ORIGINAL

BEFORE THE POLLUTION CONTROL BOARD

OF THE STATE OF ILLINOIS

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STATE OF ILLINOIS
Pollution Control Board

IN THE MATTER OF:	)	
	)	
REVISIONS TO RADIUM WATER	)	
QUALITY STANDARDS: PROPOSED	)	**R04-21**
NEW 35 ILL. ADMIN. CODE 302.307	)	**Rulemaking - Water**
AND AMENDMENTS TO 35 ILL. ADMIN.	)	
CODE 302.207 AND 302.525	)	

NOTICE OF FILING

To: See Attached Service List

Please take notice that on October 8, 2004, we filed with the Office of the Clerk of the Illinois Pollution Control Board, an original and ten copies of the attached **Supplemental Testimony Of Theodore G. Adams On Behalf Of Water Remediation Technology, LLC** a copy of which is served upon you.

WRT Environmental [Illinois] LLC

By: ______________________

One of Its Attorneys

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AND AMENDMENTS TO 35 ILL. ADMIN.	)	
CODE 302.207 AND 302.525	)	

SUPPLEMENTAL TESTIMONY OF THEODORE G. ADAMS
ON BEHALF OF WATER REMEDIATION TECHNOLOGY, LLC

I, Theodore G. Adams, President of T. G. Adams and Associates, Inc., hereby respectfully submit supplemental testimony to address questions raised by the Illinois Pollution Control Board (the "Board") and the Illinois Environmental Protection Agency (the "IEPA" or the "Agency") during the prior hearing in this matter held on August 11, 2004.

I previously submitted testimony to the Board. Certain areas of my prior testimony were the subject of questioning, and the purpose of this supplemental testimony is to address any ambiguities for the record.

I. WHAT WOULD BE A SAFE LEVEL OF RADIUM IN GENERAL USE WATERS OF ILLINOIS? (August 11, 2004 Hearing Transcript at pp. 62-63.)

The existing standard of 1 pCi/L for Radium 226 generally is recognized as a background condition in surface waters of Illinois.[1] Given that radium is a recognized carcinogen, and a degradation product of uranium and thorium, it is not surprising that the Board set such a level. By doing so, any variations from that standard would require careful consideration. From the analyses I have performed, it appears that any increase over the existing standard could result in an excessive radium exposure. Clearly, the Biota-Dose Assessment Committee approach would not allow for a general increase over these background levels without a careful data collection and site by site analysis and justification.

But the effect of the Agency's proposal is to eliminate ANY water quality standard for this carcinogen from most Illinois waters. Attachment A hereto is a map compiled from the Agency's exhibits 1 and 2; the public water supply wells with known

[1] Jacqueline Michel, Predicting the Occurrence of ^{228}Ra in Ground Water, Health Physics Vol. 51, No. 6 (December), pp. 715-721 (1986).

radium levels over 5 pCi/L are shown in red, and the downstream receiving waters are shown in yellow. Clearly, the effect of the proposal is to wipe out any radium limits for Illinois waters, even those receiving levels over background.

The Biota-Dose Assessment Committee ("BDAC") approach demonstrates that adverse effects from radium in waters may occur at levels slightly above background. Using the BDAC approach, I have calculated that beginning at levels in the range of 1.4 to 1.88 pCi/L for Radium 226, the water quality would exceed the general biota dose limit.. Attachment B to my supplemental testimony is a summary of the approach used, and the calculations I have performed. These show that even if there is no radium contamination in the sediment, the general biota dose limits would be exceeded at 1.88 pCi/L of Radium 226, in the presence of 1.88 pCi/L of Radium 228. Using the combined radium limit approach put forth by the Agency for drinking water standards, the safe limit could be 3.75 pCi/L. (<u>See</u> Attachment B at p. 2.) But if sediment levels are 12.2 pCi/g (as documented by the Florida studies in Attachment D), then the safe level would fall to 1.4 pCi/L for each. Clearly, there is very little room to relax the existing water quality standard without further data and analysis. And clearly, the expected effluent of 5 - 10 pCi/L, from several of the example POTWs contained in C. Williams Testimony Table 5, would fail the BDAC criteria. (<u>See</u> Attachment B, cases 3 through 6.)

I believe that the approach taken by the BDAC merits considerable weight. The Department of Energy ("DOE") is responsible for managing and controlling, at its facilities, a large portion of the country's radioactive materials, subject to oversight by EPA, the Nuclear Regulatory Commission ("NRC") and the states, and has devoted substantial resources to protecting the environment from radiation. The BDAC approach is based on the DOE order to its contractors, which has been recognized by EPA and other states, an important criteria for avoiding impact to human health and the environment. (<u>See</u> attachment C.) If the Board wants to have water quality standards that protect aquatic life and the environment, it would appear that the existing standard may be appropriate.

Moreover, new information arising out of sampling and investigations done in Florida, including data just published in August of this year, would indicate that radium levels in the very range that meet the BDAC biota dose limit may adversely affect mussels, including mussels such as those listed as endangered or threatened in Illinois. Attachment D hereto is a letter from one of the Florida researchers who has evaluated the bio-concentration in sediments and mussels from various lakes in Florida. These lakes must be replenished by pumping groundwater, which has radium at the levels I consider background — i.e., 1-2 pCi/L. The recently published data show that the mussels in these lakes bio-accumulate radium to levels at 200 pCi/g.

Illinois has many endangered mussels which inhabit the waters threatened to be de-regulated by the proposed rule. Attachment E hereto are maps taken from the IDNR website showing river basins where these endangered species may be found. I do not know if there is a relationship between the "background" radium and these endangered species, but clearly the effect of this proposed rule has not been adequately considered.

In conclusion, radium can cause adverse effects on aquatic life and riparian animals. It is a carcinogen to humans. And it bio-accumulates in mussels and up the aquatic food chain. Though the current standard may be virtually the same as "background," I would urge that a compelling case is required before relaxing the general water quality standard for such a material.

II. ARE THERE OTHER SOURCES OF RADIUM DISCHARGING?

The explicit assumption made by the IEPA was that an exceedance of the existing standard would occur ONLY as a result of the presence of elevated radium in drinking water or the treatment of drinking water. I would note that the **goal** of the EPA drinking water standard is zero; the 5 pCi/L reflects a risk of 1 in 10,000. But left unaddressed in this proceeding is the question, "who else could be a source?"

My prior testimony showed that radium is a degradation or breakdown product of other nuclear radioactive materials. These include thorium and uranium. But there is no evidence presented in this proceeding of who or where those potential or actual sources are, whether industrial, commercial or municipal. It seems likely that other discharges of radium exist.

At least one of the participating facilities in the AMSA study was a publicly owned treatment works ("POTW") in the northeastern Illinois area. This POTW is in an area that has a high concentration of radium in groundwater withdrawals. Because of the confidentiality terms in the AMSA and ISCORS study, I am not at liberty to divulge the name of the plant. But I can testify that, given the groundwater levels known to exist in that locale, the sludge levels reported for that POTW are consistent with the predicted sludge levels and worker exposure levels presented in my prior testimony.

This observation led me to seek information about other documented dischargers of radium. Time did not permit a review of radium dischargers in Illinois. But we did find that at least one nuclear power plant reported radium discharge levels exceeding the current standard. For the LaSalle plant, Radium 226 was reported for two outfalls at 2.6 pCi/L, and total radium values were 4.1 and 9.0 pCi/L. In a couple of instances, it appeared that the amount of radium increased across specific wastewater processes. (See Attachment I.)

The record in this proceeding does not identify other sources beside municipal drinking water treatment plants might be the beneficiary of this de-regulation. There may be others. Indeed, even among the group that was identified as needing regulatory relief — communities that need to treat their groundwater supply to meet the new drinking water standard — some already have decided that they do not need to flush their treatment water filtrate down the sewer and still can save hundreds of thousands of dollars.

III. ARE THERE OTHER IMPACTS ON PUBLICLY OWNED TREATMENT WORKS BEYOND THOSE IN AGENCY EXHIBIT 11?

The IEPA suggests in its Exhibit 11 that the POTWs will benefit by avoiding certain costs if this proposed rule were adopted. But there are other costs that will result from the adoption of the proposed rule. The overall costs appear actually to be much greater when one considers all the implications of the Agency's proposal.

The IEPA has not provided this proceeding with evidence concerning testing or monitoring of any sewage sludge levels for radium. Yet, the economic and operational impacts of radiologically contaminated influent/sludge on POTWs are well documented. For example, in Cleveland, Ohio, Advanced Medical Systems, a NRC licensee, discharged minute amounts of non-soluble radioactive particles of Co-60 over a period of 20 years into the sewer system. These minute radioactive particles contaminated the POTW and the resulting sludge. The aggregate radioactivity disposed of into the sewer system over the 20-year period was less than 0.5 Curie (i.e., 0.445 Curie). (See Attachment F.) Nevertheless, the NEORSD incurred more than $2 million in clean-up costs when these elevated radiation levels were discovered by chance. An enormous amount of radioactive contaminated material which occurred as a result of a "miniscule" amount of radioactivity is still present at the NEORSD. Co-60 has a half-life of approximately five to six years, and Co-60 does not produce radon as a by-product. In contrast, Ra226 has a half-life of 1600 years, and does produce radon as a by-product.

In comparison, a moderately-sized city with elevated radium levels may exceed this quantity in its sludge. I have completed a calculation for the amount of radium contamination found in sewer sludge from the City of Joliet's sewer system for a period of one year. The amount of radium contamination found in Joliet's sewer sludge over the course of just a single year was 0.29399 Curie. (See Attachment G, page 12 of Agency Exhibit 12.) The amount of radium contamination found in Joliet's sewer sludge over a period of one year was more than half the amount of radioactive contamination (for a 20-year period) found in the sewer system in Cleveland, Ohio. Thus, over a similar 20-year period, the Joliet POTWs would appear to generate more than 10 times the quantity of radiation that caused substantial injury to the sewer system in Cleveland, Ohio. And the Radium 226 will take longer to degrade than would the Cobalt.

On the other hand, if the radium-laden residuals (i.e., Technically Enhanced Naturally Occurring Radioactive Material ("TENORM")) are disposed of into the sewer, then the public water systems, the POTWs, and the State of Illinois can expect to have the following increased costs:

- The uncontrolled discharge of radium residuals would/could be a liability issue to municipalities/POTWs (as cited in Cleveland, Ohio);
- POTW workers will require training, personnel exposure monitoring and medical monitoring as occupational radiation workers;
- Sewer sludge and handling areas will require on-going testing;

- The POTW may be required to obtain a radioactive materials license;
- Application of sewer sludge to farm land will require on-going monitoring; and
- Sewer pipes and the POTW itself (or parts thereof) may require decontamination.

These costs are the practical result of the Agency's proposal.

There is another environmental cost of the proposal. The Agency expects that water treatment plants will flush filtrate materials down the sewer. This activity requires the pumping of additional groundwater to carry out the backflushing operation. The amount of groundwater may be on the order of 5 to 25 percent of the quantity of water being pumped for human consumption. Areas already relying on deep aquifers for potable water supply are in the same areas where the groundwater resource is being depleted. As an example, although Joliet was already extracting the largest quantity of well water from deep aquifers in 1995, there continues to be a further drawdown in the groundwater level by over 25 feet. This is among the largest drawdowns since 1995 in the northeastern Illinois area. (See "A Comparison of Potentiometric Surfaces for the Cambrian-Ordovician Aquifers of Northeastern Illinois", 1995 and 2000, Table 2 and Figure 9 attached hereto as Attachment H.) For Joliet, backflushing would therefore increase the groundwater drawdown by 0.5 to 2.5 million gallons per day. Moreover, Kane County shows the largest growth in deep well pumping of any county in the area. Id. at Table 1. This is not surprising in light of its growth. At the same time, Kane County communities have some of the highest radium levels in groundwater. Thus, the amount of water containing elevated levels of radium being extracted from the deep aquifers seems likely to continue to increase. Allowing the use of backflushing in these areas, would only increase the demand on the deep aquifer resources. And the discharge to surface waters will carry increased amounts of radium.

IV. CONCLUSION

The existing standard represents background conditions. Interestingly, the BDAC approach, required of all DOE facilities, would require site specific data and further analysis on any water quality condition over this general background level. There is clearly no basis to remove radium as a general water quality criterion without more data..

Removing the radium standard, without first imposing a control on storm and sewer discharges of radium comparable to those required of facilities regulated by the IEMA allows TENORM radium to be backwashed down sewers. This not only re-introduces a carcinogen back into the environment, it potentially exposes POTW workers to radium levels above that allowed even for workers in a nuclear plant. And it results in radium being applied to crop soils as part of the municipal sludge. From an environmental view point, all radium TENORM, especially radioactive solids, should not be permitted down sewers, regardless if one is a licensee of IEMA or not.

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CERTIFICATE OF SERVICE

The undersigned, an attorney, certify that I have served upon the individuals named on the attached Notice of Filing true and correct copies of the **Supplemental Testimony Of Theodore G. Adams On Behalf Of Water Remediation Technology, LLC** and First Class Mail, postage prepaid on October 8, 2004.

SERVICE LIST

R04-21

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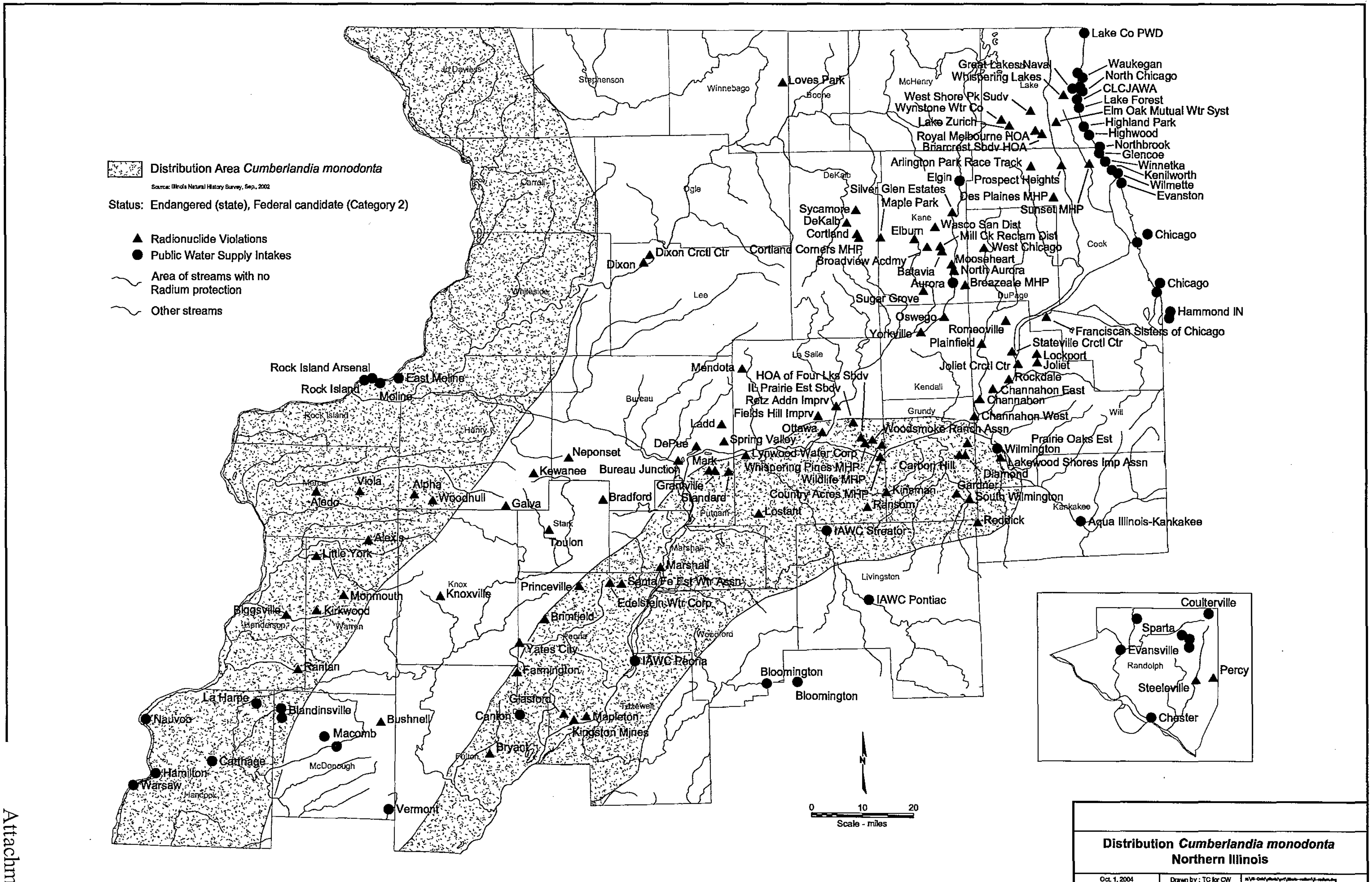
Exhibit A



Attachment A

Exhibit B

ATTACHMENT B TO SUPPLEMENTAL TESTIMONY OF THEODORE G. ADAMS ON BEHALF OF WATER REMEDIATION TECHNOLOGY, LLC

The purpose of this Attachment is to provide background on the guidance cited in my prior testimony in this matter. The federal Department of Energy ("DOE"), Office of Environmental Policy and Guidance together with the Biota Dose Assessment Committee ("BDAC") has prepared and made available a DOE technical standard, "A Graded Approach For Evaluating Radiation Doses to Aquatic and Terrestrial Biota" (DOE – STD. 1153-2002) (the "Biota Protection Standard"). (See Attachment C). The BDAC is sponsored and chaired by the DOE Office of Environmental Policy and Guidance, Air, Water and Radiation Division; it is multidisciplinary and brings together expertise in health physics, ecology, radio ecology, environmental monitoring, and risk assessment.

The DOE Memorandum dated August 27, 2002, (also part of Attachment C) states: "The technical standard provides screening methods and, if needed, methods for more detailed analysis within the general framework that can be used for demonstrating compliance with requirements contained in DOE Order 5400.5" "Radiation Protection Of The Public And The Environment". "DOE Order 5400.5 specifies the radiation protection requirements that DOE and DOE contractor employees must meet to protect aquatic animals." These limits are less than 1.0 RAD per day for aquatic animals and less than 0.1 RAD per day for terrestrial and riparian animals.

The 0.1 RAD per day for riparian animals is a relatively high radiation dose. It is the equivalent of 730,000 mrem per year exposure to man. In my earlier testimony, I stated that radiation workers are limited to an exposure of 5,000 mrem per year and that this dose must be kept as low as reasonably achievable ("ALARA"). In fact, the average nuclear plant worker receives a small fraction of this amount. One hundred (100) mrem is the maximum allowable exposure to a member of the public.

The Biota Protection Standard provides a screening method to determine whether or not the 1.0 RAD per day (aquatic animals) and the 0.1 RAD per day (terrestrial and riparian animals) DOE standard will be exceeded in any situation.

Assessment is done by reference to specific Biota Concentration Guides ("BCGs") for both water and sediment for aquatic and riparian animals and to the "Organism Responsible for Limiting Dose" for each of water and sediment.

Each BCG is specifically referenced to the applicable radionuclide. Table 6.2 of Attachment C shows the following:

Nuclide	BCG	Organism Responsible for Limiting Dose in Water
Radium 226	4 pCi/L	Riparian Animal
Radium 228	3 pCi/L	Riparian Animal

And for sediment, Table 6.2 provides:

Nuclide	BCG	Organism Responsible for Limiting Dose in Water
Radium 226	100 pCi/g	Riparian Animal
Radium 228	90 pCi/g	Riparian Animal

During the screening level process, each of the BCGs is calculated based on the assumption that it is the only radiation to which the Biota is exposed, and that exposure at the BCG level is equal to the DOE mandated level of maximum exposure for a terrestrial and/or riparian animal of 0.1 RAD per day and for an aquatic animal of 1.0 RAD per day. Divide the actual level by the BCG. If the result is greater than 1.0, the screening level has been exceeded.

