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Analysis and Summary Report of Historical Dry Well Gamma Logs for the 241-C Tank Farm – 200 West Area

R. Price
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ANALYSIS AND SUMMARY REPORT OF HISTORICAL DRY WELL GAMMA LOG FOR THE 241-C TANK FARM – 200 EAST

Data Analysis By:
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June 2001

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Title Page

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Analysis and Summary Report of Historical Dry Well Gamma Logs for the 241-C Tank Farm – 200 East Area

Summary Report

June 2001

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Randall Price

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Analysis and Summary Report of Historical Dry Well Gamma Logs for the 241-C Tank Farm – 200 East Area

1 Introduction

The single shell tank farm dry well surveillance program was established as one of several methods used to identify leaking tanks. Gross gamma logging in boreholes peripheral to and surrounding single-shell tanks was used to supplement in-tank liquid level measurements to determine the integrity of an individual tank. Until 1975, gross gamma ray data were collected in a non-digital format. In 1975, the surveillance program was updated to a digital logging system. Under the upgraded system, gross gamma ray logs were captured in digital form utilizing several types of logging detectors. These logs were then reviewed immediately after collection to identify significant changes in activity from previous logs. This examination was used to confirm or identify leaks of gamma-emitting liquid radionuclides from suspect underground tanks. The system was not intended to identify the specific radionuclides contributing to the total gross gamma ray activity; the data were used to make operational decisions regarding the integrity of tanks and their ability to safely contain high-level radioactive waste. While the system targeted gamma-emitting radionuclides as indicator species, other radionuclides (e.g., alpha- and beta emitters) and hazardous chemical constituents would also have leaked from the suspect tanks when gross gamma activity significantly increased.

Digital gross gamma ray logs were acquired for the period from January 1975 through mid-year 1999 and have been re-analyzed to determine contaminant distribution in the subsurface around boreholes during this interval. Data acquired prior to 1975 require reformatting to be useful for this analysis. The available data for each borehole varies; some begin in 1975, others as late as 1980. Data for some boreholes ends in 1989, while for others it continues until 1999. A detailed description of the analysis procedure is in "Analysis Techniques and Monitoring Results, 241-SX Dry Well Surveillance Logs," (Randall and Price, 1999a).

Isotopes identified during the spectral gamma logging analysis that occurred from 1995 to 1999 for all single-shell tank farms is integral to the analysis of the gross gamma ray data. Log data for C Tank Farm were obtained by Three Rivers Scientific from a report issued by the U.S. Dept. of Energy prepared by MACTEC-ERS (1998). The spectral gamma logging system (SGLS) employs a high-purity germanium (HPGe) detector to obtain data leading to the identification and depth of gamma-emitting radioactive isotopes. The identity of gamma-emitting radionuclides in soils surrounding a tank is required for interpretation of the tank farm gross gamma ray dry well surveillance logs. By integrating SGLS data with historical dry well surveillance data, information concerning the tank leak history along with the historical mobility and decay of man-made gamma-emitting radionuclides in the vadose zone is obtained. These analyses concern gamma-emitting contaminants and contaminant mobility (or lack of mobility) that has occurred over the time period spanned by the available data (i.e., 1975 to 1994).

This report provides a summary of the gross gamma ray data for the 241-C Tank Farm and is intended to identify changes in the gamma activity of gamma-emitting radionuclide contaminants around each accessible borehole, and is not intended to provide interpretation of the data relative to vadose zone mechanics. In general, the data analysis resulted in the identification of two types of subsurface conditions; clean dry wells and dry wells with radionuclide contamination at one or more depth intervals. Within dry wells with contaminated intervals (discrete depth zones) four

categories of contamination were identified (in general these categories are encountered in this type of historical analysis and are listed here for completeness, even though this tank farm may not experience a given category). Following this system, a borehole and/or a zone may be classified into one of several categories:

1. CLEAN: no gamma-emitting contaminants detected for the survey speeds and sensitivities of the gross gamma ray probes used; specifically no systematic trend above the naturally occurring radionuclide background in the soils is indicated by the data. Note that in several boreholes designated "clean", the SGLS detected gamma-emitting contaminants, but at levels below the detection threshold for the gross gamma tool. Where the SGLS detected a gamma-emitting isotope with an activity of less than 5 pCi/g, activity generally will not be seen on the gross gamma probes used in tank farm logging for which the detection limit is generally about 5 pCi/g.

2. CONTAMINATED

   - STABLE: gamma activity follows a decay curve of an isotope identified by HPGe or a hypothesized radionuclide based on decay characteristics; specifically the decay rate of the isotope(s) identified in the zone matches the change over time in the gross gamma log response, and no noticeable deviation from the radionuclide decay is apparent within the time period of the data.

   - UNSTABLE: evidence of contaminant migration exists within the period of data collection; specifically, in logs with proper depth control, a peak migrates with passage of time, or there is a sudden increase in Grade Thickness Product (GTP) that does not correlate with any change of logging tools or procedure. Such changes are interpreted to reflect the addition of a gamma-emitting contaminant.

     Some contamination zones were identified as initially unstable in older logs and as stable in more recent logs; i.e., instability in earlier data was succeeded by stability in more recent data.

- TANK FARM ACTIVITY: erratic log response at the bottom of dry wells or at shallow depths result from logging procedure changes, radioactive waste transfer operations, surface or near surface leaks/spills, and/or clean up of surface contamination; specifically, an irregular change is observed in gross gamma-ray log values between successive surveys at or near the surface and/or at the bottom of the dry well. These rapid and inconsistent log changes suggest that contamination may be the result of tank farm operational activities (e.g., waste transfers) or logging procedure changes, and are not related to vadose zone mechanics.

- UNDETERMINED: no specific conclusion can be reached with the available data; specifically, stability cannot be determined due to: 1) insufficient data, 2) exceeding the system design criteria (both upper and lower limits) for recording gross gamma ray data, or 3) possible effects of depth shift or surface activities.

Stable vs. unstable is an apparent condition limited by the time interval over which data were collected, the sensitivity of the tools, and the level of contamination; it is not necessarily a statement concerning the fixed or mobile nature of a given isotope in the vadose zone.

Radionuclide isotopes discussed are either identified using the HPGe data or are hypothesized to exist presently or to have existed in the past. Radionuclides cannot be identified from a gross gamma ray log alone. The hypothesized isotopes assumed or known to be present generally have a rapid rate of decay (e.g., Ru-106) which may not be identified by the HPGe tool if the level of radioactivity falls below detection limits at the time the SGLS data were obtained (mid 1990's). The

earlier presence of such isotopes can be speculated based on the fit of a decay curve of the isotope to the change over time of the gross gamma ray data and knowing that such an isotope was initially present in the leaked waste. Ru-106 was hypothesized in several C Tank Farm zones.

It is beyond the scope of this project to identify the contaminant source, rate of movement, or migration pathway and the ultimate impact of leaked waste to the environment. It is also noted that where boreholes do not exist, gamma-emitting isotopes may be present and movement can and may have occurred without detection. This investigation is limited to the immediate area (approximately 20 inch radius) around each borehole from which gamma rays are readily detected, and is not rigorous enough to interpret the condition of the space between boreholes and outside of the investigated area. Contaminants which do not emit gamma rays or whose decay products do not emit gamma rays, are not detected by gross or spectral gamma logging and are therefore not discussed in this report. While such isotopes may be present, they are beyond the scope of this report.

1.1 Background

A series of twelve tanks were constructed at the 241-C Tank in 1943 and 1944 to receive high-level, liquid, mixed waste resulting from chemical processing of spent fuel rods (Brevick, et. al., 1996). These second-generation Hanford tanks hold 530,000 gallons (each), were constructed on 100-foot centers and are 75 feet in diameter, leaving 25 feet between the sides of each tank. The peak of the dome of each tank is about 8 feet below ground surface; the base of each tank is about 40 feet below ground surface. Each tank consists of a reinforced concrete exterior with a single lining of carbon steel. These tanks are connected in four three-tank cascade and transfer lines, the details of which can be obtained from the engineering construction diagrams for this tank farm. A network of vadose monitoring boreholes (dry wells) was installed throughout the C Tank Farm as part of a leak detection and surveillance system. Borehole locations (centered on the borehole name) and the depth of logging, (listed below borehole name) are presented in Figure 1. The boreholes range in depth from 50 to 145 feet, with 57 (of 70) being 100 or more feet deep. The 1975 to 1995 digital gross gamma ray data were analyzed by Three Rivers Scientific (under subcontract to Duratek Federal Services, Richland, Washington) and the results are the subject of this report.

Tanks C-101, C-110 and C-111 in the C Farm are suspected to have leaked. The category of "suspected leaker" addresses leaks from tanks only, and not from any of the associated facilities (e.g., piping, diversion boxes or pits) which may have also released waste to the soils.

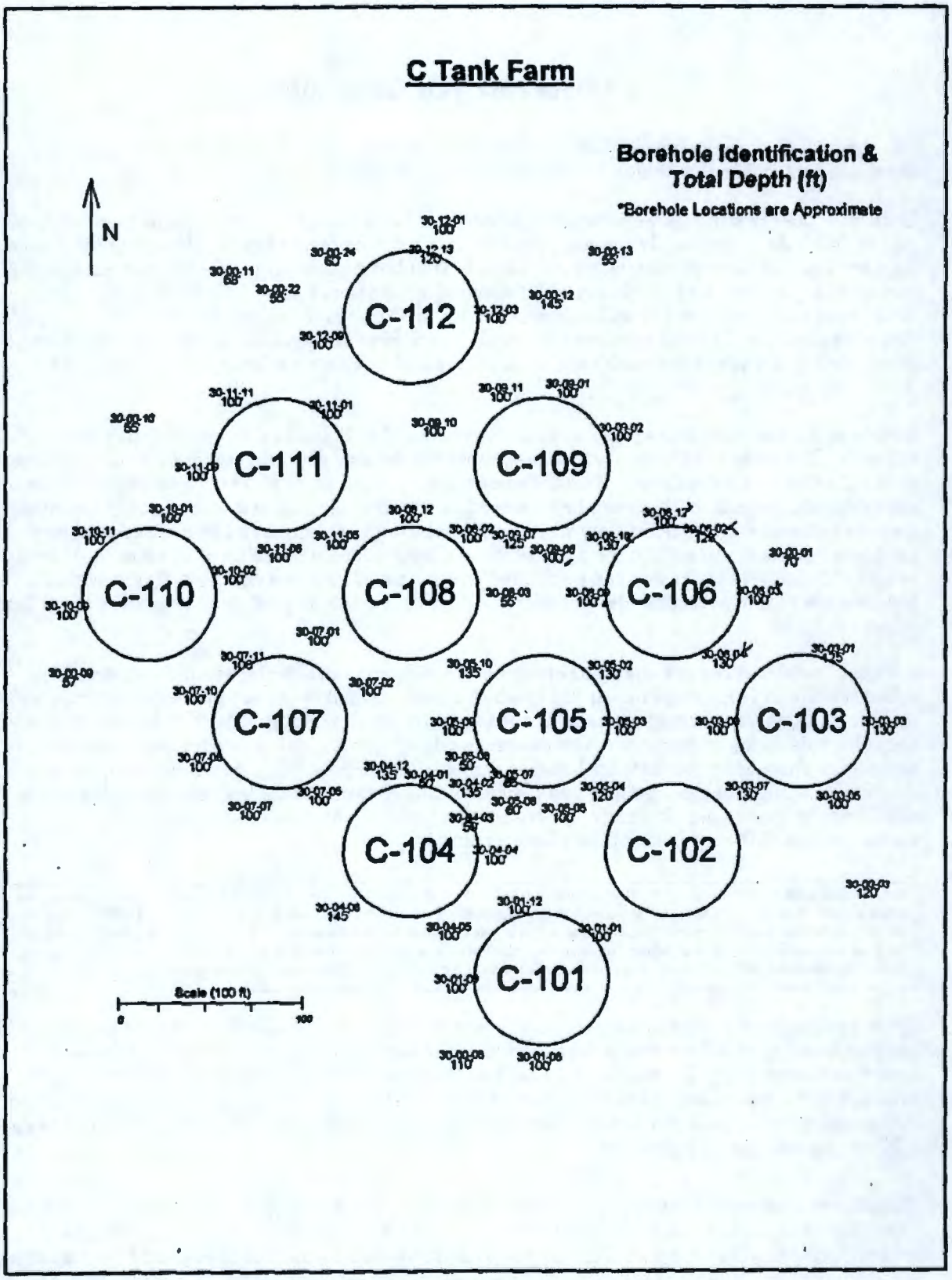

Figure 1. C Tank Farm Borehole Locations and Total Depth

1.2 Data Analysis Description

The dry well data analysis procedure used for the C Tank Farm gross gamma historical logs is discussed in detail in the Analysis Techniques report (Randall and Price, 1999a).

Data from the dry well logs were compiled to maximize trend identification. This process does not add or delete data, but merely compiles the data into a more useable format. This data set is used to create a depth vs. time plot (stack plot) to identify trends over time and zones of contamination. All historical log surveys for a single dry well (borehole) are analyzed as a whole for each radioactive zone above background in the well, allowing statements to be made about the apparent condition or rate of change of any given radioactive interval. For clarity, all logs are not plotted in the stack plot; quarterly logs are plotted to render the stack plot readable without affecting the integrity of the data.

Review of the historical gross gamma ray data revealed that limits in the system design for collecting data prior to 1986 created a situation where the zero-depth reference point for the start of data collection was inconsistent. This difference in zero-depth point makes evaluating trends in the data difficult. Several methods can be employed to overcome varying zero points and to essentially create a common starting point from which to view the data, making trend identification easier. One method applies a depth shift to the data, which is simply adjusting data up or down so that certain identifiable features in the logs can be aligned and evaluated. Since a depth shifting may mask possible downward movement identification, no depth shifting was performed to analyze the C Tank Farm.

A second method to analyze changes between successive gross gamma logs utilizes a calculation called the Grade Thickness Product (GTP) which can be applied over a depth interval wide enough to include all depth variances of peaks so as not to require depth shifting. The GTP is a summation of the values of logging instrument readings over the depth interval of interest (minus background activity), multiplied by the distance between sample point depths. This calculation yields a constant that is independent of the log depth and the specifically chosen starting/ending points. When the calculation is applied over the entire contamination interval, the result is a more accurate representation of the condition of the zone over time.

Note: Gross gamma ray data were collected using a variety of probe types. The count rates generated by these probe types do not directly correlate, as discussed in the Analysis Techniques report (Randall and Price, 1999a). Caution must therefore be used when relating GTP values in zones recorded with different probe types (e.g., the NaI probe type 04 does not record values that relate to those recorded with the Green or Red GM probe types 01 and 02). Scaling factors between the different probe types are presented in "Dry Well Probe Calibrations" (Randall, 1999).

Gross gamma ray log surveys were recorded over the length of the borehole at sampling intervals of one foot, starting at the maximum depth to which the logging detector was positioned (near or at the bottom of the dry well). In radioactive zones less than one foot thick, successive one foot sample intervals will cause variations in the apparent shape of the log in the thin contamination zone and changes in the maximum count rate in the apparent center of the zone. The GTP calculation is used to eliminate this apparent problem.

The average background activity for the GTP calculation and "Average Background" plots, which are provided, is the gamma radiation from naturally occurring potassium, uranium, and thorium (i.e. natural background) in the soil. The average background is computed and reviewed for each survey

and thus provide a level of confidence that the instrumentation worked consistently and that the gross gamma ray data are valid. The average background is calculated either between a lower and upper count rate limit or for a depth range. The lower count rate limit is generally set at zero (0) c/s; a value defined as indicating a data gap. The upper count rate limit is generally set at 50 c/s for the NaI probe (i.e., type 04 probe), a conservative value near what is considered background activity. For comparison, the original leak detection program responsible for collecting the log data considered a count rate equal to or exceeding 200 c/s a reportable occurrence for the probe type 04 (NaI).

The percentage of data values for each survey that are considered as representing the natural background (i.e. non-contaminated interval) is also calculated and presented on the summary plots as "Frequency Clean".

Zones of gamma-emitting contamination are examined for historical character using the GTP calculation. The average background activity is subtracted from peak values so that only the contaminated levels above background are included in the analysis. A graph is generated with GTP plotted against time for each depth interval analyzed. One or more decay lines are then superimposed on the graph based on isotopes identified by the SGLS data, knowledge of tank constituents, and the known presence of isotopes in other boreholes. Sometimes decay lines can be fit through the data a number of ways with none of them fitting perfectly. When two or more isotopes are identified, a least squares fit analysis for a multi-component decay is performed. A detailed discussion of how two or more curves are combined is provided in the Appendix to the "Analysis of Historical Gross Gamma Logging Data from BX Tank Farm" (Randall & Price, 1999b). The least squares fit may include hypothesized isotopes. Hypothesized isotopes are gamma-emitting radionuclides that may have been present when the gross gamma logs were recorded. These isotopes are known to exist in the inventory of the tank farm, or are identified in nearby wells, and may not be identified by the SGLS because they were at or below detection levels for the HPGe when these logs were recorded. The decay rates for each of the components are held fixed in the fitting process and the relative intensities of the components are calculated and reported in the data analysis when appropriate. The relative contribution of gross gamma rays from one component to another depends on the nature of the isotopes and the detector design.

Note: Spurious data were generated during normal data collecting activities. Spurious zero values are called data gaps and are considered as unrealistically low natural background activity when recorded with the sodium-iodide probes. Between 1975 and 1982, the equipment would occasionally record a spurious data value of minus one (-1) or zero (0). A value of minus one represents an invalid count rate. Data gaps occur at various locations in the surveys, including in the background or in the middle of a high contamination zone within a borehole. Data gaps are not included in the calculation of average background, grade thickness product, or frequency clean values.

Comparing the GTP data and the decay line(s) reveals information about the rate of change of contamination within a zone over the period that data were collected. When appropriate, multiple plots are generated to show the results for different zones within a borehole. The details for the use of GTP data are described in the Analysis Techniques Report (Randall and Price, 1999a).

The objective of the analysis is to assure that a consistent and thorough examination of dry well surveillance logs is performed and to determine if contamination abruptly entered the region of the borehole and quickly migrated out. All digital surveys within the time interval analyzed are examined to minimize undetected problems or conditions. Table 1 contains a list of the dry wells located in the C Tank Farm as well as information concerning the identity, level, and depth of contamination.

The data available for this analysis are limited. Some of the limitations are the:

- Inability to identify when down-hole contamination is a result of vadose zone transport or drag down during casing installation

- Insufficient gross gamma ray data to establish a statistical trend or rigorous statistical analysis
- Lack of HPGe data or lack of reported analysis of HPGe data
- The time interval over which data are available in not sufficiently long
- Insufficient borehole depth
- Inability to identify isotopes that have decayed to levels below the detection limits of the SGLS HPGe detector.
- Inability to fit single or combined decay curves to zones where no gamma-emitting isotopes are detected by the SGLS

Table 1. C Tank Farm Borehole Analysis Results Summary

Borehole Number	Survey Depth (feet)	Number Of Surveys	Probe Type	Category	Zone Depth (feet)	Max GTP (ft x c/s)	Year Max	Isotopes Present
30-00-01	70'	208	4	TF Activity	0-5	300	1984	^{137}Cs
				Undetermined	58-70	100	1981	^{137}Cs
30-00-03	120'	194	4	TF Activity	0-7	1300	1975	^{137}Cs
30-00-06	110'	163	4	Clean				
30-00-09	57'	350	4	Clean				
30-00-10	53'	164	4	Clean				
30-00-11	58'	168	4	Undetermined	3-14	1000	1977	^{137}Cs
30-00-12	145'	162	4	Clean				
30-00-13	55'	166	4	Clean				
30-00-22	55'	180	4	Undetermined	0-13	15K	1977	^{137}Cs
30-00-24	60'	175	4	Stable	14-24	800	1977	^{106}Ru
				Stable	24-40	700	1977	^{106}Ru
30-01-01	100'	481	4	Stable	30-53	1200	1975	^{60}Co-^{106}Ru
30-01-06	100'	311	4	Unstable Early	30-41	250	1980	^{137}Cs
				Stable	71-83	600	1975	^{106}Ru
				Stable	83-95	220	1975	^{106}Ru
30-01-09	100'	317	4	Stable	20-33	40K	1975	^{137}Cs
				Stable	33-60	14K	1975	^{137}Cs-^{106}Ru
30-01-12	100'	344	4	TF Activity	0-10	4500	1975	^{137}Cs
				Stable	10-18	100	1975	^{137}Cs
30-03-01	125'	681	4	TF Activity	0-30	12K	1975	^{137}Cs
				Undetermined	40-70	600	1976	^{137}Cs
				Unstable	90-125	300	1984	^{60}Co
30-03-03	130'	550	4	TF Activity	0-14	4K	1975	^{137}Cs
				Undetermined	14-40	2800	1975	^{137}Cs
				Unstable Early	78-100	1500	1975	^{60}Co-^{106}Ru
30-03-05	100'	515	4	TF Activity	0-20	600	1984	^{137}Cs

Borehole Number	Survey Depth (feet)	Number Of Surveys	[a]Probe Type	[b]Category	Zone Depth (feet)	Max GTP (ft x c/s)	Year Max	[c]Isotopes Present
30-03-07	130'	499	4	TF Activity	0-12	2000	1980	^{137}Cs
				Stable	42-54	170	1975	^{137}Cs
30-03-09	100'	553	4	TF Activity	0-12	8K	1980	^{137}Cs
				Stable	40-52	150	1975	^{137}Cs
				Unstable	73-94	500	1988	^{60}Co
30-04-01	50'	440	4	TF Activity	0-8	3K	1975	^{137}Cs
				Undetermined	8-22	400	1975	^{137}Cs
30-04-02	135'	335	4	TF Activity	0-12	2000	1975	^{137}Cs
				Unstable Early	32-60	3K	1975	^{60}Co
30-04-03	50'	195	4	TF Activity	0-15	600	1985	^{137}Cs
				Stable	16-30	70K	1983	^{137}Cs
				Unstable	30-48	8K	1981	^{60}Co
30-04-04	100'	425	4	TF Activity	0-8	50K	1978	^{137}Cs
				TF Activity	8-25	1800	1975	^{137}Cs
30-04-05	100'	416	4	TF Activity	0-20	9K	1978	^{137}Cs
30-04-08	145'	406	4	TF Activity	0-5	150	1975	^{137}Cs
				Stable	10-26	1000	1975	^{137}Cs
				Stable	26-38	150	1975	^{137}Cs
				Stable	38-50	120	1975	^{137}Cs
30-04-12	135'	414	4	Clean				
30-05-02	130'	569	4	TF Activity	0-14	5K	1975	^{137}Cs
				Undetermined	14-26	600	1975	^{137}Cs
				Unstable Early	68-84	250	1976	^{137}Cs, ^{60}Co
30-05-03	100'	589	4	TF Activity	0-39	9K	1985	^{137}Cs
				Unstable	67-80	400	1975	^{60}Co
30-05-04	120'	556	4	TF Activity	0-8	900	1975	^{137}Cs
30-05-05	100'	526	4	TF Activity	0-25	12K	1975	^{137}Cs
				Unstable	40-56	550	1976	^{137}Cs
				Undetermined	56-84	1800	1975	^{137}Cs, ^{60}Co
30-05-06	60'	537	4	TF Activity	0-15	1100	1975	^{137}Cs
				Stable	40-53	400	1975	^{137}Cs, ^{106}Ru
30-05-07	67'	319	2	Stable	30-45	20K	1983	^{137}Cs
				Undetermined	45-66	400	1981	^{137}Cs
30-05-08	50'	594	4	TF Activity	0-11	4K	1975	^{137}Cs
				Undetermined	11-26	13K	1975	^{137}Cs, ^{60}Co, ^{154}Eu
				Undetermined	26-53	13K	1975	^{137}Cs, ^{60}Co
30-05-09	100'	513	4	TF Activity	0-8	300	1985	^{137}Cs
30-05-10	135'	513	4	TF Activity	0-17	300	1985	^{137}Cs
				Unstable Early	17-35	500	1976	^{137}Cs, ^{60}Co, ^{106}Ru
30-06-02	123'	631	4	TF Activity	0-16	500	1984	^{137}Cs
30-06-03	100'	666	4	TF Activity	0-10	800	1975	^{137}Cs

Borehole Number	Survey Depth (feet)	Number Of Surveys	[a]Probe Type	[b]Category	Zone Depth (feet)	Max GTP (ft x c/s)	Year Max	[c]Isotopes Present
30-06-04	130'	657	4	TF Activity	0-16	2000	1984	^{137}Cs
				Stable	16-32	600	1975	^{137}Cs
30-06-09	100'	657	4	TF Activity	0-16	900	1985	^{137}Cs
30-06-10	130'	657	4	TF Activity	0-10	800	1984	^{137}Cs
				Unstable	86-115	300	1989	^{60}Co
30-06-12	100'	802	4	TF Activity	0-14	1500	1985	^{137}Cs
				Unstable Early	14-26	300	1979	^{137}Cs, ^{60}Co
30-07-01	100'	380	4	Stable	0-14	120	1975	^{137}Cs
30-07-02	100'	385	4	Clean				
30-07-05	100'	398	4	TF Activity	0-8	300	1975	^{137}Cs
30-07-07	100'	390	4	Clean				
30-07-08	100'	387	4	Clean				
30-07-10	100'	390	4	Clean				
30-07-11	100'	403	4	TF Activity	0-10	80K	1993	^{137}Cs
30-08-02	100'	68	4	TF Activity	0-6	4K	1985	^{137}Cs
				TF Activity	13-28	55K	1980	^{137}Cs
				Unstable	46-55	1500	1980	^{60}Co
				Unstable	55-84	12K	1980	^{60}Co
30-08-03	55'	317	4	Clean				
30-08-12	100'	299	4	Clean				
30-09-01	100'	316	4	Unstable Early	88-100	400	1977	^{137}Cs, ^{60}Co
30-09-02	100'	312	4	Unstable	40-58	1100	1976	^{60}Co
				Stable	82-100	200	1975	^{60}Co
30-09-06	100'	320	4	Unstable Early	72-88	1000	1983	^{60}Co
30-09-07	125'	45	4	TF Activity	0-14	300	1985	^{137}Cs
				Unstable	72-90	1100	1983	^{60}Co
30-09-10	100'	360	4	TF Activity	0-20	4K	1975	^{137}Cs
				Stable	20-38	200	1975	^{137}Cs
				Stable	50-70	100	1975	^{137}Cs
				Stable	70-94	200	1975	^{137}Cs
30-09-11	100'	349	4	Clean				
30-10-01	100'	333	4	Clean				
30-10-02	100'	357	4	Stable	42-50	80	1975	^{137}Cs
30-10-09	100'	354	4	Unstable Early	40-60	1700	1975	^{106}Ru
30-10-11	100'	336	4	Clean				
30-11-01	100'	345	4	Clean				
30-11-05	100'	277	4	Clean				
30-11-06	100'	298	4	Clean				
30-11-09	100'	305	4	Clean				
30-11-11	100'	280	4	Clean				
30-12-01	100'	384	4	Unstable Early	34-48	200	1978	^{60}Co, ^{106}Ru
30-12-03	100'	348	4	Clean				
30-12-09	100'	340	4	Clean				
30-12-13	120'	211	4	TF Activity	0-20	23K	1978	^{137}Cs

Borehole Number	Survey Depth (feet)	Number Of Surveys	[a]Probe Type	[b]Category	Zone Depth (feet)	Max GTP (ft x c/s)	Year Max	[c]Isotopes Present
				Stable	20-50	1800	1978	^{137}Cs, ^{60}Co, ^{106}Ru

[a]Probe type:
Caution must be used when relating GTP values in zones recorded with different probe types.
1 = Green GM, moderately sensitive; reads moderate levels of gamma ray activity.
2 = Red GM, least sensitive; reads highest level of gamma ray activity.
4 = NaI, most sensitive, reads lowest level of gamma ray activity and therefore used in zones of limited activity

[b]Category: defined above in 1.0 Introduction.
TF Activity; abbreviation for Tank Farm Activity

[c]Isotopes Present: Radionuclides used in GTP plot. Radionuclides identified as present by HPGe survey or hypothesized (e.g. Ru^{106}), see 1.2 Data Analysis Description.

2 Subsurface Condition Categories

2.1 Clean

A clean well is one that exhibits no observable change in the character of the activity over the logging history of the well, and does not have any isotopes identified by the SGLS greater than the average background levels of naturally occurring gamma ray emitting isotopes. Non-gamma emitting radionuclides or other contaminant species might be present but are not detected by either SDGLS or gross gamma logging. Although spurious surveys (those readings that do not repeat over time) may exist in the frequency clean and the average background plots, the trend of the data is clear. Twenty-two of 70 dry wells (i.e., 30%) in the C Tank Farm are considered clean (Figure 2) and are listed in Table 2. The remaining 49 wells are considered contaminated and are categorized and discussed in the following sections.

Table 2. C Tank Farm Clean Wells

Borehole Number	Survey Depth (feet)	Category
30-00-06	110	Clean
30-00-09	57	Clean
30-00-10	55	Clean
30-00-12	145	Clean
30-00-13	55	Clean
30-04-12	135	Clean
30-07-02	100	Clean
30-07-07	100	Clean
30-07-08	100	Clean
30-07-10	100	Clean
30-08-03	55	Clean
30-08-12	100	Clean
30-09-11	100	Clean

Borehole Number	Survey Depth (feet)	Category
30-10-01	100	Clean
30-10-11	100	Clean
30-11-01	100	Clean
30-11-05	100	Clean
30-11-06	100	Clean
30-11-09	100	Clean
30-11-11	100	Clean
30-12-03	100	Clean
30-12-09	100	Clean

2.2 Contaminated

A total of 92 contaminated zones were identified in the remaining 48 boreholes, with up to four zones identified in three boreholes. In some cases, the zones are continuous; in others, there are non-contaminated intervals between zones of contamination. This is especially true for boreholes in which there are zones of Tank Farm Activity which, typically, occur in the upper 10 feet of a borehole.

Specific gamma-emitting isotopes that are in the subsurface are identified from data acquired by the SGLS. Integration of the decay rate of the radionuclide species identified by the SGLS with the gross gamma ray data collected during the dry well surveillance program provides insight as to the rate of change, if any, of radionuclides in the subsurface. During the analysis of C Tank Farm data, four gamma-emitting isotopes were identified or hypothesized to have occurred in one or more radioactive contamination zones. They are cesium-137 (Cs-137), cobalt-60 (Co-60), europium-154 (Eu-154), and ruthenium-106 (Ru-106).

