REPORT

CHARACTERIZATION OF SOLVENT LEAKAGE AND MIGRATION NRC LICENSED DISPOSAL AREA WESTERN NEW YORK NUCLEAR SERVICE CENTER WEST VALLEY NEW YORK

By

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1.0 INTRODUCTION

1.1 OVERVIEW

This report presents the results of an investigative program to characterize the current state of known waste solvent which was disposed of in the NRC Licensed Disposal Area (NDA) of the Western New York Nuclear Service Center (WNYNSC), located approximately 45 miles south of the city of Buffalo, New York (Figure 1-1). The waste solvent was generated and disposed of by Nuclear Fuel Services (NFS) in conjunction with nuclear fuel reprocessing operations conducted prior to the implementation of the West Valley Demonstration Project (WVDP). Further information regarding the solvent, its origin and disposal, and a summary of prior studies are presented Section 2. Section 3 describes the preparatory activities which were undertaken prior to the initiation of field investigations. The methods and details of the field investigations are described in Section 4. Section 5 presents the results which were obtained, and Section 6 presents the conclusions reached on the basis of both these results and the results of prior work. On the basis of these conclusions, recommendations for additional work are made in Section 7. These recommendations address the need for further investigations, short range maintenance activities and long range management of the solvent disposals.

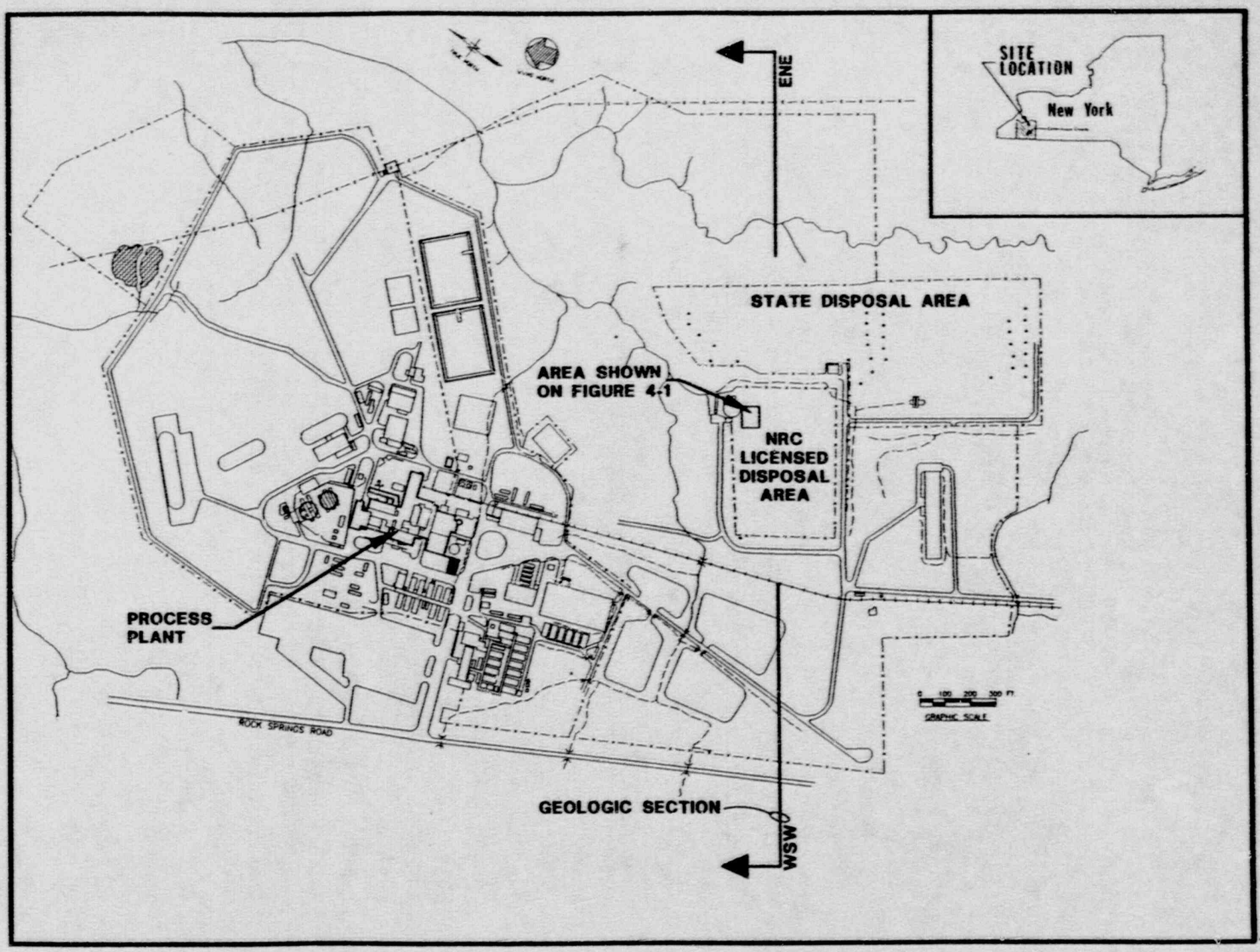


Figure 1-1 Map of the West Valley Demonstration Project.

1.2 OBJECTIVES

The primary objective of the investigation was to assess the current state of the solvent and determine if it was contained in the tanks in which it has been disposed. If the results indicated that the solvent was no longer contained in the disposal tank(s), the second objective was to determine the extent of migration.

1.3 SCOPE OF WORK

To accomplish these objectives, a multi-disciplined scope of work was authorized. The work performed included:

A literature review of non aqueous phase liquid (NAPL) transport through porous media and preliminary modeling of solvent migration based on the work encountered.

Preparation of the necessary safety and environmental documentation to assure that all work would conform to DOE orders.

Performance of proof-of-principle testing to validate the use of soil gas sampling for locating the solvent plume.

Trenching and probing to locate disposal hole boundaries and tanks.

Installation of exploratory wells in the six disposal holes which, according to disposal records left by NFS, contained solvent.

Performance of a soil gas survey to locate the lateral extent of migration from disposal holes.

Preparation of a report to summarize the findings of the investigation and make recommendations for future courses of action.

2.0 BACKGROUND INFORMATION

2.1 SITE CONDITIONS

2.1.1 Climate

The WVDP site is located in the Appalachian Uplands Physiographic Province. The climate of this area is humid. The site receives approximately 45 inches of precipitation each year. Half of this is in the form of snow. Evapotranspiration is low, compared to many other parts of the country with longer growing seasons. This causes the groundwater table to be near the surface in many areas.

2.1.2 Geology

The site is located over a bedrock valley which has been filled by a series of glacial tills and interglacial lacustrine and alluvial deposits. A simplified cross section through the disposal area is illustrated on Figure 2-1. The location of the cross section is shown on Figure 1-1. The Devonian shale bedrock which underlies the site outcrops uphill to the west. At least two till sequences are known to exist beneath the site. The uppermost till, which is the burial medium, is a silty clay till deposited during the Lavery readvance of the early late Woodfordian glaciation (LaFleur, 1979). In the disposal area, this till extends to a depth of 90 feet. Beneath the Lavery Till, a granular unit, which consists of a combination of Lacustrine and Kame Delta deposits is found. This unit extends to Buttermilk Creek, 0.6 mile from the site, where it outcrops. A second till, the Kent, is encountered below these granular deposits.

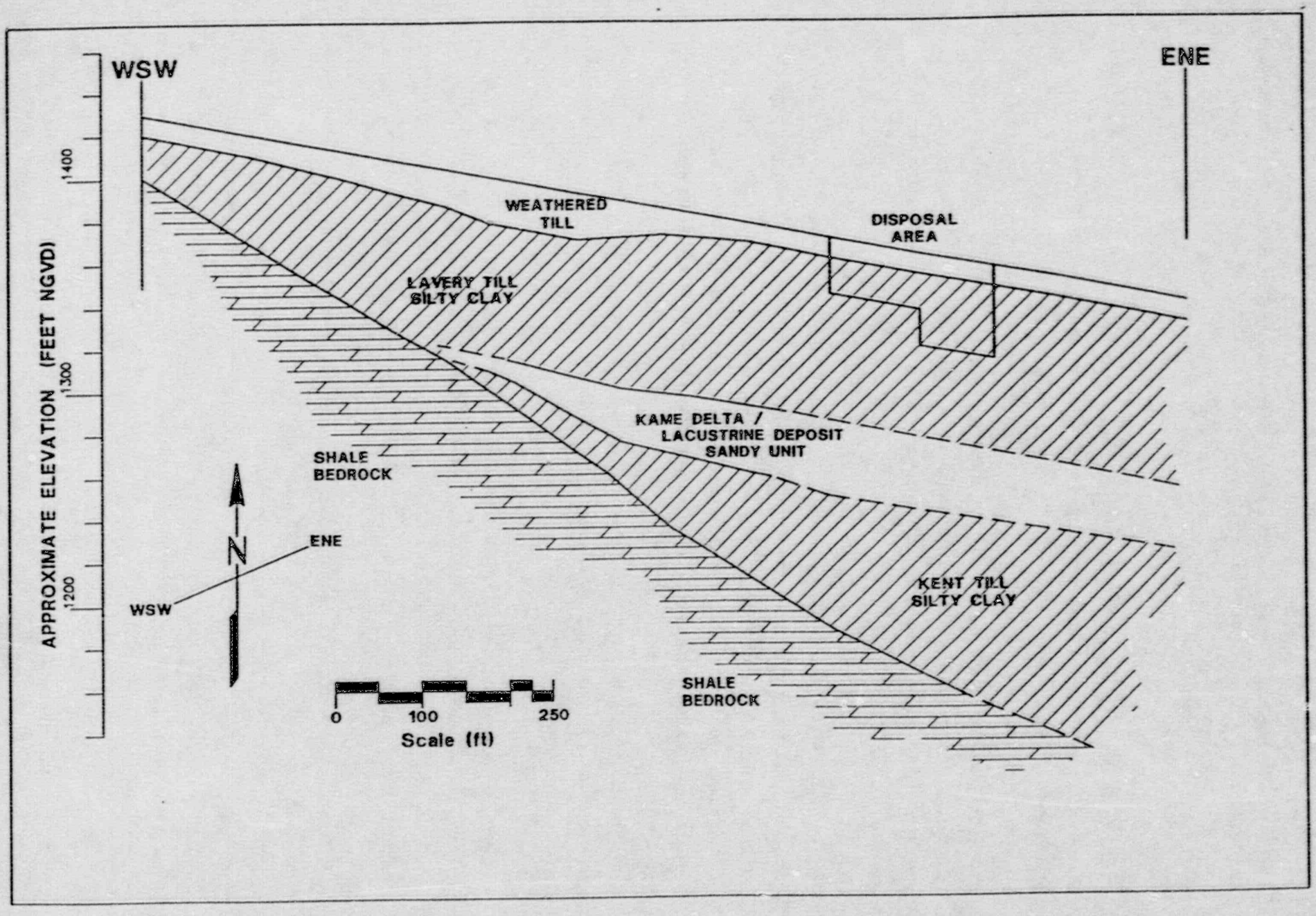


Figure 2-1 Schematic geological cross section through the NRC licensed disposal area.

The Lavery Till is comprised primarily of clay. In-situ and laboratory permeability testing (Prudic, 1982) indicate the till has a hydraulic conductivity ranging from 6.2E-5 to 1.8E-4 ft/day.

Data from wells and piezometers reveal that groundwater flow in the Lavery Till is essentially one-dimensionally downward. Piezometer data also indicate the phreatic level in the clay till is approximately 20 feet below the surface. Test trenches and observations in the disposal trenches indicate that the till is fractured near the surface (Dana, et. al., 1979). However, geotechnical analyses demonstrate that it is unreasonable to expect these fractures to extend to depths beyond 50 feet (Hoffman, et. al., 1980). Some pods of overridden proglacial sands are encountered in the clay till. None of these have been observed to exhibit lateral or vertical continuity of significant extent. Thus, relatively little migration to the deeper Lacustrine unit would be anticipated. Modeling studies by Prudic (1986) indicated that the transit time from a burial trench to the outcrop at Buttermilk Creek would be on the order of 500 to 1000 years, assuming no attenuation. This equates to a groundwater velocity in the till of approximately four inches/year.

Recent investigations by the WVDP indicate that the upper 10 feet (approx.) of the Lavery Till is extensively fractured by weathering. Prudic (1982) indicated that the overall hydraulic conductivity of the weathered till is 5 to 10 times higher than that of the unweathered till. Thus the average effective hydraulic conductivity of the weathered till would be approximately 0.5 ft/yr. The extent to which this reflects fracture flow versus a more permeable matrix is not known. Piezometric data from the weathered till indicate that it acts as a transient unconfined aquifer following periods of extensive precipitation or snow melt. Water levels as high as four feet

below the surface have been observed. The hydraulic gradient generally mimics the surface topography and is estimated to range from 0.01 to 0.1 ft/ft.

2.2 ORIGIN, NATURE AND DISPOSAL OF SOLVENT

Detailed information regarding why the solvent was generated and disposed of can be found in the report which documented the exhumation of solvent tanks from two of the disposal holes (Blickwedehl, et. al., 1988). The following summary was developed from that document.

The reprocessing of spent nuclear fuel is a very complicated chemical engineering operation. It involves dissolution of the fuel in nitric acid, solvent extraction of desirable isotopes from the acid solution and selective removal of these isotopes with ion exchange and other processing techniques. The portion of the process which is of interest to this study is the solvent extraction phase. The solvent used was tributyl-phosphate (TBP) dissolved in n-dodecane. TBP is not soluble in water. The n-dodecane, is one of the primary compounds found in kerosene and is lighter than water and immiscible in it.

The fuel reprocessing was performed on a batch basis. After each batch the solvent was cleaned for reuse. However, after repeated cleanings the solvent was no longer usable and had to be replaced. The spent solvent was stripped and washed to remove as much radioactive material as possible and then placed into a 1,000 gallon steel tank together with a sorbent material which was described by the operating personnel as 'kitty litter'. A ratio of 50 bags of sorbent, believed to be one cubic foot in size, to 500 gallons of solvent was maintained to prevent the occurrence of free liquid in the tank at the time of disposal. Disposal records indicate that many of the tanks had a high level of surface radiation and had to be handled remotely.

A total of twenty-two one thousand gallon tanks with the solvent/sorbent mixture were disposed of episodically between 1968 and 1972. The disposal holes where these tanks were placed are shown on the NDA plot plan, Figure 2-2.

2.3 SUMMARY OF RELEVANT PRIOR WORK

In November 1983, solvent was detected in a monitoring well located just outside the NDA boundary. Stepped up monitoring efforts and extensive site investigations were implemented immediately following this discovery. The investigations involved borings, well installations, analysis of soil and water samples, and geophysics. The geophysical techniques included metal detectors, electro-magnetics, conductivity and resistivity. These techniques could not locate the tanks or the contaminant plume. Seismic and acoustic emission techniques (such as ground penetrating radar) were not attempted at the advice of the geophysicists consulted. This advice was based on the damping of the clay.

During the course of the investigation, traces of solvent and radioactive contamination were observed on the ground surface over two of the disposal holes containing solvent, SH-10 and SH-11. The locations of these holes and the other disposal holes which contain waste solvent are illustrated on Figure 2-2. Further investigations led to an exhumation program during which a total of eight tanks, their contents and the material around them were removed from SH-10 and SH-11. The solvent was stabilized and packaged for disposal. The sorbent material and contaminated soil were placed in steel boxes and stored. Following the exhumation, the excavation was backfilled. Out of 4,000 gallons of solvent disposed in these two holes, approximately 400 gallons were recovered during this operation.

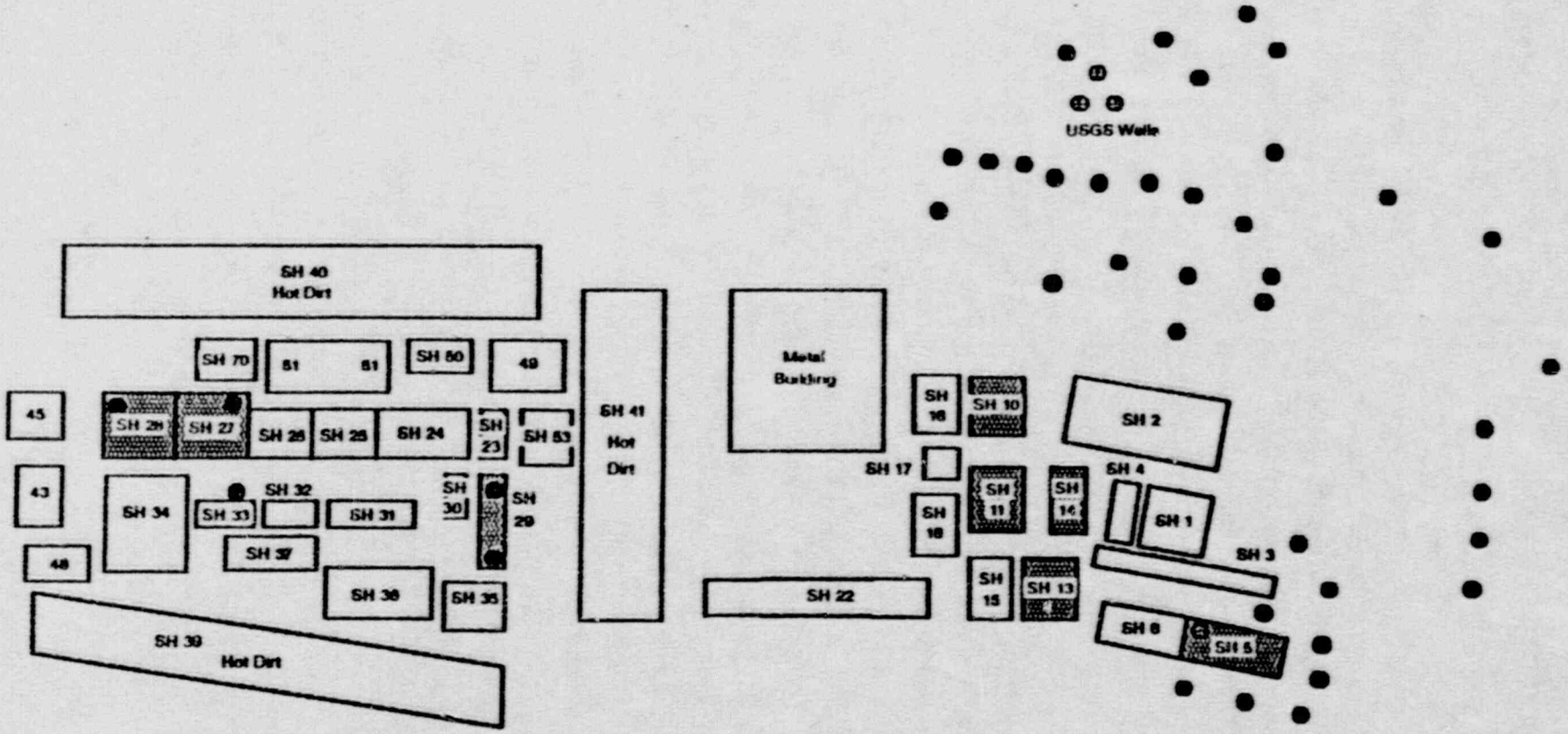


Figure 2-2. Location of disposal holes containing waste solvent and monitoring wells installed prior to investigation

Most of the solvent had left the tanks by the time they were exhumed. Further details regarding the investigations and the exhumation of the tanks from SH-10 and SH-11 are presented in the report documenting this activity (Blickwedehl et. al., 1988).

The investigations which followed the solvent discovery, together with other site characterization programs provide some insight into the mechanics of solvent migration. The general relationship between the disposal holes and the stratigraphic column in the disposal area is illustrated on Figure 2-3. The weathered till, which comprises the upper 10 ft (approximately) of the soil column, is fractured as a result of desiccation and functions as a transient aquifer perched on the underlying unweathered till, which is virtually impermeable. As a result of desiccation and settlement, the earth cover over the disposal holes is also believed to have developed cracks which allow water to infiltrate. Some water also is believed to have entered the disposal holes along the boundary between backfill and undisturbed material and through the fracture system in the weathered till. Because of the very low permeability of the unweathered till, little, if any, of the water which entered the disposal holes seeped out of it. Thus, eventually the water level in the holes reached the covers on the tanks, which were loosely attached, and flowed in. Water also may have entered the tanks through cracks in the welds. Eventually the water in the tanks displaced the solvent from the sorbent and floated the solvent on its surface. When the water level in the disposal holes reached the weathered till, the water and solvent floating on it moved laterally through the fracture system.

An extensive network of wells has been monitored continuously since the discovery of solvent in late 1983 and the response investigations in 1984. Following the exhumation of tanks from

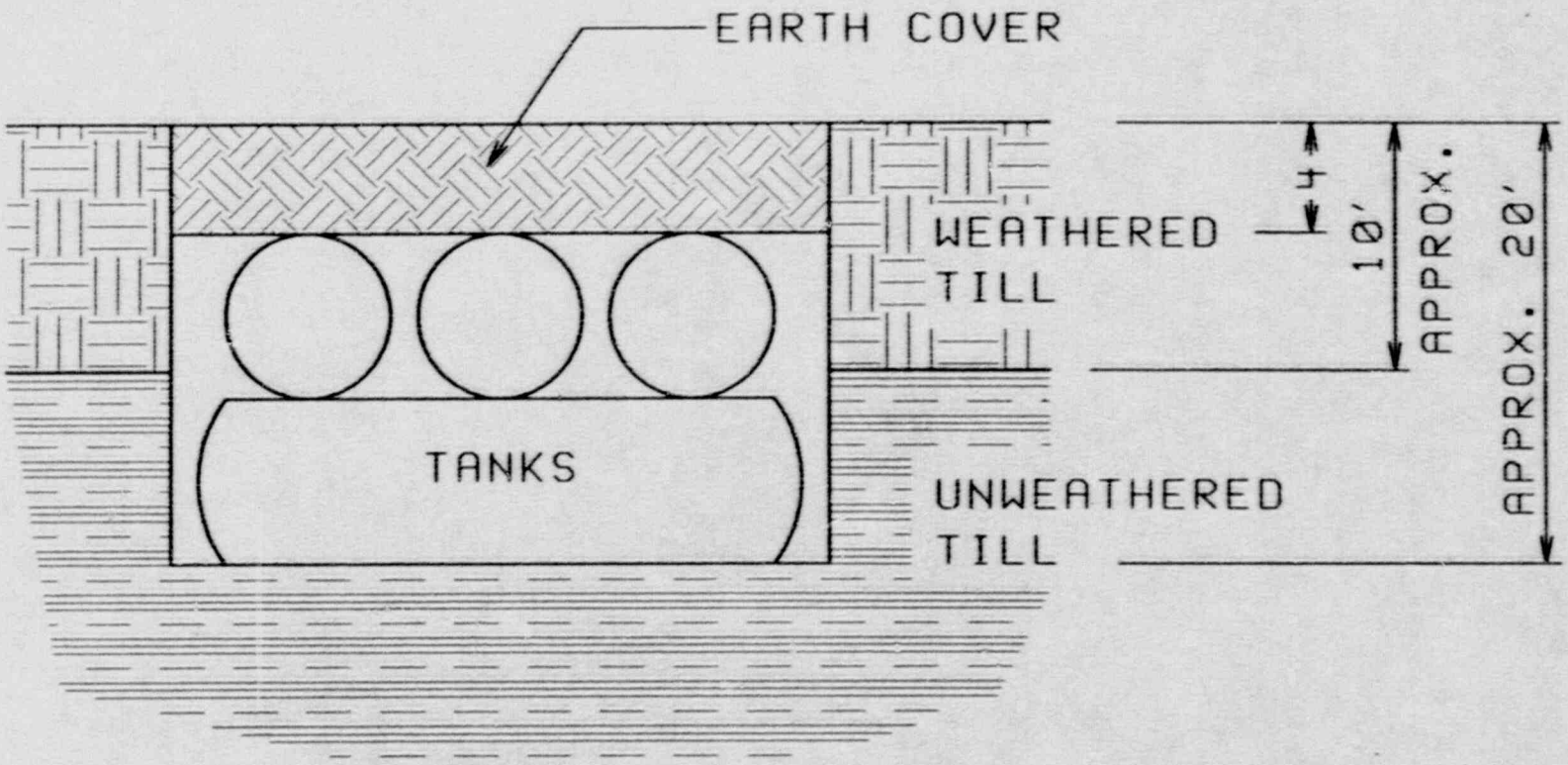


Figure 2-3 **Stratigraphic section showing relationship of subsurface materials to solvent disposals.**

SH-10 and SH-11 in 1986 and the installation of wells over SH-5, 27, 28 and 29, the monitoring results remained static until August 1988, when solvent was discovered in a monitoring well next to SH-5. This well, which has been monitored since its installation in 1986, showed no prior evidence of solvent. Borings were drilled around the perimeter of SH-5 in response to this discovery. Soil samples were extracted from the borings and analyzed for evidence of radioactivity and solvent. The results suggested that migration from the hole was minimal.

