ATTACHMENT E-13

Remedial Alternative for the Collection and Treatment of Cyanide-Contaminated Groundwater

REMEDIAL ALTERNATIVE FOR THE COLLECTION AND TREATMENT OF CYANIDE CONTAMINATED GROUNDWATER

APRIL 15, 1987

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SYLVANIA, GEORGIA

AEM

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Sylvania, Georgia

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April 15, 1987

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Introduction

A Remedial Investigation (RI) was conducted in the area of the capped, non-clean closed CCSI at the Torrington Company's wastewater treatment area (See Stottler Stagg and Associates, 1986). The RI defined an area of soil and groundwater contamination encompassing the capped CCSI and the clean closed DCSI. Remedial alternatives have been reviewed for the purpose of remediating the cyanide and potentially organic contaminated groundwater in the area of the non-clean closed CCSI and the clean closed DCSI units. The following report discusses the details of the option determined as preferable for the on-site treatment of hazardous waste.

1.0 SCOPE

The two potentially viable options for on-site treatment at the Torrington facility were determined to be the following:

(1) in-situ alkaline chlorination of cyanide contaminated soil, and

(2) collection and alkaline chlorination of cyanide contaminated groundwater.

Both options were evaluated. While option (1) would completely remedy both soil and groundwater contamination, assuming the in-situ treatment is 100% effective, this option was determined to be several times more expensive than the groundwater collection alternative, and thus not economically feasible for use at this site. The groundwater collection and alkaline chlorination treatment process was evaluated and determined to be the optimal remedial alternative for the site from both an economic and feasibility standpoint.

This report deals with the design and implementation requirements for the installation of a groundwater drainage (collection) system in the perched water table. Treatment of the collected contaminated groundwater is dependent upon the treatment and capacity capabilities of the wastewater treatment system at the site. Actual treatment of the groundwater will be addressed in a separate report, subsequent to the conduct of treatability studies at the site.

2.0 PURPOSE

The groundwater collection and treatment alternative is being examined at this time for several reasons. First, a plume of contaminated groundwater (~200 feet by 200 feet) was identified in the shallow water table in the area of the closed in-ground cyanide units (CCSI and DCSI) during the Remedial Investigation (RI).

The Torrington Company is interested in addressing options for the remediation of this contamination.

Secondly, since the CCSI was not clean closed, a post-closure care application has been submitted to Georgia EPD. As part of the post-closure care, a compliance monitoring system has been proposed (See Section C of the Post-Closure Care Application for the CCSI and DCSI - December 10, 1986).

Recent sampling of the compliance monitoring system has shown a level of cyanide in monitoring well SP-1 which exceeds the proposed groundwater protection standard of 50 ppm CN as proposed for the compliance monitoring system. Resampling of the well, however, showed cyanide levels to be at an acceptable level in the groundwater (<50 ppm CN). SP-1 is presently being resampled every two weeks to determine the level of cyanide in the groundwater at this point.

In the event that the groundwater protection standard is determined to be consistently exceeded, The Torrington Company is required under State of Georgia Hazardous Waste Regulations to submit to Georgia EPD an application for a permit modification to establish a corrective action program. The corrective action program must address how contamination at the site will be remediated. Therefore, the objective of the detailed evaluation of this remedial alternative is (1) to satisfy The Torrington Company's ultimate goal of determining an economically feasible option for remediation at the site, and

(2) in the event The Torrington Company is required by law to address this contamination on an immediate basis, to already have an acceptable remedial alternative ready for implementation, or have the implementation of the alternative already started. The overall objective of the implementation of this remedial action will be to achieve acceptable levels for groundwater quality in the most economical manner possible

3.0 GROUNDWATER FLOW

Information on the extent of groundwater contamination, the groundwater flow direction, and the groundwater discharge rates are necessary for the design and installation of a groundwater drainage system. In order to better define groundwater flow characteristics in the shallow, perched water table, four shallow monitoring wells (SP-4, SP-5, SP-6, and SP-7) have been installed in the WWTS area around the clean closed DCSI and non-clean closed CCSI. These wells were installed to serve several purposes including (1) indicators of the potentiometric surface for the shallow water table and its seasonal variation, (2) groundwater flow direction indicators, and (3) use as monitoring wells to monitor groundwater quality over time in the area of the CCSI and DCSI.

A topographic base map for the WWTS area showing the location of the capped CCSI area and shallow monitoring wells SP-1, SP-2, SP-3, SP-4, SP-5, SP-6, and SP-7 is shown as Figure 1. Various maps showing

(1) the potentiometric surface for the shallow water table with equipotential lines and the direction of groundwater flow, (2) an isopach map for the shallow water table, (3) a contour map showing the elevation of the upper surface of the confining clay layer, and (4) depth to the top of the clay confining layer are included as Figures 2, 3, 4 and 5 respectively.

Groundwater flow in the perched water table apparently changes seasonally. Figure 2 shows the potentiometric map for the perched water table in the vicinity of the capped CCSI using data collected during the recent well installation of March, 1986. The water table is significantly higher than a year ago when water levels were taken during the Remedial Investigation. Moreover, data summarized from the recent well installations at wells SP-4 through SP-7 indicate that the direction of groundwater flow is also different.

