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DIVISION OF GEOLOGICAL SURVEY
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OPEN FILE REPORT NO. 44-UR

ASSESSMENT OF HYDROGEOLOGIC AND GROUND WATER CONTAMINATION DATA IN THE VICINITY OF THE HAYWARD ELEMENTARY SCHOOL, WEST 12TH STREET, SIOUX FALLS, SOUTH DAKOTA

by

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1988

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INTRODUCTION

Purpose and Scope

The purpose of this report is to present and discuss data regarding hydrogeologic conditions and ground-water contamination in the immediate vicinity of the Hayward Elementary School, hereafter referred to as Hayward School, on West 12th Street in Sioux Falls, South Dakota, and to provide interpretations as to the source(s) of ground-water contamination.

The scope of this report is limited by the short period of time which was available to compile, evaluate, and interpret a large volume of data which has been generated primarily by Williams Pipe Line Company (WPL) and the South Dakota Department of Water and Natural Resources (DWNR). This report is not inclusive of all available data regarding the subject of investigation. Generally, only those data available by the middle of February, 1987, were considered in this report.

Site Location

The area under investigation is located on the west side of Sioux Falls, South Dakota, along West 12th Street and lies in and along the north edge of the Skunk Creek flood plain. The investigations mentioned in this report include portions of sections 14 and 23, T. 101 N., R. 50 W. (fig. 1).

Area Water Use

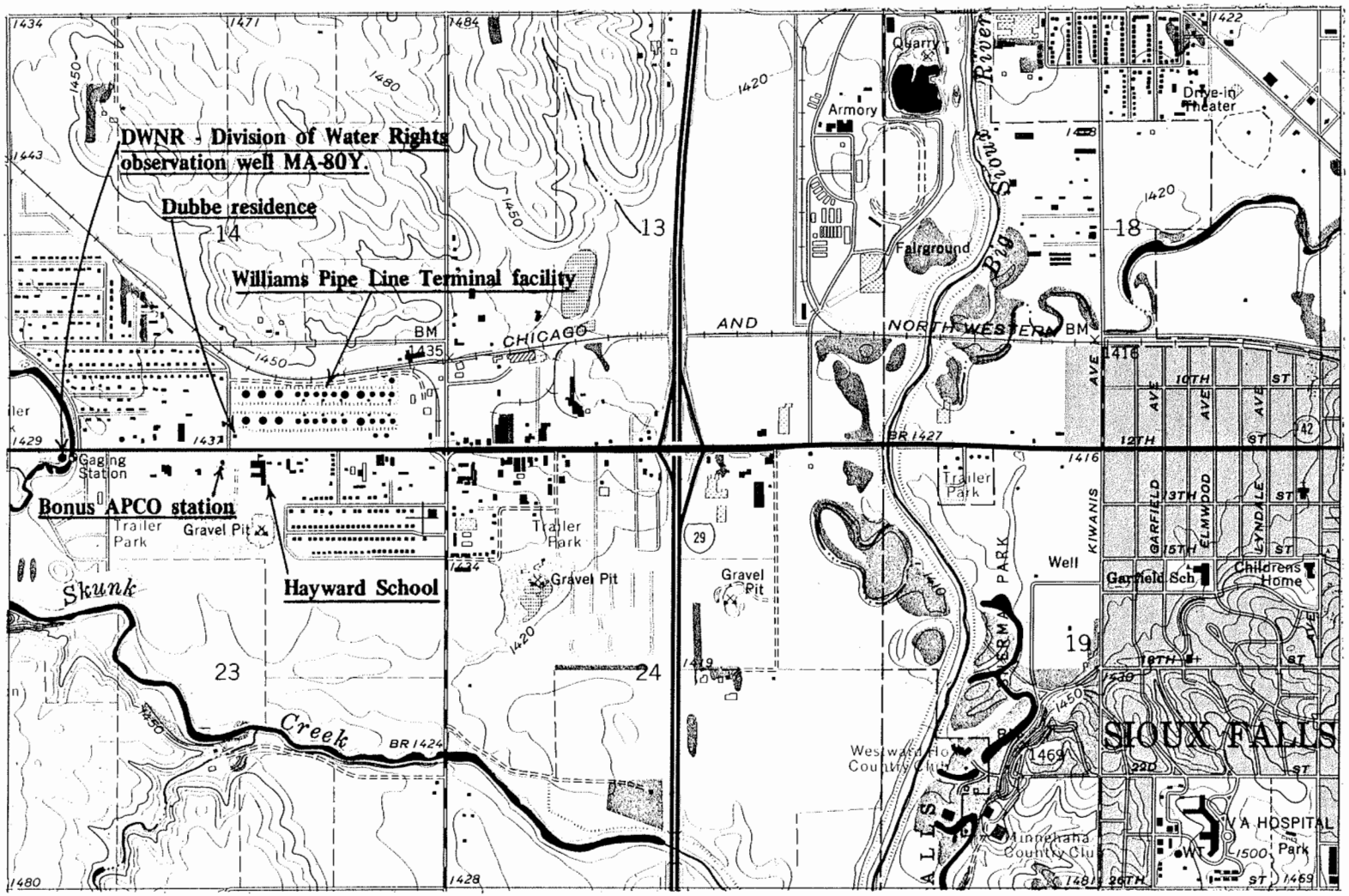
Within the immediate area of the WPL facility, the majority of businesses and residences are dependent upon private, shallow wells (less than 100 feet deep). This includes residences, which are immediately to the southeast of Hayward School, as well as the businesses and residences along West 12th Street.

In September, 1984, Hayward School connected to the Sioux Falls municipal water supply after its 62-foot deep well became contaminated. The WPL facility along West 12th Street was connected to the municipal water supply when it was built in about 1947 and was the only user of municipal water in the area for many years.

Ground water in this area is a valuable resource for present and future use. The City of Sioux Falls has future water rights (Permit No. 449-3) for parts of this area.

Contamination in the Hayward School Water Well

Reported evidence of contamination in the Hayward School water well dates back to 1984 when hydrocarbon and nitrate contamina-



Base map: Sioux Falls West, SD, USGS 7½ minute topographic map

SCALE 1:24 000

1 0 ½ 1 MILE

CONTOUR INTERVAL 10 FEET

Figure 1. Site Location.

tion were found. In 1984, students in a 6th grade class collected a water sample for petroleum analysis (January 17, 1984) as part of a school project. Aqua-Analysis, a Sioux Falls laboratory, analyzed the sample and identified hydrocarbons to be present at a concentration of 5 parts per million. Water samples showing nitrate-nitrogen contamination were analyzed by the South Dakota State Health Laboratory in 1984 (app. A). Nitrate was documented at 21 milligrams per liter (mg/L) in one of the analyses (July 18, 1984). The drinking-water standard for nitrate-nitrogen is 10 mg/L. Use of the water well was discontinued in September, 1984, when the School was connected to the Sioux Falls municipal water supply.

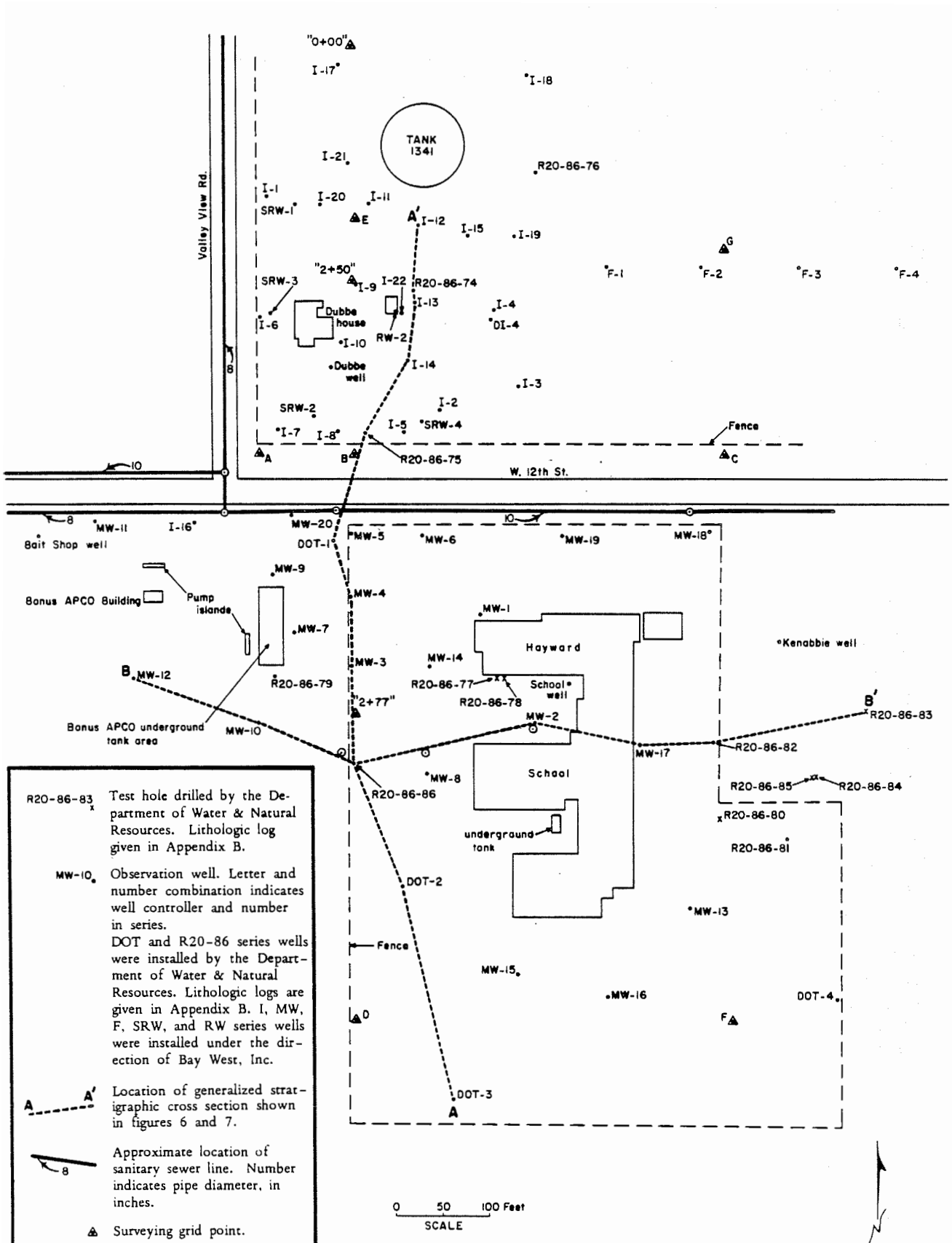
Evacuation of the Dubbe Residence

On May 30, 1986, a private residence belonging to Mrs. Myrtle Dubbe was evacuated because of explosive concentrations of hydrocarbon vapors inside the building. This residence is located on Valley View Road just north of West 12th Street (figs. 1 and 2) adjacent to the southwest portion of WPL property. The WPL property contains many large above ground storage tanks which contain petroleum and fertilizer products. The nearest tank to the Dubbe residence, Tank 1341, is approximately 150 feet to the northeast (fig. 2). The Department of Water and Natural Resources was first notified on May 30, 1986, by Minnehaha County Civil Defense of a potential problem affecting the Dubbe home. The Sioux Falls Fire Department and Minnehaha County Civil Defense initially responded to the Dubbe home incident. Mrs. Dubbe has stated to DWNR that she smelled vapors at increasing concentrations a few weeks before her home was evacuated.

Williams Pipe Line Company has never officially notified DWNR of a leak from Tank 1341 or any other tanks or lines on the western part of their property. Identification of a leak from WPL Tank 1341 as the probable vapor source affecting the Dubbe home came from maps prepared by Bay West, Inc. (a consultant hired by WPL), depicting free product (floating petroleum) on the groundwater surface on June 23, 1986, and July 30, 1986. It is unknown to DWNR whether information on those maps regarding "solubles" (dissolved ground water contamination) is from those same dates. Figure 3 depicts the free product plume for June 23, 1986. The Dubbe residence was purchased by WPL in 1986.

Evacuation of Hayward School

Hayward School is located on the south side of West 12th Street to the southeast of the Dubbe residence (fig. 2). On July 24, 1986, DWNR met with WPL and Bay West, Inc. to discuss progress of WPL's field investigations near the Dubbe residence. During that meeting, DWNR raised the possibility of future vapor



R20-86-83 — Test hole drilled by the Department of Water & Natural Resources. Lithologic log given in Appendix B.

MW-10 — Observation well. Letter and number combination indicates well controller and number in series. DOT and R20-86 series wells were installed by the Department of Water & Natural Resources. Lithologic logs are given in Appendix B. I, MW, F, SRW, and RW series wells were installed under the direction of Bay West, Inc.

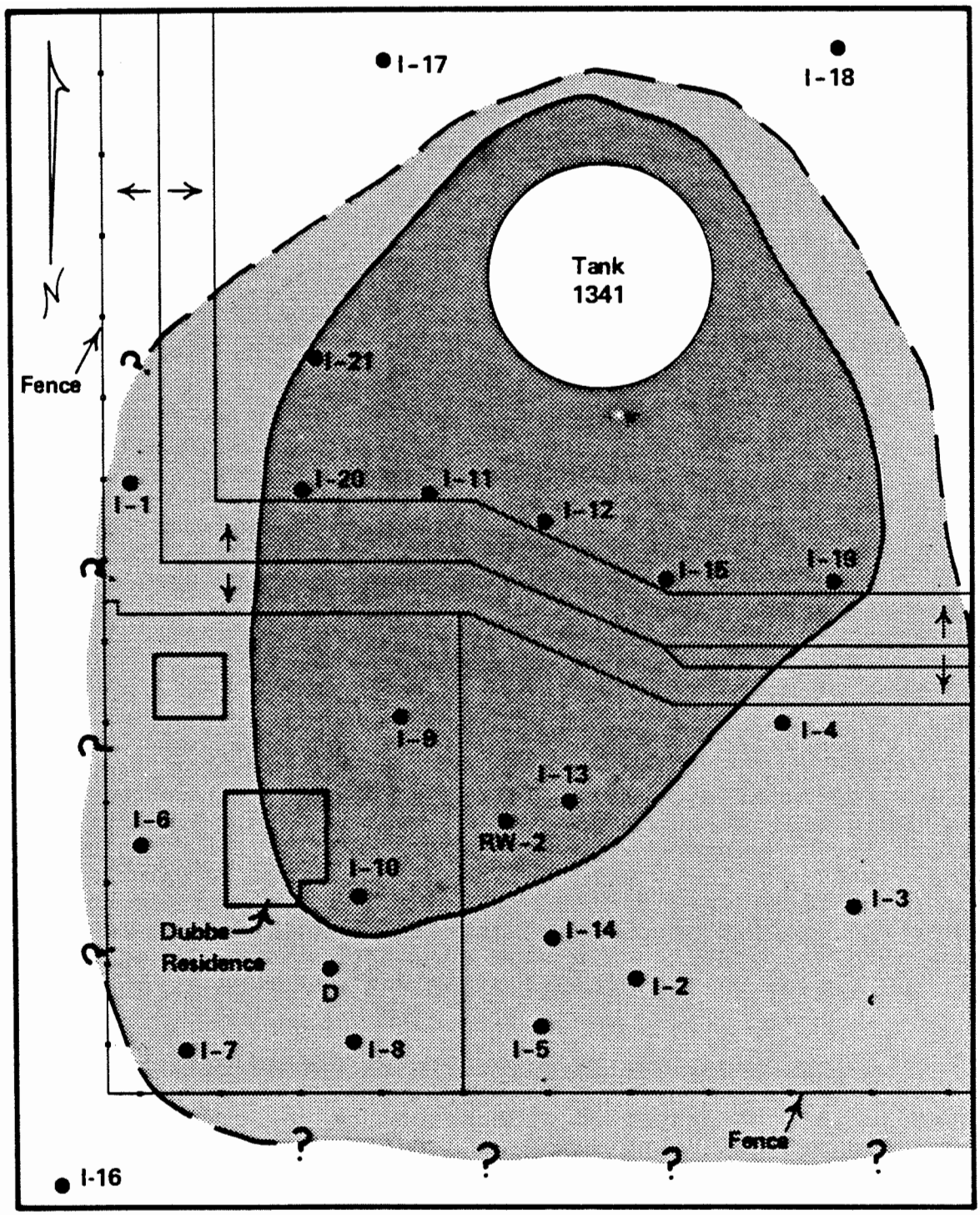
A — A' — Location of generalized stratigraphic cross section shown in figures 6 and 7.

8 — Approximate location of sanitary sewer line. Number indicates pipe diameter, in inches.

Surveying grid point.

Manhole

Figure 2. Locations of test holes and monitoring wells.



Modified from Bay West, Inc., data.

Figure 3. Free product on Williams Pipe Line property, June 23, 1986.

problems in Hayward School unless ground-water contamination in the vicinity of Tank 1341 was adequately controlled.

On September 17, 1986, the Sioux Falls Fire Department took vapor explosivity measurements in the School in response to complaints of gas fumes. Measurements were taken with an MSA, Model 2A combustible gas indicator calibrated to pentane, a gas with an explosivity level close to that of gasoline. The Fire Department recorded vapor concentrations ranging up to 40 percent of the lower explosive limit (100 percent is explosive). Following accepted safety precautions for explosivity levels in that range, the Fire Department ordered the immediate evacuation of the School on September 17, 1986. The School has not reopened because vapors have persisted.

On September 18, 1986, DWNR arranged for a meeting with the Sioux Falls Health Department, the State Fire Marshall, and the South Dakota Division of Emergency and Disaster Services. The group supported the Fire Department's evacuation decision. The Department of Water and Natural Resources requested assistance from the U.S. Environmental Protection Agency (EPA) to evaluate the vapor hazard in Hayward School. As a result, the Agency for Toxic Substances and Disease Registry (ATSDR) collected air samples for a hazard evaluation and determined that significant amounts of petroleum vapors were present, with benzene the vapor component of most concern.

The Sioux Falls School District has hired Twin City Testing Corporation (TCT) which has been monitoring the School for benzene and total hydrocarbon vapors regularly since December 5, 1986. Twin City Testing Corporation reports that the January 21 and 22, 1987, benzene vapor concentration in the janitor-crawl space was 37,000 parts per billion (ppb). This concentration is over 1,000 times the 10 to 20 ppb level of concern recommended by ATSDR. The highest benzene concentration measured by TCT in the classrooms was 3,500 ppb in room 601 (December 5, 1986). This is over 100 times the recommended limit set by ATSDR.

Investigations of Ground-Water Contamination

Because of the suspected widespread area of contamination and evacuation of the Dubbe residence and Hayward School, DWNR and WPL initiated studies to determine the source(s) of ground-water contamination, to define the extent and type(s) of contamination, and to gather information necessary to facilitate remedial action.

Forty-two monitoring wells have been installed by Bay West, Inc. to monitor the shallow water table and check for petroleum contamination in the vicinity of Tank 1341, the Dubbe residence, the Bonus APCO Station, and Hayward School. The well identifiers are arbitrarily designated by Bay West, Inc. as "MW" and "I" series wells (fig. 2). Additionally, four wells designed for

recovery of dissolved ground-water contamination, designated as "SRW" wells, and one well designed for recovery of dissolved and liquid contamination, designated as RW-2, have been installed on WPL property. Only RW-2, SRW-2 and SRW-4 are believed to be in operation (fig. 2). Well RW-2 was installed on June 10, 1986. Wells SRW-2 and SRW-4 were installed on August 19 and 20, 1986, respectively. These wells have not, however, been in continual operation.

Bay West, Inc. has also installed one well (DI-4) approximately 150 feet southeast of Tank 1341 (fig. 2) to examine a reported deeper, confined aquifer. This well is reported to be 45 feet deep (D. Mazumdar, Bay West, Inc., personal communication, 1987). Lithologic and water-level data from this well have not been made available to DWNR.

An additional series of monitoring wells has been installed by Bay West, Inc. in an east-west line along nearly the entire southern portion of WPL property to monitor the shallow water table and check for petroleum contamination. These wells are designated by Bay West, Inc. as their "F" series wells. Four of these wells are shown in figure 2. None of the "F" series wells are included in the 42 wells mentioned above. Lithologic and water-level data from these wells have not been made available to DWNR.

The Department of Water and Natural Resources has installed 11 monitoring wells (apps. B and C) in the vicinity of Tank 1341 and Hayward School for the purposes of examining the shallow hydrologic system and for verifying data provided by other investigations. These wells are identified with the prefix "R20-86" or "DOT" on figure 2.

Nearly 300 ground-water samples have been collected and analyzed for various dissolved constituents related to hydrocarbon contamination and for general water chemistry. Sampling and analysis are ongoing. Results of chemical analyses show ground water to contain detectable amounts of benzene, ethyl benzene, toluene, xylene, gasoline, fuel oil, jet fuel, lead, ammonia, and nitrate in some of the wells. Some free product was observed (fig. 4) on the ground-water surface on February 14, 1986 (wells R20-86-74, DOT-1, I-6, I-12, MW-1, MW-2, MW-4, MW-14, and MW-20), and on February 5, 1986 (wells I-11 and MW-3).

GEOLOGY

The area being investigated is underlain by Wisconsin age glacial deposits which are underlain by Precambrian age Sioux Quartzite. Glacial deposits in the area of investigation consist of till and outwash. Till is a heterogeneous mixture of clay, silt, sand, gravel, and boulder-sized material, with the predominant constituents being clay and silt-sized particles. At this point in the investigations, till is of minor importance because

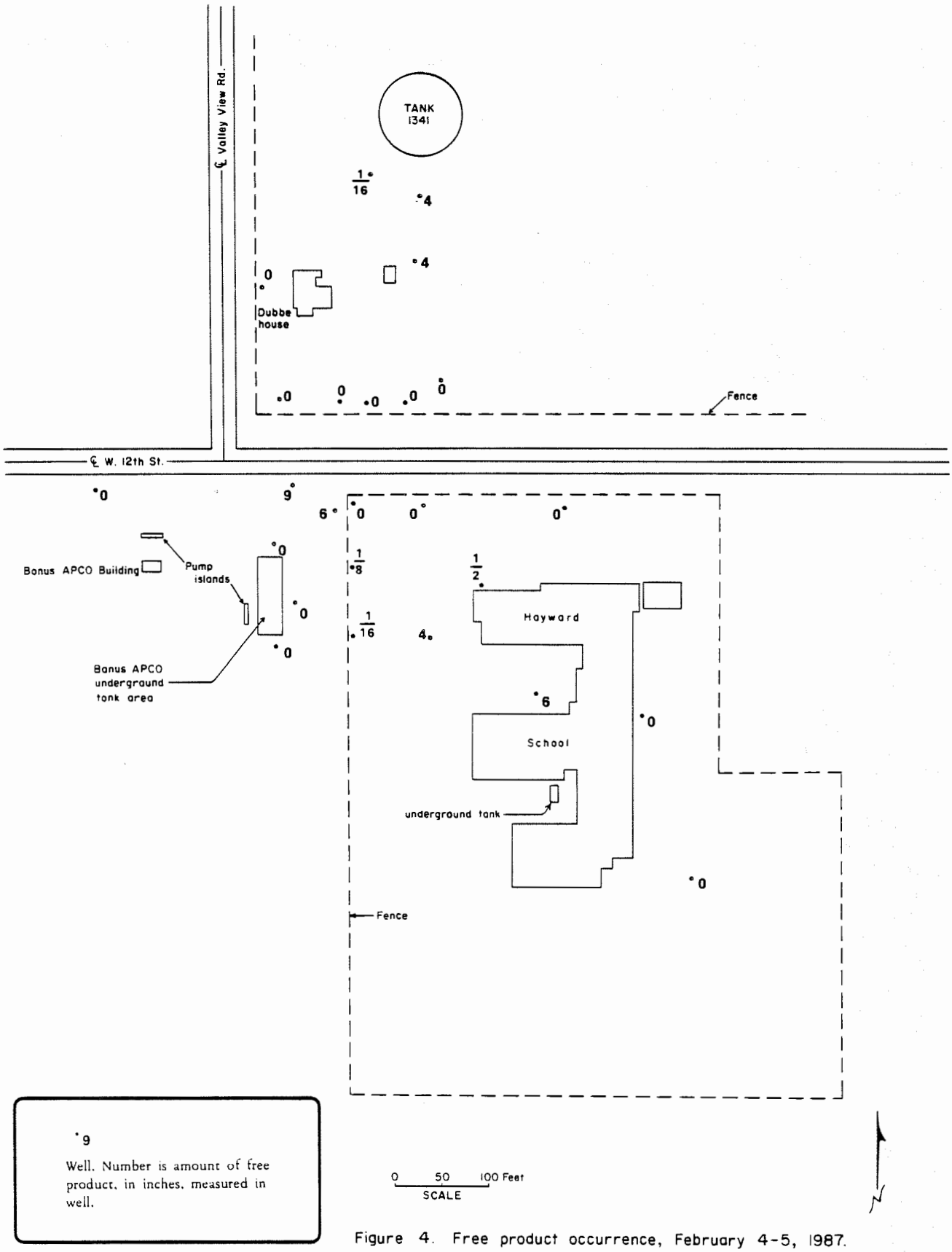


Figure 4. Free product occurrence, February 4-5, 1987.

it occurs as the dominant geologic sediment type only on the uplands to the north and south of the Skunk Creek valley (fig. 5).

Outwash directly underlies the area of interest and occurs at or very near the land surface (fig. 5). Outwash consists of stratified sand and gravel which may contain varying amounts of clay and silt, either dispersed as part of the sediment matrix or in discrete layers. The name given to this outwash by DWNR is the southern Skunk Creek management unit of the Big Sioux aquifer, known locally as the Skunk Creek aquifer. Outwash is known to range from near 0 to greater than 27 feet thick in test holes and wells drilled thus far in the vicinity of Hayward School.

The presence of a clay layer (thickness unknown) within or under the outwash has been documented in places. Verbal information from Bay West, Inc. indicated that in at least one test hole (DI-4), there is more outwash under the clay. The extent of the clay layer and underlying outwash has not been documented. The physical relationship of the surficial outwash and the apparent deeper outwash has not been established.

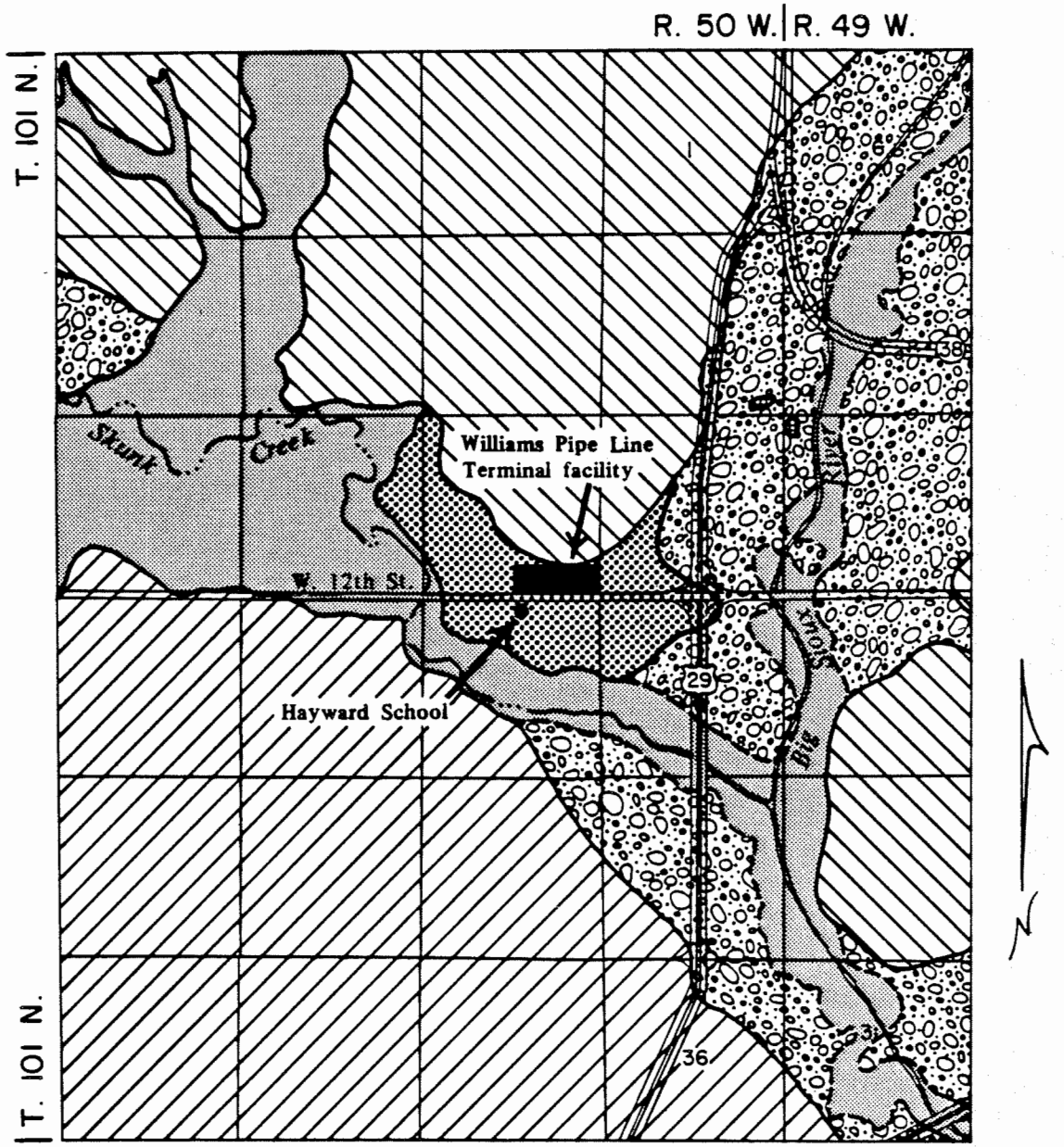
Cross sections shown on figures 6 and 7 show that the character of the sediments can vary significantly in a short, lateral distance. For the purpose of illustration, these two cross sections represent a simplification of actual lithologic conditions and show the presence of the above-mentioned clay layer below the surficial outwash. Logs of DWNR drill holes are presented in appendix B.

The bedrock unit which underlies the outwash and/or till is the Sioux Quartzite. The quartzite is a very hard, silica cemented, fine- to medium-grained rock (orthoquartzite) and contains abundant fractures. Depth and topography of the quartzite surface could be highly irregular. The quartzite surface in the area of investigation may be deeper than 45 feet from the land surface as determined by the deepest test hole (well DI-4), and may be less than 60 feet, as observed in the Hayward School well.

HYDROLOGY

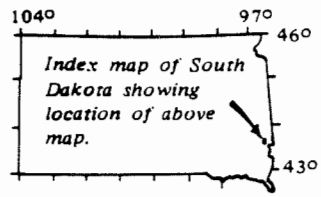
Aquifer Analysis

Three aquifer tests have been conducted on WPL property by Bay West, Inc. utilizing RW-2 as the pumping well. The Department of Water and Natural Resources has briefly examined results and data from the first two aquifer tests. Slug tests have also been conducted by Bay West, Inc. in some of the monitoring wells. Results of slug tests conducted by Bay West, Inc. have also been briefly examined by DWNR. Some comments on the aquifer tests and slug tests are presented below to provide an understanding of why the values for the various aquifer properties, described later, must be viewed with caution.



Modified from Steece (1958)

0 1/2 1 2
MILES



Semistratified deposits of gravel, sand and silt; humic; brown to black; 0-20 feet thick; in stream flood plains and lake beds.

Stratified deposits of poorly-sorted fine sand to coarse gravel; generally oxidized; level topography; 10-40 feet thick.

Terrace remnants along Skunk Creek valley; stratified deposits of poorly-sorted sand and gravel; oxidized; level topography; up to 50 feet thick.

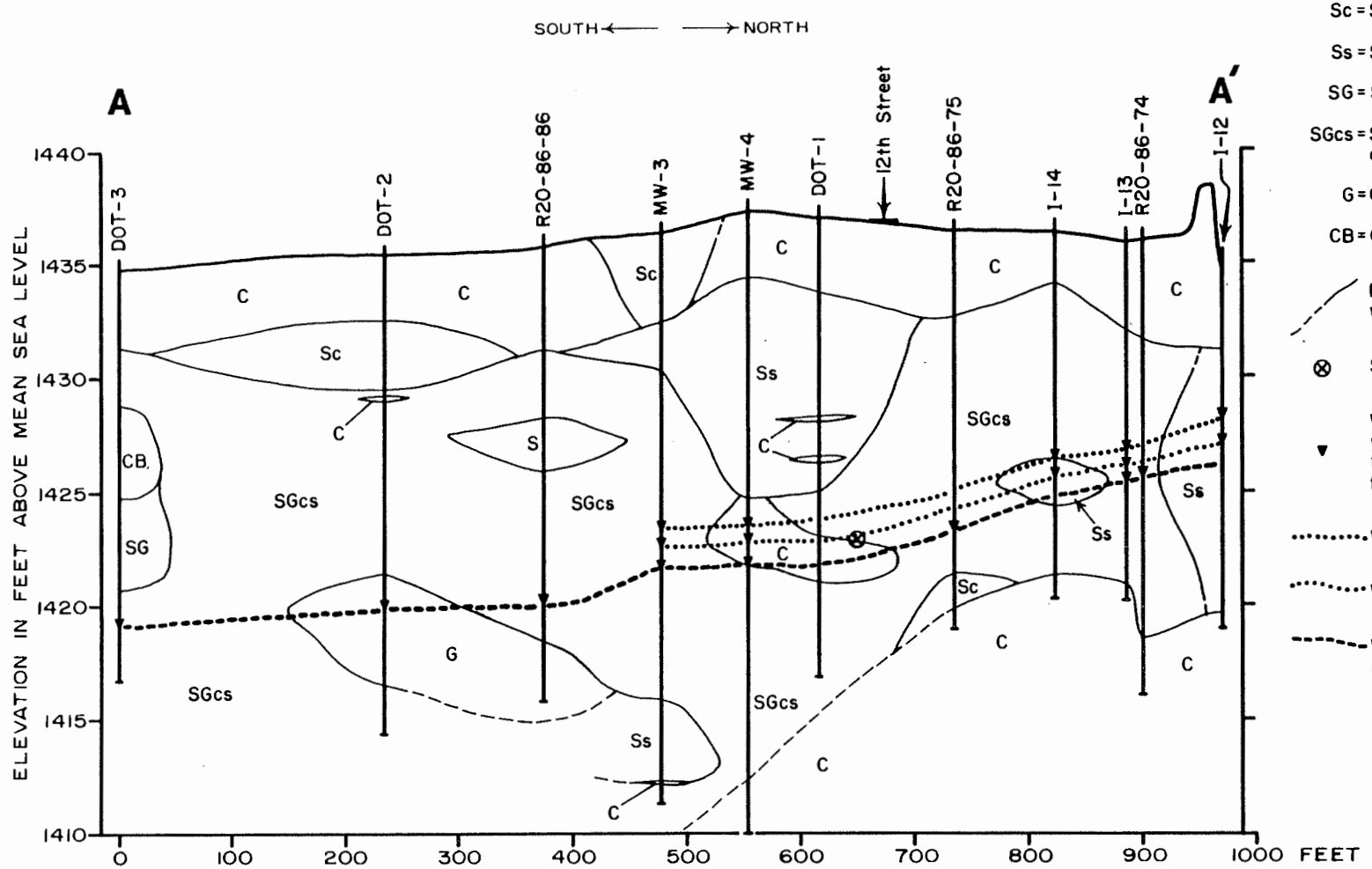
Boulder-clay till consisting of 60-70% olive-gray to olive-brown calcareous clay and silt, with rock fragments; friable; ranges up to 60 feet in exposed thickness; knob & kettle topography.

Boulder-clay till consisting of 60-70% olive-gray to olive-brown mostly calcareous clay and silt, with rock fragments; compact; generally oxidized and leached in upper part; covered with as much as 25 feet of calcareous buff loess; extremely well dissected surface; maximum exposed thickness 30 feet.

Pink to red orthoquartzite consisting wholly of silica-cemented rounded sorted quartz sand, interbedded with flaggy red to purple sericitic mudstone and coarse pebble conglomerate; well jointed, up to 100 feet exposed, dips southward about 5 degrees.

Figure 5. Site Geology.

Figure 6. Generalized stratigraphic cross section A-A'.



C = Clay

S = Sand

Sc = Sand, clayey

Ss = Sand, silty

SG = Sand and Gravel

SGcs = Sand and Gravel, clayey and silty

G = Gravel, sandy, clayey

CB = Cobbles and Boulders

Lithologic contact. Dashed where approximate

Sewer line, 12th street

Water level in monitoring well. Water levels shown for well DOT-1 are inferred from well MW-5.

Water level on 10-1-86

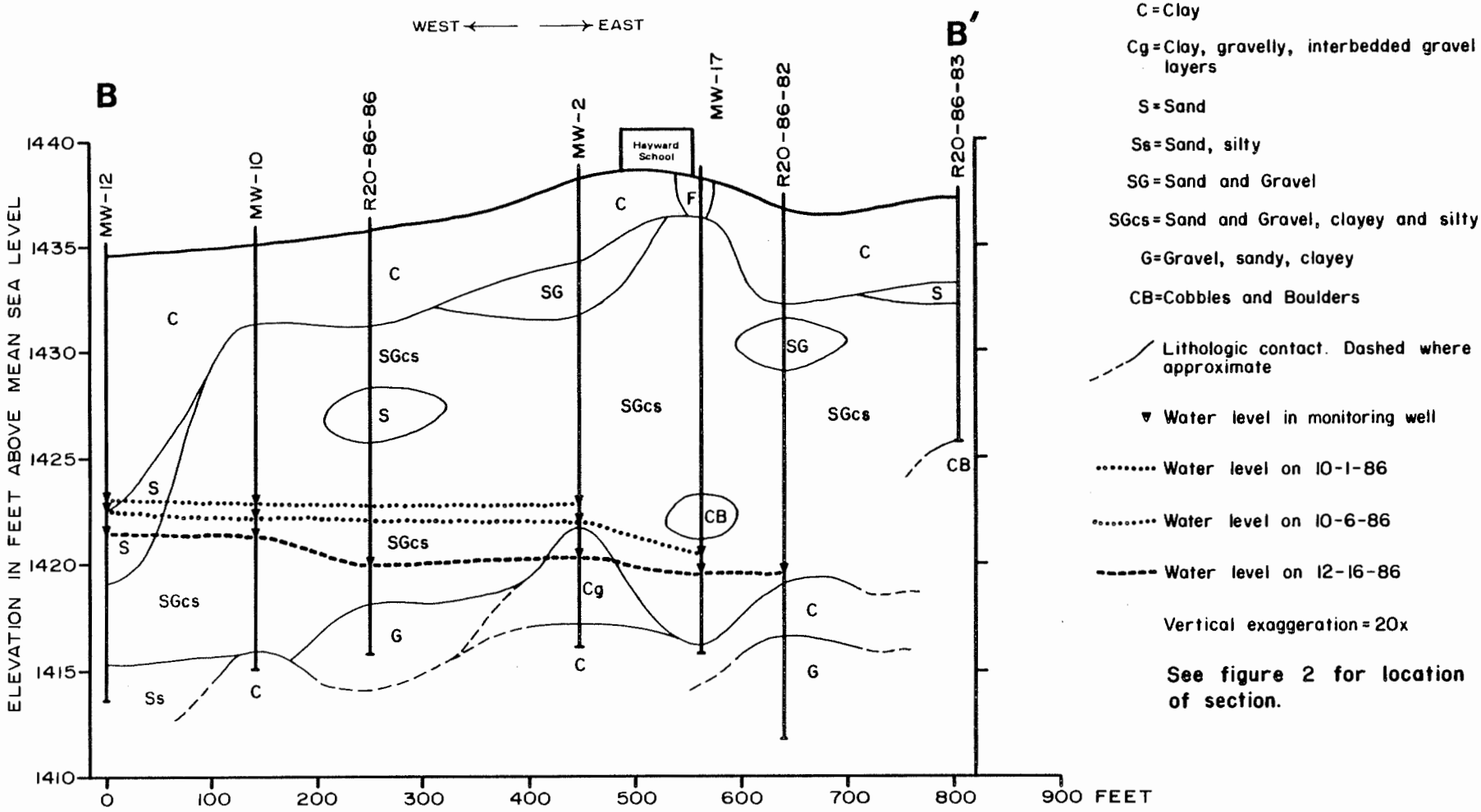
Water level on 11-6-86

Water level on 12-16-86 and 12-17-86

Vertical exaggeration = 20x

See figure 2 for location of section.

Figure 7. Generalized stratigraphic cross section B-B′.



RW-2 Aquifer Test No. 1

Analysis of the aquifer test data revealed the following problems:

The pumping rate was not held constant throughout the test and exceeds the maximum acceptable variation of 10 percent as indicated by Stallman (1971). As a result, drawdown data for values of time greater than 150 minutes (2.5 hours) cannot be utilized in the analysis because the variation in pumping rate exceeded the 10 percent limit beyond this time. This results in an insufficient pumping period for determining aquifer parameters in an unconfined aquifer (the type in question in the vicinity of Hayward School). Driscoll (1986) recommends a minimum of 72 hours of pumping for unconfined aquifers due to delayed gravity drainage.

The placement of the monitoring wells precludes obtaining reliable values for aquifer parameters because monitoring wells are spaced so far from the pumping well (RW-2). This results in relatively small drawdown values which are inadequate for analysis of the aquifer. According to Bouwer (1978), monitoring well placement should be at distances of 1, 2, and 4 times the thickness of the aquifer. Because the aquifer in question is approximately 5 feet thick in the immediate vicinity of well RW-2, the monitoring wells should be placed at distances of 5, 10, and 20 feet from the production well (RW-2) for best results. The closest monitoring well utilized in this test was 21 feet away.

Other problems associated with the analysis include utilization of different values for the discharge rate (Q) for the same time period in different sets of calculations and inadequate documentation of the procedure used to adjust water levels for the presence of free floating petroleum product on the water-table surface.

RW-2 Aquifer Test No. 2

Analysis of the aquifer test data revealed the following problems:

According to notes included on pumping-test data for monitoring well I-3, the pump was shut down at approximately 1,300 minutes (21.7 hours) into the test for an undetermined period of time. This cessation of pumping precludes utilizing the data beyond that time since the assumption of continuous discharge (pumping) is one of the conditions which must be satisfied to make use of the analytical procedure used by Bay West, Inc. In actuality, data for time greater than 160 minutes (2.7 hours) are not reliable since the discharge rate varies greater than 10 percent after that period. This results in an insufficient pumping period for determining aquifer

parameters in an unconfined aquifer. As previously mentioned, Driscoll (1986) recommends a minimum pumping time of 72 hours for unconfined aquifers.

A value of 3.3 gallons per minute was utilized by Bay West, Inc. as the constant pumping rate in the calculation of aquifer parameters. However, a simple arithmetic average of the discharge values provided by Bay West, Inc. results in an average discharge rate of 3.5 gallons per minute. If a time-weighted average is calculated for the values given, the average discharge rate is 3.8 gallons per minute, thus the value of 3.3 gallons per minute used by Bay West, Inc. is apparently too low. Use of the correct discharge rate is important because the value of the hydraulic conductivity is directly proportional to the discharge rate used in the calculation. Assuming that other values provided by Bay West, Inc. are correct, then the values calculated for hydraulic conductivity may be from 6 to 11 percent higher than indicated by Bay West, Inc. depending on whether the arithmetic average or time-weighted average discharge rate is used.

Slug Tests

A brief review of slug-test results provided by Bay West, Inc. did not reveal any analytical problems. However, from a practical viewpoint it might be argued that the results may not be representative due to the relatively high hydraulic conductivity of the aquifer. It must also be noted that DWNR has been given only slug-test data from the north side of West 12th Street and has none from Hayward School or Bonus APCO property.

Possible Values for Storativity and Hydraulic Conductivity

A review of aquifer-test data and slug-test data provided by Bay West, Inc. shows that the hydraulic conductivity of the aquifer may be in the range of 54 to 1,464 gallons per day per square foot and that the storativity of the aquifer may be in the range of 0.007 to 0.11. The average hydraulic conductivity and storativity values are calculated to be 700 gallons per day per square foot and 0.06, respectively, using data from Bay West, Inc. The large, natural range in aquifer properties will cause a variability in the rate of ground-water and contaminant movement in different parts of the aquifer.

Review of published values for hydraulic conductivity of relatively dirty and poorly sorted sands and gravels, like those of this investigation, shows an average would be about 500 gallons per day per square foot (Tyler, 1974 and Meyer, 1978). This compares well with the average calculated using Bay West, Inc. data.

For aquifer tests no. 1 and no. 2, mentioned above, (1) the lack of a constant discharge rate invalidates results calculated by Bay West, Inc. and (2) if only the constant rate discharge portions of the data from both aquifer tests are utilized, they are of insufficient duration to allow determination of true aquifer conditions, thus, values used from these tests should be used with caution to provide only indications of aquifer characteristics. Previously mentioned inconsistencies found by DWNR in Bay West, Inc. calculations of the aquifer parameters cannot be explained with data presently available to DWNR. Results of slug tests, although apparently valid, may be representative only of borehole properties rather than true aquifer conditions. This is due to the relatively high hydraulic conductivity of the aquifer and minimal amount of water displaced during the test.

Although no slug-test data are available for the area south of West 12th Street, information from Bay West, Inc. indicates that the hydraulic conductivity on the south side of West 12th Street is significantly higher than on the north side of the street on WPL property (P. Lucas, Bay West, Inc., personal communication, 1986).

Water Levels

Historic Water Level Fluctuations

Historic water level fluctuation information is available from a DWNR, Division of Water Rights, observation well (MA-80Y) near Skunk Creek (fig. 1). This well, completed in the Skunk Creek aquifer, is 53 feet deep and is located less than one-half mile from Hayward School.

Water-level data from well MA-80Y are available for the period 1980 to present. Comparison of precipitation to water levels shows a direct and rapid response (significant water-table rise) to heavy rains which fell in June, 1984. The water table did not reach such high levels again until after the heavy rains in September, 1986. Similar conditions would be expected to occur in the vicinity of the WPL-Hayward School area due to the similarity of geology in the two areas.

Current Water Levels

Figure 8 shows the depth to water from land surface for December 16 and 17, 1986. The shallow water table depth ranged from 5.8 to 18.5 feet on these dates and was at or near its lowest levels during the period of monitoring. In general, the water table is shallowest on WPL property. During September, 1986, when precipitation was unusually high, water levels were also high (app. D).

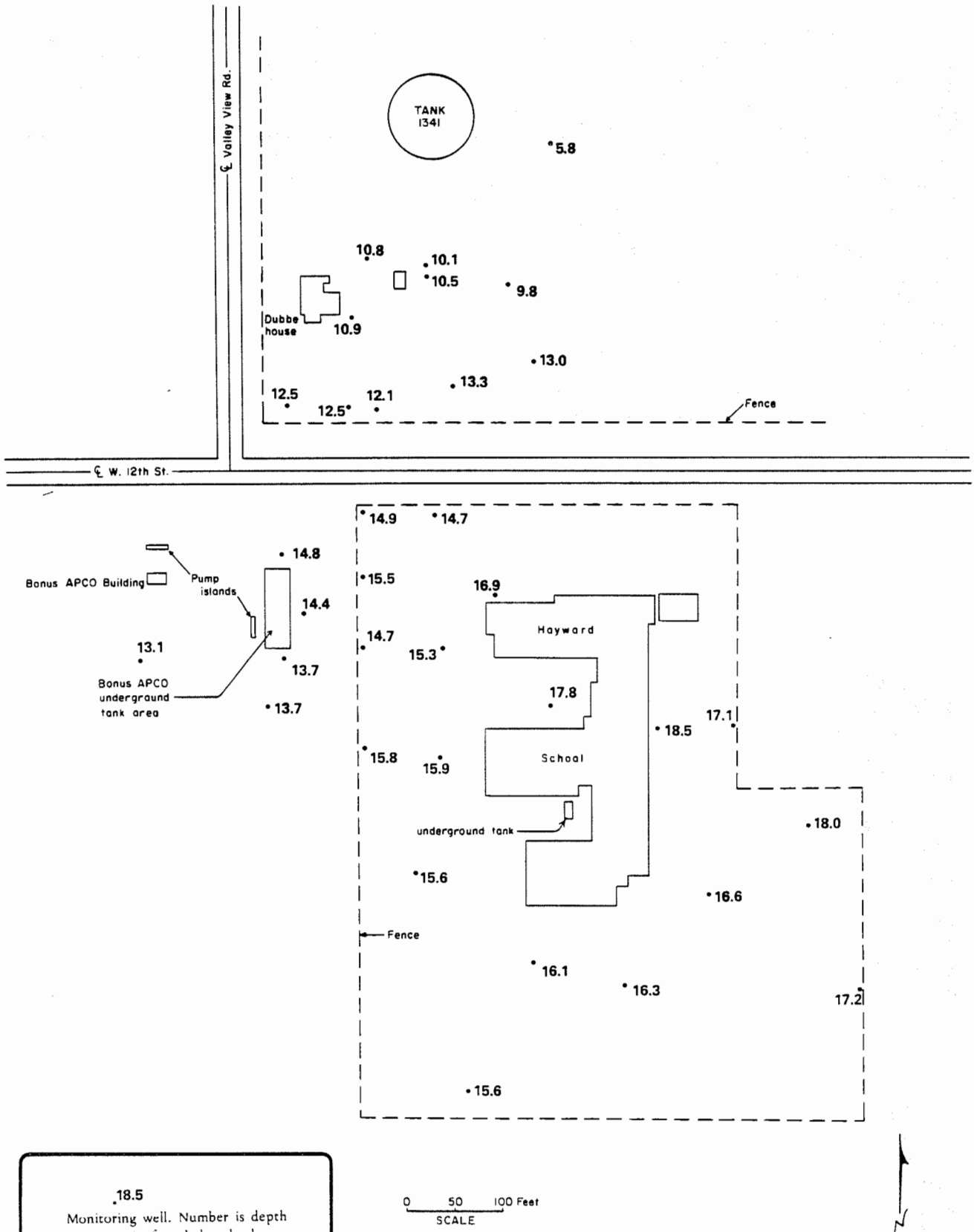


Figure 8. Depth to water from land surface, December 16-17, 1986.

An examination of water levels in wells I-2, I-7, and I-9 (app. D) shows that between June 23, 1986, and September 21, 1986, the average water-level rise was about 1.9 feet. In these same wells from September 21, 1986, to November 16 and 17, 1986, the average water-level decline was about 2.1 feet. Other individual wells had water-level fluctuations of greater magnitude but the averages of these three wells give a general indication of water-table changes. Maps depicting recent ground-water levels from June, 1986, through December, 1986, are shown in figures 9 through 14. Water-level measurements have never been taken in all monitoring wells on the same day, thus only a portion of the water-table surface in a limited area is depicted on any given map. The hydrologic system is so dynamic in this area that measurements only a few days apart can yield significantly different water levels. This is why caution was used in directly relating water level measurements from different dates.

