Groundwater survey shows little evidence of bacterial contamination near rapid infiltration wastewater treatment system. [DNR-021b] 1989?

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Wisconsin Groundwater Management Practice Monitoring Project

No. 24

GROUNDWATER
Wisconsin's
buried treasure

Wisconsin Department of Natural Resources

Groundwater Survey Shows Little Evidence of Bacterial Contamination Near Rapid Infiltration Wastewater Treatment System

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The work described in this report was done under contract for the Wisconsin Department of Natural Resources

The purpose of this study was to determine whether rapid infiltration wastewater land disposal systems are causing bacterial contamination of groundwater. Samples collected from monitoring wells upgradient and downgradient of wastewater treatment land disposal systems were analyzed for total coliform, fecal coliform and fecal streptococci. Data collected from twenty-three systems indicated that little or no bacterial contamination of the groundwater was occurring. The types of wastewater treatment land disposal systems tested included seepage cells, lagoons, and mound systems. Depths of wells sampled ranged from 5-110+ feet.

Introduction:

One of Wisconsin's most valuable natural resources is its almost unlimited supply of extremely clean groundwater. The Department of Natural Resources is charged with the responsibility of protecting this valuable resource. When designing wastewater treatment facilities, protection of groundwater is an important consideration, particularly for those facilities that discharge to land surfaces, such as mound systems, stabilization ponds, infiltration systems and lagoons. Soil is a very efficient medium for removing bacteria as wastewater percolates through it. This phenomenon has been well researched. (A bibliography of articles on this area of research has been included.) However, a 1987 DNR funded study (Schwalbe,

1989) entitled "Groundwater Contamination of Aquifers Beneath Seepage Cells" cast doubt on this assumption. In this study numerous cases of bacterial contamination of groundwater near seepage cell or rapid infiltration systems were reported.

Surprised at the Schwalbe (1979) results, the Department of Natural Resources initiated the present study to verify the former study and to get a better understanding of the nature of the problem. This study was divided into three phases (1) development of a valid sampling technique, (2) a screening of several sites for bacteriological contamination of the groundwater and (3) an in depth study of two or three sites.

Discussion:

The facilities included in this study were selected by the Department of Natural Resources to provide a cross section of land disposal wastewater systems. The systems chosen included rapid infiltration, stabilization ponds, lagoons, and mounds. A complete list of the sites tested can be found in table 1.

One of the problems associated with testing monitoring wells is differentiating bacteria that occur as a result from regrowth of bacteria in the stagnant well water from bacteria infiltrating the well from contaminated groundwater. The sampling procedure described above was devised to eliminate this problem. The first phase of this study was performed to evaluate the validity of the sampling technique. The Milton, Wisconsin wastewater plant was chosen for this part of the study because the facility is very old and is known to be causing significant levels of bacterial contamination to the groundwater in the immediate area. Samples were collected before disinfection, during disinfection and after all chlorinated water was purged from the well.

The samples of the initial bailing of the stagnant water prior to chlorination showed coliform contamination levels of 10^3 to 10^4 per 100 mL. After disinfection of the well, samples of the first and subsequent bailings were tested for the presence of free residual chlorine. If a significant level of chlorine was still present (>10 mg/L), a complete kill of coliform organisms was assumed. The bailing of the well was continued until no chlorine residual was detected. At this point the well was free of any bacterial contribution from the original stagnant water in the well and could only be impacted by bacteria entering the well directly from the aquifer.

We feel the Milton study validated the revised sampling procedure and, therefore, we proceeded to collect and analyze samples from the screening phase of the study. The appendix includes a sampling data information page from each site. This page shows a map of the site, the direction of groundwater flow, the sampling locations, well depths and miscellaneous information about the sites such as contact persons or availability of keys for locked facilities.

The intent of the screening phase was to detect a few failing systems (those with bacterial contamination in the aquifer) for in depth study. Much to our surprise and contrary to the Schwalbe (1989) results, only one of the 23 sites sampled showed any bacterial contamination. The data from this site (Glenwood City) was not considered significant since the discharge was very unconventional in that it involved an artificial wetland in part of the dispersal area. Even though the Glenwood City site was not representative of systems across the state, a series of coliform identifications of isolates were performed. The results (summarized in figure 1 and table 2) showed a large variety of coliforms indicating the contamination of the groundwater was most probably partially treated wastewater.

Since no sites were found that warranted in depth study, the emphasis of the study was changed to expand the scope of the screening. Extra sites were included and repeat visits throughout the summer were initiated. Once again, no evidence of bacterial contamination of the aquifers was found (i.e., all samples tested negative for all indicators.) A list of all the sites tested, the types of treatment and the dates sampled is provided in Table 1. A state map of all sites visited is provided in figure 2.

Materials and Methods

The procedure used for sample collection was a modification of the procedure developed by Schwalbe. (1989)

Equipment:

PVC container (PVC bailer with a screw cap on one end)

Rubber gloves

Metric Measuring cup

20 l bucket (graduated in liters)

Reagents:

A disinfection solution of 100 mg/L free chlorine is prepared by adding 80 mL of household bleach (e.g. Clorox bleach) to 25 l (6.6 gallons) of water. A polyethylene carboy is used to store and transport this solution.

Procedure for bailer disinfection:

***** Safety glasses are required and protective clothing are recommended whenever working with bleach. *****

1. Place assembled bailer in PVC container, including the length of rope required for bailing the well. The rope can also be removed and disinfected separately.
2. Fill the PVC container with the chlorine solution, allowing some of the solution to rinse down the outside of the container and cap area.
3. Tightly place cap on PVC container and invert several times to thoroughly rinse the bailer with disinfectant.
4. Allow 15 minutes for disinfection if water is <15°C and 10 minutes if water is >15°C.

5. Uncap container and pour solution into original bucket for later use.
6. Wash gloved hands in disinfectant.
7. Remove bailer from container using aseptic techniques.
8. Before use, shake excess disinfectant from bailer.

Sample collection and well disinfection:

1. Well depth and volume is determined with a tape measure and popper prior to sampling.

   1 well volume = $(3.14)\ (r^2)\ (h)\ (0.00433)$

   r = radius of well casing in inches

   h = water depth in inches

   0.00433 = conversion factor of cubic inches to gallons
2. Sample number one is collected, with a disinfected bailer, from undisturbed well water. (All samples are collected in bottles containing thiosulfate.)

3. Disinfect well and bailer by lowering bailer into well until it is completely submerged. Secure rope to bucket. Pour two well volumes of disinfectant into well, making sure to rinse down the outer area of the well, rope, and the inside of the well.
4. Lift bailer several times to mix well contents.
5. Allow 15 minutes for disinfection.
6. Check for the presence of free available chlorine using DPD test reagent. If no chlorine residual is found,

return to step three and repeat disinfection procedure.

7. Well is then bailed/purged until no free chlorine is detected. The water can be temporarily placed in buckets and then dumped where no damage by high chlorine concentration can occur.

8. Sample number two is then collected.

The samples were preserved by placing them on ice for transport to the laboratory. No more than 24 hours elapsed between sample collection and analysis.

Bacteriological Analyses:

Analyses for total coliform, fecal coliform and fecal streptococci were performed according to methods outlined in the "16th Edition of Standard Methods for The Examination of Water and Wastewater." Identifications of coliform organisms were done using the API 20E system. If more than five colonies were present on the plate, then five representative colonies were selected to be identified. The API system has a series of 21 biochemical tests that will identify Enterobacteriaceae and other Gram-negative bacteria. Following an 18-24 hour incubation time, positive and negative reactions are given a numerical value. These values are then tabulated with the results corresponding to a particular bacteria.

Conclusions:

The most significant conclusion to be drawn from this study is that properly designed land disposal wastewater systems in Wisconsin are causing no measurable impact on the bacterial quality of groundwater. The second conclusion is that the disinfection bailing technique for bacteriological examination of monitoring wells appears to be a valid environmental evaluation tool. Since most land disposal systems are of fairly recent construction, it is our opinion that these systems be monitored occasionally over time to insure that they continue to operate well in the future.

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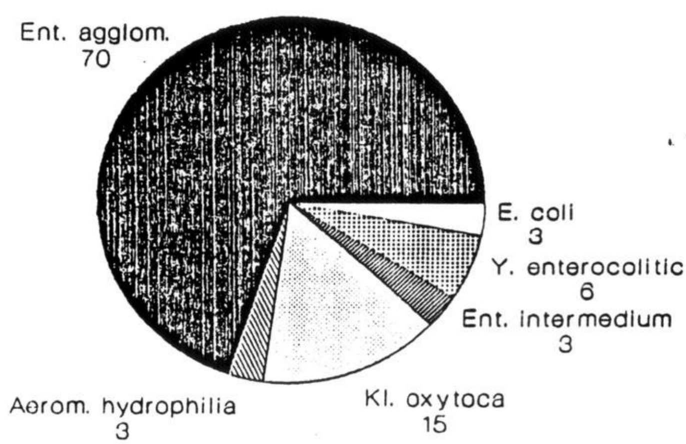
Facility	County	System	Dates Sampled (1989)
Barron-Cameron	Barron	RIF	April 4 May 1, 30 June 5
Crandon	Forest	RIF	April 17 May 8 June 12 July 10
Evansville	Rock	RIF	April 11, 25 May 9, 23
Florence	Florence	RIF	June 26 July 24 August 7, 21
Fox Lake	Columbia	RIF	April 19 May 3, 17 June 14
Glenwood City	St. Croix	Wetland	April 24 May 22 June 19 July 17
Goodman	Marinette	RIF	June 26 July 24 August 7, 21
Hayward	Sawyer	RIF	July 17, 27 August 2, 30
Interlaken Rst	Walworth	RIF	April 26 May 24 June 7, 28
Kelly Lake	Oconto	Lagoon	June 26 July 24 August 7, 21
Kettle Moraine Corr Inst	Sheboygan	Lagoon	July 31 August 8, 22, 29
Lake Geneva	Walworth	RIF	April 26 May 24 June 7, 28
Lake Tomahawk	Oneida	Mound	April 17 May 8 June 12 July 10
Lone Rock	Richland	RIF	June 20, 27 July 11, 18
Maribel	Manitowoc	Pond	July 31 August 8, 22, 29
Milltown	Polk	RIF	June 19 July 17, 27 August 2
Muscoda	Richland	Pond	June 20, 27 July 11, 18
Osseo	Eau Claire	RIF	April 24 May 22 June 19 July 17
Pardeeville	Columbia	RIF	April 19 May 3, 17 June 14
Spooner	Washburn	RIF	April 10 May 1, 30 June 5
Wautoma	Waushara	RIF	April 19 May 3, 17 June 14
Wi Veterans Home, King	Waupaca	RIF	July 12, 19, 24 August 7
Wyeville	Monroe	Mound	April 18 May 2, 16, 30

