U.S. NUCLEAR REGULATORY COMMISSION

ENVIRONMENTAL STANDARD REVIEW PLAN

5.3.4 IMPACTS TO MEMBERS OF THE PUBLIC

REVIEW RESPONSIBILITIES

Primary— Organization responsible for the review of nonradiological impacts.

Secondary— None

I. AREAS OF REVIEW

This environmental standard review plan (ESRP) directs the staff's evaluation of the human health impacts associated with the plant's cooling system. This includes impacts from etiological agents such as microorganisms, parasites, and thermo-stable viruses, formerly referred to collectively as thermophilic microorganisms, and from noise resulting from the operation of the cooling system.

The scope of this ESRP includes: (1) background information on etiological agents that could negatively affect human health, (2) methods for evaluating the potential for an increase in the numbers of these etiological agents as a result of thermal discharges, and (3) the potential for noise resulting from the plant's cooling system. Noises that are generated by the plant's paging system or from transmission wires and associated substations are addressed in ESRP 5.6.3 and are not discussed further in this ESRP.

Review Interfaces

The reviewer for this ESRP should obtain input from and provide input to the reviewers for the following ESRPs, as indicated:

- ESRP 1.4. Obtain information on any new and significant information related to ESRP 5.3.4.

- ESRPs 3.4.1 and 3.4.2. Obtain a description of the cooling system and its operational modes, a description of the location of thermal discharges for the plant, and estimated noise levels.

- ESRP 5.3.2.1. Obtain an indication of the temperature increases expected for the aquatic environments that are subject to the plant's thermal discharges.

- ESRP 5.10. Provide any mitigation measures that should be employed to (1) minimize potential impacts caused by increased numbers of deleterious etiological agents as a result of thermal discharges, and (2) minimize potentially unacceptable noise levels resulting from operation of the cooling system.

Data and Informational Needs

The type of data and information needed will be affected by site- and station-specific factors, and the degree of detail should be modified according to the anticipated magnitude of the potential impacts. The following data or information should be obtained:

- etiological agents (formerly referred to as thermophilic microorganisms)

  - a description of the location of the thermal discharges for the plant's cooling system (i.e., a cooling pond, lake, canal, small river, large river, or ocean) (from the environmental report (ER) or ESRP 3.4.1)

  - the temperature increase expected for the aquatic environment that is subject to the plant's thermal discharges (from the ER or ESRP 5.3.2.1)

  - the results of any analyses that have been made for the presence of etiological agents. These include the enteric pathogens *Vibrio* spp., *Salmonella* spp., *Shigella* spp., and *Plesiomonas shigelloides*, as well as *Pseudomonas spp.*, thermophilic fungi, noroviruses, and toxin-producing algae such as *Karenia brevis*. In addition, analyses for the presence of unusually high concentrations of the normally present *Legionella* spp. (Legionnaires' disease bacteria) and the free-living amoebae of the genera *Naegleria, Acanthamoeba*, and *Cryptosporidium*, should be cited (from the ER or the applicant). Also, historical and recent algal blooms in the vicinity of the site should be discussed.

  - a list of the outbreaks of waterborne diseases in the United States during the previous 10 years in the vicinity of the site. This list is published regularly by, and can be obtained from, the Centers for Disease Control and Prevention (CDC). Additional information on waterborne organisms of current interest can be found on the CDC website (under Emerging Infectious Diseases, www.cdc.gov), on the National Institutes of Health's website (under the National Institute of Allergy and Infectious Diseases, www.nih.gov or www3.naiad.nih.gov), and on the U.S. Environmental Protection Agency (EPA) website (under the Water subtopics, www.epa.gov).

  - an evaluation of any available data concerning the occurrence and concentrations in the vicinity of the plant of any of the etiological agents listed above and a determination of whether any of them are present under conditions and in locations that might be harmful to members of the

public who come in contact with them. If such an evaluation exists, it may be obtained from the applicant or from the State Public Health Department in the State in which the plant is being constructed.

- if applicable, a description of any monitoring program to be employed.

- noise

  - the type of cooling system, specifically, whether the plant has cooling towers or other components that are capable of producing offsite noise levels (from the ER or ESRP 3.4.2).

  - the distance to the nearest offsite residence and to the site boundary (from the ER or the reviewer of ESRP 2.5.1).

