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Fiscal Year 1985 Groundwater Investigation Drilling Program at the Y-12 Plant, Oak Ridge, Tennessee

C. Stephen Haase
George A. Gillis
Helen L. King

Environmental Sciences Division
Publication No. 2805

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ENVIRONMENTAL SCIENCES DIVISION

FISCAL YEAR 1985 GROUNDWATER INVESTIGATION DRILLING PROGRAM AT THE Y-12 PLANT, OAK RIDGE, TENNESSEE

C. Stephen Haase, George A. Gillis,* and Helen L. King

Environmental Sciences Division
Publication No. 2805

*Health, Environment, Safety, and Accountability Division, Y-12 Plant

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L. L. McCauley, Program Manager

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ABSTRACT

HAASE, C. S., G. A. GILLIS, and H. L. KING. 1986. Fiscal year 1985 groundwater investigation drilling program at the Y-12 Plant, Oak Ridge, Tennessee. ORNL/TM-9999. Oak Ridge National Laboratory, Oak Ridge, Tennessee. 108 pp.

Groundwater investigation drilling operations at ten formerly or currently used waste disposal sites in the Y-12 vicinity were completed during the period August 15 through December 20, 1985. A total of 4 core holes, 11 soil borings, and 55 groundwater investigation wells were drilled at the Beta-4 Security Pit, the Chestnut Ridge Security Pit, Kerr Hollow Quarry, New Hope Pond, the Ravine Disposal Site (Bldg. 9712), Rogers Quarry, the Sludge Disposal Basin, the United Nuclear Site, a site on Chestnut Ridge south of the Y-12 Burial Grounds, and a site on Pine Ridge north of the Y-12 Burial Grounds.

The objective of the drilling program was to characterize the geology and hydrology of the sites investigated so that an effective monitoring well network could be designed and installed. The basic approach followed at each of the sites was to identify the major features of subsurface geology and then install the necessary boreholes to investigate the hydrogeologic significance of such features.

Initially, a core hole or relatively deep borehole was drilled at an up section location to determine the general components of the subsurface geology. Study of drill cores, cuttings, and geophysical logs from this initial borehole identified geohydrologically significant targets. Those identified for investigation during the second stage of drilling at a specific site include (1) the top of the water table, (2) the interface between the base of soil and the top of weathered bedrock, (3) base of weathering in the bedrock, (4) cavity zones near the base of weathering in the top of bedrock, (5) zones of high porosity in the unweathered bedrock, and (6) fractures or fractured zones within the unweathered bedrock. After the investigatory phase was completed, groundwater investigation wells were installed to provide additional subsurface geological data and to provide data on hydrostatic heads and water quality for the shallow-flow regime in soils and upper weathered-bedrock zone and for the deep-flow regimes within the bedrock below the zone of significant weathering.

1. INTRODUCTION

This report summarizes drilling operations conducted at ten currently or formerly used waste disposal sites at the U.S. Department of Energy Y-12 facility in Oak Ridge, Tennessee. A total of 4 coreholes, 11 soil borings, and 55 groundwater investigation wells were installed during the period August 15 through December 20, 1985. At the Beta-4 Security Pit, the Chestnut Ridge Security Pit, Kerr Hollow Quarry, New Hope Pond, the Ravine Disposal Site (Bldg. 9712), Rogers Quarry, the Sludge Disposal Basin, the United Nuclear Site, a site on Chestnut Ridge immediately south of the Y-12 Burial Grounds, and a site on Pine Ridge immediately north of the Y-12 Burial Grounds (Table 1 and Fig. 1). Investigations and drilling at the latter two sites were conducted in cooperation with the U.S. Geological Survey (USGS).

The purpose of the drilling program was to install groundwater investigation wells and to conduct preliminary geohydrologic investigations to obtain data necessary for the design and installation of permanent monitor well networks at the sites under investigation. Although many such data are available from recently completed geohydrologic investigations at the Y-12 facility, all such studies centered on the plant site itself or on major waste disposal facilities immediately west of the plant in Bear Creek Valley (Law Engineering 1983a and 1983b; Bechtel 1984a, 1984b, 1984c, 1984d, and 1984e; Geraghty and Miller 1985a, 1985c, and 1986). As such, the investigations provided much data on facility-wide hydrologic systems but, in general, did not provide sufficient information about the sites discussed in this report. Furthermore, several of the sites considered in this report are located outside regions covered by previous investigations and are in areas where little is known about the site geohydrology.

The purpose of this report is to (1) present the details of the drilling program; (2) summarize the details of and the existing data on, the various sites; and (3) briefly summarize borehole siting considerations. Discussion and interpretation of geological, hydrological, and borehole geophysical data collected during drilling operations will be presented in a forthcoming report (Haase and King, in preparation).

2. BOREHOLE SITING AND DESIGN CONSIDERATIONS

The principal consideration in siting boreholes was to locate them such that a maximum amount of geological and hydrological data could be obtained from each well installed. Borehole locations were initially based on site topography, available geologic and hydrologic data, and knowledge gained from previous investigations at geohydrologically similar sites. The approach followed at each of the sites was to

Table 1. Borehole location summary

Name	N (ft)[b]	E (ft)[b]	Elevation (ft)[b]	T.D. (ft)[b]
		Beta-4 Security Pit		
GW-191	30,780	54,279	1,007.10	60.5
GW-192	30,772	54,277	1,006.04	17.5
GW-194	30,583	54,218	992.47	12.5
GW-195	30,573	54,089	1,000.23	23
GW-196	30,829	53,906	1,034.44	27
GW-197	30,734	54,087	1,001.72	17
		Chestnut Ridge Security Pit		
GW-173	28,271	59,472	1,112.97	165
GW-174	28,205	59,215	1,114.06	145
GW-176	28,294	58,450	1,122.13	145
GW-177	28,483	57,497	1,155.52	145
GW-179	28,522	58,569	1,124.33	117
		Kerr Hollow Quarry		
CH-143	24,254	63,512	910.72	600
GW-142	24,524	64,030	968.29	295
GW-143	24,257	63,522	911.04	253
GW-144	24,255	63,502	910.48	195
GW-145	24,441	63,266	837.29	110
GW-146	24,432	63,272	837.00	220
GW-147	24,731	63,428	848.41	69
GW-231	24,125	63,410	846.90	35
		New Hope Pond		
GW-148	29,202	63,817	904.53	11.1
GW-149	29,201	63,824	904.76	50.5
GW-150	28,959	64,222	912.88	11.7
GW-151	28,958	64,232	913.06	96.5
GW-152	28,614	63,718	918.36	17.3
GW-153	28,613	63,728	921.44	60
GW-154	28,987	63,346	908.60	11.2
GW-220	28,949	64,225	912.74	45.2
GW-222	28,954	63,324	908.82	25
GW-223	28,938	63,311	908.97	90.5
GW-240	28,604	63,726	919.50	29.5
		Ravine Disposal Site		
GW-198	30,455	62,466	961.54	26.5
GW-199	30,283	62,464	958.06	22.5
GW-200	30,373	61,906	966.09	57.5
GW-201	30,378	61,914	965.87	21
GW-202	30,597	61,987	964.22	20.1
		Rogers Quarry		
CH-185	23,390	56,905	828.89	841.7
CH-189	24,113	56,787	877.45	763
GW-184	23,915	57,476	924.65	130
GW-185	23,392	56,924	829.63	471.5
GW-186	23,388	56,862	828.31	171
GW-187	23,393	55,980	831.59	162
GW-188	23,663	56,174	834.33	68
GW-189	23,389	56,886	828.39	210
GW-224	23,392	55,959	832.47	126
		Sludge Disposal Basin		
CH-157	27,447	64,069	1,031.90	540
GW-155	27,722	64,333	1,058.88	177
GW-156	27,626	64,020	1,046.94	157.6
GW-157	27,477	63,892	1,044.65	145
GW-158	27,069	63,643	981.24	441
GW-159	27,764	63,496	1,048.79	157
GW-241	27,069	63,659	980.80	103
		United Nuclear Site		
GW-203	28,356	54,190	1,102.78	156
GW-205	28,364	54,008	1,101.76	164
GW-221	28,359	54,388	1,103.62	158
		USGS-IN/Y-12 Burial Grounds		
GW-162	31,331	44,483	1,036.40	125
GW-163	31,334	44,481	1,036.99	225
GW-164	31,328	44,470	1,036.40	405
		USGS-1S/Chestnut Ridge		
GW-165	27,807	44,547	1,090.39	325
GW-166	27,835	44,531	1,092.01	385

[a]N and E are Y-12 Plant coordinates. Elevation is for ground surface measured with respect to mean sea level. Total depth (T.D.) is with respect to ground surface.

[b]1 ft = 0.3048 m.

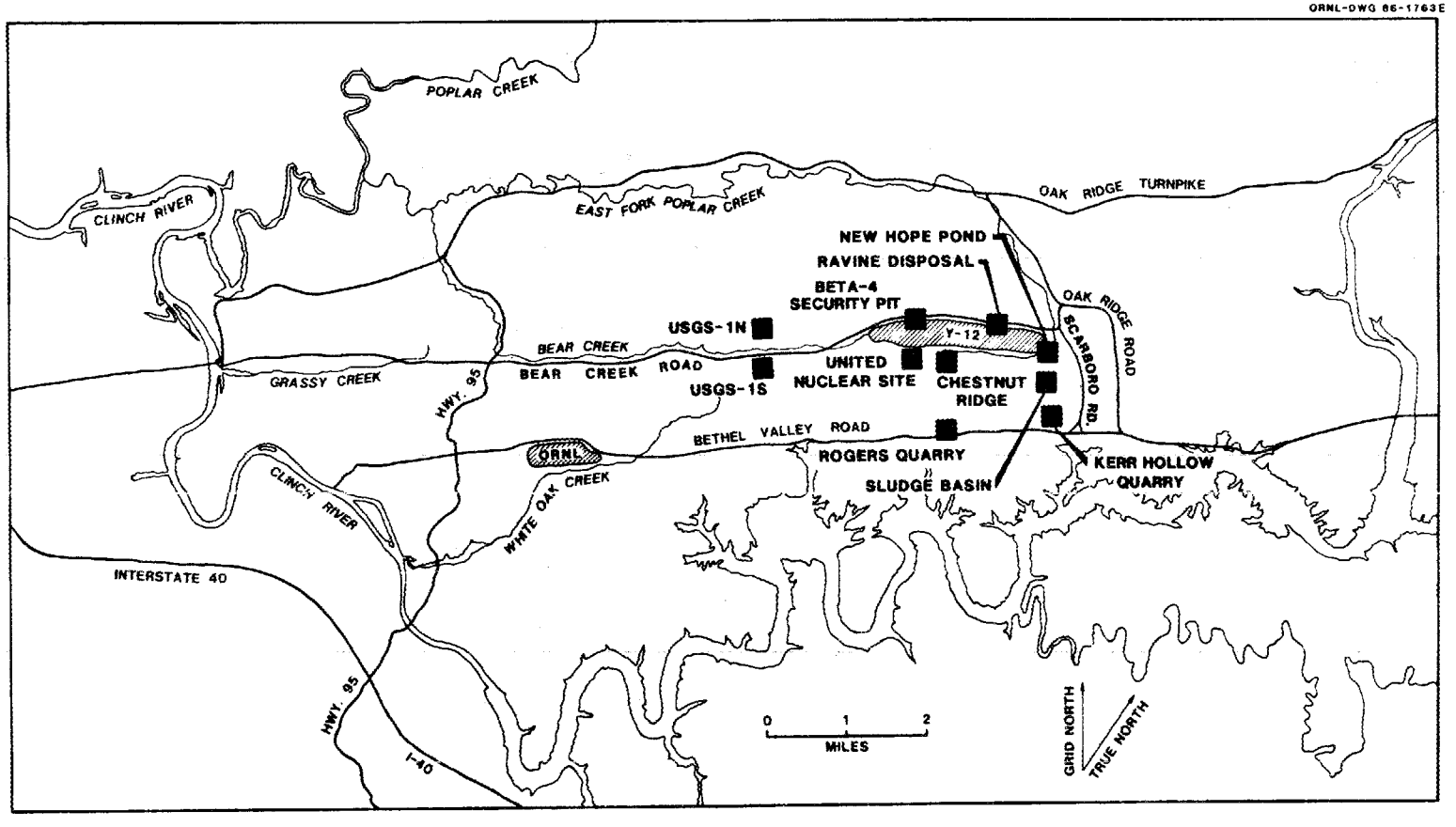

Fig. 1. Index map of U.S. Department of Energy Oak Ridge Reservation illustrating locations of the sites investigated in this study (1 mile = 1.609 km).

identify the major features of subsurface geology and then to install core holes and groundwater investigation wells to study the hydrogeologic significance of such features. The wells were designed to provide data on subsurface geology and on hydrostatic heads and water quality for shallow-flow regimes in soils and upper weathered-bedrock zones and for deeper-flow regimes in the unweathered bedrock.

Drilling at each site progressed in two stages. Initially a core hole or relatively deep borehole was drilled at an up-section location to determine the general components of the subsurface geology. Study of drill core, cuttings, and geophysical logs obtained from this initial borehole allowed geohydrologically significant targets to be identified. Investigatory drilling activity was minimal at sites, such as New Hope Pond, where subsurface geology was reasonably well understood. At sites such as the Kerr Hollow and Rogers quarries, however, investigatory drilling for the first stage was substantial because few data on site subsurface geology were available.

During the second stage of the drilling program, groundwater investigation wells were installed to intersect designated targets. The depths and design of the boreholes fall into two categories, with each one intended to investigate a particular portion of the hydrologic system. Screened groundwater investigation wells were installed to examine geohydrologic conditions in the unconsolidated material above bedrock and in the weathered rock within the uppermost 6 to 15 m (20-50 ft) of bedrock. Such wells range in depth from 9 to 60 m (30-200 ft). Open groundwater investigation wells were installed to determine geohydrologic conditions within the unweathered bedrock and deeper subsurface. Such wells range in depth from 60-120 m (200-400 ft). Targets identified for investigation during the second stage of drilling at a specific site include (1) the top of the water table, (2) the interface between the base of soil and the top of weathered bedrock, (3) the base of weathering in the bedrock, (4) cavity zones near the base of weathering in the top of bedrock, (5) zones of high porosity in the unweathered bedrock, and (6) fractures or fractured zones within the unweathered bedrock.

3. BOREHOLE CONSTRUCTION DETAILS

A general description of borehole construction procedures is provided in this section. For most boreholes, several drill rigs were available, and there were several possible variations in the general construction procedures and materials discussed below.

3.1 Soil Borings and Split-Spoon Sampling

Soil borings were drilled immediately adjacent to permanent groundwater investigation wells at selected localities. These boreholes were

temporary, auger-drilled holes for split-spoon soil sampling. After sampling was completed, soil borings were first back filled with the cuttings obtained from them during drilling and then abandoned. Split-spoon samples were taken at nominal 1.5-m (5-ft) intervals. Soil borings were drilled with Mobile B-53 or B-61 drill rigs using 15- or 20-cm-diam (6- or 8-in.-diam) hollow-stem augers. Soil borings proceeded until auger refusal; depths ranged from 3.5 to 18 m (12-60 ft). In addition to soil borings conducted specifically for sampling, split-spoon sampling was undertaken during augering of boreholes that will be used for the installation of shallow, screened groundwater investigation wells.

Split-spoon sampling within shallow auger holes allows soil from the vadose zone, above the static water table, to be chemically analyzed. Study of such samples provides an opportunity to determine if contaminants have migrated away from disposal areas through this zone at some past time. Additional characterization of the soil samples obtained was not undertaken during this project.

3.2 Core Holes

Core holes drilled during the initial stage of investigation range in depth from 165 to 257 m (540-842 ft). Core drilling was conducted with a Joy 22 drill rig using Christiansen HQ bits, core barrels, and drill rods. The diameter of core recovered is nominally 6 cm (2.4 in.) and the borehole diameter is nominally 9 cm (3.7 in.). The surface conductor for the core holes was 11.5 cm-OD (4.5 in. OD), treaded and coupled steel pipe. The surface conductor was installed in a nominal 18-cm (7-in.-diam.), water-rotary-drilled borehole that extended from ground surface to the top of unweathered bedrock. The conductor was tremie-grouted in place with a Portland Type 1 cement slurry.

A complete geophysical log package was obtained from each core hole. The standard borehole geophysics package consisted of gamma-ray, borehole-compensated density, borehole-compensated neutron porosity, single-point resistance, spontaneous potential, 40- and 163-cm (16- and 64-in.) normal resistivity, temperature, and caliper logs. Borehole-compensated acoustic velocity, sonic variable density, and acoustic borehole televiewer logs were run in addition to the standard log suite in several core holes.

The core holes were left open and uncased below the surface conductor to permit hydrologic testing of deeper subsurface horizons. Such investigations are planned for FY-86 and beyond and will make use of straddle packers and sampling equipment supported by either wireline equipment or a drill rig. At the completion of the hydrologic testing, the packers may be left in place for further long-term data collection or they may be removed, in which case the core hole will be grouted closed.

3.3 Screened Groundwater Investigation Wells

Groundwater investigation wells finished in unconsolidated materials or in the uppermost, weathered portions of bedrock were installed using sand filter packs and spiral-wound screens. Well-screen and casing material was either stainless steel or polyvinyl chloride (PVC), depending on anticipated groundwater chemistry at a particular site. A schematic diagram of a typical screened well is illustrated in Fig. 2.

Screened wells finished in soils and unconsolidated material were installed with a Mobile B53 drill rig. These wells were drilled with a 20-cm-diam (8-in.-diam) hollow-stem auger to total depth, which was generally at the point of auger refusal. Surface conductors were not installed in auger-drilled screened wells. Johnson UOP stainless steel or PVC, 10-cm-ID (4-in.-ID), spiral-wound well screens with 0.025-cm-wide (0.010-in.-wide) slots were installed; screens ranged in length from 1.5 to 6 m (5-20 ft). The casing used in the wells is Johnson UOP flush joint 11.4-cm-OD (4.5-in.-OD stainless steel or Schedule 40 PVC material. Porter-Warner sand blast sand was poured or tremied into the annulus around the screen to form the filter pack. Sufficient sand was placed in the borehole to bring the level of the sand approximately 0.3 to 0.6 m (1-2 ft) above the top of the screen. A layer of bentonite pellets 0.6 to 0.9 m thick (2-3 ft thick) was poured or tremied on top of the sand filter pack into the annulus around the casing to form an upper seal for the filter pack. A Portland Type 1 cement slurry, mixed at the ratio of 5.2 to 5.6 L (5.5-6.0 gal) per sack of solids, was tremied into the annulus around the casing to seal it from the top of the bentonite seal to the ground surface. During installation of the sand filter pack, the bentonite seal, and the grout, the casing was suspended from the drill rig to allow it to be centered in the borehole; centralizers were not used on the auger-drilled screened wells.

Screened wells finished in bedrock were installed with either a Driltech D-25, a Ingersol-Rand R300, or a Ingersol-Rand T5 drill rig. Because of the generally greater depths of these rotary-drilled wells compared to the auger-drilled screened wells, surface conductors were installed that extend through the soil and unconsolidated material to the top of solid bedrock. Depths of surface conductors ranged from 4.6 to 35 m (15-115 ft). The surface conductors were either 27.3 cm-OD (10.75 in.-OD) American Petroleum Institute (API) grade F-25, steel pipe or 26.6 cm-OD (10.5 in. OD) schedule 40 PVC pipe. Surface conductors were installed in nominal 30.4- or 38-cm-diam, air-rotary-drilled boreholes and were tremie-grouted in place with Portland Type 1 cement slurry as described above. After allowing the surface conductor grout to set, the rotary- drilled screened wells were advanced to total depth with a 25.4-cm-diam (10-in.-diam) tricone roller bit (Ingersol-Rand T5) or with a 25.4-cm-diam (10-in.-diam) air-hammer percussion bit (Driltech D-25 and Ingersol-Rand R300). The boreholes were drilled with filtered compressed air, using just enough water [typically 3.8-7.5 L/min (1-2 gpm)] to adequately clear cuttings

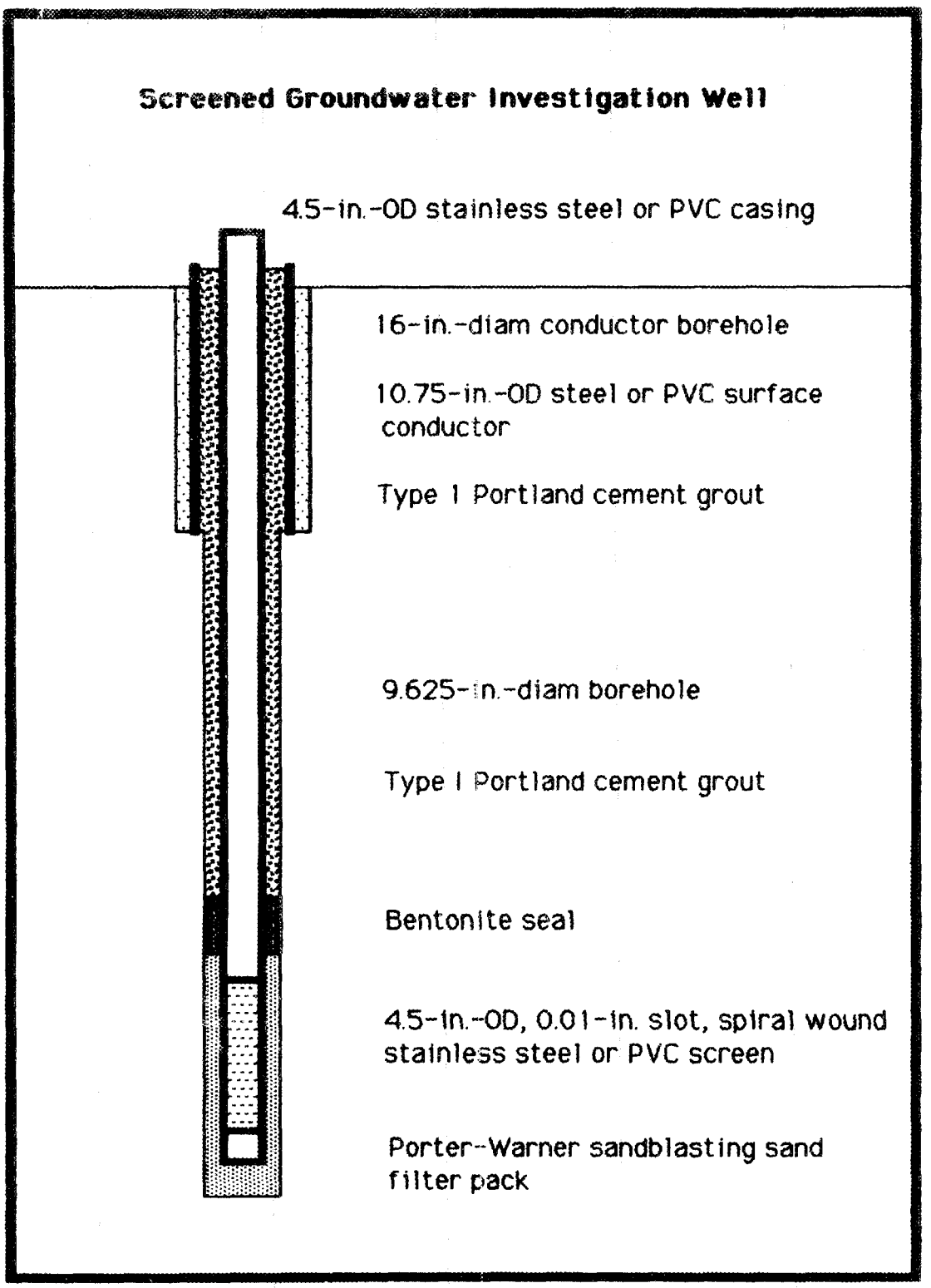

Fig. 2. Schematic diagram illustrating typical construction characteristics of a screened groundwater investigation well (1 in. = 2.54 cm).

from the borehole. NL Industries "Qwik-Foam" was used during drilling to facilitate cuttings removal. Stainless steel or PVC well screens and casing material, as discussed above, were used to complete the rotary-drilled, screened wells. Filter-pack sand and bentonite seal material were poured or tremied into the annulus. During installation of the sand filter pack, the bentonite seal, and the grout, the casing was suspended from the drill rig to allow it to be centered in the borehole; centralizers were used on rotary-drilled screened wells that are in excess of 46 m (150 ft) in depth. When used, centralizers were located at every other casing joint starting with the first joint above the top of the screen. A final centralizer was placed at the top of the casing, near ground level, to center it within the surface conductor.

3.4 Open Groundwater Investigation Wells

Rotary-drilled, open groundwater investigation wells range in depth from 61 to 122 m (200-400 ft). These wells were installed to investigate hydrologic behavior of unweathered portions of the bedrock that were sufficiently competent so that installation of a screen was not required. A schematic diagram for a typical open groundwater investigation well is illustrated in Fig. 3.

Open wells were drilled with a Driltech D-25, a Ingersol-Rand T5, or a Ingersol-Rand R300 drill rig. Surface conductors that extend through the soil and unconsolidated material layer to the top of solid bedrock were installed on all open wells. The surface conductors are either 27.3-cm-OD (10.75-in.-OD), API grade F-25, steel pipe or 26.7-cm-OD (10.5-in.-OD), Schedule 40 PVC pipe. Surface conductors were installed in nominal 38.5-cm-diam (15-in.-diam), air-rotary-drilled boreholes and were tremie-grouted in place with a Portland Type 1 cement slurry as described above. Depths of surface conductors ranged from 3 to 30 m (10-100 ft).

After allowing the surface conductor grout to set, the rotary-drilled, open wells were advanced to target depth for the bottom of the casing with a 25.4-cm-diam tricone roller bit (Ingersol-Rand T5) or a 25.4-cm-diam air-hammer percussion bit (Driltech D-25 and Ingersol-Rand R300). The boreholes were drilled with filtered compressed air, using just enough water [typically 3.8-7.5 L/min (1-2 gpm)] to adequately clear cuttings from the borehole. NL Industries "Qwik-Foam" was used on several boreholes where extreme problems with mud inflow or cuttings removal were encountered. The casing was installed using the draw works on the drill rig. The casing material was 16.8-cm-OD (6.625-in.-OD), API grade F-25, 25 kg/m (17.0 lb/ft) steel-threaded and coupled pipe. Casing joints were tack welded to prevent them from unscrewing during installation. A Halliburton Combination Guide-Float Shoe was installed on the bottom of the casing string and Halliburton S3 centralizers were tack welded at every third casing joint [approximately every 18 m (60 ft)].

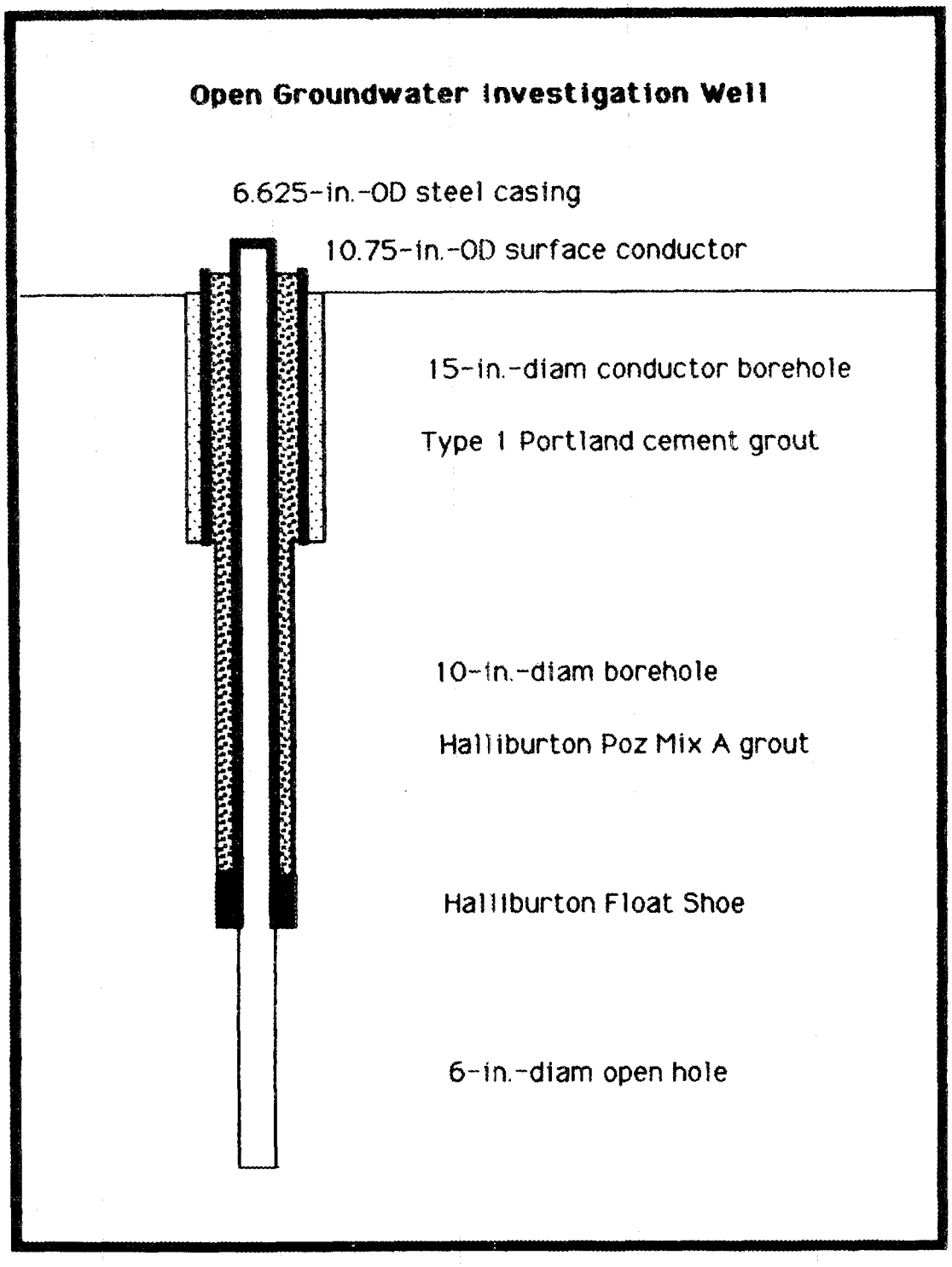

Fig. 3. Schematic diagram illustrating typical construction characteristics of an open groundwater investigation well (1 in. = 2.54 cm).

