3670

DESIGN FOR REMEDIATION OF THE GREAT MIAMI AQUIFER IN THE WASTE STORAGE AND PLANT 6 AREAS

FERNALD ENVIRONMENTAL MANAGEMENT PROJECT

FERNALD, OHIO

APRIL 2001

U.S. DEPARTMENT OF ENERGY

INFORMATION ONLY

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REV. A

DRAFT FINAL

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1.0 INTRODUCTION

This report provides: 1) A design for the Waste Storage Area (WSA) - Phase I Groundwater Restoration Module; 2) A conceptual design for the WSA-Phase II Groundwater Restoration Module, and 3) A basis for justification that no Groundwater Restoration module is required for the Plant 6 area.. As explained below, this report serves to update the conceptual design that was presented for these areas in May 2000 (DOE 2000). The design for the WSA Phase I and II Groundwater Restoration Modules presents the number and location of extraction wells needed to implement remediation of the aquifer in these areas. Because of higher than anticipated levels of contamination in the WSA-Phase I area, it is projected that the area will take longer to remediate (7 years +/-) than originally planned in the Baseline Remediation Action Strategy Report (2 years +/-). Therefore, the FEMP is intending to accelerate the installation of this module by proceeding with installation this year, well ahead of the schedule as delineated in the Remedial Action Work Plan (RAWP) for Aquifer Restoration at Operable Unit 5 (DOE 1997b). Similarly, data collected to date for the Phase II module area indicates uranium contamination levels which are above the 30 µg/L level. Because further investigation and implementation is impractical until removal of the Waste Pits is accomplished, installation of this module is being delayed until this further investigation can reasonably proceed; well beyond the schedule as delineated in the RAWP.

In May 2000 a Conceptual Design Report for Remediation of the Great Miami Aquifer in the Waste Storage and Plant 6 Areas was completed (DOE 2000). The Conceptual Design Report presented an updated characterization for the Waste Storage and Plant 6 areas, as well as a conceptual look at a remediation design for the Waste Storage Area based on:

- Groundwater sampling at 30 direct push sampling locations
- The collection of groundwater samples at 11 existing groundwater monitoring wells
- Uranium concentration data collected in December 1999 from monitoring wells in the IEMP program
- Groundwater modeling using the VAM3D site model.

The Conceptual Design Report made ten recommendations. Four recommendations were addressed in this Design Report. The four recommendations that were addressed to finalize this design were to:

1. Conduct an additional assessment of Monitoring Well 3027 in the WSA-Phase II area which was postulated based on the data evaluated, to be a result of cross-contamination. It was proposed that additional water should be pumped from the well to determine if, as anticipated, the localized pocket of higher uranium concentration can be readily reduced to <20 micrograms per liter (µg/L).

2. Conduct a pumping test in the area of the Pilot Plant Drainage Ditch Plume to verify that the proposed conceptual design flow of 200 gallons per minute can be sustained. Explore the possibility of reusing the pumping test well infrastructure as extraction infrastructure in order to start restoring the aquifer in the more highly-contaminated area after the test is completed.

3. Evaluate options for accelerating the start of restoration of the more highly contaminated areas in the Pilot Plant Drainage Ditch Plume. This would include exploring the possibilities of a phased restoration approach, similar to the concept applied to the South Field. Further evaluate the need for dual piping systems for each extraction well. Modeling indicates that: water from (WSA extraction wells 5 and 6) will not require treatment; 2) treatment of the 20 μg/L discharge may only be required for an estimated duration less than two years, and 3) the combined flow stream would be similar in concentration to the South Plume Module stream which is being handled by a single line discharge.

4. Conduct additional groundwater modeling and associated cost/benefit analysis to determine if enhancements such as re-injection would be viable alternatives to the conceptual design.

An assessment at Monitoring Well 3027 led to the conclusion that the deep pocket of contamination was due to cross-contamination from the well. The well was plugged and abandoned in October of 2000. A discussion can be found in Section 2.

A pumping test was conducted in the area of the Pilot Plant Drainage Ditch Plume from November 13 to November 20, 2000. Hydraulic conductivity values derived from the pumping test data were used to update the site groundwater model prior to modeling the design. A discussion of the pumping test can be found in Section 2.

A phased restoration approach was modeled and enhancements such as re-injection were investigated. A discussion can be found in Section 3. The design consists of five extraction wells installed in two phases. Location maps are provided in Section 3. Phase I contains three extraction wells located in the Pilot Plant Drainage Ditch Plume. WSA #1 (test well infrastructure), WSA #2, and WSA #4 will pump 400, 300, and 300 gpm respectively beginning in FY 2002. Phase II contains two extraction wells in the waste pit area (WSA Wells 5 and 6) that will pump 100 gpm each beginning in FY 2007. The Phase II scope is contingent upon additional characterization to be completed after contaminate sources are removed (currently estimated to occur in FY 2005).

The current maximum contaminant level (MCL) for total uranium in groundwater at the FEMP is 20 μg/L as recorded in the Record of Decision for Remedial Actions at Operable Unit 5 (DOE 1996). EPA has recently promulgated a standard of 30 μg/L for total uranium in groundwater. In response to this revised standard, DOE has initiated a process pursuant to CERCLA guidelines to revise the MCL for total uranium for the FEMP from 20 μg/L to 30 μg/L. Modeling predicts that the proposed WSA design will remediate the aquifer in the Phase I-Pilot Plant Drainage Ditch areas to 30 μg/L in seven years or to 20 μg/L in nine years, and in the Phase II area in approximately 2 years.

In addition to the Conceptual Design work mentioned above, additional sampling was conducted for this Design Report to further characterize the uranium plume. This additional sampling included:

- Eight direct-push sampling locations (12856, 12857a, 12858, 12829, 12830, 12831, 12832, and 12859a),
- One existing non-IEMP monitoring well (2006),
- Updating characterization maps with June 2000 IEMP uranium concentration data.

The controlling document for the collection of uranium concentration data in the Waste Storage Area was the Project Specific Plan for Conducting Direct-Push Sampling in the Waste Storage Area (PSP 52420-PSP-001). Appendix A provides this PSP. The controlling document for the collection of uranium concentration data in the Plant 6 Area was the Project Specific Plan for Conducting Direct-Push Sampling in the Plant 6 Area (PSP 52425-PSP-001). Appendix B provides this PSP.

1.1 OBJECTIVE

The objective of the Design for Remediation of the Great Miami Aquifer in the Waste Storage Area and Plant 6 Area was to assure that the latest uranium plume characterization and aquifer characteristics were used to support the Engineering design of the aquifer remediation systems. Specifically, the design objectives are to:

- Prepare an updated characterization of the vertical and lateral extent of the uranium plume.
- Refine the number and location of groundwater extraction wells that are required for the groundwater remediation systems in the Waste Storage and Plant 6 areas based on groundwater modeling predictions using the latest uranium plume characterization.

1.2 BACKGROUND

The Record of Decision for Remedial Actions at Operable Unit 5 (OU5 ROD, DOE, 1996a) states that the Great Miami Aquifer will be remediated through extraction methods using 28 extraction wells operating for approximately 27 years. Figure 1-1 illustrates that the remedy design specified in the OU5 ROD which called for seven extraction wells in the Waste Storage Area and one extraction well in the Plant 6 Area. The aquifer remediation that is currently underway is based on a more aggressive clean-up schedule than that specified in the OU5 ROD. Currently, a ten-year aquifer cleanup is anticipated, based on the remediation system design presented in the OU5 Baseline Remedial Strategy Report (BRSR), remedial design for Aquifer Restoration (DOE 1997a). The design in the BRSR targets a uranium plume that was characterized using groundwater data collected prior to 1994. Figure 1-2 illustrates the remedy design specified in the OU5 BRSR that calls for ten extraction wells in the Waste Storage Area and two extraction wells in the Plant 6 Area.

The Remedial Design and Remedial Action Work Plans for Operable Unit 5 (DOE 1996b and DOE 1997b respectively) identified that operation of remediation systems in both the Waste Storage and Plant 6 areas was scheduled to begin in October of 2003. Prior to beginning operations, the systems must be designed and constructed. This report supports the engineering design for the WSA-Plant I area, the basis for eliminating a module design for the Plant 6 area, and the preliminary design for the WSA-Phase II area.

1.3 SCOPE AND LIMITATIONS

The scope of the characterization performed for the design included:

- The collection of groundwater samples for analysis of uranium at 38 direct-push sampling locations (30 locations in the Waste Storage Area and 8 locations in the Plant 6 Area). (Note: Only 30 of the 38 locations were sampled for the Conceptual Design Report)

- The collection of groundwater samples for analysis of uranium at 12 existing groundwater monitoring wells supplementing ongoing IEMP monitoring. (Note: Only 11 of the 12 locations were sampled for the Conceptual Design Report)

- Conducting a pumping test for the purpose of assessing horizontal hydraulic conductivity, vertical hydraulic conductivity, specific yield, and anisotropy of the Great Miami Aquifer in the Pilot Plant Ditch Area. (Note: this work carried forward from conclusions made in the Conceptual Design Report)

- Groundwater modeling to establish the number and location of groundwater extraction wells needed to remediate the WSA and Plant 6 areas of the aquifer. (Note: Modeling presented in this report incorporates hydraulic conductivity findings resulting from the above-mentioned pumping test).

Figure 1-3 is a location map that shows:

- The location of the 38-direct push sampling locations used to support this characterization

- The location of the wells routinely sampled via the IEMP in June of 2000. Note that December 1999 IEMP data was used for the Conceptual Report

- The location of the twelve monitoring wells which were sampled between January and May 2000 to supplement the June 1999 IEMP data

- The location of the pumping test.

The collection of groundwater samples was limited to areas that:

- Did not interfere with ongoing remediation activities
- Were outside the Waste Pits
- Were outside Plant 6 and other buildings in the vicinity of Plant 6.

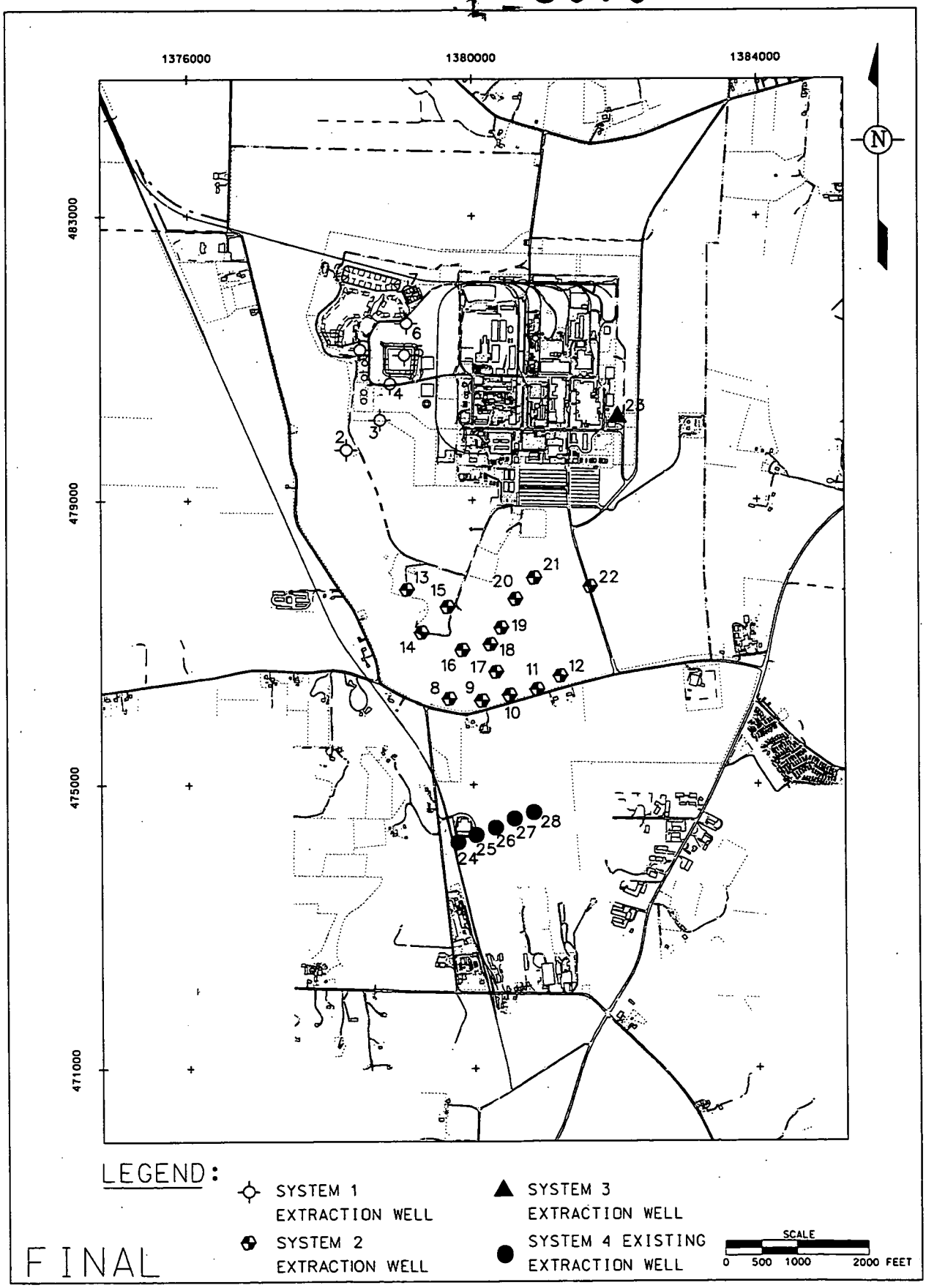

FIGURE 1-1. PROJECTED EXTRACTION WELL LOCATIONS FOR THE OU5 ROD (1996)

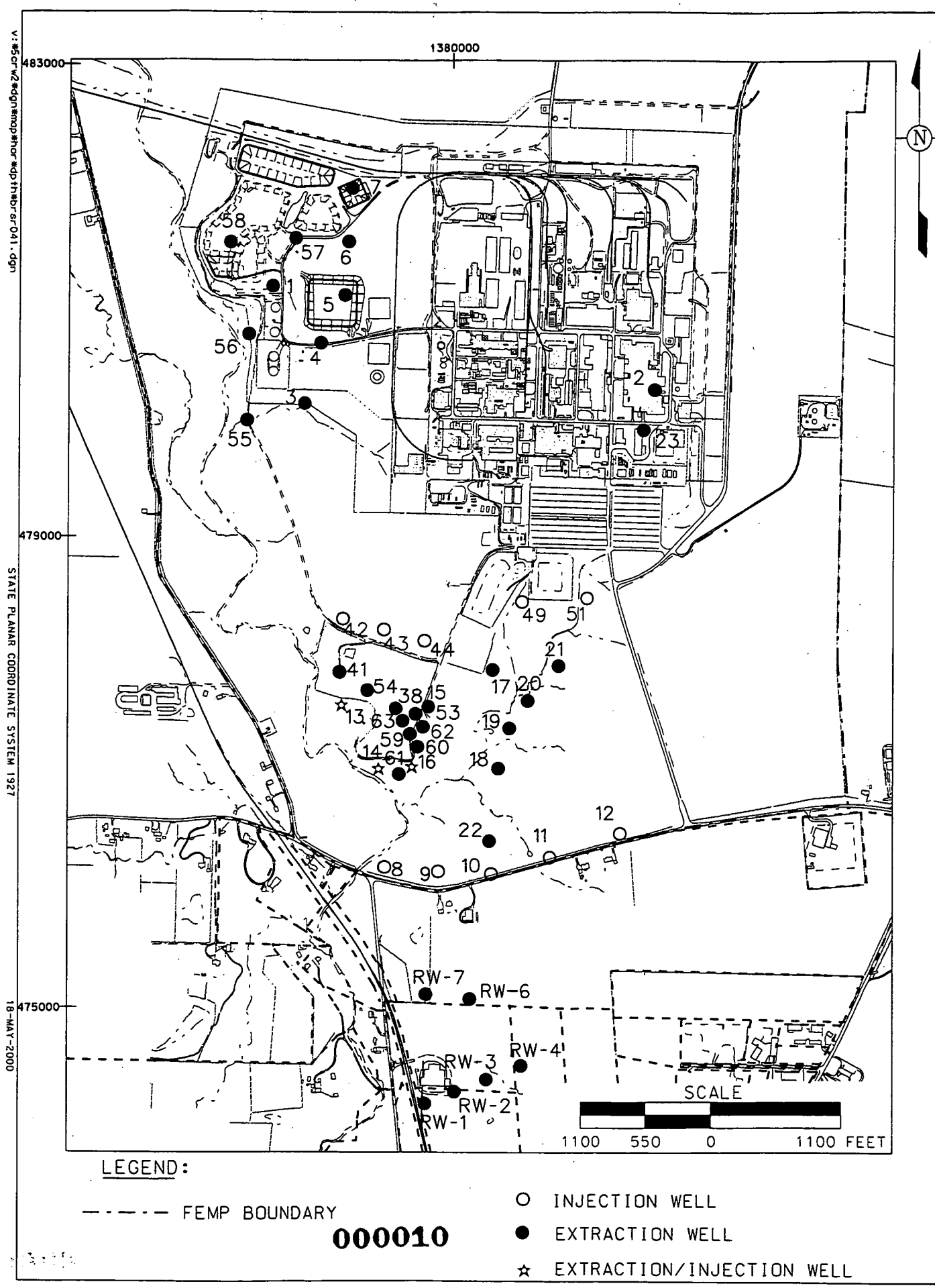

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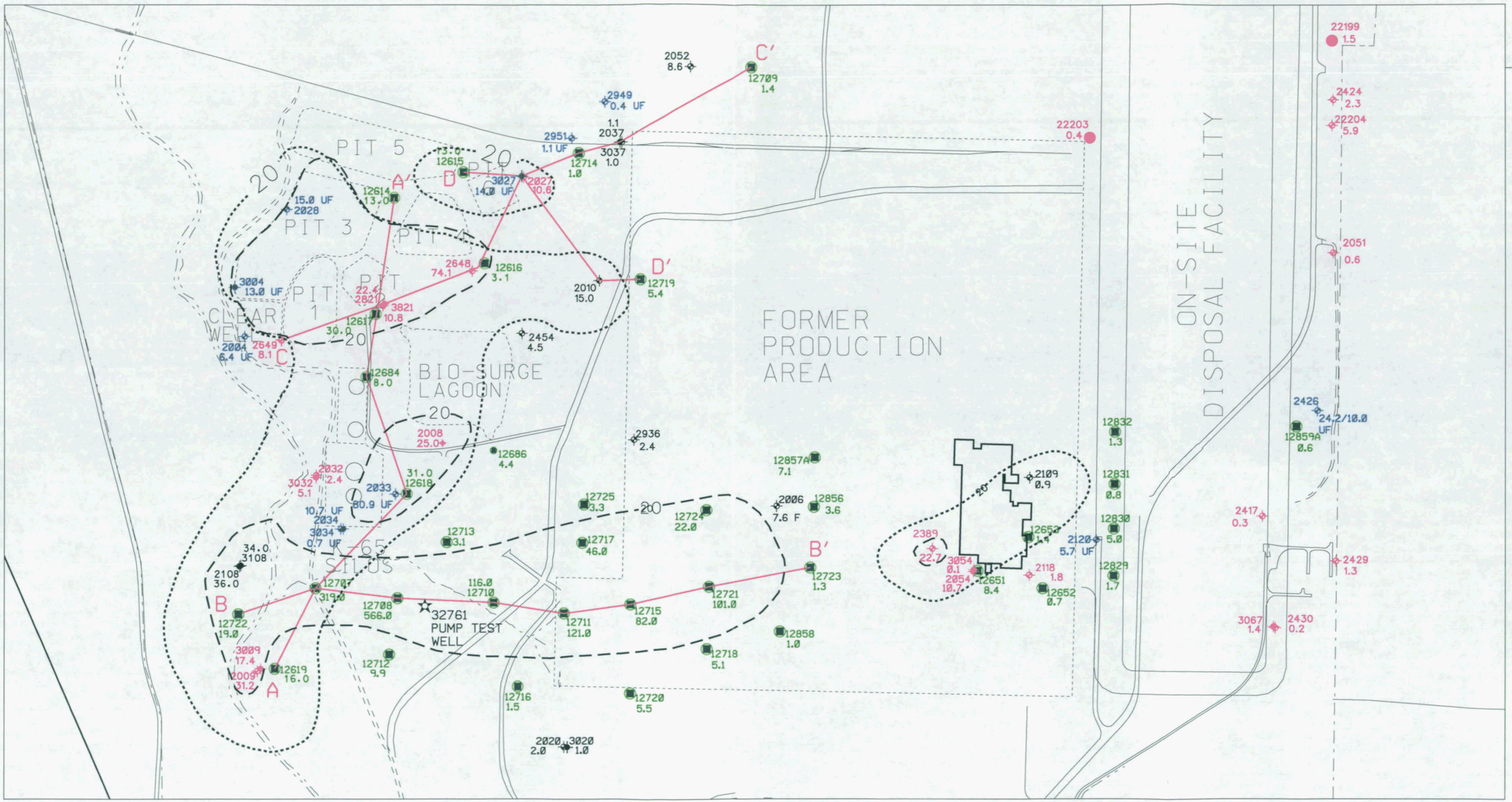
FIGURE 1-2. WELL LOCATIONS FOR THE BASELINE GROUNDWATER REMEDIAL STRATEGY (1997)



LEGEND:

- CROSS SECTION LINE
- 20 µg/L TOTAL URANIUM CONTOUR OU5 RI PLATE E-81
- CURRENT 20 µg/L TOTAL URANIUM CONTOUR
- PLANT 6 OUTLINE
- RECENT DATA (JANUARY THROUGH MAY 2000)
- COMPLETED GEOPROBE LOCATION
- MOST RECENT SED RESULT
- IEMP DATA (JUNE 2000)

SCALE: 500 250 0 500 FEET

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FIGURE 1-3. WASTE STORAGE AND PLANT 6 – DESIGN GROUNDWATER CHARACTERIZATION MAP

2.0 CHARACTERIZATION RESULTS

2.1 CHARACTERIZATION RESULTS IN THE WASTE STORAGE AREA

As a result of the RI/FS characterization, one large uranium plume (>20 µg/L) had been identified in the Waste Storage Area. Plate E-81 of the OU5 RI Report depicts the location and concentration of the plume. The source for the plume was identified as possible leakage through the base of the waste pits and contaminated runoff infiltrating through the bed of Paddys Run. Spread of the plume was caused by the slow easterly migration of the contamination with regional groundwater flow. Figure 1-3 illustrates the location and size of the uranium plume that was identified on Plate E-81 of the OU5 RI Report. Over the course of routine monitoring of OU5 RI/FS-installed monitoring wells for the IEMP (1997 to the issuance of the Conceptual Design Report), slight modifications to this plume have been made; however, the basic one-plume characterization in the WSA remained.

As a result of the conceptual design groundwater characterization, the one-plume interpretation has been superseded by a three-plume interpretation. In addition to the identification of three separate plumes, one area of "short-circuit" contamination has also been characterized. The data used to support this characterization includes:

- Uranium concentration data collected at thirty direct-push sampling locations
- Routine groundwater monitoring data collected via the IEMP in June 2000
- The most recent uranium concentration data found in the Site Environmental Database (SED) for nine wells that had either been abandoned or could not be accessed due to surface excavation activities
- Supplemental groundwater sampling at eleven groundwater monitoring wells in the first quarter of 2000.

Figure 1-3 illustrates the locations and highest uranium concentration obtained from each of the sampling points. Four cross sections A-A' through D-D' have been constructed to illustrate the nature and extent of the areas of contamination. Figure 1-3 also illustrates the locations of these four cross sections. Each cross section is discussed below.

Cross Section A-A'

Cross Section A-A' is shown in Figure 2-1. The section extends from Direct-Push Location 12619 to Direct Push Location 12614. It is oriented in a north-south direction and runs through each of the three identified uranium plumes. Refer to Figure 1-3.

The source of contamination for the southern plume is believed to be the Pilot Plant Drainage Ditch. Accordingly, this plume is identified as the Pilot Plant Drainage Ditch Plume and is discussed in greater detail in Cross Section B-B'. The north-south profile of the plume (shown in Cross Section A-A') indicates that the plume is elongated. The Pilot Plant Drainage Ditch Plume was characterized as being separated from the middle plume (identified at Direct Push Location 12618 and Monitoring Well 2008) based on low uranium concentrations found in Monitoring Wells 2034, 3034 and Direct Push Location 12713.

As Figure 1-3 shows, the middle uranium plume is the smallest of the three plumes. It could actually be slightly larger to the west and north, but the K-65 Silos and the Bio-Surge Lagoon prevent the collection of groundwater samples in those areas. Data collected in Monitoring Wells 2032 and 3032 indicate that the plume is not present to the west of the silos. Data collected to the east of the plume at Direct Push Locations 12686 and 12713 indicate that the eastern edge of the plume is located to the west of these two locations. However, there is a possibility that a very thin plume (less than five feet thick) is present at Direct-Push Location 12686, as the shallowest recoverable sample was collected five feet below the water table. It is believed that historical loading through the bed of Paddys Run, located to the west, was the source for this plume. Assuming Paddys Run infiltration was the source, it is likely that this plume has attenuated because contaminated surface water runoff going to Paddy's Run from the northern portion of the Waste Storage Area was cut off by the Waste Pit Area Runoff Control Removal Action in 1991.

Note that data collected at Monitoring Well 2033 (in the middle plume just west of Location 12618) conflicts with data collected from Direct Push Location 12618. December 1999 data for well 2033 were used in the conceptual report. The direct push sample collected at Location 12618 in December of 1999 had a uranium concentration of 31 μg/L. The direct- push sample was filtered through a 5- micron filter. In December 1999 the unfiltered uranium concentration measured at Monitoring Well 2033 was 104.3 μg/L. The turbidity of the December sample was 151 NTU. Because the turbidity of the December 1999 sample greatly exceeded the OEPA recommended 5 NTU limit, this result was considered suspect. In the conceptual report, this result was therefore interpreted as not accurately representing the concentration of the mobile fraction of uranium in the groundwater at this location. On March 27, 2000, Monitoring Well 2033 was plugged and abandoned to make way for surface excavation activities. An unfiltered groundwater sample collected just prior to the well being plugged and abandoned, had a uranium concentration of 80.9 μg/L and a turbidity of 0 NTU. Based on turbidity, the March 2000 sample result is not suspect. Additional direct-push sampling will be conducted once contaminant sources have been removed from this area.

The northern most uranium plume is centered around Direct Push Location 12617 in Cross Section A-A'. The northern plume was characterized as being separate from the middle plume based on uranium concentration data collected at Direct Push Location 12684, Refer to Figure 1-3. As with the middle plume, full characterization of the northern plume was hindered by the overlying presence of the Waste Pits. Therefore, as Pit 3 and the Clearwell are the likely sources for this plume, the extent of the plume was conservatively depicted as extending under Waste Pits 1, 2, and 3 as well as part of the Clearwell. The southern extent of the plume was defined using Direct Push Location 12684. The uranium concentration (74.1 ppb) collected from Monitoring Well 2648 seemingly conflicts with the concentration (3.1 ppb) collected from the nearly Direct Push Location 12616. Figure 2-2 is a graph of total uranium concentration versus time in Monitoring Well 2648. The graph indicates that the uranium concentration has been increasing in this well. The highest uranium concentration measured at Direct Push Location 12616 (3.1 μg/L) indicates that the significantly higher uranium contamination in Monitoring Well 2648 (74.1) must be very localized. This well will be watched closely in the future as it is possible that cross-contamination is taking place at Monitoring Well 2648 and that a short pumping action may be all that is required to remediate a small plume of contamination. The northern edge of the plume was defined using results from Direct Push Location 12614. Flow in this area is roughly to the northeast. Groundwater samples were collected northeast of this plume to determine the northeast extent of the plume.

Cross Section B-B'

Cross Section B-B' is shown in Figure 2-3. The location of the cross section is shown on Figure 1-3. Cross Section B-B' has been constructed along the axis of the east-west trending, narrow, uranium plume called the Pilot Plant Drainage Ditch Plume. As stated previously the source for the uranium contamination was the Pilot Plant Drainage Ditch. Figure 2-4 is a contour map of the Pilot Plant Drainage Ditch Plume.

It is not known if the plume originated from one source or from several sources along the Pilot Plant Drainage Ditch; however, the highest uranium concentrations occur just east of an area where the base of the Pilot Plant Drainage Ditch has eroded through the glacial overburden and has direct contact with the underlying Great Miami Aquifer. The current interpretation indicates the primary source for the plume is that section of the ditch west of its intersection with the road and east of Paddys Run (west of Location 12707) as shown on Figure 1-3. In the past, the Pilot Plant Drainage Ditch actually ran further west in order to reach the previous location of the Paddys Run channel. The Paddys Run channel was relocated to the east in the early 1970s. The uranium concentrations in the aquifer west of the present location of Paddys Run are believed to be residuals left by infiltration from the ditch before Paddys Run was relocated.
The southern edge of the plume has been well defined with data collected from Geoprobe Locations 12619, 12712, 12716, 12720, 12718, 12858 (see Figure 1-3). The eastern extent of the plume has been identified

with data collected from Direct Push Location 12723, 12856, 12857a, and 12858. The northern edge of the plume has been located using data collected from Monitoring Wells 2034 and 3034 and Direct Push Locations 12713, 12724, and 12725.

Cross Section C-C'

Cross Section C-C' is shown in Figures 2-5 and 2-5a. Figure 2-5 is constructed using December 1999 IEMP data, and was presented in the Conceptual Design Report. Figure 2-5a is constructed using June 2000 IEMP data, and the most recent data collected from Monitoring Well 3027. The location of the cross section is shown on Figure 1-3. The section extends through the northern plume from Monitoring Well 2649 to Direct Push Location 12709. As the two figures illustrate, the later interpretation shows no > 20 μg/L uranium plume at Location 3027. Uranium concentrations at Monitoring Well 3027 are discussed further below in Cross Section D-D'.

Cross Section D-D'

Cross Section D-D' is shown in Figure 2-6 and 2-6a. The section extends from Direct-Push Location 12615 to Direct Push Location 12719. Figure 2-6 is constructed using December 1999 IEMP data, and was presented in the Conceptual Design Report. Figure 2-6a is constructed using June 2000 IEMP data and data collected from Monitoring Well 3027 just prior to it being plugged and abandoned. This cross section was constructed for the Conceptual Design Report to illustrate the nature of the uranium plume that was identified from groundwater samples collected from Monitoring Well 3027. The uranium plume was characterized as being localized around the well screen in Monitoring Well 3027. This characterization was based on the following observations:

- The uranium concentration of groundwater samples collected from Monitoring Well 3027 indicate that a sharp increase in uranium concentration occurred over a very short time period. From November 17, 1998 to June 15, 1999, the concentration increased from 3.26 μg/L to 179.64 μg/L. Figure 2-7 is a uranium concentration versus time graph for Monitoring Well 3027. Field documentation shows that the turbidity of the two samples shown in Figure 2-5, with the measured uranium concentrations above 100 μg/L, were >999 NTU and therefore not representative of the dissolved uranium concentration of the aquifer at this location.

- The uranium concentrations of groundwater samples collected from Monitoring Well 2027 have not increased (see Figure 2-8).

- Direct-push groundwater samples collected around Monitoring Well 3027 did not yield uranium concentrations above 20 μg/L. Results at Locations 12714, 12615, and 12719 are all below 20 μg/L.

The Conceptual Design Report reasoned that if a uranium plume was migrating into the area or had originated in this area, then elevated uranium concentrations would be present in shallower surrounding wells and in surrounding geoprobe locations. The large uranium concentration increase observed in Monitoring Well 3027 was not indicative of a plume that was slowly migrating through an area. The

increase was more indicative of a "short-circuit", whereby surface or glacial overburden contamination migrates down the well bore.

A small scale pumping operation was conducted in October 2000 within this localized pocket of contamination. The results of this pumping effort re-inforced the interpretation that the higher levels of contamination detected were due to cross-contamination. Table 2-1 presents results of the pumping action. At the start of pumping the uranium concentration was 250 µg/L. After pumping 5,000 gallons of water from Well 3027 the uranium concentration had decreased to approx. 15 µg/L. After pumping 20,000 gallons from Well 3027, the uranium concentration decreased to 13 µg/L. On October 27, 2000, the well was plugged and abandoned. However, the well was first pumped immediately prior to being plugged. At the start of that pumping the uranium concentration of the static water in the well was 50 µg/L. After pumping 5,000 gallons from the well, the uranium concentration of the pumped water decreased to 14 µg/L. Figure 2-6a illustrates the final interpretation, which is based on the uranium concentration measured just prior to well 3027 being plugged and abandoned.

Plate E-81 of the OU5 RI Report depicts Monitoring Well 2010 as being located inside the 20 µg/L uranium contour. Recent sampling at this well indicates that the uranium concentration is 15 µg/L. Figure 2-9 shows the uranium concentration versus time for Monitoring Well 2010. As the graph indicates, the well has not been sampled routinely since 1994. The 150 µg/L uranium concentration measured in 1994 is uncharacteristically high. However, the datum had a turbidity of >999 NTU, therefore it is considered suspect. If the 150 µg/L uranium concentration was real, and did indicate a uranium plume, then collecting direct push samples immediately downgradient in 2001 would confirm the presence of the plume. However, the results from direct push location 12719 though did not indicate that a uranium plume above 20 µg/L was present (Figure 1-3). Also, data collected to the west of Monitoring Well 2010 (at Direct Push Location 12616) and South of Monitoring Well 2010 (at Monitoring Well 2454) indicate that no uranium plume is present. Sampling conducted in 2000 in well 2010 also confirms that no uranium plume is present.

2.2 CHARACTERIZATION RESULTS IN THE PLANT 6 AREA

As a result of the RI/FS, a small plume (>20 µg/L) was characterized in the Plant 6 Area. Plate E-81 of the OU5 RI Report depicts the location and concentration of the uranium plume. Figure 1-3 of this report illustrates the location and size of the uranium plume that was identified on Plate E-81 of the OU5 RI Report. The source/pathway of the plume was identified as being excavations for construction of Plant 6 that went deep into the glacial overburden and provided a pathway for contaminated perched water and/or leaking process liquids to move vertically to the underlying sand and gravel of the Great Miami Aquifer.

Design monitoring results reported in the conceptual design indicated that a uranium plume (>20 μg/L) was no longer present in the Plant 6 Area. This characterization was based on:

- Uranium concentration data collected from three direct push sampling locations
- December 1999 IEMP data
- Sampling conducted in conjunction with the well abandonment program
- Recent supplemental groundwater sampling at one groundwater monitoring well that is not in the IEMP.

The conclusion was that the uranium plume identified for the OU5 RI/FS had naturally attenuated to concentrations that are below 20 μg/L. This was attributable to the source of this plume being mitigated by: 1) shut down of Plant 6 operations in the late 1980s, and/or 2) the subsequent Perched Water Removal Action (Response Action #1, completed in December 1995) which pumped highly contaminated perched water from the Plant 6 Area.

In June 2000, Monitoring Well 2389 had a uranium concentration of 22.7 μg/L. This appears to be a one-time exceedance and does not change the conceptual model interpretation made for this area. Figure 2-10 is a time versus uranium concentration plot for Monitoring Well 2389. Sampling results collected prior and subsequent to the June result indicate that the uranium concentration was approximately 5.3 μg/L. This area will continue to be monitored as part of the IEMP.

IEMP sampling results (June 2000) for Monitoring Well 2426 indicated a > 20 μg/L uranium plume at the eastern property boundary downgradient from the Plant 6 area (Figure 1-3). The initial sample results indicated a 24.2 μg/L uranium concentration. Since > 20 μg/L uranium concentrations had not been previously observed at Monitoring Well 2426, the sample was re-analyzed yielding a uranium concentration of 10 μg/L. To verify the presence/absence of a > 20 μg/L uranium plume at the eastern property boundary, direct push location 12859a was completed just upgradient of Monitoring Well 2426. The maximum uranium concentration at Location 12859a was 0.6 μg/L indicating there was not a > 20 μg/L uranium plume at the eastern property boundary. To further verify the presence or absence of a > 20 μg/L uranium plume in this area four additional direct push locations (12829-12832, Figure 1-3) were completed on a north-south line east of Plant 6, the only confirmed source for aquifer contamination in this area. The maximum uranium results for all four locations (all ≤ 5 μg/L) further indicate there is no uranium plume requiring remediation in this area east (downgradient) of Plant 6. However, due to a concern regarding penetration through the glacial overburden in the On-Site Disposal Facility footprint, no direct push locations could be completed in that footprint. The concern is that penetrations through the glacial overburden in the footprint could compromise the protectiveness of the overburden and potentially

create a short circuit pathway for potential leakage from future OSDF cells to reach the Great Miami Aquifer.