Ground-Water Gradients

The closely spaced water level contours on WPL property show areas of greater ground-water gradients than are present on Hayward School or Bonus APCO Station properties (figs 13 and 14). The change to a lesser gradient south of WPL property roughly coincides with West 12th Street. This relationship is thought to be coincidental, and is believed to be primarily the result of a natural change in the hydraulic conductivity of the aquifer.

Ground-water gradients were examined for different dates on WPL and Hayward School property. On WPL property, gradients were determined to be about 0.011 and 0.014 on September 21, 1986, and November 6, 1986, respectively. On Hayward School property, gradients were determined to be about 0.008 and 0.012 on September 26, 1986, and November 6, 1986, respectively. Averages of the above-mentioned gradients are 0.013 and 0.010 for WPL and Hayward School areas, respectively.

Examination of the ground-water gradient across the entire area of investigation (WPL and Hayward School property) shows gradients of about 0.010, 0.010, and 0.011 on October 12, 1986, November 6, 1986, and December 16-17, 1986, respectively, with an average of 0.010. Thus, the ground-water gradients throughout the investigated area have remained essentially unchanged through a significant rise and fall of the water table. Many minor changes in gradient through time will be evident upon close examination of the data due to localized vertical and lateral variations in lithology.

Ground Water Flow Direction

Figure 15 shows ground water flow directions based on the gradients illustrated on figure 14. Ground water flow directions are (1) generally south on WPL property, (2) generally south and

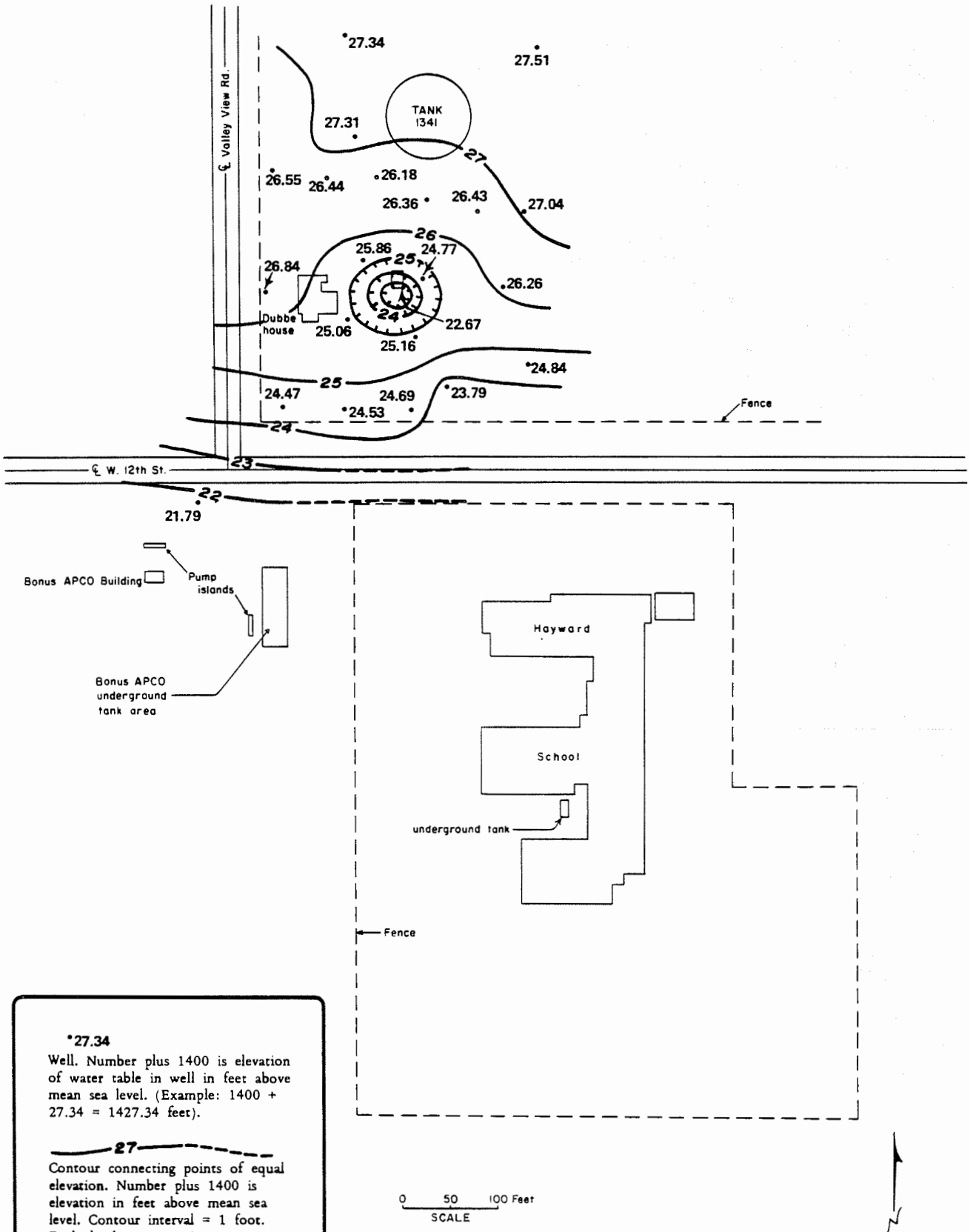


Figure 9. Water-table elevations, June 23, 1986.

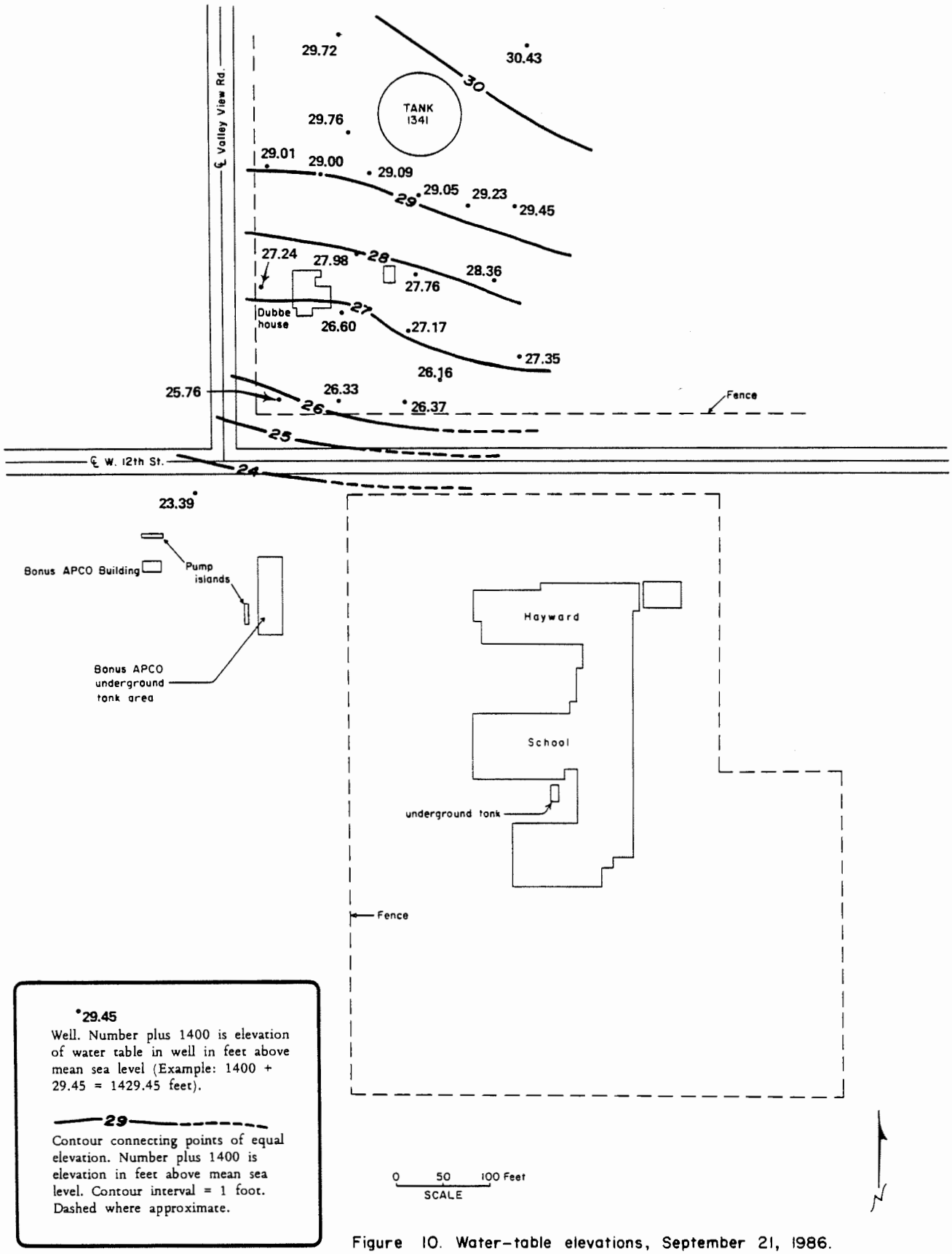


Figure 10. Water-table elevations, September 21, 1986.

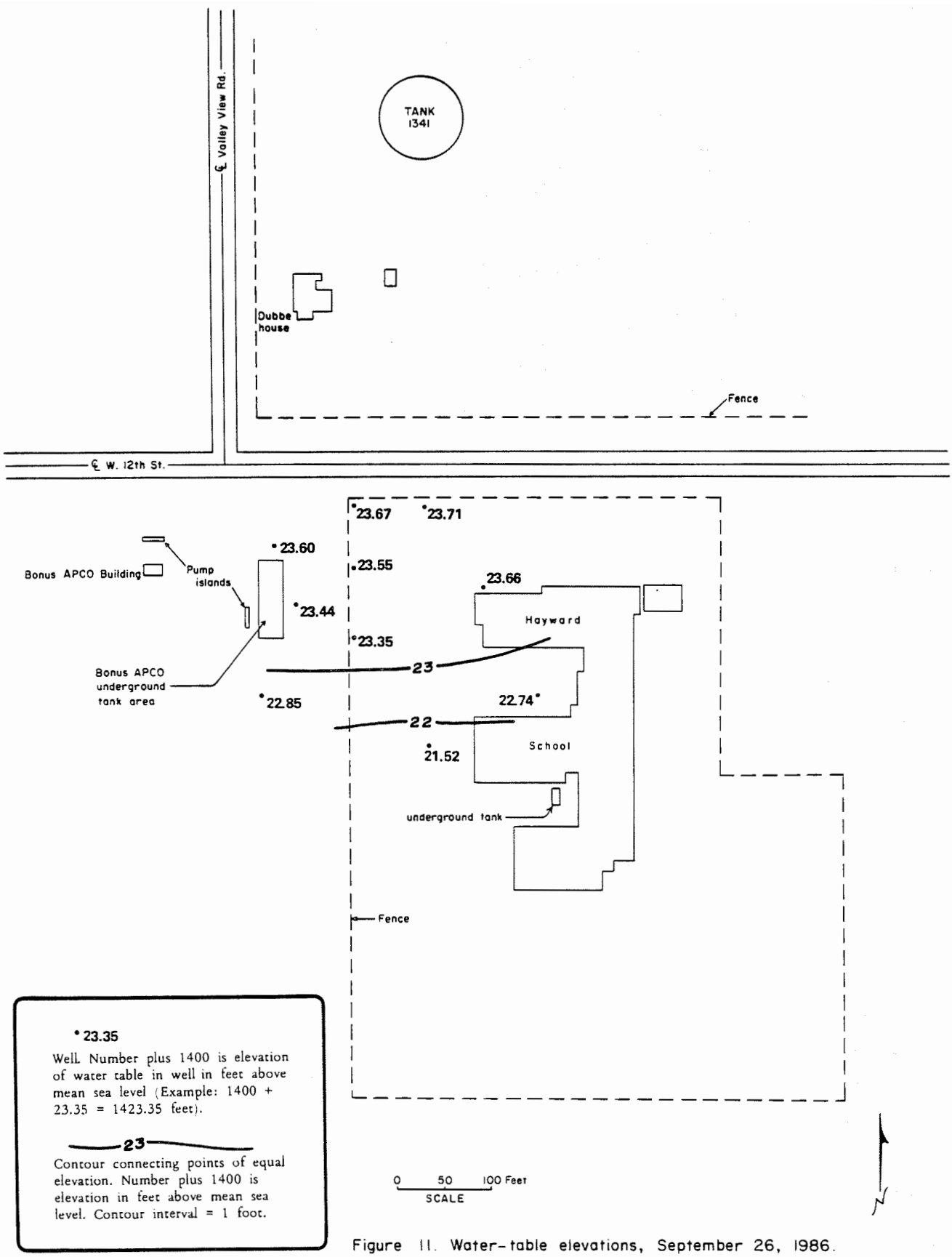
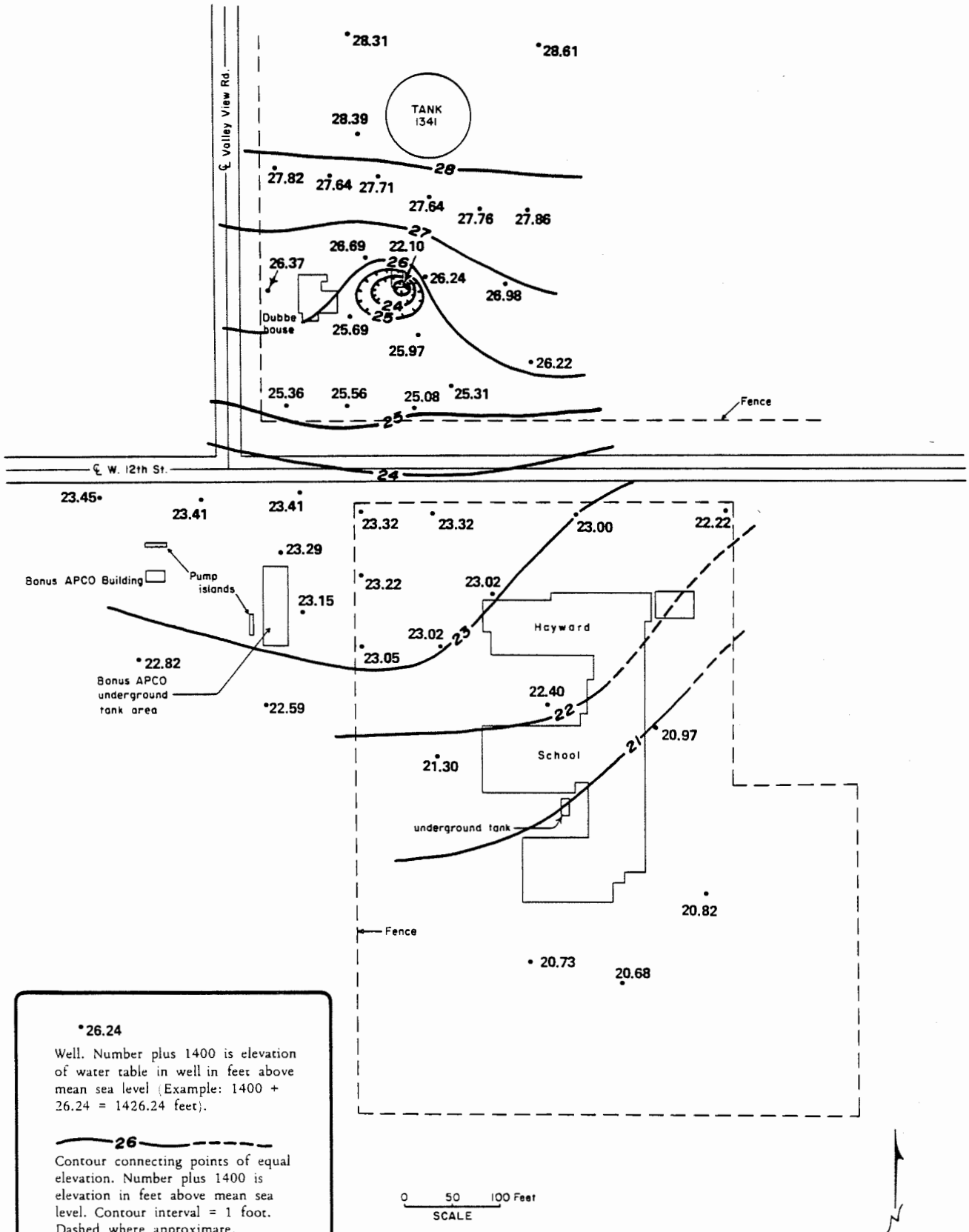


Figure 11. Water-table elevations, September 26, 1986.



•26.24

Well. Number plus 1400 is elevation of water table in well in feet above mean sea level (Example: 1400 + 26.24 = 1426.24 feet).

26

Contour connecting points of equal elevation. Number plus 1400 is elevation in feet above mean sea level. Contour interval = 1 foot. Dashed where approximate.

Figure 12. Water-table elevations, October 12, 1986.

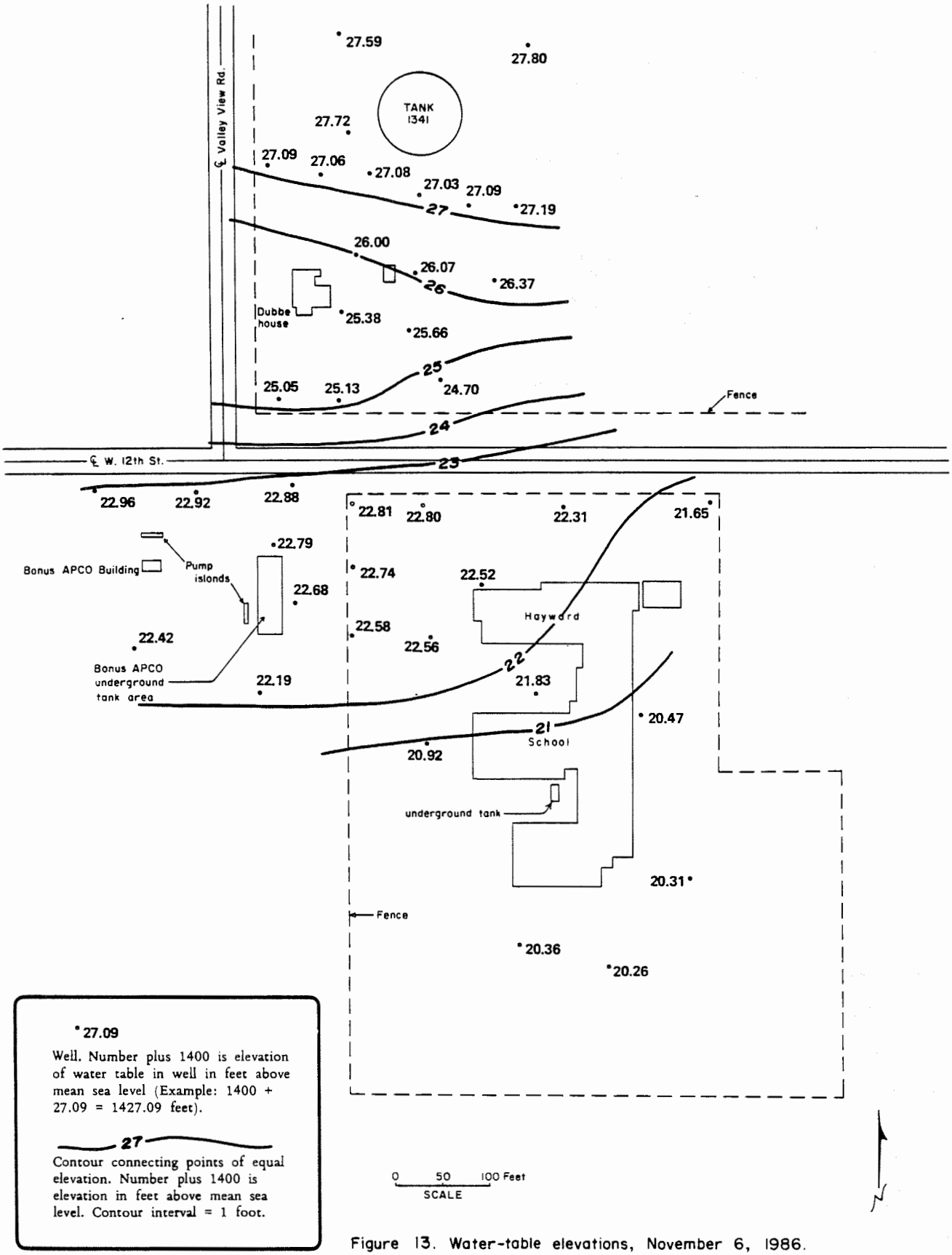


Figure 13. Water-table elevations, November 6, 1986.

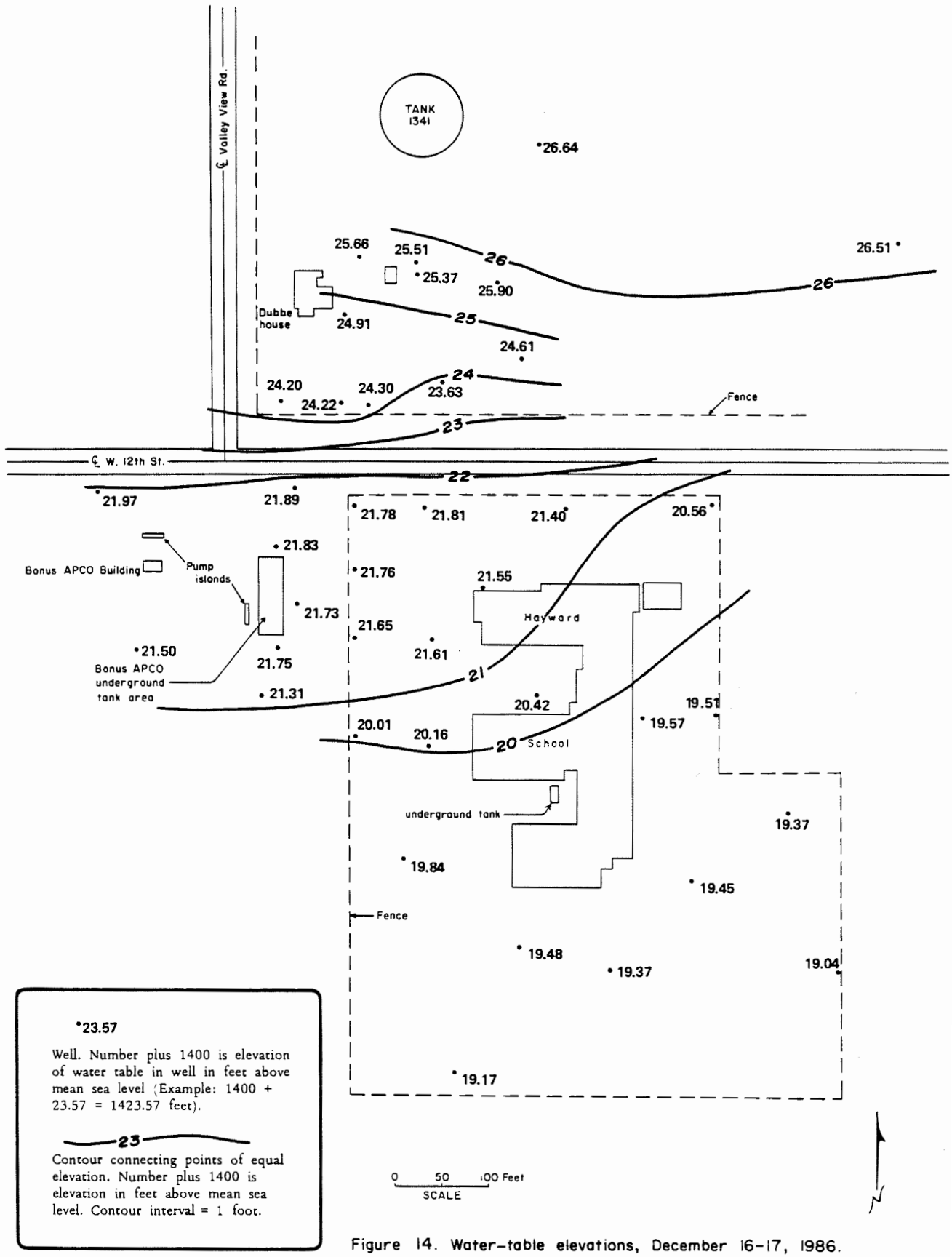


Figure 14. Water-table elevations, December 16-17, 1986.

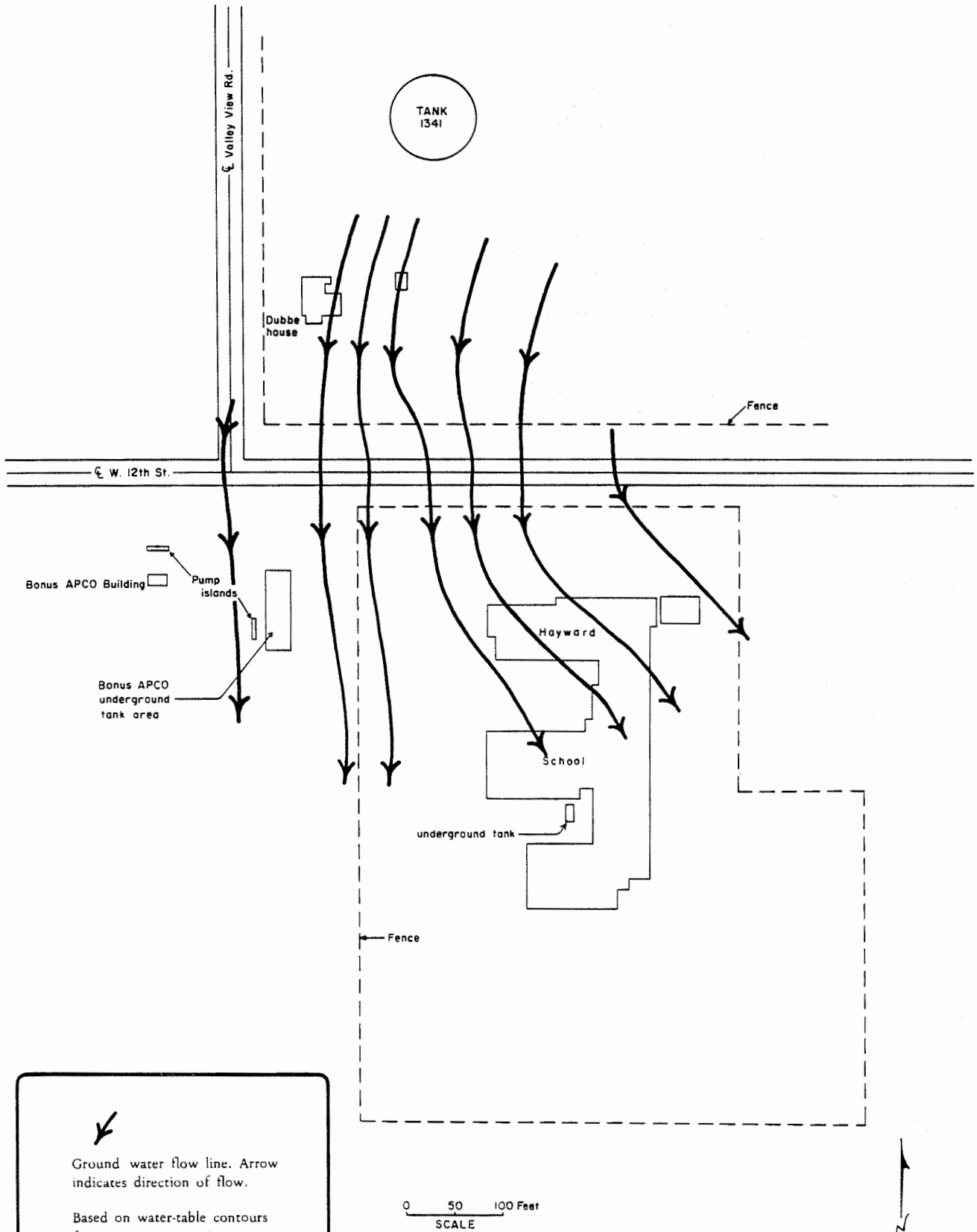


Figure 15. Ground water flow direction, December 16-17, 1986.

southeast on Hayward School property, and (3) generally south on Bonus APCO property. Thus, ground-water inflow to the area of the Bonus APCO Station underground storage tanks and Hayward School is generally from the north, or from WPL property. These flow directions have remained essentially constant through a significant rise and fall of the water-table surface. No data have been produced to indicate flow directions other than those mentioned above.

Pumping wells would have a localized effect on ground water flow direction. Wells which will be mentioned here are the three WPL recovery wells (RW-2, SRW-2, and SRW-4) and the unused Hayward School well. When pumping, each of these wells would cause ground-water flow to be directed toward the well for some small undetermined radius. The radius of influence of any of these wells on current or past flow direction is unknown. Regardless of the magnitude of influence, the three recovery wells can only have had a recent influence (since their installation in June and August, 1986) and the School well has had no influence since September, 1984, when its use was discontinued. The three recovery wells have pumped intermittently since their installation. Requests by DWNR for pumping times and rates have gone unanswered by WPL.

The influence of the three recovery wells on water levels on WPL property is believed to be small relative to the extent of contamination. Data provided by Bay West, Inc. suggest that well RW-2 may have a radius of influence of only about 100 feet. Wells SRW-2 and SRW-4 may have less influence because they are designed to pump only intermittently. Well RW-2 is designed to pump continuously, although it has not always done so. This means that the radii of influences created by the pumping wells are not intercepting the entire contaminant plume.

The historic influence of the Hayward School well upon water levels is believed to have been limited. However, lack of drawdown data and adequate pumping records do not allow for an exact determination. Pumping records do indicate, though, that the pumping rate was probably less than 10 gallons per minute. Also, this well certainly would not have pumped continuously because pumping would have been limited primarily to School class hours. At such a low rate of intermittent pumping, the effective radius of influence was probably quite small.

The east-west sanitary sewer line located under West 12th Street, north of Hayward School (fig. 2), must be considered with respect to its potential effect on ground water flow direction. The sewer line was inspected using television equipment by Midwest Underground Inspections, Inc. on February 3, 1987. The sewer line was televised for approximately 370 feet along West 12th Street east from the manhole at the northwest corner of Hayward School property. Overall, the televised line, which is composed of 10-inch diameter, 6-foot long, clay tile sewer pipe appeared to be in good condition. Several low spots in the line

were observed and one break/crack in a pipe section was observed approximately 24 feet into the line (Paul Henriksen, DWNR, personal communication, 1987).

The water table apparently fluctuates above and below the sewer line (fig. 6). If there were significant breaks in the sewer, and there are no data to substantiate such a claim, the sewer line would act as a discharge point for ground water when ground-water levels are above the sewer line. The sewer would act as a recharge point when ground-water levels were below the sewer line. Under the former conditions, some minor amount of the total ground water flow could be directed into the sewer line. Under the later conditions, ground water flow direction would probably not be significantly affected. If either of these conditions were occurring in sufficient magnitude to substantially alter the direction of ground-water flow in the study area, there should be mounding of the water table, or a depression in the water table around that portion of the sewer. Neither the cross section showing the sewer (fig. 6) or the ground water gradient maps (figs. 12, 13, and 14) indicate this. Thus, because of the apparently good condition of the sewer line and the apparent lack of appreciable influence on the ground-water levels in the immediate vicinity, the sewer line and the disturbed sediments next to the sewer line (due to sewer construction) are probably not significant factors affecting ground-water flow.

Ground-Water Velocity

Actual ground-water velocity, and thus the rate of contaminant migration is unknown. Data required to calculate the velocity are: (1) the aquifer's hydraulic conductivity, (2) the ground-water gradient, and (3) the porosity of the aquifer. However, using some known and assumed values, a possible range of velocities can be calculated. Fetter (1980) suggests that porosity for sediments of the type being investigated range from 20 to 35 percent. An average of this range equals 27.5 percent. Hydraulic conductivity values were reported to range from 54 to 1,464 gallons per day per square foot by Bay West, Inc. and an average gradient of 0.010 was reported in a previous section of this report. Ground-water velocities calculated using this set of values range from a low of 0.2 to a high of 10 feet per day (average = 3.7 feet per day).

These values must, however, be viewed with caution due to problems outlined earlier regarding Bay West, Inc.'s determination of values for aquifer properties, specifically the hydraulic conductivity in this case. Also, changes in clay and silt content of the sand and gravel can cause significant variations in ground-water velocity over a short lateral distance. In spite of these limitations, actual ground water velocity is probably within the calculated range but cannot be reliably determined with available data.

POTENTIAL SOURCES OF CONTAMINATION

Inventory of Storage Tanks

A computer search of DWNR underground storage tank files and a door-to-door survey of businesses was conducted to identify possible contamination sources. The only tanks discovered which will be addressed in this report are those on the WPL, Bonus APCO Station, and Hayward School properties. All storage tanks at the WPL facility are above ground and most transfer and transmission pipes are also located above ground. The Bonus APCO Station has underground tanks and lines. Hayward School has a 10,000 gallon capacity underground storage tank used for storage of No. 2 fuel oil. Locations of these facilities are shown on figure 2. Partial inventory records from the WPL facility and the Bonus APCO Station have been provided to DWNR.

Reported Spills and Leaks

The Department of Water and Natural Resources has reviewed its Oil and Hazardous Materials Spills files and has contacted the following agencies to document all reported spills and leaks in the immediate vicinity of Hayward School.

1. U.S. Environmental Protection Agency (EPA)
2. South Dakota Division of Emergency and Disaster Services
3. South Dakota Highway Patrol
4. Minnehaha County Civil Defense Office
5. Minnehaha County Sheriff's Office
6. Sioux Falls Fire Department
7. Wayne Township Fire Department

No reports of spills or leaks were found by DWNR other than the gasoline in the ground water, defined by Bay West, Inc. on WPL property in the vicinity of Tank 1341 (fig. 3).

Williams Pipe Line Company

Tank 1341 on WPL property has been identified by WPL's consultant as the probable source of gasoline in the ground near the tank, although as mentioned previously, no data have been supplied by WPL to document a leak from this tank. Thus, the duration and magnitude of this probable loss are unknown. Other large storage tanks belonging to WPL are also in the immediate vicinity of Tank 1341 and must be considered as potential sources as well. The Department of Water and Natural Resources is presently in the

process of examining and evaluating recently obtained maintenance and inventory records from nearby WPL tanks. Because of the implied loss of product from Tank 1341 (the attention paid to the tank by WPL's consultant), DWNR's efforts have been directed to examining that tank in more detail than surrounding ones.

Construction of Tank 1341

Tank 1341 was constructed in about 1950 and is a cylindrical steel tank 40 feet high with a diameter of 85 feet. It has a listed capacity of 40,000 barrels (1 barrel = 42 gallons; 40,000 barrels = 1,680,000 gallons). It has a floating roof which allows the tank to be filled only to a height of 36.5 feet amounting to 1,544,256 gallons (J. Honer and T. Downie, WPL, personal communication, 1986). The tank has a bottom thickness of 0.25 inches.

The topsoil was scraped away during construction to form the dikes around the tank area. The tank was then constructed on top of a bed of crushed rock which directly overlies the natural sand and gravel sediments. (W. Fredrickson, WPL, personal communication, 1986).

Product Inventory of Tank 1341

The following product inventory records of Tank 1341 are based on an examination of WPL records at their corporate headquarters in Tulsa, Oklahoma, and conversations with WPL personnel:

1950 - ?	presumably both petroleum and fertilizer were kept in the tank in the 1960's (J. Honer and T. Downie, WPL, personal communication, 1986).
? - 1972	fuel oil
4/1972 - 1975?	nitrogen fertilizer was kept in this tank until about 1975 (J. Honer and T. Downie, WPL, personal communication, 1986). WPL tank maintenance records indicate fuel oil in November, 1974, but note this tank also received water carried through pipe lines as a buffer between fertilizer and fuel oil shipments and dirty fuel oil shipments.
1975? - 1982	fuel oil
1/19/1982 - 9/9/1985	jet fuel
9/9/1985 - present	unleaded gasoline

Tank 1341 was apparently used very little for a portion of the time that it contained jet fuel. From September, 1984, through July, 1985, the tank contained 4,000 barrels of jet fuel. During this time there is no record of additions or withdrawals. The tank was, however, used extensively after it was completely filled with unleaded gasoline on September 23, 1985. The tank was reportedly empty from June 9, 1986, until August 5, 1986, following the evacuation of the Dubbe residence and during inspection and maintenance of the tank. It is DWNR's understanding that no holes or leaks were found during this inspection, however, the tank bottom was lined with fiberglass in July, 1986, before gasoline was reintroduced into the tank.

Inventory Control

According to WPL personnel (J. Honer and T. Downie, WPL, personal communication, 1986), tanks at the 12th Street Terminal are monitored daily when in use and monthly when not in use. This monitoring includes measurement of product height and temperature in the tank.

Temperature data are necessary because product volume is sensitive to temperature variation. For example, WPL personnel (J. Honer and T. Downie, WPL, personal communication, 1986) indicated that a temperature change of 1 degree F could cause a 7-gallon change on an initial volume of 10,000 gallons or 700 gallons on an initial volume of 1,000,000 gallons.

Product temperature in Tank 1341 is apparently measured using a probe located a few feet inside the tank and near the bottom. WPL personnel (J. Honer and T. Downie, WPL, personal communication, 1986) indicated that the temperature-sensing probe may not detect variations in temperature within the tank. This reported lack of sensitivity to temperature variation is believed to be the result of potential stratification of product in the tank into different temperature zones. Stratification may be caused by introduction of product into the tank which is of greatly different temperature than existing product or may be due to natural temperature differences of product in the tank which result from climatic temperature changes.

The gauges which measure product height are reportedly accurate to within 1/8 inch. This means that for Tank 1341, the daily inventory record is accurate only to plus or minus 442 gallons, not even taking temperature-sensing problems into account. Mr. G. Feldman (WPL employee) indicated that inventory measurements are rounded off when they are reported and that the amount of product added or removed is determined solely by measurement of product height and temperature. Potential variances associated with measurement of product height and temperature mean that considerable product loss can go undetected. With the above measuring procedures, any leak less than 442 gallons per day will not be detected from Tank 1341 or any similar tank.

Maintenance of Tank 1341

Soon after construction, Tank 1341 was vacuum tested to determine tank integrity. There are no known records of any other testing since that time.

Tank maintenance records are generally lacking from 1950 until 1971. The facility was owned by Great Lakes Pipeline until 1965.

?/1969	Mention was made of pit and patch welding, however, no number or depth of pits were specified.
4/27/1972	The tank bottom was said to be in good condition.
11/7/1974	Seven pits with an approximate depth of 0.0012 inch were patched or welded.
7/22/1981	One hundred seventy-three pits were noted with approximate depths ranging from 0.125 to 0.210 inch (tank bottom thickness is only 0.250 inch). There is no record of repair of these pits. The record notes that with the shipment of fertilizer, the tank may be unable to go another 8 years before cleaning.
9/28/1981	Oil was changed in the electric gauge because water was found in the gauge.
1/19/1982	Eight pits were noted with an approximate depth of 0.1 to 0.12 inch. Eight pits were noted to have been repaired by welding.
11/7/1984	Seven pits were noted with an approximate depth of 0.0012 inch. These pits were noted to have been patched or welded.
4/4/1986	One hundred sixty pits were noted with an approximate depth less than 0.05 inch. These pits were apparently welded along with numerous patches.
6/10/1986	The floor was sandblasted. Eighty-two pits were noted with an approximate depth of 0.07 inch. These pits were apparently patched.
7/1986	A fiberglass coating on the tank bottom was installed.

Based upon the maintenance records provided by WPL, repairs have been required on the bottom of Tank 1341 since at least 1969 (a period of 18 years). More than 430 pits have been noted since 1974.

South Dakota Department of Agriculture officials who license bulk fertilizer storage facilities note that fertilizer is quite corrosive to steel tanks. Tank 1341 formerly contained fertilizer. The above listed maintenance record from July 22, 1981, mentioned fertilizer. It is unclear as to whether this refers to fertilizer at that time or sometime in the past when the tank was used for fertilizer storage. Inventory records indicate fuel oil in the tank at the time of the above-mentioned maintenance record. The maintenance record does, however, support the interpretation that fertilizer is quite corrosive to steel tanks.

Maintenance of Other WPL Tanks

Figure 16 shows the number of corrosion pits and general layout of all tanks on WPL property. The significance of this map is that there are other tanks which have exhibited numerous pits through the years of inspection and thus must also be considered when looking for potential sources of contamination. A detailed examination of tanks other than Tank 1341 is beyond the scope of this report. It should be noted, however, that maintenance reports for Tanks 1337 and 1338 reveal that pitting has occurred to the extent that holes have developed through the entire thickness of the tank bottom.

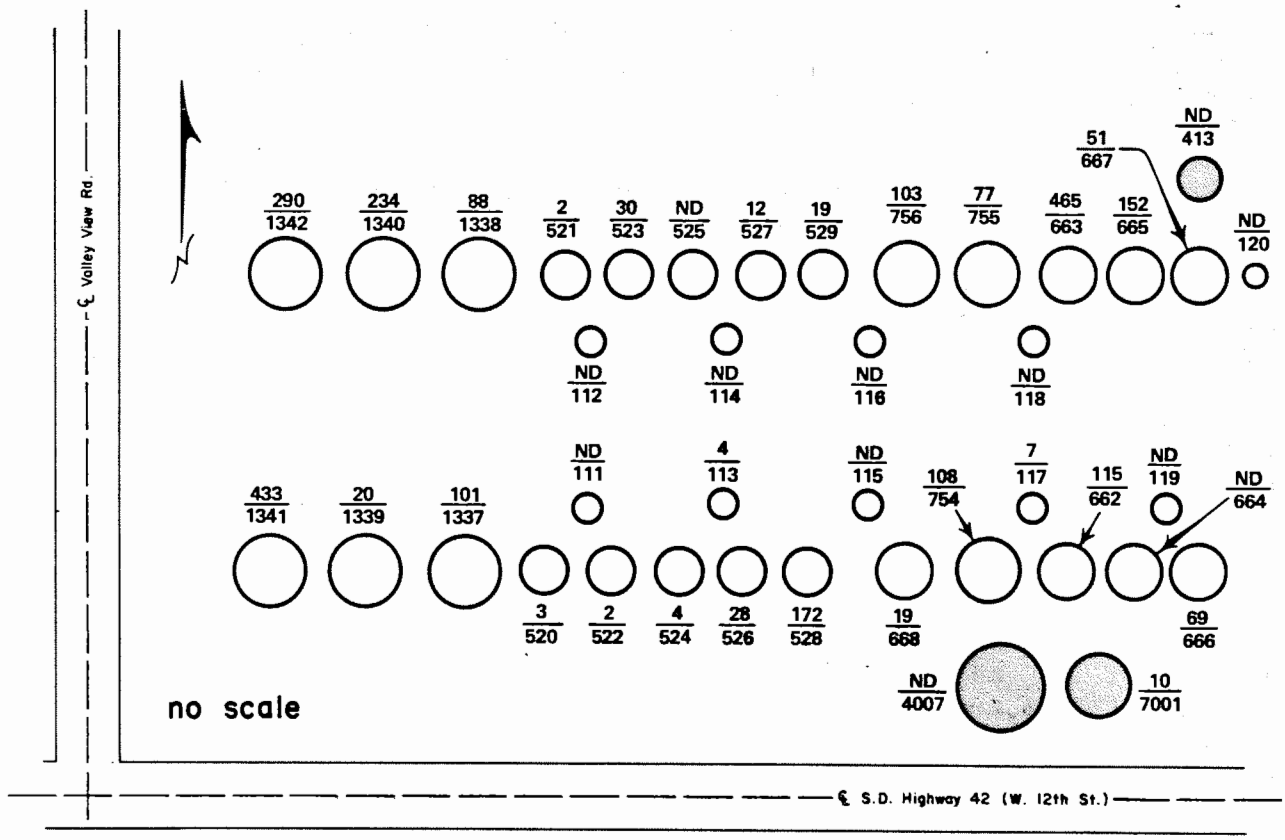
Tank maintenance periodically requires the removal of sludge. In the past, WPL buried sludge material from the tanks on site, however, there is no information on how much, or where, sludge has been buried. In reviewing WPL records, DWNR determined that a minimum of 200,630 gallons of sludge material has been removed from the tanks.

Bonus APCO Station

Tank Locations and Inventory Records

Mr. Dale Olson, registered agent for Dale Olson Oil Company, owner of the Bonus APCO Station, has not reported any loss of petroleum product. All product storage at the Bonus APCO Station is underground. Locations and capacities of these underground storage tanks are shown on figure 17. Inventory records are not available with the degree of accuracy needed, as determined by DWNR, to make interpretations regarding potential product loss from the tanks.

Tanks 9 and 10 have been abandoned since the early 1970's. The last product in tank 9 was premium gasoline and the last product



433/1341

Storage tank. Upper number is total number of corrosion pits reported in tank between 1975 and 1986.
Lower number is tank identification number.
ND indicates no data.

Tank capacities: 100 series = 84,000 gallons
500 series = 420,000 gallons
600 series = 840,000 gallons
700 series = 1,260,000 gallons
1300 series = 1,680,000 gallons

10/7001

Fertilizer storage tank. Upper number is total number of corrosion pits reported in tank between 1975 and 1986.
Lower number is tank identification number.
ND indicates no data.

Tank capacities: 413 = 260,400 gallons
4007 = 1,890,000 gallons
7001 = 1,134,000 gallons

Data from Williams Pipe Line maintenance records from 1975 to 1986.

Figure 16. Number of corrosion pits reported in Williams Pipe Line storage tanks, 1975-1986.

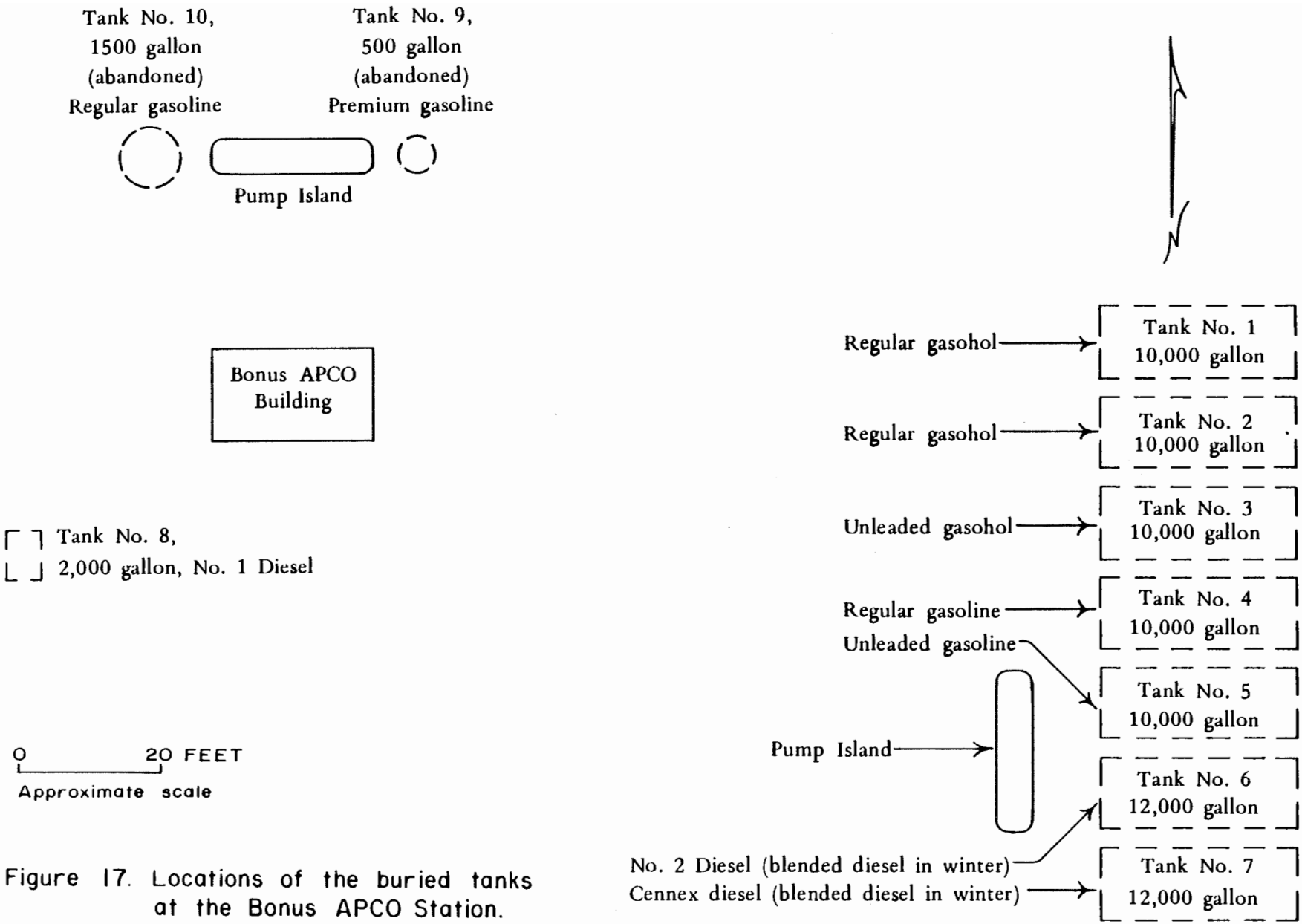


Figure 17. Locations of the buried tanks at the Bonus APCO Station.

in tank 10 was regular gasoline (D. Olson, Dale Olson Oil Co., personal communication, 1986).

Tank Testing

After evacuation of the Dubbe residence, Mr. Olson contracted with Mr. Carl Soukup to excavate two holes on the east and north sides of the Bonus APCO Station buried tanks, located to the east of the station building. The excavations were to determine if there were any petroleum leaks. Mr. Soukup reported that he saw no oil and did not taste petroleum in water encountered in the excavations (C. Soukup, personal communication, 1987).

There have been two sets of Petro-Tite Tank and Line Tester System tightness tests performed on most of Mr. Olson's tanks. The first set of tests was conducted by Bay West, Inc. on tanks 1 through 7 (fig. 17). Bay West, Inc.'s tests showed that all but one of the tested tanks, tank 3, failed the tank tightness test (minimum detection limit of 0.05 gallons per hour). Bay West, Inc. also tested the dispensing pumps and found that they did not leak. Mr. Olson reported to DWNR that Sioux Equipment Company tested the fuel dispensing lines just prior to the Bay West, Inc. test and found that they did not leak.

The second set of tests was conducted by Leak Specialists, Inc., a firm hired by Mr. Olson's insurance company, on tanks 1, 2, 4, 5, 6, 7, and 8 (fig. 17). Leak Specialists, Inc. did not retest tank 3 which was determined to be "tight" by Bay West, Inc. The tests conducted by Leak Specialists, Inc. showed that all tanks tested passed the same type of test used by Bay West, Inc. However, Leak Specialists, Inc. tightened or replaced noticeably loose pipe fittings before and during tank-tightness testing, thereby altering existing tank and line conditions. Because of the manner in which the second set of tank-tightness tests were conducted, the two sets of test results cannot be directly compared.