Two situations appear to exist. During dry periods such as the drought experienced in 1986, the water table is lower. During such times, groundwater flow appears to be controlled by the top of the confining clay layer, which it follows in a general east-northeast direction.

Recent heavy rains in the winter months have allowed for a significant increase in the water table. For example, southeast of the fenced WWTS area, the water table was greater than 10 feet below the land surface in April, 1986. The recent installation of monitoring well SP-4, however, gives a depth to the water table of just over 4 feet. Groundwater levels now show the flow direction to be in a more northerly direction. This groundwater flow direction appears to conform more to the surface topography. Since rainfall is the sole recharge source for the shallow water table, surface water runoff and rainfall infiltration into the upper clayey sand play the major role in recharging the shallow water table and therefore directly effect the groundwater flow.

Groundwater Discharge - Groundwater flow and discharge calculations are based on certain important assumptions which are outlined below:

- The saturated thickess in the perched water table is restricted to the upper clayey sand. The underlying confining clay layer is considered impermeable and not a water-bearing unit at the site. The recent monitoring wells SP-4, SP-5, SP-6, and SP-7 are screened in the upper clayey sand and therefore are considered to be reliable indicators of (1) the saturated thickness in this water table and (2) the direction of groundwater flow.

- Information on both the direction of groundwater flow and the hydraulic gradient in the area of the capped CCSI are based on data collected from the recent well installations. Data from the SP series of wells will provide accurate data that will allow for a determination of the seasonal variations in both groundwater flow and hydraulic gradient at the capped CCSI area.

Calculations to determine the discharge rate are shown as Attachment 1. The discharge was determined to be 330 gallons per day based upon the available information. However, a high estimate of 500 gallons per day will be used in determining specifications for the design of a drainage system. The daily discharge rate directly effects the drain size needed and the size requirements for a sump collection area.

4.0 DRAINAGE SYSTEM

An interceptor drainage system is recommended for collection of the contaminated groundwater. A proposed location for the drain is shown on Figure 6. The drain will be located downgradient and mostly outside the area of groundwater contamination, except at the "old control building". Thus, although the entire downgradient extent of the plume will not be controlled, the greater part of the contamination will be controlled by the drainage system. The drain will be located so as to collect the groundwater even in the event of seasonal variation in the direction of groundwater flow, as the records to date would seem to indicate. Although interceptor drains typically are located immediately downgradient of the area of concern, the planned system will have lateral drains to limit the outward spread of the contaminated groundwater.

The following general requirements are provided for the drainage system. The trench will be excavated to a minimum width of twelve inches with the actual width depending on the size of the excavating equipment. Excavation will go to a minimum depth of 1 foot into the clay layer. The drain pipe will be installed at the bottom of the upper clayey sand (SC) and into the upper few feet of the confining clay (CH). Calculation of discharge capacities across the length of the drain show that a 4-inch perforated PVC pipe would provide more than adequate drainage capacity. A durable synthetic "sock" filter will cover the perforated pipe to trap fine sands which can cause clogging problems.

To ensure that siltation is not a problem, a drain gradient of a minimum 1 foot/100 feet (0.01) will be maintained to ensure a minimum velocity of 1.4 feet per second in the pipe (SCS, 1972). An adequate base to support the piping will be maintained. Pea gravel will be filled in the trench above the pipe and its synthetic filter to a depth of 3 feet below the land surface. Above this depth, the gravel will be covered by excavated clayey sand from a clean area on-site.

Groundwater collected in the drain will gravity flow to a sump area located in the northernmost corner of the drainage system. The sump area will be designed to allow for a minimum capacity of approximately 500 gallons. Collection of groundwater from the sump area can be either by (1) piping to a wastewater treatment system or

(2) pumping on a regular basis to a holding tank prior to treatment.

Exact specifications on the holding capacity for the sump area will depend on the actual volumes of groundwater collected and the requirements for groundwater treatment. A pilot trench study is planned to more accurately determine discharge rates at the site (see Section 6). Results of the recent groundwater sampling at the capped CCSI area will provide analytical data that will allow for the design of a groundwater treatment system. If feasible, during the pilot trench study, research on treatment alternatives for the groundwater will be conducted, which may include a pilot laboratory study.

The trench wall on the opposite side of the area of contamination will be lined with an impermeable synthetic liner to act as a barrier to stop groundwater flow beyond the trench This will allow for the following: (1) further guarantee that the contaminated groundwater will not move beyond the drain, and (2) prevention that clean, or in some places relatively more clean, groundwater from below the trench from adding to the volume of groundwater to be collected and treated, and (3) permit the wells to be used for monitoring purposes and thus verification of the effectiveness of the drainage system. Due to the impermeable barrier, the downgradient wells will not be affected by the drain in the event that they are within the drain's area of influence. Lateral groundwater flow to these wells will, however, be stopped to a significant degree which will undoubtedly affect the water levels of the wells.

Concerns regarding drainage system installation - Field work during the Remedial Investigation of 1986 confirmed that the plume of cyanide contaminated groundwater had reached the "old control building" (See Figure 1). Due to the presence of the WWTS buildings in the area, only limited excavation can take place in this area. It is not feasible to work under the buildings.