Where more than one radionuclide (i.e., Radium 226 and Radium 228) is involved and where there is more than one source of radiation (i.e., water plus sediment), then divide each BCG by the actual radiation level for each radionuclide for each of water and sediment resulting in four fractions. If the aggregate sum of these four fractions is more than 1.0, then the screening level has been exceeded

<u>Sample Calculations of Water Quality Using the BCG Approach</u>

In the pages following the text of this Attachment, I have presented calculations of how the BCGs could be applied to the water quality situation for POTWs receiving water from wells with elevated radium levels. Page B-5 presents the basic formula for Radium 226 and 228 from the DOE Guidance. The next page then illustrates a sample calculation that provides an estimate of the water quality level at which the DOE Guidance would deem to be safe for purposes of protection of aquatic life. As one can see from that page, at a combined radium level of 3.75 pCi/L, without any contribution from total radium in the sediments, the water quality is deemed acceptable. (I then proceeded to examine the various cases described in Table 5 of Charles Williams' August testimony to document that cases 3, 4, 5 and 6 all result in an exceedance of the bio-dose criteria adopted by the BDAC.)

These calculations may understate the risk to aquatic life, since they include no calculated contribution from radium deposited in sediment. The IEPA has provided no figures for the present or expected radiation levels in the sediment. However, it is my opinion that **the radiation in the sediment will increase due to the continued discharge of radium into low-flow and no-flow streams.**

<u>Radioactive Contamination of Sediments</u>

It is instructive to consider the potential effect on the "safe" calculation by adding in a value for radium in sediments. The information provided by Attachment D provides data on not only the uptake of radium by benthic organisms, but also on the accumulation of radium in the surficial sediments.

In that case, lake levels were augmented by input water from deep water wells, the introduction of low radioactive input water (2 to 3 pCi/L of Radium 226). According to the 2000 and 2004 Technical Report to the Southwest Florida Water Management District, the resulting sediment contamination averaged 12.1 pCi/g of Radium 226; and the mussels had radiation levels in the flesh in excess of 205 pCi/g (and a RAD dose of 5.5 RAD per day). (See Attachment D.) **These mussels contain radiation at levels higher than acceptable for disposal anywhere, but at a low level radioactive waste disposal site.**

Although lakes differ from streams, in my opinion, the constant, daily, incremental discharge of radium into low-flow or no-flow streams, year after year, will cause an increase in the radioactive content of the sediment over time. Further studies would have to be undertaken to project the future levels of radioactive contamination in each particular stream. However, assuming that the ultimate contamination was 20 pCi/g combined radium (split 50/50), then (as shown in the final page of this Attachment B) any radium in the water in excess of 2.72 pCi/L would cause the screening level to be exceeded. And, on a combined radium basis, **based on these assumptions, the level of Radium 226 needed to exceed the screening level ranges drops from 1.88 pCi/L to 1.36 pCi/L.**

These calculations indicate that the existing general water standard of 1.0 pCi/L of Radium 226 water is not unreasonably low on a general, state-wide basis, and is very close to the level needed to avoid exceeding the screening level provided by the Biota Protection Standard.

It is important to remember that, in radiation matters, the fundamental principle is that all radiation should be kept ALARA — this is especially true with radium for which the maximum contaminant level goal of both the U.S. EPA and the IEPA is zero, which has a lengthy half-life, and for which, under both U.S. and Illinois state regulations, there is no allowable exempt amount and no allowable exempt concentration. The DOE committee's approach reflects this approach and is supportive of the basis of Illinois water quality standard for Radium 226.

Case 3- AVG 6.4 pCi/L- 50/50

Aquatic BCG Report for Level 1

Sum of Total Ratio: 1.73E+00

Sum of Water Ratio: 1.73E+00

Sum of Sediment Ratio: 4.77E-03

	Water			
Nuclide	Concentration (pCi/L)	BCG (pCi/L)	Ratio	Limiting Organism
Ra-226	3.20E+00	4.08E+00	7.85E-01	Riparian Animal
Ra-228	3.20E+00	3.40E+00	9.42E-01	Riparian Animal
	Sediment			
Nuclide	Concentration (pCi/g)	BCG (pCi/g)	Ratio	Limiting Organism
Ra-226	2.24E-01	1.01E+02	2.22E-03	Riparian Animal
Ra-228	2.24E-01	8.78E+01	2.55E-03	Riparian Animal

Case 3- MAX 11 pCi/L- 50/50

Aquatic BCG Report for Level 1

Sum of Total Ratio: 2.98E+00

Sum of Water Ratio: 2.97E+00

Sum of Sediment Ratio: 8.19E-03

	Water			
Nuclide	**Concentration (pCi/L)**	**BCG (pCi/L)**	**Ratio**	**Limiting Organism**
Ra-226	5.50E+00	4.08E+00	[illegible]	Riparian Animal
Ra-228	5.50E+00	3.40E+00	[illegible]	Riparian Animal

	Sediment			
Nuclide	**Concentration (pCi/g)**	**BCG (pCi/g)**	**Ratio**	**Limiting Organism**
Ra-226	3.85E-01	1.01E+02	3.81E-03	Riparian Animal
Ra-228	3.85E-01	8.78E+01	4.38E-03	Riparian Animal

Case 4- AVG 4.3 pCi/L- 50/50

Aquatic BCG Report for Level 1

Sum of Total Ratio: 1.16E+00

Sum of Water Ratio: 1.16E+00

Sum of Sediment Ratio: 3.20E-03

	Water			
Nuclide	Concentration (pCi/L)	BCG (pCi/L)	Ratio	Limiting Organism
Ra-226	2.15E+00	4.08E+00	5.27E-01	Riparian Animal
Ra-228	2.15E+00	3.40E+00	6.33E-01	Riparian Animal
	Sediment			
Nuclide	Concentration (pCi/g)	BCG (pCi/g)	Ratio	Limiting Organism
Ra-226	1.51E-01	1.01E+02	1.49E-03	Riparian Animal
Ra-228	1.51E-01	8.78E+01	1.71E-03	Riparian Animal

Case 4- MAX 7.5 pCi/L- 50/50

Aquatic BCG Report for Level 1

Sum of Total Ratio: 2.03E+00

Sum of Water Ratio: 2.02E+00

Sum of Sediment Ratio: 5.59E-03

	Water			
Nuclide	Concentration (pCi/L)	BCG (pCi/L)	Ratio	Limiting Organism
Ra-226	3.75E+00	4.08E+00	9.20E-01	Riparian Animal
Ra-228	3.75E+00	3.40E+00	[redacted]	Riparian Animal

	Sediment			
Nuclide	Concentration (pCi/g)	BCG (pCi/g)	Ratio	Limiting Organism
Ra-226	2.63E-01	1.01E+02	2.60E-03	Riparian Animal
Ra-228	2.63E-01	8.78E+01	2.99E-03	Riparian Animal

Case 5- AVG 10 pCi/L- 50/50

Aquatic BCG Report for Level 1

Sum of Total Ratio: 2.71E+00

Sum of Water Ratio: 2.70E+00

Sum of Sediment Ratio: 7.45E-03

	Water			
Nuclide	**Concentration (pCi/L)**	**BCG (pCi/L)**	**Ratio**	**Limiting Organism**
Ra-226	5.00E+00	4.08E+00	[redacted]	Riparian Animal
Ra-228	5.00E+00	3.40E+00	[redacted]	Riparian Animal

	Sediment			
Nuclide	**Concentration (pCi/g)**	**BCG (pCi/g)**	**Ratio**	**Limiting Organism**
Ra-226	3.50E-01	1.01E+02	3.46E-03	Riparian Animal
Ra-228	3.50E-01	8.78E+01	3.99E-03	Riparian Animal

Case 6- AVG 6.8 pCi/L- 50/50

Aquatic BCG Report for Level 1

Sum of Total Ratio: 1.84E+00

Sum of Water Ratio: 1.84E+00

Sum of Sediment Ratio: 5.06E-03

	Water			
Nuclide	**Concentration (pCi/L)**	**BCG (pCi/L)**	**Ratio**	**Limiting Organism**
Ra-226	3.40E+00	4.08E+00	8.34E-01	Riparian Animal
Ra-228	3.40E+00	3.40E+00	[redacted]	Riparian Animal

	Sediment			
Nuclide	**Concentration (pCi/g)**	**BCG (pCi/g)**	**Ratio**	**Limiting Organism**
Ra-226	2.38E-01	1.01E+02	2.35E-03	Riparian Animal
Ra-228	2.38E-01	8.78E+01	2.71E-03	Riparian Animal

Case 6- MAX 12.0 pCi/L- 50/50

Aquatic BCG Report for Level 1

Sum of Total Ratio: 3.25E+00

Sum of Water Ratio: 3.24E+00

Sum of Sediment Ratio: 8.94E-03

	Water			
Nuclide	**Concentration (pCi/L)**	**BCG (pCi/L)**	**Ratio**	**Limiting Organism**
Ra-226	6.00E+00	4.08E+00	[redacted]	Riparian Animal
Ra-228	6.00E+00	3.40E+00	[redacted]	Riparian Animal

	Sediment			
Nuclide	**Concentration (pCi/g)**	**BCG (pCi/g)**	**Ratio**	**Limiting Organism**
Ra-226	4.20E-01	1.01E+02	4.15E-03	Riparian Animal
Ra-228	4.20E-01	8.78E+01	4.78E-03	Riparian Animal

Case 5-MAX-18.0 pCi/L-50/50

Aquatic BCG Report for Level 1

Sum of Total Ratio: 4.87E+00

Sum of Water Ratio: 4.86E+00

Sum of Sediment Ratio: 1.34E-02

	Water			
Nuclide	**Concentration (pCi/L)**	**BCG (pCi/L)**	**Ratio**	**Limiting Organism**
Ra-226	9.00E+00	4.08E+00	[illegible]	Riparian Animal
Ra-228	9.00E+00	3.40E+00	[illegible]	Riparian Animal

	Sediment			
Nuclide	**Concentration (pCi/g)**	**BCG (pCi/g)**	**Ratio**	**Limiting Organism**
Ra-226	6.30E-01	1.01E+02	6.23E-03	Riparian Animal
Ra-228	6.30E-01	8.78E+01	7.17E-03	Riparian Animal

CASE 1-With Sediment Concentration of 12.2 pCi/g and a Resultant Water Concentration of 1.38 pCi/l to meet the BCG (< or = 1)

Sum of Total Ratio: 1.00E+00

Sum of Water Ratio: 7.45E-01

Sum of Sediment Ratio: 2.60E-01

	Water			
Nuclide	**Concentration (pCi/L)**	**BCG (pCi/L)**	**Ratio**	**Limiting Organism**
Ra-226	1.38E+00	4.08E+00	3.39E-01	Riparian Animal
Ra-228	1.38E+00	3.40E+00	4.06E-01	Riparian Animal
	Sediment			
Nuclide	**Concentration (pCi/g)**	**BCG (pCi/g)**	**Ratio**	**Limiting Organism**
Ra-226	1.22E+01	1.01E+02	1.21E-01	Riparian Animal
Ra-228	1.22E+01	8.78E+01	1.39E-01	Riparian Animal

DOE / Biota Dose Assessment Committee Biota Protection Screening Levels

BDAC established a screening formula to establish the allowable level of radium in water for protection of aquatic biota

$$\frac{\text{Water Ra-226}}{4.08} + \frac{\text{Water Ra-228}}{3.4} + \frac{\text{Sediments Ra-226}}{101} + \frac{\text{Sediments Ra-228}}{87.8} = X$$

- If:
  - X is greater than 1, biota is at risk and site specific studies must be done
  - X is less than 1, no additional studies are required

A Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota DOE – STD – 1153-2002

DOE / Biota Dose Assessment Committee
Biota Protection Screening Levels

Example:

Ra-226 = 2.04, Ra-228 = 1.7; .5 Ra-226 and .5 Ra-228 in sediments

$$\frac{2.04}{4.08} + \frac{1.7}{3.4} + \frac{.5}{101} + \frac{.5}{87.8} = 1.01$$

$$(.5 + .5 + .005 + .005)$$

- Therefore:
  - If Ra-226 + Ra-228 is greater than 3.75 pCi/L, the result will always be greater than 1, biota is at risk and additional studies are required

Case 1- AVG 1.3 pCi/L- 50/50

Aquatic BCG Report for Level 1

Sum of Total Ratio: 3.52E-01

Sum of Water Ratio: 3.51E-01

Sum of Sediment Ratio: 9.68E-04

	Water			
Nuclide	**Concentration (pCi/L)**	**BCG (pCi/L)**	**Ratio**	**Limiting Organism**
Ra-226	6.50E-01	4.08E+00	1.59E-01	Riparian Animal
Ra-228	6.50E-01	3.40E+00	1.91E-01	Riparian Animal
	Sediment			
Nuclide	**Concentration (pCi/g)**	**BCG (pCi/g)**	**Ratio**	**Limiting Organism**
Ra-226	4.55E-02	1.01E+02	4.50E-04	Riparian Animal
Ra-228	4.55E-02	8.78E+01	5.18E-04	Riparian Animal

Case 1- MAX 2.2 pCi/L- 50/50

Aquatic BCG Report for Level 1

Sum of Total Ratio: 5.95E-01

Sum of Water Ratio: 5.94E-01

Sum of Sediment Ratio: 1.64E-03

	Water			
Nuclide	**Concentration (pCi/L)**	**BCG (pCi/L)**	**Ratio**	**Limiting Organism**
Ra-226	1.10E+00	4.08E+00	2.70E-01	Riparian Animal
Ra-228	1.10E+00	3.40E+00	3.24E-01	Riparian Animal
	Sediment			
Nuclide	**Concentration (pCi/g)**	**BCG (pCi/g)**	**Ratio**	**Limiting Organism**
Ra-226	7.70E-02	1.01E+02	7.62E-04	Riparian Animal
Ra-228	7.70E-02	8.78E+01	8.77E-04	Riparian Animal

Case 2- AVG .86 pCi/L- 50/50

Aquatic BCG Report for Level 1

Sum of Total Ratio: 2.33E-01

Sum of Water Ratio: 2.32E-01

Sum of Sediment Ratio: 6.40E-04

	Water			
Nuclide	**Concentration (pCi/L)**	**BCG (pCi/L)**	**Ratio**	**Limiting Organism**
Ra-226	4.30E-01	4.08E+00	1.05E-01	Riparian Animal
Ra-228	4.30E-01	3:40E+00	1.27E-01	Riparian Animal
	Sediment			
Nuclide	**Concentration (pCi/g)**	**BCG (pCi/g)**	**Ratio**	**Limiting Organism**
Ra-226	3.01E-02	1.01E+02	2.98E-04	Riparian Animal
Ra-228	3.01E-02	8.78E+01	3.43E-04	Riparian Animal

Case 2- MAX 1.5 pCi/L- 50/50

Aquatic BCG Report for Level 1

Sum of Total Ratio: 4.06E-01

Sum of Water Ratio: 4.05E-01

Sum of Sediment Ratio: 1.12E-03

	Water			
Nuclide	**Concentration (pCi/L)**	**BCG (pCi/L)**	**Ratio**	**Limiting Organism**
Ra-226	7.50E-01	4.08E+00	1.84E-01	Riparian Animal
Ra-228	7.50E-01	3.40E+00	2.21E-01	Riparian Animal
	Sediment			
Nuclide	**Concentration (pCi/g)**	**BCG (pCi/g)**	**Ratio**	**Limiting Organism**
Ra-226	5.25E-02	1.01E+02	5.19E-04	Riparian Animal
Ra-228	5.25E-02	8.78E+01	5.98E-04	Riparian Animal

Exhibit C

A Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota

MODULE 1

PRINCIPLES AND APPLICATION

MODULE 1: PRINCIPLES AND APPLICATION

Attachment C

1 Introduction

The U.S. Department of Energy (DOE) is accountable to Congress and the public for the safe conduct of its activities, including facility operation, waste management and disposal activities, and remediation of environmental contamination. These routine activities may result in releases of radionuclides to the air and water, accumulation of radionuclides in soil and sediment, and the potential for plants, animals, and members of the public to be exposed to radiation. DOE Order 5400.5, "Radiation Protection of the Public and the Environment" (1990a), lists the environmental radiation protection requirements that DOE and DOE-contractor employees must meet to protect aquatic animals. In addition, dose limits below which deleterious effects on populations of aquatic and terrestrial organisms have not been observed, as discussed by the National Council on Radiation Protection and Measurements (NCRP 1991), and the International Atomic Energy Agency (IAEA 1992), are considered by DOE to be relevant to the protection of all aquatic and terrestrial biota on DOE sites.

1.1 Purpose

This DOE technical standard provides a graded approach (including screening methods and methods for detailed analyses) and related guidance that DOE and DOE contractors may use to evaluate compliance with specified limits on radiation dose to populations of aquatic animals, terrestrial plants, and terrestrial animals due to anthropogenic sources at DOE sites. Specifically, the technical standard provides dose evaluation methods that can be used to meet the requirements for protection of biota in DOE Orders 5400.1, "General Environmental Protection Program" (DOE 1990b), 5400.5 (DOE 1990a), and the dose limits for protection of biota developed or discussed by the NCRP (1991) and IAEA (1992). Accordingly, this technical standard uses the biota dose limits specified below within a graded approach to demonstrate that populations of plants and animals are adequately protected from the effects of ionizing radiation:

- **Aquatic Animals**. The absorbed dose to aquatic animals should not exceed 1 rad/d (10 mGy/d) from exposure to radiation or radioactive material releases into the aquatic environment. This dose limit is specified in DOE Order 5400.5.

- **Terrestrial Plants**. The absorbed dose to terrestrial plants should not exceed 1 rad/d (10 mGy/d) from exposure to radiation or radioactive material releases into the terrestrial environment.

- **Terrestrial Animals**. The absorbed dose to terrestrial animals should not exceed 0.1 rad/d (1 mGy/d) from exposure to radiation or radioactive material releases into the terrestrial environment.

Avoiding measurable impairment of reproductive capability is deemed to be the critical biological endpoint of concern in establishing the dose limits for aquatic and terrestrial biota. Module 1, Section 1.2.2 discusses this issue further. Guidance for interpreting and applying these dose limits with respect to the length of time and geographic area over which actual doses should be compared with the limits is provided in Module 2, Section 3.

DOE has proposed these dose limits for aquatic and terrestrial biota under proposed rule Title 10, Code of Federal Regulations, Part 834 (10 CFR 834), "Radiation Protection of the Public and the Environment" (DOE 1993). DOE has decided not to promulgate these dose limits until guidance for demonstrating compliance has been developed. Consequently, this technical standard was developed, in part, in response to comments and recommendations received by DOE through the proposed rule comment period. Principal themes in the comments included: (1) requests for development of cost-effective methods to support the use of DOE's existing and proposed biota dose limits, (2) support for a multi-tiered approach to include screening, (3) requests for guidance on biota monitoring, and (4) requests for development of a generic method to promote consistency, while retaining some flexibility for site-specific methods and information. These themes served as the guiding principles for development of the methods contained in this technical standard.

The specific methods and guidance in this technical standard are acceptable for use by DOE and DOE-contractors when evaluating doses to biota in relation to the above dose limits. The methods and guidance in this technical standard should also be useful to ecological risk assessors who must evaluate risks to biota from radionuclides that occur on DOE sites. Using the graded approach provided in this technical standard, risk assessors can use soil, sediment, and water radionuclide concentration data to determine whether radionuclide concentrations at a site are likely to result in doses in excess of those listed above and would, therefore, have the potential to impact resident populations of plants and animals. The methods can also give risk assessors an immediate qualitative assessment of the importance of doses of ionizing radiation to the resident receptors. The dose equations in this technical standard also provide methods of estimating upper-bound (e.g., conservatively derived) doses to specific plants and animals. Refer to Module 1, Section 3, for a description of intended and potential applications of the DOE graded approach.

1.2 Background

1.2.1 Increasing Interest and Need for Biota Dose Evaluation Methods

There is growing national and international interest in establishing a regulatory framework (e.g., to include standards or criteria) and supporting evaluation methodologies for demonstrating protection of the environment from the effects of ionizing radiation. Regarding environmental protection, the ICRP statement that "...if man is adequately protected then other living things are also likely to be sufficiently protected" (ICRP 1977; 1991) uses human protection to infer environmental protection from the effects of ionizing radiation. This assumption is most appropriate in cases where humans and other biota inhabit the same environment and have common routes of exposure, and less appropriate in cases where human access is restricted or pathways exist that are much more important for biota than for humans. The inclusion of radiation as a stressor within ecological risk assessments is also a consideration. Ecological risk assessments at contaminated sites being considered for remediation under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) generally require an assessment of all stressors, including radiation. Assessments of radiation impacts on contaminated ecosystems are currently underway in the U.S. under CERCLA regulations (EPA 1988).

