly limits. Higher limits apply for as weekly and single sample limits.
(b) Monthly average limit. Higher limits apply to a single sample. Total coliform limits also apply.
(c) In terms of total coliforms.
(d) At least 75 % of all observations must be less than detection. No sample may exceed 25/100 mL.
(e) In terms of total coliforms. Some excursions above detection are allowed.

Several members of Florida's Reuse Technical Advisory Committee (TAC) were primary authors of the national guidelines, served on the TAC for the national guidelines, or were peer reviewers of the guidelines.

Florida's reuse requirements are rather consistent with the national guidelines. A comparison of treatment/disinfection requirements for urban reuse (irrigation of residential properties, golf courses, and other areas accessible to the public) and for irrigation of edible food crops illustrates this consistency. Florida requires secondary treatment, filtration, and high-level disinfection. High-level disinfection requires that at least 75 percent of all observations of fecal coliforms be less than detection and that no single sample exceed 25 fecal coliforms per 100 mL. Florida restricts total suspended solids to a maximum of 5.0 mg/L before the disinfection process.

The national guidelines (3) recommend secondary treatment, filtration, and a high level of disinfection for these types of activities. The guidelines suggest that the median value of fecal coliforms be less than detection and that no sample exceed 14/100 mL. The guidelines suggest that the average turbidity before disinfection not exceed 2 NTU and that the maximum turbidity be less than 5 NTU. If total suspended solids are used to control solids/turbidity, the guidelines recommend that the average suspended solids be less than 5 mg/L.

II. Proposed Rule Revisions

Overview of This Rulemaking

The DEP initiated rulemaking on Chapter 62-610, F.A.C., ***Reuse of Reclaimed Water and Land Application***, in 1993. The purpose of this rulemaking was to refine existing rules governing reuse and to expand reuse opportunities and to facilitate permitting and implementation of viable reuse projects. As with all previous rulemaking activities on this chapter, the primary constraint has been to ensure protection of public health and environmental quality.

Rulemaking was divided into two phases to facilitate the process and to maximize public input into the more sensitive and potentially controversial aspects of the rulemaking. The Phase I revisions were adopted by the Secretary of DEP and became effective on January 9, 1996. The Phase I revisions involved relatively minor revisions to the chapter designed to refine the existing rules. The Phase I revisions are not addressed in this RIS.

The focus of the Phase II rulemaking was on the following:

1. Refinement of the rules governing ground water recharge and indirect potable reuse in Part V of Chapter 62-610, F.A.C.

2. Creation of a rule governing aquifer storage and recovery (ASR) of reclaimed water.

3. Creation of a rule governing the use of various water supplies to augment the available supplies of reclaimed water.

4. Creation of a rule governing blending of demineralization concentrate with reclaimed water.

5. Refinement of existing requirements for the use of reclaimed water in cooling towers.

Several other rule refinements have been incorporated into the Phase II revisions. Most notable are requirements for monitoring of protozoan pathogens (Giardia and Cryptosporidium) and refinement to public notification and cattle grazing requirements. In addition, the grandfathering protection provided to some reuse facilities that existed before the 1989 effective date of Chapter 62-610, F.A.C., is proposed to be eliminated.

This RIS discusses only the proposed Phase II rule revisions.

Technical Advisory Committee

This rulemaking has been conducted with significant input from the Reuse Technical Advisory Committee (TAC). Members of the Reuse TAC (listed in Appendix A) include representatives of the major professional organizations in Florida that are active in the reuse arena, representatives of the DEP, the Department of Health, the water management districts, and utilities. Members of the Reuse TAC represent a significant pool of expertise and experience in the reuse arena. The Reuse TAC includes several individuals who were heavily involved in the development of the national ***Guidelines for Water Reuse*** (3). Several members of the Reuse TAC are nationally recognized in the reuse arena.

Ground Water Recharge and Indirect Potable Reuse

Table 3 presents a summary of the treatment and disinfection standards that are proposed for the various types of ground water recharge and indirect potable reuse projects addressed in Chapter 62-610, F.A.C. This table also summarizes existing rule requirements to aid in review of the proposed changes. In addition, information on septic tanks and storage systems are included in this table. Reuse (and other) systems are listed in order of relative risk to ground water or surface waters used as sources of potable water (see also Table 12 in Chapter III).

Terminology: The DEP will standardize on the following terminology:

"Ground water recharge" is used for all land application and injection projects that serve to augment supplies of ground water.

"Indirect potable reuse" will be used for surface water discharges that augment Class I water supplies.

Given the fact that all Class F-I, G-I, and G-II ground waters are designated as sources of potable water, there probably are elements of what may be regarded by many as "potable reuse" associated with many discharges to ground water. The terminology used by the DEP avoids the need for rule definitions splitting "ground water recharge" and "indirect potable reuse" for discharges to ground water. This terminology in no way affects the level of protection afforded ground water resources. The controls placed on "ground water recharge" projects are based on the physical circumstances.

Table 3. Proposed Treatment and Disinfection Requirements

Reuse System	Proposed Treatment Level	Current Treatment Level	Comments
Injection to G-I, F-I, G-II (<3000 TDS)	Secondary treatment & filtration TOC: 3 mg/L aver, 5 mg/L max. TOX: 0.2 mg/L aver, 0.3 mg/L max. TN: 10 mg/L (average) Drinking water standards Drinking water disinfection Multiple barriers (for organics & pathogens) Pilot testing (1 year)	Secondary treatment TOC: 5 mg/L aver, 9 mg/L max. TOX: 0.2 mg/L aver, 0.3 mg/L max. Ground water standards High-level disinfection Activated carbon adsorption Full-scale testing (2 year)	Currently, applies only to Floridan & Biscayne Aquifers (TDS < 500 mg/L) Expand coverage to all F-I, G-I, G-II with TDS < 3000 mg/L. Tighten TOC limits. Revise testing protocols. Add “multiple barrier” concept. Add TN limit.
ASR using G-I, F-I, G-II (<3000 TDS)	Secondary treatment & filtration TOC: 3 mg/L aver, 5 mg/L max. TOX: 0.2 mg/L aver, 0.3 mg/L max. TN: 10 mg/L (average) Drinking water standards Drinking water disinfection Multiple barriers (for organics & pathogens)	Not addressed.	Proposed requirements are consistent with the injection case presented above.
Injection to G-II (>3000 TDS)	Secondary treatment & filtration Primary drinking water standards Drinking water disinfection ZOD for secondary drinking water standards TN: 10 mg/L (average)	Secondary treatment Ground water standards High-level disinfection	Currently, applies to all F-I, G-I, & G-II (except as described above)

Table 3. Proposed Treatment and Disinfection Requirements

Reuse System	Proposed Treatment Level	Current Treatment Level	Comments
Discharge to Class I surface waters	Secondary treatment & filtration Drinking water standards Drinking water disinfection TN: 10 mg/L (average) TOC: 3 mg/L aver, 5 mg/L max. WQBELs	Secondary treatment Drinking water standards High-level disinfection TN: 10 mg/L (average) WQBELs	Refine disinfection criteria. Require filtration. Add TOC limit.
Discharge to waters tributary or contiguous to Class I surface waters (t < 4 hr.)	Secondary treatment & filtration Drinking water standards Drinking water disinfection TN: 10 mg/L (average) TOC: 3 mg/L aver, 5 mg/L max. WQBELs	Secondary treatment Drinking water standards High-level disinfection WQBELs Storage requirements & notification	Refine disinfection criteria. Make consistent with discharges to Class I surface waters. Add TOC limit.
Injection for salinity barriers (G-II having TDS 1000-3000 mg/L & not used for potable purposes)	Secondary treatment & filtration Primary drinking water standards Drinking water disinfection ZOD for secondary standards TN: 10 mg/L (average) 1000 ft. to potable wells	Not addressed. Currently, would be handled as any injection to G-II ground water.	Proposed treatment requirements are consistent with injection to G-II having TDS > 3000 mg/L.
Part IV systems (RIBs) in unfavorable conditions (Rule 62-610.525)	Secondary treatment & filtration Drinking water standards High-level disinfection TN: 10 mg/L (average)	Secondary treatment & filtration Drinking water standards High-level disinfection	Add TN limit. Refine application of drinking water standards.
ASR using G-II (TDS 1000-3000 & not used for potable purposes)	Secondary treatment & filtration Primary drinking water standards Extended ZOD for secondary standards High-level disinfection TN: 10 mg/L (average)	Not addressed.	Proposed requirements parallel those for injection to G-II with TDS > 3000

Table 3. Proposed Treatment and Disinfection Requirements

Reuse System	Proposed Treatment Level	Current Treatment Level	Comments
ASR using G-II (TDS >3000 mg/L)	Secondary treatment & filtration Primary drinking water standards Extended ZOD for secondary standards High-level disinfection TN: 10 mg/L (average)	Not addressed.	Proposed requirements parallel those for injection to G-II with TDS > 3000
Septic tanks [not reuse]	No change.	Septic tanks.	Regulated by Dept. of Health Not subject to this rulemaking. Shown for reference only.
Discharge to Class III surface waters directly connected to ground water	Secondary treatment with filtration High-level disinfection TN: 10 mg/L (average) WQBELs Meet ground water standards at point of entrance to ground water	Not addressed.	This is a SE Florida issue focusing on discharge to the canals.
Discharge upstream (4 < t < 24 hr.) of Class I surface waters	Secondary treatment with filtration High-level disinfection TN: 10 mg/L (average) WQBELs	Secondary treatment WQBELs Meet drinking water standards in the Class I water Possible storage & notification requirements.	Current rule is very difficult to interpret and apply. Provide a transition in requirements from discharge tributary to Class I waters to discharge > 24 hr. upstream.
Unlined storage ponds for Part III in unfavorable conditions	No change.	Secondary treatment with filtration High-level disinfection Monitoring well required	Can be regulated under Part IV or under ground water rules, if needed.

Table 3. Proposed Treatment and Disinfection Requirements

System Type	Proposed Treatment Level	Current Treatment Level	Comments
Discharge to wetlands that percolate to ground water	No change.	Wetlands discharges are regulated under Chapter 62-611, F.A.C.. Percolation can be regulated under ground water rules.	No change.
Rapid-rate systems (Part IV)	No change.	Secondary treatment Basic disinfection Nitrate: 12 mg/L (max. as N)	No change.
Discharge further upstream (> 24 hr.) of Class I waters	No change.	Secondary treatment Basic disinfection WQBELs	No change.
Slow-rate systems Restricted access (Part II)	No change.	Secondary treatment Basic disinfection	No change.
Irrigation of public access areas (Part III)	No change.	Secondary treatment with filtration High-level disinfection	No change.
Injection into G-IV (deep wells)	No change.	Secondary treatment No disinfection	No change.

Table 3. Proposed Treatment and Disinfection Requirements

System Type	Proposed Treatment Level	Current Treatment Level	Comments
ASR Using G-IV	Either: 1. Meet requirements for Class I wells with treatment upon recovery, or 2. Secondary treatment with filtration, and high-level disinfection	Not addressed.	
Overland flow systems (Part VI) [systems designed not to percolate to ground water]	No change.	Reduced level of secondary treat. Low level disinfection	No change. [not reuse]
Unlined storage ponds for Part III in favorable conditions	No change.	Secondary treatment with filtration High-level disinfection Monitoring well required	No change.
Lined reject ponds (Part III systems)	No change.	Less than secondary treatment Uncertain disinfection	No change. [not reuse]
Lined system storage ponds (Parts II, IV, V)	No change.	Secondary treatment Basic disinfection	No change.
Lined system storage ponds (Part III)	No change.	Secondary treatment with filtration High-level disinfection	No change.

III. Risk Assessment Concepts

Risk Assessment Procedures

There is growing interest in the United States and in Florida in using risk assessment as a means of developing water quality standards and other environmental regulations. For chemicals that are potentially carcinogenic or have other known health effects, methods have been developed that have some degree of acceptance within the scientific community.

Unfortunately, risk assessment related to human pathogens is not as advanced or accepted as are the risk assessment methodologies for chemicals. The concept of using quantitative risk assessment for establishing standards for reclaimed water was discussed at the 1991 Joint United States/Israel Reuse Conference (4) and during development of the national ***Guidelines for Water Reuse*** (3). On both occasions, it was concluded that quantitative risk assessment appeared promising, but that methods had not been sufficiently refined to a level where there was reasonable consensus on the validity and acceptance of the models. There have been no disinfection standards, reclaimed water standards, or water quality standards for pathogenic organisms developed based on quantitative risk assessment (3, 5).

Risk Assessment Models: Risk assessment for pathogenic organisms involves the evaluation of the potential for an adverse health effect to occur as a result of human exposure to reclaimed water. Models have been developed for a relatively small number of microorganisms (some types of virus, *Giardia,* and *Cryptosporidium*) by a relatively small number of investigators (notably Haas, Regli, Gerba, and Rose). Their models (6, 7, 8, 9, 38, 40, 41, 42, 43, 44, 45) use a framework somewhat similar to what has been used for chemicals. The process involves identification of the potential hazard, dose-response identification, exposure assessment, and risk characterization. Sakaji and Funamizu (48) present an overview of risk assessment concepts.

Dose-response relationships have been developed based on a limited number of human feeding studies. An example is a 1995 study (10) of the infectivity of *Cryptosporidium*. It should be noted that the application of these dose-response models to the concentrations of microbes in reclaimed water represents an unverified extrapolation of several orders of magnitude outside of the doses administered in the feeding studies.

These quantitative risk assessment models attempt to estimate the risk of infection for an exposed individual. It should be noted that only a fraction (for some organisms, a relatively small percentage) of individuals that become infected will actually exhibit symptoms of disease.

There are differences between chemical agents and microbial exposure that probably are not fully accounted for by these models (for example, secondary spread and immunity). The accuracy of this type of model is very difficult, if not impossible, to verify.

A model developed recently by EOA (11) takes a different approach to assessing risk. This rather sophisticated and complex model simulates the risk to an entire exposed population over a period of time. Epidemiological data including the incubation period, immune status, rate at which infected individuals become diseased, duration of the disease, and recovery from the disease are modeled. Simulations can be run with and without exposure to reclaimed water and sensitivity analyses are possible. The model can be applied to specific situations and the model predictions compared to actual data. This model appears to have significant potential as a useful tool for decision makers. Unfortunately, additional work is needed to refine the relatively large number of parameters needed to define the model.

Acceptable Risks: Most investigators attempting to use quantitative risk assessment models for human pathogens have standardized on the use of an acceptable risk threshold of $1x10^{-4}$. In some instances, this $1x10^{-4}$ threshold has been applied to annual risks, while some investigators have evaluated single events. The U.S. Environmental Protection Agency has used an acceptable annual risk threshold of $1x10^{-4}$ when considering drinking water.

The nature of microbial risks has led some to question the validity of the $1x10^{-4}$ risk threshold. A timely perspective was offered by Haas (12). This individual, who has been a proponent of quantitative risk assessment, notes that waterborne illness in the United States may be as high as several million cases per year. This corresponds to an annual illness rate of about 1 in 100 ($1x10^{-2}$). He suggests that the current threshold ($1x10^{-4}$) "may be far too stringent."

As discussed in a latter section in this chapter dealing with the protozoan pathogens, quantitative risk assessment using the $1x10^{-4}$ threshold pose difficulties in attempting to establish drinking water and ground water disinfection standards. The U.S. EPA's Dr. Bruce Macler (13) noted that "the Surface Water Treatment and Enhanced Surface Water Treatment Rules' goal of one infection per 10,000 people per year was considered to be infeasible." He noted that this risk threshold would yield pathogen standards orders of magnitude below the detection level and would require substantive disinfection treatment of all ground waters.

Rose and Farrah (14) report that $1x10^{-3}$ is commonly used as the risk threshold when evaluating risks associated with recreational waters. Others have used $1x10^{-4}$ when evaluating recreational waters.

Dose: Investigators and the EPA have standardized on the use of an average consumption of potable water of 2 L/day. In evaluating risks associated with potable water, risks are assessed on an annual basis.

For nonpotable reuse activities, some investigators have focused on single exposures, while others have looked at annual risks (11, 15, 16, 48, 50, 51). Dose is based on the type of reuse activity. Suggested single event consumption values are shown in Table 4 for a range of nonpotable reuse activities.

Table 4. Doses Used for Nonpotable Reuse Activities

Reuse Activity	Dose (mL)
Recreational use, swimming, full body contact	100
Residential irrigation (worst-case, single-event ingestion)	100
Consumption of edible crops (assumes direct contact application methods)	10
Residential irrigation (routine exposure)	1
Irrigation of public access areas, golf courses, parks, etc.	1
Exposure to aerosols	0.1

Shuval, Lampert, and Fattal (51) conducted immersion studies to evaluate the amount of reclaimed water that could possibly adhere to cucumbers and lettuce. They concluded that 0.36 mL of reclaimed water could adhere to one large cucumber and 10.8 mL could adhere to three leaves of long leaf lettuce.

Potential doses can be reduced when pathogen die-off by exposure to sunlight and other factors involved in the irrigation process are considered in the analysis.

Risk Assessment of a St. Petersburg Water Reclamation Facility

As a part of the 1992 study (15, 16) of the fate of pathogens in a full-scale water reclamation facility, Dr. Joan Rose and Dr. Robert Carnahan (University of South Florida) applied risk models to the results of that study. The risk models used (16) are based on dose-response models and are shown in Table 5. Their analysis was based on ingestion of 100 mL of reclaimed water. The results of this risk assessment are presented in Table 6. This information is presented for reference only. Publication does not represent endorsement of the model by the DEP.