It can be concluded from these two sets of tests that the tanks are presently considered as "tight" (based on the National Fire Protection Association leak detection limit of 0.05 gallon per hour). It can also be concluded that any prior leakage which may have occurred from any of these tanks probably came from the pipe fittings located at or near the tops of the tanks. The potential for leaks occurring from these locations under normal tank and line usage is unknown.

DOCUMENTATION OF CONTAMINATION

Petroleum has a number of physical properties which affect its ability to cause environmental problems. Because its specific gravity is less than water, free product will tend to collect, or float, on the water table. Petroleum can migrate through subsur-

face material in three forms: (1) as dissolved contamination in the ground water, (2) as free product, accumulating primarily along the top of the water table in the capillary fringe, and (3) as vapors in the soil.

Dissolved Hydrocarbons

Gasoline contamination extends in the direction of ground-water flow from the vicinity of Tank 1341 southward across West 12th Street and underlies Hayward School. This contamination includes total hydrocarbons, benzene, toluene, and xylene (figs. 18 through 26). These contaminants were analyzed by PACE Laboratories, Inc. for WPL and by Rocky Mountain Analytical Laboratory (RMAL) and the South Dakota State Health Laboratory for DWNR.

Total Hydrocarbons

Hydrocarbon contamination is present throughout most of the area investigated. Figures 18, 19, and 20 indicate the distribution of total hydrocarbons dissolved in the ground water from June, 1986, through December, 1986. Data are relatively limited on figure 18 because many of the monitoring wells now present had not yet been installed.

Figure 18 shows that in June, 1986, ground-water contamination existed on WPL property (including the former Dubbe property) at least up to the property line along West 12th Street and Valley View Road. Amounts of contamination noted in the wells along West 12th Street are significantly above background levels, which should be zero in an uncontaminated situation. The values in figure 18 correspond very well to the free product plume and representation of dissolved contamination (solubles) shown on figure 3. Both figures represent contamination in June, 1986.

The data presented on figures 19 and 20 document contamination over a much larger area than is represented in figure 18. It is not possible to know whether contamination to the extent shown in figures 19 and 20 was present during June, 1986, because the present monitoring well network was not established at that time.

Contamination concentrations increased between times represented on figure 19 and 20 in the "F" series wells (fig. 2 and app. A) to the southeast of Tank 1341 and in wells MW-15 and MW-16 to the south of Hayward School. This may indicate spreading of the contaminant plume(s). This increase in contamination in the "F" series wells may indicate other possible contaminant sources in the vicinity of WPL's 1300-series tanks. This interpretation is supported by the direction of ground-water flow.

The pattern of total-hydrocarbons contamination is generally consistent with the direction of ground-water flow and indicates WPL property as a source of total-hydrocarbons contamination.

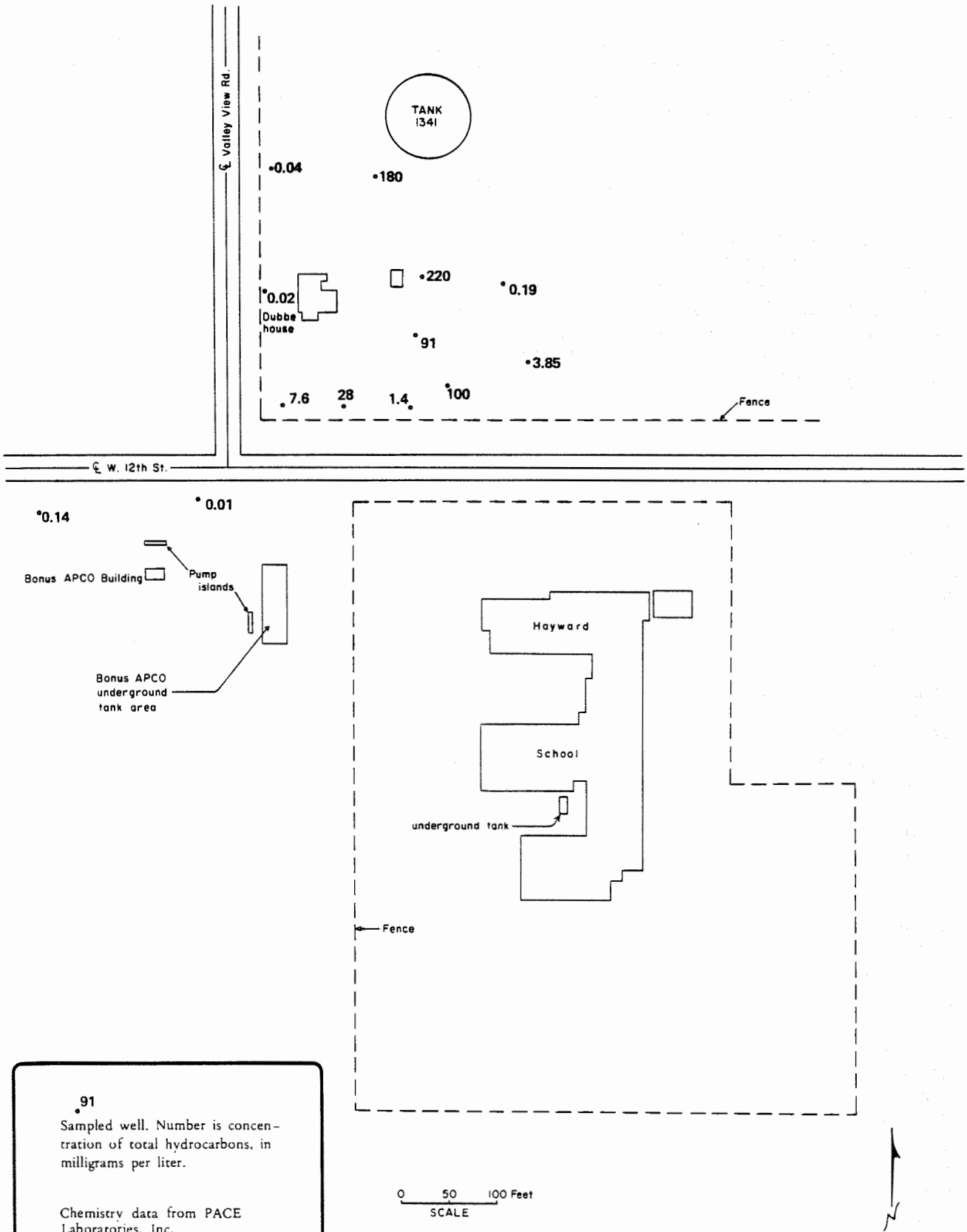
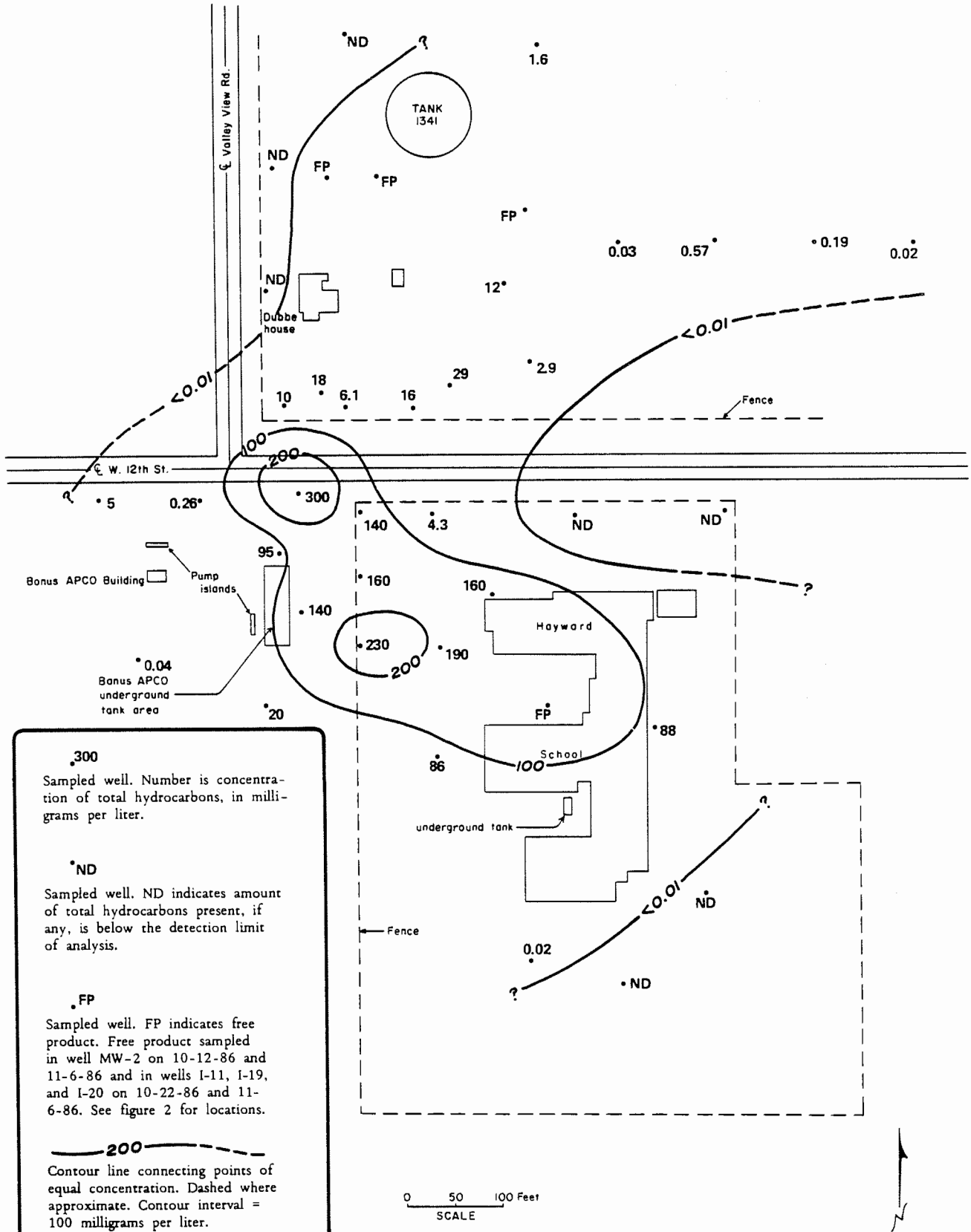


Figure 18. Distribution of total hydrocarbons, June 9-11, 1986.



300
Sampled well. Number is concentration of total hydrocarbons, in milligrams per liter.

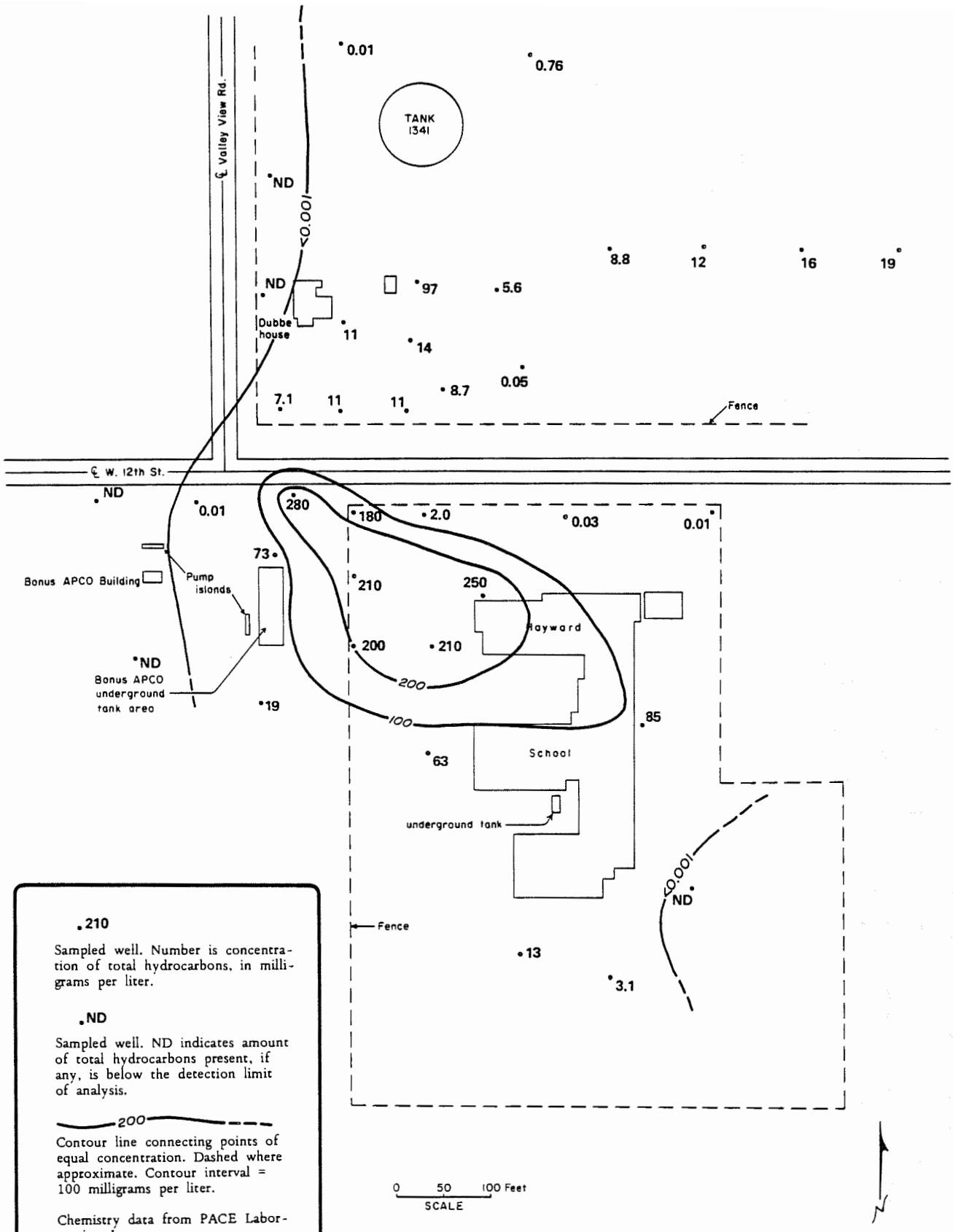
ND
Sampled well. ND indicates amount of total hydrocarbons present, if any, is below the detection limit of analysis.

FP
Sampled well. FP indicates free product. Free product sampled in well MW-2 on 10-12-86 and 11-6-86 and in wells I-11, I-19, and I-20 on 10-22-86 and 11-6-86. See figure 2 for locations.

200
Contour line connecting points of equal concentration. Dashed where approximate. Contour interval = 100 milligrams per liter.

Chemistry data from PACE Laboratories, Inc.

Figure 19. Distribution of total hydrocarbons, October 27-31, 1986.



210

Sampled well. Number is concentration of total hydrocarbons, in milligrams per liter.

ND

Sampled well. ND indicates amount of total hydrocarbons present, if any, is below the detection limit of analysis.

200

Contour line connecting points of equal concentration. Dashed where approximate. Contour interval = 100 milligrams per liter.

Chemistry data from PACE Laboratories, Inc.

Figure 20. Distribution of total hydrocarbons, December 3-10, 1986.

Comparison of figures 19 and 20 indicate advancement of the leading edge of the contaminant plume near the south end of Hayward School.

Benzene, Toluene, and Xylene

The aromatic components of petroleum, especially benzene, toluene, and xylene, have the greatest solubility. Therefore, they are most likely to contribute to dissolved ground water contamination (Farmer, 1983). Benzene, toluene, and xylene are also relatively volatile and are therefore lost to the atmosphere and sediment pore spaces as gasoline weathers (Senn and Johnson, 1987). Diesel fuel and fuel oil usually have small amounts of benzene, toluene, and xylene relative to gasoline (D. Frasch, South Dakota State Health Laboratory, personal communication, 1987). The high levels of benzene present in ground-water samples, together with its presence at elevated levels in the soil vapor and in Hayward School are indicative that the contamination is gasoline and that the problem is relatively recent in origin.

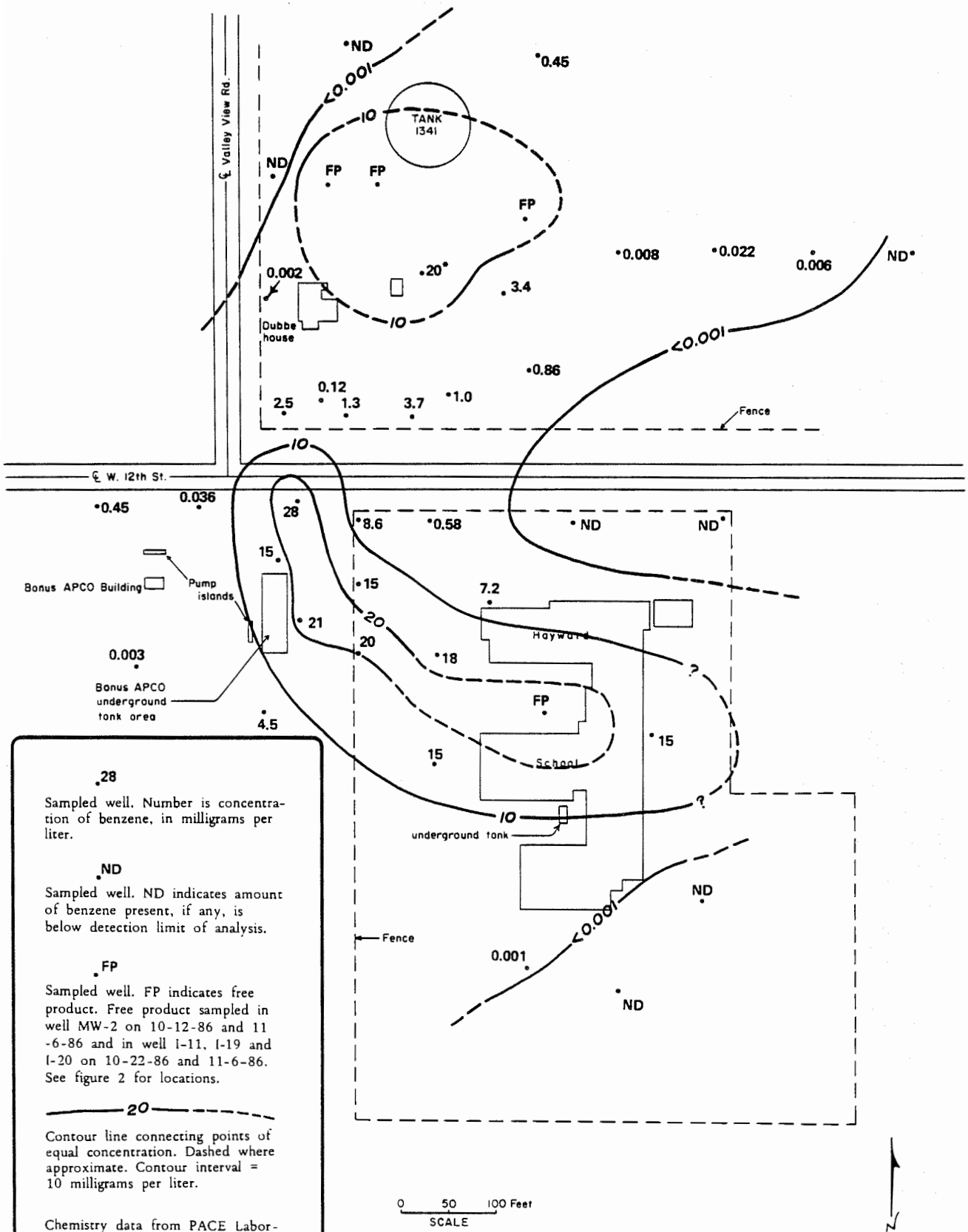
The distribution of benzene is illustrated on figures 21 and 22, whereas the distribution of toluene is illustrated on figures 23 and 24, and xylene on figures 25 and 26. A direct comparison of figures representing the same contaminant is not possible because data from the same wells were not available for the different sampling times. However, the same general trends and patterns of contaminant distribution are seen in the figures.

Some variations observed in contaminant distribution are undoubtedly related to migration of contaminants in the direction of ground-water flow. Other contributing factors which have a direct effect on the dispersion and availability of free product for migration, and thus the amounts of dissolved benzene, toluene, and xylene may be: (1) the lithologic differences in silt and clay content both laterally and vertically, (2) changes in the water-table elevation, and (3) the hydraulic conductivity of the aquifer. These same factors would affect the total-hydrocarbon distribution.

The patterns of benzene, toluene, and xylene in the ground water are generally consistent with the direction of ground-water flow and indicate WPL property as a source for these contaminants.

Comparison of figures 21 and 22 indicate a relatively consistent amount of benzene in the ground water along the WPL property line south of Tank 1341. This indicates that ground water with elevated levels of dissolved benzene is continuing to migrate off of WPL property in the direction of ground-water flow.

The increase in benzene concentrations to the south of Hayward School between October, 1986, and December, 1986, indicates an advancing front of a contaminant plume (figs. 21 and 22). This



•28

Sampled well. Number is concentration of benzene, in milligrams per liter.

•ND

Sampled well. ND indicates amount of benzene present, if any, is below detection limit of analysis.

•FP

Sampled well. FP indicates free product. Free product sampled in well MW-2 on 10-12-86 and 11-6-86 and in well I-11, I-19 and I-20 on 10-22-86 and 11-6-86. See figure 2 for locations.

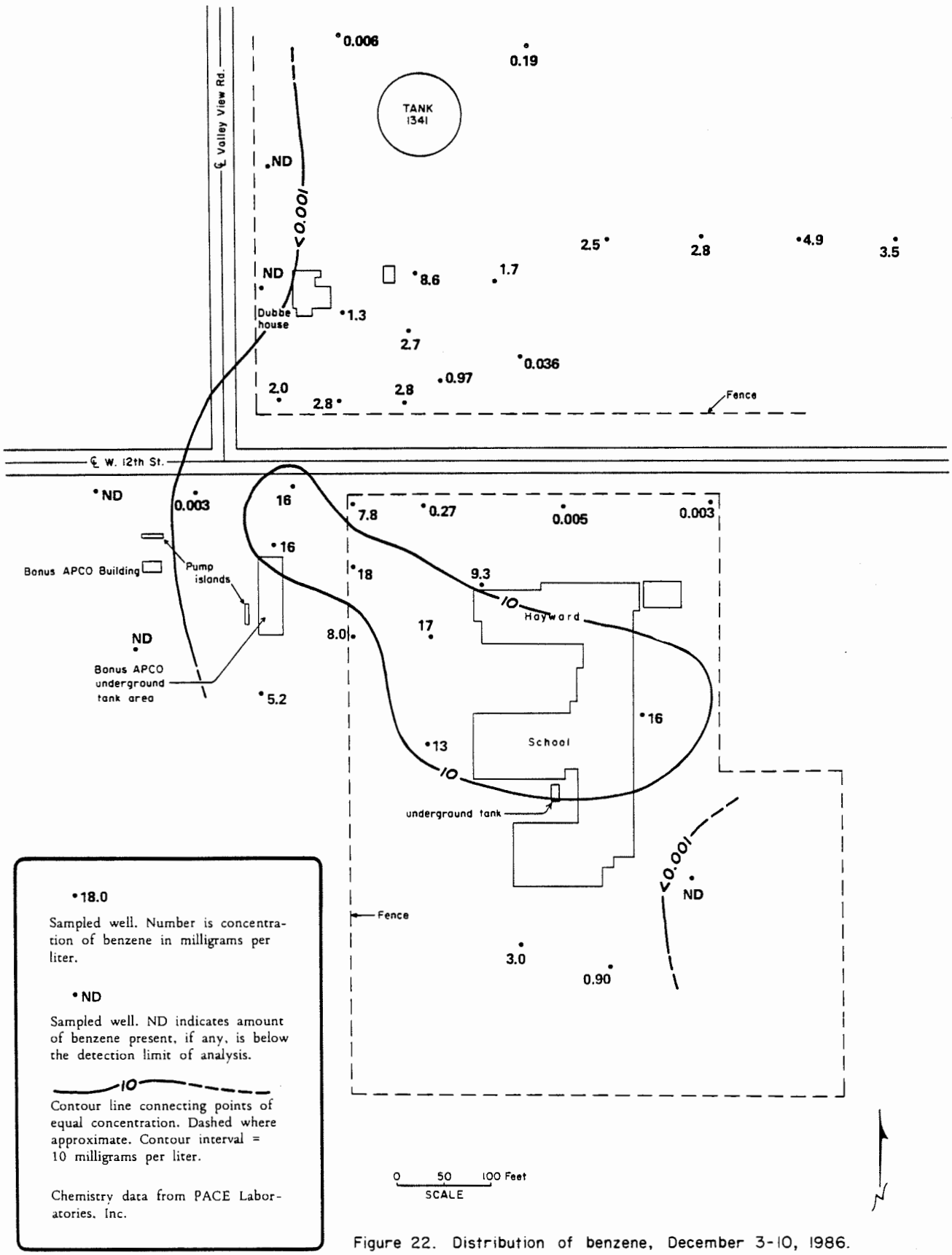
20

Contour line connecting points of equal concentration. Dashed where approximate. Contour interval = 10 milligrams per liter.

Chemistry data from PACE Laboratories, Inc., except for well R20-86-74, which is from Rocky Mountain Analytical Laboratory. See figure 2 for location.

*Well R20-86-74 sampled 11-7-86.

Figure 21. Distribution of benzene, October 27-31, 1986.



•18.0

Sampled well. Number is concentration of benzene in milligrams per liter.

•ND

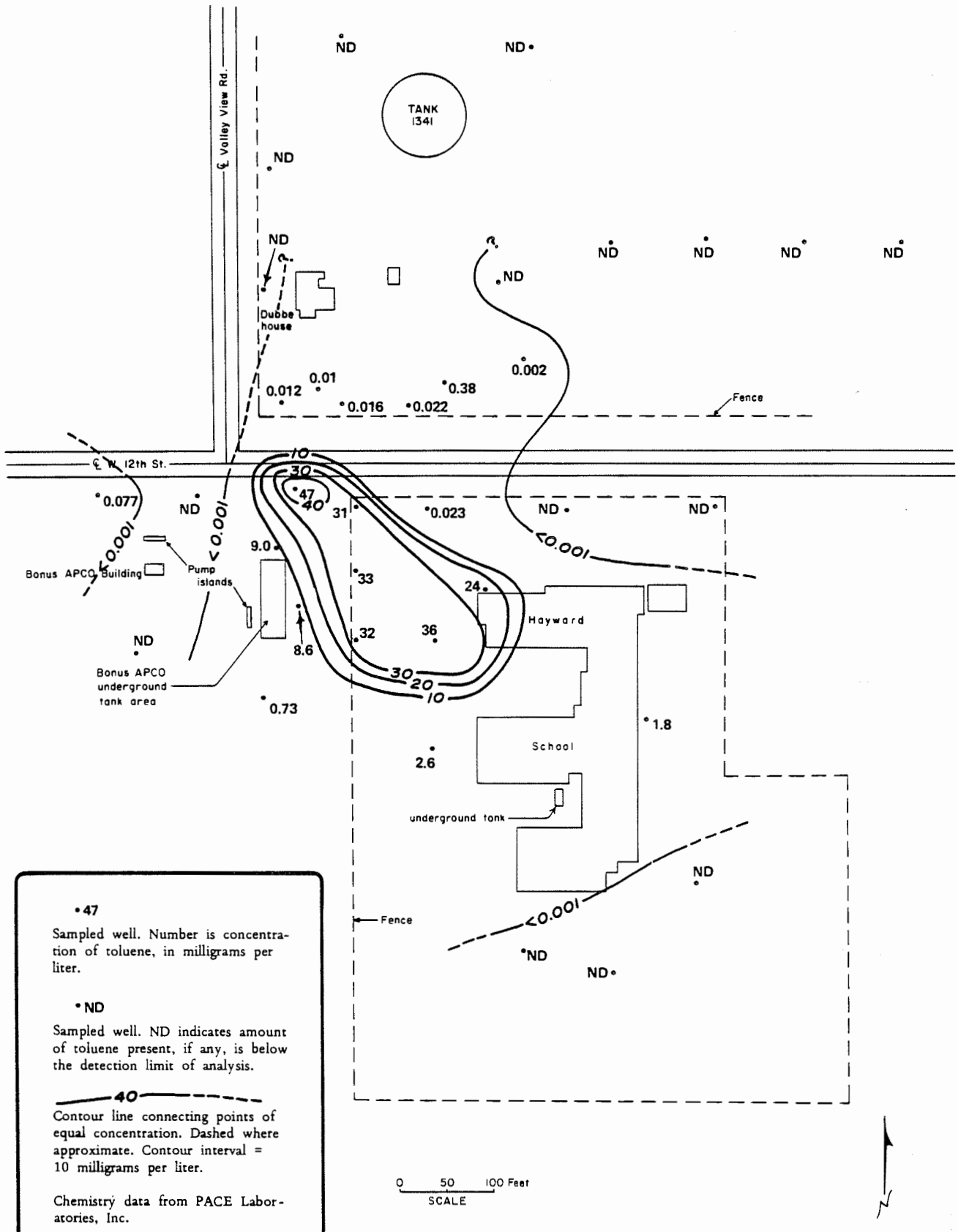
Sampled well. ND indicates amount of benzene present, if any, is below the detection limit of analysis.

10

Contour line connecting points of equal concentration. Dashed where approximate. Contour interval = 10 milligrams per liter.

Chemistry data from PACE Laboratories, Inc.

Figure 22. Distribution of benzene, December 3-10, 1986.



• 47

Sampled well. Number is concentration of toluene, in milligrams per liter.

• ND

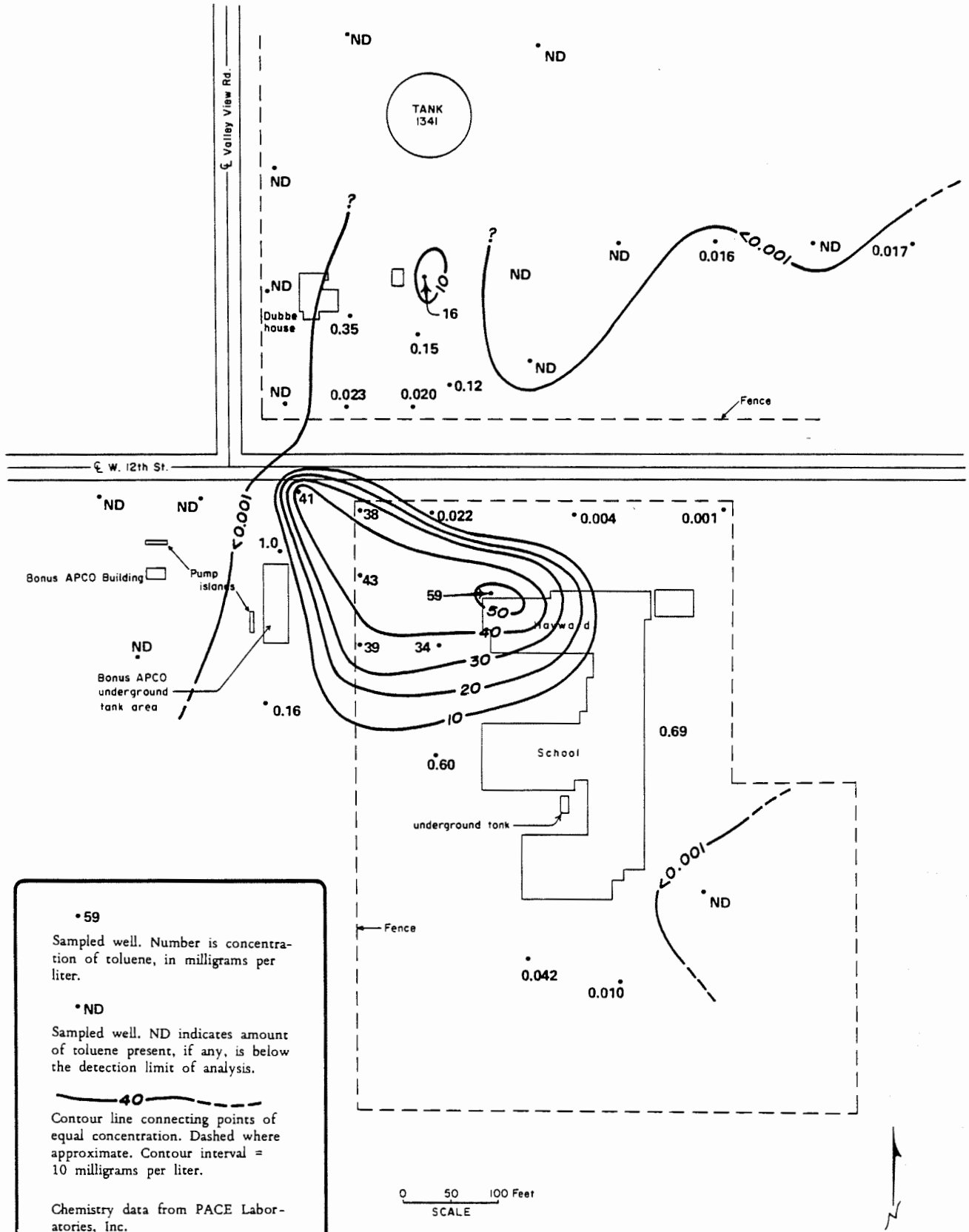
Sampled well. ND indicates amount of toluene present, if any, is below the detection limit of analysis.

40

Contour line connecting points of equal concentration. Dashed where approximate. Contour interval = 10 milligrams per liter.

Chemistry data from PACE Laboratories, Inc.

Figure 23. Distribution of toluene, October 27-31, 1986.



• 59

Sampled well. Number is concentration of toluene, in milligrams per liter.

• ND

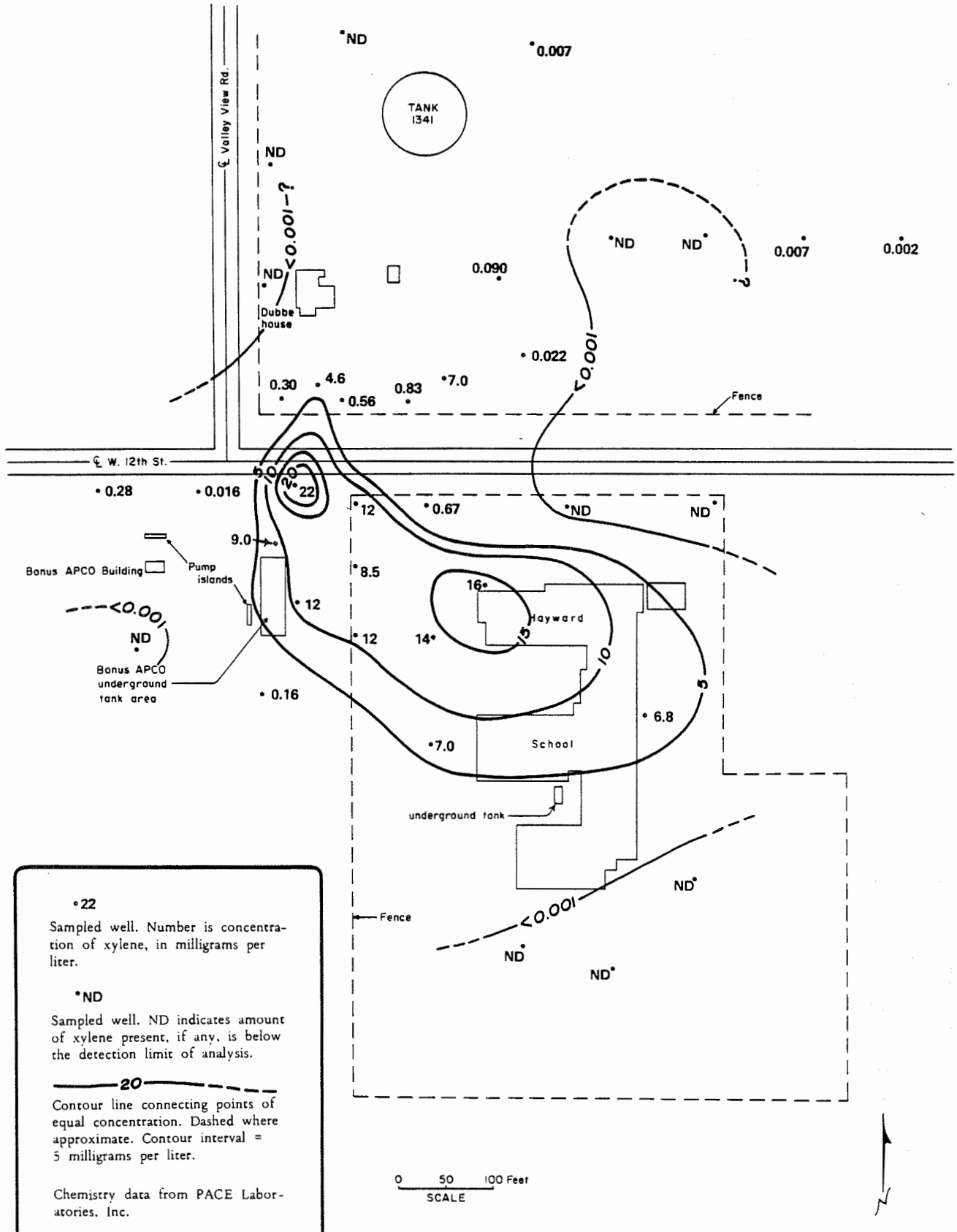
Sampled well. ND indicates amount of toluene present, if any, is below the detection limit of analysis.

40

Contour line connecting points of equal concentration. Dashed where approximate. Contour interval = 10 milligrams per liter.

Chemistry data from PACE Laboratories, Inc.

Figure 24. Distribution of toluene, December 3-10, 1986.



•22

Sampled well. Number is concentration of xylene, in milligrams per liter.

•ND

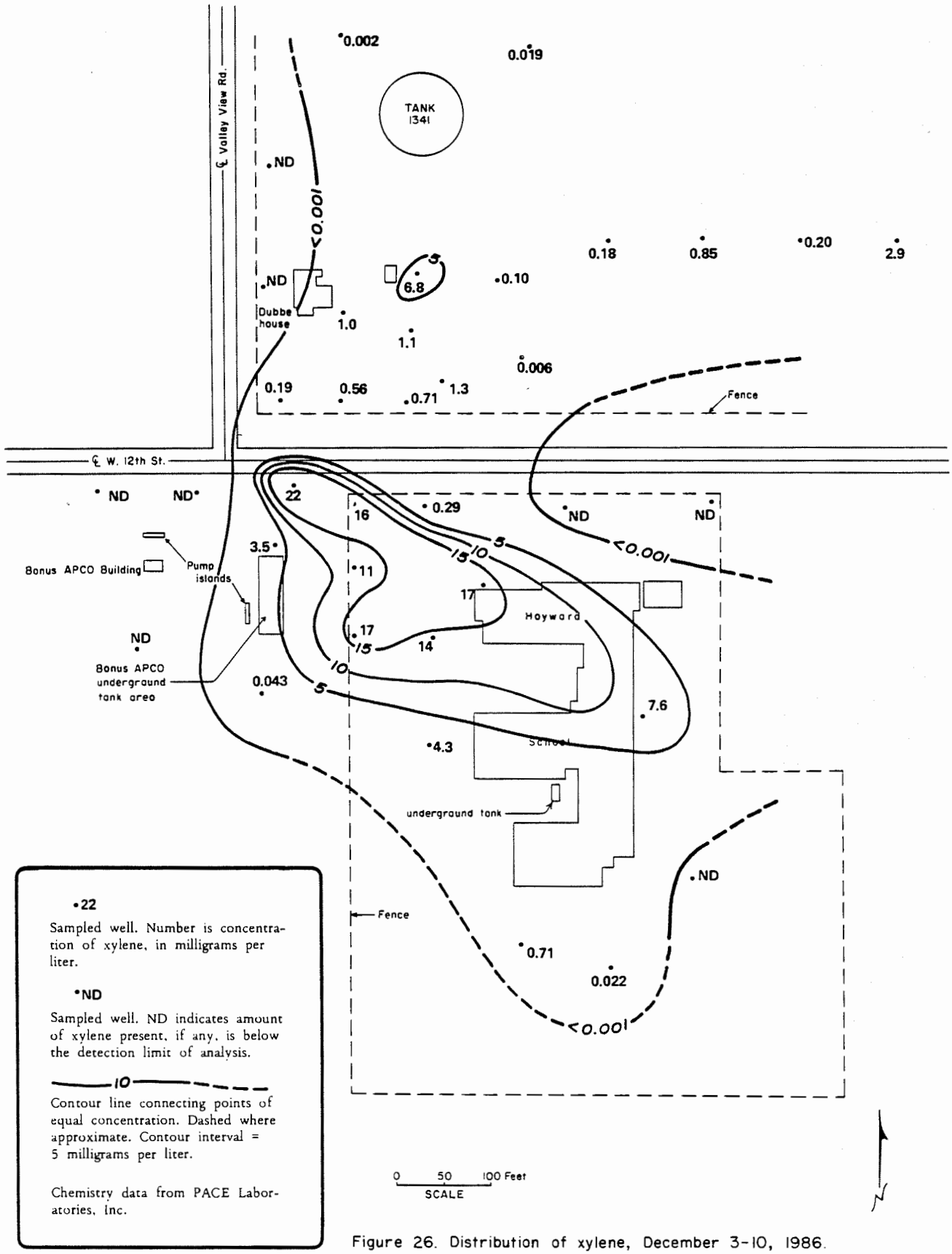
Sampled well. ND indicates amount of xylene present, if any, is below the detection limit of analysis.

20

Contour line connecting points of equal concentration. Dashed where approximate. Contour interval = 5 milligrams per liter.

Chemistry data from PACE Laboratories, Inc.

Figure 25. Distribution of xylene, October 27-31, 1986.



•22

Sampled well. Number is concentration of xylene, in milligrams per liter.

•ND

Sampled well. ND indicates amount of xylene present, if any, is below the detection limit of analysis.

10

Contour line connecting points of equal concentration. Dashed where approximate. Contour interval = 5 milligrams per liter.

Chemistry data from PACE Laboratories, Inc.

Figure 26. Distribution of xylene, December 3-10, 1986.

apparent advancement is consistent with the direction of ground-water flow.

The increased concentrations of benzene in the "F" series wells (fig. 2) between October, 1986, and December, 1986 (figs. 21 and 22), indicate possible sources of contamination on WPL property other than the immediate Tank 1341 vicinity. Increased levels of benzene in these wells is not consistent with the direction of ground-water flow, assuming the immediate Tank 1341 vicinity as the only source. This is significant because it raises the possibility that other unknown contaminant plumes are presently migrating toward Hayward School and the residential area to the south of West 12th Street.

Other Hydrocarbons

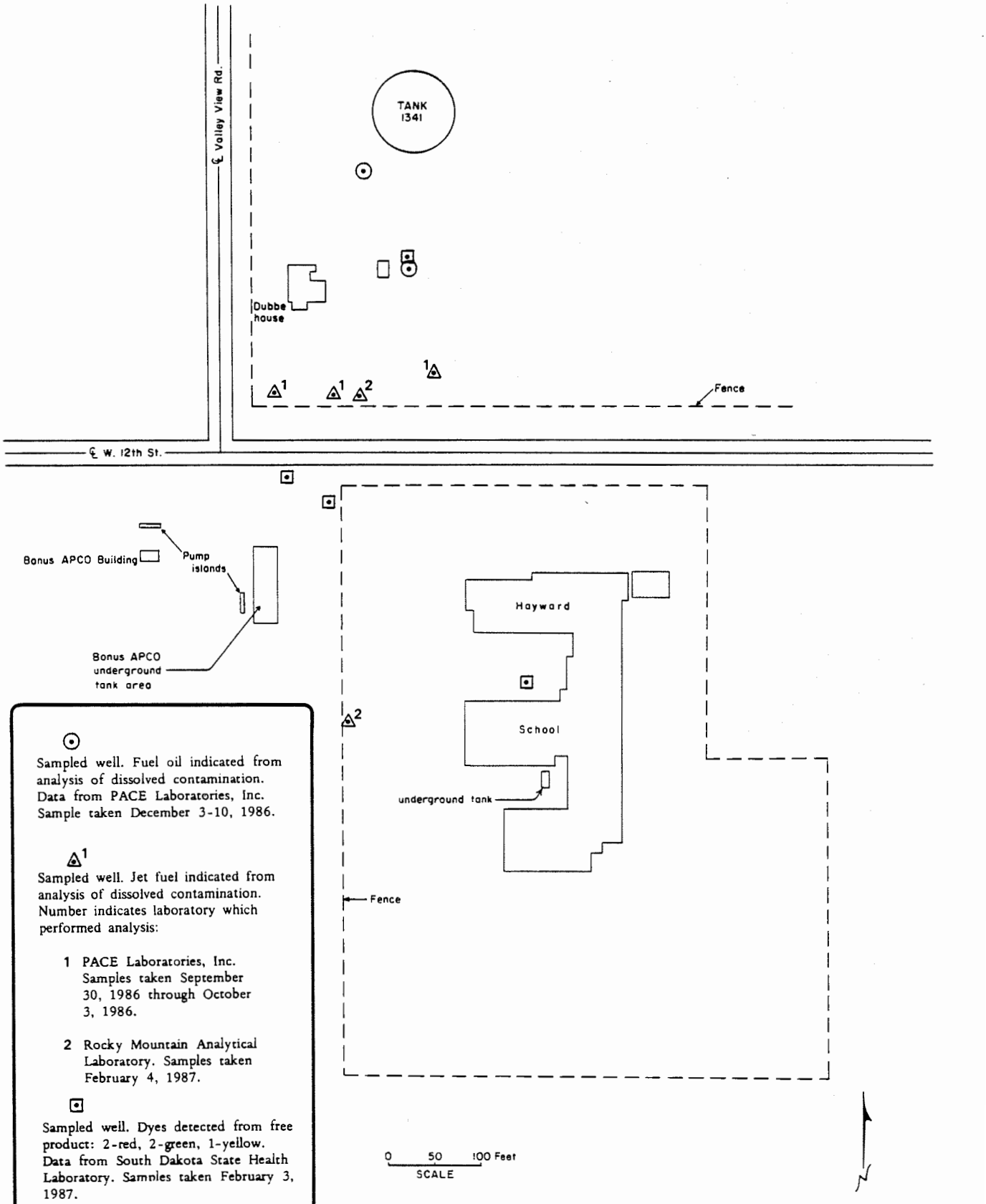
Although gasoline was the primary contaminant detected, other forms of petroleum were also detected on WPL and Hayward School properties. Water-quality data from RMAL indicate the presence of petroleum components heavier than gasoline in wells R20-86-75, R20-86-86 (fig. 27), and in the effluent from the WPL recovery wells. Ms. Maureen McDevitt (chemist, RMAL) states that results of analyses of these samples is indicative of weathered jet fuel mixed with gasoline. Analysis of samples collected by PACE Laboratories, Inc. indicates the presence of fuel oil near Tank 1341 at wells I-11 and I-13. PACE Laboratories, Inc. data have indicated jet fuel in wells along the southern boundary of WPL property. The significance of these analyses is that they indicate the presence of contaminants other than gasoline on WPL property. This is interpreted to be evidence of past spills or leaks which were unreported and/or unknown by WPL.

Solute Transport Model

The Department of Water and Natural Resources requested Dr. Arden Davis, South Dakota School of Mines and Technology, to simulate ground water contaminant movement in the Hayward School area using the U.S. Geological Survey two-dimensional solute transport model (Konikow and Bredehoeft, 1978) which has been widely used in ground water contamination studies. Dr. Davis prepared a grid of the area composed of cells with dimensions of 34.5 feet and arranged in 16 columns and 25 rows. Dr. Davis then digitized hydrologic data.

In order to approximate field conditions, the following conditions were assumed as model-input criteria:

1. Benzene was chosen as the parameter to be modeled and was assumed to be nonreactive with the porous media through which it migrated (Barker and others, 1987).



Sampled well. Fuel oil indicated from analysis of dissolved contamination. Data from PACE Laboratories, Inc. Sample taken December 3-10, 1986.

Sampled well. Jet fuel indicated from analysis of dissolved contamination. Number indicates laboratory which performed analysis:

1 PACE Laboratories, Inc. Samples taken September 30, 1986 through October 3, 1986.

2 Rocky Mountain Analytical Laboratory. Samples taken February 4, 1987.

Sampled well. Dyes detected from free product: 2-red, 2-green, 1-yellow. Data from South Dakota State Health Laboratory. Samples taken February 3, 1987.

Figure 27. Non-gasoline petroleum and free product dye patterns.

2. Recharge from precipitation was assumed to be 4 inches per year along West 12th Street, 2 inches per year along Valley View Road, and negligible elsewhere (accounts for drainage ditches which are present along the streets).

3. Free product was assumed to exist in a lens as a line source at the top of the saturated portion of the aquifer at Tank 1341.

4. Ground water moving beneath the free product at Tank 1341 was assumed to dissolve 30 mg/L benzene before June 1, 1986, and 20 mg/L after that date because of the depletion of the benzene source.

5. The recovery well (RW-2) installed by Bay West, Inc. was assumed to have been pumping at 2 gallons per minute since June, 1986. The well has not, however, operated continuously.

6. A zone of benzene source was assumed to have existed under the Bonus APCO Station buried tanks (those east of the station building). This zone was assumed to have been 34.5 feet wide (east-west) and 69 feet long (north-south).

7. Ground water moving beneath the APCO tanks was assumed to dissolve 30 mg/L benzene.

8. The east-west sewer line along West 12th Street was assumed to be receiving ground-water seepage at a small rate of 0.44 gallons per minute for a distance of 480 feet from the intersection of Valley View Road and West 12th Street to the east edge of Hayward School property.

9. The model was run to simulate ending conditions in November, 1986, assuming a leak near Tank 1341 beginning in September, 1985.

Some items worthy of note regarding the model sensitivity and predicted effects are:

1. The model does not appear to be too sensitive to recharge along the streets (drainage ditches).

2. Assumed large seepage rates into the sewer line along West 12th Street or into the disturbed material around the sewer line caused unrealistically large drawdowns (lowering of the water table) in model results.

3. The radius of influence of well RW-2 does not extend far enough to reduce benzene concentrations near Hayward School but causes the computed benzene plume to have a narrow "neck" near West 12th Street.

Implicit in the model is the use of a ground-water velocity (rate of contaminant movement) which is calculated from (1) estimated aquifer properties and (2) a ground-water gradient which was determined from water-level measurements in monitoring wells. The model indicates that contamination leaking from Tank 1341 beginning in September, 1985, could have migrated to near the south end of Hayward School by December, 1986, (in about 16 months time). It was, in fact, about 16 months after the assumed time for the start of the leak when contamination was first detected in wells MW-15 and MW-16 just south of the School. A scenario such as this would require that contaminants in ground water move at an average rate of about 2.1 feet per day (assuming 1,000 feet along the ground water flow path between the leak and the monitoring wells) which is a reasonable velocity in sediments of the type present on site.

Bearing in mind that this ground-water model is a simplified estimate of a complex situation and that little time was spent refining the model, it appears to match quite well (fig. 28) the observed distributions of dissolved petroleum contamination and the soil vapor survey. The Bonus APCO Station tanks do not appear to be a possible source of contamination of Hayward School rather, gasoline contamination which has migrated from the vicinity of Tank 1341 is strongly indicated by this model (written communication to DWNR by Dr. Davis, 1987).