Table 1

FACILITY	DATE	WELL	TOTAL COLI	FECAL COLI	FECAL STREP	IDENTIFICATION
Glenwood City	4/24/89	2 pre	<10	<10	<10	N/A
		2 post	<10	<10	<10	N/A
		3 pre	2400	10	240	1 Kl. oxytoca
						4 Ent. agglom.
		3 post	9300	20	2000	1 Kl oxytoca
						4 Ent. agglom.
	5/1/89	4 pre	<10	<10	<10	N/A
		4 post	<10	<10	<10	N/A
		3 pre	14	<2	<2	2 Ent. agglom.
						1 E. coli
						2 Ent. interm.
		3 post	1900	30	<10	4 Ent. agglom.
						1 Y. entero.
	5/22/89	1 pre	26	<2	6	1 Aerom. hydro.
						2 Kl. oxytoca
						2 Ent. agglom.
		1 post	positive	14	210	N/A
		3 pre	50	<10	<10	4 Ent. agglom.
						1 Y. entero.
		3 post	<1000	<1000	<1000	N/A
	6/19/89	4 pre	<2	<2	<2	N/A
		4 post	<2	<2	<2	N/A
		3 pre	73	20	<10	1 Kl. oxytoca
						4 Ent. agglom.
		3 post	<100	<100	<100	N/A

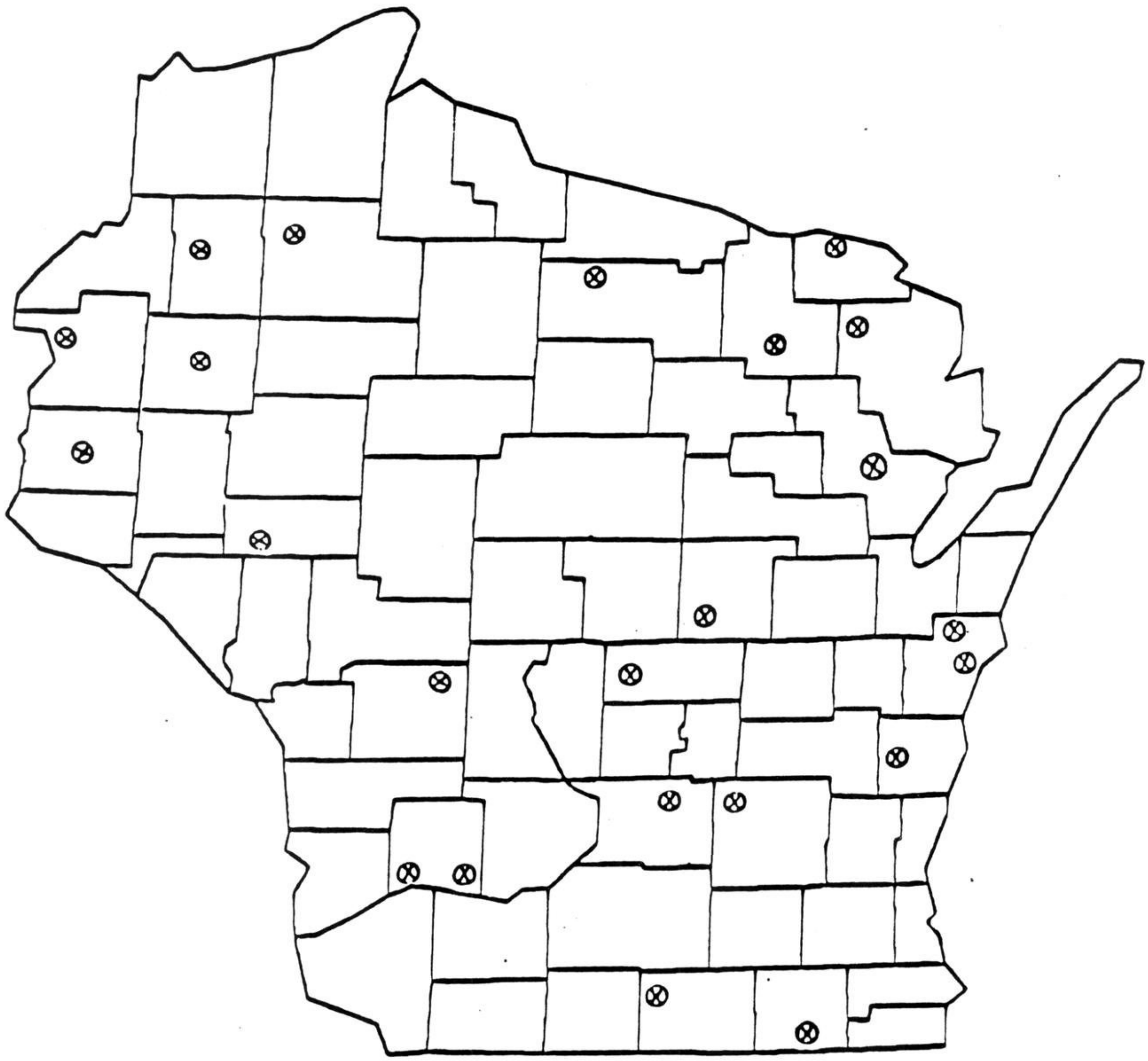
Table 2

Glenwood City WWT



values equal percent

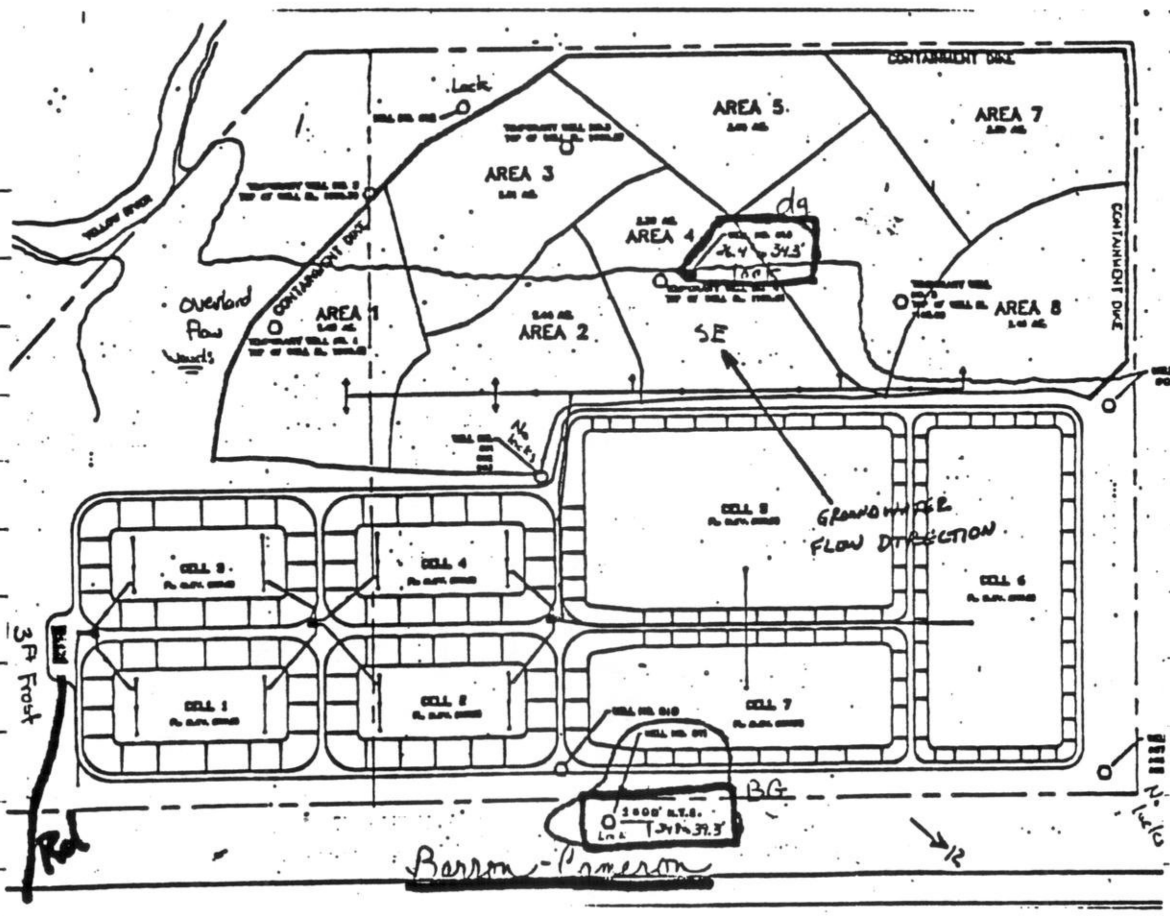
figure 1



⊗ Wastewater Treatment Plants Sampled

figure 2

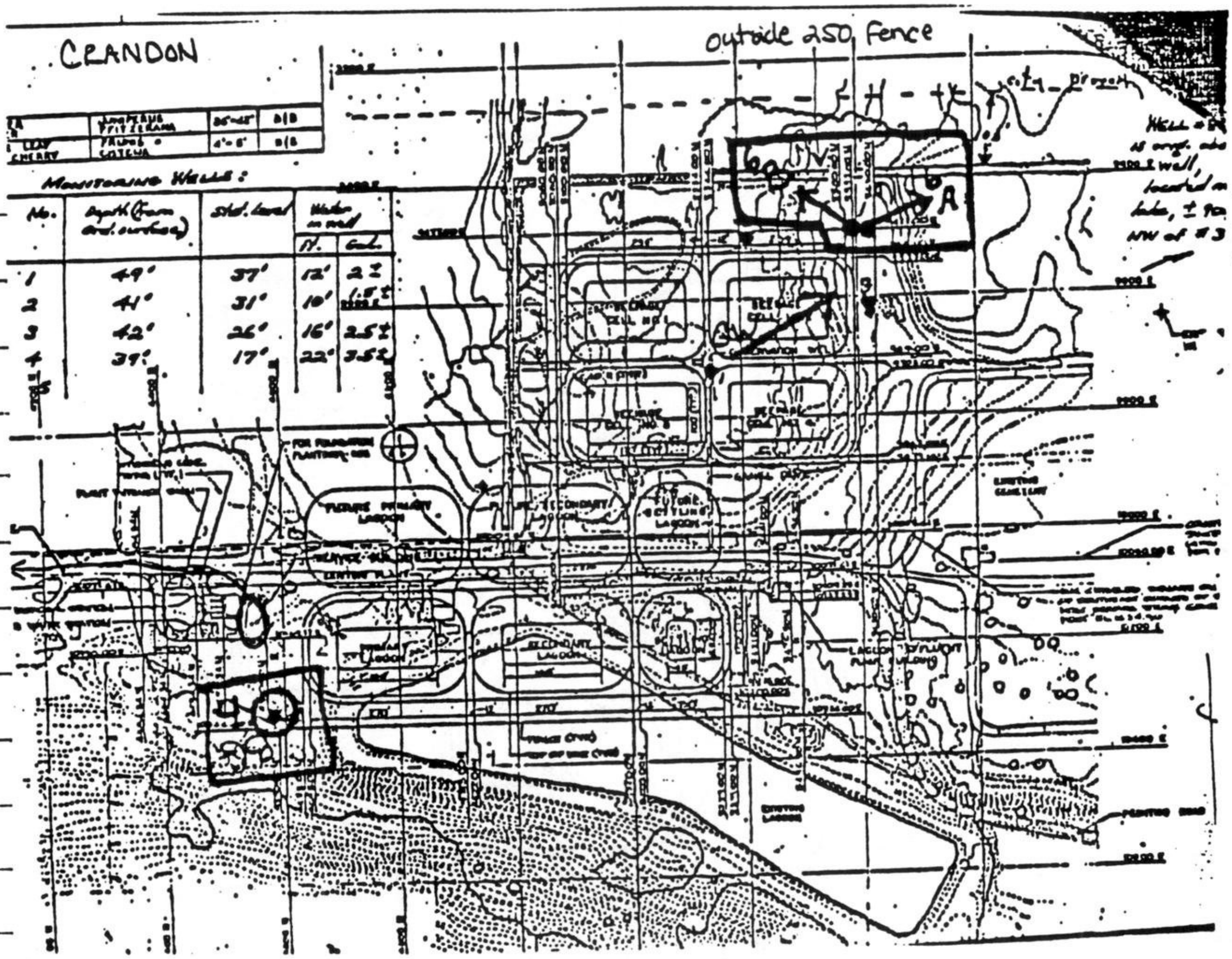
APPENDIX



Facility: Barron-Cameron
Operator: Rod Peterson (715) 537-3747

Well diameter: 2"
Well depth: #11 BG 39'3" #13 dg 34'6"
Water depth: #11 BG 4' #13 dg 9'

