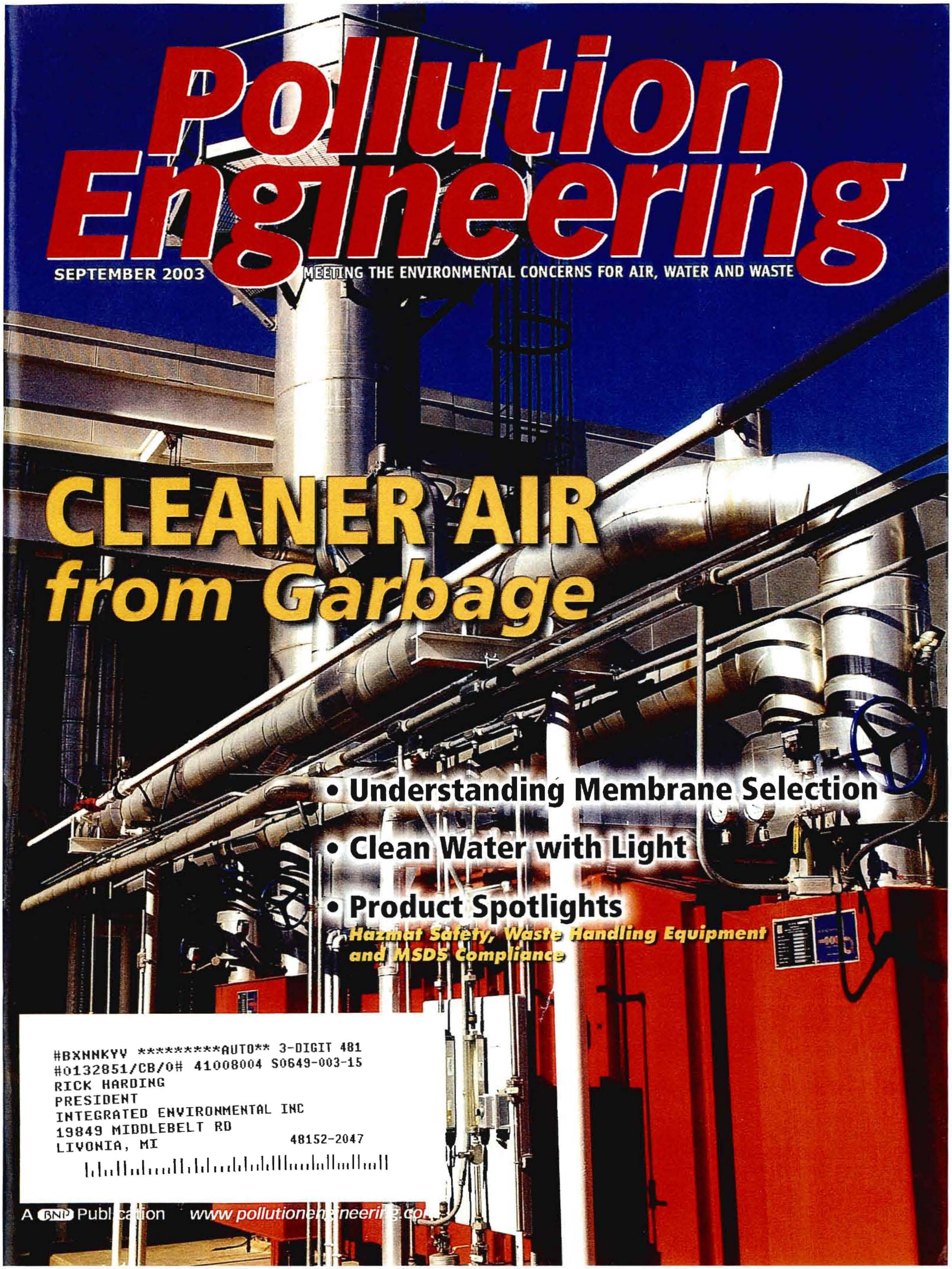
INTEGRATED ENVIRONMENTAL, INC.
www.intenv.com
Scientists Who Think Business©

A CLEAN LOOK AT DEEP WELL ISOLATION

By:

Dr. Rick P. Harding
President & Senior Principal
Integrated Environmental, Inc.
19849 Middlebelt Road
Livonia, Michigan 48152

THE ATTACHED ARTICLE WAS PUBLISHED IN "POLLUTION ENGINEERING," SEPTEMBER 2003



#BXNNKYV *********AUTO** 3-DIGIT 481
#0132851/CB/0# 41008004 S0649-003-15
RICK HARDING
PRESIDENT
INTEGRATED ENVIRONMENTAL INC
19849 MIDDLEBELT RD
LIVONIA, MI 48152-2047