II. ACCEPTANCE CRITERIA

Acceptance criteria for the analysis and evaluation of the nonradiological health impacts of the cooling system on humans are based on the following:

- 10 CFR 51.45 with respect to ERs and the analysis of potential impacts contained therein

- 10 CFR 51.75 with respect to descriptions of the environment affected by the issuance of a construction permit, early site permit, or combined license

- 10 CFR 51.95 with respect to the preparation of supplemental environmental impact statements (EISs) in support of the issuance of an operating license

Regulatory positions and specific criteria are as follows:

- The *Generic Environmental Impact Statement for License Renewal of Nuclear Plants* (NUREG-1437) (NRC 1996) contains an analysis of the effects of cooling system discharges on thermophilic microorganisms that have the potential to adversely affect human health. This analysis can provide guidance to the staff in determining the significance of the potential effects of these discharges and the extent of the analysis required.

Technical Rationale

The technical rationale for evaluating the applicant's description of nonradiological health impacts of the cooling system on humans is discussed in the following paragraphs for etiological agents and noise:

Etiological agents (formerly known as Thermophilic Microorganisms)—Etiological agents associated with cooling towers and thermal discharges can impair human health. These agents may include microorganisms, thermophilic fungi, parasites, and viruses that were formerly referred to as

thermophilic organisms because their presence or numbers can be affected by the addition of heat. While the growth rate of some etiological agents can be increased by the addition of heat, others can resist moderately high temperatures long enough to be released into a cooler body of water for growth. Thus, cooling towers and thermal discharges can act to harbor *or* accelerate some etiologic agents that ultimately affect human health once released into the environment.

These etiological agents include, but are not limited to, the enteric pathogens *Salmonella* spp., *Vibrio* spp. and *Shigella* spp. as well as *Pseudomonas* spp., toxin-producing algae, and thermophilic fungi. They also include the bacteria *Legionella* spp., which causes Legionnaires' disease, and free-living amoebae of the genera *Naegleria*, *Acanthamoeba,* and *Cryptosporidium*. Exposure to these microorganisms, or in some cases the endotoxins or exotoxins produced by the organisms, can cause illness or death. In addition, the presence of thermostable viruses should be considered.

40 CFR 141.70 regulates maximum contaminant levels of various microorganisms, including *Legionella* spp. in public drinking water systems. However, there are no regulations established for microorganisms, viruses or other pathogens associated with cooling towers or thermal discharges. No Occupational Safety and Health Administration (OSHA) or other regulatory standards for exposure to microorganisms exist at the present time.

In 1986, EPA published bacterial water-quality criteria for untreated fresh and marine water sources (EPA 1986) and made these criteria water-quality standards for the states and territories that did not adopt the criteria before 2004. For freshwater (e.g., lakes and rivers), EPA has recommended criteria that the monthly geometric mean water-quality indicator concentration be ≤33 CFU/100 mL (Colony Forming Units, CFU) for enterococci or ≤126 CFU/100 mL for *Escherichia coli*. For marine water, EPA has recommended criteria that the monthly geometric mean water-quality indicator concentration be ≤35 CFU/100 mL for enterococci. However, state and local authorities have discretionary authority to determine which interventions should be used (e.g., posting signs to alert visitors of water contamination or closing the beach for swimming) when these limits have been exceeded. This information may provide guidance to the staff for evaluating any monitoring to be performed.

Noise— Some Federal regulations for levels of noise for public exposures remain in effect today (i.e., Noise Control Act of 1972 as amended by the Quiet Communities Act of 1978); however, the primary responsibility of regulating noise was transferred to the State or local government level in 1982. The existing Federal regulations (10 CFR Parts 201–211) are limited to standards for transportation equipment, interstate rail and motor carriers, low-noise emission products, and construction equipment, so the review of cooling system impacts will require familiarity with the State and local requirements. When noise levels are below the levels that result in hearing loss, impacts have been judged primarily in terms of adverse public reactions to noise. The Department of Housing and Urban Development (24 CFR 51.101(a)(8)) uses day-night average sound levels recommended by EPA as guidelines or goals for outdoors in residential areas. Noise levels are acceptable and allowable if the day-night average sound level outside a residence is less than or equal to 65 decibels.

III. REVIEW PROCEDURES

The review procedures for impacts from etiologic agents are discussed separately from the procedures for impacts from noise.