The casing was pressure grouted in place by Halliburton Well Services. The grout formulation was Halliburton Poz Mix A with 4% bentonite, 2% Halliburton Cal Seal, and 2% calcium chloride as additives. The slurry was mixed with 21 to 23 L (5.5-6.0 gal) of water per sack (0.023 m^3; 1 ft^3) of solids. Grout slurry was circulated until return of grout of the original consistency was observed in the annulus around the casing. The inside of the casing was cleared of grout by pumping down a bottom plug to seat against the float shoe. Water pressure was maintained on the bottom plug until it was determined that the float shoe was holding properly.

Grout around well casings was allowed to set for a minimum of 24 h. After that waiting period, drilling of the open-hole interval in each well began. This interval was drilled with a 15-cm-diam (6-in.-diam) tricone roller bit (Ingersol Rand T5) or a 15-cm-diam air-hammer percussion bit (Driltech D-25 and Ingersol-Rand R300). The open-hole intervals were drilled with filtered compressed air, using just enough water [typically 3.8-7.6 L/min (1-2 gpm)] to adequately clear cuttings from the borehole. NL Industries "Qwik-Foam" was used on several boreholes where extreme problems with cuttings removal were encountered. The open hole intervals were advanced to the total depth and ranged in extent from 1.5 to 21 m.

3.5 Well Development

Well development was accomplished by removing at least seven well volumes of water from the completed well. In high-yield wells (7.6 L/min of water), development pumping was conducted more or less continuously until the required volume of water had been removed and a consistent level of water clarity had been achieved. During the early stages of development, pumping action was oscillated or momentarily stopped so as to surge the well to facilitate removal of drilling fines from the well bore. This process was repeated two to five times in screened wells and two to three times in open wells.

Low yield wells (<7.6 L/min) typically would not produce seven well volumes of water within 6 to 8 h of development time. In this case the well was pumped to dryness and allowed to recover for 24 h, at which time the process was repeated. Depending on the recovery behavior of the well, this procedure was repeated two to five times over a 1-week period.

Well development was done with either an electric submersible pump or a rotary drill rig using the air lift method. For wells up to 76 m (250 ft) in depth, an electric submersible pump was lowered to the bottom of the well on 2.54-cm-OD steel pipe. Wells deeper than 76 m were developed by air lifting water from the bottom of the well using a standard 11.4-cm-diam drill pipe and filtered compressed air from a drill rig.

4. SITES INVESTIGATED

Details of the well installation activities at each of the sites investigated are presented in this section. The discussion briefly summarizes the well-siting strategy for each site and the salient geohydrological observations made during well installation. Specific details of construction for a particular well are contained in Appendix A. Summaries of the geological formation(s) and of the fractures and cavities penetrated by a particular well are presented in Tables 2 and 3.

4.1 Beta-4 Security Pit

4.1.1 Background

The Beta-4 Security Pit site is located on the western edge of the Exclusion Area within the Y-12 complex (Fig. 1). The site was used for disposal of classified material from February 1968 through April 1976. Details of the disposal history and geography of the site are summarized elsewhere (Production Optimization Department/Y-12 Plant, 1984a).

4.1.2 Site Geology

The site is located on soils and residuum developed on the upper to middle portions of the Maryville Limestone of the Conasauga Group. The trace of the upper contact of the Maryville Limestone passes immediately south of the site. Depth to bedrock varies throughout the site, typically ranging from 3 to 4.6 m (10-15 ft). Studies in soils and weathered bedrock developed on the Conasauga Group both in Bear Creek Valley (Sledz and Huff 1981; Rothschild et al. 1984a) and in Melton Valley (Sledz and Huff 1981; Rothschild et al. 1984b) indicate that joints and fractures can exhibit a strong control on groundwater flow direction. At the Beta-4 Security Pit site, major joint directions are parallel and perpendicular to geologic strike, which parallels the ridge crests. It is anticipated, therefore, that groundwater movement at the site would be greatest in directions parallel and perpendicular to the ridge crests.

4.1.3 Drilling Summary

Locations of groundwater investigation wells installed at the Beta-4 Security Pit locality are illustrated in Fig 4. A total of eight borings were made at this locality. Borings SB-192 and SB-195 are auger/split-spoon soil borings obtained to provide samples of unconsolidated material for chemical analysis. These borings are not illustrated on Fig. 4 but are immediately adjacent to groundwater investigation wells with the same designation. At the completion of sampling, the soil borings were backfilled with cuttings and material obtained during the drilling process.

Table 2. Borehole geology summary

Name	Rock formations(s) and downhole footages[a]
CH-143	CHICK: A 0-177/KNOX 177-td
CH-157	KNOX
CH-185	CHICK: E 0-123/D 123-183/C 183-379/B 379-680/A 680-td
CH-189	CHICK: B 0-268/A 268-578/KNOX 578-td
GW-142	CHICK: A 0-220/KNOX 220-td
GW-143	CHICK: A 0-177/KNOX 177-td
GW-144	CHICK: A 0-177/KNOX 177-td
GW-145	KNOX
GW-146	KNOX
GW-147	KNOX
GW-148	CON: Maynardville
GW-149	CON: Maynardville
GW-150	CON: Maynardville
GW-151	CON: Maynardville
GW-152	CON: Maynardville
GW-153	CON: Maynardville
GW-154	CON: Maynardville
GW-155	KNOX
GW-156	KNOX
GW-157	KNOX
GW-158	KNOX
GW-159	KNOX
GW-162	CON: Pumpkin Valley
GW-163	CON: Pumpkin Valley 0-204/ROME 204-td
GW-164	CON: Pumpkin Valley 0-197/ROME 197-td
GW-165	KNOX
GW-166	KNOX
GW-173	KNOX
GW-174	KNOX
GW-176	KNOX
GW-177	KNOX
GW-179	KNOX
GW-184	CHICK: C
GW-185	CHICK: B
GW-186	CHICK: C
GW-187	CHICK: E
GW-188	CHICK: D
GW-189	CHICK: C
GW-191	CON: Maryville
GW-192	CON: Maryville
GW-194	CON: Maryville
GW-195	CON: Maryville
GW-196	CON: Maryville
GW-197	CON: Maryville
GW-198	CON: Rutledge
GW-199	CON: Rogersville
GW-200	CON: Rogersville
GW-201	CON: Rogersville
GW-202	CON: Rutledge
GW-203	KNOX
GW-205	KNOX
GW-220	CON: Maynardville
GW-221	KNOX
GW-222	CON: Maynardville
GW-223	CON: Maynardville
GW-224	CHICK: E
GW-231	KNOX
GW-240	CON: Maynardville
GW-241	KNOX

[a]A, B, C, D, and E - units of the Chickamauga Group as defined by Stockdale (1951); CHICK - Chickamauga Group; CON - Conasauga Group; KNOX - Knox Group; ROME - Rome Formation; td - total depth.

Table 3. Summary of major fractures and solution cavities encountered during drilling operations

Name	Fracture or solution cavity, depth, and approximate water yield[a]
GW-144	Frac @ 170 (W, 20-30 gpm[b])
GW-147	Frac @10-12.5(w), 19(w), 20-21(w), 24-25, 32.5-33(M), 46.5 to 47.5(W), 59.5 to 60.5
GW-149	Water @ 4.0 / (W) @ 25-28
GW-151	Frac @ 26(w)
GW-153	Frac @ 29-30
GW-154	Water @ 5.0
GW-155	Frac @ 130-136, 165-177(mW)
GW-156	Cav @ 92-93, 101-103, 106-112 / Frac @ 150
GW-157	Water @ 74 / Frac @ 114-116.5, 140(w)
GW-158	Frac @ 98(foam), 180(W, sul), 220-230, 250-260(mW, >25 gpm).
GW-159	Cav @ 112-117 / Water @ 130
GW-162	Water @ 118
GW-164	Frac @ 150(w), 197(w), 280, 392(w)
GW-165	Cav @ 103-113, 314-317(mW, >100 gpm) / Frac @ 92-96, 100-102
GW-166	Frac @ 287-290, 320-323, 358-363(W, >300 gpm)
GW-173	Frac @ 103.6 / Cav @ 108.9, 140-141
GW-174	Frac @ 143 / Cav @ 63-79.6, 91, 140
GW-177	Cav @ 68-73, 96-97.5 / Frac @ 130-133
GW-179	Cav @ 53-73 / Frac @ 112
GW-184	Frac @ 115(w), 126-130(w)
GW-185	Frac @ 73(W, 20-30 gpm), 170(w), 366(W, gas)
GW-186	Frac @ 25(w), 164-169(W)
GW-187	Frac @ 92(w), 115-121(w), 134-135(W, >25 gpm), 159-160(W, >25 gpm)
GW-188	Cav(mW) @ 27-29 / Frac @ 47-48, 55-58.5, 60-68. Lost circulation @ 60-68
GW-189	Frac @ 44(w), 143-145(W), 164-165(W), 170(W), 200(W)
GW-198	Water @ 22
GW-199	Water @ 18
GW-200	Frac @ 52(w)
GW-201	Water @ 21
GW-202	Water @ 17
GW-220	Water @ 11.0
GW-221	Frac @ 36-80, 153
GW-222	Fractured zone-cavity @ 19.0
GW-223	Cav(M) @ 57-59 / Frac @ 17-18, 27.5-29, 34-34.5, 36-36.5, 37-37.5, 38-39, 66-67, 68.5-69.5
GW-224	Frac @ 115-120(W, sul)
GW-231	Frac @ 15-16.5, 17-17.5(w), 19-20.5(w), 23-24, 25-27, 28-29
GW-240	Frac @ 29 to 30
GW-241	Cav @ 78-89 / Frac @ 89-94.6

[a]Cav - cavity; Frac - fracture or fracture interval; Water - depth at which the water table was encountered, not necessarily associated with a fracture or cavity; (M) - mud, or thick, extremely muddy water; (mW) - muddy water; (sul) - sulferous smell to water; (w) - small flow of water <5 gpm; (W) - large flow of water, >5 gpm. Yields cited are based on drillers estimates of surface discharge during drilling.

[b]1 gpm = 3.7 L/min.

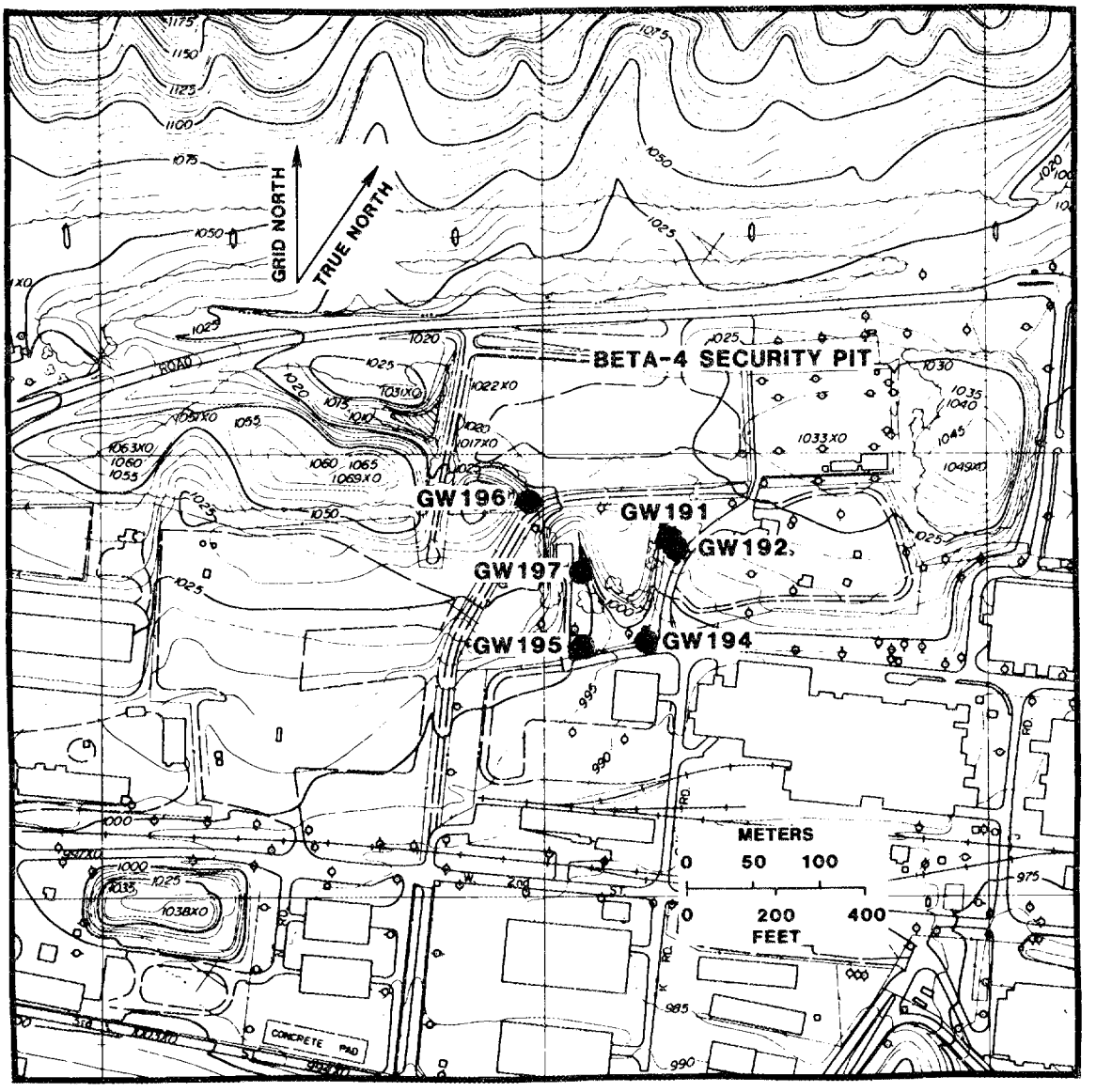

Fig. 4. Topographic map of the Beta-4 Security Pit locality. Locations of groundwater investigation wells are indicated by solid circles. Contour lines are in feet (1 ft = 0.3048 cm).

Wells GW-191, GW-194, GW-195, GW-196, and GW-197 are shallow, screened, auger-drilled boreholes that extend into the top of the water table at the approximate top of weathered bedrock. Well GW-192 extends into the unweathered bedrock zone and is paired with well GW-191 to form a piezometer cluster to investigate the vertical component of groundwater flow at the site.

Well GW-196 has the highest elevation and should serve as an up-gradient, background well for the site. Wells GW-197, GW-191, and GW-192 are approximately along strike from the site to the west and to the east, respectively, and will allow potential strike-parallel movement of material away from the site to be investigated. Wells GW-195 and GW-194 are south of the site and serve to monitor potential movement of contaminants from the site in a direction perpendicular to strike.

4.2 Chestnut Ridge Security Pit

4.2.1 Background

The Chestnut Ridge Security Pit is located on the crest of Chestnut Ridge immediately south of the central portion of the Y-12 complex (Fig. 1). Disposal of classified materials at the site is conducted in trenchs and auger holes. Details of disposal operations and general inventories of materials disposed of are summarized elsewhere (Production Optimization Department/Y-12 plant, 1984b). Before the drilling operations summarized in this report, one groundwater monitoring well, No. 1080, had been installed at the site.

4.2.2 Site Geology

The security pit is located in soil and residuum developed on top of the stratigraphically lowermost portion of the Copper Ridge Dolomite, which is the basal formation in the Knox Group. The soil and residuum locally contain abundant chert and rubble-rich horizons that occur at the top of bedrock and are dispersed irregularly throughout the soil column. Depth to bedrock at the site varies from 15 to 27 m (50-90 ft).

Available information on site hydrology was summarized by Geraghty and Miller (1985b). In general, the hydrology of the Knox Group at the site is not well understood. Groundwater flow directions in the shallow subsurface (61 m) have not been determined but are probably generally controlled by a groundwater divide that runs along the crest of Chestnut Ridge in the vicinity of the security pits. The location of the groundwater divide would influence whether water from the site would flow northward into the Bear Creek watershed or southward toward watersheds in Bethel Valley. Work by Ketelle and Huff (1984) elsewhere along Chestnut Ridge indicates that joints, fractures, and solutional features developed within the upper bedrock can exert substantial local influence on groundwater flow directions. Analysis of joint and

fracture patterns suggests that preferred groundwater flow directions within the upper bedrock are parallel and perpendicular to the ridge crest (Law Engineering, 1983b).

4.2.3 Drilling Summary

Initial plans for monitoring well installation at the Chestnut Ridge Security Pit site were developed by Geraghty and Miller (1985b). Because of the complexity of site hydrology discussed above, the original well installation plans were modified during the present drilling program to more completely address the hydrologic issues discussed above. Locations of the five groundwater investigation wells completed at this site are shown in Fig. 5.

A total of 12 borings were made at this locality. Borings SB-173, SB-174, SB-176, SB-177, and SB-179 are auger/split-spoon soil borings obtained to provide samples of unconsolidated material for chemical analysis. These borings are not illustrated in Fig. 5 but are immediately adjacent to groundwater investigation wells with the same designation. Two additional soil borings (SB-178 and SB-180), not associated with groundwater investigation wells, were also completed. They are located immediately adjacent to the northwest and northeast corners of the disposal area illustrated in Fig. 5. All soil borings at the Chestnut Ridge Security Pit site are nominally 18.3 m deep and were augered to refusal. In all cases, the soil borings bottomed in zones of chert gravel dispersed within the soil and did not reach to the top of bedrock (as determined by subsequent drilling of groundwater observation wells). Split-spoon samples were taken during the augering at 1.5-m intervals for chemical study.

Wells GW-173, GW-174, GW-176, GW-177, and GW-179 are screened and finished in the top of bedrock. The objective of these wells was to monitor groundwater occurring at the top of the water table, which typically corresponds to the soil/bedrock interface. During the installation of the surface conductor for these wells, zones of cavity formation and solutional alteration were encountered within 3 to 7.6 m (10-25 ft) of the top of bedrock. The vertical extent of such cavities ranged from 0.3 to 5 m (1-17 ft). In all cases, the surface conductor was advanced 0.3 to 1.5 m (5 ft) past the bottom of the first significant cavity encountered below the top of bedrock. Such a practice prevents potential intercavity migration of surface waters.

Wells GW-177 and GW-173 were installed to the west and to the east of the active and proposed burial areas to monitor possible migration along strike of material from the disposal area. Furthermore, well GW-177 occupies the highest topographic location and should serve as an up-gradient well for the site. Wells GW-176 and GW-174, in conjunction with existing well 1080, were placed south of the active site to monitor potential movement of material away from the site in a direction perpendicular to strike. Similarly, well GW-179 was installed north of the active disposal area to monitor potential

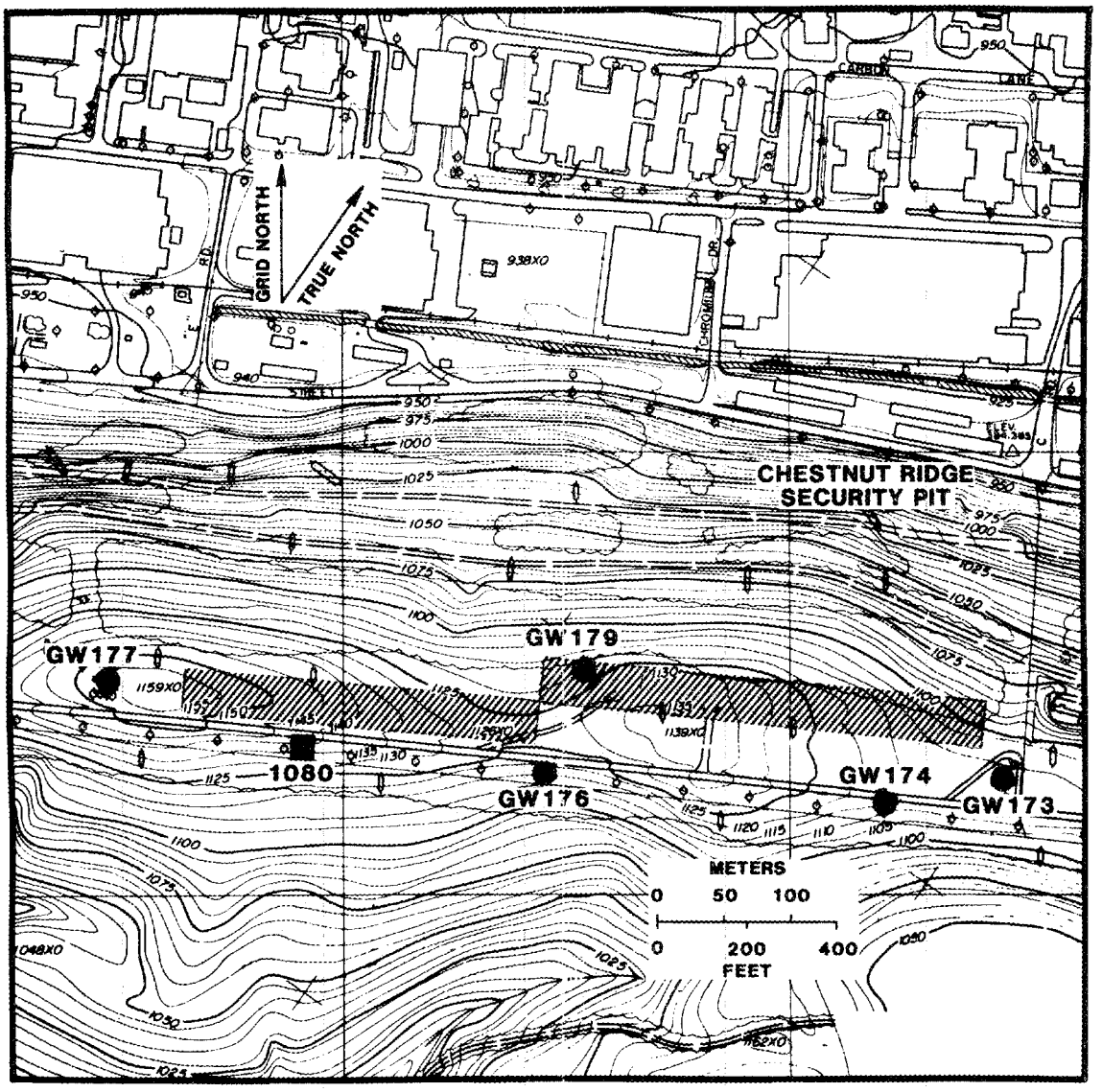

Fig. 5. Topographic map of the Chestnut Ridge Security Pit locality. Locations of groundwater investigation wells are indicated by solid circles. Solid square indicator position of existing, groundwater monitoring well. Contour lines are in feet (1 ft = 0.3.048 cm).

movement of material perpendicular to strike northward. Analysis and comparison of hydrologic data from these wells should permit identification of the groundwater divide and resolution of its significance to groundwater flow behavior at the site.

4.3 Kerr Hollow Quarry

4.3.1 Background

Kerr Hollow Quarry is located on a low ridge running along the north side of Bethel Valley (Fig. 1). The quarry was active in the 1940s and was abandoned sometime in the late 1940s. Since the early 1950s, the quarry has been used for the disposal of reactive materials from the Y-12 Plant and from Oak Ridge National Laboratory. Generalized details of the material disposed of and disposal operations conducted at the quarry were presented by Geraghty and Miller (1985d).

4.3.2 Site Geology

Kerr Hollow Quarry is located at the contact between the Newala Formation of the Knox Dolomite and Unit A of the Chickamauga Group.[1]

At the site, the contact is an unconformity and exhibits approximately 15 to 30 m of topographic relief. The uppermost Knox Group at this site consists of medium-bedded to massive dolostone with locally abundant nodular to bedded chert occurring throughout. The basal portion of the Chickamauga Group consists of abundant thin- to medium-bedded maroon and gray siltstones and thin-bedded limestones and less-abundant-to-rare, nodular-to-bedded chert. A schematic cross section of the quarry site is presented in Fig. 6. As with other strata in the Oak Ridge vicinity, both the upper Knox Group and the basal Chickamauga Group are pervasively jointed, with predominant joint directions being parallel and perpendicular to geological strike, which is approximately parallel to the ridge crests. In the vicinity of Kerr Hollow Quarry, an additional joint set that trends approximately north-south is also noted (Law Engineering, 1983b).

Porosity and density geophysical logs from the site suggest that most of the strata are "tight," with low porosity (0 to 5%) and, by inference, low permeability. Examination of drill cores demonstrates, however, that significant, major fractures and fractured intervals occur throughout the bedrock to depths of 183 m (600 ft). Furthermore, such fractured zones generally correspond to pronounced anomalies on the single point resistance and spontaneous potential geophysical logs. Taken together, the drill core and geophysical log data suggest there are thin [0.3-0.9 m (<1-3 ft)], relatively permeable,

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[1]Stockdale (1951) divided the Chickamauga Group into eight units, A through H, based on rock type and bedding patterns; Unit A is the lowermost unit.