A Clean Look at Deep Well Isolation

DEEP WELL ISOLATION TECHNOLOGY

The use of deep well isolation for waste disposal has been in practice in the United States since the 1930s, with the early wells used by oil companies to dispose of oil field brine and other wastes. Congress enacted the Safe Drinking Water Act in December 1974 that required the EPA to develop a program to protect the underground sources of drinking water in the U.S. (USDWs). The EPA passed the Underground Injection Control (UIC) Program regulations in 1980 to assist in protecting USDWs and in 1988, amended the UIC Program regulations to address the Hazardous and Solid Waste Amendments that banned the land disposal of hazardous waste unless it was treated to specific standards. The UIC regulation amendments included a demonstration—in this case, the Class I well that the hazardous constituents present in waste disposed of via deep well isolation will not migrate from the disposal location (i.e., within the earth's mantle) for 10,000 years or as long as the waste remains hazardous. This is also known as the "no migration petition."

Class I deep wells operate by injecting waste into a porous and permeable geologic formation located thousands of feet below the ground surface like, for example, brine-saturated formations. The permeability and porosity of such "injection zone" formations are sufficient to prevent the buildup of excessive pressure. This formation, or the "injection zone", is also overlain by relatively impermeable rock, known as the "the confining zone," which prevents the injected waste from moving vertically and potentially affecting USDWs. Class I wells are designed and constructed in geologically stable areas that are free of transmissive faults, or faults that could represent a pathway between the disposed waste material and USDWs. The wells feature sophisticated, multi-layer construction with many redundant safety features including corrosive-resistant materials, outer and inner casings, and constant and continuous pressure maintained in the annulus space. The construction of a typical Class I deep well is illustrated on the next page (See, **Figure 1**).

There are currently 163 Class I hazardous waste disposal wells at 51 locations. Eleven are commercially licensed to accept hazardous waste generated off-site. The commercial wells are located in the Gulf Coast region with one exception that is in the Great Lakes region. A new commercial facility was recently built near Detroit and has applied for a license to operate.[2]

DISPOSAL TECHNOLOGIES AND THE HYDROLOGIC CYCLE

The endless circulation of water between ocean, atmosphere and land is called the "hydrologic cycle." By default, any waste treatment regime that operates within or contributes pollutants to the hydrologic cycle is considerably less desirable than one that functions independently and isolated from the hydrologic cycle.

When compared to other treatment technologies such as landfilling, incineration, chemical stabilization and traditional waste treatment regimes, deep well isolation represents the only available technology that does not contribute pollutants to the nation's surface and drinking waters. Landfill leachate escapes from the collection system and pollutes ground/surface water. Incineration contributes pollutants to the atmosphere that "wash out" and pollute the surface water, which in turn recharges the groundwater. Chemical treatment technologies generate wastewaters and sludges that require landfilling, incineration or some other "final" disposal. Similarly, wastewater treatment technologies result in the generation of secondary liquid and solid wastes that require further treatment and/or dispositioning such as placement of treatment sludge in landfills or incineration. The latter represents potential sources of polluted effluent to lakes, rivers, streams and discharges to the environment from sewer piping.

PROTECTION OF OUR GREATEST NATURAL RESOURCE

Bioaccumulative and persistent pollutants such as mercury, lead, cadmium, methylene chloride and vinyl chloride have been shown to deform and kill wildlife and enter the human food chain, whereby late-developing manifestations of injury are expressed, such as cancer. These pollutants originate from a variety of sources such as coal-fueled utilities; the incineration of municipal, hazardous or medical wastes; industrial, medical and research facilities; landfills; and wastewater treatment plants. Research conducted by an Ohio citizen's group indicates that wastewater treatment plants discharge significant quantities of bioaccumulative and persistent substances to the Great Lakes Basin.[3] When it was discovered that such pollutants were being discharged into, and had critically damaged, the world's largest freshwater ecosystem, the governments of the U.S. and Canada responded by signing the Great Lakes Water Quality Agreement (GLWQA) in 1972 to "restore and maintain the chemical, physical and biological integrity of the waters of the Great Lakes Basin Ecosystem."[4]