Nationally and internationally, no standardized methods have been adopted for evaluating doses and demonstrating protection of plants and animals from the effects of ionizing radiation. In 1999, the IAEA convened a technical committee examining protection of the environment from the effects of ionizing radiation and provided recommendations and discussion points for moving forward with the development of protection frameworks and dose assessment methods. The resulting IAEA Technical Document, "Protection of the Environment from the Effects of Ionizing Radiation" (1999) references multi-tiered screening as a potentially cost-effective and easy way of demonstrating compliance with radiation criteria for protection of biota. The IAEA has subsequently hosted a series of Specialists' Meetings on radiological protection of the environment, and the Nuclear Energy Agency (NEA) and the ICRP have sponsored a series of fora on this issue. It is hoped that the methods and guidance provided in this DOE technical standard will serve as a platform for national and international discussion of radiation protection frameworks, standards, and dose assessment methods for biota.

Benefits of a Screening Process

"A multi-tiered screening approach is normally used in ecological risk assessments. Screening may also be a potentially cost-effective and easy way of demonstrating compliance with radiation criteria or standards for protection of the environment. Screening values should be used to identify radionuclides in situations of concern, and to determine whether these radionuclides warrant further assessment, or if they are at levels that require no further attention. In practice, this initial screening is expected to be sufficient in the majority of cases. When initial screening fails, additional analysis or assessment may be needed. A two- or three-tiered scheme would help ensure that the magnitude of the assessment effort would be scaled to the likelihood and severity of environmental impacts."

From: IAEA-TECDOC-1091, Protection of the Environment from the Effects of Ionizing Radiation: A Report for Discussion (July 1999)

1.2.2 Basis for Biota Dose Limits Applied in this Technical Standard

A dose limit for controlling radiological impacts from DOE activities to native aquatic animals is specified in DOE Order 5400.5. At present, DOE Orders do not specify dose limits for terrestrial organisms. However, an intended objective of DOE Orders 5400.1 and 5400.5 is to protect the aquatic and terrestrial environment, including populations of plants and animals, within and beyond the boundaries of DOE sites from impacts of routine DOE activities. The dose limits in this technical standard are consistent with (a) the intent of DOE Orders 5400.1

and 5400.5, (b) the dose limit for aquatic animals specified in DOE Order 5400.5, and (c) findings of the IAEA and NCRP regarding doses below which deleterious effects on populations of aquatic and terrestrial organisms have not been observed. They are also consistent with the intent of the IAEA document, "The Principles of Radioactive Waste Management" (IAEA 1995), in which Principle 2 states that "radioactive waste shall be managed in such a way as to provide an acceptable level of environmental protection." The background for the dose limits for aquatic and terrestrial biota is briefly discussed below. These dose limits represent expected safe levels of exposure, and are consensus No Adverse Effects Levels (NOAELs) for effects on population-relevant attributes in natural populations of biota.

1.2.2.1 Aquatic Organisms

At the request of DOE, the NCRP (1991) reviewed the literature on the effects of radiation on aquatic organisms and prepared a report on the then-current understanding of such effects. The report also provided guidance for protecting populations of aquatic organisms, concluding that a chronic dose of no greater than 1 rad/d (0.4 mGy/h) to the maximally exposed individual in a population of aquatic organisms would ensure protection of the population.

The IAEA examined and summarized the conclusions regarding aquatic organisms of several previous reviews (IAEA 1992):

- Aquatic organisms are no more sensitive than other organisms; however, because they are poikilothermic animals, temperature can control the time of expression of radiation effects.

- The radiosensitivity of aquatic organisms increases with increasing complexity, that is, as organisms occupy successively higher positions on the phylogenetic scale.

- The radiosensitivity of many aquatic organisms changes with age, or, in the case of unhatched eggs, with the stage of development.

- Embryo development in fish and the process of gametogenesis appear to be the most radiosensitive stages of all aquatic organisms tested.

- The radiation-induced mutation rate for aquatic organisms appears to be between that for *Drosophila* (fruit flies) and mice.

Furthermore, the 1992 review found that the conclusions of an earlier IAEA review (1976) were still supported; namely, that appreciable effects in aquatic populations would not be expected at doses lower than 1 rad/d (10 mGy/d) and that limiting the dose to the maximally exposed individuals to less than 1 rad/d would provide adequate protection of the population.

1.2.2.2 Terrestrial Organisms

The IAEA (1992) summarized information about the effects of acute ionizing radiation on terrestrial organisms as follows:

- Reproduction (encompassing the processes from gametic formation through embryonic development) is likely to be the most limiting endpoint in terms of survival of the population.
- Lethal doses vary widely among different species, with birds, mammals, and a few tree species being the most sensitive among those considered.
- Acute doses of 10 rad (100 mGy) or less are very unlikely to produce persistent and measurable deleterious changes in populations or communities of terrestrial plants or animals.

The IAEA (1992) also summarized information about the effects of chronic radiation on terrestrial organisms:

- Reproduction (encompassing the processes from gametogenesis through embryonic development) is likely to be the most limiting endpoint in terms of population maintenance.
- Sensitivity to chronic radiation varies markedly among different taxa; certain mammals, birds, reptiles, and a few tree species appear to be the most sensitive.
- In the case of invertebrates, indirect responses to radiation-induced changes in vegetation appear more critical than direct effects.
- Irradiation at chronic dose rates of 1 rad/d (10 mGy/d) or less does not appear likely to cause observable changes in terrestrial plant populations.
- Irradiation at chronic dose rates of 0.1 rad/d (1 mGy/d) or less does not appear likely to cause observable changes in terrestrial animal populations. The assumed threshold for effects in terrestrial animals is less than that for terrestrial plants, primarily because some species of mammals and reptiles are considered to be more radiosensitive.
- Reproductive effects on long-lived species with low reproductive capacity may require further consideration.

The NCRP and IAEA concluded for aquatic organisms and the IAEA concluded for terrestrial organisms that the statement by the ICRP (1977; 1991), "...if man is adequately protected, then other living things are also likely to be sufficiently protected" was reasonable within the limitations of the generic exposure scenarios examined. A similar assessment was made at a DOE-sponsored workshop (Barnthouse 1995) held to evaluate the adequacy of existing effects data and approaches to radiation protection of aquatic and terrestrial organisms to support moving forward with setting regulatory limits. DOE workshop participants agreed that protecting humans generally protects biota, except under the following conditions: (1) human access to a contaminated area is restricted but access by biota is not restricted, (2) unique exposure pathways exist for plants and animals that do not affect exposure of humans, (3) rare or endangered species are present, or (4) other stresses on the plant or animal population are significant.

1.2.2.3 Additional Summaries and Reviews of Radiation Effects Data on Biota Confirming NCRP and IAEA Findings

UNSCEAR. In 1996, the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) summarized and reviewed information on the responses to acute and chronic radiation of plants and animals, both as individuals and as populations (UNSCEAR 1996). The conclusions from the UNSCEAR review were consistent with findings and recommendations made earlier by the NCRP and IAEA concerning biota effects data and appropriate dose limits for protection of biota. In 2002, UNSCEAR reported that these dose rate criteria (1 rad/d for aquatic animals and terrestrial plants; 0.1 rad/d for terrestrial animals) remain defensible for protection of populations of plants and animals. The UNSCEAR plans to develop a new scientific annex to further address radioecology and effects of radiation on the environment (Gentner 2002).

UK Environment Agency. In 2001, the Environment Agency of the United Kingdom (UK) conducted a review of the available body of radiation effects data on biota (Copplestone et al. 2001). They concluded that it is unlikely that there will be any significant effects in:

- populations of freshwater and coastal organisms at chronic dose rates below 400 uGy/h (or 1 rad/d; 10 mGy/d);
- terrestrial plant populations at chronic dose rates below 400 uGy/h (or 1 rad/d; 10 mGy/d); and
- terrestrial animal populations at chronic dose rates below 40 uGy/h (or 0.1 rad/d; 1 mGy/d).

It is noteworthy that the UK Environment Agency's review findings are largely consistent with the findings and biota dose recommendations of the NCRP, the IAEA, and UNSCEAR cited above. Additionally, they concluded that it is unlikely that there will be any significant effects in populations of organisms in the deep ocean at chronic dose rates below 1,000 uGy/h (or 2.5 rad/d; 25 mGy/d).

ACRP. In 2002, the Advisory Committee on Radiation Protection (ACRP), charged with providing advice to the Canadian Nuclear Safety Commission (CNSC) regarding approaches needed for the radiological protection of the environment, provided recommendations concerning appropriate dose rate criteria for protection of biota. The ACRP recommended that the generic dose rate criterion for protecting biota should be in the range of 1-10 mGy/d (0.1-1 rad/d). The ACRP indicated that this dose rate criterion is based on population-level effects and, given the current state of knowledge and consensus views of radiation effects on biota, represents the level at which ecosystems will suffer no appreciable deleterious effects. The criterion is specified in terms of daily dose rather than annual dose. The intent is to avoid, for example, what would be the annual dose at this dose rate criterion being received in a few days. The ACRP further recommended that there should be some flexibility in the averaging time used in interpreting this dose rate criterion (CNSC-ACRP 2002).

1.2.2.4 Application of Biota Dose Limits as "Dose Rate Guidelines" for Evaluating Doses to Biota

The biota dose limits specified in this technical standard are based on the current state of science and knowledge regarding effects of ionizing radiation on plants and animals. They should not be interpreted as a "bright line" that, if exceeded, would trigger a mandatory regulatory or remedial action. Rather, they should be interpreted and applied more as "Dose Rate Guidelines" that provide an indication that populations of plants and animals could be impacted from exposure to ionizing radiation and that further investigation and action is likely necessary.

1.2.3 Protection of Populations

The intent of the graded approach (i.e., the screening and analysis methods) in this technical standard is to protect populations of aquatic animals, terrestrial animals, and terrestrial plants from the effects of exposure to anthropogenic ionizing radiation. As noted above, certain taxa are more sensitive to ionizing radiation than others. Based on this observation, it is generally assumed that protecting the more sensitive taxa will adequately protect other, less sensitive taxa. Hence, in cases where site-specific evaluations may be required, receptors should be selected that (1) are important to the structure and function of the community, (2) are expected to receive a comparatively high degree of exposure (e.g., expected to receive a radiation dose to reproductive tissues which is relatively high per unit of radionuclide present in the ecosystem, in comparison with other receptors in the same community), and (3) have a comparatively high degree of radiosensitivity (e.g., radiation effects of concern occur at relatively low doses, in comparison with other receptors in the same community). Figure 1.1 shows the relative radiosensitivity of various taxa for both aquatic and terrestrial systems.

Participants at the DOE-sponsored workshop to evaluate the adequacy of existing effects data and approaches to radiation protection of aquatic and terrestrial organisms (Barnthouse 1995) concluded that existing data support the application of recommended dose limits to

Table 6.2 Biota Concentration Guides (BCGs) for Water and Sediment (in Special Units) for Use in Aquatic System Evaluations. For use with measured radionuclide concentrations from co-located water and sediment.

Nuclide	BCG (water), pCi/L	Organism Responsible for Limiting Dose in Water	BCG (sediment), pCi/g	Organism Responsible for Limiting Dose in Sediment
^{241}Am	4E+02	Aquatic Animal	5E+03	Riparian Animal
^{144}Ce	2E+03	Aquatic Animal	3E+03	Riparian Animal
^{135}Cs	5E+02	Riparian Animal	4E+04	Riparian Animal
^{137}Cs	4E+01	Riparian Animal	3E+03	Riparian Animal
^{60}Co	4E+03	Aquatic Animal	1E+03	Riparian Animal
^{154}Eu	2E+04	Aquatic Animal	3E+03	Riparian Animal
^{155}Eu	3E+05	Aquatic Animal	3E+04	Riparian Animal
^{3}H	3E+08	Riparian Animal	4E+05	Riparian Animal
^{129}I	4E+04	Riparian Animal	3E+04	Riparian Animal
^{131}I	1E+04	Riparian Animal	5E+03	Riparian Animal
^{239}Pu	2E+02	Aquatic Animal	6E+03	Riparian Animal
^{226}Ra	4E+00	Riparian Animal	1E+02	Riparian Animal
^{228}Ra	3E+00	Riparian Animal	9E+01	Riparian Animal
^{125}Sb	4E+05	Aquatic Animal	7E+03	Riparian Animal
^{90}Sr	3E+02	Riparian Animal	6E+02	Riparian Animal
^{99}Tc	7E+05	Riparian Animal	4E+04	Riparian Animal
^{232}Th	3E+02	Aquatic Animal	1E+03	Riparian Animal
^{233}U	2E+02	Aquatic Animal	5E+03	Riparian Animal
^{234}U	2E+02	Aquatic Animal	5E+03	Riparian Animal
^{235}U	2E+02	Aquatic Animal	4E+03	Riparian Animal
^{238}U	2E+02	Aquatic Animal	2E+03	Riparian Animal
^{65}Zn	1E+01	Riparian Animal	1E+03	Riparian Animal
^{95}Zr	7E+03	Aquatic Animal	2E+03	Riparian Animal

DOE F 1325.8
(8-89)
EFG (07-90)

United States Government Department of Energy

memorandum

DATE: August 27, 2002

REPLY TO ATTN OF: Office of Environmental Policy and Guidance: Domotor: 6-0871

SUBJECT: Availability of DOE-Approved Technical Standard, "A Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota (DOE-STD-1153-2002)," for Use in DOE Compliance and Risk Assessment Activities

TO: Distribution

The purpose of this memorandum is to inform you on the availability of the recently approved Department of Energy (DOE) technical standard, "A Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota (DOE-STD-1153-2002)." The technical standard provides methods and guidance within a graded approach for use in demonstrating protection of biota (plants and animals) from potential effects of ionizing radiation. This voluntary consensus technical standard was prepared by the Air, Water, and Radiation Division (EH-412) and the Department's Biota Dose Assessment Committee, an approved DOE Technical Standards Program topical committee comprised of representatives from across the DOE complex.

The technical standard provides screening methods and, if needed, methods for more-detailed analysis within a graded framework that can be used for demonstrating compliance with requirements contained in DOE Order 5400.5, "Radiation Protection of the Public and the Environment." It can also be used to support environmental protection program elements within Environmental Management Systems at DOE sites, and for conducting ecological risk assessments of radiological impact. DOE Order 5400.5 specifies the radiation protection requirements that DOE and DOE contractor employees must meet to protect aquatic animals. In addition, dose rate guidelines below which deleterious effects have not been observed in populations of aquatic or terrestrial organisms, as recommended by the National Council on Radiation Protection and Measurements, and the International Atomic Energy Agency, are considered by DOE to be relevant for the protection of aquatic and terrestrial biota at DOE sites.

This technical standard is responsive to DOE's needs and to increasing stakeholder and regulator interest concerning protection of the environment (biota and ecosystems) from the effects of radiation. Internationally, the general practice of using human radiation protection to infer ecological protection is being re-considered for certain radiological contamination scenarios. Accordingly, explicit guidelines and methods for demonstrating radiological protection of the environment are being considered or are already under development by certain countries and international organizations. The evaluation of radiation as a stressor within ecological risk assessments is also a consideration. Ecological risk assessments at contaminated sites being considered for remediation (e.g., under the Comprehensive Environmental Response, Compensation, and Liability Act, CERCLA) generally require an assessment of all stressors, including

1.0 Rad = 20 Rem

radiation. Finally, DOE long-term stewardship (LTS) planning documents at the local and national level indicate that protection of natural resources is integral to a successful LTS program, and cited radiological impact on wildlife as a public concern at radiologically-contaminated sites requiring long-term stewardship.

The Department's graded approach for evaluating doses to biota was designed for flexibility and acceptability. It provides users with a tiered approach for demonstrating compliance with biota dose rate guidelines that is cost-effective and easy to implement, it allows for the use of measured radionuclide concentrations in environmental media typically collected as part of DOE routine site environmental surveillance programs, it incorporates ecological risk assessment concepts, and it provides guidance for site-specific biota dose assessments where needed. A copy of the technical standard and the RAD-BCG Calculator (a companion software program for use with the technical standard) can be downloaded from the Biota Dose Assessment Committee web site (http://homer.ornl.gov/oepa/public/bdac) and from the DOE Technical Standards Program home page (http://tis.eh.doe.gov/techstds/standard/standfrm.html).

The Biota Dose Assessment Committee is available as a technical resource concerning the implementation of methods and guidance contained in this technical standard. Requests for Committee assistance should be coordinated through the chairperson (Mr. Stephen Domotor, EH-412, 202-586-0871, Stephen.Domotor@eh.doe.gov). Questions concerning this technical standard, requests for a copy of the technical standard, or communication of lessons learned from its implementation should also be coordinated through Mr. Domotor (EH-412).