Cesium-137 was identified in 71 zones, most often as the sole isotope in a zone, although it is found with other gamma-emitting isotopes in 10 zones.

Cobalt-60 was identified as the sole isotope by SGLS in 12 zones in C Tank Farm boreholes. It exists in conjunction with other isotopes identified by SGLS in 11 zones.

Europium-154 is present in two zones in combination with cesium-137 and cobalt-60.

Ruthenium-106 is present as the sole isotope in four zones and is present with cobalt-60 in three zones, with cesium-137 in two zones and with both in one zone.

The isotopes identified in C Tank Farm with the SGLS exist primarily under two categories of subsurface conditions: tank farm activity and stable. Nine unstable conditions, 11 "unstable early" and 11 undetermined conditions are present in C Tank Farm. Dry well locations (centered beneath the borehole name on the map) are labeled with the conditions of subsurface zones and are shown in Figure 2. A single symbol for a dry well may indicate multiple zones of the same designation.

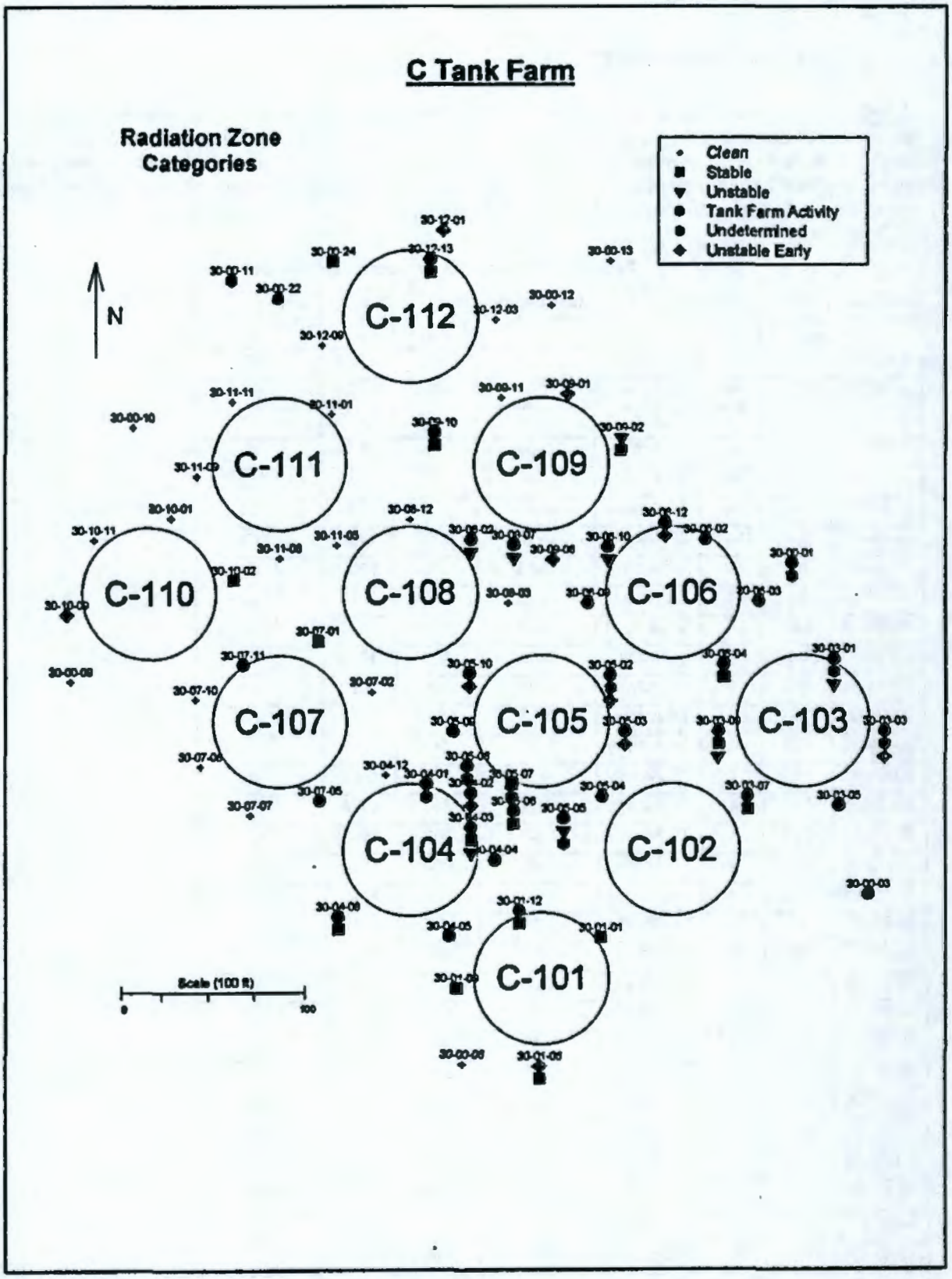

Figure 2. C Tank Farm Radiation Zone Categories

2.2.1 Tank Farm Activity

A sudden, significant change in the intensity of gross gamma rays between successive gross gamma surveys at or near the ground surface suggests that contamination may have resulted from tank farm activities or logging procedure changes. Radioactive contamination occurs at the surface in 35 wells, apparently as the result of tank farm activities (i.e., logging procedure changes, transfer line operations, valve box and conduit leaks, surface spills, etc.). These wells are listed in Table 3.

Table 3. C Tank Farm Activity Zones

Borehole Number	Survey Depth (feet)	Probe Type	Category	Zone Depth (feet)	Max GTP (ft x c/s)	Year Max GTP	Isotope Present
30-00-01	70	4	TF Activity	0-5	300	1984	^{137}Cs
30-00-03	120'	4	TF Activity	0-7	1300	1975	^{137}Cs
30-01-12	100	4	TF Activity	0-10	4500	1975	^{137}Cs
30-03-01	125	4	TF Activity	0-30	12K	1975	^{137}Cs
30-03-03	130	4	TF Activity	0-14	4K	1975	^{137}Cs
30-03-05	100	4	TF Activity	0-20	600	1984	^{137}Cs
30-03-07	130	4	TF Activity	0-12	2000	1980	^{137}Cs
30-03-09	100	4	TF Activity	0-12	8K	1980	^{137}Cs
30-04-01	50	4	TF Activity	0-8	3K	1975	^{137}Cs
30-04-02	135	4	TF Activity	0-12	2000	1975	^{137}Cs
30-04-03	50	4	TF Activity	0-15	600	1985	^{137}Cs
30-04-04	100	4	TF Activity	0-8	50K	1978	^{137}Cs
30-04-04	100	4	TF Activity	8-25	1800	1975	^{137}Cs
30-04-05	100	4	TF Activity	0-20	9K	1978	^{137}Cs
30-04-08	145	4	TF Activity	0-5	150	1975	^{137}Cs
30-05-02	130	4	TF Activity	0-14	5K	1975	^{137}Cs
30-05-03	100	4	TF Activity	0-39	9K	1985	^{137}Cs
30-05-04	120	4	TF Activity	0-8	900	1975	^{137}Cs
30-05-05	100	4	TF Activity	0-25	12K	1975	^{137}Cs
30-05-06	60	4	TF Activity	0-15	1100	1975	^{137}Cs
30-05-08	50	4	TF Activity	0-11	16K	1975	^{137}Cs
30-05-09	100	4	TF Activity	0-8	300	1985	^{137}Cs
30-05-10	135	4	TF Activity	0-17	300	1985	^{137}Cs
30-06-02	123	4	TF Activity	0-16	500	1984	^{137}Cs
30-06-03	100	4	TF Activity	0-10	800	1975	^{137}Cs
30-06-04	130	4	TF Activity	0-16	2000	1984	^{137}Cs
30-06-09	100	4	TF Activity	0-16	900	1985	^{137}Cs
30-06-10	130	4	TF Activity	0-10	800	1984	^{137}Cs
30-06-12	100	4	TF Activity	0-14	1500	1985	^{137}Cs
30-07-05	100	4	TF Activity	0-8	300	1975	^{137}Cs
30-07-11	100	4	TF Activity	0-10	80K	1993	^{137}Cs

Borehole Number	Survey Depth (feet)	Probe Type	Category	Zone Depth (feet)	Max GTP (ft x c/s)	Year Max GTP	Isotope Present
30-08-02	100	4	TF Activity	0-6	4K	1985	^{137}Cs
30-08-02	100	4	TF Activity	13-28	55K	1980	^{137}Cs
30-09-07	125	4	TF Activity	0-14	300	1985	^{137}Cs
30-09-10	100	4	TF Activity	0-20	4K	1975	^{137}Cs
30-12-13	120	4	TF Activity	0-20	23K	1978	^{137}Cs

2.2.2 Undetermined

Infrequently, stability cannot be determined due to gross gamma energy levels exceeding the system design criteria (both upper and lower limits), insufficient data, possible effects of depth shift, and surface activities. 11 of 92 zones in the 48 contaminated dry wells examined in the C Tank Farm are undetermined: These zones are listed in Table 4.

Table 4. C Tank Farm Undetermined Zones

Borehole Number	Survey Depth (feet)	Probe Type	Category	Zone Depth (feet)	Max GTP (ft x c/s)	Year Max GTP	Isotopes Present
30-00-01	70	4	Undetermined	58-70	300	1984	^{137}Cs
30-00-11	58	4	Undetermined	3-14	1000	1977	^{137}Cs
30-00-22	55	4	Undetermined	0-13	15K	1977	^{137}Cs
30-03-01	125	4	Undetermined	40-70	600	1976	^{137}Cs
30-03-03	130	4	Undetermined	14-40	2800	1975	^{137}Cs
30-04-01	50	4	Undetermined	8-22	400	1975	^{137}Cs
30-05-02	130	4	Undetermined	14-26	600	1975	^{137}Cs
30-05-05	100	4	Undetermined	56-80	1800	1975	^{137}Cs, ^{60}Co
30-05-07	67	4	Undetermined	45-66	400	1981	^{137}Cs
30-05-08	50	4	Undetermined	11-26	12K	1975	^{137}Cs, ^{60}Co, ^{154}Eu
30-05-08	50	4	Undetermined	26-53	14K	1975	^{137}Cs, ^{60}Co

2.2.3 Stable

The subsurface condition of a zone with radioactive contamination is considered stable when:

- The decay rate of the isotope(s) identified with SGLS matches the trend observed in the GTP of the gross gamma ray data, or
- Contaminants continue to decay at a rate consistent with the hypothesized isotope(s) half-life, and
- No noticeable change in concentration is apparent over the short time interval that data were collected.

Twenty-four are considered stable in C Tank Farm and these zones are listed in Table 5.

Table 5. C Tank Farm Stable Zones

Borehole Number	Survey Depth (feet)	Probe Type	Category	Zone Depth (feet)	Max GTP (ft x c/s)	Year Max GTP	Isotopes Present
30-00-24	60	4	Stable	14-24	800	1977	^{106}Ru
30-00-24	60	4	Stable	24-40	700	1977	^{106}Ru
30-01-01	100	4	Stable	30-53	1200	1975	^{137}Cs,^{106}Ru
30-01-06	100	4	Stable	71-83	600	1975	^{106}Ru
30-01-06	100	4	Stable	83-95	220	1975	^{106}Ru
30-01-09	100	4	Stable	20-33	40K	1975	^{137}Cs
30-01-09	100	4	Stable	33-60	14K	1975	^{137}Cs,^{106}Ru
30-01-12	100	4	Stable	10-18	100	1975	^{137}Cs
30-03-07	130	4	Stable	42-54	170	1975	^{137}Cs
30-03-09	100	4	Stable	40-52	150	1975	^{137}Cs
30-04-03	50	4	Stable	16-30	70K	1983	^{137}Cs
30-04-08	145	4	Stable	10-26	1000	1975	^{137}Cs
30-04-08	145	4	Stable	26-38	150	1975	^{137}Cs
30-04-08	145	4	Stable	38-50	120	1975	^{137}Cs
30-05-06	60	4	Stable	40-53	400	1975	^{137}Cs,^{60}Co
30-05-07	67	2	Stable	30-45	20K	1983	^{137}Cs
30-06-04	130	4	Stable	16-32	600	1975	^{137}Cs
30-07-01	100	4	Stable	0-14	120	1975	^{137}Cs
30-09-02	100	4	Stable	82-100	200	1975	^{60}Co
30-09-10	100	4	Stable	20-38	200	1975	^{137}Cs
30-09-10	100	4	Stable	50-70	100	1975	^{137}Cs
30-09-10	100	4	Stable	70-94	200	1975	^{137}Cs
30-10-02	100	4	Stable	42-50	80	1975	^{137}Cs
30-12-13	120	4	Stable	20-50	1800	1978	^{137}Cs, ^{60}Co, ^{154}Eu, ^{106}Ru

The term "Stable", as used in this analysis, is defined as the apparent match of the decay curve to that for the isotopes known or hypothesized to be present, and does not refer to the inherent condition of the contamination. The mobility of the radioactive contaminants in the subsurface soils before or after the gross gamma ray and SGLS data collection period is undetermined. If a new driver were introduced (e.g., the influx of a large volume of liquid), contaminants could be remobilized. Similarly, a change in geochemical conditions in the soil could also affect mobility. Given the current gross gamma and SGLS data, it cannot be determined if remobilization will or will not occur.

2.2.4 Unstable

The subsurface condition of a zone with radioactive contamination is considered unstable when, at some point within the time interval of data collection, contamination was not decreasing at the decay rate of the isotope(s) identified with SGLS. In this case, the decay curve does not match the trend observed in the GTP of the identified or hypothesized isotope. In the C Tank Farm, 20 zones are identified which exhibited instability within the time period that gross gamma ray data were collected. In 11 of these zones, instability occurs during the earlier years of data collection for certain depth intervals; however, in later years, the GTP follows the decay curve of the known or hypothesized isotopes. A listing of "unstable early" and unstable zones is presented in Table 6.

Table 6. C Tank Farm Unstable Early and Unstable Zones

Borehole Number	Survey Depth (feet)	Probe Type	Category	Zone Depth (feet)	Max GTP (ft x c/s)	Year Max GTP	Isotopes Present
30-01-06	100	4	Unstable Early	30-41	250	1980	137Cs
30-03-03	130	4	Unstable Early	78-100	1500	1975	60Co,106Ru
30-04-02	135	4	Unstable Early	32-60	3K	1975	60Co
30-05-02	130	4	Unstable Early	68-84	250	1976	137Cs,60Co
30-05-10	135	4	Unstable Early	17-35	500	1976	137Cs,60Co,106Ru
30-06-12	100	4	Unstable Early	14-26	300	1979	137Cs,60Co
30-09-01	100	4	Unstable Early	88-100	400	1977	137Cs,60Co
30-09-06	100	4	Unstable Early	72-88	1000	1983	60Co
30-10-09	100	4	Unstable Early	40-60	1700	1975	106Ru
30-12-01	100	4	Unstable Early	34-48	200	1978	60Co,106Ru
30-03-01	125	4	Unstable	90-125	300	1984	60Co
30-03-09	100	4	Unstable	73-94	500	1988	60Co
30-04-03	50	4	Unstable	30-48	8K	1981	60Co
30-05-03	100	4	Unstable	67-80	400	1975	60Co
30-05-05	100	4	Unstable	40-56	550	1976	137Cs
30-06-10	130	4	Unstable	86-115	300	1989	60Co
30-08-02	100	4	Unstable	46-55	1500	1980	60Co
30-08-02	100	4	Unstable	55-84	12K	1980	60Co
30-09-02	100	4	Unstable	40-58	1100	1976	60Co
30-09-07	125	4	Unstable	72-90	1100	1983	60Co

3 Details of Contaminated Conditions

Characteristics of the contaminated zones are summarized in the following discussions.

3.1 Stable Zones

The fixed decay rate of the isotope(s) present is used to calculate the decay curves (Figure 3). Table 7 lists the half-life of the isotopes encountered in the C Tank Farm.

When a contaminated interval contains multiple isotopes, the intensity of the slowest decay component is plotted to match the data over the most recent time period for which data exist. Faster decay isotopes are then clearly indicated as necessary to match the trend of the GTP values. When the decay curve fits the GTP plot, a stable condition is said to exist. When the decay curve does not fit any portion of the GTP plot, stability cannot be established. The factors responsible for instability are beyond the scope of this report.

Several zones within a number of wells in the C Tank Farm exhibit gross gamma ray activity above natural background. Many of these radioactive intervals are observed to be stable as verified by the change in GTP over time which coincides with the decay rate of the isotope(s) identified or hypothesized to have been present in the soil surrounding the dry well during the time interval data were collected. The isotopes present in these stable zones vary and are presented above in Table 3 through Table 6. In general, they occur as follows:

- Cs-137 is present in all of the tank farm activity and undetermined zones, in six of 20 unstable zones and in 18 of 24 stable zones.
- Ru-106 is present in seven stable zones and four "unstable early" zones.
- Co-60 occurs in three undetermined and two stable activity zones in combination with other isotopes, as the sole isotope in six unstable zones and with other isotopes in six unstable zones.
- Eu-154 occurs in one stable zone with Cs-137 and Co-60, and in one undetermined zone with Cs-137 and Co-60.

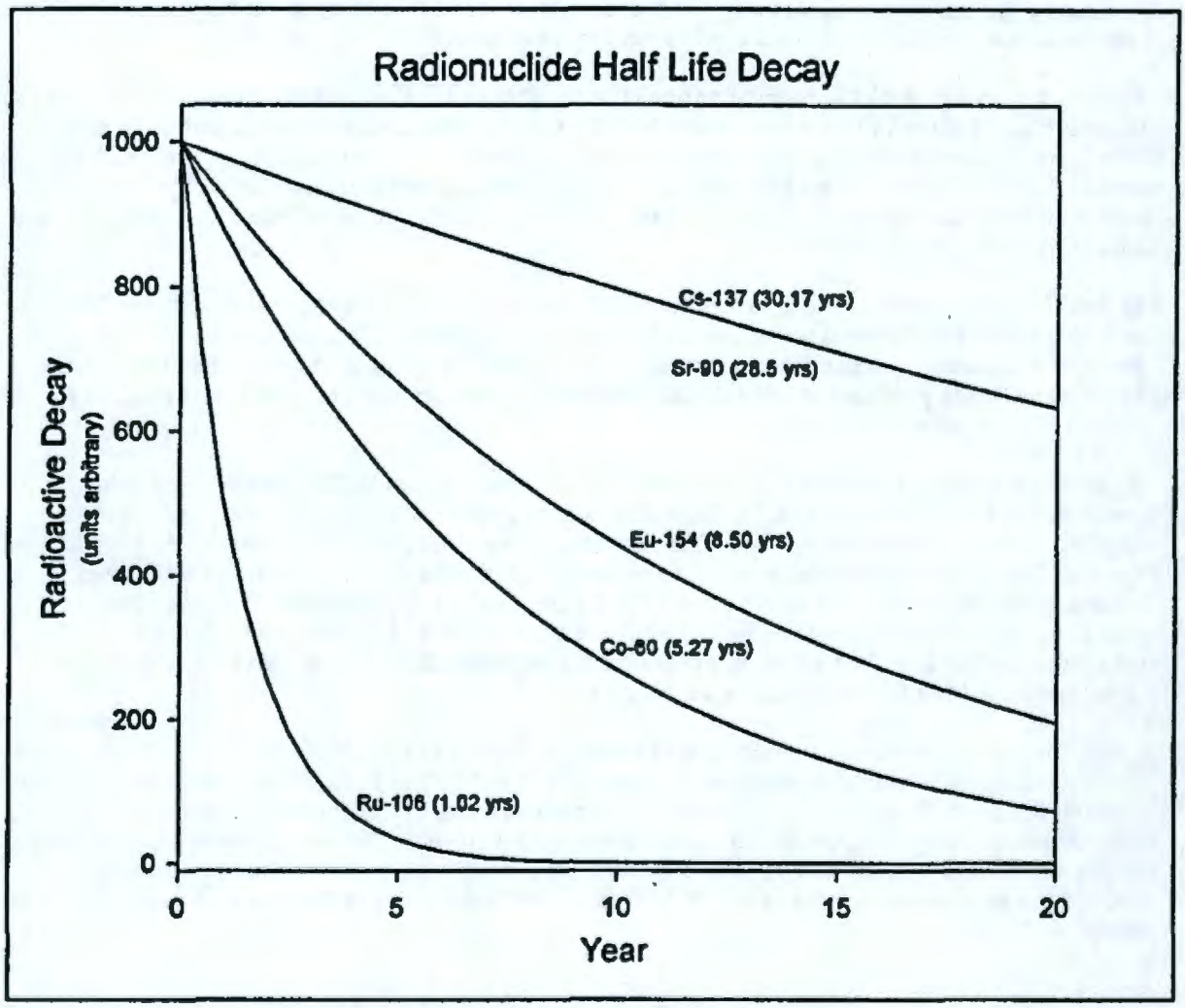

Figure 3. Radionuclide Half-life Decay Rates

Table 7. Half-life of Isotopes Identified in the C Tank Farm Boreholes

Isotope	Half Life (yrs)
Co-60	5.27
Eu-154	8.50
Cs-137	30.17
Ru-106	1.02

3.2 Depth of Contamination

About three-quarters of the dry wells within the C Tank Farm show some contamination; 48 of 70 wells (68%). Thirty-five wells show surface contamination (categorized as Tank Farm Activity) from ground surface to depths as great as 39 feet. Fourteen Tank Farm Activity zones are restricted to the upper 10 feet and all contain only Cs-137. In some boreholes, surface contamination (i.e., TF

Activity) is the only contamination in the borehole; in others, it is the uppermost zone of contamination, with other contaminant zones at greater depth.

Figures 4, 5, and 6, depict borehole locations (centered beneath the borehole name) and contaminant information. Figure 4 illustrates the depth to the top of contamination and the isotope(s) present at that depth. Figure 5 illustrates the depth to the bottom of contamination and the isotope(s) present at that depth. Figure 6 shows locations where GTP values are greater than 1,000 ft*c/s. Most contaminant zones are less than 20 feet thick. The range in thickness is from 5 feet (30-04-01 and 30-04-04) to 39 feet (30-05-03).

Several boreholes contain multiple zones, with a maximum of four zones in two boreholes (30-04-08 and 30-08-02). The observable maximum depth of contamination (Figure 5) is dependent on the depth to which detectors penetrated the subsurface. There appears to be one case in the C Tank Farm where gross gamma logging data indicate that gamma-emitting contaminants reached the bottom of a borehole (30-03-01).

It should be noted that on various stack plots for the period before 1983, there appears to be contamination at the bottom of a borehole that doesn't appear after the log survey start and stop depths were controlled by computer. This apparent contamination at the bottom of the borehole resulted from longer counting times due to operators activating the instrument a few to several seconds before activating the hoist to move the logging tool up the borehole. The absence of contamination after 1983 and the lack of confirmation by SGLS logging indicate that the contamination seen at the base of numerous boreholes before 1983 is apparent rather than real (resulting from tank farm operations, i.e. logging practices).

Depth control issues related to logging make much of the data at the surface prior to 1983 unusable for evaluating contaminant conditions. Changes and variability in background values in the 1970s through the early 1980s were common in many boreholes. Depth control issues inhibit the ability to identify any downward movement of contamination prior to 1983. However, where depth control is not an issue, data analysis can identify movement of contamination by the changes in the gross gamma ray activity occurring at a rate that is faster than the decay rate of the isotope(s) present in the zone.