Although it appears from past and current characterization efforts in this area east of Plant 6 that there is not a uranium plume requiring remediation in this area, it is recognized that there are residual, above background concentrations of uranium present. Due to the presence of the OSDF footprint, these residual concentrations cannot be fully defined. Further, it is recognized that these residual concentrations must be considered when developing pre-OSDF baseline uranium concentrations in the aquifer, and since they cannot be quantified they may confound future OSDF leak detection evaluations.

2.3 PUMPING TEST RESULTS

The site groundwater model that was used to support the Conceptual Design Report for the aquifer remediation systems had a hydraulic conductivity boundary running through the Pilot Plant Drainage Ditch Plume. Figure 2-11 illustrates the steady state model calibrated hydraulic conductivity zones and the location of previous pumping tests that were used to help calibrate the model to these zones. Figure 2-4 shows the location of the modeled hydraulic conductivity boundary in relation to the location of the uranium plume being targeted for remediation. As can be seen from both figures, hydraulic conductivity modeled north of the boundary is lower than hydraulic conductivity modeled to the south. Cleanup predictions modeled for the Pilot Plant Drainage Ditch Plume are affected by the way that hydraulic conductivity is zoned in this area. A pumping test was conducted to provide a better estimation of hydraulic conductivity for the aquifer in this area.

A seven day test, at a constant pumping rate of 750 gpm, was conducted from November 13 to November 20, 2000. The location of the test is shown in Figure 2-4. Drawdowns measured in nearby monitoring wells during the test were used to:

- Calculate an average horizontal hydraulic conductivity of 452 feet/day
- Calculate an average vertical hydraulic conductivity of 48 feet/day
- Determine that drawdown behaved isotropically in the pumping test area
- Calculate an average specific yield of 0.097.

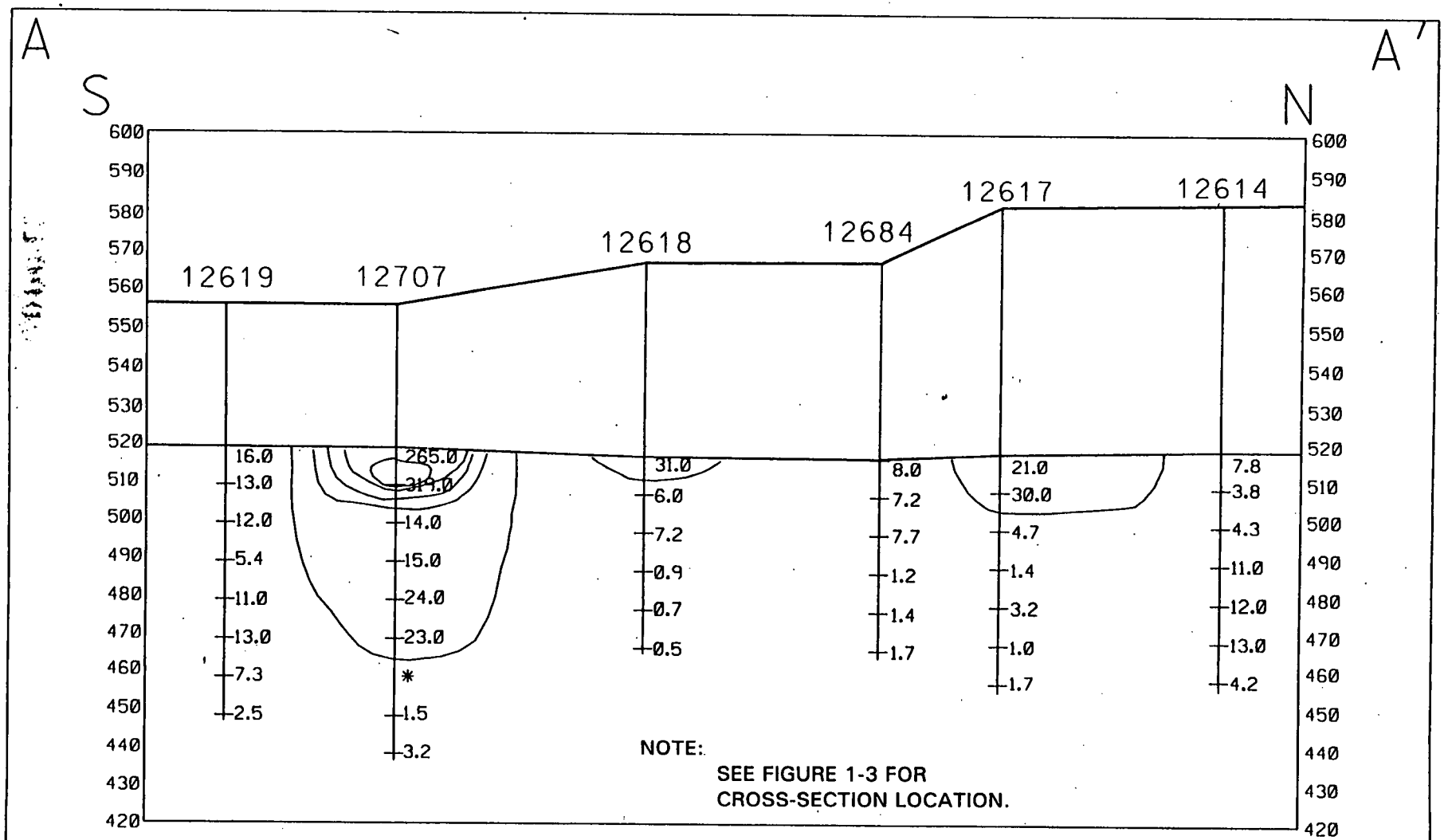
These pumping test results were used to revise the hydraulic conductivity used in this design report for groundwater modeling in the vicinity of the Pilot Plant Drainage Ditch Plume (See Section 3). Additional details concerning the pumping test are contained within the draft final Pumping Test Report, Pilot Plant Drainage Ditch Uranium Plume, Aquifer Restoration and Waste Water Project (DOE 2001).

TABLE 2-1

PUMPING ACTION RESULTS FOR WELL 3027

Date	Time	Volume	NTU	Uranium (µg/L)
10/03/2000	9:55 am	Pre-Pumping	15	250
10/03/2000	10:40 am	3-well volumes	28	25
10/03/2000	3:00 pm	5,000 gallons	3	15
10/04/2000	11:27 am	10,000 gallons	2	14
10/04/2000	3:20 pm	20,000 gallons	3	13
10/05/2000	11:31 am	20,000 gallons	1	13

*All uranium samples are unfiltered



LEGEND:

+2.5 TOTAL URANIUM (μg/L) IN GROUNDWATER

* SAMPLE NOT COLLECTED. IN A SILTY ZONE. TOOL WOULD NOT YEILD ENOUGH WATER.

020000

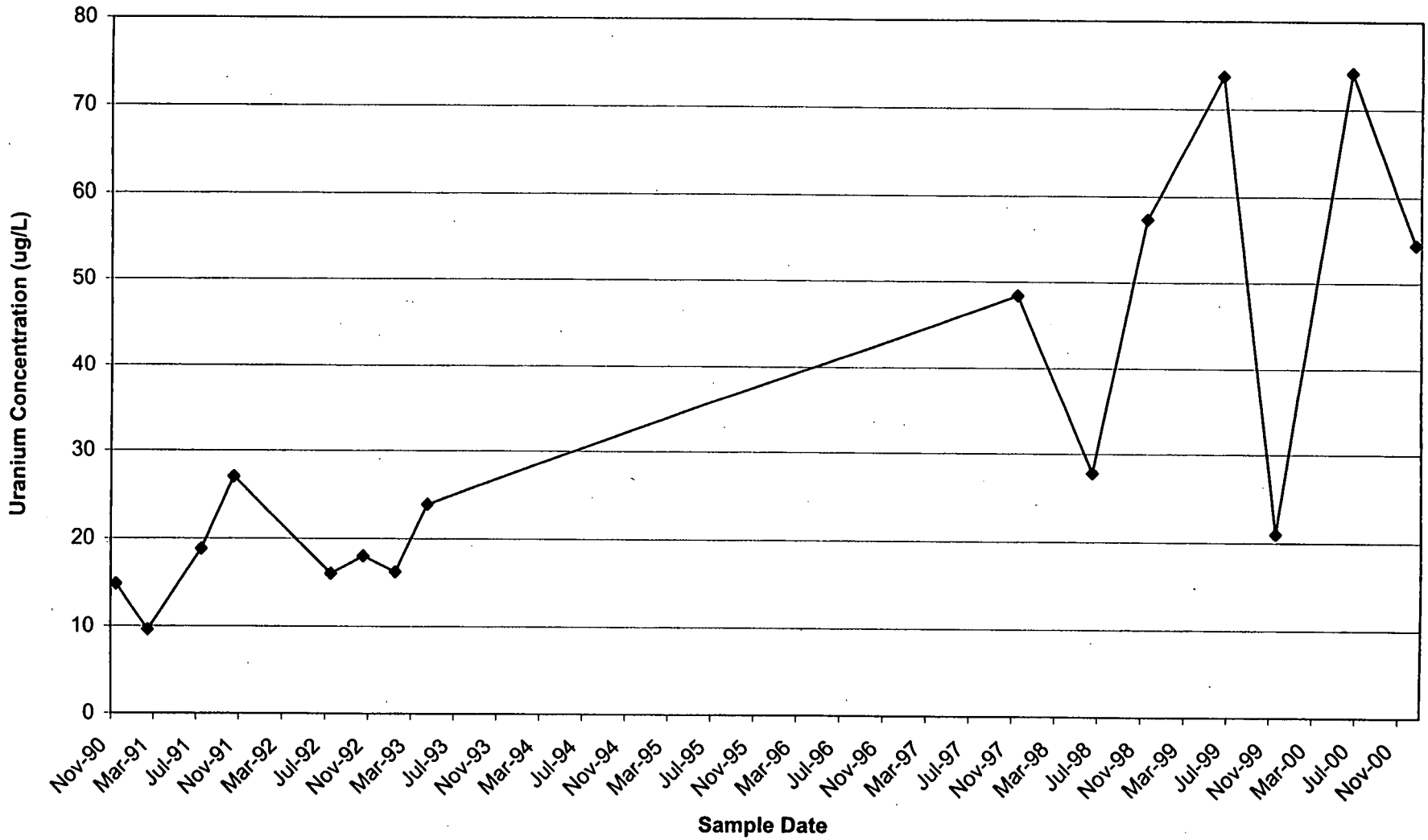
3670

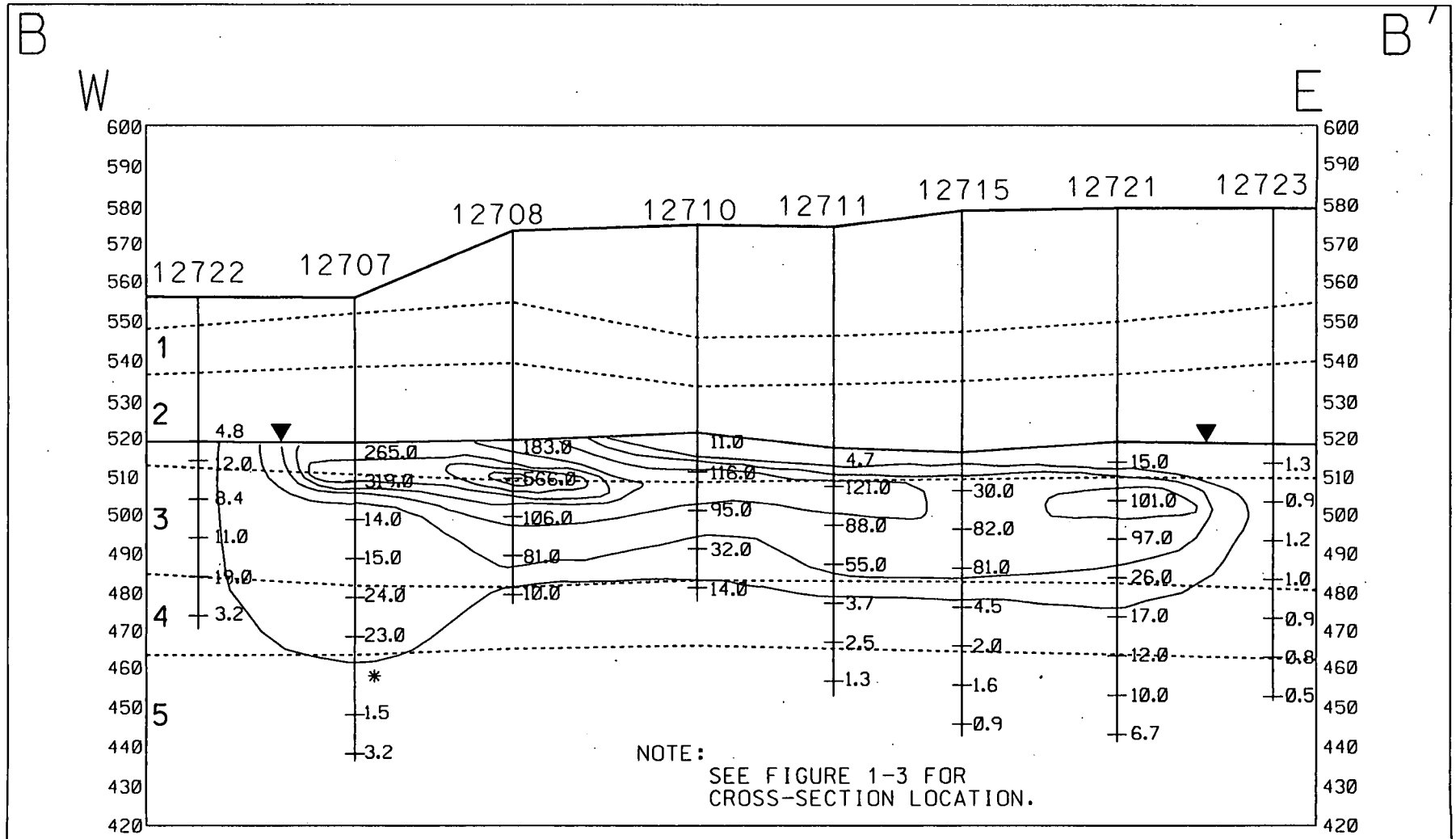
v:\5crw2\dgn\ken_b\ken00055.dgn
STATE PLANAR COORDINATE SYSTEM 1983

FIGURE 2-1. CROSS-SECTION A-A', GEOPROBE RESULTS FOR TOTAL URANIUM IN GROUNDWATER

02-MAY-2000

Figure 2-2
Uranium Concentration versus Time for Monitoring Well 2648





LEGEND:

2.5 TOTAL URANIUM (μg/L) IN GROUNDWATER

1 MODEL LAYER

* SAMPLE NOT COLLECTED. IN A SILTY ZONE. TOOL WOULD NOT YEILD ENOUGH WATER.

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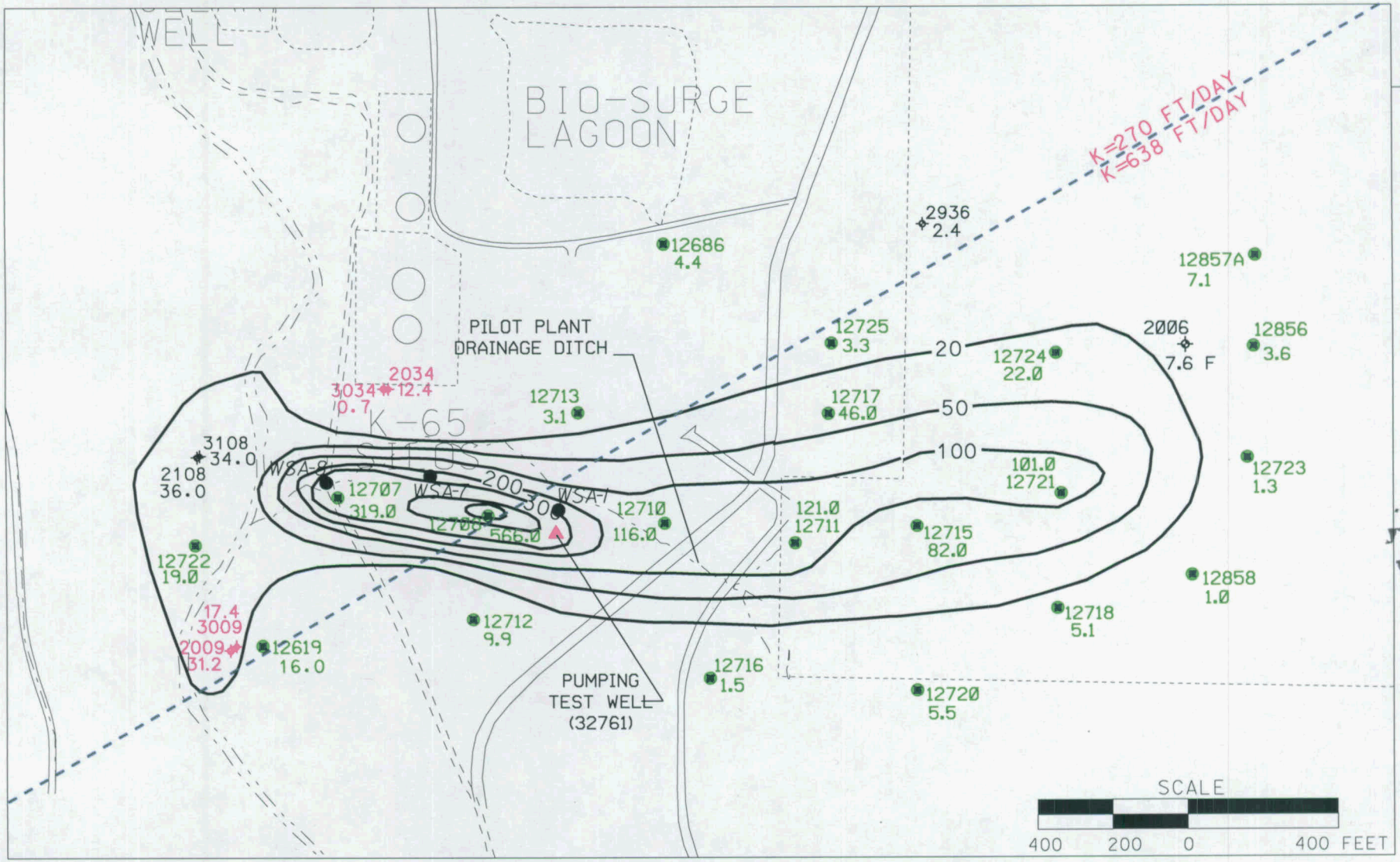
FIGURE 2-3. CROSS-SECTION B-B', GEOPROBE RESULTS FOR TOTAL URANIUM IN GROUNDWATER

220000
0670



LEGEND:

TOTAL URANIUM CONTOUR, JUNE, 2000 (μg/L)

OLD MODELED HYDRAULIC CONDUCTIVITY BOUNDARY

PROPOSED PTW LOCATION

RECENT DATA (JANUARY THROUGH MAY 2000)

COMPLETED GEOPROBE LOCATION

IEMP DATA (JUNE 2000)

DRAFT

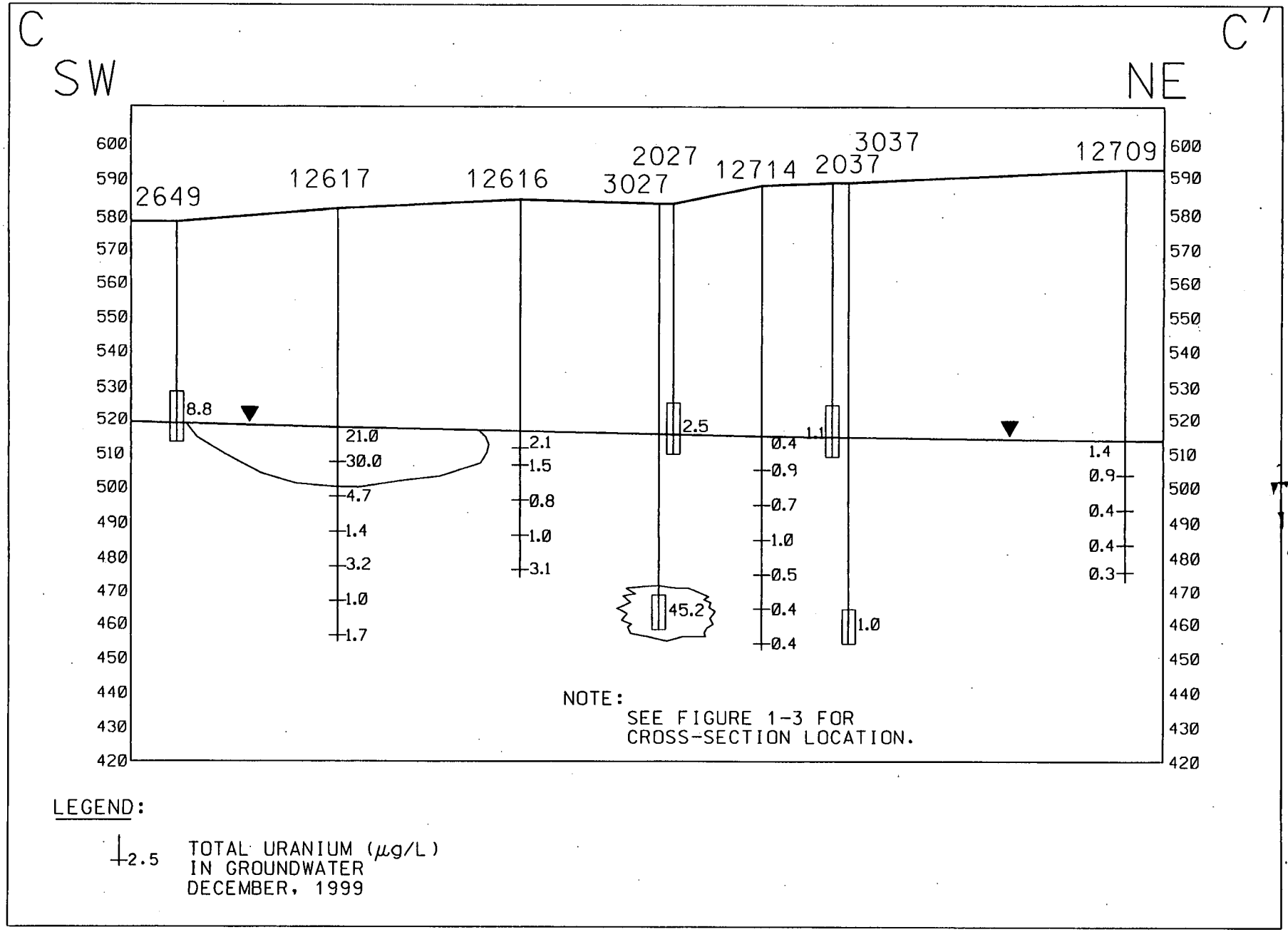
000023

F. 3670

v:*5fgp1*dgn*cd-wsa24.dgn
STATE PLANAR COORDINATE SYSTEM 1927

19-APR-2001

FIGURE 2-4. PILOT PLANT DRAINAGE DITCH PLUME



000024

1-3670

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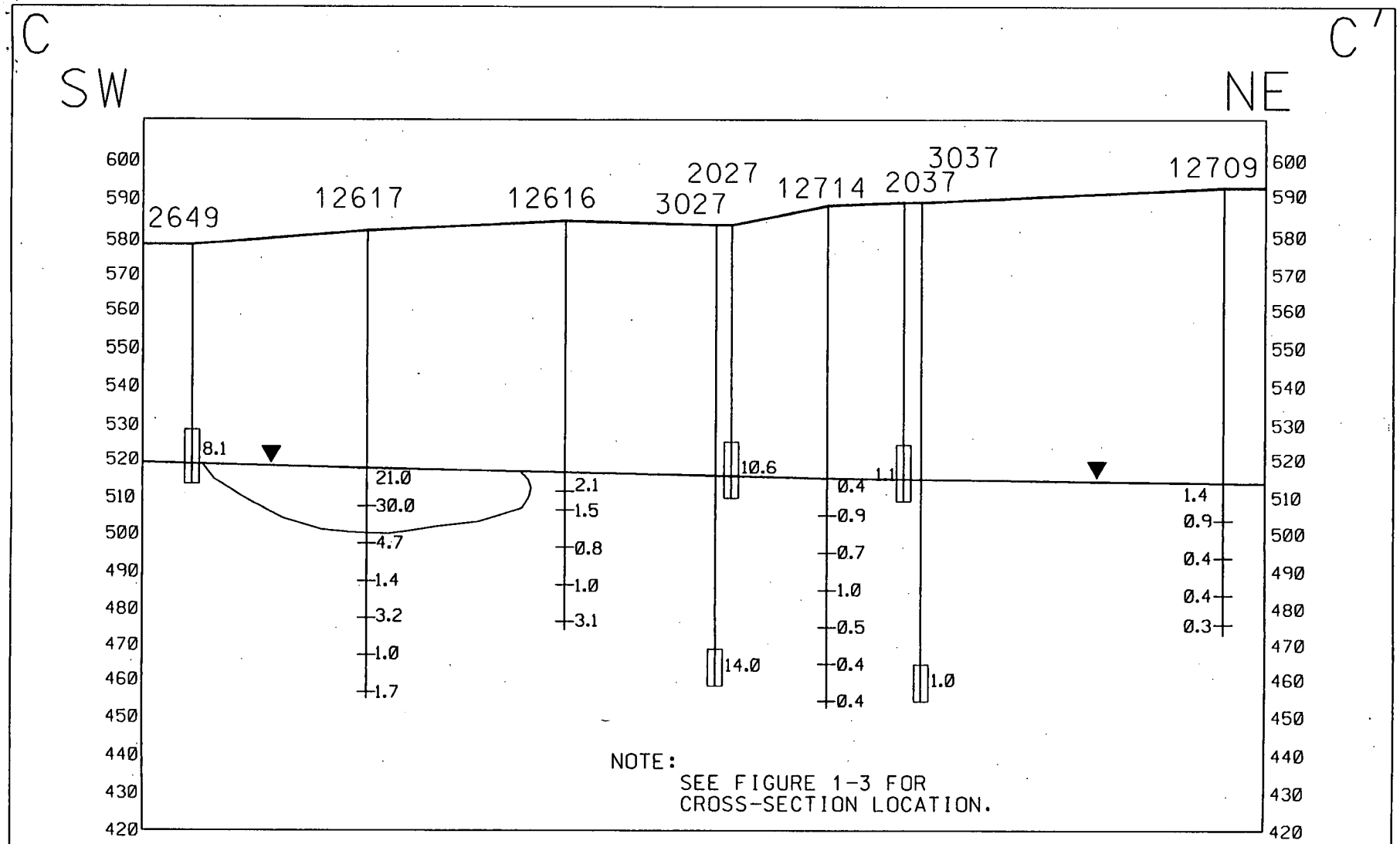
STATE PLANAR COORDINATE SYSTEM 1983

FIGURE 2-5. CROSS-SECTION C-C', GEOPROBE RESULTS FOR TOTAL URANIUM IN GROUNDWATER (DECEMBER, 1999)

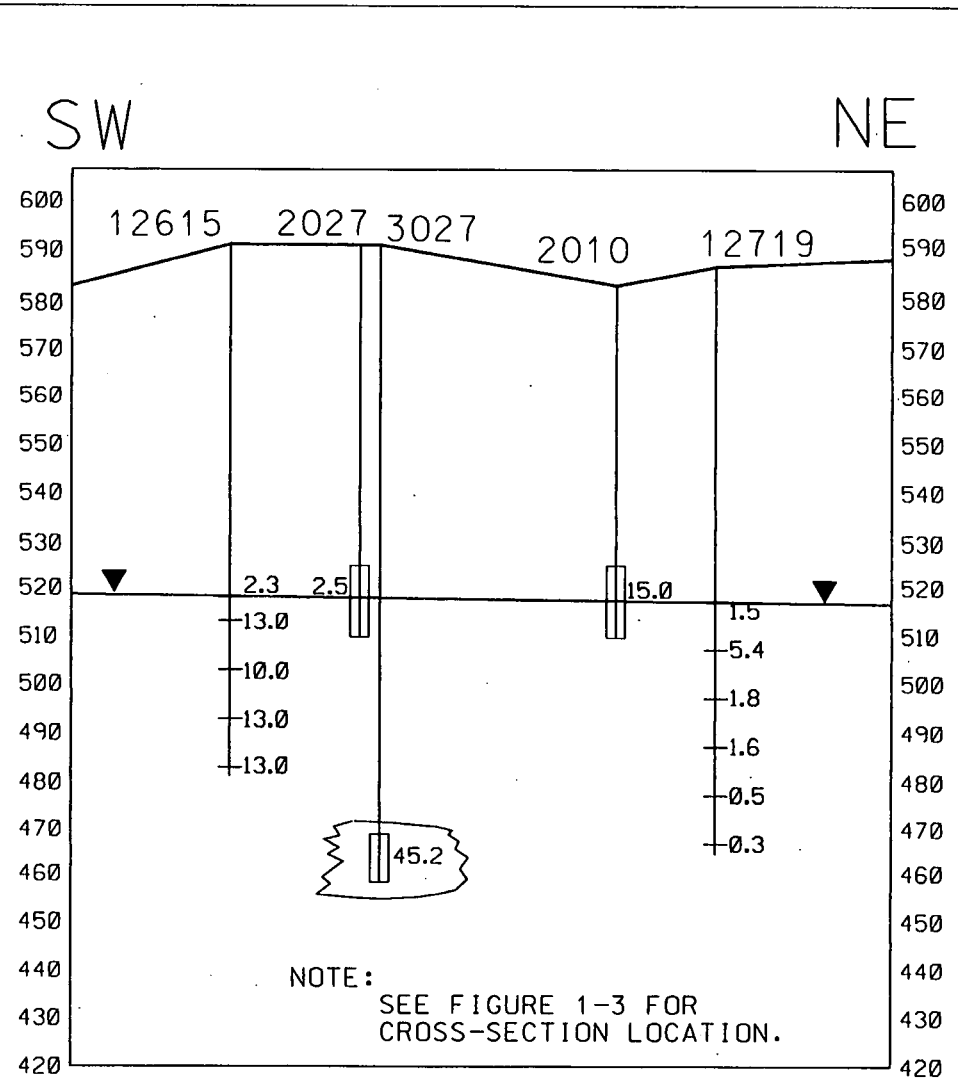
11-APR-2001



LEGEND:

2.5 TOTAL URANIUM (μg/L)
IN GROUNDWATER
JUNE, 2000

000025



LEGEND:

2.5 TOTAL URANIUM (μg/L) IN GROUNDWATER DECEMBER, 1999

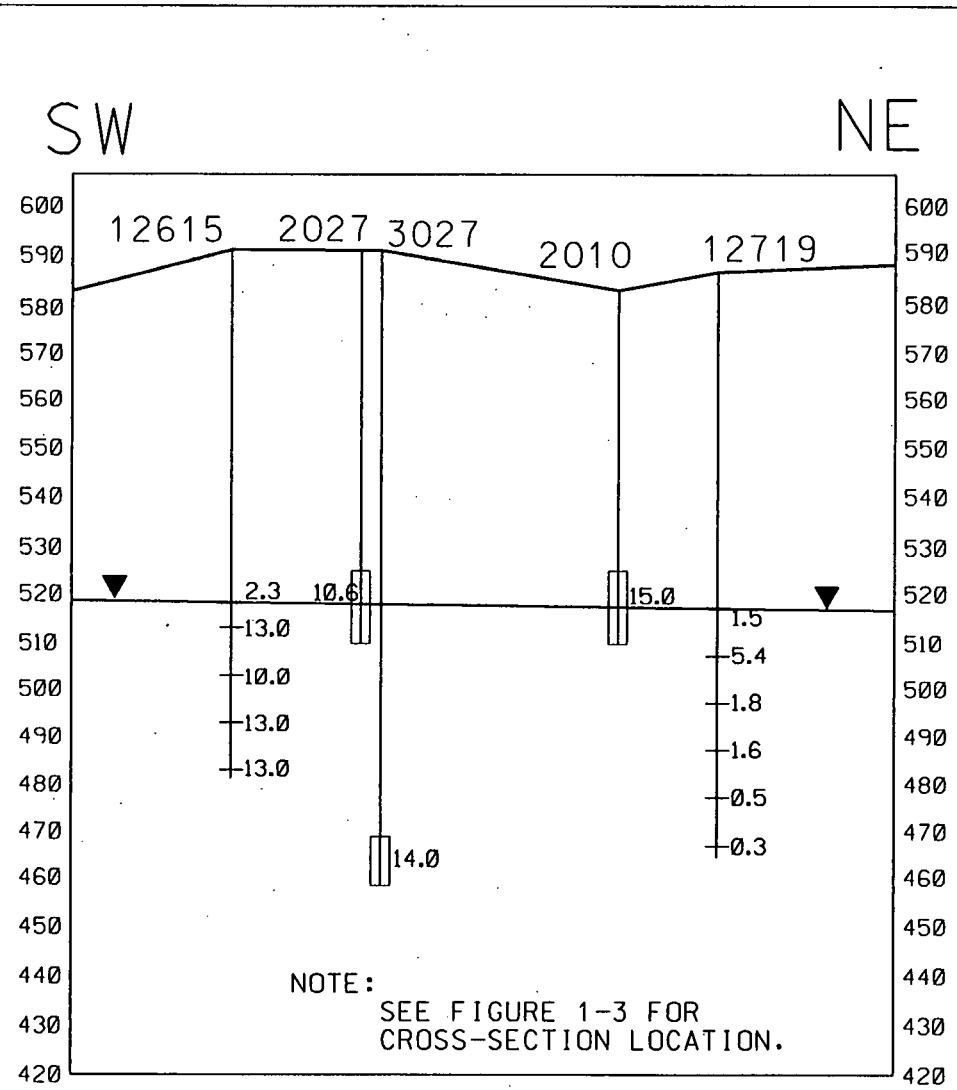
920026

1 3670

v:#5crw2#dgn#ken_b#ken00084.dgn
STATE PLANAR COORDINATE SYSTEM 1983

FIGURE 2-6. CROSS-SECTION D-D', GEOPROBE RESULTS FOR TOTAL URANIUM IN GROUNDWATER (DECEMBER, 1999)

11-APR-2001



LEGEND:

2.5 TOTAL URANIUM (μg/L) IN GROUNDWATER JUNE, 2000

000027

FIGURE 2-6A CROSS-SECTION D-D' GEOPROBE RESULTS

Figure 2-7
Total Uranium Concentration vs. Time for Monitoring Well 3027

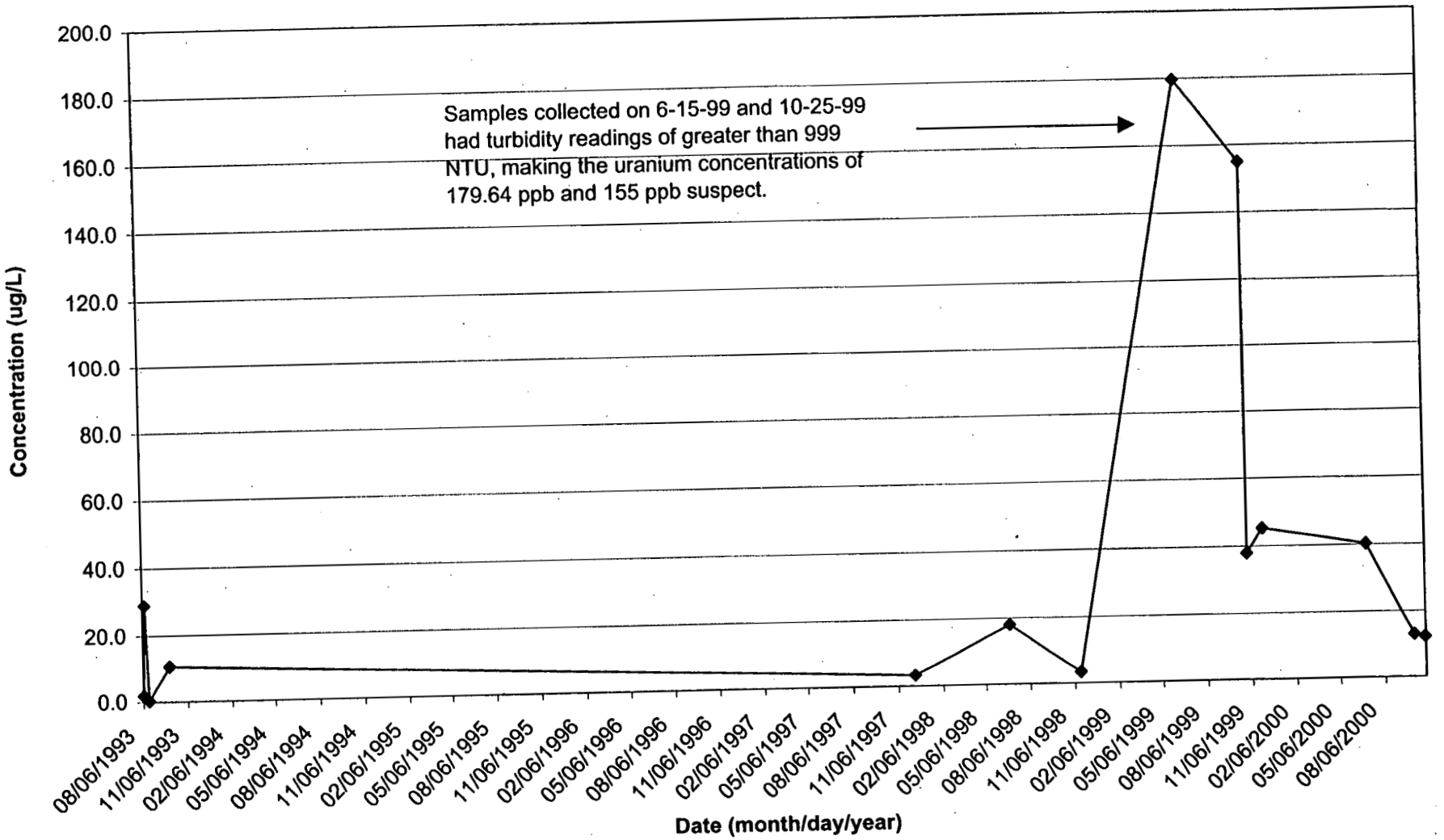
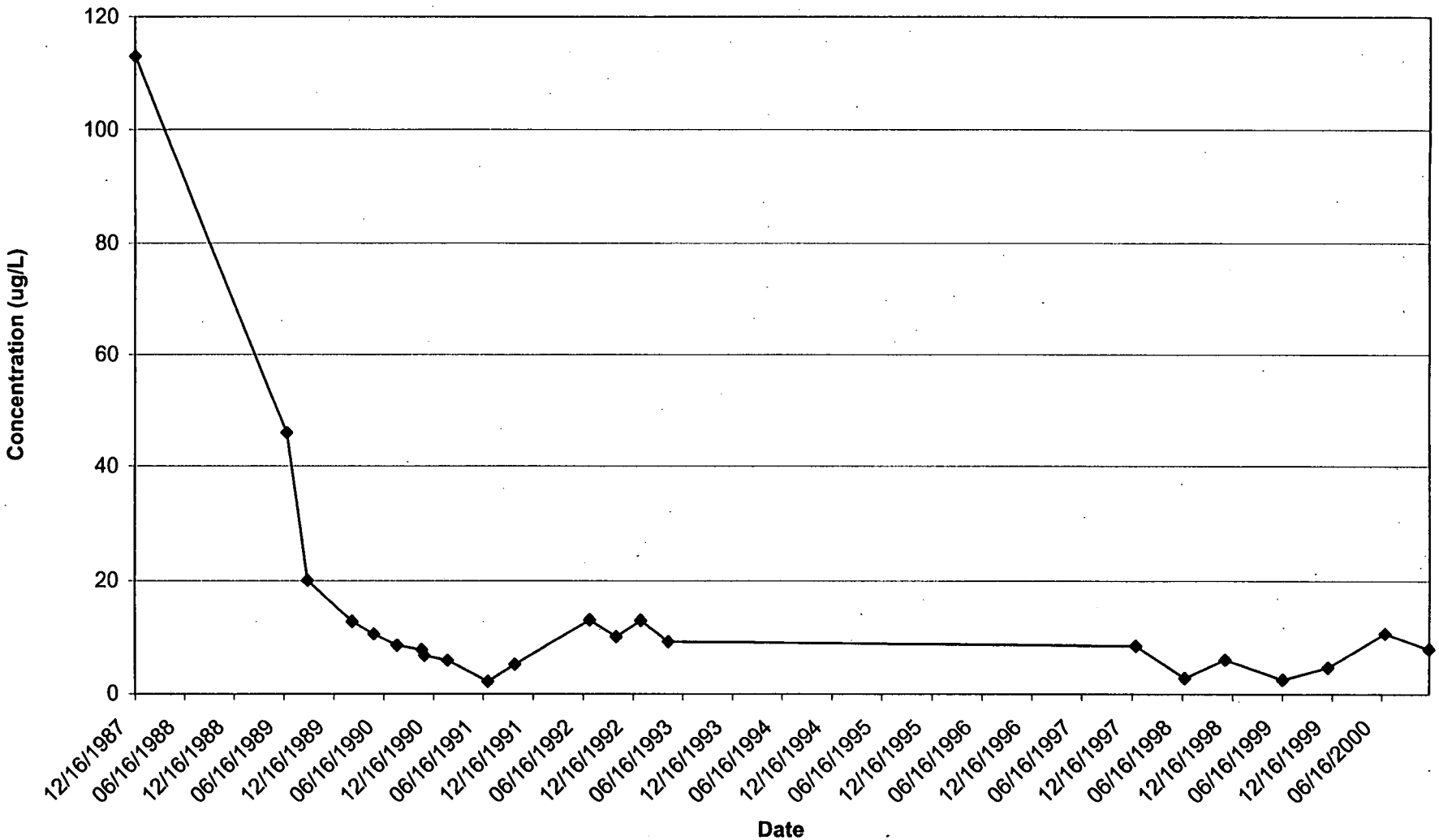


Figure 2-8
Total Uranium Concentration vs. Time for Monitoring Well 2027



000029

Figure 2-9
Uranium Concentration versus Time for Monitoring Well 2010

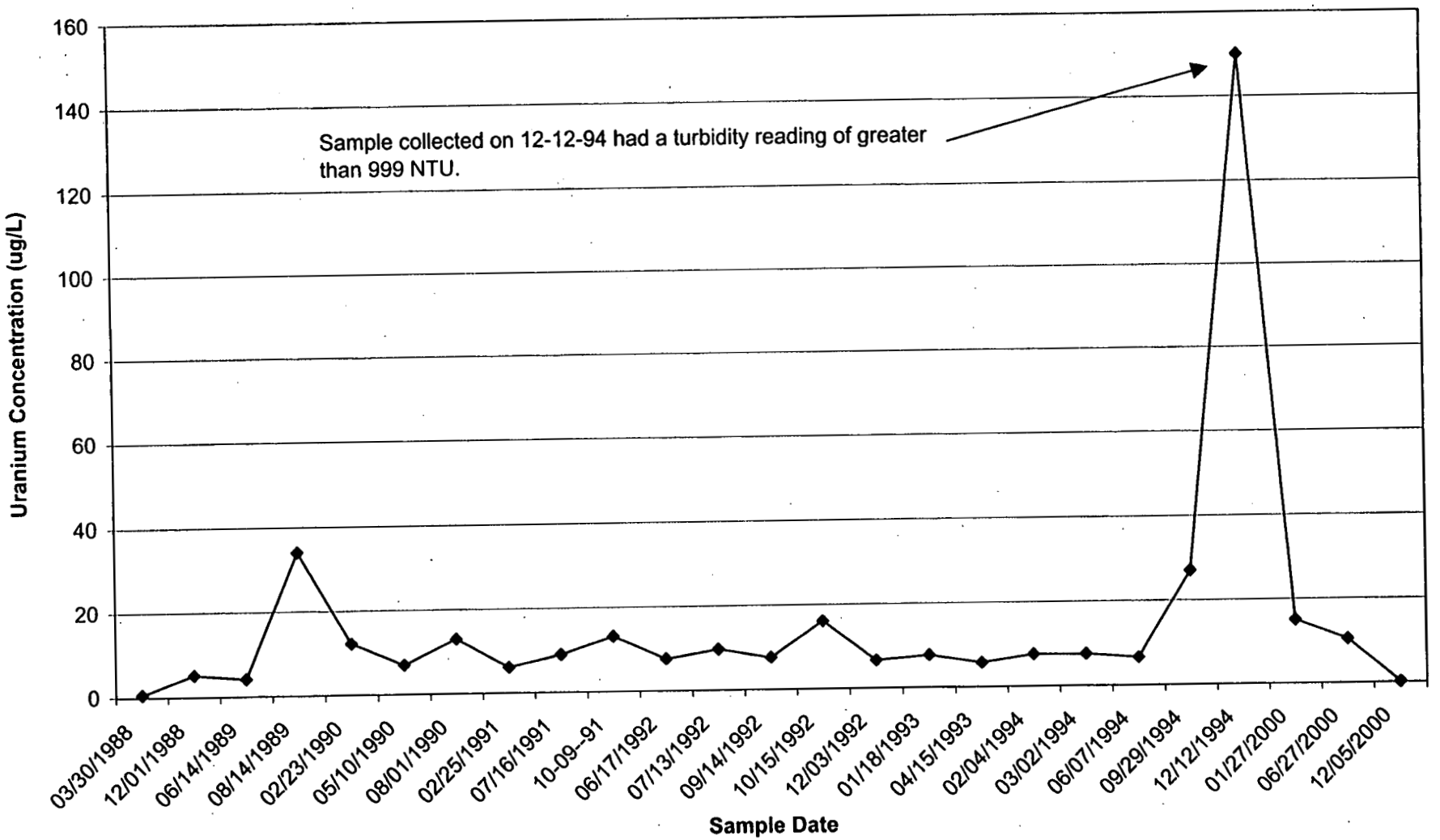
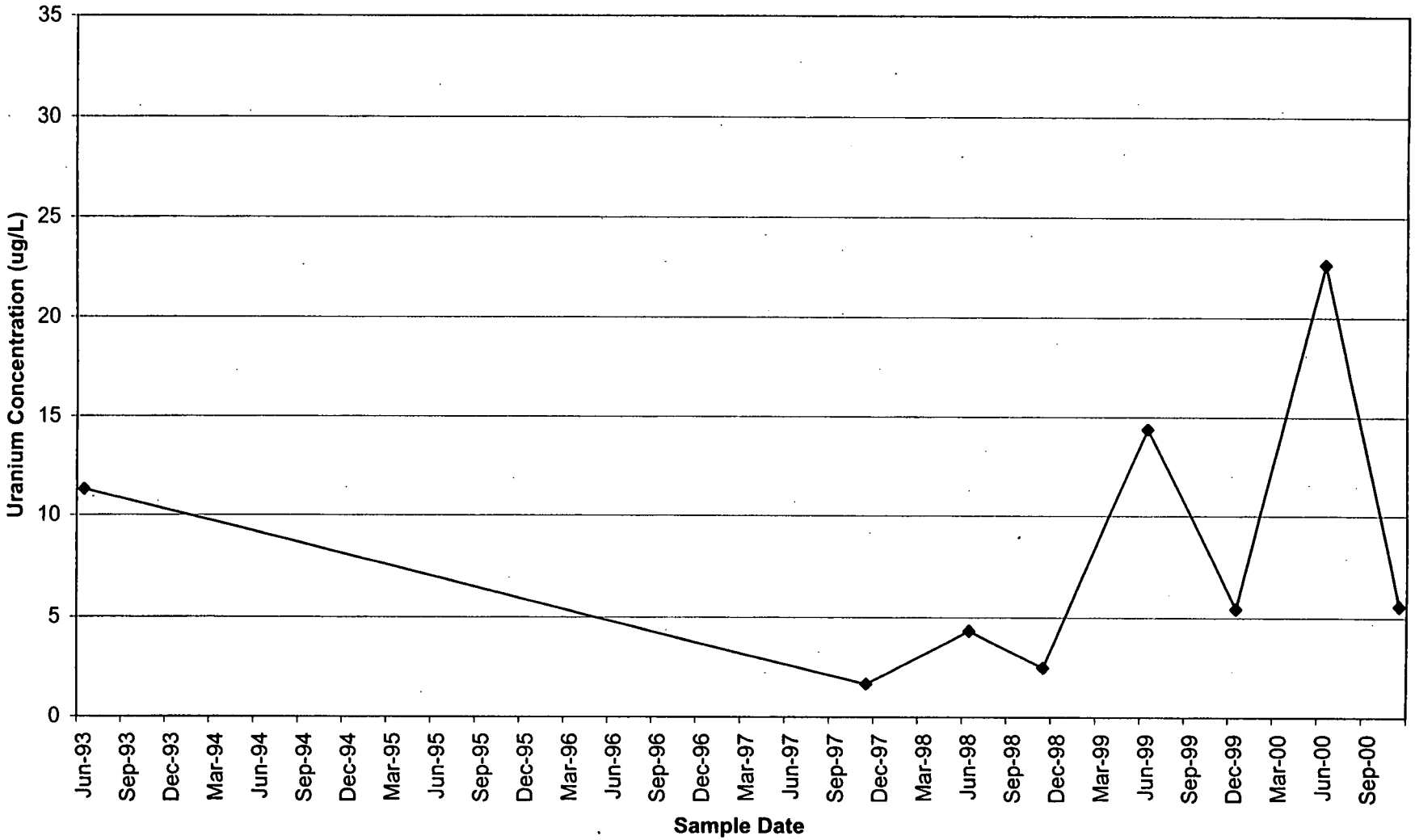


Figure 2-10
Uranium Concentration versus Time for Monitoring Well 2389



000031

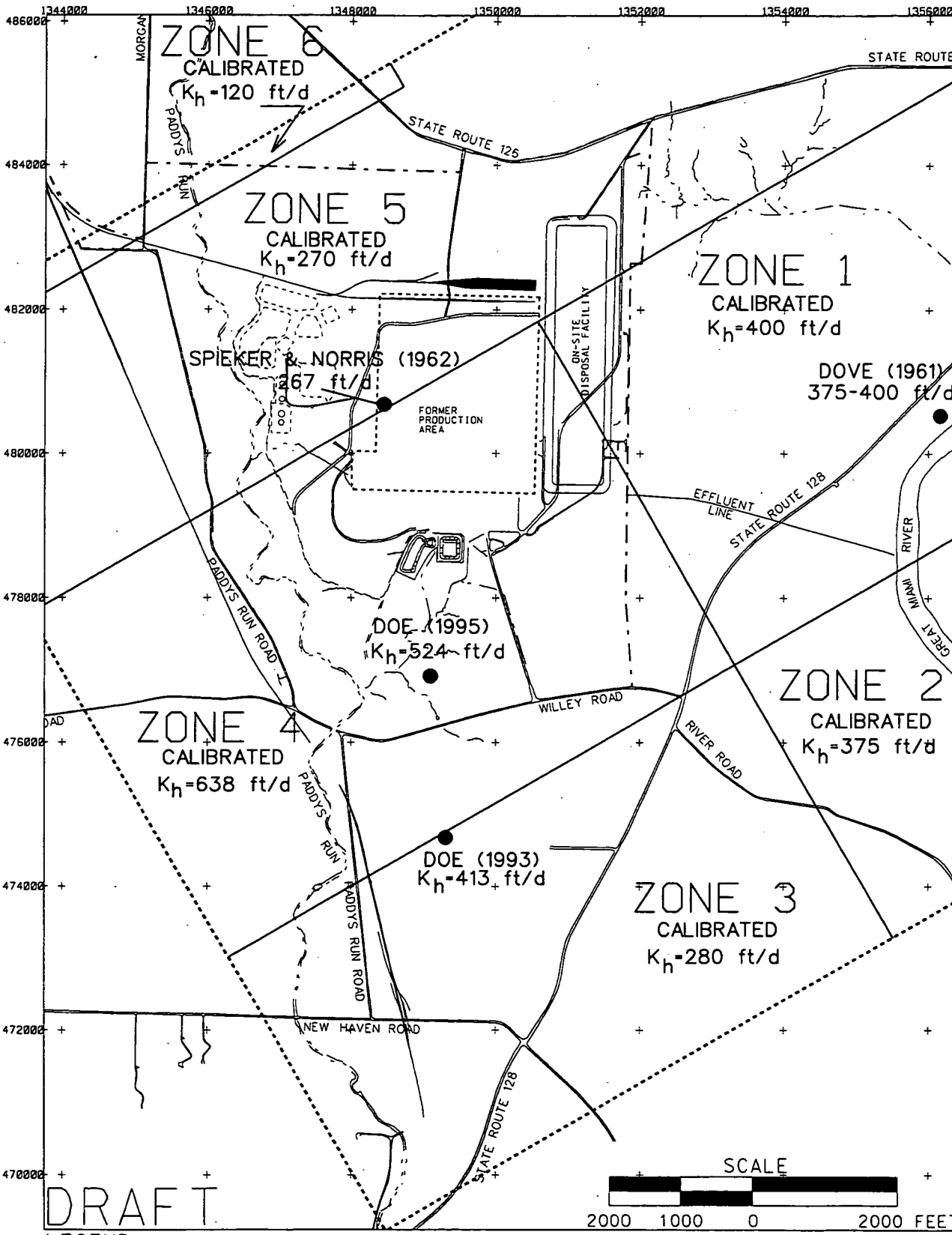


FIGURE 2-11. ZONATION OF MODELED HYDRAULIC CONDUCTIVITY

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STATE PLANAR COORDINATE SYSTEM 1983
11-APR-2001

3.0 NUMBER AND LOCATION OF EXTRACTION WELLS

3.1 INTRODUCTION

The Baseline Remedial Strategy Report (BRSR) (DOE 1997) presented a remedial design for the Waste Storage Area (WSA) consisting of 10 extraction wells with a net extraction rate of 1000 gallons per minute (gpm). Figure 1-2 shows the locations of the proposed extraction wells in the WSA.

As discussed earlier in this report, additional uranium contamination in the Great Miami Aquifer has been characterized beneath the Pilot Plant Drainage Ditch (PPDD). This additional contamination, along with updated characterization of the aquifer contamination in the remaining portions of the WSA based on direct-push sampling conducted in the WSA since 1997, requires a revision to the BRSR remedial design.

Prior to modeling additional design scenarios in the WSA and along the PPDD, a pumping test was conducted in extraction well WSA #1 which was installed in the PPDD area in August 2000 based on direct-push sampling results. The re-calibrated VAM3D groundwater model was updated as described below to reflect the results of the pumping test.

The design for the WSA (including the PPDD) consists of five extraction wells installed in two phases. Phase I consists of three extraction wells located in the PPDD plume, identified in the groundwater model as WSA #1, WSA #2, and WSA #3. For engineering design and operation WSA #1, WSA #2, and WSA #3 are identified as EW-26, EW-27, and EW-28, respectively. WSA #1 (test well infrastructure), WSA #2, and WSA #4 will pump 400, 300, and 300 gpm respectively beginning in FY 2002 (based on current schedule). Phase II consists of two extraction wells in the waste pit area (WSA #5 and WSA #6) scheduled to pump 100 gpm each beginning in FY 2007, after waste pit remediation is completed (Table 3-1). The revised well locations are shown in Figure 3-1.

The maximum contaminant level (MCL) for total uranium in groundwater at the FEMP is 20 μg/L as recorded in the Record of Decision for Remedial Actions at Operable Unit 5 (DOE 1996). EPA has recently promulgated a standard of 30 μg/L for total uranium in groundwater. In response to this revised standard, DOE has initiated a process pursuant with CERCLA guidelines to revise the MCL for total uranium for the FEMP from 20 μg/L to 30 μg/L. Modeling indicates the proposed WSA design will remediate the aquifer in the WSA and PPDD areas to 30 μg/L in seven years or to 20 μg/L in nine years.

Groundwater modeling results supporting this design are described below.

3.2 FLOW MODEL RESULTS

Groundwater elevations in the Great Miami Aquifer differ significantly from season to season due to changing amounts of recharge, with higher elevations in the Spring and early Summer months and lower elevations the Fall and early Winter months. Groundwater elevations in the Great Miami Aquifer have been observed to fluctuate up to seven feet between extreme wet and dry seasons. The VAM3D flow model has been calibrated to groundwater elevation data from representative wet and dry periods (July 1998 for the wet period, and October 1998 for the dry period). This re-calibration was accomplished by developing two sets of model boundary conditions: one for wet, and one for dry periods. The re-calibration is described in Great Miami Aquifer VAM3D Flow Model Re-Calibration (DOE 2000).

Prior to the pumping test, hydraulic conductivity in the Great Miami Aquifer was characterized in the model by six zones as shown in Figure 3-2 with supporting detail in Table 3-2. These hydraulic conductivity zones were first established in the SWIFT groundwater model as described in SWIFT Great Miami Aquifer Model Summary of Improvements Report (DOE 1994). Figure 3-2 shows the boundary between model zones 4 and 5 running through the PPDD area. Zone 5 had a horizontal hydraulic conductivity of 270 ft/day in the top half of the model and zone 4 had a horizontal hydraulic conductivity of 638 and 544 ft/day in model layers 1 through 4. The location of this model zone boundary and the need to determine viable pumping rates for the planned extraction wells motivated the aquifer pumping test at WSA #1.

The pumping test analysis resulted in a hydraulic conductivity for the top half of the Great Miami Aquifer (above the blue clay) of 452 ft/day horizontally and 48 ft/day vertically. An additional hydraulic conductivity zone (Zone 7) was added to the VAM3D model as shown in Figure 3-3 to reflect the pumping test results. Pumping test results are reported in Pumping Test Report Pilot Plant Drainage Ditch Uranium Plume Aquifer Restoration and Wastewater Project (DOE 2001). The resulting hydraulic conductivity values (horizontal and vertical) for all model zones are shown in Table 3-2.

After hydraulic conductivity zone 7 was added to the model, groundwater elevation predictions were checked against measured elevations to see if re-calibration was required. The residuals (difference between predicted and measured elevations) were all less than 1.0 foot with an average residual of 0.13 feet, a root mean square (RMS) error of 0.33 feet, and an RMS % error of 3.06. These values are close to values from the May 2000 model re-calibration (see Table 3-3). Similar comparisons were made

against July 1998 and October 1999 elevation data. In both cases, residuals after the addition of model zone 7 were not significantly different than corresponding residuals from the May 2000 re-calibration.

Based on these results, the change in hydraulic conductivities in the model to reflect results from the WSA #1 pumping test do not require a model re-calibration.

Flow modeling was used to predict groundwater elevations during the time the WSA modules (Phase I and Phase II) would be operational and to predict additional drawdown expected from the added pumping. Flow model results were also used to generate hydraulic and uranium particle tracks to illustrate zones of influence for each extraction well.

The predicted groundwater elevations for the aquifer during the time that the WSA modules will be in operation are shown in Figures 3-4 and 3-5 for the dry and wet seasons respectively. Predicted additional drawdown from operation of WSA Phases I and II are shown in Figures 3-6 and 3-7. Wells from both WSA Phases I and II were assumed to be operating for these elevation and drawdown maps to illustrate the maximum drawdown expected. Operation of the WSA Phase I and II modules at the proposed 1200 gpm pumping rate results in a predicted additional 3.0 feet of drawdown in the vicinity of the WSA and PPDD. No significant additional drawdown off site is predicted.

Groundwater and uranium particle tracks for nine years of pumping in WSA #1, #2, and #4 (from FY 2002 to FY 2009) and for two years of pumping in WSA #5 and #6 (from FY 2007 to FY 2009) are shown in Figures 3-8, 3-9, 3-10, and 3-11. Tracks for both dry and wet seasons are included. Uranium tracks are shown with a retardation of 12 corresponding to a Kd of 1.78 L/kg.

3.3 TRANSPORT MODEL RESULTS

VAM3D transport model scenarios were run to estimate how the WSA modules would perform given the observed aquifer concentrations (initial conditions) and the contaminant source terms remaining while the system is expected to be operational.

3.3.1 Initial Conditions

Preliminary transport model scenarios were run with initial conditions for total uranium developed from Kriged monitoring data. Average Kriged total uranium concentrations were assigned to each model layer. Predicted wellhead concentrations from these scenarios were significantly lower than observed concentrations from WSA #1 obtained during the pumping test. The model loaded with average Kriged values predicted 36 ppb for initial concentrations at WSA #1 but observed concentrations were around

140 ppb. This discrepancy is due to the averaging effect inherent in the Kriging process and to lack of vertical resolution in model layers 2 and 3 when compared to extraction well screen lengths.

An alternate approach was developed to provide initial conditions from hand contoured uranium concentration data. Model grid blocks were overlain onto hand contoured concentrations; then initial concentrations were assigned to each model block in layers 2 and 3 (Layer 1 in the VAM3D model is unsaturated). Cross sections of direct-push sampling data were also used during the process to represent observed vertical concentration profiles in the model. The resulting initial conditions in model layers 2 and 3 are shown in Figures 3-12 and 3-13.

The maximum concentration loaded as an initial condition from hand contours was 175 ppb in layer 2 and layer 3 between direct-push locations 12707 and 12708 just east of the confluence of Paddys Run and the PPDD. While this is lower than the 319 and 566 ppb maximum measured concentration at these locations, it is higher than the maximum average kriged concentration of 126 ppb. Furthermore, predicted wellhead concentration at WSA #1 is 98 ppb using hand contoured initial conditions compared to 36 ppb predicted from kriged initial conditions and compared to 140 ppb observed during the pumping test.

Additional 20 ppb concentrations were loaded into model layer 2 under Waste Pit 3 for contamination believed to be present but not sampled due to the presence of the pit.

This method of loading initial conditions into the model differs from that used in the Operable Unit 5 Remedial Investigation and Feasibility Study reports. Since the OU5 RI/FS modeling was used for risk assessment, initial mass loadings were conservative; that is, risks evaluated in the RI/FS process were bracketed from the high side. Because of this requirement, initial conditions for the RI/FS modeling were developed by loading the maximum concentration from each sampling point and using that maximum for the entire model layer. However, this technique tended to overestimate wellhead concentrations. In order to produce a model that can be used for remedy performance prediction, a more realistic mass loading approach is required (e.g., loading an average concentration based on hand contours of the most recent sampling data available).

Future model predictions of wellhead concentrations may be further improved by increasing vertical resolution with additional model layers. This has been done in the VAM3D zoom model developed from Phase II of the model upgrade project. However, because of unresolved comments/issues with the zoom model at the time of writing, this approach has not yet been implemented.

3.3.2 Transport Model Source Terms

Because excavation of the Waste Pit Area will be well underway by the time the WSA Phase I module is operational, OU5 RI/FS source terms representing the Waste Pits and Clearwell were removed from the model for this design. However, OU5 RI/FS source terms in the upper reaches of Paddys Run immediately adjacent to, and downgradient of the WSA were retained.

In addition to Paddys Run source terms from the OU5 RI/FS model, an additional source term was developed to model contaminant loading from the PPDD. As discussed earlier, direct-push sampling results show total uranium contamination present in the Great Miami Aquifer in the area downgradient (immediately east) of the confluence of the PPDD and Paddys Run.

Recent surface water sampling of the PPDD shows total uranium concentrations of 72 ppb (95 percent UCL on the mean). The OU5 RI/FS model used a recharge value of 50 inches per year for Paddys Run tributaries in direct contact with the Great Miami Aquifer. For areas of the Great Miami Aquifer exposed to the surface, normal recharge from rainfall was assumed to be 14 inches per year. Assuming the 50 inches per year of recharge in Paddys Run tributaries consists of both runoff and direct rainfall, the difference between these two values should give an estimate of the amount of recharge due to runoff only. Under this assumption, recharge to the Great Miami Aquifer coming from runoff through the PPDD is 36 inches per year. Thirty-six inches of recharge at 72 ppb over a model block 125 ft x 125 ft results in a source loading term of 5.8×10^{-4} lbs/day.

3.3.3 Predicted Total Uranium Concentrations and Performance Measures

Using initial conditions and source terms described above the transport model was run using flow fields corresponding to both wet and dry seasons. Sixteen modeling scenarios were run with varying numbers of extraction wells pumping rates. The selected design consists of two phases with three extraction wells in the PPDD in Phase I and two wells in the Waste Pit Area in Phase II. Phase I wells will begin operation in FY 2002, and Phase II wells would begin in FY 2007 after Waste Pit Area excavations have been completed and ground surface is accessible for well drilling and construction activities. Modeling with the wet season boundary conditions and flow field predicts this design will remediate the aquifer two years earlier than modeling with the dry season boundary conditions and flow field. Clean-up time is reduced with the wet season flow field due to increased recharge and associated flushing in the aquifer. To be conservative, the dry season model results have been used for the design and are presented here.

Total uranium concentrations in model layer two at years FY2004, FY2006, and FY2008, and FY2010 are shown in Figures 3-14, 3-17, 3-18, and 3-19, respectively. Since concentrations in model layer 3 drop

below 20 ppb after three years, concentrations for model layer three are shown at years FY2004 and FY2005 (Figures 3-15 and 3-16).

As evidenced by concentration contours in Figures 3-18 and 3-19 total uranium concentration drops below 30 ppb after FY2008 and below 20 ppb after FY2010.

The additional pumping time required in this design, when compared with the design in the Baseline Remedial Strategy Report (DOE 1997), is due in part to recently characterized higher levels of contamination in the PPDD area.

Because this design requires longer pumping time over and above the two years specified in the Baseline Remedial Strategy design, an early start is desirable for WSA Phase I where concentrations are highest. Phase I wells are located where ongoing waste pit excavation activities will not interfere with well installations.

Four additional modeling scenarios were developed to investigate how much the aquifer remedy in the WSA and PPDD could be accelerated through additional flushing from groundwater re-injection. Re-injecting treated groundwater at the PPDD source would accelerate remediation in the area by up to four years so that conceivably, total uranium concentrations in this area could be below 30 μg/L by FY 2007 and below 20 μg/L by FY 2009. However, since Phase II of the WSA extraction system can not be installed and operational until FY 2007, the savings in operational time from re-injection do not justify the additional capital investment required for re-injection well and the infrastructure to support it.

Table 3-4 shows the composite effluent concentration for WSA modules and the amount of mass predicted to be removed by year. As shown in the table, treatment would be required during the first one to two years of operation. After two years of pumping, system effluent concentrations would be below 20 μg/L. Note that initial conditions from the Phase II wells will be <20 μg/L (i.e., 200 gpm to bypass) and therefore dual headers (piping to treatment and piping to bypass treatment) will not be required for these wells.

TABLE 3-1

INDIVIDUAL WELL PUMPING RATES

Well ID	Duration and Dates of Operation for 30 µg/L Total Uranium MCL	Duration and Dates of Operation for 20 µg/L Total Uranium MCL	Pumping Rate (gpm)
WSA 1	7 years (FY 2002-FY 2009)	9 years (FY 2002-FY 2011)	400
WSA 2	7 years (FY 2002-FY 2009)	9 years (FY 2002-FY 2011)	300
WSA 4	7 years (FY 2002-FY 2009)	9 years (FY 2002-FY 2011)	300
WSA 5	2 years (FY 2007-FY 2009)	4 years (FY 2007-FY 2011)	100
WSA 6	2 years (FY 2007-FY 2009)	4 years (FY 2007-FY 2011)	100
System Total	FY 2002-FY 2007; FY 2007-FY 2009	FY 2002-FY 2007; FY 2007-FY 2011	1000; 1200

TABLE 3-2

MODEL HYDRAULIC CONDUCTIVITY ZONES BEFORE AND AFTER WSA #1 PUMPING TEST

Before WSA Pumping test				After WSA Pumping test			
Zone	Model Layer	Kh (ft/day)	Kv (ft/day)	Zone	Model Layer	Kh (ft/day)	Kv (ft/day)
1	1-12	400	20	1	1-12	400	20
2	1-12	375	18.8	2	1-12	375	18.8
3	1,2	280	22.4	3	1,2	280	22.4
	3,4	286	26.1		3,4	286	26.1
	5,6	213	25.6		5,6	213	25.6
	7,8	0.38/213*	0.038/25.6*		7,8	0.38/213*	0.038/25.6*
	9-12	200	34		9-12	200	34
4	1,2	638	51	4	1,2	638	51
	3,4	544	49.6		3,4	544	49.6
	5,6	213	25.6		5,6	213	25.6
	7,8	0.38/213*	0.038/25.6*		7,8	0.38/213*	0.038/25.6*
	9-12	200	34		9-12	200	34
5	1,2	270	21.6	5	1,2	270	21.6
	3,4	270	24.6		3,4	270	24.6
	5,6	270	32.4		5,6	270	32.4
	7,8	0.38/270*	0.038/32.4*		7,8	0.38/270*	0.038/32.4*
	9-12	270	45.9		9-12	270	45.9
6	1,2	120	9.6	6	1,2	120	9.6
	3,4	120	10.9		3,4	120	10.9
	5,6	120	14.4		5,6	120	14.4
	7,8	0.38/120*	0.038/14.4*		7,8	0.38/120*	0.038/14.4*
	9-12	120	20.4		9-12	120	20.4
7	N/A	N/A	N/A	7	1-4	453	49
					5,6	213	25.6
					7,8	0.38/213*	0.038/25.6*
					9-12	270	45.9

*First value is for blue clay where present; second value is used when blue clay not present

TABLE 3-3

GROUNDWATER ELEVATION RESIDUALS FOR OCTOBER 1998 ELEVATION DATA SET AFTER MAY 2000 RE-CALIBRATION AND AFTER ADDITIONAL MODEL ZONE 7 ADDED

Well ID	May 2000 Re-calibration	After Zone 7 Added
2002	-0.21	-0.13
2008	-0.20	0.10
2009	-0.48	-0.16
2011	0.46	0.42
2014	-0.01	0.10
2015	-0.30	-0.20
2016	0.55	0.67
2017	0.22	0.31
2020	-0.05	0.15
2032	-0.52	-0.31
2033	-0.61	-0.30
2034	-0.62	-0.33
2043	0.74	0.74
2044	0.30	0.42
2045	0.17	0.29
2046	0.30	0.43
2048	0.07	0.19
2051	-0.09	0.07
2052	0.22	0.40
2054	-0.07	0.14
2065	-0.73	-0.59
2068	0.15	0.31
2070	-0.15	-0.04
2091	-0.08	0.00
2092	-0.24	-0.16
2093	-0.31	-0.22
2095	-0.04	0.02
2096	0.70	0.76
2097	0.70	0.73
2098	0.16	0.21
21033	0.16	0.29
2106	-0.02	0.07
21063	-0.26	-0.16
21064	0.14	0.28
21065	-0.03	0.11
2107	-0.18	-0.02
2108	-0.41	-0.19
2118	-0.02	0.17
2119	0.51	0.60
2125	0.20	0.26
2126	0.55	0.57
2128	0.57	0.62
2166	-0.14	-0.04
2383	-0.10	0.03
2384	-0.34	-0.04
2385	0.05	0.19
2386	-0.09	0.05

TABLE 3-3
(Continued)

Well ID	May 2000 Re-calibration	After Zone 7 Added
2387	-0.03	0.09
2389	-0.02	0.22
2390	-0.49	-0.39
2394	0.52	0.57
2396	0.07	0.12
2397	-0.13	0.01
2398	-0.09	0.02
2399	0.01	0.13
2402	0.13	0.25
2417	-0.16	-0.01
2423	0.12	0.41
2424	0.05	0.21
2426	-0.13	0.03
2429	-0.07	0.07
2430	-0.08	0.06
2431	0.00	0.13
2432	-0.10	0.01
2434	-0.30	-0.20
2436	0.21	0.47
2446	-0.30	-0.15
2544	0.01	0.07
2545	0.28	0.33
2546	0.63	0.67
2550	-0.01	0.07
2551	-0.20	-0.14
2552	0.30	0.34
2553	0.40	0.43
2636	0.52	0.56
2648	-0.23	-0.06
2649	-0.19	-0.09
2679	0.12	0.10
2702	0.82	0.85
2728	0.59	0.56
2733	-0.27	-0.17
2821	-0.09	0.07
2880	-0.40	-0.33
2881	-0.37	-0.29
2897	-0.43	-0.35
2898	-0.63	-0.57
2899	0.17	0.23
2900	-0.18	-0.13
2949	-0.01	0.13
Average Residual	0.01	0.13
RMS Error	0.33	0.33
RMS % Error	3.12	3.06