Andy Lawrence
Andy Lawrence
Director
Office of Environmental Policy and Guidance

Distribution:
Attached

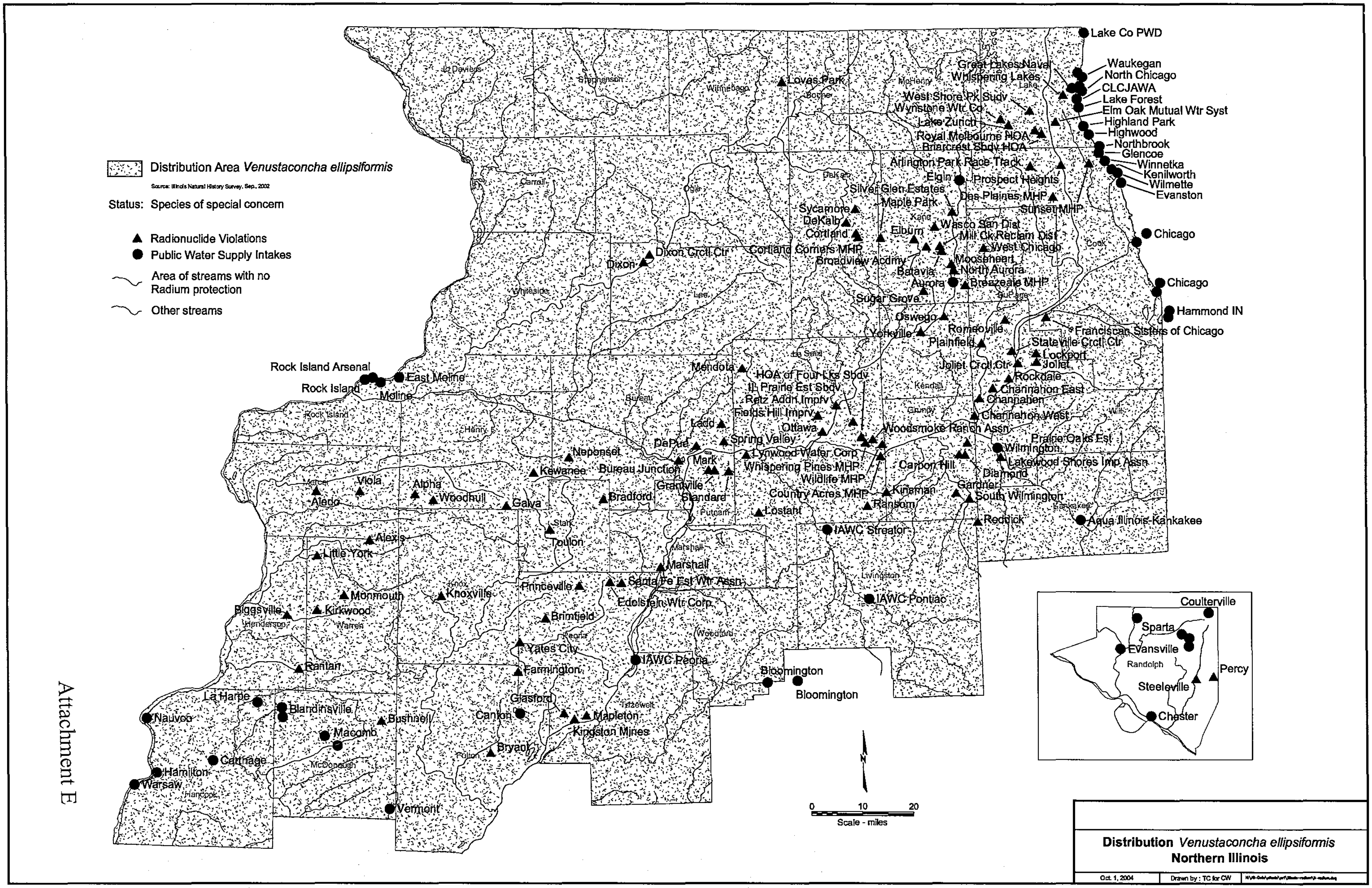
cc:
Biota Dose Assessment Committee

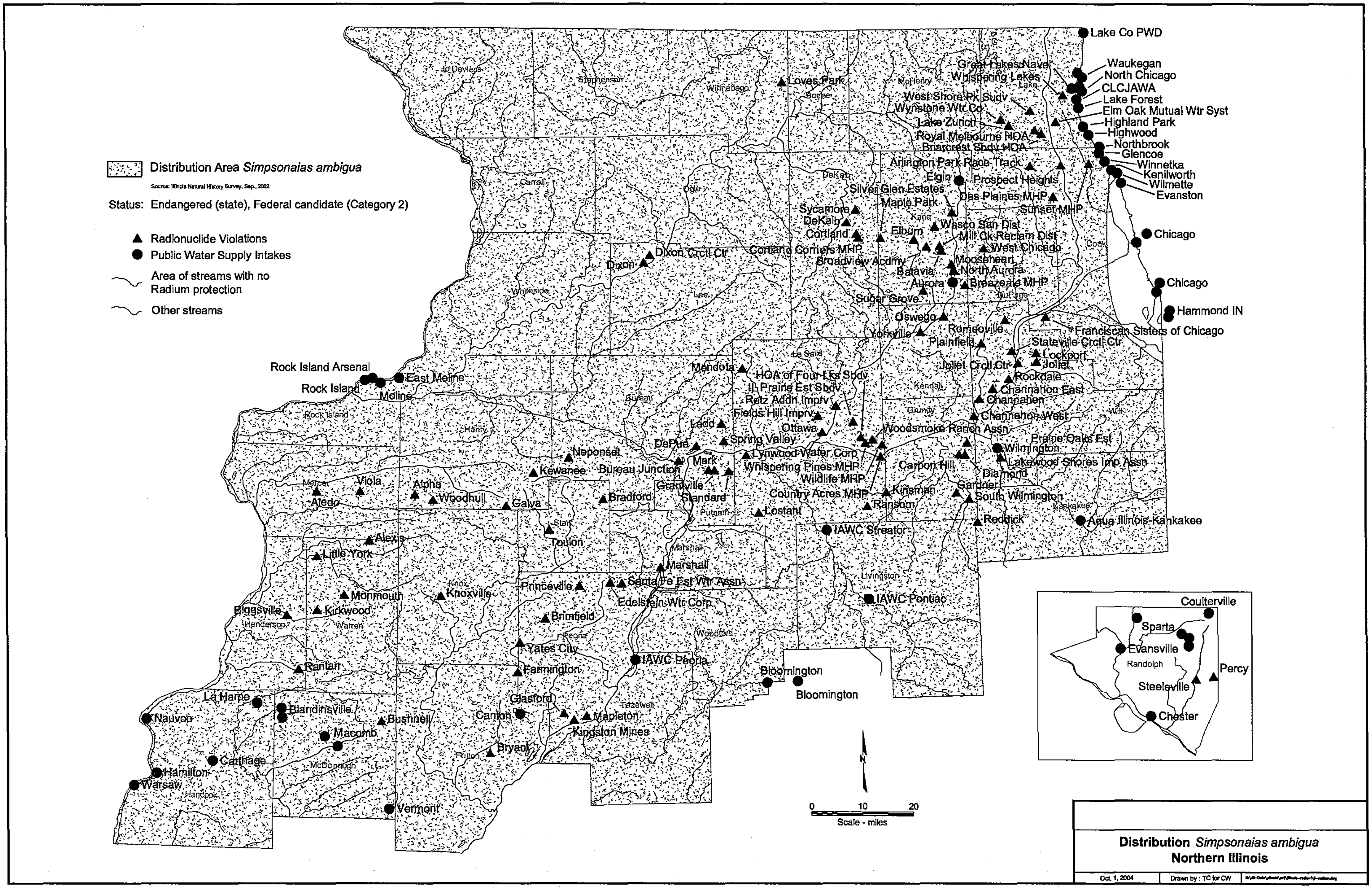
Environmental Radiological Control
Coordinating Committee

Annual Site Environmental Report
Points of Contact

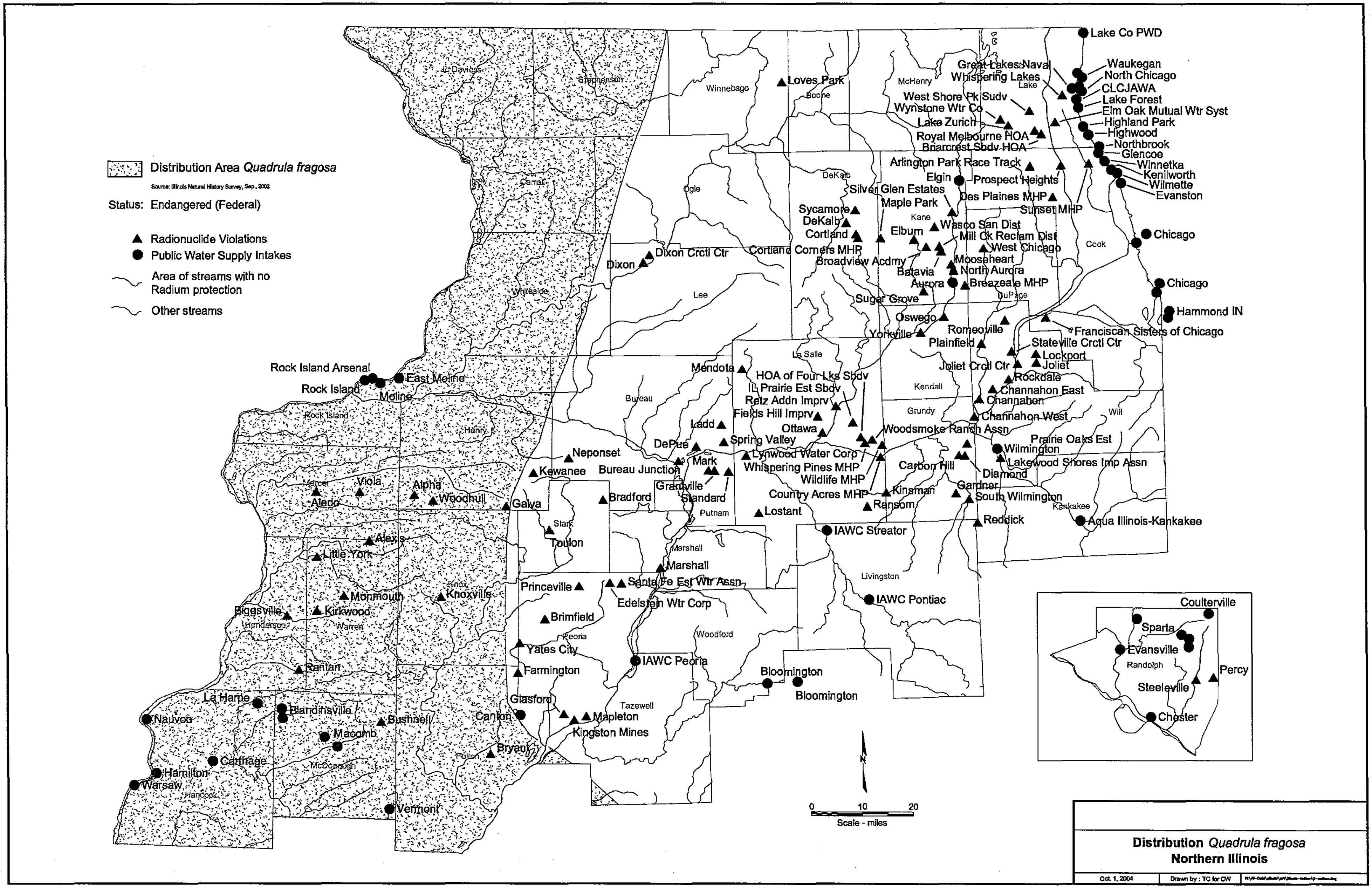
Exhibit E

Attachment E





Distribution Area *Simpsonaias ambigua*
Status: Endangered (state), Federal candidate (Category 2)
Radionuclide Violations
Public Water Supply Intakes
Area of streams with no Radium protection
Other streams
Lake Co PWD
Waukegan
North Chicago
CLCJAWA
Lake Forest
Elm Oak Mutual Wtr Syst
Highland Park
Highwood
Northbrook
Glencoe
Winnetka
Kenilworth
Wilmette
Evanston
Chicago
Chicago
Hammond IN
Franciscan Sisters of Chicago
Great Lakes Naval
Whispering Lakes
West Shore Pk Sbdv
Wynstone Wtr Co
Lake Zurich
Royal Melbourne HOA
Briarcrest Sbdv HOA
Arlington Park Race Track
Elgin
Prospect Heights
Silver Glen Estates
Des Plaines MHP
Maple Park
Sunset MHP
Sycamore
DeKalb
Cortland
Elburn
Wasco San Dist
Mill Ck Reclam Dist
West Chicago
Cortland Corners MHP
Broadview Acdmy
Mooseheart
Batavia
North Aurora
Aurora
Breezeale MHP
Sugar Grove
Oswego
Romeoville
Yorkville
Plainfield
Stateville Crctl Ctr
Lockport
Joliet Crctl Ctr
Joliet
Rockdale
Channahon East
Channahon
Channahon West
Loves Park
Dixon Crctl Ctr
Dixon
Mendota
HOA of Four Lks Sbdv
IL Prairie Est Sbdv
Reitz Addn Imprv
Fields Hill Imprv
Ladd
Ottawa
Spring Valley
DePue
Woodsmoke Ranch Assn
Prairie Oaks Est
Wilmington
Lakewood Shores Imp Assn
Lynwood Water Corp
Whispering Pines MHP
Carbon Hill
Diamond
Mark
Wildlife MHP
Gardner
Neponset
Kewanee
Bureau Junction
Granville
Standard
Country Acres MHP
Kinsman
South Wilmington
Ransom
Lostant
Reddick
Aqua Illinois-Kankakee
IAWC Streator
Rock Island Arsenal
East Moline
Rock Island
Moline
Viola
Alpha
Aledo
Woodhull
Galva
Bradford
Toulon
Alexis
Little York
Marshall
Princeville
Santa Fe Est Wtr Assn
Edelstein Wtr Corp
IAWC Pontiac
Monmouth
Knoxville
Biggsville
Kirkwood
Brimfield
Yates City
IAWC Peoria
Raritan
Farmington
Bloomington
Bloomington
La Harpe
Blandinsville
Glasford
Nauvoo
Bushnell
Canton
Mapleton
Kingston Mines
Macomb
Carthage
Bryant
Hamilton
Warsaw
Vermont
Scale - miles
0
10
20
Coulterville
Sparta
Evansville
Randolph
Percy
Steeleville
Chester
Distribution *Simpsonaias ambigua*
Northern Illinois
Oct. 1, 2004
Drawn by : TC for CW


Distribution Area Quadrula fragosa
Source: Illinois Natural History Survey, Sep., 2002
Status: Endangered (Federal)
Radionuclide Violations
Public Water Supply Intakes
Area of streams with no Radium protection
Other streams
Jo Daviess
Stephenson
Winnebago
Boone
McHenry
Lake
Carroll
Ogle
DeKalb
Kane
Cook
DuPage
Whiteside
Lee
La Salle
Kendall
Grundy
Will
Bureau
Rock Island
Henry
Mercer
Knox
Stark
Putnam
Marshall
Livingston
Kankakee
Warren
Henderson
Peoria
Woodford
Tazewell
Fulton
McDonough
Hancock
Lake Co PWD
Waukegan
North Chicago
CLCJAWA
Lake Forest
Elm Oak Mutual Wtr Syst
Highland Park
Highwood
Northbrook
Glencoe
Winnetka
Kenilworth
Wilmette
Evanston
Great Lakes Naval
Whispering Lakes
West Shore Pk Sudv
Wynstone Wtr Co
Lake Zurich
Royal Melbourne HOA
Briarcrest Sbdv HOA
Arlington Park Race Track
Elgin
Prospect Heights
Des Plaines MHP
Sunset MHP
Loves Park
Silver Glen Estates
Sycamore
Maple Park
DeKalb
Cortland
Elburn
Wasco San Dist
Mill Ck Reclam Dist
West Chicago
Cortland Corners MHP
Broadview Acdmy
Mooseheart
Batavia
North Aurora
Aurora
Breezeale MHP
Chicago
Chicago
Hammond IN
Dixon Crctl Ctr
Dixon
Sugar Grove
Oswego
Romeoville
Yorkville
Plainfield
Franciscan Sisters of Chicago
Stateville Crctl Ctr
Lockport
Joliet
Joliet Crctl Ctr
Rockdale
Channahon East
Channahon
Channahon West
Mendota
HOA of Four Lks Sbdv
IL Prairie Est Sbdv
Retz Addn Imprv
Fields Hill Imprv
Ottawa
Woodsmoke Ranch Assn
Prairie Oaks Est
Wilmington
Lakewood Shores Imp Assn
Diamond
Carbon Hill
Gardner
South Wilmington
Kinsman
Ransom
Reddick
Aqua Illinois-Kankakee
Rock Island Arsenal
Rock Island
East Moline
Moline
Ladd
Spring Valley
DePue
Neponset
Kewanee
Bureau Junction
Mark
Lynwood Water Corp
Whispering Pines MHP
Wildlife MHP
Country Acres MHP
Granville
Standard
Bradford
Lostant
IAWC Streator
Viola
Aledo
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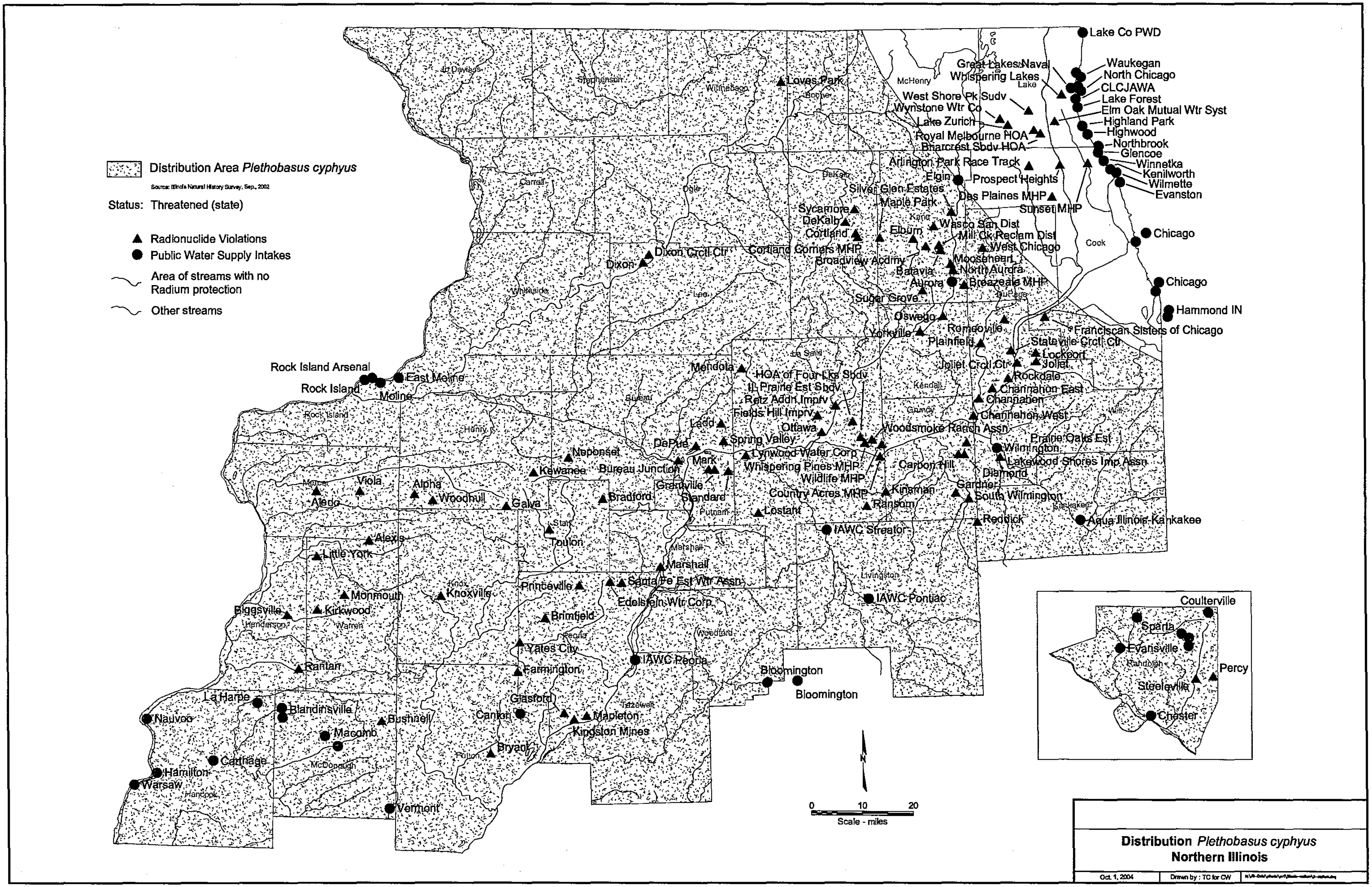
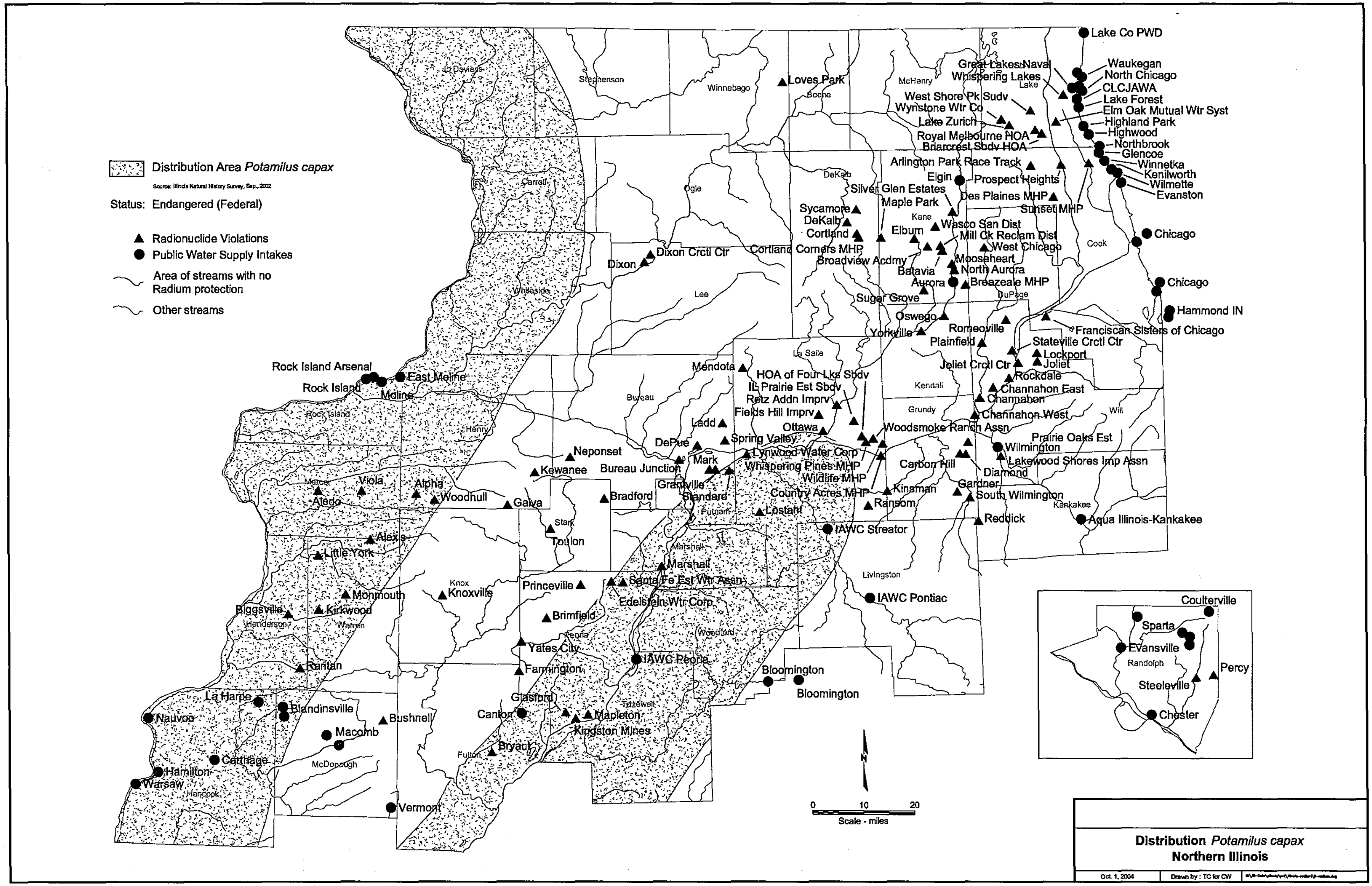
Woodhull
Galva
Toulon
Alexis
Little York
Monmouth
Knoxville
Biggsville
Kirkwood
Marshall
Santa Fe Est Wtr Assn
Edelstein Wtr Corp
Princeville
Brimfield
Yates City
IAWC Peoria
Farmington
IAWC Pontiac
Raritan
Bloomington
Bloomington
La Harpe
Blandinsville
Nauvoo
Bushnell
Macomb
Carthage
Hamilton
Warsaw
Vermont
Canton
Glasford
Mapleton
Kingston Mines
Bryant
Coulterville
Sparta
Evansville
Randolph
Percy
Steeleville
Chester
N
0 10 20
Scale - miles
Distribution Quadrula fragosa
Northern Illinois
Oct. 1, 2004
Drawn by : TC for CW