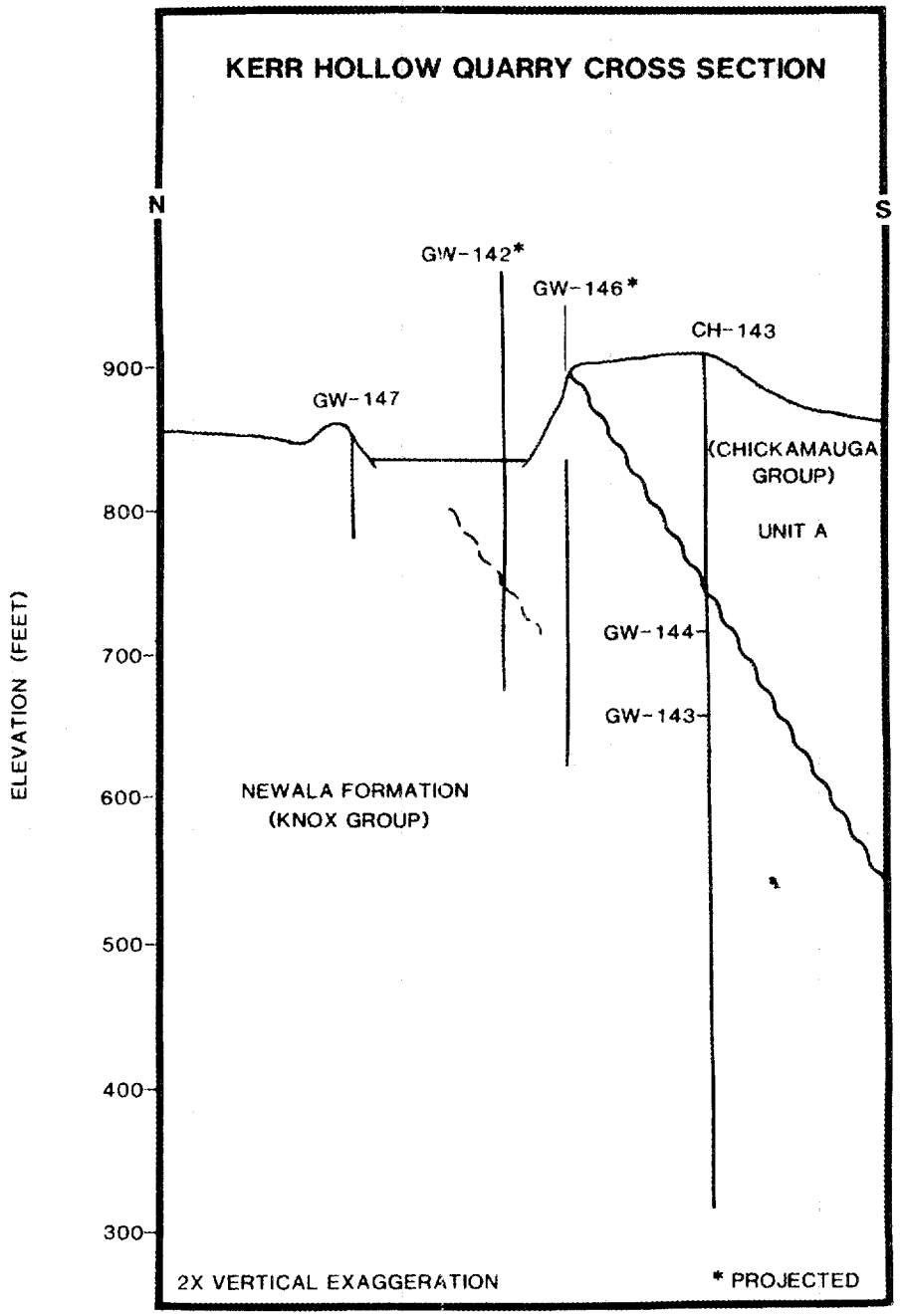

Fig. 6. Schematic cross section of Kerr Hollow Quarry locality. The line of section is from north to south, along the E 63,500 grid line. Asterisks denote boreholes that have been projected on to the line of the cross section. Wavy lines indicate the unconformity between the Chickamauga and Knox groups. Note the relief on the unconformity suggested by the two intersections illustrated. Vertical exaggeration is 2X; 1 ft = 0.3048 m.

water-bearing zones associated with most fractured zones occurring throughout the bedrock (Haase and King, in press). It appears highly probable, therefore, that groundwater movement within the bedrock occurs principally within fractures and fracture systems and not pervasively within any one stratigraphic unit. To understand the hydrologic behavior in the vicinity of the quarry it is necessary to understand the spacing, density, and orientations of fracture systems.

4.3.3 Drilling Summary

Initial plans for monitoring well installations at the Kerr Hollow Quarry site were presented by Geraghty and Miller (1985d). The original well installation plans were modified during the present drilling program to allow more complete characterization of subsurface geohydrologic conditions and to intercept hydrologic targets identified during the initial core-drilling stage of the investigation. Locations of the eight borings conducted at this site are illustrated in Fig. 7.

Boring CH-143 is a 183-m-deep core hole that was collared in the lower portion of Unit A of the Chickamauga Group. The core hole penetrated the contact with the Newala Dolomite of the Knox Group and continued approximately 122 m into the Newala. Core hole CH-143 provides a detailed map of the stratigraphy and structural character of the strata surrounding Kerr Hollow Quarry that was used to select target depths for the other groundwater observation wells at the site (Fig. 6). Because of the hydrologic importance of fractures and fractured zones, much of the drilling was aimed at such features. Because of their spacing and frequency, however, wells in this initial stage of investigation were finished to study several closely spaced fractures or groups of fractured zones. Depending on the results of chemical analysis and hydrologic data, additional wells, finished to specific fractures, may be required. Further details of the geological and geophysical data from core hole CH-143 and their interpretation will be presented elsewhere (Haase and King, in preparation).

Well GW-142 is an open well that has the highest topographic elevation. It was installed as a potential up-gradient, background well completed in unweathered bedrock. During the drilling of GW-142, only trace quantities of water were encountered in the bedrock down to depths of 61 m (200 ft). Casing was installed to a depth of 76 m (248.5 ft), after several water-bearing fractured intervals had been encountered. Subsequent drilling of the open hole portion of the well below 76 m indicates that the strata remained relatively tight and contain only small quantities of water also associated with fractured zones.

Wells GW-143 and GW-144 form a piezometer cluster designed to investigate potential hydrostatic head differences between the uppermost Knox Group and lowermost Chickamauga Group. Both wells are finished in bedrock and are screened. These wells also intersect the downdip projection of all strata that crop out in the quarry and will

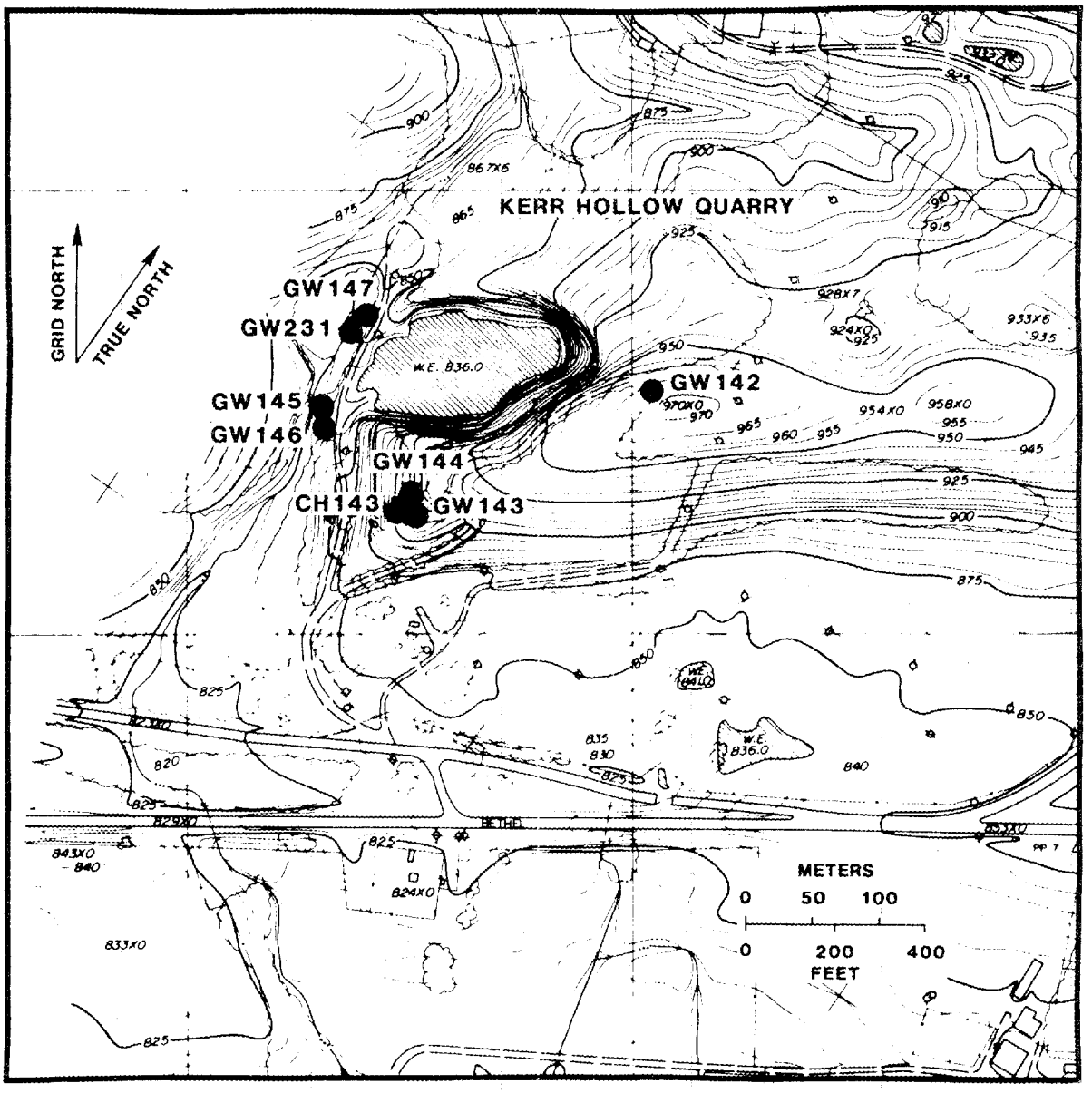

Fig. 7. Topographic map of the Kerr Hollow Quarry locality. Locations of groundwater investigation wells are indicated by solid circles. Contour lines are in feet (1 ft = 0.3048 m).

serve to monitor potential downdip migration of material out of the quarry. Both wells intersect several apparent bedding-plane-parallel fracture systems that occur within the stratigraphic interval of interest.

Wells GW-145 and GW-146 and wells GW-147 and GW-231 form two piezometer clusters along the western edge of the quarry. These wells are designed to investigate potential head differences between various stratigraphic units cropping out within the quarry and to monitor for potential strike-parallel movement of material out of the quarry. Well GW-146 is an open well finished in unweathered bedrock. Wells GW-145, GW-147, and GW-231 are screened wells finished in unweathered bedrock.

4.4 New Hope Pond

4.4.1 Background

New Hope Pond is located on the east end of the Y-12 complex (Fig. 1). It is a man-made impoundment on the East Fork of Poplar Creek. The pond serves as a settling basin for creek waters before being discharged into the natural channel and flowing off Y-12 property.

4.4.2 Site Geology

The New Hope Pond site is located on soils and residuum developed on the Maynardville Limestone of the Conasauga Group. The trace of the contact between the Maynardville Limestone and the underlying Nolichucky Shale roughly coincides with the Y-12 access road (Second Street) that passes immediately north of the pond. Depth to bedrock ranges from 3 to 4.6 m (10 to 15 ft) throughout the site. As is typical of the Conasauga Group, joints and fractures may have significant influence on groundwater flow directions. Principal joint directions at the New Hope Pond site are parallel and perpendicular to geological strike, and it is anticipated that those orientations would be preferred groundwater flow directions. At other sites, approximately 610 to 1219 m (2000 to 4000 ft) east of New Hope Pond, the Maynardville Limestone has been demonstrated to exhibit solution cavities and other solutional alteration features (Rothschild et al. 1984a). Such features can profoundly influence groundwater movement, although the impact of such features cannot be predicted as easily as that of regionally systematic joints and fractures. Although several fracture zones within the Maynardville Limestone were encountered during drilling at this site, only one significant solution cavity was encountered (in well GW-153).

4.4.3 Drilling Summary

To characterize the geohydrological setting of the New Hope Pond site, 11 borings were completed (Fig. 8). An initial plan for monitor well installation was presented by Geraghty and Miller (1985b), and the

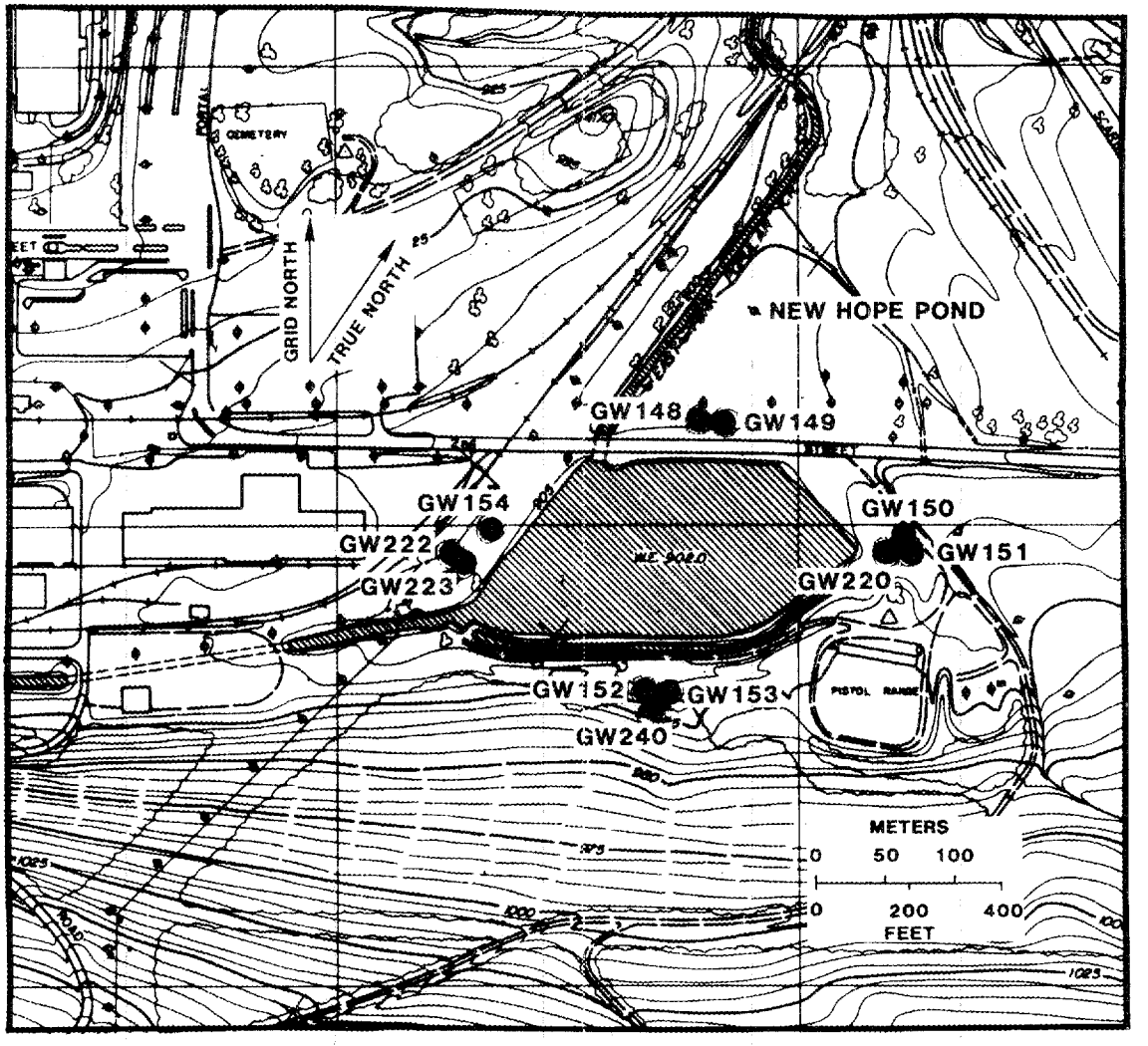

Fig. 8. Topographic map of the New Hope Pond locality. Locations of groundwater investigation wells are indicated by solid circles. Contour lines are in feet (1 ft = 0.3048 m).

present drilling program is basically an implementation of their plan, with the addition of several borings to more completely investigate site hydrology.

All groundwater investigation wells at the New Hope Pond site are screened. They were installed in piezometer clusters such that data on both lateral and vertical groundwater flow components could be obtained. Two clusters, one to the east and one to the west of the pond, were installed to monitor potential strike-parallel groundwater movement.

To the east, well GW-150 is finished in the unconsolidated soil and residuum developed on the Maynardville Limestone. Well GW-220 is completed in the lower Maynardville Limestone to a depth of 14 m (45.2 ft) and well GW-151 is completed in the basal Maynardville Limestone, in a transition zone characterized by alternating layers of shale and limestone, to a depth of 29.4 m (96.5 ft). To the west, well GW-154 is finished in the unconsolidated residuum. Well GW-222 is finished in the lower Maynardville Limestone to a depth of 7.6 m (25.0 ft) and well GW-223 is finished in the shale/limestone transition zone at the base of the Maynardville Limestone to a depth of 27.6 m (90.5 ft).

To the north of the site, well GW-148 is complete to a total depth of 3.4 m (11.1 ft) in residuum developed at the contact between the Maynardville Limestone and the Nolichucky Shale. Well GW-149 is finished in the basal Maynardville Limestone to a depth of 15.4 m (50.5 ft).

The wells in the cluster at the south site of the site are topographically the highest, and the shallowest well in the cluster (GW-152) should serve as up-gradient well, at least for flow in the unconsolidated zone. Well GW-152 is completed in Maynardville Limestone residuum to a depth of 5.3 m (17.3 ft). Wells GW-153, completed to a depth of 18.3 m (60 ft), and GW-240, completed to a depth of 9 m (29.5 ft), are both finished in the upper Maynardville Limestone.

4.5 Ravine Disposal Site (Building 9712)

4.5.1 Background

The Ravine Disposal Site is located immediately north of the Y-12 garage (Building 9712), inside the Y-12 perimeter fence that runs along the south side of Bear Creek Road (Fig. 1). The history of disposal of material at this site is poorly known, but it appears to comprise a substantial amount of wood, construction debris, and dirt. Lesser amounts of metal scrap and possibly some uranium-contaminated material were also disposed of at the site before the mid-1950s. Available data for the Ravine Disposal Site are summarized elsewhere (Production Optimization Department/Y-12, 1984c).

4.5.2 Site Geology

The Ravine Disposal Site is located on soils and residuum developed on the Rogersville Shale and Rutledge Limestone formations of the Conasauga Group. The trace of the contact between these formations runs approximately east to west and bisects the site. The trace of the contact between the Rogersville Shale and the Maryville Limestone runs along the south edge of the site. Depth to bedrock varies throughout the site, typically ranging from 3 to 4.5 m (10 to 15 ft). As with other formations in the Conasauga Group, the Rogersville Shale and Rutledge Limestone are pervasively jointed, with the principal joint directions being parallel and perpendicular to geological strike. It is suspect that such joints and fractures at the Ravine Disposal Site strongly control groundwater flow direction.

4.5.3 Drilling Summary

To investigate geohydrologic conditions at the Ravine Disposal Site, five groundwater investigation wells were installed (Fig. 9). Based on topographic considerations, groundwater should move from northwest to southeast. The effect of the original ravine should be that of a west-to-east conduit within the unconsolidated and fill material, and thus the presence of the ravine, even though it is filled in, will have a significant influence on groundwater movement.

Wells GW-198 and GW-199 straddle the original ravine on the north and south side respectively. Both wells are screened and are completed in the unconsolidated soils and residuum to depths of 8.1 and 6.9 m (26.5 and 22.5 ft), respectively. These wells should monitor hydrologic conditions within the original ravine and detect potential strike-parallel transport of material from the ravine fill.

Well GW-202 is a screened well drilled to a depth of 6.1 m (20.1 ft). It is finished in the unconsolidated soils and residuum developed on the Rutledge Limestone. This well is at the highest topographic elevation of the wells at the site and should serve as a background or up-gradient well.

Wells GW-200 and GW-201 are screened wells that form a piezometer cluster to investigate the vertical flow component for groundwater movement at the site. Well GW-200 is finished to a depth of 17.5 m (57.5 ft) in bedrock at the contact between the Maryville Limestone and Rogersville Shale, and Well GW-200 is finished to a depth of 6.4 m in residuum developed above the contact zone.

4.6 Rogers Quarry

4.6.1 Background

Rogers Quarry is located along Bethel Valley Road, approximately 4.8 km west of Kerr Hollow Quarry and 8 km east of Oak Ridge National

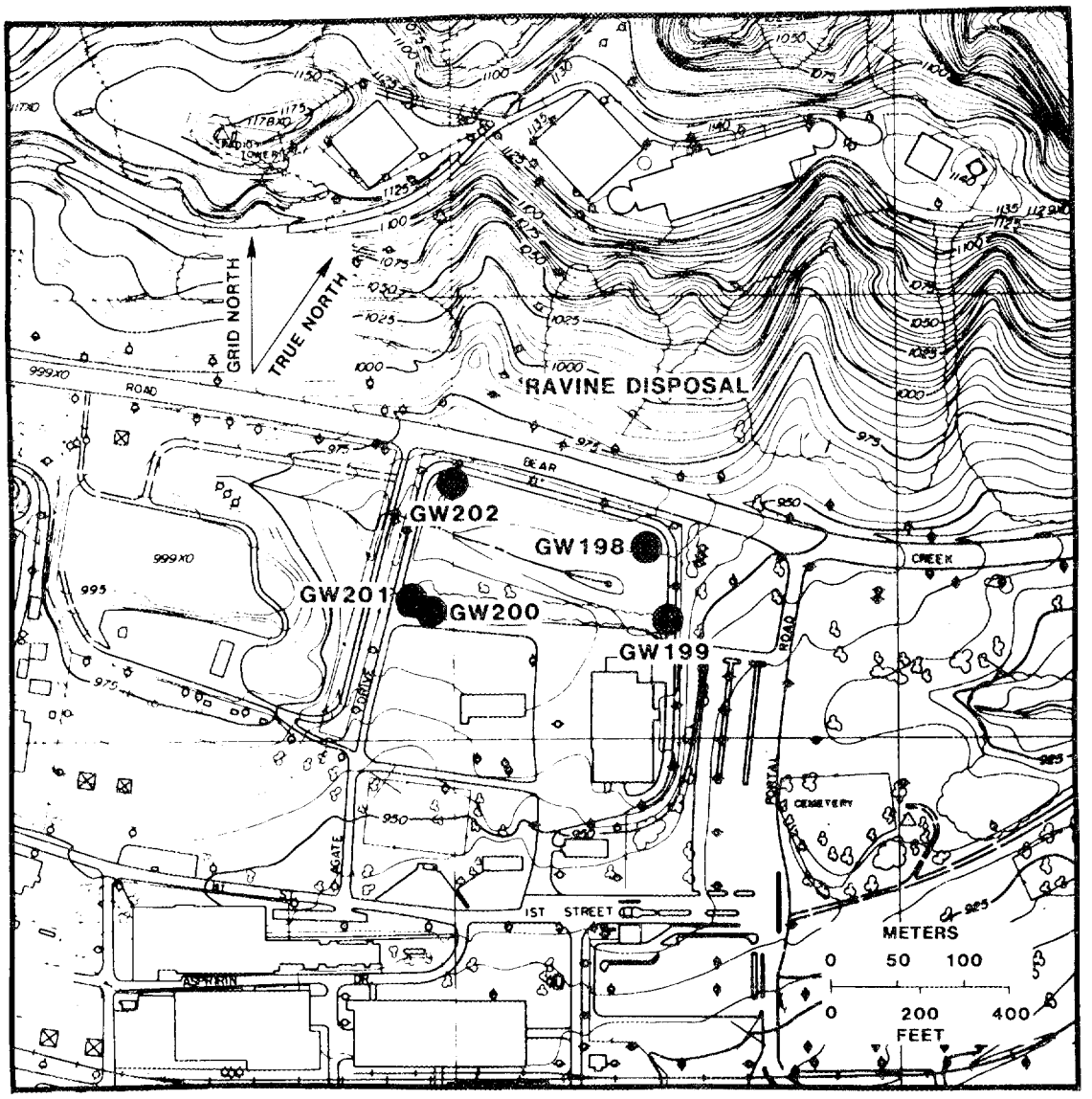

Fig. 9. Topographic map of the Ravine Disposal (Bldg. 9712) locality. Locations of groundwater investigation wells are indicated by solid circles. Contour lines are in feet (1 ft = 0.3048 m).

Laboratory (Fig. 1). The quarry is approximately 915 m (3000 ft) south of the Y-12 complex and is located on a line of low hills running along the north side of Bethel Valley at the southern edge of Chestnut Ridge. The quarry was a source of construction materials in the 1940s through the late 1950s. It was abandoned in the early 1960's and has subsequently been used for disposal of a variety of materials from the Y-12 Plant. It currently receives fly ash slurry from the Y-12 Steam Plant. Background details and a summary of disposal operations are presented elsewhere (Production Optimization Department/Y-12 Plant, 1984d).

4.6.2 Site Geology

Rogers Quarry is situated in the lower portion of the Chickamauga Group. A schematic cross section is presented in Fig. 10. The footwall (bottom) of the quarry is the uppermost portion of Unit B of the Chickamauga Group. Unit B consists of interbedded red to reddish-gray calcareous siltstones. The unit is variable in character and thickness throughout the Oak Ridge vicinity; at the quarry it is approximately 62 m (220 ft) thick but only the uppermost 15 to 30 m (50-100 ft) are exposed in the quarry proper. Within the quarry this upper portion is predominantly siltstone. The hanging wall (top) of the quarry is Unit D and the lowermost portion is Unit E of the Chickamauga Group. Units D and E consist of interbedded gray calcareous siltstones, wavy to evenly bedded limestones, and thinly bedded cherts. All of Unit D [13 m (42 ft)] and approximately 15 to 30 m (100 to 150 ft) of Unit E are exposed at the quarry. The pay zone of the quarry consists of Unit C of the Chickamauga Group. This unit is a medium to light gray, pure, evenly bedded limestone. The limestone is medium- to fine-grained and, in several intervals, approaches lithographic limestone in quality and uniformity. Unit C is approximately 45 m (150 ft) thick and is 100% exposed at the quarry.

Depths to bedrock at the quarry, away from the workings, vary from 3 to 9 m (10 to 30 ft). The contact between overburden and bedrock appears to be sharp, occurring within a few meters. All strata at Rogers Quarry have a uniform dip to the southeast of 35 to 45. Large-scale (several meters or more) folds or faults appear to be rare. On a small scale (less than several meters), however, the strata exhibit joints and fractures with the density and lateral continuity of such features varying from bed to bed. Most fractures appear to be filled with secondary calcite mineralization, although open fractures occur throughout the strata at the quarry. Thin [<0.3 to 6 m (<1 to 20 ft)] chert-rich intervals typically have the highest fracture density, followed by thin limestone-rich intervals. Siltstones typically exhibit the lowest fracture density. There are, however, numerous exceptions to the preceding generalization, and the analysis of fracture-joint patterns at the quarry will be a complex task. The limestone-rich portions of all units locally exhibit solutionally widened bedding surfaces and fractures. Such zones range from <0.3 to 1.5 m in thickness. No discrete solution cavities were noted.

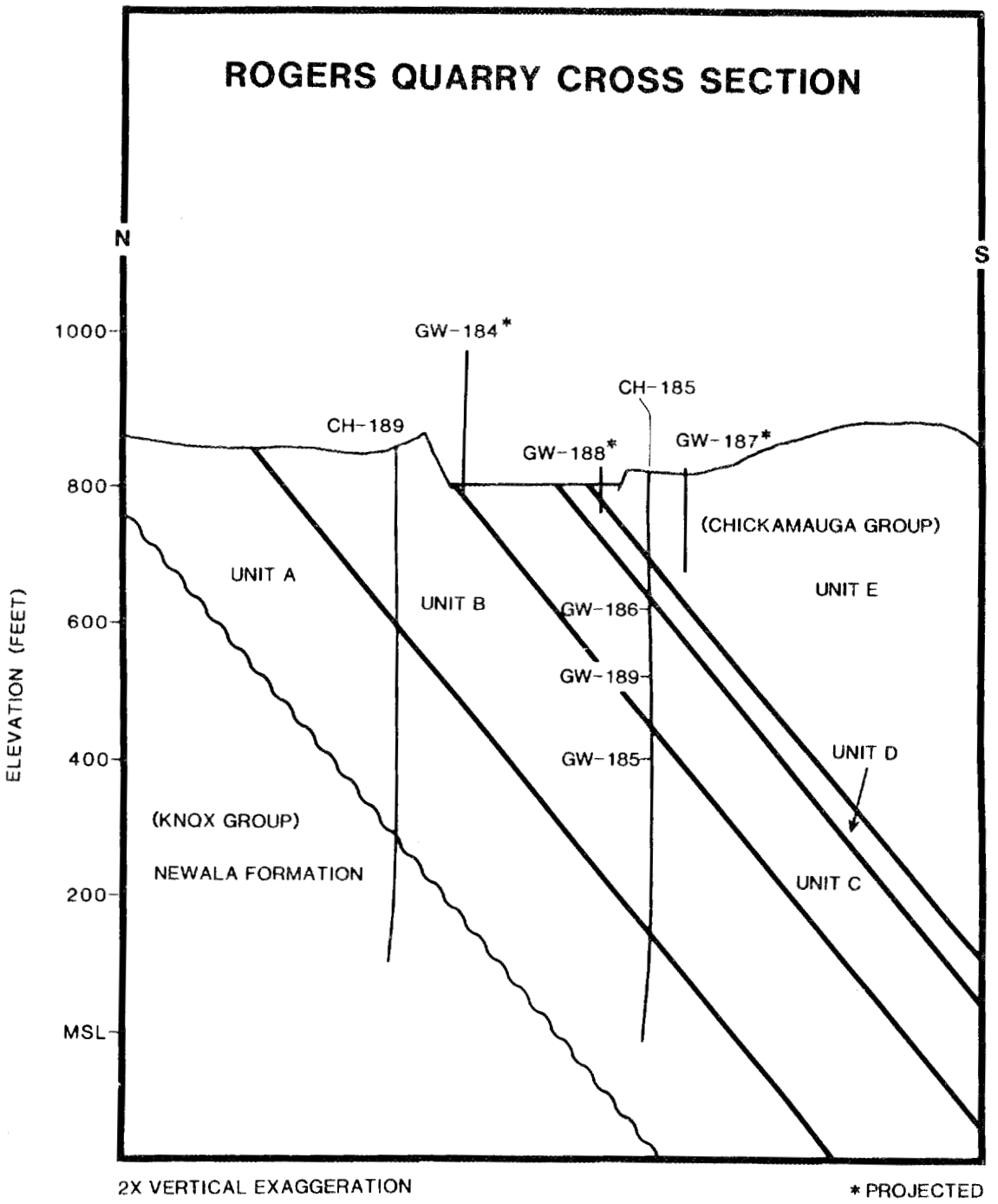

Fig. 10. Schematic cross section of Rogers Quarry locality. The line of section is from north to south, along the E 60,000 grid line. Asterisks denote boreholes that have been projected on to the line of the cross section. Vertical exaggeration is 2X; 1 ft = 0.3048 m.