While part of the plume will be beyond the reach of the drainage system (See Figure 6), the general approach of using a drainage system for groundwater collection still holds with the objectives of this remedial alternative since the majority of the cyanide contaminated groundwater will be intercepted. The groundwater collection and treatment system that is proposed is a relatively low cost alternative to remove the "worst" of the problem. However, the likelihood of a complete remediation of all contaminated groundwater may not be feasible due to the following factors: (1) irregularities in the upper surface of the confining clay surface which may result in ponding of groundwater in places, (2) variance in the upper clayey sand, (3) cyanide adsorption to soil and organic matter, and (4) the naturally low groundwater flow rate for the shallow water table. Since part of the drainage system will be located in an area known to be contaminated in front of the treatment building, certain health and safety concerns will need to be addressed prior to the installation taking place. A second concern is that piping will have to be carefully worked around during the installation of the drainage system. These concerns will be addressed as part of the ongoing work on the wastewater treatment system modifications.

A benefit of locating the drainage system in front of the "old control building" and generally inside the SP series of wells is that these wells can be used as a monitoring well system to monitor the effectiveness of the drain in both controlling the groundwater flow, and more importantly in monitoring the movement of the cyanide contaminated groundwater. The proposed location of the drainage system is based upon the most current groundwater monitoring results. However, analytical results of the groundwater sampling at the SP series of wells are now pending. These results will be forthcoming in the immediate future and will allow for any needed modifications to the proposed location of the drainage system.

5.0 IMPACT OF GROUNDWATER WITHDRAWAL, CONTAINMENT, AND RECHARGE

The drainage system is being installed to effectively control the migration of contaminated groundwater. This drainage system should not alter the direction of groundwater flow, but rather will act as a barrier to impede its progress. Only along the outer impermeable barrier of the northeast trending drain (adjacent to the fenceline) will groundwater be re-routed. At that point, groundwater will be deflected to the northeast.

The impact of groundwater withdrawal on the foundational stability of the WWTS area buildings is a concern. Groundwater withdrawal near the southwest facing side of the "old control building" may allow for minor settling on this side of the building. A similar concern is relevant adjacent to the tank farm; however, the saturated zone at this point is only the lower 2-1/2 feet of the upper clayey sand, which may not be a very significant problem.

Groundwater withdrawal will also have a significant effect on the monitoring wells at the site. Lateral groundwater movement will be effectively stopped by the drain. Thus, water levels in the shallow monitoring wells beyond the drainage system can be expected to drop significantly. However, they will still be indicative of groundwater quality in the perched water table at their respective locations.

Groundwater recharge is a method that could be used in the WWTS area to increase the rate of groundwater movement. Groundwater recharge would essentially consist of the addition of water via a sprayer or other mechanism in a location hydraulically upgradient relative to the closed units. Groundwater recharge would result in an increase in the hydraulic head upgradient of the area of contamination, thus producing an increased flushing effect of the contamination from the contaminated area.

Table 1 Schedule of Implementation for the Installation of the Sub-surface Drainage System at the Capped CCSI Area.

	April				May					June	
	6	13	20	27	4	11	18	25	31	8	15
Meeting with Contractors	x9										
Bids Received		x16									
Torrington Contract Accepted			x23								
Groundwater Sampling Phase I of Groundwater Assessment				27-28							
Pilot Trench Installation					30-31						
Pilot Treatment Study of Representative Contaminated Groundwater[1]						18					
Results Interpreted - Modifications made to Location & Equipment					4----18						
Supplies Ordered						x11					
Installation of Drainage System									29--1		

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[1] If it is determined that the present wastewater treatment system is not capable of handling the wastewater, a new design may be needed and a time delay may be incurred.

At this time, it is recommended that groundwater recharge be considered only after the groundwater drainage system has been installed and the groundwater collection and treatment system is underway and proceeding satisfactorily. The major concern with groundwater recharge is the increased volumes of groundwater that need to be processed. Until the basic groundwater collection and treatment system is underway and running, no excess water is needed since it could possibly overload the system.

6.0 DEVELOPMENT OF THE SYSTEM

Contractors experienced in the installation of subsurface agriculture drainage systems have been contacted regarding work on the drainage system. During the week of April 6-10, a Versar representative will meet at the Sylvania facility with various contractors familiar with the local soil conditions to discuss the specifications and to request bids including time schedules for the planned work.

A schedule of implementation with details through the installation of the drainage system is shown as Table 1. The main phases of field work will involve (1) the installation of a series of pilot trenches to measure groundwater discharge over a set period of time, and (2) the actual installation of the drainage system. The proposed locations for the installation of three pilot trenches is shown on Figure 7.

An additional phase of work that will involve a significant effort is an assessment of the treatability of the contaminated groundwater. Representative samples of the groundwater will be collected for a pilot treatment study, if deemed necessary. Subsequent to the study, recommendations will be given on the most feasible treatment method for the contaminated groundwater.

7.0 CONCLUSIONS

The proposed interceptor drainage system is being installed to limit hydraulically downgradient the spread of groundwater contamination. While further spreading of the plume is being prevented, the majority of the problem is not being remediated.