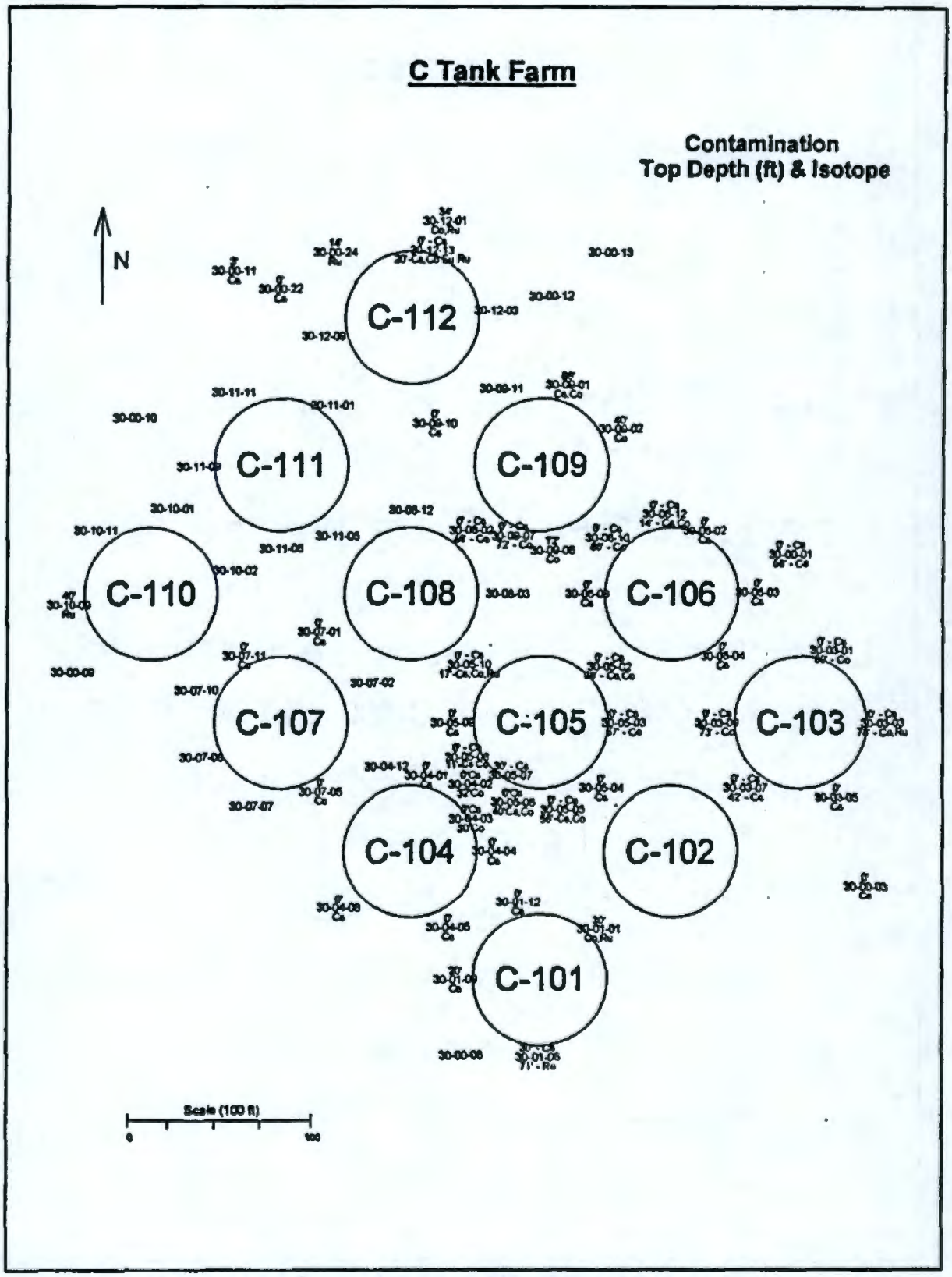

Figure 4. C Tank Farm Top of Contamination

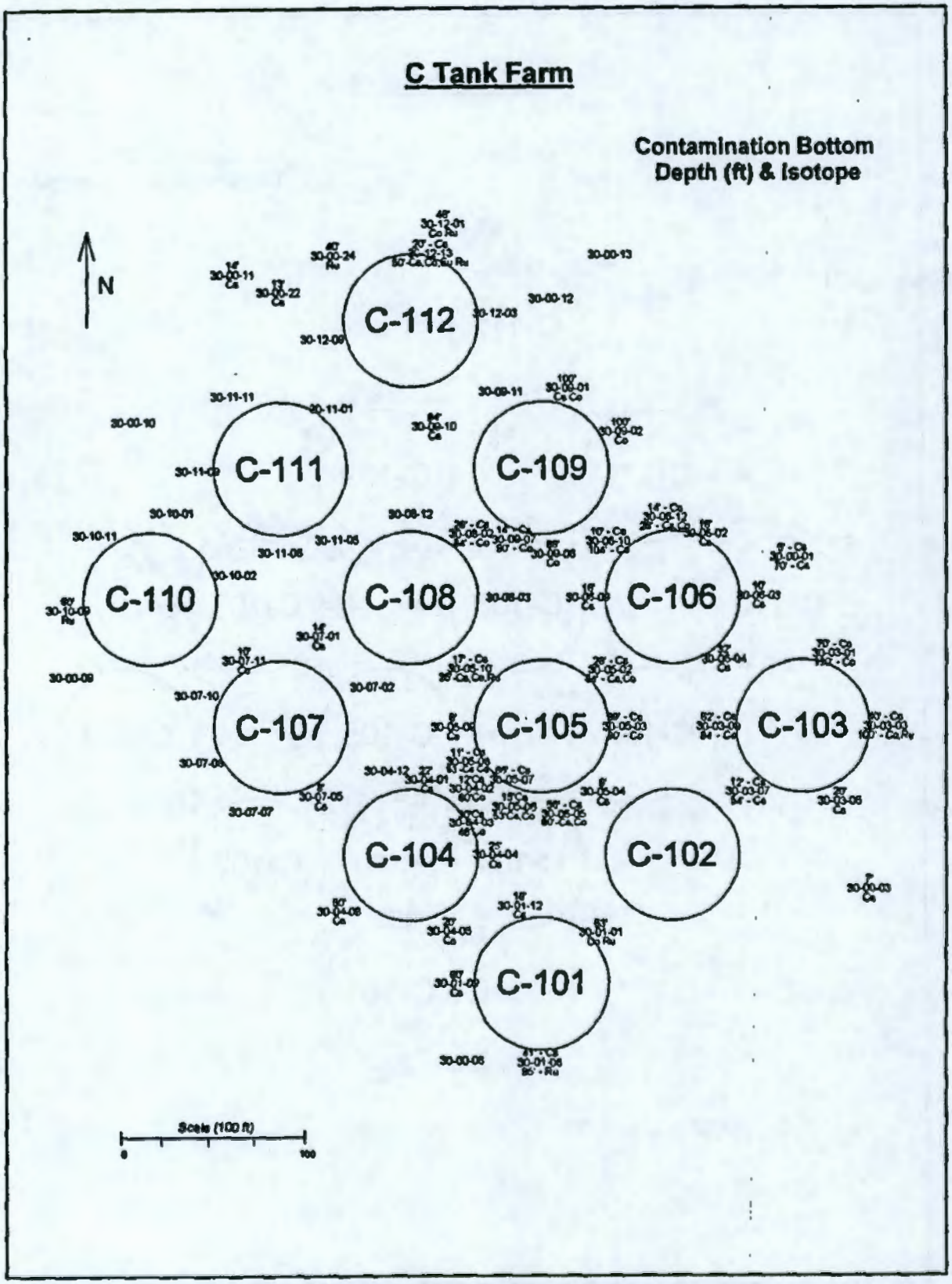

Figure 5. C Tank Farm Observable Bottom of Contamination

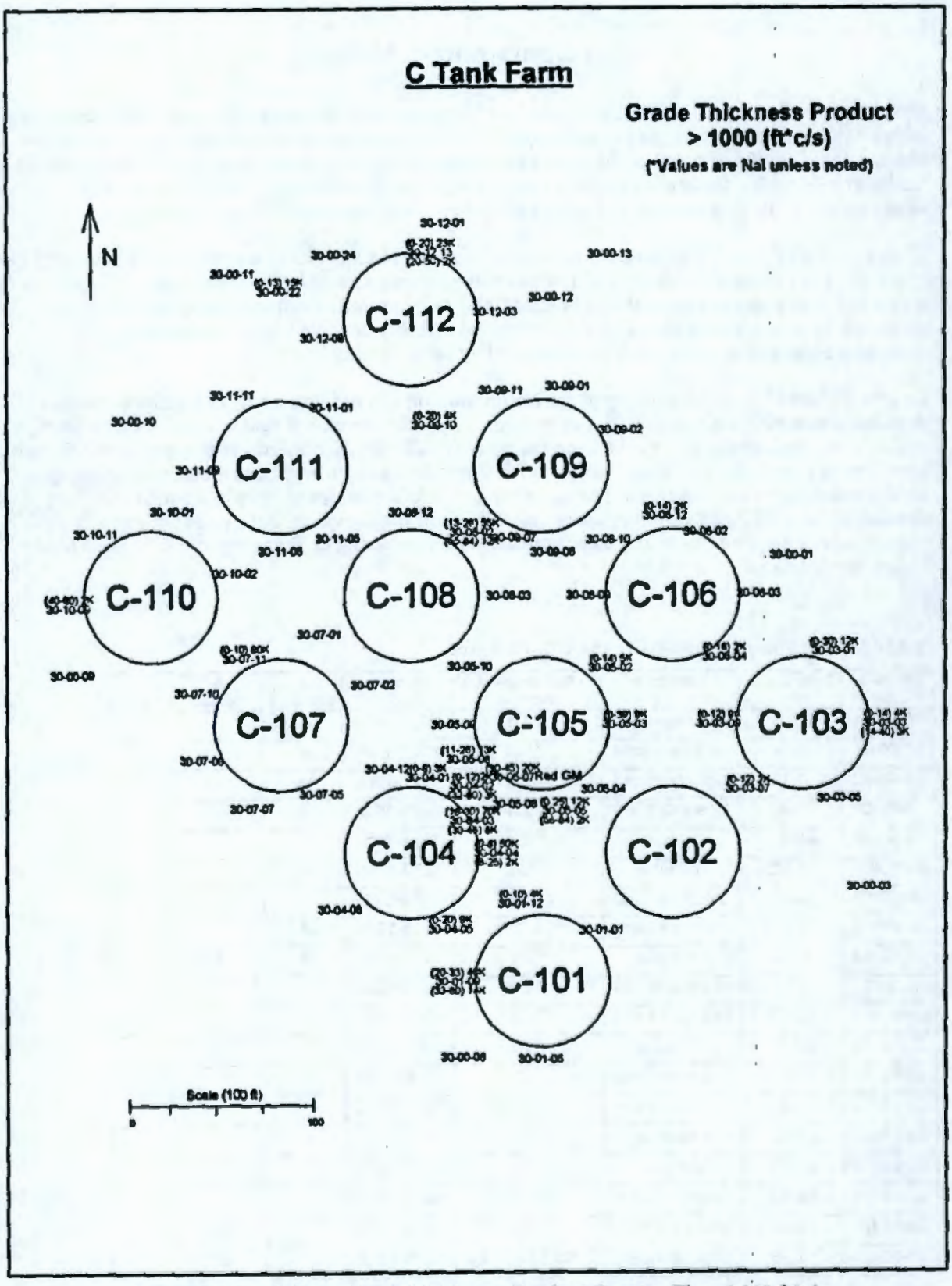

Figure 6. C Tank Farm Grade Thickness Product Greater Than 1,000 ft*c/s

3.3 Contaminant Mobility

The mobility of contaminants in the subsurface is examined by reviewing the zones with categories of: unstable, unstable-early, and undetermined. Thirty-one zones in the C Tank Farm match these three categories. Twenty-two of these zones are deep in the subsurface, at or below the base of the under ground tanks. Cesium-137, which is generally considered to not be mobile, is the sole contaminant in 10 of these zones. Co-60 is the sole contaminant in 11 of these zones.

Plots of the GTP with time illustrate movement of contaminants either into or out of a zone, and the stack plots can illustrate a change of position of contaminants within the zone. Table 8 lists these 31 zones in which contaminant mobility is most likely to be present (unstable, unstable-early, and undetermined) along with the type of contaminant mobility observed from the analysis of the historical gross gamma logs. Table 8 is ordered by borehole number.

In several zones (four) the mobility of the contamination can not be determined with out further detailed monitoring log surveys, for two reasons. First, the amount of contamination is low level, which made detection above the background activity difficult. Second, there is a gap in the historic logs (loss of survey data) during 1983 in which the disk database over flowed before the data was copied to computer backup tapes. The contaminant mobility in these zones is identified as "Not Available". The GTP plots of these zones typically show higher values before the data gap in 1983 than after the gap and frequently have indications of increasing or changing contamination levels before the data gap.

Table 8. Contaminant Mobility in the C Tank Farm

Borehole	Zone Depth (ft)	Category	Contaminant Isotope	Mobility Period	A Increase	B Migration	C NA
30-00-01	58-70	Undetermined	^{137}Cs	1975-1984	A		
30-00-11	3-14	Undetermined	^{137}Cs	1977-1990	A		
30-00-22	0-13	Undetermined	^{137}Cs	1977-1989	A		
30-01-06	30-41	Unstable Early	^{137}Cs	1979-1983	A		
30-03-01	40-70	Undetermined	^{137}Cs	1984-1986			C
30-03-01	90-125	Unstable	^{60}Co	1975-1989	A	B	
30-03-03	14-70	Undetermined	^{137}Cs	1975-1983			C
30-03-03	78-100	Unstable Early	^{60}Co, ^{106}Ru	1975-1978	A		
30-03-09	73-94	Unstable	^{60}Co	1975-1991	A	B	
30-04-01	8-22	Undetermined	^{137}Cs	1975-1986			C
30-04-02	32-60	Unstable Early	^{60}Co	1975-1987	A	B	
30-04-03	30-48	Unstable	^{60}Co	1980-1993		B	
30-05-02	14-26	Undetermined	^{137}Cs	1975-1983			C
30-05-02	68-84	Unstable Early	^{137}Cs, ^{60}Co	1975-1978	A		
30-05-03	67-80	Unstable	^{60}Co	1975-1990	A	B	
30-05-05	40-56	Unstable	^{137}Cs	1975-1995		B	
30-05-05	56-84	Undetermined	^{137}Cs, ^{60}Co	1975-1984	A		
30-05-07	45-66	Undetermined	^{137}Cs	1980-1988		B	
30-05-08	11-26	Undetermined	^{137}Cs, ^{60}Co, ^{154}Eu	1975-1977		B	

Borehole	Zone Depth (ft)	Category	Contaminant Isotope	Mobility Period	A Increase	B Migration	C NA
30-05-08	26-53	Undetermined	^{137}Cs, ^{60}Co	1975-1985		B	
30-05-10	17-35	Unstable Early	^{137}Cs, ^{60}Co, ^{106}Ru	1975-1976	A		
30-06-10	86-115	Unstable	^{60}Co	1982-1998	A		
30-06-12	14-26	Unstable Early	^{137}Cs, ^{60}Co	195-1979	A		
30-08-02	46-55	Unstable	^{60}Co	1980-1985		B	
30-08-02	55-84	Unstable	^{60}Co	1980-1988		B	
30-09-01	88-100	Unstable Early	^{137}Cs, ^{60}Co	1975-1977	A		
30-09-02	40-58	Unstable	^{60}Co	1975-1985	A		
30-09-06	72-88	Unstable Early	^{60}Co	1980-1986	A	B	
30-09-07	72-90	Unstable	^{60}Co	1982-1991		B	
30-10-09	40-60	Unstable Early	^{106}Ru *	1975-1982		B	
30-12-01	34-48	Unstable Early	^{60}Co, ^{106}Ru	1977-1978	A		

* Ru-106 does not fit the rapid decay, thus most likely rapid contaminant migration.
A: GTP (contaminant) increasing in zone
B: Contaminant in zone remains constant but migrates within zone to lower depths
C: Low contaminant level and loss of historic data (1983) prevents determination of mobility, not available

If contamination movement is identified through analysis of borehole logs, whether downward or laterally, it is reasonable to assume that movement would continue in the same manner beyond the proximity of the borehole, provided subsurface conditions have not changed. Movement may also occur in locations where there are no boreholes and thus go undetected. It is also possible that contaminants other than gamma-emitting radionuclides are moving but are not detected by gross gamma logging.

3.4 Isotopes Identified

Four man-made isotopes are known to be, or hypothesized to have been present, in the C Tank Farm at or above the detection limit based on the HPGe and gross gamma ray log analysis. They are listed in Table 7 along with the half-life of each. The most abundant isotope in the C Tank Farm is Cs-137 which occurs in 71 (of 89) zones, in 61 of which it is the only isotope. Cobalt-60 is the second most common isotope, having been identified in 22 zones; it is the only isotope in 12 of these zones. Europium-154 was detected in just one zone, and occurs with other isotopes. Ruthenium-106 was detected in nine zones, and was identified with other isotopes in five of these zones.

3.5 Subsurface Conditions During the Monitoring Period

Data evaluation in this report is limited to the period when digital data were first captured in 1975 to the last digital data collection in 1994-1999. Data collection extends only to 1989 in dry well 30-08-02. Six general conditions are possible concerning contamination over the time interval during which digital data were acquired:

1. Subsurface conditions were unstable at the beginning of digital logging and then apparently became stable,

isotopes present in contaminated intervals that were identified during the nearly twenty-year period that the digital dry well data were collected.

Subsurface contaminant conditions were identified and categorized during the analysis of the historical dry well data. The categories identified include clean, tank farm activity, undetermined, stable, and unstable. (Note that the category of unstable is further subdivided into 1) unstable, meaning at the end of data collection, the change of GTP with time was not following a known decay curve; and 2) unstable early, meaning stability was reached before the end of data collection.) This classification reflects the conditions in which contamination is present (or not present) within the period gross gamma ray data were collected electronically. It does not represent the conditions within the subsurface after 1994. However, an assumption that the trend of the data might continue unaltered past 1994 seems reasonable, barring any event that changes the hydrogeologic or geochemical conditions in the subsurface or the total contaminant inventory.

There are 22 dry wells that are classified as Clean in the C Tank Farm. Five of ten peripheral boreholes are classified as clean. Three peripheral wells have contamination with GTP greater than 1000 ft*c/s. They are Tank Farm Activity in dry well 30-00-03 and Undetermined Activity in dry wells 30-00-11 and 30-00-22. There are several tanks (e.g., tanks C-103, C-104, C-105, C-106, C-107, C-108, C-109 and C-112) which there is limited surface contamination categorized as Tank Farm Activity. These are all listed as "sound tanks" (Hanlon, 2000). Tank C-101 has one dry well categorized as tank farm Activity, and this tank is listed as assumed leaker (Hanlon, 2000). The designation of a tank as "sound" refers only to the integrity of the tank itself, and not the associated piping and facilities [e.g., valve or diversion boxes, pits etc which could easily be the location where containment was lost].

There is little or no correlation between dry wells with unstable early and unstable contaminant zones and "assumed leakers" (Hanlon, 2000). For example, tanks C-101, C-110, and C-111 are categorized as "assumed leaker", but no unstable early or unstable categorized zones are found surrounding these tanks. C-101 tank does have one undetermined zone at the south side of the tank, (30-01-06 at depth of 30-41 feet). The majority of the unstable early and unstable zones are around tanks C-103, C-104, C-105, C-106, C-108, and C-109.

The most common gamma-emitting isotope present in the subsurface of the C Tank Farm is Cs-137, which was detected in 72 of 87 zones of contamination in the C Farm dry wells. In 62 of these zones, it is the only isotope. It most commonly occurs in the shallow subsurface (typically less than 20 feet) [Tank Farm Activity zones].

The second most abundant isotope in C Farm is Co-60, which occurs in 23 zones throughout the farm. This isotope typically occurs at a depth of 40 feet or greater. Only three of these zones have maximum depths less than 50 feet, which is near the bottom of the excavation for the tanks.

There are 45 zones of contamination with GTP equal to or greater than 1,000 ft*c/s (NaI probe type 04) in the C Tank Farm; 23 of these are due to tank farm activities. These zones are primarily concentrated around tanks in the east-central part of the farm (C-103, C-104, C-105, C-106, and C-108).

Information on how or whether geology and/or geochemistry affect the direction, rate and extent of isotope migration in the subsurface is not considered in this report. However, it is noted in several boreholes that total gamma due to natural potassium-40, uranium and thorium shows a marked change at about the base of backfill (i.e., the top of the natural, in-place strata at a depth of 45 – 50 feet) in the C Tank Farm. This interface between materials of apparently different compaction (and therefore soil densities) may have influenced the mobility and distribution of contaminant isotopes.

5 References

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Hanlon, B.M., 2000, Waste Tank Summary Report for Month Ending February 29,2000, CH2MHill, Hanford Group, HNF-EP-0182-143.

MACTEC-ERS, 1998, "Hanford Tank Farm Vadose Zone C Tank Farm Report," GJO-HAN-8, GJO-98-1-TAR, MACTEC-ERS, Richland, Washington, May 1997.

Randall, R. R., 1999, "Dry Well Probe Calibrations," HNF-3861, Lockheed Martin Hanford Corporation, Richland, Washington.

Randall, R. R., R. K. Price, 1999a, "Analysis Techniques and Monitoring Results, 241-SX Dry Well Surveillance Logs," HNF-3136, Lockheed Martin Hanford Corporation, Richland, Washington.

Randall, R. R., R. K. Price, 1999b, "Analysis of Historical Gross Gamma Logging Data from BX Tank Farm," HNF-3531, Lockheed Martin Corporation, Richland, Washington.

Brief Listing of General Observations and Special Data Presentation Conditions

General Observations

Several re-occurring features in the gross gamma surveillance logs are listed in the following:

- The stack plots for many boreholes show elevated data readings at the bottom of a several surveys before 1984. The HPGe survey may or may not detect contamination at the bottom of the borehole. These elevated readings at the bottom of the borehole were examined and a grade thickness product calculation was frequently performed. The readings vary between low and high count-rates for successive surveys and are consistent with the result of manual operation of the logging equipment (before computer based depth control). The grade thickness product plot is not presented unless detectable levels of contamination are present.
- Depth control after 1984 is excellent and detailed survey features can be analyzed in complex contaminant structures after this date.
- Around 1985, the frequency clean plot often shows a drop to a value slightly less than 100%. This effect is caused by the zero readings at the surface (i.e., a change in logging procedure).
- The first 2 to 5 surveys in 1975 often show an average (natural) background that is higher than the remaining surveys.
- Occasionally, different files with different dates show the exact same data indicating electronic copying errors.
- Before the onset of depth control (around 1984), the bottom reading for surveys varies between low and high count-rates for successive surveys. The pattern between surveys is apparently random.
- The HPGe minimum detection limit for the gamma-emitting contaminants is less than the Tank Farms gross gamma surveillance probe detection limit. The detection limit for the Tank Farm logging system is about 5 pCi/g for single casing and higher for double casing.

Special Presentation Conditions

Several analysis processing and presentation methods are listed in the following:

- No data are deleted from the presentation plots; thus spurious surveys are often viewed.
- Stack plots are generated from a selected frequency (most common is quarterly). There is no selection based upon interpreted validity of the survey.
- During analysis each survey is processed and analyzed, even when some surveys are not viewed in a specific plot, such as the stack plot. A few anomalous (spurious) surveys can be presented on the stack plot that have invalid data (generally due to tool failure). And the following survey, generally the next day, is consistent with the surveys prior to the anomalous survey.
- The oldest and latest survey plots on a grade thickness plot are not necessarily the first and last in the electronic data set. The oldest and latest surveys that represent the true vadose zone condition are shown in the GTP and Clean plots. Thus the dates on the log plots may not match the dates listed in the table on the header page preceding each dry well presentation.
- The random readings at the bottom of surveys before 1984 are judged not valid unless the SGLS data indicates a measurable quantity at the bottom of a dry well.

- **While other probe data exists in the set analyzed, these data are not processed in this work scope unless they affect the conclusion for the stability of the dry well. However, the presence of these data may be useful to the reader, and thus are listed in the table of the header page.**

Tank C-100

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This section contains the analysis results for vadose zone boreholes (dry wells) associated with the "C" Tank Farm in general, and are not associated with a specific tank.

Special Notes: Borehole 30-00-11 has high gross for the level of Cs-137 reported with the HPGe log data. This indicates the possibility of either a remote Cs-137 source, or the presence of a strong beta only source, (such as Sr-90).

Borehole 30-00-01

Contamination (Cs-137) from 0-5 feet is Tank Farm Activity. Contamination (Cs-137& Co-60) from 58-70 feet is Undetermined.

Grade thickness product over 0 to 5 feet is erratic and highly variable from 1975 to 1986, indicative of tank farm activity. Since 1986, the grade thickness product may be consistent with the decay from Cs-137 (HPGe identified), but the levels in gross gamma are so low during this time period, they cannot be distinguished from background.

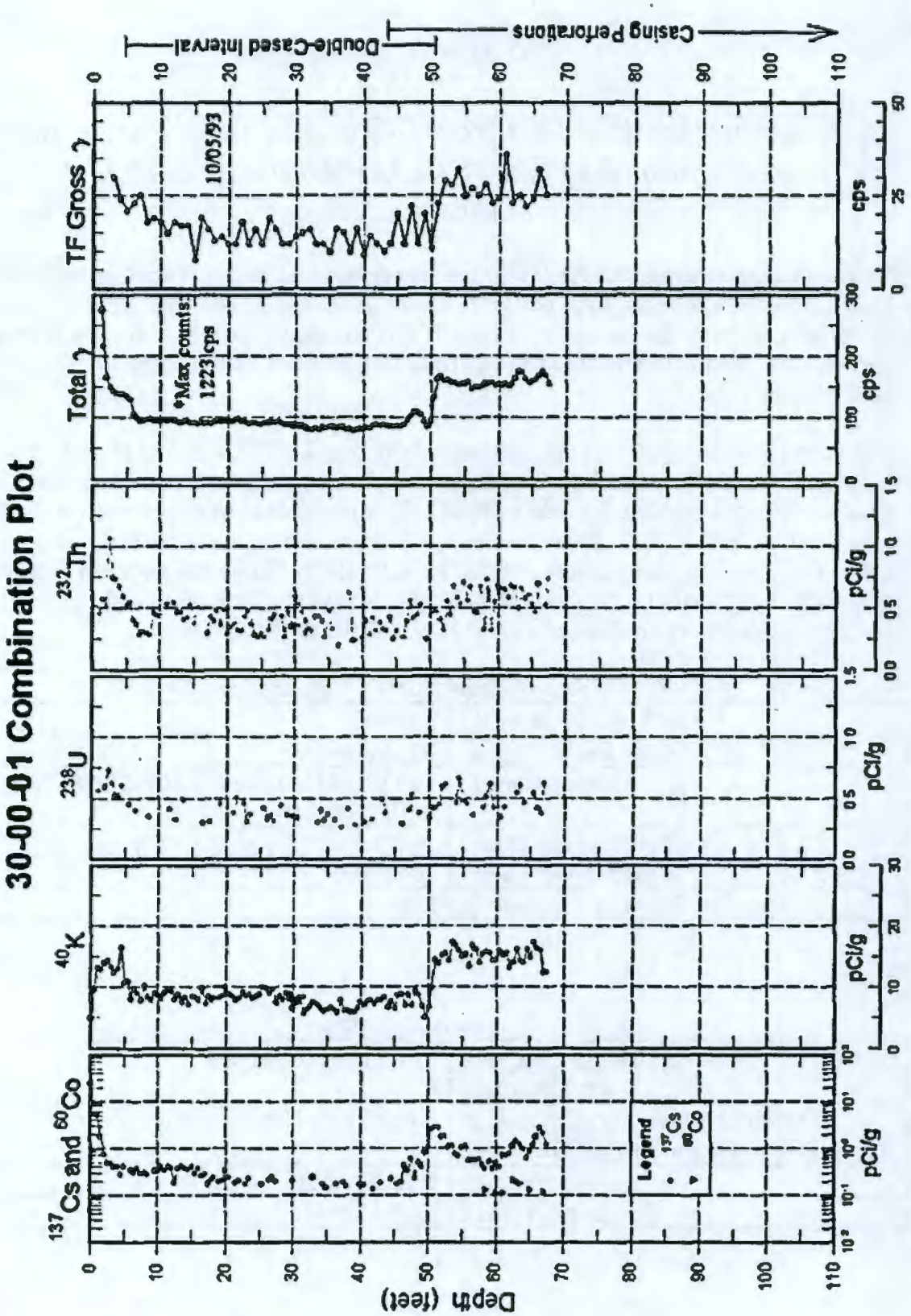
The zone from 58 to 70 feet was examined for the HPGe identified Co-60. No historical trend above background difference from the Cs-137 was observed in the grade thickness product for this interval. It is possible that the observed Co-60 is a small and recent influx. There is also some statistically insignificant indication of grade thickness product increase from 1975 to 1980. Since the poor statistical response cannot yield a rigorous classification, and the lack of a Co-60 character to the grade thickness product, the zone is classified undetermined.

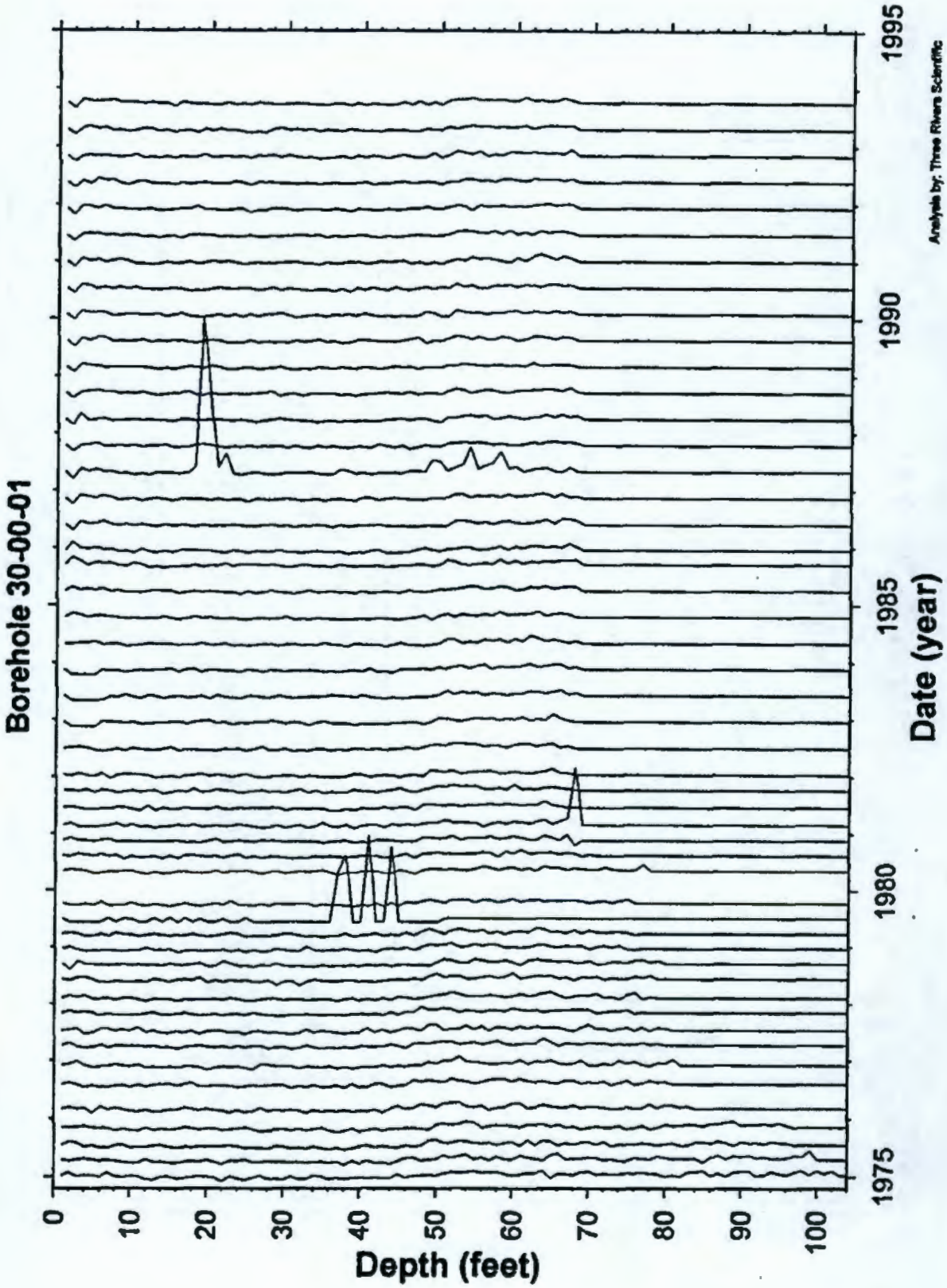
Gross Gamma Survey Information

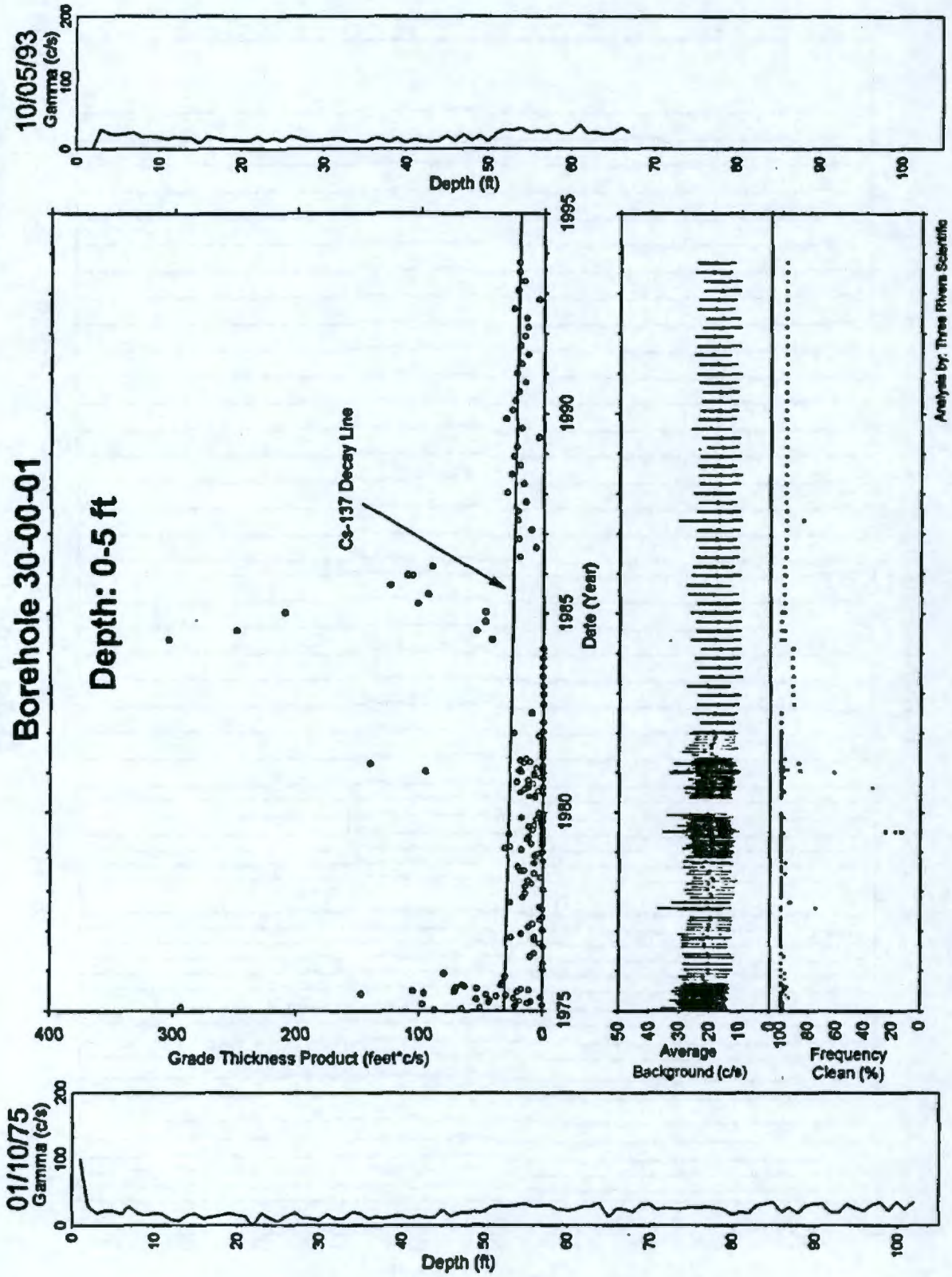
Probe Type Processed :	04: NaI
Other Probe Types :	03: Neutron
Survey Depth :	100 ft (<1976); 80 ft (1976-1980); 70 ft(1980-1994)
First Survey Date :	1/10/1975
Last Survey Date :	10/5/1993
Number Surveys Processed :	208