Several fracture zones within Unit C contained petroleum shows. Typically, fractures were noted that were partially filled with residual "dead" crude oil. However, in several occurrences [e.g., at 62 m (204 ft) in CH-185], fractures partially saturated with volatile, free crude oil were noted. Most petroleum-bearing fracture zones were also associated with minor natural gas shows.

Little is known about the subsurface hydrology at the quarry. The porosity and density geophysical logs suggest that most of the strata are "tight" with low porosity and, by inference, low permeability. A significant exception to this pattern occurs in the limestones of Units D and E and more rarely in those of Unit C. Several anomalies are noted on the electric logs for limestones of these units that suggest there are thin (<0.3-1 m), relatively permeable, water-bearing zones occurring within these units. Correlation of the electric log anomalies with drill core and with acoustic logs demonstrates that the electric log anomalies are usually associated with fractured zones (Haase and King, in press). Wells completed into two fracture zones identified from electric log anomalies (GW-187 and GW-224) had water production of 94 L/min (25 gpm) from a fracture zone at 36 m (120 ft) depth and >150 L/min (>40 gpm) from a fracture zone at 46 m (160 ft) depth. Water from both zones had a distinct "sulfur" smell. Electric logs of core hole CH-185 suggest that, at depths below 100 m (350 ft), a low resistivity fluid occurs in the well bore. Until a sample can be obtained for chemical analysis, all that can be inferred about this fluid is that it has very low resistivity, much less than is typical of "fresh" water occurring in the shallow subsurface. Electric log patterns resemble those observed in deep, brine-flooded boreholes in Melton Valley near ORNL (Haase, in preparation).

4.6.3 Drilling Summary

Initial plans for groundwater and surface water monitoring at the Rogers Quarry site were prepared by Geraghty and Miller (1985d). Their proposal was focused primarily on the surface water system and on anticipated regulatory requirements. The drilling program summarized in this document was directed to obtaining a more complete characterization of geohydrologic conditions at the quarry site. The nine boreholes completed at Rogers Quarry are illustrated in Fig. 11.

Two core holes, CH-185 and CH-189, were drilled at the site to determine subsurface geology and to identify drilling targets for groundwater investigation wells. Core hole CH-185 was collared in Unit E [0.3-38 m (1 to 123 ft)] of the Chickamauga Group and penetrated all of Units D [38-55 m (123-183 ft)], C [55-115 m (183-379 ft)], and B [115-207 m (379 to 680 ft)]. Core hole CH-185 reached a total depth of 257 m (841.7 ft) in Unit A of the Chickamauga Group. Core hole CH-189 was collared in Unit B [0-82 m (0 to 268 ft)] of the Chickamauga Group, penetrated all of Unit A [82-176 m (268-578)], and reached total depth of 233 m (763 ft) in the Newala Formation of the Knox Group [176-233 m (578-763 ft)]. Further details of the geological and geophysical data

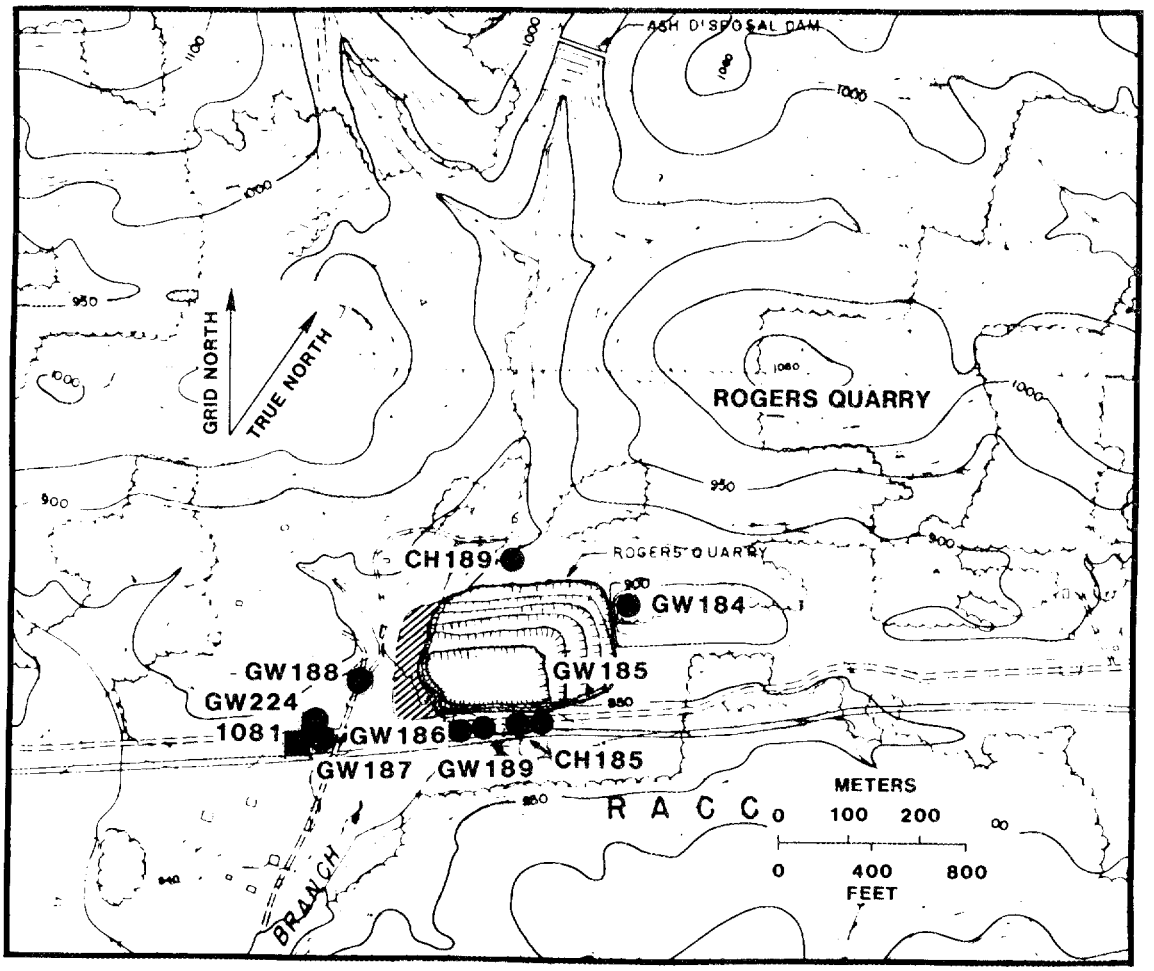

Fig. 11. Topographic map of the Rogers Quarry locality. Locations of groundwater investigation wells are indicated by solid circles. Solid squares denote existing groundwater monitoring wells. Contour lines are in feet (1 ft = 0.3048 m).

from core holes CH-185 and CH-189 and their interpretation will be presented elsewhere (Haase and King, in preparation).

Groundwater investigation well GW-184 is a screened well drilled to a depth of 40 m (130 ft). It is completed in interbedded maroon siltstones and gray limestones that occur in the lowermost portion of Unit C of the Chickamauga Group. These strata form the footwall of the quarry and are exposed along the extreme northern portions of the quarry pit. Topographic considerations suggest that groundwater at the quarry should move from north to south Because well GW-184 is open to strata occurring along the north edge of the quarry pit and because it has the highest elevation, this well should serve as an up-gradient, background well for the quarry site.

Well GW-188 is 21 m (70 ft) deep and is a screened well finished into a prominent zone of fractured limestones within Unit D of the Chickamauga Group that had been identified in CH-185. The well was positioned to monitor for potential strike-parallel movement of contaminants away from the quarry within this fracture system.

The remaining five wells at the quarry site were grouped into two piezometer clusters to investigate not only specific, hydrologically active, subsurface zones but to also investigate the vertical flow potential of the groundwater surrounding the quarry. Wells GW-187 and GW-224 are screened wells that form a cluster with an existing well, No. 1081. Well No. 1081 is 12 m (38 ft) deep and is screened in unconsolidated residuum and soil developed on Unit E of the Chickamauga Group. Wells GW-224 and GW-187 are drilled to total depths of 38 and 45 m, respectively, and are completed in prominent fracture zones within Unit E of the Chickamauga Group that were identified in core hole CH-185.

Wells GW-185, GW-186, and GW-189 form a piezometer cluster to investigate hydrologic targets within Unit C and the upper part of Unit B. Wells GW-186 and GW-189 are screened and were drilled to total depths of 52 and 64 m (171 and 210 ft), respectively. They are completed in prominent fracture zones within Unit C of the Chickamauga Group that were identified in core hole CH-185. Well GW-185 is an open well and was drilled to a total depth of 144 m (471.5 ft). It was completed to investigate hydrologic targets within strata of Unit B that underlie those investigated by well GW-184.

4.7 Sludge Disposal Basin

4.7.1 Background

The Sludge Disposal Basin is located on the northern crest of Chestnut Ridge, approximately 305 m (1000 ft) due south of New Hope Pond (Fig. 1). The site has been used to dispose of sediments and sludge removed from periodic dredging of New Hope Pond. A summary of analytical results and groundwater quality data from the disposal site

are presented by Geraghty and Miller (1985b). Two groundwater monitoring wells, Nos. 1095 and 1096, had been installed previously at the site.

4.7.2 Site Geology

The Sludge Disposal Basin is located in soil and residuum developed on top of the stratigraphically lowermost portion of the Copper Ridge Dolomite, which is the basal formation in the Knox Group. A schematic cross section of the site is shown in Fig. 12. The soil and residuum locally contain abundant chert and rubble-rich horizons that occur both at the top of bedrock and dispersed irregularly throughout the soil column. Depth to bedrock at the site ranges from 15 to 27 m (50-90 ft).

The Copper Ridge Dolomite at the site consists of thinly to thickly bedded, dark gray to buff dolostones. Dolostones range from massive bedded, without significant bedding structure, to having faint, planar laminations. Locally, dolostones contain intervals exhibiting wavy to planar cryptalgal laminations. Such intervals are typically interbedded with intraformational breccias and micrite-rich beds containing disseminated rip-up clasts. Intervals of bedded to nodular chert occur throughout the portion of the Copper Ridge Dolomite penetrated by core hole CH-157.

The Copper Ridge Dolomite at the Sludge Disposal Basin has an uniform dip to the southeast of 35 to 45. The strata exhibit joints and fractures, with the density and lateral continuity of such features varying from bed to bed. Most fractures appear to be filled with secondary calcite mineralization although open fractures occur throughout. Thin [<0.3-6 m (<1 to 20 ft)] chert-rich intervals typically have the highest fracture density, followed by thin dolostone intervals. Locally, many stratigraphic intervals exhibit solutionally widened bedding, joint, or fracture surfaces although no discrete solution cavities were noted. Locally, generally bedding plane-parallel fractures are concentrated into fracture zones from <0.3 to 1 m (<1 to 3 ft)] in thickness. Numerous high-angle fractures are also noted throughout the strata penetrated by core hole CH-157.

Little is known about the subsurface hydrology at the Sludge Disposal Basin. Available information on shallow subsurface hydrology of the site has been summarized by Geraghty and Miller (1985b). Groundwater flow directions in the shallow subsurface [61 m (200 ft)] have not been determined but are probably generally controlled by a groundwater divide that runs along the crest of Chestnut Ridge in the vicinity of the security pits. The location of the groundwater divide would influence a general control as to whether water from the site would flow northward into the Bear Creek watershed or southward toward watersheds in Bethel Valley. Work by Ketelle and Huff (1984) elsewhere along Chestnut Ridge indicates that joints, fractures, and solutional features developed within the upper bedrock exert substantial local influence on groundwater flow directions. Analysis of joint and

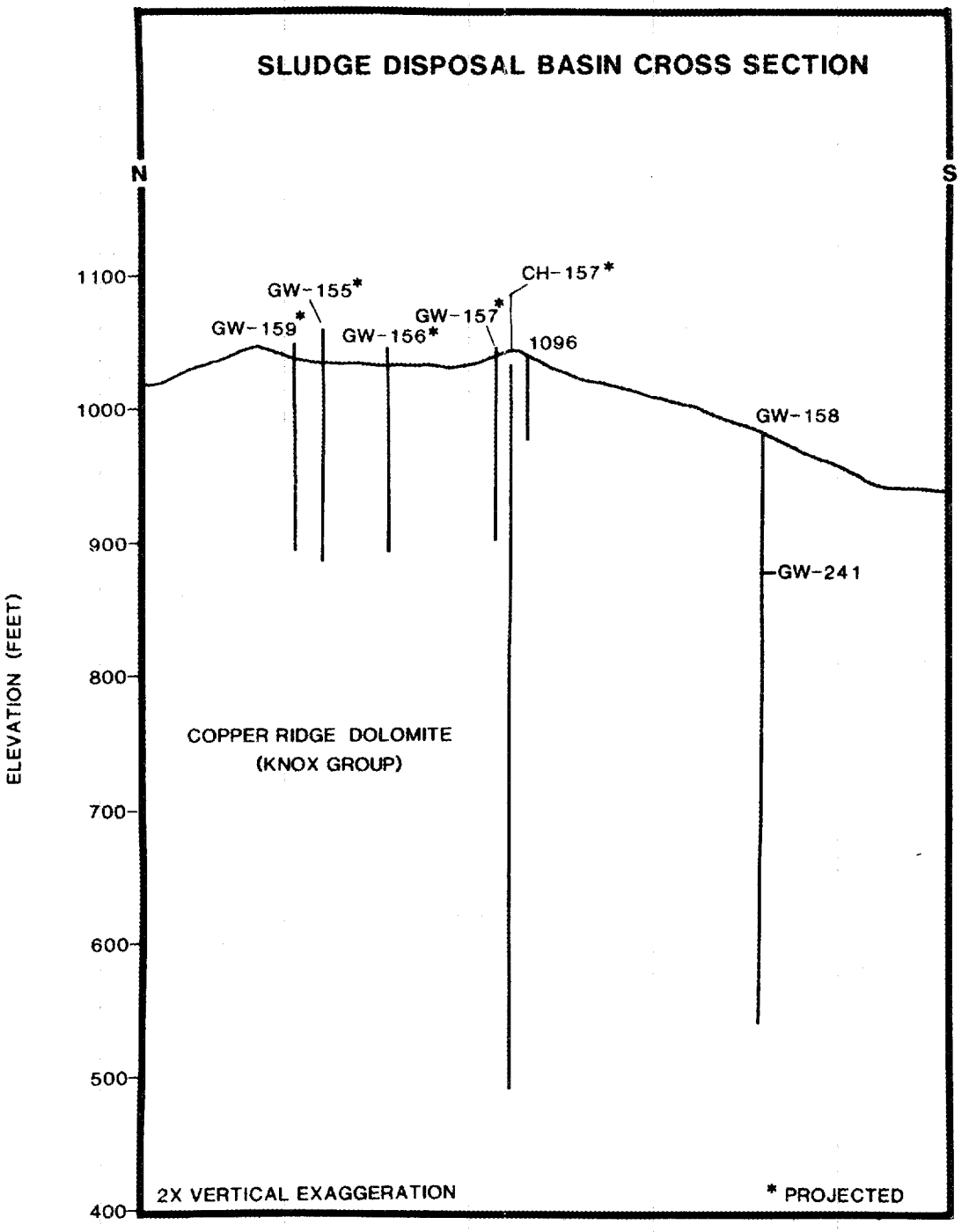

Fig. 12. Schematic cross section of Sludge Disposal Basin locality. The line of section is from north to south, along the E 63750 grid line. Asterisks denote boreholes that have been projected on to the line of the cross section. Vertical exaggeration is 2X; 1 ft = 0.3048 m.

fracture patterns suggests that preferred groundwater flow directions within the upper bedrock are parallel and perpendicular to the ridge crest.

For the generally unweathered bedrock in the deeper subsurface [61 m (200 ft)], porosity and density geophysical logs for core hole CH-157 suggest that most of the strata are "tight," with low porosity (0 to 5%) and, by inference, low permeability. Several anomalies noted on the electric logs suggest there are thin [<0.3-1 m (<1 to 3 ft)], relatively permeable, water-bearing zones occurring throughout the section. Correlation of the electric log anomalies with drill core and with a fracture density log prepared from examination of the drill core demonstrates that the electric log anomalies are usually associated with fractured zones (Haase and King, in press). The data suggest that water movement within the deeper bedrock probably occurs principally within fractures and fracture systems. To understand the hydrologic behavior in the vicinity of the Sludge Disposal Basin one must understand the spacing, density, and orientations of fracture systems.

4.7.3 Drilling Summary

Initial plans for monitoring well installation at the Sludge Disposal Basin site were presented by Geraghty and Miller (1985b). The original well installation plans were modified during the present drilling program to more completely address the hydrologic issues discussed above. Locations of the seven borings conducted at the site are illustrated in Fig. 13.

CH-157 is a 165-m-deep core hole collared in the lower portion of the Copper Ridge Dolomite The core hole provided data for a detailed map of the stratigraphy and structural character of the strata underlying the Sludge Disposal Basin site.

Screened wells were installed along the immediate perimeter of the site and at some distance from it to monitor groundwater occurring at the top of the water table, which typically corresponds to the soil/bedrock interface. Furthermore, analysis and comparison of hydrologic data from all wells at the site should permit identification of the groundwater divide and resolution of its significance to groundwater flow behavior at the site. During the installation of the surface conductor for these wells, zones of cavity formation and solutional alteration were encountered within 3 to 7.5 m (10-25 ft) of the top of bedrock. The vertical extent of such cavities ranged from (0.3 to 1.5 m (1-5 ft). In all cases, the surface conductor was advanced 1 to 5 m past the bottom of the first significant cavity encountered below the top of bedrock.

Wells GW-156 and GW-159 were installed to the west and to the east of the active and proposed burial areas to monitor possible migration along strike of material from the disposal area. The wells are both 48 m deep and are completed in the uppermost weathered bedrock.

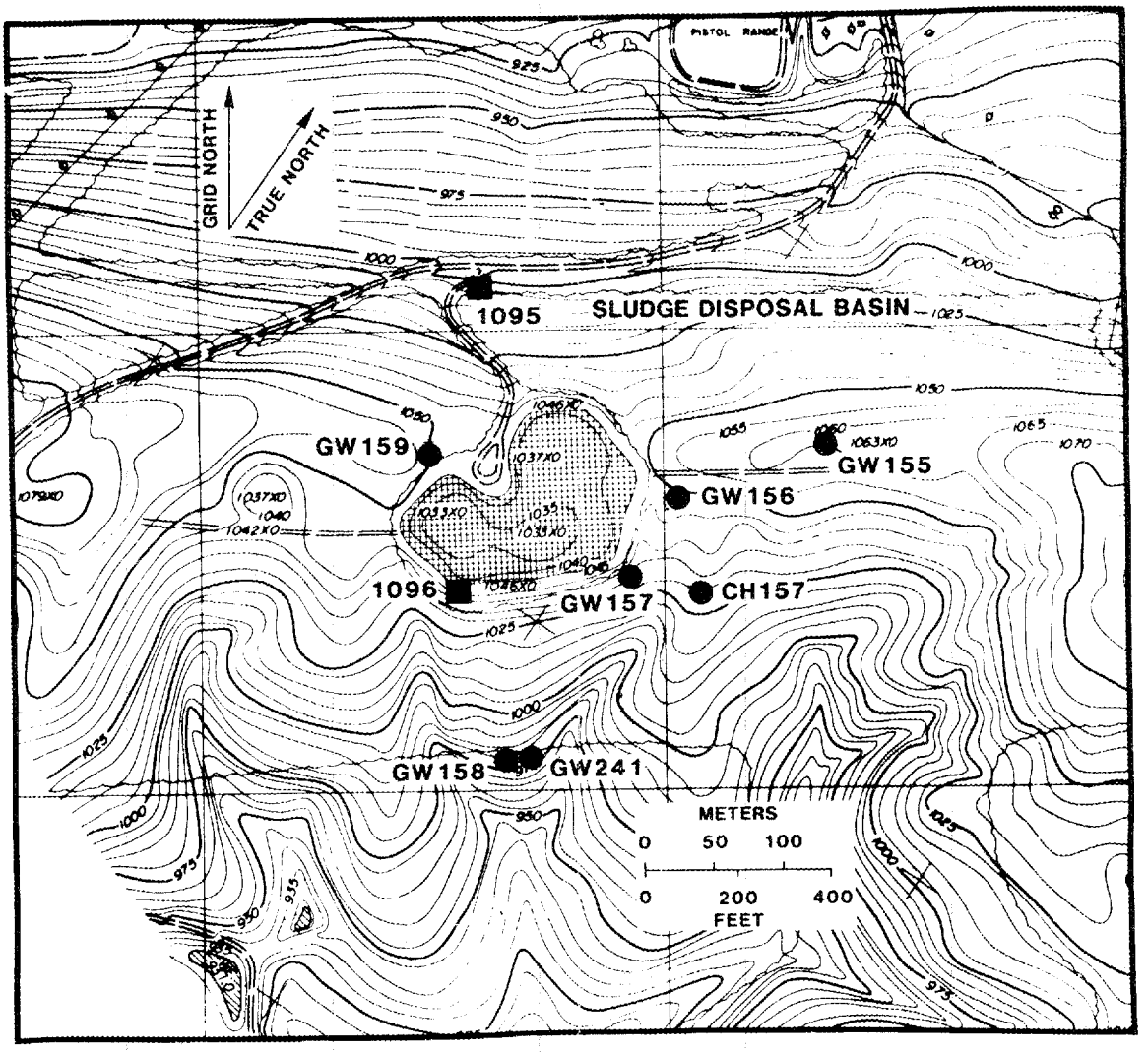

Fig. 13. Topographic map of the Sludge Disposal Basin locality. Locations of groundwater investigation wells are indicated by solid circles. Solid squares denote existing groundwater monitoring wells. Contour lines are in feet (1 ft = 0.3048 m).

These wells, together with existing well No. 1095, which is also screened in the interval at the top of bedrock, are north of the disposal area and will serve to investigate movement of material perpendicular to strike northward from the site. Comparison of hydrologic data from both groups of wells should also permit identification of the groundwater divide at the site.

Well GW-155 occupies the highest topographic location and should serve as an up-gradient, background well for the site. This well is 54 m deep and is also completed in weathered bedrock immediately below the top of rock.

Well GW-157, in conjunction with existing well No. 1096, was placed south of the active site to monitor potential movement of material away from the site southward, in a direction perpendicular to strike. Well GW-157 is 44 m deep and, like well No. 1096, is completed in weathered bedrock just below the top of rock.

Wells GW-158 and GW-241 form a piezometer cluster that was placed approximately 90 m south of the site. Well GW-241 is a 31-m-deep screened well completed at the top of bedrock. Well GW-158 is a 134-m-deep open well completed in a fractured interval. These wells will allow the vertical component of groundwater flow south of the site to be investigated and the potential, along-fracture, downdip movement of material away from the site to be monitored.

4.8 United Nuclear Site

4.8.1 Background

The United Nuclear Site is located on the northern crest of Chestnut Ridge, immediately south of the western end of the Y-12 complex (Fig. 1), and is used to dispose of waste from the Rhode Island-based company. Materials disposed of are low-level radioactive wastes and contaminated equipment packaged in 0.02-m^3 (55-gal) drums and in boxes. A summary of site disposal activities and groundwater chemistry is presented in Geraghty and Miller (1985b).

4.8.2 Site Geology

The United Nuclear Site is located in soil and residuum developed on top of the stratigraphically lowermost portion of the Copper Ridge Dolomite, which is the basal formation in the Knox Group. The soil and residuum locally contain abundant chert and rubble-rich horizons that occur both at the top of bedrock and are dispersed irregularly throughout the soil column. Depth to bedrock at the site ranges from 15 to 27 m (50-90 ft).

The geohydrologic setting of the United Nuclear Site is very similar to that discussed for the Chestnut Ridge Security Pit and the Sludge

Disposal Basin Sites. Available information on site hydrology has been summarized by Geraghty and Miller (1985b). Groundwater flow directions have not been determined but, as at the other sites mentioned, are probably generally controlled by a groundwater divide that runs along the crest of Chestnut Ridge in the vicinity of the site. The location of the groundwater divide would influence a general control as to whether water from the site would flow northward into the Bear Creek watershed or southward toward watersheds in Bethel Valley.

4.8.3 Drilling Summary

The locations of the three borings completed at this site are given in Fig. 14. All borings at the site are screened wells finished in the top of bedrock. The objective of these wells was to monitor groundwater occurring at the top of the water table, which typically corresponds to the soil/bedrock interface. During the installation of the surface conductor for these wells, zones of cavity formation and solutional alteration were encountered within 3 to 7.6 m (10-25 ft) of the top of bedrock. The vertical extent of such cavities ranged from 0.3 to 3 m (1-10 ft). In all cases, the surface conductor was advanced 0.3 to 1.5 m (1-5 ft) past the bottom of the first significant cavity encountered below the top of bedrock.

Wells GW-203, GW-205, and GW-221 were placed south of the active site to monitor potential movement of material away from the site in a direction perpendicular to strike. The wells are 47.5, 50, and 48.1 m (156, 164, and 158 ft) deep, respectively. Existing wells at the site, Nos. 1090 and 1091, are also screened in the interval at the top of bedrock. Well 1090 is northwest of the disposal area and serves to investigate movement of material perpendicular to strike northward from the site. Well 1091 is east of the site and serves to monitor potential contaminant movement parallel to strike. Comparison of hydrologic data from all wells should permit identification of the groundwater divide and resolution of its significance to groundwater flow at the site.

4.9 USGS Hydrostatic Head Wells - Site-1N

4.9.1 Background

Site USGS-1N is located on the south slope of Pine Ridge, immediately north of the active portion of the Y-12 Burials Grounds in Bear Creek Valley (Fig. 1). The wells drilled at this site were constructed in cooperation with the U.S. Geological Survey. The wells will provide information on hydrostatic heads within the lower Pumpkin Valley Shale and the Rome Formation that is required to support USGS groundwater modeling efforts for Bear Creek Valley. The wells will also become part of the Y-12 well network and will serve as up-gradient and background wells for northern portions of the Bear Creek Valley Burial Grounds.

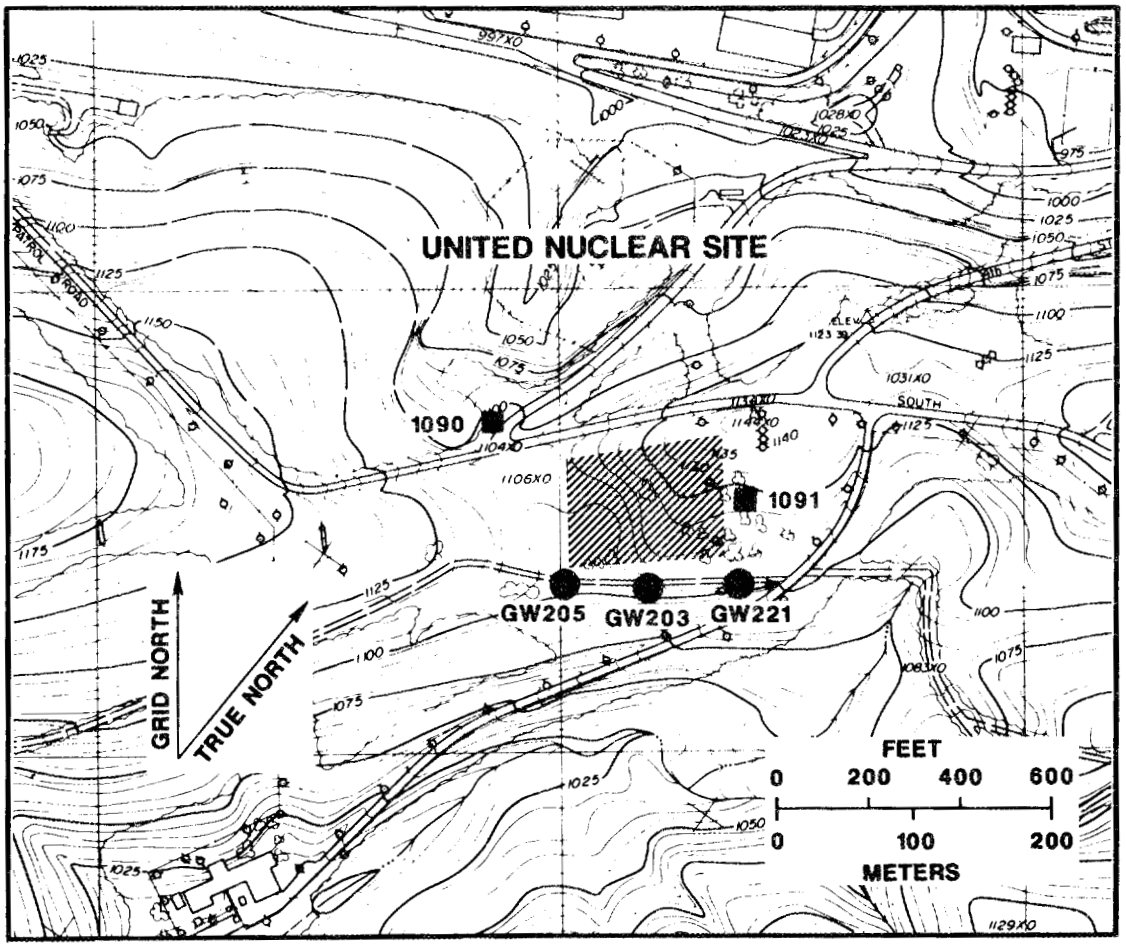

Fig. 14. Topographic map of the United Nuclear Disposal locality. Locations of groundwater investigation wells are indicated by solid circles. Solid squares denote existing groundwater monitoring wells. Contour lines are in feet (1 ft = 0.3048 m).