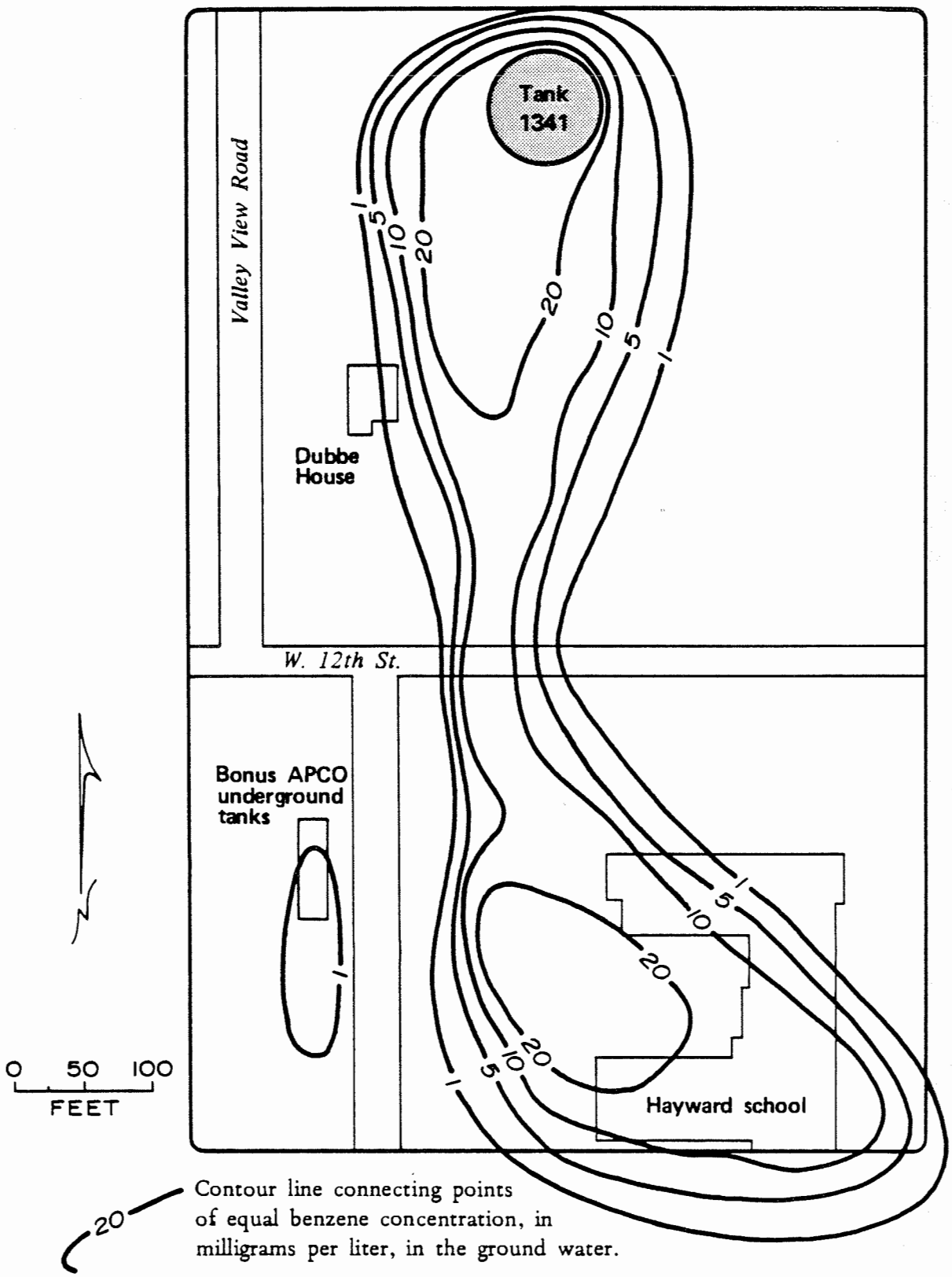
Free-Product Hydrocarbons

Analyses of free products recovered from the monitoring wells have been conducted by DWNR for areal and temporal occurrence and by the South Dakota State Health Laboratory for chemistry and dyes.

Areal and Temporal Occurrence

Free product floating on top of the water table has been observed in numerous wells. Free product varying in thickness from a thin film or sheen to as much as 9 inches has been observed in some wells. A review of which wells contained free product and when the product was observed is useful in interpreting this information.

Free product was first noted in monitoring wells in the vicinity of Tank 1341 during June, 1986. In September, 1986, free product was noted in wells MW-2 and MW-9 (sheen only in MW-9). In October, 1986, records show free product in wells I-13, I-15, I-19, I-20, RW-2, and MW-2. In November, 1986, wells I-11, I-19, I-20, and MW-2 were noted to have free product. Free-product distribution for February 4-5, 1987, was mentioned earlier in this report and is shown on figure 4. The free-product distribution shown in figure 4 occurs in a northwest to southeast trending zone from well MW-20 to MW-2, generally northeast and east of



Modified from map provided by A. Davis, So. Dak. School of Mines and Technology.

Figure 28. Benzene distribution-solute transport model.

the Bonus APCO Station underground tanks. Occurrence of free product in February is consistent with migration of product following the direction of ground-water flow from WPL property. Ground water flow data do not support an interpretation of a leak from the Bonus APCO Station tanks.

The presence or absence of free product may be related to the rise and fall of the water table. As previously mentioned, unusually heavy rains (9.62 inches) occurred during September, 1986, which led to a relatively rapid rise in the water table. Such a rise would probably trap much of the free product within the original capillary fringe which existed before the water table rose (Yaniga, 1985). After the rains in September, 1986, the water table dropped to equal or below the pre-September level. The appearance of free product in monitoring wells south of West 12th Street when the water table was again at a lower level is consistent with literature which indicates that as a water table drops, free product trapped by a rise in the water table can then accumulate upon the water table (Yaniga, 1985). The elevated total hydrocarbons concentrations (figs. 19 and 20) are near or above the solubility limit of the free product in water (American Petroleum Institute, personal communication, 1986). This provides additional evidence that free product may have actually been present in the free-product area depicted in figure 4 on the south side of West 12th Street before it was observed in some of the monitoring wells.

Chemistry

Mr. Don Frasch, Forensics Laboratory Supervisor, South Dakota State Health Laboratory, utilized gas chromatography to analyze free product. Comparison of the free product recovered from monitoring wells to the reference fuels (samples of fresh product supplied by WPL and Bonus APCO) shows all the well samples to be characteristic of gasoline. If jet fuel or diesel fuel are present in the recovered free product, then they are at concentrations of less than 5 percent.

The South Dakota State Health Laboratory also compared the lead content in free product recovered from monitoring wells (collected February 3-5, 1987) to reference fuels, mentioned above, and obtained the results shown in table 1.

Table 1. Lead content of some petroleum samples

Sample Source	Gram/gallon
reference unleaded gasoline	0.001
reference leaded gasoline	0.3
R20-86-74	0.002
I-12	0.0017
MW-20	0.0017
DOT-1	0.0012
MW-2	0.0017

These data show that gasoline found on the ground-water surface is unleaded.

Dyes

Using a thin layer dye chromatography technique, dyes from free product recovered from monitoring wells I-12, R20-86-74, DOT-1, MW-2, and MW-20 were compared to reference samples provided by WPL and the Bonus APCO Station. The following information on dye colors and concentrations was supplied by Mr. Don Frasch.

All recovered free product contains yellow to orange compounds that do not separate with the sharpness of a dye in a fresh-petroleum product. Their color and behavior during thin-layer chromatography is characteristic of old, weathered fuels. However, gas chromatography indicates that the recovered fuel is gasoline that has not been weathered to any great extent. This would indicate that the gasoline is picking up these compounds (dyes) as it travels through previously contaminated subsurface areas. Observed dye patterns in recovered free product were not the same as in the reference samples.

Well I-12, next to Tank 1341, contains very little petroleum dye. Well I-12 contains only an orange dye, characteristic of all reference fuels, while R20-86-74 contains not only the orange dye, but also two green, two red, and one yellow dye. This same pattern of dyes found in well R20-86-74 is repeated in wells MW-20, DOT-1, and MW-2 with a decrease in dye concentration being noted in that order (fig. 27).

The observed pattern of decreasing dye concentration is consistent with ground water flow direction and dilution of the dyes along the flow path. The dye information implies a movement of contaminated ground water from WPL property to both Bonus APCO

and Hayward School property. The dye information also indicates previous leaks, spills, or sludge burial on WPL property.

Soil Vapors

A soil-vapor survey is a relatively rapid method of determining areas of ground-water contamination when volatile contaminants are involved in the subsurface. Essentially, the procedure involves using a portable vapor detection meter (H*NU, Inc. model PI-101) calibrated to detect a variety of trace-vapor gases that ionize by absorption of ultraviolet light. The H*NU meter readings were used to indicate the presence, or absence, of petroleum vapors and the relative strength of the readings rather than an actual concentration of total petroleum vapors. In this investigation, the instrument was calibrated to benzene, a component of gasoline, to indicate the presence of benzene and other aromatic compounds with similar ionization potentials. Almost all of the area surveyed was amenable to this type of investigation because gasoline is highly volatile, the ground water is found at a shallow depth, and the subsurface consists primarily of permeable sand and gravel. The permeable sand and gravel allows for rapid vapor movement through the subsurface from contamination at or near the water table.

In October, 1986, EPA's Environmental Response Team (ERT) conducted a soil-vapor survey in the vicinity of Hayward School. As a result of this survey, EPA concluded that WPL Tank 1341 was the most likely cause of the organic vapor affecting the School (EPA written communication to Governor Janklow, November 14, 1986).

The Department of Water and Natural Resources conducted a soil-vapor survey (at a depth of 3 to 4 feet) between December 1, 1986, and January 8, 1987, to aid in delineating the extent of ground-water contamination. The area surveyed included the vicinity of Tank 1341 on WPL property, Hayward School property, and Bonus APCO Station property (fig. 29). The work done by the Department of Water and Natural Resources, although much more detailed in scope than earlier work done by the ERT, supported the ERT findings.

An explanation of the numbers around the perimeter of figure 29 is as follows. A grid system, which was used to locate test points for the soil-vapor survey, was established with a central north-south baseline extending from the top of an earthern dike on the northwest side of Tank 1341, southward along the edge of the north-south chain link fence on the west side of Hayward School property. The baseline starting stake was labeled "0+00." Points east of the baseline are labeled with "L" preceding the measured distance (in feet) while points west of the baseline are labeled with "R" preceding the distance. For example, the point 50 feet east of "0+00" is given the label of "0+00 L50" while the point 200 feet south and 100 feet east of "0+00 is given the

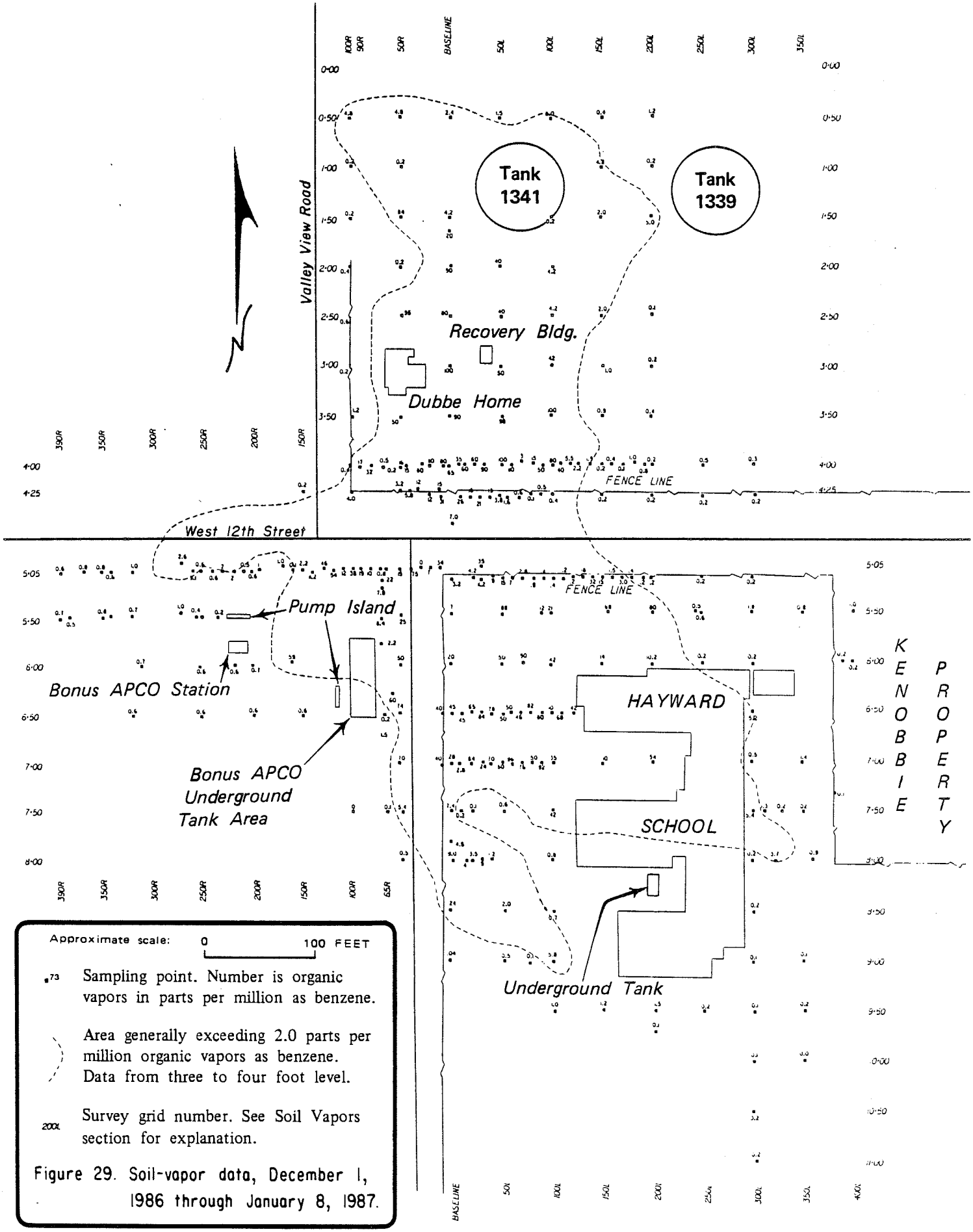


Figure 29. Soil-vapor data, December 1, 1986 through January 8, 1987.

label of "2+00 L100." The numbers around the perimeter of the map represent distances (in feet) south and east (L) or west (R) of the baseline.

Figure 29 indicates a soil-vapor plume extending from the vicinity of Tank 1341, on WPL property, to the south and southeast ending in the vicinity of the Bonus APCO Station and Hayward School.

The response of the H*NU to changes in vapor concentration was good. The meters were able to clearly delineate between contaminated and noncontaminated areas as well as delineating the areas of greatest concentration.

The low values reported along West 12th Street (fig. 29) illustrate the effects of varying amounts of silt and clay in the soil. Silty, clay surface soils did not allow vapors to penetrate above the 4-foot depth in the ditches along the north and south sides of the street. However, an auger hole drilled in the ditch just to the northeast of MW-5 yielded a vapor reading of 35 ppm (fig. 29) at the 8-foot depth. A hand-augered hole in the ditch on the north side of West 12th Street yielded similar results. This value of 35 ppm is surrounded by much lower values, which reflect that fine grained surface soils are restricting vapor migration at shallow depths in the ditches along West 12th Street. Overall, the soil-gas data closely correlate with documented ground water contamination patterns.

Nitrogen Compounds

A ground-water plume of very high nitrogen concentrations on WPL property extends at least to WPL's southern property line and quite possibly beyond (figs. 30, 31, and 32). The Department of Water and Natural Resources sampled monitoring wells (app. A) for ammonia (NH3-N), nitrate (NO3-N), and total kjeldahl nitrogen (TKN).

Figures 30, 31, and 32 indicate a nitrogen source in the vicinity of Tank 1341. Since other 1300-series tanks contained nitrogen fertilizer in the past, other tanks must also be considered as a possible source of nitrogen.

Analyses from five wells are shown in table 2. All forms of nitrogen are expressed as N; the total nitrogen value given is calculated as the sum of TKN and nitrate-nitrite nitrogen. These data were measured on water samples collected January 21-23, 1987. The following two paragraphs were provided by M. Coker (DWNR chemist) as interpretations and explanation of the nitrogen data.

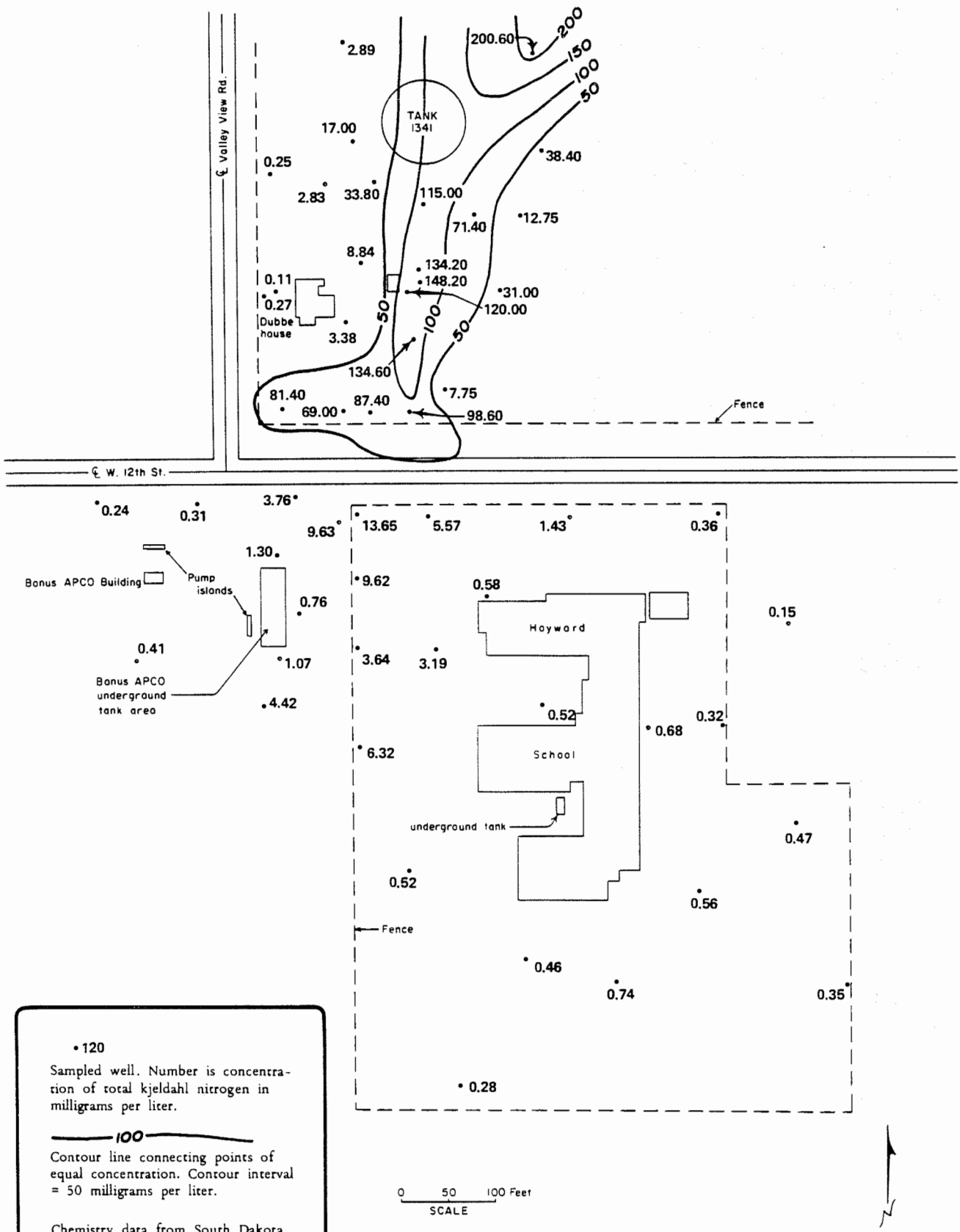


Figure 30. Distribution of total kjeldahl nitrogen, January 21-24, 1987.

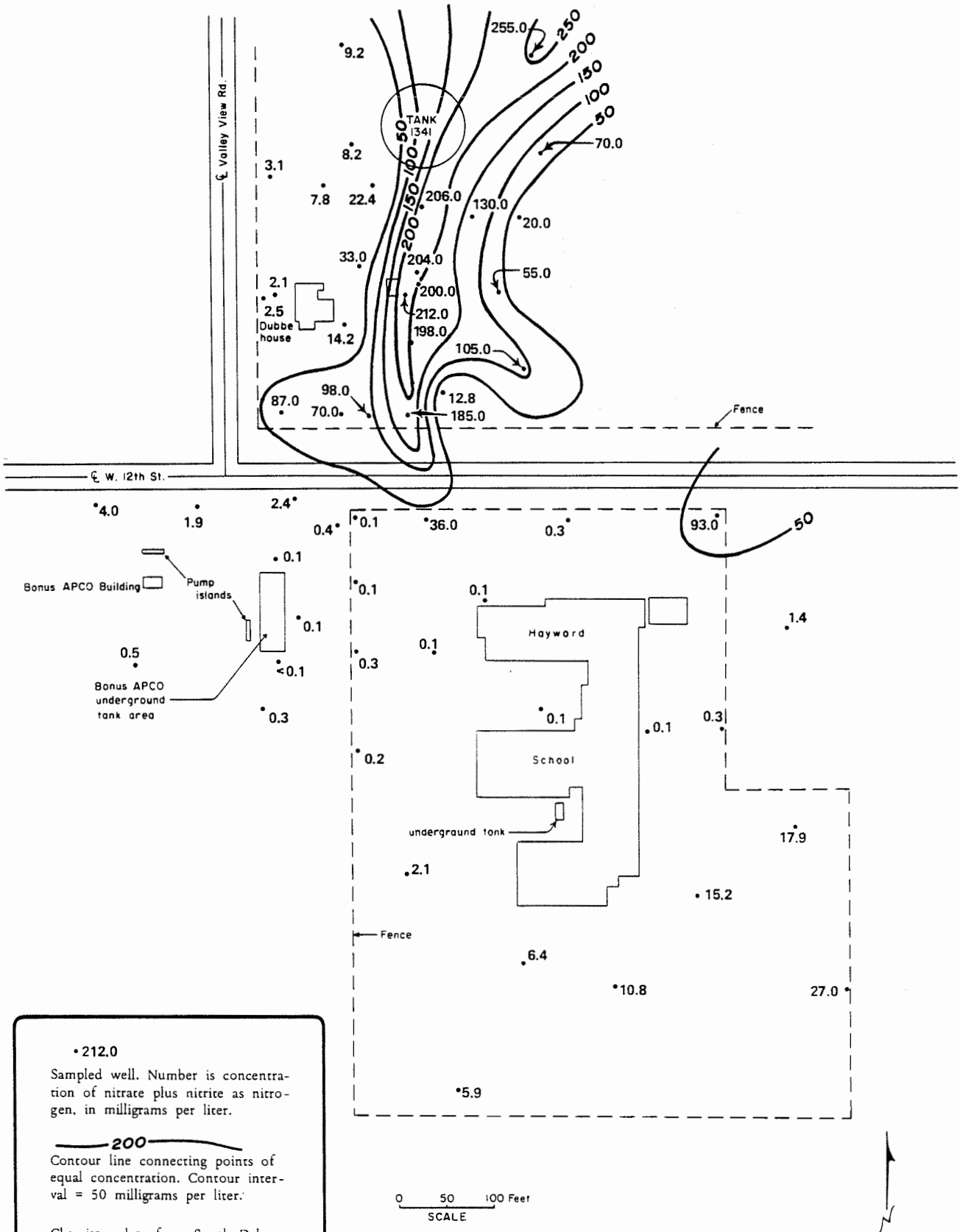


Figure 31. Distribution of nitrate plus nitrite as nitrogen, January 21-24, 1987.

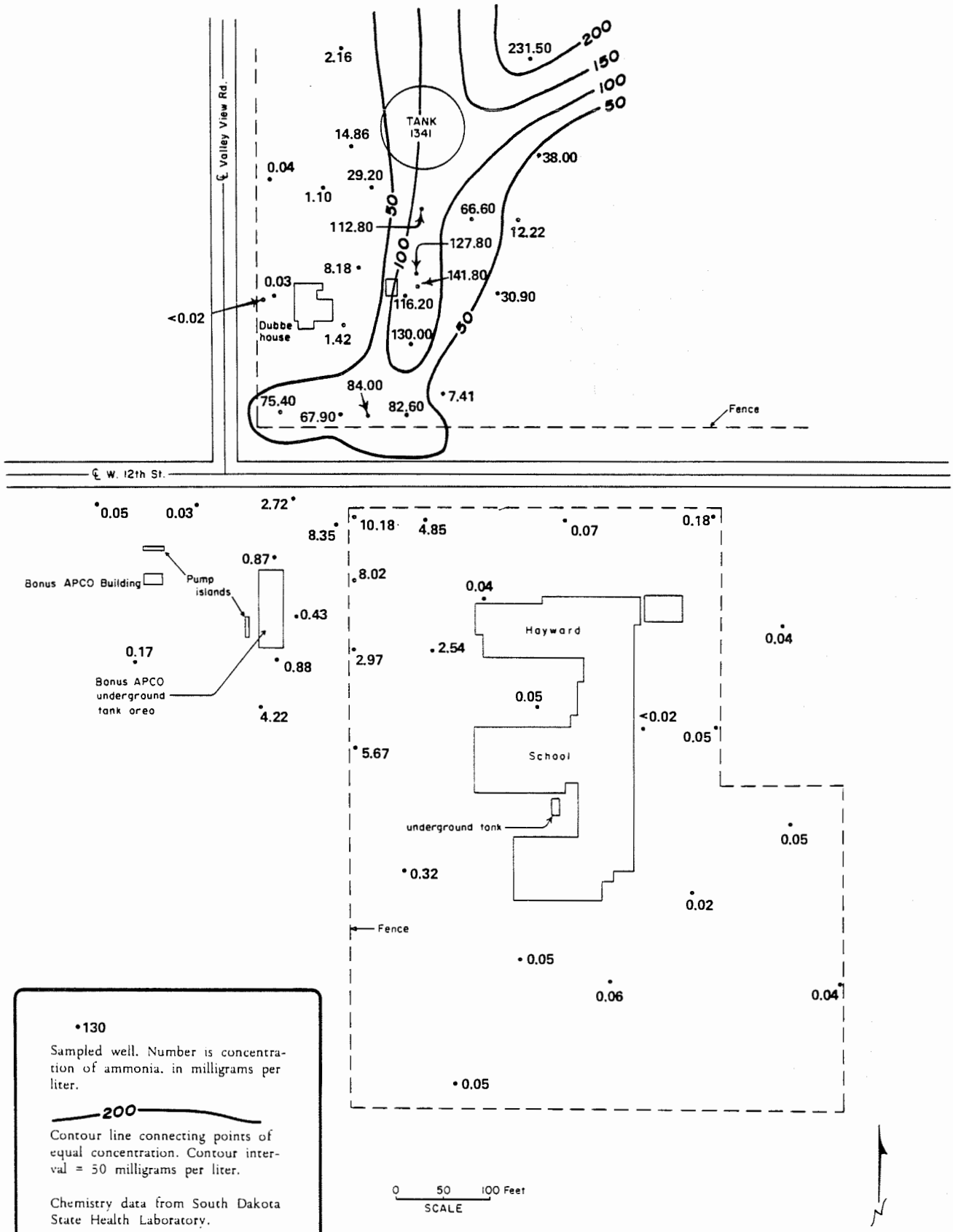


Figure 32. Distribution of ammonia, January 21-24, 1987.

Table 2. Results of nitrogen analyses from selected wells

Well No.	NH_3-N (mg/L)	TKN (mg/L)	(NO_3+NO_2)-N (mg/L)	Total N (mg/L) (Calculated)
R20-86-75	84.0	87.4	98.0	185
R20-86-76	38.0	38.4	70.0	108
I-8	67.9	69.0	70.0	139
I-12	112.8	115	206	321
I-15	66.6	71.4	130	201

The high levels of nitrogen observed in ground water from the above mentioned and other monitoring wells, and their spatial distribution, are strongly suggestive of a point source of nitrogen contamination. Several possibilities for such a point source could be considered. Runoff from large quantities of animal waste such as accumulate in feedlots can contain nitrogen levels of this magnitude, but there are no such concentrations of livestock in the immediate area. Raw sewage (domestic wastewater) typically contains 35 mg/L total N, of which about 15 mg/L is contributed by ammonia (Viessman and Hammer, 1985). These are much lower levels than those observed here (table 2). Even if, as is sometimes observed, local zones of higher nitrogen concentrations may form within septic tank drainfields, the plume of contamination in this area is too extensive to be accounted for by septic tank drainage. Leakage from a municipal sewer line should also contribute lower levels of nitrogen and is precluded as an explanation by the location of the sewer line which is downgradient from the contaminant plume.

Contamination of the ground water by a point source of nitrogen fertilizer such as "liquid nitrogen" (UAN, urea-ammonium nitrate solution) is the most compelling explanation for the observed phenomena. This interpretation is consistent with the chemical analytical data demonstrating: (1) high levels of contamination, (2) the presence of both ammonia and nitrate nitrogen in significant amounts at the same well sites, and (3) the absence of significant levels of organic nitrogen in the ground water.

The nitrogen plume is consistent with the established groundwater flow direction and indicates a potential source area to the northeast of Tank 1341. However, no conclusions as to the exact

source(s) can be made because of the lack of data from this area. A source of nitrogen from WPL property is possible because, as mentioned previously, other 1300-series tanks have also contained fertilizer in the past.

CONCLUSIONS

Evidence presented throughout this report documents the presence of contaminated ground, and ground water, on WPL and Hayward School properties. Detailed hydrogeologic information shows that conditions have been, and still are, conducive to movement of these contaminants from WPL property to the Hayward School property. Furthermore, the hydrologic information also precludes the introduction of contaminants to portions of the Hayward School area where contamination is most severe from any other known source except WPL property. While some of the supporting data is subject to interpretation, it should be pointed out and emphasized that none of the data is inconsistent with the physical system as defined and documented in the geology and hydrology sections of this report. The following is a list of conclusions based on DWNR's review of WPL maintenance and inventory records and understanding of the physical system.

1. Natural ground water flow in the investigated area is generally: (1) to the south on WPL property in the vicinity of Tank 1341 and the former Dubbe residence, (2) to the south on Bonus APCO Station property, and (3) to the south and southeast on Hayward School property.

2. Natural ground water flow directions do not appear to change with rising and falling water-table elevations. Therefore, fluctuating water levels have not significantly affected the direction of ground-water flow.

3. The general patterns of ground-water contamination are consistent with a contaminant plume originating from the vicinity of Tank 1341 and migrating in the natural ground water flow direction.

4. Contamination from a leaky, buried tank or spill at the Bonus APCO Station would move in the direction of ground-water flow to the south, and not eastward toward Hayward School.

5. The pattern of free-product occurrence on February 4 and 5, 1987, do not support an interpretation of a significant loss of product from the Bonus APCO Station tanks. If an assumed leak from these tanks were large enough to cause the presence of free product in an up-gradient position (against the direction of ground-water flow), then there would also be significant amounts of free product in a down-gradient position. This down-gradient occurrence of free product from the Bonus APCO Station tanks does not

exist, which further implies that the source area for the free product is WPL property.

6. Methods of product-volume determination at the WPL facility are not adequate to detect some significant leaks from tanks or lines. The accuracy for product-volume determination in Tank 1341 is, at best, plus or minus 442 gallons per day.

7. The only suspected or reported source of ground-water contamination in the area of Hayward School which could have caused contamination of School property to the observed extent is a plume of contamination originating on WPL property. A portion of this plume was identified on WPL property in June, 1986.

8. Although ground-water contamination was identified in June, 1986, on WPL property, the leading edge of the contamination was not defined at that time.

9. Remedial attempts by WPL in June, 1986, were inadequate to halt the southerly migration of the contaminant plume from WPL property.

10. Present remedial efforts by WPL are inadequate to halt the southerly migration of identified contaminants from WPL property.

11. Chemical analyses indicate that at least two types of petroleum contamination are present in and on the ground water (unleaded gasoline and heavier fuel such as fuel oil or jet fuel) on WPL property. This indicates multiple leaks or spills of petroleum product on WPL property.

12. The distribution and concentration of dyes in free product recovered from monitoring wells indicate multiple leaks or spills of petroleum product on WPL property which have migrated to the south off of WPL property.

13. The occurrence of a ground-water plume containing very high concentrations of nitrate-nitrogen and ammonia indicate a leak or spill of fertilizer on WPL property in the vicinity of Tank 1341 or to the northeast.

14. The increase of hydrocarbon concentrations in the "F" series wells to the southeast of Tank 1341 indicates unidentified potential sources of hydrocarbon contamination other than the implied loss of unleaded gasoline from Tank 1341. Maintenance records for WPL tanks support an interpretation of other possible sources.

15. Recovered free product from the monitoring and recovery wells is primarily unleaded gasoline which has itself be-

come contaminated with dyes and other constituents of previous contamination events.

16. Ground-water modelling and soil-vapor data support the interpretation that the source area for contaminants which caused the evacuation of Hayward School was WPL property.

17. The sanitary sewer line has minimal impact on ground-water flow.

18. Based on (1) maintenance and inventory records of WPL storage tanks, (2) age and condition of WPL storage tanks and (3) other known and suspected leaks and spills, it is likely that other ground water contamination problems will occur again in the future in this area unless WPL implements stringent maintenance practices and inventory control methods.

19. Migration of contamination from WPL property has precluded the use of a portion of the aquifer as a drinking-water supply and is endangering the use of down-gradient portions.

20. The contamination plume under Hayward School will continue moving through and beyond the School area in response to prevailing hydrologic conditions. The residential area to the southeast of the School is under immediate threat of contamination from hydrocarbons in the drinking water and from hydrocarbon vapors in basements or other enclosed underground structures.

21. Hydrocarbon-vapor concentration in Hayward School may vary depending on climate and ground-water levels. The problem will not totally cease until contaminants under and/or near the School property are removed.

22. Nitrate-nitrogen, ammonia, and other nitrogen parameters indicate nitrogen-fertilizer contamination in the ground water on WPL property. This contaminant plume extends at least to the southern WPL property line north of Hayward School. This plume may be the source of abnormally high nitrogen values in the ground water on Bonus APCO Station and Hayward School properties.

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APPENDIX A

GROUND-WATER CHEMISTRY

This appendix contains the results of chemical analyses of water samples collected from monitoring wells and private wells. They are grouped according to the well controller: Department of Water and Natural Resources, Bay West, Inc. or Private (domestic and commercial). Individual wells are grouped according to series and number within the controller groupings. Private wells are listed alphabetically. Three separate laboratories have analyzed water samples during the investigation. Data from each lab for a particular well are presented in a separate table, with the tables in the following order: PACE Laboratories, Inc. Rocky Mountain Analytical Laboratory, and the South Dakota State Health Laboratory.

Well locations are shown on figure 2, with the exceptions of Darryl's Auto and the Westwick Motel. Darryl's Auto is located northwest of, but near, the intersection of West 12th Street and Valley View Road. Westwick Motel wells are located approximately 100 to 150 feet east of the Kenobbie well.

WELL R20-86-74

Parameter	Unit*	Date Sample Taken and Date Received by Laboratory						
		11/07/86 11/08/86	11/12/86 11/13/86	11/13/86 11/15/86	11/14/86 11/18/86	11/19/86 11/21/86	11/24/86 11/25/86	02/04/87 02/05/87
Benzene	mg/L	20.000	21.000	23.000	22.000	7.600	17.000	17.000
Ethylbenzene	mg/L	2.200	1.000	1.100	1.200	ND	0.450	2.600
Toluene	mg/L	33.000	32.000	38.000	36.000	6.200	22.000	45.000
Xylenes, M	mg/L	12.000	7.000	7.500	6.800	2.400	5.200	8.100
Xylenes, O & P	mg/L	10.000	7.500	7.800	6.900	3.000	6.000	8.900
C10-C32 Hydrocarbons	mg/L	ND	ND	ND	ND	---	---	ND
Gasoline	mg/L	27.000	59.000	38.000	22.000	13.000	16.000	150.000
Kerosene	mg/L	ND	ND	ND	ND	---	---	---
Diesel fuel	mg/L	ND	ND	ND	ND	ND	ND	---
Total petroleum hydrocarbons	mg/L	9.9	19	8.6	5.9	3.3	6.7	---
Total organic carbon	mg/L	88	98	85	77	68	75	---
Cadmium	mg/L	0.0053	0.0025	0.0016	0.0012	0.0003	0.0002	ND
Lead	mg/L	0.47	0.23	0.12	0.13	0.05	0.055	0.06

Samples analyzed by Rocky Mountain Analytical Laboratory
* Unit
  mg/L: milligrams per liter
ND: not detected
---: not analyzed

WELL R20-86-74

Parameters	Unit*	Date Sample Taken and Date Received by Laboratory				
		11/07/86 11/10/86	12/17/86 12/19/86	12/17/86 01/25/87**	01/07/87 01/09/87	01/23/87 01/24/87
Conductivity	umhos	1900	2900	---	2573	2835
lab pH		6.85	6.93	---	---	---
Alkalinity (M) as CaCO3	mg/L	---	533	---	---	---
Alkalinity (P) as CaCO3	mg/L	0	0	---	---	0
Alkalinity (T) as CaCO3	mg/L	529	---	---	---	578
Bicarbonate	mg/L	645	650	---	---	705
Total solids	mg/L	18016	---	---	18734	21758
Hardness as CaCO3	mg/L	804	918	---	---	---
Calcium	mg/L	213	244	---	---	223
Magnesium	mg/L	66.0	75.0	---	---	72.2
Sodium	mg/L	22.6	21.1	---	---	20.7
Potassium	mg/L	15.0	20.4	---	---	19.4
Chloride	mg/L	9.8	10.9	---	---	12.6
Sulfate	mg/L	17.1	24.7	---	---	20.5
Ammonia as N	mg/L	---	---	---	110.20	127.80
Nitrate + Nitrite as N	mg/L	---	226	---	175.0	204.0
Total kjeldahl nitrogen	mg/L	---	---	---	---	134.20
Lead	mg/L	---	---	---	---	<0.0010
Iron	mg/L	---	---	---	457	319
Manganese	mg/L	---	---	---	64.0	43.0
Total hydro-carbons***	mg/L	---	---	77.4	---	---
Toluene	mg/L	---	---	1.4	---	---
Xylene	mg/L	---	---	0.6	---	---

Samples analyzed by South Dakota State Health Laboratory
* Unit
umhos: micromhos per centimeter
mg/L: milligrams per liter
** Date of analysis
*** Based on regular gasoline
---: not analyzed

WELL R20-86-75

Parameter	Unit*	Date Sample Taken and Date Received by Laboratory 02/04/87 02/05/87
Benzene	mg/L	0.100
Ethylbenzene	mg/L	ND
Toluene	mg/L	ND
Xylenes, M	mg/L	ND
Xylenes, O & P	mg/L	ND
C10-C32 Hydro-carbons	mg/L	0.940
Gasoline	mg/L	ND
Cadmium	mg/L	ND
Lead	mg/L	0.10

Samples analyzed by Rocky Mountain Analytical Laboratory
* Unit
mg/L: milligrams per liter
ND: not detected

WELL R20-86-75

Parameters	Unit*	Date Sample Taken and Date Received by Laboratory			
		12/12/86 12/15/86	12/18/86 12/19/86	01/07/87 01/09/87	01/21/87 01/24/87
Conductivity	umhos	1926	1856	1654	1796
lab pH		7.11	7.08	---	---
Alkalinity (M) as CaCO3	mg/L	---	518	---	---
Alkalinity (P) as CaCO3	mg/L	0	0	---	0
Alkalinity (T) as CaCO3	mg/L	4167	---	---	476
Bicarbonate	mg/L	5084	632	---	581
Total solids	mg/L	20549	---	15324	7048
Hardness as CaCO3	mg/L	552	550	---	507
Calcium	mg/L	145	144	---	130
Magnesium	mg/L	46.1	46.3	---	44.3
Sodium	mg/L	16.2	15.2	---	14.8
Potassium	mg/L	13.3	12.5	---	11.3
Chloride	mg/L	19.2	11.3	---	10.8
Sulfate	mg/L	29.6	28.0	---	25.4
Ammonia as N	mg/L	100.00	---	88.80	84.00
Nitrate + Nitrite as N	mg/L	104.0	98.0	75.0	98.0
Total kjeldahl nitrogen	mg/L	---	---	---	87.40
Lead	mg/L	---	<0.0010	---	<0.0010
Iron	mg/L	---	---	4350	458
Manganese	mg/L	---	---	520	71.8

Samples analyzed by South Dakota State Health Laboratory
* Unit
  umhos: micromhos per centimeter
  mg/L: milligrams per liter
---: not analyzed

WELL R20-86-76

Parameters	Unit*	Date Sample Taken and Date Received by Laboratory: 12/17/86 01/25/87**	01/22/87 01/24/87
Conductivity	umhos	---	1575
Alkalinity (P) as CaCO3	mg/L	---	0
Alkalinity (T) as CaCO3	mg/L	---	486
Bicarbonate	mg/L	---	593
Total solids	mg/L	---	1923
Hardness as CaCO3	mg/L	---	549
Calcium	mg/L	---	128
Magnesium	mg/L	---	55.8
Sodium	mg/L	---	28.4
Potassium	mg/L	---	7.1
Chloride	mg/L	---	8.9
Sulfate	mg/L	---	30.8
Ammonia as N	mg/L	---	38.00
Nitrate + Nitrite as N	mg/L	---	70.0
Total kjeldahl nitrogen	mg/L	---	38.40
Lead	mg/L	---	<0.0010
Iron	mg/L	---	23.5
Manganese	mg/L	---	1.50
Total hydro-carbons	mg/L	0.2	---

Samples analyzed by South Dakota State Health Laboratory
* Unit
  umhos: micromhos per centimeter
  mg/L: milligrams per liter
** Date of analysis
---: not analyzed

WELL R20-86-79

Parameter	Unit*	Date Sample Taken and Date Received by Laboratory 02/03/87 02/05/87
Benzene	mg/L	2.600
Ethylbenzene	mg/L	ND
Toluene	mg/L	0.120
Xylenes, M	mg/L	ND
Xylenes, O & P	mg/L	ND
C10-C32 Hydro-carbons	mg/L	0.220
Gasoline	mg/L	ND
Cadmium	mg/L	ND
Lead	mg/L	0.4

Samples analyzed by Rocky Mountain Analytical Laboratory
* Unit
mg/L: milligrams per liter
ND: not detected

WELL R20-86-79

Parameters	Unit*	Date Sample Taken and Date Received by Laboratory			
		12/17/86 12/19/86	12/17/86 01/25/87**	01/07/87 01/09/87	01/21/87 01/22/87
Conductivity	umhos	836	---	756	734
lab pH		7.13	---	---	---
Alkalinity (P) as CaCO3	mg/L	0	---	---	0
Alkalinity (T) as CaCO3	mg/L	411	---	---	461
Bicarbonate	mg/L	501	---	---	562
Total solids	mg/L	16321	---	53673	26624
Hardness as CaCO3	mg/L	452	---	---	525
Calcium	mg/L	126	---	---	131
Magnesium	mg/L	33.5	---	---	48.2
Sodium	mg/L	10.5	---	---	12.6
Potassium	mg/L	3.8	---	---	3.4
Chloride	mg/L	21.3	---	---	22.7
Sulfate	mg/L	37.2	---	---	32.3
Ammonia as N	mg/L	0.66	---	0.85	0.88
Nitrate + Nitrite as N	mg/L	0.2	---	<0.1	<0.1
Total kjeldahl nitrogen	mg/L	---	---	---	1.07
Lead	mg/L	0.0012	---	---	<0.0010
Iron	mg/L	---	---	185	1860
Manganese	mg/L	---	---	13.8	191
Total hydro-carbons	mg/L	---	34.4	---	---

Samples analyzed by South Dakota State Health Laboratory
* Unit
  umhos: micromhos per centimeter
  mg/L: milligrams per liter
** Date of analysis
---: not analyzed

WELL R20-86-81

Parameters	Unit*	Date Sample Taken and Date Received by Laboratory			
		12/12/86 12/15/86	12/18/86 12/19/86	12/18/86 01/25/87**	01/22/87 01/22/87
Conductivity	umhos	856	878	---	915
lab pH		7.37	7.21	---	---
Alkalinity (M) as CaCO3	mg/L	---	379	---	---
Alkalinity (P) as CaCO3	mg/L	0	0	---	0
Alkalinity (T) as CaCO3	mg/L	25200	---	---	335
Bicarbonate	mg/L	30700	462	---	409
Total solids	mg/L	146127	---	---	3099
Hardness as CaCO3	mg/L	462	464	---	410
Calcium	mg/L	110	112	---	87.7
Magnesium	mg/L	45.4	44.9	---	46.3
Sodium	mg/L	14.9	14.0	---	15.1
Potassium	mg/L	4.0	3.7	---	3.4
Chloride	mg/L	45.0	19.5	---	19.6
Sulfate	mg/L	29.5	26.8	---	50.4
Ammonia as N	mg/L	<0.02	---	---	0.05
Nitrate + Nitrite as N	mg/L	9.9	11.6	---	17.9
Total kjeldahl nitrogen	mg/L	---	---	---	0.47
Lead	mg/L	---	<0.0010	---	<0.0010
Iron	mg/L	---	---	---	353
Manganese	mg/L	---	---	---	13.8
Gasoline	mg/L	---	---	<0.1	---

Samples analyzed by South Dakota State Health Laboratory
* Unit
  umhos: micromhos per centimeter
  mg/L: milligrams per liter
** Date of analysis
---: not analyzed

WELL R20-86-82

Parameters	Unit*	Date Sample Taken and Date Received by Laboratory		
		12/12/86 12/15/86	12/18/86 12/19/86	01/22/87 01/22/87
Conductivity	umhos	788	755	767
lab pH		7.35	7.19	---
Alkalinity (M) as CaCO3	mg/L	---	401	---
Alkalinity (P) as CaCO3	mg/L	0	0	0
Alkalinity (T) as CaCO3	mg/L	472	---	400
Bicarbonate	mg/L	576	489	488
Total solids	mg/L	1026	---	14110
Hardness as CaCO3	mg/L	433	425	418
Calcium	mg/L	106	104	103
Magnesium	mg/L	41.0	40.1	39.2
Sodium	mg/L	13.8	12.5	13.4
Potassium	mg/L	3.6	3.5	3.3
Chloride	mg/L	18.4	16.6	17.8
Sulfate	mg/L	26.2	22.4	24.1
Ammonia as N	mg/L	0.08	---	0.05
Nitrate + Nitrite as N	mg/L	0.9	0.2	0.3
Total kjeldahl nitrogen	mg/L	---	---	0.32
Lead	mg/L	---	<0.0010	<0.0010
Iron	mg/L	---	---	565
Manganese	mg/L	---	---	26.5

Samples analyzed by South Dakota State Health Laboratory
* Unit
  umhos: micromhos per centimeter
  mg/L: milligrams per liter
---: not analyzed

WELL R20-86-86

Parameter	Unit*	Date Sample Taken and Date Received by Laboratory 02/03/87 02/05/87
Benzene	mg/L	14.000
Ethylbenzene	mg/L	ND
Toluene	mg/L	ND
Xylenes, M	mg/L	ND
Xylenes, O & P	mg/L	2.000
C10-C32 Hydro-carbons	mg/L	5.000
Gasoline	mg/L	ND
Cadmium	mg/L	ND
Lead	mg/L	0.04

Samples analyzed by Rocky Mountain Analytical Laboratory
* Unit
mg/L: milligrams per liter
ND: not detected

WELL R20-86-86

Parameters	Unit*	Date Sample Taken and Date Received by Laboratory		
		12/17/86 12/19/86	12/17/86 01/25/87**	01/22/87 01/22/87
Conductivity	umhos	1089	---	1015
lab pH		7.00	---	---
Alkalinity (M) as CaCO3	mg/L	576	---	---
Alkalinity (P) as CaCO3	mg/L	0	---	0
Alkalinity (T) as CaCO3	mg/L	---	---	404
Bicarbonate	mg/L	703	---	493
Total solids	mg/L	---	---	22114
Total dissolved solids	mg/L	701	---	---
Hardness as CaCO3	mg/L	613	---	436
Calcium	mg/L	166	---	99.8
Magnesium	mg/L	48.3	---	45.4
Sodium	mg/L	12.9	---	13.9
Potassium	mg/L	7.1	---	6.7
Chloride	mg/L	19.1	---	20.0
Sulfate	mg/L	29.4	---	37.5
Ammonia as N	mg/L	---	---	5.67
Nitrate + Nitrite as N	mg/L	<0.1	---	0.2
Total kjeldahl nitrogen	mg/L	---	---	6.32
Lead	mg/L	<0.0010	---	<0.0010
Iron	mg/L	---	---	2010
Manganese	mg/L	---	---	123
Total hydro-carbons***	mg/L	---	153	---
Benzene	mg/L	---	ND	---
Toluene	mg/L	---	0.8	---
Xylene	mg/L	---	ND	---

Samples analyzed by South Dakota State Health Laboratory
* Unit
umhos: micromhos per centimeter
mg/L: milligrams per liter
** Date of analysis
*** Based on regular gasoline
---: not analyzed

WELL DOT-1

Parameter	Unit*	Date Sample Taken and Date Received by Laboratory 02/03/87 02/05/87
Benzene	mg/L	24.000
Ethylbenzene	mg/L	2.300
Toluene	mg/L	51.000
Xylenes, M	mg/L	9.900
Xylenes, O & P	mg/L	11.000
C10-C32 Hydro-carbons	mg/L	ND
Gasoline	mg/L	180.000
Cadmium	mg/L	ND
Lead	mg/L	0.03

Samples analyzed by Rocky Mountain Analytical Laboratory
* Unit
mg/L: milligrams per liter
ND: not detected

WELL DOT-1

Parameters	Unit*	Date Sample Taken and Date Received by Laboratory				
		12/12/86 12/15/86	12/17/86 12/19/86	12/17/86 01/25/87**	01/07/86 01/09/87	01/21/87 01/22/87
Conductivity	umhos	1097	1074	---	1040	1008
lab pH		6.94	6.88	---	---	---
Alkalinity (P) as CaCO3	mg/L	0	0	---	---	0
Alkalinity (T) as CaCO3	mg/L	879	579	---	---	404
Bicarbonate	mg/L	1072	706	---	---	493
Total solids	mg/L	4792	2926	---	3200	1988
Hardness as CaCO3	mg/L	587	571	---	---	326
Calcium	mg/L	165	163	---	---	67.9
Magnesium	mg/L	42.4	39.9	---	---	38.0
Sodium	mg/L	17.8	16.2	---	---	14.8
Potassium	mg/L	9.0	9.1	---	---	8.8
Chloride	mg/L	11.8	10.3	---	---	8.9
Sulfate	mg/L	26.0	28.7	---	---	26.0
Ammonia as N	mg/L	8.77	7.85	---	6.76	8.35
Nitrate + Nitrite as N	mg/L	0.3	0.2	---	0.7	0.4
Total kjeldahl nitrogen	mg/L	---	---	---	---	9.63
Lead	mg/L	---	<0.0010	---	---	<0.0010
Iron	mg/L	---	---	---	271	100
Manganese	mg/L	---	---	---	18.8	8.7
Total hydro-carbons***	mg/L	---	---	357	---	---
Benzene	mg/L	---	---	16.6	---	---
Toluene	mg/L	---	---	7.5	---	---
Xylene	mg/L	---	---	1.7	---	---