An assessment of the exposure to man from a worst case release scenario is presented in Blickwedehl et. al., (1988). While this assessment and other data regarding migration of the solvent do not suggest an imminent hazard to public health and safety, the presence of solvent in the till could materially affect the options available for the ultimate closure of the NDA. Laboratory testing indicates the solvent degrades the containment capability of the till (WVNS, 1985). This could enhance the mobility of radionuclides which would be virtually immobile in a groundwater environment without the presence of solvent. In the event that the solvent undergoes extensive migration, technically and economically attractive closure alternatives could be limited to more costly (in terms of both worker radiation exposure and financial resources) technologies.

3.0 PREPARATORY ACTIVITIES

3.1 LITERATURE REVIEW AND MODELING

The objective of the literature review and modeling effort was to provide information to guide the field investigations. The scope of this effort was limited to preliminary calculations, based on data available from existing sources and a number of assumptions.

The results of the analyses indicate that the observed migration of solvent from SH-10 and SH-11 is consistent with the site database and that residual non-aqueous phase liquid (NAPL) contamination more than 60 ft. away from a source should be anticipated in discrete locations, which are referred to as "ganglia" in the literature. Also, in consideration of the results presented, it appears that fracture flow is the most significant factor in the behavior of the solvent in the subsurface environment.

As a result of the findings of this effort, the proposed far-field exploration using soil gas sampling was considered appropriate. The exploration program focused on locations which were downgradient of the sources and in the direction of any dominant fracture orientations which were suggested by other studies.

3.1.1 General Approach

Most of this discussion is based on the recent writings by Hunt et al. (1988), Freeze and Cherry (1979), and deMarsily (1986). The Hunt article presents an excellent discussion of the behavior of non-aqueous phase liquids. Observations obtained from these reports are:

1. The behavior of the solvent will be very different than that of groundwater.

2. It is likely that most of the solvent exists in the form of ganglia (localized pockets of a uniform dimension called blobs or pockets extended in one dimension called stringers) which may exist above and below the water table in the weathered till.

3. The behavior of the solvent will be governed by the water-solvent and air-solvent interfacial surface tensions; this is complicated by the presence of TBP and its degradation products in the solvent.

4. If these ganglia do exist they are very stable. Thus, removal of the solvent via conventional methods, such as pumping, are not likely be effective. This is due to the existence of significant residual contamination and the fracture network.

5. Residual contamination is a term for the blobs and ganglia left behind as a result of solvent migration; it is analogous to the concept of field moisture, i.e., the quantity of moisture which will not evaporate from soil.

The solvent-water interfacial surface tension has an assumed value of about 50 dynes/cm. This assumption was required because no specific data could be found for n-dodecane. This assumption is based on the fact that other nonpolar hydrocarbons such as n-hexane and n-octane exhibit this value. The presence of TBP, TBP degradation products and ionic species in the system will tend to alter this value. Most likely they will reduce the interfacial surface tension.

3.1.2 Model Formulation

In this model the solvent is assumed to move on top of the (transient) saturated zone in the weathered till. An infinite source of solvent is assumed to exist as a result of releases from the tanks in the burial holes. A steady state solution is approximated from this.

The calculation begins with the time dependent conservation of mass equations for the multiphase system as written by Corapcioglu and Baehr's (1987) equation's 1 thru 6.

$$\frac{\partial}{\partial t}(\rho_w \theta_w) + \nabla \cdot \mathbf{J}_w$$

$$= \sum_{k=1}^{N} (R_{sol_w}^k - R_{pre_w}^k) + \sum_{k=1}^{N} (R_{cond_w}^k - R_{vol_w}^k) \qquad \text{water}$$

$$+ \sum_{k=1}^{N} (R_{des_w}^k - R_{ads_w}^k) - \sum_{k=1}^{N} R_{bio_w}^k - \sum_{k=1}^{N} R_{chm_w}^k \qquad (1)$$

$$\frac{\partial}{\partial t}(\rho_a \theta_a) + \nabla \cdot \mathbf{J}_a$$

$$= \sum_{k=1}^{N} (R_{vol_w}^k - R_{cond_w}^k) + \sum_{k=1}^{N} (R_{vol_i}^k - R_{cond_i}^k) \qquad \text{air}$$

$$+ \sum_{k=1}^{N} (R_{des_a}^k - R_{ads_a}^k) - \sum_{k=1}^{N} R_{bio_a}^k - \sum_{k=1}^{N} R_{chm_a}^k \qquad (2)$$

$$\frac{\partial}{\partial t}(\rho_i \theta_i) + \nabla \cdot \mathbf{J}_i$$

$$= \sum_{k=1}^{N} (R_{pre_w}^k - R_{sol_w}^k) + \sum_{k=1}^{N} (R_{cond_i}^k - R_{vol_i}^k) \qquad \text{oil}$$

$$+ \sum_{k=1}^{N} (R_{des_i}^k - R_{ads_i}^k) - \sum_{k=1}^{N} R_{bio_i}^k - \sum_{k=1}^{N} R_{chm_i}^k \qquad (3)$$

or for the constituents :

$$\theta_l + \theta_a + \theta_w = n \qquad \text{(porosity)} \quad (4)$$

$$\frac{\partial}{\partial t}(l_k\theta_l) + \nabla \cdot \mathbf{J}_{kl} \qquad \text{oil}$$

$$= (R_{pro_w}^k - R_{vol_w}^k) + (R_{cond_l}^k - R_{vol_l}^k) + (R_{des_l}^k - R_{ads_l}^k) - R_{bio_l}^k - R_{chm_l}^k \quad (5a)$$

$$\frac{\partial}{\partial t}(C_k\theta_w) + \nabla \cdot \mathbf{J}_{kw} \qquad \text{water}$$

$$= (R_{vol_w}^k - R_{pro_w}^k) + (R_{cond_w}^k - R_{vol_w}^k) + (R_{des_w}^k - R_{ads_w}^k) - R_{bio_w}^k - R_{chm_w}^k \quad (5b)$$

$$\frac{\partial}{\partial t}(G_k\theta_a) + \nabla \cdot \mathbf{J}_{ka} \qquad \text{air}$$

$$= (R_{vol_w}^k - R_{cond_w}^k) + (R_{vol_l}^k - R_{cond_l}^k) + (R_{des_a}^k - R_{ads_a}^k) - R_{bio_a}^k - R_{chm_a}^k \quad (5c)$$

For adsorbed constituents on the solid grains

$$\frac{\partial}{\partial t}(S_k\rho_s) = (R_{ads_w}^k - R_{des_w}^k) + (R_{ads_l}^k - R_{des_l}^k) + (R_{ads_a}^k - R_{des_a}^k) - R_{bio_s}^k - R_{chm_s}^k \quad (5d)$$

SUMMING :

$$\frac{\partial}{\partial t}[C_k\theta_w + G_k\theta_a + l_k\theta_l + S_k\rho_s] + \nabla \cdot [\mathbf{J}_{kw} + \mathbf{J}_{ka} + \mathbf{J}_{kl}] = -R_{bio}^k - R_{chm}^k \quad (5e)$$

$$k = 1, 2, \cdots, N$$

where R_{bio}^k and R_{chm}^k are the total rates (summed over phases) of molecular transformation of the kth constituent due to microbial and abiotic reactions, respectively. The constituent specific equations (5a)–(5e), of course, are related to the phase equations. For example (5a) is related to (3) as

$$\sum_{k=1}^{N} l_k = \rho_l \qquad \sum_{k=1}^{N} \mathbf{J}_{kl} = \mathbf{J}_l \quad (6)$$

For the first simplification, steady state conditions were assumed. Also, the movement was assumed to be parallel to the water table. Consequently, there would be no spatial change in the volumetric water, air or solvent contents. Furthermore, all interphase mass transfer, chemical reactions, and microbial reactions were neglected.

At this point, time dependence has been eliminated and the flow equations for the water, organic and air phases have been decoupled. Of interest is the simplified equation for the organic phase (solvent) flux:

$$\vec{\nabla} \cdot \vec{J} = 0 \quad ; \quad \vec{J}_{ki} = \vec{q} \cdot I_k - \vec{\vec{D}} \vec{\nabla} I_k$$

This equation is simplified even further by neglecting the effects of diffusion and dispersion - that is, only adjective transport is considered. Thus the solvent flux equation reduces to:

$$\vec{\nabla} \cdot \vec{q} = 0 \quad \text{or} \quad q = K \frac{dH}{dx} = \text{constant}$$

The major unknown in the above equation is the solvent gradient. Because steady state conditions are assumed, there is no vertical movement of the solvent-water interface at the water table. More accurately, there is no movement normal to the interface. The sum of all of the forces is zero at all points in the system. This is true along the entire interface.

Consider now an initial point at the interface (the source location) and a horizontally displaced point along the interface (the detection location). On the water side of the interface at the receptor location the total head has been reduced relative to its value at the source location - it is down gradient. Therefore it is assumed that the gradient on the solvent side of the interface must be reduced by the corresponding amount. If this were not the case there would be vertical movement. The net result of all of this is that the solvent gradient is equal to the water table gradient, so density effects are ignored. The equation therefore reduces to:

$$q = K \, (dH/dz)_{H_2O}$$

Which is Darcy's Law. The preceding derivation delineates the process required to simplify a rigorous multiphase approach to a solvable model.

3.1.3 Model Application

The minimum distance traveled by the solvent discovered in 1983 was 65 feet over a span of 14 years. The observed average linear velocity Ve is thus 65/14 = 9.6 ft/yr.

The effective porosity of the till is assumed to be 0.2 to 0.4. However, near the water table the till is very near saturation. Assuming that only air is to be excluded, a solvent saturation of less than 1 to 2 percent of the total soil volume can be derived. From another perspective, the predominance of fracture flow would also lead to a very low porosity. At this time, porosity as related to solvent flow cannot be given a priori. However, as seen here, there are compelling rationalizations for low values. This is very important in accounting for the apparent rapid movement of the solvent.

Substituting known values into the abbreviated flow model.

$$K = (Ve) * p / (dH/dx) = 4.6 * \begin{bmatrix} 0.01 \\ 0.02 \end{bmatrix} / \begin{bmatrix} 0.01 \\ 0.1 \end{bmatrix}$$

$$= 0.5 \text{ to } 9.2 \text{ ft/yr.}$$

This agrees with estimates reported by Prudic (1986) for the weathered till.

Some difference in the permeability of the solvent-till and water-till system is expected due to the different viscosities of solvent and water. In addition, there is a strong indication that solvent may interact with the clay particles in the till and possibly alter the till's specific permeability (WVNS, 1985).

However, it appears that within the context of this simple model neither viscosity differences nor major alterations of the till are important in explaining the extent of movement of the solvent over the 14 years. The major factor is the low effective porosity and hence the 'high' solvent linear velocities.

The calculations described in the preceding paragraphs represent an attempt to reconcile the observed fact of significant solvent movement in a relatively low permeability setting. The findings indicate that when reasonable assumptions are made the facts can be explained.

Finally, fractures likely play an important role in the behavior of solvent and water in the weathered till and may explain the spatial characteristics of contamination in the field. Even the concept of a water table in the weathered till must be viewed with a degree of suspicion. Transient flow is evident, but the existence of a continuous local water table has not been demonstrated. Flow may be limited to the proximity of fractures. None-the-less, the above calculations demonstrate that a continuum model can be made to mimic, what is most likely, a fracture flow system. Consequently, any interpretation should be made with care.

3.1.4 Alternate Modeling Approach -- Location and Extent

Hunt et al. (1988), present a number of relationships which can be used to estimate the maximum vertical and horizontal extent of immiscible organic ganglia. These are given both for the unsaturated and saturated zones. Most importantly, these equations and the accompanying discussion in the article provide insight into the migration and fate of organic phases in the ground. Their predictions correlate well with field experiences and this has some very important implications for the solvent in the NDA.

According to Hunt, et al., the maximum horizontal extent of a ganglion can be estimated as

$$L[h] = 2\sigma[ow] / \rho[w] \, g \, (dH/dz) \, r[t]$$

where

$\sigma[ow]$ = organic-water interfacial surface tension,

$\rho[w]$ = density of water,

g = gravitational constant,

(dH/dz) = hydraulic gradient,

$r[t]$ = pore throat radius.

The question is, what is the throat diameter required for the creation of stringers at least 20 m in length.

Solving for spherical particles where the diameter d = r[t]/0.077:

$$d(mm) = 2\sigma[ow] / \rho[w] \; .077 \; g \; (dH/dz) \; L[h]$$

$$= 2.57e\text{-}3 \; \sigma[ow] \; / \; (dH/dz) \; L[h](m)$$

$$= 2.57e\text{-}3 \; (50 \text{ dynes/cm}) \; / \begin{bmatrix} 0.01 \\ \\ 0.1 \end{bmatrix} \; (20m)$$

$$= 0.06 \text{ to } 0.6 \text{ mm.}$$

These diameters are representative of fine to coarse sand. It can therefore be concluded that within a till, in which particle sizes are expected to be much smaller, it would be quite possible to create solvent stringers of a length equal to or greater than 20 m or 65 feet despite the presence of many fractures. Thus, immobilization as a result of capillary encapsulation will result in ganglia greater than 65 feet in length, i.e., solvent would be found at a distance of 65 feet or further from the source. As these calculations are thermodynamic and not kinetic in nature they give no estimate as to when the stringers would arrive at 20 meters.

Significant fluctuations have been observed in the transient water table associated with the weathered till. To evaluate the expected effect on the distribution of solvent an examination of arguments presented by Hunt et al. (1988) was made. These strongly suggest that the net result of water movement would be to distribute the solvent vertically as a relatively immobile phase in a significant portion of both the unsaturated and saturated zones. This is demonstrated with some bounding calculations. In the unsaturated zone the stable length of a stringer in the vertical direction is approximated (neglecting the density difference) by:

$$L[v]unsat\ (m) = 1.72e\text{-}3\ \sigma[oa] / d$$

where:

$\sigma[oa]$ = organic-air interfacial surface tension and

d = particle diameter.

Using a value of 30 dynes/cm for the solvent-air surface tension, a one meter stringer in the unsaturated zone would be stable in soils having a particle diameter of:

$$d = 1.67e\text{-}3\ (30) / 1.0$$

$$= 0.05\ mm$$

This corresponds to a fine sand. At this diameter even longer stringers would be stable below the water table. Thus it would appear that a significant amount of solvent could be 'locked up' as residual saturation in the weathered zone of the till.

3.1.5 Summary

Based on the preliminary studies described above, it is possible to reach the following conclusions regarding the behavior of solvent in the NDA.

1. The observed migration from SH-10 and SH-11 to well 82-5A reasonably fits other observations made to date, including the distance which the solvent has migrated, and the small amount of solvent which remained in SH-10 and SH-11 relative to the disposed quantities.

2. If solvent has left tanks in other holes, it can be expected to have migrated a similar distance.

3. The direction of solvent migration would be generally in the direction of the water table gradient.

4. Solvent may be immobilized in the soil in stable ganglia at different elevations. A uniform distribution of solvent is not anticipated. Solvent trapped in fractures may be more mobile than solvent trapped in soil ganglia.

5. Immobilization of solvent in ganglia will increase the difficulty of extraction of the solvent by conventional methods.

3.2 PROOF OF PRINCIPLE TESTING

Soil gas sampling is a technique being developed for the tracking of hydrocarbon contamination in the subsurface. The technique is based on measuring the concentrations of volatile organic compounds (VOC's) in the soil gases as an indicator of contamination in or on the groundwater below. The technique has been very successful for tracking below-ground fuel and solvent spills. However, success appears to be site and compound specific. Generally, confirmation by direct measurement is used to validate the applicability of the technique for specific cases.

Passive soil sampling was used at the site several years ago as part of a research project conducted by Pennsylvania State University (Abdo, 1988). The results of this study were somewhat nebulous. The person who conducted the project indicated that an active technique, such as the vacuum withdrawal method under consideration for this investigation, might be successful.

As a general rule, compounds with low boiling points and relatively high vapor pressures offer the greatest chance for a successful soil gas survey. Dodecane, unfortunately, does not possess either of these characteristics. Its boiling point is 101 degrees C, which is in the upper end of the applicable range. Its vapor pressure at 25 degrees C is less than 1 mm of Hg, which is lower than most compounds which have been successfully tracked with soil gas measurements.

In consideration of potential cost savings, reduced worker exposure, and diminished logistical problems (relative to borings) the use of soil gas surveying was considered a desirable

method to track solvent migration. While the above limitations suggested a potential for failure, they were not sufficient to dismiss the use of the technique. The low vapor pressure considerations were offset by the fine grain nature of the till. Because of the small pore sizes, high capillary forces could be expected. The solvent might, therefore, be exposed to fairly high soil suction values which would cause volatilization.

Because the chances of success were uncertain, it was decided to conduct a proof of principle test of the technique. The test was performed in a 55 gallon steel drum. A thin layer of solvent was placed on the bottom of the drum to simulate a slick floating on water, and the drum was then filled with sand. Kerosene was used for the solvent because of its availability. This was considered applicable, since dodecane is a primary constituent of kerosene. Fine sand was used for the soil rather than clay because of the difficulty associated with simulating the fabric and structure of the weathered clay till in the laboratory. The use of sand was considered to be conservative because the matric potentials in the sand would be much lower than would be expected in the clay till. This is because the particle sizes and voids are larger in the sand. Thus, the potential for solvent volatilization would be less for the sand than for the clay.

The test was performed in a heated building in the early spring. The temperature was approximately 50 degrees F during testing. To perform the test, the soil gas probe was driven into the sand and stopped at 6 inch intervals for a soil gas sample to be withdrawn and tested with a gas chromatograph. Positive results were not achieved until the probe tip was within 6 inches of the kerosene. The surface of the sand in the drum was then heated in an attempt to create an upward temperature gradient, such as exists in the ground during the summer. The driving and sampling were repeated. In this case, positive results were achieved when the probe was approximately a foot above the solvent. The last step in the testing was to spray water on the surface of the sand

to simulate precipitation conditions. The probe and sample procedure was again repeated. For this case, positive results were not attained until the probe was directly above the solvent.

In consideration of the results of the proof of principle testing, it was concluded that the soil gas technique was only suitable when warm to hot and dry surface and near conditions persisted at the investigation site. Such conditions result in an upward moisture gradient. During periods of precipitation or when air temperatures decreased to nominal ground temperatures (approx 50 degrees F), the potential for false negative results was considered significant.

4.0 FIELD INVESTIGATIONS

4.1 MONITORING WELLS

Ten monitoring wells were installed in the six disposal holes which contain waste solvent tanks. The purpose of the wells was to detect solvent leakage from the buried tanks.

The installation procedure, WVNS SOP 40-1, was developed to place up to two wells in each burial hole. The criteria for well location were:

1) the well was within known limits of the hole;

2) buried tanks were not to be breached by the well or well installation equipment;

3) the range of well screen would be equal to the depth of the hole; and

4) the amount of excavated material would be minimized.

The six disposal holes were initially staked out using the approximate special hole boundaries as determined from plant burial records. A backhoe was used to excavate shallow trenches across the staked boundaries in an attempt to identify changes in lithologic conditions that would indicate the precise boundaries of the special holes. A thin walled soil core sampler was used to confirm the presence or absence of a buried solvent tank near the boundary. A well was then installed at the location that was determined to be within the special hole confines, yet was not occupied by one of the buried solvent tanks.

The approximate locations of the six special holes containing solvent tanks are shown on Figure 4-1. A typical well installation in relation to the tanks and the disposal hole is illustrated on Figure 4-2. The number of tanks, dose rate at disposal, and burial date for each disposal hole are shown on Table 4-1. A more specific description of SOP 40-1 is covered in the following text.

4.1.1 Initial Locations

A surveyor staked the corners of the six disposal holes which contained solvent tanks. WVDP Drawing 900D-257 Rev. 5 gave the approximate locations of the special holes and was used by the surveyor to mark the boundaries. These boundaries (Figure 4-1) were estimated to be accurate to ±6 feet on the basis of interviews with former NFS employees.

4.1.2 Trenching Operations

Exploratory trenches were excavated in an attempt to find the exact edges of the six special burial holes containing solvent tanks. The trenches were dug no deeper than necessary to find the burial hole boundaries. The trenches were excavated by a backhoe with a two foot wide bucket. Excavation was limited to lifts no greater than six inches. The exploratory trench was started at a distance of eight feet inside and perpendicular to the previously marked special hole boundary. The trench was dug directly toward that boundary to a maximum length of eight feet beyond it (a total trench length of 16 feet). See Figure 4-3.

The excavated soil was frisked for beta/gamma and alpha radiation contamination using a Ludlum model 3-2 meter with Ludlum Model 44-9 and 43-5 probes. Organic vapors were monitored by an H-Nu portable volatile organics meter, and a metal detector was used to check for evidence of buried metallic objects below the trench invert.

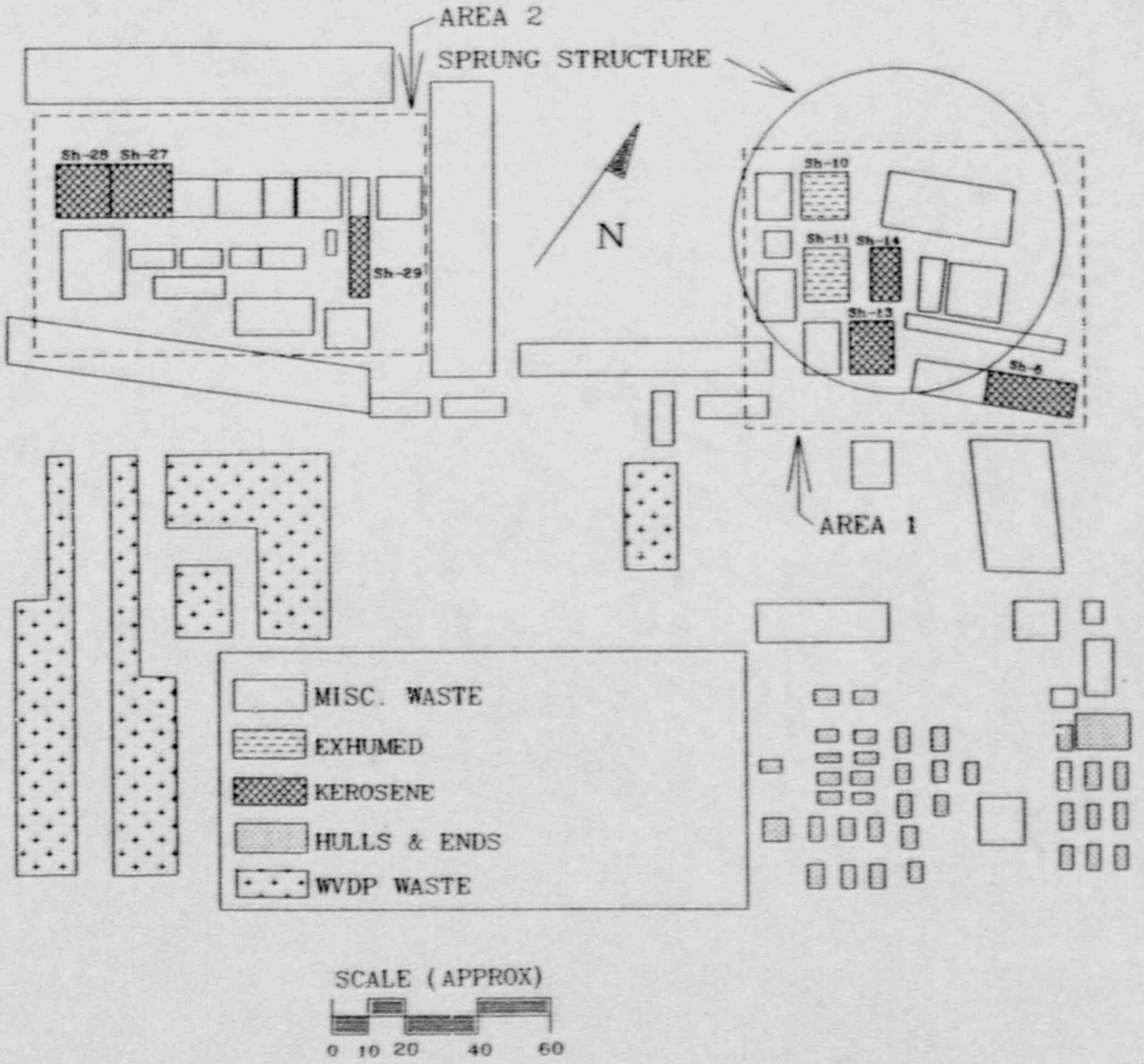


Figure 4-1 Location map of NRC Licensed Disposal Area showing areas of exploration.