TABLE 3-4

COMPOSITE PERFORMANCE MEASURES FOR THE WSA DESIGN

Time (FY)	Total Water Pumped (gpm)	System Conc (ppb)	Mass Removed (lbs)	Cumulative Mass Removed (lbs)	Flow to Treatment	Concentration to Treatment	Flow to Bypass	Concentration to Bypass
2002	1000	64.4	0.0	0.0	1000	64.4	0	0.0
2003	1000	22.8	143.8	143.8	400	29.2	600	18.6
2004	1000	16.9	84.2	228.0	0	0.0	1000	16.9
2005	1000	13.8	66.0	294.0	0	0.0	1000	13.8
2006	1000	11.8	55.1	349.0	0	0.0	1000	11.8
2007	1000	10.2	47.6	396.6	0	0.0	1000	10.2
2008	1200	8.9	48.2	444.9	0	0.0	1200	8.9
2009	1200	8.2	43.2	488.0	0	0.0	1200	8.2
2010	1200	7.6	38.9	526.9	0	0.0	1200	7.6
2011	1200	7.2	35.2	562.2	0	0.0	1200	7.2

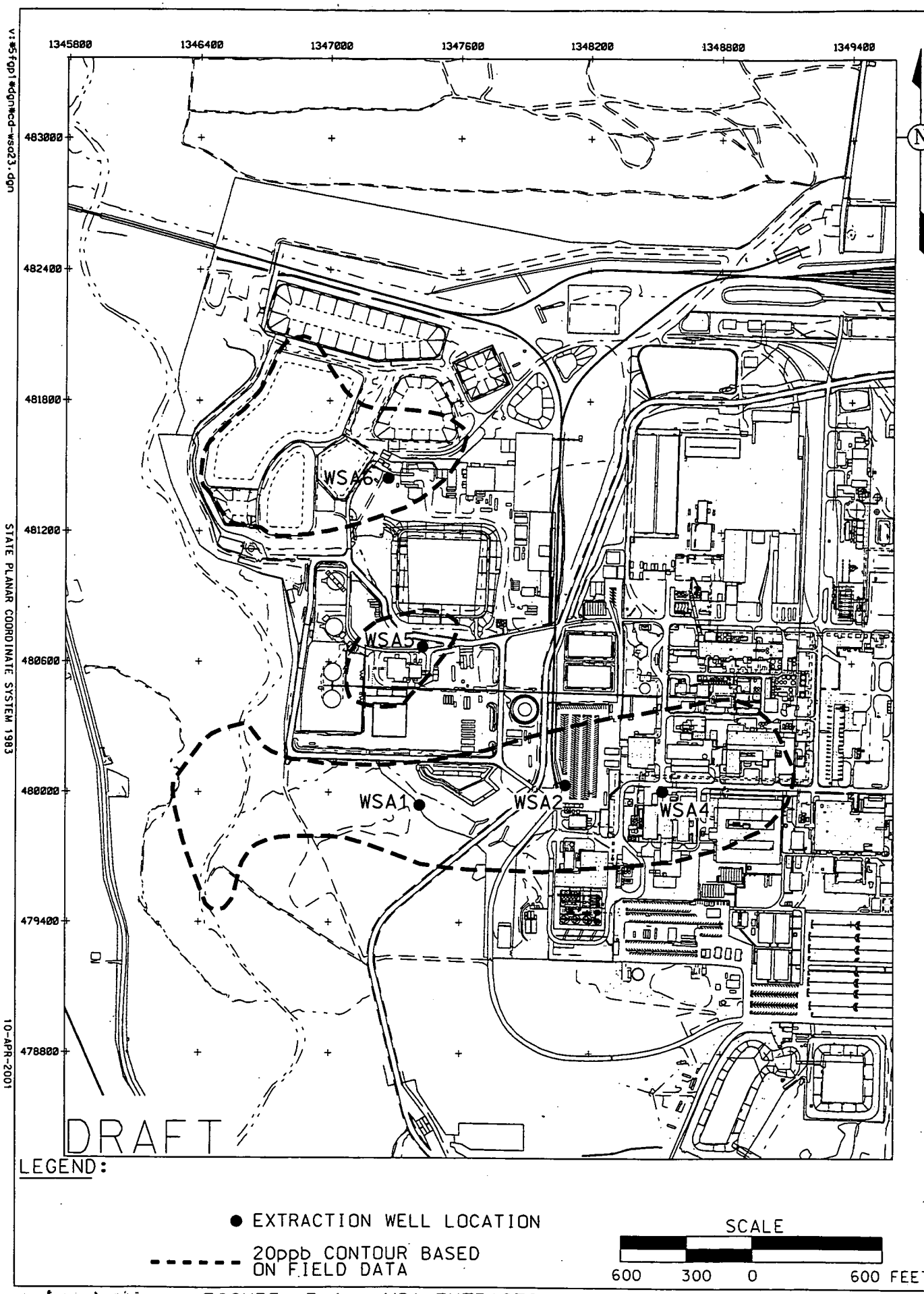


FIGURE 3-1. WSA EXTRACTION WELL LOCATIONS

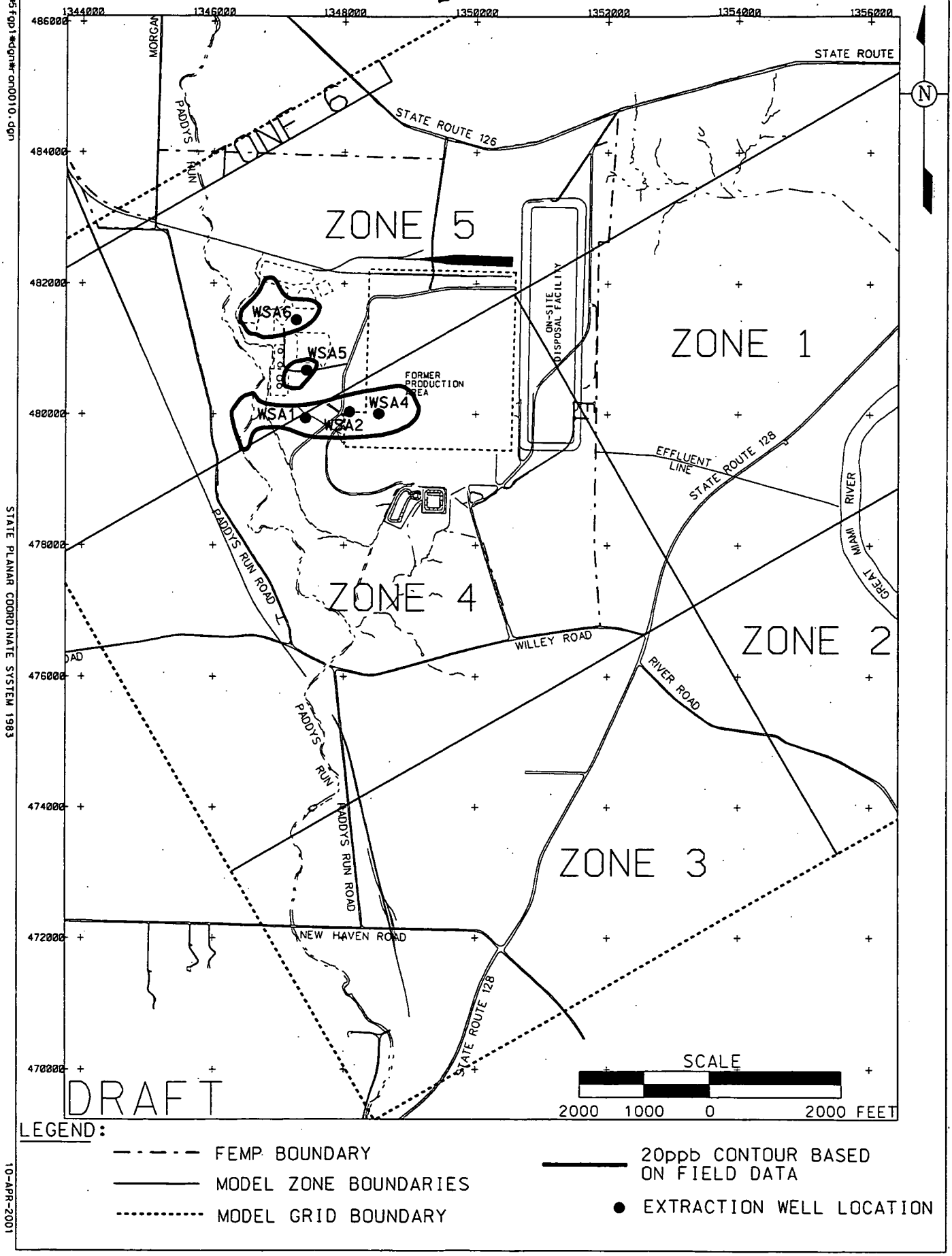
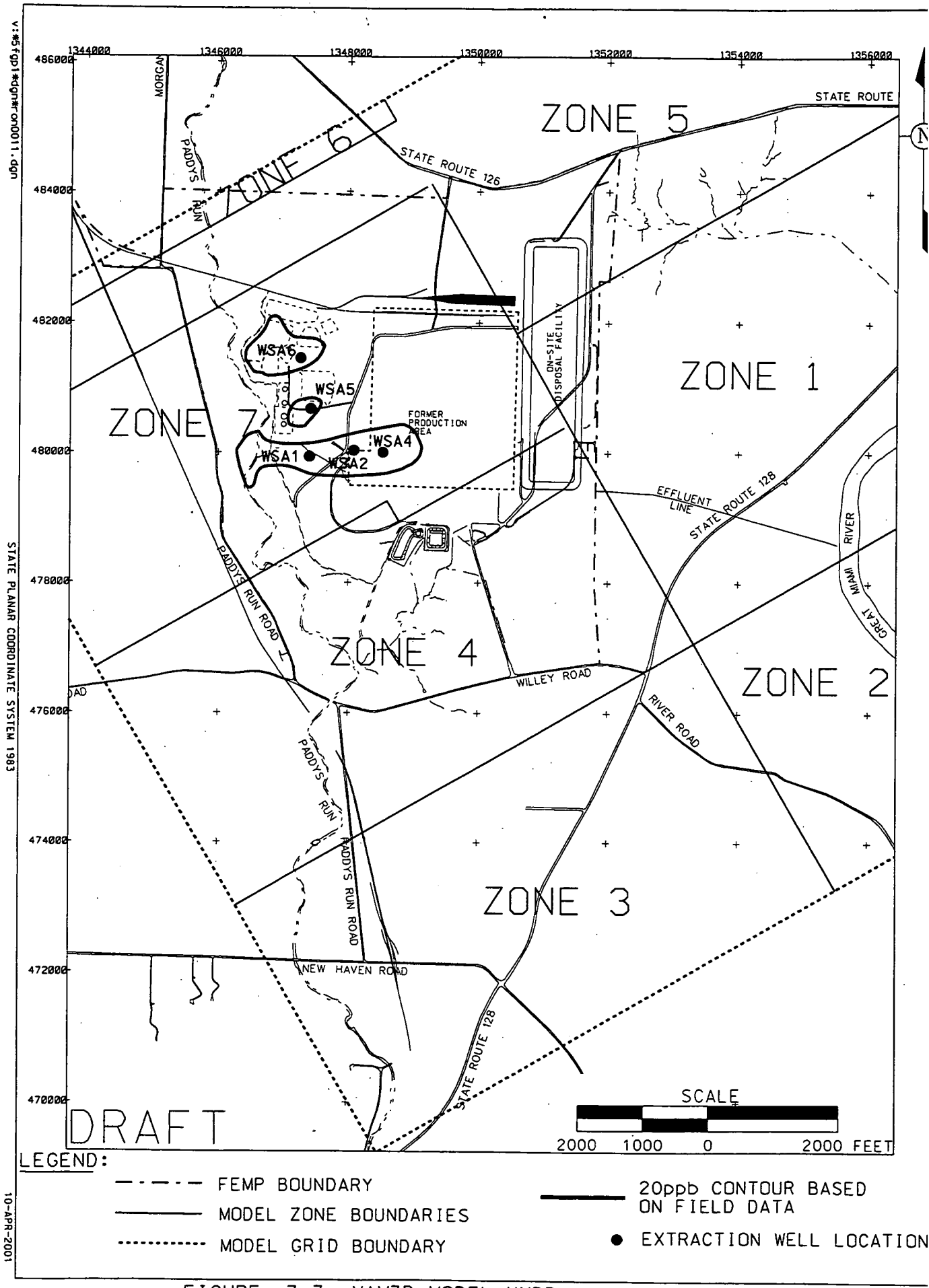