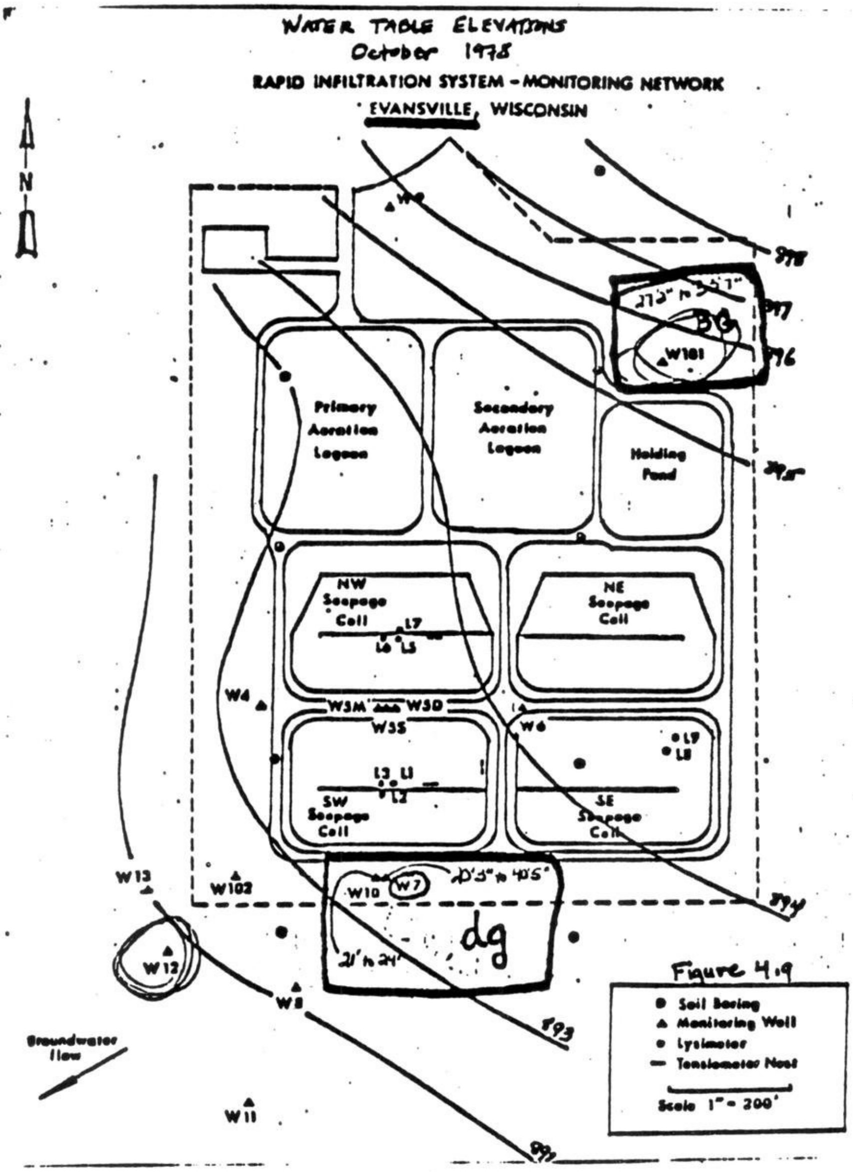
Wells are locked.



Facility: Crandon
Operator: Frank Sturzl (715) 478-2836

Well diameter: 2"
Well depth: #4 BG 40' #6 A 42'
Water depth: #4 BG 12' #6 A 4'

Wells are locked.



Facility: Evansville

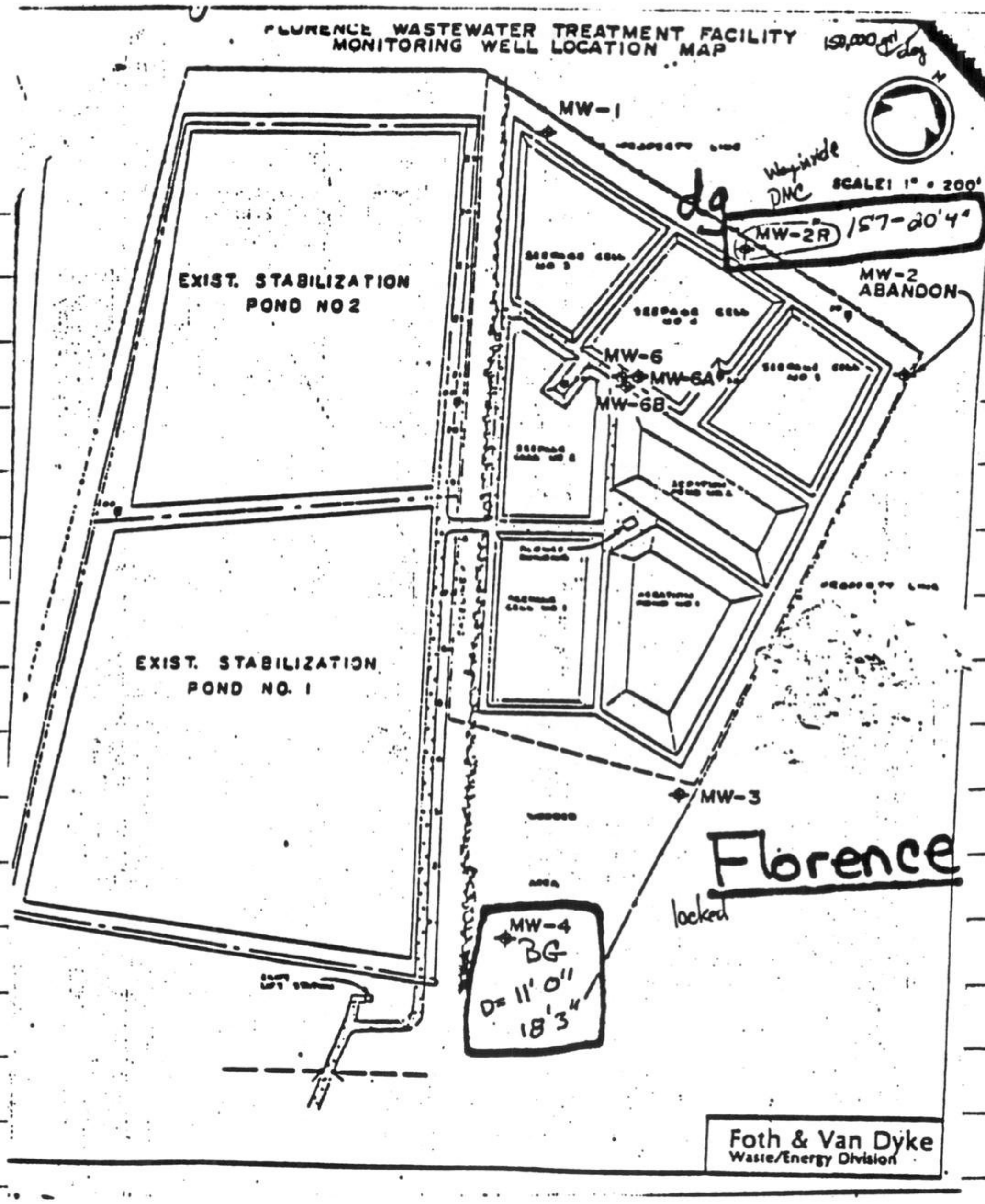
Operator: Ken Grenawalt (608) 882-4426

Well diameter: 2"

Well depth: #1 BG 33'7" #7 dg 40'5"

Water depth: #1 BG 7' #7 dg 21'

Wells are locked.



Facility: Florence

Operator: Bob Friberg (715) 528-3330

Well diameter: 2"

Well depth: #4 BG 18'3" #2R dg 20'4"

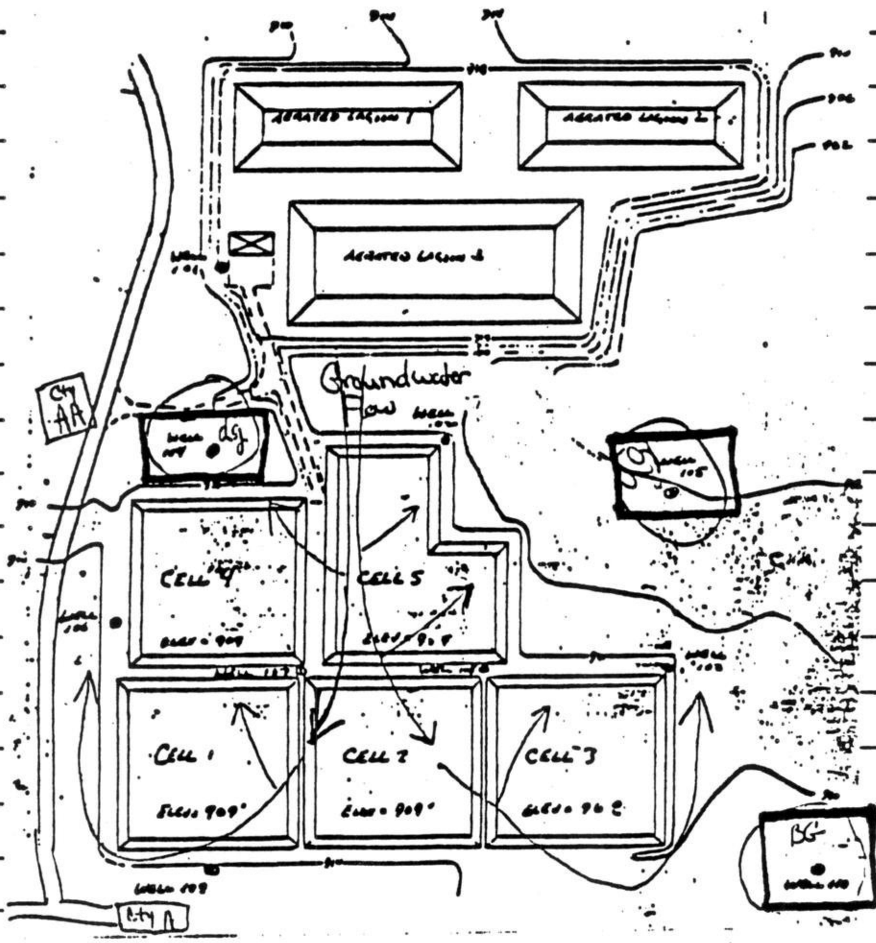
Water depth: #4 BG 7' #2R dg 5'

Wells are locked (some have no locks).