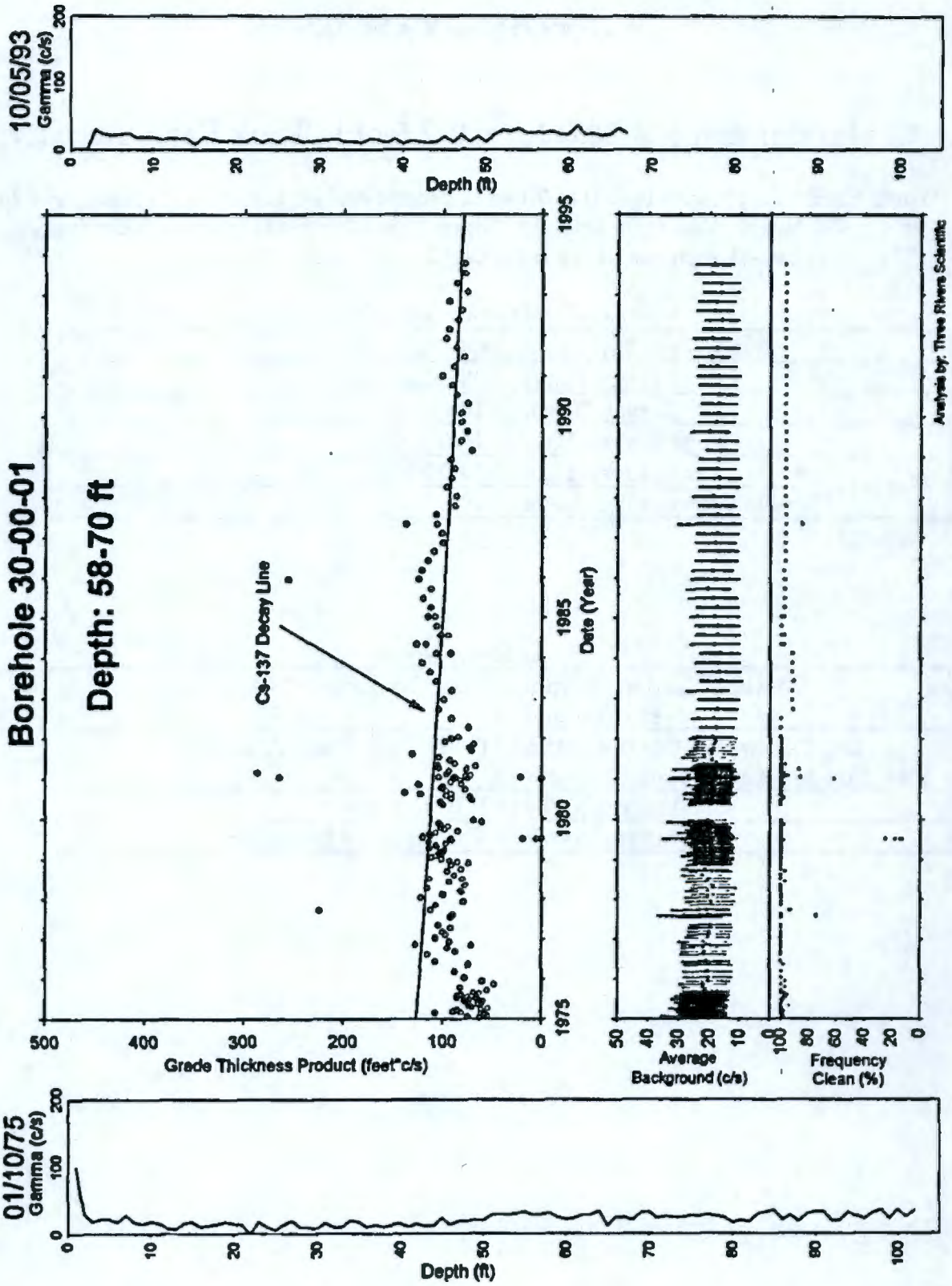
Analysis Notes

Method Used to Compute Background :	Threshold 0<val<50
Depth(s) where Contamination Identified in Gross Gamma Surveys :	0-5 ft Tank Farm Activity
Analyst Name :	R.R. Randall
Company Name :	Three Rivers Scientific


30-00-01 Combination Plot
Double-Cased Interval
Casing Perforations
TF Gross γ
10/05/93
Total γ
*Max counts: 1223 cps
232Th
238U
40K
137Cs and 60Co
Legend
137Cs
60Co
cps
pCi/g
Depth (feet)


Borehole 30-00-01
Depth (feet)
0
10
20
30
40
50
60
70
80
90
100
Date (year)
1975
1980
1985
1990
1995
Analysis by: Three Rivers Scientific


Borehole 30-00-01
Depth: 0-5 ft
10/05/93
Gamma (c/s)
Depth (ft)
Cs-137 Decay Line
Date (Year)
Grade Thickness Product (feet*c/s)
Average Background (c/s)
Frequency Clean (%)
Analysis by: Three Rivers Scientific
01/10/75
Gamma (c/s)
Depth (ft)


Borehole 30-00-01
Depth: 58-70 ft
10/05/93
Gamma (c/s)
Depth (ft)
Cs-137 Decay Line
Grade Thickness Product (feet*c/s)
Date (Year)
Average Background (c/s)
Frequency Clean (%)
Analysis by: Three Rivers Scientific
01/10/75
Gamma (c/s)
Depth (ft)

Borehole 30-00-03

Contamination (Cs-137) from 0-7 feet is Tank Farm Activity.

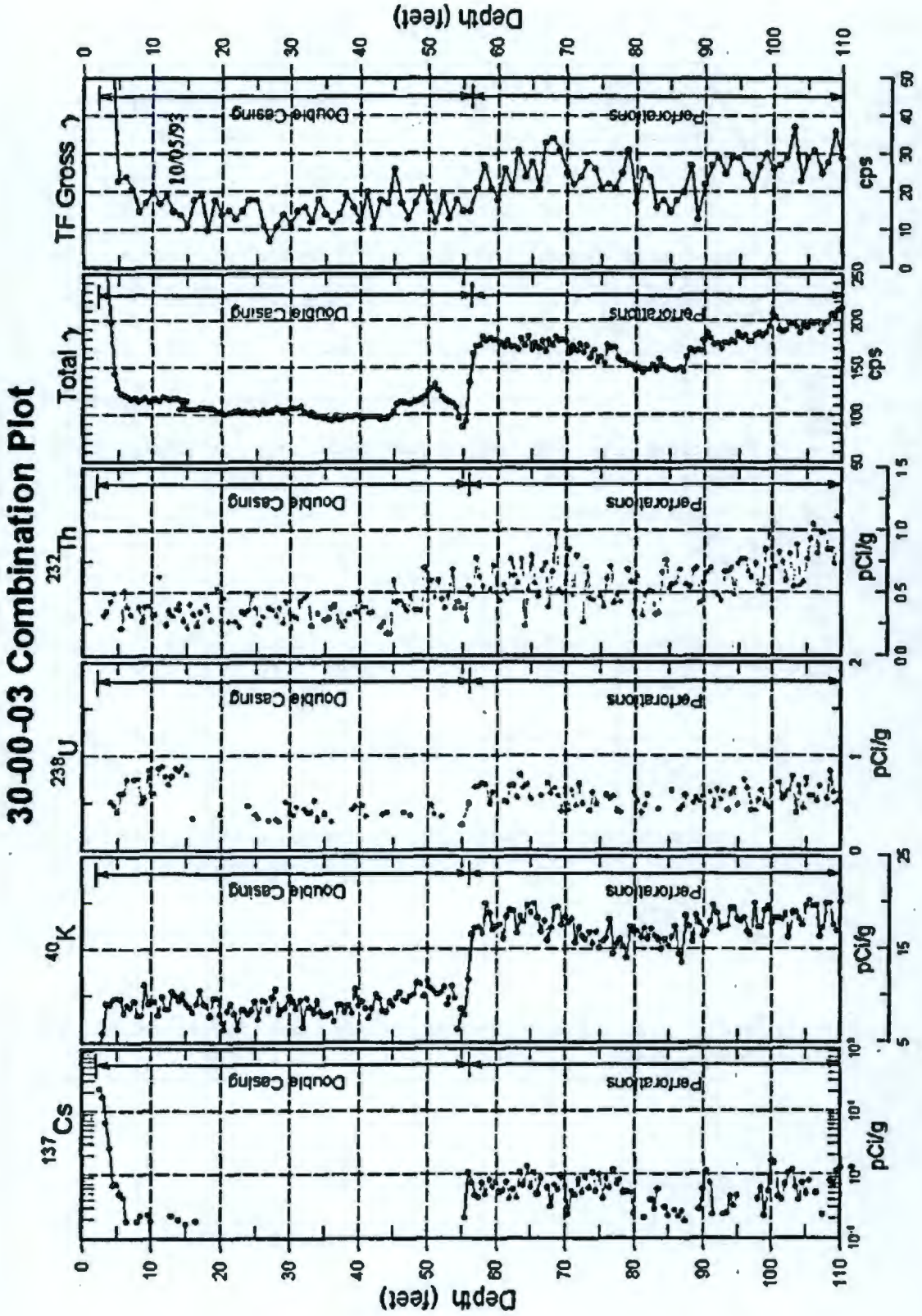
Grade thickness product over 0 to 7 feet is erratic and highly variable from 1975 to 1986, indicative of tank farm activity. Since 1986, the grade thickness product is still not consistent with the decay from Cs-137 (HPGe identified).

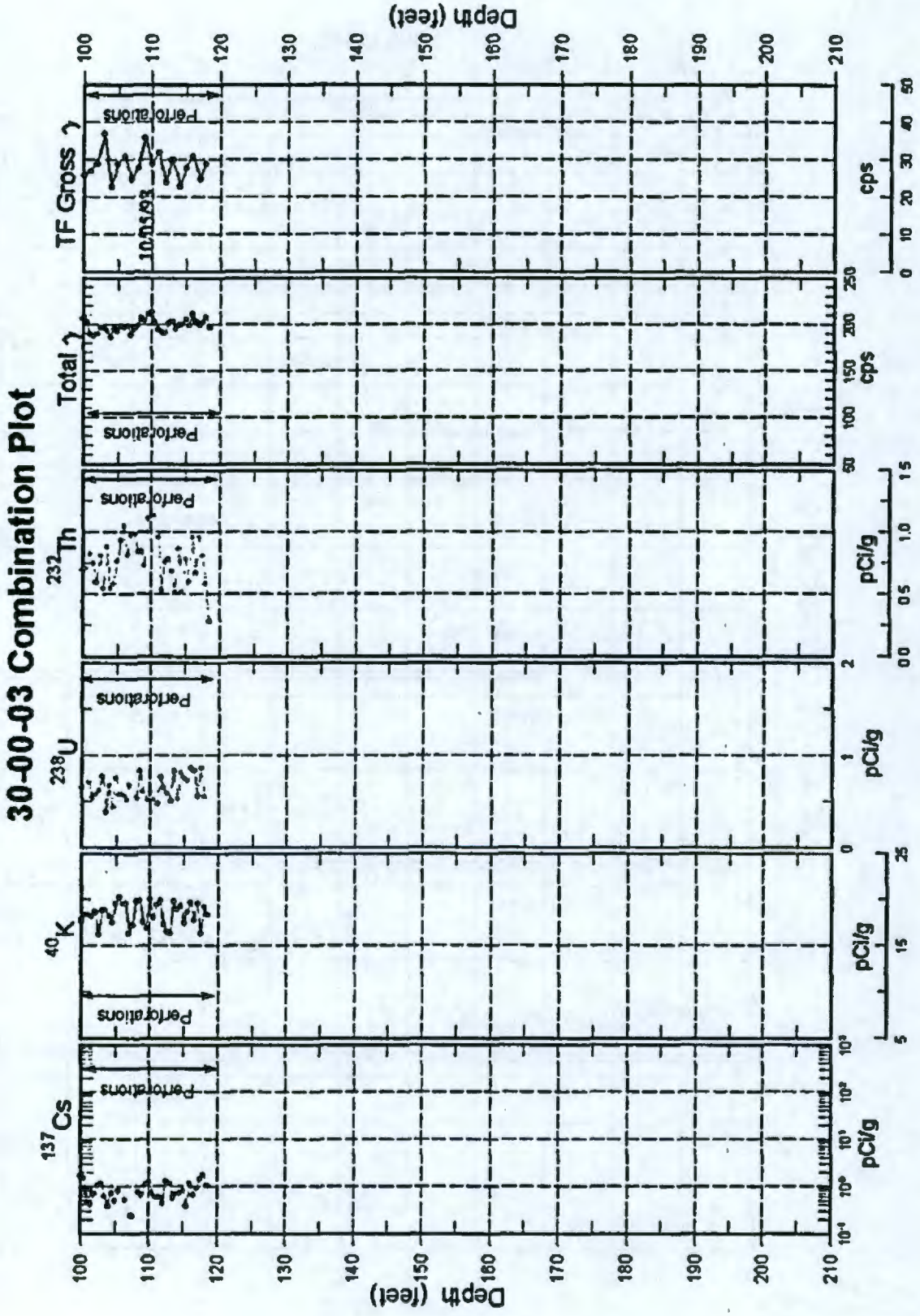
Gross Gamma Survey Information

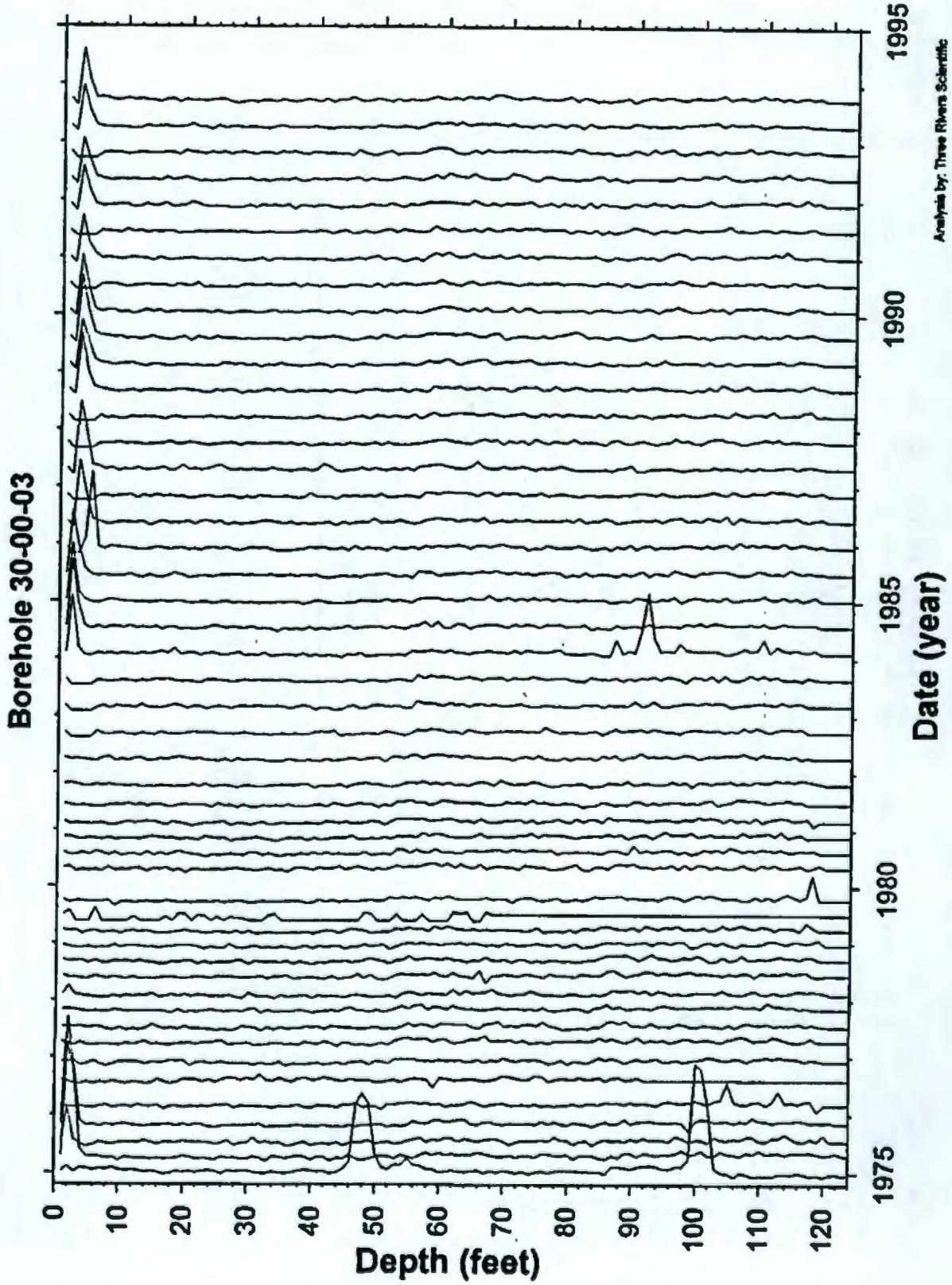
Probe Type Processed :	04: NaI
Other Probe Types :	03: Neutron
Survey Depth :	120 ft
First Survey Date :	1/10/1975
Last Survey Date :	10/05/1993
Number Surveys Processed :	194

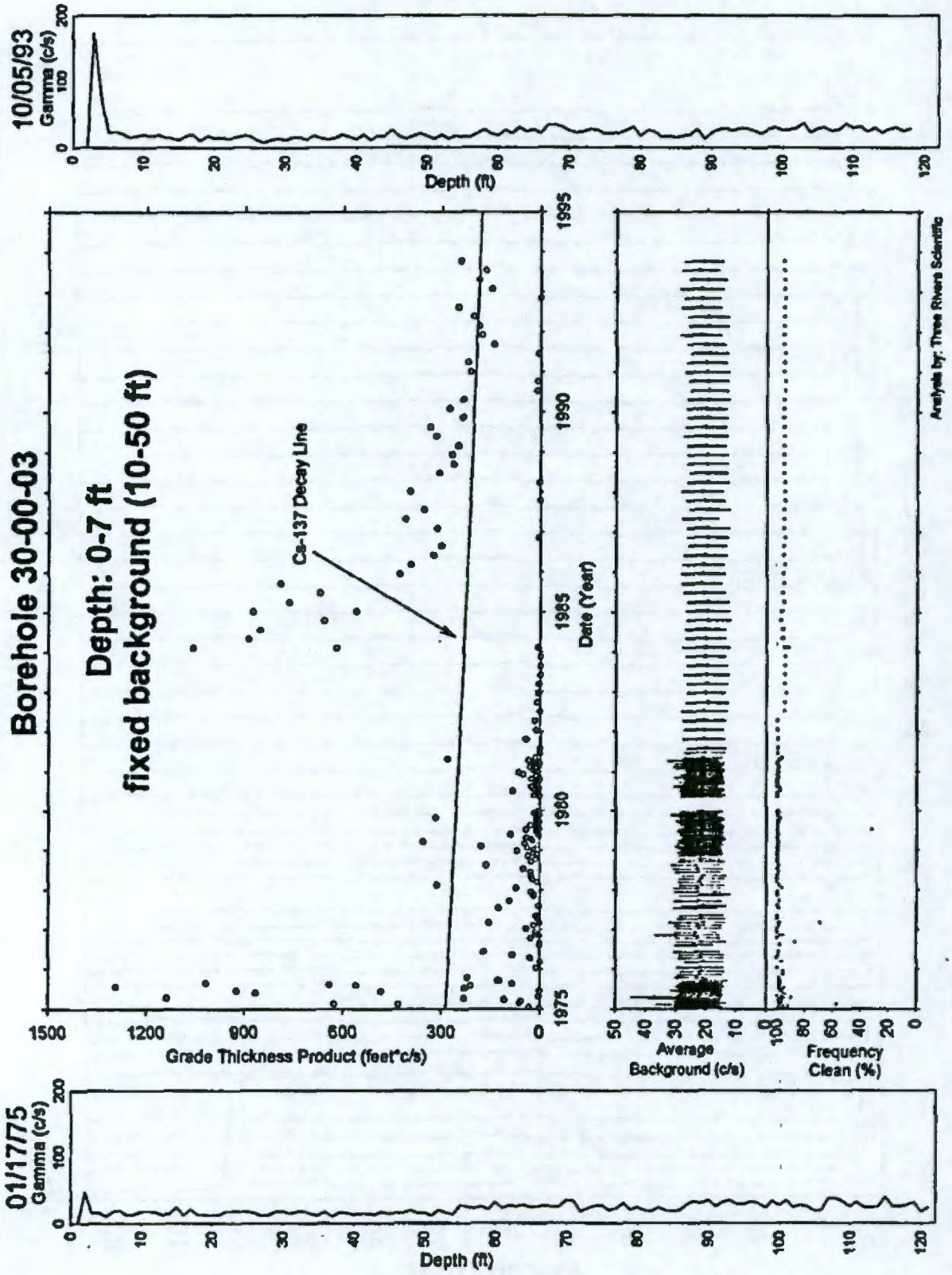
Analysis Notes

Method Used to Compute Background :	Fixed background (0-50 ft)
Depth(s) where Contamination Identified in Gross Gamma Surveys :	0-7 ft Tank Farm Activity
Analyst Name :	R.R. Randall
Company Name :	Three Rivers Scientific


30-00-03 Combination Plot
TF Gross γ
Total γ
232Th
238U
40K
137Cs
Double Casing
Perforations
10/05/93
cps
pCi/g
Depth (feet)


30-00-03 Combination Plot
137Cs
40K
238U
232Th
Total γ
TF Gross γ
Perforations
10/15/93
pCi/g
cps
Depth (feet)


Borehole 30-00-03
Depth (feet)
0
10
20
30
40
50
60
70
80
90
100
110
120
Date (year)
1975
1980
1985
1990
1995
Analysis by: Three Rivers Scientific


Borehole 30-00-03
Depth: 0-7 ft
fixed background (10-50 ft)
Cs-137 Decay Line
Grade Thickness Product (feet*c/s)
Date (Year)
Average Background (c/s)
Frequency Clean (%)
Analysis by: Three Rivers Scientific
10/05/93
Gamma (c/s)
Depth (ft)
01/17/75
Gamma (c/s)
Depth (ft)

Borehole 30-00-06

No Gamma Ray Emitting Contamination Identified.

No significant levels of gamma ray contamination are present, based upon gross gamma data, above the survey probe detection threshold between 1975 and 1994 in the vadose zone from 2 to 110 feet. The HPGe logging system detected Cs-137 at less than 2 pCi/g, except near the surface (less than 2 feet).

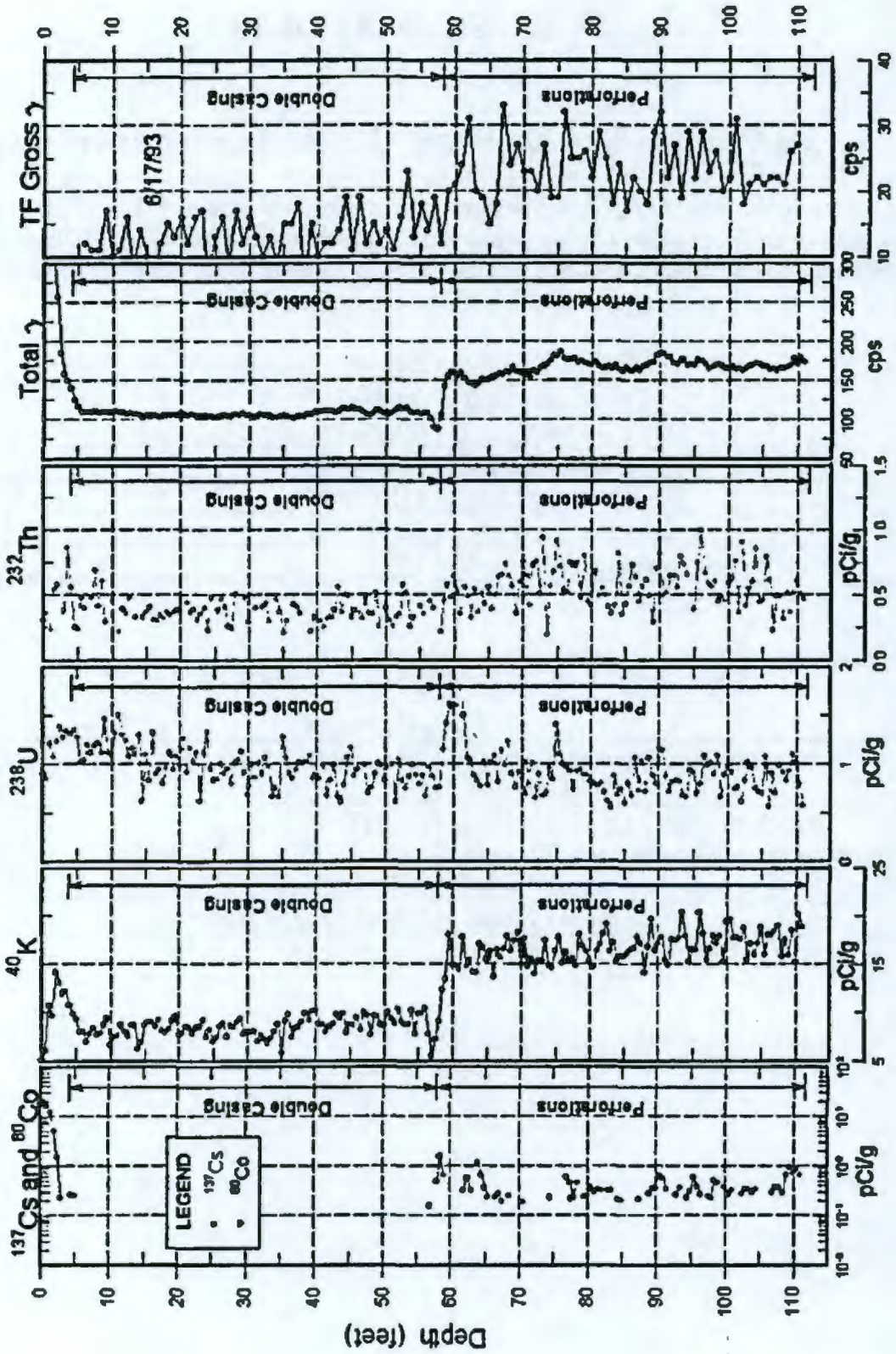
Gross Gamma Survey Information

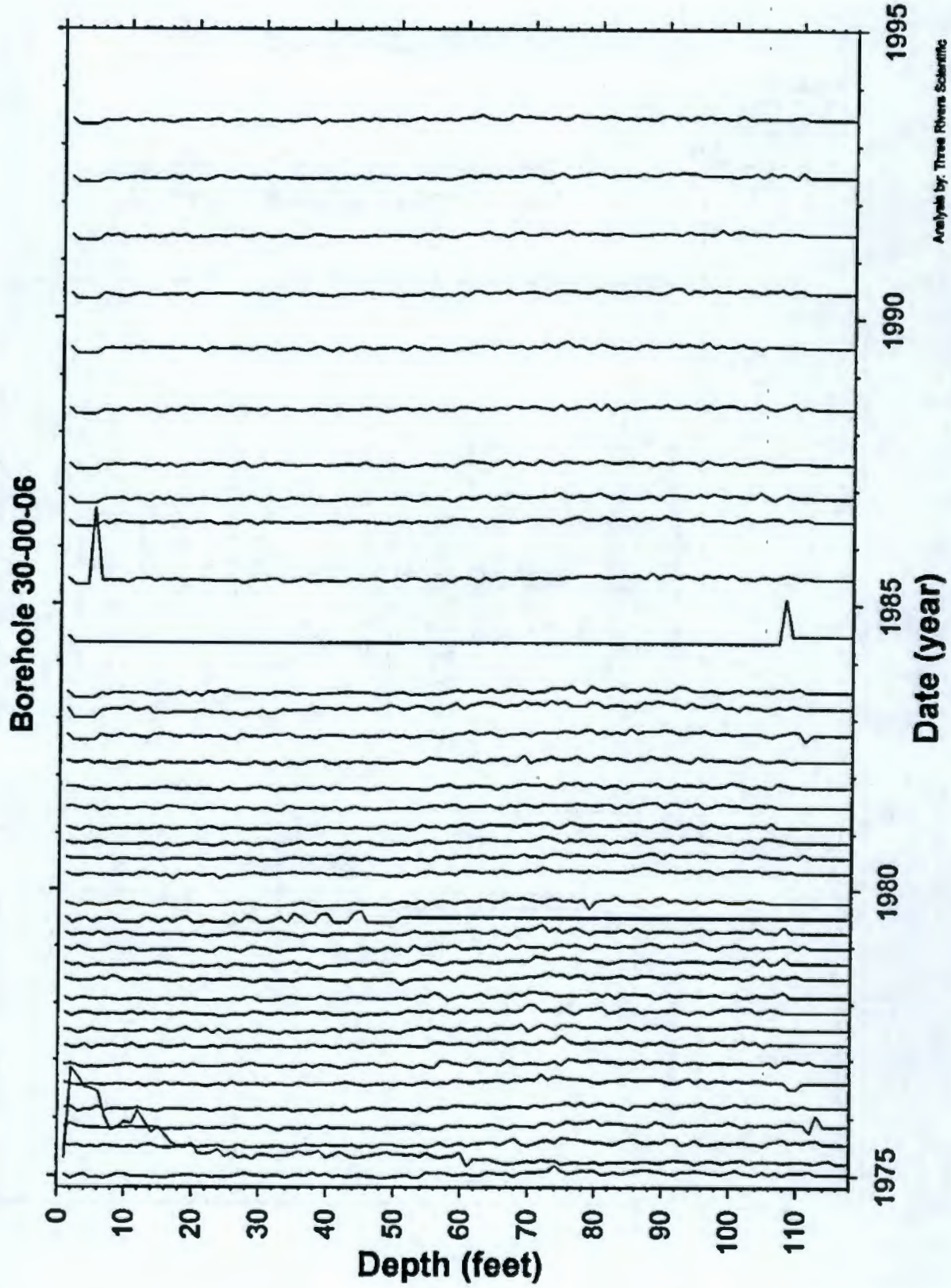
Probe Type Processed :	04: NaI
Other Probe Types :	03: Neutron
Survey Depth :	110 ft
First Survey Date :	1/10/1975
Last Survey Date :	6/17/1993
Number Surveys Processed :	163