Samples analyzed by South Dakota State Health Laboratory
* Unit
umhos: micromhos per centimeter
mg/L: milligrams per liter
** Date of analysis
*** Based on regular gasoline
---: not analyzed

WELL DOT-2

Parameters	Unit*	Date Sample Taken and Date Received by Laboratory		
		12/17/86	12/17/86	01/22/87
		12/19/86	01/25/87**	01/22/87
Conductivity	umhos	784	---	756
lab pH		7.35	---	---
Alkalinity (M) as CaCO3	mg/L	368	---	---
Alkalinity (P) as CaCO3	mg/L	0	---	0
Alkalinity (T) as CaCO3	mg/L	---	---	361
Bicarbonate	mg/L	449	---	440
Total solids	mg/L	---	---	2356
Total dissolved solids	mg/L	484	---	---
Hardness as CaCO3	mg/L	434	---	404
Calcium	mg/L	110	---	101
Magnesium	mg/L	38.8	---	37.0
Sodium	mg/L	9.2	---	10.8
Potassium	mg/L	4.6	---	7.3
Chloride	mg/L	17.9	---	24.2
Sulfate	mg/L	38.2	---	45.0
Ammonia as N	mg/L	---	---	0.32
Nitrate + Nitrite as N	mg/L	1.3	---	2.1
Total kjeldahl nitrogen	mg/L	---	---	0.52
Lead	mg/L	0.0014	---	0.0015
Iron	mg/L	---	---	938
Manganese	mg/L	---	---	38.5
Gasoline	mg/L	---	ND	---

Samples analyzed by South Dakota State Health Laboratory
* Unit
  umhos: micromhos per centimeter
  mg/L: milligrams per liter
** Date of analysis
ND: not detected
---: not analyzed

WELL DOT-3

Parameters	Unit*	Date Sample Taken and Date Received by Laboratory		
		12/16/86	12/16/86	01/22/87
		12/19/86	01/25/87**	01/24/87
Conductivity	umhos	838	---	822
lab pH		7.28	---	---
Alkalinity (M) as CaCO3	mg/L	353	---	---
Alkalinity (P) as CaCO3	mg/L	0	---	0
Alkalinity (T) as CaCO3	mg/L	---	---	380
Bicarbonate	mg/L	431	---	464
Total solids	mg/L	---	---	1513
Total dissolved solids	mg/L	528	---	---
Hardness as CaCO3	mg/L	445	---	426
Calcium	mg/L	111	---	105
Magnesium	mg/L	40.8	---	39.9
Sodium	mg/L	10.0	---	10.8
Potassium	mg/L	3.3	---	3.0
Chloride	mg/L	12.9	---	14.0
Sulfate	mg/L	39.1	---	44.5
Ammonia as N	mg/L	---	---	0.05
Nitrate + Nitrite as N	mg/L	14.1	---	5.9
Total kjeldahl nitrogen	mg/L	---	---	0.28
Lead	mg/L	<0.0010	---	<0.0010
Iron	mg/L	---	---	117
Manganese	mg/L	---	---	6.70
Gasoline	mg/L	---	<0.1	---

Samples analyzed by South Dakota State Health Laboratory
* Unit
  umhos: micromhos per centimeter
  mg/L: milligrams per liter
** Date of analysis
---: not analyzed

WELL DOT-4

Parameters	Unit*	Date Sample Taken and Date Received by Laboratory		
		12/16/86 12/19/86	12/16/86 01/25/87**	01/22/87 01/24/87
Conductivity	umhos	943	---	989
lab pH		7.29	---	---
Alkalinity (P) as CaCO3	mg/L	0	---	0
Alkalinity (T) as CaCO3	mg/L	360	---	365
Bicarbonate	mg/L	439	---	445
Total solids	mg/L	37639	---	21445
Hardness as CaCO3	mg/L	518	---	495
Calcium	mg/L	125	---	119
Magnesium	mg/L	50.1	---	48.0
Sodium	mg/L	14.1	---	13.9
Potassium	mg/L	4.3	---	3.5
Chloride	mg/L	23.8	---	21.3
Sulfate	mg/L	33.0	---	58.2
Ammonia as N	mg/L	0.09	---	0.04
Nitrate + Nitrite as N	mg/L	28.0	---	27.0
Total kjeldahl nitrogen	mg/L	---	---	0.35
Lead	mg/L	0.0011	---	<0.0010
Iron	mg/L	---	---	1240
Manganese	mg/L	---	---	65.0
Gasoline	mg/L	---	<0.1	---

Samples analyzed by South Dakota State Health Laboratory
* Unit
  umhos: micromhos per centimeter
  mg/L: milligrams per liter
** Date of analysis
---: not analyzed

WELL I-1

Parameter	Unit*	Date Sample Taken and Date Received by Laboratory					
		06/09-11/86 06/12/86	08/05-07/86 08/08/86	09/08-09/86 09/10/86	09/30-10/03/86 10/03/86	10/27-31/86 10/31/86	12/03-10/86 12/04-11/86
Benzene	mg/L	<0.001	ND	ND	ND	ND	ND
Toluene	mg/L	<0.001	ND	ND	ND	ND	ND
Xylene	mg/L	0.002	0.004	0.005	ND	ND	ND
Total hydro-carbons	mg/L	0.04	0.03	0.02	ND	ND	ND
Hexane extract-ables as Jet fuel	mg/L	---	---	---	ND	---	---

Samples analyzed by PACE Laboratories, Inc.
* Unit
  mg/L: milligrams per liter
ND: not detected
---: not analyzed

WELL I-1

Parameter	Unit*	Date Sample Taken and Date Received by Laboratory: 01/22/87 01/24/87	01/22/87 01/24/87
Conductivity	umhos	577	575
Alkalinity (P) as CaCO3	mg/L	0	0
Alkalinity (T) as CaCO3	mg/L	237	245
Bicarbonate	mg/L	289	299
Total solids	mg/L	31296	57670
Hardness as CaCO3	mg/L	301	287
Calcium	mg/L	79.0	72.6
Magnesium	mg/L	25.2	25.6
Sodium	mg/L	8.0	8.4
Potassium	mg/L	2.5	2.6
Chloride	mg/L	17.1	11.0
Sulfate	mg/L	66.5	58.9
Ammonia as N	mg/L	0.04	0.04
Nitrate + Nitrite as N	mg/L	3.1	2.9
Total kjeldahl nitrogen	mg/L	0.25	0.22
Lead	mg/L	<0.0010	<0.0010
Iron	mg/L	2380	1620
Manganese	mg/L	532	395

Samples analyzed by South Dakota State Health Laboratory
* Unit
  umhos: micromhos per centimeter
  mg/L: milligrams per liter

WELL I-2

Parameter	Unit*	Date Sample Taken and Date Received by Laboratory					
		06/09-11/86 06/12/86	08/05-07/86 08/08/86	09/08-09/86 09/10/86	09/30-10/03/86 10/03/86	10/27-31/86 10/31/86	12/03-10/86 12/04-11/86
Benzene	mg/L	7.1	0.28	0.47	0.19	1.0	0.97
Toluene	mg/L	8.1	0.34	0.23	0.16	0.38	0.12
Xylene	mg/L	10	1.4	3.0	0.98	7.0	1.3
Total hydrocarbons	mg/L	100	10	7.9	6.4	29	8.7
Hexane extractables as							
Gasoline	mg/L	---	---	---	---	---	2.5
Fuel oil No. 1	mg/L	---	---	---	---	---	ND
Fuel oil No. 2	mg/L	---	---	---	---	---	ND
Jet fuel	mg/L	---	---	---	14	---	ND
Ethylene dibromide	mg/L	---	---	---	ND	---	---

Samples analyzed by PACE Laboratories, Inc.
* Unit
mg/L: milligrams per liter
ND: not detected
---: not analyzed

WELL I-2

Parameter	Unit*	Date Sample Taken and Date Received by Laboratory 01/23/87 01/24/87
Conductivity	umhos	1423
Alkalinity (P) as CaCO3	mg/L	0
Alkalinity (T) as CaCO3	mg/L	487
Bicarbonate	mg/L	594
Total solids	mg/L	1488
Hardness as CaCO3	mg/L	584
Calcium	mg/L	134
Magnesium	mg/L	60.7
Sodium	mg/L	18.3
Potassium	mg/L	8.3
Chloride	mg/L	10.6
Sulfate	mg/L	158
Ammonia as N	mg/L	7.41
Nitrate + Nitrite as N	mg/L	12.8
Total kjeldahl nitrogen	mg/L	7.75
Lead	mg/L	0.0155
Iron	mg/L	629
Manganese	mg/L	34.0

Samples analyzed by South Dakota State Health Laboratory
* Unit
  umhos: micromhos per centimeter
  mg/L: milligrams per liter

WELL I-3

Parameter	Unit*	Date Sample Taken and Date Received by Laboratory					
		06/09-11/86 06/12/86	08/05-07/86 08/08/86	09/08-09/86 09/10/86	09/30-10/03/86 10/03/86	10/27-31/86 10/31/86	12/03-10/86 12/04-11/86
Benzene	mg/L	0.10	ND	ND	ND	0.86	0.036
Toluene	mg/L	0.25	ND	ND	ND	0.002	ND
Xylene	mg/L	0.49	0.001	0.006	ND	0.022	0.006
Total hydro-carbons	mg/L	3.85	0.02	0.03	ND	2.9	0.05

Samples analyzed by PACE Laboratories, Inc.
* Unit
  mg/L: milligrams per liter
ND: not detected

WELL I-3

Parameter	Unit*	Date Sample Taken and Date Received by Laboratory 01/23/87 01/24/87
Conductivity	umhos	1487
Alkalinity (P) as CaCO3	mg/L	0
Alkalinity (T) as CaCO3	mg/L	377
Bicarbonate	mg/L	460
Total solids	mg/L	9909
Hardness as CaCO3	mg/L	692
Calcium	mg/L	176
Magnesium	mg/L	61.3
Sodium	mg/L	15.7
Potassium	mg/L	6.8
Chloride	mg/L	9.9
Sulfate	mg/L	<10.0
Nitrate + Nitrite as N	mg/L	105.0
Lead	mg/L	<0.0010
Iron	mg/L	409
Manganese	mg/L	23.0

Samples analyzed by South Dakota State Health Laboratory
* Unit
umhos: micromhos per centimeter
mg/L: milligrams per liter

WELL I-4

Parameter	Unit*	Date Sample Taken and Date Received by Laboratory			
		06/09-11/86 06/12/86	08/05-07/86 08/08/86	10/27-31/86 10/31/86	12/03-10/86 12/04-11/86
Benzene	mg/L	0.015	0.58	3.4	1.7
Toluene	mg/L	0.005	0.004	ND	ND
Xylene	mg/L	0.013	0.060	0.090	0.10
Total hydro-carbons	mg/L	0.19	3.2	12	5.6

Samples analyzed by PACE Laboratories, Inc.
* Unit
  mg/L: milligrams per liter
ND: not detected

WELL I-4

Parameter	Unit*	Date Sample Taken and Date Received by Laboratory 01/23/87 01/24/87	01/23/87 01/24/87
Conductivity	umhos	1284	1355
Alkalinity (P) as CaCO3	mg/L	0	0
Alkalinity (T) as CaCO3	mg/L	470	471
Bicarbonate	mg/L	573	575
Total solids	mg/L	5462	5704
Hardness as CaCO3	mg/L	552	536
Calcium	mg/L	146	140
Magnesium	mg/L	45.5	45.3
Sodium	mg/L	15.9	15.5
Potassium	mg/L	6.8	6.7
Chloride	mg/L	7.9	8.7
Sulfate	mg/L	15.5	15.0
Ammonia as N	mg/L	30.90	33.75
Nitrate + Nitrite as N	mg/L	55.0	53.0
Total kjeldahl nitrogen	mg/L	31.00	34.65
Lead	mg/L	<0.0010	0.0023
Iron	mg/L	215	477
Manganese	mg/L	41.0	102

Samples analyzed by South Dakota State Health Laboratory
* Unit
  umhos: micromhos per centimeter
  mg/L: milligrams per liter

WELL I-5

Parameter	Unit*	Date Sample Taken and Date Received by Laboratory					
		06/09-11/86 06/12/86	08/05-07/86 08/08/86	09/08-09/86 09/10/86	09/30-10/03/86 10/03/86	10/27-31/86 10/31/86	12/03-10/86 12/04-11/86
Benzene	mg/L	0.14	1.0	ND	3.9	3.7	2.8
Toluene	mg/L	0.012	0.05	0.002	0.033	0.022	0.020
Xylene	mg/L	0.20	0.56	0.35	0.73	0.83	0.71
Total hydro-carbons	mg/L	1.4	7.5	0.75	19	16	11
Hexane extract-ables as							
Gasoline	mg/L	---	---	---	---	---	ND
Fuel oil No. 1	mg/L	---	---	---	---	---	ND
Fuel oil No. 2	mg/L	---	---	---	---	---	ND
Jet fuel	mg/L	---	---	---	ND	---	ND
Ethylene dibromide	mg/L	---	---	---	ND	---	---

Samples analyzed by PACE Laboratories, Inc.
* Unit
mg/L: milligrams per liter
ND: not detected
---: not analyzed

WELL I-5

Parameter	Unit*	Date Sample Taken and Date Received by Laboratory 01/23/87 01/24/87
Conductivity	umhos	2385
Alkalinity (P) as CaCO3	mg/L	0
Alkalinity (T) as CaCO3	mg/L	528
Bicarbonate	mg/L	644
Total solids	mg/L	21045
Hardness as CaCO3	mg/L	689
Calcium	mg/L	154
Magnesium	mg/L	73.9
Sodium	mg/L	20.2
Potassium	mg/L	13.5
Chloride	mg/L	10.5
Sulfate	mg/L	16.9
Ammonia as N	mg/L	82.60
Nitrate + Nitrite as N	mg/L	185.0
Total kjeldahl nitrogen	mg/L	98.60
Lead	mg/L	<0.0010
Iron	mg/L	520
Manganese	mg/L	108

Samples analyzed by South Dakota State Health Laboratory
* Unit
  umhos: micromhos per centimeter
  mg/L: milligrams per liter

WELL I-6

Parameter	Unit*	Date Sample Taken and Date Received by Laboratory					
		06/09-11/86 06/12/86	08/05-07/86 08/08/86	09/08-09/86 09/10/86	09/30-10/03/86 10/03/86	10/27-31/86 10/31/86	12/03-10/86 12/04-11/86
Benzene	mg/L	<0.001	ND	ND	ND	0.002	ND
Toluene	mg/L	<0.001	ND	ND	ND	ND	ND
Xylene	mg/L	<0.001	ND	ND	ND	ND	ND
Total hydro-carbons	mg/L	0.02	ND	ND	ND	ND	ND
Hexane extract-ables as Jet fuel	mg/L	---	---	---	ND	---	---

Samples analyzed by PACE Laboratories, Inc.
* Unit
mg/L: milligrams per liter
ND: not detected
---: not analyzed

WELL I-6

Parameter	Unit*	Date Sample Taken and Date Received by Laboratory 01/23/87 01/24/87
Conductivity	umhos	570
Alkalinity (P) as CaCO3	mg/L	0
Alkalinity (T) as CaCO3	mg/L	246
Bicarbonate	mg/L	300
Total solids	mg/L	9052
Hardness as CaCO3	mg/L	290
Calcium	mg/L	79.2
Magnesium	mg/L	22.3
Sodium	mg/L	8.1
Potassium	mg/L	2.2
Chloride	mg/L	15.1
Sulfate	mg/L	45.9
Ammonia as N	mg/L	<0.02
Nitrate + Nitrite as N	mg/L	2.5
Total kjeldahl nitrogen	mg/L	0.27
Lead	mg/L	<0.0010
Iron	mg/L	332
Manganese	mg/L	399

Samples analyzed by South Dakota State Health Laboratory
* Unit
  umhos: micromhos per centimeter
  mg/L: milligrams per liter

WELL I-7

Parameter	Unit*	Date Sample Taken and Date Received by Laboratory					
		06/09-11/86 06/12/86	08/05-07/86 08/08/86	09/08-09/86 09/10/86	09/30-10/03/86 10/03/86	10/27-31/86 10/31/86	12/03-10/86 12/04-11/86
Benzene	mg/L	0.027	0.030	0.44	2.5	2.5	2.0
Toluene	mg/L	0.026	ND	0.002	0.014	0.012	ND
Xylene	mg/L	1.3	0.010	0.069	0.28	0.30	0.19
Total hydro-carbons	mg/L	7.6	0.19	0.96	11	10	7.1
Hexane extract-ables as Jet fuel	mg/L	---	---	---	1.2	---	---
Ethylene dibromide	mg/L	---	---	---	ND	---	---

Samples analyzed by PACE Laboratories, Inc.
* Unit
mg/L: milligrams per liter
ND: not detected
---: not analyzed

WELL I-7

Parameter	Unit*	Date Sample Taken and Date Received by Laboratory	
		12/18/86 12/19/86	01/23/87 01/24/87
Conductivity	umhos	1740	1648
lab pH		7.10	---
Alkalinity (M) as CaCO3	mg/L	474	---
Alkalinity (P) as CaCO3	mg/L	0	0
Alkalinity (T) as CaCO3	mg/L	---	460
Bicarbonate	mg/L	578	561
Total solids	mg/l	---	7640
Hardness as CaCO3	mg/L	538	---
Calcium	mg/L	133	126
Magnesium	mg/L	50.1	48.7
Sodium	mg/L	17.6	17.0
Potassium	mg/L	13.6	13.0
Chloride	mg/L	11.2	10.6
Sulfate	mg/L	44.8	38.7
Ammonia as N	mg/L	---	75.40
Nitrate + Nitrite as N	mg/L	78.0	87.0
Total kjeldahl nitrogen	mg/L	---	81.40
Lead	mg/L	<0.0010	<0.0010
Iron	mg/L	---	1650
Manganese	mg/L	---	102

Samples analyzed by South Dakota State Health Laboratory
* Unit
  umhos: micromhos per centimeter
  mg/L: milligrams per liter

WELL I-8

Parameter	Unit*	Date Sample Taken and Date Received by Laboratory						
		06/09-11/86 06/12/86	08/05-07/86 08/08/86	08/18-19/86 08/20/86	09/08-09/86 09/10/86	09/30-10/03/86 10/03/86	10/27-31/86 10/31/86	12/03-10/86 12/04-11/86
Benzene	mg/L	0.55	1.0	---	0.12	0.16	1.3	2.8
Toluene	mg/L	0.34	0.020	---	ND	ND	0.016	0.023
Xylene	mg/L	4.3	0.67	---	0.75	0.63	0.56	0.56
Total hydro-carbons	mg/L	28	7.9	---	1.9	3.3	6.1	11
Hexane extract-ables as								
Gasoline	mg/L	---	---	---	---	---	---	ND
Fuel oil No. 1	mg/L	---	---	---	---	---	---	ND
Fuel oil No. 2	mg/L	---	---	---	---	---	---	ND
Jet fuel	mg/L	---	---	---	---	1.9	---	ND
Ethylene dibromide	mg/L	---	---	---	---	ND	---	---
Lead	mg/L	---	---	0.1	---	---	---	---

Samples analyzed by PACE Laboratories, Inc.
* Unit
mg/L: milligrams per liter
ND: not detected
---: not analyzed

WELL I-8

Parameter	Unit*	Date Sample Taken and Date Received by Laboratory: 12/18/86 12/19/86	01/23/87 01/24/87
Conductivity	umhos	1553	1426
lab pH		7.10	---
Alkalinity (M) as CaCO3	mg/L	505	---
Alkalinity (P) as CaCO3	mg/L	0	0
Alkalinity (T) as CaCO3	mg/L	---	416
Bicarbonate	mg/L	616	508
Total solids	mg/L	---	10104
Hardness as CaCO3	mg/L	471	447
Calcium	mg/L	122	113
Magnesium	mg/L	40.5	40.1
Sodium	mg/L	12.5	11.7
Potassium	mg/L	9.5	7.9
Chloride	mg/L	10.6	12.2
Sulfate	mg/L	33.5	25.3
Ammonia as N	mg/L	---	67.90
Nitrate + Nitrite as N	mg/L	64.0	70.0
Total kjeldahl nitrogen	mg/L	---	69.00
Lead	mg/L	<0.0010	0.0159
Iron	mg/L	---	300
Manganese	mg/L	---	91.0

Samples analyzed by South Dakota State Health Laboratory
* Unit
  umhos: micromhos per centimeter
  mg/L: milligrams per liter
---: not analyzed

WELL I-9

Parameter	Unit*	Date Sample Taken and Date Received by Laboratory 12/03-10/86 12/04-11/86
Hexane extractables as		
Gasoline	mg/L	15
Fuel oil No. 1	mg/L	ND
Fuel oil No. 2	mg/L	ND
Jet fuel	mg/L	ND

Samples analyzed by PACE Laboratories, Inc.
* Unit
mg/L: milligrams per liter
ND: not detected

WELL I-9

Parameter	Unit*	Date Sample Taken and Date Received by Laboratory		
		12/18/86 12/19/86	12/18/86 01/25/87**	01/23/87 01/24/87
Conductivity	umhos	1127	---	983
lab pH		7.12	---	---
Alkalinity (M) as CaCO3	mg/L	374	---	---
Alkalinity (P) as CaCO3	mg/L	0	---	0
Alkalinity (T) as CaCO3	mg/L	---	---	378
Bicarbonate	mg/L	456	---	461
Total Solids	mg/L	---	---	14287
Hardness as CaCO3	mg/L	565	---	468
Calcium	mg/L	154	---	125
Magnesium	mg/L	43.9	---	38.0
Sodium	mg/L	7.4	---	6.6
Potassium	mg/L	6.0	---	5.8
Chloride	mg/L	23.0	---	10.9
Sulfate	mg/L	31.3	---	18.7
Ammonia as N	mg/L	---	---	8.18
Nitrate + Nitrite as N	mg/L	44.0	---	33.0
Total kjeldahl nitrogen	mg/L	---	---	8.84
Lead	mg/L	<0.0010	---	<0.0010
Iron	mg/L	---	---	270
Manganese	mg/L	---	---	250
Total hydro-carbons***	mg/L	---	122.3	---
Benzene	mg/L	---	ND	---
Toluene	mg/L	---	2.7	---
Xylene	mg/L	---	1.2	---

Samples analyzed by South Dakota State Health Laboratory
* Unit
umhos: micromhos per centimeter
mg/L: milligrams per liter
** Date of analysis
*** Based on regular gasoline
---: not analyzed

WELL I-10

Parameter	Unit*	Date Sample Taken and Date Received by Laboratory 12/03-10/86 12/04-11/86
Benzene	mg/L	1.3
Toluene	mg/L	0.35
Xylene	mg/L	1.0
Total hydro-carbons	mg/L	11
Hexane extract-ables as		
Gasoline	mg/L	12
Fuel oil No. 1	mg/L	ND
Fuel oil No. 2	mg/L	ND
Jet fuel	mg/L	ND

Samples analyzed by PACE Laboratories, Inc.
* Unit
mg/L: milligrams per liter
ND: not detected

WELL I-10

Parameter	Unit*	Date Sample Taken and Date Received by Laboratory: 12/18/86 12/19/86	01/23/87 01/24/87
Conductivity	umhos	1026	670
lab pH		7.17	---
Alkalinity (M) as CaCO3	mg/L	308	---
Alkalinity (P) as CaCO3	mg/L	0	0
Alkalinity (T) as CaCO3	mg/L	---	304
Bicarbonate	mg/L	376	371
Total solids	mg/L	---	5157
Hardness as CaCO3	mg/L	540	341
Calcium	mg/L	141	88.5
Magnesium	mg/L	45.6	29.2
Sodium	mg/L	6.8	5.5
Potassium	mg/L	3.3	3.0
Chloride	mg/L	13.0	8.4
Sulfate	mg/L	27.6	17.5
Ammonia as N	mg/L	---	1.42
Nitrate + Nitrite as N	mg/L	58.0	14.2
Total kjeldahl nitrogen	mg/L	---	3.38
Lead	mg/L	0.0022	<0.0010
Iron	mg/L	---	487
Manganese	mg/L	---	100

Samples analyzed by South Dakota State Health Laboratory
* Unit
  umhos: micromhos per centimeter
  mg/L: milligrams per liter
---: not analyzed

WELL I-11

Parameter	Unit*	Date Sample Taken and Date Received by Laboratory	
		06/09-11/86 06/12/86	12/03-10-86 12/04-11/86
Benzene	mg/L	11	---
Toluene	mg/L	18	---
Xylene	mg/L	14	---
Total hydro-carbons	mg/L	180	---
Hexane extract-ables as			
Gasoline	mg/L	---	6100
Fuel oil No. 1	mg/L	---	ND
Fuel oil No. 2	mg/L	---	2600
Jet fuel	mg/L	---	ND

Samples analyzed by PACE Laboratories, Inc.
* Unit
mg/L: milligrams per liter
ND: not detected
---: not analyzed

WELL I-11

Parameter	Unit*	Date Sample Taken and Date Received by Laboratory 01/24/87 01/24/87
Conductivity	umhos	1041
Alkalinity (P) as CaCO3	mg/L	0
Alkalinity (T) as CaCO3	mg/L	428
Bicarbonate	mg/L	522
Total solids	mg/L	17350
Hardness as CaCO3	mg/L	346
Calcium	mg/L	89.6
Magnesium	mg/L	29.8
Sodium	mg/L	13.8
Potassium	mg/L	5.2
Chloride	mg/L	10.2
Sulfate	mg/L	21.9
Ammonia as N	mg/L	29.20
Nitrate + Nitrite as N	mg/L	22.4
Total kjeldahl nitrogen	mg/L	33.80
Lead	mg/L	<0.0010
Iron	mg/L	1110
Manganese	mg/L	160

Samples analyzed by South Dakota State Health Laboratory
* Unit
  umhos: micromhos per centimeter
  mg/L: milligrams per liter

WELL I-12

Parameter	Unit*	Date Sample Taken and Date Received by Laboratory 12/03-10-86 12/04-11/86
Hexane extractables as		
Gasoline	mg/L	ND
Fuel oil No. 1	mg/L	ND
Fuel oil No. 2	mg/L	ND
Jet fuel	mg/L	ND

Samples analyzed by PACE Laboratories, Inc.
* Unit
mg/L: milligrams per liter
ND: not detected

WELL I-12

Parameter	Unit*	Date Sample Taken and Date Received by Laboratory 01/22/87 01/24/87
Conductivity	umhos	2745
Alkalinity (P) as CaCO3	mg/L	0
Alkalinity (T) as CaCO3	mg/L	574
Bicarbonate	mg/L	700
Total solids	mg/L	18568
Hardness as CaCO3	mg/L	944
Calcium	mg/L	253
Magnesium	mg/L	75.9
Sodium	mg/L	13.0
Potassium	mg/L	12.6
Chloride	mg/L	14.6
Sulfate	mg/L	13.4
Ammonia as N	mg/L	112.80
Nitrate + Nitrite as N	mg/L	206.0
Total kjeldahl nitrogen	mg/L	115.00
Lead	mg/L	<0.0010
Iron	mg/L	1470
Manganese	mg/L	206

Samples analyzed by South Dakota State Health Laboratory
* Unit
  umhos: micromhos per centimeter
  mg/L: milligrams per liter

WELL I-13

Parameter	Unit*	Date Sample Taken and Date Received by Laboratory: 06/09-11/86 06/12/86	12/03-10/86 12/04-11/86
Benzene	mg/L	14	8.6
Toluene	mg/L	22	16
Xylene	mg/L	15	6.8
Total hydrocarbons	mg/L	220	97
Hexane extractables as			
Gasoline	mg/L	---	18
Fuel oil No. 1	mg/L	---	ND
Fuel oil No. 2	mg/L	---	2.2
Jet fuel	mg/L	---	ND

Samples analyzed by PACE Laboratories, Inc.
* Unit
mg/L: milligrams per liter
ND: not detected
---: not analyzed

WELL I-13

Parameter	Unit*	Date Sample Taken and Date Received by Laboratory 01/23/87 01/24/87
Conductivity	umhos	2825
Alkalinity (P) as CaCO3	mg/L	0
Alkalinity (T) as CaCO3	mg/L	584
Bicarbonate	mg/L	712
Total solids	mg/L	10382
Calcium	mg/L	197
Magnesium	mg/L	71.3
Sodium	mg/L	19.9
Potassium	mg/L	19.9
Chloride	mg/L	13.6
Sulfate	mg/L	18.5
Ammonia as N	mg/L	141.80
Nitrate + Nitrite as N	mg/L	200.0
Total kjeldahl nitrogen	mg/L	148.20
Lead	mg/L	<0.0010
Iron	mg/L	782
Manganese	mg/L	115

Samples analyzed by South Dakota State Health Laboratory
* Unit
  umhos: micromhos per centimeter
  mg/L: milligrams per liter

WELL I-14

Parameter	Unit*	Date Sample Taken and Date Received by Laboratory: 06/09-11/86 06/12/86	12/03-10/86 12/04-11/86
Benzene	mg/L	3.1	2.7
Toluene	mg/L	6.9	0.15
Xylene	mg/L	9.9	1.1
Total hydrocarbons	mg/L	91	14
Hexane extractables as			
Gasoline	mg/L	---	2.1
Fuel oil No. 1	mg/L	---	ND
Fuel oil No. 2	mg/L	---	ND
Jet fuel	mg/L	---	ND

Samples analyzed by PACE Laboratories, Inc.
* Unit
mg/L: milligrams per liter
ND: not detected
---: not analyzed

WELL I-14

Parameter	Unit*	Date Sample Taken and Date Received by Laboratory 01/23/87 01/24/87
Conductivity	umhos	2573
Alkalinity (P) as CaCO3	mg/L	0
Alkalinity (T) as CaCO3	mg/L	502
Bicarbonate	mg/L	612
Total solids	mg/L	4853
Calcium	mg/L	192
Magnesium	mg/L	62.9
Sodium	mg/L	16.1
Potassium	mg/L	15.7
Chloride	mg/L	10.8
Sulfate	mg/L	14.3
Ammonia as N	mg/L	130.00
Nitrate + Nitrite as N	mg/L	198.0
Total kjeldahl nitrogen	mg/L	134.60
Lead	mg/L	<0.0010
Iron	mg/L	104
Manganese	mg/L	200

Samples analyzed by South Dakota State Health Laboratory
* Unit
  umhos: micromhos per centimeter
  mg/L: milligrams per liter

WELL I-15

Parameter	Unit*	Date Sample Taken and Date Received by Laboratory 01/21/87 01/24/87
Conductivity	umhos	2022
Alkalinity (P) as CaCO3	mg/L	0
Alkalinity (T) as CaCO3	mg/L	474
Bicarbonate	mg/L	578
Total solids	mg/L	9995
Hardness as CaCO3	mg/L	694
Calcium	mg/L	187
Magnesium	mg/L	55.2
Sodium	mg/L	15.1
Potassium	mg/L	10.3
Chloride	mg/L	9.5
Sulfate	mg/L	18.9
Ammonia as N	mg/L	66.60
Nitrate + Nitrite as N	mg/L	130.0
Total kjeldahl nitrogen	mg/L	71.40
Lead	mg/L	<0.0010
Iron	mg/L	316
Manganese	mg/L	55.0

Samples analyzed by South Dakota State Health Laboratory
* Unit
  umhos: micromhos per centimeter
  mg/L: milligrams per liter

WELL I-16

Parameter	Unit*	Date Sample Taken and Date Received by Laboratory				
		06/09-11/86 06/12/86	08/18-19/86 08/20/86	09/30-10/30/86 10/03/86	10/27-31/86 10/31/86	12/03-10/86 12/04-11/86
Benzene	mg/L	<0.001	ND	ND	0.036	0.003
Toluene	mg/L	<0.001	ND	0.002	ND	ND
Xylene	mg/L	0.001	ND	0.15	0.016	ND
Total hydro-carbons	mg/L	0.01	ND	0.57	0.26	0.01

Samples analyzed by PACE Laboratories, Inc.
* Unit
mg/L: milligrams per liter
ND: not detected

WELL I-16

Parameter	Unit*	Date Sample Taken and Date Received by Laboratory		
		12/16/86 12/19/86	12/16/86 01/25/87**	01/21/87 01/22/87
Conductivity	umhos	717	---	705
lab pH		7.26	---	---
Alkalinity (P) as CaCO3	mg/L	0	---	0
Alkalinity (T) as CaCO3	mg/L	341	---	355
Bicarbonate	mg/L	416	---	433
Total solids	mg/L	2660	---	31712
Hardness as CaCO3	mg/L	375	---	371
Calcium	mg/L	101	---	100
Magnesium	mg/L	29.8	---	29.4
Sodium	mg/L	17.5	---	17.7
Potassium	mg/L	3.0	---	2.9
Chloride	mg/L	11.0	---	20.2
Sulfate	mg/L	40.1	---	39.1
Ammonia as N	mg/L	0.02	---	0.03
Nitrate + Nitrite as N	mg/L	1.7	---	1.9
Total kjeldahl nitrogen	mg/L	---	---	0.31
Lead	mg/L	<0.0010	---	<0.0010
Iron	mg/L	---	---	2920
Manganese	mg/L	---	---	185
Gasoline	mg/L	---	<0.1	---

Samples analyzed by South Dakota State Health Laboratory
* Unit
  umhos: micromhos per centimeter
  mg/L: milligrams per liter
** Date of analysis
---: not analyzed

WELL I-17

Parameter	Unit*	Date Sample Taken and Date Received by Laboratory: 08/05-07/86 / 08/08/86	09/08-09/86 / 09/10/86	10/27-31/86 / 10/31/86	12/03-10/86 / 12/04-11/86
Benzene	mg/L	ND	ND	ND	0.006
Toluene	mg/L	ND	ND	ND	ND
Xylene	mg/L	0.001	0.001	ND	0.002
Total hydro-carbons	mg/L	0.01	0.02	ND	0.01

Samples analyzed by PACE Laboratories, Inc.
* Unit
  mg/L: milligrams per liter
ND: not detected

WELL I-17

Parameter	Unit*	Date Sample Taken and Date Received by Laboratory 01/22/87 01/24/87
Conductivity	umhos	572
Alkalinity (P) as CaCO3	mg/L	0
Alkalinity (T) as CaCO3	mg/L	251
Bicarbonate	mg/L	306
Total solids	mg/L	61626
Hardness as CaCO3	mg/L	282
Calcium	mg/L	73.1
Magnesium	mg/L	24.3
Sodium	mg/L	4.5
Potassium	mg/L	3.4
Chloride	mg/L	9.9
Sulfate	mg/L	14.5
Ammonia as N	mg/L	2.16
Nitrate + Nitrite as N	mg/L	9.2
Total kjeldahl nitrogen	mg/L	2.89
Lead	mg/L	<0.0010
Iron	mg/L	3990
Manganese	mg/L	602

Samples analyzed by South Dakota State Health Laboratory
* Unit
umhos: micromhos per centimeter
mg/L: milligrams per liter

WELL I-18

Parameter	Unit*	Date Sample Taken and Date Received by Laboratory: 09/08-09/86 09/10/86	10/27-31/86 10/31/86	12/03-10/86 12/04-11/86
Benzene	mg/L	0.10	0.45	0.19
Toluene	mg/L	0.003	ND	ND
Xylene	mg/L	0.008	0.007	0.019
Total hydro-carbons	mg/L	0.23	1.6	0.76

Samples analyzed by PACE Laboratories, Inc.
* Unit
  mg/L: milligrams per liter
ND: not detected

WELL I-18

Parameter	Unit*	Date Sample Taken and Date Received by Laboratory 01/24/87 01/24/87
Sulfate	mg/L	283
Ammonia as N	mg/L	231.50
Nitrate + Nitrite as N	mg/L	255.0
Total kjeldahl nitrogen	mg/L	200.60
Lead	mg/L	<0.0010
Iron	mg/L	802
Manganese	mg/L	2700

Samples analyzed by South Dakota State Health Laboratory

* Unit
  mg/L: milligrams per liter

WELL I-19

Parameter	Unit*	Date Sample Taken and Date Received by Laboratory 12/03-10/86 12/04-11/86
Hexane extractables as		
Gasoline	mg/L	1000
Fuel oil No. 1	mg/L	ND
Fuel oil No. 2	mg/L	ND
Jet fuel	mg/L	ND

Samples analyzed by PACE Laboratories, Inc.
* Unit
mg/L: milligrams per liter
ND: not detected

WELL I-19

Parameter	Unit*	Date Sample Taken and Date Received by Laboratory 01/22/87 01/24/87
Conductivity	umhos	1039
Alkalinity (P) as CaCO3	mg/L	0
Alkalinity (T) as CaCO3	mg/L	409
Bicarbonate	mg/L	499
Total solids	mg/L	46969
Calcium	mg/L	105
Magnesium	mg/L	42.4
Sodium	mg/L	14.6
Potassium	mg/L	4.6
Chloride	mg/L	9.1
Sulfate	mg/L	28.6
Ammonia as N	mg/L	12.22
Nitrate + Nitrite as N	mg/L	20.0
Total kjeldahl nitrogen	mg/L	12.75
Lead	mg/L	<0.0010
Iron	mg/L	3310
Manganese	mg/L	463

Samples analyzed by South Dakota State Health Laboratory

* Unit
- umhos: micromhos per centimeter
- mg/L: milligrams per liter

WELL I-20

Parameter	Unit*	Date Sample Taken and Date Received by Laboratory 01/22/87 01/24/87
Conductivity	umhos	628
Alkalinity (P) as CaCO3	mg/L	0
Alkalinity (T) as CaCO3	mg/L	297
Bicarbonate	mg/L	362
Total solids	mg/L	30634
Hardness as CaCO3	mg/L	320
Calcium	mg/L	82.0
Magnesium	mg/L	28.1
Sodium	mg/L	4.3
Potassium	mg/L	3.0
Chloride	mg/L	11.6
Sulfate	mg/L	16.2
Ammonia as N	mg/L	1.10
Nitrate + Nitrite as N	mg/L	7.8
Total kjeldahl nitrogen	mg/L	2.83
Lead	mg/L	<0.0010
Iron	mg/L	3480
Manganese	mg/L	564

Samples analyzed by South Dakota State Health Laboratory
* Unit
umhos: micromhos per centimeter
mg/L: milligrams per liter

WELL I-21

Parameter	Unit*	Date Sample Taken and Date Received by Laboratory 01/22/87 01/24/87
Conductivity	umhos	736
Alkalinity (P) as CaCO3	mg/L	0
Alkalinity (T) as CaCO3	mg/L	323
Bicarbonate	mg/L	394
Total solids	mg/L	53319
Calcium	mg/L	85.2
Magnesium	mg/L	22.9
Sodium	mg/L	6.6
Potassium	mg/L	5.1
Chloride	mg/L	14.3
Sulfate	mg/L	14.5
Ammonia as N	mg/L	14.86
Nitrate + Nitrite as N	mg/L	8.2
Total kjeldahl nitrogen	mg/L	17.00
Lead	mg/L	<0.0010
Iron	mg/L	4770
Manganese	mg/L	572

Samples analyzed by South Dakota State Health Laboratory

* Unit
  umhos: micromhos per centimeter
  mg/L: milligrams per liter

WELL I-22

Parameter	Unit*	Date Sample Taken and Date Received by Laboratory 01/22/87 01/24/87
Conductivity	umhos	2704
Alkalinity (P) as CaCO3	mg/L	0
Alkalinity (T) as CaCO3	mg/L	614
Bicarbonate	mg/L	749
Total solids	mg/L	49758
Hardness as CaCO3	mg/L	831
Calcium	mg/L	212
Magnesium	mg/L	73.2
Sodium	mg/L	16.6
Potassium	mg/L	17.2
Chloride	mg/L	13.9
Sulfate	mg/L	19.1
Ammonia as N	mg/L	116.20
Nitrate + Nitrite as N	mg/L	212.0
Total kjeldahl nitrogen	mg/L	120.00
Lead	mg/L	<0.0010
Iron	mg/L	2510
Manganese	mg/L	712

Samples analyzed by South Dakota State Health Laboratory
* Unit
umhos: micromhos per centimeter
mg/L: milligrams per liter

WELL SRW-2

Parameter	Unit*	Date Sample Taken and Date Received by Laboratory 10/27-31-86 10/31/86
Benzene	mg/L	0.12
Toluene	mg/L	0.01
Xylene	mg/L	4.6
Total hydro-carbons	mg/L	18

Samples analyzed by PACE Laboratories, Inc.

* Unit
  mg/L: milligrams per liter

WELL SRW-3

Parameter	Unit*	Date Sample Taken and Date Received by Laboratory 01/23/87 01/24/87
Conductivity	umhos	528
Alkalinity (P) as CaCO3	mg/L	0
Alkalinity (T) as CaCO3	mg/L	272
Bicarbonate	mg/L	351
Total solids	mg/L	24263
Hardness as CaCO3	mg/L	264
Calcium	mg/L	69.7
Magnesium	mg/L	22.0
Sodium	mg/L	7.0
Potassium	mg/L	2.3
Chloride	mg/L	28.2
Sulfate	mg/L	41.6
Ammonia as N	mg/L	0.03
Nitrate + Nitrite as N	mg/L	2.1
Total kjeldahl nitrogen	mg/L	0.11
Lead	mg/L	<0.0010
Iron	mg/L	1190
Manganese	mg/L	548

Samples analyzed by South Dakota State Health Laboratory

* Unit

umhos: micromhos per centimeter

mg/L: milligrams per liter

WELL DI-4

Parameter	Unit*	Date Sample Taken and Date Received by Laboratory 12/03-10/86 12/04-11/86
Benzene	mg/L	ND
Toluene	mg/L	0.001
Xylene	mg/L	0.001
Total hydro-carbons	mg/L	0.01

Samples analyzed by PACE Laboratories, Inc.
* Unit
  mg/L: milligrams per liter
ND: not detected

WELL DI-4

Parameter	Unit*	Date Sample Taken and Date Received by Laboratory 01/23/87 01/24/87
Conductivity	umhos	518
Alkalinity (P) as CaCO3	mg/L	0
Alkalinity (T) as CaCO3	mg/L	247
Bicarbonate	mg/L	301
Total solids	mg/L	175741
Total dissolved solids	mg/L	336
Total suspended solids	mg/L	172110
Hardness as CaCO3	mg/L	236
Calcium	mg/L	56.1
Magnesium	mg/L	23.2
Sodium	mg/L	12.2
Potassium	mg/L	6.4
Chloride	mg/L	10.8
Sulfate	mg/L	27.1
Ammonia as N	mg/L	0.11
Nitrate + Nitrite as N	mg/L	<0.1
Total kjeldahl nitrogen	mg/L	0.24
Lead	mg/L	<0.0010
Iron	mg/L	2200
Manganese	mg/L	76.0

Samples analyzed by South Dakota State Health Laboratory
* Unit
umhos: micromhos per centimeter
mg/L: milligrams per liter

WELL MW-1

Parameter	Unit*	Date Sample Taken and Date Received by Laboratory: 09/30-10/03/86 / 10/03/86	10/27-31/86 / 10/31/86	12/03-10/86 / 12/04-11/86
Benzene	mg/L	15	7.2	9.3
Toluene	mg/L	36	24	59
Xylene	mg/L	16	16	17
Total hydro-carbons	mg/L	270	160	250

Samples analyzed by PACE Laboratories, Inc.
* Unit
mg/L: milligrams per liter

WELL MW-1

Parameter	Unit*	Date Sample Taken and Date Received by Laboratory: 10/27/86 10/31/86	02/04/87 02/05/87	02/02/87 02/05/87
Benzene	mg/L	9.600	7.300	8.600
Ethylbenzene	mg/L	1.900	3.700	21.000
Toluene	mg/L	29.000	54.000	92.000
Xylenes, M	mg/L	8.600	13.000	76.000
Xylenes, O & P	mg/L	9.300	13.000	75.000
C10-C32 hydrocarbons	mg/L	---	ND	ND
Gasoline	mg/L	78.000	160.000	220.000
Kerosene	mg/L	ND	---	---
Total petroleum hydrocarbons	mg/L	32	---	---
Total organic carbon	mg/L	123	---	---
Cadmium	mg/L	---	ND	ND
Lead	mg/L	---	0.06	0.03

Samples analyzed by Rocky Mountain Analytical Laboratory
* Unit
  mg/L: milligrams per liter
ND: not detected
---: not analyzed

WELL MW-1

Parameter	Unit*	Date Sample Taken and Date Received by Laboratory		
		12/17/86 12/19/86	12/17/86 01/25/87**	01/21/87 01/22/87
Conductivity	umhos	653	---	712
lab pH		7.22	---	---
Alkalinity (M) as CaCO3	mg/L	353	---	---
Alkalinity (P) as CaCO3	mg/L	0	---	0
Alkalinity (T) as CaCO3	mg/L	---	---	363
Bicarbonate	mg/L	431	---	443
Total solids	mg/L	---	---	4271
Total dissolved solids	mg/L	432	---	---
Hardness as CaCO3	mg/L	359	---	372
Calcium	mg/L	92.2	---	95.6
Magnesium	mg/L	31.2	---	32.5
Sodium	mg/L	20.2	---	15.3
Potassium	mg/L	3.2	---	2.9
Chloride	mg/L	14.3	---	8.8
Sulfate	mg/L	14.4	---	20.3
Ammonia as N	mg/L	---	---	0.04
Nitrate + Nitrite as N	mg/L	0.2	---	0.1
Total kjeldahl nitrogen	mg/L	---	---	0.58
Lead	mg/L	<0.0010	---	<0.0010
Iron	mg/L	---	---	566
Manganese	mg/L	---	---	9.50
Total hydro-carbons***	mg/L	---	448	---
Benzene	mg/L	---	30	---
Toluene	mg/L	---	7	---
Xylene	mg/L	---	1.6	---

Samples analyzed by South Dakota State Health Laboratory
* Unit
umhos: micromhos per centimeter
mg/L: milligrams per liter
** Date of analysis
*** Based on regular gasoline
---: not analyzed

WELL MW-2

Parameter	Unit*	Date Sample Taken and Date Received by Laboratory 01/22/87 01/22/87
Conductivity	umhos	798
Alkalinity (P) as CaCO3	mg/L	0
Alkalinity (T) as CaCO3	mg/L	403
Bicarbonate	mg/L	492
Total solids	mg/L	1527
Hardness as CaCO3	mg/L	451
Calcium	mg/L	119
Magnesium	mg/L	37.3
Sodium	mg/L	12.6
Potassium	mg/L	3.3
Chloride	mg/L	15.3
Sulfate	mg/L	27.1
Ammonia as N	mg/L	0.05
Nitrate + Nitrite as N	mg/L	0.1
Total kjeldahl nitrogen	mg/L	0.52
Lead	mg/L	<0.0010
Iron	mg/L	32.2
Manganese	mg/L	3.63

Samples analyzed by South Dakota State Health Laboratory
* Unit
  umhos: micromhos per centimeter
  mg/L: milligrams per liter

WELL MW-3

Parameter	Unit*	Date Sample Taken and Date Received by Laboratory: 09/30-10/03/86 / 10/03/86	10/27-31/86 / 10/31/86	12/03-10/86 / 12/04-11/86
Benzene	mg/L	18	20	8.0
Toluene	mg/L	22	32	39
Xylene	mg/L	9.8	12	17
Total hydro-carbons	mg/L	200	230	200
Ethylene dibromide	mg/L	ND	---	---

Samples analyzed by PACE Laboratories, Inc.
* Unit
  mg/L: milligrams per liter
ND: not detected
---: not analyzed

WELL MW-3

Parameter	Unit*	Date Sample Taken and Date Received by Laboratory 10/29/86 10/31/86
Total petroleum hydrocarbons	mg/L	8.2
Total organic carbon	mg/L	34

Samples analyzed by Rocky Mountain Analytical Laboratory
* Unit
mg/L: milligrams per liter

WELL MW-3

Parameter	Unit*	Date Sample Taken and Date Received by Laboratory		
		12/17/86 12/19/86	12/17/86 01/25/87**	01/22/87 01/22/87
Conductivity	umhos	994	---	925
lab pH		7.08	---	---
Alkalinity (M) as CaCO3	mg/L	543	---	---
Alkalinity (P) as CaCO3	mg/L	0	---	0
Alkalinity (T) as CaCO3	mg/L	---	---	501
Bicarbonate	mg/L	662	---	611
Total solids	mg/L	---	---	10210
Total dissolved solids	mg/L	655	---	---
Hardness as CaCO3	mg/L	560	---	493
Calcium	mg/L	156	---	133
Magnesium	mg/L	41.5	---	39.1
Sodium	mg/L	13.5	---	13.4
Potassium	mg/L	5.1	---	4.8
Chloride	mg/L	13.7	---	10.7
Sulfate	mg/L	33.1	---	38.0
Ammonia as N	mg/L	---	---	2.97
Nitrate + Nitrite as N	mg/L	0.2	---	0.3
Total kjeldahl nitrogen	mg/L	---	---	3.64
Lead	mg/L	<0.0010	---	0.0016
Iron	mg/L	---	---	662
Manganese	mg/L	---	---	59.0
Total hydro-carbons***	mg/L	---	235	---
Benzene	mg/L	---	7.2	---
Toluene	mg/L	---	5.5	---
Xylene	mg/L	---	0.8	---

Samples analyzed by South Dakota State Health Laboratory
* Unit
umhos: micromhos per centimeter
mg/L: milligrams per liter
** Date of analysis
*** Based on regular gasoline
---: not analyzed

WELL MW-4

Parameter	Unit*	Date Sample Taken and Date Received by Laboratory: 09/30-10/03/86 / 10/03/86	10/27-31/86 / 10/31/86	12/03-10/86 / 12/04-11/86
Benzene	mg/L	20	15	18
Toluene	mg/L	40	33	43
Xylene	mg/L	14	8.5	11
Total hydrocarbons	mg/L	300	160	210
Hexane extractables as				
Gasoline	mg/L	36	---	37
Fuel oil No. 1	mg/L	---	---	ND
Fuel oil No. 2	mg/L	---	---	ND
Jet fuel	mg/L	---	---	ND

Samples analyzed by PACE Laboratories, Inc.
* Unit
mg/L: milligrams per liter
ND: not detected
---: not analyzed