Alternatives to improve the rate of groundwater collection and treatment would involve the use of a second trench system further upgradient, perhaps in line with the CCSI "cap", to collect the most highly contaminated groundwater. At that time, the use of groundwater recharging in the upgradient portion of the perched water table may be considered at that time as a means to produce an increased flushing effect and therefore move the contaminated groundwater more quickly towards the drainage system.

A third alternative would involve completely encapsulating the area of contaminated groundwater with a drain. This would result in collection of 100% of the contaminated groundwater and in conjunction with a groundwater recharge program, this option may be the most effective alternative in remediating the problem.

However, for each of these modifications to the basic interceptor drain, the cost of each of these remedial alternatives would increase. Therefore, it is recommended that at this time The Torrington Company proceed with installation of the remedial alternative developed in this document. Once it is determined that the groundwater collection and treatment system is successful, the above additional alternatives should be evaluated

ATTACHMENT 1 Calculation of Drainage Discharge

$Q = KiA$ $\qquad K=6.25 \text{ X } 10^{-4}$ cm/S $\qquad =0.89$ in/hr

$= \frac{Ki\ d_e l}{43,200}$ $\qquad = \frac{(0.89)(.025)(4)(250)}{43,200}$ $\qquad$ =.0005 cfs
=44.5 cfd

=1260/liters/day
=330 gallons/day

K = hydraulic conductivity (in/hour)
i = hydraulic gradient which varies from 0.017 to 0.025
d_e = saturated thickness discharging into drain (ft)
l = length of drain measured perpendicular to the direction of groundwater flow (ft)

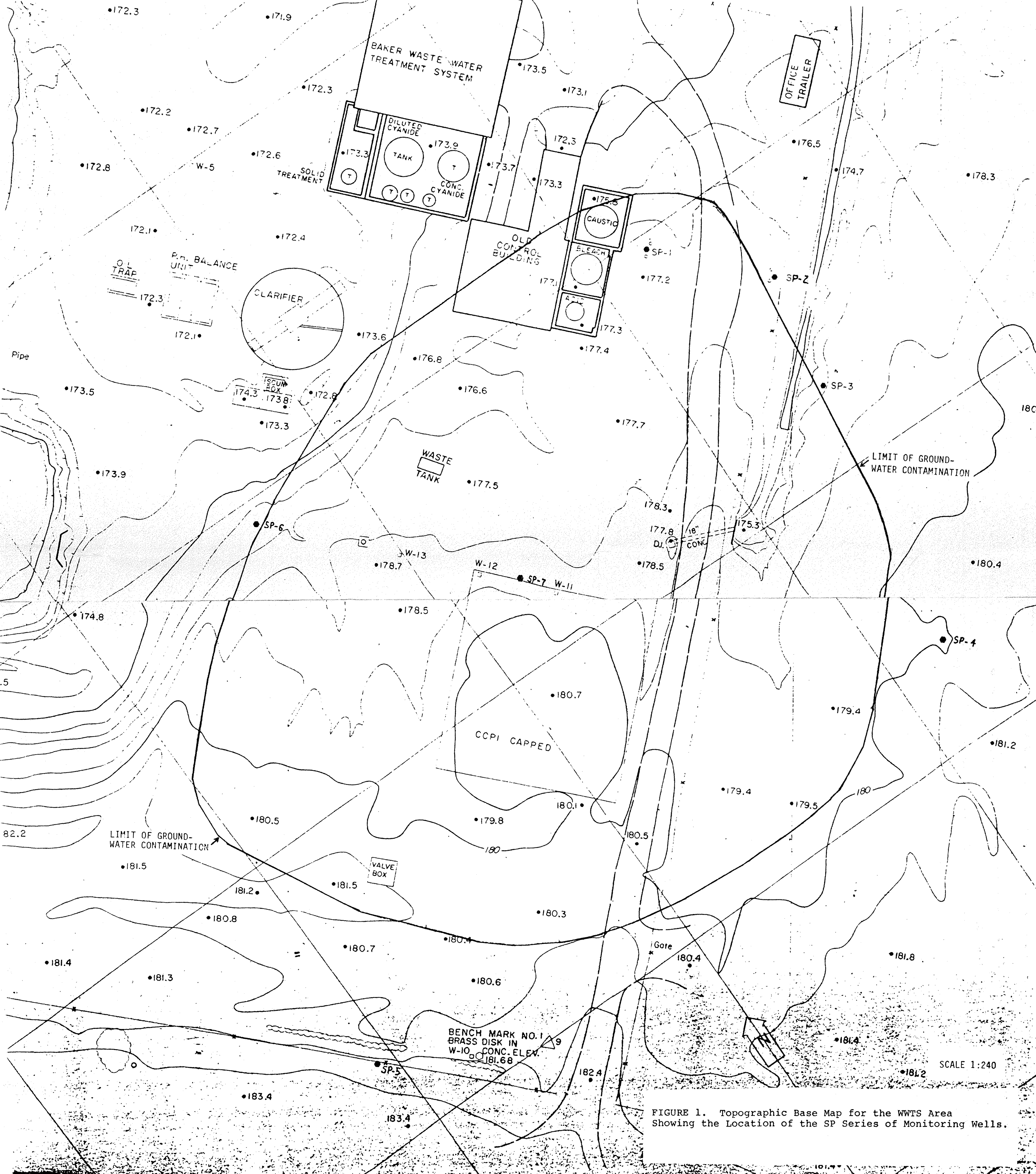

FIGURE 1. Topographic Base Map for the WWTS Area Showing the Location of the SP Series of Monitoring Wells.