Analysis Notes

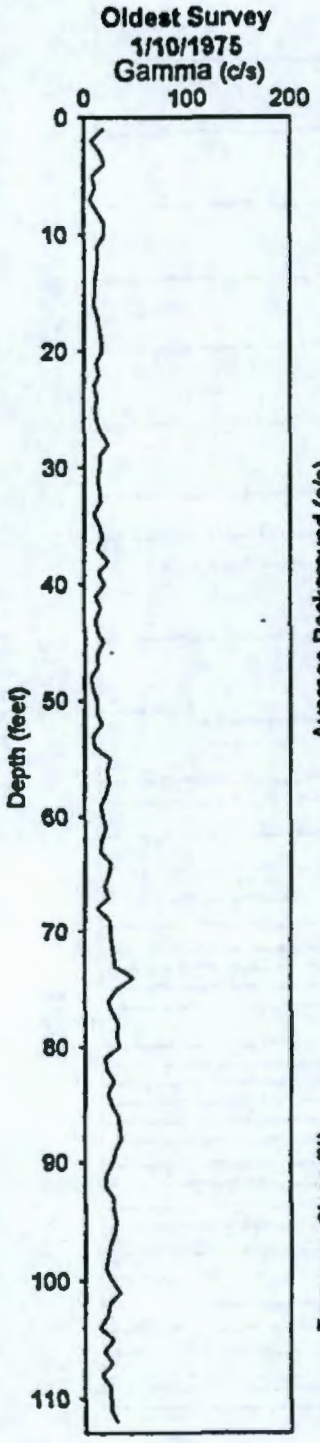
Method Used to Compute Background :	Threshold 0<val<50
Depth(s) where Contamination Identified in Gross Gamma Surveys :	NONE
Analyst Name :	R.R. Randall
Company Name :	Three Rivers Scientific

30-00-06 Combination Plot

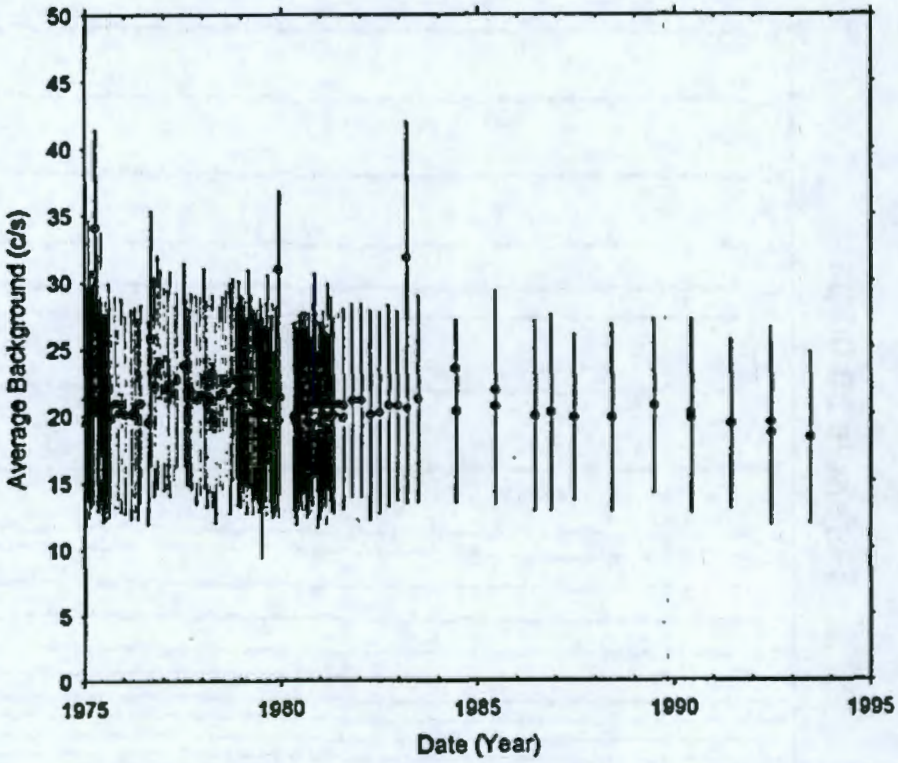


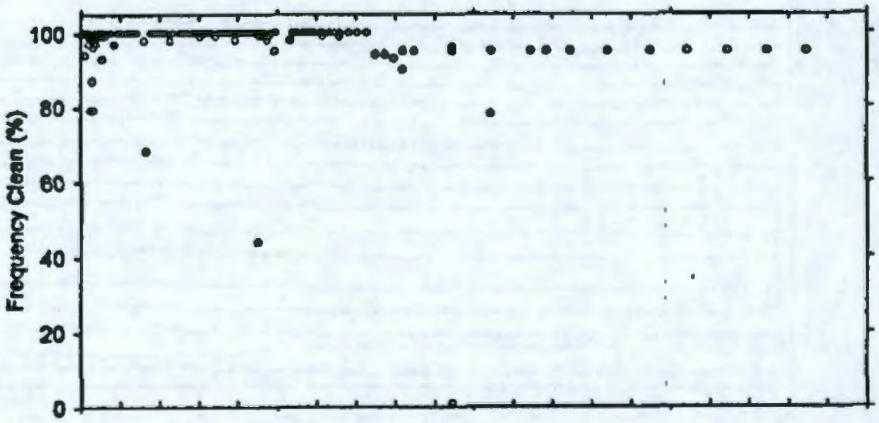

Borehole 30-00-06
Depth (feet)
0
10
20
30
40
50
60
70
80
90
100
110
Date (year)
1975
1980
1985
1990
1995
Analysis by: Three Rivers Scientific

Borehole 30-00-06



No Gamma-Ray Emitting Contamination Above Survey Detection Threshold





Analysis by: Three Rivers Scientific

Borehole 30-00-09

No Gamma Ray Emitting Contamination Identified.

No significant levels of gamma ray contamination are present, based upon gross gamma data, above the survey probe detection threshold between 1975 and 1994 in the vadose zone from 2 to 55 feet. The HPGe logging system detected Cs-137 at 5 pCi/g at 2 feet, and less for the remainder of the logged depths.

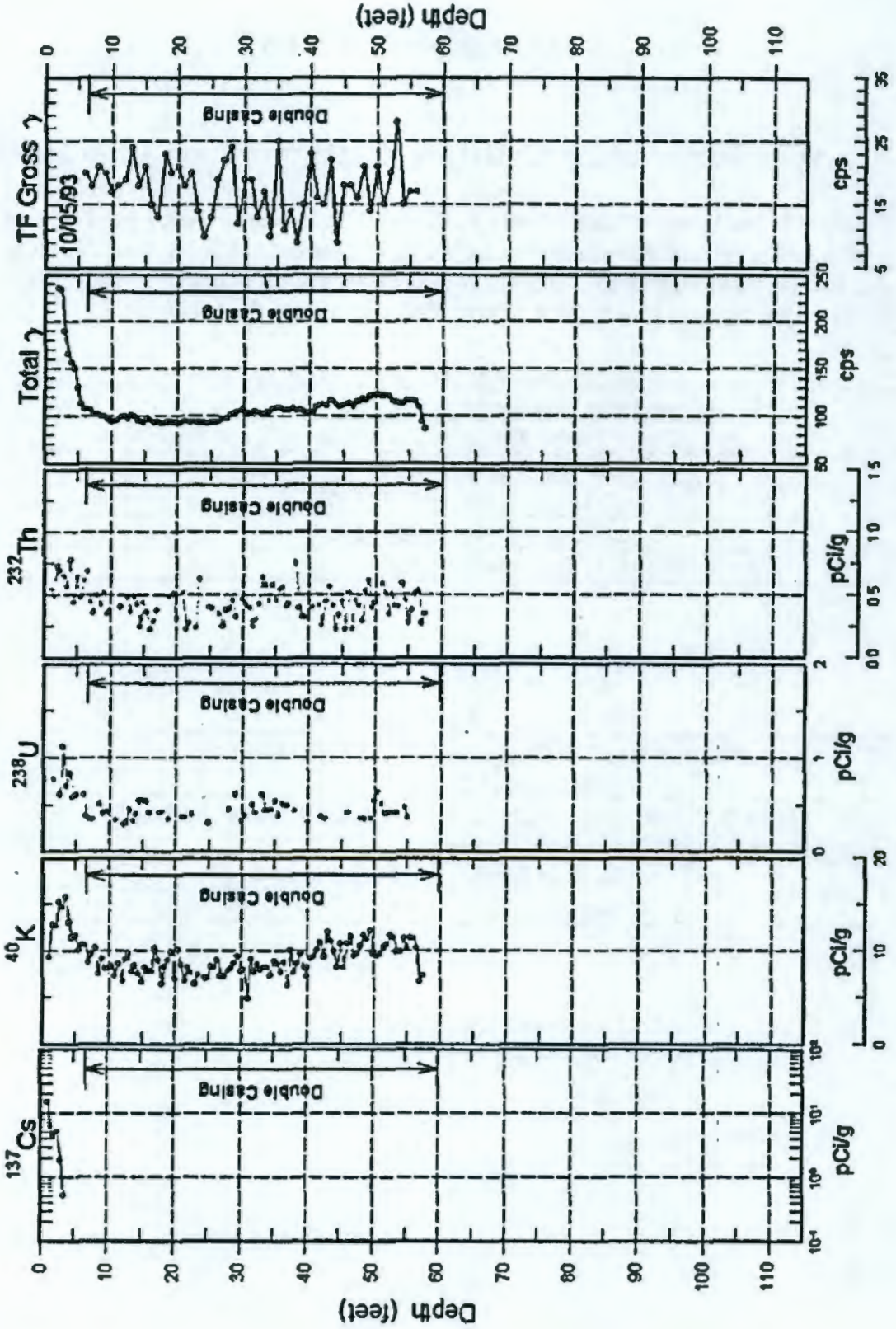
Gross Gamma Survey Information

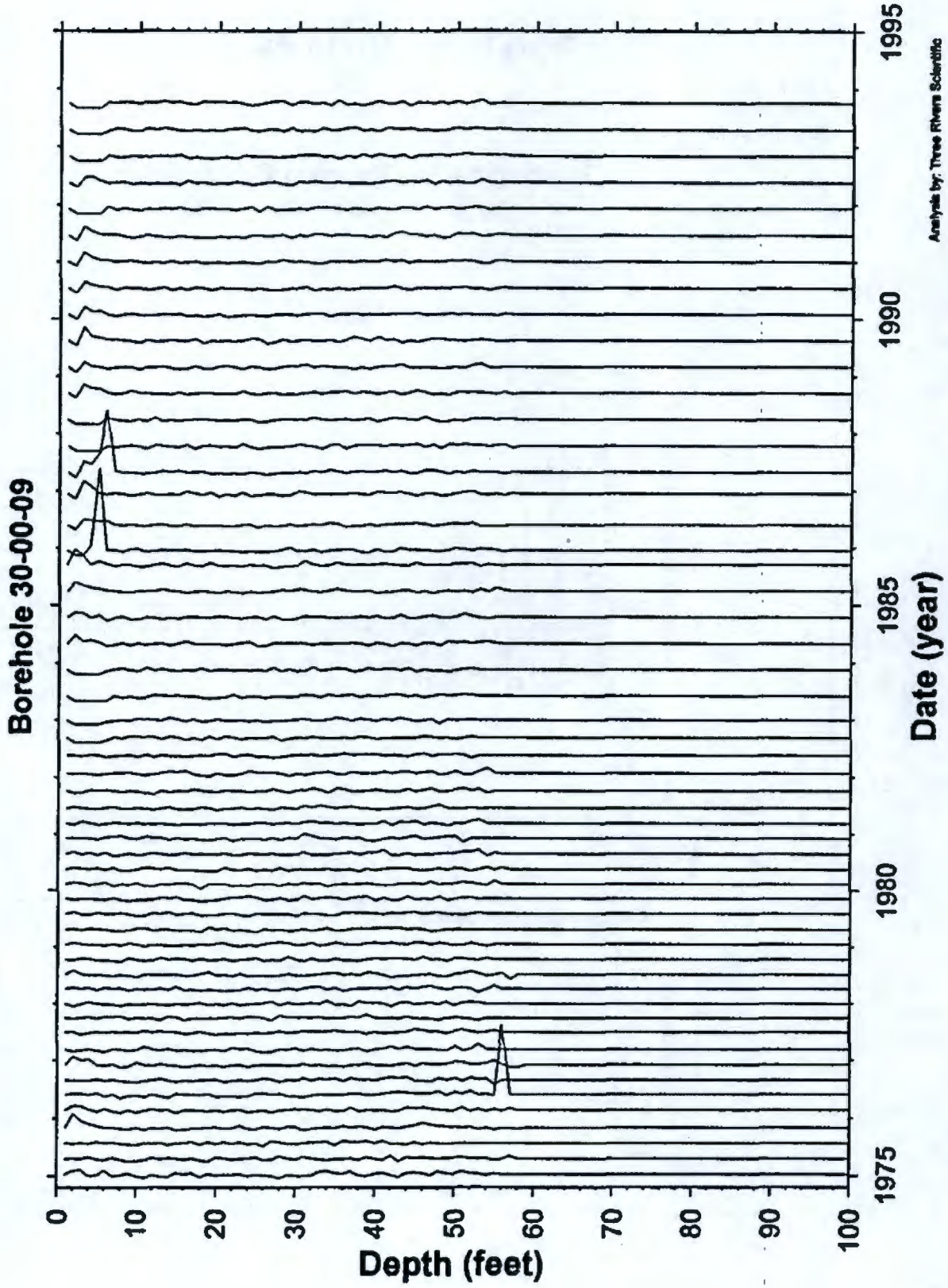
Probe Type Processed :	04: NaI
Other Probe Types :	03: Neutron
Survey Depth :	55 ft
First Survey Date :	1/10/1975
Last Survey Date :	10/5/1993
Number Surveys Processed :	350

Analysis Notes

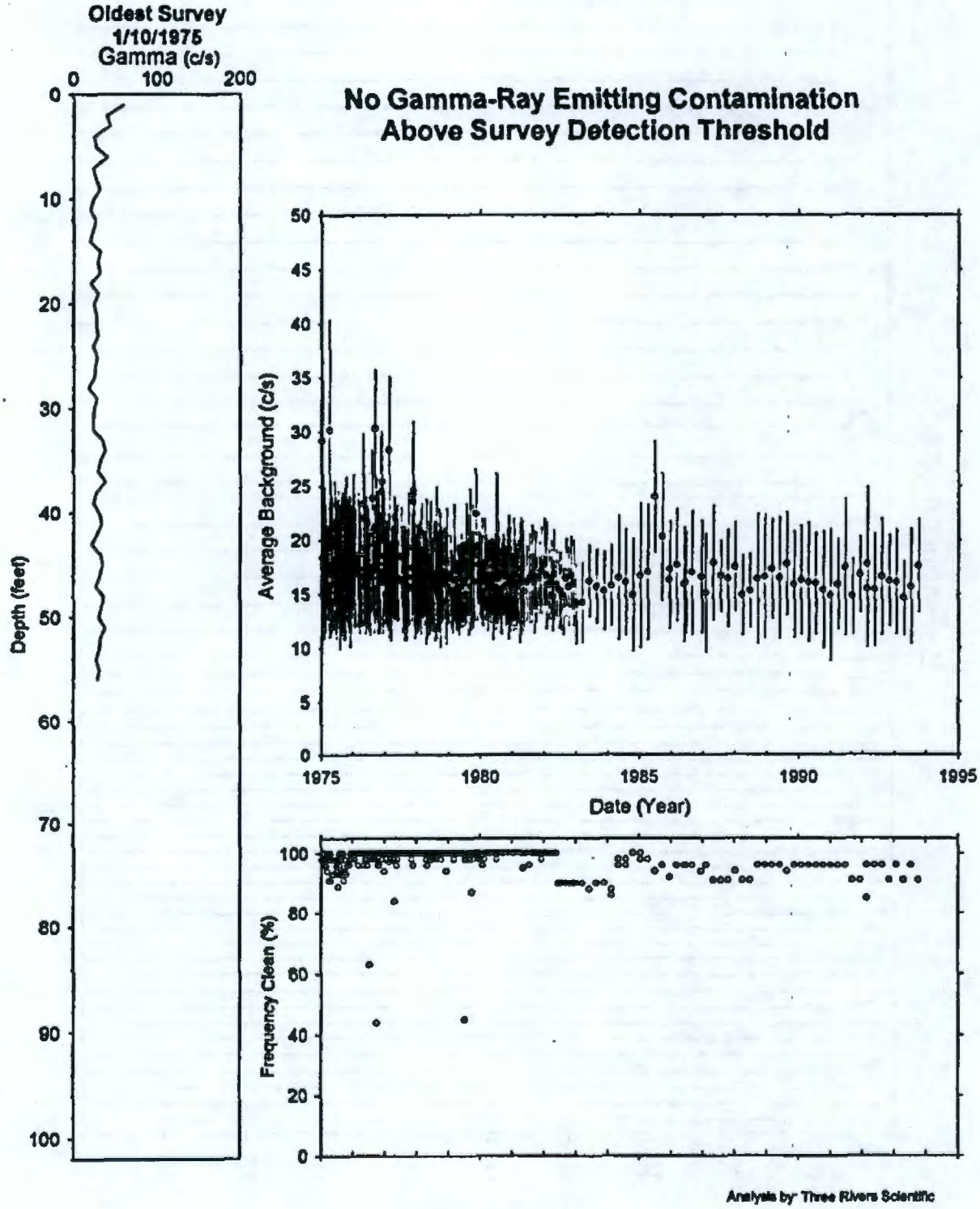
Method Used to Compute Background :	Threshold 0<val<50
Depth(s) where Contamination Identified in Gross Gamma Surveys :	0-5 ft Tank Farm Activity
Analyst Name :	R.R. Randall
Company Name :	Three Rivers Scientific

30-00-09 Combination Plot




Borehole 30-00-09
Depth (feet)
0
10
20
30
40
50
60
70
80
90
100
Date (year)
1975
1980
1985
1990
1995
Analysis by: Three Rivers Scientific

Borehole 30-00-09



Borehole 30-00-10

No Gamma Ray Emitting Contamination Identified.

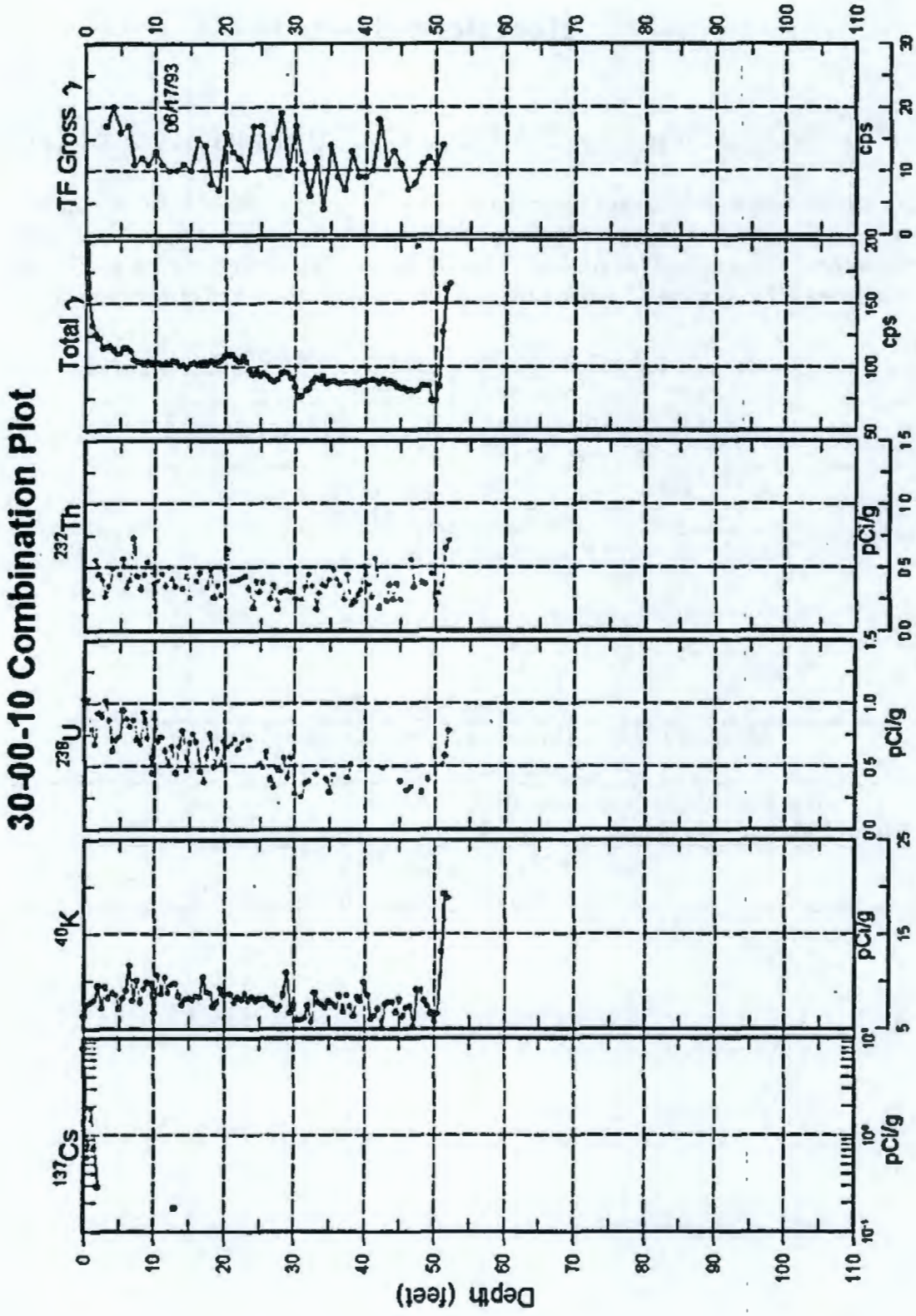
No significant levels of gamma ray contamination are present, based upon gross gamma data, above the survey probe detection threshold between 1975 and 1994 in the vadose zone from 2 to 55 feet. The HPGe logging system detected Cs-137 at 2 pCi/g near the surface (1 feet), and less for the remainder of the logged depths.

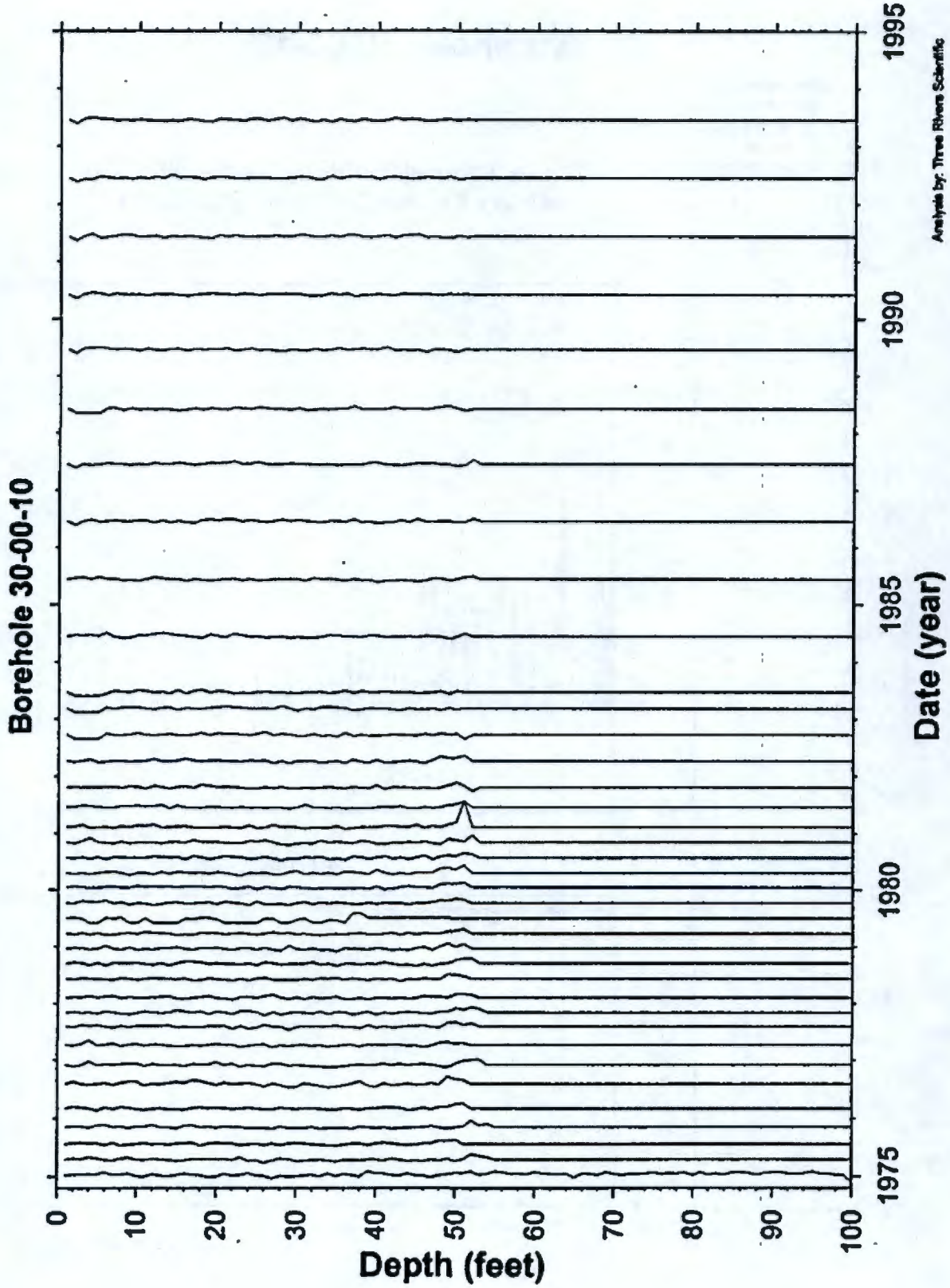
Gross Gamma Survey Information

Probe Type Processed :	04: NaI
Other Probe Types :	03: Neutron
Survey Depth :	55 ft
First Survey Date :	1/10/1975
Last Survey Date :	6/17/1993
Number Surveys Processed :	164

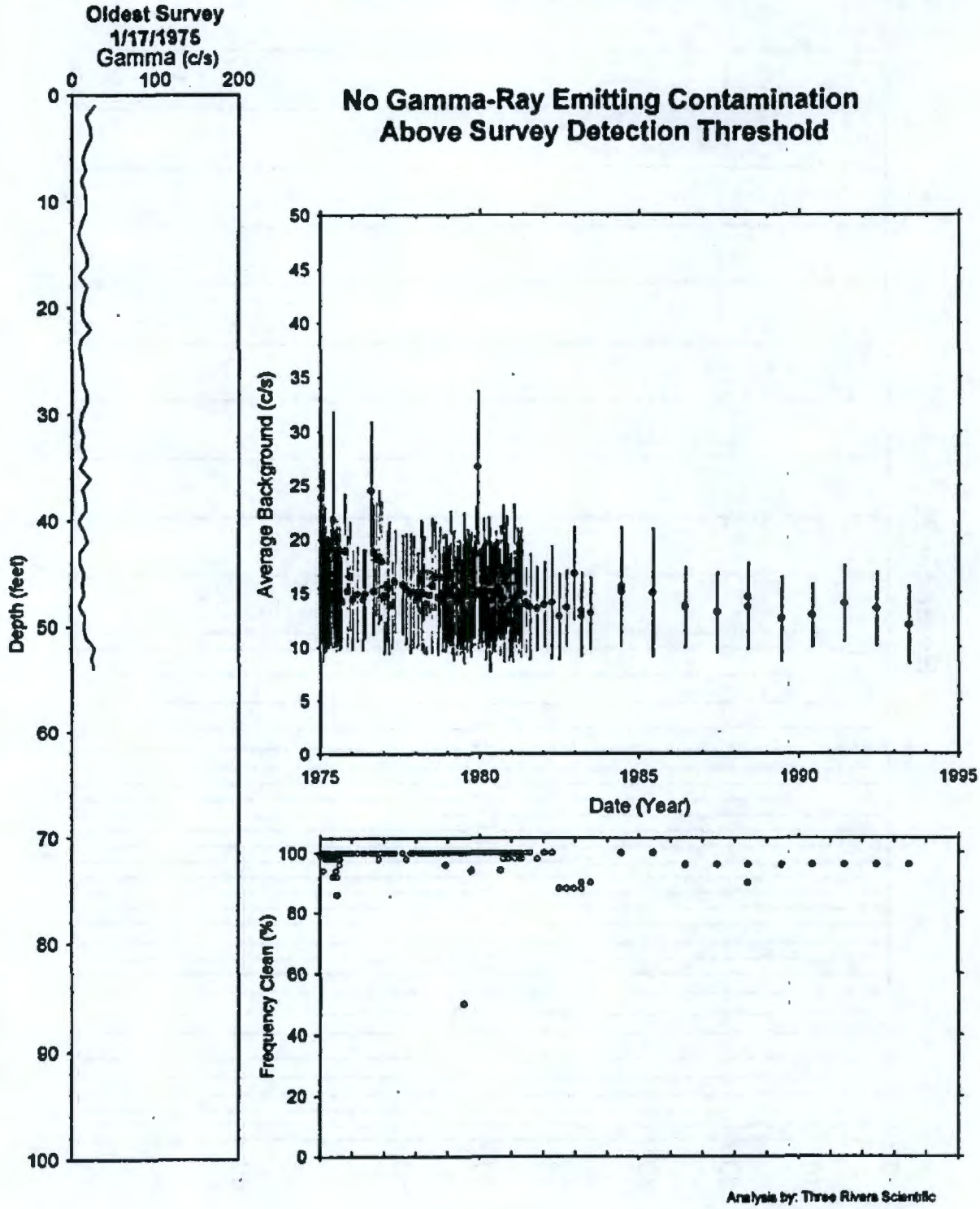
Analysis Notes

Method Used to Compute Background :	Threshold 0<val<50
Depth(s) where Contamination Identified in Gross Gamma Surveys :	NONE
Analyst Name :	R.R. Randall
Company Name :	Three Rivers Scientific


30-00-10 Combination Plot
TF Gross γ
06/17/93
Total γ
232Th
238U
40K
137Cs
cps
pCi/g
Depth (feet)


Borehole 30-00-10
Depth (feet)
0
10
20
30
40
50
60
70
80
90
100
Date (year)
1975
1980
1985
1990
1995
Analysis by: Three Rivers Scientific

Borehole 30-00-10



Borehole 30-00-11

Contamination (Cs-137) from 3-14 feet is Undetermined.