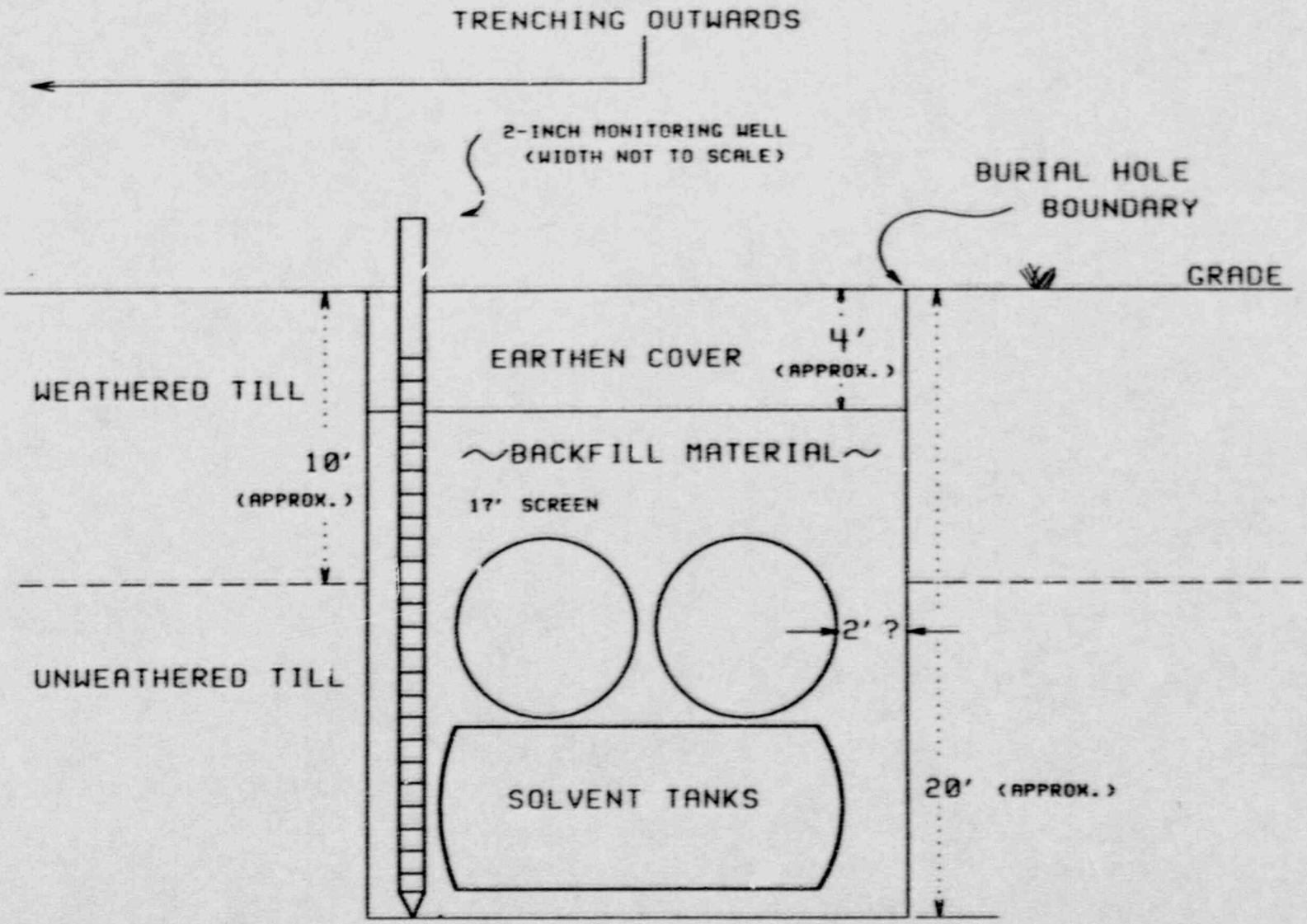


Figure 4-2 Schmatic diagram of well installations in disposal holes.

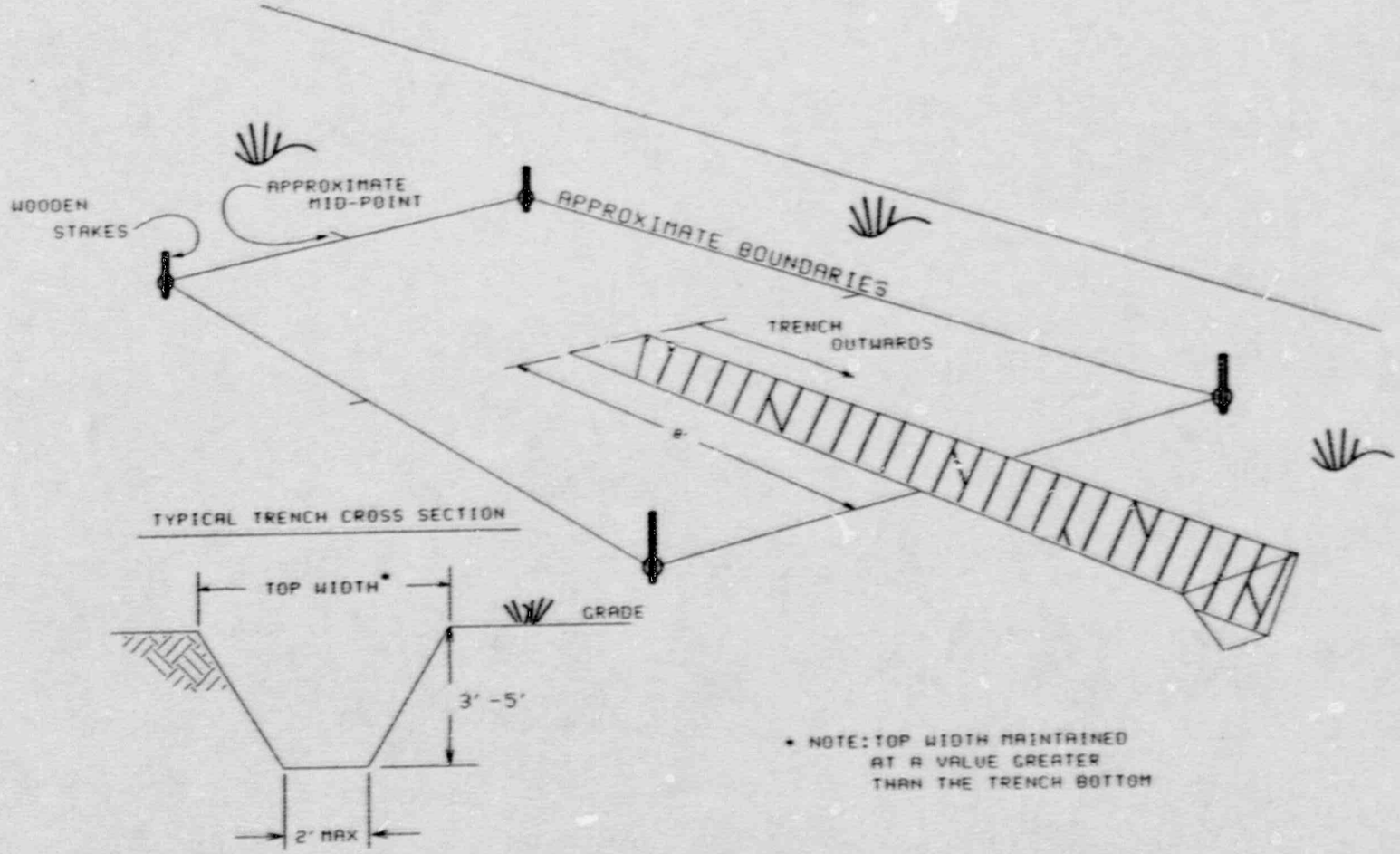


Figure 4-3 Schematic diagram of trenching operations used to locate the edge of disposal holes.

TABLE 4-1

STATUS OF SPECIAL HOLES SUSPECTED OF CONTAINING SOLVENT

Hole	No. of Tanks	Dose Time of Disposal	Date
SH-5	4	400 mR/hr	05/69
SH-10*	6	30 R/hr	10/69
SH-11*	2	45 R/hr	11/69
SH-13	3	40 R/hr	05/70
SH-14	2	50 R/hr	08/70
SH-27	2	100 R/hr	03/72
SH-28	2	10 R/hr	03/72
SH-29	1	35 R/hr	04/72

*Exhumed 1986

Note: Data based on examination of Nuclear Fuel Services burial records.

Soil that was not radioactively contaminated was placed beside the trench. Significant quantities of contaminated soil were encountered. Therefore, Field Change 1 to SOP 40-1 was implemented on May 4, 1989. This Field Change directed soil which was radioactively contaminated to levels greater that 200 CPM beta/gamma to be packaged in accordance with the Radiation and Safety Department's direction. The extent to which contaminated soil was encountered is presented in Table 4-2. When areas of widespread contamination were encountered, the trench was backfilled and excavation was restarted in another area.

If liquid was observed to be seeping into the trench, excavation was stopped and the trench was backfilled. Field Change 1 altered this requirement to have the liquid pumped as per SOP 9-9, Section 6.2.3. The pump discharge was directed to a 1000 gallon storage tank.

Excavation ceased as soon as the edge of a disposal hole was detected by changes in lithology. Trenching was not permitted to exceed five feet in depth without performing soil probing in advance of the excavation.

The inability to define the special hole boundaries by this method and the discovery of solvent tanks less than five feet below grade led to the implementation of Field Change #2 on May 11, 1989. This Field Change allowed the trench to exceed 16 feet in length. Field Change #3, dated May 22, 1989, allowed maximum trench depth to reach seven feet as long as probing was done in advance of excavation.

Table 4-2

SOIL CONTAMINATION LEVELS ENCOUNTERED DURING TRENCHING OPERATIONS

Hole #	Depth of Tank Top Below Grade	Soil Depth	Soil Type	Contamination Observed
5	5'	0' to 3'	Sand-gravel	background (approx.)
		3'	Top of clay	160 CPM beta/gamma
13	4 1/2'	0' to 3'	Sand-gravel	
		3' 10"	Clay	1000 CPM beta/gamma
		8' 2"	Clay	2000 CPM beta/gamma
14	5 1/2'	0' to 3'	Sand-gravel	
		> 3'	Clay	
27	10'	0' to 3'	Sand-gravel	200 to 700 CPM beta/gamma
		10'	Clay	1500 to 2000 DPM beta/gamma and 1500 DPM alpha
28	9 1/2'	0' to 3'	Sand	150 to 300 CPM beta
				350 CPM beta/gamma
		7'	Clay	12 CPM alpha
29	8 1/2'	0' to 3'	Sand-gravel	100 to 600 CPM beta/gamma
				2500 CPM hot spot
		3 1/2' to 5 1/2'	Clay	1000 to 8000 CPM beta/gamma
		8 1/2'	Clay	10,000 CPM beta/gamma
		≥12'	Clay	>40,000 CPM beta/gamma

4.1.3 Soil Probing

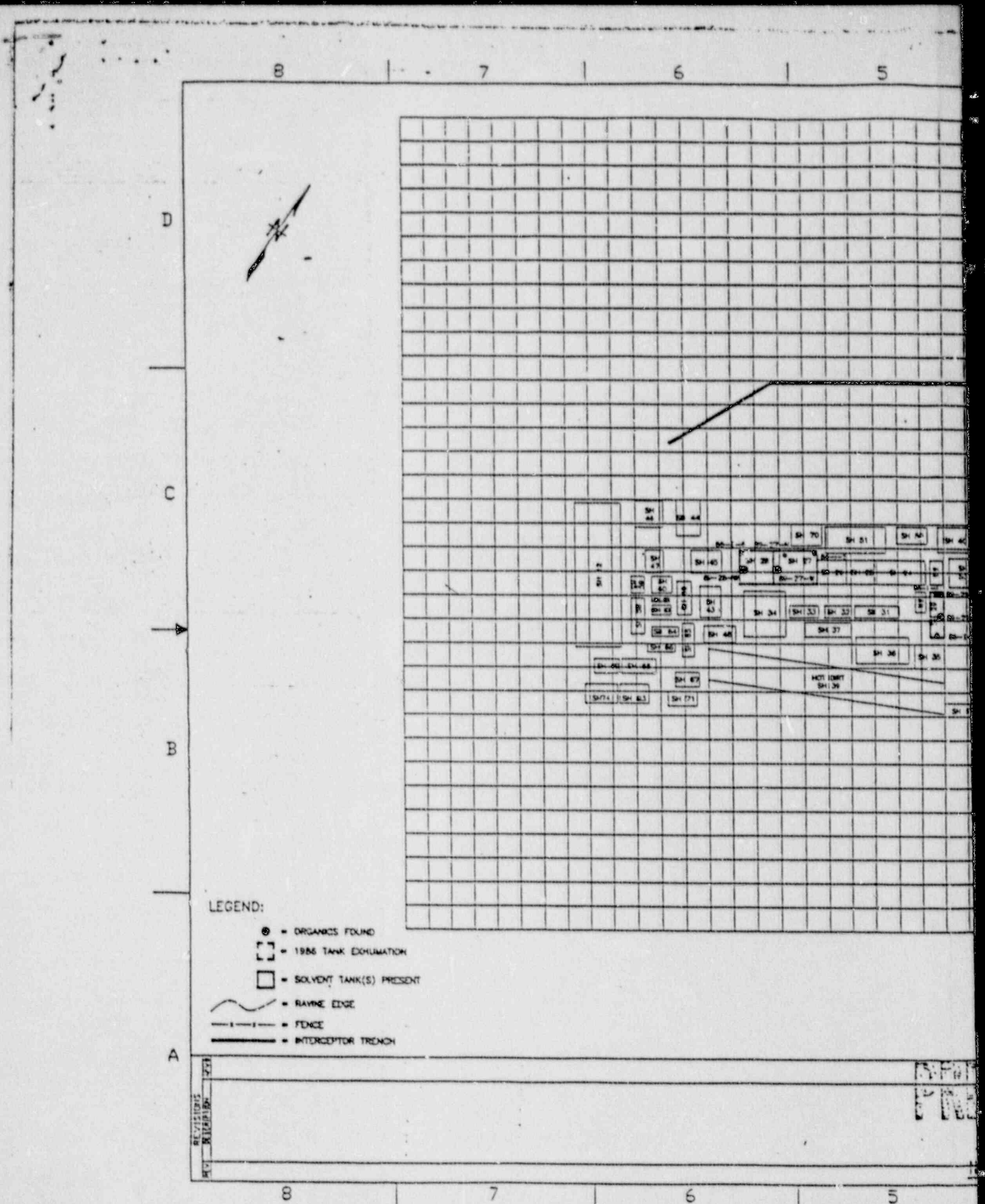
If during trenching operations, subsurface conditions were insufficient to allow identification of the disposal hole boundaries, soil sampling was performed below the trench invert to provide additional data to delineate the special hole boundaries.

Soil sampling was performed using a thin walled, 3/4 inch diameter 15 inch long soil sampling tube with extension rods. The sampler was pushed or driven to a maximum of 15 inches below the trench invert. The tube was then withdrawn, taking a soil core with it. The removed soil core was frisked for beta/gamma and alpha contamination using the portable frisker. The sample was then inspected for lithologic evidence of coming from undisturbed parent till or the disturbed backfill soil.

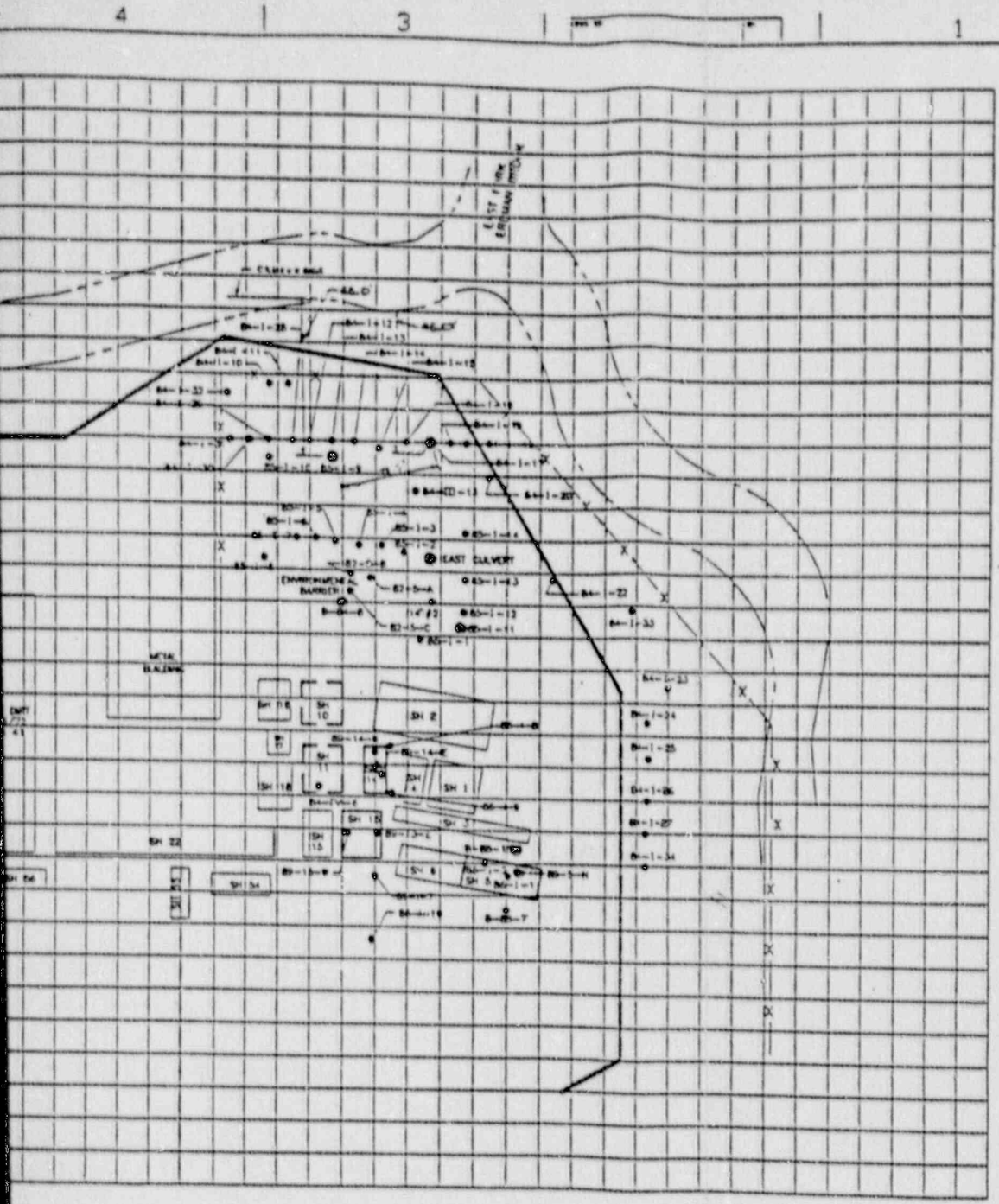
At the direction of the field supervisor soil samples were taken from below the trench floor in sufficient number and pattern in an attempt to identify the disposal hole boundary.

Field Change #2 directed the soil sampling tube to serve as a probe to check for the presence of the buried solvent tanks. The soil sampling and trenching was performed in alternating steps to a maximum depth of five feet below grade. If evidence of a buried solvent tank was felt with the soil sampling tube, additional soil samples were obtained to gather information regarding the orientation and depth of the tank.

Trench sections were backfilled as soon as exploration activities ceased. This was to minimize the possibility of liquid infiltration and the spread of contamination. Backfilling was accomplished by placing clean clay in the trench with a backhoe or shovel in six inch layers. Each layer was compacted with a motorized tamper and/or the backhoe bucket.


8
7
6
5
D
C
B
A
LEGEND:
= ORGANICS FOUND
= 1986 TANK EXHUMATION
= SOLVENT TANK(S) PRESENT
= RAVINE EDGE
= FENCE
= INTERCEPTOR TRENCH
REVISIONS

Figur



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Open trenches in the process of being investigated were covered with plastic during non-working periods and inclement weather.

4.1.4 Subsurface Probing

Field Change #4 to the SOP, dated July 6, 1989, was made to allow additional techniques to be performed to find the solvent tanks. Upon defining the special hole boundaries, the thin walled soil core sampler was used to verify the presence or absence of the buried solvent tanks. The purpose of this was to identify candidate locations for the monitoring wells that would not strike the tank.

A series of evenly spaced (about one foot) soil cores were taken along the trench floor using the thin walled soil sampler. Cores were removed at progressively deeper depths in approximately 15 inch lengths. Cores were taken at increasing depths until a solvent tank was felt or the sampler was fully extended. The sampler was 7 feet long when all the extension rods were used.

The removed cores were inspected for lithologic condition, and surveyed for radioactive contamination and the presence of spent solvent. If evidence of a buried solvent tank was encountered, the depth below grade of the sampler tip (and tank) was noted. The depths reached by the sampler in each core hole were compared to each other. This was useful in estimating tank orientation and depth.

Additional soil cores, trenching, and probing were then conducted at the discretion of the field supervisor to aid in identification of the tank position.

Once the buried solvent tanks were located as precisely as possible, final probings were made at the proposed well locations to verify that the well would be within the special hole boundaries but would not strike a tank.

If solvent or water filled a probe hole, the hole was plugged with clay and the trench above it was backfilled using the previously described methods. Field Change #4 revised this requirement to allow for the liquid to be sampled and pumped out. The flooded probe hole was then investigated further, and other soil cores/probings were made. Field Change #4 also eliminated the requirement to immediately backfill the trench.

The selected locations for well installation were marked. If the well installation could not proceed immediately, the trench was backfilled with compacted soil using the methods previously described.

4.1.5 Well Installation

Installation of the ten exploratory wells was performed by driving a 2-3/8 inch outside diameter well to the approximate depth of the special hole. A light duty drilling rig consisting of a tripod, motorized cathead, and 140 pound drive weight (Figure 4-4) was used.

A pilot hole was initially opened at the chosen location by using an AW flush coupled drill rod with a steel probe point attached to the lead end and AW flush jointed steel casing. The AW casing fits over the AW drill rod.