FIGURE 3-2. VAM3D MODEL HYDRAULIC CONDUCTIVITY ZONES BEFORE WASTE STORAGE AREA PUMPING TEST



000046 FIGURE 3-3. VAM3D MODEL HYDRAULIC CONDUCTIVITY ZONES AFTER WASTE STORAGE AREA PUMPING TEST

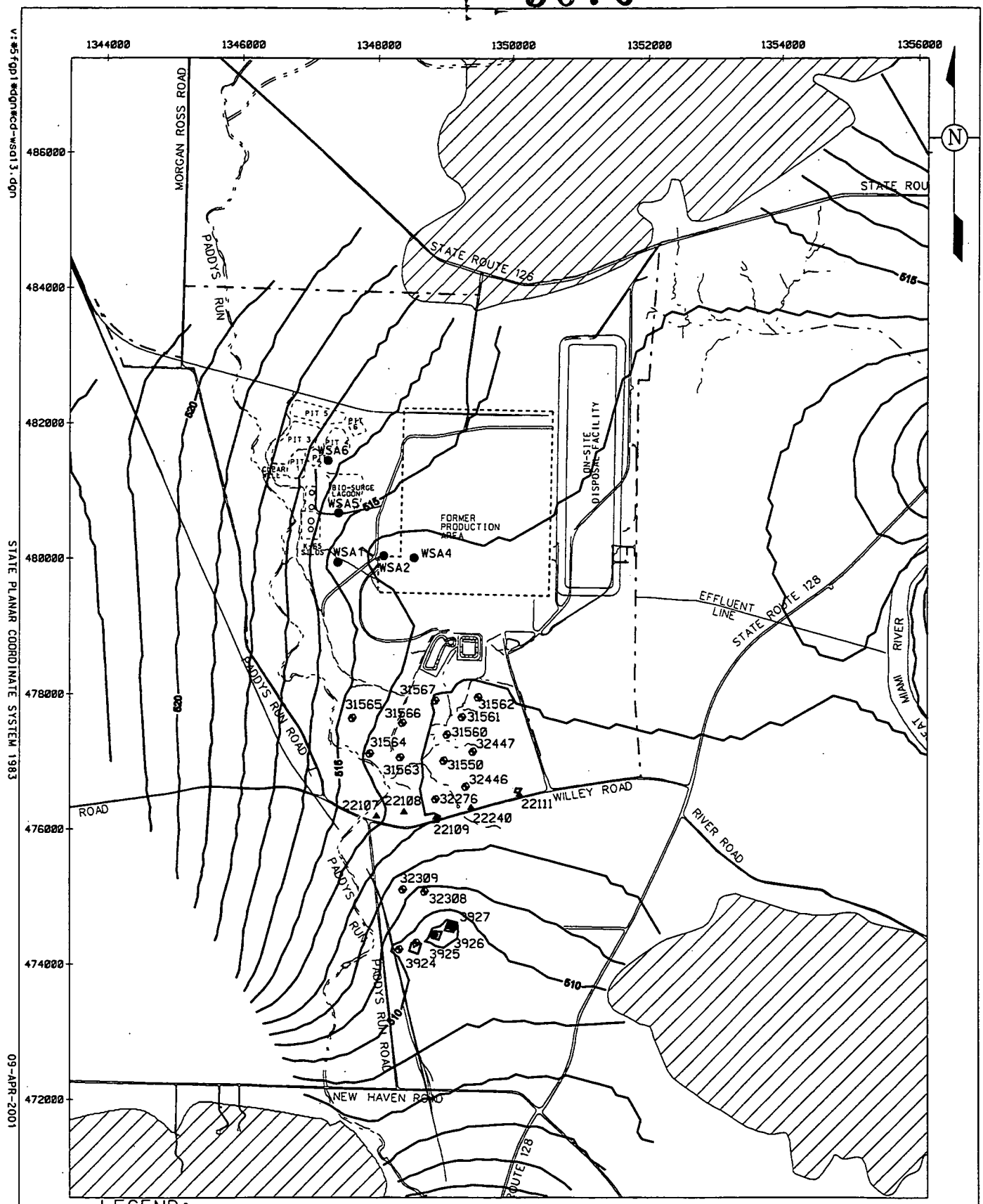


FIGURE 3-4. MODELED GROUNDWATER ELEVATION CONTOURS FOR DRY CONDITIONS

STATE PLANAR COORDINATE SYSTEM 1983

09-APR-2001

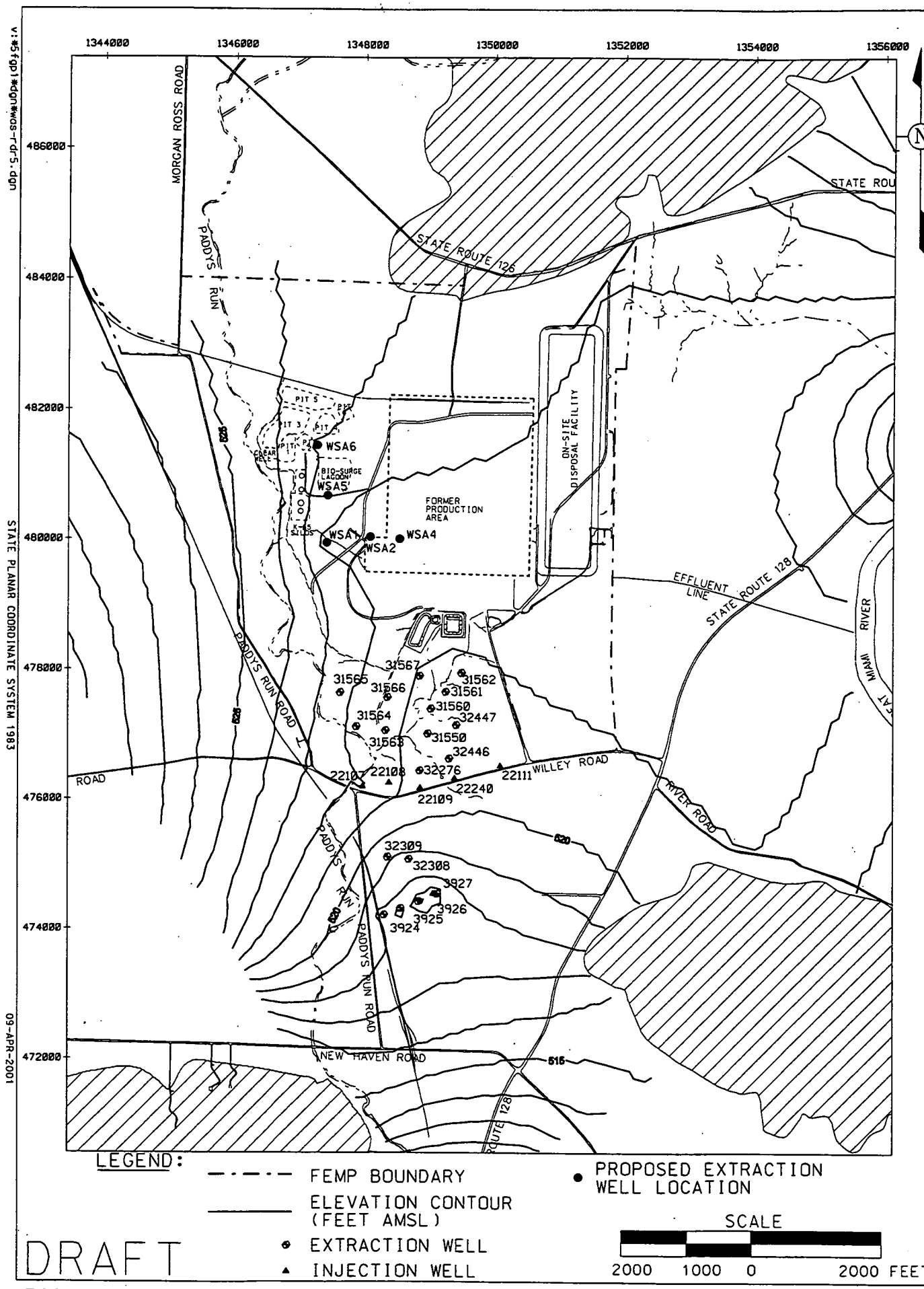


FIGURE 3-5. MODELED GROUNDWATER ELEVATION CONTOURS FOR WET CONDITION

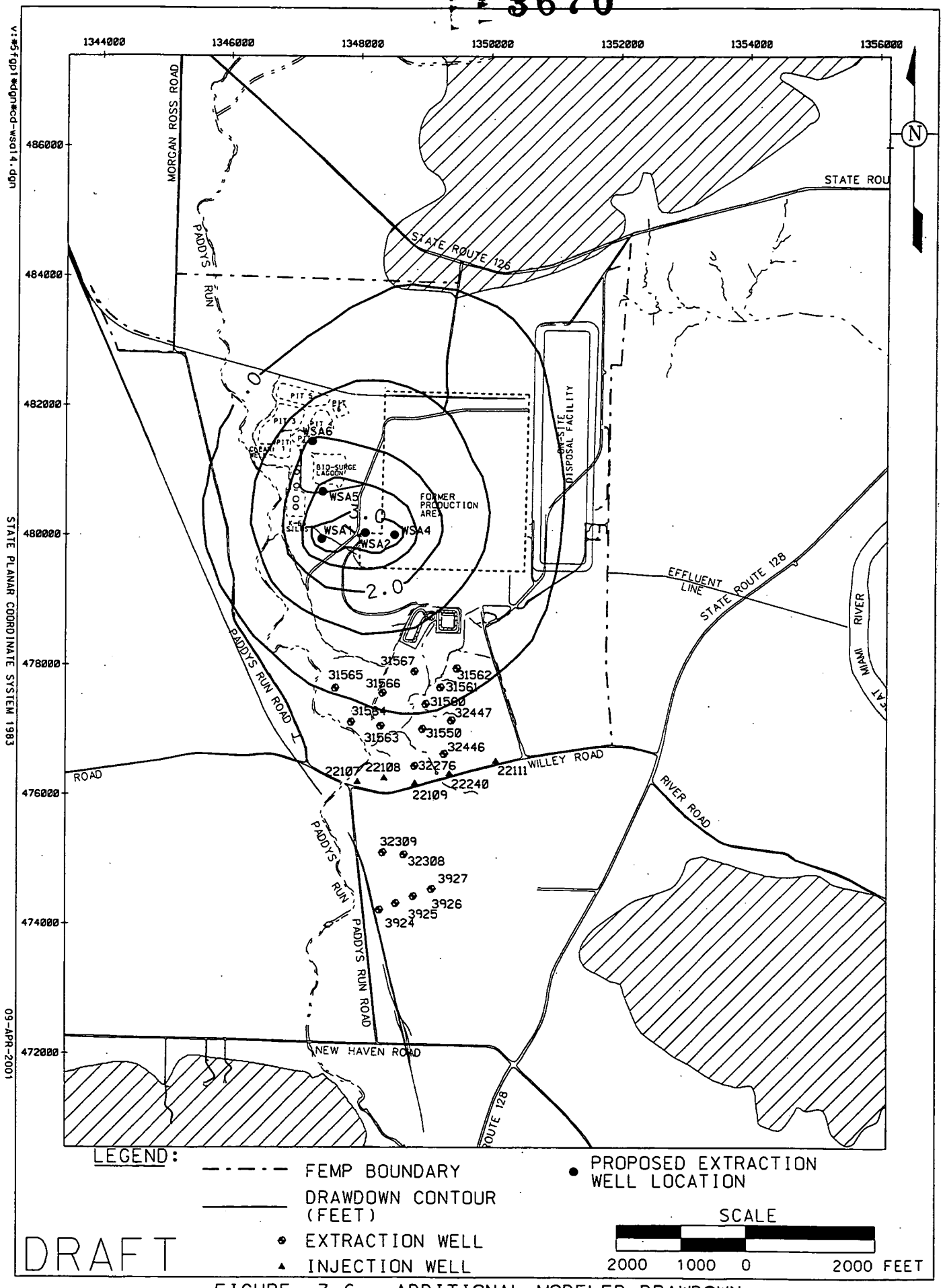


FIGURE 3-6. ADDITIONAL MODELED DRAWDOWN CONTOURS FOR WSA PUMPING - DRY CONDITION

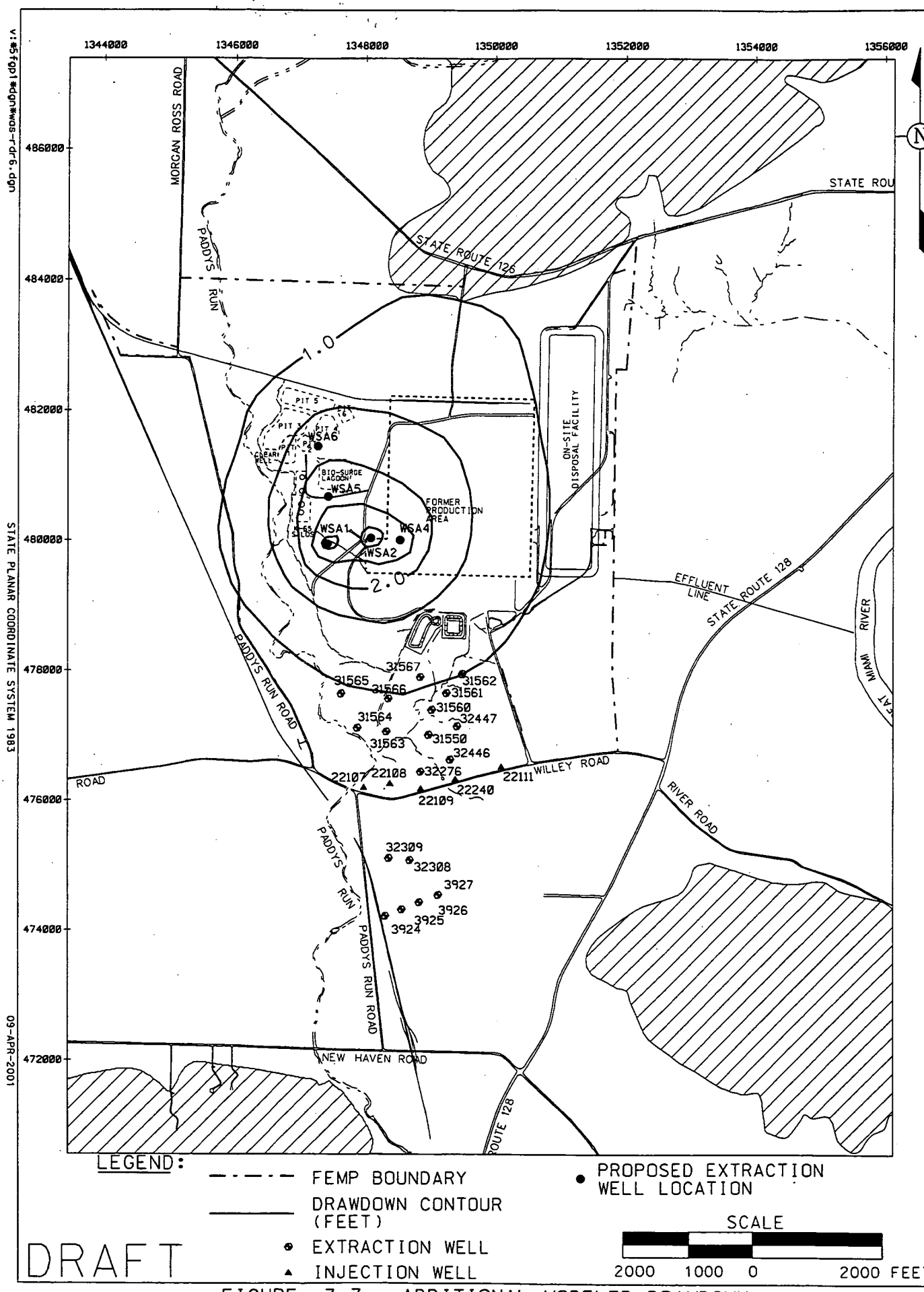


FIGURE 3-7. ADDITIONAL MODELED DRAWDOWN CONTOURS FOR WSA PUMPING - WET CONDITIONS

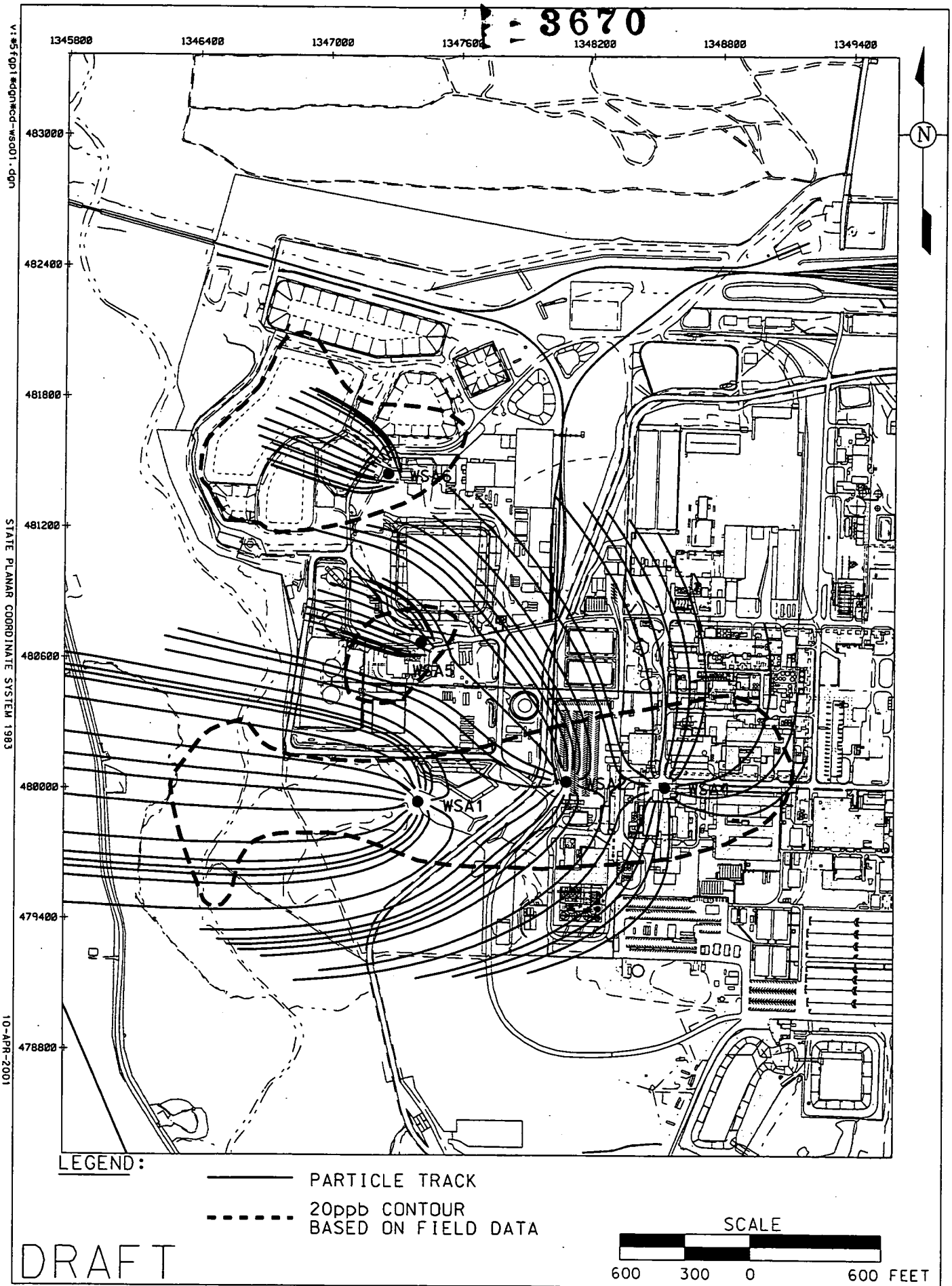


FIGURE 3-8. GROUNDWATER PARTICLE TRACKS
FOR 9 YEARS (NO RETARDATION) DRY CONDITIONS

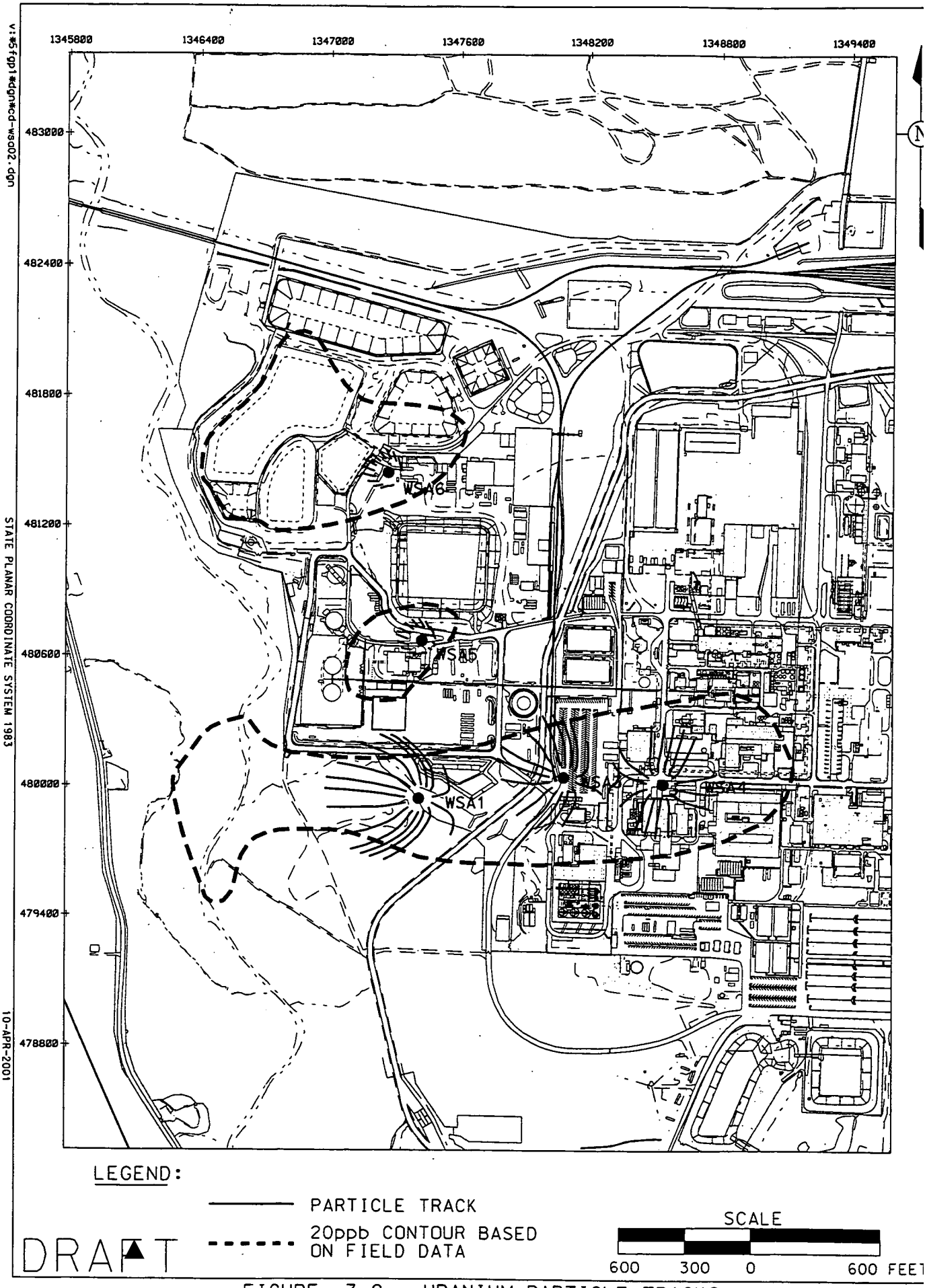


FIGURE 3-9. URANIUM PARTICLE TRACKS FOR 9 YEARS (WITH RETARDATION) DRY CONDITIONS

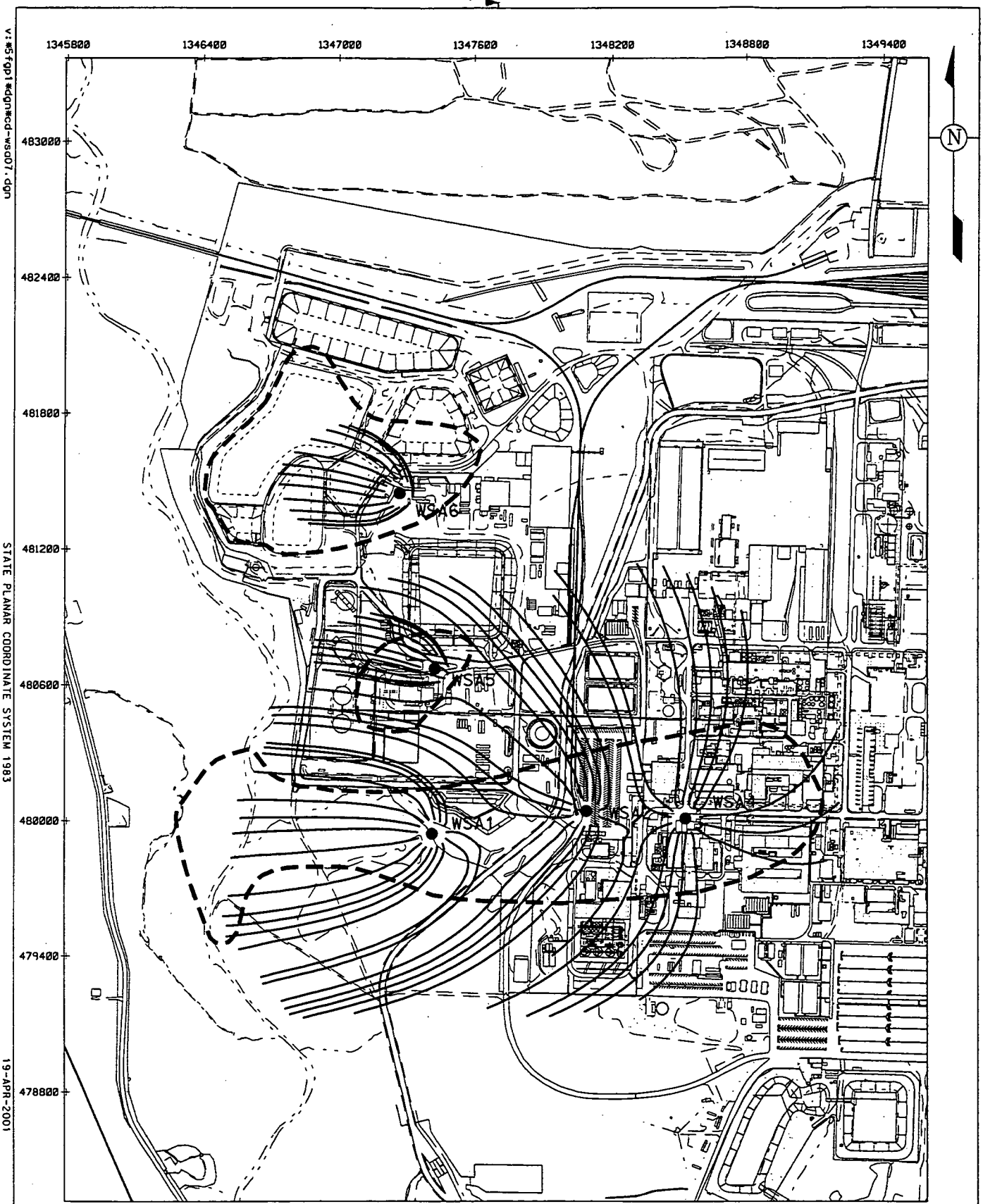


FIGURE 3-10. GROUNDWATER PARTICLE TRACKS FOR 9 YEARS (NO RETARDATION) WET CONDITIONS

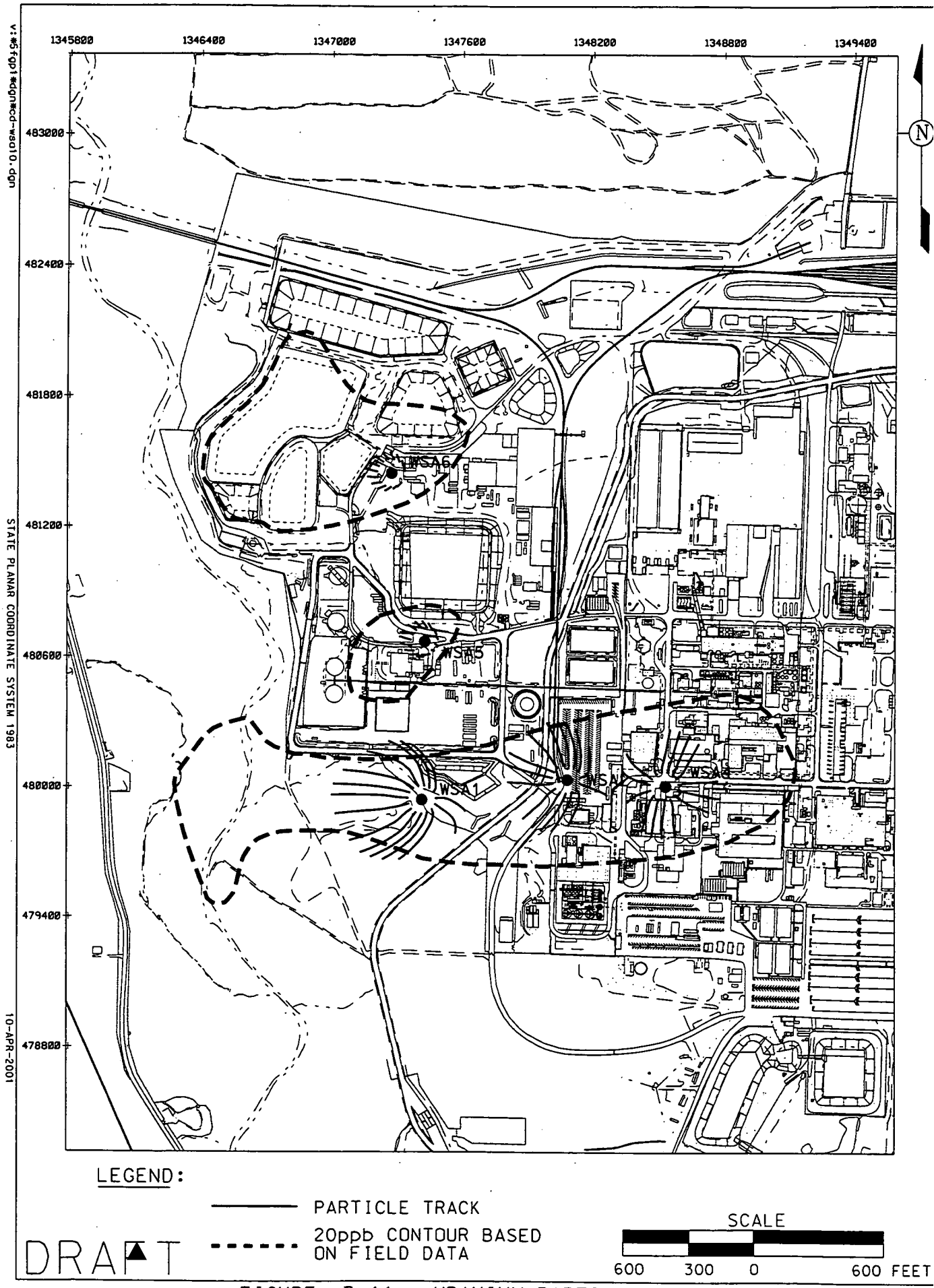


FIGURE 3-11. URANIUM PARTICLE TRACKS FOR 9 YEARS (WITH RETARDATION) WET CONDITIONS

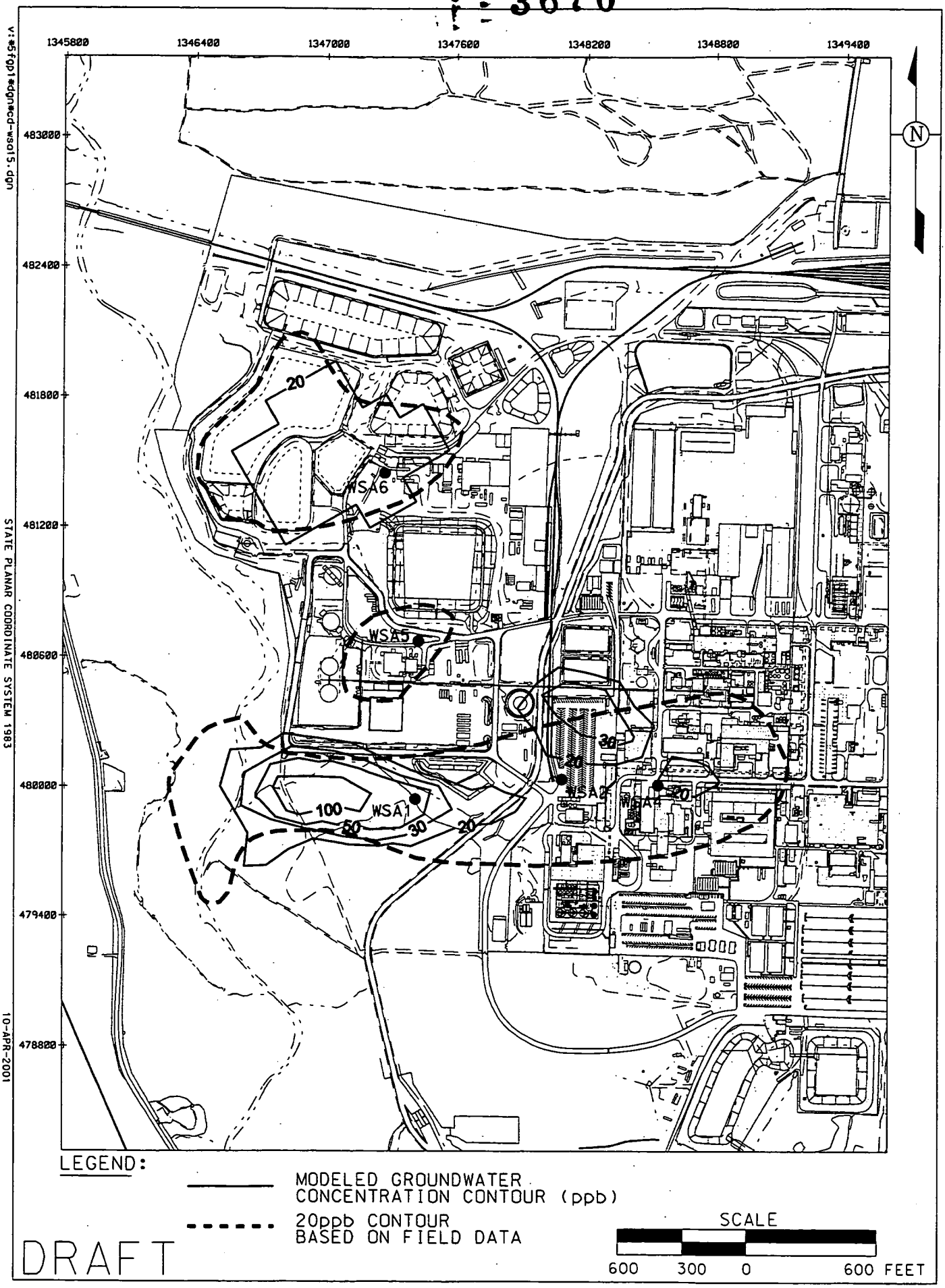
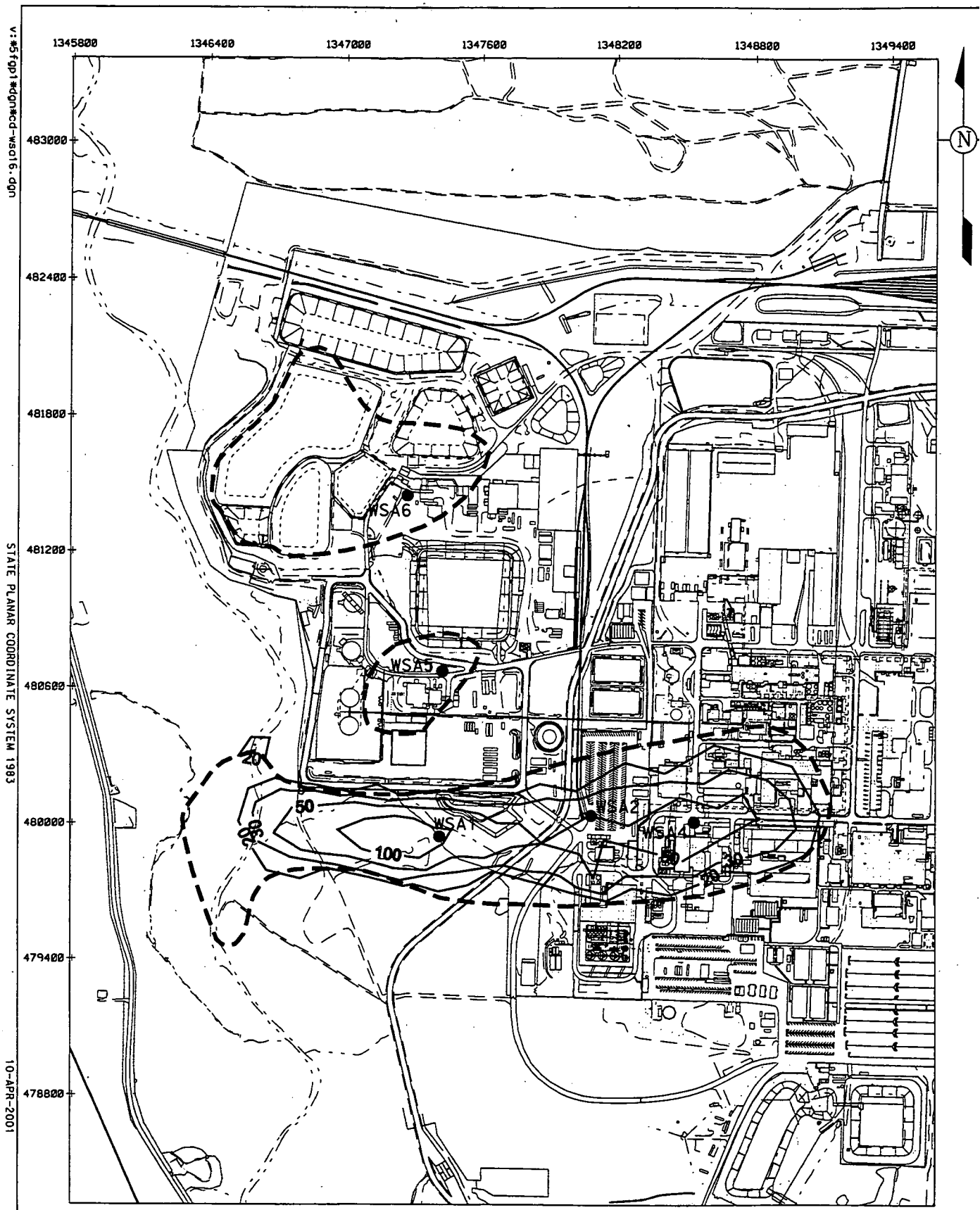


FIGURE 3-12. INITAL TOTAL URANIUM CONCENTRATIONS IN MODEL LAYER 2



LEGEND:

MODELED GROUNDWATER CONCENTRATION CONTOUR (ppb)

20ppb CONTOUR BASED ON FIELD DATA

SCALE

600 300 0 600 FEET

DRAFT

FIGURE 3-13. INITAL TOTAL URANIUM CONCENTRATIONS IN MODEL LAYER 3

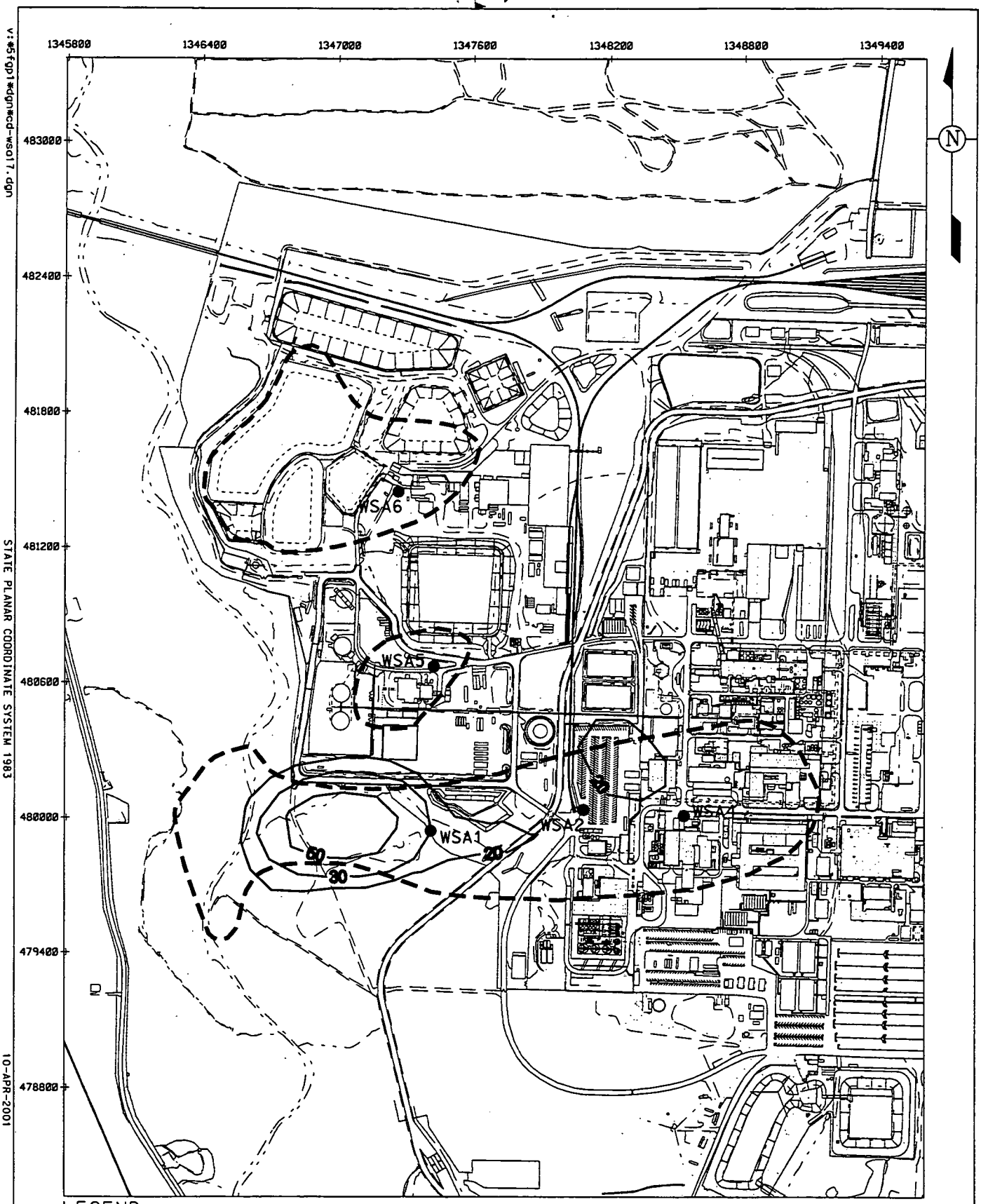


FIGURE 3-14. TOTAL URANIUM CONCENTRATIONS IN MODEL LAYER 2 AT FY2004 (DRY CONDITIONS)

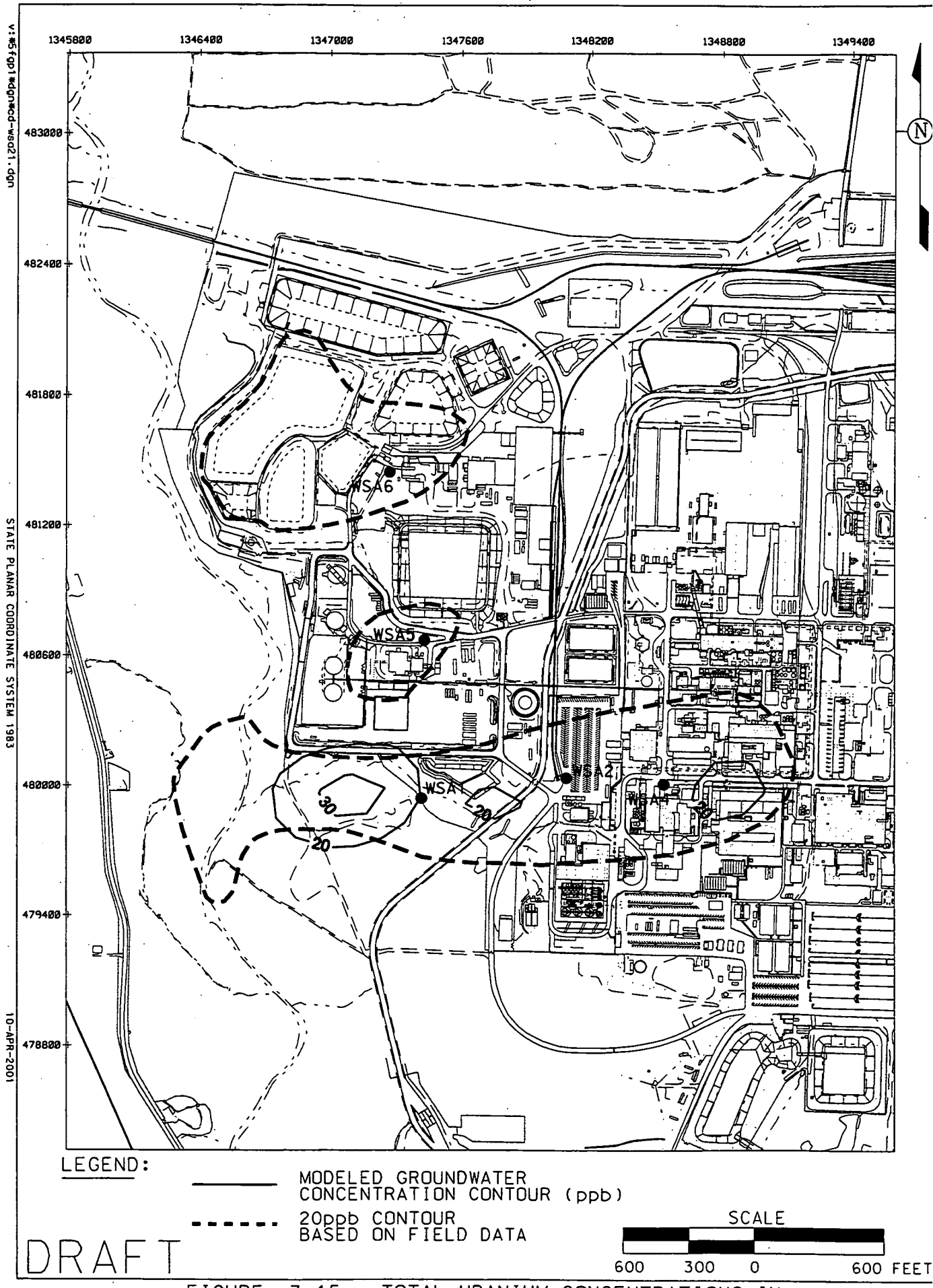


FIGURE 3-15. TOTAL URANIUM CONCENTRATIONS IN MODEL LAYER 3 AT FY2004 (DRY CONDITIONS)

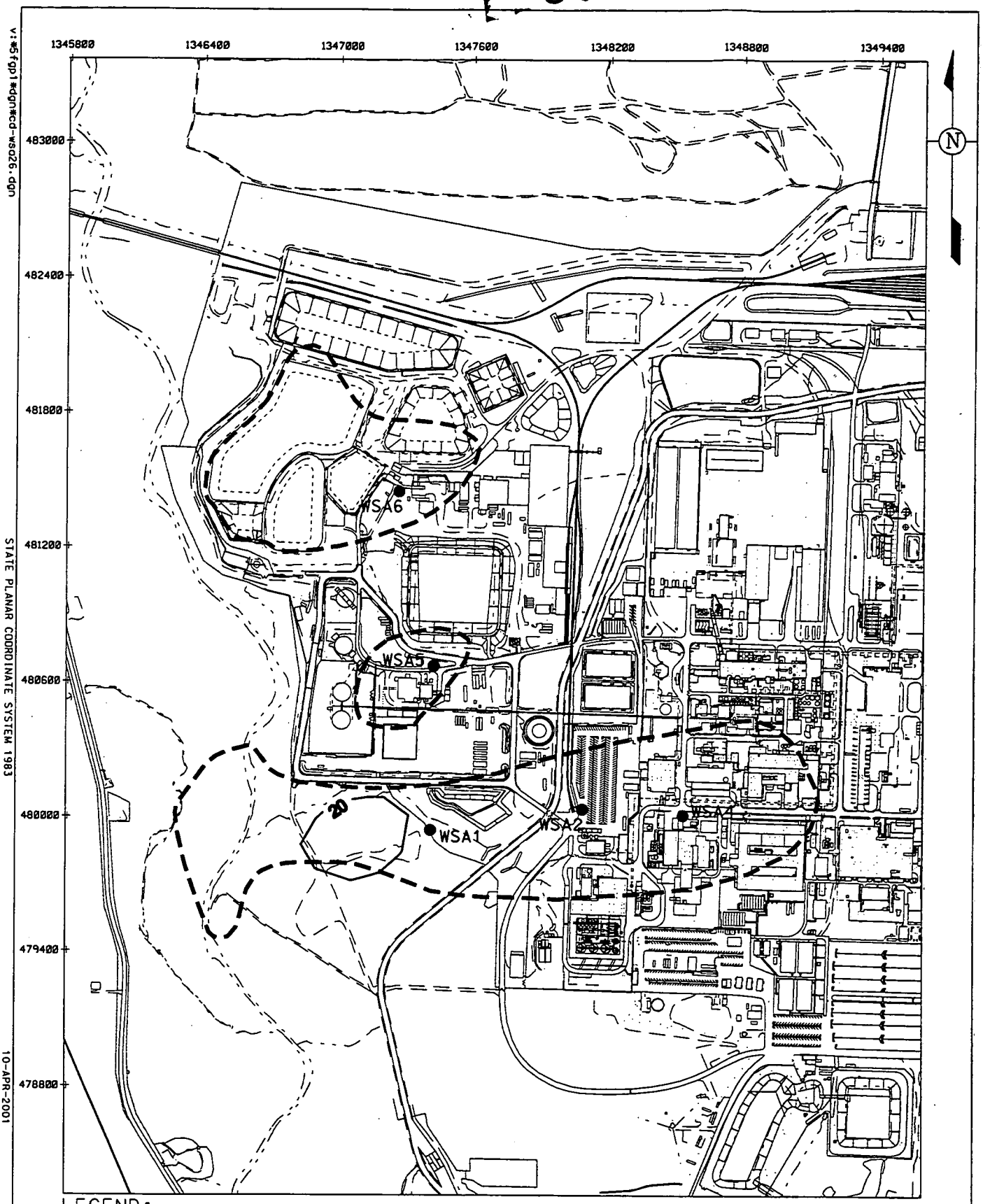


FIGURE 3-16. TOTAL URANIUM CONCENTRATIONS IN MODEL LAYER 3 AT FY2005 (DRY CONDITIONS)

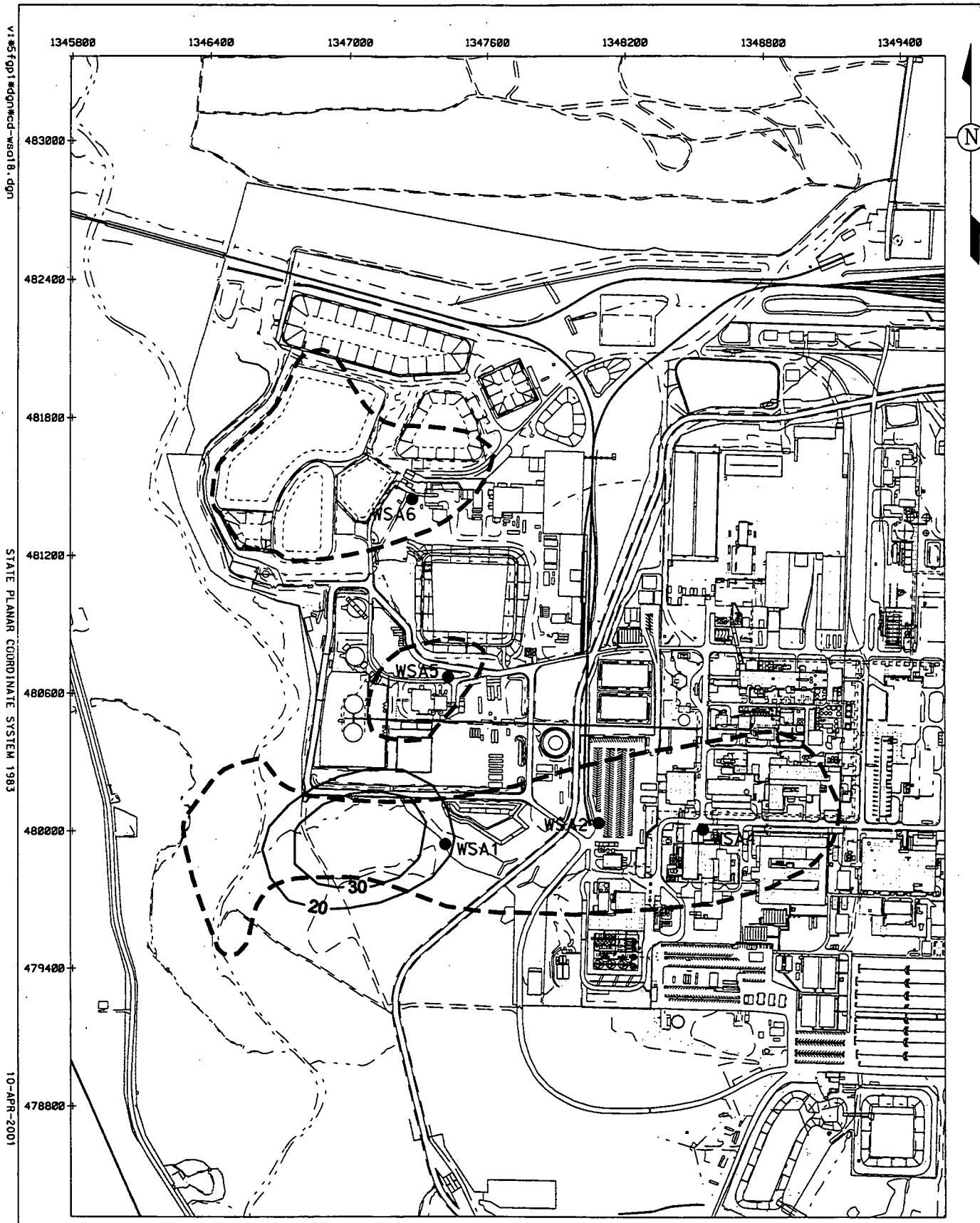


FIGURE 3-17. TOTAL URANIUM CONCENTRATIONS IN MODEL LAYER 2 AT FY2006 (DRY CONDITIONS)

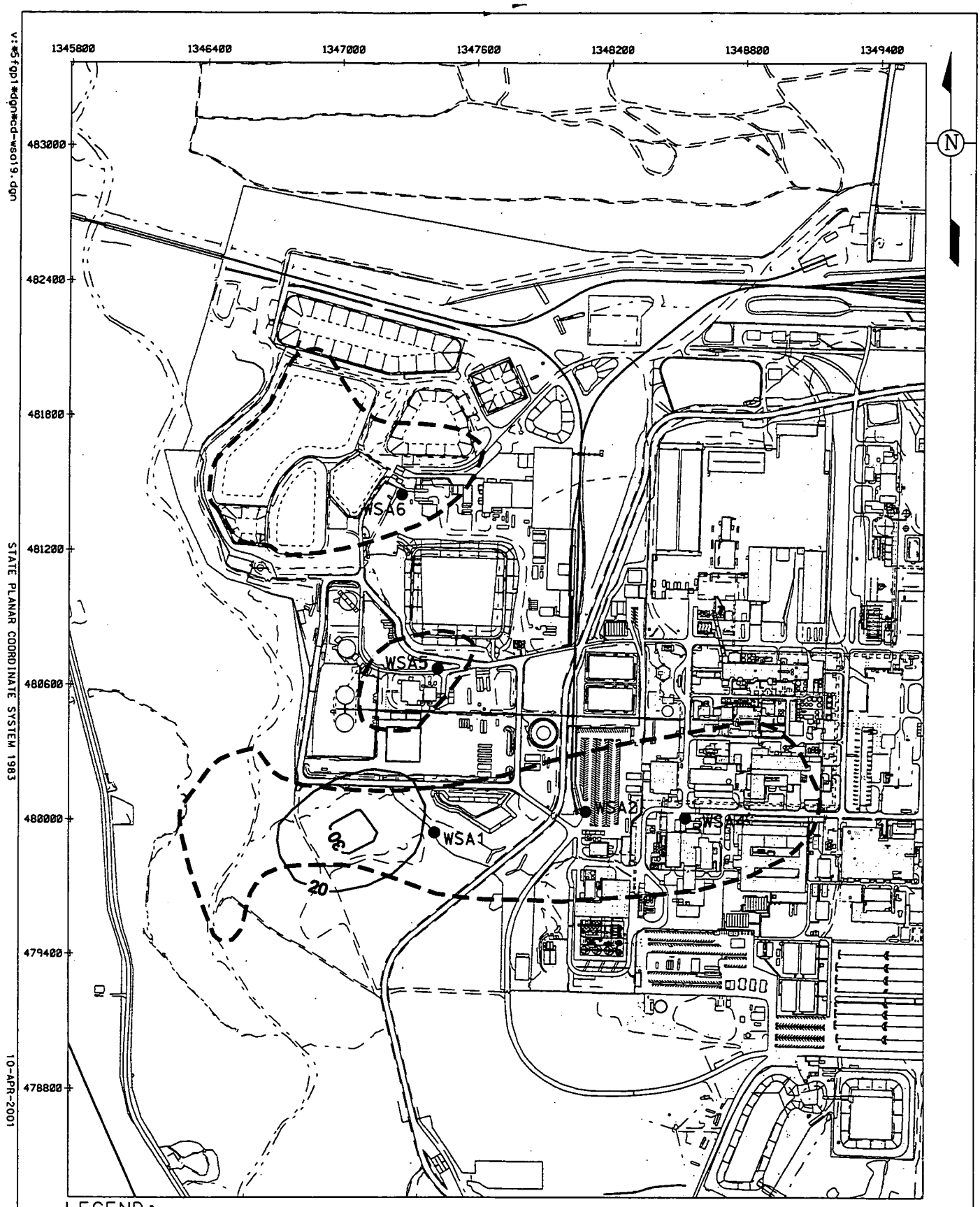


FIGURE 3-18. TOTAL URANIUM CONCENTRATIONS IN MODEL LAYER 2 AT FY2008 (DRY CONDITIONS)

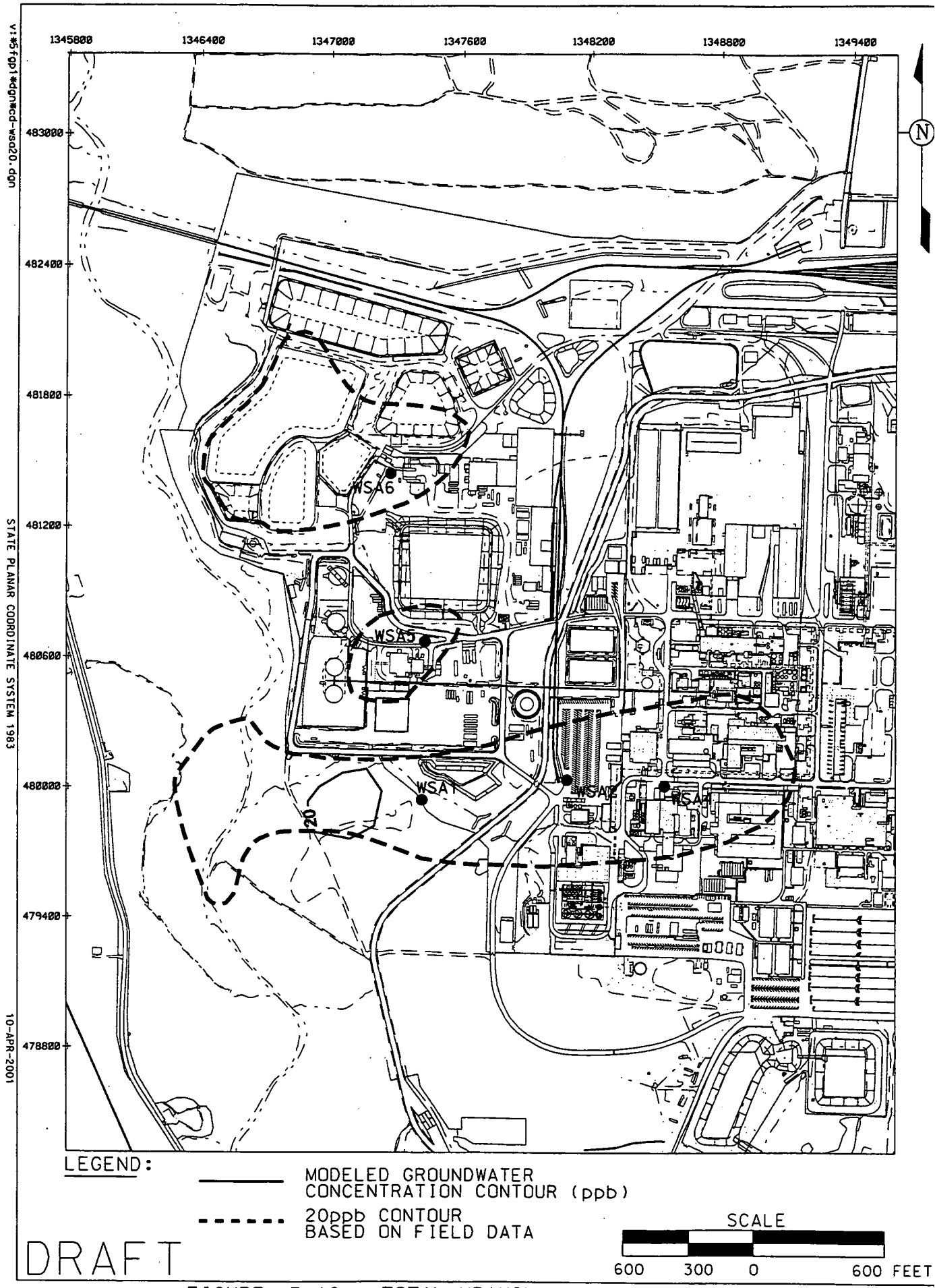


FIGURE 3-19. TOTAL URANIUM CONCENTRATIONS IN MODEL LAYER 2 AT FY2010 (DRY CONDITIONS)

4.0 CONCLUSIONS AND RECOMMENDATIONS

Conclusions of this report include:

- Uranium concentrations in the Great Miami Aquifer beneath Plant 6 have dissipated such that concentrations are now below the Final Remediation Level of 20 ppb. Therefore, no aquifer remediation system will be planned for the Plant 6 Area. Monitoring in the area will continue to determine if the one time uranium FRL exceedance at Monitoring Well 2389 remains or dissipates.