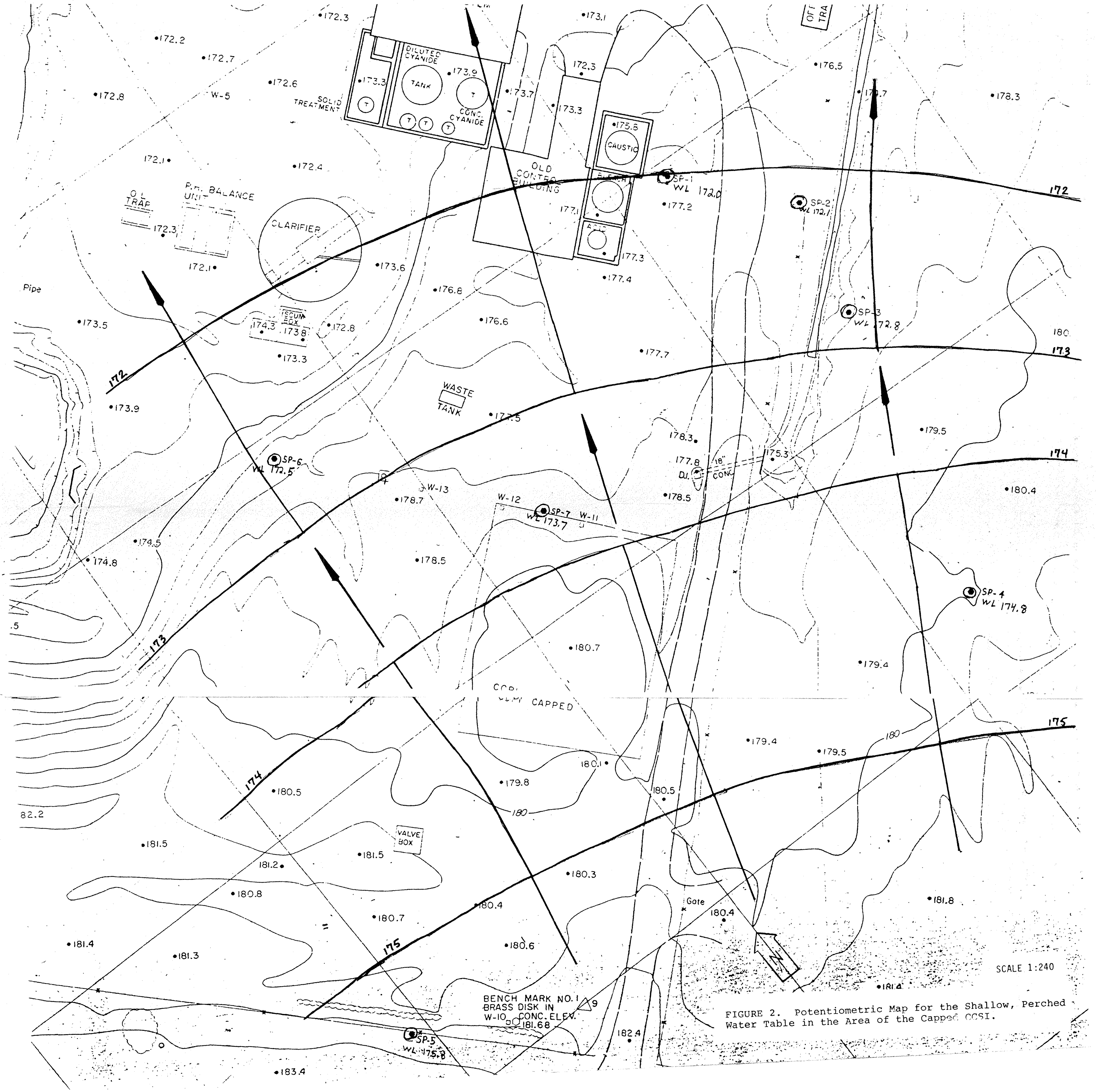

FIGURE 2. Potentiometric Map for the Shallow, Perched Water Table in the Area of the Capped CCSI.