Etiologic Agents (formerly Thermophilic Microorganisms)

Consideration of the impact of etiologic agents on the public health is important, especially for those plants using cooling ponds, lakes, canals, or small rivers because the operation of these plants may significantly increase the presence and numbers of harmful waterborne diseases. Additional information regarding these organisms can be found in the Appendix to this ESRP. The following review procedures should be used:

(1) Review of available data, site description, and cooling system description, to determine whether a potential exists of a detrimental impact from the thermal discharges on the concentration levels of deleterious etiological agents. If this potential exists, then further analysis of any available data would be appropriate, especially if public recreation occurs within the vicinity of the discharge or if the plant is located in the southern regions of the United States. The minimum review should include:

- Consultation with the State Public Health Department.
- Review of any records associated with waterborne disease outbreaks in the region.

(2) If it appears to be likely that thermal discharges from the plant would increase the number of deleterious etiologic agents to levels that could cause a public health problem, the applicant should be requested to consider mitigative measures to minimize the potential impacts.

- Mitigative measures may include:
  - setting up and executing a monitoring program for etiologic agents or other harmful biological agents to insure acceptable levels.
  - limiting public activities that allow contact with discharge waters in the vicinity of the site.
  - the use of respirators and protective clothing by plant workers to protect against mists from cooling towers or dusts inhaled during cleaning processes or limiting maintenance activities on the cooling system to times when the structures or components are dewatered.
- The reviewer should analyze any mitigative measures and forward them to the reviewer for ESRP 5.10.

(3) Irrespective of the plant cooling system design or the type of station discharge water body, if there has been an outbreak of waterborne disease during the previous 10 years in the vicinity of the site, at the minimum, mitigative measures may include:

- Consultation with the State Public Health Department.
- In the absence of monitoring data, consideration should be made of limiting public activities that allow contact with discharge waters in the vicinity of the site.
- The use of respirators and protective clothing by plant workers to protect against mists from cooling towers or dusts inhaled during cleaning processes or limiting maintenance activities on the cooling system to times when the structures or components are dewatered.

Noise

The primary responsibility of regulating noise was transferred to the State or local government level in 1982 and, as a result, the review of cooling system impacts will require familiarity with the applicable State and local requirements. When noise levels are below the levels that result in hearing loss, impacts have been judged primarily in terms of adverse public reactions to the noise. The principal sources of noise from plant operations include natural-draft and mechanical-draft cooling towers. Other occasional noise sources may include auxiliary equipment, such as pumps to supply cooling water from a remote reservoir. Generally, power-plant sites do not result in offsite noise levels greater than 10 dB(A) above background (NRC 1996). Noise level increases larger than 10 dB(A) would be expected to lead to interference with outdoor speech communication, particularly in rural areas or low-population areas where the day-night background noise level is in the range of 45 to 55 dB(A). Surveys around major sources of noise, such as major highways or airports, have found that when the day-night level increases beyond 60 to 65 dB(A), noise complaints increase significantly. Noise levels below 60 to 65 dB(A) are considered to be of small significance (NRC 1996). More recently, the impact of noise was considered in the *Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities, Supplement 1 Regarding the Decommissioning of Nuclear Power Reactors* (NRC 2002). In that document, the criterion for assessing the level of significance was not expressed in terms of sound levels. Rather, the level of significance was based on the effect of noise on human activities and threatened or endangered species. The criterion in NUREG-0586 Supplement 1 (NRC 2002) is stated as follows:

> The noise impacts ... are considered detectable if sound levels are sufficiently high to disrupt normal human activities on a regular basis. The noise impacts ... are considered destabilizing if sound levels are sufficiently high that the affected area is essentially unsuitable for normal human activities, or if the behavior or breeding of a threatened or endangered species is affected.

(1) The reviewer should become familiar with the applicable State noise limits for residential areas and other types of land use.

(2) The reviewer should determine whether the plant has or will have cooling towers or other components of the cooling system capable of contributing to offsite noise levels.

- If no cooling towers or other noise-producing components of the cooling system are anticipated, the analysis is complete.

- If cooling towers or other noise-producing components of the cooling system are present, the reviewer should compare the anticipated day night average level of noise determined at the site boundary (based on the dB(A-scale)) from the cooling system with applicable State noise limits.