WELL MW-4

Parameter	Unit*	Date Sample Taken and Date Received by Laboratory 02/03/87 02/05/87
Benzene	mg/L	21.000
Ethylbenzene	mg/L	2.800
Toluene	mg/L	41.000
Xylenes, M	mg/L	8.600
Xylenes, O & P	mg/L	9.500
C10-C32 hydro-carbons	mg/L	ND
Gasoline	mg/L	130.000
Cadmium	mg/L	0.02
Lead	mg/L	0.7

Samples analyzed by Rocky Mountain Analytical Laboratory
* Unit
  mg/L: milligrams per liter
ND: not detected

WELL MW-4

Parameter	Unit*	Date Sample Taken and Date Received by Laboratory: 12/17/86 12/19/86	12/17/86 01/25/87**	01/21/87 01/22/87
Conductivity	umhos	727	---	1049
lab pH		6.95	---	---
Alkalinity (M) as CaCO3	mg/L	576	---	---
Alkalinity (P) as CaCO3	mg/L	0	---	0
Alkalinity (T) as CaCO3	mg/L	---	---	476
Bicarbonate	mg/L	703	---	581
Total solids	mg/L	---	---	11841
Total dissolved solids	mg/L	699	---	---
Hardness as CaCO3	mg/L	591	---	370
Calcium	mg/L	168	---	88.7
Magnesium	mg/L	41.7	---	36.2
Sodium	mg/L	16.9	---	15.8
Potassium	mg/L	7.6	---	8.0
Chloride	mg/L	12.8	---	13.0
Sulfate	mg/L	25.7	---	26.7
Ammonia as N	mg/L	---	---	8.02
Nitrate + Nitrite as N	mg/L	<0.1	---	0.1
Total kjeldahl nitrogen	mg/L	---	---	9.62
Lead	mg/L	0.0023	---	<0.0010
Iron	mg/L	---	---	1540
Manganese	mg/L	---	---	69.2
Total hydro-carbons***	mg/L	---	666	---
Benzene	mg/L	---	40.4	---
Toluene	mg/L	---	7.6	---
Xylene	mg/L	---	1.3	---

Samples analyzed by South Dakota State Health Laboratory
* Unit
umhos: micromhos per centimeter
mg/L: milligrams per liter
** Date of analysis
*** Based on regular gasoline
---: not analyzed

WELL MW-5

Parameter	Unit*	Date Sample Taken and Date Received by Laboratory: 09/30-10/03/86 / 10/03/86	10/27-31/86 / 10/31/86	12/03-10/86 / 12/04-11/86
Benzene	mg/L	0.72	8.6	7.8
Toluene	mg/L	0.18	31	38
Xylene	mg/L	3.1	12	16
Total hydrocarbons	mg/L	19	140	180
Hexane extractables as				
Gasoline	mg/L	---	---	41
Fuel oil No. 1	mg/L	---	---	ND
Fuel oil No. 2	mg/L	---	---	ND
Jet fuel	mg/L	---	---	ND
Ethylene dibromide	mg/L	ND	---	---

Samples analyzed by PACE Laboratories, Inc.
* Unit
mg/L: milligrams per liter
ND: not detected
---: not analyzed

WELL MW-5

Parameter	Unit*	Date Sample Taken and Date Received by Laboratory 10/28/86 10/29/86
Benzene	mg/L	12.000
Ethylbenzene	mg/L	1.200
Toluene	mg/L	32.000
Xylenes, M	mg/L	5.800
Xylenes, O & P	mg/L	6.800
Gasoline	mg/L	32.000
Kerosene	mg/L	ND
Total petroleum hydrocarbons	mg/L	7
Total organic carbon	mg/L	18

Samples analyzed by Rocky Mountain Analytical Laboratory
* Unit
  mg/L: milligrams per liter
ND: not detected

WELL MW-5

Parameter	Unit*	Date Sample Taken and Date Received by Laboratory		
		12/16/86 12/19/86	12/16/86 01/25/87**	01/21/87 01/22/87
Conductivity	umhos	738	---	565
lab pH		7.10	---	---
Alkalinity (P) as CaCO3	mg/L	0	---	0
Alkalinity (T) as CaCO3	mg/L	373	---	272
Bicarbonate	mg/L	455	---	332
Total solids	mg/L	2678	---	17204
Hardness as CaCO3	mg/L	---	---	260
Calcium	mg/L	102	---	72.8
Magnesium	mg/L	24.5	---	19.1
Sodium	mg/L	8.4	---	8.0
Potassium	mg/L	8.3	---	5.1
Chloride	mg/L	7.8	---	11.3
Sulfate	mg/L	15.3	---	19.6
Ammonia as N	mg/L	11.20	---	10.18
Nitrate + Nitrite as N	mg/L	<0.1	---	0.1
Total kjeldahl nitrogen	mg/L	---	---	13.65
Lead	mg/L	0.0034	---	<0.0010
Iron	mg/L	---	---	1280
Manganese	mg/L	---	---	90.2
Total hydro-carbons***	mg/L	---	402	---
Benzene	mg/L	---	24.8	---
Toluene	mg/L	---	6.9	---
Xylene	mg/L	---	1.2	---

Samples analyzed by South Dakota State Health Laboratory
* Unit
umhos: micromhos per centimeter
mg/L: milligrams per liter
** Date of analysis
*** Based on regular gasoline
---: not analyzed

WELL MW-6

Parameter	Unit*	Date Sample Taken and Date Received by Laboratory: 09/30-10/03/86 / 10/03/86	10/27-31/86 / 10/31/86	12/03-10/86 / 12/04-11/86
Benzene	mg/L	0.73	0.58	0.27
Toluene	mg/L	0.26	0.023	0.022
Xylene	mg/L	4.9	0.67	0.29
Total hydrocarbons	mg/L	28	4.3	2.0
Hexane extractables as				
Gasoline	mg/L	---	---	2.0
Fuel oil No. 1	mg/L	---	---	ND
Fuel oil No. 2	mg/L	---	---	ND
Jet fuel	mg/L	---	---	ND

Samples analyzed by PACE Laboratories, Inc.
* Unit
mg/L: milligrams per liter
ND: not detected
---: not analyzed

WELL MW-6

Parameter	Unit*	Date Sample Taken and Date Received by Laboratory 10/29/86 10/31/86
Benzene	mg/L	0.520
Ethylbenzene	mg/L	ND
Toluene	mg/L	0.055
Xylenes, M	mg/L	0.300
Xylenes, O & P	mg/L	0.490
Gasoline	mg/L	4.900
Kerosene	mg/L	3.600
Total petroleum hydrocarbons	mg/L	4
Total organic carbon	mg/L	53

Samples analyzed by Rocky Mountain Analytical Laboratory
* Unit
  mg/L: milligrams per liter
ND: not detected

WELL MW-6

Parameter	Unit*	Date Sample Taken and Date Received by Laboratory		
		12/16/86 12/19/86	12/16/86 01/25/87**	01/21/87 01/22/87
Conductivity	umhos	943	---	1050
lab pH		7.04	---	---
Alkalinity (M) as CaCO3	mg/L	415	---	---
Alkalinity (P) as CaCO3	mg/L	0	---	0
Alkalinity (T) as CaCO3	mg/L	---	---	396
Bicarbonate	mg/L	506	---	483
Total solids	mg/L	---	---	36780
Total dissolved solids	mg/L	600	---	---
Hardness as CaCO3	mg/L	496	---	505
Calcium	mg/L	133	---	131
Magnesium	mg/L	39.9	---	43.3
Sodium	mg/L	12.7	---	14.6
Potassium	mg/L	7.2	---	7.9
Chloride	mg/L	8.1	---	14.6
Sulfate	mg/L	17.0	---	23.0
Ammonia as N	mg/L	---	---	4.85
Nitrate + Nitrite as N	mg/L	20.0	---	36.0
Total kjeldahl nitrogen	mg/L	---	---	5.57
Lead	mg/L	0.0056	---	<0.0010
Iron	mg/L	---	---	5500
Manganese	mg/L	---	---	214
Total hydro-carbons***	mg/L	---	33.5	---
Toluene	mg/L	---	0.06	---
Xylene	mg/L	---	0.07	---

Samples analyzed by South Dakota State Health Laboratory
* Unit
umhos: micromhos per centimeter
mg/L: milligrams per liter
** Date of analysis
*** Based on regular gasoline
---: not analyzed

WELL MW-7

Parameter	Unit*	Date Sample Taken and Date Received by Laboratory: 09/30-10/03/86 10/03/86	Date Sample Taken and Date Received by Laboratory: 10/27-31/86 10/31/86
Benzene	mg/L	14	21
Toluene	mg/L	10	8.6
Xylene	mg/L	9.8	12
Total hydro-carbons	mg/L	140	140
Ethylene dibromide	mg/L	ND	---

Samples analyzed by PACE Laboratories, Inc.
* Unit
mg/L: milligrams per liter
ND: not detected
---: not analyzed

WELL MW-7

Parameter	Unit*	Date Sample Taken and Date Received by Laboratory 10/29/86 10/31/86
Benzene	mg/L	26.000
Ethylbenzene	mg/L	ND
Toluene	mg/L	7.500
Xylenes, M	mg/L	6.800
Xylenes, O & P	mg/L	6.200
Gasoline	mg/L	13.000
Kerosene	mg/L	ND
Total petroleum hydrocarbons	mg/L	3
Total organic carbon	mg/L	155

Samples analyzed by Rocky Mountain Analytical Laboratory
* Unit
mg/L: milligrams per liter
ND: not detected

WELL MW-7

Parameter	Unit*	Date Sample Taken and Date Received by Laboratory 01/21/87 01/22/87
Conductivity	umhos	802
Alkalinity (P) as CaCO3	mg/L	0
Alkalinity (T) as CaCO3	mg/L	340
Bicarbonate	mg/L	415
Total solids	mg/L	11730
Hardness as CaCO3	mg/L	361
Calcium	mg/L	83.1
Magnesium	mg/L	37.2
Sodium	mg/L	11.8
Potassium	mg/L	2.6
Chloride	mg/L	19.4
Sulfate	mg/L	49.3
Ammonia as N	mg/L	0.43
Nitrate + Nitrite as N	mg/L	0.1
Total kjeldahl nitrogen	mg/L	0.76
Lead	mg/L	0.0068
Iron	mg/L	865
Manganese	mg/L	37.5

Samples analyzed by South Dakota State Health Laboratory
* Unit
  umhos: micromhos per centimeter
  mg/L: milligrams per liter

WELL MW-8

Parameter	Unit*	Date Sample Taken and Date Received by Laboratory: 09/30-10/03/86 / 10/03/86	10/27-31/86 / 10/31/86	12/03-10/86 / 12/04-11/86
Benzene	mg/L	14	15	13
Toluene	mg/L	2.1	2.6	0.60
Xylene	mg/L	5.6	7.0	4.3
Total hydro-carbons	mg/L	86	86	63

Samples analyzed by PACE Laboratories, Inc.
* Unit
  mg/L: milligrams per liter
ND: not detected

WELL MW-8

Parameter	Unit*	Date Sample Taken and Date Received by Laboratory 10/29/86 10/31/86
Benzene	mg/L	24.000
Ethylbenzene	mg/L	ND
Toluene	mg/L	2.800
Xylenes, M	mg/L	4.100
Xylenes, O & P	mg/L	4.400
Gasoline	mg/L	12.000
Kerosene	mg/L	ND
Total petroleum hydrocarbons	mg/L	3
Total organic carbon	mg/L	23

Samples analyzed by Rocky Mountain Analytical Laboratory
* Unit
mg/L: milligrams per liter
ND: not detected

WELL MW-8

Parameter	Unit*	Date Sample Taken and Date Received by Laboratory: 12/17/86 12/19/86	12/17/86 01/25/87**
Nitrate + Nitrite as N	mg/L	<0.1	---
Lead	mg/L	0.0052	---
Total hydrocarbons***	mg/L	---	109
Toluene	mg/L	---	1.2
Xylene	mg/L	---	0.14

Samples analyzed by South Dakota State Health Laboratory
* Unit
umhos: micromhos per centimeter
mg/L: milligrams per liter
** Date of analysis
*** Based on regular gasoline
---: not analyzed

WELL MW-9

Parameter	Unit*	Date Sample Taken and Date Received by Laboratory: 09/30-10/03/86 10/03/86	10/27-31/86 10/31/86	12/03-10/86 12/04-11/86
Benzene	mg/L	14	15	16
Toluene	mg/L	20	9.0	1.0
Xylene	mg/L	6.8	9.0	3.5
Total hydro-carbons	mg/L	180	95	73
Ethylene dibromide	mg/L	ND	---	---

Samples analyzed by PACE Laboratories, Inc.
* Unit
mg/L: milligrams per liter
ND: not detected
---: not analyzed

WELL MW-9

Parameter	Unit*	Date Sample Taken and Date Received by Laboratory 10/29/86 10/31/86
Benzene	mg/L	23.000
Ethylbenzene	mg/L	0.460
Toluene	mg/L	13.000
Xylenes, M	mg/L	6.060
Xylenes, O & P	mg/L	4.100
Gasoline	mg/L	13.000
Kerosene	mg/L	ND
Total petroleum hydrocarbons	mg/L	2
Total organic carbon	mg/L	187

Samples analyzed by Rocky Mountain Analytical Laboratory
* Unit
mg/L: milligrams per liter
ND: not detected

WELL MW-9

Parameter	Unit*	Date Sample Taken and Date Received by Laboratory		
		12/17/86 12/19/86	12/17/86 01/25/87**	01/21/87 01/22/87
Conductivity	umhos	821	---	706
lab pH		7.10	---	---
Alkalinity (M) as CaCO3	mg/L	384	---	---
Alkalinity (P) as CaCO3	mg/L	0	---	0
Alkalinity (T) as CaCO3	mg/L	---	---	330
Bicarbonate	mg/L	468	---	403
Total solids	mg/L	---	---	22608
Total dissolved solids	mg/L	519	---	---
Hardness as CaCO3	mg/L	443	---	369
Calcium	mg/L	119	---	101
Magnesium	mg/L	35.4	---	28.3
Sodium	mg/L	10.4	---	11.8
Potassium	mg/L	2.8	---	2.9
Chloride	mg/L	27.8	---	24.9
Sulfate	mg/L	45.6	---	47.4
Ammonia as N	mg/L	---	---	0.87
Nitrate + Nitrite as N	mg/L	0.4	---	0.1
Total kjeldahl nitrogen	mg/L	---	---	1.30
Lead	mg/L	<0.0010	---	0.0025
Iron	mg/L	---	---	1620
Manganese	mg/L	---	---	54.5
Total hydro-carbons***	mg/L	---	22	---
Benzene	mg/L	---	ND	---
Toluene	mg/L	---	0.02	---
Xylene	mg/L	---	0.02	---

Samples analyzed by South Dakota State Health Laboratory
* Unit
umhos: micromhos per centimeter
mg/L: milligrams per liter
** Date of analysis
*** Based on regular gasoline
ND: not detected
---: not analyzed

WELL MW-10

Parameter	Unit*	Date Sample Taken and Date Received by Laboratory: 09/30/-10/03/86 10/03/86	10/27-31/86 10/31/86	12/03-10/86 12/04-11/86
Benzene	mg/L	0.91	4.5	5.2
Toluene	mg/L	0.046	0.73	0.16
Xylene	mg/L	0.084	0.16	0.043
Total hydro-carbons	mg/L	4.2	20	19
Ethylene dibromide	mg/L	ND	---	---

Samples analyzed by PACE Laboratories, Inc.
* Unit
  mg/L: milligrams per liter
ND: not detected
---: not analyzed

WELL MW-10

Parameter	Unit*	Date Sample Taken and Date Received by Laboratory 10/28/86 10/29/86
Gasoline	mg/L	0.590
Kerosene	mg/L	ND
Total petroleum hydrocarbons	mg/L	ND
Total organic carbon	mg/L	42

Samples analyzed by Rocky Mountain Analytical Laboratory
* Unit
  mg/L: milligrams per liter
ND: not detected

WELL MW-10

Parameter	Unit*	Date Sample Taken and Date Received by Laboratory		
		12/16/86 12/19/86	12/16/86 01/25/87**	01/21/87 01/22/87
Conductivity	umhos	912	---	766
lab pH		7.14	---	---
Alkalinity (P) as CaCO3	mg/L	0	---	0
Alkalinity (T) as CaCO3	mg/L	416	---	377
Bicarbonate	mg/L	508	---	460
Total solids	mg/L	5464	---	20998
Hardness as CaCO3	mg/L	450	---	396
Calcium	mg/L	123	---	109
Magnesium	mg/L	34.7	---	30.1
Sodium	mg/L	10.9	---	10.5
Potassium	mg/L	4.7	---	4.8
Chloride	mg/L	17.2	---	15.7
Sulfate	mg/L	40.6	---	44.0
Ammonia as N	mg/L	1.21	---	4.22
Nitrate + Nitrite as N	mg/L	0.3	---	0.3
Total kjeldahl nitrogen	mg/L	---	---	4.42
Lead	mg/L	0.0014	---	<0.0010
Iron	mg/L	---	---	3000
Manganese	mg/L	---	---	251
Total hydro-carbons***	mg/L	---	3.4	---

Samples analyzed by South Dakota State Health Laboratory
* Unit
umhos: micromhos per centimeter
mg/L: milligrams per liter
** Date of analysis
*** Based on regular gasoline
---: not analyzed

WELL MW-11

Parameter	Unit*	Date Sample Taken and Date Received by Laboratory: 09/30-10/03/86 10/03/86	10/27-31/86 10/31/86	12/03-10/86 12/04-11/86
Benzene	mg/L	ND	0.45	ND
Toluene	mg/L	ND	0.077	ND
Xylene	mg/L	0.12	0.28	ND
Total hydrocarbons	mg/L	2.5	5.0	ND
Hexane extractables as Gasoline	mg/L	96	---	---

Samples analyzed by PACE Laboratories, Inc.
* Unit
mg/L: milligrams per liter
ND: not detected
---: not analyzed

WELL MW-11

Parameter	Unit*	Date Sample Taken and Date Received by Laboratory		
		12/16/86 12/19/86	12/17/86 01/25/87**	01/21/87 01/22/87
Conductivity	umhos	624	---	610
lab pH		7.23	---	---
Alkalinity (P) as CaCO3	mg/L	0	---	0
Alkalinity (T) as CaCO3	mg/L	292	---	276
Bicarbonate	mg/L	356	---	337
Total solids	mg/L	2153	---	25283
Hardness as CaCO3	mg/L	333	---	324
Calcium	mg/L	92.8	---	91.7
Magnesium	mg/L	24.5	---	23.2
Sodium	mg/L	6.3	---	5.5
Potassium	mg/L	2.4	---	2.2
Chloride	mg/L	17.0	---	21.5
Sulfate	mg/L	21.0	---	26.9
Ammonia as N	mg/L	<0.02	---	0.05
Nitrate + Nitrite as N	mg/L	3.5	---	4.0
Total kjeldahl nitrogen	mg/L	---	---	0.24
Lead	mg/L	0.0103	---	<0.0010
Iron	mg/L	---	---	5040
Manganese	mg/L	---	---	420
Total hydro-carbons***	mg/L	---	0.2	---

Samples analyzed by South Dakota State Health Laboratory
* Unit
umhos: micromhos per centimeter
mg/L: milligrams per liter
** Date of analysis
*** Based on gasoline
---: not analyzed

WELL MW-12

Parameter	Unit*	Date Sample Taken and Date Received by Laboratory: 09/30-10/03/86 — 10/03/86	10/27-31/86 — 10/31/86	12/03-10/86 — 12/04-11/86
Benzene	mg/L	ND	0.003	ND
Toluene	mg/L	ND	ND	ND
Xylene	mg/L	ND	ND	ND
Total hydro-carbons	mg/L	ND	0.04	ND
Ethylene dibromide	mg/L	ND	---	---

Samples analyzed by PACE Laboratories, Inc.
* Unit
  mg/L: milligrams per liter
ND: not detected
---: not analyzed

WELL MW-12

Parameter	Unit*	Date Sample Taken and Date Received by Laboratory 10/28/86 10/29/86
Total petroleum hydrocarbons	mg/L	ND
Total organic carbon	mg/L	3.0

Samples analyzed by Rocky Mountain Analytical Laboratory
* Unit
  mg/L: milligrams per liter
ND: not detected

WELL MW-12

Parameter	Unit*	Date Sample Taken and Date Received by Laboratory 01/21/87 01/22/87
Conductivity	umhos	598
Alkalinity (P) as CaCO3	mg/L	0
Alkalinity (T) as CaCO3	mg/L	317
Bicarbonate	mg/L	387
Total solids	mg/L	36465
Hardness as CaCO3	mg/L	324
Calcium	mg/L	88.2
Magnesium	mg/L	25.2
Sodium	mg/L	11.7
Potassium	mg/L	2.8
Chloride	mg/L	22.6
Sulfate	mg/L	<10.0
Ammonia as N	mg/L	0.17
Nitrate + Nitrite as N	mg/L	0.5
Total kjeldahl nitrogen	mg/L	0.41
Lead	mg/L	<0.0010
Iron	mg/L	1760
Manganese	mg/L	166

Samples analyzed by South Dakota State Health Laboratory
* Unit
  umhos: micromhos per centimeter
  mg/L: milligrams per liter

WELL MW-13

Parameter	Unit*	Date Sample Taken and Date Received by Laboratory: 09/30-10/03/86 10/03/86	10/27-31/86 10/31/86	12/03-10/86 12/04-11/86
Benzene	mg/L	ND	ND	ND
Toluene	mg/L	ND	ND	ND
Xylene	mg/L	0.012	ND	ND
Total hydro-carbons	mg/L	0.15	ND	ND

Samples analyzed by PACE Laboratories, Inc.
* Unit
  mg/L: milligrams per liter
ND: not detected

WELL MW-13

Parameter	Unit*	Date Sample Taken and Date Received by Laboratory 10/28/86 10/29/86
Total petroleum hydrocarbons	mg/L	ND
Total organic carbon	mg/L	198

Samples analyzed by Rocky Mountain Analytical Laboratory
* Unit
mg/L: milligrams per liter
ND: not detected

WELL MW-13

Parameter	Unit*	Date Sample Taken and Date Received by Laboratory 01/21/87 01/22/87
Conductivity	umhos	1001
Alkalinity (P) as CaCO3	mg/L	0
Alkalinity (T) as CaCO3	mg/L	344
Bicarbonate	mg/L	420
Total solids	mg/L	30243
Hardness as CaCO3	mg/L	457
Calcium	mg/L	109
Magnesium	mg/L	45.0
Sodium	mg/L	13.0
Potassium	mg/L	3.2
Chloride	mg/L	17.5
Sulfate	mg/L	71.3
Ammonia as N	mg/L	0.02
Nitrate + Nitrite as N	mg/L	15.2
Total kjeldahl nitrogen	mg/L	0.56
Lead	mg/L	0.0026
Iron	mg/L	1620
Manganese	mg/L	99.8

Samples analyzed by South Dakota State Health Laboratory
* Unit
  umhos: micromhos per centimeter
  mg/L: milligrams per liter

WELL MW-14

Parameter	Unit*	Date Sample Taken and Date Received by Laboratory: 09/30-10/03/86 10/03/86	10/27-31/86 10/31/86	12/03-10/86 12/04-11/86
Benzene	mg/L	21	18	17
Toluene	mg/L	35	36	34
Xylene	mg/L	16	14	14
Total hydro-carbons	mg/L	290	190	210
Hexane extract-ables as				
Gasoline	mg/L	---	---	56
Fuel oil No. 1	mg/L	---	---	ND
Fuel oil No. 2	mg/L	---	---	ND
Jet fuel	mg/L	---	---	ND

Samples analyzed by PACE Laboratories, Inc.
* Unit
  mg/L: milligrams per liter
ND: not detected
---: not analyzed

WELL MW-14

Parameter	Unit*	Date Sample Taken and Date Received by Laboratory: 10/29/86 10/31/86	02/04/87 02/06/87
Total petroleum hydrocarbons	mg/L	12	---
Total organic carbon	mg/L	40	---
C10-C32 hydrocarbons	mg/L	---	ND
Gasoline	mg/L	---	200.000

Samples analyzed by Rocky Mountain Analytical Laboratory
* Unit
  mg/L: milligrams per liter
ND: not detected
---: not analyzed

WELL MW-14

Parameter	Unit*	Date Sample Taken and Date Received by Laboratory		
		12/17/86 12/19/86	12/17/86 01/25/87**	01/22/87 01/22/87
Conductivity	umhos	792	---	761
lab pH		7.26	---	---
Alkalinity (M) as CaCO3	mg/L	422	---	---
Alkalinity (P) as CaCO3	mg/L	0	---	0
Alkalinity (T) as CaCO3	mg/L	---	---	370
Bicarbonate	mg/L	515	---	451
Total solids	mg/L	---	---	21496
Total dissolved solids	mg/L	519	---	---
Hardness as CaCO3	mg/L	434	---	375
Calcium	mg/L	116	---	98.5
Magnesium	mg/L	35.1	---	31.3
Sodium	mg/L	12.2	---	13.0
Potassium	mg/L	5.3	---	5.0
Chloride	mg/L	29.2	---	12.0
Sulfate	mg/L	23.8	---	23.8
Ammonia as N	mg/L	---	---	2.54
Nitrate + Nitrite as N	mg/L	<0.1	---	0.1
Total kjeldahl nitrogen	mg/L	---	---	3.19
Lead	mg/L	0.0010	---	<0.0010
Iron	mg/L	---	---	2100
Manganese	mg/L	---	---	106
Total hydro-carbons***	mg/L	---	446	---
Benzene	mg/L	---	18.7	---
Toluene	mg/L	---	7.2	---
Xylene	mg/L	---	3.2	---

Samples analyzed by South Dakota State Health Laboratory
* Unit
umhos: micromhos per centimeter
mg/L: milligrams per liter
** Date of analysis
*** Based on regular gasoline
---: not analyzed

WELL MW-15

Parameter	Unit*	Date Sample Taken and Date Received by Laboratory: 09/30-10/03/86 10/03/86	10/27-31/86 10/31/86	12/03-10/86 12/04-11/86
Benzene	mg/L	ND	0.001	3.0
Toluene	mg/L	0.002	ND	0.042
Xylene	mg/L	0.004	ND	0.71
Total hydro-carbons	mg/L	0.06	0.02	13

Samples analyzed by PACE Laboratories, Inc.
* Unit
  mg/L: milligrams per liter
ND: not detected

WELL MW-15

Parameter	Unit*	Date Sample Taken and Date Received by Laboratory 10/28/86 10/29/86
Total petroleum hydrocarbons	mg/L	ND
Total organic carbon	mg/L	5.3

Samples analyzed by Rocky Mountain Analytical Laboratory
* Unit
  mg/L: milligrams per liter
ND: not detected

WELL MW-15

Parameter	Unit*	Date Sample Taken and Date Received by Laboratory 01/21/87 01/22/87
Conductivity	umhos	885
Alkalinity (P) as CaCO3	mg/L	0
Alkalinity (T) as CaCO3	mg/L	420
Bicarbonate	mg/L	512
Total solids	mg/L	2797
Hardness as CaCO3	mg/L	506
Calcium	mg/L	132
Magnesium	mg/L	42.8
Sodium	mg/L	10.2
Potassium	mg/L	3.3
Chloride	mg/L	14.9
Sulfate	mg/L	46.2
Ammonia as N	mg/L	0.05
Nitrate + Nitrite as N	mg/L	6.4
Total kjeldahl nitrogen	mg/L	0.46
Lead	mg/L	<0.0010
Iron	mg/L	129
Manganese	mg/L	5.95

Samples analyzed by South Dakota State Health Laboratory
* Unit
  umhos: micromhos per centimeter
  mg/L: milligrams per liter

WELL MW-16

Parameter	Unit*	Date Sample Taken and Date Received by Laboratory: 09/30-10/03/86 10/03/86	10/27-31/86 10/31/86	12/03-10/86 12/04-11/86
Benzene	mg/L	0.005	ND	0.90
Toluene	mg/L	0.015	ND	0.010
Xylene	mg/L	0.13	ND	0.022
Total hydro-carbons	mg/L	0.15	ND	3.1

Samples analyzed by PACE Laboratories, Inc.
* Unit
  mg/L: milligrams per liter
ND: not detected

WELL MW-16

Parameter	Unit*	Date Sample Taken and Date Received by Laboratory			
		12/17/86	12/17/86	01/21/87	01/21/87
		12/19/86	01/25/87**	01/22/87	01/22/87
Conductivity	umhos	984	---	891	949
lab pH		7.18	---	---	---
Alkalinity (P) as CaCO3	mg/L	0	---	0	0
Alkalinity (T) as CaCO3	mg/L	420	---	443	388
Bicarbonate	mg/L	512	---	540	473
Total solids	mg/L	4619	---	14329	13131
Hardness as CaCO3	mg/L	521	---	505	457
Calcium	mg/L	128	---	124	105
Magnesium	mg/L	48.9	---	47.4	47.4
Sodium	mg/L	13.1	---	12.4	12.4
Potassium	mg/L	3.2	---	3.1	2.8
Chloride	mg/L	11.5	---	13.7	14.6
Sulfate	mg/L	37.9	---	35.7	36.3
Ammonia as N	mg/L	0.02	---	0.06	0.06
Nitrate + Nitrite as N	mg/L	18.8	---	10.8	10.9
Total kjeldahl nitrogen	mg/L	---	---	0.74	0.74
Lead	mg/L	0.0117	---	0.0026	0.0030
Iron	mg/L	---	---	50.0	519
Manganese	mg/L	---	---	2.72	26.9
Gasoline	mg/L	---	<0.01	---	---

Samples analyzed by South Dakota State Health Laboratory
* Unit
  umhos: micromhos per centimeter
  mg/L: milligrams per liter
** Date of analysis
---: not analyzed

WELL MW-17

Parameter	Unit*	Date Sample Taken and Date Received by Laboratory: 09/30-10/03/86 10/03/86	10/27-31/86 10/31/86	12/03-10/86 12/04-11/86
Benzene	mg/L	ND	15	16
Toluene	mg/L	0.004	1.8	0.69
Xylene	mg/L	0.013	6.8	7.6
Total hydro-carbons	mg/L	0.07	88	85

Samples analyzed by PACE Laboratories, Inc.
* Unit
mg/L: milligrams per liter
ND: not detected

WELL MW-17

Parameter	Unit*	Date Sample Taken and Date Received by Laboratory 01/21/87 01/22/87
Conductivity	umhos	774
Alkalinity (P) as CaCO3	mg/L	0
Alkalinity (T) as CaCO3	mg/L	397
Bicarbonate	mg/L	484
Total solids	mg/L	16638
Hardness as CaCO3	mg/L	424
Calcium	mg/L	108
Magnesium	mg/L	37.6
Sodium	mg/L	12.4
Potassium	mg/L	3.0
Chloride	mg/L	13.5
Sulfate	mg/L	34.8
Ammonia as N	mg/L	<0.02
Nitrate + Nitrite as N	mg/L	0.1
Total kjeldahl nitrogen	mg/L	0.68
Lead	mg/L	<0.0010
Iron	mg/L	1140
Manganese	mg/L	32.5

Samples analyzed by South Dakota State Health Laboratory
* Unit
  umhos: micromhos per centimeter
  mg/L: milligrams per liter

WELL MW-18

Parameter	Unit*	Date Sample Taken and Date Received by Laboratory: 10/27-31/86, 10/31/86	Date Sample Taken and Date Received by Laboratory: 12/03-10/86, 12/04-11/86
Benzene	mg/L	ND	0.003
Toluene	mg/L	ND	0.001
Xylene	mg/L	ND	ND
Total hydro-carbons	mg/L	ND	0.01

Samples analyzed by PACE Laboratories, Inc.
* Unit
  mg/L: milligrams per liter
ND: not detected

WELL MW-18

Parameter	Unit*	Date Sample Taken and Date Received by Laboratory		
		12/17/86 12/19/86	12/17/86 01/25/87**	01/22/87 01/22/87
Conductivity	umhos	927	---	1231
lab pH		7.36	---	---
Alkalinity (P) as CaCO3	mg/L	0	---	0
Alkalinity (T) as CaCO3	mg/L	241	---	215
Bicarbonate	mg/L	294	---	262
Total solids	mg/L	84430	---	219962
Hardness as CaCO3	mg/L	456	---	562
Calcium	mg/L	115	---	129
Magnesium	mg/L	41.0	---	58.3
Sodium	mg/L	25.1	---	23.5
Potassium	mg/L	4.8	---	6.5
Chloride	mg/L	34.0	---	25.7
Sulfate	mg/L	40.4	---	55.3
Ammonia as N	mg/L	0.22	---	0.18
Nitrate + Nitrite as N	mg/L	54.0	---	93.0
Total kjeldahl nitrogen	mg/L	---	---	0.36
Lead	mg/L	<0.0010	---	<0.0010
Iron	mg/L	---	---	7580
Manganese	mg/L	---	---	410
Gasoline	mg/L	---	ND	---

Samples analyzed by South Dakota State Health Laboratory
* Unit
  umhos: micromhos per centimeter
  mg/L: milligrams per liter
** Date of analysis
ND: not detected
---: not analyzed

WELL MW-19

Parameter	Unit*	Date Sample Taken and Date Received by Laboratory: 10/27-31/86 / 10/31/86	12/03-10/86 / 12/04-11/86
Benzene	mg/L	ND	0.005
Toluene	mg/L	ND	0.004
Xylene	mg/L	ND	ND
Total hydrocarbons	mg/L	ND	0.03

Samples analyzed by PACE Laboratories, Inc.
* Unit
  mg/L: milligrams per liter
ND: not detected

WELL MW-19

Parameter	Unit*	Date Sample Taken and Date Received by Laboratory: 12/17/86 01/25/87**	01/21/86 01/22/87
Conductivity	umhos	---	708
Alkalinity (P) as CaCO3	mg/L	---	0
Alkalinity (T) as CaCO3	mg/L	---	213
Bicarbonate	mg/L	---	260
Total solids	mg/L	---	143816
Hardness as CaCO3	mg/L	---	370
Calcium	mg/L	---	88.5
Magnesium	mg/L	---	36.2
Sodium	mg/L	---	19.2
Potassium	mg/L	---	5.6
Chloride	mg/L	---	28.6
Sulfate	mg/L	---	156
Ammonia as N	mg/L	---	0.07
Nitrate + Nitrite as N	mg/L	---	0.3
Total kjeldahl nitrogen	mg/L	---	1.43
Lead	mg/L	---	<0.0010
Iron	mg/L	---	3770
Manganese	mg/L	---	186
Gasoline	mg/L	<0.1	---

Samples analyzed by South Dakota State Health Laboratory
* Unit
  umhos: micromhos per centimeter
  mg/L: milligrams per liter
** Date of analysis
---: not analyzed

WELL MW-20

Parameter	Unit*	Date Sample Taken and Date Received by Laboratory: 10/27-31/86 / 10/31/86	12/03-10/86 / 12/04-11/86
Benzene	mg/L	28	16
Toluene	mg/L	47	41
Xylene	mg/L	22	22
Total hydrocarbons	mg/L	300	280
Hexane extractables as			
Gasoline	mg/L	---	58
Fuel oil No. 1	mg/L	---	ND
Fuel oil No. 2	mg/L	---	ND
Jet fuel	mg/L	---	ND

Samples analyzed by PACE Laboratories, Inc.
* Unit
mg/L: milligrams per liter
ND: not detected
---: not analyzed

WELL MW-20

Parameter	Unit*	Date Sample Taken and Date Received by Laboratory		
		12/17/86 12/19/86	12/17/86 01/25/87**	01/21/87 01/22/87
Conductivity	umhos	821	---	867
lab pH		7.06	---	---
Alkalinity (M) as CaCO3	mg/L	392	---	---
Alkalinity (P) as CaCO3	mg/L	0	---	0
Alkalinity (T) as CaCO3	mg/L	---	---	356
Bicarbonate	mg/L	478	---	434
Total solids	mg/L	---	---	20973
Hardness as CaCO3	mg/L	456	---	348
Calcium	mg/L	126	---	85.5
Magnesium	mg/L	34.3	---	32.6
Sodium	mg/L	13.6	---	11.9
Potassium	mg/L	4.0	---	4.7
Chloride	mg/L	14.2	---	10.1
Sulfate	mg/L	42.9	---	40.2
Ammonia as N	mg/L	---	---	2.72
Nitrate + Nitrite as N	mg/L	1.9	---	2.4
Total kjeldahl nitrogen	mg/L	---	---	3.76
Lead	mg/L	<0.0010	---	<0.0010
Iron	mg/L	---	---	1200
Manganese	mg/L	---	---	58.0
Total hydro-carbons***	mg/L	---	446	---
Benzene	mg/L	---	2.5	---
Toluene	mg/L	---	7.2	---
Xylene	mg/L	---	1.6	---

Samples analyzed by South Dakota State Health Laboratory
* Unit
umhos: micromhos per centimeter
mg/L: milligrams per liter
** Date of analysis
*** Based on regular gasoline
---: not analyzed

WELL F-1

Parameter	Unit*	Date Sample Taken and Date Received by Laboratory: 10/27-31/86 10/31/86	12/03-10/86 12/04-11/86
Benzene	mg/L	0.008	2.5
Toluene	mg/L	ND	ND
Xylene	mg/L	ND	0.18
Total hydrocarbons	mg/L	0.03	8.8
Hexane extractables as			
Gasoline	mg/L	---	ND
Fuel oil No. 1	mg/L	---	ND
Fuel oil No. 2	mg/L	ND	ND
Jet fuel	mg/L	---	ND

Samples analyzed by PACE Laboratories, Inc.
* Unit
mg/L: milligrams per liter
ND: not detected
---: not analyzed

WELL F-2

Parameter	Unit*	Date Sample Taken and Date Received by Laboratory: 10/27-31/86 10/31/86	12/03-10/86 12/04-11/86
Benzene	mg/L	0.022	2.8
Toluene	mg/L	ND	0.016
Xylene	mg/L	ND	0.85
Total hydrocarbons	mg/L	0.57	12
Hexane extractables as			
Gasoline	mg/L	---	ND
Fuel oil No. 1	mg/L	---	ND
Fuel oil No. 2	mg/L	ND	ND
Jet fuel	mg/L	---	ND

Samples analyzed by PACE Laboratories, Inc.
* Unit
mg/L: milligrams per liter
ND: not detected
---: not analyzed

WELL F-3

Parameter	Unit*	Date Sample Taken and Date Received by Laboratory: 10/27-31/86 / 10/31/86	Date Sample Taken and Date Received by Laboratory: 12/03-10/86 / 12/04-11/86
Benzene	mg/L	0.006	4.9
Toluene	mg/L	ND	ND
Xylene	mg/L	0.007	0.20
Total hydrocarbons	mg/L	0.19	16
Hexane extractables as			
Gasoline	mg/L	---	ND
Fuel oil No. 1	mg/L	---	ND
Fuel oil No. 2	mg/L	ND	ND
Jet fuel	mg/L	---	ND

Samples analyzed by PACE Laboratories, Inc.
* Unit
mg/L: milligrams per liter
ND: not detected
---: not analyzed

WELL F-4

Parameter	Unit*	Date Sample Taken and Date Received by Laboratory: 10/27-31/86 / 10/31/86	12/03-10/86 / 12/04-11/86
Benzene	mg/L	ND	3.5
Toluene	mg/L	ND	0.017
Xylene	mg/L	0.002	2.9
Total hydro-carbons	mg/L	0.02	19
Hexane extract-ables as			
Gasoline	mg/L	---	ND
Fuel oil No. 1	mg/L	---	ND
Fuel oil No. 2	mg/L	ND	ND
Jet fuel	mg/L	---	ND

Samples analyzed by PACE Laboratories, Inc.
* Unit
mg/L: milligrams per liter
ND: not detected
---: not analyzed

WELL F-4

Parameter	Unit*	Date Sample Taken and Date Received by Laboratory 10/27/86 10/28/86
Total petroleum hydrocarbons	mg/L	ND
Total organic carbon	mg/L	9.0

Samples analyzed by Rocky Mountain Analytical Laboratory
* Unit
  mg/L: milligrams per liter
  ND: not detected

Darryl's Auto Shop

Parameter	Unit*	Date Sample Taken and Date Received by Laboratory 08/18-19/86 08/20/86
Benzene	mg/L	ND
Toluene	mg/L	ND
Xylene	mg/L	ND
Total hydro-carbons	mg/L	ND

Samples analyzed by PACE Laboratories, Inc.
* Unit
  mg/L: milligrams per liter
ND: not detected

Darryl's Auto Shop

Parameter	Unit*	Date Sample Taken and Date Received by Laboratory: 06/05/86 06/06/86	Date Sample Taken and Date Received by Laboratory: 06-05-86 ?
Conductivity	umhos	638	---
lab pH		7.32	---
Total dissolved solids	mg/L	372	---
Calcium	mg/L	71.2	---
Magnesium	mg/L	22.9	---
Sodium	mg/L	8.6	---
Potassium	mg/L	2.7	---
Chloride	mg/L	14.0	---
Sulfate	mg/L	46.9	---
Iron	mg/L	0.03	---
Manganese	mg/L	0.04	---
Arsenic	mg/L	<0.0010	---
Barium	mg/L	0.077	---
Cadmium	mg/L	<0.0010	---
Chromium	mg/L	<0.0010	---
Lead	mg/L	0.0035	---
Mercury	mg/L	<0.0002	---
Nitrate + Nitrite as N	mg/L	1.7	---
Total hydrocarbons**	mg/L	---	<0.05

Samples analyzed by South Dakota State Health Laboratory
* Unit
umhos: micromhos per centimeter
mg/L: milligrams per liter
** Based on gasoline and No. 2 diesel
---: not analyzed

Dubbe (inside tap)

Parameter	Unit*	Date Sample Taken and Date Received by Laboratory 06/03/86 06/05/86
Benzene	mg/L	<0.001
Toluene	mg/L	<0.001
Xylene	mg/L	<0.001
Total hydro-carbons	mg/L	<0.01

Samples analyzed by PACE Laboratories, Inc.
* Unit
mg/L: milligrams per liter

Dubbe (outside tap, 6-inch well)

Parameter	Unit*	Date Sample Taken and Date Received by Laboratory 06/03/86 06/05/86
Benzene	mg/L	0.17
Toluene	mg/L	0.33
Xylene	mg/L	0.070
Total hydro-carbons	mg/L	2.2

Samples analyzed by PACE Laboratories, Inc.
* Unit
mg/L: milligrams per liter

Hayward Elementary School

Parameter	Unit*	Date Sample Taken and Date Received by Laboratory: 12/08/83 12/19/83	05/29/84 ?	07/18/84 ?
Conductivity	umhos	1231	---	---
lab pH		7.41	---	---
Alkalinity (M) as CaCO3	mg/L	387	---	---
Bicarbonate	mg/L	472	---	---
Total dissolved solids	mg/L	815	---	---
Hardness as CaCO3	mg/L	623	---	---
Calcium	mg/L	161	---	---
Magnesium	mg/L	53.8	---	---
Sodium	mg/L	19.2	---	---
Potassium	mg/L	5.9	---	---
Chloride	mg/L	25.0	---	---
Sulfate	mg/L	272	---	---
Nitrate as N	mg/L	0.4	14.2	21.0
Nitrite as N	mg/L	0.05	---	---
Iron	mg/L	<0.02	---	---
Manganese	mg/L	0.69	---	---
Fluoride	mg/L	0.22	---	---

Samples analyzed by South Dakota State Health Laboratory
* Unit
  umhos: micromhos per centimeter
  mg/L: milligrams per liter
---: not analyzed

Kenobbie

Parameter	Unit*	Date Sample Taken and Date Received by Laboratory: 09/30-10/03/86 10/03/86	10/27-31/86 10/31-11/03-86	12/03-10/86 12/04-11/86
Benzene	mg/L	ND	0.002	ND
Toluene	mg/L	ND	ND	ND
Xylene	mg/L	ND	ND	ND
Total hydrocarbons	mg/L	0.01	0.04	ND
Hexane extractables	mg/L	---	ND	---

Samples analyzed by PACE Laboratories, Inc.
* Unit
  mg/L: milligrams per liter
ND: not detected
---: not analyzed

Kenobbie

Parameter	Unit*	Date Sample Taken and Date Received by Laboratory		
		06/05/86 06/06/86	06/05/86 06/27/86**	01/23/87 01/24/87
Conductivity	umhos	1012	---	806
Alkalinity (P) as CaCO3	mg/L	---	---	0
Alkalinity (T) as CaCO3	mg/L	---	---	327
Bicarbonate	mg/L	---	---	399
Total solids	mg/L	---	---	547
Total dissolved solids	mg/L	612	---	---
Hardness as CaCO3	mg/L	---	---	423
Calcium	mg/L	110	---	106
Magnesium	mg/L	39.0	---	38.5
Sodium	mg/L	12.3	---	11.1
Potassium	mg/L	4.2	---	4.0
Chloride	mg/L	23.6	---	22.5
Sulfate	mg/L	116	---	92.6
Ammonia as N	mg/L	---	---	0.04
Nitrate + Nitrite as N	mg/L	1.6	---	1.4
Total kjeldahl nitrogen	mg/L	---	---	0.15
Lead	mg/L	<0.0010	---	<0.0010
Iron	mg/L	0.01	---	0.26
Manganese	mg/L	0.52	---	0.65
Arsenic	mg/L	<0.0010	---	---
Barium	mg/L	0.113	---	---
Cadmium	mg/L	<0.0010	---	---
Chromium	mg/L	<0.0010	---	---
Mercury	mg/L	<0.0002	---	---
Total hydro-carbons***	mg/L	---	0.05	---

Samples analyzed by South Dakota State Health Laboratory
* Unit
umhos: micromhos per centimeter
mg/L: milligrams per liter
** Date of analysis
*** Based on gasoline and No. 2 diesel
---: not analyzed

M & W Bait Shop

Parameter	Unit*	Date Sample Taken and Date Received by Laboratory 06/09-11/86 06/12/86
Benzene	mg/L	0.001
Toluene	mg/L	0.008
Xylene	mg/L	0.010
Total hydro-carbons	mg/L	0.14

Samples analyzed by PACE Laboratories, Inc.
* Unit
  mg/L: milligrams per liter

Westwick Motel

Parameter	Unit*	Date Sample Taken and Date Received by Laboratory 08/18-19/86 08/20/86
Benzene	mg/L	ND
Toluene	mg/L	ND
Xylene	mg/L	ND
Total hydro-carbons	mg/L	ND

Samples analyzed by PACE Laboratories, Inc.
* Unit
  mg/L: milligrams per liter
ND: not detected

Westwick Motel (Well no. 1)

Parameter	Unit*	Date Sample Taken and Date Received by Laboratory: 09/30-10/03/86 10/03/86	12/03-10/86 12/04-11/86
Benzene	mg/L	ND	ND
Toluene	mg/L	ND	ND
Xylene	mg/L	ND	ND
Total hydro-carbons	mg/L	ND	ND

Samples analyzed by PACE Laboratories, Inc.
* Unit
  mg/L: milligrams per liter
ND: not detected

Westwick Motel (Well no. 2)

Parameter	Unit*	Date Sample Taken and Date Received by Laboratory: 09/30-10/03/86 10/03/86	12/03-10/86 12/04-11/86
Benzene	mg/L	ND	ND
Toluene	mg/L	ND	ND
Xylene	mg/L	ND	ND
Total hydro-carbons	mg/L	ND	ND

Samples analyzed by PACE Laboratories, Inc.
* Unit
  mg/L: milligrams per liter
ND: not detected

Westwick Motel

Parameter	Unit*	Date Sample Taken and Date Received by Laboratory: 06/05/86 06/27/86**	01/23/87 01/24/87
Conductivity	umhos	---	772
Alkalinity (P) as CaCO3	mg/L	---	0
Alkalinity (T) as CaCO3	mg/L	---	329
Bicarbonate	mg/L	---	401
Total solids	mg/L	---	538
Hardness as CaCO3	mg/L	---	422
Calcium	mg/L	---	107
Magnesium	mg/L	---	37.6
Sodium	mg/L	---	10.4
Potassium	mg/L	---	4.0
Chloride	mg/L	---	21.5
Sulfate	mg/L	---	84.2
Ammonia as N	mg/L	---	0.06
Nitrate + Nitrite as N	mg/L	---	2.6
Total kjeldahl nitrogen	mg/L	---	0.19
Lead	mg/L	---	<0.0010
Iron	mg/L	---	0.26
Manganese	mg/L	---	0.74
Total hydro-carbons***	mg/L	<0.05	---

Samples analyzed by South Dakota State Health Laboratory
* Unit
umhos: micromhos per centimeter
mg/L: milligrams per liter
** Date of analysis
*** Based on gasoline and No. 2 diesel
---: not analyzed

APPENDIX B

LOGS OF DEPARTMENT OF WATER AND NATURAL RESOURCES TEST HOLES AND MONITORING WELLS

LEGAL LOCATION and LOCATION

The logs are listed by smallest township number, then the smallest range number, the smallest section number, and then by quarter section: NE = A; NW = B; SW = C; SE = D. A comparison of **LEGAL LOCATION** and **LOCATION** is as follows. A **LEGAL LOCATION** of NW SE NE SW sec. 30, T. 99 N., R. 64 W. is the same as a **LOCATION** of 099N-64W-30CADB.

LATITUDE and LONGITUDE

The format is **DD.MMSS** where **D** is degrees, **M** is minutes, and **S** is seconds.

DRILLING COMPANY

SDGS is an abbreviation for South Dakota Geological Survey. **DOT** is an abbreviation for Department of Transportation.

TOTAL DRILL HOLE DEPTH and SCREEN LENGTH

The numbers are presented in feet.

SCREEN TYPE and CASING TYPE

PVC is an abbreviation for polyvinylchloride. **MFG.** is an abbreviation for "manufactured" and indicates a product that is commercially available. **SCH.** is an abbreviation for "schedule" and refers to casing thickness.

CASING TOP ELEVATION and GROUND SURFACE ELEVATION

The numbers are presented in feet above mean sea level. **I** - the elevation was determined using a surveying instrument. The elevations were surveyed to the nearest 0.01 foot. **T** - the elevation was estimated from 7 1/2-minute series topographic map.

CASING DIAMETER

The numbers are presented in inches.

COUNTY: MINNEHAHA LOCATION: 101N-50W-14DCCA
LEGAL LOCATION: NE SW SW SE SEC. 14, T. 101 N., R. 50 W.
LATITUDE: 43.3241 LONGITUDE: 96.4757
LAND OWNER:
PROJECT: WILLIAMS PIPE LINE
DRILLING COMPANY: SDGS
DRILLER: D. IVERSON DRILLER'S LOG:
GEOLOGIST: D. ILES GEOLOGIST'S LOG: X
DATE DRILLED: 12-08-1986 DRILLING METHOD: HOLLOWSTEM
GROUND SURFACE ELEVATION: 1432.45 I
TOTAL DRILL HOLE DEPTH: 15.0 TEST HOLE NUMBER: R20-86-76
WATER RIGHTS WELL: SDGS WELL NAME: R20-86-76
OTHER WELL NAME:
BASIN: BIG SIOUX AQUIFER: BIG SIOUX
MANAGEMENT UNIT: SOUTHERN SKUNK CREEK
SCREEN TYPE: PVC, MFG. SCREEN LENGTH: 10.4
CASING TYPE: PVC, SCH. 80 CASING DIAMETER: 2.0
CASING TOP ELEVATION: 1434.65 I
CASING STICK-UP: 2.20 TOTAL CASING AND SCREEN: 16.9
WELL MAINTENANCE DATE:
USGS HYDROLOGICAL UNIT CODE: 10170203
ELECTRIC LOG INFORMATION:
SPONTANEOUS POTENTIAL: SINGLE POINT RESISTIVITY:
NATURAL GAMMA: EXTRA:
SAMPLES: X

LITHOLOGIC DESCRIPTIONS ARE BASED PRIMARILY ON RECOVERY FROM SPLIT-BARREL SAMPLES WHICH WERE TAKEN CONTINUOUSLY FROM LAND SURFACE TO BOTTOM OF DRILL HOLE. THE SPLIT-BARREL SAMPLER WAS 30 INCHES LONG AND 3 INCHES IN DIAMETER.