Different viruses exhibit a wide range of relative infectivities. Table 5 presents models for a highly infective Rotavirus and a moderately infective Echovirus. Risks associated with ingestion of the moderately infective virus are orders of magnitude less than the risks associated with ingestion of the same numbers of a highly infective virus. Of course, there also are viruses that can be considered as having low infectivities. When analyzing a water sample for enterovirus, one normally does not attempt to identify individual viruses that are present (due to factors and limitations such as cell cultures used, analytical equipment, laboratory capabilities, and cost). As a result, in estimating risks using the model, one must make assumptions about what type of virus are present. Many investigators make the conservative assumption that all virus that may be present are highly infective Rotavirus. If one were to assume that the virus present were distributed in equal proportions between highly infective virus, moderately infective virus, and virus having low infectivity, the overall risk (based on expected value calculations) would be approximately one-third of the risk predicted for a highly infective virus.

Table 5. Risk Models Used in the St. Petersburg Study

Organism	Model Used	Parameters
Echovirus 12 (moderately infective)	$P_i = 1 - (1 + N/\vartheta)^{-I}$ (beta-Poisson)	$I = 0.374$ $\vartheta = 186.7$
Rotavirus (highly infective)	$P_i = 1 - (1 + N/\vartheta)^{-I}$ (beta-Poisson)	$I = 0.26$ $\vartheta = 0.42$
Cryptosporidium	$P_i = 1 - e^{-rN}$ (exponential)	$r = 0.00467$
Giardia	$P_i = 1 - e^{-rN}$ (exponential)	$r = 0.0198$

Note: P_i = Probability of infection.
N = Number of the organisms that are ingested.

Table 6. Estimated Risks From the St. Petersburg Study

Organism	Concentration #/100 L (a)	Exposure #/100 mL	Units	Estimated Risk (b)	Notes
Rotavirus	0.01	1.0×10^{-5}	PFU (h)	6.2×10^{-6}	(c)(d)
Echovirus	0.01	1.0×10^{-5}	PFU	2.0×10^{-8}	(d)(e)
Rotavirus	0.13	1.3×10^{-4}	PFU	8.0×10^{-5}	(c)(f)
Echovirus	0.13	1.3×10^{-4}	PFU	2.7×10^{-7}	(e)(f)
Cryptosporidium	0.75	7.5×10^{-4}	oocysts	3.5×10^{-6}	(d)(g)
Cryptosporidium	5.35	5.35×10^{-3}	oocysts	2.5×10^{-5}	(f)(g)
Giardia	0.49	4.9×10^{-4}	cysts	9.8×10^{-6}	(d)(g)
Giardia	3.3	3.3×10^{-3}	cysts	6.6×10^{-5}	(f)(g)

Notes:
- (a) Observed concentrations in reclaimed water at a St. Petersburg water reclamation facility.
- (b) Estimated risk of infection to an exposed individual.
- (c) Assumes that all virus are highly infectious Rotavirus.
- (d) Average concentration observed in the reclaimed water.
- (e) Assumes that all virus are moderately infectious Echovirus 12.
- (f) Maximum concentration observed in reclaimed water.
- (g) Assumes that all cysts and oocysts are viable.
- (h) Plaque forming units.

Observations Using Risk Numbers

This section presents an overview of risks associated with nonpotable reuse activities using the results of the St. Petersburg study and the models used by the principle investigators on that project. The results of the St. Petersburg study (15, 16) represent the most comprehensive data set currently available on the pathogen content of reclaimed water in Florida. This information is presented for reference only. Publication of this information does not represent endorsement of these methodologies for establishment of numeric criteria for human pathogens in reclaimed water or in other waters. The models described in Table 5 are used in this analysis.

Annual Risks: The results of the risk calculations for St. Petersburg's reclaimed water in Table 6 consider only a single ingestion of 100 mL of reclaimed water. Simple probability calculations can be used to estimate annual risks resulting from more prolonged exposure to reclaimed water. Table 7 presents the results of such calculations for four scenarios. In the first scenario, an individual is exposed to aerosols. The exposure (through ingestion) was estimated at 0.1 mL per day for 365 days. In the second scenario, a golfer or park visitor is exposed to 1 mL on each of 60 days during a year. In the third scenario, a resident is exposed to 1 mL of reclaimed water on each of 150 days during a year. The fourth scenario involves the conservative assumption of exposure of a residential property owner to 1 mL of reclaimed water on each of the 365 days in a year. In all cases, the average concentrations observed in the St. Petersburg study were used.

Table 7. Annual Risks by Exposure Scenario

Organism	Case 1 0.1 mL/day 365 days/yr.	Case 2 1 mL/day 60 days/yr.	Case 3 1 mL/day 150 days/yr.	Case 4 1 mL/day 365 days/yr.
Rotavirus (a)	$2.3x10^{-6}$	$3.7x10^{-6}$	$9.3x10^{-6}$	$2.3x10^{-5}$
Echovirus (b)	$7.3x10^{-9}$	$1.2x10^{-8}$	$3.0x10^{-8}$	$7.3x10^{-8}$
Cryptosporidium	$1.3x10^{-6}$	$2.1x10^{-6}$	$5.3x10^{-6}$	$1.3x10^{-5}$
Giardia	$3.5x10^{-6}$	$5.8x10^{-6}$	$1.5x10^{-5}$	$3.5x10^{-5}$

Notes: (a) Assumes all virus is a highly infective Rotavirus.
(b) Assumes all virus is a moderately infective Echovirus.

$1x10^{-4}$ Risk Level: Table 8 presents concentrations of the various pathogens corresponding to a risk of $1x10^{-4}$. This is based on a single event and data are presented for several doses. The doses used are: 100 mL for recreation (swimming), 100 mL for residential irrigation using hose bibbs, 1 mL for irrigation of other pubic access areas, and 0.1 mL for exposure to aerosols.

Table 8. Pathogen Concentrations Corresponding to 1x10^{-4} Risk

Organism	Units	0.1 mL	1 mL	10 mL	100 mL
Rotavirus (a)	PFU	165	16.5	1.65	0.165
Echovirus (b)	PFU	50,000	5,000	500	50
Cryptosporidium	oocysts	22,000	2,200	220	22
Giardia	cysts	5,000	500	50	5

Notes: (a) Assumes all virus is a highly infective Rotavirus.
(b) Assumes all virus is a moderately infective Echovirus.

Consumption Needed for 1x10^{-4} Risk: The risk models can be used to calculate the volume of reclaimed water that would have to be consumed in order to result in a risk of 1x10^{-4}. Table 9 presents the volume of reclaimed water that would have to be ingested to result in a 1x10^{-4} risk of infection. These calculations were based on the average concentrations of pathogens observed in the St. Petersburg study. For all organisms, over 1.0 L of reclaimed water would have to be ingested.

Table 9. Volume Needed to be Ingested to Have a 1x10^{-4} Risk

Organism	Volume (L)
Rotavirus (highly infective)	1.65
Echovirus (moderately infective)	500
Cryptosporidium	2.9
Giardia	1.0

Risk of Ingesting One Organism: Several of these organisms are reported to be "highly infectious." Some individuals maintain that exposure to even a single organism may be sufficient to cause infection. Using the models described in Table 5 to ingestion of a single microbe yields probabilities of infection of 27 percent for a Rotavirus, 0.2 percent for an Echovirus, 0.5 percent for *Cryptosporidium*, and 2 percent for *Giardia*. As noted previously, infection does not necessarily result in symptomatic disease.

<u>EOA Study</u>

The EOA study (11) presents a promising new approach to assessing risks associated with reuse activities. The model simulates both infection and disease over an entire population. It offers the ability to compare various alternatives (including no action scenarios) and sensitivity analysis can be performed. The model could be expanded to enable simulation over time and to model various components of the population (based on age or immune status).

The report focused on an example application for Giardia (reflecting the availability of information for Giardia). A recreation impoundment used for full body contact (swimming) was evaluated. The analysis forecast significantly higher disease prevalence in a community with a public swimming impoundment than in the same community without a swimming impoundment. The same disease prevalence was predicted if the impoundment was fed by reclaimed water or if a completely pathogen free water source was used.

The model was also applied to the 1993 Cryptosporidium outbreak in Milwaukee. The investigators were able to develop a parameterized model that described the epidemiology of the Milwaukee outbreak.

Preliminary models were also constructed for *Cryptosporidium spp*., *Shigella spp*., *Salmonella spp*., *Salmonella spp*., *Vibrio cholerae*, pathogenic *E. coli*, enterovirus, *Hepatitis A* virus, and *Rotavirus*. A range of reuse activities were considered.

This model offers much promise for the evaluation of reuse projects. Unfortunately, the data requirements are extensive. Data requirements will be increased significantly if subpopulations (such as young children or AIDS patients) are to be modeled.

Protozoan Pathogens

The protozoan pathogens (notably *Cryptosporidium* and *Giardia*) have received much attention over the last decade. The massive, 1993 outbreak of Cryptosporidiosis in Milwaukee (17) captured the attention of water resource managers worldwide. About 400,000 individuals became ill as a result of *Cryptosporidium* in Milwaukee's public drinking water system. Both *Giardia* and *Cryptosporidium* are recognized as the causes of significant diarrheal disease in the United States, as well as elsewhere in the world.

Although one species of *Cryptosporidium* was first identified in 1907 in mice (18), *Cryptosporidium* was not known to be a human pathogen until 1976. Infection by *Cryptosporidium* is regarded as being self-limiting in immunocompetant individuals. It is a much more serious infection in immunocompromised individuals. Patients with AIDS typically are unable to clear the infection and the infection is frequently fatal.

Both *Cryptosporidium* and *Giardia* have low infective doses. Some public health officials have stated that ingestion of as few as one oocyst of *Cryptosporidium* may result in infection in some individuals. While a possibility, this may be somewhat overstated. Applying the *Cryptosporidium* model in Table 5 to ingestion of one oocyst yields an estimated probability of infection of about 0.5 percent. A 1995 study established the median infectious dose (ID_{50}) at 132 oocysts (10).

There are significant animal reservoirs of these protozoan pathogens, particularly for *Cryptosporidium*. Calves are a particularly significant source of *Cryptosporidium* contamination.

Tables 10 and 11 present information on the prevalence of *Cryptosporidium* and *Giardia*, respectively, in the environment and in treated drinking water. Available data on Florida waters are included in both tables. These tables focus on relatively high quality waters, since these waters would generally be regarded as being reasonable sources of irrigation water. Polluted waters tend to exhibit higher concentrations of both pathogens. For comparison purposes, both tables include a characterization of St. Petersburg's reclaimed water. Table 10 also includes limited data on irrigation canals in Arizona which are located within ranch lands.

York and Burg (46) compared the quality of reclaimed water with the quality of other high-quality sources of irrigation water. Based on the frequency of occurrence and concentrations of the protozoan pathogens, they concluded that reclaimed water is an excellent source of water for irrigation.

Inspection of Tables 10 and 11 reveals that these organisms are rather widespread. *Cryptosporidium* has come to be regarded as being ubiquitous in the environment. In reviewing these tables and in evaluating data for protozoan pathogens, it must be noted that all cysts and oocysts are not viable. Microscopic examination of cysts and oocysts may enable investigators to make estimates of the percentage of cysts and oocysts that have complete internal structure and that may be presumed to be infective. However, existing data sets typically do not include this level of sophistication.

It also should be noted that the percentages of samples testing positive for these organisms reflect the detection limits of the individual sample collections. It is likely that these percentages would increase if large volumes of water had been processed in all sampling activities.

The information in Tables 10 and 11 on these organisms in treated drinking water is interesting. As noted previously, the levels of the protozoan pathogens in drinking water poses difficulties in trying to deal with these organisms in the Enhanced Surface Water Treatment Rule and in the Ground Water Disinfection Rule. Applying the risk model for Giardia for an assumed ingestion of two liters per day, and wanting to achieve a $1x10^{-4}$ annual risk level, yields a Giardia concentration of 0.0007 cysts/100 L (9, 19, 44). Similar calculations for *Cryptosporidium* indicate that the average concentration of *Cryptosporidium* in treated drinking water would have to be about 0.003 oocysts/100 L to have an annual risk of infection of $1x10^{-4}$ (44, 45). For each of these protozoan pathogens, these levels are significantly below the current detection levels and are much less than concentrations reported in Tables 10 and 11 for treated drinking water.

Haas and Rose (20) suggested an "action level" for *Cryptosporidium* of between 10 and 30 oocysts/100 L in treated drinking water. They suggest that at concentrations above these levels outbreak conditions may result. They suggest that utilities consider modifications of plant operations and public notification above the action level. It is interesting to note that application of the risk model in Table 5 to consumption of two liters of drinking water containing 10 oocysts/100 L yields a daily risk of about $1x10^{-3}$ -- a daily risk significantly greater than the target of $1x10^{-4}$ as an annual risk!

Glicker and Edwards (21) applied the Rose risk model to an actual case study. They concluded that the model overestimated the risk of Giardia by over an order of magnitude.

The EPA is in a data gathering mode (using the Information Collection Rule) to assemble additional information on pathogens in drinking water. At some future time, this data may be used in establishing national drinking water standards. If, and when, this happens, Florida could consider possible revisions to its drinking water and ground water standards. This also may result in corresponding revisions to Florida's reuse and other ground water discharge requirements.

Filtration and passage through soils are effective in removing cysts and oocysts from water (18, 22, 23, 24, 25). Filters in a St. Petersburg water reclamation facility removed about two logs (99 percent) of cysts and oocysts (15, 16). Rose (22) concluded that filters are capable of two log reduction in concentrations of protozoans. Removals of cysts and oocysts by soil systems should be comparable or greater. One study (18) found loamy sand exhibited better removals than either silty loam or clay loam. A study of riverbank filtration in the Netherlands (39) found that passage through 25 to 30 meters of sandy soils removed greater than 2.6 logs of enterovirus and greater than 4.7 logs of Reoviruses. Given the larger sizes of the protozoan pathogens, removals are expected to be greater than that observed for viruses.

Sheikh and Cooper (49) evaluated several protozoan (*Giardia*, *Cryptosporidium*, and *Cyclospora*) and other pathogens (*Escherichia coli* 0157:H7, *Legionella*, and *Salmonella*) in a study of a large agricultural reuse project in Monterey County, California. Neither *E. coli* 0157:H7 nor *Legionella* were detected in the untreated wastewater. *Legionella*, *E. coli* 0157:H7, *Salmonella*, *Cryptosporidium*, and *Cyclospora* were never detected in the reclaimed water. *Giardia* was detected in 80 percent of the reclaimed water samples at concentrations ranging from 3 to 9 cysts per 100 mL. However, all *Giardia* cysts were devoid of internal structure and were considered to be non-viable.

The proposed revisions to Florida's reuse rules include periodic monitoring for *Cryptosporidium* and *Giardia* within water reclamation facilities that provide high-level or "drinking water" disinfection. This monitoring is proposed in an effort to learn more about the fate of these pathogens in water reclamation facilities.

Relative Risks of Reuse Activities

Chapter 62-610, F.A.C., addresses a wide range of reuse activities. Table 12 presents an overview of the relative risks associated with reuse activities addressed in Chapter 62-610, F.A.C., including ground water recharge and indirect potable reuse activities. The focus in this table is on relative risks associated with release of reclaimed water to surface waters or ground waters that are, or may be, used for drinking water supplies.

Part III of Chapter 62-610, F.A.C., addresses use of reclaimed water to irrigate public access areas (such as golf courses, parks, playgrounds, and other landscaped areas), residential properties, and edible food crops. Part III also applies to other uses of reclaimed water in urban areas (such as toilet flushing, fire protection, aesthetic uses, and others). Table 13 presents estimates of the relative risks of these types of reuse activities. Risks for these types of activities primarily involves human contact with reclaimed water.

The relative risk rankings in Tables 12 and 13 are based primarily on the professional judgment of the authors along with input received from the peer reviewers.