- If no State noise limits are available and if the day-night noise level is below 60 to 65 dB(A), no further analysis is needed.

- If the noise levels exceed the State noise limits or in the absence of such limits if the day-night noise level exceeds 65 dB(A), the reviewer should request the applicant to propose measures for mitigating the impact from the noise. The reviewer should analyze these mitigation measures and forward them to the reviewer for ESRP 5.10.

IV. EVALUATION FINDINGS

Etiologic Agents (formerly Thermophilic Microorganisms)

When the reviewer determines that the proposed plant does not fall within the parameters discussed above (i.e., uses a cooling pond, lake, or canal or uses once-through cooling systems with discharges to other than small rivers or had a documented outbreak of a waterborne disease within the last 10 years that could be affected by operation of a cooling system), the reviewer should:

- Provide a statement for the EIS similar to the following: The proposed plant utilizes a cooling system as described in ESRP 3.4.1. Because this system does not use a cooling pond, lake, or canal or discharge to a river with a flow rate below 9×10^{10} m^3/yr (3.15×10^{12} ft^3/yr), there is little potential for a detrimental increase in etiological agents that would have a deleterious effect on public health (NUREG-1437). There have been no reported cases of a waterborne disease in the vicinity of the site within the last 10 years that could be related to the operation of a cooling system.

- Risk analysis may be warranted to mitigate against the buildup of deliterious microbes (and/or biofilms) that could result in generation of etiologic agents or pose a health risk to on-site workers, such as maintenance workers (see ESRP 3.6.3).

If the reviewer determines that the proposed plant does fall within the parameters given above, i.e., uses a cooling pond, lake, or canal or uses once-through cooling with a discharge to a small river (i.e., flow rate below 9×10^{10} m^3/yr [3.15×10^{12} ft^3/yr]), then the reviewer should:

- Provide the results of the analyses and evaluation given above for the EIS, including the results of the consultation with the State Public Health Department, related to any regional outbreaks of waterborne diseases.

- Discuss any mitigative measures that should be used to minimize negative human health impacts resulting from a potential increase in the levels of etiologic agents.

Noise

When the reviewer determines that the proposed plant does not have cooling towers or other components of the cooling system capable of contributing to offsite noise levels, the reviewer should provide a statement for the EIS similar to the following:

> The proposed plant utilizes a cooling system as described in ESRPs 3.4.1 and 3.4.2 that does not depend on a cooling tower or other components that contribute to offsite noise levels. Thus, the noise levels related to operation of the cooling system are not pertinent to this plant.

When the reviewer determines that the proposed plant does have cooling towers or other components of the cooling system capable of producing offsite noise levels and has determined that the day-night noise level emanating from the cooling system during operation is below 65 dB(A) at the site boundary, the reviewer should provide a statement for the EIS that is similar to the following:

> The day-night noise levels that are anticipated from the plant's cooling system are less than 65 dB(A) at the site boundary, which is considered to be of small significance to the public. Thus, no mitigation alternatives are necessary.

When the reviewer determines that the cooling towers or other components of the cooling system from the applicant's plant will produce day-night noise levels above 65 dB(A) at the site boundary, the reviewer should describe the magnitude of the noise levels and the mitigative factors that will be employed.

V. IMPLEMENTATION

The method described in this ESRP will be used by the staff in evaluating conformance with NRC requirements, except in those cases in which the applicant proposes an acceptable alternative for complying with specified portions of the regulations.

VI. REFERENCES

10 CFR 51.45, "Environmental report."

10 CFR 51.75, "Draft environmental impact statement — construction permit, early site permit, or combined license."

10 CFR 51.95, "Supplement to final environmental impact statement."

24 CFR Part 51. Code of Federal Regulations, Title 24, *Housing and Urban Development*, Part 51, "Environmental Criteria and Standards."

40 CFR Part 141. Code of Federal Regulations, Title 40, *Protection of the Environment*, Part 141, "National Primary Drinking Water Regulations."

40 CFR Parts 201–211. Code of Federal Regulations, Title 40, Protection of the Environment, Parts 201–211, "Subchapter G—Noise Abatement Programs."

Centers for Disease Control (CDC). 1996. *Surveillance for Waterborne-Disease Outbreaks—United States, 1993-1994.* M.H. Kramer, B.L. Herwaldt, G.F. Craun, R.L. Calderon, D.D. Juranek. Source: MMWR 45(SS-1):1-33. April 12, 1996.