0	-	1.8	CLAY, BLACK, SILTY (TOPSOIL)
1.8	-	2.4	CLAY, BROWN, SANDY; NONCALCAREOUS
2.4	-	13.0	SAND AND GRAVEL, YELLOWISH-BROWN TO REDDISH-BROWN, MEDIUM SAND TO MEDIUM PEBBLE GRAVEL, SOME VERY COARSE PEBBLE GRAVEL, CLAYEY, POORLY SORTED; OXIDIZED, SECONDARY WHITE CARBONATE, SLIGHT FUEL ODOR 5-7.5 FT, SLIGHT PAINT THINNER ODOR 10-12.5 FT, WET BELOW 7.5 FT
13.0	-	15.0	CLAY, LIGHT-GRAY, SANDY; CALCAREOUS, PORTIONS ARE OXIDIZED TO YELLOW-BROWN, INTERVAL MAY BE PREDOMINANTLY SAND SINCE VERY LITTLE RECOVERY WAS OBTAINED

* * * *

COUNTY: MINNEHAHA LOCATION: 101N-50W-14DCCC
LEGAL LOCATION: SW SW SW SE SEC. 14, T. 101 N., R. 50 W.
LATITUDE: 43.3240 LONGITUDE: 96.4758

LAND OWNER: WILLIAMS PIPE LINE
PROJECT: WILLIAMS PIPE LINE
DRILLING COMPANY: SDGS
DRILLER: D. IVERSON DRILLER'S LOG:
GEOLOGIST: D. ILES GEOLOGIST'S LOG: X
DATE DRILLED: 11-06-1986 DRILLING METHOD: HOLLOWSTEM
GROUND SURFACE ELEVATION: 1436.00 T
TOTAL DRILL HOLE DEPTH: 20.0 TEST HOLE NUMBER: R20-86-74
WATER RIGHTS WELL: SDGS WELL NAME: R20-86-74
OTHER WELL NAME:
BASIN: BIG SIOUX AQUIFER: BIG SIOUX
MANAGEMENT UNIT: SOUTHERN SKUNK CREEK
SCREEN TYPE: PVC, MFG. SCREEN LENGTH: 10.4
CASING TYPE: PVC, SCH. 80 CASING DIAMETER: 2.0
CASING TOP ELEVATION: 1438.23 I
CASING STICK-UP: 2.60 TOTAL CASING AND SCREEN: 18.6
WELL MAINTENANCE DATE:
USGS HYDROLOGICAL UNIT CODE: 10170203
ELECTRIC LOG INFORMATION:
SPONTANEOUS POTENTIAL: SINGLE POINT RESISTIVITY:
NATURAL GAMMA: EXTRA:
SAMPLES: X

LITHOLOGIC DESCRIPTIONS ARE BASED PRIMARILY ON RECOVERY FROM SPLIT-BARREL SAMPLES WHICH WERE TAKEN CONTINUOUSLY FROM LAND SURFACE TO BOTTOM OF DRILL HOLE. THE SPLIT-BARREL SAMPLER WAS 30-INCHES LONG BY 3-INCH DIAMETER.

0	-	1.0	TOPSOIL, BLACK
1.0	-	4.5	CLAY, YELLOWISH-BROWN
4.5	-	8.8	SAND, BROWN, MEDIUM TO VERY COARSE; WITH SOME VERY FINE PEBBLE GRAVEL, GASOLINE ODOR
8.8	-	17.5	SAND AND GRAVEL, GRAY-BROWN, MEDIUM SAND TO MEDIUM PEBBLE GRAVEL; PRIMARILY SAND NEAR TOP WITH AN INCREASE IN GRAVEL SIZE AND CONTENT WITH DEPTH, GASOLINE ODOR
17.5	-	20.0	CLAY, GRAY TO GRAY-BROWN, PEBBLY; SLIGHT GASOLINE ODOR

* * * *

COUNTY: MINNEHAHA LOCATION: 101N-50W-14DCCC 1
LEGAL LOCATION: SW SW SW SE SEC. 14, T. 101 N., R. 50 W.
LATITUDE: 43.3238 LONGITUDE: 96.4759
LAND OWNER:
PROJECT: WILLIAMS PIPE LINE
DRILLING COMPANY: SDGS
DRILLER: D. IVERSON DRILLER'S LOG:

GEOLOGIST: D. ILES GEOLOGIST'S LOG: X
DATE DRILLED: 12-08-1986 DRILLING METHOD: HOLLOWSTEM
GROUND SURFACE ELEVATION: 1436.35 I
TOTAL DRILL HOLE DEPTH: 20.0 TEST HOLE NUMBER: R20-86-75
WATER RIGHTS WELL: SDGS WELL NAME: R20-86-75
OTHER WELL NAME:
BASIN: BIG SIOUX AQUIFER: BIG SIOUX
MANAGEMENT UNIT: SOUTHERN SKUNK CREEK
SCREEN TYPE: PVC, MFG. SCREEN LENGTH: 10.4
CASING TYPE: PVC, SCH. 80 CASING DIAMETER: 2.0
CASING TOP ELEVATION: 1438.25 I
CASING STICK-UP: 1.90 TOTAL CASING AND SCREEN: 20.5
WELL MAINTENANCE DATE:
USGS HYDROLOGICAL UNIT CODE: 10170203
ELECTRIC LOG INFORMATION:
SPONTANEOUS POTENTIAL: SINGLE POINT RESISTIVITY:
NATURAL GAMMA: EXTRA:
SAMPLES: X

LITHOLOGIC DESCRIPTIONS ARE BASED PRIMARILY ON

RECOVERY FROM SPLIT-BARREL SAMPLES WHICH WERE TAKEN CONTINUOUSLY FROM LAND SURFACE TO BOTTOM OF DRILL HOLE. THE SPLIT-BARREL SAMPLER WAS 30 INCHES LONG AND 3 INCHES IN DIAMETER.

0	-	1.7	CLAY, BLACK, SILTY (TOPSOIL)
1.7	-	3.8	CLAY, BROWN, SILTY; NONCALCAREOUS
3.8	-	17.5	SAND AND GRAVEL, YELLOWISH-BROWN TO REDDISH-BROWN, MEDIUM SAND TO MEDIUM PEBBLE GRAVEL, SOME COARSE TO VERY COARSE PEBBLE GRAVEL, VERY CLAYEY, POORLY SORTED; HIGHLY OXIDIZED, WATER AT 14.6 FEET, DRILLER REPORTS GAS SMELL FROM 12.5 TO 17.5 FEET
17.5	-	19.0	SAND, BROWN, VERY FINE TO COARSE, CLAYEY, MODERATELY SORTED; COAL FRAGMENTS, DRILLER REPORTS GAS ODOR
19.0	-	20.0	CLAY, GRAY, SILTY TO SANDY

* * * *

COUNTY: MINNEHAHA LOCATION: 101N-50W-23ABAB
LEGAL LOCATION: NW NE NW NE SEC. 23, T. 101 N., R. 50 W.
LATITUDE: 43.3235 LONGITUDE: 96.4753
LAND OWNER:
PROJECT: WILLIAMS PIPE LINE
DRILLING COMPANY: SDGS
DRILLER: D. IVERSON DRILLER'S LOG:
GEOLOGIST: D. ILES GEOLOGIST'S LOG: X
DATE DRILLED: 12-11-1986 DRILLING METHOD: HOLLOWSTEM

GROUND SURFACE ELEVATION: 1437.13 I
TOTAL DRILL HOLE DEPTH: 11.5 TEST HOLE NUMBER: R20-86-83
USGS HYDROLOGICAL UNIT CODE: 10170203
ELECTRIC LOG INFORMATION:
SPONTANEOUS POTENTIAL: SINGLE POINT RESISTIVITY:
NATURAL GAMMA: EXTRA:
SAMPLES: X

LITHOLOGIC DESCRIPTIONS ARE BASED PRIMARILY ON RECOVERY FROM SPLIT-BARREL SAMPLES WHICH WERE TAKEN CONTINUOUSLY FROM LAND SURFACE TO BOTTOM OF DRILL HOLE. THE SPLIT-BARREL SAMPLER WAS 30 INCHES LONG AND 3 INCHES IN DIAMETER.

0 -	2.0	CLAY, BLACK, SILTY (TOPSOIL)
2.0 -	4.0	CLAY, BROWN, SILTY; NONCALCAREOUS
4.0 -	5.0	SAND, YELLOWISH-BROWN, MEDIUM TO VERY COARSE, GRAVELLY, MODERATELY SORTED; OXIDIZED
5.0 -	11.5	SAND AND GRAVEL, YELLOWISH-BROWN TO REDDISH-BROWN, MEDIUM SAND TO COARSE PEBBLE GRAVEL, CLAYEY, POORLY SORTED; HIGHLY OXIDIZED, HIT ROCK AT 11.5 AND COULD NOT PENETRATE FURTHER

NO DRILLER'S LOG AVAILABLE - LOG FROM SAMPLE DESCRIPTIONS ONLY.

* * * *

COUNTY: MINNEHAHA LOCATION: 101N-50W-23ABBA
LEGAL LOCATION: NE NW NW NE SEC. 23, T. 101 N., R. 50 W.
LATITUDE: 43.3236 LONGITUDE: 96.4758
LAND OWNER:
PROJECT: WILLIAMS PIPE LINE
DRILLING COMPANY: SDGS
DRILLER: D. IVERSON DRILLER'S LOG:
GEOLOGIST: D. ILES GEOLOGIST'S LOG: X
DATE DRILLED: 12-09-1986 DRILLING METHOD: HOLLOWSTEM
GROUND SURFACE ELEVATION: 1438.15 I
TOTAL DRILL HOLE DEPTH: 17.5 TEST HOLE NUMBER: R20-86-77
USGS HYDROLOGICAL UNIT CODE: 10170203
ELECTRIC LOG INFORMATION:
SPONTANEOUS POTENTIAL: SINGLE POINT RESISTIVITY:
NATURAL GAMMA: EXTRA:
SAMPLES: X

LITHOLOGIC DESCRIPTIONS ARE BASED PRIMARILY ON RECOVERY FROM SPLIT-BARREL SAMPLES WHICH WERE TAKEN CONTINUOUSLY FROM LAND SURFACE TO BOTTOM OF DRILL HOLE. THE SPLIT-BARREL SAMPLER WAS 30 INCHES LONG AND 3 INCHES IN DIAMETER.

0	-	2.5	FILL AND ASPHALT
2.5	-	5.0	CLAY, BROWN, SILTY; NONCALCAREOUS, OXIDIZED
5.0	-	9.5	SAND, BROWN, MEDIUM TO VERY COARSE, CONTAINS SOME VERY FINE PEBBLE GRAVEL, WELL-SORTED; OXIDIZED
9.5	-	10.5	SAND, YELLOWISH-BROWN TO REDDISH-BROWN, MEDIUM TO VERY COARSE; CONTAINS SOME VERY FINE TO FINE PEBBLE GRAVEL, WELL-SORTED; HIGHLY OXIDIZED, DRILLER REPORTS GAS ODOR
10.5	-	17.4	SAND AND GRAVEL, YELLOWISH-BROWN, MEDIUM SAND TO COARSE PEBBLE GRAVEL, CLAYEY, MODERATELY SORTED; OXIDIZED, ROCK LAYER AT 10.4 FT, WHITE CLAY LAYERS AT 15 FT, WATER AT 16.9 FT, LARGE ROCKS AT 15.4 AND 17.2 FT, PAINT THINNER AND ROTTEN GAS ODOR FROM 15 TO 17.4 FEET
17.4	-	17.5	ROCK; COULD NOT PENETRATE

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COUNTY: MINNEHAHA LOCATION: 101N-50W-23ABBA 1
LEGAL LOCATION: NE NW NW NE SEC. 23, T. 101 N., R. 50 W.
LATITUDE: 43.3236 LONGITUDE: 96.4758
LAND OWNER:
PROJECT: WILLIAMS PIPE LINE
DRILLING COMPANY: SDGS
DRILLER: D. IVERSON DRILLER'S LOG:
GEOLOGIST: D. ILES GEOLOGIST'S LOG: X
DATE DRILLED: 12-09-1986 DRILLING METHOD: HOLLOWSTEM
GROUND SURFACE ELEVATION: 1438.24 I
TOTAL DRILL HOLE DEPTH: 17.2 TEST HOLE NUMBER: R20-86-78
USGS HYDROLOGICAL UNIT CODE: 10170203
ELECTRIC LOG INFORMATION:
SPONTANEOUS POTENTIAL: SINGLE POINT RESISTIVITY:
NATURAL GAMMA: EXTRA:
SAMPLES: X

LITHOLOGIC DESCRIPTIONS ARE BASED PRIMARILY ON RECOVERY FROM SPLIT-BARREL SAMPLES WHICH WERE TAKEN CONTINUOUSLY FROM LAND SURFACE TO BOTTOM OF DRILL HOLE. THE SPLIT-BARREL SAMPLER WAS 30 INCHES LONG AND 3 INCHES IN DIAMETER.

0	-	3.0	CLAY, BLACK, SILTY (TOPSOIL)
3.0	-	5.0	CLAY, BROWN; NONCALCAREOUS
5.0	-	17.2	SAND AND GRAVEL, YELLOWISH-BROWN, MEDIUM SAND TO COARSE PEBBLE GRAVEL, CLAYEY, POORLY SORTED; OXIDIZED, FAINT PAINT THINNER ODOR 10-12.5 FT, ROTTEN GAS

ODOR 12.5-15 FT, AND STRONG GAS ODOR 15-17.2 FT, WET AT 17 FT; HIT ROCK AT 17.2 FT, COULD NOT PENETRATE

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COUNTY: MINNEHAHA LOCATION: 101N-50W-23ABBA 2
LEGAL LOCATION: NE NW NW NE SEC. 23, T. 101 N., R. 50 W.
LATITUDE: 43.3234 LONGITUDE: 96.4755
LAND OWNER:
PROJECT: WILLIAMS PIPE LINE
DRILLING COMPANY: SDGS
DRILLER: D. IVERSON DRILLER'S LOG:
GEOLOGIST: D. ILES GEOLOGIST'S LOG: X
DATE DRILLED: 12-10-1986 DRILLING METHOD: HOLLOWSTEM
GROUND SURFACE ELEVATION: 1436.43 I
TOTAL DRILL HOLE DEPTH: 11.5 TEST HOLE NUMBER: R20-86-80
USGS HYDROLOGICAL UNIT CODE: 10170203
ELECTRIC LOG INFORMATION:
SPONTANEOUS POTENTIAL: SINGLE POINT RESISTIVITY:
NATURAL GAMMA: EXTRA:
SAMPLES: X

LITHOLOGIC DESCRIPTIONS ARE BASED PRIMARILY ON RECOVERY FROM SPLIT-BARREL SAMPLES WHICH WERE TAKEN CONTINUOUSLY FROM LAND SURFACE TO BOTTOM OF DRILL HOLE. THE SPLIT-BARREL SAMPLER WAS 30 INCHES LONG AND 3 INCHES IN DIAMETER.

0	-	2.5	CLAY, BLACK, SILTY; NONCALCAREOUS (TOPSOIL)
2.5	-	4.5	CLAY, BROWN; NONCALCAREOUS
4.5	-	5.0	SAND, YELLOW-BROWN, MEDIUM TO VERY COARSE, WELL-SORTED
5.0	-	7.5	SAND AND GRAVEL, YELLOWISH-BROWN TO REDDISH-BROWN, COARSE SAND TO FINE PEBBLE GRAVEL, SOME MEDIUM TO COARSE PEBBLE GRAVEL, POORLY SORTED; OXIDIZED, HIGHLY OXIDIZED ZONE AT 6.4 FT, CONTAINS MANY FRIABLE GRANITE PEBBLES THAT CRUMBLE TO GIVE SAND A WHITE APPEARANCE
7.5	-	10.0	SAND AND GRAVEL, DARK-YELLOWISH-BROWN, COARSE SAND TO COARSE PEBBLE GRAVEL, CLAYEY, POORLY SORTED; HIGHLY OXIDIZED
10.0	-	11.5	NO SAMPLE; HIT ROCK AT 11.5 FEET, COULD NOT PENETRATE

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COUNTY: MINNEHAHA LOCATION: 101N-50W-23ABBA 3

LEGAL LOCATION: NE NW NW NE SEC. 23, T. 101 N., R. 50 W.
LATITUDE: 43.3235 LONGITUDE: 96.4753
LAND OWNER:
PROJECT: WILLIAMS PIPE LINE
DRILLING COMPANY: SDGS
DRILLER: D. IVERSON DRILLER'S LOG:
GEOLOGIST: D. ILES GEOLOGIST'S LOG: X
DATE DRILLED: 12-11-1986 DRILLING METHOD: HOLLOWSTEM
GROUND SURFACE ELEVATION: 1437.50 I
TOTAL DRILL HOLE DEPTH: 14.7 TEST HOLE NUMBER: R20-86-84
USGS HYDROLOGICAL UNIT CODE: 10170203
ELECTRIC LOG INFORMATION:
SPONTANEOUS POTENTIAL: SINGLE POINT RESISTIVITY:
NATURAL GAMMA: EXTRA:
SAMPLES: X

LITHOLOGIC DESCRIPTIONS ARE BASED PRIMARILY ON RECOVERY FROM SPLIT-BARREL SAMPLES WHICH WERE TAKEN CONTINUOUSLY FROM LAND SURFACE TO BOTTOM OF DRILL HOLE. THE SPLIT-BARREL SAMPLER WAS 30 INCHES LONG AND 3 INCHES IN DIAMETER.

0	-	2.3	CLAY, BLACK, SILTY (TOPSOIL)
2.3	-	4.0	CLAY, BROWN, SILTY; NONCALCAREOUS
4.0	-	14.7	SAND AND GRAVEL, YELLOWISH-BROWN, MEDIUM SAND TO COARSE PEBBLE GRAVEL, SILTY TO CLAYEY, POORLY SORTED; OXIDIZED, WET AT 14.4 FEET, HIT ROCK AT 14.7 FEET, COULD NOT PENETRATE FURTHER

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COUNTY: MINNEHAHA LOCATION: 101N-50W-23ABBA 4
LEGAL LOCATION: NE NW NW NE SEC. 23, T. 101 N., R. 50 W.
LATITUDE: 43.3235 LONGITUDE: 96.4753
LAND OWNER:
PROJECT: WILLIAMS PIPE LINE
DRILLING COMPANY: SDGS
DRILLER: D. IVERSON DRILLER'S LOG:
GEOLOGIST: D. ILES GEOLOGIST'S LOG: X
DATE DRILLED: 12-11-1986 DRILLING METHOD: HOLLOWSTEM
GROUND SURFACE ELEVATION: 1437.52 I
TOTAL DRILL HOLE DEPTH: 14.7 TEST HOLE NUMBER: R20-86-85
USGS HYDROLOGICAL UNIT CODE: 10170203
ELECTRIC LOG INFORMATION:
SPONTANEOUS POTENTIAL: SINGLE POINT RESISTIVITY:
NATURAL GAMMA: EXTRA:
SAMPLES:

THIS HOLE IS A REDRILL OF HOLE R20-86-84.
DRILLING TERMINATED BY ROCKS AT SAME DEPTH

(14.7 FEET).

0	-	2.3	CLAY, BLACK, SILTY (TOPSOIL)
2.3	-	4.0	CLAY, BROWN, SILTY; NONCALCAREOUS
4.0	-	14.7	SAND AND GRAVEL, YELLOWISH-BROWN, MEDIUM SAND TO COARSE PEBBLE GRAVEL, SILTY TO CLAYEY, POORLY SORTED; OXIDIZED, HIT ROCK AT 14.7 FEET, COULD NOT PENETRATE FURTHER

NO SAMPLES TAKEN. LOG TAKEN FROM R20-86-84.

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COUNTY: MINNEHAHA LOCATION: 101N-50W-23ABBB
LEGAL LOCATION: NW NW NW NE SEC. 23, T. 101 N., R. 50 W.
LATITUDE: 43.3237 LONGITUDE: 96.4800
LAND OWNER:
PROJECT: WILLIAMS PIPE LINE
DRILLING COMPANY: DOT
DRILLER: K. NEYHART DRILLER'S LOG:
GEOLOGIST: M. MEYER GEOLOGIST'S LOG: X
DATE DRILLED: 12-09-1986 DRILLING METHOD: HOLLOWSTEM
GROUND SURFACE ELEVATION: 1436.94 I
TOTAL DRILL HOLE DEPTH: 20.0 TEST HOLE NUMBER:
WATER RIGHTS WELL: SDGS WELL NAME:
OTHER WELL NAME: DOT-1
BASIN: BIG SIOUX AQUIFER: BIG SIOUX
MANAGEMENT UNIT: SOUTHERN SKUNK CREEK
SCREEN TYPE: PVC, MFG. SCREEN LENGTH: 10.4
CASING TYPE: PVC, SCH. 80 CASING DIAMETER: 2.0
CASING TOP ELEVATION: 1439.64 I
CASING STICK-UP: 2.70 TOTAL CASING AND SCREEN: 21.7
WELL MAINTENANCE DATE:
USGS HYDROLOGICAL UNIT CODE: 10170203
ELECTRIC LOG INFORMATION:
SPONTANEOUS POTENTIAL: SINGLE POINT RESISTIVITY:
NATURAL GAMMA: EXTRA:
SAMPLES: X

LITHOLOGIC DESCRIPTIONS ARE BASED PRIMARILY ON RECOVERY FROM SPLIT-BARREL SAMPLES WHICH WERE TAKEN CONTINUOUSLY FROM LAND SURFACE TO BOTTOM OF DRILL HOLE. THE SPLIT-BARREL SAMPLER WAS 24 INCHES LONG AND 2 INCHES IN DIAMETER.

0	-	2.0	ASPHALT AND CLAY, DARK-GRAY CLAY; WITH SAND AND GRAVEL (PAVED AREA)
2.0	-	3.3	CLAY, BROWN, SILTY; NONCALCAREOUS, MOIST
3.3	-	12.0	SAND, BROWN TO YELLOWISH-BROWN, FINE TO VERY COARSE, SILTY, GRAVELLY, WELL-

		SORTED; BROWN CLAY FROM 8.7 TO 8.9 AND 10.5 TO 10.6 FEET, FAINT PETROLEUM ODOR FROM 8 TO 12 FEET
12.0 -	14.0	SAND AND GRAVEL, YELLOWISH-BROWN, MEDIUM SAND TO COARSE PEBBLE GRAVEL, SILTY; CONTAINS BOULDERS, HARD DRIVING, OXIDIZED, FAINT PETROLEUM ODOR
14.0 -	16.0	GRAVEL, YELLOWISH-BROWN, VERY FINE TO MEDIUM PEBBLES, SANDY, CLAYEY; OXIDIZED, SATURATED, STRONG PETROLEUM ODOR
16.0 -	20.0	SAND AND GRAVEL, YELLOWISH-BROWN TO REDDISH-BROWN, VERY COARSE SAND TO MEDIUM PEBBLE GRAVEL, CLAYEY; HIGHLY OXIDIZED, SATURATED, FAINT PETROLEUM ODOR FROM 18 TO 20 FEET

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COUNTY: MINNEHAHA LOCATION: 101N-50W-23ABBB 1
LEGAL LOCATION: NW NW NW NE SEC. 23, T. 101 N., R. 50 W.
LATITUDE: 43.3236 LONGITUDE: 96.4801
LAND OWNER:
PROJECT: WILLIAMS PIPE LINE
DRILLING COMPANY: SDGS
DRILLER: D. IVERSON DRILLER'S LOG:
GEOLOGIST: D. ILES GEOLOGIST'S LOG: X
DATE DRILLED: 12-09-1986 DRILLING METHOD: HOLLOWSTEM
GROUND SURFACE ELEVATION: 1435.46 I
TOTAL DRILL HOLE DEPTH: 22.5 TEST HOLE NUMBER: R20-86-79
WATER RIGHTS WELL: SDGS WELL NAME: R20-86-79
OTHER WELL NAME:
BASIN: BIG SIOUX AQUIFER: BIG SIOUX
MANAGEMENT UNIT: SOUTHERN SKUNK CREEK
SCREEN TYPE: PVC, MFG. SCREEN LENGTH: 10.4
CASING TYPE: PVC, SCH. 80 CASING DIAMETER: 2.0
CASING TOP ELEVATION: 1437.46 I
CASING STICK-UP: 2.00 TOTAL CASING AND SCREEN: 21.4
WELL MAINTENANCE DATE:
USGS HYDROLOGICAL UNIT CODE: 10170203
ELECTRIC LOG INFORMATION:
SPONTANEOUS POTENTIAL: SINGLE POINT RESISTIVITY:
NATURAL GAMMA: EXTRA:
SAMPLES: X

LITHOLOGIC DESCRIPTIONS ARE BASED PRIMARILY ON RECOVERY FROM SPLIT-BARREL SAMPLES WHICH WERE TAKEN CONTINUOUSLY FROM LAND SURFACE TO BOTTOM OF DRILL HOLE. THE SPLIT-BARREL SAMPLER WAS 30 INCHES LONG AND 3 INCHES IN DIAMETER.

0	-	1.6	CLAY, BLACK, SILTY (TOPSOIL)
1.6	-	4.4	CLAY, BROWN, SILTY, VERY SANDY; NON-CALCAREOUS, OXIDIZED
4.4	-	7.0	SAND, YELLOWISH-BROWN, MEDIUM TO COARSE, GRAVELLY, CLAYEY, WELL-SORTED; OXIDIZED
7.0	-	22.5	SAND AND GRAVEL, YELLOWISH-BROWN, MEDIUM SAND TO COARSE PEBBLE GRAVEL, CLAYEY, POORLY SORTED; OXIDIZED, COBBLE GRAVEL ZONE AT 7 FT, WET AT 15 FT, NO SAMPLE 15-17.5 FT, ROTTEN GAS ODOR 17.5-20 FEET

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COUNTY: MINNEHAHA LOCATION: 101N-50W-23ABBB 2
LEGAL LOCATION: NW NW NW NE SEC. 23, T. 101 N., R. 50 W.
LATITUDE: 43.3235 LONGITUDE: 96.4755
LAND OWNER:
PROJECT: WILLIAMS PIPE LINE
DRILLING COMPANY: SDGS
DRILLER: D. IVERSON DRILLER'S LOG:
GEOLOGIST: D. ILES GEOLOGIST'S LOG: X
DATE DRILLED: 12-10-1986 DRILLING METHOD: HOLLOWSTEM
GROUND SURFACE ELEVATION: 1436.57 I
TOTAL DRILL HOLE DEPTH: 25.0 TEST HOLE NUMBER: R20-86-82
WATER RIGHTS WELL: SDGS WELL NAME: R20-86-82
OTHER WELL NAME:
BASIN: BIG SIOUX AQUIFER: BIG SIOUX
MANAGEMENT UNIT: SOUTHERN SKUNK CREEK
SCREEN TYPE: PVC, MFG. SCREEN LENGTH: 10.4
CASING TYPE: PVC, SCH. 80 CASING DIAMETER: 2.0
CASING TOP ELEVATION: 1438.67 I
CASING STICK-UP: 2.10 TOTAL CASING AND SCREEN: 26.0
WELL MAINTENANCE DATE:
USGS HYDROLOGICAL UNIT CODE: 10170203
ELECTRIC LOG INFORMATION:
SPONTANEOUS POTENTIAL: SINGLE POINT RESISTIVITY:
NATURAL GAMMA: EXTRA:
SAMPLES: X

LITHOLOGIC DESCRIPTIONS ARE BASED PRIMARILY ON RECOVERY FROM SPLIT-BARREL SAMPLES WHICH WERE TAKEN CONTINUOUSLY FROM LAND SURFACE TO BOTTOM OF DRILL HOLE. THE SPLIT-BARREL SAMPLER WAS 30 INCHES LONG AND 3 INCHES IN DIAMETER.

0	-	3.0	CLAY, BLACK, SILTY (TOPSOIL)
3.0	-	4.3	CLAY, BROWN, VERY SANDY; CALCAREOUS
4.3	-	17.5	SAND AND GRAVEL, YELLOWISH-BROWN, COARSE SAND TO FINE PEBBLE GRAVEL, WITH SOME MEDIUM TO COARSE PEBBLE GRAVEL, CLAYEY,

		MODERATELY SORTED; OXIDIZED NOT CLAYEY FROM 5 TO 7.5 FEET, DAMP BELOW 12.1 FEET, COBBLE GRAVEL FROM 12.1 TO 17.5 FEET
17.5 -	20.0	CLAY, YELLOWISH-BROWN TO GREENISH-YELLOW, SANDY TO PEBBLY; SLIGHTLY CALCAREOUS, OXIDIZED, PAINT THINNER ODOR, WET BELOW 19.7 FEET
20.0 -	25.0	GRAVEL, YELLOWISH-BROWN, VERY FINE TO MEDIUM PEBBLE GRAVEL, SILTY TO SANDY, CLAYEY, POORLY SORTED; OXIDIZED, HIGHLY OXIDIZED FROM 22.5 TO 25 FEET, CONTAINS WATER, PAINT THINNER ODOR

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COUNTY: MINNEHAHA LOCATION: 101N-50W-23ABBB 3
LEGAL LOCATION: NW NW NW NE SEC. 23, T. 101 N., R. 50 W.
LATITUDE: 43.3235 LONGITUDE: 96.4800
LAND OWNER:
PROJECT: WILLIAMS PIPE LINE
DRILLING COMPANY: SDGS
DRILLER: D. IVERSON DRILLER'S LOG:
GEOLOGIST: D. ILES GEOLOGIST'S LOG: X
DATE DRILLED: 12-12-1986 DRILLING METHOD: HOLLOWSTEM
GROUND SURFACE ELEVATION: 1435.79 I
TOTAL DRILL HOLE DEPTH: 20.0 TEST HOLE NUMBER: R20-86-86
WATER RIGHTS WELL: SDGS WELL NAME: R20-86-86
OTHER WELL NAME:
BASIN: BIG SIOUX AQUIFER: BIG SIOUX
MANAGEMENT UNIT: SOUTHERN SKUNK CREEK
SCREEN TYPE: PVC, MFG. SCREEN LENGTH: 10.4
CASING TYPE: PVC, SCH. 80 CASING DIAMETER: 2.0
CASING TOP ELEVATION: 1437.79 I
CASING STICK-UP: 2.00 TOTAL CASING AND SCREEN: 21.8
WELL MAINTENANCE DATE:
USGS HYDROLOGICAL UNIT CODE: 10170203
ELECTRIC LOG INFORMATION:
SPONTANEOUS POTENTIAL: SINGLE POINT RESISTIVITY:
NATURAL GAMMA: EXTRA:
SAMPLES: X

LITHOLOGIC DESCRIPTIONS ARE BASED PRIMARILY ON RECOVERY FROM SPLIT-BARREL SAMPLES WHICH WERE TAKEN CONTINUOUSLY FROM LAND SURFACE TO BOTTOM OF DRILL HOLE. THE SPLIT-BARREL SAMPLER WAS 30 INCHES LONG AND 3 INCHES IN DIAMETER.

0 -	2.5	CLAY, BLACK, SILTY (TOPSOIL)
2.5 -	4.6	CLAY, BROWN, SILTY; NONCALCAREOUS
4.6 -	7.5	SAND AND GRAVEL, YELLOWISH-BROWN, MEDIUM

		SAND TO MEDIUM PEBBLE GRAVEL, SOME COARSE PEBBLE GRAVEL, SILTY TO CLAYEY, POORLY SORTED; OXIDIZED
7.5 -	10.0	SAND, YELLOWISH-BROWN, COARSE TO VERY COARSE, GRAVELLY, WELL-SORTED; OXIDIZED, CLEAN
10.0 -	17.5	SAND AND GRAVEL, YELLOWISH-BROWN, MEDIUM SAND TO MEDIUM PEBBLE GRAVEL, SOME VERY COARSE PEBBLE GRAVEL, SILTY TO CLAYEY, POORLY SORTED; OXIDIZED, PAINT THINNER ODOR 12.5 TO 15 FEET, ROTTEN GAS ODOR FROM 15 TO 17.5 FEET, WATER BELOW 16.71 FEET
17.5 -	20.0	GRAVEL, YELLOWISH-BROWN, VERY FINE TO MEDIUM PEBBLE GRAVEL, SANDY, CLAYEY, MODERATELY SORTED; OXIDZIED, ROTTEN GAS ODOR 17.5 TO 18 FEET

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COUNTY: MINNEHAHA LOCATION: 101N-50W-23ABBB 4
LEGAL LOCATION: NW NW NW NE SEC. 23, T. 101 N., R. 50 W.
LATITUDE: 43.3238 LONGITUDE: 96.4759
LAND OWNER:
PROJECT: WILLIAMS PIPE LINE
DRILLING COMPANY: SDGS
DRILLER: L. SCHULZ DRILLER'S LOG:
GEOLOGIST: D. ILES GEOLOGIST'S LOG: X
DATE DRILLED: 12-19-1986 DRILLING METHOD: AUGER
GROUND SURFACE ELEVATION: 1435.00 T
TOTAL DRILL HOLE DEPTH: 18.0 TEST HOLE NUMBER: A2-86-379
USGS HYDROLOGICAL UNIT CODE: 10170203
ELECTRIC LOG INFORMATION:
SPONTANEOUS POTENTIAL: SINGLE POINT RESISTIVITY:
NATURAL GAMMA: EXTRA:
SAMPLES:

0 -	2.0	CLAY, BLACK (TOPSOIL)
2.0 -	3.0	CLAY, BROWN, SILTY
3.0 -	5.5	SAND, REDDISH-BROWN, FINE TO MEDIUM
5.5 -	7.4	SAND AND GRAVEL; FAINT PETROLEUM ODOR
7.4 -	13.0	SAND AND GRAVEL; WEATHERED GASOLINE ODOR
13.0 -	18.0	SAND AND GRAVEL; STRONG GASOLINE AND PAINT THINNER ODOR

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COUNTY: MINNEHAHA LOCATION: 101N-50W-23ABBC

LEGAL LOCATION: SW NW NW NE SEC. 23, T. 101 N., R. 50 W.
LATITUDE: 43.3234 LONGITUDE: 96.4758
LAND OWNER:
PROJECT: WILLIAMS PIPE LINE
DRILLING COMPANY: DOT
DRILLER: K. NEYHART DRILLER'S LOG:
GEOLOGIST: M. MEYER GEOLOGIST'S LOG: X
DATE DRILLED: 12-09-1986 DRILLING METHOD: HOLLOWSTEM
GROUND SURFACE ELEVATION: 1435.45 I
TOTAL DRILL HOLE DEPTH: 21.0 TEST HOLE NUMBER:
WATER RIGHTS WELL: SDGS WELL NAME:
OTHER WELL NAME: DOT-2
BASIN: BIG SIOUX AQUIFER: BIG SIOUX
MANAGEMENT UNIT: SOUTHERN SKUNK CREEK
SCREEN TYPE: PVC, MFG. SCREEN LENGTH: 10.4
CASING TYPE: PVC, SCH. 80 CASING DIAMETER: 2.0
CASING TOP ELEVATION: 1438.05 I
CASING STICK-UP: 2.60 TOTAL CASING AND SCREEN: 22.8
WELL MAINTENANCE DATE:
USGS HYDROLOGICAL UNIT CODE: 10170203
ELECTRIC LOG INFORMATION:
SPONTANEOUS POTENTIAL: SINGLE POINT RESISTIVITY:
NATURAL GAMMA: EXTRA:
SAMPLES: X

LITHOLOGIC DESCRIPTIONS ARE BASED PRIMARILY ON RECOVERY FROM SPLIT-BARREL SAMPLES WHICH WERE TAKEN CONTINUOUSLY FROM LAND SURFACE TO BOTTOM OF DRILL HOLE. THE SPLIT-BARREL SAMPLER WAS 24 INCHES LONG AND 2 INCHES IN DIAMETER.

0	-	2.0	CLAY, DARK- TO LIGHT-BROWN, SILTY (TOPSOIL)
2.0	-	2.8	SILT AND CLAY, LIGHT-BROWN; MOIST
2.8	-	6.0	SAND, BROWN, MEDIUM TO VERY COARSE, GRAVELLY, SILTY, MODERATELY SORTED; OXIDIZED
6.0	-	14.0	SAND AND GRAVEL, YELLOWISH-BROWN, MEDIUM SAND TO COARSE PEBBLE GRAVEL, CLAYEY, POORLY SORTED; OXIDIZED, DARK-RED SANDY CLAY 6.3 TO 6.4 FEET, MOIST, PETROLEUM ODOR 8 TO 10 FEET, HNU READING IN SAMPLE JAR ABOUT 15 PPM
14.0	-	19.0	GRAVEL, YELLOWISH-BROWN TO REDDISH-BROWN, VERY FINE TO COARSE PEBBLES, VERY SANDY, CLAYEY, POORLY SORTED; HIGHLY OXIDIZED, WET AT 15.4 FEET, GRAY-BROWN CLAY 18.3 TO 18.5 FEET
19.0	-	21.0	SAND AND GRAVEL, YELLOWISH-BROWN TO RED-DISH-BROWN, COARSE SAND TO MEDIUM PEBBLE GRAVEL, VERY CLAYEY; HIGHLY OXIDIZED, POORLY SORTED, GRAY-BROWN CLAY LAYER 20.3 TO 20.7 FEET

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COUNTY: MINNEHAHA LOCATION: 101N-50W-23ABBC 1
LEGAL LOCATION: SW NW NW NE SEC. 23, T. 101 N., R. 50 W.
LATITUDE: 43.3232 LONGITUDE: 96.4758
LAND OWNER:
PROJECT: WILLIAMS PIPE LINE
DRILLING COMPANY: DOT
DRILLER: K. NEYHART DRILLER'S LOG:
GEOLOGIST: M. MEYER GEOLOGIST'S LOG: X
DATE DRILLED: 12-10-1986 DRILLING METHOD: HOLLOWSTEM
GROUND SURFACE ELEVATION: 1434.77 I
TOTAL DRILL HOLE DEPTH: 20.0 TEST HOLE NUMBER:
WATER RIGHTS WELL: SDGS WELL NAME:
OTHER WELL NAME: DOT-3
BASIN: BIG SIOUX AQUIFER: BIG SIOUX
MANAGEMENT UNIT: SOUTHERN SKUNK CREEK
SCREEN TYPE: PVC, MFG. SCREEN LENGTH: 10.4
CASING TYPE: PVC, SCH. 80 CASING DIAMETER: 2.0
CASING TOP ELEVATION: 1437.27 I
CASING STICK-UP: 2.50 TOTAL CASING AND SCREEN: 22.4
WELL MAINTENANCE DATE:
USGS HYDROLOGICAL UNIT CODE: 10170203
ELECTRIC LOG INFORMATION:
SPONTANEOUS POTENTIAL: SINGLE POINT RESISTIVITY:
NATURAL GAMMA: EXTRA:
SAMPLES: X

LITHOLOGIC DESCRIPTIONS ARE BASED PRIMARILY ON RECOVERY FROM SPLIT-BARREL SAMPLES WHICH WERE TAKEN CONTINUOUSLY FROM LAND SURFACE TO BOTTOM OF DRILL HOLE. THE SPLIT-BARREL SAMPLER WAS 24 INCHES LONG AND 2 INCHES IN DIAMETER.

0 -	2.0	CLAY, DARK-BROWN, SILTY (TOPSOIL)
2.0 -	3.5	CLAY, MEDIUM-BROWN, SILTY; NO SAMPLE FROM 0 TO 4 FEET
3.5 -	6.0	SAND AND GRAVEL, YELLOWISH-BROWN TO REDDISH-BROWN, MEDIUM SAND TO COARSE PEBBLE GRAVEL, SILTY, POORLY SORTED; HIGHLY OXIDIZED, DRY
6.0 -	10.0	ROCKS; NO SAMPLE, COULD NOT DRIVE SAMPLER
10.0 -	12.0	SAND AND GRAVEL, YELLOWISH-BROWN, MEDIUM SAND TO VERY FINE PEBBLE GRAVEL, MODERATELY SORTED; OXIDIZED, DRY
12.0 -	14.0	SAND, YELLOWISH-BROWN, MEDIUM TO VERY COARSE SAND, SOME VERY FINE TO FINE PEBBLE GRAVEL; OXIDIZED, DRY
14.0 -	20.0	SAND AND GRAVEL, YELLOWISH-BROWN TO REDDISH-BROWN, COARSE SAND TO FINE PEBBLE GRAVEL, SOME MEDIUM TO COARSE PEBBLES, CLAYEY, MODERATELY SORTED; OXIDIZED,

WET, HIT BOULDER AT 15 FT, COULD NOT PENETRATE, MOVED 10 FT WEST, DRILLED 20 FT, NO SAMPLES 15 TO 20 FEET

* * * *

COUNTY: MINNEHAHA LOCATION: 101N-50W-23ABBD
LEGAL LOCATION: SE NW NW NE SEC. 23, T. 101 N., R. 50 W.
LATITUDE: 43.3234 LONGITUDE: 96.4754
LAND OWNER:
PROJECT: WILLIAMS PIPE LINE
DRILLING COMPANY: SDGS
DRILLER: D. IVERSON DRILLER'S LOG:
GEOLOGIST: D. ILES GEOLOGIST'S LOG: X
DATE DRILLED: 12-10-1986 DRILLING METHOD: HOLLOWSTEM
GROUND SURFACE ELEVATION: 1437.38 I
TOTAL DRILL HOLE DEPTH: 25.0 TEST HOLE NUMBER: R20-86-81
WATER RIGHTS WELL: SDGS WELL NAME: R20-86-81
OTHER WELL NAME:
BASIN: BIG SIOUX AQUIFER: BIG SIOUX
MANAGEMENT UNIT: SOUTHERN SKUNK CREEK
SCREEN TYPE: PVC, MFG. SCREEN LENGTH: 10.4
CASING TYPE: PVC, SCH. 80 CASING DIAMETER: 2.0
CASING TOP ELEVATION: 1439.48 I
CASING STICK-UP: 2.10 TOTAL CASING AND SCREEN: 26.9
WELL MAINTENANCE DATE:
USGS HYDROLOGICAL UNIT CODE: 10170203
ELECTRIC LOG INFORMATION:
SPONTANEOUS POTENTIAL: SINGLE POINT RESISTIVITY:
NATURAL GAMMA: EXTRA:
SAMPLES: X

LITHOLOGIC DESCRIPTIONS ARE BASED PRIMARILY ON RECOVERY FROM SPLIT-BARREL SAMPLES WHICH WERE TAKEN CONTINUOUSLY FROM LAND SURFACE TO BOTTOM OF DRILL HOLE. THE SPLIT-BARREL SAMPLER WAS 30 INCHES LONG AND 3 INCHES IN DIAMETER.

0	-	1.0	CLAY, BLACK, SILTY (TOPSOIL)
1.0	-	2.3	CLAY, BROWN, SILTY; NONCALCAREOUS
2.3	-	12.5	SAND AND GRAVEL, YELLOWISH-BROWN TO REDDISH-BROWN, MEDIUM SAND TO VERY COARSE PEBBLE GRAVEL, SOME COBBLE GRAVEL, CLAYEY; HIGHLY OXIDIZED
12.5	-	15.0	NO SAMPLE; DRILLERS LOG REPORTS HARD LAYER FROM 12.5 TO 14.5 FEET
15.0	-	25.0	SAND AND GRAVEL, YELLOWISH-BROWN, MEDIUM SAND TO VERY COARSE PEBBLE GRAVEL, CLAYEY, POORLY SORTED; YELLOWISH-BROWN TO LIGHT-GRAY CLAY PRESENT FROM 17.5 TO 20 FT, WET AT 16.5 FT, NO SAMPLE 19.5

TO 22.5 FT, OXIDIZED, ROTTEN ODOR FROM 22.5 TO 25 FEET

* * * *

COUNTY: MINNEHAHA LOCATION: 101N-50W-23ABBD 1
LEGAL LOCATION: SE NW NW NE SEC. 23, T. 101 N., R. 50 W.
LATITUDE: 43.3233 LONGITUDE: 96.4753
LAND OWNER:
PROJECT: WILLIAMS PIPE LINE
DRILLING COMPANY: DOT
DRILLER: K. NEYHART DRILLER'S LOG:
GEOLOGIST: M. MEYER GEOLOGIST'S LOG: X
DATE DRILLED: 12-11-1986 DRILLING METHOD: HOLLOWSTEM
GROUND SURFACE ELEVATION: 1436.27 I
TOTAL DRILL HOLE DEPTH: 22.0 TEST HOLE NUMBER:
WATER RIGHTS WELL: SDGS WELL NAME:
OTHER WELL NAME: DOT-4
BASIN: BIG SIOUX AQUIFER: BIG SIOUX
MANAGEMENT UNIT: SOUTHERN SKUNK CREEK
SCREEN TYPE: PVC, MFG. SCREEN LENGTH: 10.4
CASING TYPE: PVC, SCH. 80 CASING DIAMETER: 2.0
CASING TOP ELEVATION: 1438.77 I
CASING STICK-UP: 2.50 TOTAL CASING AND SCREEN: 24.6
WELL MAINTENANCE DATE:
USGS HYDROLOGICAL UNIT CODE: 10170203
ELECTRIC LOG INFORMATION:
SPONTANEOUS POTENTIAL: SINGLE POINT RESISTIVITY:
NATURAL GAMMA: EXTRA:
SAMPLES:

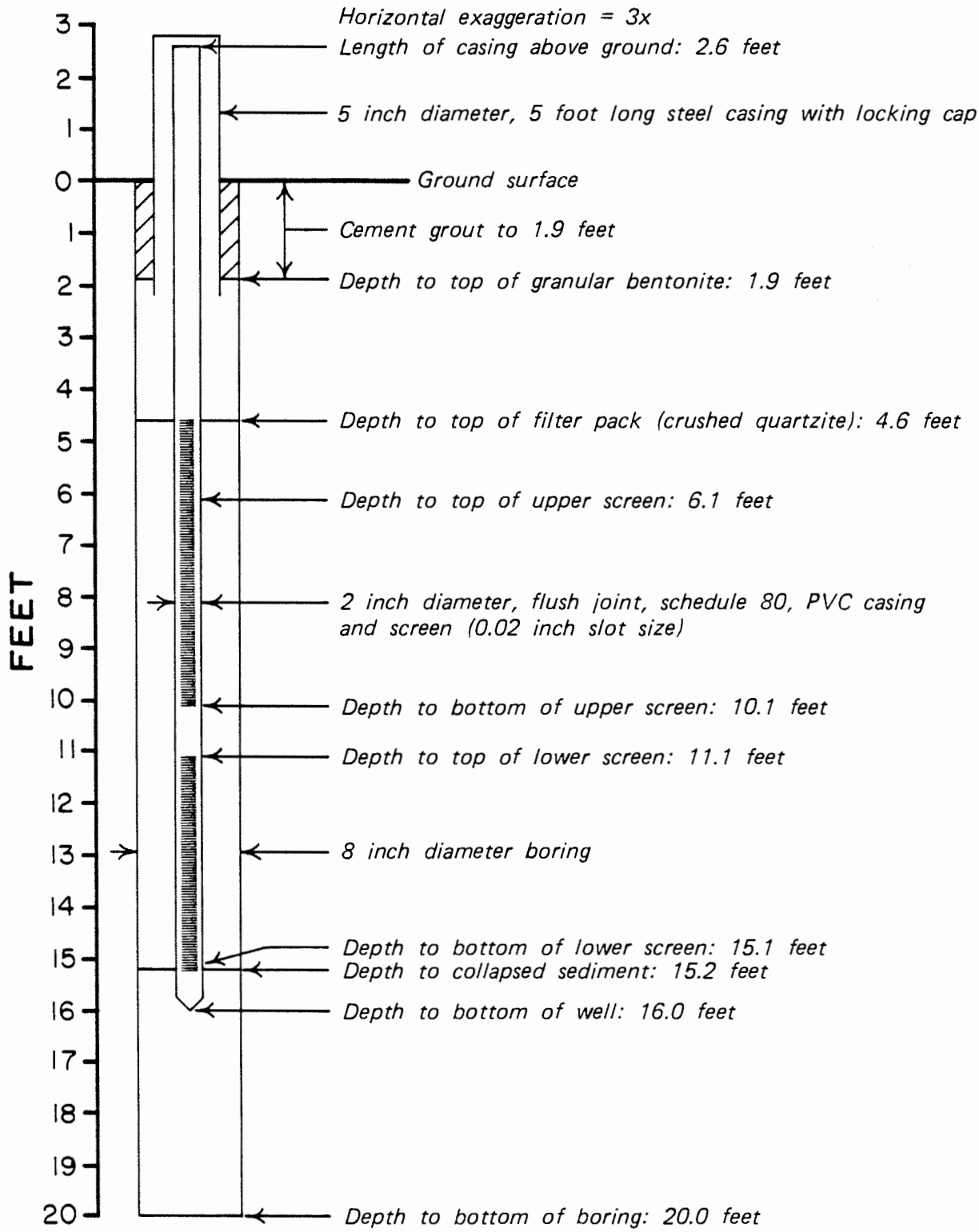
LITHOLOGIC DESCRIPTIONS ARE BASED PRIMARILY ON RECOVERY FROM SPLIT-BARREL SAMPLES WHICH WERE TAKEN CONTINUOUSLY FROM LAND SURFACE TO BOTTOM OF DRILL HOLE. THE SPLIT-BARREL SAMPLER WAS 24 INCHES AND 2 INCHES IN DIAMETER.