4.9.2 Site Geology

The site is located on soil and residuum developed on the Pumpkin Valley Shale of the Conasauga Group. Depth to solid bedrock at the site was approximately 3.5 m (12 ft). The Pumpkin Valley strata intersected consist of interbedded maroon and gray-brown siltstones and shales. Rome Formation strata penetrated during the drilling consist of a massive 15- to 23-m-thick (50- to 75-ft-thick) gray green sandstone at the top of the formation, followed by interbedded maroon and gray sandstones, siltstones, and shales occurring in the middle portions of the formation. Strata of the lower Rome Formation were not penetrated.

4.9.3 Drilling Summary

Locations of the three wells installed at site USGS-1N are illustrated in Fig. 15. The wells form a piezometer cluster to investigate the vertical flow of groundwater at this locality. Well GW-162, with a total depth of 38 m (125 ft), is completed in interbedded siltstones and shales of the lower member of the Pumpkin Valley Shale. Well GW-163 has a total depth of 69 m (225 ft) and is completed in a massive, gray-green sandstone at the top of the Rome Formation. This well produced water at the rate of approximately 3.7 to 7.6 L/min (1 to 2 gpm) during drilling. It is currently artesian with a flow rate of approximately 1.9 L/min (0.5 gpm). Well GW-164 has a total depth of 123 m (405 ft) and is completed in interbedded sandstones, siltstones, and shales of the middle portion of the Rome Formation. The well produced approximately 3.7 to 7.6 L/min (1-2 gpm) of water during drilling of the upper 113-m-deep (370-ft-deep) section. After this interval was cased off, little water was produced during the drilling of the open hole portion until a depth of approximately 122 m (400 ft) was reached. At that depth a fractured interval was encountered and the well began to produce approximately 3.7 L/min of water. The well is currently artesian, with a flow rate estimated at <1.9 L/min (<0.5 gpm).

4.10 USGS Hydrostatic Head Wells - Site-1S

4.10.1 Background

Site USGS-1S is located on the slope of Chestnut Ridge, slightly north of the northern crest of that ridge (Fig. 1). The site is immediately south of the active portion of the Y-12 Burial Grounds in Bear Creek Valley (Fig. 1). The wells drilled at this site were constructed in cooperation with the U.S. Geological Survey. The wells will provide data on hydrostatic heads within the lower Copper Ridge Dolomite that are required to support USGS groundwater modeling efforts for Bear Creek Valley. The wells will also become part of the Y-12 well network and will serve as up-gradient wells for the southern portions of the Bear Creek Valley Burial Grounds.

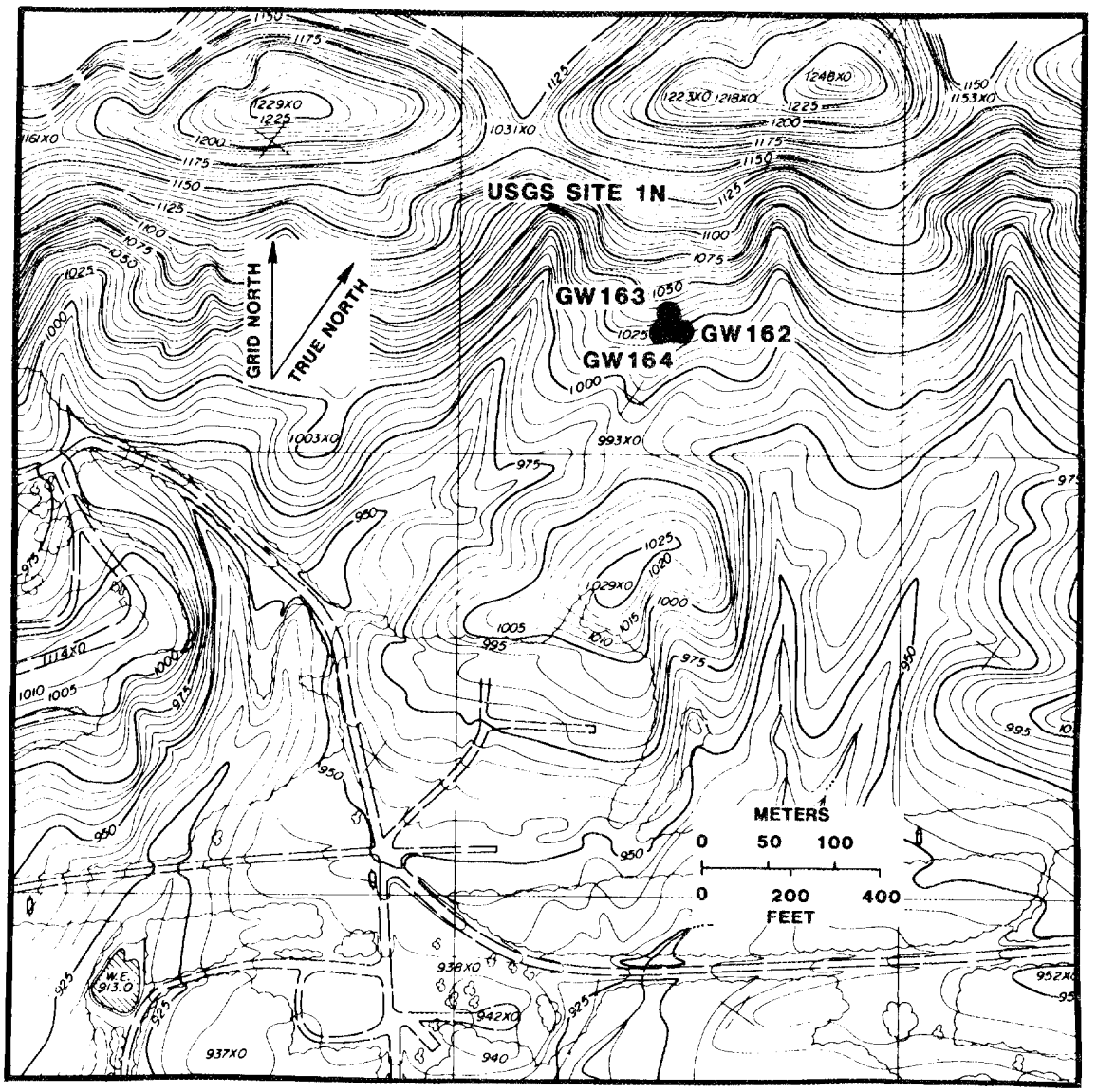

Fig. 15. Topographic map of the USGS-1N locality. Locations of groundwater investigation wells are indicated by solid circles. Solid squares denote existing groundwater monitoring wells. Contour lines are in feet (1 ft = 0.3048 m).

4.10.2 Site Geology

The borings at this locality are located in soil and residuum developed on the Copper Ridge Dolomite. Depth to bedrock at the site ranges from 12 to 23 m (40 to 75 ft). Site geohydrological conditions are generally similar to those discussed for the Sludge Disposal Basin, the Chestnut Ridge Security Pit, and the United Nuclear sites.

4.10.3 Drilling Summary

Locations of the two borings installed at this site are illustrated in Fig. 16. The wells were installed to form a piezometer cluster that investigates the vertical component of groundwater movement at the site and two of several significant fracture and cave intervals encountered at depths below 61 m (200 ft). Well GW-165 is drilled to a total depth of 100 m (325 ft) and is completed in a major cave and fracture zone. The well produced over 378 L/min of slightly turbid water during development. Well GW-166 has a total depth of 117 m (385 ft) and is completed in a 1-m-long (3-ft-long) mud-filled cave or fractured zone. During development, this well produced in excess of 1440 L/min (300 gpm) of very muddy water.

5. SUMMARY

Geological and geophysical data obtained from the core holes and deep groundwater investigation wells installed during this drilling program provide information essential to the documentation of site geology at each locality. Such information, combined with hydrologic data from the groundwater investigation wells, will allow the hydrologic behavior of each site to be interpreted in a comprehensive geological framework. Because of the strong control that site geology exerts on groundwater flow in the Oak Ridge vicinity, such an understanding is essential to the design of an effective contaminant monitoring program. The boreholes installed in this drilling project represent the first step in such a monitoring effort.

Although the wells installed were designed and located with groundwater characterization as the primary objective, they also provide an initial monitoring capability around the sites. In particular, construction techniques were used that should permit use of the groundwater investigation wells in a comprehensive contaminant monitoring network. Any decision pertaining to the applicability of the wells discussed in this report to such a monitoring effort must await evaluation of data obtained from them during the initial year(s) of their operation.

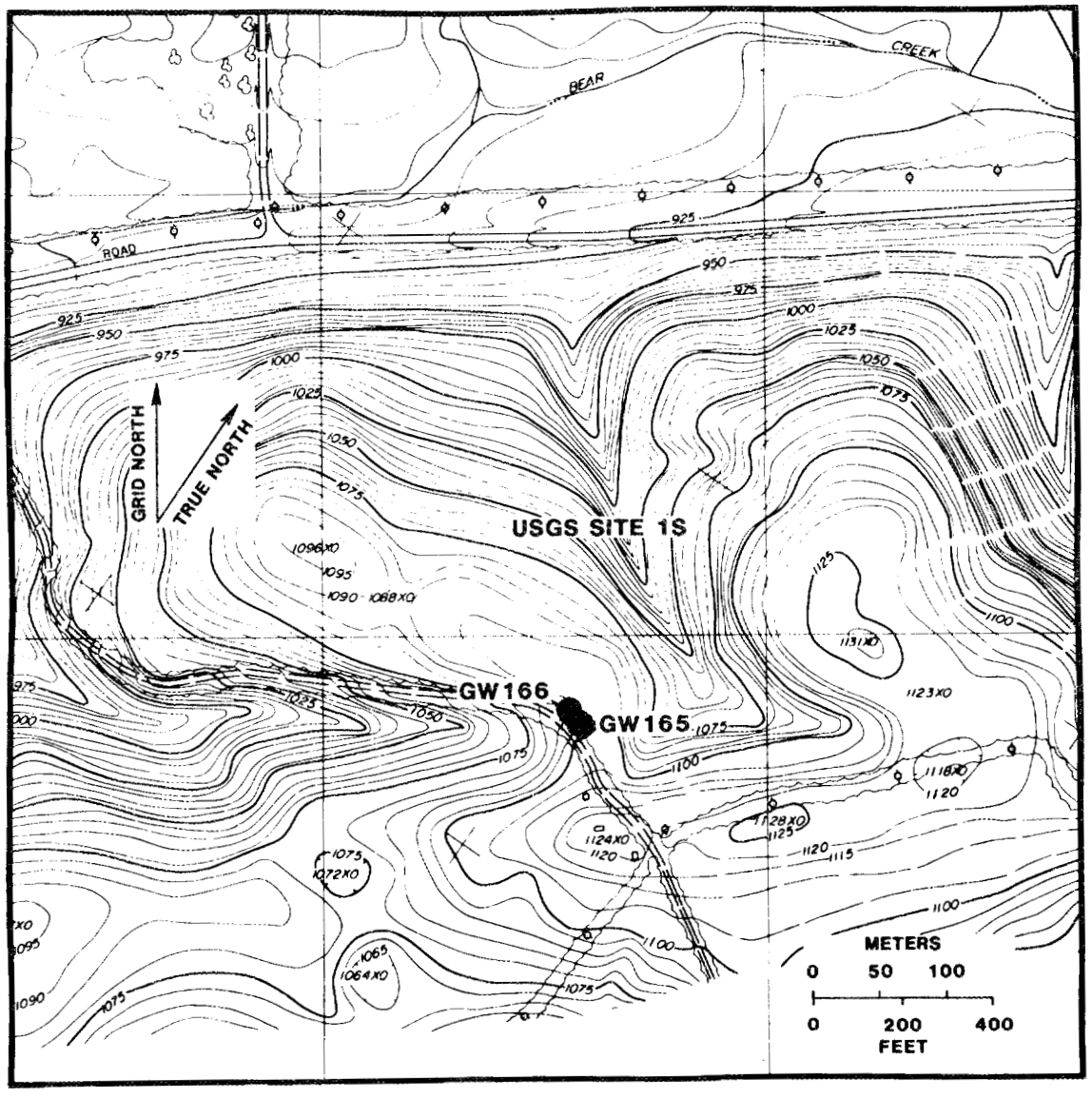

Fig. 16. Topographic map of the USGS-1S locality. Locations of groundwater investigation wells are indicated by solid circles. Solid squares denote existing groundwater monitoring wells. Contour lines are in feet (1 ft = 0.3048 m).

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APPENDIX

Borehole Construction Diagrams

WELL CONSTRUCTION SUMMARY

Well Name: CH 143 **Total Depth:** 600'

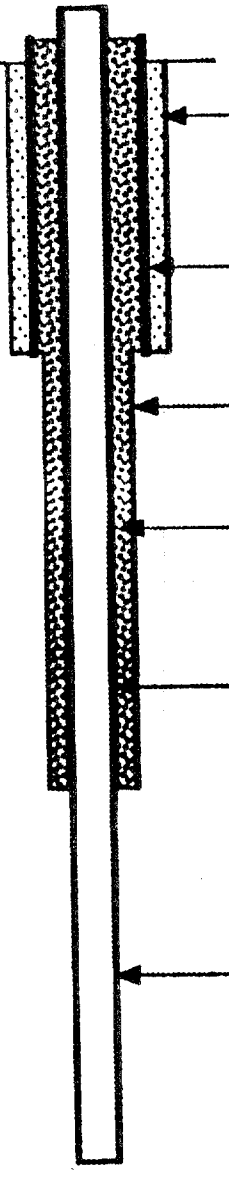
Location: Kerr Hollow Quarry

Drilled By: GEOTEK (Stone & R.M. Collins) **Date Completed:** 22 AUG 85

Notes:

Geologic Summary

TOWR @ 9'
TOFR @ 50.7'



		Downhole Depths	
Conductor Hole Dia: —		Top	—
		Bottom	
Surface Conductor Type: NONE I.D. — O.D. —		Top	—
		Bottom	—
Borehole Dia: 7"		Top	0
		Bottom	54'
Grout: PORTLAND, TYPE I			
Casing Type: STEEL I.D. 4" O.D. 4½"		Top	0
		Bottom	54'
Open Hole Dia: 3.7"		Top	54'
		Bottom	600'

WELL CONSTRUCTION SUMMARY

Well Name: CHIEF **Total Depth:** 540'

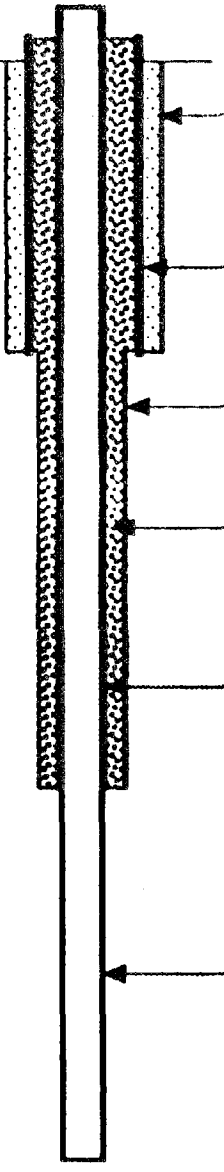
Location:

Drilled By: SECTEK, S Collins **Date Completed:** 7 OCT 85

Notes:

Geologic Summary

LOST CIRCULATION @ 63'
TOFR @ 76'
Water @ 85'



		Downhole Depths	
Conductor Hole Dia: —	Top	—	
	Bottom	—	
Surface Conductor Type: NONE I.D. ____ O.D. ____	Top	—	
	Bottom	—	
Borehole Dia: 7"	Top	0'	
	Bottom	81'	
Grout: PORTLAND, TYPE 1			
Casing Type: STEEL I.D. 4" O.D. 4½"	Top	0	
	Bottom	81'	
Open Hole Dia: 3.7"	Top	81'	
	Bottom	540'	

WELL CONSTRUCTION SUMMARY

Well Name: [illegible] **Total Depth:** 841.7'

Location: [illegible]

Drilled By: GEOTEK (STEVE & [illegible] GOLINS) **Date Completed:** 16 Sep 85

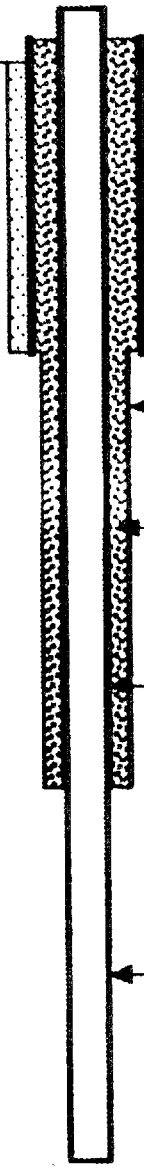
Notes:

Geologic Summary

lost Circ @ 172.4 (4" [illegible])

Gas/oil show @ 204.0'

[illegible]



		Downhole Depths	
Conductor Hole Dia: —		Top	—
		Bottom	—
Surface Conductor Type: — I.D. — O.D. —		Top	—
		Bottom	—
Borehole Dia: 7"		Top	0
		Bottom	30.3'
Grout: Portland, Type I			
Casing Type: STEEL I.D. 4" O.D. 4½"		Top	0
		Bottom	30.3'
Open Hole Dia: 3.7"		Top	30.8'
		Bottom	841.7'

WELL CONSTRUCTION SUMMARY

Well Name: [illegible] **Total Depth:** [illegible]

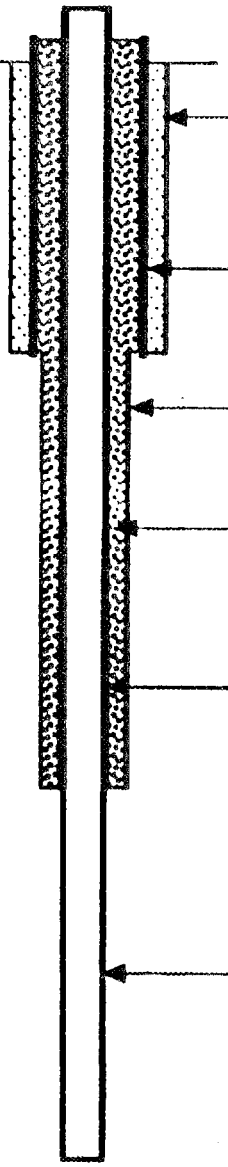
Location: [illegible]

Drilled By: GSATEK (STEVE [illegible]) **Date Completed:** [illegible]

Notes:

Geologic Summary

TOFR @ 18'



		Downhole Depths	
Conductor Hole Dia: —		Top	—
		Bottom	—
Surface Conductor Type: — I.D. — O.D. —		Top	—
		Bottom	—
Borehole Dia: 7"		Top	0'
		Bottom	23'
Grout: PORTLAND, TYPE I			
Casing Type: STEEL I.D. 4" O.D. 4 1/2"		Top	0'
		Bottom	23'
Open Hole Dia: 3.7"		Top	23'
		Bottom	763'

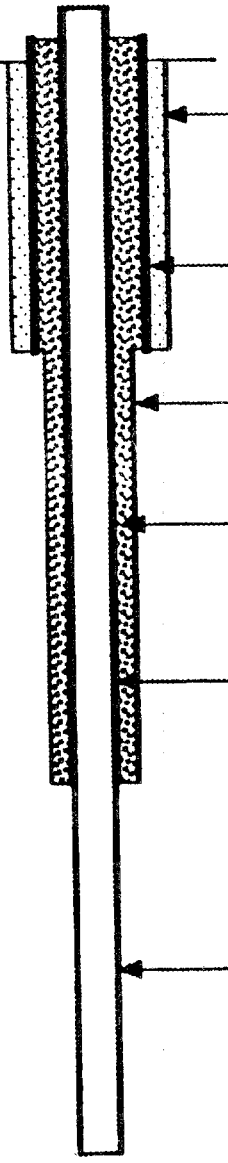
WELL CONSTRUCTION SUMMARY

Well Name: 5W142 **Total Depth:** 295'

Location: KERR HOLLOW QUARRY

Drilled By: GEOTEK (RM & RANDY COLLINS) **Date Completed:** 30 OCT 85

Notes:



Conductor Hole Dia: 16 3/4"

Surface Conductor
Type: PVC #40
I.D. 11 3/4" **O.D.** 12 1/2"

Borehole Dia: 11"

Grout: Halliburton

Casing
Type: Steel
I.D. 6 1/8" **O.D.** 6 5/8"

Open Hole Dia: 6"

Downhole Depths

	Top	Bottom
Conductor Hole	0	20'
Surface Conductor	0	20'
Borehole	20'	250'
Casing	Above Surface	248.5'
Open Hole	250'	295'

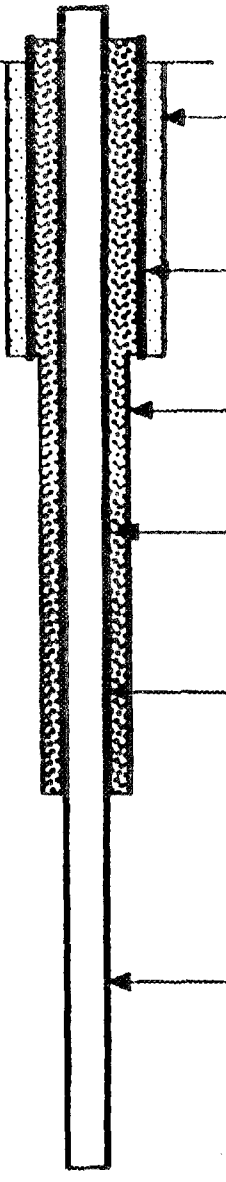
Geologic Summary

WELL CONSTRUCTION SUMMARY

Well Name: GW143 **Total Depth:** 253'
Location: KERR HOLLOW QUARRY
Drilled By: SEATSK (RM & RANDY COLLINS) **Date Completed:** 24 OCT 85
Notes:

Geologic Summary

Solid rock @ 18'



Downhole Depths

		Top	Bottom
Conductor Hole Dia: 16 3/4"		0	20'
Surface Conductor Type: PVC #40 I.D. 9 7/8" O.D. 10 5/8"		0	20'
Borehole Dia: 10"		20'	[illegible]
Grout: Halliburton			
Casing Type: steel I.D. 6 1/8" O.D. 6 5/8"		Above Surface	205'
Open Hole Dia: 6"		205'	253'

WELL CONSTRUCTION SUMMARY

Well Name: SW144 **Total Depth:** 195'

Location: KERR HOLLOW QUARRY

Drilled By: GEOTEK (R.M. & RANDY COLLINS) **Date Completed:** 24 OCT 85

Notes:

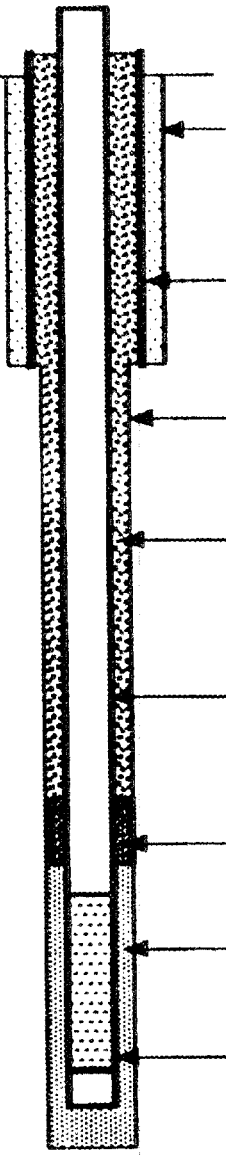
Geologic Summary

water @ 170' ~30-30 gpm

T.C.F.R. 40'

31' - 4" mud seam

185' - 186' [illegible]



Downhole Depths

		Top	Bottom
Conductor Hole Dia: 15"		0'	40'
Surface Conductor Type: PVC #40 I.D. 11 3/4" O.D. 12 1/2"		0'	40'
Borehole Dia: 11"		40'	195'
Filler: Portland, Type I			
Casing (with Screen) Type: PVC #40 I.D. 4" O.D. 4 1/2"		Above Surface 3'	190'
Seal: Bentonite		145'	142'
Pack: Sand (.05 ft cuttings)		142'	195.0'
Screen Type: PVC #40 I.D. 4" O.D. 4 1/2"		150'	190'

WELL CONSTRUCTION SUMMARY

Well Name: HL 145 **Total Depth:** 110'

Location: KERR HOLLOW QUARRY

Drilled By: GEOTEK (R. Ill. & Randy Collins) **Date Completed:** 14 OCT 85

Notes:

Geologic Summary

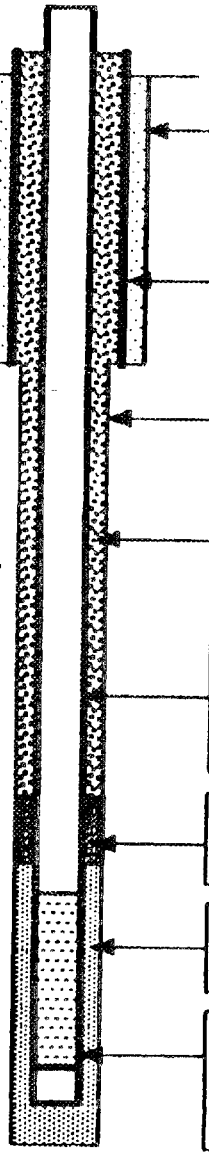
T.O.F.R. 12'

34' fracture w/ water + mud

60' fractured zone

67' fractured [illegible] w/ water

102' fractured zone w/ water



		Downhole Depths Top	Bottom
Conductor Hole Dia:		0	
Surface Conductor Type: PVC #40 I.D. 11 3/4" O.D. 12 1/2"		0'	12'
Borehole Dia: 11"			110'
Filler: Grout, Portland Type I			
Casing (with Screen) Type: PVC #40 I.D. 4" O.D. 4 1/2"		Above Surface 3'	109'
Seal: Bentonite		84'	86'
Pack: Sand (1.0 ft of cuttings)		86'	110.0
Screen Type: PVC #40 I.D. 4" O.D. 4 1/2"		88.5'	108.5'

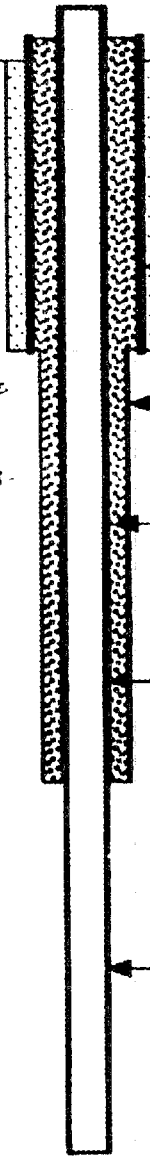
WELL CONSTRUCTION SUMMARY

Well Name: GW146 **Total Depth:** 220'
Location: KERR HOLLOW QUARRY
Drilled By: GEOTEK (R.M. & RANDY COLLINS) **Date Completed:** 9 OCT 85
Notes:

Geologic Summary

Solid rock 11'

Fractured zones at 207' and [illegible] 218-219'