The AW drill rod came in two foot sections (one with a six inch steel drive point attached) with six inch couplers. The AW casing consisted of a five foot lead end, a five foot extension

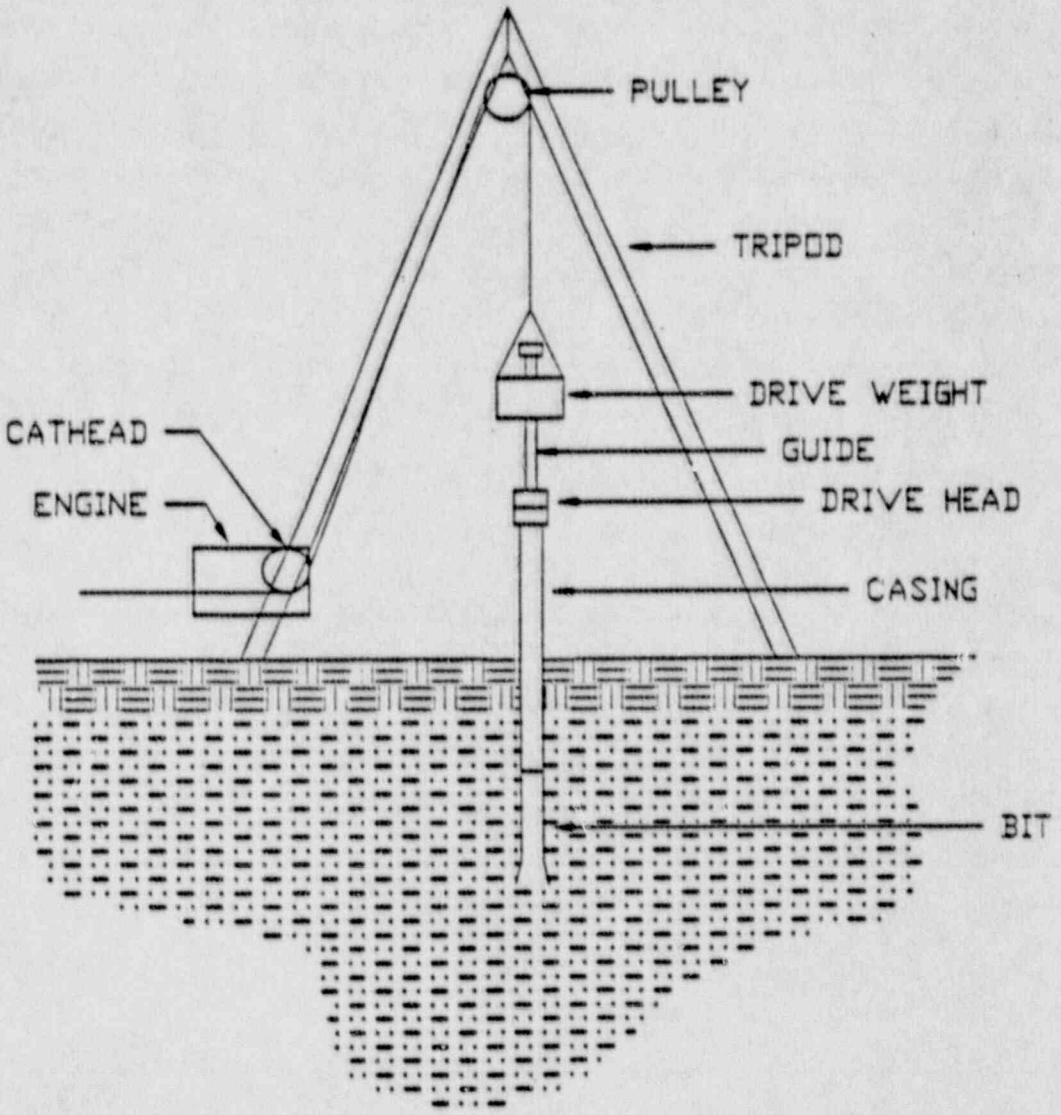


Figure 4-4 Tripod rig used for driving wells and casing.

section, and numerous two foot extensions. A drive head was attached to the uppermost section of drill rod or casing to protect the threads from the force of the dropped weight.

The AW drill rod and AW casing were alternately driven into the subsurface in increments of three to nine feet. Additional sections of drill rod and casing were added as the pieces were driven deeper. The drive rate of the drill rod and casing were controlled to allow the depth to the bottom of the special hole to be determined and to insure against puncturing the buried tank.

The drill rod and casing were driven to a depth that would allow the well screen to cover the entire depth of the special hole. The bottom of the hole was determined from an increase in soil resistance to driving and from knowing the depth to the top of the solvent tank and its approximate dimensions.

After the AW drill rod and AW casing were driven to the desired depth they were removed. First the drill rod was extracted by driving the rod up with the drive weight and motorized cathead until it was loose enough to be pulled by hand. The casing was pulled the same way. During withdrawal operations, the drill rod and casing were continuously monitored for alpha and beta/gamma contamination. Contaminated sections were either decontaminated on the spot or were packaged and stored for disposal as low level radioactive waste. The bore hole created was about 2 1/4 inches in diameter.

Once the AW drill rod and AW casing were cleared from the bore hole, the well screen was installed. A 2-3/8 inch outside diameter flush jointed stainless steel slotted well screen was used. The screens came in five foot and three foot sections. The latter included a six inch pointed tip. Non-slotted riser sections come in 5 foot lengths and were equipped with lockable

caps. Each well, when installed, consisted of a three foot tip section, one or two five foot screens, and a five foot riser with cap.

A three foot tip screen and a five foot screen were initially placed in the borehole and pushed down as far as possible by hand. Then the AW drill rod tip and several extension sections were placed inside the well screen and well tip sections and attached to the drive head. The 140 pound weight was dropped on the drive head and the force was transferred to the tip of the well, driving the well to the bottom of the borehole.

The well was driven to the desired depth by this method. The objective was to have the well screen cover the depth of the special hole with about two feet of riser extended above grade level.

Initially, the screen was advanced by driving the riser pipe. This resulted in damage to the riser. Therefore, the screen was advanced by driving a rod which extended into the well and exerted force on the tip. The number of blows per inch of screen travel were counted during the driving process. To protect the well screen from stretching during this activity, the well screen was driven by an external, above ground technique if the blow counts exceeded 12 per 6 inches of screen travel. However, this resulted in damage to the riser and joints between sections. The procedure was therefore revised to let the penetration resistance exceed 12 blows per 6 inches of screen travel at the discretion of the field supervisor.

After the well screen reached the desired depth, the trench was backfilled by the previously described methods. Concrete collars, one foot in depth and two feet in diameter, were then poured. Figure 4-5 illustrates the final well installation.

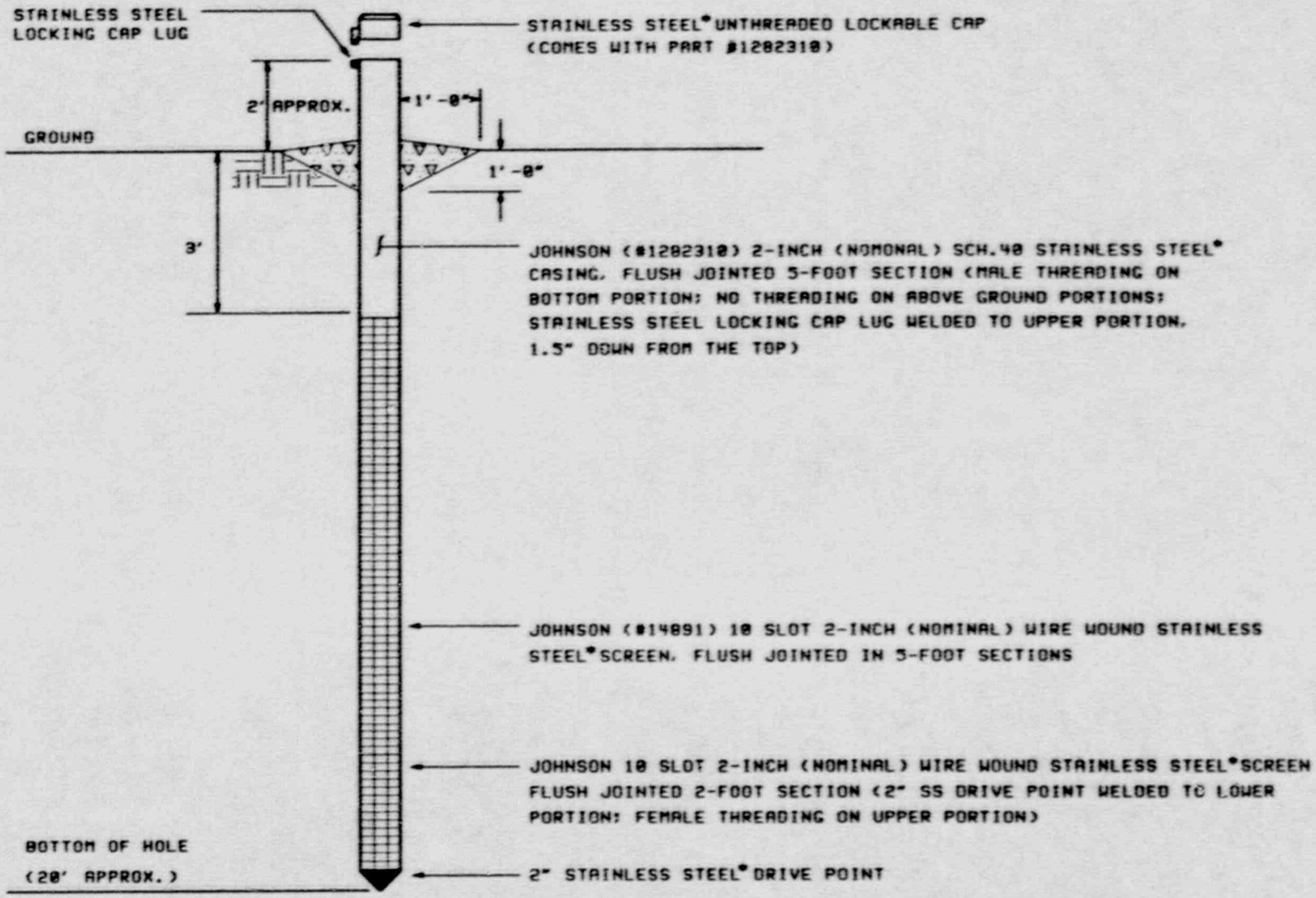


Figure 4-5 Details of exploratory well installations.

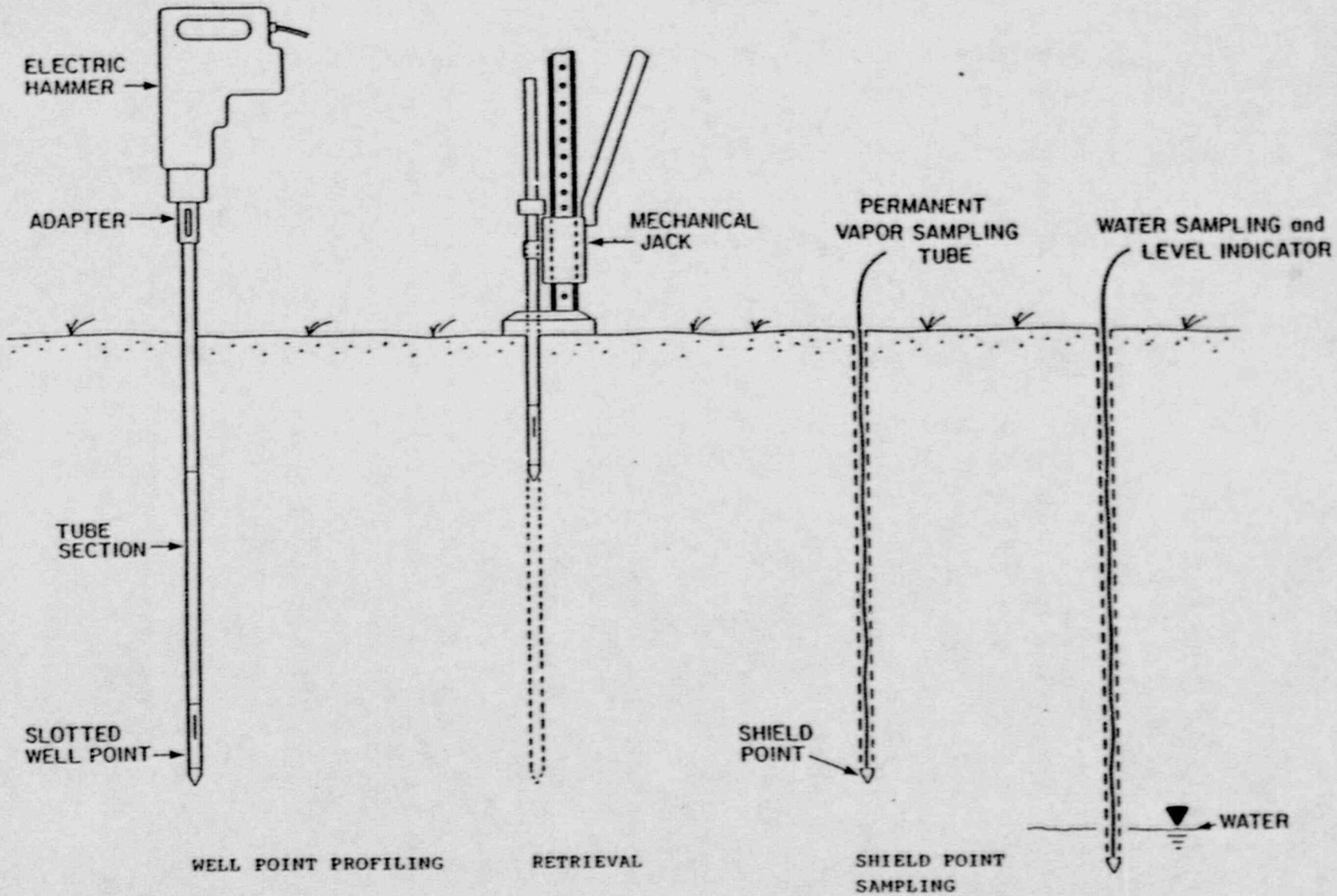
4.2 SOIL GAS INVESTIGATIONS

4.2.1 Soil Gas Probe Installation

Soil gas probes were installed in two areas. The first was in the vicinity of special hole 29, and the second was near several USGS wells north of the sprung structure. Individual locations chosen for soil gas probe placement were based on the known presence of free solvent in the soil.

A special collar was installed to prevent the spread of contamination in near surface materials if the driving of the soil probe forced contaminated liquid upward. A six inch diameter auger was first used to bore a hole about 3 1/2 feet below the ground surface. The soil and auger were checked for contamination as they were removed. A five foot length of two inch inside diameter PVC pipe was then placed into the bore and gently tapped several inches deeper into the soil. The annular space left between the borehole and the outside of the PVC pipe was then filled with a cement-bentonite grout and allowed to cure for a minimum of 12 hours.

A pilot hole for the slotted soil gas probe was then created by driving a 36 inch section of hollow 5/8 inch tempered steel shaft with a flush pointed tip attached to the lead end. Driving force was provided with an electric demolition hammer. Additional sections of 36 inch shaft were added as necessary. The tip of the shaft was driven to a point about five inches higher than the desired final depth of the soil gas probe. The shafts were then extracted, using either hand force or a modified jack (Figure 4-6). During extraction the shafts were continuously monitored for contamination.



" Graphic description of operation"

Figure 4-6 Procedure for installation of soil gas vapor probes.

The permanent vapor point was made by crimping a section of 3/16 inch outside diameter flexible plastic tubing to a slotted soil gas probe point. The probe was placed at the bottom of the 5/8 inch diameter shafts and the tubing was fed through the inside. The probe point merely fit against the shaft section - it was not threaded into it or otherwise tightly affixed to it. This assembly was then placed into the pilot hole and driven about five inches deeper than the pilot hole using the demolition hammer. The shaft sections were then removed and monitored for contamination. This extraction was made by hand. The soil gas probe point was left in the ground with the plastic tubing protruding from the surface.

About 3/8 of a cup of glass beads were then poured down the pilot hole, followed by clean dry sand to a level of about two inches above the bottom of the augured bore hole. The purpose of the glass beads and sand was to fill the annular space between the pilot hole and 3/16 inch plastic tubing and probe point with a porous material. This would allow soil vapors to collect.

The space inside the PVC pipe above the sand was then filled to near the top with either a cement - bentonite grout or a bentonite slurry. This sealed the pilot hole and porous medium so that soil vapors would not escape to the atmosphere and also assured that gases withdrawn from the probe would not be diluted with air from the surface. The plastic tubing was then coiled on the inside of the PVC pipe and a cap installed. Figure 4-7 illustrates a typical installation.

4.2.2 Soil Gas Sampling

Soil gas sampling was accomplished by attaching a small vacuum pump to the end of the plastic tubing and purging the tubing for a period ranging from 45 seconds to 4 minutes.

While the vacuum pump was drawing soil gases, a needle and syringe were pushed through a self sealing septum upstream of the vacuum pump. A gas sample was drawn with the syringe. The syringe was then transferred to the lab area where 10 cc was injected into a gas chromatograph. The gas chromatograph data was evaluated for a dodecane peak.

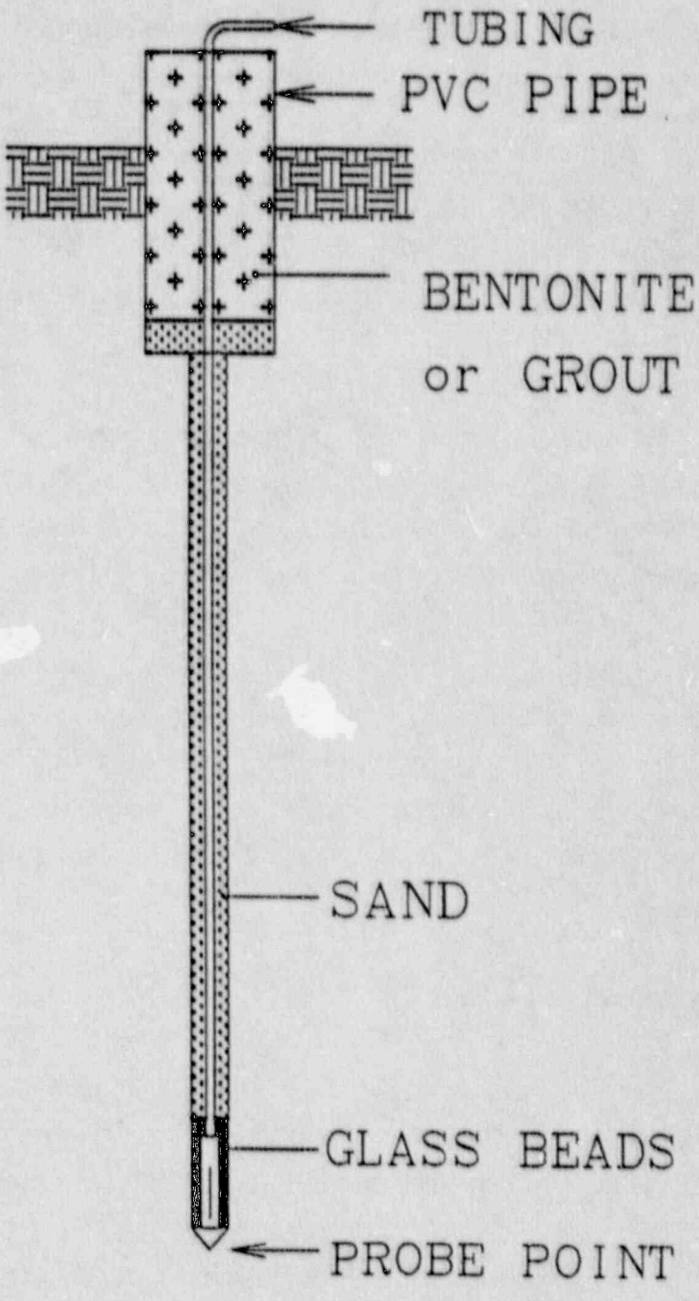


Figure 4-7 Details of soil gas vapor point installation.

5.0 RESULTS

5.1 FINDINGS OF INVESTIGATION

5.1.1 Installation of Exploratory Wells

The activities to locate and install the exploratory wells yielded information on the depths and orientation of the tanks, contamination levels of the soil, general dimensions of the special holes, and conditions of the fill soil. In addition, direct evidence of solvent leakage was observed in five of the six disposal holes.

The wells, besides giving evidence of solvent leakage, also revealed that a significant quantity of water had infiltrated into the holes. This could ultimately lead to complete filling and perhaps overflow of the disposal hole.

As the primary goal of this work was to install the monitoring wells, the information gathered during the installation process tends to be specific to the individual burial hole. Thus, characteristics noted at one disposal hole may not have been applicable to another. Details of the findings for each disposal hole follow.

5.1.1.1 Special Hole 13

SH-13 is located inside the sprung structure which was erected for the exhumation of solvent tanks from SH-10 and SH-11. It is located slightly south of SH-11 and SH-14 (Figure 4-1). NFS burial records indicated three solvent tanks with a contact dose rate of 40 REM/hr were buried in SH-13 during May, 1970 (Table 4-1).

No lithologic evidence of the special hole boundaries was observed while trenching. Trenching did, however, result in two tanks being uncovered at depths of 3.8 and 4.6 feet below grade. The deeper tank was slightly turned on its side. The tanks were oriented in a north-south direction. The location of the tank limits were estimated based on known tank dimensions. Stakes were placed at the estimated limits. The visible portion of the tanks appeared to be in good physical condition. The third tank reported to be in the hole was never found.

Increased resistance to soil probing, along with a marked change from a brown clay with numerous seams to a homogenous gray clay, gave indication of sloped hole walls on the east and west sides. A soil probe hole slightly to the west of what was believed to be the western boundary of SH-13 filled with a liquid that had the appearance of solvent found in the other holes investigated. No sample was taken, and the probe hole was plugged with clay and the trench backfilled.

The upper three feet (approx.) of soil over SH-13 consisted of a sand and gravel material that was highly permeable to water flow. A layer of burlap was noted near the bottom of this porous layer (Table 4-2).

Two attempts were made to drive a borehole for well screen installation on the north side of the hole. On both attempts, the AW drill rod and casing failed to stay in a vertical direction. In addition, water infiltration led to increasing contamination levels on the trench bottom. A sample of this higher activity liquid (which had an organic layer on it) was extracted for analyses. The results are included on Table 5-2.

Attempts to place a well on the north side were aborted and the trench was backfilled.

Wells were then installed on the east (89-13-E) and west sides (89-13-W) of the tanks (Figure 5-1) without incident (Table 5-1). Liquid seeping into the trench for well 89-13-W, however, did form a layer which had the visual appearance of emulsified organic. This material was not sampled. After the wells were installed powdered bentonite was packed in a ring around the well riser where it passed from the porous surface layer into the non-porous fill soil to prevent water from leaking down into the well.

Well soundings taken since installation are plotted on Figures 5-2 and 5-3. These show an approximate 1.5 month long stabilization period. No solvent has been observed in the wells.

5.1.1.2 Special Hole 14

SH-14 is also located in the sprung structure. It is several feet to the west of SH-11 (Figure 4-1). Burial records indicate two solvent tanks with a contact dose rate of 50 REM/hr were buried in SH-14 during August 1970.

As with SH-13, no lithologic evidence of the special hole boundaries was observed during trenching operations. Trenching did result in exposure of the two tanks at a depth of 5.5 feet below grade. The tanks were oriented in a north-south direction. The tank edges were estimated from known tank dimensions and staked. The visible portion of the tanks appeared to be in good physical condition. The upper three feet of soil above the tanks consisted of a porous sand/gravel mixture (Table 4-2).