Grade thickness product over 3 to 14 feet may suffer from depth control errors prior to 1986, but after 1986 depth control errors should not affect the grade thickness product results. Between 1986 and 1990 there is no agreement between observed grade thickness and the Cs-137 (HPGe identified) decay. The data collection frequency is too low after 1990 to make an assessment of the classification from 1990 to 1994, thus the category is undetermined.

The level of Cs-137 from the HPGe survey would not typically generate the observed level of gross gamma. This indicates the possibility of either a remote Cs-137 source, or the presence of a strong beta only source, (such as Sr-90).

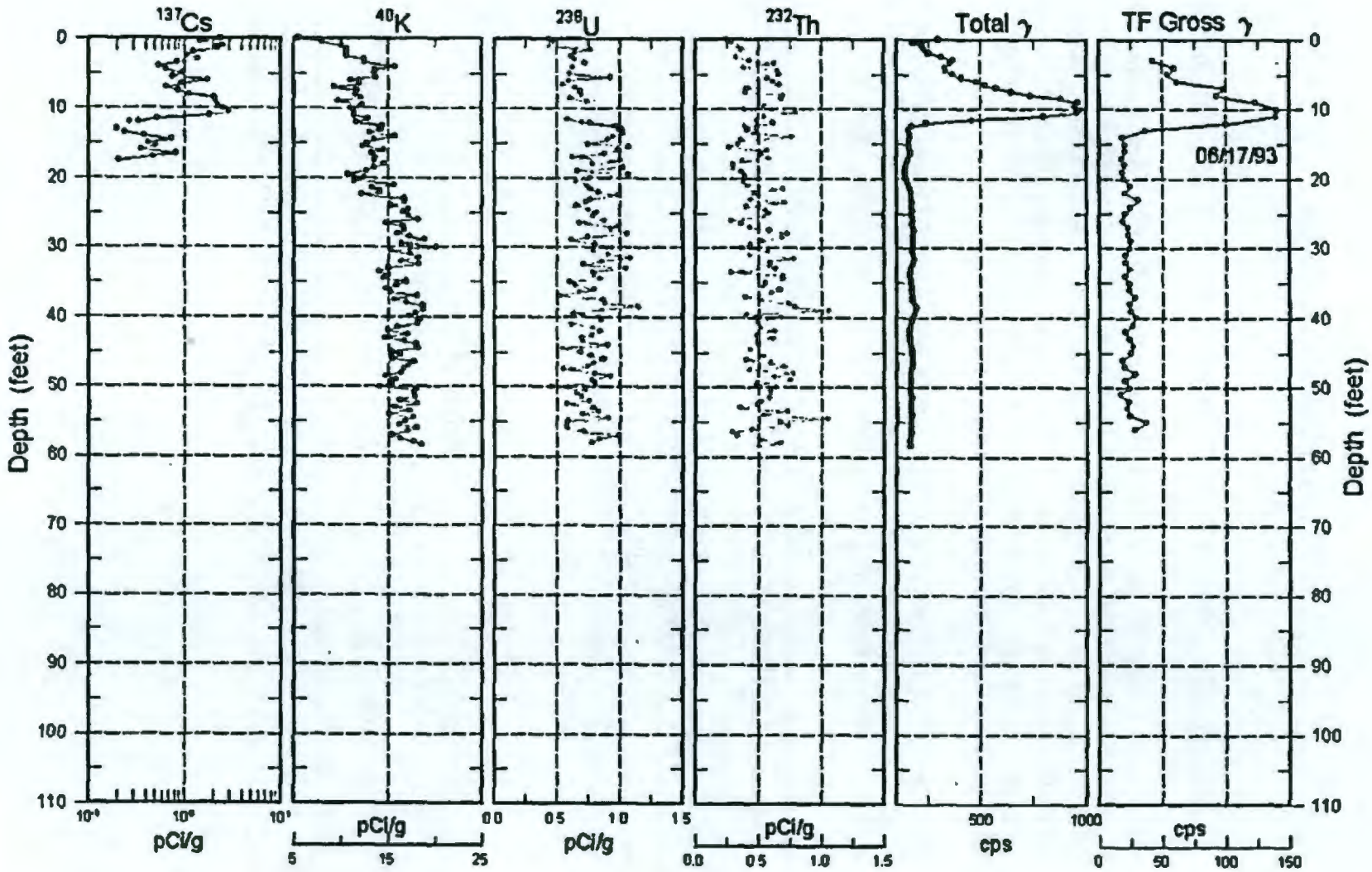
Gross Gamma Survey Information

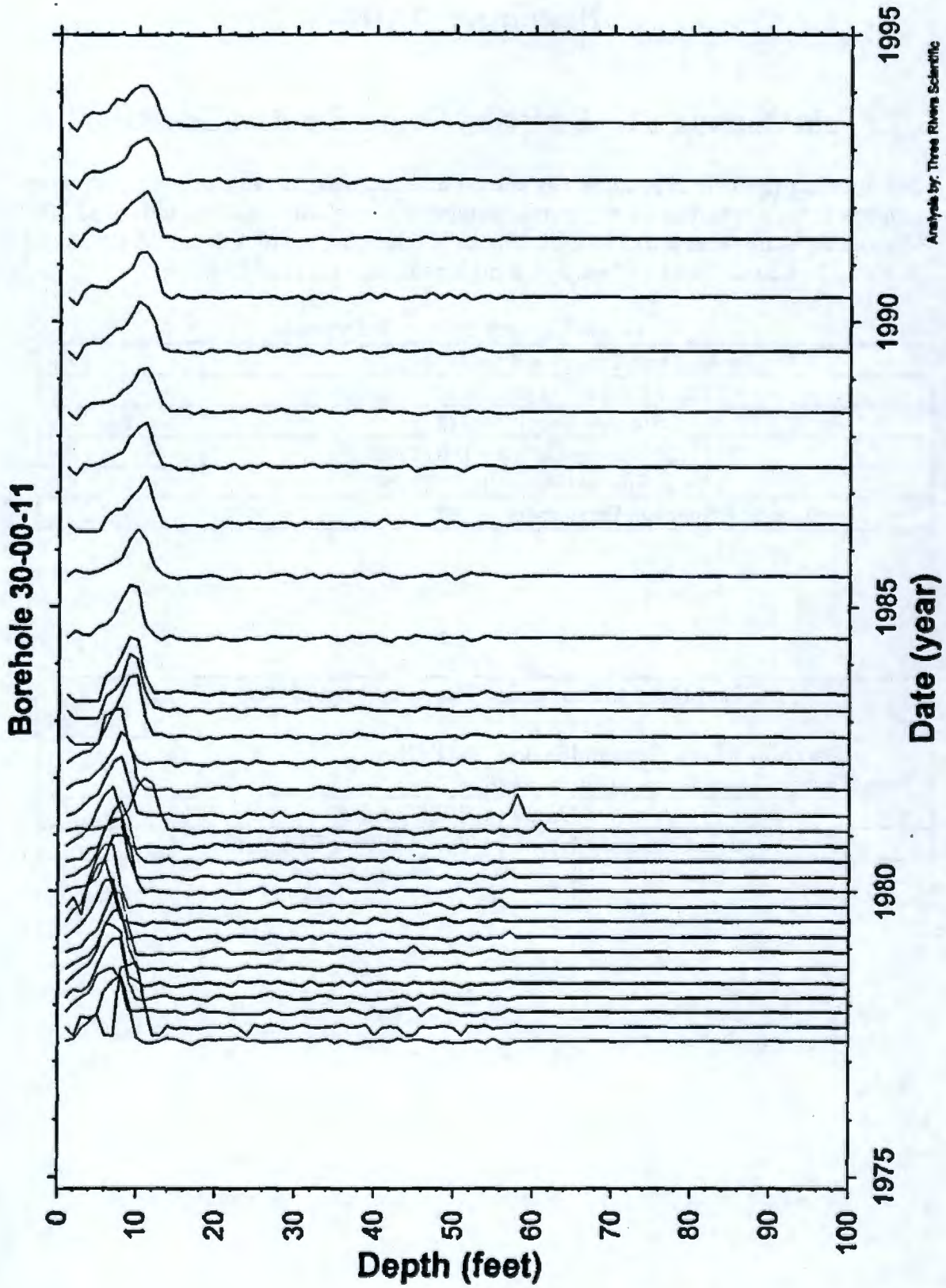
Probe Type Processed :	04: NaI
Other Probe Types :	03: Neutron
Survey Depth :	58 ft
First Survey Date :	5/13/1977
Last Survey Date :	6/17/1993
Number Surveys Processed :	168

Analysis Notes

Method Used to Compute Background :	Threshold 0<val<50
Depth(s) where Contamination Identified in Gross Gamma Surveys :	3-14 ft Tank Farm Activity
Analyst Name :	R.R. Randall
Company Name :	Three Rivers Scientific

30-00-11 Combination Plot




Borehole 30-00-11
Depth (feet)
0
10
20
30
40
50
60
70
80
90
100
Date (year)
1975
1980
1985
1990
1995
Analysis by: Three Rivers Scientific

Borehole 30-00-12

No Gamma Ray Emitting Contamination Identified.

No significant levels of gamma ray contamination are present, based upon gross gamma data, above the survey probe detection threshold between 1975 and 1994 in the vadose zone from 2 to 145 feet. The HPGe logging system detected Cs-137 at 0.4 pCi/g or less from 2 to 145 feet, but a high reading at 0 ft of 13 pCi/g.

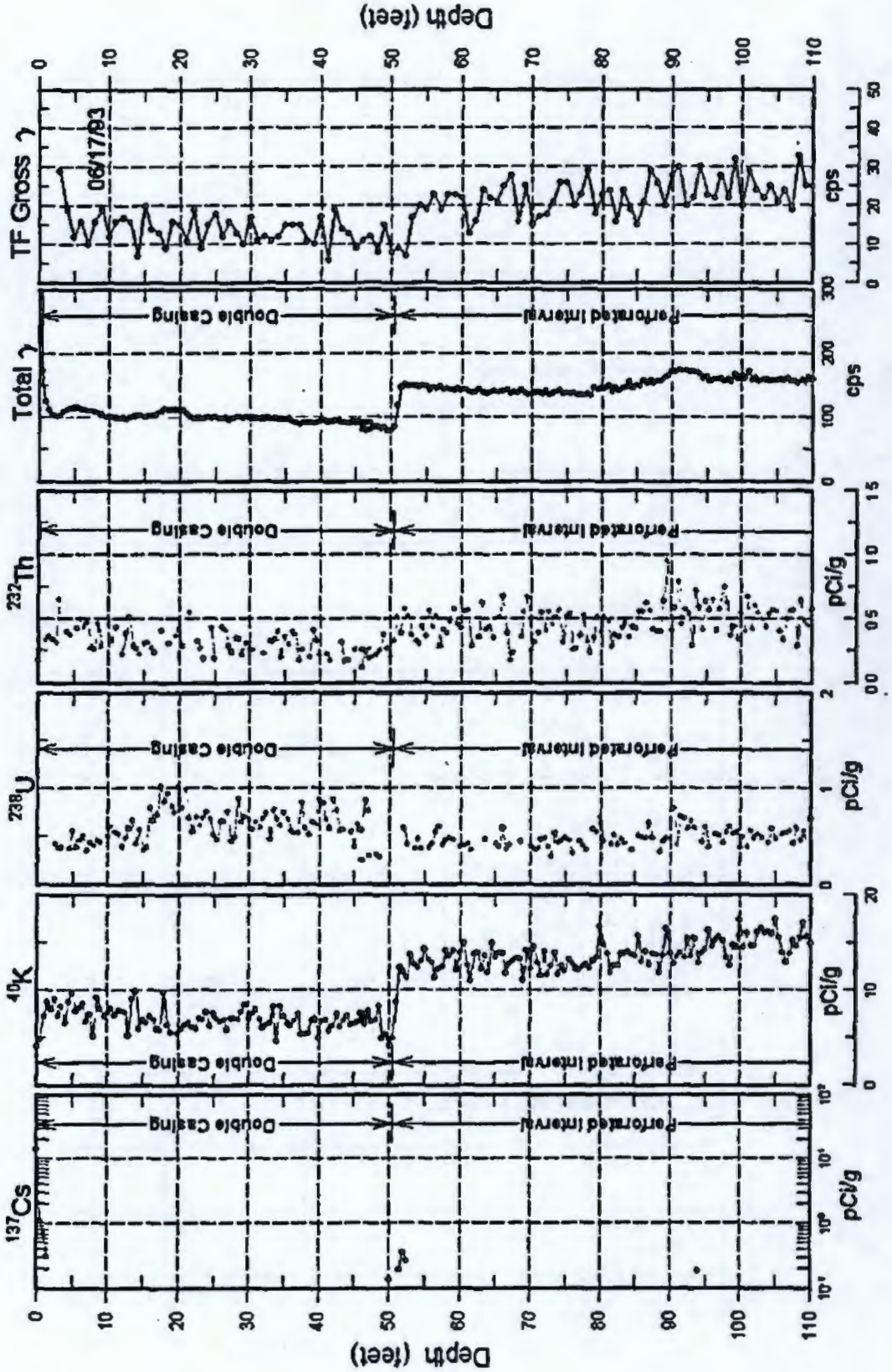
Gross Gamma Survey Information

Probe Type Processed :	04: NaI
Other Probe Types :	03: Neutron
Survey Depth :	145 ft
First Survey Date :	1/10/1975
Last Survey Date :	6/17/1993
Number Surveys Processed :	162

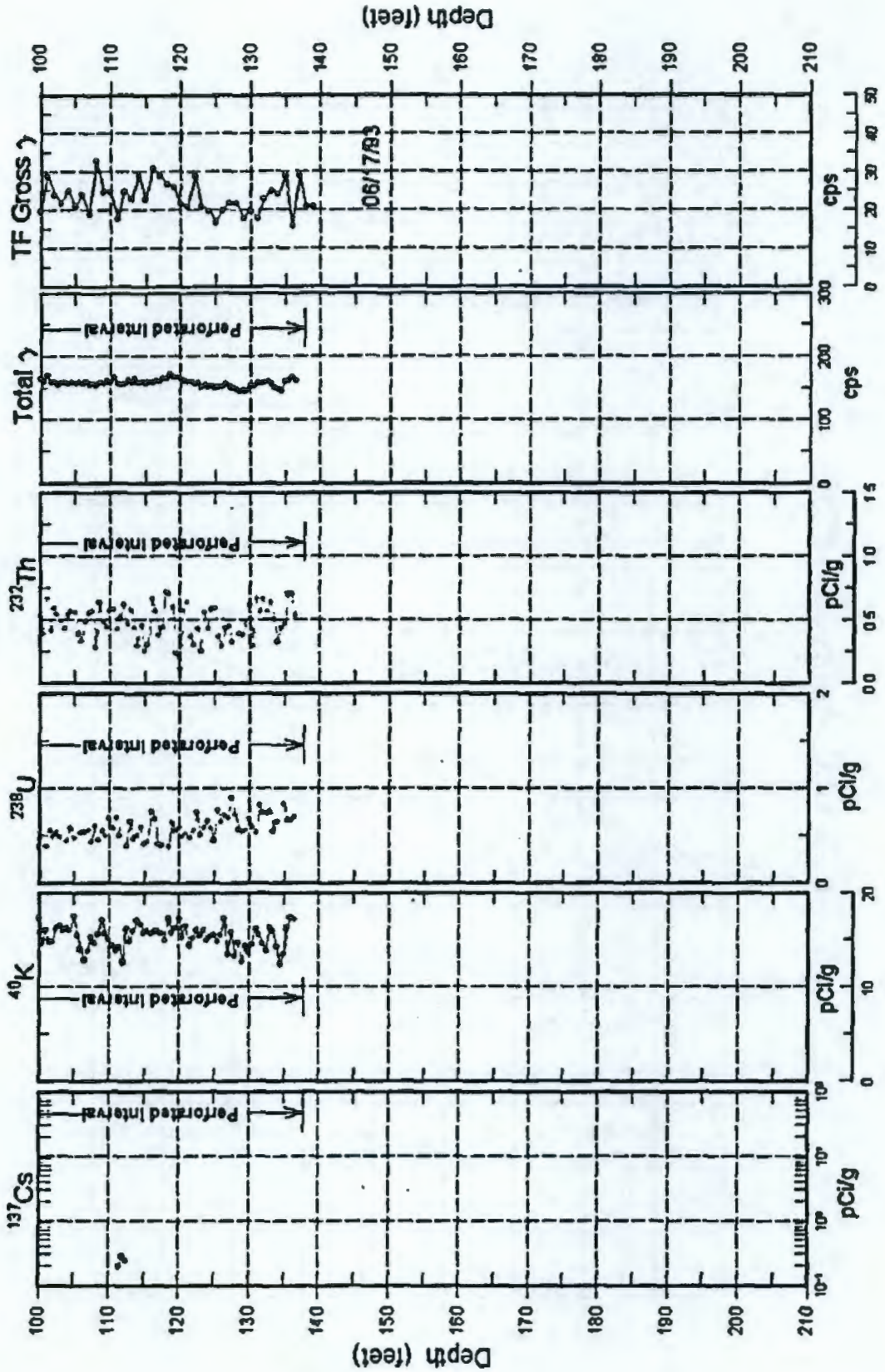
Analysis Notes

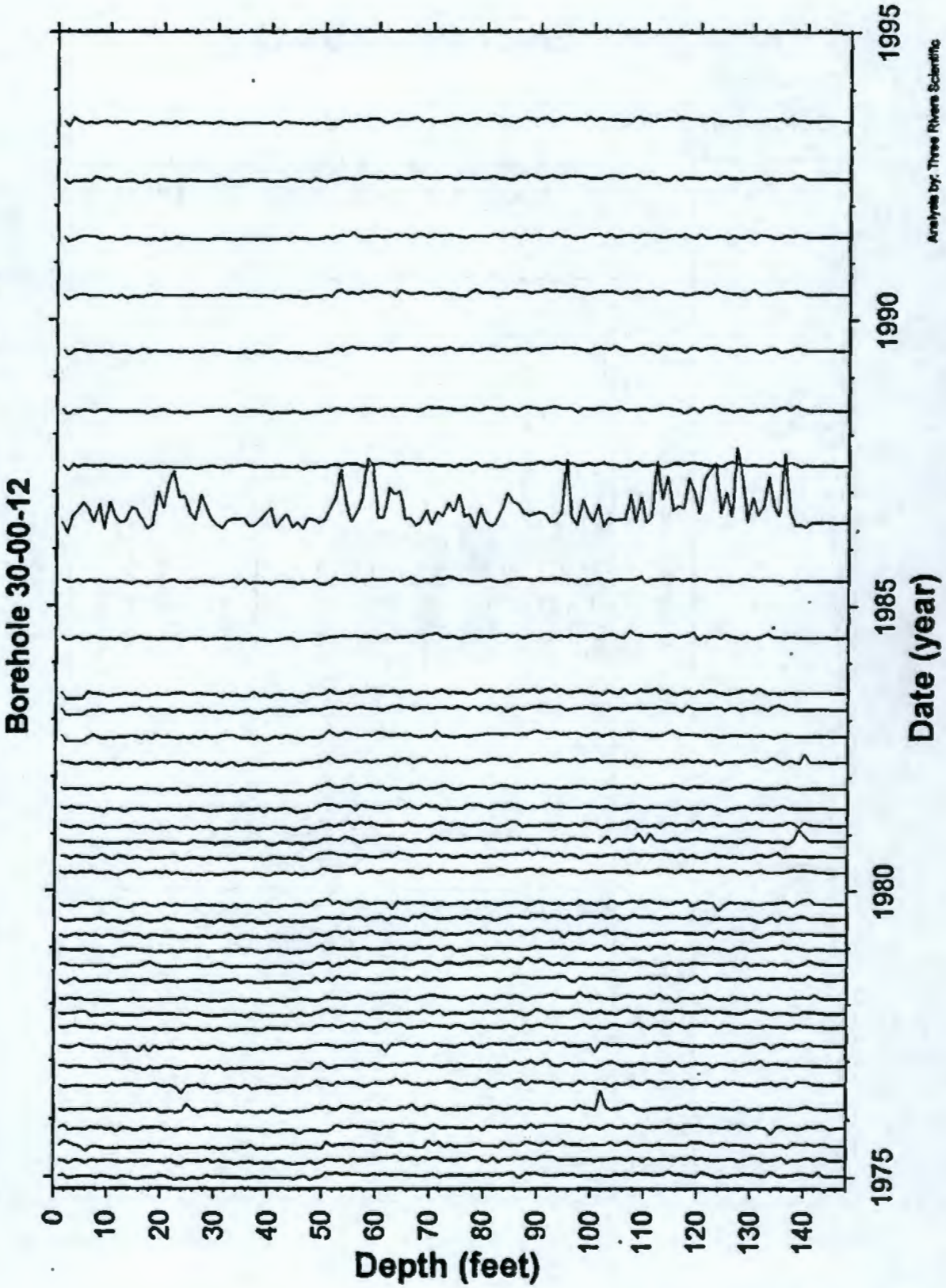
Method Used to Compute Background :	Threshold 0<val<50
Depth(s) where Contamination Identified in Gross Gamma Surveys :	NONE
Analyst Name :	R.R. Randall
Company Name :	Three Rivers Scientific

30-00-12 Combination Plot

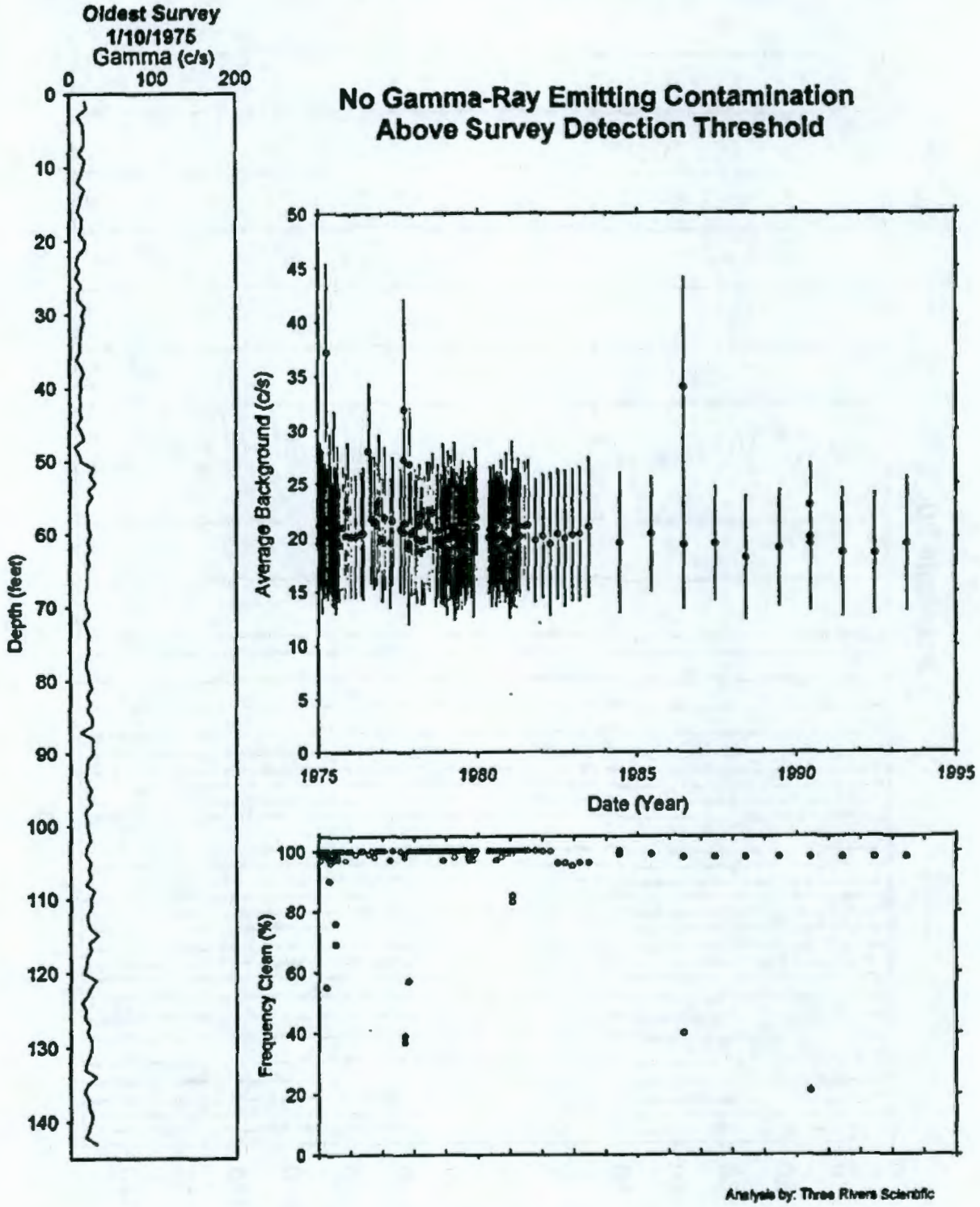


30-00-12 Combination Plot




Borehole 30-00-12
Depth (feet)
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
Date (year)
1975
1980
1985
1990
1995
Analysis by: Three Rivers Scientific

Borehole 30-00-12



Borehole 30-00-13

No Gamma Ray Emitting Contamination Identified.

No significant levels of gamma ray contamination are present, based upon gross gamma data, above the survey probe detection threshold between 1977 and 1994 in the vadose zone from 2 to 55 feet. The HPGe logging system detected Cs-137 at 0.5 pCi/g near the surface (1 feet), and no other detection for the remainder of the logged depths.