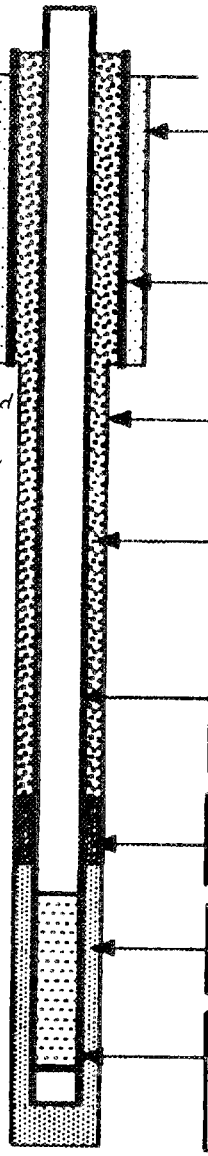
		Downhole Depths	
Conductor Hole Dia:		Top	
		Bottom	
Surface Conductor Type: PVC I.D. 11 3/4" O.D. 12 1/2"		Top	0'
		Bottom	13'
Borehole Dia: 11"		Top	
		Bottom	190'
Grout: Halliburton			
Casing Type: steel I.D. 6 1/8" O.D. 6 5/8"		Top	Above Surface
		Bottom	190'
Open Hole Dia: 6"		Top	190'
		Bottom	220'

WELL CONSTRUCTION SUMMARY

Well Name: GW147 **Total Depth:** 69'
Location: KERR HOLLOW QUARRY
Drilled By: GEOTEK (RANDY COLLINS) **Date Completed:** 25 SEP 85
Notes: Surface casing temporary

Geologic Summary

Solid Rock @ 6'
Fractured Zones
10 - 12.5' w/ water
19' w/ water
20 - 21' w/ water
24 - 25'
32.5 - 33' mud seam
[illegible] w/ [illegible] water
59.5 - 60.5



		Downhole Depths Top	Bottom
Conductor Hole Dia: 10"		0	69'
Surface Conductor Type: PVC #40 I.D. 9 7/8" O.D. 10 3/8"		0	4.6'
Borehole Dia: 10"		0	69'
Filler: Grout, Portland Type I			
Casing (with Screen) Type: PVC #40 I.D. 4" O.D. 4 1/2"		Above Surface 3'	69'
Seal: Bentonite		49.5'	52'
Pack: Sand		52'	69'
Screen Type: PVC #40 I.D. 4" O.D. 4 1/2"		53.1	68.1

WELL CONSTRUCTION SUMMARY

Well Name: GW148 **Total Depth:** 11.1'

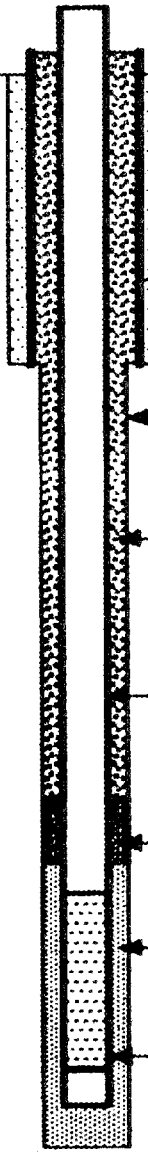
Location: NEW HOPE (IND)

Drilled By: GEOTEK (GASSAGE) **Date Completed:** 30JUL85

Notes:

Geologic Summary

split spoon soil samples [illegible] 5 AND 10'



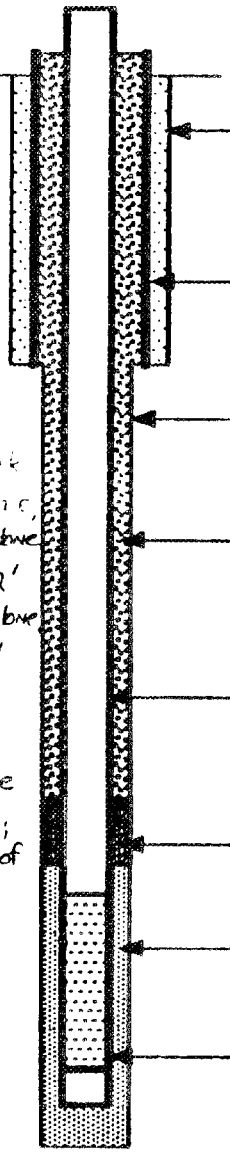
		Downhole Depths Top	Bottom
Conductor Hole Dia: NA		-	-
Surface Conductor Type: NONE I.D. - O.D. -		-	-
Borehole Dia: 8" (Auger)		0	11.1'
Filler: Grout, Portland Type I			
Casing (with Screen) Type: PVC #40 I.D. 4" O.D. 4½"		Above surface 3'	11.1'
Seal: Bentonite		2.6'	4.6'
Pack: Sand		4.6'	11.1'
Screen Type: PVC #40 I.D. 4" O.D. 4½"		5.6	10.6

WELL CONSTRUCTION SUMMARY

Well Name: GW 146 **Total Depth:** 50.5'
Location: New Hope Pond
Drilled By: GEOTEK (R.H. Collins) **Date Completed:** 14 Aug 85
Notes:

Geologic Summary

water @ 4'
[illegible] 3.7' [illegible]
minor limestone
Solid rock @ 12'
oolitic limestone
gray - green
shale
25'-28' very
hard dense
limestone;
heavy flow of
water



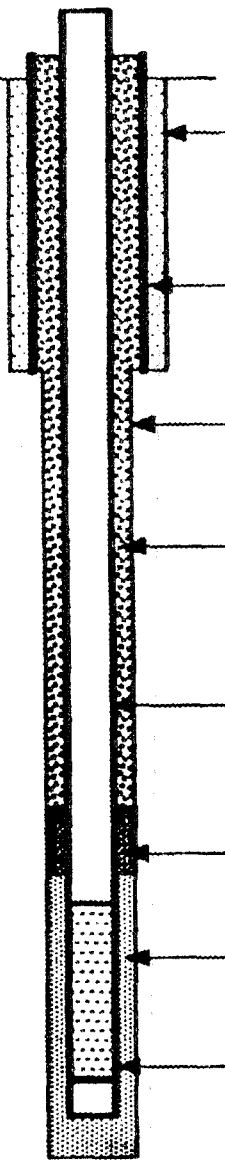
		Downhole Depths	
Conductor Hole Dia: NA		Top	-
		Bottom	-
Surface Conductor Type: NONE I.D. - O.D. -		Top	-
		Bottom	-
Borehole Dia: 11"		Top	0
		Bottom	50.5'
Filler: grout, Portland Type I			
Casing (with Screen) Type: PVC #40 I.D. 4" O.D. 4½"		Top	Above surface 3'
		Bottom	47.5
Seal: Bentonite		Top	34'
		Bottom	36'
Pack: Sand (3.0 ft of cuttings)		Top	36'
		Bottom	50.5'
Screen Type: PVC #40 I.D. 4" O.D. 4½"		Top	37'
		Bottom	47'

WELL CONSTRUCTION SUMMARY

Well Name: GLYKO **Total Depth:** 11.7'
Location: NEW HOPE POND
Drilled By: GEOTEK (GOSSAGE) **Date Completed:** 01 AUG 85
Notes:

Geologic Summary

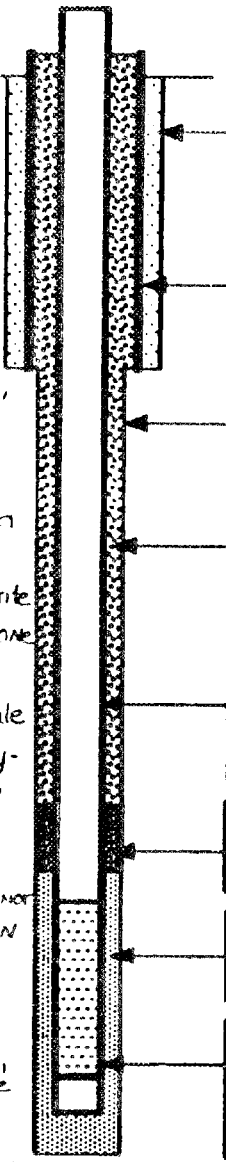
water at 8'
Split spoon samples 5-7' and 10-11.7'



		Downhole Depths Top	Downhole Depths Bottom
Conductor Hole Dia: NA		-	-
Surface Conductor Type: NONE I.D. - O.D. -		-	-
Borehole Dia: 8" (Auger)		0	11.7'
Filler: Grout, Portland Type I			
Casing (with Screen) Type: PVC #40 I.D. 4" O.D. 4½"		Above Surface 3'	11.7'
Seal: Bentonite		3'	5'
Pack: Sand		5'	11.7'
Screen Type: PVC #40 I.D. 4" O.D. 4½"		6.2	11.2

WELL CONSTRUCTION SUMMARY

Well Name: RW151 **Total Depth:** 96.5'
Location: NEW HOPE POND
Drilled By: GEOTEK (RANDY COLLINS) **Date Completed:** 14 AUG 85
Notes:



Geologic Summary

Solid rock @ 12'
lt. gray - dk
[illegible]
some mottled
water @ 26'
med gray micrite
(fractured zone
per driller)
41' - 43' gray shale
43' - 48' med gray-
reddish gray
micrite
56' gr - reddish
micrite w/ minor
dk gray - green
shale
65' mottled gray
micrite
72' gray micrite,
minor shale
86' "
96' med. - lt. gray
micrite, minor shale

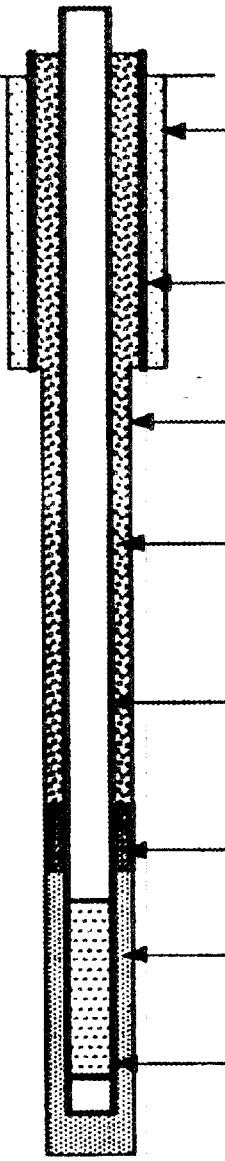
Downhole Depths

		Top	Bottom
Conductor Hole Dia: 11"		0'	96.5
Surface Conductor	Type: PVC; I.D. 11 3/4"; O.D. 12 1/2"	0'	12'
Borehole Dia: 11"		0	96.5'
Filler: Grout, Portland Type I			
Casing (with Screen)	Type: PVC #40; I.D. 4"; O.D. 4 1/2"	Above Surface 3'	96.5
Seal: Bentonite		83'	85'
Pack: Sand		85'	96.5'
Screen	Type: PVC #40; I.D. 4"; O.D. 4 1/2"	86'	96'

WELL CONSTRUCTION SUMMARY

Well Name: SW152 **Total Depth:** 17.3'
Location: NEW HOPE POND
Drilled By: GEOTEK (GOSSAGE) **Date Completed:** 02 AUG 85
Notes:

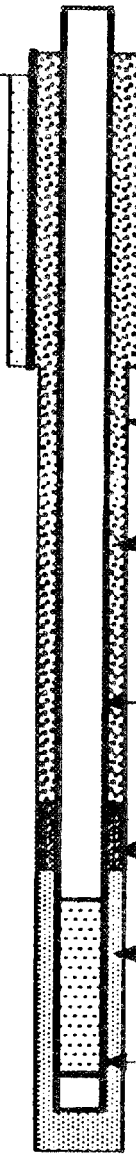
Geologic Summary



		Downhole Depths	
Conductor Hole Dia: NA		Top	-
		Bottom	-
Surface Conductor Type: NONE I.D. - O.D. -		Top	-
		Bottom	-
Borehole Dia: 8" (AUGER)		Top	0
		Bottom	17.3'
Filler: GROUT, PORTLAND TYPE I			
Casing (with Screen) Type: PVC #40 I.D. 4" O.D. 4½"		Top	Above Surface 3'
		Bottom	17.3'
Seal: BENTONITE		Top	8.8'
		Bottom	10.8'
Pack: SAND		Top	10.8'
		Bottom	17.3'
Screen Type: PVC #40 I.D. 4" O.D. 4½"		Top	11.8'
		Bottom	16.8'

WELL CONSTRUCTION SUMMARY

Well Name: E.J 153 **Total Depth:** 60'
Location: NEW HOPE POND
Drilled By: GEOTEK (RANDY COLLINS) **Date Completed:** 31 OCT 85
Notes:



Downhole Depths

Conductor Hole Dia: _____ — Top: ; Bottom: 29'

Surface Conductor
Type: PVC #40
I.D. 11¾" / 9⅝" O.D. 12½" / 10⅝"
Top: ; Bottom: 18' (12") 29' (10")

Borehole Dia: 10" — Top: ; Bottom:

Filler: Grout, Portland Type I

Casing (with Screen)
Type: PVC #40
I.D. 4" O.D. 4½"
Top: ; Bottom:

Seal: Bentonite — Top: 43'; Bottom: 45'

Pack: Sand — Top: 45'; Bottom: 60'

Screen
Type: PVC #40
I.D. 4" O.D. 4½"
Top: 49.5'; Bottom: 59.5'

Geologic Summary

WELL CONSTRUCTION SUMMARY

Well Name: SCC 154 **Total Depth:** 11.2'

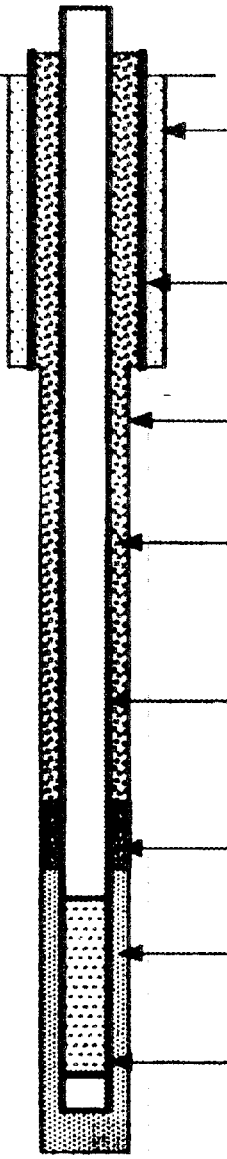
Location: New Hope Pond

Drilled By: GEOTEK (GOSSAGE) **Date Completed:** 30 JUL 85

Notes:

Geologic Summary

water at 5'



		Downhole Depths	
Conductor Hole Dia: NA		Top	-
		Bottom	-
Surface Conductor Type: NONE I.D. - O.D. -		Top	-
		Bottom	-
Borehole Dia: 8" (AUGER)		Top	0
		Bottom	11.2'
Filler: GROUT			
Casing (with Screen) Type: PVC I.D. 4" O.D. 4½"		Top	Above Surface 3'
		Bottom	11.2'
Seal: BENTONITE		Top	2.7'
		Bottom	4.7'
Pack: SAND		Top	4.7'
		Bottom	11.2'
Screen Type: PVC I.D. 4" O.D. 4½"		Top	5.7'
		Bottom	10.7

WELL CONSTRUCTION SUMMARY

Well Name: 611155 **Total Depth:** 177'

Location: SLUDGE DISPOSAL BASIN

Drilled By: A.L. CLARK (CAMPBELL) **Date Completed:** 19 OCT 85

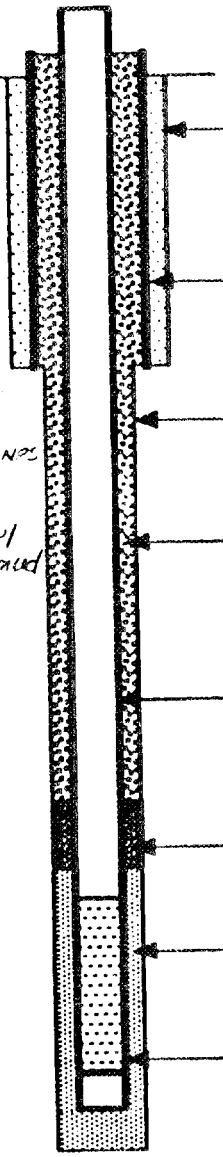
Notes:

Geologic Summary

TOFR 89'

Fractured zones

165-177 w/ water/mud



		Downhole Depths Top	Bottom
Conductor Hole Dia: 15"		0	95'
Surface Conductor Type: steel I.D. 10" O.D. 10 3/4"			95'
Borehole Dia: 8 1/2"		95'	177'
Filler: CEMENT, PORTLAND TYPE I			
Casing (with Screen) Type: PVC (164') I.D. 4" O.D. 4 1/2"		+3	177
Seal: Bentonite		162	165
Pack: Sand		165	177
Screen Type: PVC (10') I.D. 4" O.D. 4 1/2"		167	177

WELL CONSTRUCTION SUMMARY

Well Name: SW 156 **Total Depth:** 157.6'
Location: SLUDGE DISPOSAL BASIN
Drilled By: A.L. CLARK (CAMPBELL) **Date Completed:** 18 OCT 85
Notes:

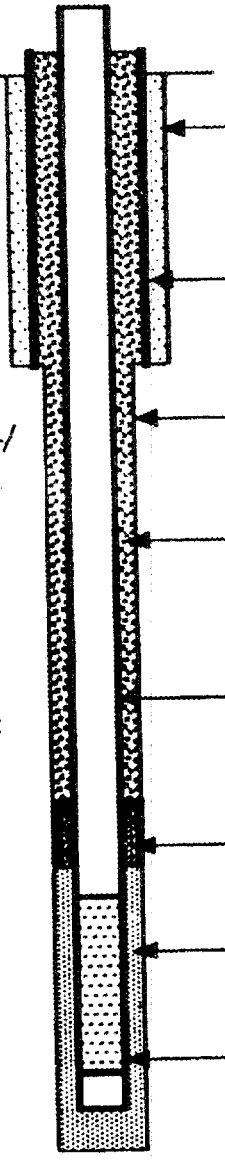
Geologic Summary

TOWR 84'
TOFR 93'

CAVITY AT 92-93' AND [illegible] CONNECTED.

CAVITY AT 106-112'

Drilling break @ 150.



		Downhole Depths Top	Bottom
Conductor Hole Dia: 15"		0'	94'
Surface Conductor Type: ____ I.D. 10" O.D. 10 3/4"			94'
Borehole Dia: 8 1/2"		94	157.6'
Filler: Cement, Portland Type I			
Casing (with Screen) Type: PVC I.D. 4" O.D. 4 1/2"		+3	157
Seal: Bentonite		142	145
Pack: SAND		145	157.6
Screen Type: PVC I.D. 4" O.D. 4 1/2"		147	157

WELL CONSTRUCTION SUMMARY

Well Name: OW 157 **Total Depth:** 145'

Location: SLUDGE DISPOSAL BASIN

Drilled By: A.L. CLARK (CAMPBELL) **Date Completed:** 18 Oct 85

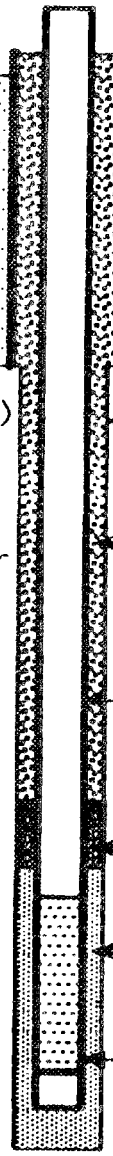
Notes:

Geologic Summary

T.O.W.R. 18'
T.O.F.R. 94'
(some water)

Water at 74'
(sand lense?)

114-116'
140' w/ water



		Downhole Depths	
Conductor Hole Dia: 15"		Top	0
		Bottom	103
Surface Conductor Type: I.D. 10" O.D. 10 3/4"		Top	0
		Bottom	103
Borehole Dia: 8"		Top	103
		Bottom	145'
Filler: Cement, Portland Type I			
Casing (with Screen) Type: PVC I.D. 4" O.D. 4 1/2"		Top	+3
		Bottom	145
Seal: bentonite		Top	130
		Bottom	133
Pack: sand		Top	133
		Bottom	145
Screen Type: PVC I.D. 4" O.D. 4 1/2"		Top	135
		Bottom	145

WELL CONSTRUCTION SUMMARY

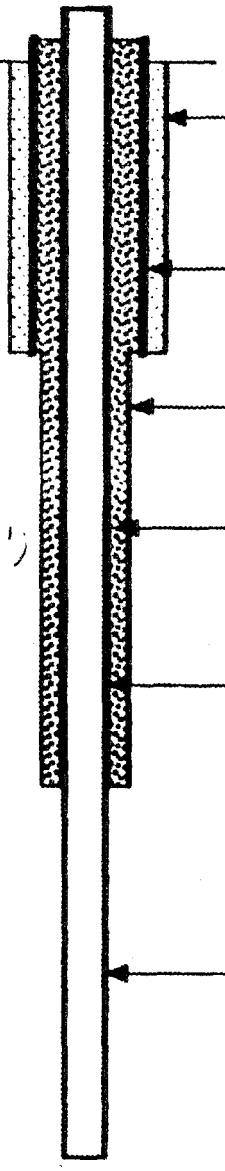
Well Name: Gul 158 **Total Depth:** 441'
Location: SLUDGE DISPOSAL BASIN
Drilled By: A.L. CLARK (CLARK) **Date Completed:** 25 OCT 85
Notes:

Geologic Summary

TOWR - 87'
TOFR - 93

WATER BREAKS
160 (SULFUR)
260 (25 gpm)
310
324

97-98 Cave
(FOAM in CAVE!)



Downhole Depths

Conductor Hole Dia: 15"
Top 0
Bottom 94'

Surface Conductor
Type: STEEL
I.D. 10" **O.D.** 10 3/4"
Top 0
Bottom 94'

Borehole Dia: 10"
Top 94
Bottom 356'

Grout: HALLIBURTON Howco POZMIX A 2%B
Top 2' STICK UP
Bottom 356'

Casing
Type: STEEL
I.D. 6" **O.D.** 6 5/8"
Top 2' STICK UP
Bottom 356'

Open Hole Dia: 6"
Top 356'
Bottom 441'

WELL CONSTRUCTION SUMMARY

Well Name: GW159 **Total Depth:** 157'

Location: SLUDGE DISPOSAL BASIN

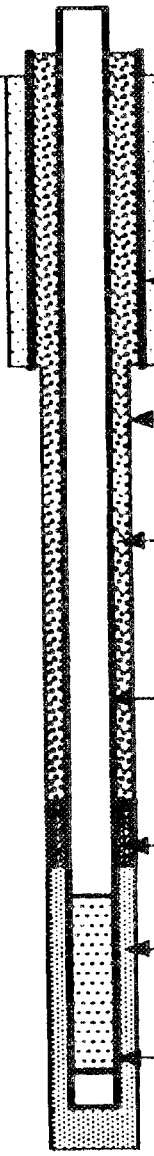
Drilled By: A.L. CLARK (CAMPBELL) **Date Completed:** 18 OCT 85

Notes:

Geologic Summary

T.O.F.R. 100'

CAVE 112'-117'



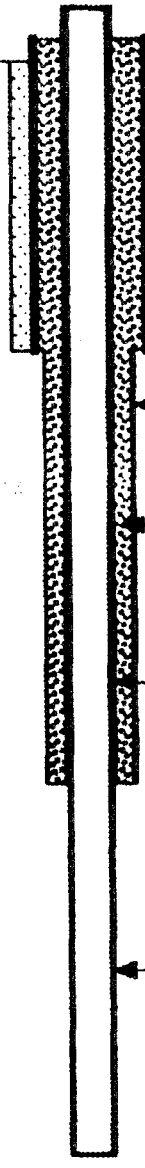
		Downhole Depths	
Conductor Hole Dia: 15"		Top	0
		Bottom	123
Surface Conductor Type: ____ I.D. 10" O.D. 10 3/4"		Top	
		Bottom	123'
Borehole Dia: 8 1/2"		Top	123
		Bottom	157
Filler: Cement, portland Type I			
Casing (with Screen) Type: PVC I.D. 4" O.D. 4 1/2"		Top	+3
		Bottom	157
Seal: bentonite		Top	142
		Bottom	145
Pack: Sand		Top	145
		Bottom	157
Screen Type: PVC I.D. 4" O.D. 4 1/2"		Top	147
		Bottom	157

WELL CONSTRUCTION SUMMARY

Well Name: GW162 **Total Depth:** 125'
Location: SITE US65-1N
Drilled By: A.L. CLARK (CAMPBELL) **Date Completed:** 16Nov85
Notes:

Geologic Summary

T.O.F.R. 12'



		Downhole Depths Top	Bottom
Conductor Hole Dia: 15"		0	26'
Surface Conductor Type: I.D. 10" O.D. 10 3/4"		0	26'
Borehole Dia: 10"		26'	92'
Grout: Cement, Portland type I			
Casing Type: I.D. 6 1/8" O.D. 6 5/8"			92'
Open Hole Dia: 6"		92'	125'

WELL CONSTRUCTION SUMMARY

Well Name: GW163 **Total Depth:** 225'
Location: SITE US65-1N
Drilled By: A.L. CLARK (CAMPBELL) **Date Completed:** 14Nov85
Notes:

Geologic Summary

T.O.F.R. 12'

12 - 200' shale
minor Limestone

152' water
218' water

Downhole Depths

		Top	Bottom
Conductor Hole Dia: 15"		0	34'
Surface Conductor Type: I.D. 10" O.D. 10 3/4"		0	34'
Borehole Dia: 10"		34'	208'
Grout: HALLIBURTON Poz Mix A 2% bentonite			
Casing Type: I.D. 6 1/8" O.D. 6 5/8"			208'
Open Hole Dia: 6"		208'	225'

WELL CONSTRUCTION SUMMARY

Well Name: GW 164 **Total Depth:** 415'

Location: SITE USOS-1N

Drilled By: A.L. CLARK (CAMPBELL) **Date Completed:** 08 Nov 85

Notes:

* Borehole 360-378' @ 8½" dia.