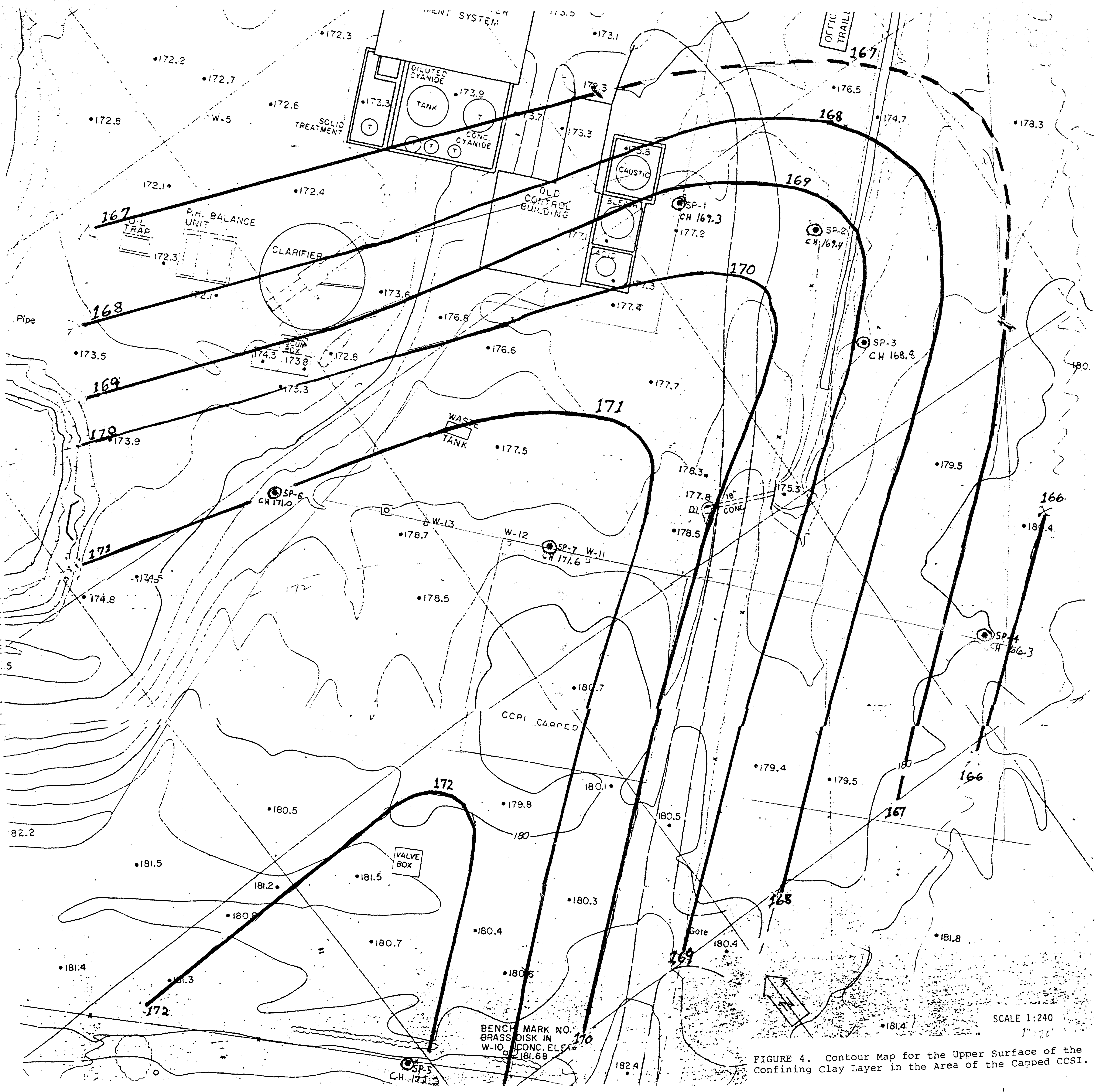

FIGURE 4. Contour Map for the Upper Surface of the Confining Clay Layer in the Area of the Capped CCSI.