Table 10. *Cryptosporidium* in the Environment

Water Type	% Positive	Average (oocysts/100 L)	Range (oocysts/100 L)	Ref.	Notes
Reclaimed water (St. Petersburg)	17	0.75	ND-5.35	15	12 samples
Irrigation canals (in AZ)	100	555,000	530,000-580,000	26	2 samples
Surface waters (all categories)	51	43	ND-29,000	23	181 samples in 17 states
Rivers (pristine)	32	29	ND-24,000	23	59 samples
Lakes (pristine)	53	9.3	ND-307	23	34 samples
Springs	---	4	---	23	7 samples
Ground water	5.5	0.3	ND-4	23	12 samples
Ground Waters	17	41	---	27	74 samples
Source waters of surface water treatment plants	87	270	ND-48,400	19	66 water treatment plants in 14 states and 1 Canadian province - 85 samples
Surface water supplies for drinking water plants	51.5	240	ND-6510	28	1991-1993, 262 samples at 72 water plants
Rivers in a protected watershed (Western USA)	83	2	ND-13	29	6 samples
Catskill Watershed Delaware Malcolm Brook	46 37 52	1.4 0.8 1.0	ND-17.3 ND-15 ND-48	30	3 protected watersheds that serve as sources of drinking water for New York City.
Filtered drinking water	26.8	1.52	ND-48	31	66 water treatment plants in 14 states & 1 Canadian province - 85 samples
Treated drinking water	13.4	3.3	ND-57	28	1991-1993, 262 samples at 72 water plants
Filtered drinking water (Western USA)	20	0.1	---	29	10 samples
Non-filtered drinking water (Western USA)	50	0.6	---	29	4 samples
Treated drinking water	17	0.1	---	23	36 samples
Phillippi Creek (FL)	13	16	ND-158	32	An urban stream in Sarasota, 16 samples
5 streams (FL)	4	6.6	ND-157	32	In the vicinity of Sarasota, 24 samples
Sarasota Bay (FL)	0	ND	ND	32	4 samples at 1 point in a high-quality estuary.
Tampa Bypass Canal (FL)	43	3.1	ND-11	22	7 samples

Note: ND = Less than detection

Table 11. *Giardia* in the Environment

Water Type	% Positive	Average (cysts/100 L)	Range (cysts/100 L)	Ref.	Notes
Reclaimed water (St. Petersburg)	25	0.49	ND-3.3	15	12 samples
Surface waters (all categories)	15	3	ND-625	23	181 samples in 17 states
Rivers (pristine)	6.8	0.35	ND-12	23	59 samples
Lakes (pristine)	12	0.5	ND-7	23	34 samples
Springs	0	<0.25	---	23	7 samples
Ground water	0	<0.25	---	23	12 samples
Ground Waters	9.5	16	---	27	74 samples
Source waters of surface water treatment plants	81.2	277	ND-6600	19	66 water plants in 14 states & 1 Canadian province - 85 samples
Surface water supplies for drinking water plants	45	200	ND-4380	28	262 samples at 72 water plants, 1991-1993
Rivers in protected watershed (Western USA)	17	0.6	---	29	6 samples
Catskill Watershed Delaware Malcolm Brook	36 29 46	1.2 0.7 1.3	ND-9.3 ND-8.2 ND-23.4	30	3 protected watersheds that serve as sources of drinking water for New York City
3 pristine river systems (near Seattle, WA)	42	6.3	ND-520	33	222 samples at 17 sites over 9 months
Portland, OR water supply reservoir	19	0.34-2.77	---	21	A protected reservoir. Several data sets
Filtered drinking water	17.1	4.45	ND-64	31	66 water plants in 14 states & 1 Canadian province - 82 samples
Treated drinking water	4.6	2.6	ND-9	28	262 samples at 72 water plants, 1991-1993
Treated drinking water	0	<0.25	---	23	36 samples
Phillippi Creek (FL)	6	9.8	ND-157	32	an urban stream in Sarasota, 16 samples
5 streams (FL)	0	ND	ND	32	24 samples from streams in the vicinity of Sarasota
Sarasota Bay (FL)	0	ND	ND	32	4 samples at 1 point in a high-quality estuary.
Tampa Bypass Canal (FL)	14	0.42	ND-2.9	22	

Note: ND = Less than detection.

Table 12. Relative Risks Associated With Reuse Activities

Relative Risk Ranking (High to Low)	Reuse System Type
1	Injection to G-I, F-I, G-II (<3000 mg/L TDS)
2	ASR using G-I, F-I, G-II (<3000 mg/L TDS)
3	Injection to G-II (>3000 mg/L TDS)
4	Discharge to Class I surface waters
5	Discharge to waters tributary or contiguous to Class I surface waters (t < 4 hr)
6	Injection for salinity barrier (G-II having TDS 1000-3000 mg/L; ground water not used for potable purposes)
7	Rapid-rate systems (RIBs) in unfavorable conditions (Rule 62-610.525, F.A.C.)
8	ASR using G-II (1000 < TDS < 3000 mg/L; ground water not used for potable purposes)
9	ASR using G-II (TDS >3000 mg/L)
10	Septic tanks & drainfields [1.6 million in Florida; contribute 160 mgd to ground water; regulated by Department of Health]
11	Discharge to surface waters directly connected to ground water (canals in SE Florida)
12	Discharge upstream (4 < t < 24 hr.) of Class I surface waters
13	Unlined storage ponds for Part III projects (those located in unfavorable hydrogeologic conditions)

Table 12. Relative Risks Associated With Reuse Activities

Relative Risk Ranking (High to Low)	Reuse System Type
14	Discharge to wetlands that percolate to ground water
15	Rapid-rate systems (Part IV)
16	Discharge further upstream (t > 24 hr.) of Class I waters
17	Slow-rate systems (Part II)
18	Irrigation of public access areas (Part III)
19	Injection into G-IV ground water (deep wells)
20	ASR Using G-IV ground water
21	Overland flow systems (Part VI) [systems designed not to percolate to ground water]
22	Unlined storage ponds for Part III projects (those located in favorable hydrogeologic conditions)
23	Lined reject ponds (Part III) [store reclaimed water not meeting standards]
24	Lined system storage ponds (Parts II, IV)
25	Lined system storage ponds (Part III)

Table 13. Relative Risks Associated With Reuse Activities Allowed by Part III

Relative Risk Ranking (High to Low)	Reuse Activities
1	Residential irrigation using hose bibbs
2	Residential irrigation using in-ground sprinkler systems
3	Irrigation of edible food crops (crops that are not peeled, skinned, cooked, or thermally processed before human consumption)
4	Irrigation of edible food crops (crops that are peeled, skinned, cooked, or thermally processed before human consumption)
5	Irrigation of public access areas (golf courses, schools, parks, landscaped areas, athletic fields, highway medians, etc.)
6	Use in open cooling towers (Regulated by Part VII of Chapter 62-610, F.A.C.)
7	Vehicle washing
8	Decorative water features (ponds, fountains, etc.)
9	Toilet flushing (commercial, industrial, hotel, motels, etc.)
10	Water supply in commercial laundries
11	Cleaning of roads, sidewalks, and work areas
12	Fire protection (hydrants)
13	Ice making for ice rinks
14	Fire protection (sprinklers)
15	Mixing of concrete
16	Construction dust control
17	Flushing of sewers and reclaimed water lines

IV. Impacts of the Proposed Rule Revisions Related to Ground Water Recharge and Indirect Potable Reuse

Fundamentals

These types of systems are designed to introduce reclaimed water into ground water (ground water recharge) or into surface waters that are used as a source of supply for drinking water purposes.

Surface water-based reuse systems focus on discharges of reclaimed water to Class I waters and are categorized as "indirect potable reuse." Surface waters are subject to full drinking water treatment before the finished drinking water is released to a public drinking water supply system.

Ground water recharge activities include both injection projects regulated by Part V of Chapter 62-610, F.A.C., and land application projects regulated by Part IV. The focus is on Class F-I, G-I, and G-II ground waters, which are classified as being "potable." Of note is the fact that some individuals will consume ground water without treatment or disinfection. This is particularly true for ground waters having TDS concentrations less than 3,000 mg/L. As the TDS concentration approaches 3,000 mg/L, the need to provide significant treatment (at the point of withdrawal) to the ground water using demineralization methods (such as reverse osmosis) increases. Above 3,000 mg/L, virtually everyone provides extensive treatment for reduction of TDS at the point of withdrawal.

It is assumed that individuals consume 2 L/day of water. This is independent of the source of water (ground water or surface water). As noted previously, it has been assumed that treated water meeting Florida's primary and secondary drinking water standards is safe for human consumption and the risks of drinking these waters represents a reasonable and acceptable risk to public health.

The following sections present the estimated changes in risk to public health resulting from the proposed revisions to Chapter 62-610, F.A.C. Incremental risks are assessed for the changes in rule requirements. As noted previously, qualitative risk assessment has been used. Reuse activities are discussed in the order of relative risk presented in Tables 3 and 12.

Aquifer storage and recovery (ASR) involves injection of reclaimed water into ground water with subsequent withdrawal before use in a reuse system. The ASR system then becomes a form of "storage" and is a component of the reuse system. ASR systems will be evaluated in Chapter V in the discussion of other proposed changes to Chapter 62-610, F.A.C.

Injection to F-I, G-I, G-II Ground Water Having TDS Less Than 3,000 mg/L

Existing Rules: Detailed rules governing injection of reclaimed water into high-quality aquifers currently are contained in Rule 62-600.540(3), F.A.C. These rules currently are referenced in Part V of Chapter 62-610, F.A.C. (see Rule 62-610.560, F.A.C.).

Historical Perspective: The existing rules were adopted in response to a specific statutory mandate that once appeared in Section 403.859, F.S. The statutory language was established in opposition to a proposed injection project in the Orlando area. The statute essentially prohibited injection into portions of the Floridan and Biscayne Aquifers having TDS concentrations of 500 mg/L or less. Rule 62-600.540(3), F.A.C., was developed with significant input from a technical advisory committee consisting of recognized national experts. The rulemaking drew heavily upon experience with Water Factory 21 in Orange County, California (see project description in Appendix B). Rulemaking was constrained to the specific conditions contained in the statute. The basic treatment and disinfection requirements in this existing rule are technically sound and provide for protection of public health. However, the resulting rule contains overly restrictive requirements on project development and permitting (including requiring operation of the full-scale treatment facility for two years with no injection before a final permitting decision on injection would be made). These restrictive permitting requirements reflected the statute and the statutory intent of stopping such injection projects.

In response to recommendations from Partners for a Better Florida (34), the statutory prohibition on this type of reuse project was removed in 1994. Partners for a Better Florida noted the importance of this type of reuse project for water resource management in Florida.

Proposed Rule Revisions: As noted in Table 3, the key revisions to these rule requirements include:

1. Expanding the coverage to all F-I, G-I, and G-II ground water having TDS less than 3,000 mg/L.

2. Tightening the total organic carbon (TOC) limit from 5 mg/L average (9 mg/L maximum) to 3 mg/L average (5 mg/L maximum).

3. Adding a total nitrogen limit of 10 mg/L (average).

4. Replacing full-scale testing with pilot testing requirements.

5. Implementing the “multiple barrier” concept.

6. Refining disinfection requirements.

The estimated changes in risk that would result from implementing the proposed rule revisions are discussed in the following sections.

Expanding Coverage: This is a logical refinement to this rule. As mandated by the original statute, the existing rules apply only to portions of the Floridan and Biscayne Aquifers (both contain G-II ground water) containing less than 500 mg/L of TDS. Certainly, other G-II ground water merits the same level of protection. In addition, F-I and G-I ground waters are designated as being sole source, potable aquifers, which merit the highest level of protection. The upper bound on F-I and G-I ground water is 3,000 mg/L (as established by the ERC). Applying these stringent rule requirements to all F-I, G-I, and G-II less than 3,000 mg/L of TDS is appropriate and consistent with prudent protection of potable aquifers in the state.

This change will reduce possible health risks associated with this type of project in F-I, G-I, and G-II ground waters not previously covered by these rule provisions.

TOC Limits: TOC by itself does not have a direct health significance. However, it is an important measure of the quality of wastewater treatment provided at the water reclamation facility and of the quality of the reclaimed water produced. TOC is an indicator of the concentrations of organic compounds in the reclaimed water -- including known compounds and the large number of compounds which cannot currently be identified. Some of these organic compounds have health significance.

The pilot study (35) for the Tampa Water Resource Recovery Project (see summary in Appendix B) and other operating projects have demonstrated that the more stringent TOC limit can be achieved.

Treatment technologies and costs needed to meet various TOC limits are highly variable and very dependent on the quality of the raw wastewater. Meeting a TOC limit of 5 mg/L (average) will significantly increase the cost of a facility (perhaps as much as 50 to 100 percent) over what was needed to meet drinking water standards (with no TOC limit). Going from a TOC limit of 5 mg/L to 1 mg/L will probably require the addition of full reverse osmosis treatment, which could add on the order of 25 percent to the total cost of the treatment facility. Meeting a 3-mg/L TOC limit should fall somewhere between the two. These rough cost figures assume that reductions in inorganic constituents are not needed to meet basic drinking water standards. If inorganics reductions are needed to meet drinking water standards, the cost of meeting drinking water standards without TOC limits will be greater and the incremental costs for meeting various TOC limits probably will be significantly lower than these rough estimates.

The tightening of the TOC limit is achievable and should result in reduced risk to public health.

Adding a Total Nitrogen Limit: The total nitrogen limit is proposed to ensure that the ground water standard for nitrate (10 mg/L as N) will be met. The total nitrogen limit assures that the possible conversion of some nitrogen species to nitrate upon injection will not cause violations of the nitrate standard.

This total nitrogen standard may not result in significant cost increases, since treatment technologies designed to achieve the TOC and total organic halogen (TOX) limits also may remove nitrogen below the 10 mg/L limit. This is dependent on the treatment technologies used.

The addition of the total nitrogen limit will have a potential benefit of reducing risks to public health.

Pilot Testing: The proposed pilot testing requirements are designed to demonstrate treatment technologies and to document that a proposed reuse project will adequately protect public health. The change from full-scale to pilot testing will result in significant cost savings to utilities developing this type of project, while still generating sufficient information to judge project performance, conduct health effects testing, and enable final design. The change also will reduce uncertainty in the permitting process, which may encourage utilities to pursue this type of reuse project. The change to pilot testing should result in no change in risks associated with these projects.

Multiple Barriers: The proposed rule requires multiple barriers for control of organic compounds and pathogens. This involves the use of multiple treatment/disinfection processes to achieve removals of these classes of contaminants. This replaces the existing requirement for activated carbon treatment.

At the time the existing rules were written, activated carbon was regarded as the most effective means of controlling organic compounds. During the last decade, there have been significant advances in other treatment technologies, particularly in the area of membrane treatment technologies.

The concept of multiple barriers is consistent with the emerging guidelines on indirect potable reuse. Implementation of this rule revision is expected to have potential for reducing risks to public health.

Refining Disinfection Requirements: The requirements for compliance with high-level disinfection is proposed to be replaced with the more stringent bacteriological requirements in the drinking water rules (Chapter 62-550, F.A.C.). This should result in an unquantified reduction in risk to public health.

<u>Injection to G-II Ground Water Having TDS Greater Than 3,000 mg/L</u>

Existing rules governing injection to G-II ground water are contained in Rule 62-600.540(2), F.A.C. In Part V of Chapter 62-610, F.A.C., existing Rule 62-610.560(3), F.A.C., provides a cross-reference to these rules.

The proposed revisions refine these existing rule requirements. It is proposed to add a 10-mg/L total nitrogen limit, add a requirement for filtration, require compliance with the drinking water bacteriological requirements, and to refine the application of the drinking water standards.

The requirement for filtration is implied in the existing high-level disinfection requirements (imposes a 5.0 mg/L total suspended solids limit). Specifying filtration is not regarded as being a new requirement and it will not have a cost or risk impact.

The addition of the total nitrogen limit and use of the drinking water disinfection criteria were assessed in the previous section. As noted previously, these changes will have an unquantified, reduction in risk to public health.

Existing rules simply require meeting of "ground water standards" (these are the drinking water standards). The timing or location of compliance is not specified. The proposed revisions provide details to this statement. The primary drinking water standards, which have public health significance, will be applied as single sample maxima as end-of-pipe limits (as the reclaimed water is injected). The secondary standards (have aesthetic considerations) along with the state primary standard for sodium will not be applied as reclaimed water limits. Rather, the permittee must demonstrate compliance with the secondary standards and sodium at the edge of a zone of discharge. The refinement in application of the drinking water standards is not anticipated to have any significant impact on health risks associated with this type of project.

Discharge to Class I Surface Waters

Class I waters are intended to serve as potable water supply. Designation of Class I waters frequently extends significantly upstream fro the reservoir or lake that actually serves as the potable water source. In some instances, the Class I designation is provided upstream to the headwaters of the tributary streams.

Existing requirements are contained in Rules 62-600.420(2) and 62-600.510(2), F.A.C. In Part V, existing Rule 62-610.554(4), F.A.C., provides a cross-reference to the requirements in Chapter 62-600, F.A.C.

The proposed revisions refine the existing rule provisions. A requirement for filtration is added, drinking water disinfection requirements will be added, and the manner in which the drinking water standards are to be applied is clarified. The filtration requirement is not considered as a new requirement, since it is an integral part of the existing high-level disinfection requirement. As discussed previously, the substitution of the drinking water bacteriological requirements for high-level disinfection will reduce the risk to public health.

The application of the drinking water standards as reclaimed water limits will be refined. The primary standards, which are health based, will be applied as single sample maxima. The secondary standards and sodium (a state primary standard) will be applied as annual average limits. The multipliers in Chapter 62-600, F.A.C., will be used to establish monthly, weekly, and single sample limits for the secondary parameters and sodium. This is primarily to establish operational criteria for compliance purposes. It is not anticipated to have significant health impacts.

Limits on TOC (3 mg/L average, 5 mg/L maximum) are proposed for this type of project. This is consistent with the TOC limits contained in the draft permit for the Tampa Water Resource Recovery Project, is consistent with recent guidance documents dealing with augmentation of potable water resources with reclaimed water, and was endorsed by the Reuse TAC. Imposing the TOC limits should result in reduced risks to public health.

It is anticipated that the proposed revisions will result in reductions in risk to public health.

Discharge to Waters Tributary or Contiguous to Class I Waters

Existing requirements are contained in Rule 62-600.510(3), F.A.C. In Part V, existing Rule 62-610.555(1), F.A.C., provides a cross-reference to the requirements in Chapter 62-600, F.A.C. The existing rule requirements and the proposed revisions to this class of reuse system are nearly identical to the existing rules and proposed revisions for discharges to Class I waters, as discussed above. The result is that the proposed revisions are anticipated to result in reduced risks to public health.