Distribution Area Plethobasus cyphyus
Source: Illinois Natural History Survey, Sep., 2002
Status: Threatened (state)
Radionuclide Violations
Public Water Supply Intakes
Area of streams with no Radium protection
Other streams
Lake Co PWD
Great Lakes Naval
Whispering Lakes
Waukegan
North Chicago
CLCJAWA
Lake Forest
Elm Oak Mutual Wtr Syst
Highland Park
Highwood
Northbrook
Glencoe
Winnetka
Kenilworth
Wilmette
Evanston
West Shore Pk Sudv
Wynstone Wtr Co
Lake Zurich
Royal Melbourne HOA
Briarcrest Sbdv HOA
Arlington Park Race Track
Elgin
Prospect Heights
Des Plaines MHP
Sunset MHP
Silver Glen Estates
Maple Park
Sycamore
DeKalb
Cortland
Elburn
Wasco San Dist
Mill Ck Reclam Dist
West Chicago
Cortland Corners MHP
Broadview Acdmy
Mooseheart
North Aurora
Batavia
Aurora
Breazeale MHP
Sugar Grove
Chicago
Chicago
Hammond IN
Oswego
Romeoville
Franciscan Sisters of Chicago
Yorkville
Plainfield
Stateville Crctl Ctr
Lockport
Joliet Crctl Ctr
Joliet
Rockdale
Channahon East
Channahon
Channahon West
Loves Park
Dixon Crctl Ctr
Dixon
Mendota
HOA of Four Lks Sbdv
IL Prairie Est Sbdv
Retz Addn Imprv
Fields Hill Imprv
Ottawa
Woodsmoke Ranch Assn
Ladd
Spring Valley
DePue
Lynwood Water Corp
Whispering Pines MHP
Wildlife MHP
Mark
Bureau Junction
Granville
Standard
Country Acres MHP
Kinsman
Ransom
Lostant
Carbon Hill
Prairie Oaks Est
Wilmington
Lakewood Shores Imp Assn
Diamond
Gardner
South Wilmington
Reddick
Aqua Illinois-Kankakee
IAWC Streator
IAWC Pontiac
Rock Island Arsenal
Rock Island
East Moline
Moline
Neponset
Kewanee
Viola
Aledo
Alpha
Woodhull
Galva
Bradford
Toulon
Alexis
Little York
Marshall
Monmouth
Knoxville
Princeville
Santa Fe Est Wtr Assn
Edelstein Wtr Corp
Biggsville
Kirkwood
Brimfield
Yates City
Farmington
IAWC Peoria
Bloomington
Bloomington
Raritan
La Harpe
Blandinsville
Nauvoo
Bushnell
Glasford
Canton
Mapleton
Kingston Mines
Macomb
Carthage
Bryant
Hamilton
Warsaw
Vermont
0 10 20
Scale - miles
Coulterville
Sparta
Evansville
Randolph
Percy
Steeleville
Chester
Distribution Plethobasus cyphyus
Northern Illinois
Oct. 1, 2004
Drawn by: TC for CW


Distribution Area Potamilus capax
Source: Illinois Natural History Survey, Sep., 2002
Status: Endangered (Federal)
Radionuclide Violations
Public Water Supply Intakes
Area of streams with no Radium protection
Other streams
Lake Co PWD
Waukegan
North Chicago
CLCJAWA
Lake Forest
Elm Oak Mutual Wtr Syst
Highland Park
Highwood
Northbrook
Glencoe
Winnetka
Kenilworth
Wilmette
Evanston
Great Lakes Naval
Whispering Lakes
West Shore Pk Sudv
Wynstone Wtr Co
Lake Zurich
Royal Melbourne HOA
Briarcrest Sbdv HOA
Arlington Park Race Track
Elgin
Prospect Heights
Des Plaines MHP
Sunset MHP
Silver Glen Estates
Maple Park
Sycamore
DeKalb
Cortland
Elburn
Wasco San Dist
Mill Ck Reclam Dist
West Chicago
Cortland Corners MHP
Broadview Acdmy
Batavia
Mooseheart
North Aurora
Aurora
Breazeale MHP
Sugar Grove
Oswego
Yorkville
Romeoville
Plainfield
Franciscan Sisters of Chicago
Stateville Crctl Ctr
Lockport
Joliet Crctl Ctr
Joliet
Rockdale
Channahon East
Channahon
Channahon West
Prairie Oaks Est
Wilmington
Lakewood Shores Imp Assn
Diamond
Gardner
South Wilmington
Reddick
Aqua Illinois-Kankakee
Chicago
Chicago
Hammond IN
Loves Park
Dixon Crctl Ctr
Dixon
Mendota
HOA of Four Lks Sbdv
IL Prairie Est Sbdv
Retz Addn Imprv
Fields Hill Imprv
Ottawa
Woodsmoke Ranch Assn
Ladd
Spring Valley
DePue
Mark
Lynwood Water Corp
Whispering Pines MHP
Wildlife MHP
Carbon Hill
Country Acres MHP
Kinsman
Ransom
Lostant
Granville
Standard
Bureau Junction
IAWC Streator
IAWC Pontiac
Rock Island Arsenal
Rock Island
East Moline
Moline
Neponset
Kewanee
Viola
Alpha
Woodhull
Aledo
Galva
Bradford
Toulon
Alexis
Little York
Monmouth
Knoxville
Princeville
Santa Fe Est Wtr Assn
Edelstein Wtr Corp
Marshall
Biggsville
Kirkwood
Brimfield
Yates City
Farmington
IAWC Peoria
Raritan
Bloomington
Bloomington
La Harpe
Blandinsville
Nauvoo
Bushnell
Macomb
Glasford
Canton
Mapleton
Kingston Mines
Bryant
Carthage
Hamilton
Warsaw
Vermont
Jo Daviess
Stephenson
Winnebago
Boone
McHenry
Lake
Carroll
Ogle
DeKalb
Kane
Cook
Whiteside
Lee
DuPage
La Salle
Kendall
Grundy
Will
Rock Island
Henry
Bureau
Mercer
Stark
Putnam
Marshall
Kankakee
Livingston
Knox
Henderson
Warren
Peoria
Woodford
Tazewell
Fulton
McDonough
Hancock
Coulterville
Sparta
Evansville
Randolph
Percy
Steeleville
Chester
N
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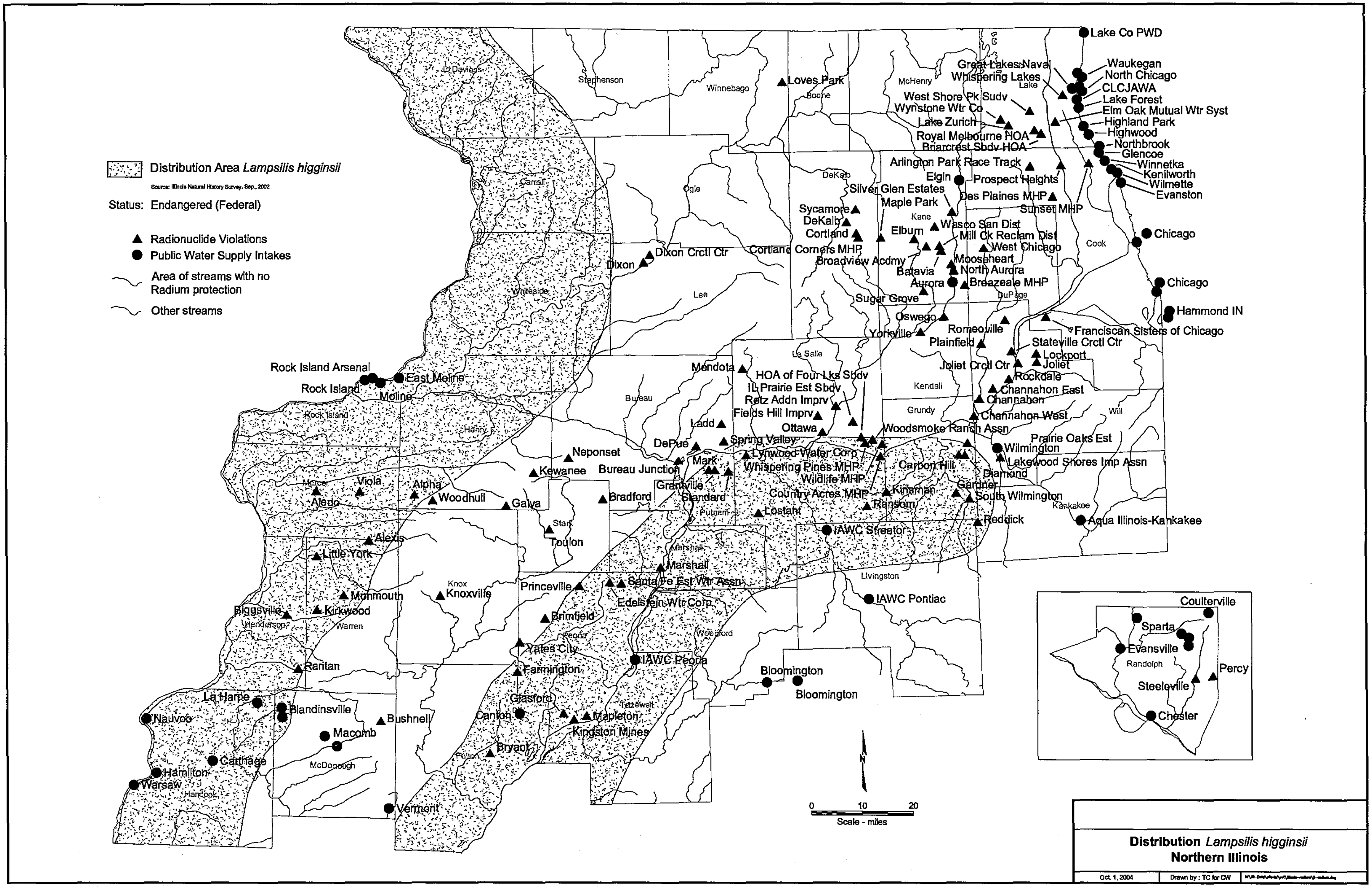
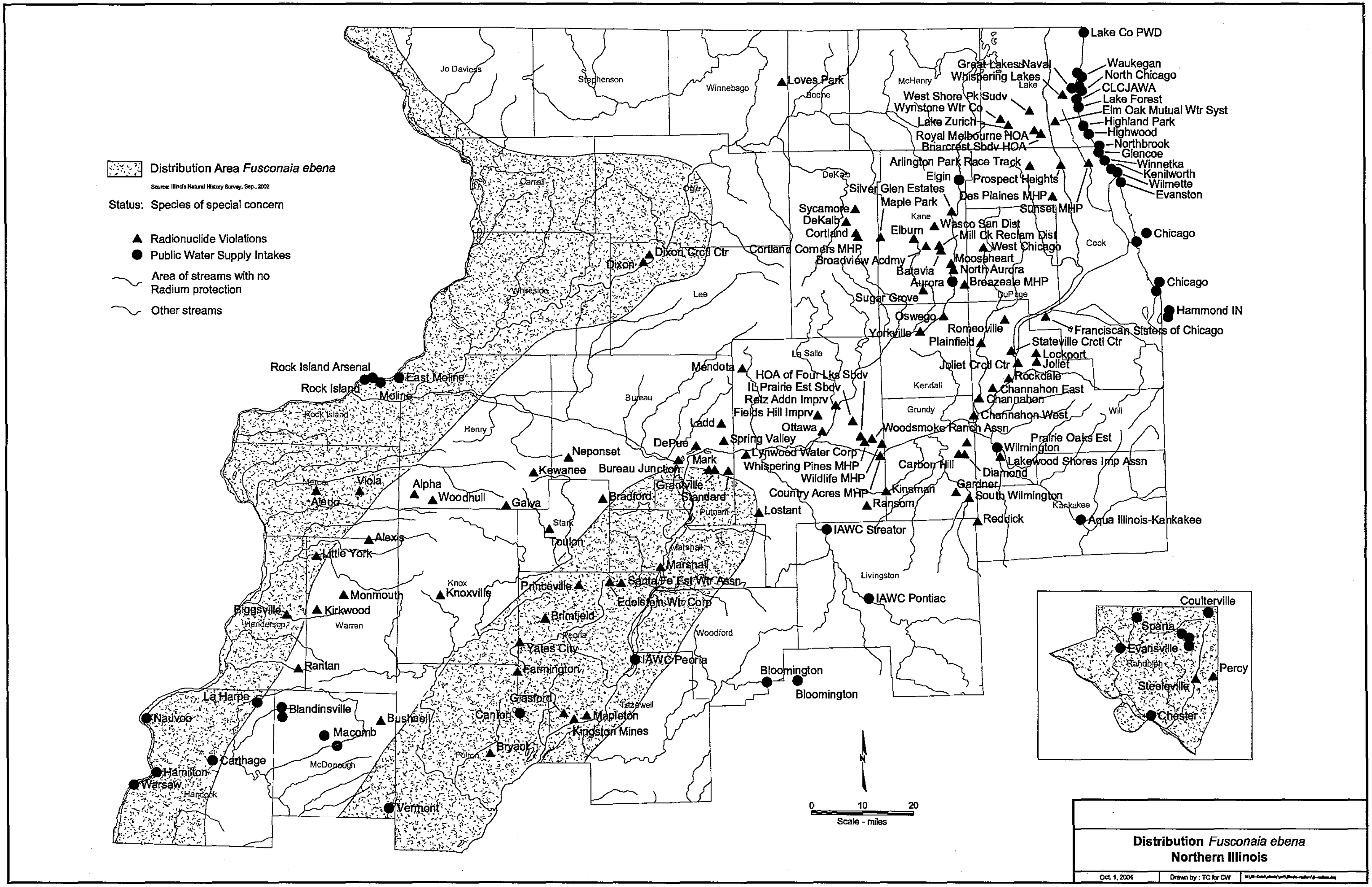
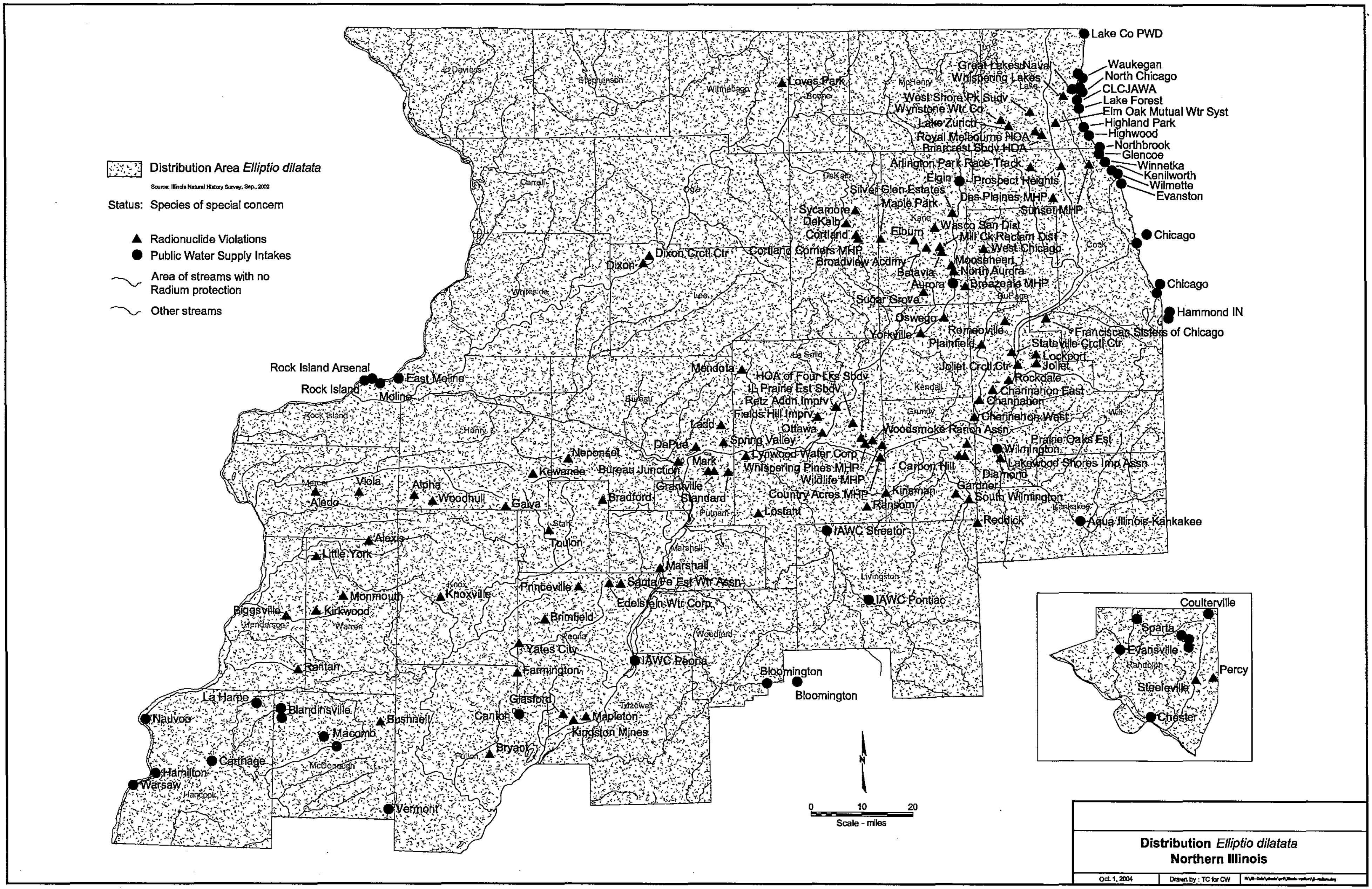
Scale - miles
Distribution Potamilus capax
Northern Illinois
Oct. 1, 2004
Drawn by: TC for CW