- The uranium plume in the Waste Storage Area is smaller than what was characterized during the RI/FS (approximately 55 acres current versus approximately 70 acres RI/FS).

- The portion of the Waste Storage Area uranium plume in the vicinity of the confluence of Paddys Run and the Pilot Plant Drainage Ditch has been redefined and extended to the east. Groundwater uranium concentrations up to 566 μg/L have been found in this area.

- Groundwater modeling predicts that three aquifer remediation wells pumping a combined total of 1000 gallons per minute from FY02 to FY07 and supplemented by an additional 2 wells for a combined flow of 1200 gallons per minute from FY07 to FY09 will effectively remediate the Waste Storage Area to 30 ppb.

- Groundwater Modeling predicts that three aquifer remediation wells pumping a combined total of 1000 gallons per minute from FY02 to FY07 and supplemented by an additional 2 wells for a combined flow of 1200 gallons from FY07 to FY11 will effectively remediate the Waste Storage Area to 20 ppb.

- The conceptual design pumping rate and predicted time required to restore the aquifer in the Waste Storage Area are substantially greater than that predicted in the 1997 BRSR. This is primarily due to the higher concentration plume identified in the vicinity of the Pilot Plant Drainage Ditch; however, the waste storage area conceptual design pumping rate (1000 to 1200 gallons per minute) are less than those predicted in the 1997 BRSR for the Waste Storage Area and Plant 6 Area Modules combined (1500 gallons per minute).

- Residual uranium contamination in the aquifer east of the Plant 6 area may confound future OSDF leak detection evaluations.

Recommendations are as follows:

- Install additional monitoring wells in optimal locations based on the information collected for the design to better track remedy progress.

- Further evaluate the need for dual piping for the WSA-Phase II extraction system as modeling based on current information indicates water discharged from Wells 5 and 6 will not require treatment.

- Continue monitoring in the Plant 6 Area until aquifer restoration certification is completed and approved by the US EPA and Ohio EPA.

- In the development of pre-waste placement baseline for OSDF Cell 7 (and perhaps Cell 6), consider the residual uranium contamination in the aquifer east of Plant 6.

- Conduct future additional characterization after suspected sources have been removed in those areas that were not accessible during the design characterization effort. This would be done to verify the need for the Phase II installation and to ensure that the Phase I installation is sufficient to meet cleanup objectives.

- Verify that VOC contamination (TCE), which is known to be present in the aquifer in the vicinity of the Clearwell and Paddys Run, will not significantly impact re-injection efforts and/or NPDES permitted discharges to the Great Miami River.

- Continue to monitor uranium concentrations in Monitoring Well 2648 and possibly perform a pumping action to determine if uranium concentration can be readily brought back down to <20 μg/L.

5.0 REFERENCES

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APPENDIX A

PSP FOR CONDUCTING DIRECT-PUSH SAMPLING IN THE WASTE STORAGE AREA

3670

PROJECT SPECIFIC PLAN FOR CONDUCTING DIRECT-PUSH SAMPLING IN THE WASTE STORAGE AREA

PROJECT NUMBER 52420-PSP-001

NOVEMBER 1999

Prepared by

Fluor Daniel Fernald

Prepared for

U.S. Department of Energy
Fernald Field Office

Under Contract DE-AC05-92OR21972

PROJECT SPECIFIC PLAN FOR CONDUCTING DIRECT-PUSH SAMPLING IN THE WASTE STORAGE AREA

PROJECT NUMBER 52420-PSP-001
November 1999

APPROVAL:

William G. Hertel — 11/4/99
William Hertel, Team Coach — Date
Aquifer Restoration and Wastewater Project/Hydrogeology Section

Frank Thompson — 11-3-99
Frank Thompson
Quality Assurance — Date

Mike Frank — 11/3/99
Mike Frank, Team Coach — Date
Environmental Monitoring/Soil and Miscellaneous Media Projects

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1.0 INTRODUCTION

Six locations (12614, 12615, 12616, 12617, 12618, and 12619) have been selected in the Waste Storage Area, Silos Area, and south of the Silo Area to conduct direct push groundwater sampling using a Geoprobe™ sampling tool. The six locations selected for direct push sampling are shown in Figure 1. The total uranium concentration of both filtered and unfiltered groundwater samples will be determined to further delineate the horizontal and vertical extent of the 20 μg/L total uranium plume. Data collection will be conducted at ASL-B. Data will not be validated. The additional data obtained from the direct push locations will be used in the design of the Waste Storage Area Aquifer Remediation Module.

Data collected from any of the six direct push locations may indicate a need for additional direct push locations in order to properly define the vertical and horizontal extent of the 20 μg/L total uranium plume. Any additional sampling, connected to the locations given above, will be identified through variances to the PSP.

2.0 MANAGEMENT AND ORGANIZATION

All of the sampling and field activities defined in this PSP will be conducted by Fluor Daniel Fernald (FDF) personnel. Responsibilities of project personnel are provided below. The FDF ARWWP/ Hydrogeology Section Team Coach (Bill Hertel) is responsible for:

- Providing a technical lead for the oversight and programmatic direction of sampling activities and the interpretation of sampling data
- Establishing and maintaining the scope, schedule, and cost baseline

The FDF Environmental Monitoring/Soils and Miscellaneous Media Projects Section Team Coach (Mike Frank) is responsible for:

- Safety walkdowns of the work areas, ensuring personnel are trained to safety and technical requirements, procuring applicable work permits, and ensuring that safety and PSP requirements are being adhered to during field implementation.
- Managing and conducting direct-push sampling activities

The FDF ARWWP/Hydrogeology Section Technical Lead (Ken Broberg) is responsible for:

- Oversight and programmatic direction of sampling activities and the interpretation of sampling data
- Reporting to the FDF ARWWP/Hydrogeology Section Team Coach on the progress and findings of PSP activities

PSP personnel contacts are listed below.

KEY PROJECT PERSONNEL

CONTACT	NAME	PHONE
ARWWP/Hydrogeology Section Team Coach	Bill Hertel	648-3894
Environmental Monitoring Soils and Misc. Media Section	Mike Frank	648-5459
ARWWP/Hydrogeology Section Technical Lead	Ken Broberg	648-5824
Laboratory	Audrey Hannum	648-4943
Quality Assurance	Scott Wheeler	648-4949
Health & Safety	Keith Lanning	648-4333

3.0 DIRECT PUSH SAMPLING

Analysis of groundwater samples obtained with a direct-push sampling tool will be used to refine the horizontal extent and determine the vertical extent of the 20 µg/L total uranium plume at select locations. The direct-push sampling tool will be used to collect groundwater samples from different vertical depths within the aquifer, rather than at a fixed monitoring depth.

At each direct-push sampling location groundwater samples will be collected at the following depths below the water table: 1 foot, 10 feet, and at subsequent depth intervals of 10 feet until it can be verified that the entire vertical thickness of the 20 µg/L total uranium plume has been sampled. Groundwater samples will be analyzed for both filtered and unfiltered total uranium.

3.1 SURVEYING AND STAKING DIRECT PUSH SAMPLING LOCATIONS

The ground elevation and location of each direct-push sampling location will be surveyed. A survey stake will be driven into the ground at each location and labeled. Field crews shall conform to the requirements stated in Procedure No. SH-0018, *Penetration Permits*, Rev. 2 PCN 1, March 8, 1999, (or future revisions) prior to penetrating the ground surface beyond 6 inches at each sampling location. The corresponding direct-push sampling location number for the sampling location will be written on the survey stake. Each direct-push sampling location will be identified by a unique number.

3.2 DIRECT PUSH REQUIREMENTS

Field crews shall conform to the requirements stated in Procedure No. SH-0018, *Penetration Permits*, dated March 8, 1999, (or future revisions) prior to penetrating the ground surface. Collection of groundwater samples using a direct push sampling tool is described in Data Quality Objective GW-030.

A Geoprobe™ mill-slotted sampler will be used to collect groundwater samples using direct push techniques as outlined in EQT-06, *Geoprobe Model 5400-Operation and Maintenance*. The slot size of the sampler will be 0.02-inches and the length of the slotted section will be 2 feet. The well point will be advanced with either 1.0 or 1.25-inch Outside Diameter (OD) probe rods. Samples will be collected through 3/8 or ½-inch OD polyethylene tubing equipped with a foot valve (ball check valve). New tubing will be used at each sampling depth for sample collection. The middle of the mill-slotted screen in the push rods will be positioned at the desired sampling depth.

For planning purposes, estimated ground surface elevations and depths to water for each direct-push sampling location are provided in Table 3-2. Table 3-3 is a copy of a Geoprobe™ Aquifer Sampling Depth Form. A unique Geoprobe™ Aquifer Sampling Depth Form will be prepared for each direct-push sampling event as discussed below.

- The sampling location will be identified on the Geoprobe™ Aquifer Sampling Depth Form by location number.

- The surveyed surface elevation of the direct-push hole (see Section 3.1) will be recorded on the Geoprobe™ Aquifer Sampling Depth Form.

- The depth to water will be measured using a water level indicator to the nearest 0.1 feet. The depth to water will be recorded on the Geoprobe™ Aquifer Sampling Depth Form.

- A groundwater sample will be collected from a depth of 1 foot below the water table. If water is not collectible at 1 foot below the water table, then the sampler screen will be positioned 2 or 3 feet below the water table for the first depth sample.

- The direct-push rods will be advanced to a depth that will position the middle of the sampling screen at the required sampling depth of 10 feet below the water table. The depth to water will be re-measured using a water level indicator. Past experience with direct-push sampling at the FEMP has shown that sometimes the water table within the direct-push hole has not totally stabilized when the first sample is collected (1 foot below water table), but will have stabilized by the time the second sample is collected. Record the second water level on the Geoprobe™ Aquifer Sampling Depth Form.

  Note: The sample at 10 feet below the water table may be collected first if there is a need to remove clay from the mill-slots of the sampler rod. Refer to the procedure outlined below.

- Using the water level measured when the sampling tool is at a depth of 10 feet below the water table, enter the sampling depth for the rest of the samples (e.g., 20 feet, 30 feet, 40 feet, 50 feet, 60 feet, 70 feet, 80 feet, and 90 feet below the water table) on the Geoprobe™ Aquifer Sampling Depth Form.

- Proceed with collecting groundwater samples at the rest of the sampling depths by positioning the middle of the sampling screen at the required sampling depths. If clay should enter the probe rods, the clay should be removed through the addition of water into the probe rods above the clay as well as advancing the rods 10 feet below the water table to loosen the compacted clay in the rods. The procedure which will be followed is outlined below.

- Using 0.5-inch OD polythylene tubing, push the tubing into the rods and attempt to force the clay up into the tubing.

- Add up to one liter of deionized water to the probe rods in 250 ml increments with surging following each addition. The surging should be performed with 3/8-inch polyethylene tubing with a ball check valve installed. The surging will convert the clay into a slurry that can be pumped to the surface by oscillating the tubing.

- In addition to the standard purge volume for 10 feet below the water table (bwt), (0.6 liters), collect five times the volume of water added to the probe rods prior to collecting the 10 feet bwt sample.

- Following collection of the 10 feet bwt sample, raise the probe rods to the 1 foot bwt depth for sample collection. A total of one liter of water should be purged from 1 foot bwt prior to sample collection to ensure a representative sample is collected.

Water sampling will continue at depth increments of 10 feet until the lower limit of the 20 µg/L uranium plume has been located, or as directed by the ARWWP/Hydrogeology Section Technical Lead. If obstructions are encountered or equipment complications prevent the push rods from extending to desired depths, then a different method for obtaining the sample may need to be used. Alternate methods will be approved by the ARWWP/Hydrogeology Section Team Coach.

3.3 GROUNDWATER SAMPLE COLLECTION

One probe rod volume of groundwater will be purged at each sampling depth prior to collecting groundwater samples. The push rods will be purged from near the top of the water column or as close to the top (within 10 feet) to ensure representative samples are collected. Groundwater samples will be collected from as close to the screened interval as possible, taking care to avoid any clogging within the sampling tube due to accumulated silt/sand that has entered the mill slots. The same polyethylene tubing used to collect the groundwater sample from a particular interval or a dedicated purge tube will be used to purge the next sample interval. Purge volumes are based on the sample's depth below the water table. Estimated purge volumes for both a 1.25-inch casing and a 1.0-inch casing are provided on the Geoprobe™ Aquifer Sampling Depth Form (Table 3-3).

All samples will be pre-filtered using a five micron in-line filter attached to the discharge end of a peristaltic pump. These samples will be listed as unfiltered on the Chain-of-Custody and Sample Collection Log. By definition, a filtered sample is filtered by a 0.45 micron filter. Both a filtered and an unfiltered groundwater sample will be collected for the analysis of total uranium. The unfiltered

sample will be run through a five micron filter only. The filtered sample will be run through both a five micron filter and a 0.45 micron filter.

Table 3-1 lists the preservation requirement, holding time, optimum/minimum sample volumes, and container type that will be used to collect the water sample. Estimated preservative volumes are listed for both optimum and minimum volumes. Minimal preservative volumes should be used to obtain a pH of less than two in order to prevent dissolution of solids in the sample. If more than 1.5 times the amount of nitric acid specified in Table 3-1 is required for lowering the pH to <2, then the ARWWP technical lead will be contacted for direction. Analyses will be ASL B and samples will be analyzed onsite at the Uranium and Thorium Analysts (UTA) Lab.

Table 3-4 lists the required QA/QC samples to be collected. One rinsate sample for total uranium analysis shall be collected prior to the start of each probe hole location by rinsing a clean mill-slotted sampler rod. A duplicate unfiltered sample will be collected at each sampling location at a depth of 20 feet below the water table. This depth was selected as it is expected to be located within the total uranium plume.

3.4 PROBE HOLE PLUGGING

The probe rods used for groundwater sampling will be completely removed from the borehole and the aquifer material will be allowed to collapse naturally up to the water table. A clean set of probe rods will be installed back into the probe hole in preparation for grouting immediately following removal of the probe rods used for sampling. Each probe hole will be plugged with a sand interval followed by a bentonite slurry to the ground surface. The aquifer material will be allowed to collapse naturally up to the water table. After driving the probe rods to a depth of three feet above the water table, a 3-foot thick interval of clean silica sand will be placed into the base of the borehole above the water table. A bentonite slurry will be mixed to SCQ specifications (approximately 9.4 pounds per gallon) and pumped through the probe rods to the bottom of the rods as the rods are removed. Plugging the hole with bentonite slurry will begin 3 feet above the sand and continue to the ground surface. The EQT-06 procedure, *Geoprobe Model 5400 Operation and Maintenance*, will be followed for grout pump assembly and preparation of the grout mixture. For the grout pumping method, the procedure outlined in *Geoprobe Owner's Manual - GS-1000 Grout Machine/Operating Instructions* (Section C- Secondary Tool String-Grout Pull Cap) will be followed.

The volume of bentonite slurry used in the plugging process will be monitored and recorded on a Borehole Abandonment Record. The probe hole will be inspected two to three days following grouting and, if necessary, bentonite pellets placed into the hole to the ground surface. In this event, the Borehole Abandonment Record will be revised with the additional volume information.

Grout volumes have been estimated for each direct-push location using preliminary survey elevations, depth to water elevations, and the following formula (Volume [gallons] = Depth to water level in feet multiplied by 0.13) assuming 1.25-inch rods are used and the final hole diameter is roughly 1.75 inches. It will be necessary to recalculate these volumes if the depth to water is significantly different than estimated in Table 3-2. The volume estimates for each direct-push location are as follows:

12614	7.7 gallons
12615	8.7 gallons
12616	7.8 gallons
12617	7.3 gallons
12618	7.0 gallons
12619	4.3 gallons

3.5 SAMPLE IDENTIFICATION

All groundwater samples collected for laboratory analysis will be assigned a unique sample identification number, also known as a Fernald Analytical Computerized Tracking System (FACTS) identification number. The FACTS number will identify the sampling location and depth (feet below the water table) at which the sample was collected. As an example, the sample identifier for a sample collected at location 12614 at a depth of 1 foot below the water table would be "12614-01." The sample identifier for a duplicate sample collected at a depth of 20 feet below the water table would be "12614-20-D."

A rinsate from each sampling location will be collected and identified using the location number and letter "X." The "X" designates it as a rinsate sample. For example, a rinsate from borehole 12614 will be identified as "12614-X." Duplicate filtered and unfiltered sample will be collected at each location from the depth of 20 feet below the water table. The duplicate samples will be analyzed for total uranium.

4.0 EQUIPMENT DECONTAMINATION

Probe rods and samplers will be decontaminated to Level I prior to initiating probing at the first location and between borehole locations using a high pressure spray wash as per SMPL-02.

5.0 WASTE DISPOSAL

Small amounts of groundwater, decontamination water, and contact wastes will be generated during field activities. Management of these waste streams will be coordinated with Waste Disposition Support Services (WDSS) through the Project Waste Identification Document (PWID) process. Decontamination will be minimized in the field. Whenever possible, equipment will be decontaminated at a facility that discharges either directly or indirectly to the AWWT through the storm water collection system. Contact waste generation will be minimized by limiting contact with sample media, and by using only those disposable materials as are necessary. This waste stream will be evaluated against dumpster criteria during the PWID process. If it does not meet these criteria, an alternative disposition will be identified. A FEMP Wastewater Discharge permit is required for purge water disposal (Form FS-F-4045).

6.0 HEALTH & SAFETY

Personnel shall conform to precautionary surveys performed by the personnel representing the Utility Engineer, Safety and Health, and Radiological Control. Concurrence to applicable safety permits (indicated by the signature of personnel assigned to this project) is expected from all project personnel in the performance of their assigned duties. The EM Team Coach will ensure that all EM personnel performing project-related activities have read or been trained to the EM sampling procedures applicable to this work in addition to the applicable surveys that protect worker safety and health is an acknowledgment of understanding the PSP requirements and safety precautions outlined in the procedures and permits. A copy of applicable safety permits/surveys issued for worker safety and health shall be available for reference/review at each sample location, and at the completion of the project, the completed forms shall be submitted for incorporation into the project files. All EM sampling personnel will adhere to the safety and health requirements from IT and will sign off on all applicable IT safety and health documents.

7.0 QUALITY ASSURANCE/QUALITY CONTROL REQUIREMENTS

7.1 PROJECT REQUIREMENTS FOR SURVEILLANCE

Self-assessment of work processes and operations may be undertaken to assure quality of performance. Self-assessment shall be performed by the Environmental Monitoring/Soils and Miscellaneous Media Projects Team Coach, and shall encompass technical and procedural requirements. Such self-assessment may be conducted at any point in the project.

Independent assessment shall be performed by the FDF QA organization by conducting surveillances. At a minimum, surveillances and inspections shall consist of an evaluation of the QA Program and procedures, a verification that they have been effectively implemented, and a review of associated project documentation.

7.2 VARIANCES TO THE PROJECT SPECIFIC PLAN

Variances shall be performed and documented in accordance with the requirements of Section 15.3 of the SCQ. They shall be documented on the Variance/Field Change Notice (V/FCN) form, FD-F-4162. If the variance is time-critical the requirements of Section 15.3.1 shall be followed. This allows approval of the variance by hard copy, electronic mail, or fax with the original V/FCN to follow and be completed within five working days. Verbal approval is not allowed for variances; some form of documentation is required as stated in Section 15.3.1 of the SCQ. A location movement < 10 feet will not require a variance.

8.0 DATA MANAGEMENT

A data management process will be implemented so information collected during the direct-push activity will be properly managed following completion of the field activities. As specified in Section 5.1 of the SCQ, sampling teams will describe daily activities on the Field Activity Log with sufficient detail so that the sampling team can reconstruct a particular situation without reliance on memory. Sample Collection Logs will be completed according to instructions specified in Section 6.1 of the SCQ.

All field measurements, observations, and sample collection information will be recorded as required and applicable on the Sample Collection Log, the Field Activity Log, and the Chain of Custody/Request for Analysis Form, the Borehole Abandonment Record, and the Geoprobe Aquifer Sampling Depth Form. The method of sample collection will be specified in the Field Activity Log. A unique sample identification number will appear on the Chain of Custody/Request for Analysis and will be used to identify the sample during analysis, data entry, and data management.

Technicians will review all field data for completeness and accuracy and then forward the data package to the Data Quality organization for final review. The field data package will be filed in the records of the Environmental Monitoring project.

The Data Management organization will perform data entry into the Site-Wide Environmental Database. Field logs will be maintained in loose-leaf form during the field recording activities. Analytical data will be reviewed by the Project Lead prior to entry of transfer of the data into the SED from the FACTS database.

TABLE 3-1

GEOPROBE™ SAMPLING ANALYTICAL REQUIREMENTS (ASL B)

Analyte	Lab[b]	Preservative[a]	Holding Time	Optimum Volume	Minimum Volume	Container	Approximate Detection Levels
Total Uranium	UTA Lab	HNO_3 PH<2 2 drops/1 drop	6 months	50 ml	20 ml	120 ml plastic	1 µg/L

[a]Estimated preservative volumes listed for optimum and minimum sample volumes. HNO_3 is 70 percent, 16N. Refer to Table 1 in SMPL-02 procedure for other volume information on the HNO_3 preservatives. Each drop of acid contains approximately 0.05 ml.
[b]All samples to be analyzed at ASL B as per FEMP SCQ specifications and audit requirements.

TABLE 3-2

ACTUAL SURFACE ELEVATIONS AND ESTIMATED DEPTH TO WATER TABLE FOR EACH DIRECT-PUSH SAMPLING LOCATION

Sampling Location	Actual Ground Surface Elevations (Feet amsl)	Estimated Depth to Water (Feet bgs)
12614	582.68	61.18
12615	589.93	69.43
12616	583.73	62.23
12617	579.29	58.47
12618	576.48	55.64
12619	555.49	34.02

TABLE 3-3

GEOPROBE™ AQUIFER SAMPLING DEPTH FORM

Location	Surface Elevation	Depth to Water, First Measurement in feet	Depth to Water, Second Measurement in feet
_____	_____ amsl[a]	_____ bgs[b]	_____ bgs

	Target Sampling Depth (feet bwt)									
	1' bwt[c]	10' bwt	20' bwt	30' bwt	40' bwt	50' bwt	60' bwt	70' bwt	80' bwt	90' bwt
	Actual Sampling Depth (feet bgs)									
	_____ bgs	_____ bgs	_____ bgs	_____ bgs	_____ bgs	_____ bgs	_____ bgs	_____ bgs	_____ bgs	_____ bgs
Purge Volume[d] (Liters) 1.25-inch Casing	0.13	0.62	1.3	1.9	2.5	3.0	3.6	4.2	4.8	5.5
Purge Volume[d] Liters) 1.0-inch Casing	0.08	0.4	0.8	1.2	1.6	1.9	2.3	2.7	3.1	3.5

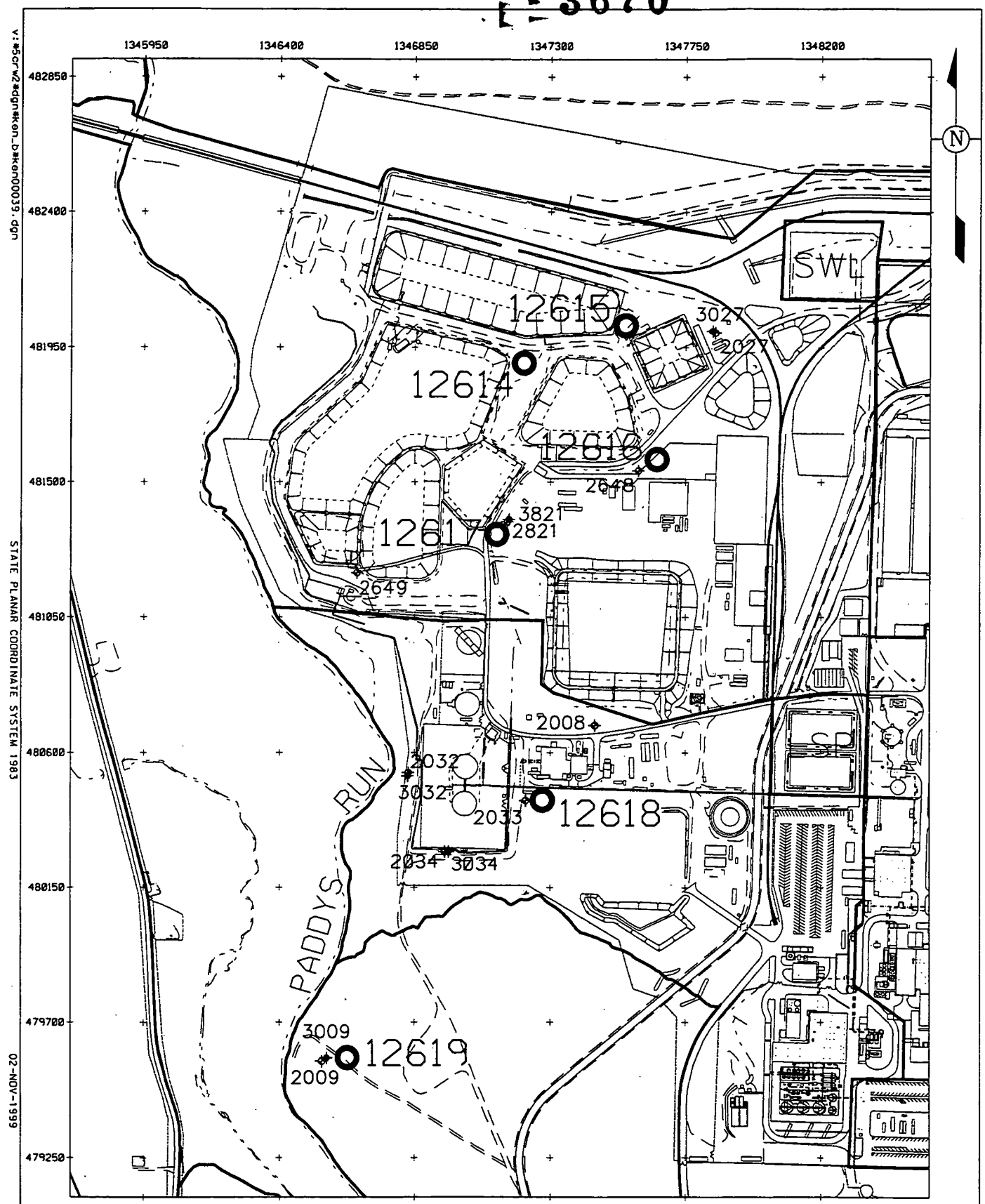
[a]Note: amsl - above mean sea level
[b]bgs - below ground surface
[c]bwt - below water table
[d]Additional purge volume may be required if sample intervals were collected out of sequence or water was added to the probe rods (refer to Section 3.2).

TABLE 3-4

QA/QC SAMPLES, ANALYTICAL REQUIREMENTS

QA/QC Sample	Analyte	Lab	Preservative[a]	Holding Time	Optimum Volume	Minimum Volume	Container
Rinsate	Total Uranium	UTA	HNO_3 pH<2 2 drops/1 drop	6 month	50 ml	20 ml	120 ml plastic
Field Duplicate	Total Uranium	UTA	HNO_3 pH<2 2 drops/1 drop	6 month	50 ml	20 ml	120 ml plastic

[a]Estimated preservative volume listed for optimum and minimum sample volumes. HNO_3 is 70 percent, 16N. One rinsate sample shall be collected at each location. The rinsate will be collected by rinsing the mill-slotted sampling rod.



LEGEND:

REMEDIATION AREA BOUNDARY

PROPOSED GEOPROBE LOCATION

SCALE

450 225 0 450 FEET

DRAFT

FIGURE 1. PROPOSED GEOPROBE LOCATIONS

VARIANCE / FIELD CHANGE NOTICE - 3670	V/F No. 10
WBS NO.: 52420-PSP-001	Page 1 of 1
PROJECT TITLE: PSP-Conducting Direct Push Sampling in the Waste Storage Area	Date: 10-20-00

VARIANCE / FIELD CHANGE NOTICE (Include justification):

Variance:

Direct push sampling will be conducted at three additional locations (Locations 12856, 12857, and 12858. More locations may be sampled pending the results of these three locations. If an additional location is required, it will be uniquely numbered, surveyed, and then sampled as outlined in the PSP.

Justification:

Additional direct push locations are needed to support pre-design monitoring.

ECDC CONTROLLED COPY NO. 455

REQUESTED BY: Ken Broberg KAB Date: 10-20-00

X IF REQD	VARIANCE/FCN APPROVAL	DATE	X IF REQD	VARIANCE/FCN APPROVAL	DATE
X	QUALITY ASSURANCE Bill S. Wilt for Frank Thompson	10/20/00		Water Monitoring Team Coach	
	DATA QUALITY MANAGEMENT		X	Soils and Misc. Media Sampling Team Coach Tom Bulkley	10/24/00
	ANALYTICAL CUSTOMER SUPPORT		X	Hydrogeology Team Coach [illegible]	10/20/00
	ARWWP Project Manager			Waste Water Treatment Operations Team Coach:	

VARIANCE/FCN APPROVED [X]YES [ ]NO

REVISION REQUIRED: [ ]YES [x]NO

DISTRIBUTION

PROJECT MANAGER:	DOCUMENT CONTROL:	OTHER:
QUALITY ASSURANCE:	OTHER:	OTHER:
FIELD MANAGER:	OTHER:	OTHER:

VARIANCE / FIELD CHANGE NOTICE	V/F No. 9
WBS NO.: 52420-PSP-001	Page 1 of 1
PROJECT TITLE: PSP-Conducting Direct Push Sampling in the Waste Storage Area	Date: 04-19-00

VARIANCE / FIELD CHANGE NOTICE (Include justification):

Variance:

Direct push sampling will be conducted at four additional locations (Locations 12721, 12722, 12723, and 12724).

Justification:

Additional direct push locations are needed to support pre-design monitoring in the Waste Storage Area, and Pilot Plant Drainage Ditch Area.

REQUESTED BY: Ken Broberg KBB Date: 04-19-00

X IF REQD	VARIANCE/FCN APPROVAL	DATE	X IF REQD	VARIANCE/FCN APPROVAL	DATE
	[illegible]	4-24-00			
X	QUALITY ASSURANCE [illegible]	4-24-00	[illegible]	~~Water Monitoring Team Coach~~	
	DATA QUALITY MANAGEMENT		X	Soils and Misc. Media Sampling Team Coach: [illegible] for Tom Bahnle	
	ANALYTICAL CUSTOMER SUPPORT		X	Hydrogeology Team Coach: [illegible]	4/19
	ARWWP Project Manager			Waste Water Treatment Operations Team Coach:	

VARIANCE/FCN APPROVED [X]YES [ ]NO

REVISION REQUIRED: [ ]YES [x]NO

DISTRIBUTION

PROJECT MANAGER:	DOCUMENT CONTROL:	OTHER:
QUALITY ASSURANCE:	OTHER:	OTHER:
FIELD MANAGER:	OTHER:	OTHER:

3670

VARIANCE / FIELD CHANGE NOTICE

V/F No. 8

WBS NO.: 52420-PSP-001

Page 1 of 1

PROJECT TITLE: PSP-Conducting Direct Push Sampling in the Waste Storage Area

Date: 04-03-00

VARIANCE / FIELD CHANGE NOTICE (Include justification):

Variance:

Direct push sampling will be conducted at six additional locations (Locations 12715, 12716, 12717, 12718, 12719 and 12720).

Groundwater samples will be collected from monitoring Wells 2020, and 3020. The groundwater samples will be analyzed for total uranium and techneium-99. If the groundwater sample collected is greater than 5 NTU, filter the sample using a 5 micron filter, and re-check turbidity. If turbidity is still greater than 5 NTU then filter using a 0.45 micron filter. If filtering is required to get the sample turbidity down below 5 NTU, submit both the unfiltered sample that is above 5 NTU and the filtered sample that is below 5 NTU for analysis. No field QA/QC samples will be collected. No validation is required.

Justification:

Additional direct push locations are needed to support pre-design monitoring in the Waste Storage Area, and Pilot Plant Drainage Ditch Area.

Additional groundwater sampling is needed to aid in the determination of the geometry of the uranium plume in the Pilot Plant Drainage Ditch Area.