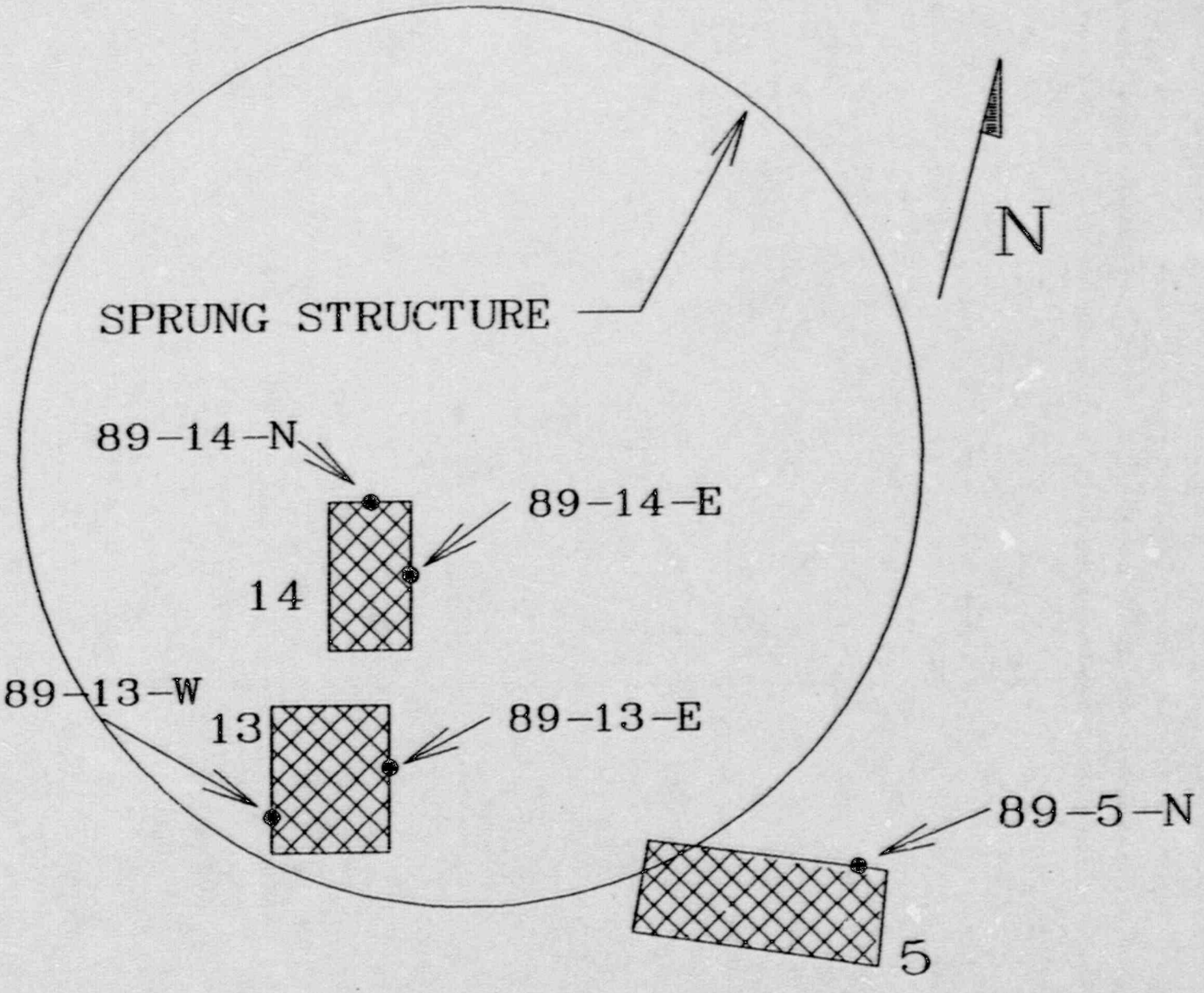


Figure 5-1 Location of disposal holes and exploratory wells in the vicinity of the sprung structure.

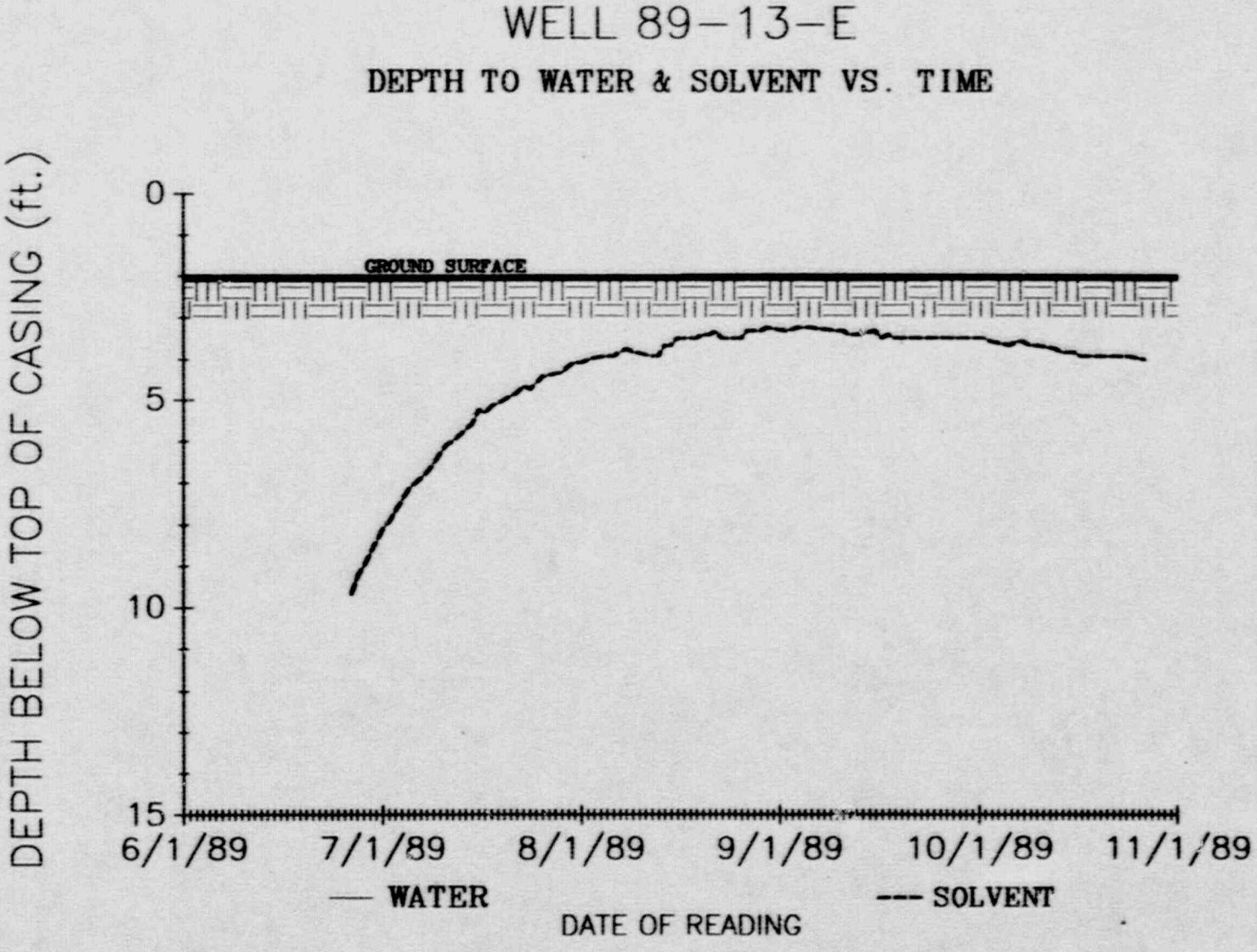


Figure 5-2 Hydrograph for well 89-13-E.

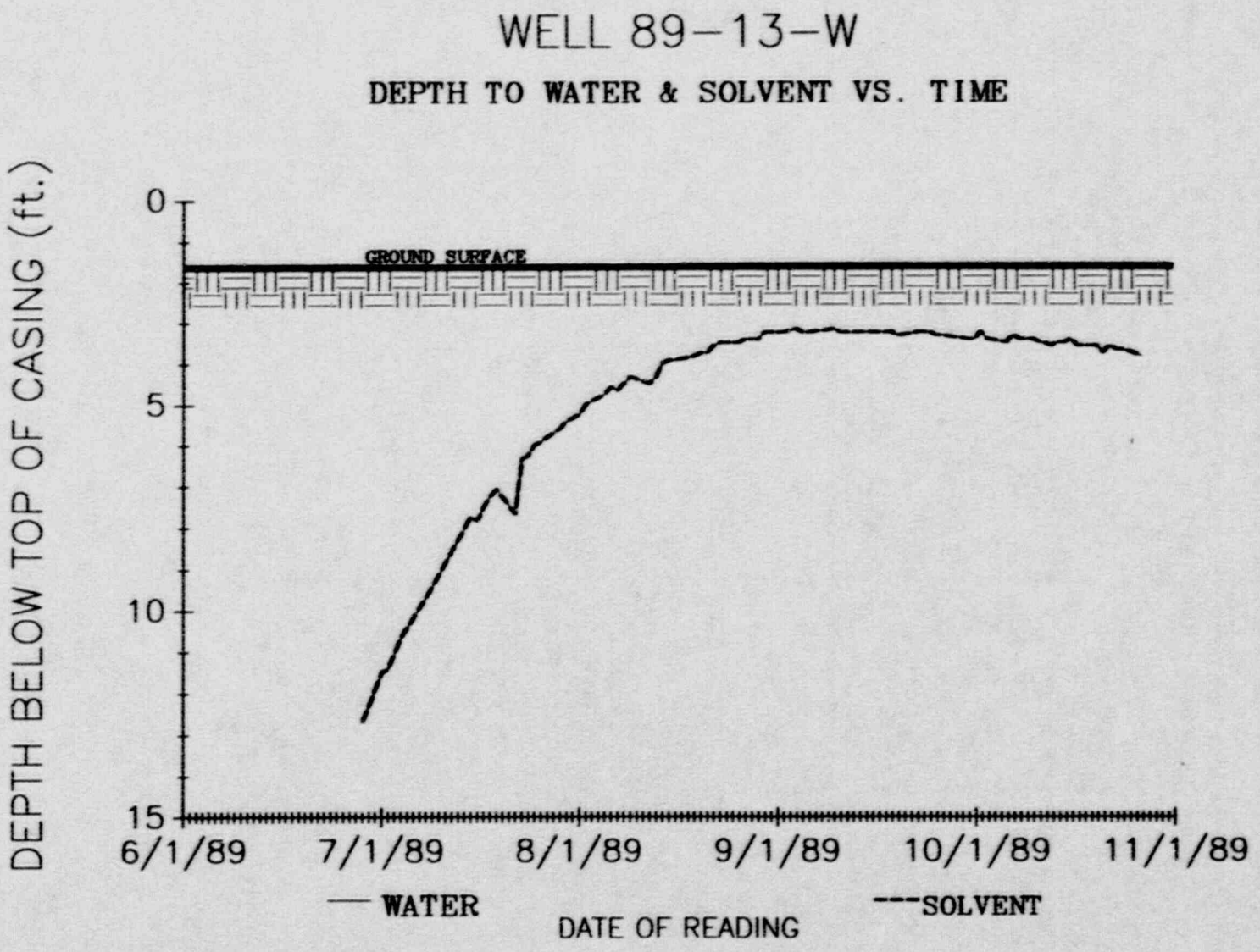


Figure 5-3 Hydrograph for well 89-13-W.

Table 5-1

DETAILS OF WELL CONSTRUCTION

Well Number & Inst. Date	Construction	Stick Up above Concrete Collar	Bentonite Seal (Below Grade)	Amount of Screen Below Grade
89-13-E 5/20/89	5' riser 5' screen 3' tip	24 1/2"	3'	7 1/2'
89-13-W 6/22/89	5' riser 5' screen 3' tip	19 1/4"	3' 4"	7 1/2'
89-14-N 6/06/89	5' riser 5' screen 3' tip	24"	3'	7 1/2'
89-14-E 6/09/89	5' riser 5' screen 3' tip	21"	2 1/2'	7 1/2'
89-5-N 9/12/89	5' riser 5' screen 3' tip	20 1/2"	3'	7 1/2'
89-27-N 7/25/89	5' riser (2) 5' screen 3' tip	22 1/2"	2'	12 1/2'
89-27-W 7/26/89	5' riser (2) 5' screen 3' tip	22"	2'	12 1/2'
89-28-W 8/30/89	(2) 3' risers 5' riser 5' screen 3' tip	28"	2 1/2'	7 1/2'
89-29-N 7/12/89	5' riser (2) 5' screen 3' tip	23"	2 1/2'	12 1/2'
89-29-E 6/29/89	5' riser (2) 5' screen 3' tip	21 1/2"	3'	12 1/2'

Table 5-2

RADIOCHEMICAL DATA ENCOUNTERED IN LIQUID SAMPLES

Hole No.	5	13	27	28	28	28	28	29	29
Date	5/19	6/13	7/26	8/1	8/2	8/31	8/31	5/21	5/25
Sample Type	water & solvent	water & solvent	water & mainly solvent	solvent	water & solvent mix	water & solvent mix	water & solvent mix	water	solvent
Sample Source	trench seepage	trench/ bore hole seepage	bore hole	probe hole	*bore hole	*upper layer of new well installation	*lower layer of new well installation	*trench seepage	probe hole
SAMPLE RESULTS IN uCi/ml									
Gr. alpha	1.04E-7	9.59E-3	1.00E-3	3.25E-4	3.33E-3	2.29E-4	2.27E-4	<5.12E-6	<5.12E-6
Gr. beta	1.41E-5	8.21E-2	2.09E-3	2.58E-3	1.02E-1	1.84E-3	1.76E-3	7.93E-3	3.55E-5
ACTIVITY BY NUCLIDE IN uCi/ml									
Na-22					3.33E-4 (±.13)				
Co-60	<5.8E-7		3.38E-5 (±.54)		5.33E-4 (±.11)	3.36E-5 (±.85)	2.97E-5 (±.25)	<1.07E-5	<3.00E-5
Sr-90								6.08E-3 (±.08)	
Sb-125	<8.3E-7		2.42E-3 (±.05)	2.89E-3 (±.66)	2.42E-3 (±.15)	2.56E-3 (±.09)	2.38E-3 (±.03)		
I-129	4.9E-4 (±.4)				4.31E-4 (±1.78)	1.23E-3 (±.1)			1.4E-4 (±.25)
Cs-137	<1.5E-6	2.85E-3 (±.2)	2.33E-4 (±.12)		7.41E-2	2.6E-5 (±.1)	1.86E-5 (±.23)	<1.28E-5	<5.70E-6
Eu-154					9.09E-4 (±.08)				

Table 5-2

RADIOCHEMICAL DATA ENCOUNTERED IN LIQUID SAMPLES

(Continued)

Eu-155			1.96E-4 (±.31)			
Am-241	<1.6E-7	4.12E-4 (±.12)	3.51E-3 (±.03)	5.55E-5 (±.43)	<4.87E-6	2.46E-6 (±.87)
U-235	<1.3E-7		<2.86E-5			

* Taken from same hole.

Wells were installed on the east (89-14-E) and north (89-14-N) sides of the special hole. The locations of these wells are shown on Figure 5-1. The detailed dimensions of the well installation are shown on Table 5-1.

Well 89-14-N was initially installed without a bentonite seal. Initial soundings of this well (Figure 5-5) led to the conclusion that water in the porous surface layer was migrating downward along the riser into the screen. Therefore, a powdered bentonite seal was installed around the riser where it passed into the impervious fill. Well 89-14-E was installed with the bentonite seal and showed a 1.5 month stabilization period as shown by the water levels plotted on Figure 5-5.

A layer of solvent first appeared in well 89-14-N in the middle of September, 1989. No solvent has been observed in well 89-14-E.

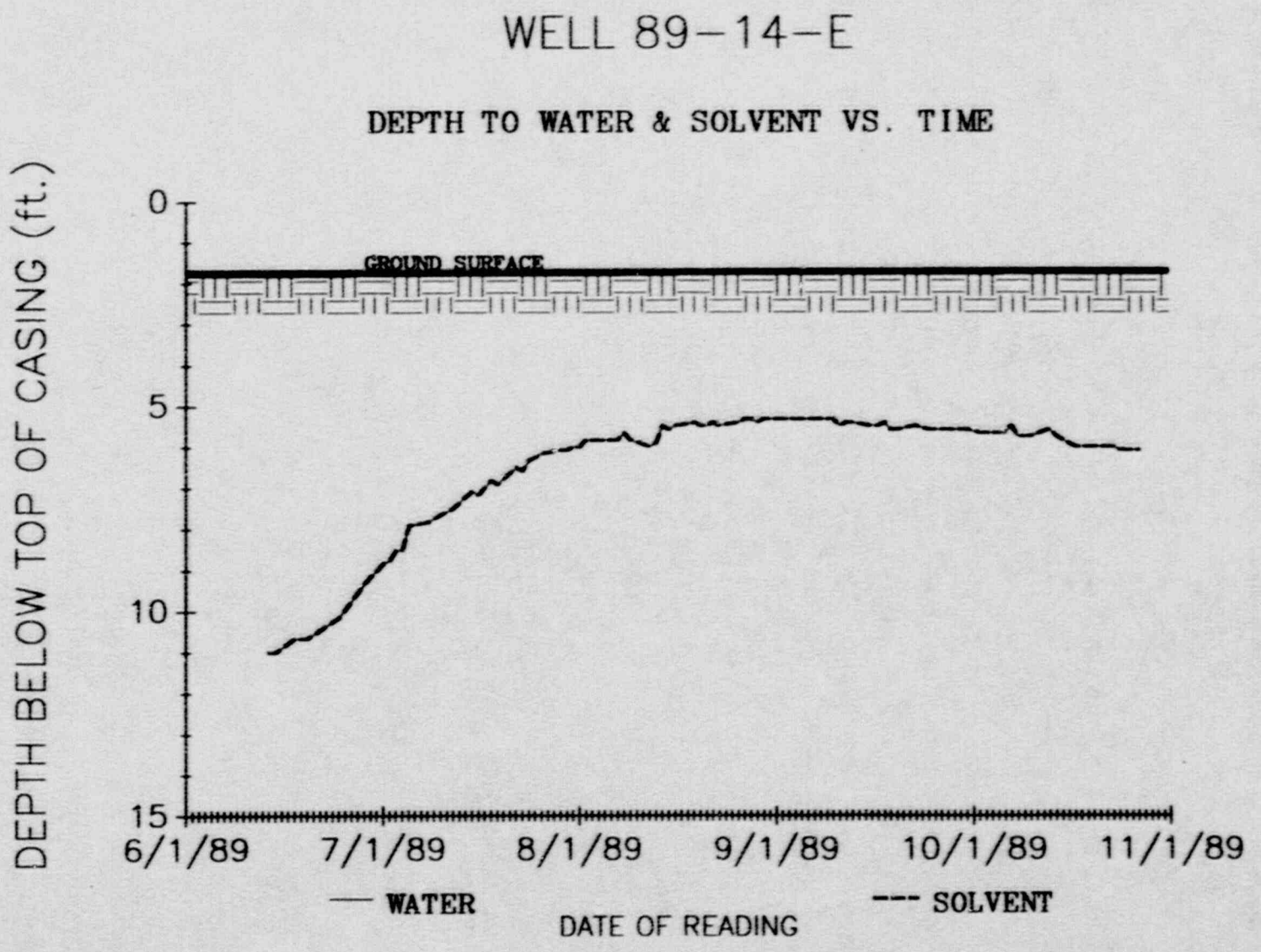


Figure 5-4 Hydrograph for well 89-14-E.

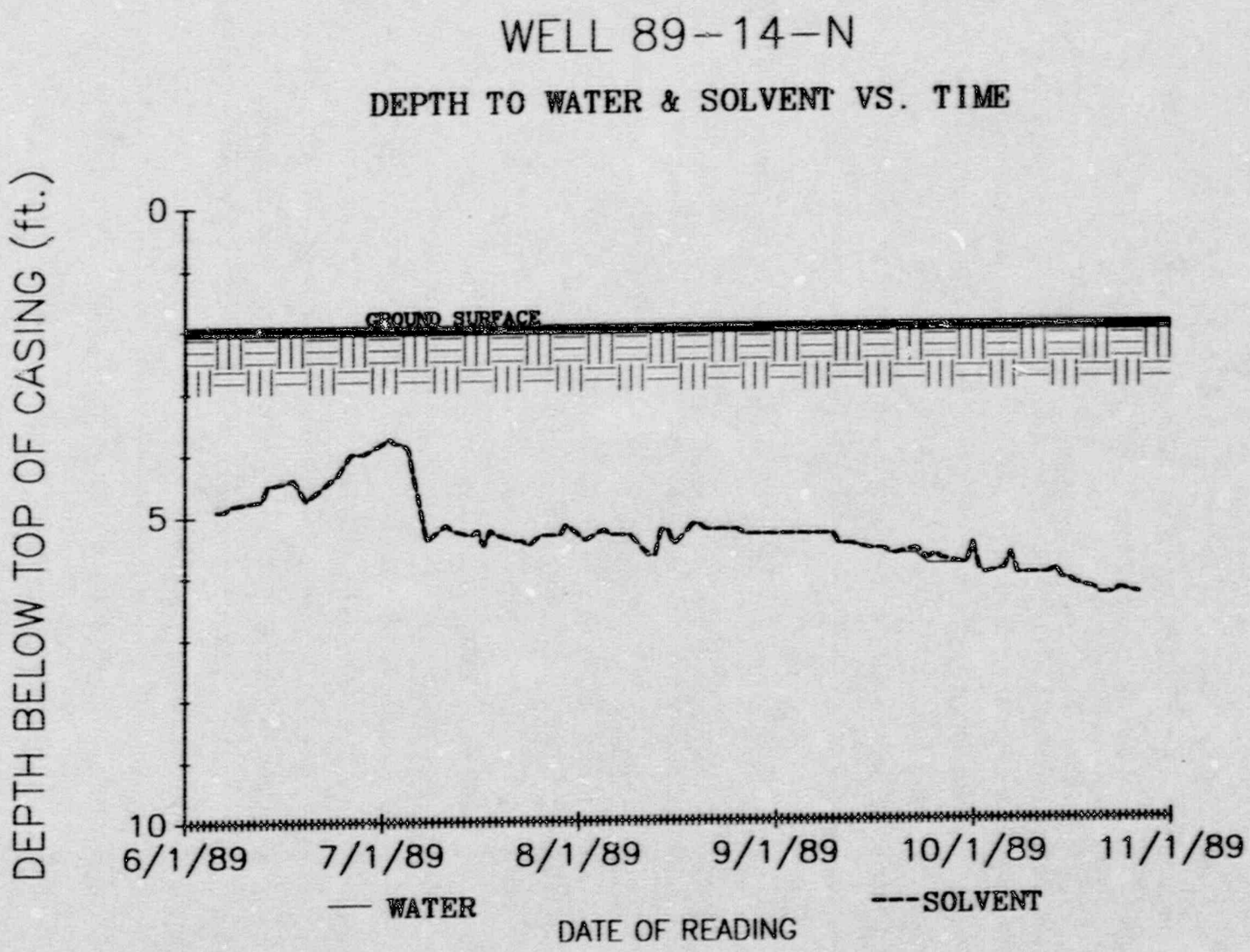


Figure 5-5 Hydrograph for well 89-14-N.

5.1.1.3 Special Hole 27

SH-27 is located south of the northern boundary of the NDA and west of the structures erected for the exhumation of solvent tanks from SH-10 and SH-11. It is bordered to the west by SH-28 and to the east by SH-26 (Figure 4-1). Burial records indicate that two solvent tanks with a contact dose rate of 100 REM/hr (Table 4-1) were disposed of during March 1972.

No lithologic evidence of the disposal hole boundaries was observed during trenching. Based on probe data, the solvent tanks were estimated to be about ten feet below grade. The orientation of the tanks could not, therefore, be easily estimated. The high dose rate believed to be associated with these tanks made extensive trenching and further probing undesirable.

Probing did reveal evidence of significant solvent leakage. It was also noted that the soil cores removed became more plastic as their depth increased. Eventually the core sampler failed to be able to retrieve a core. No boundary was found between SH-27 and SH-28. Wells were installed on the north (89-27-N) and west (89-27-W) sides of known tank edges.

Well 89-27-N was installed without incident. However, during removal of the AW drill rod during installation of well 89-27-W, contamination levels of 1500 DPM alpha and 1500 DPM beta-gamma were noted. The inside of the drill rod was also filled with solvent. A sample of the solvent was taken for analysis and the rest was poured back into the borehole. The results of the analysis, which are presented on Table 5-2, revealed elevated levels of radioactivity relative to samples from other holes. The AW drill rod and AW casing removed were effectively decontaminated at the work site. Both wells had a powdered bentonite seal installed.

Soundings of 89-27-N are plotted on Figure 5-6. These data indicate a 2 month long stabilization period. No solvent has been observed.

Soundings of 89-27-W (Figure 5-7) showed an immediate response and an approximately five foot thick solvent layer. The initial fluid levels have remained stable. The analytical results from samples of water and solvent are presented on Table 5-3.

5.1.1.4 Special Hole 28

SH-28 is located south of the northern NDA boundary and west of the structures erected for solvent tank exhumation. It is to the immediate west of SH-27 as is shown on Figure 4-1. Burial records indicated two solvent tanks with a contact dose rate of 10 REM/hr were buried here during March 1972 (Table 4-1), along with a box of miscellaneous material.

Trenching on the west side of the special hole revealed a faint lithologic indication of the hole boundary. A sloped wall with a gray, homogenous soil was observed on the west side, and a browner material with numerous seams was encountered on the east side. This proved of little significance other than showing that a lithologic boundary could, on occasion, be detected.