Distribution *Lampsilis higginsii*
Northern Illinois



Distribution Area Fusconaia ebena
Status: Species of special concern
Radionuclide Violations
Public Water Supply Intakes
Area of streams with no Radium protection
Other streams
Jo Daviess
Stephenson
Winnebago
Boone
McHenry
Lake
Carroll
Ogle
DeKalb
Kane
Cook
DuPage
Whiteside
Lee
Rock Island
Henry
Bureau
La Salle
Kendall
Grundy
Will
Kankakee
Mercer
Stark
Putnam
Marshall
Livingston
Knox
Warren
Henderson
Peoria
Woodford
Tazewell
Fulton
McDonough
Hancock
Lake Co PWD
Great Lakes Naval
Whispering Lakes
Waukegan
North Chicago
CLCJAWA
Lake Forest
Elm Oak Mutual Wtr Syst
Highland Park
Highwood
Northbrook
Glencoe
Winnetka
Kenilworth
Wilmette
Evanston
Loves Park
West Shore Pk Sudv
Wynstone Wtr Co
Lake Zurich
Royal Melbourne HOA
Briarcrest Sbdv HOA
Arlington Park Race Track
Elgin
Prospect Heights
Des Plaines MHP
Sunset MHP
Silver Glen Estates
Maple Park
Sycamore
DeKalb
Cortland
Elburn
Wasco San Dist
Mill Ck Reclam Dist
West Chicago
Cortland Corners MHP
Broadview Acdmy
Mooseheart
Batavia
North Aurora
Aurora
Breazeale MHP
Sugar Grove
Chicago
Chicago
Hammond IN
Oswego
Yorkville
Romeoville
Plainfield
Franciscan Sisters of Chicago
Stateville Crctl Ctr
Lockport
Joliet Crctl Ctr
Joliet
Rockdale
Channahon East
Channahon
Channahon West
Dixon Crctl Ctr
Dixon
Rock Island Arsenal
East Moline
Rock Island
Moline
Mendota
HOA of Four Lks Sbdv
IL Prairie Est Sbdv
Retz Addn Imprv
Fields Hill Imprv
Ladd
Ottawa
Spring Valley
DePue
Woodsmoke Ranch Assn
Prairie Oaks Est
Wilmington
Lynwood Water Corp
Mark
Whispering Pines MHP
Wildlife MHP
Carbon Hill
Lakewood Shores Imp Assn
Diamond
Gardner
Neponset
Kewanee
Bureau Junction
Granville
Standard
Country Acres MHP
Kinsman
Ransom
South Wilmington
Viola
Aledo
Alpha
Woodhull
Galva
Bradford
Lostant
Reddick
Aqua Illinois-Kankakee
Toulon
IAWC Streator
Alexis
Little York
Marshall
Santa Fe Est Wtr Assn
IAWC Pontiac
Monmouth
Knoxville
Princeville
Edelstein Wtr Corp
Biggsville
Kirkwood
Brimfield
Yates City
IAWC Peoria
Raritan
Farmington
Bloomington
Bloomington
La Harpe
Blandinsville
Bushnell
Glasford
Canton
Mapleton
Kingston Mines
Nauvoo
Macomb
Bryant
Carthage
Hamilton
Warsaw
Vermont
Coulterville
Sparta
Evansville
Randolph
Percy
Steeleville
Chester
0 10 20
Scale - miles
Distribution Fusconaia ebena
Northern Illinois
Oct. 1, 2004
Drawn by : TC for CW


Distribution Area Elliptio dilatata
Source: Illinois Natural History Survey, Sep., 2002
Status: Species of special concern
Radionuclide Violations
Public Water Supply Intakes
Area of streams with no Radium protection
Other streams
Lake Co PWD
Waukegan
North Chicago
CLCJAWA
Lake Forest
Elm Oak Mutual Wtr Syst
Highland Park
Highwood
Northbrook
Glencoe
Winnetka
Kenilworth
Wilmette
Evanston
Great Lakes Naval
Whispering Lakes
West Shore Pk Sudv
Wynstone Wtr Co
Lake Zurich
Royal Melbourne HOA
Briarcrest Sbdv HOA
Arlington Park Race Track
Elgin
Prospect Heights
Silver Glen Estates
Des Plaines MHP
Maple Park
Sunset MHP
Sycamore
DeKalb
Wasco San Dist
Cortland
Elburn
Mill Ck Reclam Dist
Cortland Corners MHP
West Chicago
Broadview Acdmy
Mooseheart
North Aurora
Batavia
Aurora
Breazeale MHP
Sugar Grove
Chicago
Hammond IN
Oswego
Romeoville
Franciscan Sisters of Chicago
Yorkville
Plainfield
Stateville Crctl Ctr
Lockport
Joliet Crctl Ctr
Joliet
Rockdale
Channahon East
Channahon
Channahon West
Woodsmoke Ranch Assn
Prairie Oaks Est
Wilmington
Lakewood Shores Imp Assn
Carbon Hill
Diamond
Gardner
Kinsman
South Wilmington
Ransom
Reddick
Aqua Illinois-Kankakee
Loves Park
Dixon Crctl Ctr
Dixon
Mendota
HOA of Four Lks Sbdv
IL Prairie Est Sbdv
Retz Addn Imprv
Fields Hill Imprv
Ladd
Ottawa
Spring Valley
DePue
Lynwood Water Corp
Whispering Pines MHP
Wildlife MHP
Country Acres MHP
Mark
Bureau Junction
Granville
Standard
Lostant
IAWC Streator
Neponset
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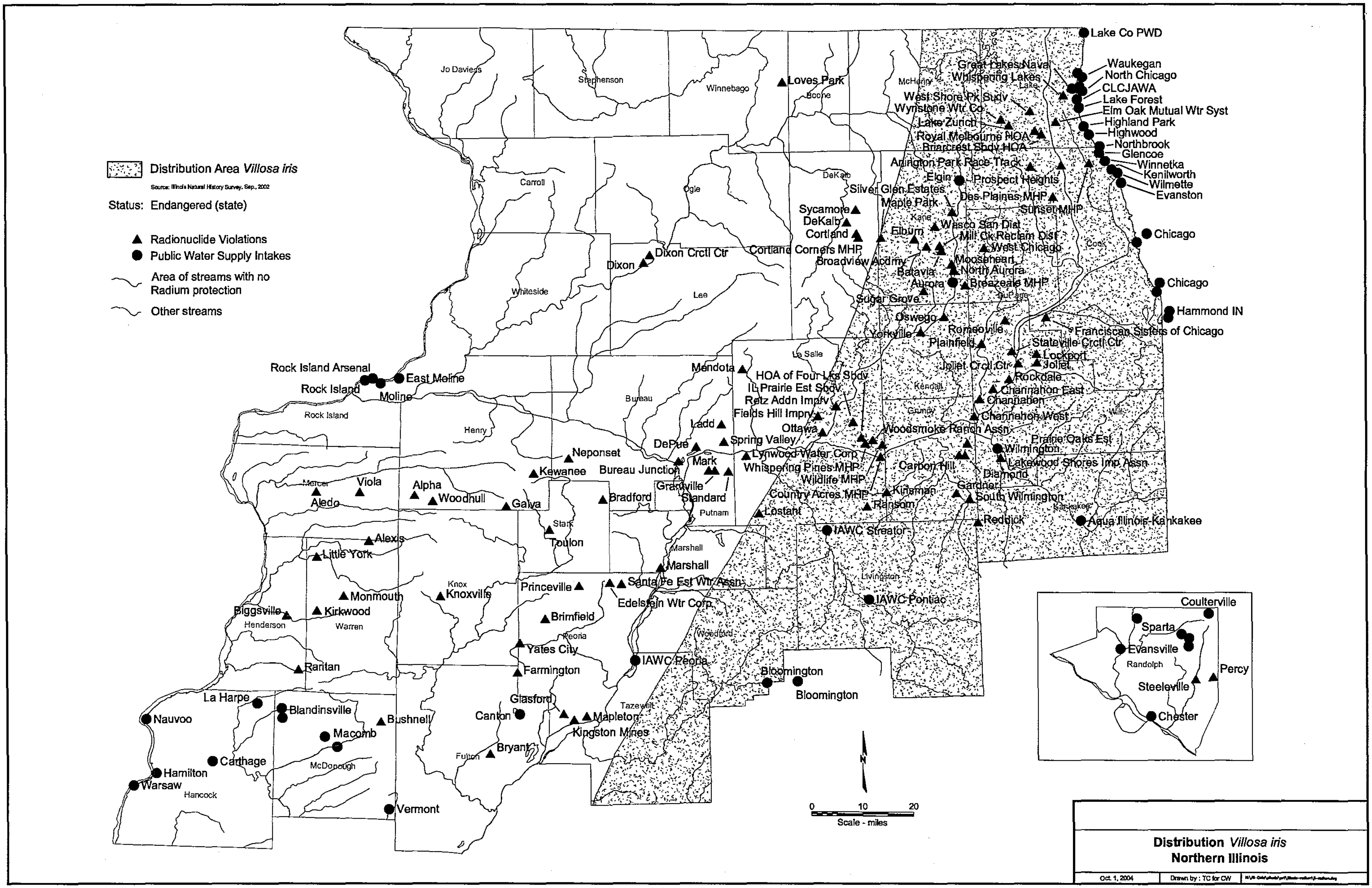
Rock Island Arsenal
Rock Island
East Moline
Moline
Viola
Aledo
Alpha
Woodhull
Galva
Toulon
Alexis
Little York
Marshall
Monmouth
Knoxville
Princeville
Santa Fe Est Wtr Assn
Edelstein Wtr Corp
IAWC Pontiac
Biggsville
Kirkwood
Brimfield
Yates City
IAWC Peoria
Farmington
Raritan
Bloomington
La Harpe
Blandinsville
Nauvoo
Bushnell
Canton
Glasford
Mapleton
Kingston Mines
Macomb
Bryant
Carthage
Hamilton
Warsaw
Vermont
Coulterville
Sparta
Evansville
Percy
Steeleville
Chester
0 10 20
Scale - miles
Distribution Elliptio dilatata
Northern Illinois
Oct. 1, 2004
Drawn by : TC for CW



Distribution Area Villosa iris
Source: Illinois Natural History Survey, Sep., 2002
Status: Endangered (state)
Radionuclide Violations
Public Water Supply Intakes
Area of streams with no Radium protection
Other streams
Lake Co PWD
Waukegan
North Chicago
CLCJAWA
Lake Forest
Elm Oak Mutual Wtr Syst
Highland Park
Highwood
Northbrook
Glencoe
Winnetka
Kenilworth
Wilmette
Evanston
Chicago
Chicago
Hammond IN
Franciscan Sisters of Chicago
Loves Park
Dixon Crctl Ctr
Dixon
Rock Island Arsenal
East Moline
Rock Island
Moline
Aqua Illinois-Kankakee
IAWC Streator
IAWC Pontiac
IAWC Peoria
Bloomington
Bloomington
Nauvoo
Hamilton
Warsaw
Carthage
La Harpe
Blandinsville
Macomb
Bushnell
Vermont
Canton
Bryant
Kingston Mines
Mapleton
Glasford
Farmington
Yates City
Brimfield
Princeville
Edelstein Wtr Corp
Santa Fe Est Wtr Assn
Marshall
Toulon
Galva
Woodhull
Alpha
Viola
Aledo
Alexis
Little York
Monmouth
Kirkwood
Biggsville
Raritan
Knoxville
Kewanee
Neponset
Bradford
Bureau Junction
Granville
Standard
Mark
DePue
Ladd
Spring Valley
Mendota
Ottawa
Lostant
Coulterville
Sparta
Evansville
Percy
Steeleville
Chester
Randolph
Scale - miles
0 10 20
Distribution Villosa iris
Northern Illinois
Oct. 1, 2004
Drawn by : TC for CW

Exhibit F

conclusion can be drawn from the locations of the more highly contaminated material, nor is there any indication that other areas of higher concentration exist.

The amount of Co-60 contained in the incinerator ash deposited in the NFA and the Old Sludge Lagoon was calculated as 405.9 mCi. Additionally, the Northern section of the SFA contains 38.5 mCi of Co-60 in the form of contaminated sludge (B. Koh and Associates, Inc., February 1995).

3.1.4.10 Main Plant

Based upon the results of the radiological analyses performed by RSO, Inc., levels of contamination associated with the Main Plant do not present radiological hazards to workers exceeding the exposure limits specified by the NRC in 10 CFR 20.

The estimated activity from the Fume Incinerator Tanks, Fume Incinerator Tank #1 (104 μCi), Fume Incinerator Tank #2 (12 μCi) and Fume Incinerator Tank #3 (400 μCi) resulted in a total activity of approximately 0.5 mCi.

3.2 ALARA

NEORSD is committed to keeping radiation exposure to employees and the general public as low as reasonably achievable (ALARA), commensurate with sound economic and social considerations. The NEORSD management has demonstrated their commitment by assigning high priority to procedure changes and work plans that will reasonably reduce personnel and environmental radiation exposures. Furthermore, NEORSD will place primary emphasis on design and engineering features to maintain exposure ALARA. When practical, design features will be selected in lieu of administrative controls to maintain exposures ALARA. The existing NEORSD Radiological Control Plan (Dames & Moore, March 1993) promulgates the NEORSD

Attachment F

Exhibit G

ATTACHMENT

City of Joliet - Water and Wastewater Plants - Radium Capture in Sewage Sludge

The following is a hypothetical analysis of radium being captured in sewage sludge assuming all water pumped from city wells reaches the sewage plant.

Water Supply
2003 data used (Source: September 2003 Engineering Evaluation Report)
Average Daily Pumpage = 16 mgd
Average Radium Content = 13.3 pCi/L (Range: 8.1 to 17 pCi/L)

Radium Production
Average Daily: 16 mgd x 3.785 L/gal. = 60.56 E+06 L/day
60.56 E+06 L/day x13.3 pCi/L = 805.45 E+06 pCi/day
Annual: 805.45 E+06 pCi/day x 365 days/year = **293.99 E+09 pCi/year**
[1 Ci = E+12 pCi —> 293.99 E+09 / E+12 = 293.99 E-03 = 0.294 Ci/year]

Sewage Plant
(2002 data from DWPC data base)

	West Plant	East Plant	Totals
Ave.Daily Flow	7.628 mgd	17.7986 mgd	25.4266 mgd
Annual Sludge Production (2002)	988 dry tons	2400 dry tons	3388 dry tons
Approved Application Rate	2.4-2.6 dry tons/acre	3.3-3.5 dry tons/acre	

Proportionate Flow: West plant 7.628/25.4266 = 30%; East Plant 17.7986/25.4266 = 70%

Assume all radium from the water supply is captured in the sewage plant sludge.
Assume 1 gram radium = 1 Ci (original definition) -> 1 pCi radium = 1.0 E-12 grams radium

West Plant

Sludge: (988 dry tons)(2000 #/ton)(453.5924 gr/#) = 8.963 E+08 grams

Proportionate Radium: 293.99 E+09 pCi x 30% = 88.2 E+09 pCi radium

Radium/Sludge Mix: (88.2 E+09 pCi radium) /(8.963 E+08 gr Sludge) = 98.40 pCi/gram

Sludge Loading: $\frac{\text{(2.5 dt/ac)(2000 \#/ton)(453.5924 gr/\#)}}{\text{(1 acre)(43560 sq.ft/ac)}}$ = 52.065 grams/sq.ft.

Radium Loading: (98.40 pCi/gr) / (52.065 gr/sq.ft) = 1.8899 —> 1.89 pCi/sq.ft.

Assume soil weight = 120 #/cu.ft : (120#/cu.ft) x (453.5924 gr/#) = 54431.09 grams/cu.ft.

Assume 0.5 ft. plow down: $\frac{\text{(1.89 pCi/sq.ft)}}{\text{(54431.09 gr/cu.ft)(0.5 ft)}}$ **= 6.94 E-05 pCi/gram Radium/Soil Field Mix**

Application Area: (988 dry tons) / (2.5 dry tons/ acre) = 395.2 acres

East Plant

Sludge: (2400 dry tons)(2000 #/ton)(453.5924 gr/#) = 2.177 E+09 grams

Proportionate Radium: 293.99 E+09 pCi x 70% = 205.79 E+09 pCi radium

Radium/Sludge Mix:(205.79E+09 pCi radium)/(2.177 E+09 gr Sludge) = 94.53pCi/gram

Sludge Loading: $\frac{\text{(3.4 dt/ac)(2000 \#/ton)(453.5924 gr/\#)}}{\text{(1 acre)(43560 sq.ft/ac)}}$ = 70.809 grams/ sq.ft.

Radium Loading: (94.53 pCi/gr) / (70.809 gr/sq.ft) = 1.335 pCi/sq.ft.

Assume soil weight = 120 #/cu.ft : (120#/cu.ft) x (453.5924 gr/#) = 54431.09 grams/cu.ft.

Assume 0.5 ft. plow down: $\frac{\text{(1.335 pCi/sq.ft)}}{\text{(54431.09 gr/cu.ft)(0.5 ft)}}$ **= 4.90 E-05 pCi/gram Radium/Soil Field Mix**

Application Area: (2400 dry tons) / (3.4 dry tons/ acre) = 705.9 acres

Exhibit H

Data/Case Study 2002-02

A Comparison of Potentiometric Surfaces for the Cambrian-Ordovician Aquifers of Northeastern Illinois, 1995 and 2000

by
Stephen L. Burch
Groundwater Section

Illinois State Water Survey
A Division of the Illinois Department of Natural Resources

2002

Attachment H

A Comparison of Potentiometric Surfaces for the Cambrian-Ordovician Aquifers of Northeastern Illinois, 1995 and 2000

by

Stephen L. Burch

Illinois State Water Survey
Champaign, IL

Table 1. Distribution of Pumpage from Deep Bedrock Wells in Northeastern Illinois, 1995-1999 (mgd)

Year	*County*	*Public*	*Industrial*	*Total*
1995	Cook	4.97	6.20	11.17
	DuPage	2.02	0.30	2.32
	Grundy	2.59	6.36	8.95
	Kane	13.77	0.40	14.17
	Kendall	1.58	0.31	1.89
	Lake	2.46	1.07	3.53
	McHenry	2.68	1.53	4.21
	Will	15.18	5.91	21.09
	Total	**45.25**	**22.08**	**67.33**
1996	Cook	4.42	6.58	11.00
	DuPage	2.27	0.25	2.52
	Grundy	2.58	6.98	9.56
	Kane	15.50	0.50	16.00
	Kendall	1.65	0.29	1.94
	Lake	2.51	1.03	3.54
	McHenry	2.36	1.92	4.28
	Will	15.23	6.06	21.29
	Total	**46.52**	**23.61**	**70.13**
1997	Cook	3.80	6.43	10.23
	DuPage	2.28	0.25	2.53
	Grundy	2.56	6.78	9.34
	Kane	15.57	0.32	15.89
	Kendall	1.75	0.30	2.05
	Lake	2.71	0.93	3.64
	McHenry	3.20	2.35	5.55
	Will	15.62	5.82	21.44
	Total	**47.49**	**23.18**	**70.67**
1998	Cook	4.43	6.74	11.17
	DuPage	1.52	0.25	1.77
	Grundy	2.66	6.96	9.62
	Kane	16.10	0.30	16.40
	Kendall	2.03	0.30	2.33
	Lake	2.89	0.94	3.83
	McHenry	3.00	2.40	5.40
	Will	15.33	5.27	20.60
	Total	**47.96**	**23.16**	**71.12**
1999	Cook	4.17	7.04	11.21
	DuPage	1.80	0.25	2.05
	Grundy	2.76	7.12	9.88
	Kane	16.12	0.34	16.46
	Kendall	2.15	0.30	2.45
	Lake	3.07	0.83	3.90
	McHenry	3.53	2.09	5.62
	Will	15.14	5.23	20.37
	Total	**48.74**	**23.20**	**71.94**

Groundwater withdrawals from the deep bedrock aquifers declined and then steadied briefly at the end of the twentieth century, as public water supplies in Cook, DuPage, and Lake Counties switched to Lake Michigan water. Demand on the deep bedrock aquifers increased slowly in the southwest counties (Lake, McHenry, and Kane). During the 1995-1999 period, pumpage for public and industrial supplies from deep bedrock wells (Cambrian-Ordovician) rose slightly from 67.3 to about 72 mgd. Table 1 shows the distribution of pumpage in the eight-county Chicago region between 1995 and 1999, subdivided by public and industrial use categories, and by counties.