Geologic Summary

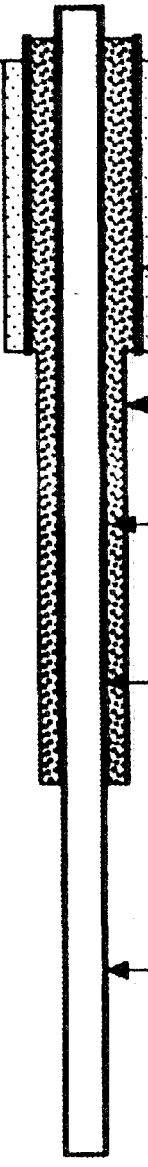
Top of Rock @ 10'

Sand 10-127' Fractures @ 150 to 197 w/ water

Coal @ 197'

280' - 4" cavity

300' - [illegible]



Downhole Depths

	Top	Bottom
Conductor Hole Dia: 15"	0	38'
Surface Conductor — Type: ____ I.D. 10" O.D. 10¾"	0	36'
Borehole Dia: 10" *	38'	370'
Grout: HALLIBURTON [illegible]		
Casing — Type: ____ I.D. 6⅛" O.D. 6⅝"		370'
Open Hole Dia: 6"	378 *	405

WELL CONSTRUCTION SUMMARY

Well Name: 501165 **Total Depth:** 325'

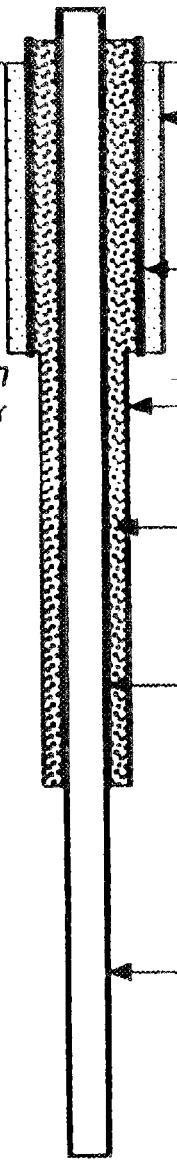
Location: SITE USGS-15

Drilled By: A.L. CLARK (CLARK) **Date Completed:** 27 NOV 85

Notes:

Geologic Summary

TOWR 70'
TOFR 116'
CAVE: 103-113
FRACS: 92-96, 100-102, 312
CAVE @ 314-317 muddy water



Downhole Depths

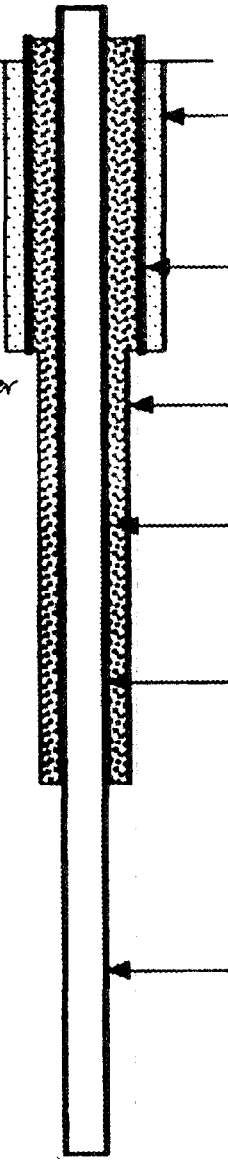
		Top	Bottom
Conductor Hole Dia: 15'		0	119'
Surface Conductor Type: STEEL I.D. 10 O.D. 10 3/4		0	119'
Borehole Dia: 10"		119'	276'
Grout: HALLIBURTON POZ MIX 2% BEN			
Casing Type: STEEL I.D. 6 O.D. 6 5/8		1' stickup	276'
Open Hole Dia: 6"		276.0	325.0

WELL CONSTRUCTION SUMMARY

Well Name: 6W166 **Total Depth:** 385'
Location: SITE USGS-15
Drilled By: A.L. CLARK (CLARK) **Date Completed:** 12Nov85
Notes:

Geologic Summary

TOWR 50'
TOFR 67'
FRACS 287-290
320-323
CAVE/FRACS
358-363
muddy water
>200 gpm



Downhole Depths

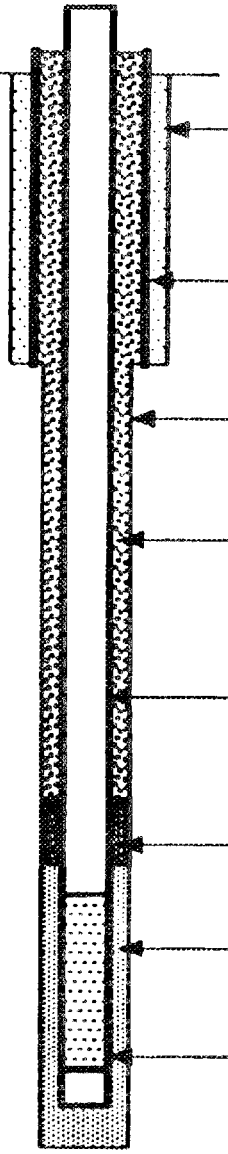
		Top	Bottom
Conductor Hole Dia: 15"		0	96'
Surface Conductor Type: STEEL I.D. 10" O.D. 10¾"		0	96'
Borehole Dia: 10"		96'	380'
Grout: HALLIBURTON FLOW CHEK BENTONITE			
Casing Type: STEEL I.D. 6" O.D. 6⅝"		2' STICKUP	380'
Open Hole Dia: 6"		380	385

WELL CONSTRUCTION SUMMARY

Well Name: GW 173 **Total Depth:** 165'
Location: CHESTNUT RIDGE SECURITY PITS
Drilled By: A.L. CLARK **Date Completed:** 15 AUG 85
Notes:

Geologic Summary

TCWR 73'
TDFR 105'
FRAC @ 103.6
CAVE 108.6
140-141



		Downhole Depths	
Conductor Hole Dia: 15"		Top	0'
		Bottom	74'
Surface Conductor Type: STEEL I.D. 10" O.D. 10 3/4"		Top	0'
		Bottom	73.1'
Borehole Dia: 10"		Top	74'
		Bottom	165'
Filler: CEMENT, CLASS A			
Casing (with Screen) Type: stainless steel, 304 I.D. 4" O.D. 4 1/2"		Top	74'
		Bottom	165'
Seal: BENTONITE		Top	152'
		Bottom	154'
Pack: SAND		Top	154'
		Bottom	165'
Screen Type: stainless steel, Johnson I.D. 4" O.D. 4 1/2"		Top	155'
		Bottom	165'

WELL CONSTRUCTION SUMMARY

Well Name: GW 174 **Total Depth:** 145'

Location: CHESTNUT RIDGE SECURITY PITS

Drilled By: A.L. CLARK (CLARK) **Date Completed:** 15 AUG 85

Notes:

Geologic Summary

TOWR: 51

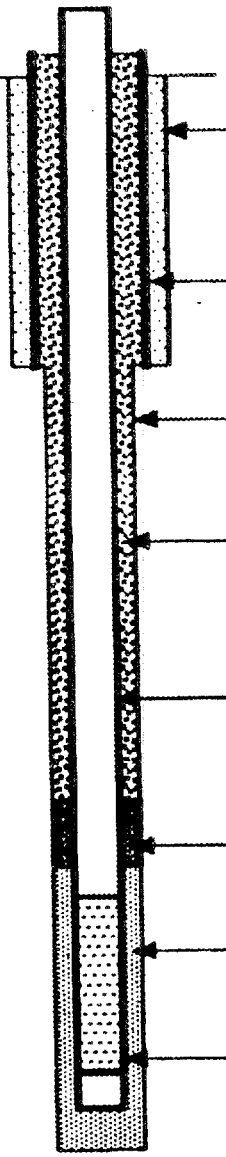
TOFR: 80

CAVG 63-79.6

91

140

FRAC @ 143



		Downhole Depths	
Conductor Hole Dia: 15"		Top	0'
		Bottom	80
Surface Conductor Type: STEEL I.D. 10 O.D. 10 3/4		Top	0'
		Bottom	80'
Borehole Dia: 10"		Top	80'
		Bottom	145'
Filler: CEMENT, TYPE 1			
Casing (with Screen) Type: STAINLESS STEEL, 304 I.D. 4" O.D. 4 1/2"		Top	80'
		Bottom	145'
Seal: BENTONITE		Top	132
		Bottom	134
Pack: SAND		Top	134
		Bottom	145
Screen Type: STAINLESS STEEL, 304 I.D. 4" O.D. 4 1/2"		Top	135
		Bottom	145

WELL CONSTRUCTION SUMMARY

Well Name: SCU 176 **Total Depth:** 145'
Location: CHESTNUT RIDGE SECURITY PITS
Drilled By: A.L. CLARK **Date Completed:** 27AUG85
Notes:

Geologic Summary

TOFR 84'

		Downhole Depths Top	Bottom
Conductor Hole Dia: 15'		0	89.6
Surface Conductor Type: STEEL I.D. 10" O.D. 10 3/4"		0'	88'
Borehole Dia: 10"		89.6'	145'
Filler: CEMENT, TYPE 1			
Casing (with Screen) Type: STAINLESS STEEL 304 I.D. 4" O.D. 4 1/2"		3' stickup	145'
Seal: BENTONITE		132	134
Pack: SAND		134	145
Screen Type: STAINLESS STEEL I.D. 4" O.D. 4 1/2"		135	145

WELL CONSTRUCTION SUMMARY

Well Name: GW 177 **Total Depth:** 145

Location: CHESTNUT RIDGE SECURITY PIT

Drilled By: A.L. CLARK (CAMPBELL) **Date Completed:** 24 OCT 85

Notes:

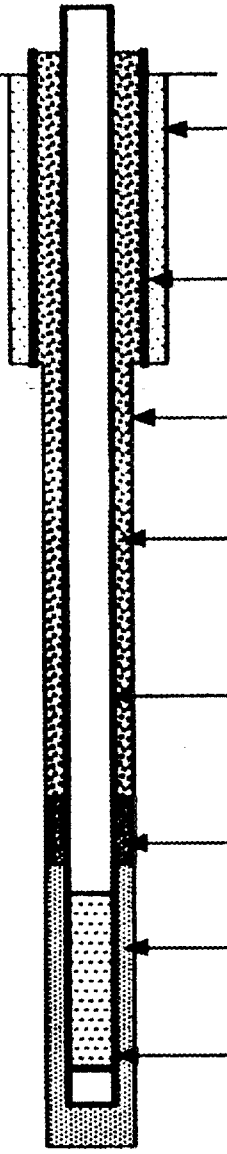
Geologic Summary

Top of Rock - 62'

Cavity 68 - 73'

96 - 97.5'

Fractures 130 - 133'



		Downhole Depths	
Conductor Hole Dia: 15"		Top	0
		Bottom	82'
Surface Conductor Type: ____ I.D. 10" O.D. 10 3/4"		Top	
		Bottom	82'
Borehole Dia: 8"		Top	82'
		Bottom	145'
Filler: Cement, Portland Class I			
Casing (with Screen) Type: PVC I.D. 4" O.D. 4 1/2"		Top	+3
		Bottom	143
Seal: bentonite		Top	127
		Bottom	130
Pack: SAND		Top	130
		Bottom	145.0'
Screen Type: PVC I.D. 4" O.D. 4 1/2		Top	133'
		Bottom	143'

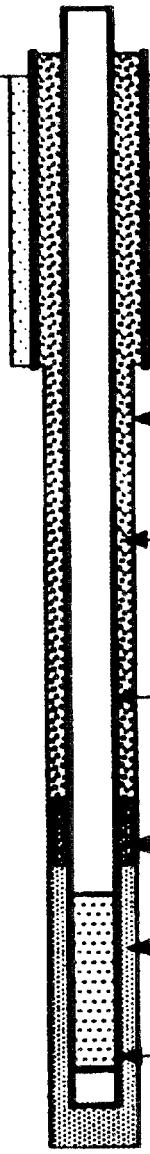
WELL CONSTRUCTION SUMMARY

Well Name: SCW 124 **Total Depth:** 117'

Location: CHESTNUT RIDGE SECURITY PITS

Drilled By: A.L. CLARK (CAMPBELL) **Date Completed:** 03 DEC 85

Notes:



Downhole Depths

Conductor Hole Dia: 15"

Top	0
Bottom	78'

Surface Conductor
Type: STEEL
I.D. 10 **O.D.** 10 3/4

Top	0
Bottom	76'

Borehole Dia: 8"

Top	
Bottom	117'

Filler: CEMENT, CLASS A

Casing (with Screen)
Type: STAINLESS STEEL, 304
I.D. 4" **O.D.** 4 1/2"

Top	
Bottom	117'

Seal: BENTONITE

Top	104'
Bottom	106'

Pack: SAND

Top	106'
Bottom	117'

Screen
Type: STAINLESS STEEL
I.D. 4" **O.D.** 4 1/2

Top	107'
Bottom	117'

Geologic Summary

WELL CONSTRUCTION SUMMARY

Well Name: SW 184 **Total Depth:** 130'

Location: Rogers Quarry

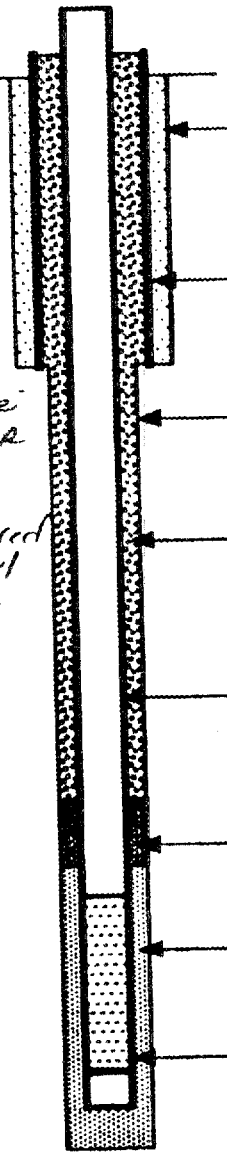
Drilled By: GEOTEK (R M. Collins) **Date Completed:** 15 Nov 85

Notes:

Geologic Summary

115' fractured w/ water

126 - 130 fractured zone w/ water



		Downhole Depths Top	Bottom
Conductor Hole Dia: 16"		0	8'
Surface Conductor Type: PVC, sch 40 I.D. 9 7/8" O.D. 10 7/8"		0	8'
Borehole Dia: 10"		8'	130'
Filler: CEMENT, Portland Type I			
Casing (with Screen) Type: PVC, sch 40 I.D. 4" O.D. 4 1/2"			127.5'
Seal: BENTONITE		98'	101.5'
Pack: SAND		101.5'	130.0'
Screen Type: PVC, sch 40 I.D. 4" O.D. 4 1/2"		107.5	127.5'

WELL CONSTRUCTION SUMMARY

Well Name: GW 195 **Total Depth:** 471.5
Location: ROGERS QUARRY
Drilled By: GEOTEK (R.A. COLLINS) **Date Completed:** 10 Dec 85
Notes:

Geologic Summary

TOWR 5.0
TOFR 17.0
Frac Q
73' 20-30 gpm
170' water
366 freshwater
oil smell

Downhole Depths

Conductor Hole Dia: 16"

Top	0
Bottom	17

Surface Conductor
Type: PVC
I.D. 10" **O.D.** 10 5/8

Top	0
Bottom	17

Borehole Dia: 10"

Top	0
Bottom	405

Grout: HALLIBURTON, POZMIX A

Casing
Type: Steel
I.D. 6" **O.D.** 6 5/8"

Top	+1.0
Bottom	405

Open Hole Dia: 6.0"

Top	405
Bottom	471.5

WELL CONSTRUCTION SUMMARY

Well Name: Sul 186 **Total Depth:** 171'
Location: Rogers Quarry
Drilled By: GEOTEK (R.M. Collins) **Date Completed:** 20 Dec 85
Notes:

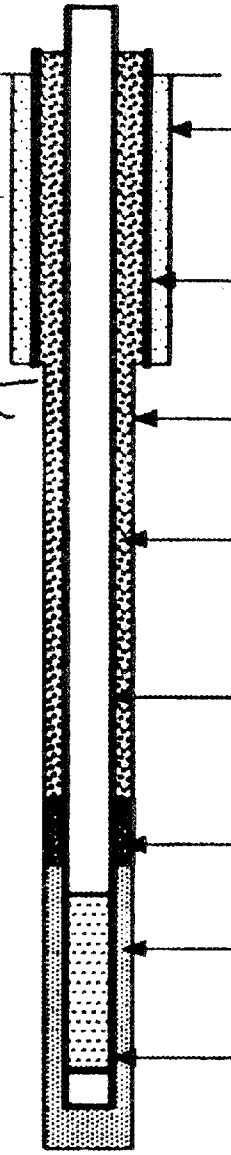
Geologic Summary

TOUR 12.0
TOFR 14.5

Frac @
25 w
164-169 W

Limestone & Shale
12-25

Limestone
25-171



		Downhole Depths	
Conductor Hole Dia: 15"		Top	0
		Bottom	14.5
Surface Conductor Type: PVC, sch #40 I.D. 10" O.D. 10 5/8		Top	0
		Bottom	14.5
Borehole Dia: 10"		Top	14.5
		Bottom	171.0
Filler: Cement, Type I			
Casing (with Screen) Type: PVC, sch #40 I.D. 4.0 O.D. 4 1/2		Top	+1.0
		Bottom	170.0
Seal: bentonite		Top	139.0
		Bottom	142.0
Pack: Sand		Top	142.0
		Bottom	171.0
Screen Type: PVC, slotted I.D. 4 O.D. 4 1/2		Top	150.0
		Bottom	170.0

WELL CONSTRUCTION SUMMARY

Well Name: Gw 187 **Total Depth:** 162'

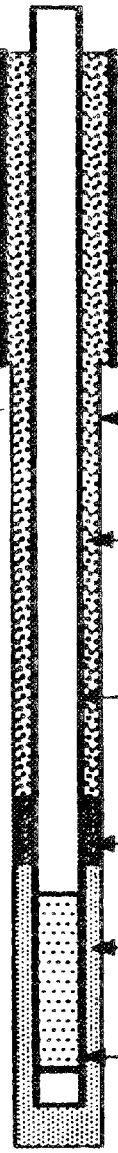
Location: ROGERS QUARRY

Drilled By: GEOTECH (R.M. COLLINS) **Date Completed:** 04 Dec 85

Notes:

Geologic Summary

TOWR 7'
TOFR 15'
Fract @ 92(w)
18-121(w)
{134-135(w)
159-160(w)
each > 25 gpm
Shale & Limestone
15-92
Gray Limestone
92-160



Downhole Depths

		Top	Bottom
Conductor Hole Dia: 15'		0	7'
Surface Conductor	Type: PVC sch; I.D. 10"; O.D. 10 3/8"	0	7'
Borehole Dia: 10"		7'	162.0'
Filler: CEMENT			
Casing (with Screen)	Type: PVC, sch 40; I.D. 4"; O.D. 4 1/2"	3' stickup	162.0'
Seal: BENTONITE		136.5'	139.0'
Pack: SAND		139.0'	162.0'
Screen	Type: PVC sch 40; I.D. 4"; O.D. 4 1/2"	147.0'	162.0'

WELL CONSTRUCTION SUMMARY

Well Name: GW 188 **Total Depth:** 68'

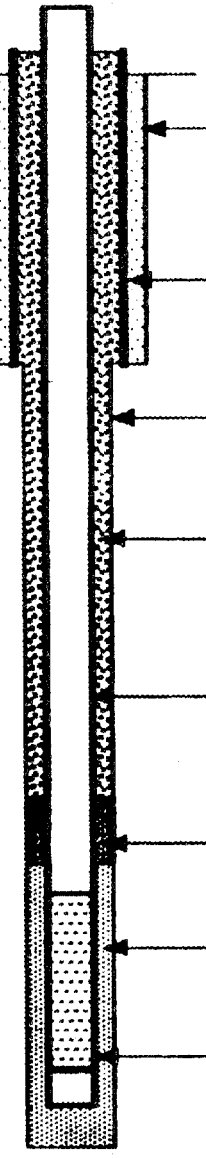
Location: ROGERS QUARRY

Drilled By: GEOTEK (RANDY COLLINS) **Date Completed:** 03 OCT 85

Notes:

Geologic Summary

Weathered rock at 13'
Solid rock at 14'
Cavity 27-29' w/ muddy water
Fractured zones
47-48'
55-58.5'
60-68'
lost circulation at 60' and 70'



		Downhole Depths	
Conductor Hole Dia: 11'		Top	0
		Bottom	68'
Surface Conductor Type: PVC #40 I.D. 9 7/8" O.D. 10 5/8"		Top	0
		Bottom	15'
Borehole Dia:		Top	0
		Bottom	68'
Filler: Grout, Portland Type I			
Casing (with Screen) Type: PVC #40 I.D. 4" O.D. 4 1/2"		Top	Above Surface 3'
		Bottom	
Seal: Bentonite		Top	47.5'
		Bottom	49'
Pack: Sand		Top	49'
		Bottom	68'
Screen Type: PVC #40 I.D. 4" O.D. 4 1/2"		Top	52.5'
		Bottom	67.5'

WELL CONSTRUCTION SUMMARY

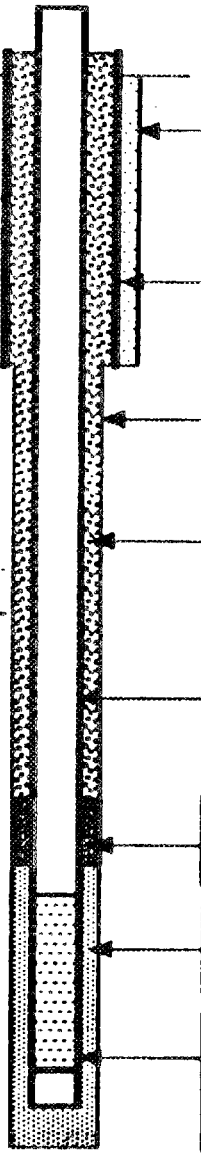
Well Name: GW-199 **Total Depth:** 210'
Location: ROGERS QUARRY
Drilled By: GEOTEK (R.M. COLLINS) **Date Completed:** 18 Dec 85
Notes:

Geologic Summary

TOWR 17.0
TOFR 19.0

Frac @
44 (W)
143-145 W
164-165
170 (W)
200 W

R-170 Limestone
170-210 Limestone & Chert



		Downhole Depths	
Conductor Hole Dia: 15"		Top	0
		Bottom	19.0
Surface Conductor Type: PVC, sch #40 I.D. 10" O.D. 10 5/8"		Top	0
		Bottom	19.0
Borehole Dia: 10"		Top	19.0
		Bottom	210.0
Filler: Cement, type I			
Casing (with Screen) Type: PVC, sch #40 I.D. 4" O.D. 4 1/2"		Top	+1.0
		Bottom	210.0
Seal: bentonite		Top	176.0
		Bottom	180.0
Pack: sand		Top	180.0
		Bottom	210.0
Screen Type: PVC, slotted I.D. 4 O.D. 4 1/2		Top	190.0
		Bottom	210.0

WELL CONSTRUCTION SUMMARY

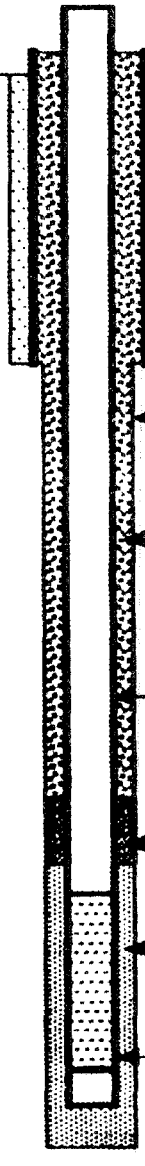
Well Name: S.J 191 **Total Depth:** 60.5'

Location: BETA 4 SECURITY PIT

Drilled By: GEOTEK (R.M. COWINS) **Date Completed:** 29 OCT 85

Notes:

Geologic Summary



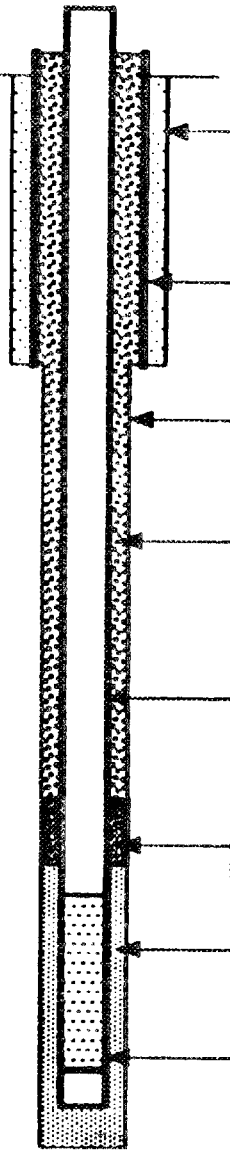
		Downhole Depths Top	Downhole Depths Bottom
Conductor Hole Dia:			
Surface Conductor Type: PVC (#40) I.D. 11 3/4" O.D. 12 1/2"		0'	17'
Borehole Dia: 11"			60.5'
Filler: Grout			
Casing (with Screen) Type: PVC (#40) I.D. 4" O.D. 4 1/2"		Above surface	60'
Seal: BENTONITE		42'	45'
Pack: SAND		45'	60.5'
Screen Type: PVC (#40) I.D. 4" O.D. 4 1/2"		49.5	59.5

WELL CONSTRUCTION SUMMARY

Well Name: GW 192 **Total Depth:** 17.5'
Location: BETA 4 SECURITY PIT
Drilled By: GEOTEK (GOSSAGE) **Date Completed:** 30 Sep 85
Notes:

Geologic Summary

TOWR 175



		Downhole Depths Top	Downhole Depths Bottom
Conductor Hole Dia: NONE		—	—
Surface Conductor Type: ____ I.D. ____ O.D. ____		—	—
Borehole Dia: 6"		0	17.5
Filler: CEMENT, TYPE			
Casing (with Screen) Type: PVC, sch #40 I.D. 4" O.D. 4½"			17.5
Seal: BENTONITE		4.5	6.5
Pack: SAND		6.5	17.5
Screen Type: PVC I.D. 4" O.D. 4½		7.5	17.5

WELL CONSTRUCTION SUMMARY

Well Name: GW 194 **Total Depth:** 12.5'+

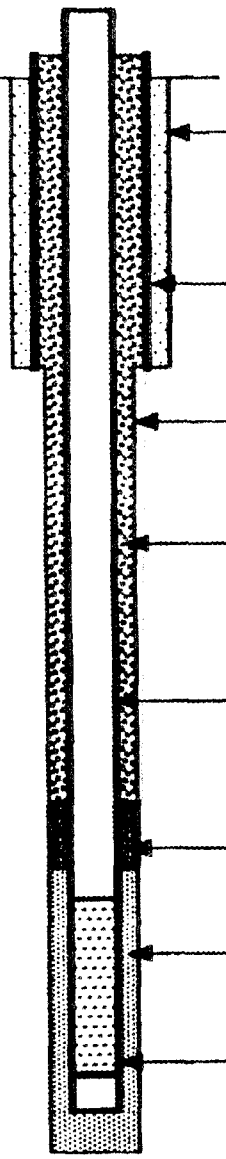
Location: BETA 4 SECURITY PIT

Drilled By: GEOTOK (GOSSAGE) **Date Completed:** 30 SEP 85

Notes:

Geologic Summary

TOWR 12.5



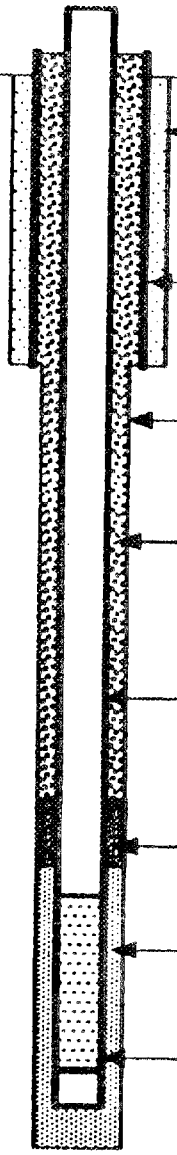
		Downhole Depths	
Conductor Hole Dia: NONE		Top	—
		Bottom	—
Surface Conductor Type: I.D. O.D.		Top	—
		Bottom	—
Borehole Dia: 8"		Top	0
		Bottom	12.5'
Filler: CEMENT, TYPE 1			
Casing (with Screen) Type: PVC, sch 40 I.D. 4" O.D. 4½"		Top	
		Bottom	12.5'
Seal: BENTONITE		Top	4.5
		Bottom	6.5
Pack: SAND		Top	6.5
		Bottom	12.5
Screen Type: PVC, sch 40 I.D. 4" O.D. 4½"		Top	7.5
		Bottom	12.5

WELL CONSTRUCTION SUMMARY

Well Name: GW 195 **Total Depth:** 23.0'
Location: BETA 4 SECURITY PIT
Drilled By: GEOTEK (GOSSAGE) **Date Completed:** 30Sep85
Notes:

Geologic Summary

TOWR 23



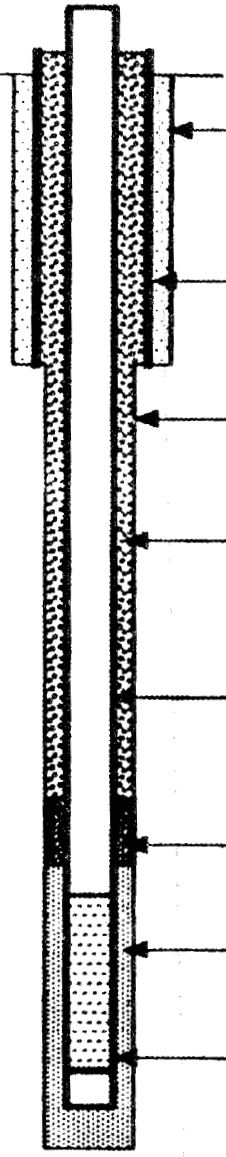
		Downhole Depths	
Conductor Hole Dia: NONE		Top	—
		Bottom	—
Surface Conductor Type: I.D. O.D.		Top	—
		Bottom	—
Borehole Dia: 6"		Top	0
		Bottom	23.0'
Filler: CEMENT			
Casing (with Screen) Type: PVC, sch 40 I.D. 4" O.D. 4½		Top	
		Bottom	23.0'
Seal: BENTONITE		Top	13.0'
		Bottom	15.0
Pack: SAND		Top	15.0
		Bottom	23.0'
Screen Type: PVC, sch 40 I.D. 4" O.D. 4½		Top	17.0'
		Bottom	23.0'

WELL CONSTRUCTION SUMMARY

Well Name: GW 196 **Total Depth:** 27.0'
Location: BETA 4 SECURITY PIT
Drilled By: GEOTEK (GOSSAGE) **Date Completed:** 30Sep88
Notes:

Geologic Summary

TOWR 27.0



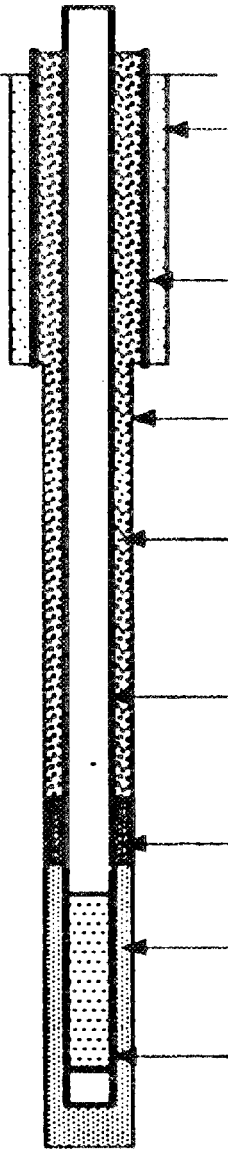
		Downhole Depths Top	Bottom
Conductor Hole Dia: NONE		—	—
Surface Conductor Type: I.D. O.D.		—	—
Borehole Dia: 8"		0'	27.0
Filler: CEMENT, TYPE 1			
Casing (with Screen) Type: PVC I.D. 4" O.D. 4½"			27.0
Seal: BENTONITE		19.0'	21.0'
Pack: SAND		21.0'	27.0'
Screen Type: PVC, sch 40 I.D. 4" O.D. 4½"		22.0'	27.0'

WELL CONSTRUCTION SUMMARY

Well Name: Well K17 **Total Depth:** 17.0'
Location: Beta 4 Security Pit
Drilled By: Geotek (Gossage) **Date Completed:** 30 Sep 85
Notes:

Geologic Summary

TOWR 17.0'



		Downhole Depths Top	Downhole Depths Bottom
Conductor Hole Dia: NONE			
Surface Conductor Type: ____ I.D. ____ O.D. ____			
Borehole Dia: 6"		0'	17.0
Filler: CEMENT			
Casing (with Screen) Type: PVC, sch 40 I.D. 4" O.D. 4½"			12.0'
Seal: BENTONITE		9.0'	11.0'
Pack: SAND		11.0'	12.0'
Screen Type: PVC sch 40 I.D. 4" O.D. 4½		12.0'	17.0'

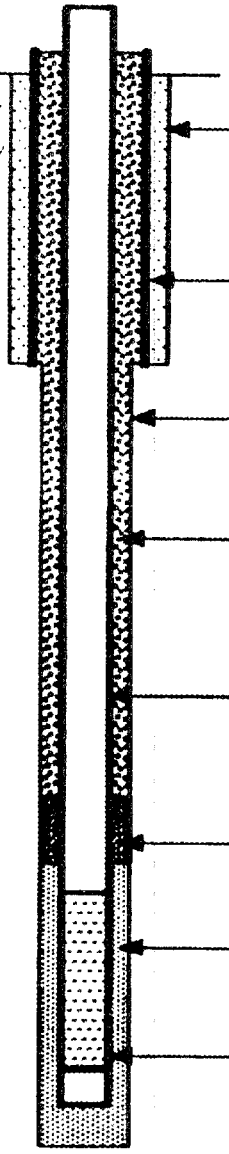
WELL CONSTRUCTION SUMMARY

Well Name: GW 192 **Total Depth:** 26.5'
Location: RAVINE DISPOSAL SITE
Drilled By: GEOTEK (605546E) **Date Completed:** 11SEP85
Notes:

Geologic Summary

T.O.W.S. 0.6'
T.O.F.R. 26.5'

water at 22'



Downhole Depths

Conductor Hole Dia: NA — Top: - Bottom: -

Surface Conductor
Type: NA
I.D. - **O.D.** -
Top: - Bottom: -

Borehole Dia: 8" (MICER) — Top: 0' Bottom: 26.5'

Filler: CEMENT

Casing (with Screen)
Type: PVC
I.D. 4" **O.D.** 4½"
Top: Bottom: 26.5

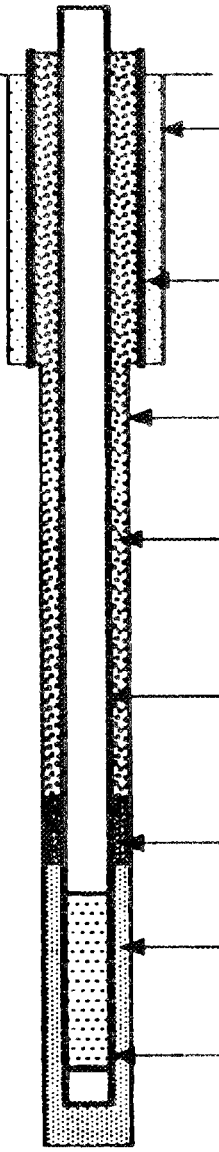
Seal: BENTONITE — Top: 13.5 Bottom: 15.5

Pack: SAND — Top: 15.5 Bottom: 26.5

Screen
Type: PVC
I.D. 4" **O.D.** 4½"
Top: 16.5 Bottom: 26.5

WELL CONSTRUCTION SUMMARY

Well Name: GW 199 **Total Depth:** 22.5'
Location: RAVINE DISPOSAL SITE
Drilled By: GEOTEK (GOSSAGE) **Date Completed:** 11 Sep 85
Notes:



Geologic Summary

T.O.W.R. 0.5'
water @ 15'
T.O.F.S. 22.5'

		Downhole Depths	
Conductor Hole Dia: NA		Top	-
		Bottom	-
Surface Conductor Type: NA I.D. - O.D. -		Top	-
		Bottom	-
Borehole Dia: 8" (AUGER)		Top	0'
		Bottom	22.5'
Filler: CEMENT			
Casing (with Screen) Type: PVC I.D. 4" O.D. 4 1/2		Top	
		Bottom	22.5
Seal: BENTONITE		Top	14.5
		Bottom	16.5
Pack: SAND		Top	16.5
		Bottom	22.5
Screen Type: PVC I.D. 4" O.D. 4 1/2"		Top	17.5
		Bottom	22.5

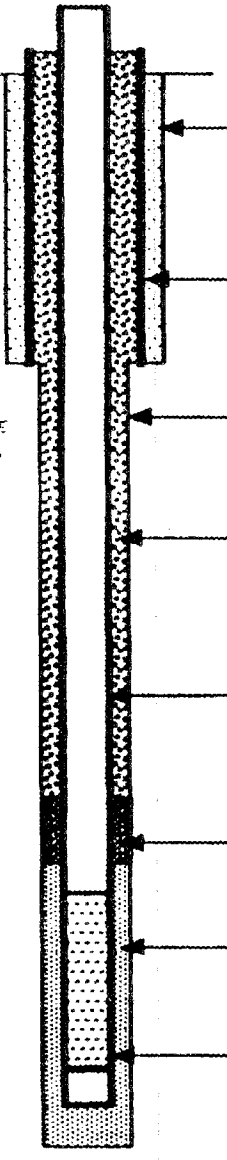
WELL CONSTRUCTION SUMMARY

Well Name: GW 200 **Total Depth:** 57.5'
Location: RAVINE DISPOSAL SITE
Drilled By: GEOTEK (R.M. COLLINS) **Date Completed:** 30 OCT 85
Notes:

Geologic Summary

T.O.F.R. - 19'

FRACTURED ZONE



		Downhole Depths Top	Downhole Depths Bottom
Conductor Hole Dia:			
Surface Conductor Type: PVC (#40) I.D. 11 3/4" O.D. 12 1/2"		0'	19'
Borehole Dia: 11"			57.5'
Filler: Cement, Portland Type I			
Casing (with Screen) Type: PVC (#40) I.D. 4" O.D. 4 1/2"		Above Surface 2.5'	57.5'
Seal: Bentonite		41.2'	44'
Pack: Sand		44'	57.5'
Screen Type: PVC (#40) I.D. 4" O.D. 4 1/2"		47'	57'

WELL CONSTRUCTION SUMMARY

Well Name: GW 201 **Total Depth:** 21.0'

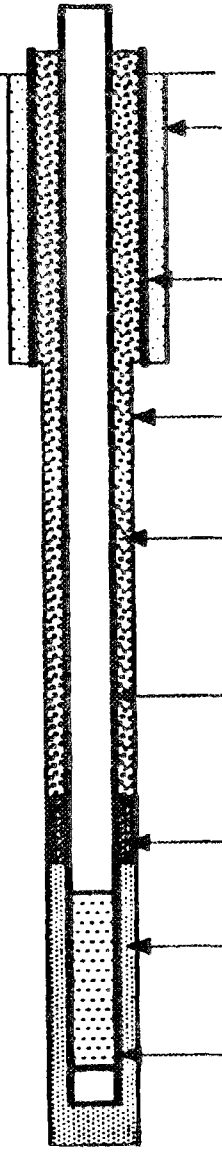
Location: RAVINE DISPOSAL SITE

Drilled By: GEOTEK (GOSSAGE) **Date Completed:** 14 SEP 85

Notes:

Geologic Summary

T.O.W.R. 2.5'
WATER @ 17'
T.O.F.R. 21'



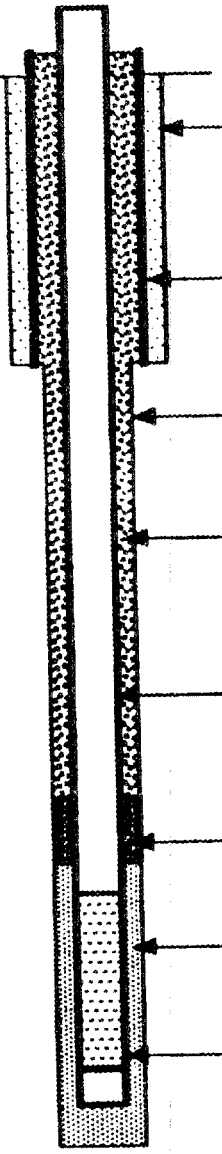
		Downhole Depths	
Conductor Hole Dia: NA		Top	-
		Bottom	-
Surface Conductor Type: NA I.D. - O.D. -		Top	-
		Bottom	-
Borehole Dia: 8" (AUGER)		Top	0'
		Bottom	21.0'
Filler: CEMENT			
Casing (with Screen) Type: PVC I.D. 4 O.D. 4½		Top	
		Bottom	21.0
Seal: BENTONITE		Top	13.0
		Bottom	15.0
Pack: SAND		Top	15.0
		Bottom	21.0
Screen Type: PVC I.D. 4" O.D. 4½"		Top	16.0
		Bottom	21.0

WELL CONSTRUCTION SUMMARY

Well Name: SW-202 **Total Depth:** 20.1'
Location: RAVINE DISPOSAL SITE
Drilled By: GEOTEK (GOSSAGE) **Date Completed:** 12 Sep 85
Notes:

Geologic Summary

T.O.W.R. 0.3'
water @ 17.0'
T.O.F.R. 20.1'



		Downhole Depths	
Conductor Hole Dia: NA		Top	-
		Bottom	-
Surface Conductor Type: NA I.D. - O.D. -		Top	-
		Bottom	-
Borehole Dia: 8" (AUGER)		Top	0'
		Bottom	20.1'
Filler: cement, portland, type I			
Casing (with Screen) Type: PVC I.D. 4" O.D. 4½"		Top	
		Bottom	20.1
Seal: BENTONITE		Top	12.1
		Bottom	14.1
Pack: SAND		Top	14.1
		Bottom	20.1
Screen Type: PVC I.D. 4" O.D. 4½"		Top	15.1
		Bottom	20.1

WELL CONSTRUCTION SUMMARY

Well Name: SW 203 **Total Depth:** 156'

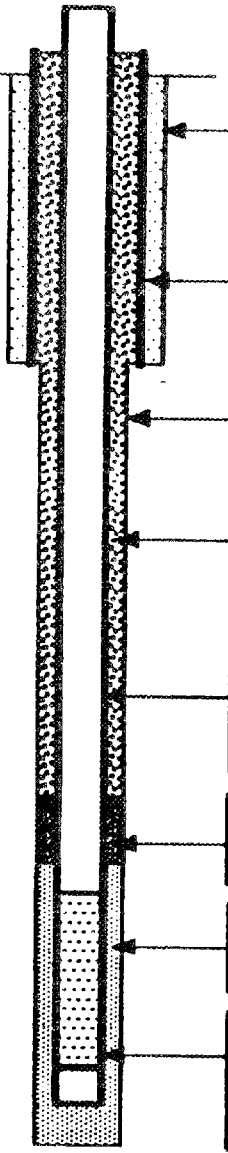
Location: UNITED NUCLEAR SITE

Drilled By: A.L. CLARK (CAMPBELL) **Date Completed:** 24 OCT 85

Notes:

Geologic Summary

Top of Rock 56'



		Downhole Depths	
Conductor Hole Dia: 15"		Top	0'
		Bottom	94'
Surface Conductor Type: steel I.D. 10" O.D. 10 3/4"		Top	
		Bottom	94'
Borehole Dia: 8 1/2"		Top	94'
		Bottom	156'
Filler: cement, portland, type I			
Casing (with Screen) Type: PVC I.D. 4" O.D. 4 1/2"		Top	+3
		Bottom	156'
Seal: bentonite		Top	141
		Bottom	144
Pack: Sand		Top	144
		Bottom	156
Screen Type: PVC I.D. 4" O.D. 4 1/2"		Top	146'
		Bottom	156'

WELL CONSTRUCTION SUMMARY

Well Name: GW 205 **Total Depth:** 164'

Location: UNITED NUCLEAR SITE

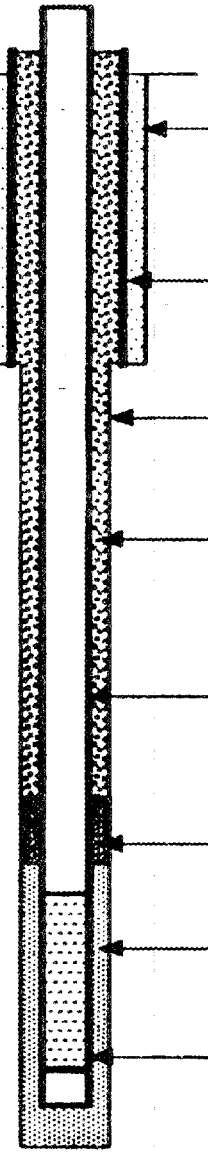
Drilled By: GEOTEK (CAMPBELL) **Date Completed:** 25 Oct 85

Notes:

Geologic Summary

T.O.W.S. 100'
T.O.F.P. 100

Fracture @ 159' of water



		Downhole Depths	
Conductor Hole Dia: 15"		Top	0
		Bottom	154'
Surface Conductor Type: steel I.D. 10" O.D. 12 3/4"		Top	0'
		Bottom	154'
Borehole Dia: 10"		Top	154'
		Bottom	164'
Filler: CEMENT, PORTLAND, TYPE I			
Casing (with Screen) Type: PVC I.D. 4" O.D. 4 1/2"		Top	+3
		Bottom	164'
Seal: BENTONITE		Top	149
		Bottom	152
Pack: SAND		Top	152
		Bottom	164
Screen Type: PVC I.D. 4" O.D. 4 1/2"		Top	154'
		Bottom	164'

WELL CONSTRUCTION SUMMARY

Well Name: GW 220 **Total Depth:** 45.2'

Location: New Hope Pond

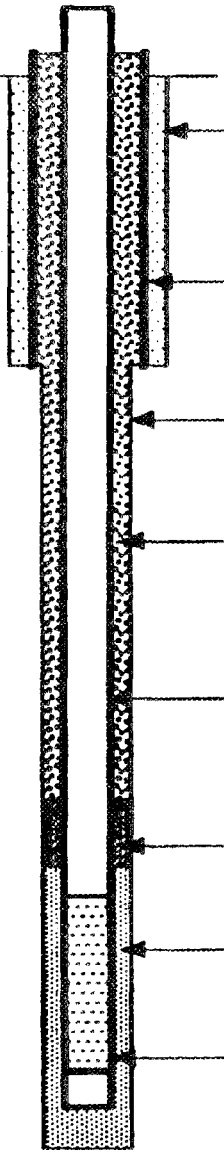
Drilled By: GeoTek (Randy Collins) **Date Completed:** 22 Aug 85

Notes:

Geologic Summary

Sand Pack @ 11' w/ water

25' - T.D. mod. to dark gray micrite



Downhole Depths

Conductor Hole Dia: 16 3/4"

Top	0
Bottom	13'

Surface Conductor
Type: PVC #40
I.D. 11 3/4" **O.D.** 12 1/2"

Top	0
Bottom	13'

Borehole Dia: 11"

Top	13'
Bottom	45.2'

Filler: Grout, Portland Type I

Casing (with Screen)
Type: PVC #40
I.D. 4" **O.D.** 4 1/2"

Top	Above Surface 3'
Bottom	45.2'

Seal: Bentonite

Top	28'
Bottom	31'

Pack: Sand (~3 ft of cuttings)

Top	31'
Bottom	45.2

Screen
Type: PVC #40
I.D. 4" **O.D.** 4 1/2"

Top	34.7'
Bottom	44.7

WELL CONSTRUCTION SUMMARY

Well Name: GW 221 **Total Depth:** 158'

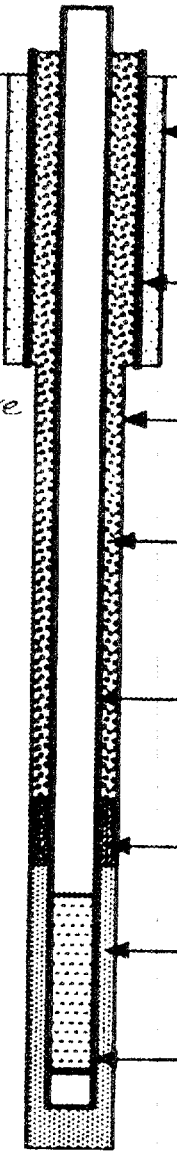
Location: UNITED NUCLEAR SITE

Drilled By: A.L. CLARK (CAMPBELL) **Date Completed:** 24 OCT 85

Notes:
92' of 6 5/8" OD F-25 casing grouted between 0-92 ft.

Geologic Summary

T.O.W.R.
T.O.F.R.
36-80' solid rx w/ large mud seams
153' - 4" fracture
146-153' LS
153-158' chert



Downhole Depths

	Top	Bottom
Conductor Hole Dia: 15"	0	42'
Surface Conductor — Type: steel; I.D. 10"; O.D. 12 3/4"		42'
**		
Borehole Dia: 6"	92'	158'
Filler: CEMENT, PORTLAND, TYPE I		
Casing (with Screen) — Type: PVC; I.D. 4"; O.D. 4 1/2"	+3	158'
Seal: Bentonite	143	146
Pack: Sand	140	158
Screen — Type: PVC; I.D. 4"; O.D. 4 1/2"	142'	158'

WELL CONSTRUCTION SUMMARY

Well Name: SW 222 **Total Depth:** 25'

Location: New Hope Pond

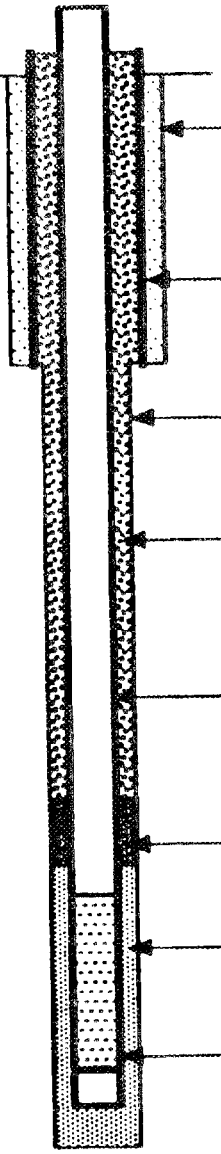
Drilled By: GEOTEK (Randy Collins) **Date Completed:** 24 Aug 85

Notes:

Geologic Summary

Solid Rock @ 10'

Fractured zone/ cavity @ ~19'; adjacent waste pond begins to drain.



		Downhole Depths Top	Downhole Depths Bottom
Conductor Hole Dia:	16 3/4"	0	11'
Surface Conductor Type: PVC #40 I.D. 11 3/4" O.D. 13 1/2"		0	11'
Borehole Dia:	11"	11'	25'
Filler:	Grout, Portland Type I		
Casing (with Screen) Type: PVC #40 I.D. 4" O.D. 4 1/2"		Above Surface 3'	25'
Seal:	Bentonite	16'	18'
Pack:	Sand	18'	25'
Screen Type: PVC #40 I.D. 4" O.D. 4 1/2"		19.5'	24.5'

WELL CONSTRUCTION SUMMARY

Well Name: GJ 222 **Total Depth:** 90.5'

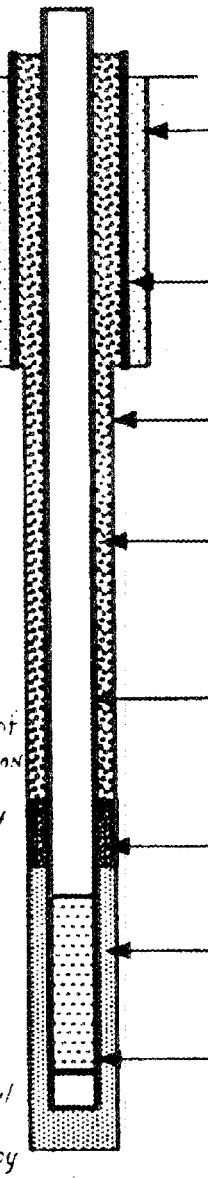
Location: New Hope Pond

Drilled By: GEOTEK (Randy Collins) **Date Completed:** 21 Aug 85

Notes:

Geologic Summary

Solid rock @ 10'
Mr gray micrite
rock @ 17'
68 - micrite
68' - micrite w/ shale, spotty calcite veined
71' - micrite, minor shale
Fractured zones per driller:
7-10'
34 - 34.5
36 - 36.5'
37 - 37.5'
38 - 39'
*37 - 37' - mud in fracture; making lots of water; solution surfaces on cuttings; soft & broken up to 65'
66 - 67'
68.5 - 69.5'
*Borehole appears to be in communication w/ waste pond to SW, probably by way of fractures at this level or above.



		Downhole Depths Top	Bottom
Conductor Hole Dia: 16 3/4		0	11'
Surface Conductor Type: PVC #40 I.D. 11 3/4" O.D. 12 1/2"		0	11'
Borehole Dia: 11"		11'	90.5
Filler: Grout, Portland Type I			
Casing (with Screen) Type: PVC #40 I.D. 4" O.D. 4 1/2"		Above Surface 3'	90.5'
Seal: Bentonite		76.5'	79'
Pack: Sand		79'	90.5'
Screen Type: PVC #40 I.D. 4" O.D. 4 1/2"		80'	90'

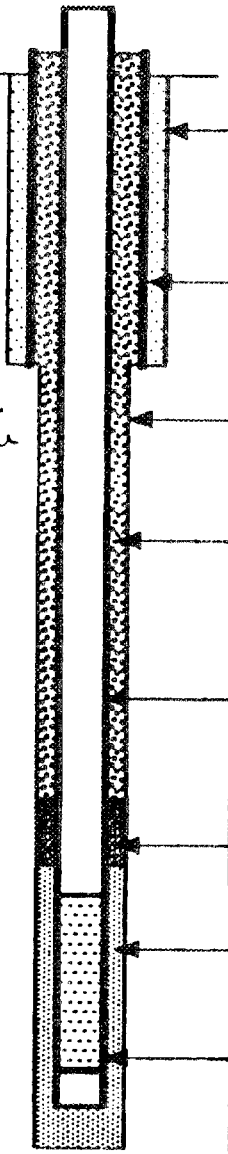
WELL CONSTRUCTION SUMMARY

Well Name: GW 224 **Total Depth:** 126'
Location: ROGERS QUARRY
Drilled By: GEOTEK (R.M COLLINS) **Date Completed:** 21Nov85
Notes:

Geologic Summary

TOWR 7'
TOFR 18'
FRAC @ 115-120 (W, sol)
> 25 gpm

18-126
Blue-green shale and Limestone



		Downhole Depths	
Conductor Hole Dia: 16"		Top	0
		Bottom	7'
Surface Conductor Type: PVC, sch 40 I.D. 12" O.D. 12 3/4		Top	0
		Bottom	7'
Borehole Dia: 10"		Top	70'
		Bottom	126.0'
Filler: CEMENT			
Casing (with Screen) Type: PVC, sch 40 I.D. 4" O.D. 4 1/2"		Top	3' stickup
		Bottom	126.0'
Seal: BENTONITE		Top	101.5'
		Bottom	103.0'
Pack: SAND		Top	103.0'
		Bottom	126.0'
Screen Type: PVC, sch I.D. 4" O.D. 4 1/2"		Top	106.0'
		Bottom	126.0'

WELL CONSTRUCTION SUMMARY

Well Name: 6(1) 231 **Total Depth:** 35'

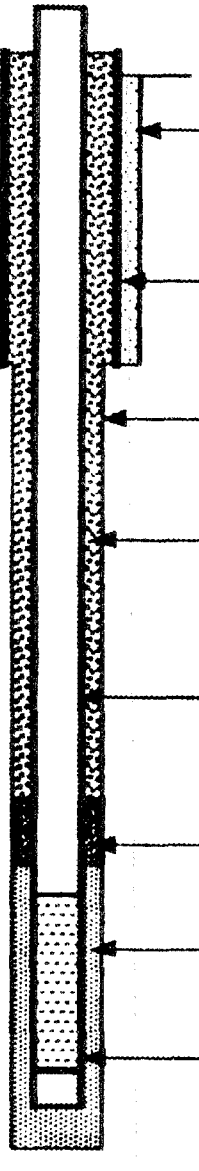
Location: KERR HOLLOW QUARRY

Drilled By: GEOTEK (RANDY COLLINS) **Date Completed:** 02 OCT 85

Notes:
Surface conductor temporary – not grouted

Geologic Summary

Solid Rock @ 10.5'
Fractured zones:
15 - 16.5'
17 - 17.5' water
19 - 20.5' water
23 - 24'
25 - 27'
28 - 29'



		Downhole Depths	
Conductor Hole Dia: 11"		Top	0
		Bottom	35'
Surface Conductor Type: PVC #40 I.D. 9 7/8" O.D. 10 5/8"		Top	0'
		Bottom	11'
Borehole Dia: 11"		Top	0'
		Bottom	35'
Filler: Grout Portland Type I			
Casing (with Screen) Type: PVC #40 I.D. 4" O.D. 4 1/2"		Top	Above Surface 3'
		Bottom	35'
Seal: Bentonite		Top	21.3'
		Bottom	22.8'
Pack: Sand		Top	22.8'
		Bottom	35'
Screen Type: PVC #40 I.D. 4" O.D. 4 1/2"		Top	24.5'
		Bottom	34.5'

WELL CONSTRUCTION SUMMARY

Well Name: Sel 240 **Total Depth:** 29.5'
Location: New Hope Pond
Drilled By: GEOTEK (R.M. Collins) **Date Completed:** 31 Oct 85
Notes:

Geologic Summary

TOFR 14

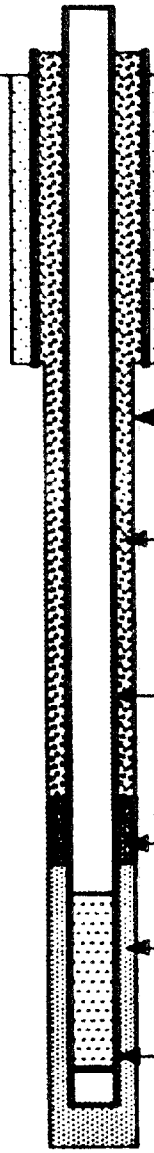
FRAC @ 89-30

Downhole Depths

		Top	Bottom
Conductor Hole Dia: 16.0		0	14.0'
Surface Conductor Type: PVC, sch 40 I.D. 12 O.D.		0'	14.0'
Borehole Dia: 11"		14.0'	29.5'
Filler: CEMENT, TYPE I			
Casing (with Screen) Type: PVC, sch 40 I.D. 4" O.D. 4½"		13.0	29.0'
Seal: BENTONITE		19.0'	21.0'
Pack: SAND		21.0'	29.5'
Screen Type: PVC, sch 40 I.D. 4" O.D. 4½"		24.0'	29.0'

WELL CONSTRUCTION SUMMARY

Well Name: GW 241 **Total Depth:** 103'
Location: SLUDGE DISPOSAL BASIN
Drilled By: A.L. CLARK (CLARK) **Date Completed:** 30JAN86
Notes:



		Downhole Depths	
Conductor Hole Dia: NONE		Top	—
		Bottom	—
Surface Conductor Type: ____ I.D. ____ O.D. ____		Top	—
		Bottom	—
Borehole Dia: 8½"		Top	0'
		Bottom	103.0'
Filler: CEMENT			
Casing (with Screen) Type: stainless steel I.D. 4 O.D. 4½		Top	+3
		Bottom	100
Seal: BENTONITE		Top	76.0'
		Bottom	78.0'
Pack: SAND		Top	78.0'
		Bottom	103.0'
Screen Type: stainless steel #304 I.D. 4" O.D. 4½"		Top	79.0'
		Bottom	100.0'

Geologic Summary

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