FOX LAKE WASTEWATER TREATMENT FACILITY

SCALE 1" : 200'

WELL LOCATIONS ARE APPROXIMATE

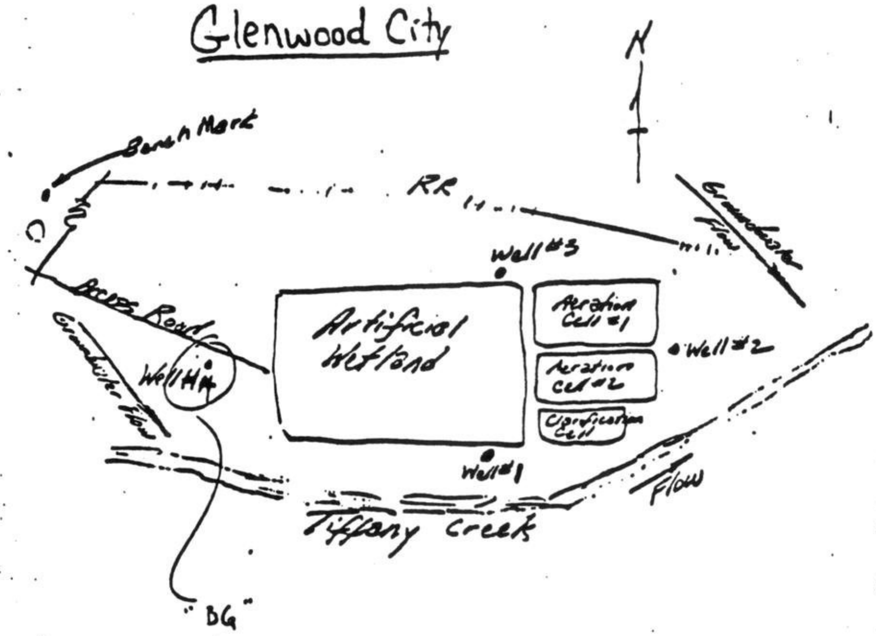


Facility: Fox Lake
Operator: Jeff Hafenstein (414) 928-2020

Well diameter: 2"
Well depth: #110 BG 31'2" #104 dg 15'6"
Water depth: #110 BG 10' #104 dg 9'

Some wells are locked, other are not.

Glenwood City



Facility: Glenwood City

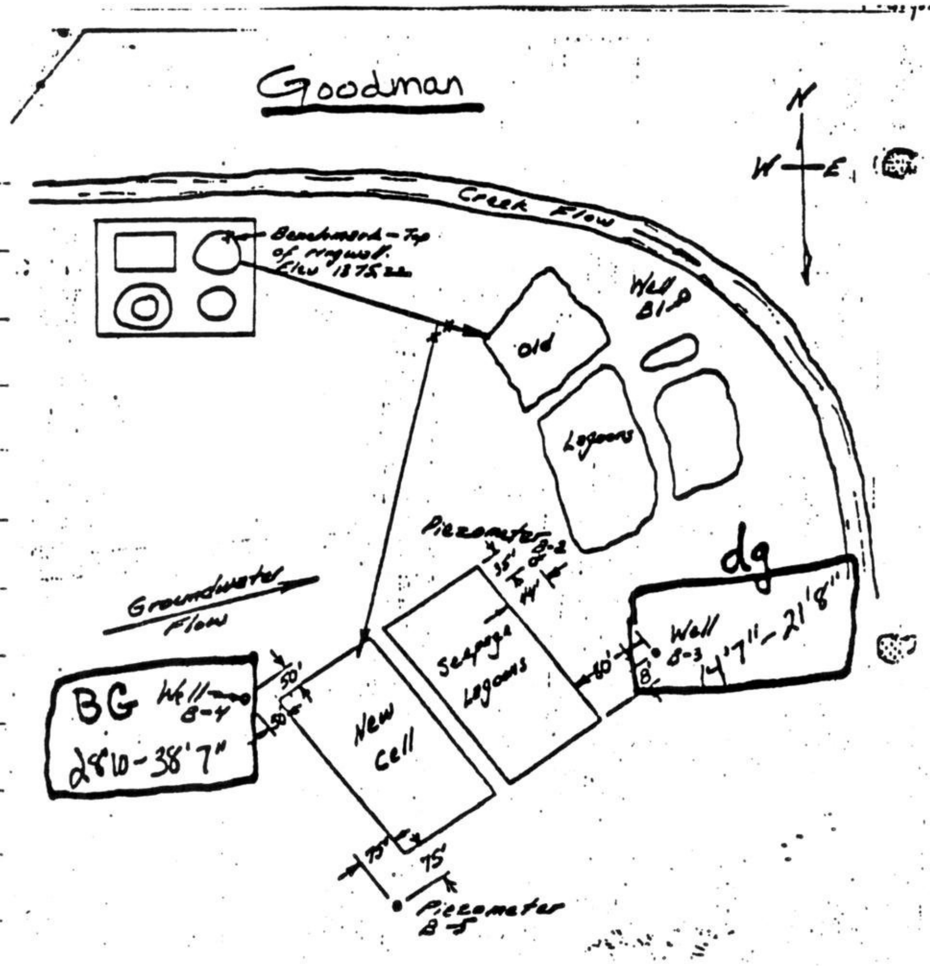
Operator: Dave Booth (715)265-4455

Well diameter: 2"

Well depth: #1 15'3" #2 14'5" #3 14'6" #4 17'

Water depth: #1 10' #2 10' #3 10' #4 12'

Wells are unlocked.



Facility: Goodman

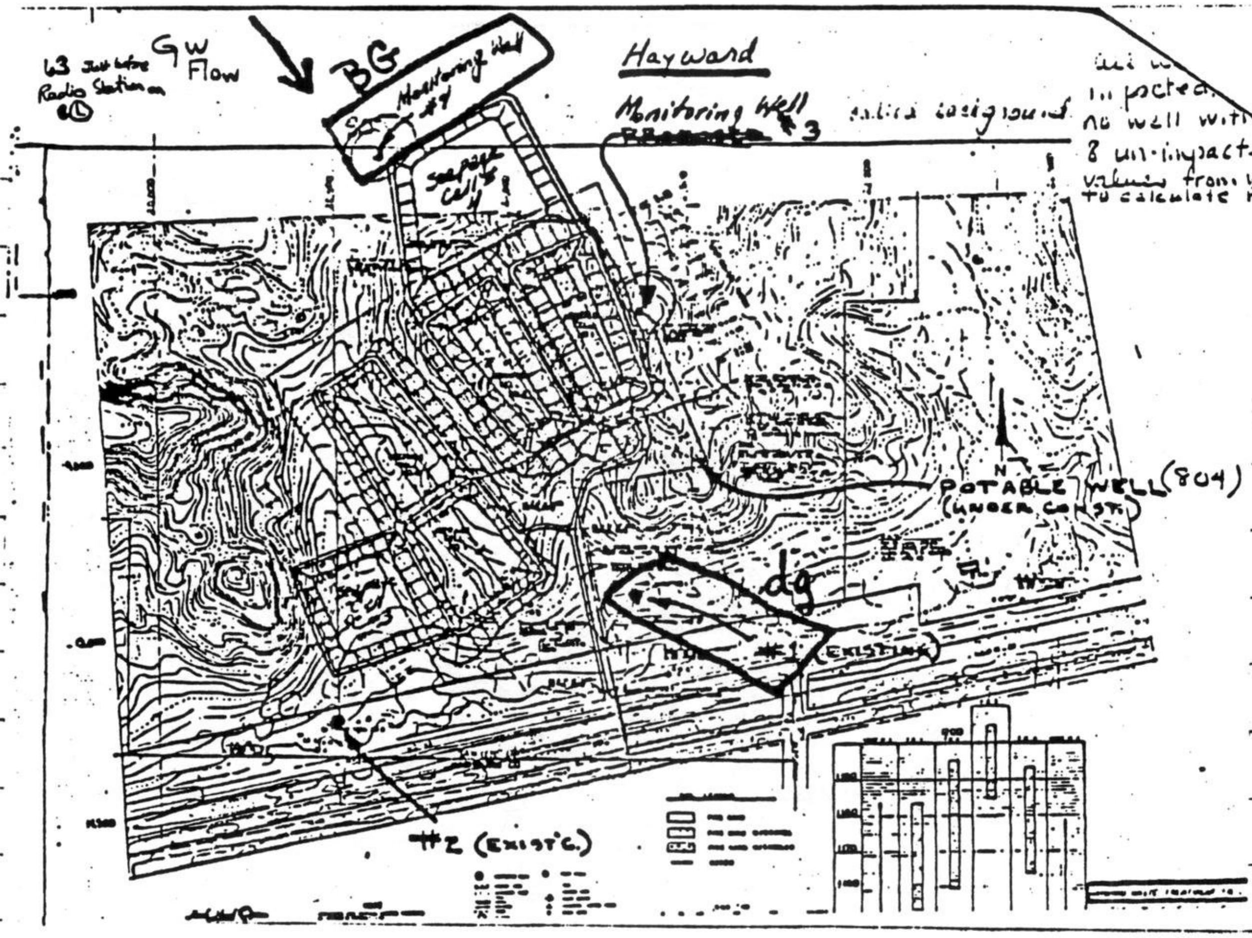
Operator: Tony Larich (715) 336-2306 home

Well diameter: 2"

Well depth: #B-4 BG 38'7" #B-3 dg 21'8"

Water depth: #B-4 BG 10' #B-3 dg 7'

Wells are locked.