The Chicago region has about 150 public water-supply facilities and another 100 industrial facilities. Most of these facilities are small users and are not especially important when considered individually. Consequently, it has been found convenient to examine the membership of those public water-supply facilities pumping more than 1.0 mgd from the deep bedrock aquifers in 1999. The number of facilities is the same as in the last report (Visocky, 1997). The composition of the group has changed to include the communities of Lemont, Oswego, Romeoville, and Plainfield, however. Bartlett, Bellwood, Elgin, and Lockport dropped off the list because their daily pumping rates decreased to less than 1.0 mgd. Pumpage at the other facilities ranged from 1.15 to 10.05 mgd, as shown in Table 2. Joliet and Aurora are decidedly the largest deep bedrock public water supplies in the Chicago region.

Table 2. Public Water-Supply Facilities in the Chicago Region Pumping More than 1.0 mgd from Deep Bedrock Aquifers, 1999

Community	*Pumpage (mgd)*
Joliet*	10.05
Aurora	5.80
Crystal Lake	2.25
Lake Zurich	1.95
Morris	1.81
Batavia	1.60
West Chicago	1.58
Montgomery	1.46
North Aurora	1.40
Geneva	1.33
St. Charles	1.32
Lemont	1.27
Oswego	1.26
Western Springs	1.23
Romeoville	1.15
Plainfield	1.15

Note:
*This number reflects the last report from Joliet for 1995 pumpage.

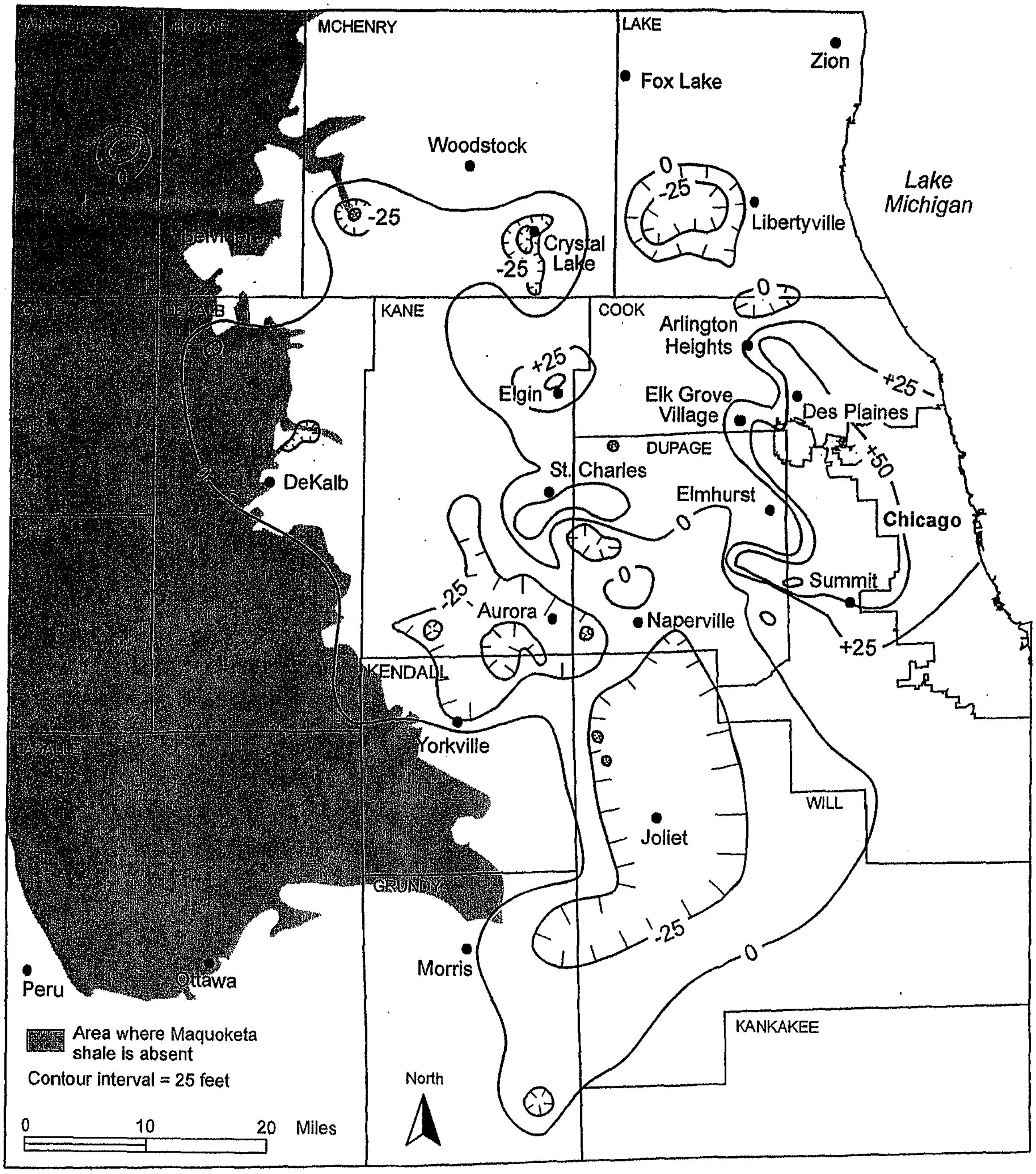


Figure 9. Changes in groundwater level in deep bedrock wells in northeastern Illinois between 1995 and 2000

Exhibit I

15

Please print or type in the unshaded areas only (fill-in areas are spaced for elite type, i.e., 12 characters/inch).

Form Approved. OMB No. 2040-0086.

FORM 1 GENERAL — EPA — U.S. ENVIRONMENTAL PROTECTION AGENCY
GENERAL INFORMATION
Consolidated Permits Program
(Read the "General Instructions" before starting.)

I. EPA I.D. NUMBER
F ILD000803643 D

LABEL ITEMS
I. EPA I.D. NUMBER
III. FACILITY NAME
V. FACILITY MAILING ADDRESS
VI. FACILITY LOCATION

PLEASE PLACE LABEL IN THIS SPACE

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GENERAL INSTRUCTIONS
If a preprinted label has been provided, affix it in the designated space. Review the information carefully; if any of it is incorrect, cross through it and enter the correct data in the appropriate fill-in area below. Also, if any of the preprinted data is absent (*the area to the left of the label space lists the information that should appear*), please provide it in the proper fill-in area(s) below. If the label is complete and correct, you need not complete Items I, III, V, and VI (*except VI-B which must be completed regardless*). Complete all items if no label has been provided. Refer to the instructions for detailed item descriptions and for the legal authorizations under which this data is collected.

II. POLLUTANT CHARACTERISTICS

INSTRUCTIONS: Complete A through J to determine whether you need to submit any permit application forms to the EPA. If you answer "yes" to any questions, you must submit this form and the supplemental form listed in the parenthesis following the question. Mark "X" in the box in the third column if the supplemental form is attached. If you answer "no" to each question, you need not submit any of these forms. You may answer "no" if your activity is excluded from permit requirements; see Section C of the instructions. See also, Section D of the instructions for definitions of bold-faced terms.

SPECIFIC QUESTIONS	YES	NO	FORM ATTACHED	SPECIFIC QUESTIONS	YES	NO	FORM ATTACHED
A. Is this facility a publicly owned treatment works which results in a discharge to waters of the U.S.? (FORM 2A)		X		B. Does or will this facility (*either existing or proposed*) include a concentrated animal feeding operation or aquatic animal production facility which results in a discharge to waters of the U.S.? (FORM 2B)		X	
C. Is this a facility which currently results in discharges to waters of the U.S. other than those described in A or B above? (FORM 2C)	X		X	D. Is this a proposed facility (*other than those described in A or B above*) which will result in a discharge to waters of the U.S.? (FORM 2D)		X	
E. Does or will this facility treat, store, or dispose of hazardous wastes? (FORM 3)	X			F. Do you or will you inject at this facility industrial or municipal effluent below the lowermost stratum containing, within one quarter mile of the well bore, underground sources of drinking water? (FORM 4)		X	
G. Do you or will you inject at this facility any produced water or other fluids which are brought to the surface in connection with conventional oil or natural gas production, inject fluids used for enhanced recovery of oil or natural gas, or inject fluids for storage of liquid hydrocarbons? (FORM 4)		X		H. Do you or will you inject at this facility fluids for special processes such as mining of sulfur by the Frasch process, solution mining of minerals, in situ combustion of fossil fuel, or recovery of geothermal energy? (FORM 4)		X	
I. Is this facility a proposed stationary source which is one of the 28 industrial categories listed in the instructions and which will potentially emit 100 tons per year of any air pollutant regulated under the Clean Air Act and may affect or be located in an attainment area? (FORM 5)		X		J. Is this facility a proposed stationary source which is NOT one of the 28 industrial categories listed in the instructions and which will potentially emit 250 tons per year of any air pollutant regulated under the Clean Air Act and may affect or be located in an attainment area? (FORM 5)		X	

III. NAME OF FACILITY

1 SKIP LASALLE COUNTY STATION

IV. FACILITY CONTACT

A. NAME & TITLE (last, first, & title)	B. PHONE (area code & no.)
2 FATORA, STEVEN - CHEMISTRY MGR	815 415 3200

V. FACILITY MAILING ADDRESS

A. STREET OR P.O. BOX
3 2601 NORTH 21ST ROAD

B. CITY OR TOWN	C. STATE	D. ZIP CODE
4 MARSEILLES	IL	61341

VI. FACILITY LOCATION

A. STREET, ROUTE NO. OR OTHER SPECIFIC IDENTIFIER
5 2601 NORTH 21ST ROAD

B. COUNTY NAME
LASALLE

C. CITY OR TOWN	D. STATE	E. ZIP CODE	F. COUNTY CODE (if known)
6 MARSEILLES	IL	61341	

Attachment I

CONTINUED FROM THE FRONT

VII. SIC CODES (4-digit, in order of priority)

A. FIRST		B. SECOND	
7 4911	(specify) ELECTRICAL GENERATION & DISTR	7	(specify)
C. THIRD		**D. FOURTH**	
7	(specify)	7	(specify)

VIII. OPERATOR INFORMATION

A. NAME: 8 EXELON GENERATION COMPANY, LLC

B. Is the name listed in Item VIII-A also the owner? ☒ YES ☐ NO

C. STATUS OF OPERATOR (Enter the appropriate letter into the answer box; if "Other", specify.)
F = FEDERAL, S = STATE, P = PRIVATE, M = PUBLIC (other than federal or state), O = OTHER (specify)
P (specify)

D. PHONE (area code & no.): A 630 657 3215

E. STREET OR P.O. BOX: 4300 WINFIELD ROAD

F. CITY OR TOWN: B WARRENVILLE

G. STATE: IL

H. ZIP CODE: 60555

IX. INDIAN LAND

Is the facility located on Indian lands? ☐ YES ☒ NO

X. EXISTING ENVIRONMENTAL PERMITS

A. NPDES (Discharges to Surface Water): 9 N IL0048151	D. PSD (Air Emissions from Proposed Sources): 9 P	
B. UIC (Underground Injection of Fluids): 9 U	E. OTHER (specify): 9 75004008 6	(specify) AIR OPERATING PERMIT (FESOP)
C. RCRA (Hazardous Wastes): 9 R A-514	E. OTHER (specify): 9	(specify)

XI. MAP

Attach to this application a topographic map of the area extending to at least one mile beyond property bounderies. The map must show the outline of the facility, the location of each of its existing and proposed intake and discharge structures, each of its hazardous waste treatment, storage, or disposal facilities, and each well where it injects fluids underground. Include all springs, rivers and other surface water bodies in the map area. See instructions for precise requirements.

XII. NATURE OF BUSINESS (provide a brief description)

GENERATION OF ELECTRIC POWER..

XIII. CERTIFICATION (see instructions)

I certify under penalty of law that I have personally examined and am familiar with the information submitted in this application and all attachments and that, based on my inquiry of those persons immediately responsible for obtaining the information contained in the application, I believe that the information is true, accurate and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment.

A. NAME & OFFICIAL TITLE (type or print)	B. SIGNATURE	C. DATE SIGNED
SUSAN R. LANDAHL - PLANT MANAGER	Susan R. Landahl	10-24-03

COMMENTS FOR OFFICIAL USE ONLY

C

Please print or type in the unshaded areas only.

EPA I.D. NUMBER *(copy from Item 1 of form 1)*
IL D000803643

Form Approved.
OMB No. 2000-0059 Approval expires 12-31-85

FORM 2C NPDES	EPA	U.S. ENVIRONMENTAL PROTECTION AGENCY **APPLICATION FOR PERMIT TO DISCHARGE WASTEWATER** **EXISTING MANUFACTURING, COMMERCIAL, MINING AND SILVICULTURAL OPERATIONS** *Consolidated Permits Program*

I. OUTFALL LOCATION

For each outfall, list the latitude and longitude to the nearest 15 seconds and the name of the receiving water.

A. OUTFALL NUMBER *(list)*	B. LATITUDE 1. DEG.	2. MIN.	3. SEC.	C. LONGITUDE 1. DEG	2. MIN.	3. SEC.	D. RECEIVING WATER *(name)*
001	41	18	38	88	39	58	Illinois River
A01	41	18	38	88	39	58	Illinois River
B01	41	18	38	88	39	58	Illinois River
C01	41	18	38	88	39	58	Illinois River
D01	41	18	38	88	39	58	Illinois River
E01	41	18	38	88	39	58	Illinois River
F01	41	18	38	88	39	58	Illinois River
G01	41	18	38	88	39	58	Illinois River
H01	41	18	38	88	39	58	Illinois River
I01	41	18	38	88	39	58	Illinois River
002	41	18	40	88	39	46	Illinois River

II. FLOWS, SOURCES OF POLLUTION, AND TREATMENT TECHNOLOGIES

A. Attach a line drawing showing the water flow through the facility. Indicate sources of intake water, operations contributing wastewater to the effluent, and treatment units labeled to correspond to the more detailed descriptions in Item B. Construct a water balance on the line drawing by showing average flows between intakes, operations, treatment units, and outfalls. If a water balance cannot be determined *(e.g. for certain mining activities)*, provide a pictorial description of the nature and amount of any source of water and any collection or treatment measures

B. For each outfall, provide a description of: (1) All operations contributing wastewater to the effluent, including process wastewater, sanitary wastewater, cooling water, and storm water runoff; (2) The average flow contributed by each operation; and (3) The treatment received by the wastewater. Continue on additional sheets if necessary.

1. OUTFALL NO *(list)*	2. OPERATION(S) CONTRIBUTING FLOW a. OPERATION *(list)*	b. AVERAGE FLOW *(include units)*	3. TREATMENT a. DESCRIPTION	b. LIST CODES FROM TABLE 2C-1	
001	Cooling Pond Blowdown (Main Cond. Cooling	34.98 MGD	Evaporative Heat Dissipation,	X-X	
	Water, Clean Condensate System Flushing		Discharge to Surface Water	4-A	
	Demineralizer Regenerant Wastes				
	House Service Water, Sewage Treatment				
	Plant Effluent, Radwaste Treatment System				
	Effluent, Wastewater Treatment System Effluent,				
	Auxiliary Reactor Equipment Cooling Water,				
	Reverse Osmosis System Reject Water				
	Water Softener Renerant Waste				
	Cooling Pond Intake Screen Backwash, North				
	Site Uncontaminated Storm Runoff, South Site				
	Uncontaminated Storm Runoff).				
A01	Demineralizer Regenerant Wastes	Intermittent	Equilization, Buffering with Circ-	XX	XX
	(Make-up Demineralizer Regenerant Waste,		ulating Water or Neutralization,		2-K
	Off-Spec Demineralized Water, MU Demin.		Treatment in Wastewater	XX	
	Maintenance Wastewater, Unit 1 Waterbox				
	Vacuum Pump Condensate (Lake Water),				
	Radwaste Treatment Acid/ Caustic System				
	Drains				
B01	Sewage Treatment Plant Effluent	0.020 MGD	Equalization, Activated Sludge,	X-X	3-A
	(Sanitary Wastewater, Eyewash Station Waste-		Sedimentation,		1-U
	water)		Sludge to Aerobic Digestion,	5-A	
			Drying Beds, On-Site Storage	5-H	X-X

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CONTINUED FROM THE FRONT

C. except for storm runoff, leaks, or spills, are any of the discharges described in Items II-A or B intermittent or seasonal?

[X] YES *(complete the following table)* [ ] NO *(go to Section III)*

1. OUTFALL NUMBER *(list)*	2. OPERATION*(s)* CONTRIBUTING FLOW *(list)*	3. FREQUENCY a. DAYS PER WEEK *(specify average)*	3. FREQUENCY b. MONTHS PER YEAR *(specify average)*	4. FLOW a. FLOW RATE *(in mgd)* 1. LONG TERM AVERAGE	4. FLOW a. FLOW RATE *(in mgd)* 2. MAXIMUM DAILY	4. FLOW b. TOTAL VOLUME *(specify with units)* 1. LONG TERM AVERAGE	4. FLOW b. TOTAL VOLUME *(specify with units)* 2. MAXIMUM DAILY	4. FLOW c. DUR-ATION *(in days)*
A01	Demineralizer Regenerant Wastes			0.047	0.047			1
E01	Unit 1 and 2 Radwaste Treatment System			0.011	0.027			1
F01	Aux. Reactor Equip. Cooling and Flushing Water				55.58			1
002	Il. River Make-Up Water Intake Screen Backwash				0.432			20

III. PRODUCTION

A. Does an effluent guideline limitation promulgated by EPA under Section 304 of the Clean Water Act apply to your facility?

[X] YES *(complete Item III-B)* [ ] NO *(go to Section IV)*

B. Are limitations in the applicable effluent guideline expressed in terms of production *(or other measure of operation)*?

[ ] YES *(complete Item III-C)* [X] NO *(go to Section IV)*

C. If you answered "yes" to Item III-B, list the quantity which represents an actual measurement of your level of production, expressed in terms and units used in the applicable effluent guideline, and indicate the affected outfalls.

1. AVERAGE DAILY PRODUCTION a. QUANTITY PER DAY	b. UNITS OF MEASURE	c. OPERATION, PRODUCT, MATERIAL, ETC. *(specify)*	2. AFFECTED OUTFALLS *(list outfall numbers*
NA	NA	NA	NA

IV. IMPROVEMENTS

A. Are you now required by any Federal, State or Local authority to meet any implementation schedule for the construction, upgrading or operation of wastewater treatment equipment or practices or any other environmental programs which may affect the discharges described in this application? This includes, but is not limited to, permit conditions, administrative or enforcement orders, enforcement compliance schedule letters, stipulations, court orders, and grant or loan conditions.

[ ] YES *(complete the following table)* [X] NO *(go to Item IV-B)*

1. IDENTIFICATION OF CONDITION, AGREEMENT, ETC.	2. AFFECTED OUTFALLS a. NO.	2. AFFECTED OUTFALLS b. SOURCE OF DISCHARGE	3. BRIEF DESCRIPTION OF PROJECT	4. FINAL COMPLIANCE DATE a. RE-QUIRED	4. FINAL COMPLIANCE DATE b. PRO-JECTED
NA	NA	NA	NA	NA	

B. OPTIONAL: You may wish to attach additional sheets describing any additional water pollution control programs *(or other environmental projects which may affect your discharges)* you now have underway or which you plan. Indicate whether each program is now underway or planned, and indicate your actual or planned schedules for construction.

[ ] MARK "X" IF DESCRIPTION OF ADDITIONAL CONTROL PROGRAMS IS ATTACHED.

 CONTINUE ON PAGE 3

EPA I.D. NUMBER *(copy from Item 1 of form 1)*
ILD000803643

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OMB No. 2000-0059 Approval expires 12-31-85

CONTINUED FROM PAGE 2

V. INTAKE AND EFFLUENT CHARACTERISTICS

A, B,& C: See instructions before proceeding - Complete one set of tables for each outfall - Annotate the outfall number in the space provided. NOTE: Tables V-A, V-B, and V-C are included on separate sheets numbered V-1 through V-9.