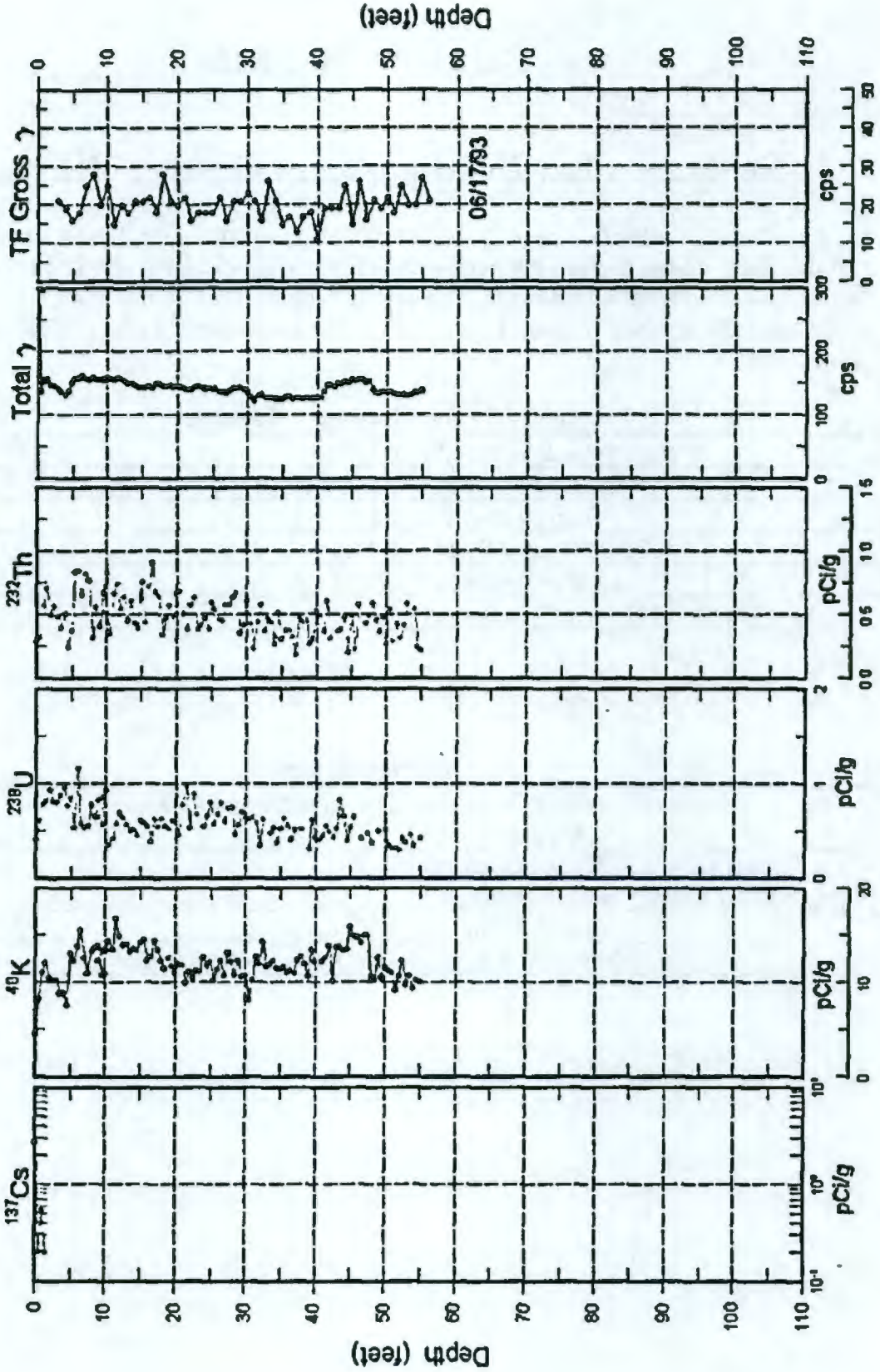
Gross Gamma Survey Information

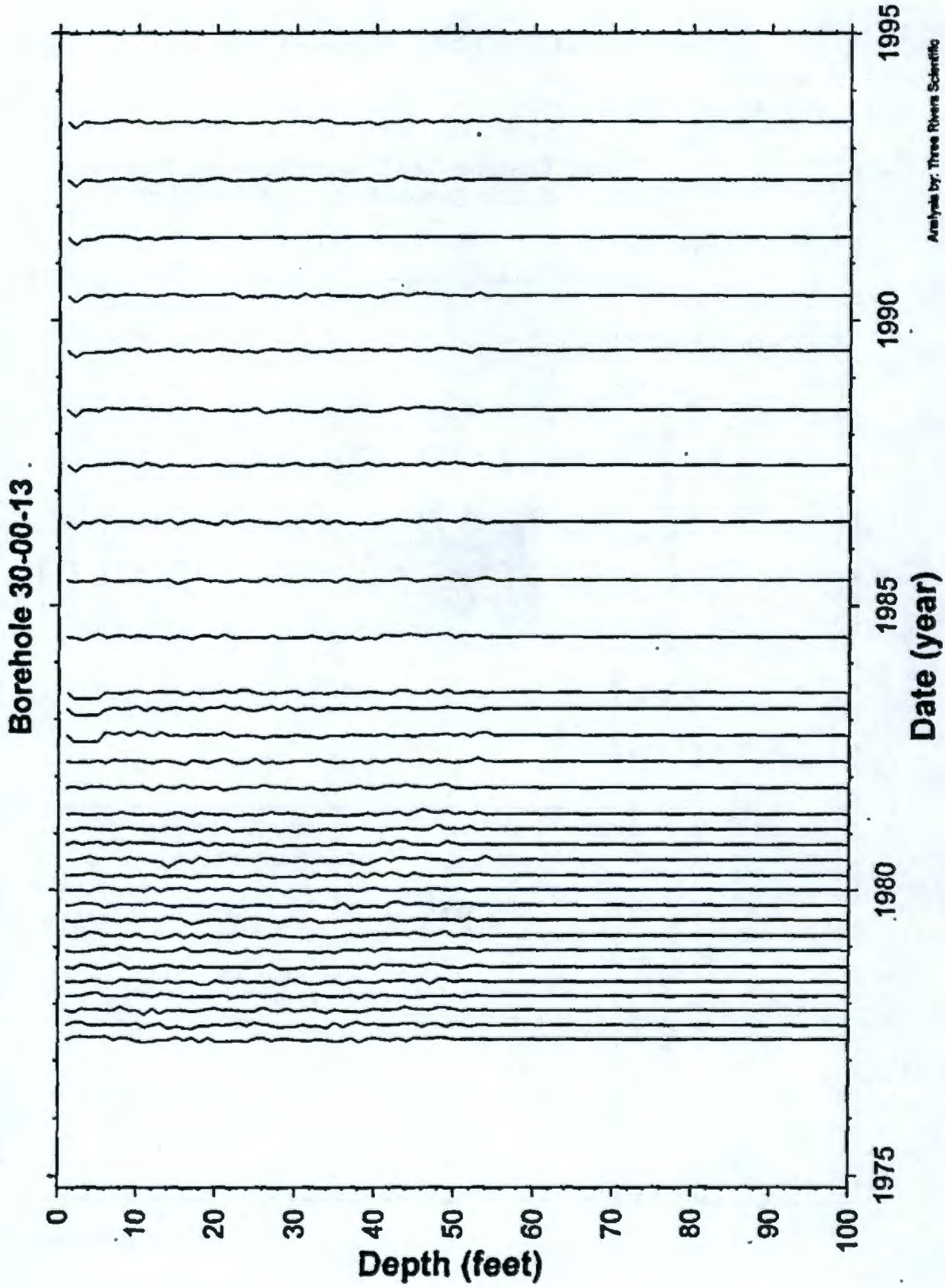
Probe Type Processed :	04: NaI
Other Probe Types :	03: Neutron
Survey Depth :	55 ft
First Survey Date :	5/13/1977
Last Survey Date :	6/17/1993
Number Surveys Processed :	166

Analysis Notes

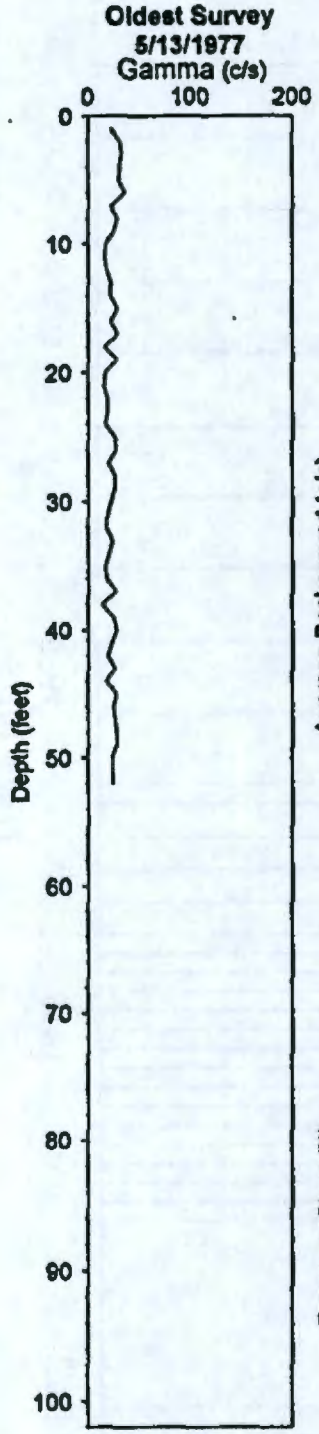
Method Used to Compute Background :	Threshold 0<val<50
Depth(s) where Contamination Identified in Gross Gamma Surveys :	NONE
Analyst Name :	R.R. Randall
Company Name :	Three Rivers Scientific

30-00-13 Combination Plot

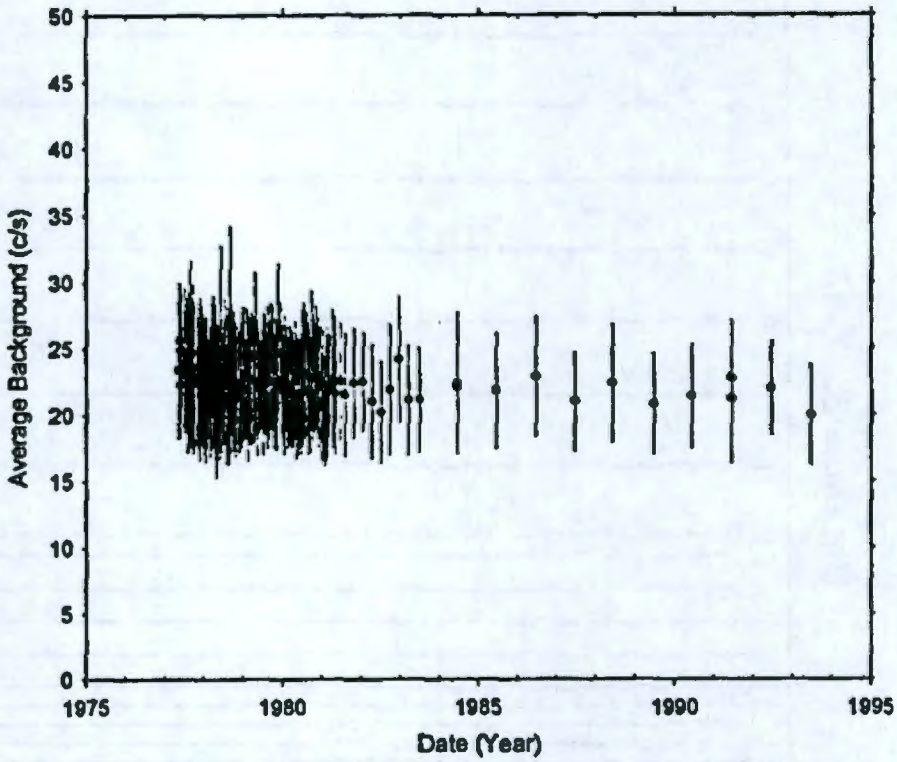


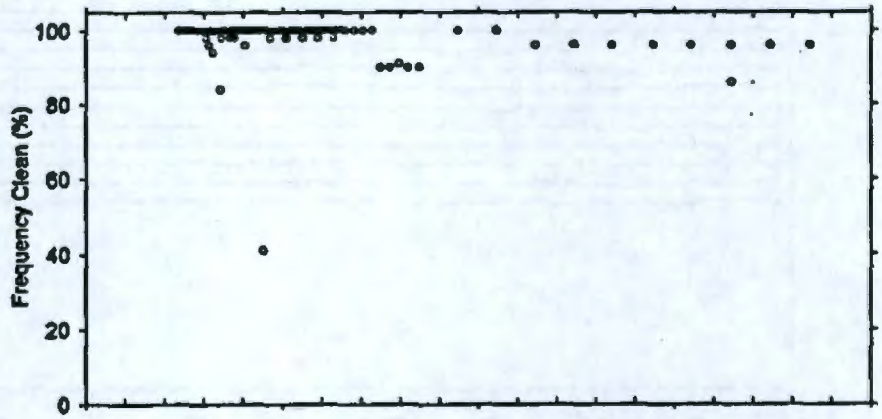

Borehole 30-00-13
Depth (feet)
0
10
20
30
40
50
60
70
80
90
100
Date (year)
1975
1980
1985
1990
1995
Analysis by: Three Rivers Scientific

Borehole 30-00-13



No Gamma-Ray Emitting Contamination Above Survey Detection Threshold





Analysis by Three Rivers Scientific

Borehole 30-00-22

Contamination (Cs-137) from 0-13 feet is Undetermined.

Grade thickness product over 0 to 13 feet may suffer from depth control errors prior to 1986, but after 1986 depth control errors do not affect the grade thickness product results. Between 1986 and 1994 there is good agreement between observed grade thickness product for this interval and the Cs-137 (HPGe identified) decay. Since both the data collection frequency from 1986 to 1994 is too low, and the lack of data match prior to 1986, the category is classified undetermined.

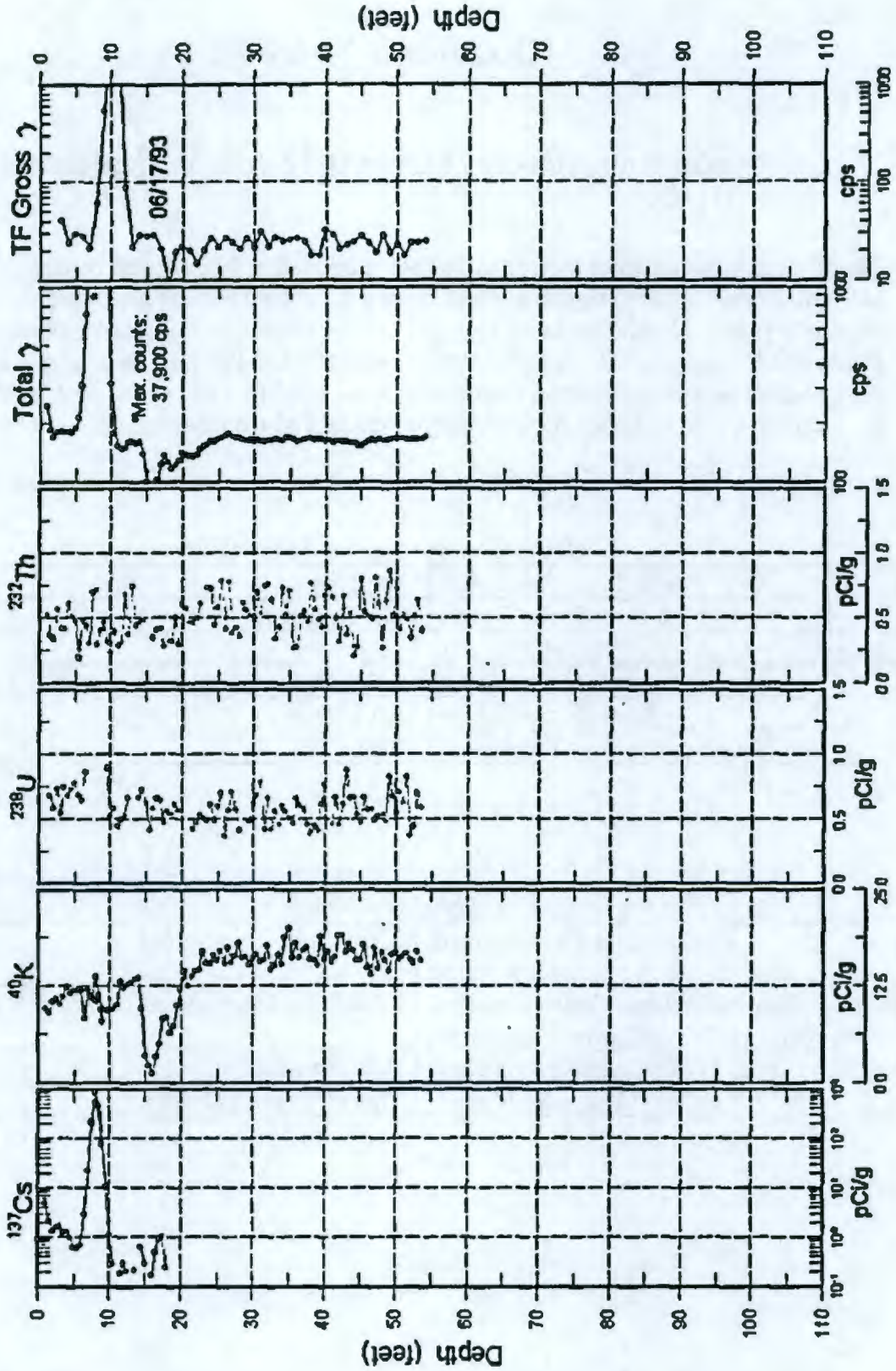
Gross Gamma Survey Information

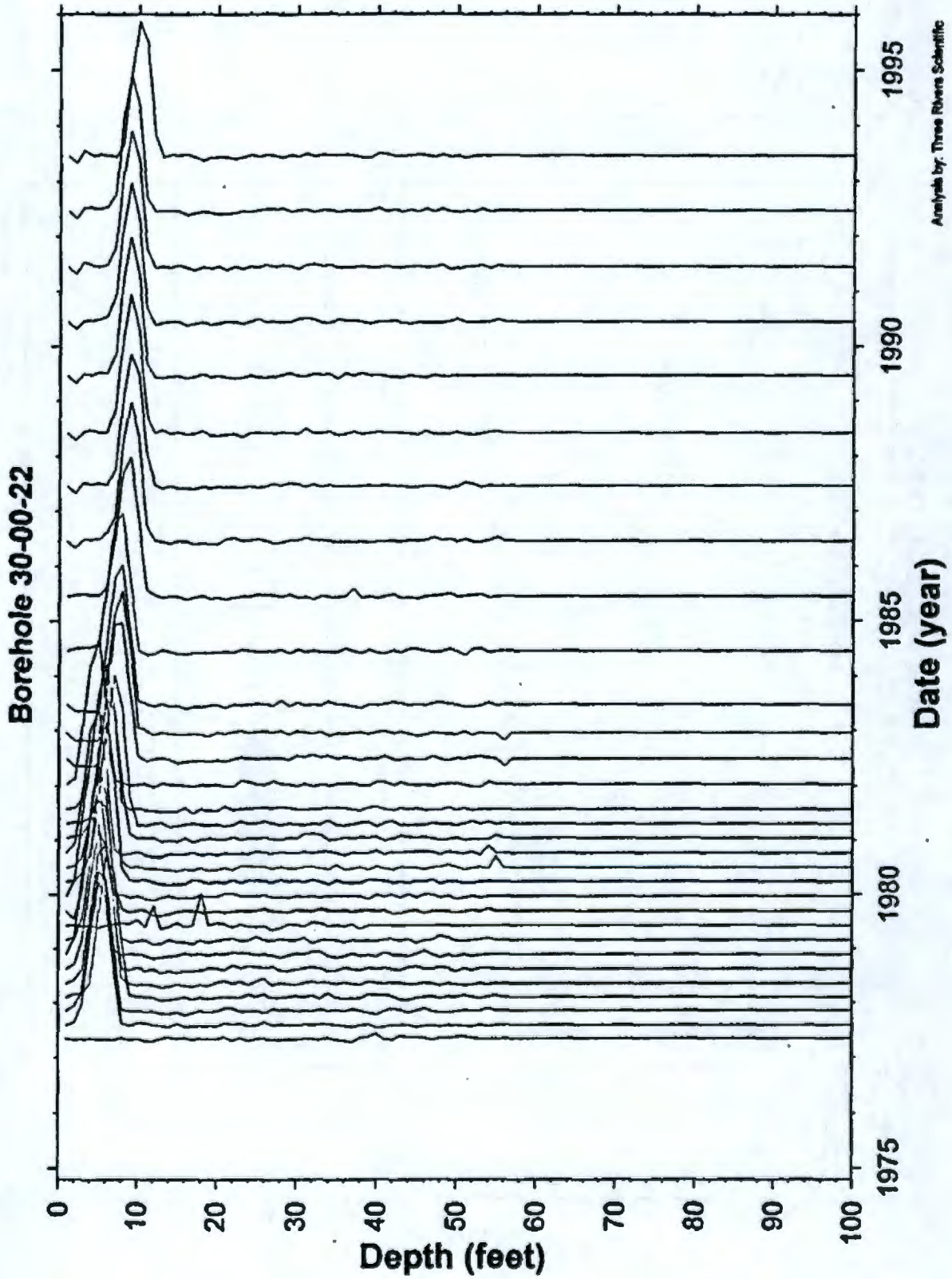
Probe Type Processed :	04: NaI
Other Probe Types :	03: Neutron
Survey Depth :	55 ft
First Survey Date :	5/6/1975
Last Survey Date :	6/17/1993
Number Surveys Processed :	180

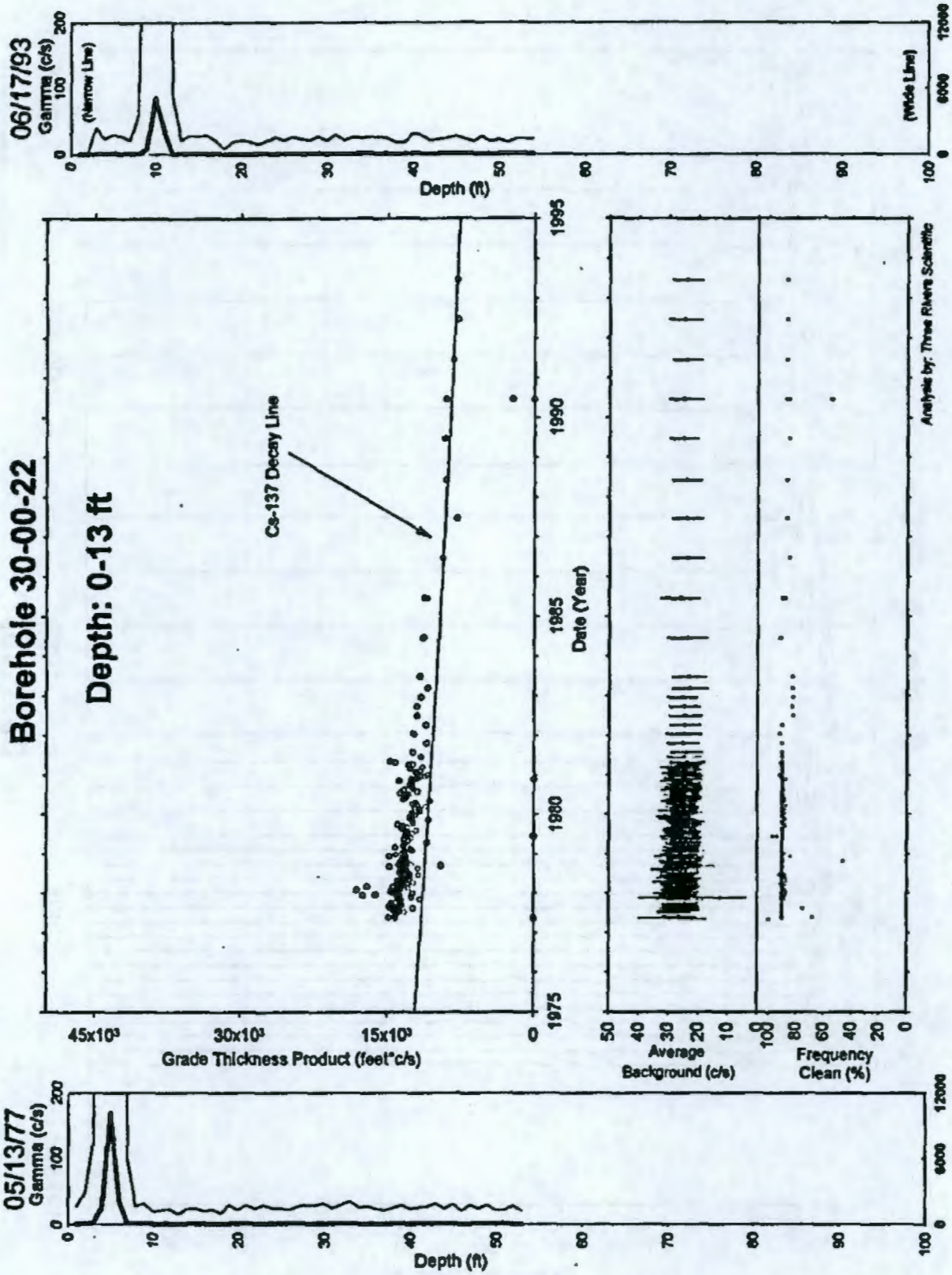
Analysis Notes

Method Used to Compute Background :	Threshold 0<val<50
Depth(s) where Contamination Identified in Gross Gamma Surveys :	0-13 ft Undetermined
Analyst Name :	R.R. Randall
Company Name :	Three Rivers Scientific

30-00-22 Combination Plot




Borehole 30-00-22
Depth (feet)
0
10
20
30
40
50
60
70
80
90
100
Date (year)
1975
1980
1985
1990
1995
Analysis by: Three Rivers Scientific


06/17/93
Gamma (c/s)
(Narrow Line)
(Wide Line)
Depth (ft)
Borehole 30-00-22
Depth: 0-13 ft
Cs-137 Decay Line
Date (Year)
Grade Thickness Product (feet*c/s)
Average Background (c/s)
Frequency Clean (%)
Analysis by: Three Rivers Scientific
05/13/77
Gamma (c/s)
Depth (ft)

Borehole 30-00-24

Contamination (Ru-106) from 14-24 feet is Stable.
Contamination (Ru-106) from 24-40 feet is Stable.

Grade thickness product over 14 to 24 feet is decreasing consistent with Ru-106 (Hypothesis) decay. The zone category is stable.

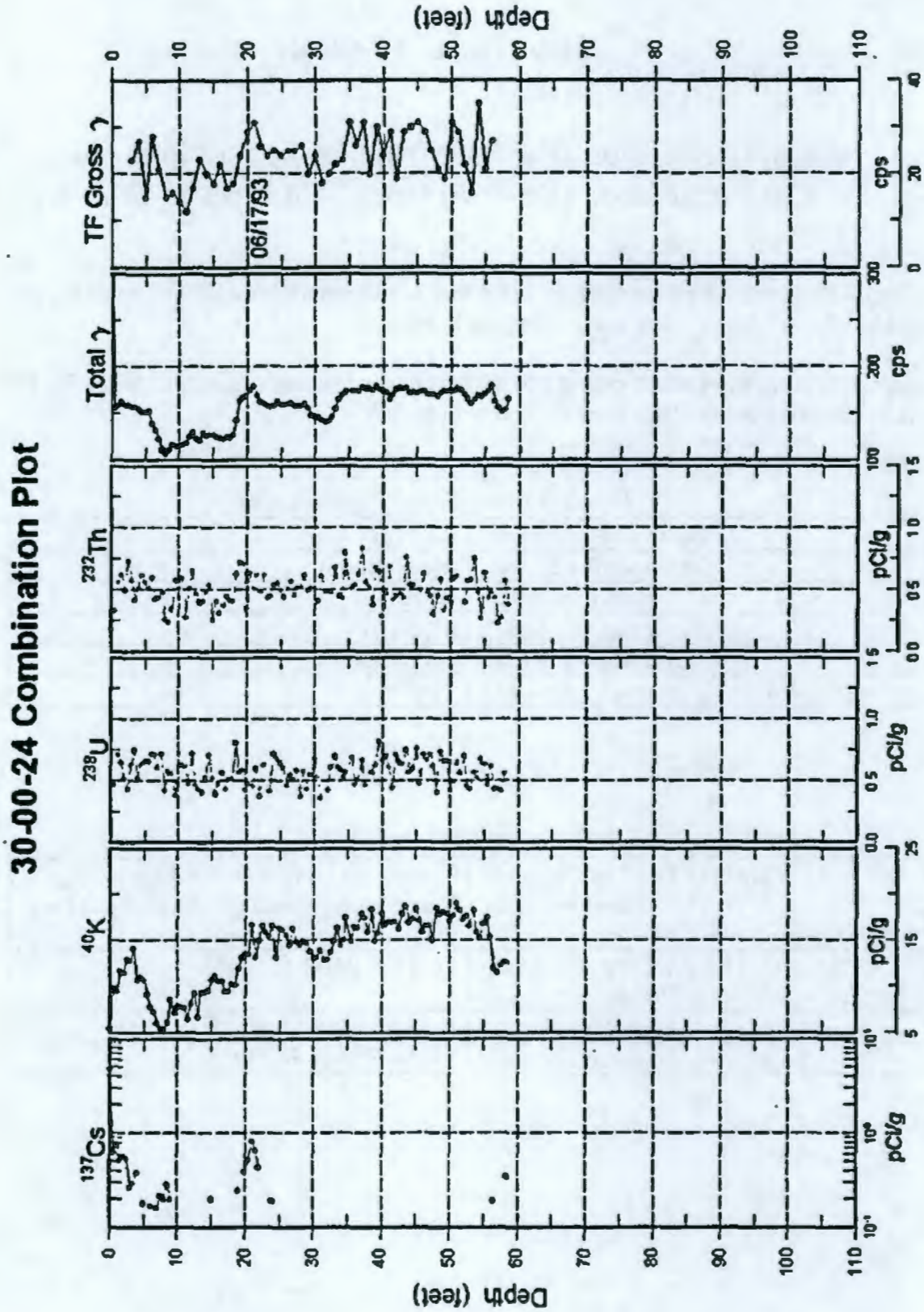
Grade thickness product over 24 to 40 feet is decreasing consistent with Ru-106 (Hypothesis) decay. The zone category is stable.