Facility: Hayward

Operator: Milo Kadlec (715) 634-4612

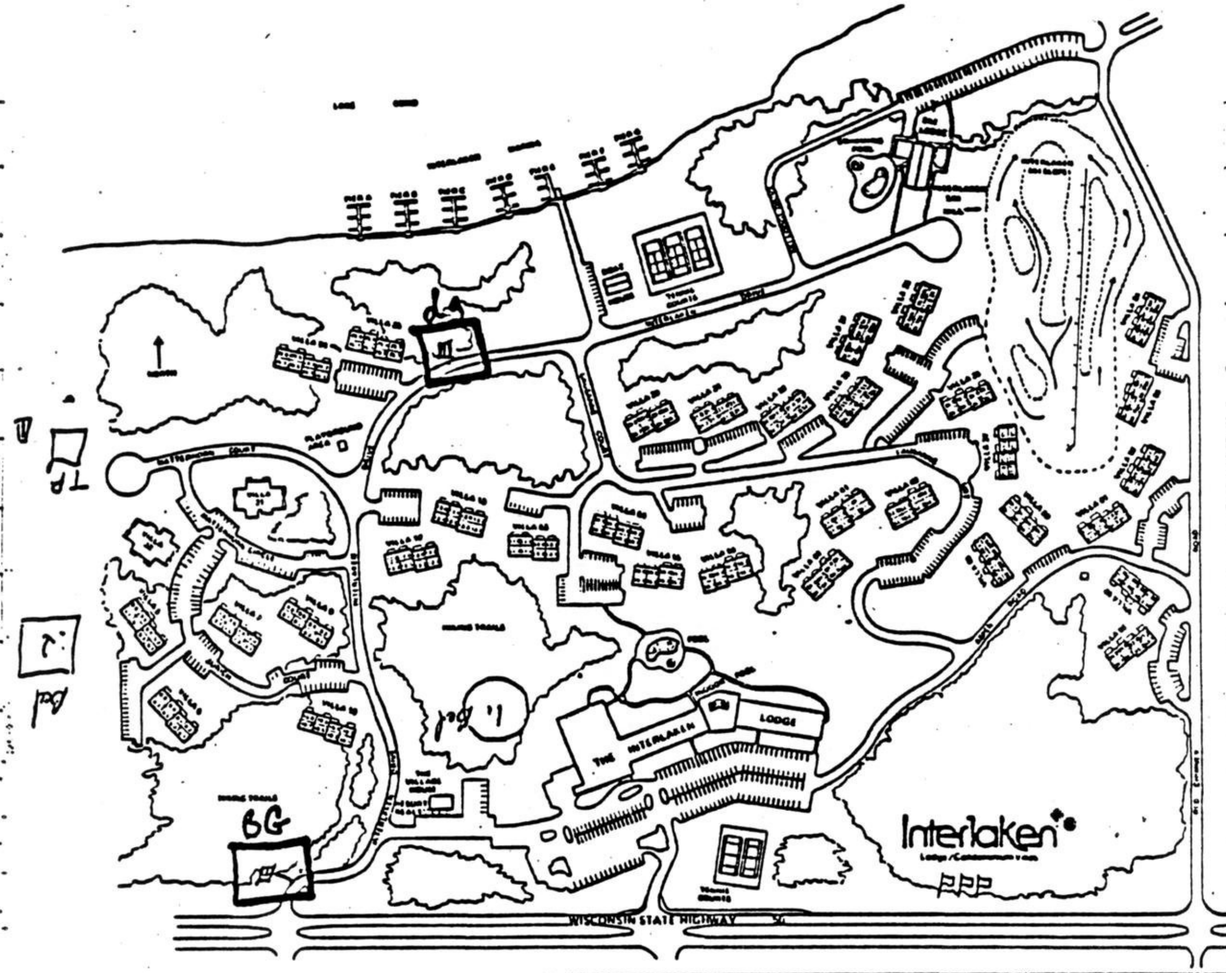
Well diameter: 2"

Well depth: #4 BG 110+' #1 dg 40'

Water depth: #4 BG 25+' #1 dg 10'

Wells are unlocked.

Interlaken Resort (312) 932-5700



Facility: Interlaken Resort

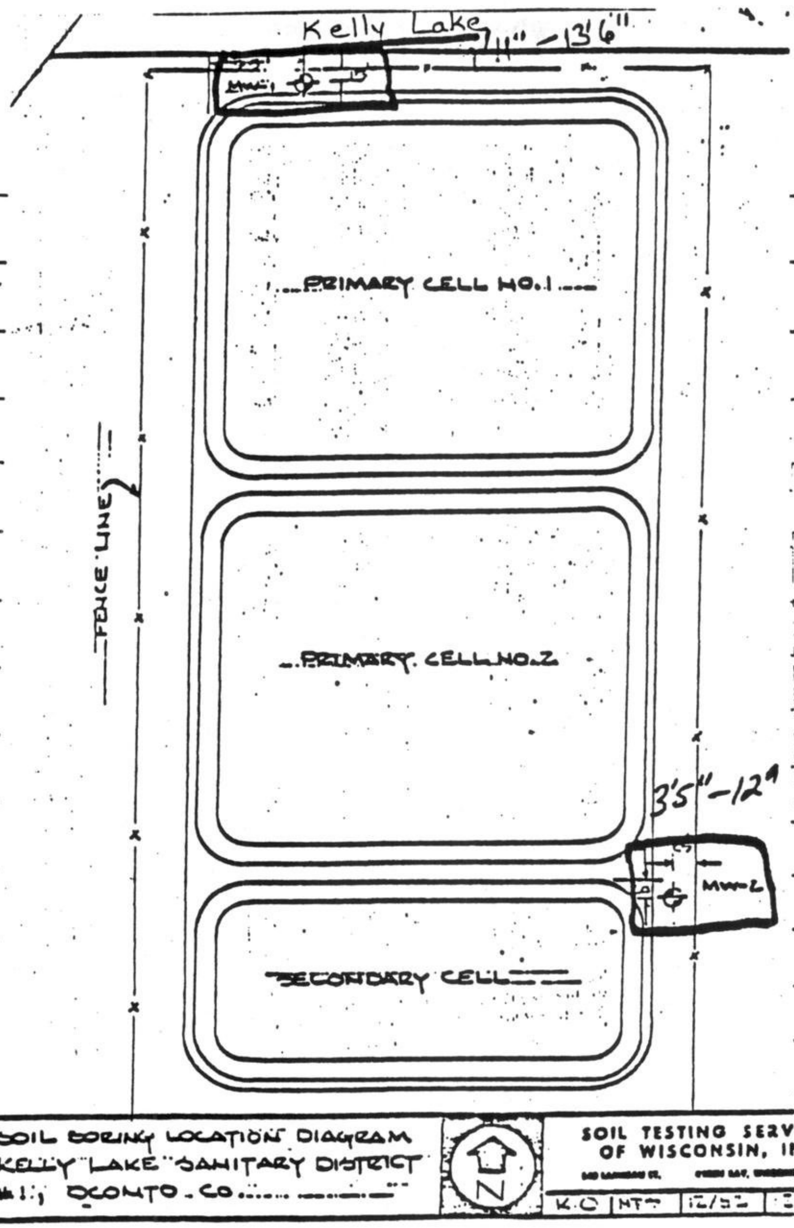
Operator: Ron (414) 248-9121 Ext 608

Well diameter: 2"

Well depth: BG 57'6" dg 17'2"

Water depth: BG 8' dg 5'

Wells are unlocked.



Facility: Kelly Lake

Operator: Bob St. Louis (414) 842-2500 home

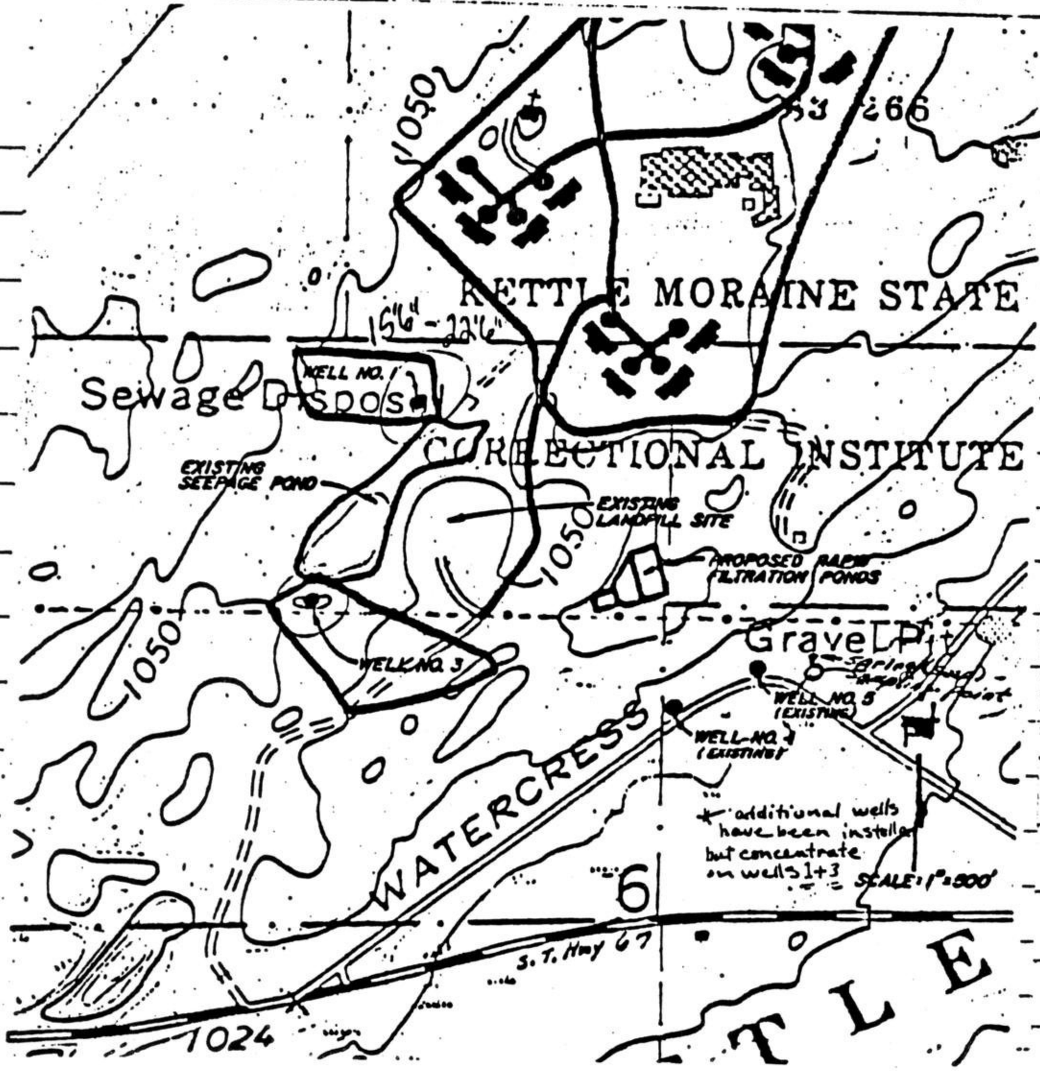
Well diameter: 2"

Well depth: #1 13'6" #2 12'

Water depth: #1 4' #2 9'

Wells are unlocked.

Kettle Moraine Corr.