Salinity Barriers Into G-II Ground Water Having TDS Between 1,000 and 3,000 mg/L

The proposed treatment and disinfection requirements for this type of system are the same as for injection to G-II ground waters containing greater than 3,000 mg/L of TDS. However, the proposed treatment and disinfection requirements for this type of salinity barrier project are not as stringent (protective) as the requirements for most injection projects involving injection to Class G-II ground water having TDS less than 3,000 mg/L.

Proposed Rule 62-610.562(4), F.A.C., involves a balancing of several factors. First, landward or upward migration of saltwater poses a threat to the potable ground water. This is an existing problem in many coastal areas of Florida that is projected to become more severe and extensive as Florida's population grows by about 40 percent between 1995 and 2020.

Systems can be designed and operated such that injecting a fresh water at or near the fresh/saltwater interface will retard or reverse the upward or landward migration of saltwater. This has been done successfully in California using reclaimed water (or other water sources).

As an injection system builds a mound of freshwater in the aquifer, this increased head serves to retard upward or landward migration of saltwater. However, building this freshwater mound may also create a pressure gradient that would allow a portion of the injected fluid to move landward, possibly to inland potable water supply wells.

The proposed rule contains requirements for the salinity barrier injection system to be designed and operated to ensure that potable water supply wells are not adversely affected. A 1,000-foot setback distance is imposed from the injection wells to potable water supply wells. Ground water monitoring will be required.

In the event that an applicant cannot provide reasonable assurance that the injected reclaimed water will not migrate to potable water supply wells, the salinity barrier system could not be permitted under this proposed rule. The more stringent requirements for ground water recharge into G-II ground waters would be applicable. This would also apply to facilities constructed under the proposed salinity barrier rule that exhibited migration of injected reclaimed water toward potable water supply wells.

The proposed treatment and disinfection requirements coupled with the operational and setback distance requirements for this class of salinity barrier project should provide a level of public health protection equivalent to the requirements and controls placed on ground water recharge projects involving injection into G-II ground water containing less than 3,000 mg/L of TDS. Any potential increased risk is offset by the need to control the risks to potable water supplies from unchecked saltwater intrusion.

Part IV Systems in Unfavorable Hydrogeologic Conditions

Part IV of Chapter 62-610, F.A.C., deals with rapid-rate land application systems. These types of systems are relatively common in Florida. Limits on hydraulic loading rates and requirements for alternating wetting and drying cycles are imposed by Part IV.

A special case is addressed in existing Rule 62-610.525, F.A.C. These long-standing rule requirements date back to the early 1980s and are applicable to rapid-rate land application systems located in unfavorable hydrogeologic conditions (such as karst areas). These requirements also apply to rapid-rate systems that do not meet the basic design and operation requirements for rapid-rate systems in Part IV of Chapter 62-610, F.A.C. (for example, projects loaded at rates higher than normally allowed in Part IV, or projects that do not involve wetting/drying cycles). It should be noted that the provisions of Rule 62-610.525, F.A.C., apply only to a very small subset of all rapid-rate land application projects covered by Part IV of Chapter 62-610, F.A.C.

The proposed revisions refine the existing requirements in Rule 62-610.525, F.A.C. A 10-mg/L total nitrogen limit is proposed to ensure compliance with the ground water standard for nitrate. This will ensure that conversion of some nitrogen species (organic and ammonia) to nitrate after the reclaimed water is applied to the land application system does not result in water quality problems. This revision is anticipated to result in reduced risks to public health.

In addition, as is being done elsewhere in the chapter, the application of the drinking water standards is proposed to be refined. The primary standards, which are health based, will be applied as single sample maxima. The secondary standards and sodium (a state primary standard) will be applied as annual average limits. The multipliers in Chapter 62-600, F.A.C., will be used to establish monthly, weekly, and single sample limits for the secondary parameters and sodium. This is not anticipated to have significant health impacts.

Reclaimed water has been used to recharge ground water in Los Angeles County, California for over 30 years (36). In some areas, reclaimed water accounts for about 30 percent of the water withdrawn for public water supply. The quality of the reclaimed water used for ground water recharge in large spreading basins is comparable to the quality required by Florida's regulations in Rule 62-610.525, F.A.C. A rather comprehensive health effects study was completed in 1996 (36). The study investigated a wide range of health effects including cancers (all combined and eight specific sites), heart disease, stroke, and infectious diseases (*Giardia*, *Hepatitis A*, *Salmonella*, *Shigella*, and others). The study concluded that: "The results of this epidemiologic study provide no evidence that reclaimed water has an adverse effect on health." This is the same conclusion drawn by an earlier health study in Los Angeles County in the mid-1980s.

Discharge to Waters Directly Connected to Ground Water

Requirements for this type of system are contained in proposed Rule 62-610.555(4), F.A.C. The focus is on the canals of Southeast Florida and similar situations in Florida. In Southeast Florida, the canals represent an extension of the Biscayne Aquifer and in some instances may provide opportunities for ground water recharge in the area.

The proposed treatment and disinfection requirements include: secondary treatment, filtration, high-level disinfection, the 10-mg/L total nitrogen limit, and requirements for meeting of ground water standards (drinking water standards) at the point(s) where reclaimed water enters the ground water. These rule requirements have been framed to be consistent with other existing and proposed rule provisions, notably the ground water rules and the rules governing rapid-rate land application systems in unfavorable hydrogeologic conditions (Rule 62-610.525, F.A.C.).

The key difference between the proposed rule provisions for the discharge to waters directly connected to ground water and the requirements in Rule 62-610.525, F.A.C., involves the point of application of the drinking water standards. For the land application systems regulated by Rule 62-610.525, F.A.C., drinking water standards normally are to be met as an end-of-pipe limit as reclaimed water is released to the land application system. This reflects the fact that a zone of discharge normally will not be provided for these types of systems. For surface waters with direct connection to ground water, the proposed requirement is for compliance with the ground water standards (are the drinking water standards) at the point(s) of entrance into the ground water. This will allow for dilution credits in the receiving water body. If the point(s) of entrance into the ground water system is located very near to the discharge location, the ground water standards would essentially have to be met at the point of discharge.

The 10-mg/L total nitrogen limit is designed to ensure that nitrification does not result in violations of the ground water standards. This limit probably will not impose new burdens on this type of discharge. This is because these surface water discharges will be subject to water quality based effluent limitations (WQBELs) established under the provisions of Chapter 62-650, F.A.C. It is likely that the WQBELs will restrict total nitrogen to levels that may be significantly less than 10 mg/L in order to protect surface water quality.

As noted in Chapter I of this RIS, the existing rules are presumed to be fully protective of public health. Given the consistency of this rule with other existing rules, it follows that this proposed rule will not pose unacceptable risks to public health.

Discharge Upstream From Class I Waters

Existing requirements for discharges to waters that flow into Class I surface waters are contained in Rule 62-600.510(3), F.A.C. These rules apply specifically to discharges located within 24 hours travel time of the Class I water, and are cross-referenced in Rule 62-610.555(2), F.A.C. Proposed rules dealing with this type of reuse system are located in proposed Rules 62-610.555(2) and (3), F.A.C. Two cases are discussed: travel times between 4 and 24 hours, and travel times greater than 24 hours. Travel times less than 4 hours are considered as discharges “contiguous to or tributary to Class I waters,” which are addressed in Rule 62-610.555(1), F.A.C., and were discussed previously in this RIS.

Travel Times of 4 to 24 Hours: This case is discussed in Rule 62-610.555(2), F.A.C. The proposed rule will require secondary treatment, filtration, high-level disinfection, and compliance with a 10-mg/L total nitrogen limit. This proposed rule is designed to provide a transition from the stringent requirements for discharges within four hours travel time of Class I waters and the minimal requirements imposed on discharges located more than 24 hours travel time from Class I waters. The approach is consistent with the increased emphasis on source water protection contained in the federal drinking water program.

Provision of high-level disinfection will provide for decreased risks related to microorganisms.

The 10-mg/L total nitrogen limit is designed to ensure that nitrification does not result in violations of the nitrate standard. This limit probably will not impose new burdens on this type of discharge. This is because these surface water discharges will be subject to a WQBEL established under the provisions of Chapter 62-650, F.A.C. It is likely that the WQBEL will restrict total nitrogen to levels that may be significantly less than 10 mg/L in order to protect surface water quality.

The overall impact of the proposed revisions is estimated to be a reduction in risk to consumers of water from the downstream Class I waters.

Travel Times Greater Than 24 Hours: As noted in proposed Rule 62-610.555(3), F.A.C., this case is not considered “indirect potable reuse,” is regulated under existing surface water discharge rules, and is not subject to regulation under Chapter 62-610, F.A.C. Since no changes are proposed, there is no change in the risks associated with this situation.

Unlined Storage Ponds

Existing Rule 62-610.464(4)(a), F.A.C., specifically allows for unlined storage ponds for projects permitted under Part III of Chapter 62-610, F.A.C. Reclaimed water used in these projects has been filtered and must meet the high-level disinfection criteria. Monitoring has shown that reclaimed water that has received this level of treatment meets the majority of drinking water standards. No setback distances are required from unlined storage ponds to potable water supply wells. Rule 62-610.463(3)(b), F.A.C., requires a ground water monitoring well adjacent to unlined storage ponds. If problems are encountered, the unlined storage pond could be regulated using the existing ground water rules, or the unlined storage pond could be regulated under Part IV (probably under Rule 62-525) of Chapter 62-610, F.A.C. In any case, the storage pond would have to achieve compliance with the ground water standards, which are the drinking water standards.

Within the wellhead protection rules, existing Rule 62-521.400(1)(a), F.A.C., specifically allows for unlined storage ponds associated with Part III reuse projects to be located within the 500-foot wellhead protection area.

During this rulemaking, one county repeatedly has pushed for additional regulation of unlined storage ponds associated with reuse projects permitted under Part III of Chapter 62-610, F.A.C. The county has expressed concern that unlined storage ponds could be located in close proximity to public water supply wells, and in karst areas, these unlined storage ponds could serve to recharge the wells and contribute significant quantities of reclaimed water to the drinking water system. The county also noted that under the permitting concept contained in Part III of Chapter 62-610, F.A.C., the DEP may not know of the existence of all unlined storage ponds within a reuse system.

The potential need to create detailed regulations for unlined storage ponds was discussed at the March 1997 public workshop. At the workshop, the overwhelming majority of attendees and the Reuse TAC expressed their belief that additional regulation of unlined storage ponds was not justified or needed

Table 12 presents the relative risk associated with unlined storage ponds located in unfavorable hydrogeologic conditions. Of course, in more favorable hydrogeologic conditions, the relative risk associated with unlined storage ponds diminishes significantly, as noted in Table 12.

The DEP is proposing establishment of a 200-foot setback distance from unlined storage ponds to potable water supply wells in Part III of Chapter 62-610, F.A.C. Moderating provisions are proposed that would allow for possible reductions in this setback distance based on favorable hydrogeologic conditions. A requirement for an "inventory of storage systems" is being proposed to ensure that the DEP knows the location of all unlined storage ponds. While risks associated with the current rule provisions related to unlined storage ponds are regarded as being acceptable and manageable, these two proposed rule provisions are anticipated to reduce any potential risks associated with some unlined storage ponds.

Discharge to Wetlands That Percolate to Ground Water

Discharges of reclaimed water to wetlands are regulated by Chapter 62-611, F.A.C. During this rulemaking on Chapter 62-610, F.A.C., the same county that pushed for additional regulation of unlined storage ponds also requested additional regulation of wetlands that may percolate to ground water. This county maintains that wetlands that percolate to ground water, if located in close proximity to public water supply wells, could serve to recharge the wells and contribute significant quantities of reclaimed water to the drinking water system.

It should be noted that the vast majority of wetlands systems permitted under Chapter 62-611, F.A.C., are designed and function as surface water discharge systems. However, wetlands systems normally are not lined. As a result, some percolation to ground water may occur with virtually all wetlands systems. In cases where wetlands may contribute significant quantities of water to underlying aquifers, the ground water recharge aspects can be regulated under the ground water rules contained in Chapters 62-520 and 62-522, F.A.C. These rules enable DEP to require ground water monitoring and to impose more stringent reclaimed water limits on discharges to the wetlands, if additional controls are needed to comply with the ground water quality standards. These ground water permitting requirements currently are being used by the

DEP district offices when dealing with wetlands that may feature significant percolation to ground water.

Wetlands projects offer advantages and should be encouraged. Reflecting this, Chapter 62-610, F.A.C., currently classifies wetlands creation, enhancement, and restoration as being considered "reuse" [see Rule 62-610.810(2)(g), F.A.C.]. The facts that any percolation to ground water from a wetland system probably will not be very rapid, and that percolation through the accumulated muck layer can provide relatively high degrees of treatment, do not support a need for additional regulation of this type of system.

The issue of the possible need for additional regulation of wetlands that percolate to ground water has been discussed with representatives of the DEP's domestic wastewater, wetlands, ground water, and permitting programs. The consensus is that detailed regulations for wetlands that percolate to ground water are not needed in Chapter 62-610, F.A.C. The DEP will continue to rely on the ground water rules in dealing with this small subset of wetlands projects. When the wetlands rules (Chapter 62-611, F.A.C.) are next opened for rulemaking, we will add suitable cross-references to the applicable ground water rules. As a result, DEP does not intend to pursue additional regulations for wetlands that percolate to ground water during the Phase II rulemaking on Chapter 62-610, F.A.C.

V. Impacts of Other Proposed Rule Revisions

Fundamentals

Chapter IV discussed the risk impacts of ground water recharge and indirect potable reuse projects. Chapter V presents an evaluation of the anticipated risk impacts associated with other proposed revisions to Chapter 62-610, F.A.C. This chapter focuses on new rule requirements for ASR, supplemental water supplies, blending of demineralization concentrate with reclaimed water, and cooling towers.

Aquifer Storage and Recovery (ASR)

Proposed Rule 62-610.466, F.A.C., will regulate ASR projects that are associated with reuse projects permitted under Part III of Chapter 62-610, F.A.C. These ASR projects are not intended to be ground water recharge projects. They are designed to serve as storage systems. It is intended that water that is injected for storage will be subsequently withdrawn for use in the reuse system.

The requirements for ASR systems have been formulated to be consistent with the requirements for ground water recharge projects that involve injection. The risks associated with the revisions to the rules governing ground water recharge by injection were discussed in the previous chapter. Given that ASR involves the recovery of the injected fluid, the risks associated with ASR will be significantly less than the risks associated with injection for ground water recharge. Table 12 presents the relative ranking of risks associated with ground water recharge and ASR projects.

The main area in which the requirements for ASR differ from the injection requirements involves use of G-II ground water containing between 1,000 and 3,000 mg/L of TDS for ASR. The injection case addressed in Part V of Chapter 62-610, F.A.C., requires full treatment and disinfection (compliance with primary and secondary drinking water standards and the TOC and TOX limits). For ASR in this class of ground water, proposed Rule 62-610.466(9)(b), F.A.C., will require less restrictive treatment requirements before injection into the ASR system. In the case where the ground water is not used for potable purposes, an extended zone of discharge will be allowed for the secondary drinking water standards and for sodium (a state primary standard) for the ASR system. While the lower treatment level poses an unquantified increase in risk to public health, this risk is managed by the facts that the injected fluid will be withdrawn, the aquifer is not used for potable water supply, ground waters containing TDS greater than 1,000 mg/L have increased potential for being further treated upon withdrawal, proposed setback distances, and operational controls placed on the ASR system. All ground water standards must be met at the edge of the extended zone of discharge.

In light of the state objectives of encouraging and promoting reuse, the advantages of ASR as a long-term storage system, and the controls placed on ASR systems, any increased risk is regarded as being managed and within an acceptable range.

Supplemental Water Supplies

Proposed Rule 62-610.472, F.A.C., addresses the addition of surface water, treated stormwater, ground water, and potable water to a reuse system to supplement the supply of reclaimed water. This proposed rule only affects reuse systems permitted under Part III of Chapter 62-610, F.A.C. It has been shown that the use of supplemental water supplies may enable maximization of the use of reclaimed water supplies and can reduce overall water use within a community. These types of waters currently are used successfully to supplement reclaimed water supplies in several reuse systems in Florida (examples include Altamonte Springs, Cape Coral, and CONSERV II).

From the standpoint of risks to the users of reclaimed water, the risk associated with the use of treated drinking water as a supplemental water supply is estimated to be negligible. The potential risk to the user of reclaimed water is relatively small when ground water is used as a supplemental water supply. Treated stormwater and surface waters pose greater risks to the users of reclaimed water than do either drinking water or ground water. However, treated stormwater or surface waters will be required to meet the same fecal coliform and total suspended solids limits (high-level disinfection criteria) that are imposed on the reclaimed water. The risks posed to users of reclaimed water are regarded as being minimal and within an acceptable range.

Use of supplemental water supplies also may pose a degree of risk to the water used to supplement the reclaimed water supply. The concern is for backflow of reclaimed water into a drinking water system, the ground water, or a surface water. This risk is managed by requiring backflow prevention devices on ground water wells (an approved device is required) and on drinking water lines (an air gap is required). For the use of treated stormwater or surface waters, a one-way flow device (such as a flap valve) will be required.

Blending of Demineralization Concentrate with Reclaimed Water

Utilities using membrane treatment technologies to treat brackish or saline water for drinking water purposes create two water streams. The product water stream contains reduced concentrations of TDS and is further processed for use as drinking water. The salts removed by the membrane process appear in increased concentrations in a concentrate stream. This demineralization concentrate must be disposed of in an environmentally sound fashion. In some circumstances the concentrate may be discharged to surface waters, land applied, or injected into subsurface formations. Another option involves blending of the concentrate with reclaimed water and using the resulting mixture in a reuse system permitted under Chapter 62-610, F.A.C. Section 403.0882, F.S., which was enacted in 1997, addresses the management of demineralization concentrate.