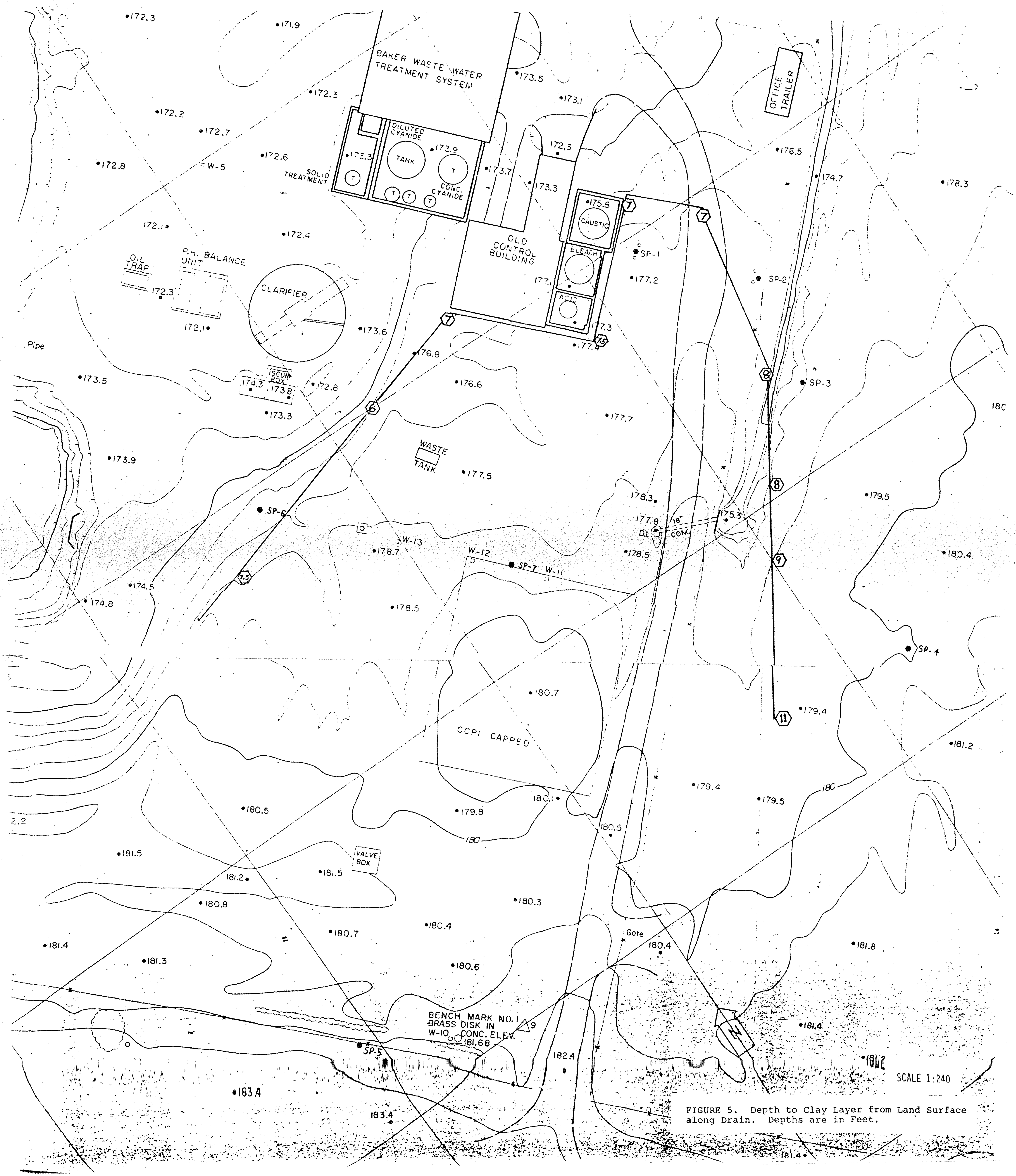

FIGURE 5. Depth to Clay Layer from Land Surface along Drain. Depths are in Feet.