Facility: Kettle Moraine Correctional Institute

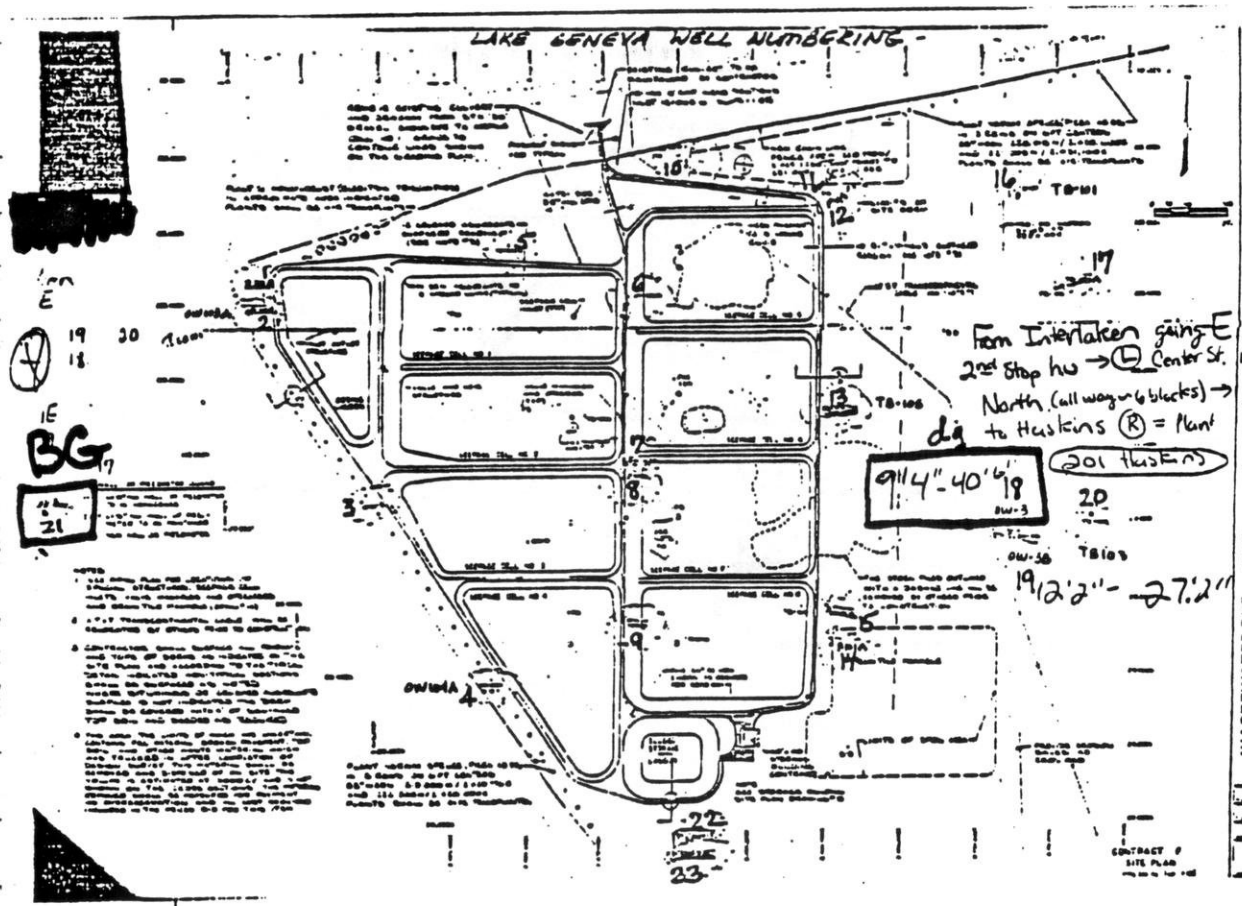
Operator: Wally Luckow (414) 526-3244

Well diameter: 2"

Well depth: #1 22'6" #3 23'

Water depth: #1 7' #3 7'2"

Wells are locked.



Facility: Lake Geneva

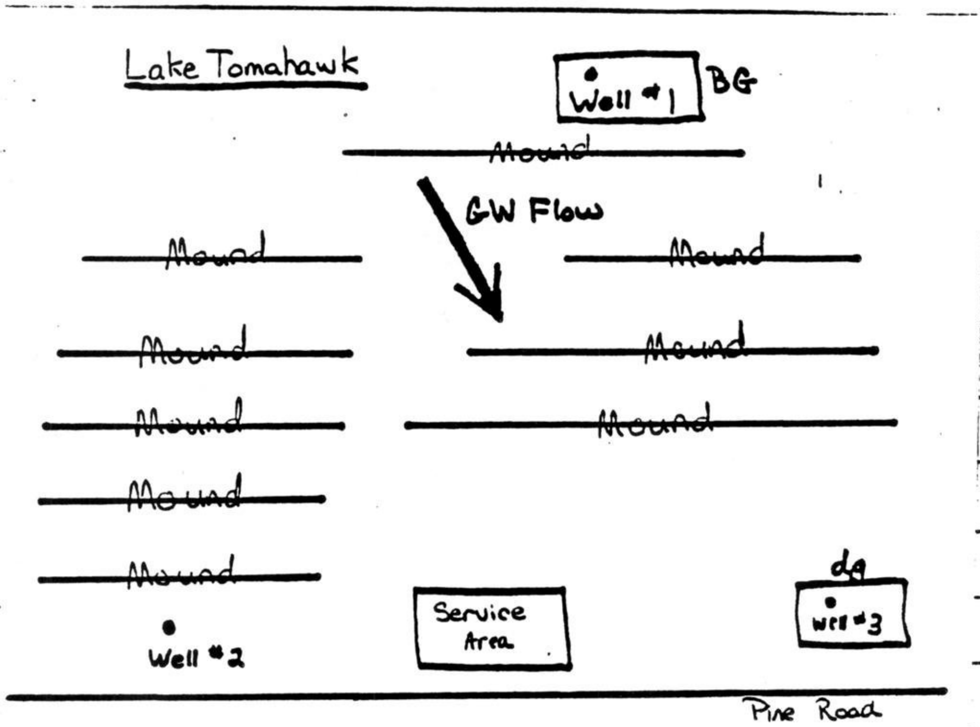
Operator: Robert Shepstone (414) 248-2394

Well diameter: 2"

Well depth: # 18 dg 40'6" # 21 BG 16'4"

Water depth: # 18 dg 31'2" # 21 BG 6'

Wells are locked.



Facility: Lake Tomahawk

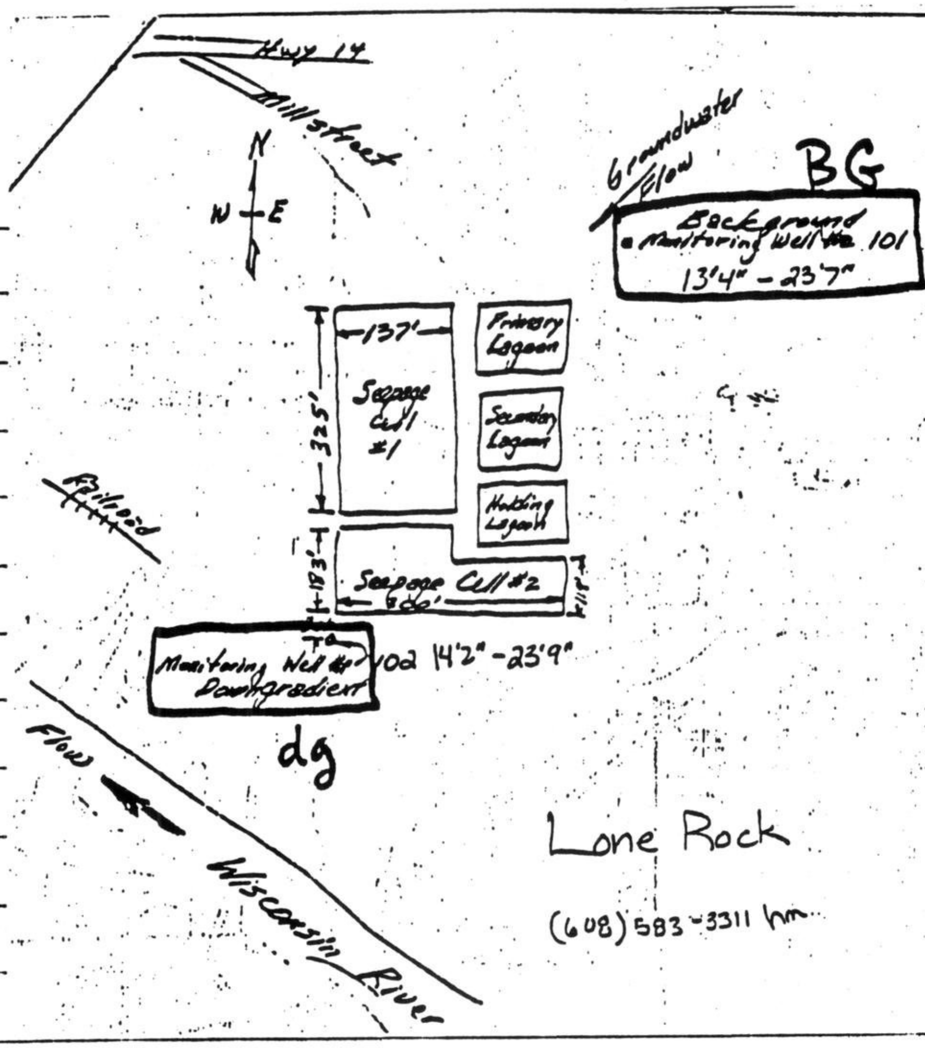
Operator: Rob Young (715) 356-9823 home

Well diameter: 2"

Well depth: #1 BG 66'10" #3 dg 55'5"

Water depth: #1 BG 7' #3 dg 13'

Wells are locked.



Facility: Lone Rock

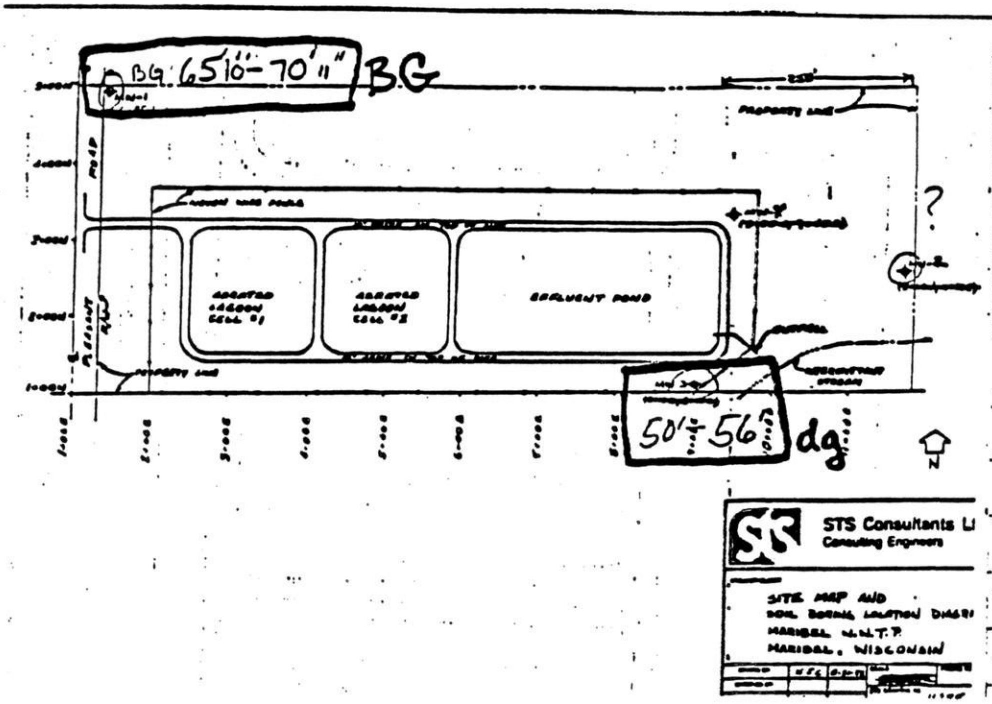
Operator: Sylvestor Bindl (608) 583-3311 home

Well diameter: 2"

Well depth: # 101 BG 23'7" # 102 dg 23'9"

Water depth: # 101 BG 10' # 102 9'

Wells are unlocked.