Probing indicated the tanks to be about 9.5 feet below grade. Free solvent was also encountered during the probing. A sample of this solvent at the proposed site of a north well was taken for analysis. The results of the analysis are presented on Table 5-2. The soil cores removed that had solvent contamination were more plastic than dry cores. The solvent leakage and fill degradation did not appear to be as severe as that encountered in SH-27.

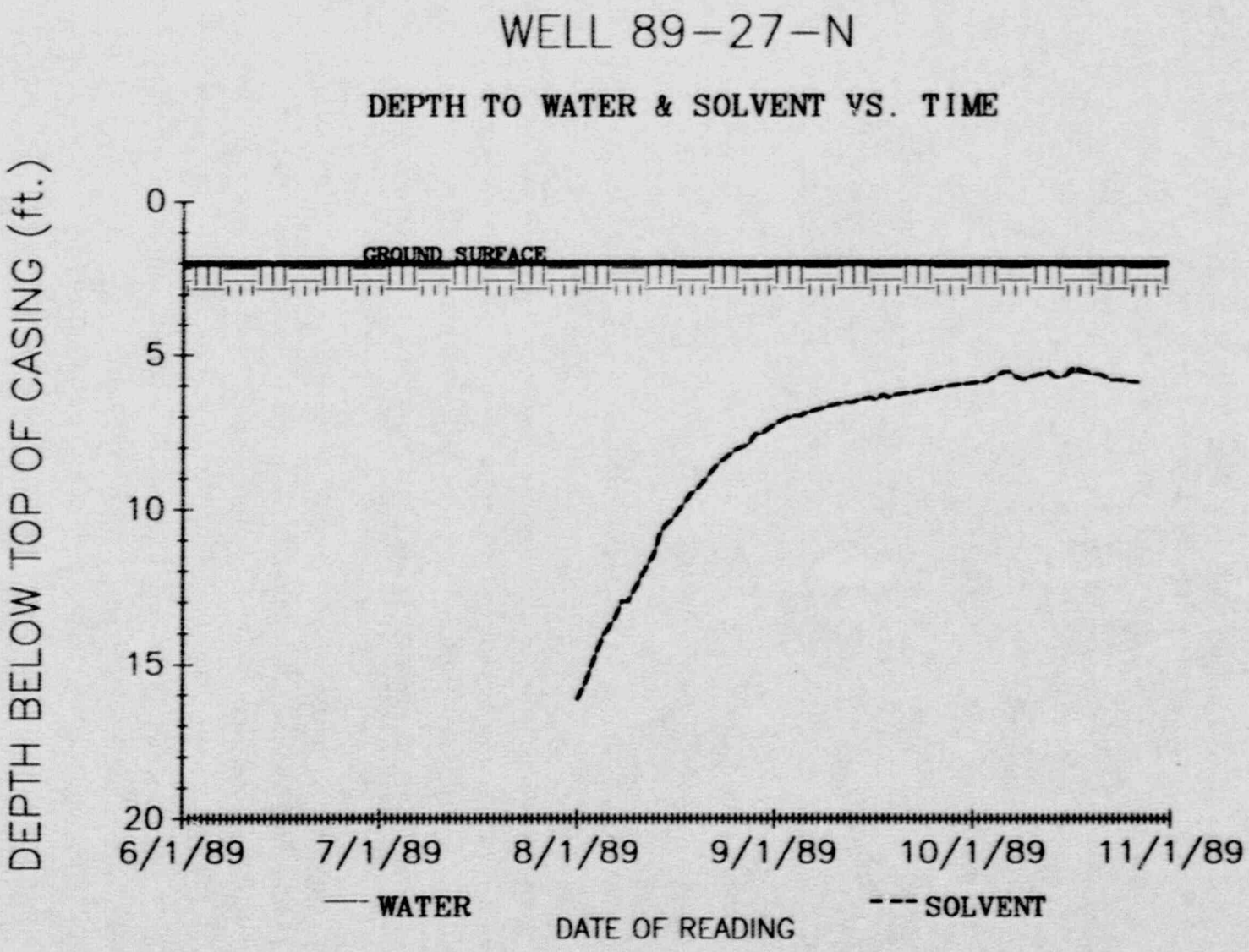


Figure 5-6 Hydrograph for well 89-27-N.

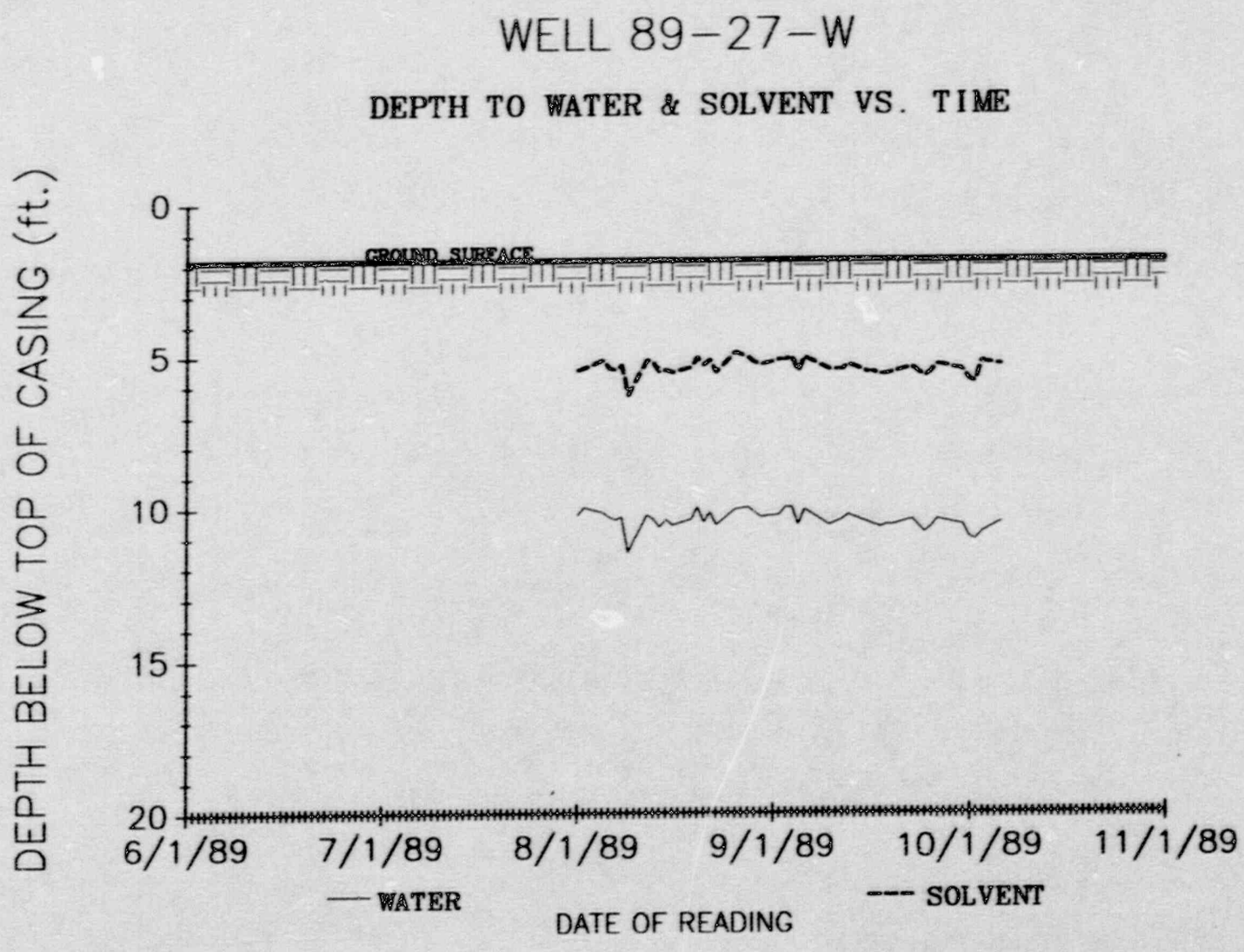


Figure 5-7 Hydrograph for well 89-27-W.

TABLE 5-3

ANALYTICAL RESULTS OF SAMPLES TAKEN FROM EXPLORATORY WELLS

Analytical Results (uCi/mL)

Well	Date Sampled	Phase	Gross Alpha	Gross Beta	Co-60	Sr-90	Sb-125	I-129	Cs-137	Eu-154	Eu-155	Am-241	U-235
89-5-N	10/30/89	Solvent	<1E-6	4.25E-6	<1.48E-6	<3.55E-7	<1.16E-5	4.25E-4 (±0.37)	<5.14E-6	<7.89E-6	<5.53E-5	<6.71E-6	<6.95E-6
89-27-W	10/30/89	Solvent	2.77E-4	1.41E-3	3.14E-5 (±0.3)	6.81E-6 (±1.13)	2.37E-3 (±0.04)	3.99E-4 (±0.38)	4.18E-5 (±0.38)	<1.96E-6	<1.94E-6	1.77E-4	<1.86E-6 (±0.12)
89-28-W	10/30/89	Solvent	1.3E-4	1.46E-3	3.27E-5 (±0.32)	1.55E-5 (±0.18)	2.42E-3 (±0.04)	3.61E-4 (±0.21)	1.69E-5 (±0.30)	<1.94E-6	<1.9E-6	8.69E-5 (±0.95)	<1.86E-6
89-5-N	10/31/89	Water	<5.61E-8	3.82E-5	<1.0E-7	1.18E-5 (±0.06)	<2.09E-7	1.91E-5 (±0.59)	<2.07E-7	<7.75E-8	<7.67E-8	<1.02E-7	<6.80E-8
89-27-N	10/30/89	Water	1.3E-7	5.23E-6	<1.11E-7	1.26E-6 (±0.19)	<2.29E-7	<4.46E-6	<6.01E-7	<6.08E-8	<7.76E-8	<1.03E-7	<8.07E-8
89-27-W	10/30/89	Water	5.87E-3	4.27E-3	1.74E-6 (±0.34)	8.71E-4 (±0.31)	1.05E-4 (±0.04)	1.24E-4 (±0.13)	5.66E-5 (±0.14)	<2.41E-7	<2.69E-7	3.47E-4	<2.16E-7 (±0.04)
89-28-W	10/30/89	Water	1.05E-4	6.81E-3	1.14E-5 (±0.08)	2.16E-3 (±0.04)	<2.5E-6	<8.06E-6	1.78E-3 (±0.01)	2.24E-5 (±0.20)	<7.44E-7	1.22E-4 (±0.05)	<6.19E-7
89-29-E	10/31/89	Water	<5.44E-8	1.70E-6	<1.06E-7	6.77E-8 (±2.25)	<2.56E-7	<3.8E-6	<2.14E-7	<6.79E-8	<6.57E-8	<8.58E-8	7.43E-8
89-29-N	10/30/89	Water	1.56E-7	3.26E-6	<3.77E-8	1.10E-6 (±0.17)	<3.12E-7	<1.72E-6	8.35E-7 (±2.36)	<2.48E-7	<6.9E-7	<2.44E-7	<2.04E-7

The exact locations of the buried solvent tanks could not be estimated by probing because of depth. A proposed well at the known north edge of a solvent tank was not installed due to time constraints and the high levels of activity in well 89-28-W.

Well 89-28-W is located to the west of a known tank edge. During removal of the AW drill rod on August 2, 1989, low levels of contamination were noted (350 CPM beta/gamma and 12 CPM alpha) and the drill rod was decontaminated. Removal of the AW casing indicated similar levels of contamination on its outside. However, much higher levels of contamination were found on the inside of the casing. The levels of activity increased as the lower pieces were pulled up. The top of the lowest five foot casing section gave a frisker reading of 42,000 CPM beta/gamma. Work was stopped, and the casing ends were bagged, with the last section left partially inserted in the borehole. A liquid sample was taken from the borehole for analysis. The results are presented on Table 5-2. The level of activity in this sample was higher than had been encountered previously. The liquid sample had a frisked reading of 150,000 CPM beta/gamma and was much blacker and thinner than the solvent that had been encountered previously. No determination was made as to why the very high contamination levels were only found on the inside of the AW casing.

Because the levels of contamination encountered were higher than anticipated, a modified well installation procedure was implemented. The well screen was installed on August 30, 1989. A 1-1/4 inch outside diameter well screen (as opposed to 2-3/8 in) was used to minimize liquid displacement during installation. The well screen was pushed in by hand. The tripod, cathead and weight were not used.

Because the extent to which the borehole had collapsed was not known, extra riser sections were used for this well instead of screen so that a screen section would not be left extending into the porous surface layer (Table 5-1). Still, the well screen spans most of the special hole depth.

Two liquid samples were obtained from this well on August 31, 1989. Samples were taken from the top and bottom of the liquid in the well with the intent to analyze what was in the water and what was in the solvent, however, the liquid had not separated into layers. The samples had the same appearance as the one taken on August 2, but had a contact frisk level of only 400 CPM beta/gamma. The result of the analysis are listed on Table 5-2.

89-28-W has not been sounded due to the high contamination level of the liquid in it. The analytical results of solvent and water samples taken from the well are presented on Table 5-3.

5.1.1.5 Special Hole 29

SH-29 is located to the west of the structure erected for exhumation of solvent tanks from SH-10 and SH-11. It is not immediately adjacent to other special holes (Figure 4-1). Burial records indicated a single tank with a contact dose rate of 35 REM/hr was buried here during April 1972.

No lithologic evidence of special hole boundaries were observed while trenching. A sample of trench seepage was taken for analysis on May 21, 1989. The analysis results are displayed on Table 5-2.

Probing revealed the location of the single tank. It is oriented in a north-south direction about 8.5 feet below grade. Soil cores also indicated several pockets of contaminated soil with elevated

readings up to 10,000 CPM. These hot spots could be from contaminated fill or from contamination entrapped in fissures during periods of high water level in the burial hole. They also are consistent with the ganglia concept discussed in Section 2.

Free solvent was found near the southern end of the tank and a sample was retained for analysis on May 25. The results are presented on Table 5-2. The sample was taken from one of seven probe holes made in the trench floor. The probe holes were within one to four feet of each other, and extended to at least seven feet below grade. The sample was taken from the only probe hole that filled with solvent. This suggests that the solvent may be confined to a pocket or section of the disposal hole.

Wells were installed on the north (89-29-N) and east (89-29-E) edges of the tank (Figure 5-8) without incident (Table 5-1). Both wells have bentonite seals.

Well 89-29-N showed a 1.5 month stabilization period with no solvent observed (Figure 5-9). Since early September, 1989, fluid levels have been erratic. The reason for this has not been determined. A 1.5 month stabilization period was observed in well 89-29-E (Figure 5-10). A thin layer of solvent has appeared on the water surface in this well, but this is not an adequate quantity to sample. The analytical results of a water sample from the well are presented in Table 5-3.

5.1.1.6 Special Hole 5

SH-5 is located to the southeast of the sprung structure. It is in a diagonal direction to most of the other special holes and may actually extend inside of the sprung structure (Figure 4-1). Burial records indicate four solvent tanks were disposed of in SH-5 during May, 1969. The Contact dose rate estimated for the tanks was 0.4 REM/hr.

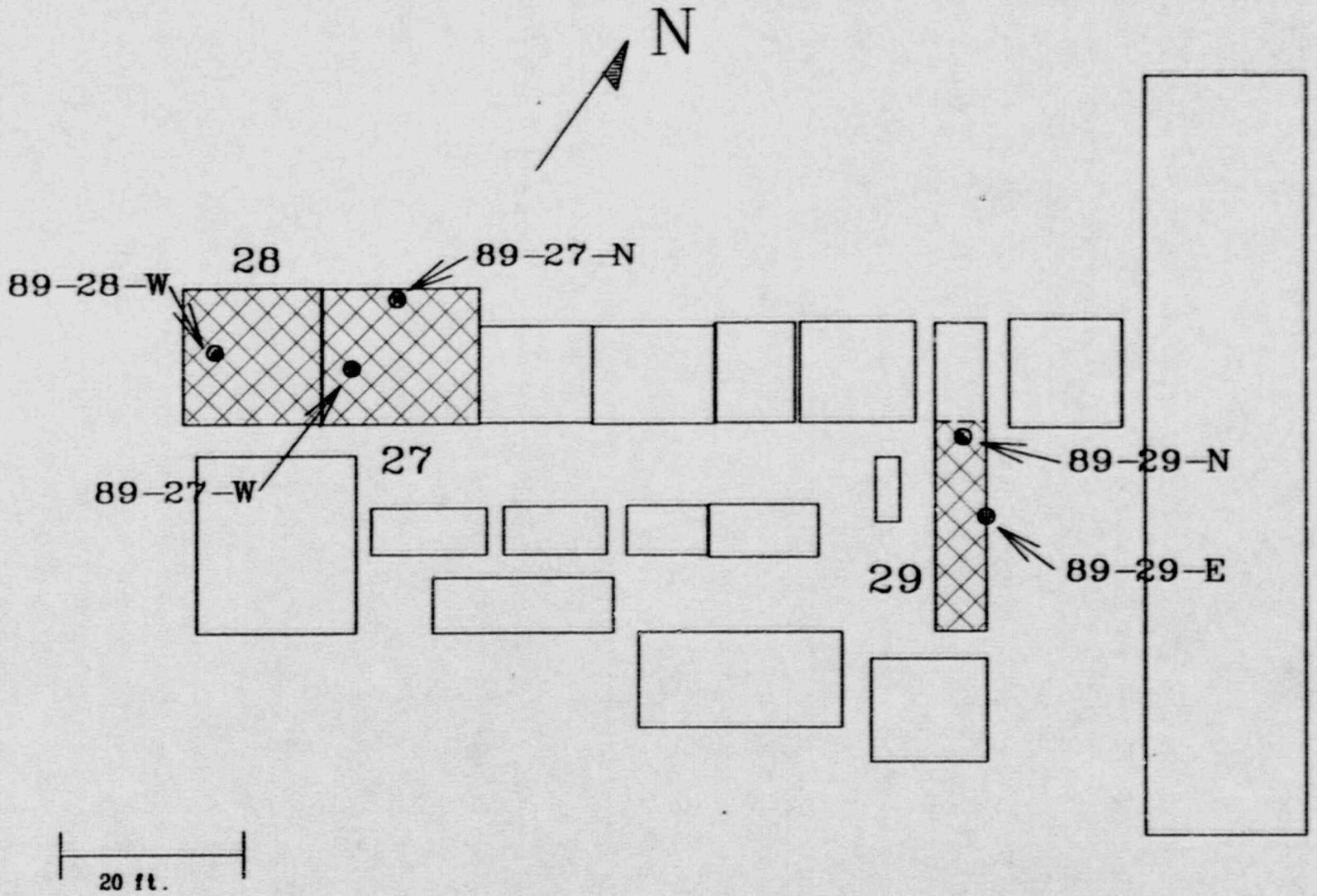


Figure 5-8 Location of exploratory wells west of sprung structure.

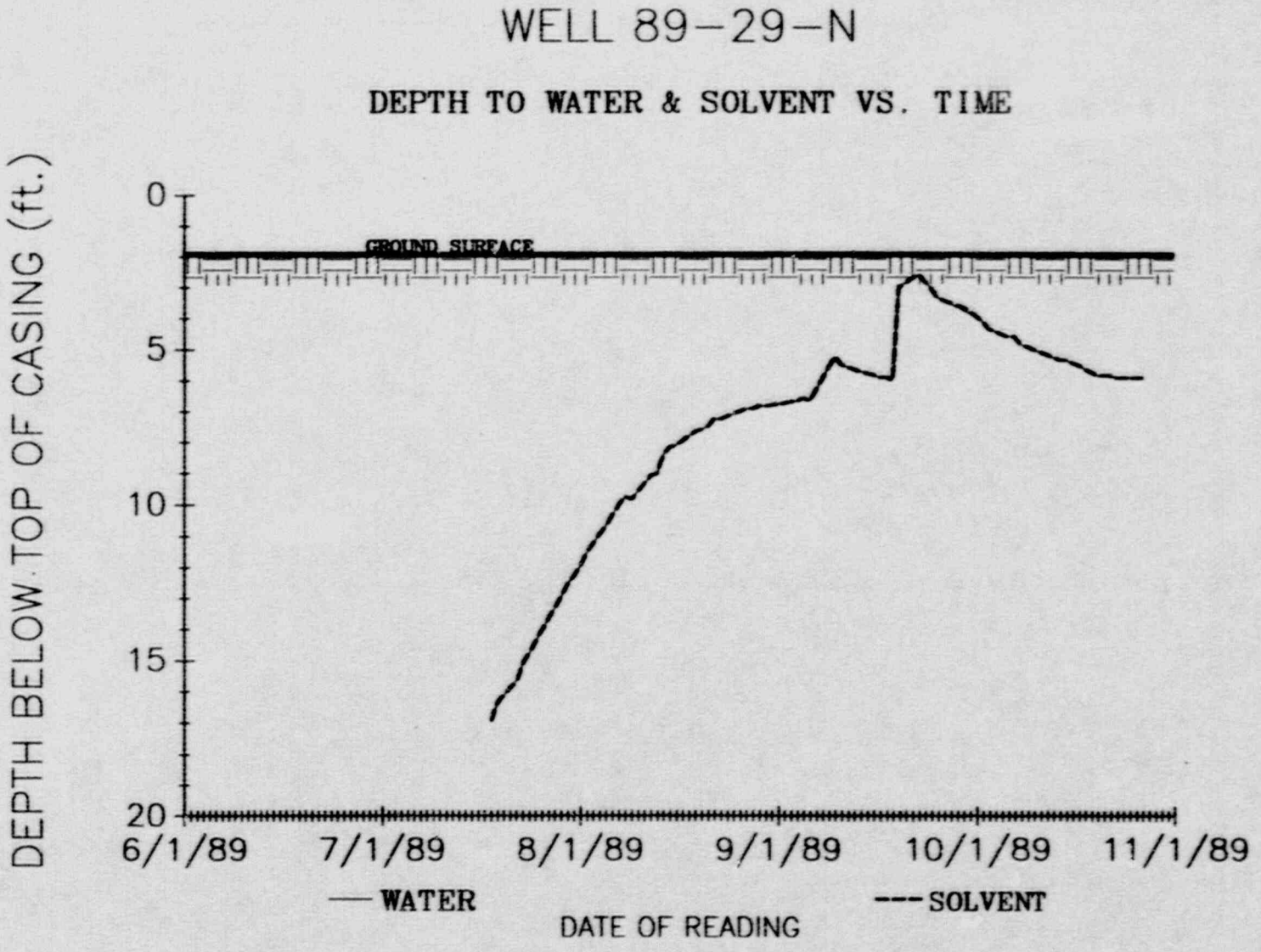


Figure 5-9 Hydrograph for well 89-29-N.