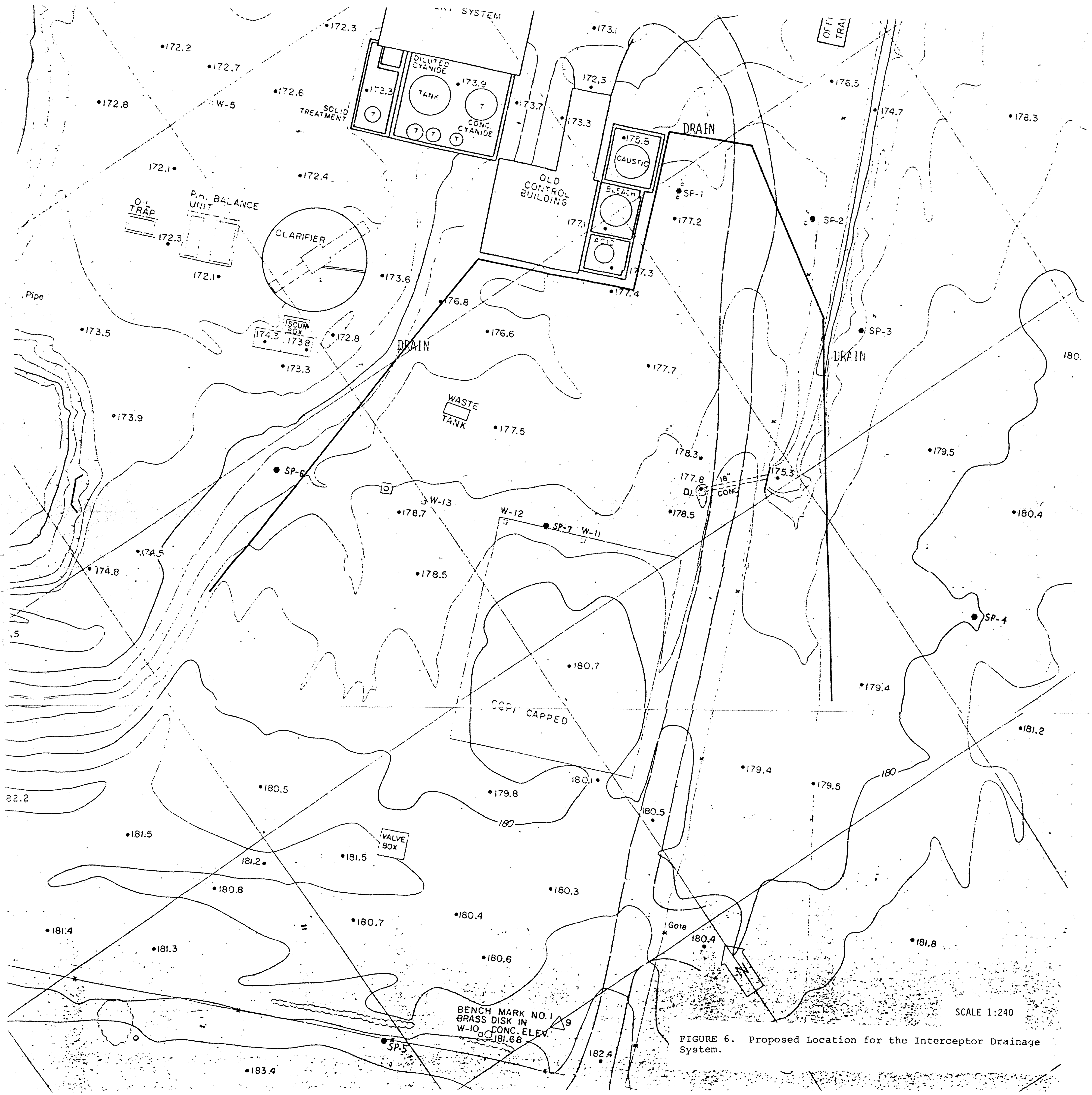

FIGURE 6. Proposed Location for the Interceptor Drainage System.

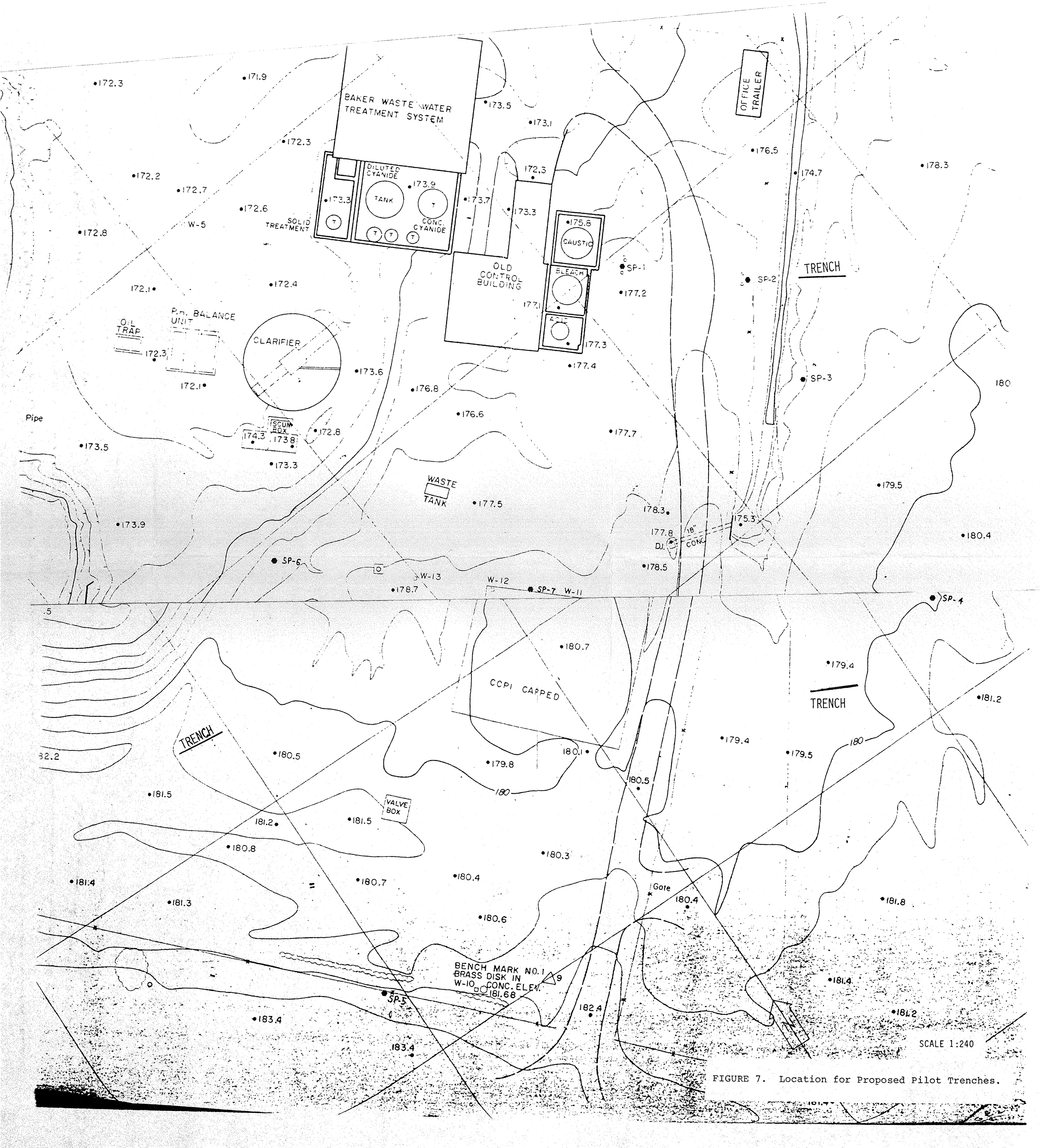

FIGURE 7. Location for Proposed Pilot Trenches.