Facility: Maribel

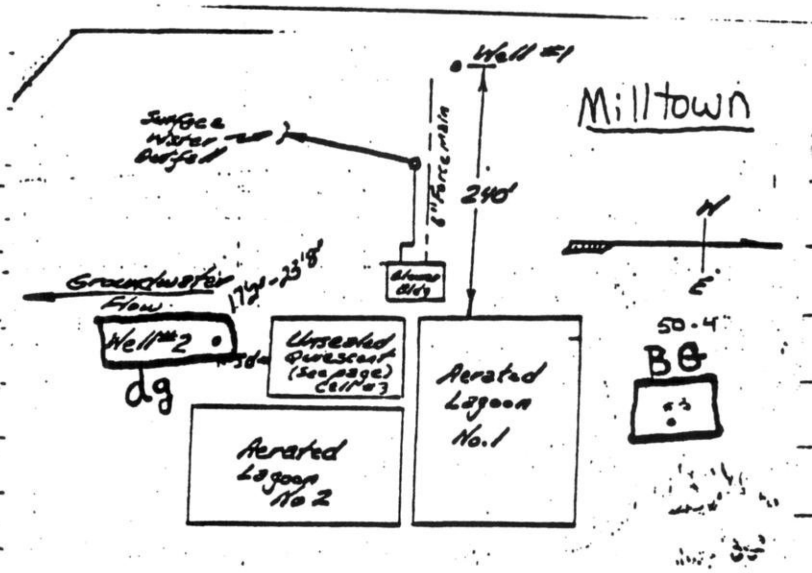
Operator: Frank Dart (414) 863-8571 home

Well diameter: 2"

Well depth: #1 BG 70'11" #3 dg 56'

Water depth: #1 BG 5' #3 dg 6'

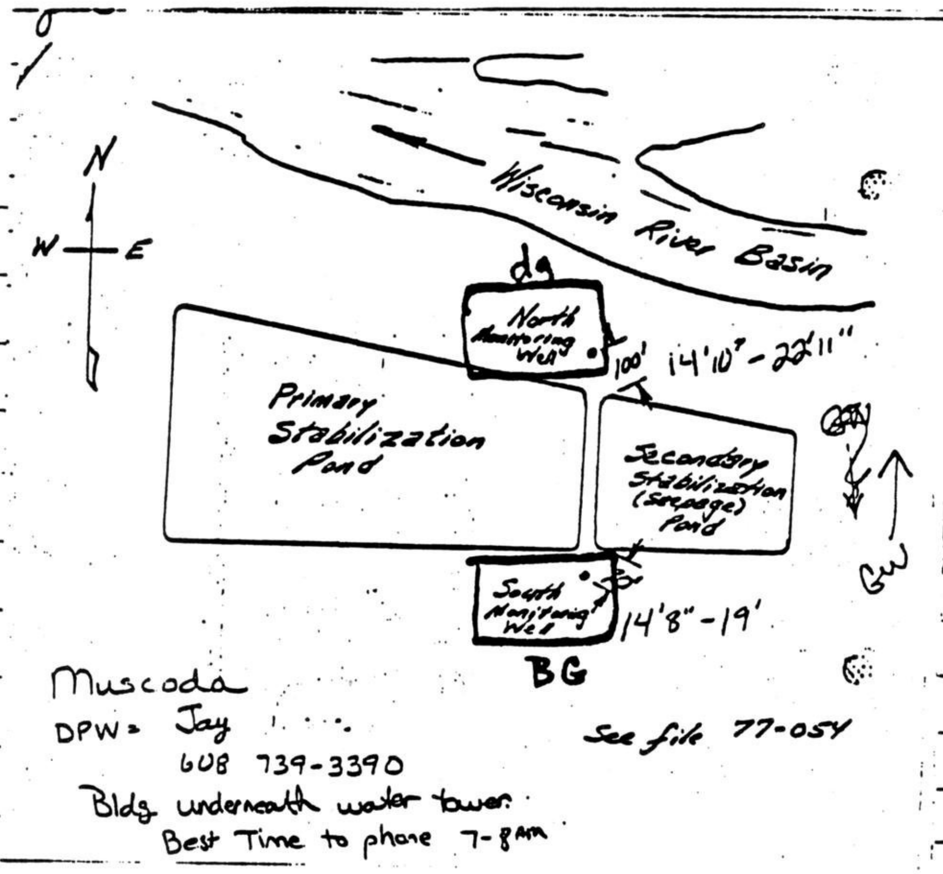
Wells are locked.



Facility : Milltown
Operator : Rick Fisher (715) 825-3288

Well diameter : 2"
Well depth : #3 BG 25' #2 dg 23'8"
Water depth : #3 BG 9' #2 dg 6'

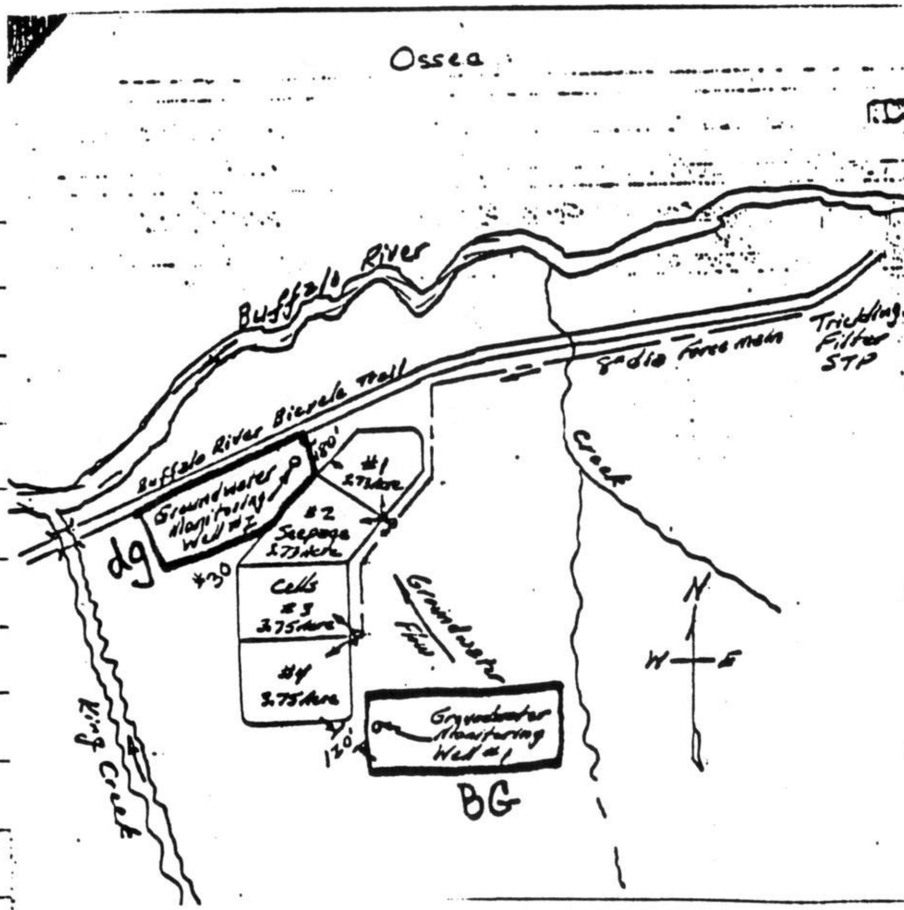
Wells are unlocked.



Facility: Muscoda
Operator: Jay Goers (608) 739- 3390

Well diameter: 2"
Well depth: BG 19' dg 22'11"
Water depth: BG 5' dg 8'

Wells are unlocked.



Facility: Osseo

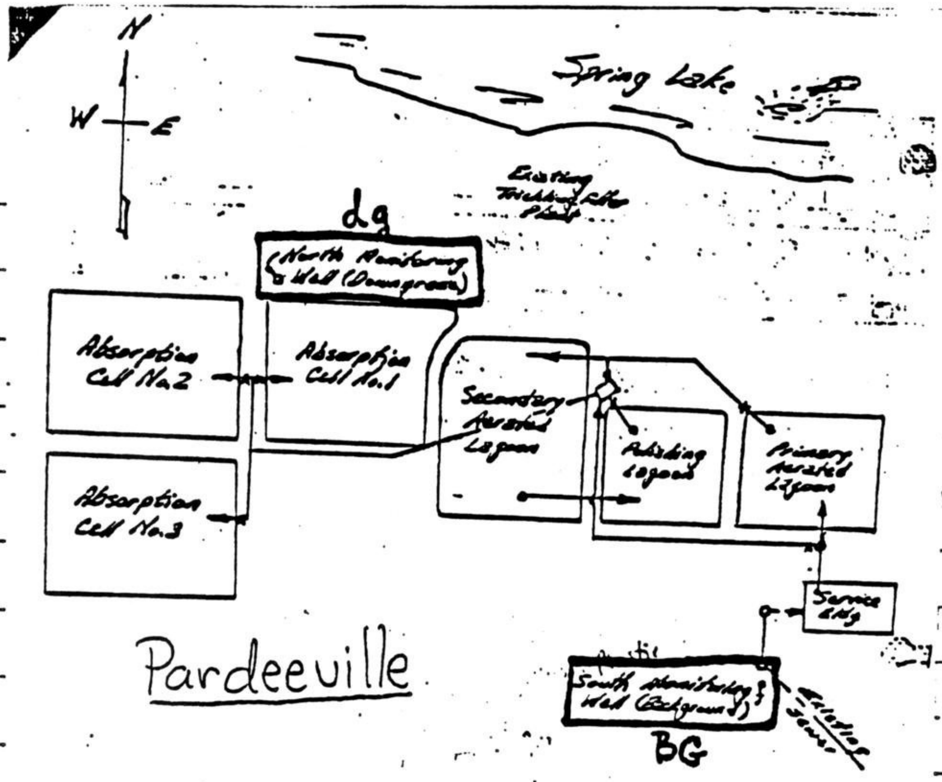
Operator: Dale Olson (715) 597-3449

Well diameter: 2"

Well depth: #1 BG 34'10" #2 dg 25'10"

Water depth: #1 BG 8' #2 dg 13'

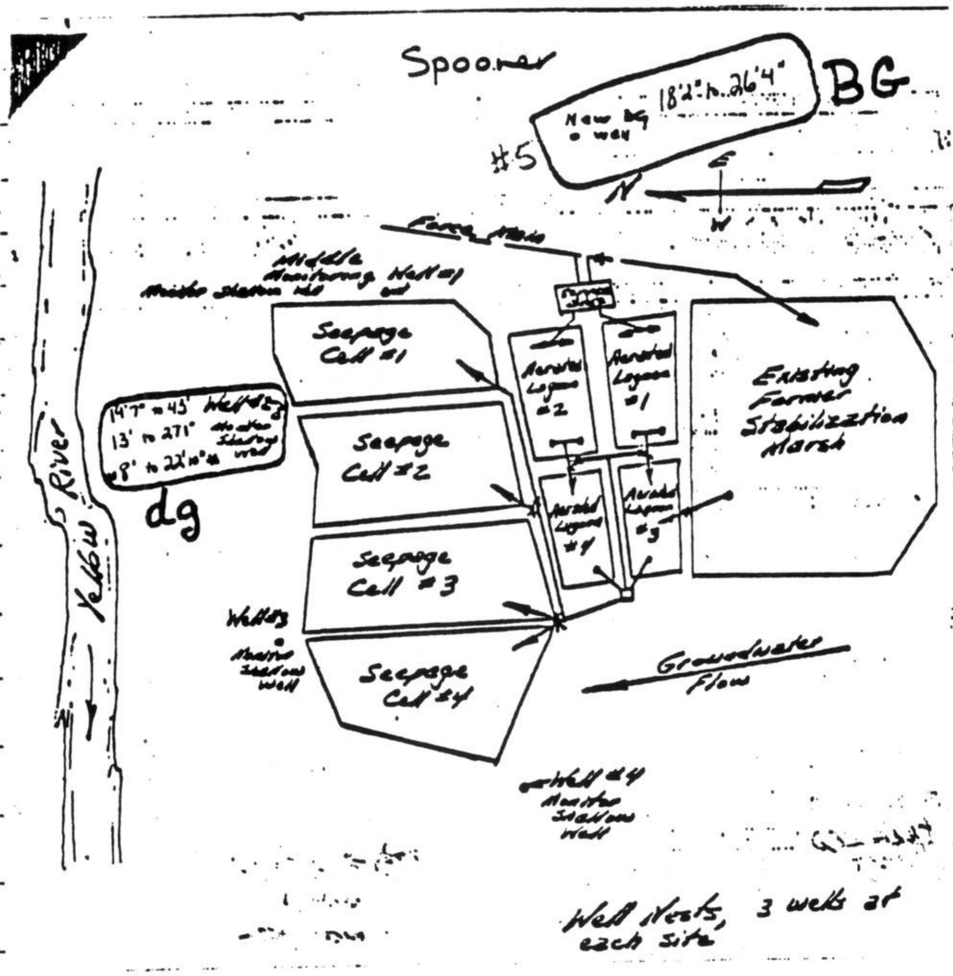
Wells are unlocked.