D. Use the space below to list any of the pollutants listed in Table 2c-3 of the instructions, which you know or have reason to believe is discharged or may be discharged from any outfall. For every pollutant you list, briefly describe the reasons you believe it to be present and report any analytical data in your possession

1. POLLUTANT	2. SOURCE	1. POLLUTANT	2. SOURCE
NA	NA	NA	NA

VI. POTENTIAL DISCHARGES NOT COVERED BY ANALYSIS

Is any pollutant listed in Item V-C a substance or a component of a substance which you currently use or manufacture as an intermediate or final product or byproduct?

[ ] YES *(list all such pollutants below)* [X] NO *(go to Item VI-B)*

CONTINUED FROM THE FRONT

VII. BIOLOGICAL TOXICITY TESTING DATA

Do you have knowledge or reason to believe that any biological test for acute or chronic toxicity has been made on any of you discharges or on a receiving water in relation to your discharge within the last 3 years?

[ ] YES *(identify the test(s) and describe their purposes below)* [X] NO *(go to Section VIII)*

VIII. CONTRACT ANALYSIS INFORMATION

Were any of the analyses reported in Item V performed by a contract laboratory or consulting firm?

[X] YES *(list the name, address, and telephone number of, and pollutants analyzed by, each such laboratory or firm below)* [ ] NO *(go to Section IX)*

A. NAME	B. ADDRESS	C. TELEPHONE *(area code & no.)*	D. POLLUTANTS ANALYZED *(list)*
Test America	850 W. Bartlett Road, Bartlett, IL 60103	(847) 783-4960	All except pH, TRO, Oil & Grease, & TSS

IX. CERTIFICATION

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system or those persons directly responsible for gathering the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

A. NAME & OFFICIAL TITLE *(type or print)*	B. PHONE NO. *(area code & no.)*
Susan Landahl / Station Manager	815-415-3700
C. SIGNATURE	D. DATE SIGNED
Susan R. Landahl	10-24-03

Please print or type in the unshaded areas only.

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FORM **2C** NPDES

EPA

U.S. ENVIRONMENTAL PROTECTION AGENCY
APPLICATION FOR PERMIT TO DISCHARGE WASTEWATER
EXISTING MANUFACTURING, COMMERCIAL, MINING AND SILVICULTURAL OPERATIONS
Consolidated Permits Program

1. OUTFALL NO *(list)*	2. OPERATION(S) CONTRIBUTING FLOW		3. TREATMENT		
	a. OPERATION *(list)*	b. AVERAGE FLOW *(include units)*	a. DESCRIPTION	b. LIST CODES FROM TABLE 2C-1	
C01	Wastewater Treatment System Effluent	0.021 MGD	Oil/Water Separation,	X-X	
	(Turbine Building Fire and Miscellaneous Non-		Equalization, Coagulation,	X-X	2-D
	Radioactive Waste Sump, Demineralizer Make-		Flocculation, Sedimentation,	1-G	1-U
	up Water Filter Backwash, Diesel Fuel Storage		Multimedia Filtration,	1-Q	
	and Service Water Building Sump, Auxiliary		Sludge to Drying Beds,	5-H	
	Boiler Blowdown, Demineralizer Regenerant		On-Site Storage	X-X	
	Waste, Water Softener Regenerant Waste,				
	Heating Bay Building Roof Area, Fire Protection				
	System Maintenance, Service Water System				
	Maintenance, Domestic Water System				
	Maintenance, Clean Condensate System				
	Maintenance, Laboratory Liquid Wastes,				
	Station Heat System Condensate)				
D01	Cooling Water Intake Screen Backwash		Screening	1-T	
	(Cooling Pond)				
E01	Unit 1 and 2 Radwaste Treatment System	Intermittent	Fabric Filtration, Charcoal Filtration	X-X	X-X
	Effluent (Equipment Drains in the Turbine,		Equalization, Ion Exchange	X-X	2-J
	Auxiliary and Reactor Buildings; Floor Drains		Reuse/Recycle of Treated Effluent	4-C	
	in the Turbine, Radwaste, Auxiliary				
	and Reactor Buildings;				
	Condensate Polisher Wastes from the Turbine				
	Building; Decontamination and Laundry Waste)				
F01	Auxiliary Reactor Equipment Cooling and	Intermittent	Evaporative Heat Dissipation	X-X	
	Flushing Water				
G01	North Site Storm Water Runoff (Fire Protection	Intermittent	Oil/Water Separation	X-X	
	System Flushing /Maint.,[Alt. Route], Service		Sedimentation	1-U	
	Water System Flushing/ Maint. [Alt. Route],				
	Domestic Water System Flushing and Maint.				
	[Alt. Route], Clean Condensate System				
	Flushing and Maint. [Alt. Route] North Site				
	Uncontaminated Stormwater Runoff)				
H01	South Site Stormwater Runoff (Fire Protection	Intermittent	Oil/Water Separation	X-X	
	System Flushing/Maint.,[Alt. Route], Service		Sedimentation	1-U	
	Water System Flushing/Maint. [Alt. Route],				
	Domestic Water System Flushing and Maint.				
	[Alt. Route], Clean Condensate System				
	Flushing and Maint. [Alt. Route] South Site				
	Uncontaminated Stormwater Runoff)				

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Please print or type in the unshaded areas only.

EPA I.D. NUMBER *(copy from Item 1 of form 1)*
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FORM **2C** NPDES

EPA

U.S. ENVIRONMENTAL PROTECTION AGENCY
APPLICATION FOR PERMIT TO DISCHARGE WASTEWATER
EXISTING MANUFACTURING, COMMERCIAL, MINING AND SILVICULTURAL OPERATIONS
Consolidated Permits Program

1. OUTFALL NO *(list)*	2. OPERATION(S) CONTRIBUTING FLOW		3. TREATMENT		
	a. OPERATION *(list)*	b. AVERAGE FLOW *(include units)*	a. DESCRIPTION	b. LIST CODES FROM TABLE 2C-1	
I01	Reverse Osmosis System Reject Water	0.003 MGD	Multimedia Filtration,	1-Q	
			Reverse Osmosis	1-S	
			Electrodeionization	X-X	
002	Illinois River Make-up Water Intake Screen	Intermittent	Screening	1-T	
	Backwash				

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ITEM V-B CONTINUED FROM FRONT

1. POLLUTANT AND CAS NUMBER *(if available)*	2. MARK 'X'		3. EFFLUENT							4. UNITS		5. INTAKE *(optional)*		
	b. BELIEVED PRESENT	c. BELIEVED ABSENT	a. MAXIMUM DAILY VALUE		b. MAXIMUM 30 DAY VALUE *(if available)*		c. LONG TERM AVRG. VALUE *(if available)*		d. NO. OF ANALYSES	a. CONCENTRATION	b. MASS	a. LONG TERM AVERAGE VALUE		d. NO. OF ANALYSES
			(1) CONCENTRATION	(2) MASS	(1) CONCENTRATION	(2) MASS	(1) CONCENTRATION	(2) MASS				(1) CONCENTRATION	(2) MASS	
g. Nitrogen, Total Organic *(as N)*	X		0.30	0.028					1	mg/L	lbs/day			
h. Oil and Grease	X		9	0.826	3.9	0.358001	< 2.4	< 0.220308	1	mg/L	lbs/day			
i. Phosphorus *(as P)*, Total (7723-14-0)	X		0.32	0.029					1	mg/L	lbs/day			
j. Radioactivity														
(1) Alpha, Total	X		< 3						1	pCi/L				
(2) Beta, Total	X		210.0						1	pCi/L				
(3) Radium, Total	X		9.0						1	pCi/L				
(4) Radium 226, Total	X		< 0.3						1	pCi/L				
k. Sulfate *(as SO_4)* (14808-79-8)	X		8	0.734					1	mg/L	lbs/day			
l. Sulfide *(as S)*		X												
m. Sulfite *(as SO_3)* (14265-46-3)		X												
n. Surfactants	X		< 0.20	< 0.018					1	mg/L	lbs/day			
o. Aluminum, Total (7429-90-5)	X		< 0.20	< 0.018					1	mg/L	lbs/day			
p. Barium, Total (7440-39-3)	X		< 0.20	< 0.018					1	mg/L	lbs/day			
q. Boron, Total (7440-42-8)	X		< 0.20	< 0.018					1	mg/L	lbs/day			
r. Cobalt, Total (7440-48-4)	X		< 0.040	< 0.004					1	mg/L	lbs/day			
s. Iron, Total (7439-89-6)	X		1.30	0.119					1	mg/L	lbs/day			
t. Magnesium, Total (7439-95-4)	X		0.55	0.05					1	mg/L	lbs/day			
u. Molybdenum, Total (7439-98-7)	X		<0.030	< 0.003					1	mg/L	lbs/day			
v. Manganese, Total (7439-96-5)	X		0.03	0.003					1	mg/L	lbs/day			
w. Tin, Total (7440-31-5)	X		< 1.0	< 0.092					1	mg/L	lbs/day			
x. Titanium, Total (7440-32-6)	X		< 0.5	< 0.046					1	mg/L	lbs/day			

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ITEM V-B CONTINUED FROM FRONT

1. POLLUTANT AND CAS NUMBER (if available)	2. MARK 'X' b. BELIEVED PRESENT	c. BELIEVED ABSENT	3. EFFLUENT a. MAXIMUM DAILY VALUE (1) CONCENTRATION	(2) MASS	b. MAXIMUM 30 DAY VALUE (if available) (1) CONCENTRATION	(2) MASS	c. LONG TERM AVRG. VALUE (if available) (1) CONCENTRATION	(2) MASS	d. NO. OF ANALYSES	4. UNITS a. CONCENTRATION	b. MASS	5. INTAKE (optional) a. LONG TERM AVERAGE VALUE (1) CONCENTRATION	(2) MASS	d. NO. OF ANALYSES
g. Nitrogen, Total Organic (as N)	X		< 0.50	< 0.059					1	mg/L	lbs/day			
h. Oil and Grease	X		7.7	0.905	5.3	0.622885	2.7	0.318298	12	mg/L	lbs/day			
i. Phosphorus (as P), Total (7723-14-0)	X		< 0.10	< 0.012						mg/L	lbs/day			
j. Radioactivity														
(1) Alpha, Total	X		7.4						1	pCi/L				
(2) Beta, Total	X		19.0						1	pCi/L				
(3) Radium, Total	X		4.1						1	pCi/L				
(4) Radium 226, Total	X		2.6						1	pCi/L				
k. Sulfate (as SO_4) (14808-79-8)	X		152	17.9					1	mg/L	lbs/day			
l. Sulfide (as S)		X												
m. Sulfite (as SO_3) (14266-45-3)		X												
n. Surfactants	X		< 0.03	< 0.004					1	mg/L	lbs/day			
o. Aluminum, Total (7429-90-5)	X		< 0.1	< 0.012					1	mg/L	lbs/day			
p. Barium, Total (7440-39-3)	X		0.03	0.004					1	mg/L	lbs/day			
q. Boron, Total (7440-42-8)	X		0.28	0.033					1	mg/L	lbs/day			
r. Cobalt, Total (7440-48-4)	X		< 0.020	< 0.002					1	mg/L	lbs/day			
s. Iron, Total (7439-89-6)	X		< 0.10	< 0.012					1	mg/L	lbs/day			
t. Magnesium, Total (7439-95-4)	X		27.1	3.18					1	mg/L	lbs/day			
u. Molybdenum, Total (7439-98-7)	X		< 0.020	< 0.002					1	mg/L	lbs/day			
v. Manganese, Total (7439-96-5)	X		< 0.01	< 0.001					1	mg/L	lbs/day			
w. Tin, Total (7440-31-5)	X		< 2.0	< 0.235					1	mg/L	lbs/day			
x. Titanium, Total (7440-32-6)	X		< 0.020	< 0.002					1	mg/L	lbs/day			

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ITEM V-B CONTINUED FROM FRONT

1. POLLUTANT AND CAS NUMBER (if available)	2. MARK 'X'		3. EFFLUENT							4. UNITS		5. INTAKE (optional)		
	b. BELIEVED PRESENT	c. BELIEVED ABSENT	a. MAXIMUM DAILY VALUE (1) CONCENTRATION	a. MAXIMUM DAILY VALUE (2) MASS	b. MAXIMUM 30 DAY VALUE (if available) (1) CONCENTRATION	b. MAXIMUM 30 DAY VALUE (if available) (2) MASS	c. LONG TERM AVRG. VALUE (if available) (1) CONCENTRATION	c. LONG TERM AVRG. VALUE (if available) (2) MASS	d. NO. OF ANALYSES	a. CONCENTRATION	b. MASS	a. LONG TERM AVERAGE VALUE (1) CONCENTRATION	a. LONG TERM AVERAGE VALUE (2) MASS	d. NO. OF ANALYSES
g. Nitrogen, Total Organic (as N)	X		1.87	0.225					1	mg/L	lbs/day			
h. Oil and Grease	X		< 5	< 0.602					1	mg/L	lbs/day			
i. Phosphorus (as P), Total (7723-14-0)	X		5.28	0.635					1	mg/L	lbs/day			
j. Radioactivity														
(1) Alpha, Total	X		3						1	pCi/L				
(2) Beta, Total	X		36.0						1	pCi/L				
(3) Radium, Total	X		1.2						1	pCi/L				
(4) Radium 226, Total	X		0.4						1	pCi/L				
k. Sulfate (as SO_4) (14808-79-8)	X		212	25.5					1	mg/L	lbs/day			
l. Sulfide (as S)		X												
m. Sulfite (as SO_3) (14266-46-3)		X												
n. Surfactants	X		< 0.03	< 0.004					1	mg/L	lbs/day			
o. Aluminum, Total (7429-90-5)	X		<0.10	< 0.012					1	mg/L	lbs/day			
p. Barium, Total (7440-39-3)	X		< 0.02	< 0.002					1	mg/L	lbs/day			
q. Boron, Total (7440-42-8)	X		0.31	0.037					1	mg/L	lbs/day			
r. Cobalt, Total (7440-48-4)	X		< 0.02	< 0.002					1	mg/L	lbs/day			
s. Iron, Total (7439-89-6)	X		0.11	0.013					1	mg/L	lbs/day			
t. Magnesium, Total (7439-95-4)	X		34.9	4.20					1	mg/L	lbs/day			
u. Molybdenum, Total (7439-98-7)	X		< 0.020	< 0.002					1	mg/L	lbs/day			
v. Manganese, Total (7439-96-5)	X		0.06	0.008					1	mg/L	lbs/day			
w. Tin, Total (7440-31-5)	X		< 2.0	< 0.241					1	mg/L	lbs/day			
x. Titanium, Total (7440-32-6)	X		< 0.020	< 0.002					1	mg/L	lbs/day			

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ITEM V-B CONTINUED FROM FRONT

1. POLLUTANT AND CAS NUMBER *(if available)*	2. MARK 'X'		3. EFFLUENT							4. UNITS		5. INTAKE *(optional)*		
	b. BELIEVED PRESENT	c. BELIEVED ABSENT	a. MAXIMUM DAILY VALUE		b. MAXIMUM 30 DAY VALUE *(if available)*		c. LONG TERM AVRG. VALUE *(if available)*		d. NO. OF ANALYSES	a. CONCENTRATION	b. MASS	a. LONG TERM AVERAGE VALUE		b. NO. OF ANALYSES
			(1) CONCENTRATION	(2) MASS	(1) CONCENTRATION	(2) MASS	(1) CONCENTRATION	(2) MASS				(1) CONCENTRATION	(2) MASS	
g. Nitrogen, Total Organic *(as N)*	X		< 0.40	< 0.157					1	mg/L	lbs/day			
h. Oil and Grease	X		1	0.392					4	mg/L	lbs/day			
i. Phosphorus *(as P)*, Total (7723-14-0)	X		0.03	0.012					1	mg/L	lbs/day			
j. Radioactivity														
(1) Alpha, Total	X		< 3.00						1	pCi/L				
(2) Beta, Total	X		5.00						1	pCi/L				
(3) Radium, Total	X		2.20						1	pCi/L				
(4) Radium 226, Total	X		2.60						1	pCi/L				
k. Sulfate *(as SO_4)* (14808-79-8)	X		680	266.7					1	mg/L	lbs/day			
l. Sulfide *(as S)*		X												
m. Sulfite *(as SO_3)* (14265-45-3)		X												
n. Surfactants	X		< 0.07	< 0.027					1	mg/L	lbs/day			
o. Aluminum, Total (7429-90-5)	X		< 0.3	< 0.118					1	mg/L	lbs/day			
p. Barium, Total (7440-39-3)	X		< 0.1	< 0.039					1	mg/L	lbs/day			
q. Boron, Total (7440-42-8)	X		0.31	0.122					1	mg/L	lbs/day			
r. Cobalt, Total (7440-48-4)	X		< 0.05	< 0.020					1	mg/L	lbs/day			
s. Iron, Total (7439-89-6)	X		0.82	0.322					1	mg/L	lbs/day			
t. Magnesium, Total (7439-95-4)	X		15.4	6.040					1	mg/L	lbs/day			
u. Molybdenum, Total (7439-98-7)	X		< 0.2	< 0.078					1	mg/L	lbs/day			
v. Manganese, Total (7439-96-5)	X		< 0.003	< 0.001					1	mg/L	lbs/day			
w. Tin, Total (7440-31-5)	X		< 0.8	< 0.314					1	mg/L	lbs/day			
x. Titanium, Total (7440-32-6)	X		< 0.8	< 0.314					1	mg/L	lbs/day			

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ITEM V-B CONTINUED FROM FRONT

1. POLLUTANT AND CAS NUMBER (*if available*)	2. MARK 'X'		3. EFFLUENT							4. UNITS		5. INTAKE (*optional*)		
	b. BELIEVED PRESENT	c. BELIEVED ABSENT	a. MAXIMUM DAILY VALUE		b. MAXIMUM 30 DAY VALUE (*if available*)		c. LONG TERM AVRG. VALUE (*if available*)		d. NO. OF ANALYSES	a. CONCENTRATION	b. MASS	a. LONG TERM AVERAGE VALUE		d. NO. OF ANALYSES
			(1) CONCENTRATION	(2) MASS	(1) CONCENTRATION	(2) MASS	(1) CONCENTRATION	(2) MASS				(1) CONCENTRATION	(2) MASS	
g. Nitrogen, Total Organic (*as N*)	X		0.69	272					1	mg/L	lbs/day			
h. Oil and Grease	X		< 5	< 1971					1	mg/L	lbs/day			
i. Phosphorus (*as P*), Total (7723-14-0)	X		0.7	288					1	mg/L	lbs/day			
j. Radioactivity														
(1) Alpha, Total	X		3						1	pCi/L				
(2) Beta, Total	X		15.7						1	pCi/L				
(3) Radium, Total	X		0.8						1	pCi/L				
(4) Radium 226, Total	X		< 0.1						1	pCi/L				
k. Sulfate (*as SO_4*) (14808-79-8)	X		94	37052					1	mg/L	lbs/day			
l. Sulfide (*as S*)		X												
m. Sulfite (*as SO_3*) (14266-46-3)		X												
n. Surfactants	X		< 0.03	< 12					1	mg/L	lbs/day			
o. Aluminum, Total (7429-90-5)	X		0.360	142					1	mg/L	lbs/day			
p. Barium, Total (7440-39-3)	X		0.028	11.0					1	mg/L	lbs/day			
q. Boron, Total (7440-42-8)	X		0.235	93					1	mg/L	lbs/day			
r. Cobalt, Total (7440-48-4)	X		< 0.020	< 7.9					1	mg/L	lbs/day			
s. Iron, Total (7439-89-6)	X		0.540	213					1	mg/L	lbs/day			
t. Magnesium, Total (7439-95-4)	X		21.5	8475					1	mg/L	lbs/day			
u. Molybdenum, Total (7439-98-7)	X		< 0.020	< 7.9					1	mg/L	lbs/day			
v. Manganese, Total (7439-96-5)	X		0.031	12					1	mg/L	lbs/day			
w. Tin, Total (7440-31-5)	X		< 2.0	< 788					1	mg/L	lbs/day			
x. Titanium, Total (7440-32-6)	X		< 0.02	< 8					1	mg/L	lbs/day			

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