Proposed Rule 62-610.865, F.S., addresses the blending of demineralization concentrate with reclaimed water. This proposed rule is consistent with the statutory requirements in Section 403.0882, F.S. The main concern with a blending operation is the possibility that increased salt concentrations in the reclaimed water/concentrate blend will adversely affect vegetation irrigated with reclaimed water. To manage this potential risk to vegetation, the proposed rule contains requirements for storage of the concentrate, operational controls (including an operating protocol), and establishment of a minimum blend ratio designed to protect sensitive vegetation.

Proposed Rule 62-610.865(6)(c), F.A.C., requires that the reclaimed water/concentrate blend meet the full requirements of the appropriate part of Chapter 62-610, F.A.C. For projects permitted under Part III, this includes the high-level disinfection criteria. As a result, risks to public health resulting from the use of a reclaimed water/concentrate blend were judged to be minimal.

Industrial Uses - Cooling Towers

Industrial uses of reclaimed water are addressed in Part VII of Chapter 62-610, F.A.C. Part VII applies only to reclaimed water having origin as domestic wastewater. Part VII does not apply to the reuse of industrial wastewaters. Existing Rule 62-610.652(1), F.A.C., establishes secondary treatment and basic disinfection as the minimum acceptable levels of treatment and disinfection for all industrial uses of reclaimed water

Reclaimed water can be safely used as cooling water. Several reuse systems in Florida currently use reclaimed water for cooling purposes. Most of these reuse systems meet the requirements of Part III of Chapter 62-610, F.A.C. A power plant in Lakeland uses reclaimed water that has received only secondary treatment and basic disinfection.

The proposed revisions to Part VII will impose more stringent requirements on reclaimed water used in open cooling towers. The proposed revisions will require either of the following be met:

1. All requirements of Part III of Chapter 62-610, F.A.C., (including filtration and high-level disinfection) shall be met. Setback distances will not be required from the cooling tower to the site property line.

2. Secondary treatment and basic level disinfection will be allowed if a 300-foot setback distance is provided from the cooling tower to the property line. Additional controls on aerosols, sprays, and mists are proposed.

These two cases are consistent with the ***Guidelines for Water Reuse*** (3).

It must be noted that surface water or ground water frequently are used as water sources for cooling water in open cooling tower applications. As noted in Tables 10 and 11, surface water, ground water, and even treated drinking water may not be completely pathogen-free. For the protozoan pathogens, reclaimed water compares very favorably to other high-quality water supplies.

It also must be noted that the warm, moist environment offered by a cooling tower represents a favorable environment for microorganisms. Cooling towers, regardless of their water source, tend to sustain rather lush biological growths and may harbor concentrations of various pathogens (*Legionella* and *Klebsiella* are of particular note). To combat the accumulation of biological growths in cooling towers, the cooling water typically is treated rather extensively with disinfectants and chemicals designed to inhibit biological growths.

The potential pathway of concern focuses on pathogens contained in reclaimed water that may be aerosolized in the cooling tower, carried by wind to adjacent areas accessible to the public and ingested. For the pathogens of concern that may be found in reclaimed water, the organisms must be captured by saliva and swallowed.

For the case involving compliance with the full requirements of Part III of Chapter 62-610, F.A.C., the reclaimed water will be of quality comparable to other sources of cooling water (surface water and ground water). As a result, the risk of using reclaimed water should not be appreciably different from the risk if other waters were used. As noted previously, the annual risk of infection from ingestion of aerosolized pathogens is less than $1x10^{-4}$.

The case involving the 300-foot setback distance and basic disinfection poses a greater potential risk. The setback distance and additional controls on aerosols, sprays, and mists are designed to manage this potential risk.

Currently, use of reclaimed water that has received secondary treatment and basic disinfection without setback distances is allowed by Part VII of Chapter 62-610, F.A.C. Both proposed cases represent additional controls on this type of reuse system. These new controls will result in decreased risks, when compared to the risks associated with existing rule requirements.

Grazing of Dairy Cattle

Existing Rule 62-610.425, F.A.C., imposes a 15-day waiting period from the time of the last application of reclaimed water to the time that dairy cattle are allowed to graze on the land. This rule is located in Part II of Chapter 62-610, F.A.C., and the minimum treatment requirements consist of secondary treatment and basic disinfection (annual average of 200 fecal coliforms/100 mL). These existing rule requirements will remain as an option if the proposed amendment is adopted.

The EPA's ***Guidelines for Water Reuse*** (3) recommend elimination of the waiting period if intermediate disinfection (14 fecal coliforms per 100 mL) is provided.

The proposed revisions to this rule will create a second option for the grazing of dairy cattle on lands irrigated with reclaimed water. The proposed revision would eliminate the waiting period, if high-level disinfection (75 percent of observations of fecal coliforms less than detection) is provided. Originally, the intend was to mimic the recommendation in the Guidelines for Water Reuse (3). However, based largely on recommendations from the Department of Health, the Reuse TAC endorsed use of high-level disinfection for the elimination of the waiting period. Requiring high-level disinfection is more conservative and more protective of public health. In addition, high-level disinfection is becoming a very popular level of disinfection for many reuse systems in Florida.

The potential increase in risk associated with the elimination of the waiting period is offset by the reduced risk associated with the increased disinfection level.

Monitoring for Protozoan Pathogens

With increased interest in the protozoan pathogens, the DEP is proposing to require monitoring for *Cryptosporidium* and *Giardia* within water reclamation facilities that provide high-level or “drinking water” disinfection. For most reuse systems, monitoring will be required once during each two-year period. Most smaller facilities (those having capacities less than 1 mgd) will be required to sample once during each five-year permit cycle. Ground water recharge and indirect potable reuse projects permitted under Part V will be required to sample quarterly. Sampling will be limited to a single point at the end of the treatment facility. The estimated cost of the sampling is about $400 per facility.

This will enable the DEP to evaluate treatment technologies for the protozoan pathogens. Monitoring also will provide feedback to the owner/operator on the effectiveness of their treatment facilities. This monitoring could serve as a technical basis for possible future rulemaking, if this monitoring documents problems or significant differences between treatment technologies. This monitoring will not have a direct risk impact. However, data collected may be useful in future risk management activities.

Public Notification

Within Part III of the chapter, revisions are proposed to strengthen requirements for public notification. Permittees will be required to provide notification to users of reclaimed water at the time of connection and annually thereafter. Effective notification is essential to ensuring that users of reclaimed water make wise and informed decisions regarding use of reclaimed water. Rynne, et al. (47) suggest that accidental ingestion of reclaimed water can be reduced 100 fold by effective public notification and appropriate hygienic practices.

Elimination of Grandfathering Protection

Existing Rule 62-610.100(9)(b), F.A.C., states that Chapter 62-610, F.A.C., shall apply only to projects permitted after the April 5, 1989 effective date of the chapter. Projects permitted before this date were “grandfathered” and are not subject to the requirements of Chapter 62-610, F.A.C., until such time as the facilities are modified or expanded. Rule 62-610.100(9)(c), F.A.C., does require that projects permitted before the effective date that provide reclaimed water for activities allowed under Part III shall comply with the high-level disinfection requirements. However, continuous monitoring, operating protocols, reject storage, increased operator staffing, and filters are not required.

At the July 14-15, 1998 public workshop, the Reuse TAC recommended that this grandfathering protection for projects permitted before April 5, 1989 that provide reclaimed water for activities regulated by Part III of Chapter 62-610, F.A.C., be eliminated. The Reuse TAC unanimously recommended that all facilities providing reclaimed water for activities regulated by Part III come into compliance with the Part III requirements by January 1, 2010.

The 2010 deadline is over 20 years after the original adoption of Chapter 62-610, F.A.C. Many facilities permitted before the 1989 effective date will exceed their useful lives before 2010. The 2010 deadline is over 10 years in the future, which will allow for the planning, design, and construction needed to bring them into compliance with the Part III requirements.

The DEP permitting staffs report that the vast majority of facilities that have difficulties meeting the high-level disinfection requirements are facilities that because of the current grandfathering protection do not have to comply with the full requirements of Part III of Chapter 62-610, F.A.C.

Removing this grandfathering protection in 2010 should result in an unquantified decrease in risk associated with reuse activities associated with these facilities.

VI. Summary and Conclusions

This RIS has been prepared in response to the statutory requirements in Section 120.81(6), F.S. The proposed Phase II revisions to the reuse rules in Chapter 62-610, F.A.C., are addressed in this RIS.

As discussed in Chapter III, quantitative risk assessment methodologies are not sufficiently developed to enable their use in this RIS. As a result, the RIS relies primarily on qualitative assessment of risks.

Existing rules have been developed based on the best available scientific data and have been adopted by the ERC. In general, existing rules have been regarded as being fully protective of public health and environmental quality. Therefore, this RIS focuses on an assessment of the changes in levels of risk associated with the proposed revisions to the reuse rules. Reflecting the focus of this rulemaking, the RIS concentrates on ground water recharge and indirect potable reuse activities.

The Phase II rulemaking focused on the following:

1. Refinement of the rules governing ground water recharge and indirect potable reuse in Part V of Chapter 62-610, F.A.C.

2. Creation of a rule governing aquifer storage and recovery (ASR) of reclaimed water.

3. Creation of a rule governing the use of various water supplies to augment the available supplies of reclaimed water.

4. Creation of a rule governing blending of demineralization concentrate with reclaimed water.

5. Refinement of existing requirements for the use of reclaimed water in cooling towers.

Several other rule refinements have been incorporated into the Phase II revisions. Most notable are requirements for monitoring of the protozoan pathogens (Giardia and Cryptosporidium), elimination of some grandfathering protection, and refinement of public notification and cattle grazing requirements.

Incremental risks (changes in moving from the existing rule requirements to the proposed rule requirements) are presented in Chapters IV and V. Chapter IV deals with issues related to ground water recharge and indirect potable reuse. Other proposed rule revisions are addressed in Chapter V.

The proposed rule revisions generally refine existing rule requirements. The proposed revisions are expected to have relatively minor impacts on public health. Where rule requirements are proposed for change, rules will become more stringent. As a result, the proposed changes are expected to result in greater protection of public health.

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Appendix A
Reuse Technical Advisory Committee

Name/Affiliation	Representing/Qualifications
David W. York, Ph.D., P.E. Reuse Coordinator Florida DEP Tallahassee [Chairman]	Has served as Florida's Reuse Coordinator since the start of the reuse program in 1986. Coordinated all reuse-related rulemaking since 1986. Chairman, Reuse Coordinating Committee. Member TAC & peer reviewer for national ***Guidelines for Water Reuse***. Member TAC for WEF/AWWA indirect potable reuse guidelines. Represented USA at a joint US/Israel Reuse Conference. Involved in pioneering reuse projects dating back to the early 1970s.
William M. Brant, P.E. Director Miami-Dade Water & Sewer Dept.	Represents utilities. Responsible for wastewater management and reuse in Dade County.
James Crook, Ph.D., P.E. Black and Veatch Cambridge, MA	An invited participant in the Reuse TAC. Internationally recognized reuse expert. Former Chairman, WEF Water Reuse Committee. Chairman, NAS committee on indirect potable reuse. Represented USA at a joint US/Israel Reuse Conference. Former head of the California reuse program. Primary author of national ***Guidelines for Water Reuse***. Author of health effects chapter in national guidelines for indirect potable reuse. Author of numerous reuse papers.
Salvatore D'Angelo, P.E. Boyle Engineering Corp. Orlando	An invited participant in the Reuse TAC. Chairman, joint WEF/AWWA project for development of guidelines for indirect potable reuse. Former chairman, WEF Water Reuse Committee. Former chairman, FWEA Water Reuse Committee. Very active in reuse projects in Florida.
Mark Hammond Southwest Florida Water Management District Brooksville	Represents the water management districts. Involved in Florida's reuse program since its inception. Significant contributor to SWFWMD's excellent reuse program.

Name/Affiliation	Representing/Qualifications
Willie R. Horton, P.E. Director Broward County Office of Environmental Services	Represents utilities. Responsible for reuse and wastewater management in Broward County.
Thomas Lothrop, P.E. Director of Environmental Services City of Orlando	Represents the Florida Water Environment Association. Former chairman, FWEA Water Reuse Committee. Responsible for several award-winning reuse projects.
Robert L. Matthews, P.E. Camp Dresser & McKee, Inc. Ft. Myers	Represents the Florida Engineering Society. Major contributor to national ***Guidelines for Water Reuse***. Involved in many reuse projects in Florida.
Pepe Menendez, P.E. Florida Department of Health Tallahassee	Represents the Department of Health and the public health community. Member AWWA & WEF Water Reuse Committees
Donald Newnham, P.E. Altamonte Springs	Represents the Florida Section of the American Water Works Association. Former Public Works Director of Altamonte Springs. Championed development of the award-winning Project APRICOT.
Jeff Swartz, P.G. Florida DEP Tallahassee	Represents the DEP's ground water program. Extensive experience in land application and reuse projects. Expertise in hydrogeologic aspects of reuse projects. Developed DEP's LANDAP program.
Joseph V. Towry Field Operations Manager City of St. Petersburg	Represents the Florida Water & Pollution Control Operators Association. Chairman, Florida Water Reuse Committee. Manages St. Petersburg's award-winning, landmark reuse system.
Harley Young, Ph.D., P.E. South District Florida DEP Ft. Myers	Represents the Florida DEP district offices. Extensive experience in permitting reuse projects. Winner of WEF's prestigious Rudolph Award.

Appendix B

Summaries of Ground Water Recharge and Indirect Potable Reuse Projects

Project Summary: Tampa Water Resource Recovery Project

Location: Tampa, Florida

Type of Project: Surface water augmentation

Status: Pilot Study (completed). In November, 1998, Tampa Bay Water decided to implement a desalination project in lieu of the Water Resource Recovery Project.

Water Augmented: Reclaimed water was to be discharged into the Tampa Bypass Canal. Water from the Bypass Canal was to be used to augment flows in the Hillsborough River, which flows into the Hillsborough Reservoir (Tampa's primary source of drinking water).

Plant Capacity: Plant sizes evaluated included 15, 35, and 50 mgd.

Description of Treatment Train: Tampa's Howard F. Curren Wastewater Treatment Plant (a 70-mgd advanced treatment facility which currently discharges to Tampa Bay) was to be modified to include: preaeration, lime treatment and recarbonation, gravity filtration, GAC adsorption, and ozone disinfection.

Reclaimed Water Quality:

Parameter	Quality
Nitrate (as N)	1.3 mg/L
Chloride	139 mg/L
Total Dissolved Solids	461 mg/L
TKN (as N)	0.3 mg/L
TOC	1.9 mg/L
TOX	13 μg/L
THM	2.8 μg/L
Giardia	< Detection
Cryptosporidium	< Detection
Enterovirus	< Detection
Drinking Water Standards	Will Be Met
Turbidity	0.05 NTU

Notes: The pilot study was partially funded by the State of Florida and included extensive health effects studies.

The project has been funded by the EPA and the Southwest Florida Water Management District.

During the development of the permit, "Ecosystem Team Permitting" was used to refine the project to achieve the greatest net environmental benefits from the project.

Project Summary: Upper Occoquan

Location: Centreville, Virginia

Type of Project: Surface water augmentation.

Status: Operational.

Receiving Water: Bull Run, which flows into the Occoquan Reservoir. This reservoir is the source of drinking water for the Virginia suburbs of Washington, D.C.

Plant Capacity: Currently 27 mgd. The treatment plant is being expanded to 54 mgd.

Description of Treatment Train: Chemical clarification and two-stage recarbonation with intermediate settling, multi-media filtration, activated carbon, ion exchange, and chlorination/dechlorination.

Reclaimed Water Quality:

Parameter	Quality
Total Suspended Solids	0.30 mg/L
TKN	0.5 mg/L
COD	8.2 mg/L
TOC	2.90 mg/L
Nitrate	17.9 mg/L
Dissolved Oxygen	7.5 mg/L
Giardia	< Detection
Cryptosporidium	< Detection
Enterovirus	< Detection
Drinking Water Standards	Are Met
Turbidity	0.33 NTU

Notes: The Occoquan Policy mandated the construction of a state-of-the-art regional wastewater reclamation plant to replace the watershed's eleven small secondary treatment plants. The Upper Occoquan Sewage Authority was created to meet these provisions of the Occoquan Policy.

The Upper Occoquan Plant meets drinking water standards, although it is not required to do so.

Project Summary: Water Factory 21

Location: Orange County, California

Type of Project: Ground Water Recharge by Direct injection.

Water Augmented: A blend of reclaimed water and deep ground water is injected into four coastal aquifers (Talbert, Alpha, Beta, and Lambda Aquifers). The injected water serves to retard saltwater intrusion while augmenting the supply of potable water.

Flow: Water Factory 21 produces 15 mgd of reclaimed water which is blended with 7.6 mgd of deep well water before being injected.

Description of Treatment Train: Water Factory 21 includes: chemical clarification, recarbonation, multi-media filtration, granular activated carbon (GAC) or reverse osmosis, and chlorination and blending with deep well water. The water treated at Water Factory 21 is secondary effluent from an Orange County Sanitation District wastewater treatment facility.