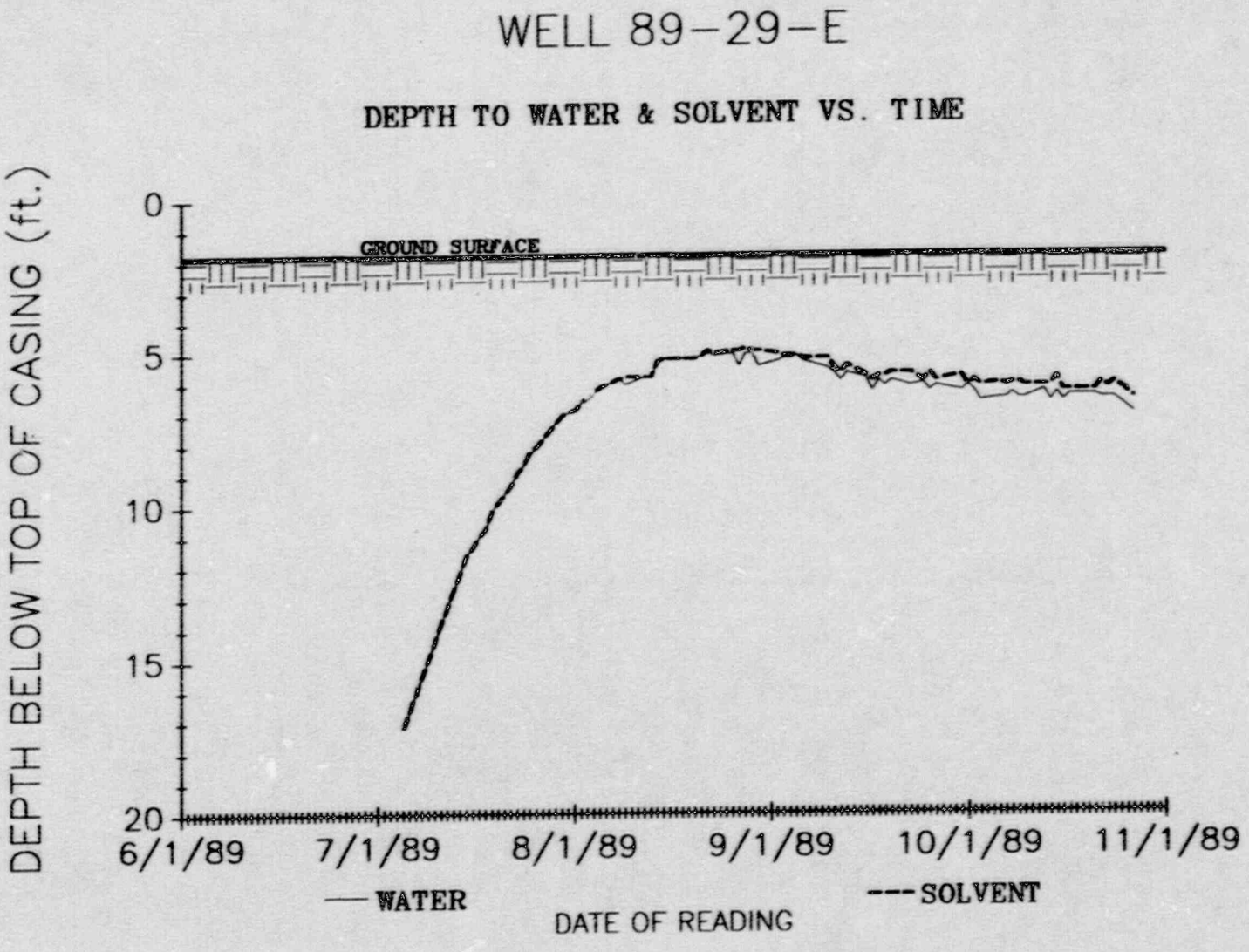


Figure 5-10 Hydrograph for well 89-29-E.

No lithologic evidence of the disposal hole boundaries were observed while trenching. The physical obstructions presented by the sprung structure and a small hill hampered trenching operations. These features also directed precipitation runoff through the area, which further complicated exploration efforts.

Incorrect records of the special hole boundaries led to a concrete vault in SH-7 being uncovered. There was no record of the existence of this vault in the data turned over to the WVDP. Black, rotting organic material was also discovered in the excavation near SH-7 and a strong petroleum odor was frequently present. A sample of the fluid which seeped into the trench was taken on May 19, 1989. The results are presented on Table 5-2.

Probe resistance indicative of tanks was encountered at about five feet below grade. The specific tank orientations could not be determined from these data. Probing also revealed free solvent in the special hole. Well 89-5-N was installed to the north of a known tank edge. The location of the well is shown on Figure 5-1.

Well soundings, which are plotted on Figure 5-11 have not been taken long enough to indicate a stabilized fluid level. A solvent layer is, however, present. The analytical results of samples of solvent and water from the well are presented on Table 5-3.

5.1.2 Soil Gas Analysis

Two sets of soil gas probes were installed in two unique areas for preliminary testing purposes. One set was placed around SH-29 (Figure 5-12) and the other near USGS wells B84-8 and 85-I-11 just northwest of the sprung structure (Figure 5-14). The areas were chosen based upon their relative remoteness from other burial holes and the known presence of solvent in the subsurface. Although the sampling gave negative or inconclusive results, several available sampling techniques and refinements were not implemented due to time and weather constraints.

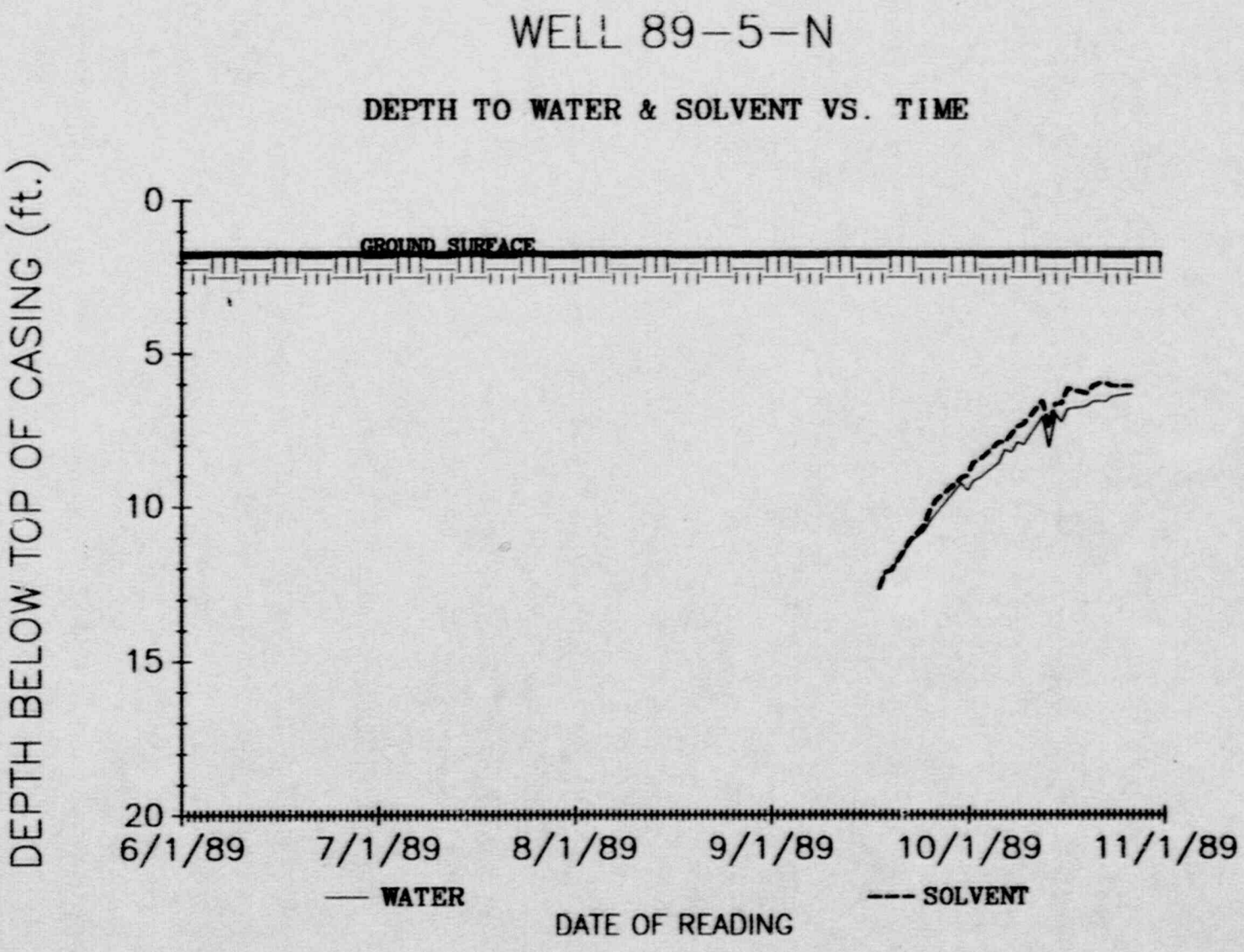


Figure 5-11 Hydrograph for well 89-05-N.

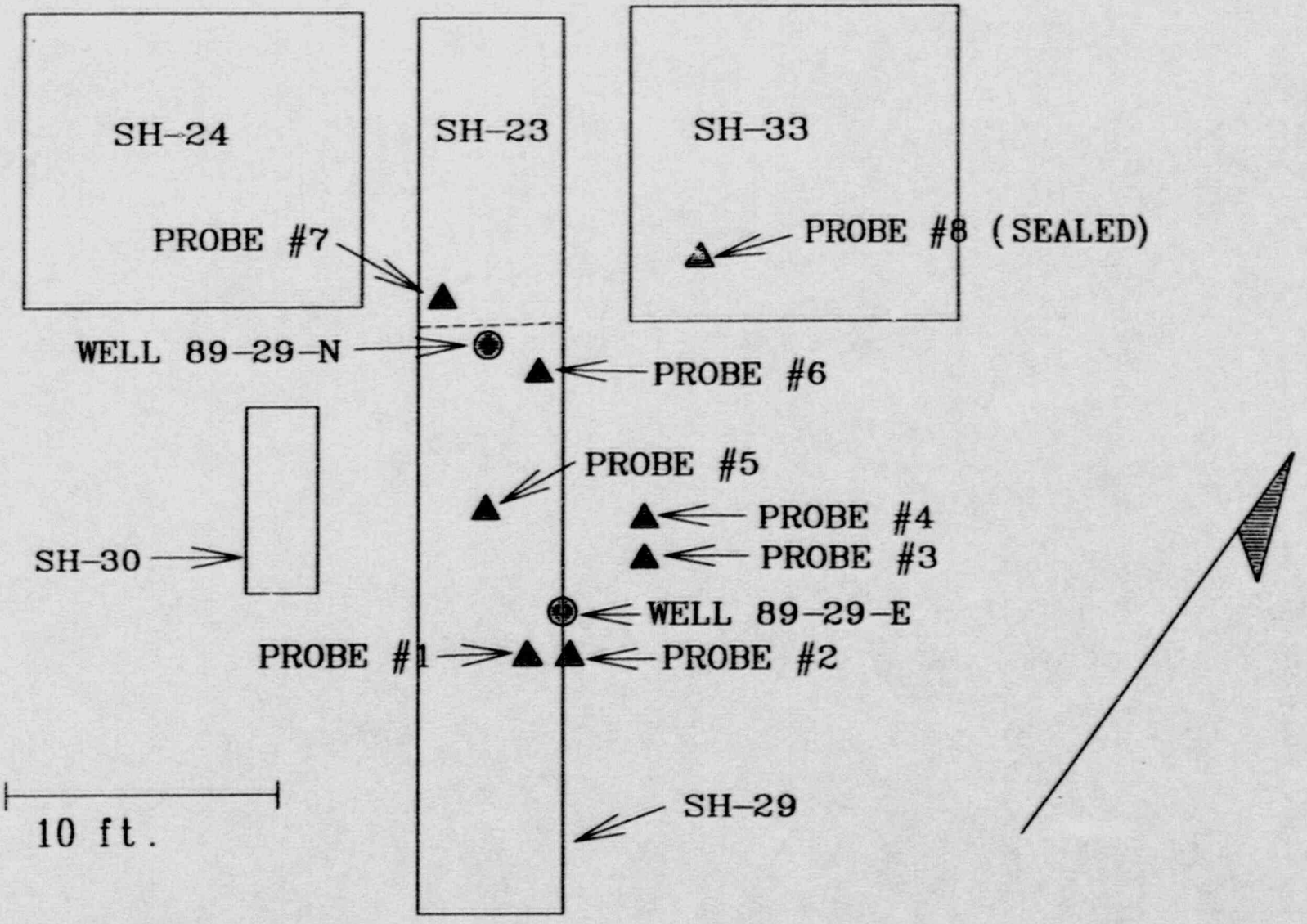


Figure 5-12 Location of soil gas probes in area 2 west of sprung structure.

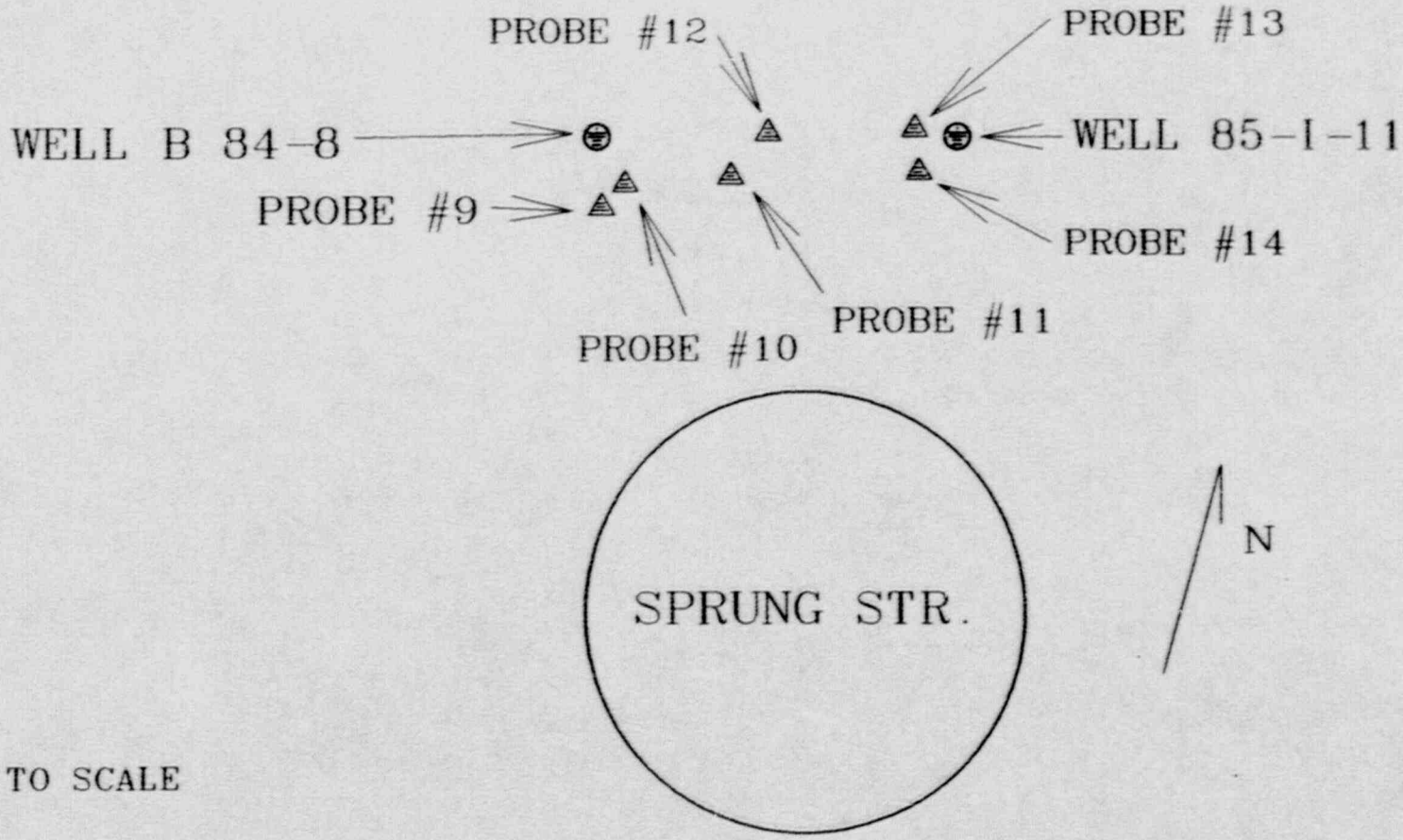


Figure 5-13 Location of soil gas probes in area 1 near sprung structure.

5.1.2.1 Special Hole 29 Area Soil Gas Survey

Eight soil gas sampling points were located in the vicinity of SH-29. Three are within the boundaries of the burial hole. Two are in the vicinity of the hole boundary, and two are in the undisturbed clay till on the fringe. The last location was sealed and abandoned due to the presence of a solid object which was struck during advancement of the pilot shaft. This spot was noted to be in the vicinity of SH-33. The depth of each sample probe is presented on Table 5-4. The depths were selected to be near the expected top of any liquid in the hole. Two were placed at shallow depths in order to investigate vertical concentrations of vapor as well as to accommodate elevation fluctuations of any liquid.

Before the gas chromatograph could be calibrated with a known dodecane sample, rain brought most of the probe points to saturation. This precluded further soil gas sampling.

5.1.2.2 USGS Well Area Soil Gas Survey

Six probes were installed near the 82-5 series USGS wells and other wells that were installed after the initial discovery of solvent. These probes were installed northwest of the sprung structure in pairs at depths of approximately 4 in. and 16 in. above the level of solvent in the wells (Table 5-4). There was a probe pair at well B-84-8, a pair at well 85-I-11, and a pair located halfway between the two wells (Figure 5-13).

Samples were drawn from the probes on September 5. A known sample of dodecane was run through the gas chromatograph to provide a curve to compare collected samples against. Purge times for the sample lines were 1 minute for probes 9 & 10, and 30 seconds for probes 11 through 14. Probe 13 was under water so no sample was

Table 5-4

SOIL GAS VAPOR PROBE INSTALLATION DATA

Probe Number	Depth of Probe Below Grade	Depth of PVC Pipe Below Grade	PVC Filling Material
1	6'	3 1/2'	Concrete Grout
2	approx. 5'	3 1/2'	Concrete Grout
3	7' 4"	3 1/2'	Concrete Grout
4	5' 3"	3 1/2'	Concrete Grout
5	7' 1"	4 1/2'	Concrete Grout
6	7'	3 1/2'	Concrete Grout
7	7'	3 1/2'	Concrete Grout
8	NA	3 1/2'	Concrete Grout
9	6' 4"	4 1/2'	Bentonite Slurry
10	7' 2"	4 1/2'	Bentonite Slurry
11	6'	4 1/2'	Bentonite Slurry
12	7' 2"	4 1/2'	Bentonite Slurry
13	8' 3"	4 1/2'	Bentonite Slurry
14	7' 1"	4 1/2'	Bentonite Slurry

drawn. An ambient air sample was also analyzed at the location. None of the obtained gas samples yielded any indication of dodecane; however, there was some unknown gas noted in the samples taken from probes 9 through 12.

6.0 CONCLUSIONS

6.1 CURRENT STATUS OF THE DISPOSAL HOLES

During the investigation it was discovered that water had entered all of the disposal holes which contain solvent disposal tanks. As is shown on Figure 6-1, the depth to water and solvent encountered in the exploratory wells ranged from 1.5 to 10 feet below the ground surface. This is consistent with water level observations at other locations in the NDA. Evidence of radioactive contamination was encountered in samples of the soil and water. In consideration of this it is reasonable to conclude that the disposal holes investigated constitute sources of radioactively contaminated leachate and that this leachate is in contact with the near surface soils. Hydrologic studies performed prior to this investigation indicate that lateral migration through these near surface soils should be anticipated.

Solvent has migrated out of the tanks in five of the six disposal holes investigated and is in a free state in the disposal holes. This conclusion is supported by the fact that free solvent was encountered on the water surface in the exploratory wells or in the soil removed during trenching and coring. In some cases the layer of solvent floating on the water surface was several feet thick. Radioactive contamination was encountered in all of the solvent samples which were analyzed.

6.2 MIGRATION OF SOLVENT BEYOND THE DISPOSAL HOLES

There is reason to suspect that lateral migration of the solvent and the aqueous leachate beneath it has occurred or will occur in the future. The results of a literature review and attempts at

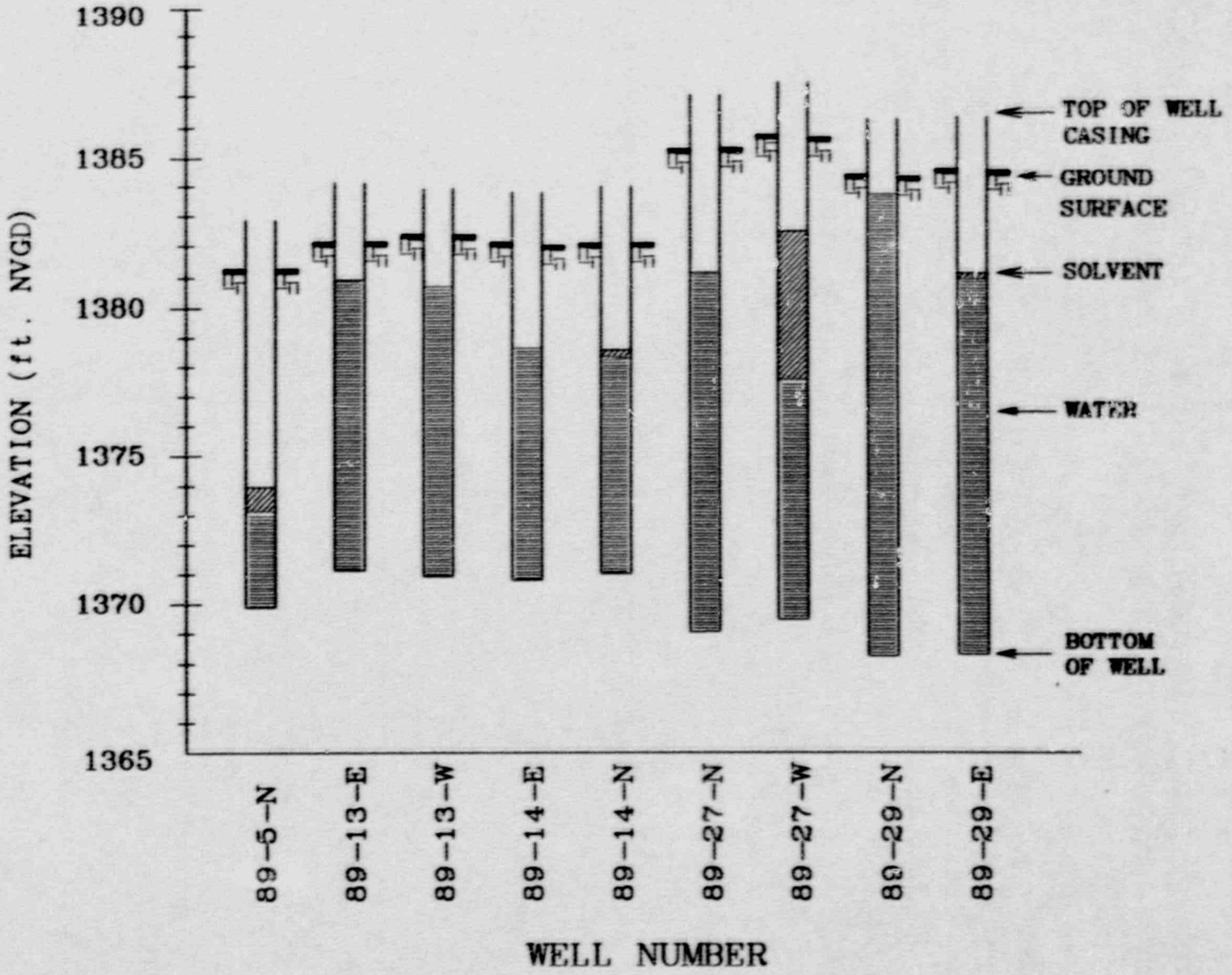


Figure 6-1 Highest recorded water and solvent levels in expoloratory wells.

preliminary modeling were presented in Section 3.2. These results indicate that migration velocities of up to several meters per year should be expected for non aqueous phase liquids (NAPL's) in fine grained soils such as the clay till. These results also indicate that migration and subsequent immobilization would occur along preferential pathways referred to as ganglia.

The negative readings encountered during the soil gas sampling are considered to be inconclusive. Dodecane has a high boiling point and a low vapor pressure. Therefore it does not lend itself to easy detection by the soil gas method. However, prior limited success with passive soil gas techniques and the proof of principle testing suggest that detection should be feasible, if favorable weather conditions exist. Considering the fact that soil gas testing was only performed after weather conditions were less than ideal, there is a good chance that the test results encountered to date are false negatives.

7.0 RECOMMENDATIONS

In consideration of the findings of this investigation and the results of prior efforts to address the solvent migration problem, several lines of action are recommended to address 1) further investigations, 2) short range maintenance and 3) long range management. These are discussed in the sections which follow. In order to assure the acceptance of future work by regulatory authorities, it is important that future work conform to applicable standards for RCRA Remedial Action Plans.

7.1 FURTHER INVESTIGATIONS

Further investigations relative to the solvent should focus on continued data gathering from existing monitoring devices. The depth to solvent and water in the burial holes should be monitored in the wells installed for this investigation. The solvent and water in the wells should be sampled and analyzed for the parameters on Table 5-2. The water/solvent level measurements should be made weekly and the samples should be taken monthly to evaluate the response to climatic stress. The data should be interpreted by a hydrogeologist in conjunction synoptic climatic data recorded by the WVDP environmental laboratory.