REQUESTED BY: Ken Broberg KAB Date: 04-03-00

X IF REQD	VARIANCE/FCN APPROVAL	DATE	X IF REQD	VARIANCE/FCN APPROVAL	DATE
X	QUALITY ASSURANCE for FRANK THOMPSON	4/3/00	X	Water Monitoring Team Coach	4/5/00
	DATA QUALITY MANAGEMENT		X	Soils and Misc. Media Sampling Team Coach Thomas Balkey	4/3/00
	ANALYTICAL CUSTOMER SUPPORT		X Ken Broberg	Hydrogeology Team Coach: for W.A. Hertel	4-3-00
	ARWWP Project Manager			Waste Water Treatment Operations Team Coach:	

VARIANCE/FCN APPROVED [X]YES [ ]NO

REVISION REQUIRED: [ ]YES [x]NO

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PROJECT MANAGER:	DOCUMENT CONTROL:	OTHER:
QUALITY ASSURANCE:	OTHER:	OTHER:
FIELD MANAGER:	OTHER:	OTHER:

VARIANCE / FIELD CHANGE NOTICE	V/F No. 7
WBS NO.: 52420-PSP-001	Page 1 of 1
PROJECT TITLE: PSP-Conducting Direct Push Sampling in the Waste Storage Area	Date: 03-13-00

VARIANCE / FIELD CHANGE NOTICE (Include justification):

Variance:

Direct push sampling will be conducted at five additional locations (Locations 12710, 12711, 12712, 12713, and 12714).

Justification:

Additional direct push locations are needed to support pre-design monitoring in the Waste Storage Area, and south of the Waste Storage Area.

REQUESTED BY: Ken Broberg KAB Date: 03-13-00

X IF REQD	VARIANCE/FCN APPROVAL	DATE	X IF REQD	VARIANCE/FCN APPROVAL	DATE
X	QUALITY ASSURANCE			SDFP Team Coach	
	DATA QUALITY MANAGEMENT		X	Soils and Misc. Media Sampling Team Coach	3/14
	ANALYTICAL CUSTOMER SUPPORT		X	Hydrogeology Team Coach:	3/13
	ARWWP Project Manager			Waste Water Treatment Operations Team Coach:	

VARIANCE/FCN APPROVED [X]YES [ ]NO

REVISION REQUIRED: [ ]YES [x]NO

DISTRIBUTION

PROJECT MANAGER:	DOCUMENT CONTROL:	OTHER:
QUALITY ASSURANCE:	OTHER:	OTHER:
FIELD MANAGER:	OTHER:	OTHER:

3670

VARIANCE / FIELD CHANGE NOTICE

V/F No. 6

WBS NO.: 52420-PSP-001

Page 1 of 1

PROJECT TITLE: PSP-Conducting Direct Push Sampling in the Waste Storage Area

Date: 03-01-00

VARIANCE / FIELD CHANGE NOTICE (Include justification):

Variance:

Direct push sampling will be conducted at an additional location (Location 12709).

Justification:

Additional direct push location is needed to support pre-design monitoring in the Waste Storage Area.

REQUESTED BY: Ken Broberg KAB Date: 03-01-00

X IF REQD	VARIANCE/FCN APPROVAL	DATE	X IF REQD	VARIANCE/FCN APPROVAL	DATE
X	QUALITY ASSURANCE Frank Thompson	3-2-00		SDFP Team Coach	
	DATA QUALITY MANAGEMENT		X	Soils and Misc. Media Sampling Team Coach Tom Bubelogr	3/1/00
	ANALYTICAL CUSTOMER SUPPORT		X	Hydrogeology Team Coach: [illegible]	03/01/00
	ARWWP Project Manager			Waste Water Treatment Operations Team Coach:	

VARIANCE/FCN APPROVED [X]YES [ ]NO

REVISION REQUIRED: [ ]YES [x]NO

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PROJECT MANAGER:	DOCUMENT CONTROL:	OTHER:
QUALITY ASSURANCE:	OTHER:	OTHER:
FIELD MANAGER:	OTHER:	OTHER:

VARIANCE / FIELD CHANGE NOTICE	V/F No. 5
WBS NO.: 52420-PSP-001	Page 1 of 1
PROJECT TITLE: PSP-Conducting Direct Push Sampling in the Waste Storage Area	Date: 02-24-00

VARIANCE / FIELD CHANGE NOTICE (Include justification):

Variance:

Direct push sampling will be conducted at an additional location (Location 12708).

In addition to the collection of groundwater samples, soil samples will be collected and analyzed in accordance with the PSP for Pre-Design Sampling in the Area-2, Phase 2, Parts 2 and 3 (20450-PSP-001). One sample will be collected at the surface and another sample will be collected at a depth of four to five feet below ground surface. Samples will be labeled as follows: A2P2-PT2-Boring Number-depth. Samples will be analyzed for constituents in List A.

Justification:

Additional direct push location is needed to support pre-design monitoring in the Waste Storage Area.

Soil sample analytical results are needed to support soil excavation efforts.

REQUESTED BY: Ken Broberg KBB Date: 02-24-00

X IF REQD	VARIANCE/FCN APPROVAL	DATE	X IF REQD	VARIANCE/FCN APPROVAL	DA
X	Quality Assurance for F. Thompson	2/25/00	X	SDFP Team Coach	2/2
	DATA QUALITY MANAGEMENT		X	Soils and Misc. Media Sampling Team Coach	2/2
	ANALYTICAL CUSTOMER SUPPORT		X	Hydrogeology Team Coach:	2/2
	ARWWP Project Manager			Waste Water Treatment Operations Team Coach:	

VARIANCE/FCN APPROVED [X]YES [ ]NO

REVISION REQUIRED: [ ]YES [x]NO

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PROJECT MANAGER:	DOCUMENT CONTROL:	OTHER:
QUALITY ASSURANCE:	OTHER:	OTHER:
FIELD MANAGER:	OTHER:	OTHER:

3670

VARIANCE / FIELD CHANGE NOTICE

V/F No. 34 KRB

WBS NO.: 52420-PSP-001

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PROJECT TITLE: PSP-Conducting Direct Push Sampling in the Waste Storage Area

Date: 02-07-00

VARIANCE / FIELD CHANGE NOTICE (Include justification):

3670

Variance:

Direct-push sampling will be conducted at three additional locations (Location 12685, 12686, and 12707).

Groundwater samples will be collected from monitoring wells 3108, 2108, 2037, 3037, 2052, 2010, 2454, and 2936. Samples will be analyzed for total uranium and technetium-99.

Justification:

Additional sampling is needed to aid in the determination of the geometry of the uranium plume in the Waste Storage Area.

REQUESTED BY: Ken Broberg KRB Date: 02-07-00

X IF REQD	VARIANCE/FCN APPROVAL	DATE	X IF REQD	VARIANCE/FCN APPROVAL	DATE
X	QUALITY ASSURANCE	2/3/00		Water Monitoring Team Coach	
	DATA QUALITY MANAGEMENT		X	Soils and Misc. Media Sampling Team Coach	2/8/00
	ANALYTICAL CUSTOMER SUPPORT		X	Hydrogeology Team Coach	02/08/00
	ARWWP Project Manager			Waste Water Treatment Operations Team Coach:	

VARIANCE/FCN APPROVED [X]YES [ ]NO

REVISION REQUIRED: [ ]YES [x]NO

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PROJECT MANAGER:	DOCUMENT CONTROL:	OTHER:
QUALITY ASSURANCE:	OTHER:	OTHER:
FIELD MANAGER:	OTHER:	OTHER:

VARIANCE / FIELD CHANGE NOTICE

V/F No. 23

WBS NO.: 52420-PSP-001

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PROJECT TITLE: PSP-Conducting Direct Push Sampling in the Waste Storage Area

Date: 01-17-00

VARIANCE / FIELD CHANGE NOTICE (Include justification):

Variance:
Direct-push sampling will be conducted at an additional location (Location 12684)

Justification:

Additional sampling is needed to aid in the determination of the geometry of the uranium plume in the Waste Storage Area.

REQUESTED BY: Ken Broberg KAB Date: 01-17-00

X IF REQD	VARIANCE/FCN APPROVAL	DATE	X IF REQD	VARIANCE/FCN APPROVAL	DAT
X	QUALITY ASSURANCE Frank Thompson	1-17-00		Water Monitoring Team Coach	
	DATA QUALITY MANAGEMENT		X	Soils and Misc. Media Sampling Team Coach:	1/17/
	ANALYTICAL CUSTOMER SUPPORT		X	Hydrogeology Team Coach: Will G. Hall	1/17
	ARWWP Project Manager			Waste Water Treatment Operations Team Coach:	

VARIANCE/FCN APPROVED [X]YES [ ]NO

REVISION REQUIRED: [ ]YES [x]NO

DISTRIBUTION

PROJECT MANAGER:	DOCUMENT CONTROL:	OTHER:
QUALITY ASSURANCE:	OTHER:	OTHER:
FIELD MANAGER:	OTHER: 000094	OTHER:

VARIANCE / FIELD CHANGE NOTICE	V/F 52420-PSP-001-2
WBS NO.: ECDC # 52420-PSP-001	Page 1 of 1
PROJECT TITLE: PSP for Conducting Direct-Push Sampling in the Waste Storage Area	Date 12/17/1999

VARIANCE / FIELD CHANGE NOTICE (Include justification): L-3670

Field Change Notice:

The purpose of this variance is to document the field test of a modified sampler design to collect groundwater samples under this PSP. The modified sampler consists of a mill-slotted rod sampler with a 1-inch diameter stainless steel well screen inserted inside the rod sampler. The slot size on the mill-slotted sampler and internal wire-wrapped well screen is 0.020-inch and 0.004-inch, respectively. The length of the rod sampler and screen is approximately 2 feet. The first location for this field test will be location 12619. Additional locations may be added under this PSP where the modified sampler will be utilized.

The objective of the modified sampler is to reduce the volume of sand and silt that typically enters the sampler when using solely the mill-slotted rod sampler. Slight modifications to the sampler, such as using a larger slot size for the internal screen, may be attemtped on future locations if deemed appropriate.

JUSTIFICATION:

If the modified sampler reduces the volume of fine-grained sand and silt that enters into the sampler rod, significant time would be saved in sample collection and filtering. High volumes of sand and silt typically results in frequently clogged sample tubing/check valves, longer collection time, and longer sample processing time.

Requested By: Mike Frank Date: 12/17/1999

X IF REQD	VARIANCE/FCN APPROVAL	DATE	X IF REQD	VARIANCE/FCN APPROVAL	DATE
X	Frank Thompson QUALITY ASSURANCE	12-12-99	X	Walter G. Hurst ARWWP HYDROGEOLOGY TEAM COACH	12/17/99
	DATA QUALITY MANAGEMENT		X	SMMP TEAM COACH Mike Frank	12/17/99
	ANALYTICAL CUSTOMER SUPPORT		X	ARWWP HYDROGEOLOGY SECTION TECHNICAL LEAD	
	OTHER			WASTE ACCEPTANCE ORGANIZATION	

VARIANCE/FCN APPROVED [X]YES [ ]NO

REVISION REQUIRED: [ ]YES [x]NO

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QUALITY ASSURANCE:	OTHER:	OTHER:
FIELD MANAGER:	OTHER:	OTHER:

VARIANCE / FIELD CHANGE NOTICE

V/F No. 1

WBS NO.: 52420-PSP-001

Page 1 of

PROJECT TITLE: PSP-Conducting Direct Push Sampling in the Waste Storage Area

Date: 12-01-99

VARIANCE / FIELD CHANGE NOTICE (Include justification):

Variance:

With the exception of Locations 12614 and 12615, an additional groundwater sample will be collected at each sampling depth, at each location, for analysis of technetium-99. At the time that this variance is being prepared, sampling is in progress at Location 12616. Please collect technetium samples at as many prescribed depths as possible from this location. If you have to collect some of the shallower samples on the way out of the hole, please attempt to do so.

The samples will be a minimum of 300 ml (500 ml preferred) each. Samples will be filtered through a 5 micron filter only, and preserved with HNO3 to a pH <2. Samples will be submitted to the onsite laboratory for analysis, MDL of 10 pCi/L, ASL-B. Duplicate samples will be collected at a depth of 20-feet below the water table at each sampling location and analyzed for Technetium.

Justification:

Technetium-99 is an FRL constituent in the OU5 Rod. Technetium concentrations in the aquifer in the Waste Storage Area in the past have exceeded the groundwater FRL of 94 pCi/l. Analysis of the Geoprobe samples for Technetium will provide more up to date information for the design of the Waste Storage Area Aquifer Remediation Module.

REQUESTED BY: Ken Broberg KAB Date: 12/01/99

X IF REQD	VARIANCE/FCN APPROVAL	DATE	X IF REQD	VARIANCE/FCN APPROVAL	DAT
X	QUALITY ASSURANCE Frank Thompson	12-1-99		Water Monitoring Team Coach	
	DATA QUALITY MANAGEMENT		X	Soils and Misc. Media Sampling Team Coach	12/1
	ANALYTICAL CUSTOMER SUPPORT		X	Hydrogeology Team Coach: William G. Hall	12/01
	ARWWP Project Manager			Waste Water Treatment Operations Team Coach:	

VARIANCE/FCN APPROVED [X]YES [ ]NO

REVISION REQUIRED: [ ]YES [x]NO

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PROJECT MANAGER:	DOCUMENT CONTROL:	OTHER:
QUALITY ASSURANCE:	OTHER:	OTHER:
FIELD MANAGER:	OTHER:	OTHER:

APPENDIX B

PSP FOR CONDUCTING DIRECT-PUSH SAMPLING IN THE PLANT 6 AREA

3670

PROJECT SPECIFIC PLAN FOR CONDUCTING DIRECT-PUSH SAMPLING IN THE PLANT 6 AREA

PROJECT NUMBER 52425-PSP-001

NOVEMBER 1999

Prepared by

Fluor Daniel Fernald

Prepared for

U.S. Department of Energy
Fernald Field Office

Under Contract DE-AC05-92OR21972

000098

PROJECT SPECIFIC PLAN FOR CONDUCTING DIRECT-PUSH SAMPLING IN THE PLANT 6 AREA

PROJECT NUMBER 52425-PSP-001
November 1999

APPROVAL:

Kenneth A Brolny for — 12-10-99
William Hertel, Team Coach — Date
Aquifer Restoration and Wastewater Project/Hydrogeology Section

Frank Thompson — 12-13-99
Frank Thompson
Quality Assurance — Date

Mike Frank — 12/13/99
Mike Frank, Team Coach — Date
Environmental Monitoring/Soil and Miscellaneous Media Projects

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1.0 INTRODUCTION

Three locations (12651, 12652, and 12653) have been selected in the Plant 6 area to conduct direct push groundwater sampling using a Geoprobe™ sampling tool. The three locations selected for direct push sampling are shown in Figure 1. The total uranium concentration of both filtered and unfiltered groundwater samples will be determined to further delineate the horizontal and vertical extent of the 20 micrograms per liter (µg/L) total uranium plume in the vicinity of Plant 6. Data collection will be conducted at ASL-B. Data will not be validated. The additional data obtained from the direct push locations will be used in the design of the Plant 6 Aquifer Remediation Module.

Data collected from any of the three direct push locations may indicate a need for additional direct push locations in order to properly define the vertical and horizontal extent of the 20 µg/L total uranium plume. Any additional sampling connected to the locations given above will be identified through variances to this PSP.

2.0 MANAGEMENT AND ORGANIZATION

All of the sampling and field activities defined in this PSP will be conducted by Fluor Daniel Fernald (FDF) personnel. Responsibilities of project personnel are provided below. The FDF ARWWP/ Hydrogeology Section Team Coach (Bill Hertel) is responsible for:

- Providing technical leadership, oversight, and programmatic direction of sampling activities and interpretation of sampling data
- Establishing and maintaining the scope, schedule, and cost baseline.

The FDF Environmental Monitoring/Soils and Miscellaneous Media Projects Section Team Coach (Mike Frank) is responsible for:

- Safety walkdowns of the work areas, ensuring personnel are trained to safety and technical requirements, procuring applicable work permits, and ensuring that safety and PSP requirements are being adhered to during field implementation
- Managing and conducting direct-push sampling activities.

The FDF ARWWP/Hydrogeology Section Technical Lead (Ken Broberg) is responsible for:

- Providing oversight, programmatic direction of sampling activities and interpretation of sampling data
- Reporting to the FDF ARWWP/Hydrogeology Section Team Coach on the progress and findings of PSP activities.

PSP personnel contacts are listed below.

KEY PROJECT PERSONNEL

CONTACT	NAME	PHONE
ARWWP/Hydrogeology Section Team Coach	Bill Hertel	648-3894
Environmental Monitoring Soils and Misc. Media Section	Mike Frank	648-5459
ARWWP/Hydrogeology Section Technical Lead	Ken Broberg	648-5824
Laboratory	Audrey Hannum	648-4943
Quality Assurance	Scott Wheeler	648-4949
Health & Safety	Keith Lanning	648-4333

3.0 DIRECT PUSH SAMPLING

Analysis of groundwater samples obtained with a direct-push sampling tool will be used to refine the horizontal extent and to determine the vertical extent of the 20 µg/L total uranium plume at select locations. The direct-push sampling tool will be used to collect groundwater samples from different vertical depths within the aquifer, rather than at a single, fixed monitoring depth.

At each direct-push sampling location groundwater samples will be collected at the following depths below the water table: 1 foot, 10 feet, and at subsequent depth intervals of 10 feet until it can be verified that the entire vertical thickness of the 20 µg/L total uranium plume has been sampled. Groundwater samples will be analyzed for both filtered and unfiltered total uranium.

3.1 SURVEYING AND STAKING DIRECT PUSH SAMPLING LOCATIONS

The ground elevation and location of each direct-push sampling location will be surveyed. A survey stake will be driven into the ground at each location or the location will be marked with spray paint, and labeled. Field crews shall conform to the requirements stated in Procedure No. SH-0018, *Penetration Permits*, Rev. 2 PCN 1, March 8. 1999, (or future revisions) prior to penetrating the ground surface beyond 6 inches at each sampling location. The corresponding direct-push sampling location number for the sampling location will be written on the survey stake or spray painted next to the location. Each direct-push sampling location will be identified by a unique number.

3.2 DIRECT PUSH REQUIREMENTS

Field crews shall conform to the requirements stated in Procedure No. SH-0018, *Penetration Permits*, dated March 8, 1999, (or future revisions) prior to penetrating the ground surface. Collection of groundwater samples using a direct push sampling tool is described in Data Quality Objective GW-030.

A Geoprobe™ mill-slotted sampler will be used to collect groundwater samples using direct push techniques as outlined in Procedure No. EQT-06, *Geoprobe Model 5400-Operation and Maintenance*. The slot size of the sampler will be 0.02 inches and the length of the slotted section will be 2 feet. The well point will be advanced with either 1.0 or 1.25-inch Outside Diameter (OD) probe rods. Samples will be collected through 3/8 or 0.50-inch OD polyethylene tubing equipped with a foot valve (ball

check valve). New tubing will be used at each sampling depth for sample collection. The middle of the mill-slotted screen in the push rods will be positioned at the desired sampling depth.

For planning purposes, estimated ground surface elevations and depths to water for each direct-push sampling location are provided in Table 3-2. Table 3-3 is a copy of a Geoprobe™ Aquifer Sampling Depth Form. A unique Geoprobe™ Aquifer Sampling Depth Form will be prepared for each direct-push sampling event as discussed below.

- The sampling location will be identified on the Geoprobe™ Aquifer Sampling Depth Form by location number.

- The surveyed surface elevation of the direct-push boring hole (see Section 3.1) will be recorded on the Geoprobe™ Aquifer Sampling Depth Form.

- The depth to water will be measured using a water level indicator to the nearest 0.1 feet. The depth to water will be recorded on the Geoprobe™ Aquifer Sampling Depth Form.

- A groundwater sample will be collected from a depth of 1 foot below the water table. If water is not collectible at 1 foot below the water table, then the sampler screen will be positioned 2 or 3 feet below the water table for the first depth sample.

- The direct-push rods will be advanced to a depth that will position the middle of the sampling screen at the required sampling depth of 10 feet below the water table. The depth to water will be re-measured using a water level indicator. Past experience with direct-push sampling at the FEMP has shown that sometimes the water table within the direct-push hole has not totally stabilized when the first sample is collected (1 foot below water table), but will have stabilized by the time the second sample is collected. Record the second water level on the Geoprobe™ Aquifer Sampling Depth Form.

  Note: The sample at 10 feet below the water table may be collected first if there is a need to remove clay from the mill-slots of the sampler rod. Refer to the procedure outlined below.

- Using the water level measured when the sampling tool is at a depth of 10 feet below the water table, enter the sampling depth for the rest of the samples (e.g., 20 feet, 30 feet, 40 feet, 50 feet, 60 feet, 70 feet, 80 feet, and 90 feet below the water table) on the Geoprobe™ Aquifer Sampling Depth Form.

- Proceed with collecting groundwater samples at the rest of the sampling depths by positioning the middle of the sampling screen at the required sampling depths. If clay should enter the probe rods, the clay should be removed through the addition of water into the probe rods above the clay as well as advancing the rods 10 feet below the water table to loosen the compacted clay in the rods. The procedure which will be followed is outlined below.

- Using 0.5-inch OD polythylene tubing, push the tubing into the rods and attempt to force the clay up into the tubing.

- Add up to one liter of deionized water to the probe rods in 250 milliliter (mL) increments with surging following each addition. The surging should be performed with 3/8-inch polyethylene tubing with a ball check valve installed. The surging will convert the clay into a slurry that can be pumped to the surface by oscillating the tubing.

- In addition to the standard purge volume for 10 feet below the water table (bwt), (0.6 liters), collect five times the volume of water added to the probe rods prior to collecting the 10 feet bwt sample.

- Following collection of the 10 feet bwt sample, raise the probe rods to the 1 foot bwt depth for sample collection. A total of one liter of water should be purged from 1 foot bwt prior to sample collection to ensure a representative sample is collected.

Water sampling will continue at depth increments of 10 feet until the lower limit of the 20 μg/L uranium plume has been located, or as directed by the ARWWP/Hydrogeology Section Technical Lead. If obstructions are encountered or equipment complications prevent the push rods from extending to desired depths, then a different method for obtaining the sample may need to be used. Alternate methods will be approved by the ARWWP/Hydrogeology Section Team Coach.

3.3 GROUNDWATER SAMPLE COLLECTION

One probe rod volume of groundwater will be purged at each sampling depth prior to collecting groundwater samples. The push rods will be purged from near the top of the water column or as close to the top (within 10 feet) to ensure representative samples are collected. Groundwater samples will be collected from as close to the screened interval as possible, taking care to avoid any clogging within the sampling tube due to accumulated silt/sand that has entered the mill slots. The same polyethylene tubing used to collect the groundwater sample from a particular interval or a dedicated purge tube will be used to purge the next sample interval. Purge volumes are based on the sample's depth below the water table. Estimated purge volumes for both a 1.25-inch casing and a 1.0-inch casing are provided on the Geoprobe™ Aquifer Sampling Depth Form (Table 3-3).

All samples will be pre-filtered using a 5 micron in-line filter attached to the discharge end of a peristaltic pump. These samples will be listed as unfiltered on the Chain-of-Custody and Sample Collection Log. By definition, a filtered sample is filtered by a 0.45 micron filter. Both a filtered and

an unfiltered groundwater sample will be collected for the analysis of total uranium. The unfiltered sample will be run through a 5 micron filter only. The filtered sample will be run through both a 5 micron filter and a 0.45 micron filter.

Table 3-1 lists the preservation requirement, holding time, optimum/minimum sample volumes, and container type that will be used to collect the water sample. Estimated preservative volumes are listed for both optimum and minimum volumes. Minimal preservative volumes should be used to obtain a pH of less than two. If more than 1.5 times the amount of nitric acid specified in Table 3-1 is required for lowering the pH to <2, then the ARWWP technical lead will be contacted for direction. Analyses will be ASL B and samples will be analyzed onsite at the Uranium and Thorium Analysts (UTA) Lab.

Table 3-4 lists the required QA/QC samples to be collected. One rinsate sample for total uranium analysis shall be collected prior to the start of each probe hole location by rinsing a clean mill-slotted sampler rod. A duplicate unfiltered sample will be collected at each sampling location at a depth of 20 feet below the water table. This depth was selected as it is expected to be located within the total uranium plume.

3.4 PROBE HOLE PLUGGING

The probe rods used for groundwater sampling will be completely removed from the borehole and the aquifer material will be allowed to collapse naturally up to the water table. A clean set of probe rods will be installed back into the probe hole in preparation for grouting immediately following removal of the probe rods used for sampling. Each probe hole will be plugged with a sand interval followed by a bentonite slurry to the ground surface. The aquifer material will be allowed to collapse naturally up to the water table. After driving the probe rods to a depth of three feet above the water table, a 3-foot thick interval of clean silica sand will be placed into the base of the borehole above the water table. A bentonite slurry will be mixed to SCQ specifications (approximately 9.4 pounds per gallon) and pumped through the probe rods to the bottom of the rods as the rods are removed. Plugging the hole with bentonite slurry will begin 3 feet above the sand and continue to the ground surface. The EQT-06 procedure, *Geoprobe Model 5400 Operation and Maintenance*, will be followed for grout pump assembly and preparation of the grout mixture. For the grout pumping method, the procedure outlined in *Geoprobe Owner's Manual - GS-1000 Grout Machine/Operating Instructions* (Section C- Secondary Tool String-Grout Pull Cap) will be followed.

The volume of bentonite slurry used in the plugging process will be monitored and recorded on a Borehole Abandonment Record. The probe hole will be inspected two to three days following grouting and, if necessary, bentonite pellets will be placed into the hole to the ground surface. In this event, the Borehole Abandonment Record will be revised with the additional volume information.

Grout volumes have been estimated for each direct-push location using estimated survey elevations, estimated depth to water elevations, and the following formula (Volume [gallons] = Depth to water level in feet multiplied by 0.13) assuming 1.25-inch rods are used and the final hole diameter is roughly 1.75 inches. It will be necessary to recalculate these volumes if the surveyed surface elevation and/or actual depth to water measurements are significantly different than estimated in Table 3-2. The volume estimates for each direct-push location are as follows:

12651	7.97 gallons
12652	8.25 gallons
12653	8.25 gallons

3.5 SAMPLE IDENTIFICATION

All groundwater samples collected for laboratory analysis will be assigned a unique sample identification number, also known as a Fernald Analytical Computerized Tracking System (FACTS) identification number. The FACTS number will identify the sampling location and depth (feet below the water table) at which the sample was collected. As an example, the sample identifier for a sample collected at location 12651 at a depth of 1 foot below the water table would be "12651-01." The sample identifier for a duplicate sample collected at a depth of 20 feet below the water table would be "12651-20-D."

A rinsate from each sampling location will be collected and identified using the location number and letter "X." The "X" designates it as a rinsate sample. For example, a rinsate from borehole 12651 will be identified as "12651-X." Duplicate filtered and unfiltered sample will be collected at each location from the depth of 20 feet below the water table. The duplicate samples will be analyzed for total uranium.

4.0 EQUIPMENT DECONTAMINATION

Probe rods and samplers will be decontaminated to Level I prior to initiating probing at the first location and between borehole locations using a high pressure spray wash according to the SMPL-02 procedure.

5.0 WASTE DISPOSAL

Small amounts of groundwater, decontamination water, and contact wastes will be generated during field activities. Management of these waste streams will be coordinated with Waste Disposition Support Services (WDSS) through the Project Waste Identification Document (PWID) process. Decontamination will be minimized in the field. Whenever possible, equipment will be decontaminated at a facility that discharges either directly or indirectly to the AWWT through the storm water collection system. Contact waste generation will be minimized by limiting contact with sample media, and by using only those disposable materials as are necessary. This waste stream will be evaluated against dumpster criteria during the PWID process. If it does not meet these criteria, an alternative disposition will be identified. A FEMP Wastewater Discharge permit is required for purge water disposal (Form FS-F-4045).

6.0 HEALTH & SAFETY

3670

Personnel shall conform to precautionary surveys performed by the personnel representing the Utility Engineer, Safety and Health, and Radiological Control. All project personnel are expected to conform to applicable safety permits in the performance of their assigned duties; this is indicated by the signature of personnel assigned to this project on the briefing records to the permits and this PSP, before the start of field work activities. The EM Team Coach will ensure that all EM personnel performing project-related activities, have read or been trained to the EM sampling procedures applicable to this work in addition to the applicable surveys that protect worker safety and health is an acknowledgment of understanding the PSP requirements and safety precautions outlined in the procedures and permits. A copy of applicable safety permits/surveys issued for worker safety and health shall be available for reference/review at each sample location, and at the completion of the project, the completed forms shall be submitted for incorporation into the project files.

7.0 QUALITY ASSURANCE/QUALITY CONTROL REQUIREMENTS

7.1 PROJECT REQUIREMENTS FOR SURVEILLANCE

Self-assessment of work processes and operations may be undertaken to assure quality of performance. Self-assessment shall be performed by the Environmental Monitoring/Soils and Miscellaneous Media Projects Team Coach, and shall encompass technical and procedural requirements. Such self assessment may be conducted at any point in the project.

Independent assessment shall be performed by the FDF QA organization by conducting surveillances. At a minimum, surveillances and inspections shall consist of an evaluation of the QA Program and procedures, a verification that they have been effectively implemented, and a review of associated project documentation.

7.2 VARIANCES TO THE PROJECT SPECIFIC PLAN

Variances shall be performed and documented in accordance with the requirements of Section 15.3 of the SCQ. They shall be documented on the Variance/Field Change Notice (V/FCN) form, FD-F-4162. If the variance is time-critical the requirements of Section 15.3.1 shall be followed. This allows approval of the variance by hard copy, electronic mail, or fax with the original V/FCN to follow and be completed within five working days. Verbal approval is not allowed for variances; some form of documentation is required as stated in Section 15.3.1 of the SCQ. However, a location movement < 10 feet will not require a variance.

8.0 DATA MANAGEMENT

A data management process will be implemented so information collected during the direct-push activity will be properly managed following completion of the field activities. As specified in Section 5.1 of the SCQ, sampling teams will describe daily activities on the Field Activity Log with sufficient detail so that the sampling team can reconstruct a particular situation without reliance on memory. Sample Collection Logs will be completed according to instructions specified in Section 6.1 of the SCQ.

All field measurements, observations, and sample collection information will be recorded as required and applicable on the Sample Collection Log, the Field Activity Log, and the Chain of Custody/Request for Analysis Form, the Borehole Abandonment Record, and the Geoprobe Aquifer Sampling Depth Form. The method of sample collection will be specified in the Field Activity Log. A unique sample identification number will appear on the Chain of Custody/Request for Analysis and will be used to identify the sample during analysis, data entry, and data management.

Technicians will review all field data for completeness and accuracy and then forward the data package to the Data Quality organization for final review. The field data package will be filed in the records of the Environmental Monitoring project.

The Data Management organization will perform data entry into the Site-wide Environmental Database (SED). Field logs will be maintained in loose-leaf form during the field recording activities. Analytical data will be reviewed by the Project Lead prior to entry of transfer of the data into the SED from the FACTS database.

TABLE 3-1

GEOPROBE™ SAMPLING ANALYTICAL REQUIREMENTS (ASL B)

Analyte	Lab[b]	Preservative[a]	Holding Time	Optimum Volume	Minimum Volume	Container	Approximate Detection Levels
Total Uranium	UTA Lab	HNO_3 PH<2 2 drops/1 drop	6 months	50 mL	20 mL	120 mL plastic	1 µg/L

[a]Estimated preservative volumes listed for optimum and minimum sample volumes. HNO_3 is 70 percent concentration, 16 Normal (N). Refer to Table 1 in SMPL-02 procedure for other volume information on the HNO_3 preservatives. Each drop of acid contains approximately 0.05 mL.
[b]All samples to be analyzed at ASL B as per FEMP SCQ specifications and audit requirements.

TABLE 3-2

ESTIMATED SURFACE ELEVATIONS AND ESTIMATED DEPTH TO WATER TABLE FOR EACH DIRECT-PUSH SAMPLING LOCATION

Sampling Location	Estimated Ground Surface Elevations (feet amsl)	Estimated Depth to Water (feet bgs)
12651	579.50	61.33
12652	581.39	63.45
12653	581.39	63.45

TABLE 3-3

GEOPROBE™ AQUIFER SAMPLING DEPTH FORM

Location	Surface Elevation	Depth to Water, First Measurement in feet	Depth to Water, Second Measurement in feet
_____	_____ amsl[a]	_____ bgs[b]	_____ bgs

	Target Sampling Depth (feet bwt)									
	1' bwt[c]	10' bwt	20' bwt	30' bwt	40' bwt	50' bwt	60' bwt	70' bwt	80' bwt	90' bwt
	Actual Sampling Depth (feet bgs)									
	_____ bgs	_____ bgs	_____ bgs	_____ bgs	_____ bgs	_____ bgs	_____ bgs	_____ bgs	_____ bgs	_____ bgs
Purge Volume[d] (Liters) 1.25-inch Casing	0.13	0.62	1.3	1.9	2.5	3.0	3.6	4.2	4.8	5.5
Purge Volume[d] Liters) 1.0-inch Casing	0.08	0.4	0.8	1.2	1.6	1.9	2.3	2.7	3.1	3.5

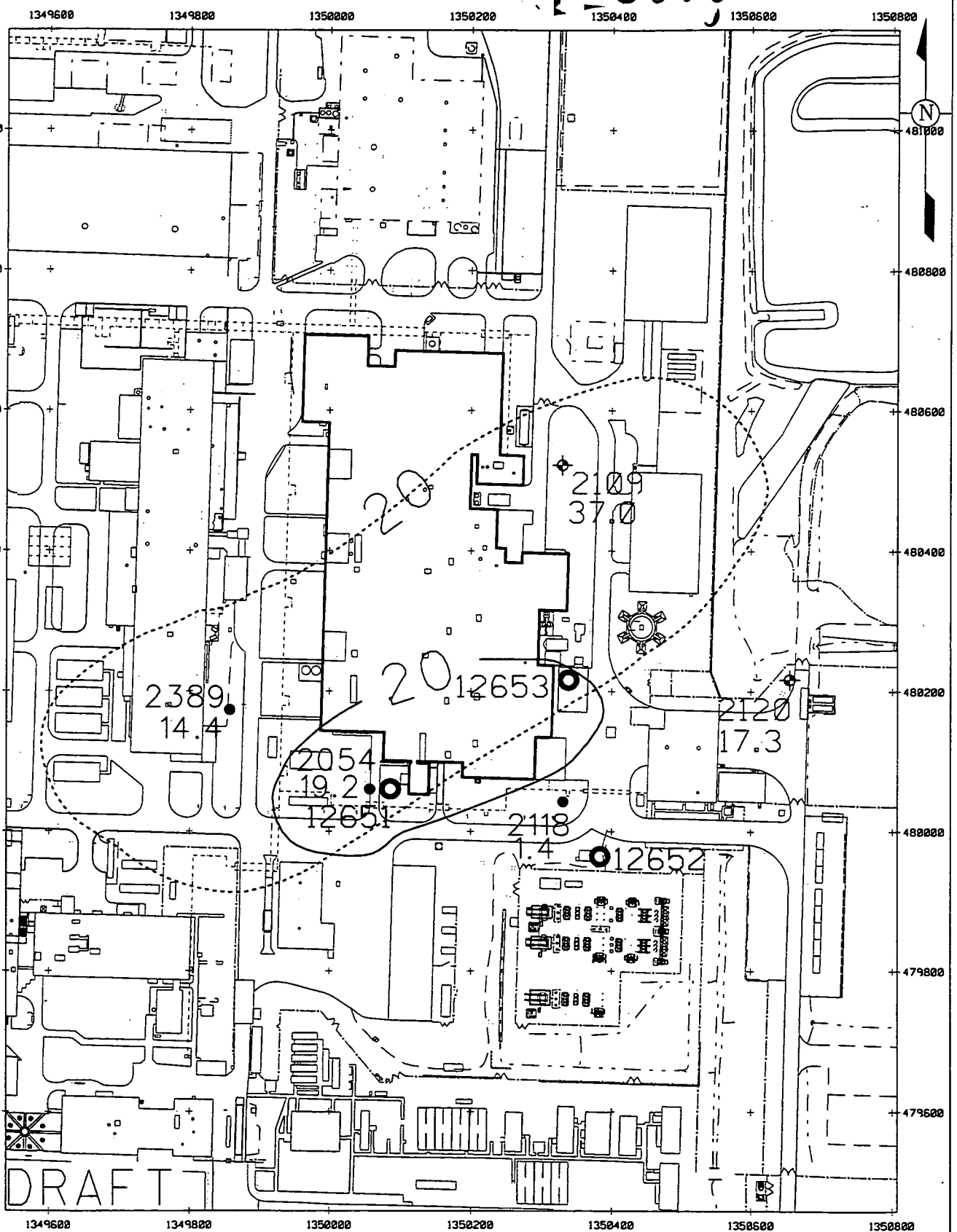
[a]Note: amsl - above mean sea level
[b]bgs - below ground surface
[c]bwt - below water table
[d]Additional purge volume may be required if sample intervals were collected out of sequence or water was added to the probe rods (refer to Section 3.2).