Reclaimed Water Quality (Treated by RO):

Parameter	Quality
Total Dissolved Solids	61 mg/L
Chloride	18.4 mg/L
Fluoride	0.21 mg/L
Total Coliform Bacteria	< 1.0 / 100 mL
THM (in the blend)	9.7 μg/L
COD	3.0 mg/L
TOC	0.72 mg/L
Total Nitrogen (as N)	2.6 mg/L
Drinking Water Standards	Are Met
Turbidity	0.05 NTU

Notes: Originally, injection of reclaimed water for Water Factory 21 was intended to create a barrier to saltwater intrusion. However, reclaimed water also moves landward and augments the potable water supply.

In 1991, Water Factory 21's permit was revised to allow injection of 100% reclaimed water, which will eliminate the use of deep well water for blending.

Project Summary: Denver Potable Water Demonstration Project

Location: Denver, Colorado

Type of Project: Direct Potable Reuse

Status: Pilot Study (completed).

Plant Capacity: Potable reuse demonstration plant capacity 1.0 mgd

Treatment Train: Lime clarification, recarbonation, filtration, UV irradiation, activated carbon adsorption, reverse osmosis, air stripping, ozonation, and chloramination.

Reclaimed Water Quality (Treated by RO):

Parameter	Quality
Total Dissolved Solids	18 mg/L
Total Suspended Solids	< Detection
Chloride	19 mg/L
Fluoride	< Detection
Total Coliform	< Detection
TKN	5 mg/L
TOC	< Detection
TOX	8 µg/L
Sodium	4.8 mg/L
Giardia	< Detection
Cryptosporidium	< Detection
Drinking Water Standards	Were Met
Turbidity	0.06 NTU

Notes: This pilot project was designed to evaluate the potential for direct potable reuse. The project received federal funding and included extensive health effects studies. The study concluded that it was possible to produce a reclaimed water of high quality that would be of a quality equal to or better than potable water.

However, the City of Denver does not plan to implement direct or indirect potable reuse, at this time.

Project Summary: El Paso

Location: El Paso, Texas

Type of Project: Ground Water Recharge by Injection.

Status: Operational.

Water Augmented: Hueco Bolson Aquifer.

Plant Capacity: The Fred Hervey Water Reclamation Plant has a capacity of 10 mgd.

Treatment Train: High pH lime treatment, recarbonation, sand filtration, ozone disinfection, and GAC filtration

Reclaimed Water Quality:

Parameter	Quality
Total Dissolved Solids	670 mg/L
Chloride	171 mg/L
Fluoride	0.90 mg/L
Nitrate	1.6 mg/L
Sodium	164 mg/L
Giardia	< Detection
Cryptosporidium	< Detection
Drinking Water Standards	Are Met
Turbidity	0.14 NTU

Notes: The portion of reclaimed water not sold to the Newman Power Plant for cooling and boiler feed water is injected into the Hueco Bolson to recharge the ground water.

The final holding ponds are sampled every eight hours and analyzed for the permit parameters. If the nitrate or turbidity limits are violated, the reclaimed water is returned for additional treatment.

Project Summary: San Diego Water Repurification Project

Location: San Diego, California

Type of Project: Surface Water Augmentation

Status: Pilot Plant (completed). Full-Scale Demonstration Plant (completed). Planning for the full-scale 20-mgd project is underway.

Water Augmented: Reclaimed water will be discharged to San Diego's San Vincente Reservoir where it will be blended with imported water.

Plant Capacities: The pilot plant (Aqua II) had a capacity of 0.3 mgd. The demonstration plant (Aqua III) had a capacity of 1.0 mgd. The full-scale water reclamation facility proposed for the North City Water Reclamation Facility will be 20 mgd.

Description of Treatment Train: The Aqua III demonstration facility included: water hyacinth ponds, coagulation with lime, multi-media filtration, UV disinfection, cartridge filtration, aeration, activated carbon, and chlorination.

The full-scale repurification facility will include: activated sludge, reverse osmosis, coagulation, static mixing, flocculation, and high-rate downflow gravity filtration through anthracite coal.

Reclaimed Water Quality:

Parameter	Quality
Chloride	33.93 mg/L
Fluoride	< 0.125 mg/L
COD	< 15.0 mg/L
TOC	< 1.0 mg/L
Nitrate	1.81 mg/L
Sodium	16.99 mg/L
Drinking Water Standards	Will Be Met

Notes: The Aqua III study demonstrated that the process can reliably produce a reclaimed water that will meet drinking water standards. Health effects studies were performed which demonstrated the safety of the reclaimed water. The water reclamation facility removed between 99.9999% (6 log reduction) and 99.99999% (8 log reduction) of enterovirus.

Funding for the full-scale project is anticipated from the EPA, the Bureau of Reclamation, City of San Diego, San Diego County Water Authority, and the Metropolitan Water District of Southern California.

Appendix C

National Reuse Guidelines

Note: ***Guidelines for Water Reuse*** (3) were published by EPA and USAID in 1992.

Summary of National Guidelines for Water Reuse[1]

Types of Reuse	Treatment	Reclaimed Water Quality[2]	Reclaimed Water Monitoring	Setback Distances [3]	Comments
Urban Reuse All types of landscape irrigation, (e.g., golf courses, parks, cemeteries) -also vehicle washing, toilet flushing, use in fire protection systems and commercial air conditioners, and other uses with similar exposure to the water.	Secondary[4] Filtration[5] Disinfection[6]	pH = 6 - 9 < 10 mg/L BOD[7] < 2 NTU[8] No detectable fecal coliform/100 mL[9,10] 1 mg/L Cl_2 residual (min.)[11]	pH – weekly BOD – weekly Turbidity – continuous Coliform – daily Cl_2 residual - continuous	50 ft (15m) to potable water supply wells	See Table 19 for other recommended limits. At controlled-access irrigation sites where design and operational measures significantly reduce the potential of public contact with reclaimed water, a lower level of treatment, e.g., secondary treatment and disinfection to achieve < 14 fecal coli/100 mL, may be acceptable. Chemical (coagulant and/or polymer) addition prior to filtration may be necessary to meet water quality recommendations. The reclaimed water should not contain measurable levels of pathogens.[12] Reclaimed water should be clear, odorless, and contain no substances that are toxic upon ingestion. A higher chlorine residual and/or a longer contact time may be necessary to assure that viruses and parasites are inactivated or destroyed. A chlorine residual of 0.5 mg/L or greater in the distribution system is recommended to reduce odors, slime, and bacterial regrowth. See Section 2.4.3 for recommended treatment reliability.
Restricted Access Area Irrigation Sod farms, silvaculture sites, and other areas where public access is prohibited, restricted, or infrequent.	Secondary[4] Disinfection[6]	pH = 6 – 9 < 30 mg/L BOD[7] < 30 mg/L SS < 200 fecal coliform/100 mL[9,13,14] 1 mg/L Cl_2 residual (min.)[11]	pH – weekly BOD – weekly SS – daily Coliform – daily Cl_2 residual - continuous	300 ft (90 m) to potable water supply wells. 100 ft (30 m) to areas accessible to the public (if spray irrigation)	See Table 19 for other recommended limits. If spray irrigation, SS less than 30 mg/L may be necessary to avoid clogging of sprinkler heads. See Section 2.4.3 for recommended treatment reliability.
Agricultural Reuse – Food Crops Not Commercially Processed[15] Surface or spray irrigation of any food crop, including crops eaten raw.	Secondary[4] Filtration[5] Disinfection[6]	pH = 6 - 9 < 10 mg/L BOD[7] < 2 NTU[8] No detectable fecal coliform/100 mL[9,10] 1 mg/L Cl_2 residual (min.)[11]	pH – weekly BOD – weekly Turbidity – continuous Coliform – daily Cl_2 residual - continuous	50 ft (15m) to potable water supply wells	See Table 19 for other recommended limits. Chemical (coagulant and/or polymer) addition prior to filtration may be necessary to meet water quality recommendations. The reclaimed water should not contain measurable levels of pathogens[12]. A higher chlorine residual and/or a longer contact time may be necessary to assure that viruses and parasites are inactivated or destroyed. High nutrient levels may adversely affect some crops during certain growth stages. See Section 2.4.3 for recommended treatment reliability.

Types of Reuse	Treatment	Reclaimed Water Quality[2]	Reclaimed Water Monitoring	Setback Distances [3]	Comments
Agricultural Reuse – Food Crops Commercially Processed;[15] ***Surface Irrigation of Orchards and Vineyards***	Secondary[4] Disinfection[6]	pH = 6 – 9 < 30 mg/L BOD[7] < 30 mg/L SS < 200 fecal coliform/100 mL[9,13,14] 1 mg/L Cl_2 residual (min.)[11]	pH – weekly BOD – weekly SS – daily Coliform – daily Cl_2 residual - continuous	300 ft (90 m) to potable water supply wells. 100 ft (30 m) to areas accessible to the public	See Table 19 for other recommended limits. If spray irrigation, SS less than 30 mg/L may be necessary to avoid clogging of sprinkler heads. High nutrient levels may adversely affect some crops during certain growth stages. See Section 2.4.3 for recommended treatment reliability.
Agricultural Reuse – Non-Food Crops Pasture for milking animals; fodder, fiber and seed crops.	Secondary[4] Disinfection[6]	pH = 6 – 9 < 30 mg/L BOD[7] < 30 mg/L SS < 200 fecal coliform/100 mL[9,13,14] 1 mg/L Cl_2 residual (min.)[11]	pH – weekly BOD – weekly SS – daily Coliform – daily Cl_2 residual - continuous	300 ft (90 m) to potable water supply wells. 100 ft (30 m) to areas accessible to the public (if spray irrigation)	See Table 19 for other recommended limits. If spray irrigation, SS less than 30 mg/L may be necessary to avoid clogging of sprinkler heads. High nutrient levels may adversely affect some crops during certain growth stages. Milking animals should be prohibited from grazing for 15 days after irrigation ceases. A higher level of disinfection, e.g., to achieve < 14 fecal coli/100 mL, should be provided if this waiting period is not adhered to. See Section 2.4.3 for recommended treatment reliability.
Recreational Impoundments Incidental contact (e.g., fishing and boating) and full body contact with reclaimed water allowed.	Secondary[4] Filtration[5] Disinfection[6]	pH = 6 - 9 < 10 mg/L BOD[7] < 2 NTU[8] No detectable fecal coliform/100 mL[9,10] 1 mg/L Cl_2 residual (min.)[11]	pH – weekly BOD – weekly Turbidity – continuous Coliform – daily Cl_2 residual - continuous	500 ft (150 m) to potable water supply wells (minimum) if bottom not sealed	Dechlorination may be necessary to protect aquatic species of flora and fauna. Reclaimed water should be non-irritating to skin and eyes. Reclaimed water should be clear, odorless, and contain no substances that are toxic upon ingestion. Nutrient removal may be necessary to avoid algae growth in impoundments. Chemical (coagulant and/or polymer) addition prior to filtration may be necessary to meet water quality recommendations. The reclaimed water should not contain measurable levels of pathogens.[12] A higher chlorine residual and/or a longer contact time may be necessary to assure that viruses and parasites are inactivated or destroyed. Fish caught in impoundments can be consumed. See Section 2.4.3 for recommended treatment reliability.

Types of Reuse	Treatment	Reclaimed Water Quality[2]	Reclaimed Water Monitoring	Setback Distances [3]	Comments
Landscape Impoundments Aesthetic impoundments where public contact with reclaimed water is not allowed.	Secondary[4] Disinfection[6]	< 30 mg/L BOD[7] < 30 mg/L SS < 200 fecal coliform/100 mL[9,13,14] 1 mg/L Cl_2 residual (min.)[11]	pH – weekly SS – daily Coliform – daily Cl_2 residual - continuous	500 ft (150 m) to potable water supply wells (minimum) if bottom not sealed	Dechlorination may be necessary to protect aquatic species of flora and fauna. Nutrient removal may be necessary to avoid algae growth in impoundments. See Section 2.4.3 for recommended treatment reliability.
Construction Uses Soil compaction, dust control, washing aggregates, making concrete.	Secondary[4] Disinfection[6]	< 30 mg/L BOD[7] < 30 mg/L SS < 200 fecal coliform/100 mL[9,13,14] 1 mg/L Cl_2 residual (min.)[11]	BOD – weekly SS – daily Coliform – daily Cl_2 residual - continuous		Worker contact with reclaimed water should be minimized. A higher level of disinfection, e.g., to achieve < 14 fecal coli/100 mL, should be provided where frequent worker contact with reclaimed water is likely. See Section 2.4.3 for recommended treatment reliability.
Industrial Reuse Once through cooling	Secondary[4]	pH = 6 – 9 < 30 mg/L BOD[7] < 30 mg/L SS < 200 fecal coliform/100 mL[9,13,14] 1 mg/L Cl_2 residual (min.)[11]	pH –daily BOD – weekly SS – weekly Coliform – daily Cl_2 residual - continuous	300 ft (90 m) to areas accessible to the public.	Windblown spray should not reach areas accessible to users or the public.
Industrial Reuse Recirculating cooling towers	Secondary[4] Disinfection[6] (chemical coagulation and filtration[5] may be needed)	Variable, depends on recirculation ratio (see Section 3.3.1)		300 ft (90 m) to areas accessible to the public. May be reduced if high level of disinfection is provided.	Windblown spray should not reach areas accessible to users or the public. See Table 13 for additional recommended limits. Additional treatment by user is usually provided to prevent scaling, corrosion, biological growths, fouling and foaming. See Section 2.4.3 for recommended treatment reliability.
Other Industrial Uses	Depends on site specific use (See Sections 3.3.2 and 3.3.3)				

Types of Reuse	Treatment	Reclaimed Water Quality[2]	Reclaimed Water Monitoring	Setback Distances [3]	Comments
Environmental Reuse Wetlands, marshes, wildlife habitat, stream augmentation.	Variable Secondary[4] and disinfection[6] (min.)	Variable, but not to exceed: < 30 mg/L BOD[7] < 30 mg/L SS < 200 fecal coliform/100 mL[9,13,14]	BOD – weekly SS – daily Coliform – daily Cl_2 residual - continuous		Dechlorination may be necessary to protect aquatic species of flora and fauna. Possible effects on groundwater should be evaluated. Receiving water quality requirements may necessitate additional treatment. The temperature of the reclaimed water should not adversely affect ecosystem. See Section 2.4.3 for recommended treatment reliability.
Groundwater Recharge By spreading or injection into nonpotable aquifers.	Site specific and use dependent. Primary (min.) for spreading. Secondary[4] (min.) for injection.	Site specific and use dependent.	Depends on treatment and use.	Site specific.	Facility should be designed to ensure that no reclaimed water reaches potable water supply aquifers. See Section 3.6 for more information. For injection projects, filtration and disinfection may be needed to prevent clogging. See Section 2.4.3 for recommended treatment reliability.
Indirect Potable Reuse Groundwater recharge by spreading into potable aquifers.	Site specific. Secondary[4] and disinfection[6] (min.). May also need filtration[5] and/or advanced wastewater treatment.[16]	Site specific. Meet drinking water standards after percolation through vadose zone.	Includes, but not limited to the following: pH – daily Coliform – daily Cl_2 residual – continuous Drinking water standards – quarterly Other[17] – depends on constituent	2000 ft (600 m) to extraction wells. May vary depending on treatment provided and site-specific conditions.	The depth to ground water (i.e., thickness of the vadose zone) should be at least 6 feet (2 m) at the maximum ground water mounding point. The reclaimed water should be retained underground for at least 1 year prior to withdrawal. Recommended treatment is site-specific and depends on factors such as type of soil, percolation rate, thickness of vadose zone, native ground water quality, and dilution. Monitoring wells are necessary to detect influence of the recharge operation on the ground water. See Sections 3.6 and 3.7 for more information. The reclaimed water should not contain measurable levels of pathogens after percolation through the vadose zone.[12] See Section 2.4.3 for recommended treatment reliability.

Types of Reuse	Treatment	Reclaimed Water Quality[2]	Reclaimed Water Monitoring	Setback Distances [3]	Comments
Indirect Potable Reuse Groundwater recharge by injection into potable aquifers	Secondary[4] Filtration[5] Disinfection[6] Advanced wastewater treatment[16]	Includes, but not limited to the following: pH = 6.5 – 8.5 < 2 NTU[8] No detectable fecal coliform/100 mL[9,10] 1 mg/L Cl_2 residual (min.)[11] Meet drinking water standards	Includes, but not limited to the following: pH – daily Turbidity – continuous Coliform – daily Cl_2 residual – continuous Drinking water standards – quarterly Other[17] – depends on constituent	2000 ft (600 m) to extraction wells. May vary depending on site-specific conditions.	The reclaimed water should be retained underground for at least 1 year prior to withdrawal. Monitoring wells are necessary to detect influence of the recharge operation on the ground water. Recommended quality levels should be met at the point of injection. See Sections 3.6 and 3.7 for more information. The reclaimed water should not contain measurable levels of pathogens at the point of injection.[12] A higher chlorine residual and/or a longer contact time may be necessary to assure virus inactivation. See Section 2.4.3 for recommended treatment reliability.
Indirect Potable Reuse Augmentation of surface supplies	Secondary[4] Filtration[5] Disinfection[6] Advanced wastewater treatment[16]	Includes, but not limited to the following: pH = 6.5 – 8.5 < 2 NTU[8] No detectable fecal coliform/100 mL[9,10] 1 mg/L Cl_2 residual (min.)[11] Meet drinking water standards	Includes, but not limited to the following: pH – daily Turbidity – continuous Coliform – daily Cl_2 residual – continuous Drinking water standards – quarterly Other[17] – depends on constituent	Site specific	Recommended level of treatment is site-specific and depends on factors such as receiving water quality, time and distance to the point of withdrawal, dilution, and subsequent treatment prior to distribution for potable uses. See Section 3.7 for more information. The reclaimed water should not contain measurable levels of pathogens.[12] A higher chlorine residual and/or a longer contact time may be necessary to assure virus inactivation. See Section 2.4.3 for recommended treatment reliability.