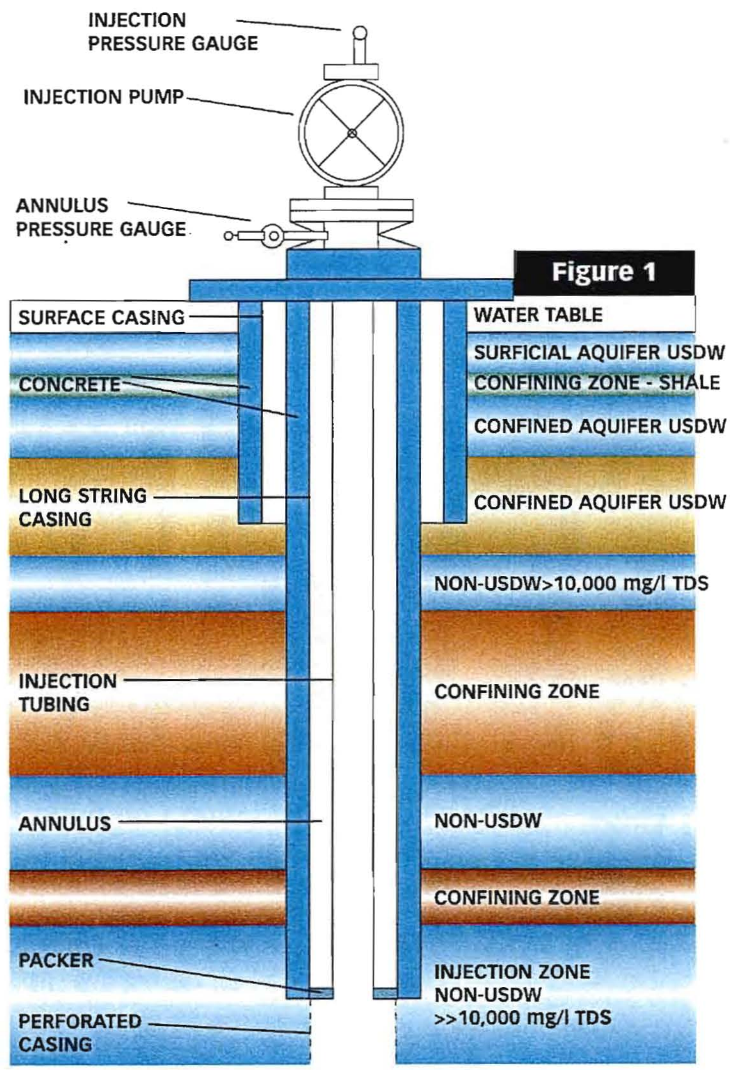
The GLWQA was renewed in 1978, and called upon both countries to "virtually eliminate" discharge of "any and all persistent toxic substances" to the Great Lakes.[4] In 1983, the GLWQA was amended to include phosphorous load reduction and in 1987, protocol expanded the GLWQA to include airborne pollutants.

However, the complexity of controlling persistent, bioaccumulative pollutants led to inconsistencies among the states in the development, implementation and regulation of water quality standards. In 1995, the EPA issued the Final Water Quality Guidance for the Great Lakes System (also known as the Great Lakes Water Quality Initiative, or GLI) "to establish a consistent level of environmental protection for the Great Lakes ecosystem, particularly in regards to state water quality standards and the National Pollution Discharge Elimination System (NPDES) programs."[5]

The GLI, which was developed to work in conjunction with the GLWQA and the Clean Water Act, established federal regulatory criteria for 29 contaminants that were considered to pose long-term health threats, with separate criteria for the protection of aquatic life, wildlife and human health, and included methodologies for the development of criteria for additional pollutants and procedures for implementing effluent limits and total maximum daily loads. Additionally, the EPA is currently considering proposals to improve the NPDES permit process to better track and control pollutant discharges. Recent changes in the wastewater treatment regulations[6] will result in increased demand for alternative disposal methods and facilities in addition to the future restrictions imposed by the GLWQA.

Deep well isolation addresses the provisions of the GLWQA and the GLI by reducing or eliminating the discharge of persistent, bioaccumulative pollutants to the Great Lakes Basin and removing these toxins from the hydrologic cycle, consistent with U.S. international commitment. Furthermore, the use of deep well isolation to dispose of liquid wastes

Deep Well Isolation



USDW = United States Drinking Water
**** TDS = Total Dissolved Solids***

would effectively address the need to comply with a modified NPDES program and reduce the economic impact of environmental compliance on industry, and thus, the consumer.