The soil gas probes which have already been installed should be sampled when weather conditions again become favorable. This will not occur until the summer of 1990. The sampling should include a rigorous program to determine an optimum vacuum purge time and to calibrate the gas chromatograph to achieve detection levels in the part per billion range. If positive results can be achieved, further soil gas probes should be installed in order to track the extent of lateral migration of the solvent. If, after the capability of the method is extended to the limit, negative results are still encountered, further attempts at soil gas sampling should be abandoned.

In the next section, an interceptor trench is recommended as a short term maintenance activity. The walls of this trench should be examined during construction to the extent practicable. This should involve visual observations, photographic documentation and measurement of radiation levels. Samples of soil should be obtained where fractures and zones of seepage are evident. The samples should be analyzed for the presence of dodecane and the same radiological parameters used for the well sampling.

An attempt should be made to apply borehole seismic tomography to the location of the solvent tanks in the boreholes. This technique uses computer processing to enhance seismic imagery for the purpose of developing a three dimensional model of subsurface conditions. The technique is very new and represents cutting edge technology. As was explained in Section 2.3, prior attempts to locate the tanks by geophysical methods have not been successful. This new technique represents a major leap forward in sensitivity. Therefore, it may be successful where other more conventional methods have failed. The information on precise tank geometry is important to a successful remediation effort. In consideration of this importance, an attempt to utilize this method is recommended.

7.2 INTERIM MAINTENANCE MEASURES

Installation of an interceptor ditch between the boundary of the NDA and Erdmann Brook is recommended. The purpose of this ditch is to intercept any migration which might be occurring along ganglia (fringers) or through fractures in the weathered till. Because this migration would take place along preferential pathways, interception with wells is considered technically unfeasible. A conceptual design and layout of the trench is illustrated on Figure 7-1. Detailed plans and specifications for the installation of the trench should be prepared based on this layout, borings, to locate the weathered/unweathered till interface, and a topographic survey.

Liquid pumped from the trench should be routed to a temporary holding tank. Solvent, if encountered, will float to the top and should be held in the tank until there is enough material to be solidified. Water in the tank should be sampled. If it is contaminated it should be pretreated as necessary and transported to the low-level radioactive waste treatment facility. During prior dewatering of this area it was necessary to pretreat the water to lower the I-129 activity.

7.3 LONG TERM MANAGEMENT

Removal or stabilization should be initiated for the solvent and sorbent material still remaining in the tanks, solvent which has migrated from the disposal tanks and solvent which is immobilized in or migrating through the till. A study should be performed to select the most appropriate method of achieving these objectives. The scope of the feasibility study should involve the identification and screening of technologies which could be used to implement the activities listed above, development and screening of alternative which apply these alternatives and detailed analyses and cost estimates of the alternatives which pass the screening process. The technologies considered should include scavenger wells, vacuum extraction, in-situ vitrification, soil mixing, exhumation, penetration of the tanks to vacuum the contents, soil washing, solidification, incineration, bioengineering, and biodegradation. The selection of an action plan should be based on ability to isolate the solvent from the environment, cost, implementability and potential impacts on the selection of an alternative for Phase II stabilization of the NDA.

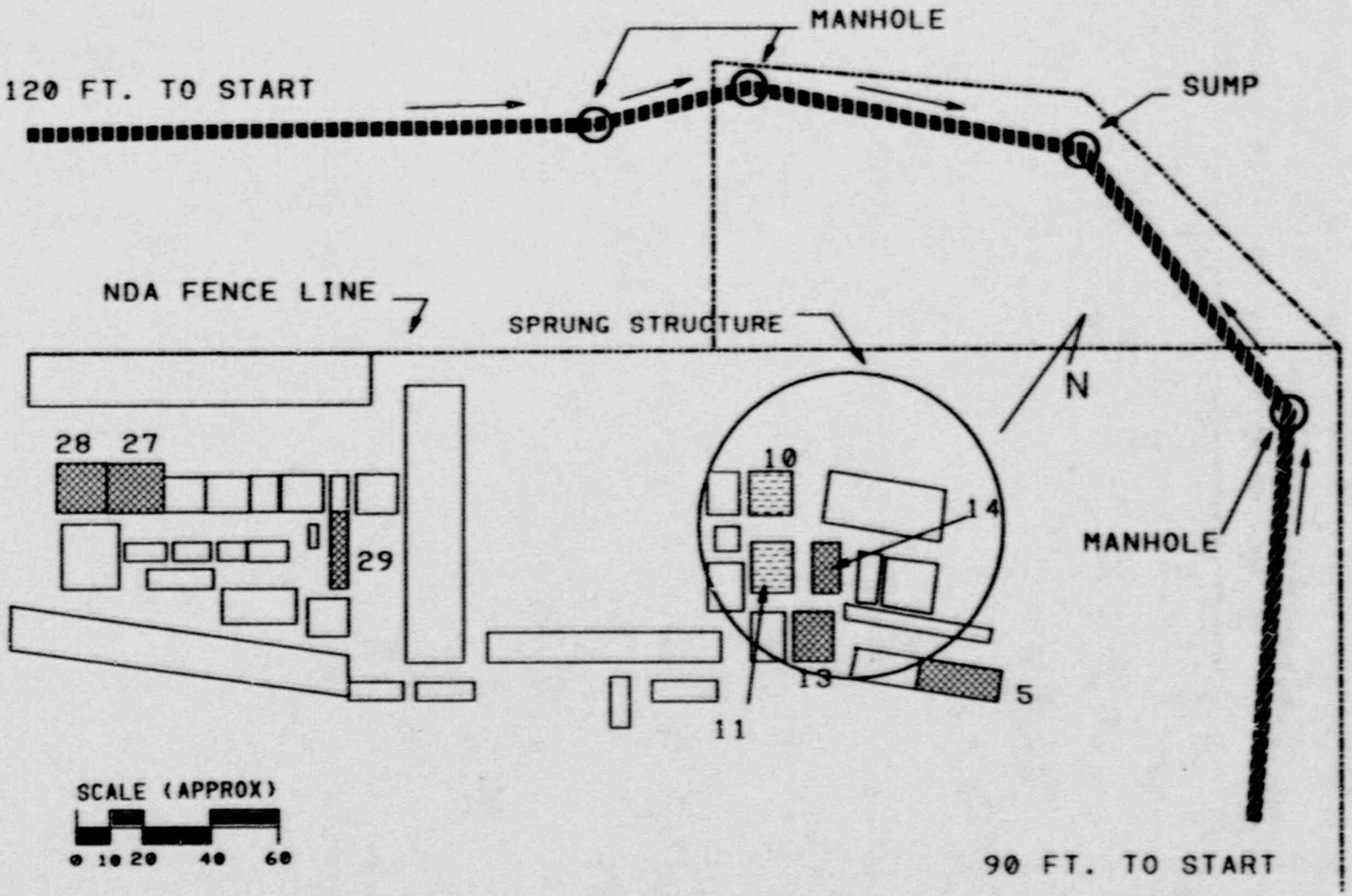


Figure 7-1 Conceptual layout of interceptor trench system.

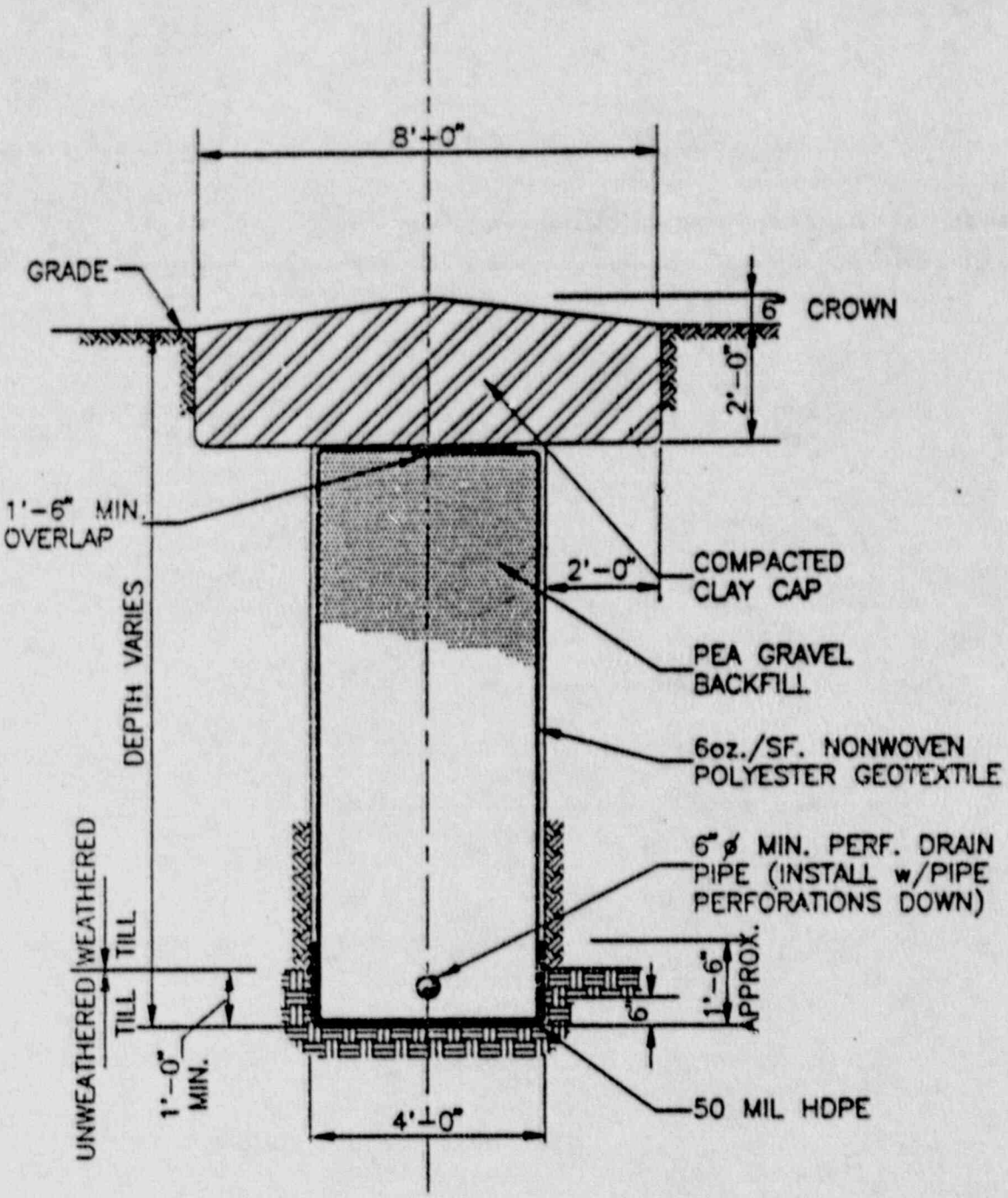


Figure 7-2 Typical cross section for interceptor trench system.

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ATTACHMENT 2

Solvent Migration in the NRC Licensed Disposal Area (NDA) at the West Valley Demonstration Project

ISSUE/ACTION The DOE contractor at the West Valley Demonstration Project (WVDP) recommends immediate abatement/remedial action regarding the migration of solvent contaminated with radionuclides in the NRC Licensed Disposal Area (NDA) on WVDP premises. The West Valley Project Office (WVPO) has taken steps to install an engineered interceptor trench to abate any potential migration to surface water as part of facility maintenance. (WVPO is reviewing DOE authority under the WVDP Act to pump out free solvent remaining in the burial holes.) Further removal/remedial action regarding the source term has previously been considered outside of the scope of the WVDP. DOE asserts that the State of New York (NYSERDA) should fund or conduct such actions. DOE response action under CERCLA (DOE Order 5400.4) may be necessary.

BACKGROUND: The previous operator of the reprocessing facility at West Valley disposed of a radionuclide contaminated solvent, n-dodecane (kerosene) and tri-butyl phosphate (both currently considered nonhazardous), in the NDA in 22 (known) 1000 gallon carbon steel tanks in 8 "special holes" or burial holes from 1968 to 1972.

In November of 1983, solvent was detected in a monitoring well and subsequent investigation revealed ground surface contamination around 2 of the special holes. DOE carried out an exhumation, stabilization, and repackaging program on the 2 special holes, including the 8 tanks, their contents and the material around them. Only 430 gallons of the 4000 gallons of solvent originally disposed of in these 2 holes was recovered. The remainder had migrated.

Because DOE considered remediation of this buried material to be outside the scope of the authority of the WVDP Act, DOE entered into a special arrangement with New York in coordination with the House Committee on Interior and Insular Affairs and the House Committee on Science and Technology to spend up to $1.5M of NYSERDA funds to abate the immediate problem to protect the public health and safety. The NYSERDA funds were counted as part of the State's 10% contribution to the WVDP. Both House committees expressed concern that WVDP expenditures not include "long term remediation" of this non-WVDP responsibility.

On 8-17-88 more radionuclide contaminated solvent was discovered in another monitoring well in a different area of the NDA. After a 9-28-88 meeting among NE, ID, GC, and NYSERDA, NE agreed to have a study undertaken by DOE's M&O contractor from the $250,000 remaining from the $1.5M which would include a report with a recommended course of action and related cost and schedule.

On 11-14-89 more radionuclide contaminated solvent was detected in monitoring wells approximately 40 feet from ravines of tributaries to the Buttermilk Creek watershed, a source of public water supply. The contractor is recommending installation of an engineered interceptor trench to contain of the migrating solvent plume within the area of current expansion and within the vicinity of the NDA at a preliminary estimated cost of $50,000. This is considered an appropriate maintenance expense necessary to operate the NDA facility in a manner which protects public health and safety within the scope of the WVDP Act (see Cooperative Agreement Section 4.08). The contractor is recommending follow-up action for long term remediation of the source term. (WVPO is reviewing the appropriateness of the WVDP undertaking pumping out free solvent remaining within the burial holes.) Long term remediation would include removal, exhumation or stabilization of the solvent still remaining in the buried tanks, and solvent which has migrated.

SENSITIVITIES: Agreement has not been reached on responsibility for such long term remediation. DOE takes the position that such action regarding wastes disposed previous to DOE's possession of the WVDP premises is beyond the scope of DOE's authority and responsibility. This position is based on the provisions of the WVDP Act, the legislative history, the Cooperative Agreement as revised to conform to recommendations regarding DOE's responsibility for previously disposed wastes made by the Investigations and Oversight Subcommittee of the House Committee on Science and Technology in 1981, and subsequent congressional budgeting actions.

NYSERDA has historically stated that DOE expressly assumed the risk of such "operating" problems when negotiating the Cooperative Agreement, and in return NYSERDA received no "facility credit" (credit for use of the existing facilities toward the 10% State contribution).

DOE is currently in "exclusive use and possession" of the WVDP premises pursuant to the Cooperative Agreement and NRC licensing actions. NYSERDA has no current license to operate and is prohibited from taking any action under the license on WVDP premises. If NYSERDA is to take responsibility for abatement/removal/remediation activities directly, it must do so with DOE oversight through contract or seek licensing authority through the NRC with DOE assistance. Conversely, since DOE is the current operator and in charge of the facility, DOE has some responsibility to take affirmative steps to ensure that any threat to the public health and safety is detected and abated or remediated as appropriate.

A spirit of cooperation has resulted from efforts to jointly prepare an Environmental Impact Statement (EIS) with NYSERDA addressing final closure of the entire site. It had been anticipated that responsibility for abatement/removal/remediation activities associated with closure would be negotiated one the scope of these activities was defined in the EIS process. This dispute threatens the success of this effort.

Because the solvent degrades the containment capability of the clay soil at the site, closure alternatives for the site could be limited or adversely impacted if solvent undergoes extensive migration.

NEPA review has been made for the interceptor trench contractor recommendation.

WVPO/ID recently initiated discussions with regulatory agencies and NYSERDA to begin negotiation of compliance issues associated with the WVDP. Resolution of issues related to the solvent migration will be addressed.

If pending analyses confirm the presence of listed hazardous waste constituents, then the above mentioned media may be mixed wastes, subject to applicable treatment, storage, disposal, permitting, and land ban requirements. Of primary concern is the status of the waste solvent material and the water leachate to be collected, pumped and treated; as well as any affected soil to be excavated.

Any water generated by this solvent control project destined for treatment or release to existing plant discharge facilities may be considered an additional point source, and/or impact existing point source discharges. State approval of a permit modification may therefore be necessary.

Under DOE Order 5400.4, it is DOE's policy to respond to releases and potentially imminent releases of such hazardous substances where such releases are on, or the sole source of the release is from, a facility under DOE jurisdiction, custody, or control, consistent with CERCLA, the NCP, and E.O. 12580.

OPTIONS FOR LONG TERM REMEDIATION OR ADDITIONAL NON-WVDP IMMEDIATE RESPONSE:

1. If NYSERDA refuses to accept responsibility for long term remediation or removal and DOE finds it is necessary to take further action (deemed beyond WVDP scope) because of the release of hazardous substances (radionuclides included) into the environment or there may be an imminent and substantial danger to the public health or welfare because of release of "contaminants or pollutants":

    a. with appropriate funding, DOE may make a CERCLA response action pursuant to DOE Order 5400.4 (10-6-89), i.e., abatement/removal/remediation under CERCLA Section 104 with cost recovery with the assistance of the DOJ under Section 107.

    b. DOE may explore the possibility of EPA (or the New York Department of Environmental Conservation (NYSDEC)) issuing NYSERDA an administrative order under CERCLA Section 106. (Note: RCRA corrective actions under Section 3008(h) may be appropriate if DOE continued operations are not threatened and NYSERDA is clearly responsible.)

2. Negotiate an agreement to provide NYSERDA assistance:

    a. by contract on full reimbursement/indemnification basis.

    b. by overseeing the work of a NYSERDA funded contractor (full cost recover/indemnification for DOE as in 2.a. above).

c. by assisting NYSERDA in obtaining the necessary licensing amendments to independently conduct the work.

3. DOE may seek additional authority/funding through separate legislation.

4. DOE may review and determine the parameters of its existing authority to conduct further response actions consistent with the contractors recommendations under the WVDP Act with appropriate congressional oversight committees and OMB.

RECOMMENDATION: WVPO recommends immediately installing the interceptor ditch, and coordinating responsibility for pumping free solvent remaining in the burial holes. DOE should request NYSERDA to accept responsibility for further response, and coordinate resolution of long term remediation issues with the regulators. If NYSERDA refuses to take appropriate action to provide necessary funding and assistance for further response actions deemed necessary by DOE to protect the public health or welfare or the environment, DOE should initiate steps necessary to proceed under DOE Order 5400.4 (CERCLA).

ATTACHMENT 2

SOLVENT FACT SHEET
November 20, 1989

- Organic solvent (similar to kerosene) was first detected in Well 82-5-A in November 1983. Well 82-5-A is approximately 60 feet from Special Holes 10 and 11.

- Special Holes 10 and 11 contained eight tanks with an aggregate volume of 4,000 gallons of solvent (see Figure 1) which were disposed with an equal volume of sorbent by shallow land burial in 1969. The tanks were exhumed in 1985-1986. Approximately 400 gallons of the original 4,000 gallons were collected.

- Monitoring wells did not indicate further migration of the solvent until August 1988 when it was detected in a monitoring well near Special Hole 5. Investigations were conducted during the summer of 1989 over the entire area where solvent had been disposed. The results of this evaluation are contained in a recent draft report which recommends installation of an interceptor trench system (see Figure 2).

- Solvent was detected on November 14, 1989 in Well 85-I-9 which is approximately 40 feet northwest from Well 82-5-A (see Figure 3). An augered hole 84-I-17 which is about 20 feet east of 85-I-9 also contained solvent.

- The gradient of shallow groundwater flow is from Special Holes 10 and 11 through Well 85-I-9 towards the nearest surface water which is about 40 feet from 85-I-9.

STATUS OF SPECIAL HOLES SUSPECTED OF CONTAINING SOLVENT

Hole	No. of Tanks	Dose	Date
SH-5	4	400 mR	05/69
SH-10*	6	30 R	10/69
SH-11*	2	45 R	11/69
SH-13	3	40 R	05/70
SH-14	2	50 R	08/70
SH-27	2	100 R	03/72
SH-28	2	10 R	03/72
SH-29	1	35 R	04/72

*Exhumed 1986

Note: Data based on examination of Nuclear Fuel Services burial records.

Figure 1

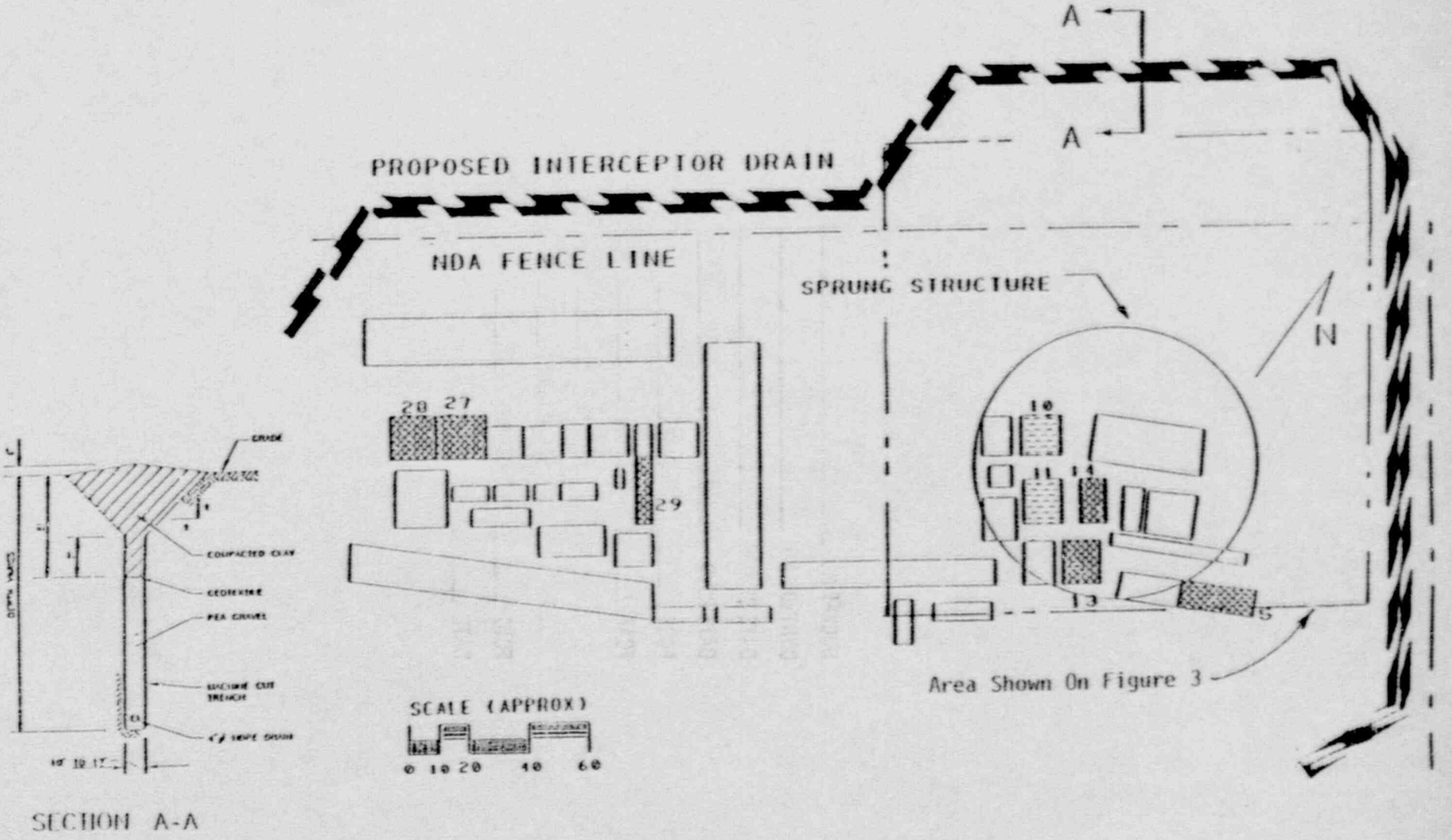

Figure - 2 **Conceptual design of interceptor trench system.**

DOCKET NO. M-32
CONTROL NO. 26253
DATE OF DOC. Jan. 2, 1990
DATE RCVD. Jan. 9, 1990

FCUF ____ PDR ✓
FCAF ✓ LPDR ✓
I & E REF. ✓
SAFEGUARDS ____
FCTC ____ OTHER ✓
DATE 1/10/90 INITIAL SAC