Footnotes

1) These guidelines are based on water reclamation and reuse practices in the U.S., and they are especially directed at states that have not developed their own regulations or guidelines. While the guidelines should be useful in many areas outside the U.S., local conditions may limit the applicability of the guidelines in some countries (see Chapter 8). It is explicitly stated that the direct application of these suggested guidelines will not be used by AID as strict criteria for funding.
2) Unless otherwise noted, recommended quality limits apply to the reclaimed water at the point of discharge from the treatment facility.
3) Setback distances are recommended to protect potable water supply sources from contamination and to protect humans from unreasonable health risks due to exposure to reclaimed water.
4) Secondary treatment processes include activated sludge processes, trickling filters, rotating biological contactors, and many stabilization pond systems. Secondary treatment should produce effluent in which the BOD and SS do not exceed 30 mg/L.
5) Filtration means the passage of wastewater through natural undisturbed soils or filter media such as sand and/or anthracite.
6) Disinfection means the destruction, inactivation, or removal of pathogenic microorganisms by chemical, physical, or biological means. Disinfection may be accomplished by chlorination, ozonation, other chemical disinfectants, UV radiation, membrane processes, or other processes.
7) As determined by the 5-day BOD test.
8) The recommended turbidity limit should be met prior to disinfection. The average turbidity should be based on a 24-hour time period. The turbidity should not exceed 5 NTU at any time. If SS is used in lieu of turbidity, the average SS should not exceed 5 mg/L.
9) Unless otherwise noted, recommended coliform limits are median values from bacteriological results of the last 7 days for which analyses have been completed. Either the membrane filter or fermentation tube technique may be used.
10) The number of fecal coliform organisms should not exceed 14/100 mL in any sample.
11) Total chlorine residual after a contact period of 30 minutes.
12) It is advisable to fully characterize the microbiological quality of the reclaimed water prior to implementation of a reuse program.
13) The number of fecal coliform organisms should not exceed 800/100 mL in any sample.
14) Some stabilization pond systems may be able to meet this coliform limit without disinfection.
15) Commercially processed food crops are those that, prior to sale to the public or others, have undergone chemical or physical processing sufficient to destroy pathogens.
16) Advanced wastewater treatment processes include chemical clarification, carbon adsorption, reverse osmosis and other membrane processes, air stripping, ultrafiltration, and ion exchange.
17) Monitoring should include inorganic and organic compounds, or classes of compounds, that are known or suspected to be toxic, carcinogenic, teratogenic, or mutagenic and are not included in the drinking water standards.

Appendix D

Peer Review of the Draft Risk Impact Statement

Peer Review Panel

The draft risk impact statement (dated October 31, 1997) was distributed to the following three individuals for peer review:

Robert C. Cooper, Ph.D.

- Professor Emeritus, University of California at Berkeley
- Expert in microbiology and the public health aspects of reuse.
- Involved in risk impact studies of reuse activities
- Represented U.S. at the 1991 Israel/U.S. Reuse Conference

James Crook, Ph.D., P.E.

- Black & Veatch in Boston, Massachusetts
- Former head of the California Reuse Program
- Chairman, Water Environment Federation's Water Reuse Committee
- Member, Florida Reuse Technical Advisory Committee
- Chairman, National Academy of Sciences Committee on Indirect Potable Reuse
- Primary author of EPA's ***Guidelines for Water Reuse***
- Represented U.S. at the 1991 Israel/U.S. Reuse Conference

Kenneth Thompson

- Director of Water Quality, Irvine Ranch Water District in Irvine, California
- Chairman, American Water Works Association's Water Reuse Committee
- Associated with one of the world's foremost reuse systems
- Involved in an innovative risk assessment of reuse activities

The Charge to the Peer Reviewers

The peer reviewers were requested to review the draft risk impact statement (RIS) for adequacy and accuracy.

Copies of Florida's existing and proposed rules related to reuse were provided to the peer reviewers as background information solely to assist in their review of the draft RIS.

The following sections address the comments offered by the peer reviewers. Where the reviewers did not number their comments, numbers within circles have been added to identify individual comments. The full text of comments received from the peer reviewers are included in this appendix.

Dr. Robert C. Cooper

1. The compliments are acknowledged and appreciated. We concur that Florida's regulations, like California's, are protective of public health.

2. We concur with Dr. Cooper's conclusion that Florida's rule requirements are adequate to protect public health. As noted, reuse in the United States has developed an excellent track record for protection of public health.

3. We concur that filtration, high levels of disinfection, treatment facility reliability measures, and continuous monitoring are essential for reuse activities featuring potential for human contact with reclaimed water. Florida's regulations provide for these features and controls.

4. We concur that Florida's reuse requirements are adequate to protect public health. As noted, the risk assessment included in the RIS supports this conclusion.

Dr. James Crook

a. The compliments are acknowledged and appreciated.

1. The language in the draft RIS and the text suggested by Dr. Crook are very similar, both in wording and in meaning. The three paragraphs that follow the paragraph in question provide the expansion requested. However, this paragraph was expanded during preparation of the final RIS.

2. In Florida, the statement in the draft RIS is accurate. Within the Department of Environmental Protection, programs for reuse, domestic wastewater, industrial wastewater, ground water, surface water, drinking water, and underground injection control all reside within the same division. These programs are integrated into any rulemaking activity that affects the other programs. In addition, all standards in each of these program areas are adopted by the Environmental Regulation Commission. Significant revisions were made to the ground water standards in Chapter 62-520, F.A.C., in 1994 and the wellhead protection rule was adopted in 1995. All of these programs were actively involved in these

rulemaking activities, and the significance of the interactions of the programs was considered. The fact that there were significant numbers of reuse, domestic wastewater, industrial wastewater, septic tank, storm water, and other inputs to ground water was known by the individuals and programs involved in these rulemaking activities. The text in the RIS was expanded to include these observations.

3. This paragraph was revised to reflect the turbidity guideline contained in the ***Guidelines for Water Reuse***. It should be noted that Florida relies on both TSS (as a permit limit) and turbidity (as a means of operational control).

4. As noted, the TOC limitation has been discussed at several meetings of the Reuse TAC. The proposed 3.0 mg/L limit (tightened from the existing limit of 5.0 mg/L) represents the collective recommendation of the Reuse TAC. In response to this comment, the proposed TOC limitation was discussed at the July 1998 public workshop, and the Reuse TAC once again endorsed the proposed 3 mg/L TOC limit as being sufficient.

5. The proposed rules do not require specific treatment technologies, such as GAC, RO, or other AWT processes, be used as part of the multiple barriers for control of organics. This is consistent with the philosophy of allowing the design engineer to select the most appropriate technologies for a particular application. The Department reviews the design in detail to ensure that it provides reasonable assurances that rule requirements, including the required multiple treatment barriers are provided. In addition, it appears that GAC, RO, or other AWT process would be needed to achieve the TOC and TOX limits.

6. In response to this comment, the possible need for TOC limits on discharges to Class I surface waters was discussed at the July 1998 workshop. In addition, the draft permit for the Tampa Water Resource Recovery Project was reviewed at the workshop. At the workshop, the Reuse TAC endorsed the addition of the 3 mg/L TOC limit for discharges to Class I waters. The proposed rules and the RIS have been revised accordingly.

7. This text has been revised accordingly.

8. The 1.0 mL dose for public access and residential irrigation systems has been used by previous investigators.

9. The units are cysts or oocysts per 100 liters. Units have been added to the final RIS.

10. The ranking of relative risks in Tables 12 and 13 is based on professional judgment by DEP staff has been noted in the final RIS.

11. Dr. Crook's suggestion for moving the "vehicle washing," "commercial laundries," and "ice rinks" further up in Table 13 was considered during preparation of the final RIS.

12. Dr. Crook's opinion is noted. However, without specific documentation to the contrary, DEP's position remains that the existing ground water standards, which are based on the

primary and secondary drinking water standards coupled with the minimum criteria (free froms) are protective of public health.

13. The proposed 3.0 mg/L TOC limit is based on recommendations from the Reuse TAC. It is assumed that members of the Reuse TAC considered public health, available technologies, costs, and other factors into their individual recommendations. The cost estimates are provided here only as a point of reference.

14. As discussed in the response to Comment 5, further definition of multiple barriers will not be pursued.

15. The paragraph in question deals specifically with salinity barrier wells. For this type of project, migration of reclaimed water to a public water supply well is prohibited. The 1,000-foot setback distance is proposed as an additional barrier. As described in the next paragraph in the draft RIS, if migration to a public water supply well were to occur (or was projected to occur), additional treatment requirements would be imposed.

    The possibility of using the 2,000-foot setback distance from the EPA's Guidelines for Water Reuse was discussed again at the July 1998 workshop. At the workshop, the Reuse TAC again rejected the 2,000-foot setback distance.

16. The text was refined in the final RIS to reflect the fact that there was a single earlier study that was published in several different reports over a period of several years.

17. The 24-hour criteria simply continues existing rule requirements. It is interesting to note that at a stream velocity of one foot per second, this translates to an upstream distance of over 16 miles. If the position is taken that any upstream discharge that results in a drop of "reclaimed water" entering a downstream water intake would result in the categorization of virtually every municipal (and industrial) discharge along the Ohio, Missouri, Tennessee, Mississippi Rivers (and other streams) as being indirect potable reuse. Of course any surface water discharge must result in compliance with downstream water quality standards -- including standards for downstream Class I surface waters (potable supplies). Also, Class I waters generally extend significantly upstream from a reservoir or lake used for public water supply. In some cases, Class I waters extend all the way upstream to the origins of tributary streams.

18. This comment is related to Comment 17.

19. At the December 1997 public workshop, it was agreed that the proposed rules dealing with manufacture of paper would be withdrawn. As a result, this topic is not included in the final RIS.

20. At the December 1997 public workshop, it was agreed that the proposed rules dealing with recreational impoundments would be withdrawn. As a result, this topic is not included in the final RIS.

21. The issue of monitoring for the protozoan pathogens was discussed in detail at the July 1998 workshop. Dr. Crook's suggestions were considered by the Reuse TAC, at the workshop. While the approach suggested by Dr. Crook was not endorsed by the Reuse TAC, significant refinements in the proposed pathogen monitoring were made. The final RIS has been revised to reflect the Reuse TAC's recommendations for pathogen monitoring.

22. In essence, Dr. Crook suggests establishing a "no detectable" pathogen standard (or standards, since several classes of organisms, and many individual organisms would be involved). This would equate to the establishment of numeric criteria for these organisms (the detection levels). This concept has been discussed and rejected by the Reuse TAC on several occasions, including the July 1998 workshop. Reclaimed water generated by facilities in Florida has been shown to be "essentially pathogen free" -- pathogens are normally absent, although they may be occasionally found in low concentrations. Information on reclaimed water quality is contained in the RIS along with some basic risk assessment data reflecting reclaimed water quality. Given risk analysis data supports the acceptability of reuse practices, it would be very difficult to justify more stringent pathogen standards. Also, it probably can be argued that no water is completely "pathogen free." Certainly, data presented in Tables 10 and 11 in the draft RIS demonstrates that even treated drinking water may, on occasions, contain measurable levels of pathogens.

23. The 1998 NRC report dealing with potable reuse was discussed at the July 1998 workshop. The provisions of the draft permit for the Tampa Water Resource Recovery Project also were reviewed. The possibility of requiring *in vivo* toxicological testing was discussed, but was not endorsed by the Reuse TAC. Florida's existing rules already require mutagenicity testing.

Mr. Kenneth Thompson

1. The compliment is acknowledged and appreciated.

2. Florida's surface water quality standards are generally consistent with the so called "Goldbook" and other guidance documents.

3. This editorial change was made in the final RIS.

4. This editorial change was made in the final RIS.

5. These fecal coliform limits are accurate.

6. Mr. Thompson suggested replacing total nitrogen (TN) with total inorganic nitrogen (TIN) in the proposed rules. This suggestion appears to have merit, particularly when a subsequent conversation revealed that research has demonstrated that organic nitrogen has not been found to convert readily to inorganic forms. This recommendation was discussed at the July 1998 public workshop. However, the Reuse TAC concluded that the impact of

using TIN probably would not be significant, and the use of TN was more conservative. As a result, the Reuse TAC endorsed continued use of TN.

The proposed TOC limit of 3.0 mg/L (average) is based on recommendations from the Reuse TAC. Mr. Thompson's recommendation of a TOC limit of 1.0 mg/L also was discussed at the July 1998 public workshop. The Reuse TAC endorsed the use of a 3 mg/L TOC limit.

7. As discussed in Comment 6, the suggestion to use TIN appeared to have promise. However, the Reuse TAC endorsed continued reliance on TN at the July 1998 workshop.

   Total dissolved solids (TDS) are regulated as a secondary drinking water parameter (limit is 500 mg/L) and are included in existing rule requirements.

8. As discussed in Comment 6, the Reuse TAC endorsed the continued use of TN at the July 1998 workshop.

9. This item in Table 3 deals with discharges to surface waters that are directly connected to potable ground water. Surface water quality standards must be met. In addition, compliance with the ground water standards will be required at the point(s) where the water enters the ground water system. A note has been added to this table indicating that this applies to Class III surface waters.

10. The 12 mg/L nitrate standard is an existing rule requirement for rapid-rate systems regulated by Part IV of Chapter 62-610, F.A.C. Justification for, or support for changing this 12 mg/L nitrate standard to either TN or TIN has not been offered during this rulemaking activity.

11. This item relates to ASR in Class G-IV ground waters having TDS greater than 10,000 mg/L. Given their salinity, these aquifers may have relatively limited potential for ASR as part of a reuse system. While providing the full level of treatment and disinfection before injection may be desirable under some (perhaps most) circumstances, the intent is to provide the designers some flexibility in developing their ASR system.

12. Mr. Thompson's recommendation for use of a 10 mL dose for hose bibb applications is noted.

13. While use of a 100-mL dose may be very conservative, it has been used by some investigators, notably Dr. Joan Rose.

14. The truth of this statement is recognized.

15. The proposed rules will require that permittees monitor for Giardia and Cryptosporidium. The form to be used for reporting the results of this monitoring will require reporting the total concentrations of Giardia cysts and Cryptosporidium oocysts. In addition, the

permittee will be given the opportunity to also report concentrations of "viable" cysts and oocysts, if he/she chooses to investigate the viability of the cysts and oocysts.

16. The suggested re-ranking of relative risks in Table 12 was considered during development of the final RIS is developed. Mr. Thompson suggested moving surface discharge concepts and septic tanks further up on the table, while moving ASR and salinity barriers lower.

17. The suggested re-ranking of relative risks in Table 13 was considered during development of the final RIS is developed. The changes proposed by Mr. Thompson are considered relatively minor. The most significant changes would move the edible crop irrigation and vehicle washing activities higher on the relative risk scale.

18. Swimming is not addressed in existing or proposed rules and there are no reuse systems in Florida that provide for swimming in waters augmented with reclaimed water.

19. As noted in Comment 6, tightening the TOC limit to 1.0 mg/L was considered at the July 1998 workshop. In fact, California's proposed ground water recharge rules were reviewed at the workshop. At the workshop, the Reuse TAC once again endorsed the proposed 3 mg/L TOC limit.

20. As discussed in previous comments, the possibility of replacing TN with TIN was discussed at the July 1998 workshop. After the discussion, the Reuse TAC endorsed continued reliance on TN.

21. Clarifying language has been added to the final RIS.

22. As noted in Comment 6, tightening the TOC limit to 1.0 mg/L was considered at the July 1998 workshop. The potential for adding a TOC goal of 1 mg/L at the point of withdrawal also was discussed. The Reuse TAC endorsed a reclaimed water TOC limit of 3 mg/L at the point of injection and did not endorse a TOC goal at the point of withdrawal. It should be noted that a 3:1 dilution in the receiving ground water system coupled with the 3 mg/L TOC limit will result in a TOC at the point of withdrawal of 1 mg/L.

23. This statement has been revised in the final RIS.

24. The key difficulty is the lack of a universally accepted treatment train that would serve as the BAT. In addition, the underlying philosophy in Florida's rules has been to provide the applicant and the designer flexibility in their design process. As technology evolves, a rigid BAT in rule may restrict innovation.

25. Concerns with defining a BAT are noted in the response to Comment 24.

26. In a subsequent conversation, it was learned that this comment contained a typographical error -- "C+" should be replaced with "CT."

Currently, detailed disinfection requirements are contained in Chapter 62-600, F.A.C. If additional details are needed for the proposed disinfection requirements, they will be added to Chapter 62-600, F.A.C., when that chapter is next opened for revision.

27. See the response to Comment 26.

28. Florida's reliance on TSS dates back to the original experimental work that served as the basis for our high-level disinfection criteria. We also employ turbidity for operational control in association with the operating protocol.

29. See the response to Comment 28.

30. This is a good observation. Water balances could be required as part of a permit application or as a permit condition under existing rules.