NATURAL DETOXIFICATION OF THE INJECTED WASTE

Isolating wastes from surface and drinking water clearly improves our environment by keeping contaminants out of the hydrologic cycle and the food chain. Additionally, the isolation of these wastes within the earth's mantle will cause them to undergo reactions with naturally occurring material in the injection zone that will make the wastes less hazardous. Such reactions include neutralization, hydrolysis, ion exchange, precipitation and co-precipitation. For example, carbonates (limestone and dolomite) react with acidic wastes to elevate low pH wastes. Sand (silicon dioxide) will dissolve in alkaline aqueous solutions to lower the pH level. Clay components will react with alkaline or acidic wastes to bring pH levels closer to neutrality. Many types of organic compounds will hydrolyze in acidic, alkaline and neutral aqueous solutions, thereby rendering these wastes less hazardous. Metal ions in the waste are immobilized through ion exchange. Documentation that these reactions occur has been verified by research completed by E.I. Dupont de Nemours and Company.[7] Dupont's research and other similar studies show that hazardous wastes are generally rendered non-hazardous after injection. Additionally, deep well isolation technology allows the subsequent removal of wastes from the injection zone should new recycling approaches be developed that offer cost-effective separation and reuse of chemical components within the wastes.

When compared to other disposal technologies, deep well isolation provides a disposal option that: a) represents virtually no probability of impact to the drinking waters of the nation; b) isolates wastes deep within the earth's mantle where they will react with naturally occurring material that will render the waste less/non-hazardous; and c) allows for the subsequent removal of the wastes to take advantage of new recycling technologies.

EPA COMPARATIVE RISK ANALYSIS

In November 1989, EPA published the findings of a comparative risk analysis of a number of treatment technologies, including deep well isolation.[8] The study concluded that of the approximately two-dozen waste management and disposal activities evaluated, deep well injection was one of the most desirable alternatives on a relative risk basis. The study evaluated a range of risk types, including impact to groundwater, and concluded that deep well isolation poses virtually no threat to aquifers. Other risks evaluated as part of the 1989 EPA study were health and ecological effects and public welfare. For all categories of risk evaluated, deep well isolation was shown to be one of the lowest risk alternatives. Because deep well isolation removes the waste from the hydrologic cycle.

COST/BENEFIT AND LIABILITY

The relative cost/benefit of some common technologies (See **table 1**) was compared using key parameters such as cost to construct and close, as well as respective discharges to the environment. As the table shows, deep well isolation represents the lowest cost to construct, operate and close on average of the four disposal technologies compared.

Without even considering the cost savings associated with deep well technology, the benefits of not involving discharges to the nation's surface or drinking waters through the injection process far outweigh any benefits obtained from other disposal technologies. The fact that deep well technology does not involve discharges to a sewer system, lake or river makes it more preferable than conventional treatment plants and incinerators, even if the costs are greater than the alternatives.

PAST EXPERIENCE

Past experience indicates that deep well isolation facilities that are operated pursuant to the UIC Program requirements are safe and do not result in contamination of the groundwater. In a

Deep Well Isolation

TREATMENT/DISPOSAL TECHNOLOGY COMPARISON

Table 1	TECHNOLOGY			
	Deep Well Injection	Wastewater Treatment	Landfill	Incineration
Construction Costs (millions of dollars)	3 [9]	5 to 10 [12]	2 to 7 [5,6]	300 [3]
Annual Operation and Maintenance Costs (millions of dollars)	4.4 [9]	0.65 [12]	0.48 to 1.68 [6]	36 [10]
Closure/Post Closure Costs (millions of dollars)	0.4 [15]	0.18 [12]	0.432 to 1.512 [6]	3 [8]
Design Life (years)	20	20	15 [6]	20
Proximity to Waters of the State	Isolated from Drinking Waters	Direct	Direct	Indirect
Discharges (gallons) Per Year Per Unit to Surface Waters	None	400,000 filter cake 8 million water [12]	leachate, methane, hexane	9 million CO_2 ash (metals, dioxins)
Disposal Cost Per Gallon (dollars) [1]	0.25 to 1.50 [13]	0.30 to 3.50 [12]	0.39 to 0.78 [11]	0.8 to 48 [8]
Average Annual Volume Treated Per Unit (million of gallons) [1]	10 [14]	8 [12]	20.25 [4,6]	2 [2]
Total Cost/Average Annual Volume [7]	0.78	0.73 to 1.35	0.14 to 0.50	169.50

Deep well isolation is a well-established technology that the U.S. EPA believes offers the public and the environment an extremely low level of risk due to the multiple levels of safety features.[1]

Notes:

(1) Gallons are based on a per unit weight equivalent of eight pounds.
(2) Based on 8,000 pounds per hour or 63 X $(10)^6$ BTUs per hour.
(3) Based on information regarding the Tooele Incinerator, Army Depot, in Tooele, Utah.
(4) One ton is assumed to be equivalent to one cubic yard of material.
(5) Average landfill unit volume assumed to be 25 million cubic yards.
(6) Based on personal conversation with Mr. Dan Gilbert, Manager, Corporate Communications, Envotech Management Services Inc.
(7) Total Construction, Annual Operation and Maintenance, and Closure/Post Closure Costs divided by the Average Annual Volume Treated Per Unit.
(8) Based on personal conversation with Mr. Tom Emond, Technical Manager, APTUS.
(9) Information provided by Petrotech Engineering Inc.
(10) Estimate based on a value of 12 percent of the construction costs.
(11) Based on information provided by Mr. Dan Gilbert, Manager, Corporate Communications, Envotech Management Services Inc. Mr. Gilbert provided an average value of $100 per ton and we established a range for this number based on professional experience and judgment.
(12) Based on information provided by Detroit-area commercial wastewater treatment companies.
(13) Information provided by Chemwaste of Vickery, Ohio.
(14) Estimate based on value of 17 percent of hazardous waste in Michigan deep well injected, divided by 12 captive wells.
(15) Information provided by K&D Industrial Services Inc. and Petrotech Engineering Inc.

report entitled, "Deep Well Injection of Hazardous Waste in Michigan" published by the Michigan Deep Well Injection Committee[9], deep well injection was determined to be "safe to operate." Additionally, this report states that according to a 1986 draft report on deep well isolation at Class I facilities in Illinois, the annualized cost of alternatives to the state's four hazardous waste isolation facilities would range from 16 to 40 times higher than the annualized cost of isolation.[10] This finding is consistent with the above-noted Table No. 1 cost analysis.

CONCLUSION

Deep well waste disposal technology can provide a safe and cost-competitive alternative to the disposal of wastes in the best interest of the environment, public health and safety, and the U.S. economy. The technique permits removal of hazardous and non-hazardous liquid wastes from the hydrologic cycle resulting in a final disposal method.

Dr. Harding is President and Senior Principal of Integrated Environmental Inc. in Livonia, Mich. with more than 30 years of experience in the evaluation and management of hazardous substances. He can be reached at Integrated Environmental Inc. by phone at (248) 477-5021, or at www.intenv.com. **PE**

1 United States Environmental Protection Agency, Office of Water (4601), Washington, D.C. 20460. EPA 816-R-01-007, March 2001, "Class I Underground Injection Control Program: Study of the Risks Associated with Class I Underground Injection Wells," page xiii.

2 Environmental Disposal Systems, Inc. Operating License Application to the State of Michigan dated September 2002, 28470 Citrin Drive, Romulus, Michigan 48174.

3 "Persistent Pollution of Lake Erie," Citizens Policy Center, 402 Terminal Tower, Cleveland, Ohio 44113, (216) 861-5200, December, 1995.

4 "Great Lakes Water Quality Agreement 1978" (available at the U.S. EPA website: www.epa.gov/glnpo/glwqa).

5 "Water Quality Guidance for the Great Lakes System, Great Lakes Water Quality Initiative," obtained from the Michigan State University Institute for Environmental Technology website (www.iet.msu.edu).

6 Federal Register/Vol. 65, No. 247, Friday December 22, 2000, Rules and Regulations, p 81243, Environmental Protection Agency 40 CFR Parts 136 and 437: "Effluent Limitations Guidelines, Pretreatment Standards, and New Source Performance Standards for the Centralized Waste Treatment Point Source Category."

7 Serivner, "What Happens Underground After Injection," 1986, Underground Injection, Volume 1, Number 1.

8 "OSWER Comparative Risk Project, Executive Summary and Overview," U.S. EPA, Office of Emergency and Remedial Response, Washington, D.C. 20460, EPA 540/1-89/003, November 1989, PB90-272501.

9 "Deep Well Injection of Hazardous Waste in Michigan," Michigan Deep Well Injection Committee, MDNR, May 1986.

10 "Economic Impacts of Alternative Technologies for Treatment and Disposal of Liquid Hazardous Wastes", M. Guthrie, G Patrick, T. Sargent, Presented at the International Symposium on Subsurface Injection of Liquid Wastes, March, 1986.

Reader Interest Review

Please fill in the appropriate number on the Reader Service Card to indicate the level of interest in the article.

High **455** Medium **456** Low **457**