Centers for Disease Control (CDC). 2006. *Surveillance for Waterborne-Disease Outbreaks—United States, 2003-2004.* E.J. Dziuban, J.L. Liang, G.F. Craun, V. Hill, P. Yu, J. Painter, M. R. Moore, R. L. Calderon, S. L. Roy, M. J. Beach. Source: MMWR 45(SS-1):1-24. December 22, 2006.

Noise Control Act, as amended, 42 USC 4901 et seq. Public Laws 92-574 (October 27, 1972) and 95-609 (November 8, 1978).

Tyndall, R.L. 1981. Presence of Pathogenic Microorganisms in Power Plant Cooling Waters—Report for October 1, 1979, to September 30, 1981. NUREG/CR-2980. Oak Ridge, Tennessee: Oak Ridge National Laboratory, Environmental Sciences Division.

Tyndall, R.L., K.S. Ironside, P.L. Metler, E.L. Tan, T.C. Hazen, and C.B. Fliermans. 1989. Effect of thermal additions on the density and distribution of thermophilic amoebae and pathogenic Naegleria Fowleri in a newly created cooling lake. *Applied and Environmental Microbiology*, 55, 722-732.

U.S. Environmental Protection Agency (EPA). 1986. *Bacterial Ambient Water Quality Marine and Fresh Recreational Waters*. EPA Publication No. 440/5-84-002. Office of Water Regulations and Standards Criteria and Standards Division, Washington, D.C.

U.S. Food and Drug Administration (FDA). 1996. *Foodborne Pathogenic Microorganisms and Natural Toxins 1992* (Bad Bug Book). Center for Food Safety & Applied Nutrition, Washington, D.C.

U.S. Nuclear Regulatory Commission (NRC). 1996. *Generic Environmental Impact Statement for License Renewal of Nuclear Plants*. NUREG-1437, Vol. 1, Washington, D.C.

U.S. Nuclear Regulatory Commission (NRC). 2002. *Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities Supplement 1 Regarding the Decommissioning of Nuclear Power Reactors*. NUREG-0586, Supplement 1, Volumes 1 and 2, Washington, D.C.

PAPERWORK REDUCTION ACT STATEMENT

The information collections contained in the Environmental Standard Review Plan are covered by the requirements of 10 CFR Part 51, and were approved by the Office of Management and Budget, approval number 3150-0021.

PUBLIC PROTECTION NOTIFICATION

The NRC may not conduct or sponsor, and a person is not required to respond to, a request for information or an information collection requirement unless the requesting document displays a currently valid OMB control number.

APPENDIX

Etiologic Agents - Background

Etiologic agents associated with cooling towers and thermal discharges can impair human health. These agents may include microorganisms, parasites, viruses, and chemical toxins that were formerly referred to as thermophilic organisms because their presence or numbers can be affected by the addition of heat. While the growth rate of some etiological agents can be increased by the addition of heat, others can resist moderately high temperatures long enough to be released into a cooler body of water for growth. Thus, cooling towers and thermal discharges can act to harbor or accelerate some etiologic agents that ultimately affect human health once released into the environment.

The etiologic agents include, but are not limited to, the enteric pathogens *Salmonella* spp., *Vibrio* spp. and *Shigella* spp., and *Plesiomonas* shigelloides, as well as *Pseudomonas* spp., thermophilic fungi, noroviruses, and toxin-producing algae such as Karenia brevis. They also include the bacteria *Legionella* spp., which causes Legionnaires' disease, and free-living amoebae of the genera *Naegleria, Acanthamoeba, and Crytosporidium*. Exposure to these microorganisms, or in some cases the endotoxins or exotoxins produced by the organisms, can cause illness or death. In addition, the presence of thermostable viruses, such as the Echovirus and Norovirus, or Microcystin toxin (from blue-green algae) should be considered. Additional information on waterborne organisms of current interest can be found on the CDC website (under Emerging Infectious Diseases, www.cdc.gov), on the National Institutes of Health's website (under the National Institute of Allergy and Infectious Diseases, www. nih.gov or www3.naiad.nih.gov), or on the U.S. EPA website (under the Water subtopics, www.epa.gov).