31. We concur.

32. The existing annual reuse report form currently requests data on the volumes injected and recovered over an annual cycle for an ASR system. This will enable identification of projects functioning in a fashion more akin to injection than ASR.

33. The compliment is acknowledged and appreciated.

Robert C. Cooper, Ph.D.
4863 Venner Rd.
Martinez, California 94553

February 11, 1998

David W. York, Ph.D.
Reuse Coordinator
Department of Environmental Protection
Twin Towers Office Building
2600 Blair Road
Tallahassee, Florida 32399-2400

Dear Dr. York:

1. As per your request I have examined the proposed phase II revisions to Florida's water reuse rules. As my area of expertise is in waterborne infectious disease I was particularly interested in that aspect of your documents. In this regard I found the document to be quite complete and the regulations to be similar to those applied by a number of states, including California, with which I am most familiar. There are some minor differences but in my opinion these differences do not impact on the public health.

2. One must assume that that the effluvia from a human population will contain infectious agents

to a greater or lesser degree; thus, the rational for public health concern when people are exposed

to such reclaimed materials. The primary means for the protection of the public is to treat the water for the removal of pathogenic agents and/or limit the degree of exposure of humans to the product. The treatment processes required by Florida and associated exposure restrictions are adequate for this purpose. The experience in California using similar standards has been very positive. There has been no epidemiological evidence that infectious disease transmission has occurred because of exposure to reclaimed water that meets these kinds of requirements. It is my understanding that Florida has had the same experience.

3. I have been involved in a number of demonstration projects in which the reclaimed water was to be used in a manner such that human contact would be significant, such as crop irrigation, swimming etc. The treatment train used in these projects have included secondary treatment, filtration and disinfection (Known as "Title 22" in California). This type of treatment train has been evaluated by extensive monitoring as well as being challenged with huge doses of viral and parasitic agents; in every case the process has been shown to effectively remove agents of infectious disease (In all these instances the chlorine dose requirement was high - I am uncertain as to the Florida disinfection requirements). We know that these processes are capable of producing an acceptable water, but the most important public health issue is the reliability of the process. In this regard your regulations should include provisions to maintain treatment plant reliability, such as built in redundancy and adequate in-time monitoring for the timely detection of problems.

4. The Florida requirements include adequate protection from cross connections with the potable supply, criteria for aerosol drift and distance from wells. The infectious disease risk values given in your *Risk Impact Statement* are typical of the numbers seen using the type of risk models described. The risk endpoint is infection and not disease and the risk values tend to be quite conservative. The risk numbers produced **(10^{-8} to 10^{-5})** are in a range that is generally acceptable to health jurisdictions.

In my opinion these regulations appear to be adequate for the protection of the public's health.

Sincerely yours,

Robert C. Cooper, Ph.D.
Professor Emeritus
University of California, Berkeley

BLACK & VEATCH

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18 February

David W. York, Ph.D., P.E.
Reuse Coordinator
State of Florida
Department of Environmental Protection
Twin Towers Office Building
2600 Blair Stone Road
Tallahassee, FL 32339-2400

Dear Dr. York:

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Thank you for giving me the opportunity to review the *Draft Risk Impact Statement* on Phase II Revisions to Chapter 62-610, F.A.C. It is a well-written, comprehensive document addressing the risks associated with the reuse of reclaimed water in Florida. My comments on the document are as follows:

1. Page 3, last paragraph: It is stated that "Some individuals may argue that ground water standards (based on drinking water standards) may not adequately reflect concerns related to discharge of treated reclaimed water and effluent to the ground water." It would be more accurate to say, "Some individuals argue that ground water standards (based on drinking water standards) do not adequately----" I agree with that revised statement, based, in part, on the recognition that the drinking water standards are based on using the most protected sources of supply available. Furthermore, sewage is known to contain a myriad of chemical constituents not likely to be present in many "natural" waters; thus, merely meeting current drinking water standards does not assure that water is safe for potable purposes. I believe the last paragraph on Page 3 should be expanded to explain the rationale for the argument.

2. Page 4, second paragraph: It states "When considering the significance of discharges to ground water in Florida, it is impossible to conclude...". That's an opinion you have formed that may or may not be in accord with opinions by some others. I suggest that you soften that sentence by replacing "Impossible to conclude" with "unlikely".

3. Page 6, last paragraph: After the second sentence in this paragraph, I suggest adding "The guidelines recommend that the average turbidity prior to disinfection not exceed 2 NTU, based on continuous turbidity monitoring. They also indicate that continuously monitored turbidity is superior to daily suspended solids measurements as an aid to treatment operation." I would then begin the next sentence with "However, if total suspended solids are used..."

4. Page 9, Table 3: To reiterate an opinion I have expressed at several reuse TAC meetings,

I believe that the proposed TOC limit of 3 mg/L is too liberal, and organics removal processes should be specifically required to reduce the TOC to 1 mg/L or less. While our existing information does not permit the establishment of a TOC limit based on health effects data, it is prudent to attain the lowest practical level in light of the unknowns associated with trace organics that may be present in treated wastewater.

5. Page 9, Table 3: While I agree with the multiple barrier approach, one may argue that secondary treatment and filtration provide multiple barriers for organics removal. I'm sure this is not your intent. GAC, RO, or other AWT processes would be required to achieve the organics removal necessary to meet the TOC and TOX requirements; thus, it would be useful to revise the proposed regulations to include a requirement that AWT processes are required for organics removal and are subject to approval by DEP.

6. Page 9-13, Table 3: The requirements for discharges to Class I surface waters are not as restrictive as the requirements for ground water recharge with reclaimed water, e.g., they are less restrictive regarding organics removal treatment processes and limits for TOC. I assume this inconsistency is due, in part, to the need to conform to existing regulations regarding surface water discharges. However, in my opinion, the requirements for surface water discharges into drinking water sources of supply are not restrictive enough.

7. Page 16, last paragraph: It states that "When analyzing a water sample for enterovirus, one normally is not able to identify individual viruses that are present." Is this true, or is a function of cell cultures used, analytical equipment, laboratory capabilities, and cost?

8. Page 16, Table 4: The exposure (ingestion?) for irrigation projects is estimated to be 1 mL/day. What is this based on? Would a higher estimate be more accurate, considering the potential contact with the grass, ground, or objects that were previously wet with reclaimed water? The same comment applies to the last paragraph on Page 17.

9. Page 23, Table 10: The units are missing from the columns headed "Average" and "Range".

10. Pages 25-27, Tables 12 and 13: A reference should be provided for these tables.

11. Page 27, Table 13: I recommend that "Vehicle washing", "Water supply in commercial laundries", and "Ice making for ice rinks" be kept in the same order but moved up to follow "Use in open cooling towers".

12. Page 28, fourth paragraph: I disagree with the sentence "As noted previously, it has been assumed that treated water meeting Florida's primary and secondary drinking water standards is safe for human consumption and the risks of drinking these waters represents a reasonable and acceptable risk to public health." As previously stated in my first comment, merely meeting the drinking water standards does not necessarily assure that the water is safe.

13. Page 30, fourth paragraph: This paragraph seems to imply that the decision to select a TOC limit of 3 mg/L is based mainly on cost. Although costs should be taken into account during regulatory development, the main goal is health protection, which should not be compromised for the sake of making a water reuse application cost-effective.

14. Page 31, first full paragraph: Requiring multiple barriers is laudable, but the language is somewhat vague and may be misinterpreted (see Comment #5). Can multiple barriers be better defined in the regulations?

15. Page 33, fourth full paragraph: Based on aquifer conditions**,** a separation distance of 1,000 feet between injection wells and potable water extraction wells may or not be adequate to assure a reasonable reclaimed water residence time in the underground. I am in favor of the proposed California criteria for this situation, i.e., a separation distance of 2,000 feet between injection and extraction wells and a residence time in the underground of at least one year for the reclaimed water.

16. Page 34, third full paragraph: The last sentence in this paragraph states "This **is** the same conclusion drawn by several other health studies in Los Angeles County in the mid-1980s."
    What other health studies are you talking about? I am aware of only one other epidemiological study in Los Angeles County. It was completed in the early 1980s and involved essentially the same study area as the 1996 study.

17. Page 35, fourth full paragraph: Why are "….minimal requirements imposed on discharges located more than 24 hours travel time of Class I waters."? Are there data to indicate that there is a substantial improvement in the wastewater component after 24 hours of travel?

18. Page 36, Second full paragraph: It is not clear to me why surface water discharges located more than 24 hours travel time to Class I waters are not considered to be indirect potable reuse. The fact that the definition precludes it as a type of indirect potable reuse doesn't change the actual situation. Such discharges do result in indirect potable reuse.

19. Page 40, last two paragraphs: Although I don't believe it to be a problem, it would be worthwhile to mention any potential health effects from chemicals in reclaimed water that may be incorporated into paper products and subsequently desorbed into food or other products. I know of no data on this subject.

20. Pages 42, last paragraph to Page 43, first two lines: It is important to mention that the recreational lakes at Santee are used for boating and fishing but not full-body contact, i.e. swimming.

21. Page 43, last paragraph: Parasite monitoring at a facility once every five years will not provide much useful information regarding water quality. It's far too infrequent to have any meaningful value. A more comprehensive monitoring program would be to have monthly monitoring for the first year and reducing the frequency to quarterly for the next two years. Depending on results, monitoring could then be further reduced to annual samples or discontinued.

22. There is the lingering question I have always had about the level of disinfection, specifically the chlorine residual and contact time, to assure virus inactivation. Florida's regulations are similar to, but not quite as restrictive as, those in California for most uses. While the EPA *Guidelines for Water Reuse* are similar to Florida's reuse regulations with regard to disinfection, the EPA guidelines state that "The reclaimed water should not contain measurable levels of pathogens." and indicate that the water should be fully characterized upon implementation of a project to determine adequate disinfection conditions. Some public health concerns may be allayed if the Florida regulations

specifically stated that reclaimed water requiring high level disinfection shall not contain measurable levels of pathogens.

23. The *Draft Risk Impact Statement* does not mention or address the need for toxicological testing of reclaimed water used for indirect potable reuse. It is noteworthy that an NRC report currently being finalized, *Issues in Potable Reuse: The Viability of Augmenting Di4nking Water Supplies with Reclaimed Water,* recommends *in vivo* toxicological testing of reclaimed water used for indirect potable reuse.

Although I don't believe that the Florida water reuse regulations are as restrictive as they should be in some cases, the *Draft Risk Assessment Statement* is a good primer on the subject. Please contact me if you have any questions or comments regarding my review of the document.

Sincerely,
BLACK & VEATCH

James Crook, Ph.D., P.E.

IRVINE RANCH WATER DISTRICT
15600 Sand Canyon Ave., P.O. Box 57000, Irvine, CA 92619-7000 (714) 453-5300

February 27, 1998

David York, Ph.D., P.E.
Reuse Coordinator
Department of Environmental Protection
Twin Towers Office Building
2600 Blair Stone Road
Tallahassee, Florida 32399-2400

Subject: Peer Review of Draft Risk Impact Statement

Dear Dr. York,

1 I would like to thank you for the opportunity to review the Florida Department of Environmental Protection Draft Risk Impact Statement. I would like to commend your staff on the overall quality of the document which will important guidance for the advancement of water reuse in the State of Florida. Below are comments for specific sections of the document.

2 **PAGE 3 (Surface Water Paragraph 1)**

Comment: Is this Policy Consistent with Goldbook Standards?

Class I waters are defined as surface waters used for public water supply. In some instances, water quality standards for Class I waters are more stringent than standards for Class II shellfishing waters or for Class III recreation waters.

3 **PAGE 4 (Paragraph 1)**

Comment: Should be wastewater.

"…Ground…"

4 **PAGE 4 (Paragraph 5)**

Comment. discharges to ground water

... ground water discharges...

5 **<u>PAGE 5 (Table 2)</u>**

Column 1 Row 3
200 (a) comment: seem high
Column 1 Row 4
200 (b) comment: seem high

6 **<u>PAGE 9 (Second Column 1st Paragraph)</u>**

TN: 10 mg/L (average)

Comment: Use TIN not TN/TOC <1
Reduce Stds if demonstrated Recovery and reduced loss into potable aquifer. TIN not TN, many not need a Nitrogen standard since desalting will probably be needed.

7 **<u>PAGE 10 (Table 3)</u>**

<u>1st Paragraph 2nd Column:</u> TN: 10 mg/L (average)

<u>2nd Paragraph 2nd Column:</u> TN: 10 mg/L (average)

<u>3rd Paragraph 2nd Column:</u> TN: 10 mg/L (average)
1000 ft. to potable wells [Why? If not used for potable]

<u>4th Paragraph 2nd Column:</u> TN: 10 mg/L (average)

<u>5th Paragraph 2nd Column:</u> TN: 10 mg/L (average)

Comment: Use TIN
General Comment: I do not see any TDS Limits Proposed?

8 **<u>PAGE 11 (Table 3)</u>**

Comments:

<u>1st Row 2nd Column:</u> TN – (change to TIN)

<u>3rd Row 2nd Column:</u> TN – (change to TIN)
[Side Note: Surface water standards should be adequate.]

<u>4th Row 2nd Column:</u> TN - (change to TIN)

9 **<u>PAGE 11 (Table 3 – 4th Column 3rd Row)</u>**

Comment: Be more specific and relate standard to non-potable surface waters.

10 **<u>PAGE 11 (Table 3 – 3rd Column 2nd Row)</u>**

Comment: 12 mg/L (max as N) [Use TIN 10 for consistency]

11 **PAGE 13 (Table 3 – 2nd Column 1st Row)**

1. Meet requirements for Class I wells with treatment upon recovery or

Comments: Treatment prior to injection seems to be the best approach.

12 **PAGE 16 (Table 4 – 2nd Row)**

Comment: 100 ml. (This seems too high for residential hosebibs and would recommend to reduce by 90%)

13 **PAGE 16 (1st Paragraph)**

Comment: Ingestion of 100 ml seems too high for the majority of water reuse applications.

14 **PAGE 16 (Below Table 6)**

Comment: The problem with very conservative assumptions is that they create too high of risk levels.

15 **PAGE 21 (Paragraph 6)**

The proposed revisions to Florida's reuse rules include periodic monitoring for Cryptosporidium and Giardia within water reclamation facilities that provide high-level or "drinking water" disinfection.

Comment: Will this include viability testing as well? If not what will DEP be able to do with the data?

16 **PAGE 25-26 (Table 12 - Relative Risks Associated with Reuse Activities)**

Comment: I would suggest list below to reorder the activities

1, 3, 4, 5, 7, 10, 9, 11, 12, 16, 2, 6, 8, 13, 14, 15, 17, 18, 19, 20, 21, 22, 23, 24

17 **PAGE 27 (Table 13 - Relative Risks Associated with Reuse Activities Allowed by Part III)**

Comment: change order accordingly

3, 4, 1, 2, 5, 6, 10, 7, 8, 9, 11, 12, 13, 14. 15, 17, 16

18 *Comment:* Why isn't swimming in restricted and non-restricted impoundments included?

19 **PAGE 29 (Last section "Proposed Rule Revisions")**

2. Tightening the total organic carbon (TOC) limit from 5 mg/L average (9 mg/L maximum) to **3 mg/L** average (5 mg/L maximum).

Comment: Go to 1 mg/l for Direct Injection.

20 3. *Adding a total nitrogen limit of 10 mg/L (average).*

Comment: TIN more practical

21 **PAGE 30 (Paragraph 3)**

TOC Limits: TOC by itself does not have a direct health significance.

Comment: Too much is uncharacterized to make this determination.

22 **PAGE 30 (Paragraph 4)**

Comment: I would recommend that the TOC goal should be 1 mg/l of wastewater TOC @ point of withdrawal.

23 **PAGE 30 (Paragraph 6)**

This total nitrogen standard probably will not result in increased costs, since treatment technologies designed to achieve the TOC and total organic halogen (TOX) limits likely will @ remove nitrogen well below the IO mg/L limit.

Comment: TN + TC Removal Processes are different and additional costs may occur.

24 **PAGE 30 (Paragraph 7)**

Comment: It would be better to develop a standard BAT and only revise pilot demonstrations for deviations.

25 **PAGE 31 (Paragraph 3)**

Comment: BAT would accomplish this also.

26 **PAGE 31 (Paragraph 5)**

Comment: Why not develop a C+ for different disinfectant including filter performance requirements.

27 **PAGE 31 (Paragraph 7)**

Comment: Same comment as above

28 **PAGE 31 (Paragraph 8)**

Comment: Secondary turbidity would provide better protection to the filters.

29 **PAGE 31 (Paragraph 8)**

Comment: Fine turbidity would not be identified in the SS test and not provide a good indicator for pathogen removal.

30 **PAGE 37 (First Paragraph)**

Comment: A requirement to demonstrate water loss would allow for a quick determine of problem ponds.

31 **PAGE 37 (5th Paragraph)**

Comment: Wetlands are great denitrifiers. Dr. Alex Home, University of California, Berkeley, has broken new ground in this area.

32 **PAGE 38 (Last Paragraph)**

Comment: Add an annual water balance requirement to identify systems that allow a large amount of less water into the G.W. table.

33 In summary, the comments noted above are fairly minor in nature due to the overall high quality of the document. If you have any question regarding the comments above, please feel free to contact me at (714) 453-5850. Again, thank you for the opportunity to serve as part of the Peer Review Panel. I look forward to us sharing information on different reuse projects in the future.

Sincerely Yours,

Kenneth Thompson
Director of Water Quality