TABLE 3-4

QA/QC SAMPLES, ANALYTICAL REQUIREMENTS

QA/QC Sample	Analyte	Lab	Preservative[a]	Holding Time	Optimum Volume	Minimum Volume	Container
Rinsate	Total Uranium	UTA	HNO_3 pH<2 2 drops/1 drop	6 month	50 mL	20 mL	120 mL plastic
Field Duplicate	Total Uranium	UTA	HNO_3 pH<2 2 drops/1 drop	6 month	50 mL	20 mL	120 mL plastic

[a]Estimated preservative volume listed for optimum and minimum sample volumes. HNO_3 is 70 percent concentration, 16 Normal (N).
One rinsate sample shall be collected at each location. The rinsate will be collected by rinsing the mill-slotted sampling rod.



LEGEND:

PLANT 6 OUTLINE

20ppb TOTAL URANIUM PLUME

PLATE E-81 PLUME

PROPOSED GEOPROBE LOCATION

SCALE

200 100 0 200 FEET

PROPOSED GEOPROBE LOCATIONS FOR PLANT 6

STATE PLANAR COORDINATE SYSTEM 1927

15-NOV-1999

v:\5cr\w2\dgn\ken_b\ken00041.dgn

VARIANCE / FIELD CHANGE NOTICE 3670	V/F No. 3
WBS NO.: 52425-PSP-001	Page 1 of 1
PROJECT TITLE: PSP-Conducting Direct Push Sampling in the Plant-6 Area	Date: 11-08-00

VARIANCE / FIELD CHANGE NOTICE (Include justification):

Variance:
Direct push sampling will be conducted at an additional location (Location 12859). More locations may be sampled pending the results of this location. If an additional location is required, it will be uniquely numbered, surveyed, and then sampled as outlined in the PSP.

Justification:

Additional location is needed to support pre-design monitoring.

ECDC CONTROLLED
COPY NO.
455

REQUESTED BY: Ken Broberg KAB Date: 11-08-00

X IF REQD	VARIANCE/FCN APPROVAL	DATE	X IF REQD	VARIANCE/FCN APPROVAL	DATE
X	QUALITY ASSURANCE for Frank Thompson	11/8/00		Water Monitoring Team Coach	
	DATA QUALITY MANAGEMENT		X	Soils and Misc. Media Sampling Team Coach	11/13/00
	ANALYTICAL CUSTOMER SUPPORT		X	Hydrogeology Team Coach:	11/13/00
	ARWWP Project Manager			Waste Water Treatment Operations Team Coach:	

VARIANCE/FCN APPROVED [X]YES [ ]NO

REVISION REQUIRED: [ ]YES [x]NO

DISTRIBUTION

PROJECT MANAGER:	DOCUMENT CONTROL:	OTHER:
QUALITY ASSURANCE:	OTHER:	OTHER:
FIELD MANAGER:	OTHER:	OTHER:

VARIANCE / FIELD CHANGE NOTICE

V/F No. 2

WBS NO.: 52425-PSP-001

Page 1 of

PROJECT TITLE: PSP-Conducting Direct Push Sampling in the Plant-6 Area

Date: 12-17-99

VARIANCE / FIELD CHANGE NOTICE (Include justification):

Variance:
Technetium-99 will be added to the analyte list.

The groundwater samples collected for technetium-99 analysis will be a minimum of 300 ml (500 ml preferred) each. Samples will be filtered through a 5 micron filter only, and preserved with HNO3 to a pH <2. Samples will be submitted to the onsite laboratory for analysis, MDL of 10 pCi/L, ASL-B. Duplicate samples will be collected at a depth of 20-feet below the water table at each sampling location and analyzed for Technetium.

Justification:

Technetium-99 is an FRL constituent in the OU5 Rod. Technetium concentrations in the glacial overburden in the Plant-6 area have the potential for creating FRL exceedances for technetium-99 in the aquifer beneath it. Analysis of the Geoprobe samples for Technetium will provide more up to date information for the design of the Plant-6 Aquifer Remediation Module.

REQUESTED BY: Ken Broberg Date: 12/17/99

X IF REQD	VARIANCE/FCN APPROVAL	DATE	X IF REQD	VARIANCE/FCN APPROVAL	DATE
X	QUALITY ASSURANCE	12-17-99		Water Monitoring Team Coach	
	DATA QUALITY MANAGEMENT		X	Soils and Misc. Media Sampling Team Coach	12/17/
	ANALYTICAL CUSTOMER SUPPORT		X	Hydrogeology Team Coach:	12/17/
	ARWWP Project Manager			Waste Water Treatment Operations Team Coach:	

VARIANCE/FCN APPROVED [X]YES [ ]NO

REVISION REQUIRED: [ ]YES [x]NO

DISTRIBUTION

PROJECT MANAGER:	DOCUMENT CONTROL:	OTHER:
QUALITY ASSURANCE:	OTHER:	OTHER:
FIELD MANAGER:	OTHER:	OTHER:

VARIANCE / FIELD CHANGE NOTICE 3670	V/F 52425-PSP-001-1
WBS NO.: ECDC # 52425-PSP-001	Page 1 of 1
PROJECT TITLE: PSP for Conducting Direct-Push Sampling in the Plant 6 Area	Date 12/17/1999

VARIANCE / FIELD CHANGE NOTICE (Include justification):

Field Change Notice:

The purpose of this variance is to document the field test of a modified sampler design to collect groundwater samples under this PSP. The modified sampler consists of a mill-slotted rod sampler with a 1-inch diameter stainless steel well screen inserted inside the rod sampler. The slot size on the mill-slotted sampler and internal wire-wrapped well screen is 0.020-inch and 0.004-inch, respectively. The length of the rod sampler and screen is approximately 2 feet. Additional locations may be added under this PSP where the modified sampler will be utilized.

The objective of the modified sampler is to reduce the volume of sand and silt that typically enters the sampler when using solely the mill-slotted rod sampler. Slight modifications to the sampler, such as using a larger slot size for the internal screen, may be attempted on future locations if deemed appropriate.

JUSTIFICATION:

If the modified sampler reduces the volume of fine-grained sand and silt that enters into the sampler rod, significant time would be saved in sample collection and filtering. High volumes of sand and silt typically results in frequently clogged sample tubing/check valves, longer collection time, and longer sample processing time.

Requested By: Mike Frank Date: 12/17/1999

X IF REQD	VARIANCE/FCN APPROVAL	DATE	X IF REQD	VARIANCE/FCN APPROVAL	DATE
X	QUALITY ASSURANCE	12-17-99	X	ARWWP HYDROGEOLOGY TEAM COACH	12/17/99
	DATA QUALITY MANAGEMENT		X	SMMP TEAM COACH	12/17/99
	ANALYTICAL CUSTOMER SUPPORT		X	ARWWP HYDROGEOLOGY SECTION TECHNICAL LEAD	
	OTHER			WASTE ACCEPTANCE ORGANIZATION	

VARIANCE/FCN APPROVED [X]YES [ ]NO | REVISION REQUIRED: [ ]YES [x]NO

DISTRIBUTION

PROJECT MANAGER:	DOCUMENT CONTROL:	OTHER:
QUALITY ASSURANCE:	OTHER:	OTHER:
FIELD MANAGER:	OTHER:	OTHER:

APPENDIX C

DIRECT-PUSH SAMPLING RESULTS

APPENDIX C

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Unfiltered uranium concentration data was collected at 38 direct-push sampling locations. For direct-push sampling, unfiltered means that the sample was only filtered through a 5 milron filter. The data are presented by location in this Appendix. The following information is provided for each sampling location.

- Easting survey coordinate
- Northing survey coordinate
- Reference surface elevation
- Depth (feet) to the water table
- Work duration (time sampling was conducted)
- Unfiltered uranium sampling result for each sampling depth.

TABLE C-1

GEOPROBE 12614
WASTE STORAGE AREA

Easting '83 = 1347251.37
Northing '83 = 481945.26
Reference Elevation = 582.68 feet amsl
Depth to Water Table = 64.8 feet
Work Duration - November 8, 1999-November 18, 1999

Sample Point	Elevation (ft amsl)	Depth Below Surface (ft)	Depth Below Water Table (@ 517.88 feet amsl)	Total Uranium Concentration (µg/L)
1	514.88	67.8	3	7.8
2	507.88	74.8	10	3.8
3	497.88	84.8	20	4.3
4	497.88	84.8	20D	4.3
5	487.88	94.8	30	11
6	477.88	104.8	40	12
7	467.88	114.8	50	13
8	457.88	124.8	60	4.2

TABLE C-2

GEOPROBE 12615
WASTE STORAGE AREA

Easting '83 = 1347546.70
Northing '83 = 482018.50
Reference Elevation = 590.60 feet amsl
Depth to Water Table = 73.2 feet
Work Duration - November 18, 1999-November 24, 1999

Sample Point	Elevation (ft amsl)	Depth Below Surface (ft)	Depth Below Water Table (@ 517.40 feet amsl)	Total Uranium Concentration (µg/L)
1	516.4	74.2	1	2.3
2	507.4	83.2	10	13
3	497.4	93.2	20	9.2
4	497.4	93.2	20D	10
5	487.4	103.2	30	13
6	477.4	113.2	40	13

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TABLE C-3

GEOPROBE 12616
WASTE STORAGE AREA

Easting '83 = 1347585.36
Northing '83 = 481556.17
Reference Elevation = 583.73 feet amsl
Depth to Water Table = 67.7 feet
Work Duration - November 29, 1999-December 2, 1999

Sample Point	Elevation (ft amsl)	Depth Below Surface (ft)	Depth Below Water Table (@ 516.03 feet amsl)	Total Uranium Concentration (µg/L)
1	511.03	72.7	5	2.1
2	506.03	77.7	10	1.5
3	496.03	87.7	20	0.8
4	496.03	87.7	20D	0.8
5	486.03	97.7	30	1.0
6	476.03	107.7	40	3.1

TABLE C-4

GEOPROBE 12617
WASTE STORAGE AREA

Easting '83 = 1347225.39
Northing '83 = 481285.79
Reference Elevation = 581.08 feet amsl
Depth to Water Table = 64.0 feet
Work Duration - January 18, 2000-January 25, 2000

Sample Point	Elevation (ft amsl)	Depth Below Surface (ft)	Depth Below Water Table (@ 517.08 feet amsl)	Total Uranium Concentration (µg/L)
1	516.08	65.0	1	21
2	507.08	74.0	10	30
3	497.08	84.0	20	4.7
4	497.08	84.0	20D	4.6
5	487.08	94.0	30	1.4
6	477.08	104.0	40	3.2
7	467.08	114.0	50	1.0
8	457.08	124.0	60	1.7

TABLE C-5

GEOPROBE 12618
WASTE STORAGE AREA

Easting '83 = 1347219.92
Northing '83 = 480432.27
Reference Elevation = 576.48 feet amsl
Depth to Water Table = 60.4 feet
Work Duration - December 7, 1999-December 14, 1999

Sample Point	Elevation (ft amsl)	Depth Below Surface (ft)	Depth Below Water Table (@ 516.08 feet amsl)	Total Uranium Concentration (µg/L)
1	515.08	61.4	1	31
2	506.08	70.4	10	6.0
3	496.08	80.4	20	5.8
4	496.08	80.4	20D	7.2
5	486.08	90.4	30	0.9
6	476.08	100.4	40	0.7
7	466.08	110.4	50	0.5

TABLE C-6

GEOPROBE 12619
WASTE STORAGE AREA

Easting '83 = 1346549.31
Northing '83 = 479572.76
Reference Elevation = 555.49 feet amsl
Depth to Water Table = 37.0 feet
Work Duration - December 15, 1999-December 21, 1999

Sample Point	Elevation (ft amsl)	Depth Below Surface (ft)	Depth Below Water Table (@ 518.49 feet amsl)	Total Uranium Concentration (µg/L)
1	517.49	38.0	1	16
2	508.49	47.0	10	13
3	498.49	57.0	20	12
4	498.49	57.0	20D	12
5	488.49	67.0	30	5.4
6	478.49	77.0	40	11
7	468.49	87.0	50	13
8	458.49	97.0	60	7.3
9	448.49	107.0	70	2.5

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TABLE C-7

GEOPROBE 12684
WASTE STORAGE AREA

Easting '83 = 1347143.84
Northing '83 = 480922.99
Reference Elevation = 576.67 feet amsl
Depth to Water Table = 61.0 feet
Work Duration - January 19, 2000-January 31, 2000

Sample Point	Elevation (ft amsl)	Depth Below Surface (ft)	Depth Below Water Table (@ feet 515.67 amsl)	Total Uranium Concentration (µg/L)
1	514.67	62.0	1	8.0
2	505.67	71.0	10	7.2
3	495.67	81.0	20	7.6
4	495.67	81.0	20D	7.7
5	485.67	91.0	30	1.2
6	475.67	101.0	40	1.4
7	465.67	111.0	50	1.7

TABLE C-8

GEOPROBE 12686
WASTE STORAGE AREA

Easting '83 = 1347700
Northing '83 = 480655
Reference Elevation = 576.00 feet amsl
Depth to Water Table = 55.0 feet
Work Duration - February 16, 2000-February 24, 2000

Sample Point	Elevation (ft amsl)	Depth Below Surface (ft)	Depth Below Water Table (@ feet 521.00 amsl)	Total Uranium Concentration (µg/L)
1	501.70	74.3	20	4.4
2	501.70	74.3	20D	4.2
3	491.00	85.0	30	1.0
4	481.00	95.0	40	1.9
5	471.00	105.0	50	0.8

Note: A water sample was not collected at the water table and at a depth of ten feet below the water table due to the presence of silt.

TABLE C-9

GEOPROBE 12707
WASTE STORAGE AREA

Easting '83 = 1346826.44
Northing '83 = 479978.25
Reference Elevation = 555.35 feet amsl
Depth to Water Table = 37.0 feet
Work Duration - February 8, 2000-February 15, 2000

Sample Point	Elevation (ft amsl)	Depth Below Surface (ft)	Depth Below Water Table (@ feet 518.35 amsl)	Total Uranium Concentration (µg/L)
1	517.35	38.0	1	265
2	508.35	47.0	10	319
3	498.35	57.0	20	13
4	498.35	57.0	20D	14
5	488.35	67.0	30	15
6	478.35	77.0	40	24
7	468.35	87.0	50	23
8	458.35	97.0	60	*
9	448.35	107.0	70	1.5
10	438.35	117.0	80	3.2

* No sample was collected at a depth of 60 feet below the water table due to the presence of silt.

TABLE C-10

GEOPROBE 12708
WASTE STORAGE AREA

Easting '83 = 1347228.79
Northing '83 = 479929.42
Reference Elevation = 572.72 feet amsl
Depth to Water Table = 53.7 feet
Work Duration - February 28, 2000-March 2, 2000

Sample Point	Elevation (ft amsl)	Depth Below Surface (ft)	Depth Below Water Table (@ feet 519.02 amsl)	Total Uranium Concentration (µg/L)
1	518.02	54.7	1	183
2	509.02	63.7	10	566
3	499.02	73.7	20	106
4	499.02	73.7	20D	106
5	489.02	83.7	30	81
6	479.02	93.7	40	10

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TABLE C-11

GEOPROBE 12709
WASTE STORAGE AREA

Easting '83 = 1348970.15
Northing '83 = 482536.48
Reference Elevation = 590.43 feet amsl
Depth to Water Table = 77.3 feet
Work Duration - March 12, 2000-March 15, 2000

Sample Point	Elevation (ft amsl)	Depth Below Surface (ft)	Depth Below Water Table (@ feet 513.13 amsl)	Total Uranium Concentration (µg/L)
1	511.13	79.3	2	1.4
2	503.13	87.3	10	0.9
3	493.13	97.3	20	0.4
4	493.13	97.3	20D	0.3
5	483.13	107.3	30	0.4
6	475.13	115.3	38	0.3

TABLE C-12

GEOPROBE 12710
WASTE STORAGE AREA

Easting '83 = 1347700.68
Northing '83 = 479907.90
Reference Elevation = 574.22 feet amsl
Depth to Water Table = 55.9 feet
Work Duration - March 9, 2000-March 13, 2000

Sample Point	Elevation (ft amsl)	Depth Below Surface (ft)	Depth Below Water Table (@ feet 518.32 amsl)	Total Uranium Concentration (µg/L)
1	516.32	57.9	2	11
2	508.32	65.9	10	116
3	498.32	75.9	20	95
4	498.32	75.9	20D	93
5	488.32	85.9	30	32
6	480.32	93.9	38	14

TABLE C-13

GEOPROBE 12711
WASTE STORAGE AREA

Easting '83 = 1348048
Northing '83 = 479854.48
Reference Elevation = 573.74 feet amsl
Depth to Water Table = 56.7 feet
Work Duration - March 9, 2000-March 13, 2000

Sample Point	Elevation (ft amsl)	Depth Below Surface (ft)	Depth Below Water Table (@ feet 517.04 amsl)	Total Uranium Concentration (µg/L)
1	515.04	58.7	2	4.7
2	507.04	66.7	10	121
3	497.04	76.7	20	87
4	497.04	76.7	20D	88
5	487.04	86.7	30	55
6	477.04	96.7	40	3.7
7	467.04	106.7	50	2.5
8	457.04	116.7	60	1.3

TABLE C-14

GEOPROBE 12712
WASTE STORAGE AREA

Easting '83 = 1347188.23
Northing '83 = 479651.98
Reference Elevation = 571.76 feet amsl
Depth to Water Table = 50 feet
Work Duration - April 6, 2000-April 12, 2000

Sample Point	Elevation (ft amsl)	Depth Below Surface (ft)	Depth Below Water Table (@ 521.76 feet amsl)	Total Uranium Concentration (µg/L)
1	516.76	55	5	1.1
2	511.76	60	10	8.0
3	501.76	70	20	9.1
4	491.76	80	30	9.9
5	481.76	90	40	1.7

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TABLE C-15

GEOPROBE 12713
WASTE STORAGE AREA

Easting '83 = 1347469.99
Northing '83 = 480205.10
Reference Elevation = 575.14 feet amsl
Depth to Water Table = 56.9 feet
Work Duration - March 13, 2000-March 16, 2000

Sample Point	Elevation (ft amsl)	Depth Below Surface (ft)	Depth Below Water Table (@ feet 518.24 amsl)	**Total Uranium Concentration** (µg/L)
1	516.24	58.9	2	0.7
2	508.24	66.9	10	0.8
3	498.24	76.9	20	2.9
4	498.24	76.9	20D	3.1
5	488.24	86.9	30	0.5
6	478.24	96.9	40	0.4
7	468.24	106.9	50	2.7
8	459.24	115.9	59	1.0

TABLE C-16

GEOPROBE 12714
WASTE STORAGE AREA

Easting '83 = 1347251.37
Northing '83 = 481945.26
Reference Elevation = 582.68 feet amsl
Depth to Water Table = 73.0 feet
Work Duration - March 15, 2000-March 23, 2000

Sample Point	Elevation (ft amsl)	Depth Below Surface (ft)	Depth Below Water Table (@ feet 509.68 amsl)	Total Uranium Concentration (µg/L)
1	508.68	74.0	1	0.4
2	499.68	83.0	10	0.9
3	489.68	93.0	20	0.7
4	489.68	93.0	20D	0.7
5	479.68	103.0	30	1.0
6	469.68	113.0	40	0.5
7	459.68	123.0	50	0.4
8	449.68	133.0	60	0.4

TABLE C-17

GEOPROBE 12715
WASTE STORAGE AREA

Easting '83 = 1348375.99
Northing '83 = 479899.17
Reference Elevation = 577.93 feet amsl
Depth to Water Table = 62.0 feet
Work Duration - March 22, 2000-March 27, 2000

Sample Point	Elevation (ft amsl)	Depth Below Surface (ft)	Depth Below Water Table (@ feet 515.93 amsl)	Total Uranium Concentration (µg/L)
1	505.93	72.0	10	30
2	495.93	82.0	20	82
3	495.93	82.0	20D	80
4	485.93	92.0	30	81
5	475.93	102.0	40	4.5
6	465.93	112.0	50	2.0
7	455.93	122.0	60	1.6
8	445.93	132.0	70	0.9

Note: A sample was not collected at the water table due to the presence of silt.

TABLE C-18

GEOPROBE 12716
WASTE STORAGE AREA

Easting '83 = 1347820.94
Northing '83 = 479494.85
Reference Elevation = 576.29 feet amsl
Depth to Water Table = 62.5 feet
Work Duration - March 27, 2000-March 29, 2000

Sample Point	Elevation (ft amsl)	Depth Below Surface (ft)	Depth Below Water Table (@ feet 513.79 amsl)	Total Uranium Concentration (µg/L)
1	508.79	67.5	5	0.6
2	503.79	72.5	10	0.6
3	493.79	82.5	20	0.5
4	493.79	82.5	20D	0.5
5	483.79	92.5	30	1.5
6	473.79	102.5	40	0.8

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TABLE C-19

GEOPROBE 12717
WASTE STORAGE AREA

Easting '83 = 1348139.79
Northing '83 = 480201.47
Reference Elevation = 576.65 feet amsl
Depth to Water Table = 59 feet
Work Duration - April 18, 2000-April 24, 2000

Sample Point	Elevation (ft amsl)	Depth Below Surface (ft)	Depth Below Water Table (@ 517.65 feet amsl)	Total Uranium Concentration (µg/L)
1	512.65	64	5	46
2	507.65	69	10	9.0
3	497.65	79	20	4.3
4	497.65	79	20D	4.3
5	487.65	89	30	1.7
6	477.65	99	40	1.3

TABLE C-20

GEOPROBE 12718
WASTE STORAGE AREA

Easting '83 = 1348752.07
Northing '83 = 479679.09
Reference Elevation = 578.04 feet amsl
Depth to Water Table = 61.5 feet
Work Duration - March 28, 2000-March 30, 2000

Sample Point	Elevation (ft amsl)	Depth Below Surface (ft)	Depth Below Water Table (@ feet 516.54 amsl)	Total Uranium Concentration (µg/L)
1	511.54	66.5	5	2.8
2	506.54	71.5	10	4.0
3	496.54	81.5	20	3.6
4	496.54	81.5	20D	3.9
5	486.54	91.5	30	5.1
6	476.54	101.5	40	2.9
7	466.54	111.5	50	1.8

TABLE C-21

GEOPROBE 12719
WASTE STORAGE AREA

Easting '83 = 1348408.53
Northing '83 = 481478.18
Reference Elevation = 586.06 feet amsl
Depth to Water Table = 70 feet
Work Duration - March 29, 2000-April 3, 2000

Sample Point	Elevation (ft amsl)	Depth Below Surface (ft)	Depth Below Water Table (@ feet 516.06 amsl)	Total Uranium Concentration (µg/L)
1	511.06	75.0	5	1.5
2	506.06	80.0	10	5.4
3	496.06	90.0	20	1.8
4	496.06	90.0	20D	1.4
5	486.06	100.0	30	1.6
6	476.06	110.0	40	0.5
7	466.06	120.0	50	0.3

TABLE C-22

GEOPROBE 12720
WASTE STORAGE AREA

Easting '83 = 1348375.30
Northing '83 = 479461.66
Reference Elevation = 574.78 feet amsl
Depth to Water Table = 56.6 feet
Work Duration - April 3, 2000-April 6, 2000

Sample Point	Elevation (ft amsl)	Depth Below Surface (ft)	Depth Below Water Table (@ 518.18 feet amsl)	Total Uranium Concentration (µg/L)
1	513.18	61.6	5	NS
2	508.18	66.6	10	1.4
3	498.18	76.6	20	2.2
4	498.18	76.6	20D	2.5
5	488.18	86.6	30	5.5
6	478.18	96.6	40	0.8
7	468.18	106.6	50	≈0.5

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TABLE C-23

GEOPROBE 12721
WASTE STORAGE AREA

Easting '83 = 13483762.64
Northing '83 = 479985.72
Reference Elevation = 578.61 feet amsl
Depth to Water Table = 60 feet
Work Duration - April 6, 2000-April 10, 2000

Sample Point	Elevation (ft amsl)	Depth Below Surface (ft)	Depth Below Water Table (@ feet 518.61 amsl)	Total Uranium Concentration (µg/L)
1	513.61	65	5	15
2	508.61	70	10	101
3	498.61	80	20	95
4	498.61	80	20D	97
5	488.61	90	30	26
6	478.61	100	40	17
7	468.61	110	50	12
8	458.61	120	60	10
9	448.61	130	70	6.7

TABLE C-24

GEOPROBE 12722
WASTE STORAGE AREA

Easting '83 = 1346486.51
Northing '83 = 479902.81
Reference Elevation = 551.87 feet amsl
Depth to Water Table = 28.5 feet
Work Duration - April 25, 2000-April 27, 2000

Sample Point	Elevation (ft amsl)	Depth Below Surface (ft)	Depth Below Water Table (@ 523.37 feet amsl)	Total Uranium Concentration (µg/L)
1	518.37	33.5	5	4.8
2	513.37	38.5	10	12
3	503.37	48.5	20	8.4
4	503.37	48.5	20 D	8.3
5	493.37	58.5	30	11
6	483.27	68.5	40	*
7	473.37	78.5	50	19
8	463.37	88.5	60	3.2

* No sample was collected at a depth of forty feet below the water table due to the presence of silt.

TABLE C-25

GEOPROBE 12723
WASTE STORAGE AREA

Easting '83 = 1349265.10
Northing '83 = 480079.65
Reference Elevation = 579.11 feet amsl
Depth to Water Table = 63 feet
Work Duration - April 13, 2000-April 17, 2000

Sample Point	Elevation (ft amsl)	Depth Below Surface (ft)	Depth Below Water Table (@ 516.11 feet amsl)	Total Uranium Concentration (µg/L)
1	511.11	68	5	1.3
2	506.11	73	10	0.9
3	496.11	83	20	1.2
4	496.11	83	20 D	1.2
5	486.11	93	30	1.0
6	476.11	103	40	0.9
7	466.11	113	50	0.8
8	456.11	123	60	0.5

TABLE C-26

GEOPROBE 12724
WASTE STORAGE AREA

Easting '83 = 1348750.03
Northing '83 = 480362.18
Reference Elevation = 579.69 feet amsl
Depth to Water Table = 63 feet
Work Duration - April 25, 2000-April 27, 2000

Sample Point	Elevation (ft amsl)	Depth Below Surface (ft)	Depth Below Water Table (@ 516.69 feet amsl)	Total Uranium Concentration (µg/L)
1	511.69	68	5	18
2	506.69	73	10	22
3	496.69	83	20	3.7
4	496.69	83	20 D	3.9
5	486.69	93	30	3.6
6	476.69	103	40	4.4
7	466.69	113	50	2.4
8	456.69	123	60	1.6

TABLE C-27

GEOPROBE 12725
WASTE STORAGE AREA

Easting '83 = 1348148.23
Northing '83 = 480390.06
Reference Elevation = 577.5 feet amsl
Depth to Water Table = 58.5 feet
Work Duration - May 2, 2000-May 4, 2000

Sample Point	Elevation (ft amsl)	Depth Below Surface (ft)	Depth Below Water Table (@ 519 feet amsl)	Total Uranium Concentration (µg/L)
1	514	63.5	5	3.3
2	509	68.5	10	0.8
3	489	78.5	20	0.5
4	489	78.5	20 D	0.5
5	479	88.5	30	0.4
6	469	98.5	40	1.0
7	459	108.5	50	1.2
8	449	118.5	60	0.4

TABLE C-28

GEOPROBE 12857A
WASTE STORAGE AREA

Easting '83 = 1349280.33
Northing '83 = 480621.33
Reference Elevation = 578.5 feet amsl
Depth to Water Table = 65.0 feet bgs
Work Duration - December 6-December 12, 2001

Sample Point	Elevation (ft amsl)	Depth Below Surface (ft)	Depth Below Water Table (@ 513.8 feet amsl)	Total Uranium Concentration (µg/L)
1	510.5	68.0	3	7.1
2	503.5	75.0	10	3.6
3	493.5	85.0	20	1.7
4	493.5	85.0	20D	2.1
5	483.5	95.0	30	2.4
6	473.5	105.0	40	0.7
7	463.5	115.0	50	1.5
8	453.5	125.0	60	1.7

TABLE C-29

GEOPROBE 12858
WASTE STORAGE AREA

Easting '83 = 1349105.82
Northing '83 = 479765.54
Reference Elevation = 578.0 feet amsl
Depth to Water Table = 65.0 feet
Work Duration - December 9, 2000 - December 11, 2000

Sample Point	Elevation (ft amsl)	Depth Below Surface (ft)	Depth Below Water Table (@ 512.5 feet amsl)	Total Uranium Concentration (µg/L)
1	512.0	66.0	513.0	0.9
2	503.0	75.0	10	1.0
3	493.0	85.0	20	0.7
4	493.0	85.0	20D	0.7
5	483.0	95.0	30	0.9
6	473.0	105.0	40	0.9
7	463.0	115.0	50	0.7
8	463.0	125.0	60	0.6

TABLE C-30

GEOPROBE 12856
WASTE STORAGE AREA

Easting '83 = 1349276.49
Northing '83 = 480402.09
Reference Elevation = 578.8 feet amsl
Depth to Water Table = 65.0 feet bgs
Work Duration - December 12-December 18, 2000

Sample Point	Elevation (ft amsl)	Depth Below Surface (ft)	Depth Below Water Table (@ 513.8 feet amsl)	Total Uranium Concentration (µg/L)
1	510.8	68.0	3	3.6
2	503.8	75.0	10	3.4
3	493.8	85.0	20	2.9
4	493.8	85.0	20D	2.8
5	483.8	95.0	30	1.5
6	473.8	105.0	40	2.2
7	463.8	115.0	50	0.7
8	453.8	125.0	60	0.3

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TABLE C-31

GEOPROBE 12831
PLANT 6 AREA

Easting '83 = 1350740.12
Northing '83 = 480479.09
Reference Elevation = 584.5 feet amsl
Depth to Water Table = 74.0 feet
Work Duration - February 20-February 26, 2001

Sample Point	Elevation (ft amsl)	Depth Below Surface (ft)	Depth Below Water Table (@ 505.5 feet amsl)	Total Uranium Concentration (µg/L)
1	507.5	77.0	3	0.5
2	500.5	84.0	10	0.8
3	490.5	94.0	20	0.5
4	490.5	94.0	20D	0.5
5	480.5	104.0	30	0.6
6	NA	NA	40	NS
7	460.5	124.0	50	0.4
8	450.5	134.0	60	0.3

TABLE C-32

GEOPROBE 12651
PLANT 6 AREA

Easting '83 = 1350074.26
Northing '83 = 480063.67
Reference Elevation = 579.42 feet amsl
Depth to Water Table = 66.0 feet
Work Duration - January 5, 2000-January 6, 2000

Sample Point	Elevation (ft amsl)	Depth Below Surface (ft)	Depth Below Water Table (@ 513.42 feet amsl)	Total Uranium Concentration (µg/L)
1	512.42	67.0	1	7.5
2	503.42	76.0	10	8.4
3	493.42	86.0	20	1.4
4	493.42	86.0	20D	1.5
5	483.42	96.0	30	2.3
6	473.42	106.0	40	1.0
7	463.42	116.0	50	0.4
8	453.42	126.0	60	0.4
9	443.42	136.0	70	0.3
10	433.42	146.0	80	0.3
11	423.42	156.0	90	0.4

TABLE C-33

GEOPROBE 12652
PLANT 6 AREA

Easting '83 = 1350392.32
Northing '83 = 479978.09
Reference Elevation = 579.54 feet amsl
Depth to Water Table = 66.0 feet
Work Duration - December 27, 1999-January 4, 2000

Sample Point	Elevation (ft amsl)	Depth Below Surface (ft)	Depth Below Water Table (@ 513.54 feet amsl)	Total Uranium Concentration (µg/L)
1	512.54	67.0	1	0.6
2	503.54	76.0	10	0.7
3	493.54	86.0	20	0.6
4	493.54	86.0	20D	0.6
5	483.54	96.0	30	0.7
6	473.54	106.0	40	0.4
7	463.54	116.0	50	0.3
8	453.54	126.0	60	0.5
9	443.54	136.0	70	0.4

TABLE C-34

GEOPROBE 12653
PLANT 6 AREA

Easting '83 = 1350322.73
Northing '83 = 480229.92
Reference Elevation = 579.40 feet amsl
Depth to Water Table = 66.0 feet
Work Duration - January 10, 2000-January 13, 2000

Sample Point	Elevation (ft amsl)	Depth Below Surface (ft)	Depth Below Water Table (@ 513.40 feet amsl)	Total Uranium Concentration (µg/L)
1	512.40	67.0	1	0.9
2	503.40	76.0	10	1.4
3	493.40	86.0	20	0.7
4	493.40	86.0	20D	0.6
5	483.40	96.0	30	0.7
6	473.40	106.0	40	0.4
7	463.40	116.0	50	0.6
8	453.40	126.0	60	0.3
9	443.40	136.0	70	0.3
10	433.40	146.0	80	0.5

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TABLE C-35

GEOPROBE 12859A
PLANT 6 AREA

Easting '83 = 1351631.18
Northing '83 = 480772.18
Reference Elevation = 596.5 feet amsl
Depth to Water Table = 84.0 feet bgs
Work Duration - November 21-November 29, 2000

Sample Point	Elevation (ft amsl)	Depth Below Surface (ft)	Depth Below Water Table (@ 512.5 feet amsl)	Total Uranium Concentration (µg/L)
1	509.5	87.0	3	0.4
2	502.5	94.0	10	0.5
3	492.5	104.0	20	0.2
4	492.5	104.0	20D	0.3
5	482.5	114.0	30	0.6
6	472.5	124.0	40	0.6
7	462.5	134.0	50	0.3

TABLE C-36

GEOPROBE 12829
PLANT 6 AREA

Easting '83 = 1350740.60
Northing '83 = 480053.23
Reference Elevation = 582.6 feet amsl
Depth to Water Table = 70.0 feet bgs
Work Duration - February 1-February 7, 2001

Sample Point	Elevation (ft amsl)	Depth Below Surface (ft)	Depth Below Water Table (@ 512.6 feet amsl)	Total Uranium Concentration (µg/L)
1	509.6	73.0	3	1.6
2	502.6	80.0	10	1.7
3	492.6	90.0	20	0.8
4	492.6	90.0	20D	0.5
5	482.6	100.0	30	0.8
6	472.6	110.0	40	0.3
7	462.6	120.0	50	0.5
8	452.6	130.0	60	0.4

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TABLE C-37

GEOPROBE 12830
PLANT 6 AREA

Easting '83 = 1350739.01
Northing '83 = 480271.52
Reference Elevation = 581.2 feet amsl
Depth to Water Table = 69.0 feet bgs
Work Duration - February 12-February 15, 2001

Sample Point	Elevation (ft amsl)	Depth Below Surface (ft)	Depth Below Water Table (@ 512.6 feet amsl)	Total Uranium Concentration (µg/L)
1	NA	NA	3	NS
2	502.2	79.0	10	5.0
3	492.2	89.0	20	1.4
4	492.2	89.0	20D	1.5
5	482.2	99.0	30	1.0
6	472.2	109.0	40	1.8
7	462.2	119.0	50	0.8
8	452.2	129.0	60	0.8

TABLE C-38

GEOPROBE 12832
PLANT 6 AREA

Easting '83 = 1350744.44
Northing '83 = 480746.66
Reference Elevation = 581.5 feet amsl
Depth to Water Table = 76.0 feet bgs
Work Duration - February 26-March 1, 2001

Sample Point	Elevation (ft amsl)	Depth Below Surface (ft)	Depth Below Water Table (@ 505.5 feet amsl)	Total Uranium Concentration (µg/L)
1	502.5	79.0	3	0.8
2	495.5	86.0	10	0.8
3	485.5	96.0	20	1.3
4	485.5	96.0	20D	1.3
5	475.5	1060	30	0.6
6	465.5	116.0	40	0.7
7	455.5	126.0	50	0.4
8	445.5	136.0	60	0.2