The test methods for verifying the presence of these agents are known, but the degree to which their presence can be controlled in aquatic environments is variable. The inhalation or ingestion of small quantities of these organisms or associated endotoxins/exotoxins may impair the health of individuals that are immunosuppressed (NRC 1996).

Notable examples of etiologic agents that are hard to control that may be present in surface water, include the bacteria *Legionella* spp., which causes Legionnaires' disease, and free-living amoebae of the genera *Naegleria*, *Acanthamoeba*, and *Crytosporidium*. Some of the known cases of Legionellosis were traced to the aerosolization of waterborne *Legionella* spp. by cooling towers and evaporative condensers. *Legionella* is normally found in natural surface waters, and thus it is not surprising that they are found in even greater numbers in water from cooling towers and evaporative condensers. This type of equipment can amplify *Legionella* spp. concentrations and disperse the pathogen through aerosolization (NRC 1996).

Naegleria fowleri causes primary amoebic meningoencephalitis (PAM) and *Acanthamoebic keratitis* and *Acanthamoebic uveitis* cause granulomatious amoebic encephalitis (GAE). GAE is a particular risk for persons who are immunodeficient, although infections have occurred in otherwise healthy individuals (FDA 1996). The primary infection site is thought to be the lungs. The organisms that are in the brain are generally associated with blood vessels, suggesting vascular dissemination (FDA 1996). Only 100 to

200 reports of PAM have occurred worldwide (NRC 1996). Sources of infection for PAM generally include heated swimming pools, thermal springs, and a variety of naturally or artificially heated surface waters. During 1993 to 1994, only one case of PAM was reported by the Centers for Disease Control (CDC 1996). The one case was caused by *Naegleria fowleri* and was associated with swimming in both a waste-water holding pond and in the Rio Grande River.

A study of cooling waters from 11 nuclear-power plants and associated control source waters indicated that only two sites were positive for the pathogenic *Naegleria fowleri* (Tyndall 1981). In addition to testing for pathogenic amoebae in cooling waters, the 11 nuclear-power plants in the 1981 study were also studied for the presence of *Legionella* spp. In general, the artificially heated waters showed only a slight increase (i.e., ≤10-fold) in concentrations of *Legionella* spp. relative to source water. In a few cases, source waters had higher levels than did heated waters. Infectious *Legionella* spp. were found in 7 of 11 test waters and 5 of 11 source waters (NRC 1996). An additional study of *Legionella* spp. presence in the environs of coal-fired electric power plants showed that *Legionella* was only infrequently found in locations that were not adjacent to cleaning operations. It was concluded that exposure to *Legionella* spp. from power-plant operations was a potential problem for part of the workforce, but that it would not be a public-health issue because concentrated aerosols of the bacteria would not traverse plant boundaries (NRC 1996).

Because the route of infection with *Naegleria* spp. is through inhalation, workers exposed to aerosols that could harbor this pathogen should have respiratory protection. Although the observed risk from *Naegleria fowleri* is low, heavily used bodies of fresh water merit special attention and possibly routine monitoring for pathogenic *Naegleria* spp. Because *Naegleria* spp. concentrations in fresh water can be increased by thermal additions, nuclear power plants that utilize cooling lakes, canals, ponds, or small rivers may enhance the naturally occurring amoebae.

In general, the staff recognize the potential propagation of etiological agents, water-borne diseases, and associated public health impact stemming from heated effluents. Factors that affect the distribution of these agents, in general or those specific to cooling towers, are not well understood and further investigations are needed. With the advent of new bioanalytical techniques, such as genomics and proteomics technology, there are opportunities to employ assays to monitor for the presence of harmful pathogens in and around cooling tower effluents. In addition, because the route of infection of some of these agents (e.g., *Legionella* and *Naegleria fowleri*) is through inhalation it may be prudent to include proven industrial-hygiene principles (e.g. personal protection equipment) for workers who are at a high risk of exposure to such agents (e.g. maintenance workers), unless a monitoring program is used to assure that such agents are not present. Workers who become infected can pose a public health risk.

Overall, public-health questions require special consideration, especially for plants using cooling ponds, lakes, canals, or small rivers having low flow rates (less than 9×10^{10} m^3/yr [3.15×10^{12} ft^3/yr]) and in cases where the public shares access and use of these low-flow bodies of water, because the effluents from these plants may significantly promote the presence and numbers of etiological agents (Tyndall 1989, NRC 1996).