Facility: Pardeeville
Operator: Don Silver (608) 429-3054

Well diameter: 2"
Well depth: BG 31' 6" dg 33'
Water depth: BG 10' dg 20'

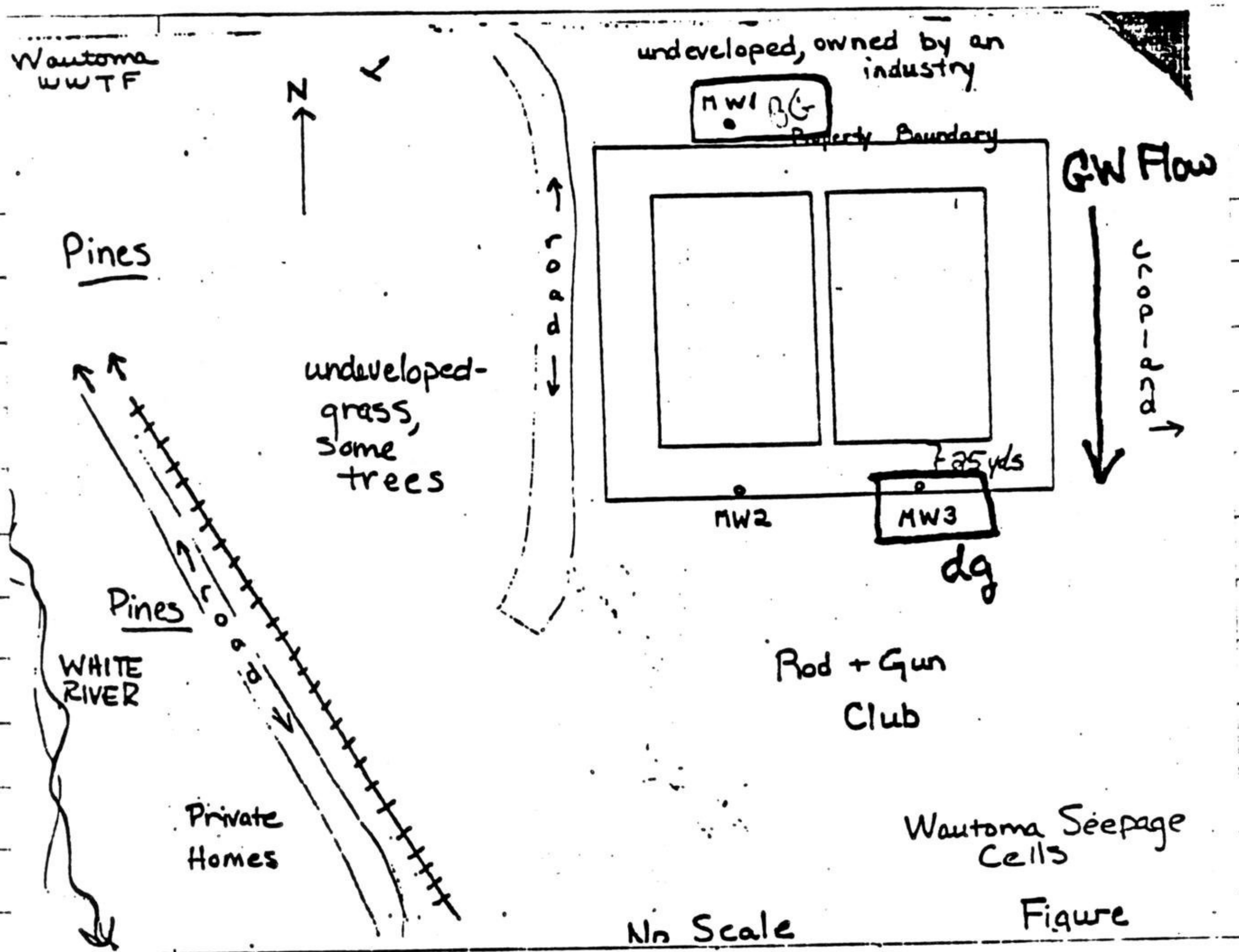
Wells are unlocked.



Facility: Spooner
Operator: Al Cusick

Well diameter: 2"
Well depth: BG 26'4" #2 A dg 22'10"
Water depth: BG 8' #2 A dg 14'

Wells are unlocked.



Facility: Wautoma

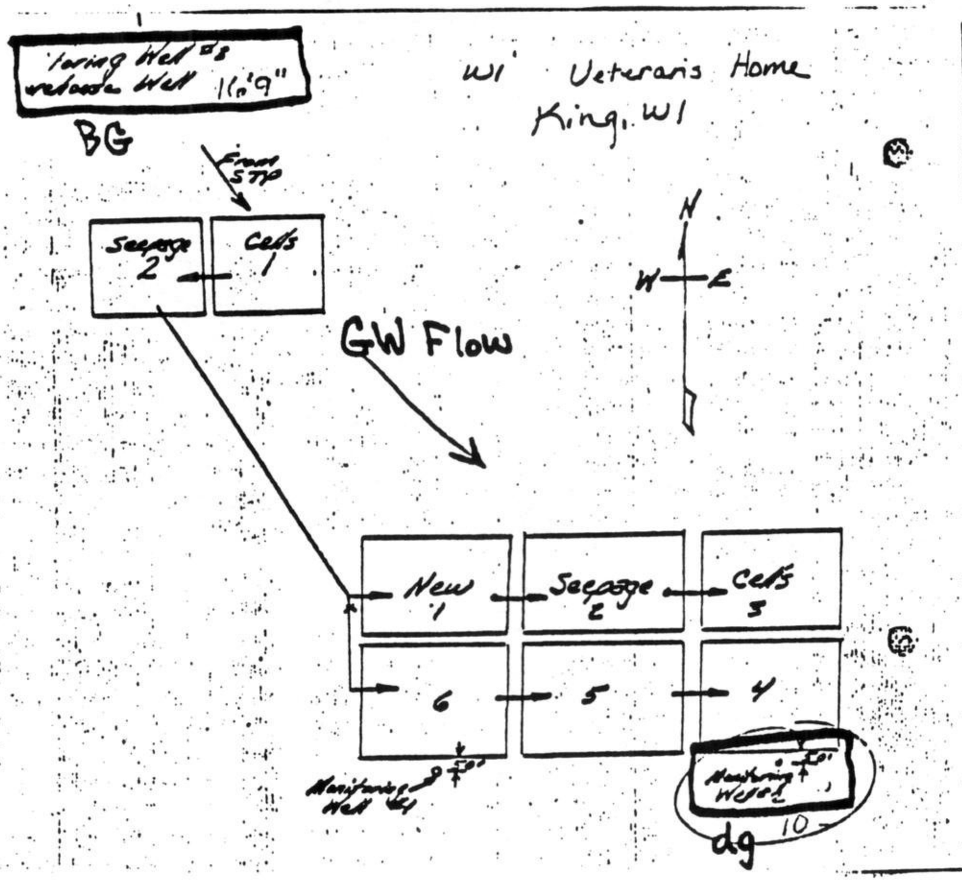
Operator: Russ Nero (City Clerk) (414)787-4044

Well diameter: 2"

Well depth: #1 BG 38'10" #3 dg 27'

Water depth: #1 BG 10' #3 dg 15'

Wells are unlocked.

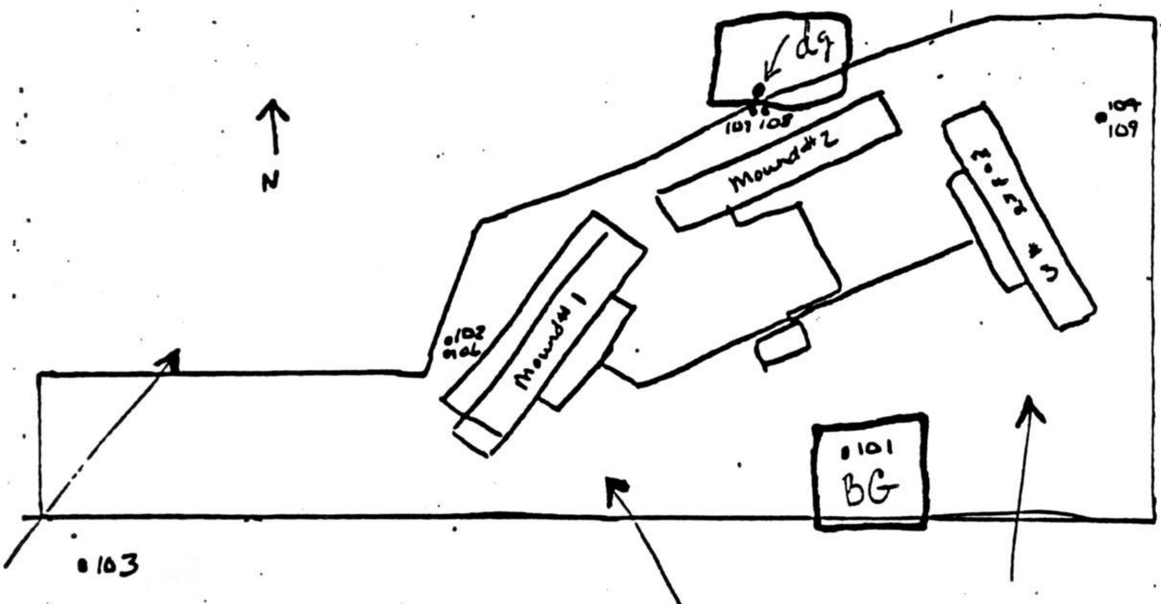


Facility: Wisconsin Veterans Home, King WI
Operator: Russ Thompson (715) 258-5586 ext 29

Well diameter: 2"
Well depth: #3 BG 23' #2 dg 17' 8"
Water depth: #3 BG 7' #2 dg 7'

Wells have no locks.

Wyeville (608) 372-5139



arrows indicate
GW Flow Direction

no scale

Facility: Wyeville
Operator: Phyllis Sorenson (Controller) (608) 372-5139 home

Well diameter: 2"
Well depth: #101 BG 17'7" #dg 16'8"
Water depth: #101 BG 8' #dg 7'

Wells are locked.

050856- Groundwater Survey Shows Little Evidence of Bacterial Contamination Near Rapid Infiltration Wastewater Treatment System