0	-	2.0	CLAY, DARK-BROWN, SILTY; GRADING TO LIGHT-BROWN BELOW 1.5 FEET, NO SAMPLE
2.0	-	4.0	CLAY, LIGHT-BROWN, SILTY; MOIST, NO SAMPLE
4.0	-	18.0	SAND AND GRAVEL, REDDISH-BROWN TO YELLOWISH-BROWN, COARSE SAND TO VERY COARSE PEBBLE GRAVEL, CLAYEY, POORLY SORTED; OXIDIZED, DRY, NO SAMPLE FROM 6-8 AND 12-14 FT DUE TO ROCKS, FAINT PETROLEUM ODOR BELOW 10 FT(?), WET AT 16 FT, GRAY-BROWN CLAY LAYERS 15.4-15.8 FEET
18.0	-	22.0	NO SAMPLE; ASSUMED TO BE SIMILAR TO INTERVAL FROM 4 TO 18 FEET

APPENDIX C

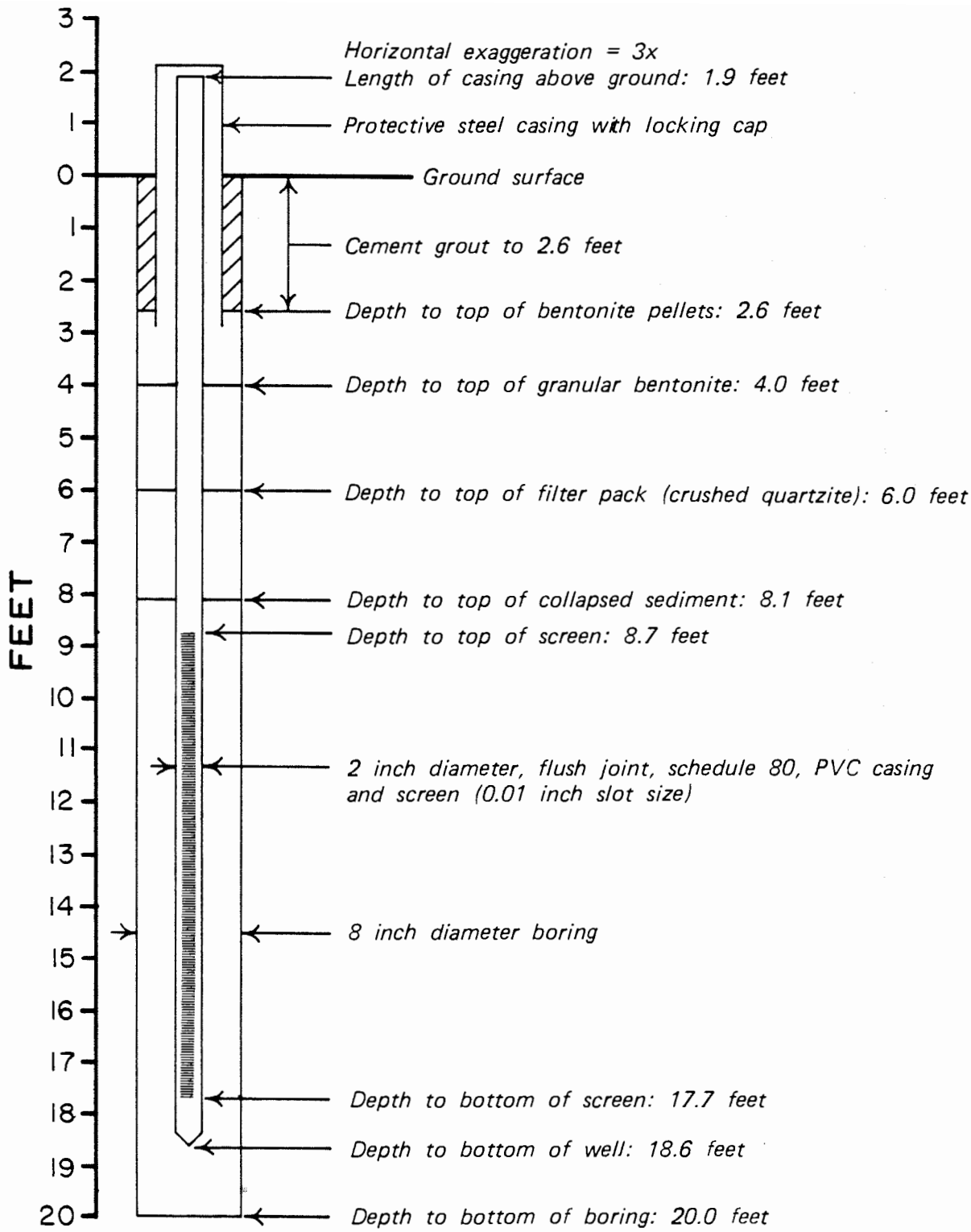
DIAGRAMS OF DEPARTMENT OF WATER AND NATURAL RESOURCES MONITORING-WELL CONSTRUCTION

The figures contained in this appendix are detailed descriptions of the monitoring wells installed by the Department of Water and Natural Resources. R20-86 series wells are listed first, followed by the DOT series wells. Lithologic logs of the test holes are given in appendix B.



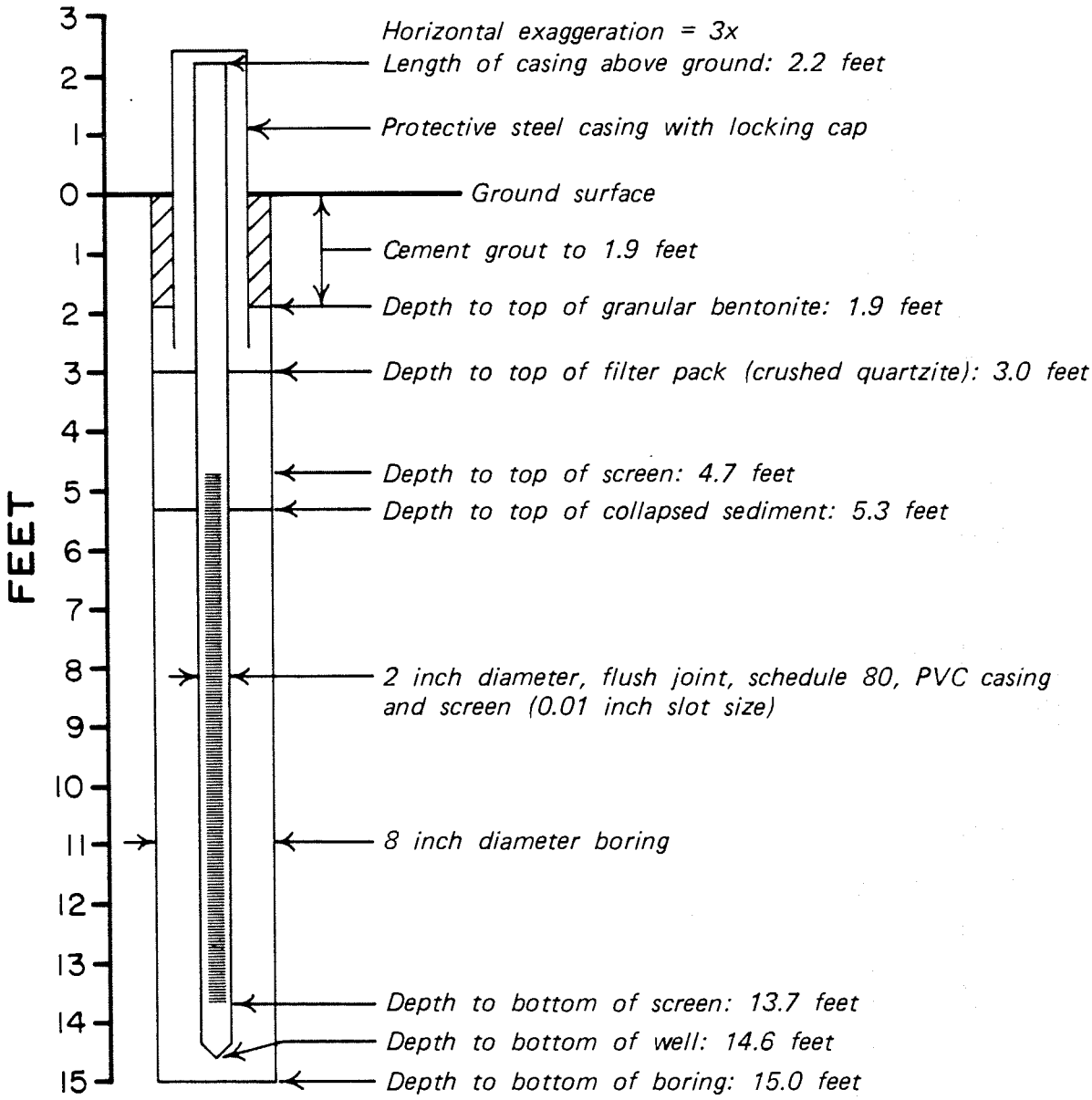
DWNR monitoring well R20-86-74

Appendix C-2

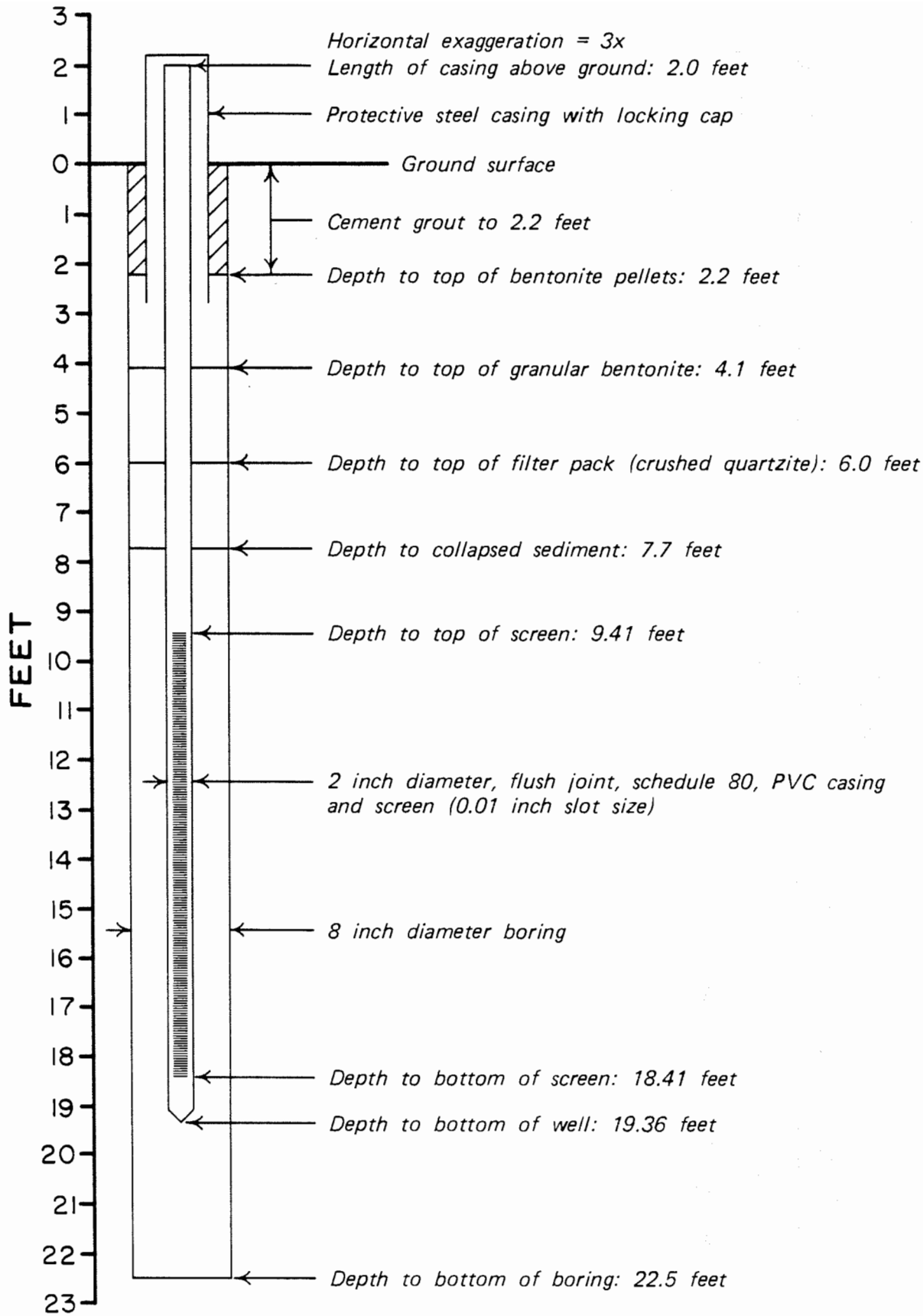


DWNR monitoring well R20-86-75

Appendix C-3

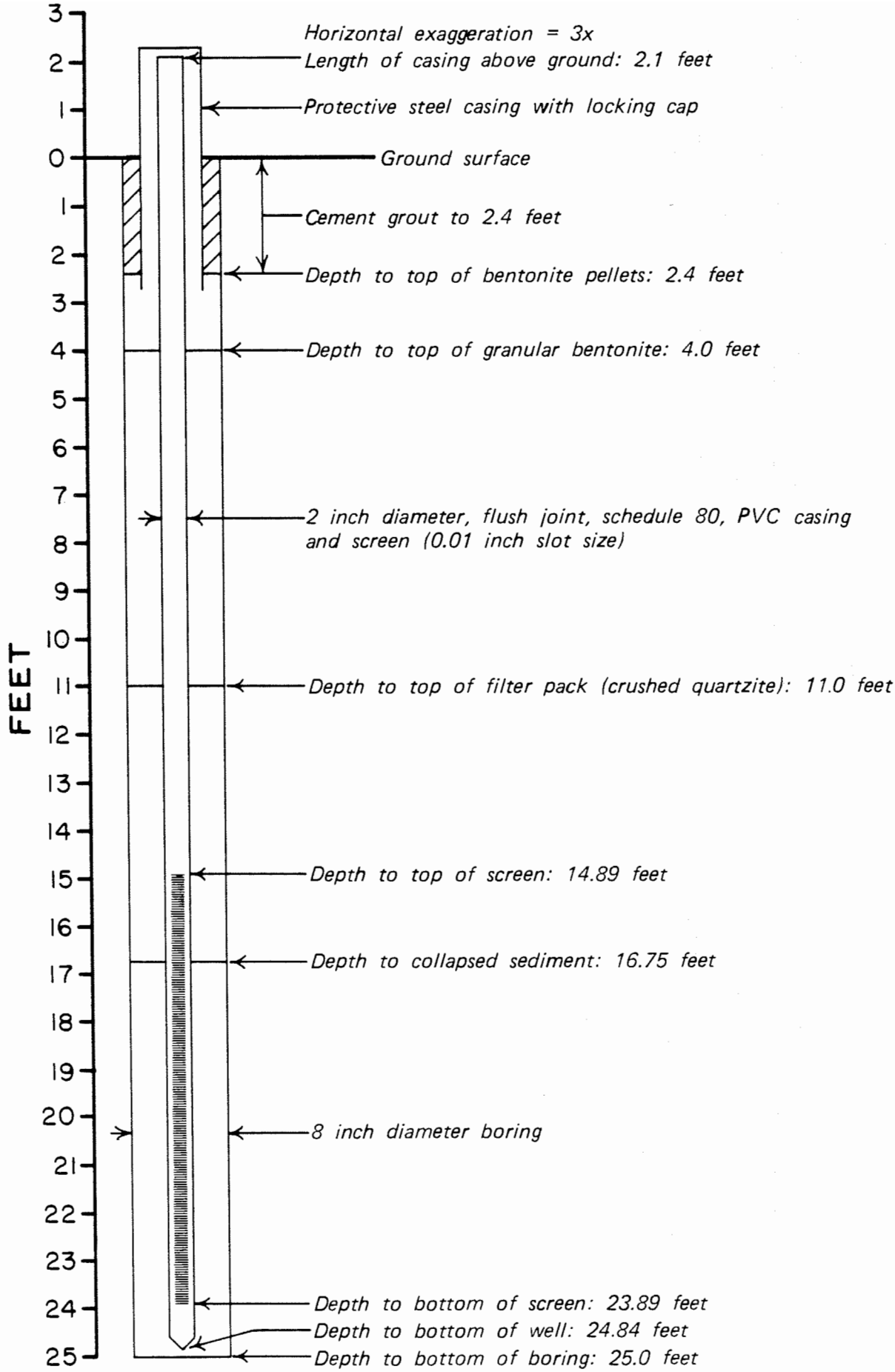


DWNR monitoring well R20-86-76



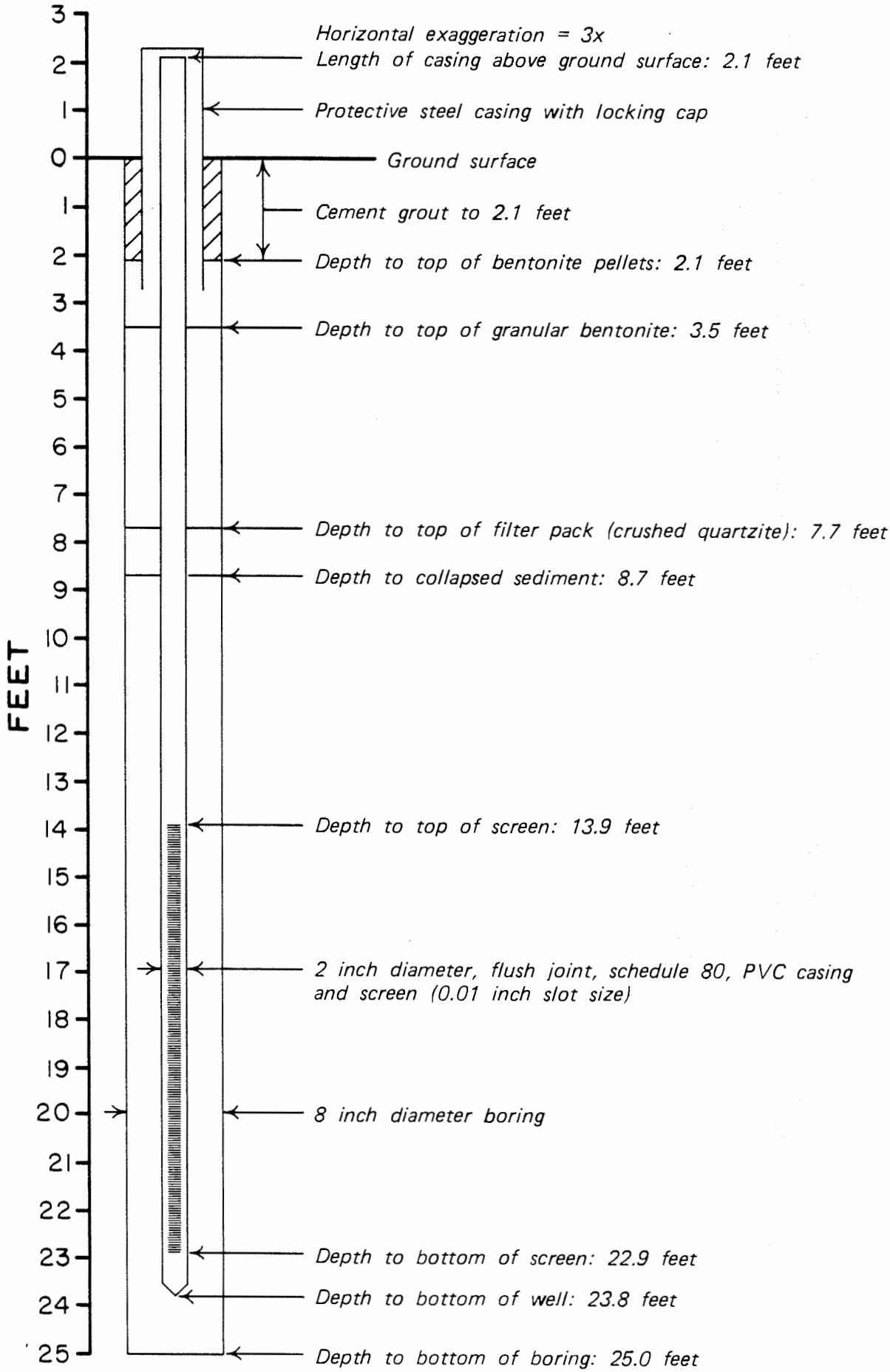
DWNR monitoring well R20-86-79

Appendix C-5



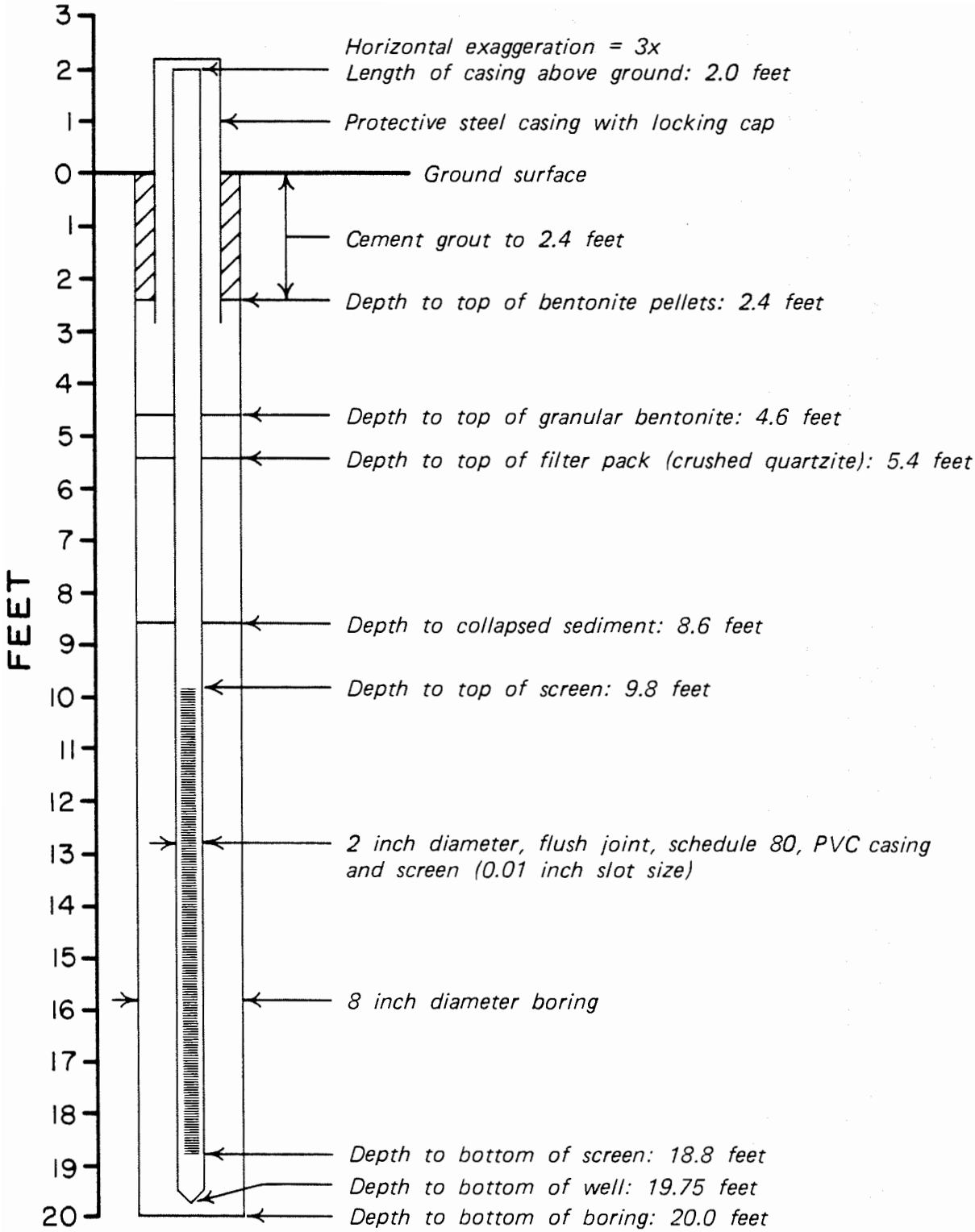
DWNR monitoring well R20-86-81

Appendix C-6

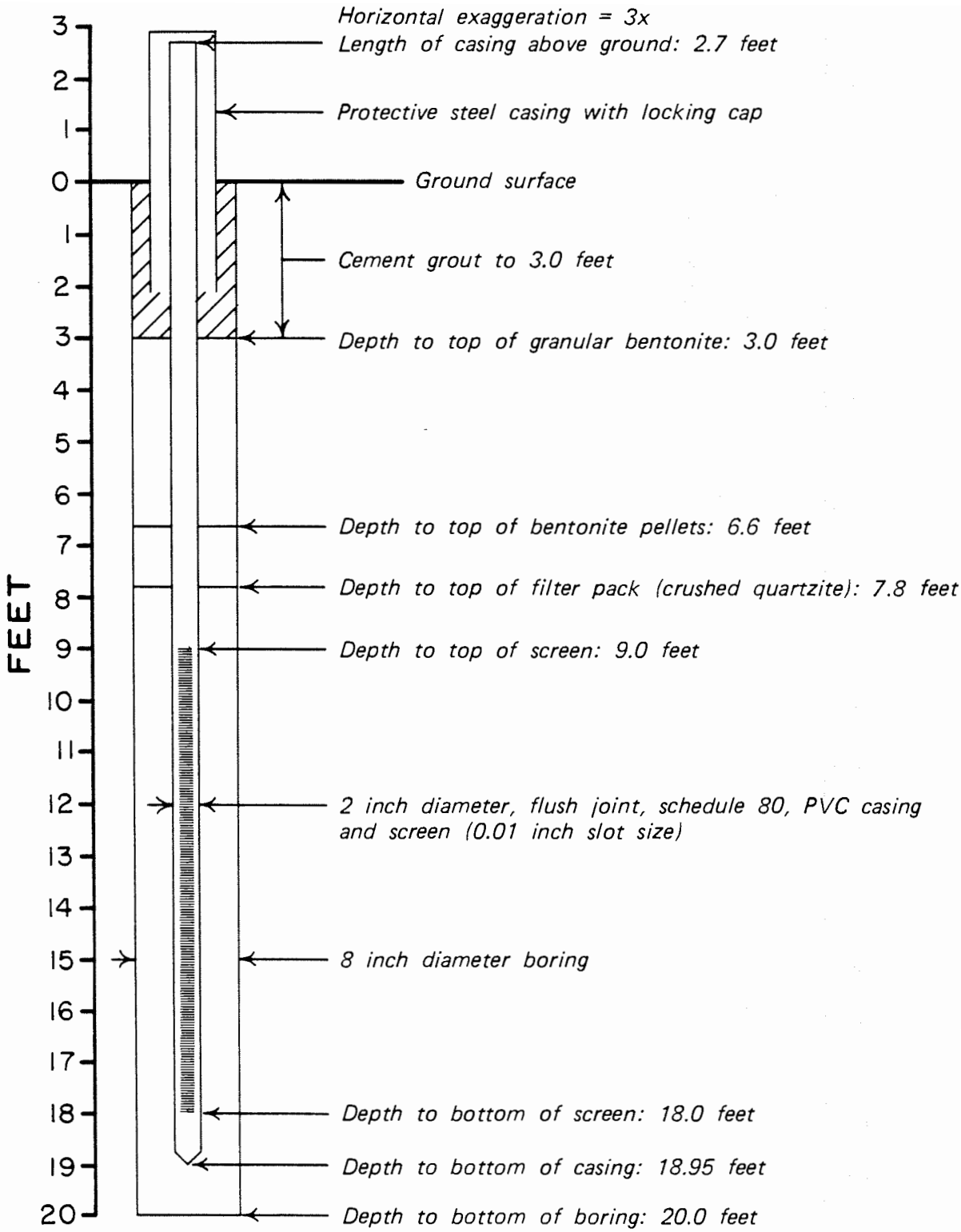


DWNR monitoring well R20-86-82

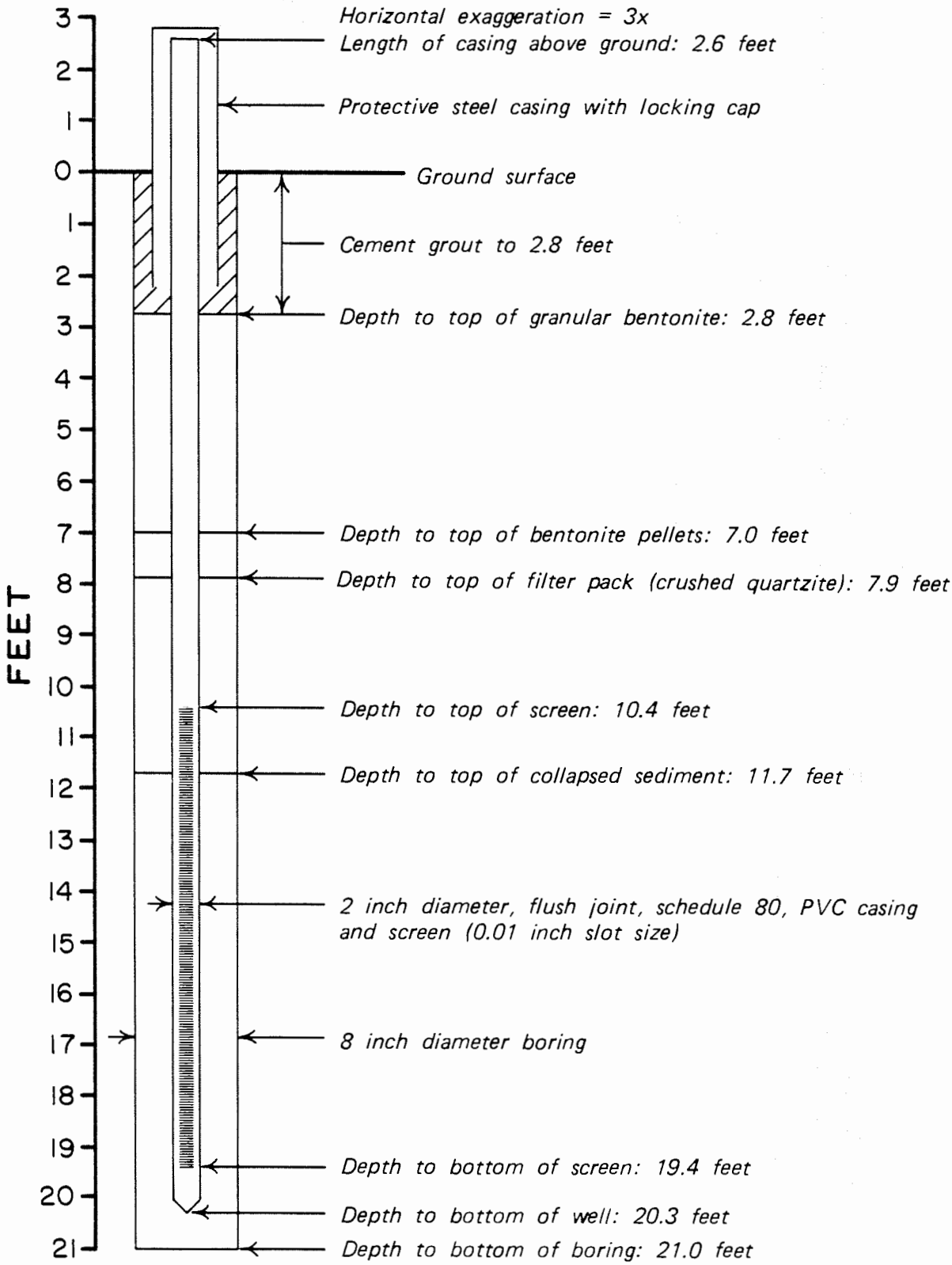
Appendix C-7



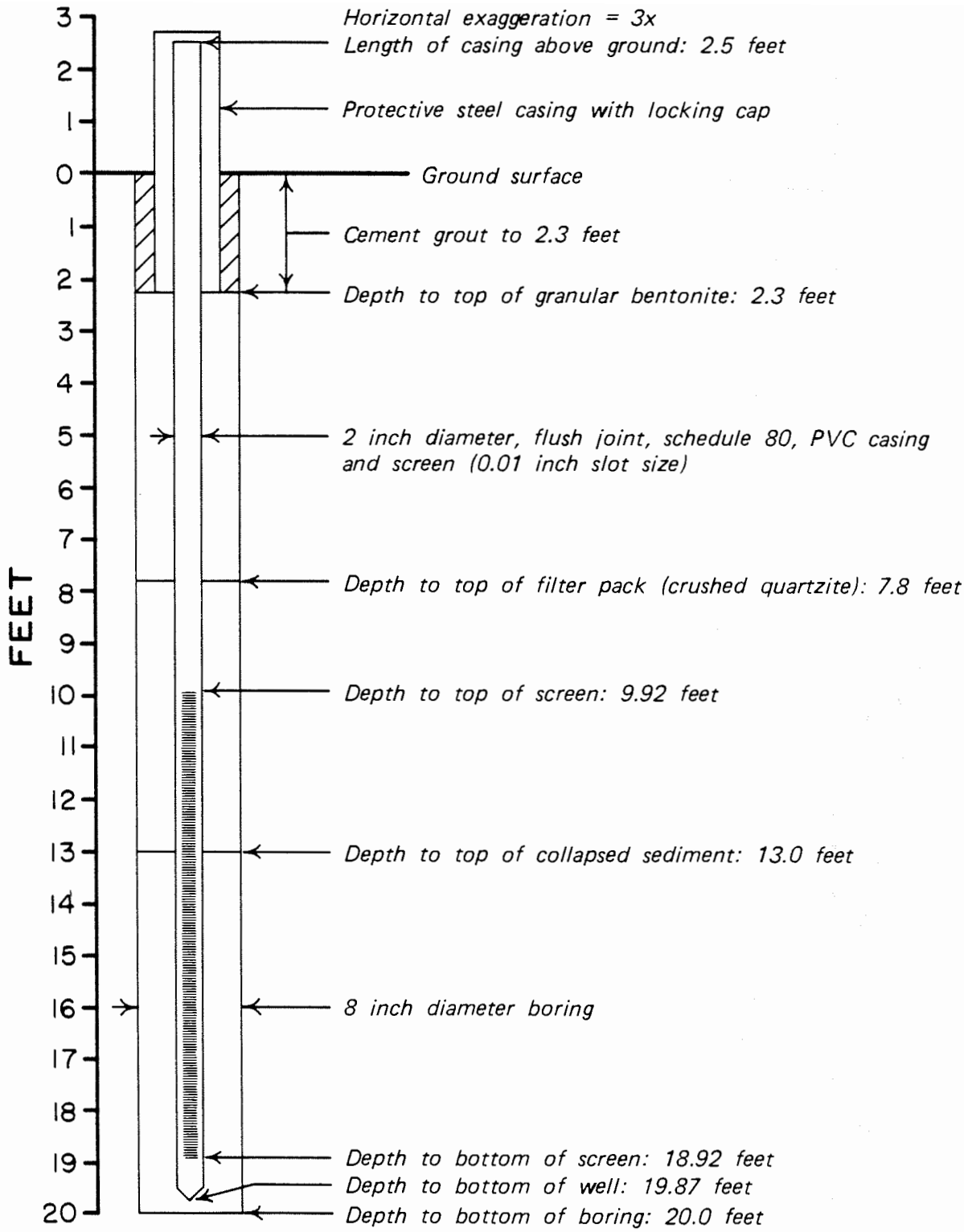
DWNR monitoring well R20-86-86



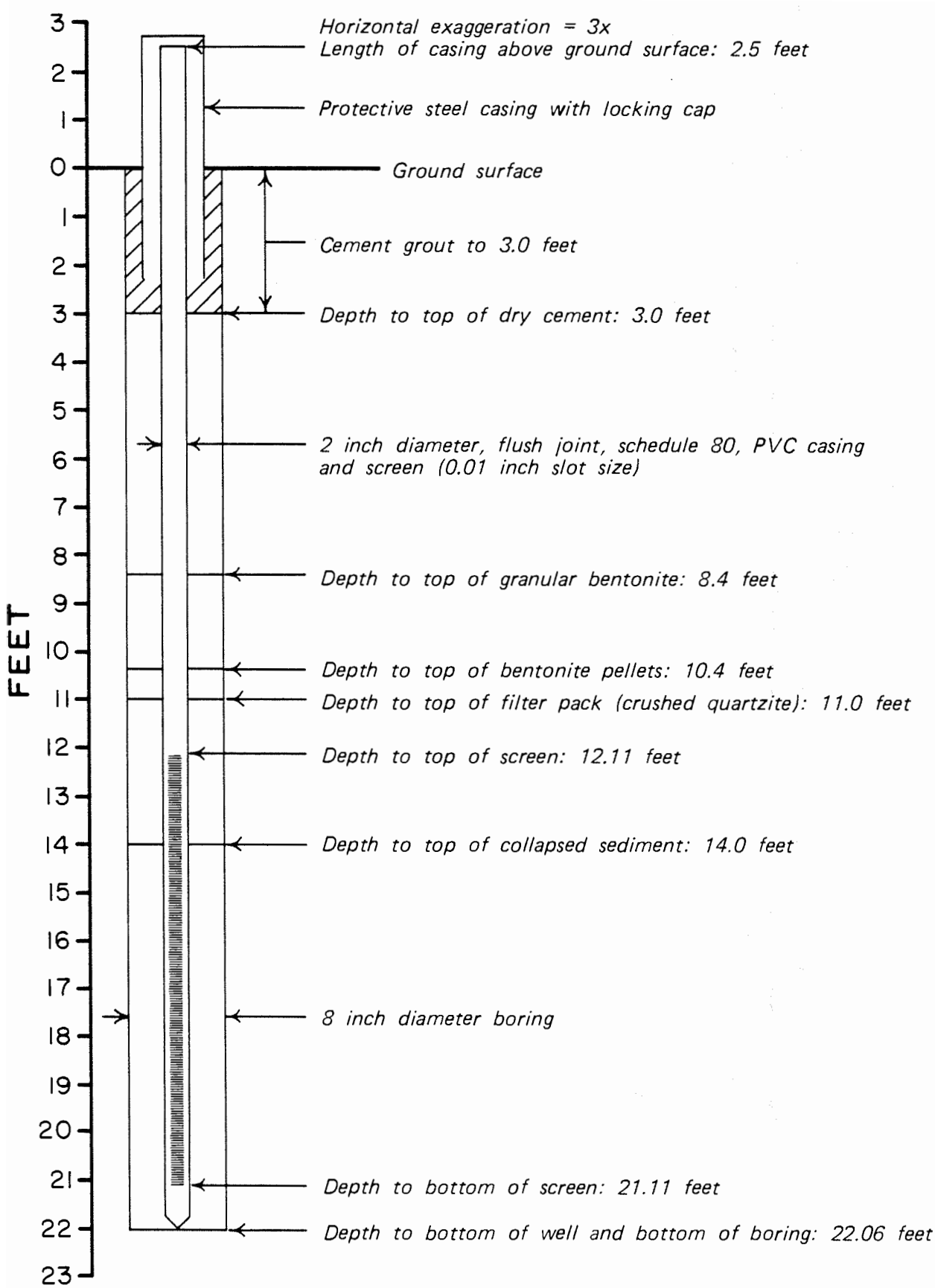
DWNR monitoring well DOT-1



DWNR monitoring well DOT-2



DWNR monitoring well DOT-3



DWNR monitoring well DOT-4

APPENDIX D

WATER LEVELS

This appendix contains water-level measurements for the monitoring wells installed under the direction of the Department of Water and Natural Resources (DWNR) and Bay West, Inc. Data for each well grouping are presented in two tables: Depth to water from casing top and Ground-water elevations. All DWNR wells (R20-86 and DOT series) are grouped together. Bay West, Inc. wells are separated by series (MW, I, and F). Elevations are presented in feet above mean sea level. Depth to water from casing top is presented in feet.

DWNR WELLS: DEPTH TO WATER FROM CASING TOP

	Casing Top Elevation	Date 12/16/86	12/17/86	01/06/87
DOT-1	1439.64	17.33	---	18.39
DOT-2	1438.05	18.21	---	---
DOT-3	1437.27	18.10	---	---
DOT-4	1438.77	19.73	---	---
R20-86-74	1438.23	---	12.72	---
R20-86-75	1438.25	---	13.95	14.31
R20-86-76	1434.65	---	8.01	---
R20-86-79	1437.46	15.71	---	16.45
R20-86-81	1439.48	20.11	---	---
R20-86-82	1438.67	19.16	---	---
R20-86-86	1437.79	17.78	---	18.37

---: no measurement taken

DWNR WELLS: GROUND-WATER ELEVATIONS

	Casing Top Elevation	Date 12/16/86	12/17/86	01/06/87
DOT-1	1439.64	1422.31	---	1421.25
DOT-2	1438.05	1419.84	---	---
DOT-3	1437.27	1419.17	---	---
DOT-4	1438.77	1419.04	---	---
R20-86-74	1438.23	---	1425.51	---
R20-86-75	1438.25	---	1424.30	1423.94
R20-86-76	1434.65	---	1426.64	---
R20-86-79	1437.46	1421.75	---	1421.01
R20-86-81	1439.48	1419.37	---	---
R20-86-82	1438.67	1419.51	---	---
R20-86-86	1437.79	1420.01	---	1419.42

---: no measurement taken

MW-WELLS: DEPTH TO WATER FROM CASING TOP

	Casing Top Elevation	Date					
		09/26/86	10/01/86	10/10/86	10/12/86	11/06/86	12/16/86
MW-1	1439.52	16.16	16.21	16.43	16.50	17.00	17.97
MW-2	1440.70	17.96	17.96	18.21	18.30	18.87	20.28
MW-3	1438.30	14.95	14.99	15.71	15.25	15.72	16.65
MW-4	1439.66	16.11	16.15	16.36	16.44	16.92	17.90
MW-5	1438.84	15.17	15.23	15.45	15.52	16.03	17.06
MW-6	1438.30	14.59	14.66	14.91	14.98	15.50	16.49
MW-7	1438.96	15.52	15.62	15.74	15.81	16.28	17.23
MW-8	1438.35	16.83	16.85	16.99	17.05	17.43	18.19
MW-9	1438.76	15.16	15.19	15.39	15.47	15.97	16.93
MW-10	1437.27	14.42	14.44	14.60	14.68	15.08	15.96
MW-11	1439.13	---	15.50	15.61	15.68	16.17	17.16
MW-12	1437.04	---	13.99	14.16	14.22	14.62	15.54
MW-13	1438.46	---	17.29	17.56	17.64	18.15	19.01
MW-14	1439.21	---	15.91	16.11	16.19	16.65	17.60
MW-15	1438.62	---	---	17.81	17.89	18.26	19.14
MW-16	1438.01	---	17.14	17.25	17.33	17.75	18.64
MW-17	1441.03	---	---	19.98	20.06	20.56	21.46
MW-18	1439.58	---	---	17.28	17.36	17.93	19.02
MW-19	1438.91	---	---	15.78	15.91	16.60	17.51
MW-20	1439.67	---	---	16.19	16.26	16.79	17.78

---: no measurement taken

MW-WELLS: GROUND-WATER ELEVATIONS

	Casing Top Elevation	Date					
		09/26/86	10/01/86	10/10/86	10/12/86	11/06/86	12/16/86
MW-1	1439.52	1423.36	1423.31	1423.09	1423.02	1422.52	1421.55
MW-2	1440.70	1422.74	1422.74	1422.49	1422.40	1421.83	1420.42
MW-3	1438.30	1423.35	1423.31	1422.59	1423.05	1422.58	1421.65
MW-4	1439.66	1423.55	1423.51	1423.30	1423.22	1422.74	1421.76
MW-5	1438.84	1423.67	1423.61	1423.39	1423.32	1422.81	1421.78
MW-6	1438.30	1423.71	1423.64	1423.39	1423.32	1422.80	1421.81
MW-7	1438.96	1423.44	1423.34	1423.22	1423.15	1422.68	1421.73
MW-8	1438.35	1421.52	1421.50	1421.36	1421.30	1420.92	1420.16
MW-9	1438.76	1423.60	1423.57	1423.37	1423.29	1422.79	1421.83
MW-10	1437.27	1422.85	1422.83	1422.67	1422.59	1422.19	1421.31
MW-11	1439.13	---	1423.63	1423.52	1423.45	1422.96	1421.97
MW-12	1437.04	---	1423.05	1422.88	1422.82	1422.42	1421.50
MW-13	1438.46	---	1421.17	1420.90	1420.82	1420.31	1419.45
MW-14	1439.21	---	1423.30	1423.10	1423.02	1422.56	1421.61
MW-15	1438.62	---	---	1420.81	1420.73	1420.36	1419.48
MW-16	1438.01	---	1420.87	1420.76	1420.68	1420.26	1419.37
MW-17	1441.03	---	---	1421.05	1420.97	1420.47	1419.57
MW-18	1439.58	---	---	1422.30	1422.22	1421.65	1420.56
MW-19	1438.91	---	---	1423.13	1423.00	1422.31	1421.40
MW-20	1439.67	---	---	1423.48	1423.41	1422.88	1421.89

---: no measurement taken

I-WELLS: DEPTH TO WATER FROM CASING TOP

	Casing Top Elevation	Date								
		06/23/86	07/30/86	09/21/86	10/01/86	10/10/86	10/12/86	10/22/86	11/06/86	12/16/86
I-1	1438.05	11.50	11.29	9.04	9.81	10.27	10.23	10.66	10.96	---
I-2	1438.30	14.51	14.80	12.14	12.45	12.91	12.99	13.30	13.60	14.67
I-3	1438.85	13.08	13.50	10.57	11.08	11.63	11.70	---	13.28	14.24
I-4	1437.60	11.34	11.71	9.24	10.04	10.54	10.62	11.00	11.23	11.70
I-5	1439.66	13.73	14.01	12.05	12.30	13.24	13.34	---	---	---
I-6	1437.76	10.92	12.21	10.52	11.03	11.34	11.39	11.64	---	---
I-7	1438.45	13.98	14.30	12.69	---	13.01	13.09	13.23	13.40	14.25
I-8	1438.78	14.25	14.53	12.45	---	13.12	13.22	13.51	13.65	14.56
I-9	1437.80	11.94	12.25	9.82	10.62	11.00	11.11	11.49	11.80	12.14
I-10	1437.81	12.75	13.01	11.21	11.70	12.05	12.12	12.38	12.43	12.90
I-11	1434.31	8.13	7.31	5.22	6.02	6.52	6.60	6.95	7.23	---
I-12	1434.99	8.63	8.45	5.94	6.74	7.27	7.35	7.70	7.96	---
I-13	1437.59	12.82	12.11	9.83	10.83	11.15	11.35	11.58	11.52	12.22
I-14	1437.40	12.24	12.58	10.23	10.95	11.29	11.43	11.70	11.74	---
I-15	1434.24	7.81	7.54	5.01	5.85	6.40	6.48	6.86	7.15	---
I-16	1438.29	16.50	17.17	14.90	14.60	14.80	14.88	15.08	15.37	---
I-17	1435.26	7.92	8.45	5.54	6.34	6.85	6.95	7.31	7.67	---
I-18	1434.35	6.84	7.40	3.92	4.50	5.61	5.74	6.14	6.55	---
I-19	1434.28	7.24	7.72	4.83	5.70	6.26	6.42	6.77	7.09	---
I-20	1435.18	8.74	8.23	6.18	6.93	7.44	7.54	7.84	8.12	---
I-21	1435.05	8.19	8.46	5.74	6.55	7.05	7.11	7.47	7.78	---
I-22	1437.84	---	---	---	---	---	---	---	---	---

---: no measurement taken or data indicated to be incorrect by Bay West, Inc.

NOTE: Wells I-3 and I-5 were damaged. Repair of the wells resulted in altered casing top elevations. All casing top elevations listed above were determined by the State of South Dakota after repair of the wells. After a comparison of State and Bay West, Inc., elevation data, a conversion factor of 1336.10 was used to convert Bay West elevations to mean sea level. This correction resulted in prerepair elevations of 1437.92 and 1438.42 for wells I-3 and I-5, respectively. For well I-3 casing top elevation, use 1437.92 for 6/23/86 through 10/12/86 and use 1438.85 thereafter. For well I-5 casing top elevation, use 1438.42 for 6/23/86 through 10/12/86 and use 1439.66 thereafter.

I-WELLS: GROUND-WATER ELEVATIONS

	Casing Top Elevation	Date								
		06/23/86	07/30/86	09/21/86	10/01/86	10/10/86	10/12/86	10/22/86	11/06/86	12/16/86
I-1	1438.05	1426.55	1426.76	1429.01	1428.24	1427.78	1427.82	1427.39	1427.09	---
I-2	1438.30	1423.79	1423.50	1426.16	1425.85	1425.39	1425.31	1425.00	1424.70	1423.63
I-3	1438.85	1424.84	1424.42	1427.35	1426.84	1426.29	1426.22	---	1425.57	1424.61
I-4	1437.60	1426.26	1425.89	1428.36	1427.56	1427.06	1426.98	1426.60	1426.37	1425.90
I-5	1439.66	1424.69	1424.41	1426.37	1426.12	1425.18	1425.08	---	---	---
I-6	1437.76	1426.84	1425.55	1427.24	1426.73	1426.42	1426.37	1426.12	---	---
I-7	1438.45	1424.47	1424.15	1425.76	---	1425.44	1425.36	1425.22	1425.05	1424.20
I-8	1438.78	1424.53	1424.25	1426.33	---	1425.66	1425.56	1425.27	1425.13	1424.22
I-9	1437.80	1425.86	1425.55	1427.98	1427.18	1426.80	1426.69	1426.31	1426.00	1425.66
I-10	1437.81	1425.06	1424.80	1426.60	1426.11	1425.76	1425.69	1425.43	1425.38	1424.91
I-11	1434.31	1426.18	1427.00	1429.09	1428.29	1427.79	1427.71	1427.36	1427.08	---
I-12	1434.99	1426.36	1426.54	1429.05	1428.25	1427.72	1427.64	1427.29	1427.03	---
I-13	1437.59	1424.77	1425.48	1427.76	1426.76	1426.44	1426.24	1426.01	1426.07	1425.37
I-14	1437.40	1425.16	1424.82	1427.17	1426.45	1426.11	1425.97	1425.70	1425.66	---
I-15	1434.24	1426.43	1426.70	1429.23	1428.39	1427.84	1427.76	1427.38	1427.09	---
I-16	1438.29	1421.79	1421.12	1423.39	1423.69	1423.49	1423.41	1423.21	1422.92	---
I-17	1435.26	1427.34	1426.81	1429.72	1428.92	1428.41	1428.31	1427.95	1427.59	---
I-18	1434.35	1427.51	1426.95	1430.43	1429.85	1428.74	1428.61	1428.21	1427.80	---
I-19	1434.28	1427.04	1426.56	1429.45	1428.58	1428.02	1427.86	1427.51	1427.19	---
I-20	1435.18	1426.44	1426.95	1429.00	1428.25	1427.74	1427.64	1427.34	1427.06	---
I-21	1435.05	1427.31	1427.04	1429.76	1428.95	1428.45	1428.39	1428.03	1427.72	---
I-22	1437.84	---	---	---	---	---	---	---	---	---

---: no measurement taken or data indicated to be incorrect by Bay West, Inc.

NOTE: Wells I-3 and I-5 were damaged. Repair of the wells resulted in altered casing top elevations. All casing top elevations listed above were determined by the State of South Dakota after repair of the wells. After a comparison of State and Bay West, Inc., elevation data, a conversion factor of 1336.10 was used to convert Bay West elevations to mean sea level. This correction resulted in prerepair elevations of 1437.92 and 1438.42 for wells I-3 and I-5, respectively. For well I-3 casing top elevation, use 1437.92 for 6/23/86 through 10/12/86 and use 1438.85 thereafter. For well I-5 casing top elevation, use 1438.42 for 6/23/86 through 10/12/86 and use 1439.66 thereafter.