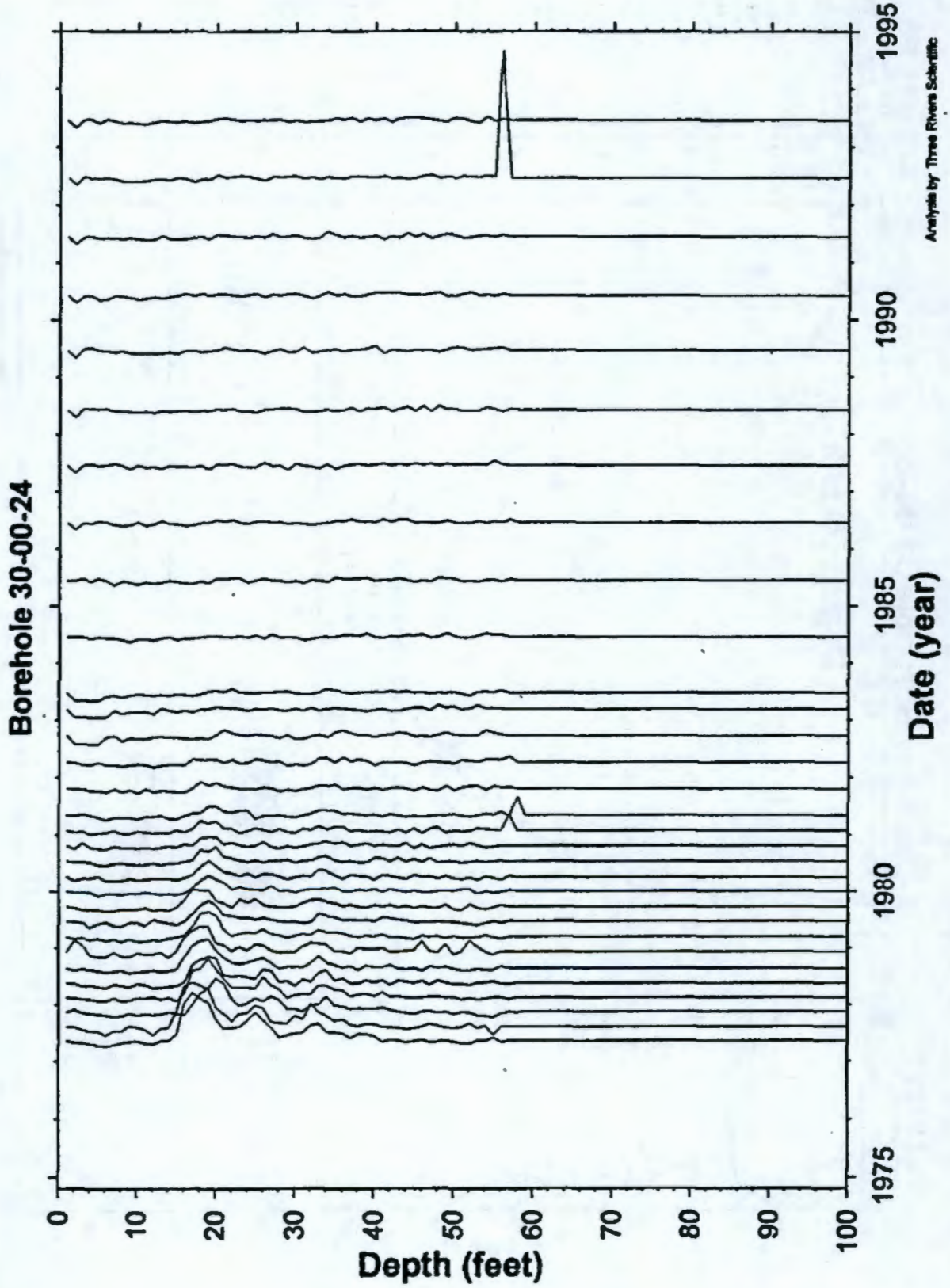
Gross Gamma Survey Information

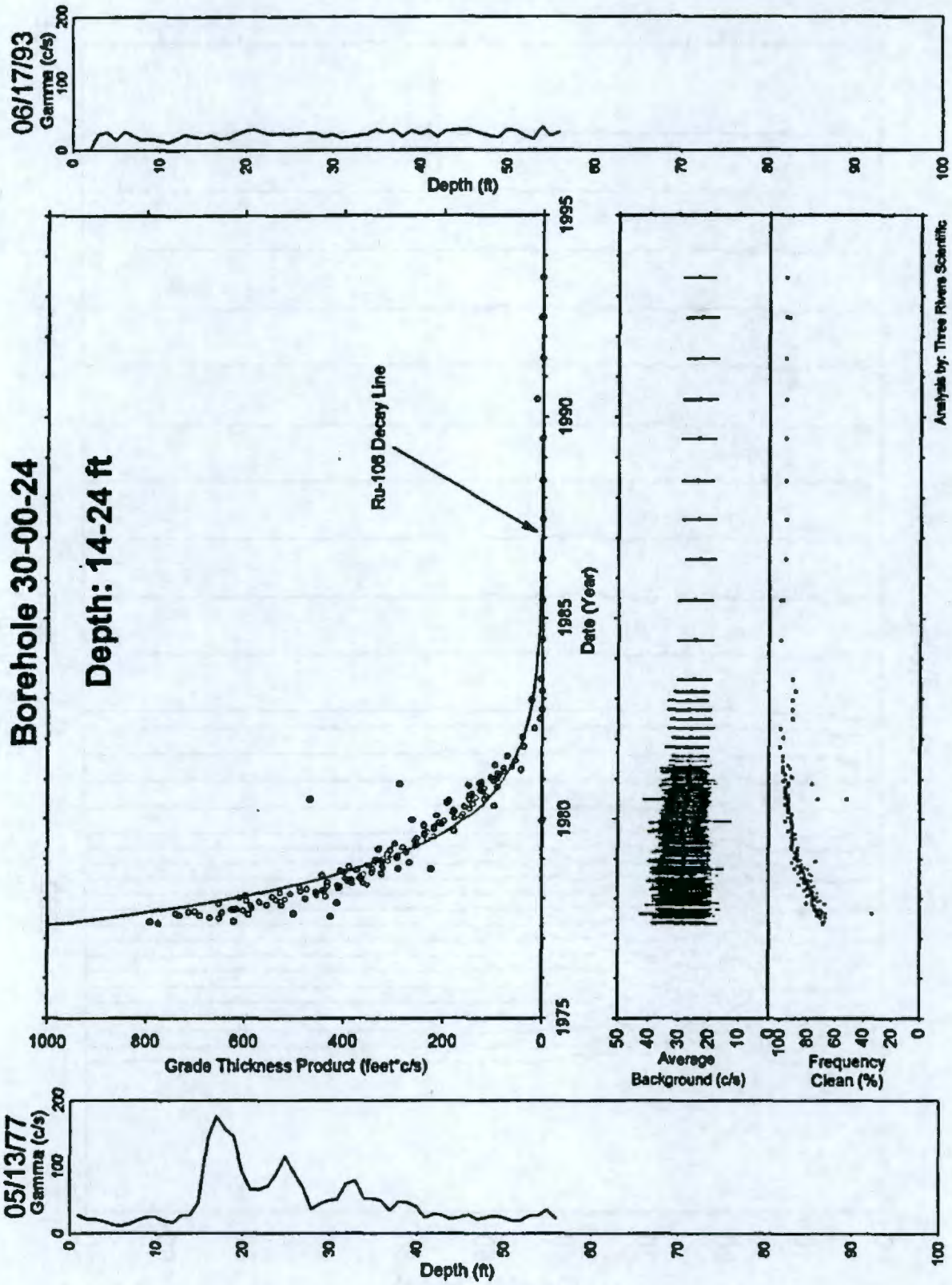
Probe Type Processed :	04: NaI
Other Probe Types :	03: Neutron
Survey Depth :	60 ft
First Survey Date :	5/13/1977
Last Survey Date :	6/17/1993
Number Surveys Processed :	175

Analysis Notes

Method Used to Compute Background :	Threshold 0<val<50 for 14-24 feet; Fixed background (45-53 ft) for 24-40 feet
Depth(s) where Contamination Identified in Gross Gamma Surveys :	14-24 & 24-40 ft Stable
Analyst Name :	R.R. Randall
Company Name :	Three Rivers Scientific


30-00-24 Combination Plot
TF Gross γ
06/17/93
Total γ
232Th
238U
40K
137Cs
cps
pCi/g
Depth (feet)


Borehole 30-00-24
Depth (feet)
0
10
20
30
40
50
60
70
80
90
100
Date (year)
1975
1980
1985
1990
1995
Analysis by Three Rivers Scientific


06/17/93
Gamma (c/s)
Depth (ft)
Borehole 30-00-24
Depth: 14-24 ft
Ru-106 Decay Line
Date (Year)
Grade Thickness Product (feet*c/s)
Average Background (c/s)
Frequency Clean (%)
Analysis by: Three Rivers Scientific
05/13/77
Gamma (c/s)
Depth (ft)

Tank C-101

Table of Contents

Tank C-101 81
Borehole 30-01-01 82
Borehole 30-01-06 86
Borehole 30-01-09 92
Borehole 30-01-12 97

This section contains the analysis results for vadose zone boreholes (dry wells) associated with the Tank 101 in the "C" Tank Farm.

Special Notes: None

Borehole 30-01-01

Contamination (Co-60 & Ru-106) from 30-53 feet is Stable.

The grade thickness product over 30 to 53 feet is decreasing at a rate consistent with the least square fit of Co-60 (HPGe identified) and Ru-106 (hypothesis). The resulting least square ratio of gross gamma from Co-60 to gross gamma from Ru-106 as of 1/10/1975 is 0.238. The zone category is stable.

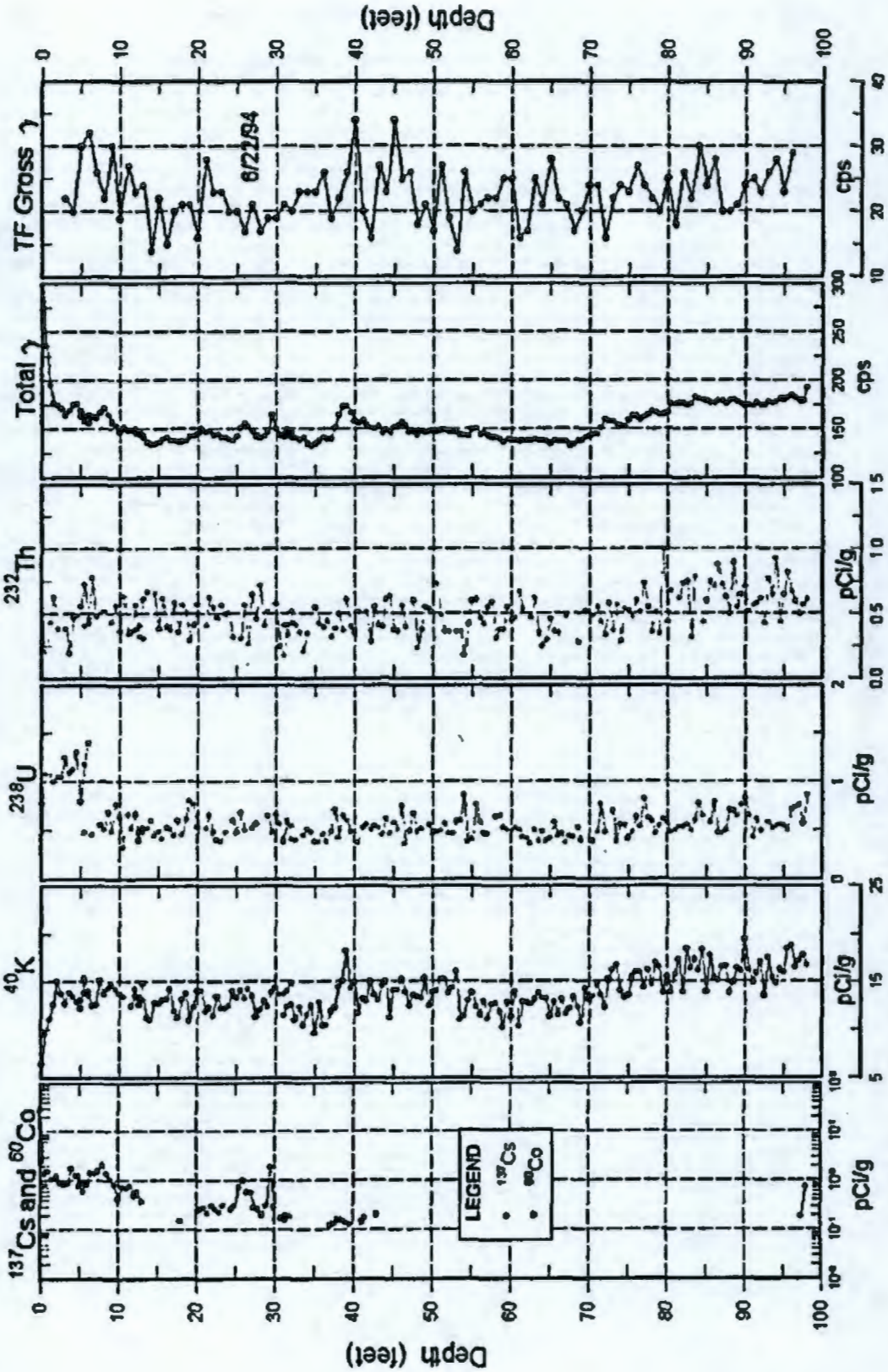
Gross Gamma Survey Information

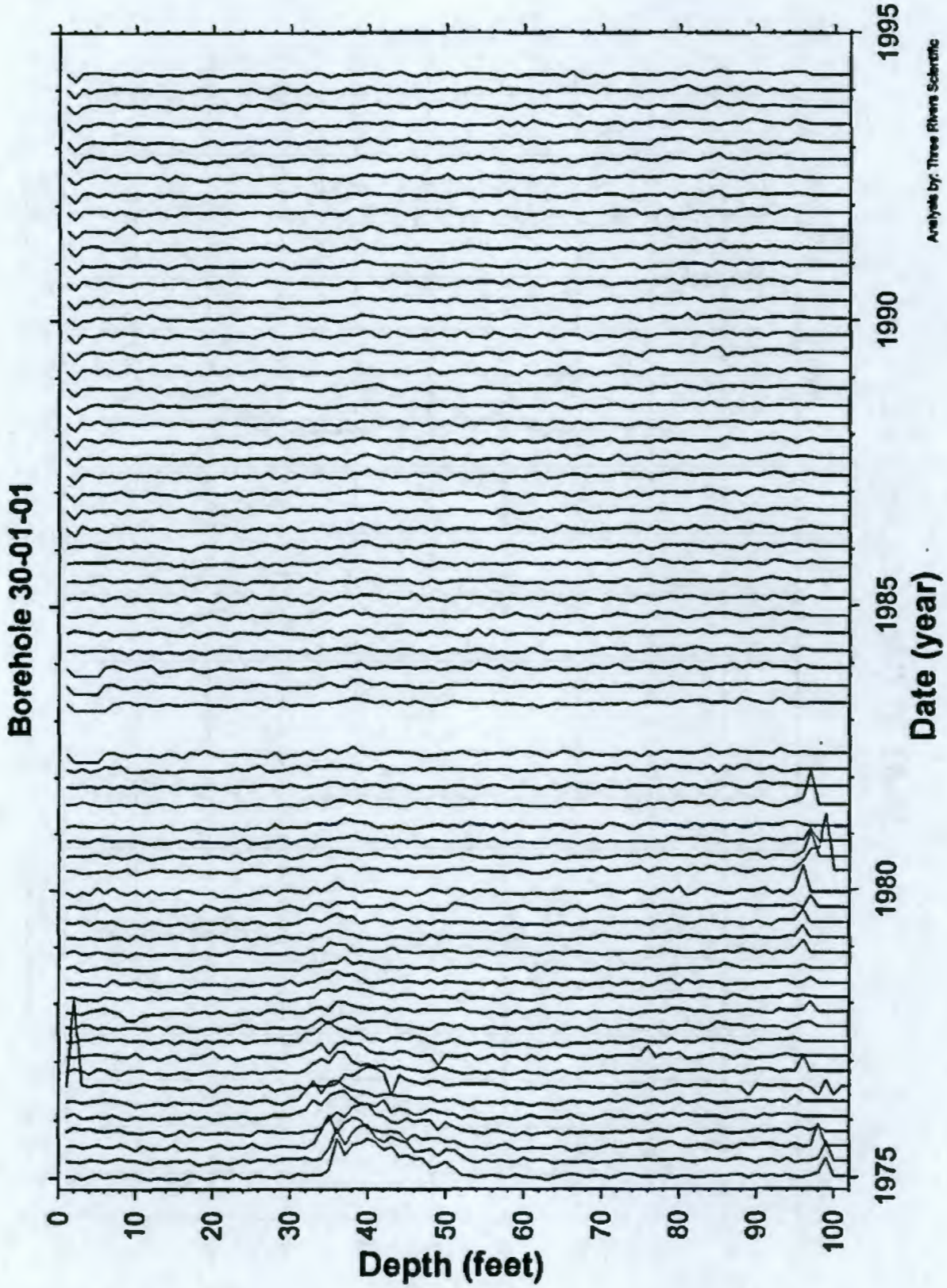
Probe Type Processed :	04: NaI
Other Probe Types :	03: Neutron
Survey Depth :	100 ft
First Survey Date :	1/10/1975
Last Survey Date :	6/22/1994
Number Surveys Processed :	481

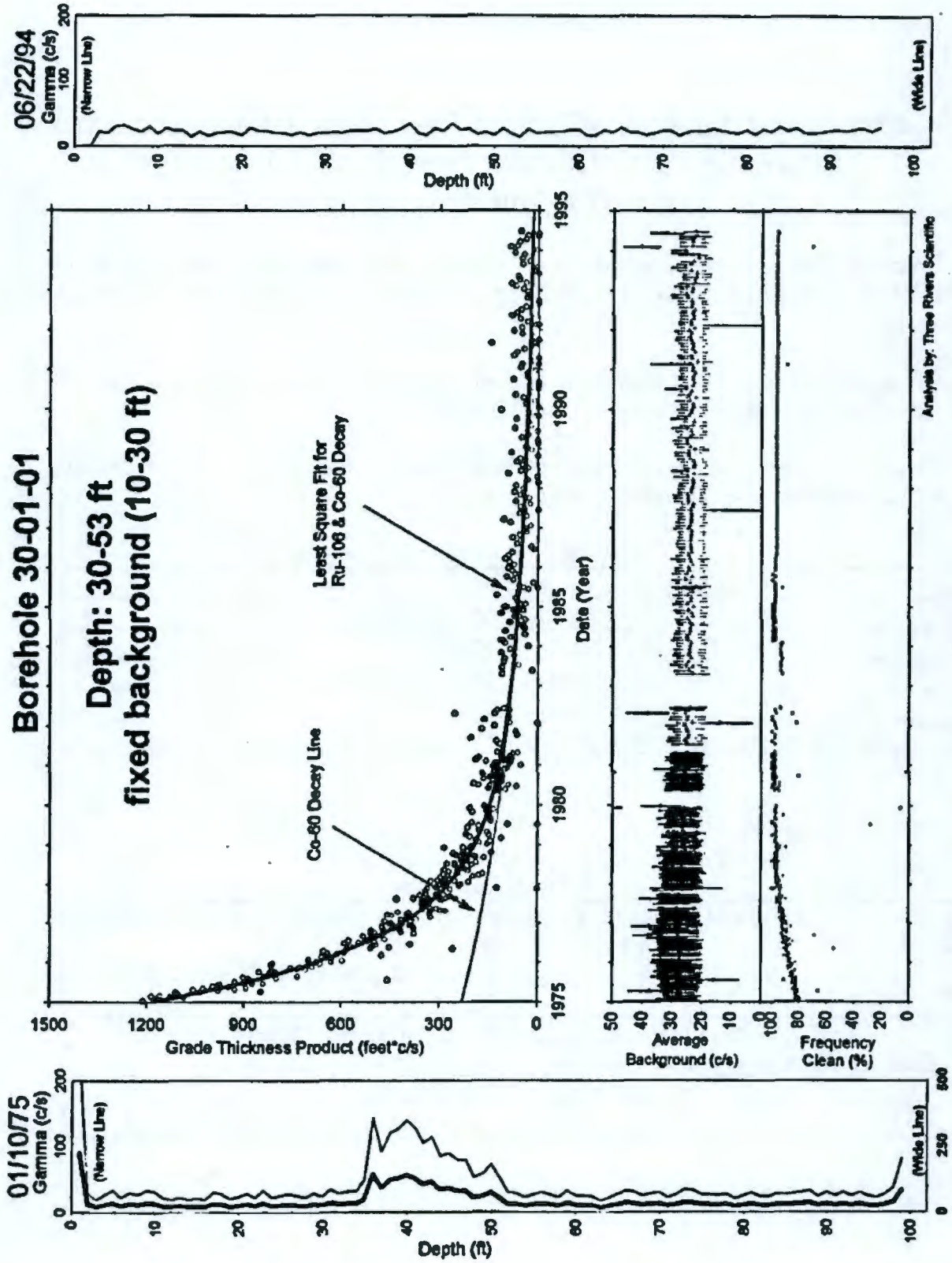
Analysis Notes

Method Used to Compute Background :	Fixed Background (10-30 ft)
Depth(s) where Contamination Identified in Gross Gamma Surveys :	30-53 ft Stable
Analyst Name :	R.R. Randall
Company Name :	Three Rivers Scientific

30-01-01 Combination Plot




Borehole 30-01-01
Depth (feet)
0
10
20
30
40
50
60
70
80
90
100
Date (year)
1975
1980
1985
1990
1995
Analysis by: Three Rivers Scientific


06/22/94
Gamma (c/s)
(Narrow Line)
(Wide Line)
Depth (ft)
Borehole 30-01-01
Depth: 30-53 ft
fixed background (10-30 ft)
Least Square Fit for
Ru-106 & Co-60 Decay
Co-60 Decay Line
Grade Thickness Product (feet*c/s)
Date (Year)
Average
Background (c/s)
Frequency
Clean (%)
Analysis by: Three Rivers Scientific
01/10/75
Gamma (c/s)
(Narrow Line)
(Wide Line)
Depth (ft)

Borehole 30-01-06

Contamination (Cs-137) from 30-41 feet is Unstable Early.
Contamination (Ru-106) from 71-83 feet is Stable.
Contamination (Ru-106) from 83-95 feet is Stable.

Grade thickness product over 30 to 41 feet increases from 1979 to 1980, and after 1983 is consistent with Cs-137 (HPGe identified) decay. The category is unstable early.

Grade thickness product over 71 to 83 feet is decreasing consistent with Ru-106 (Hypothesis) decay. The zone category is stable.

Grade thickness product over 83 to 95 feet is decreasing consistent with Ru-106 (Hypothesis) decay. The zone category is stable.

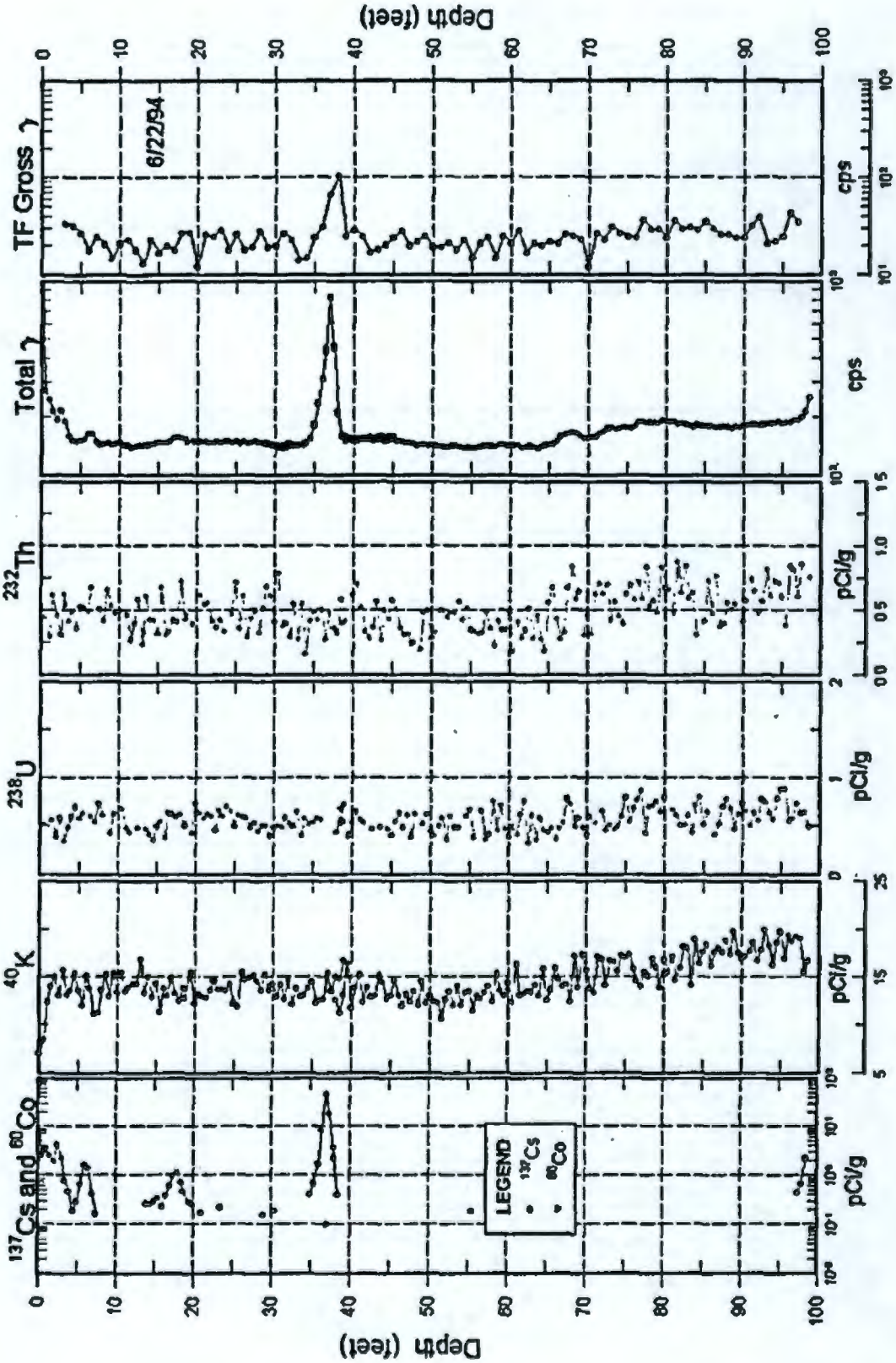
Gross Gamma Survey Information

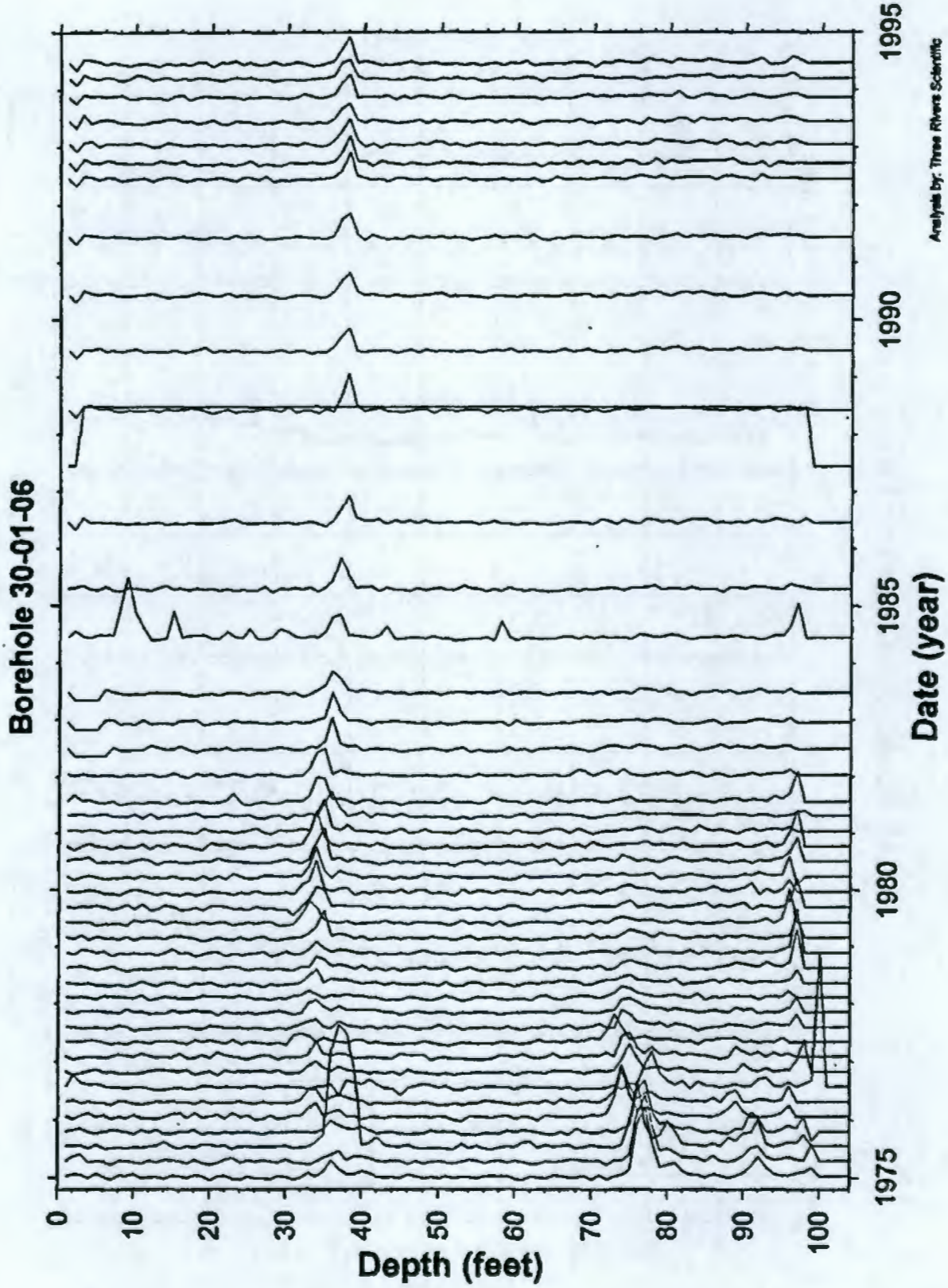
Probe Type Processed :	04: NaI
Other Probe Types :	03: Neutron
Survey Depth :	100 ft
First Survey Date :	1/10/1975
Last Survey Date :	6/22/1994
Number Surveys Processed :	311

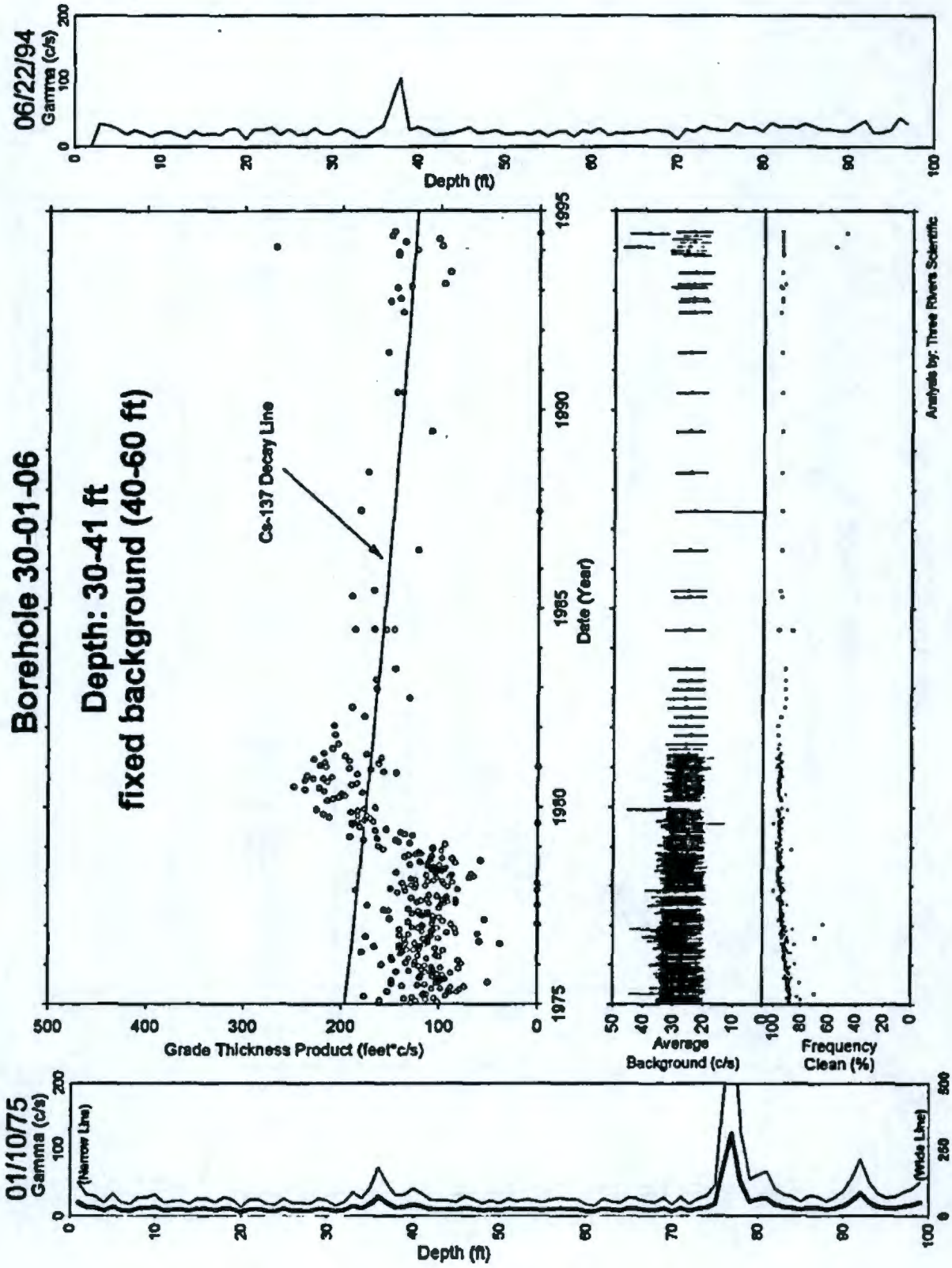
Analysis Notes

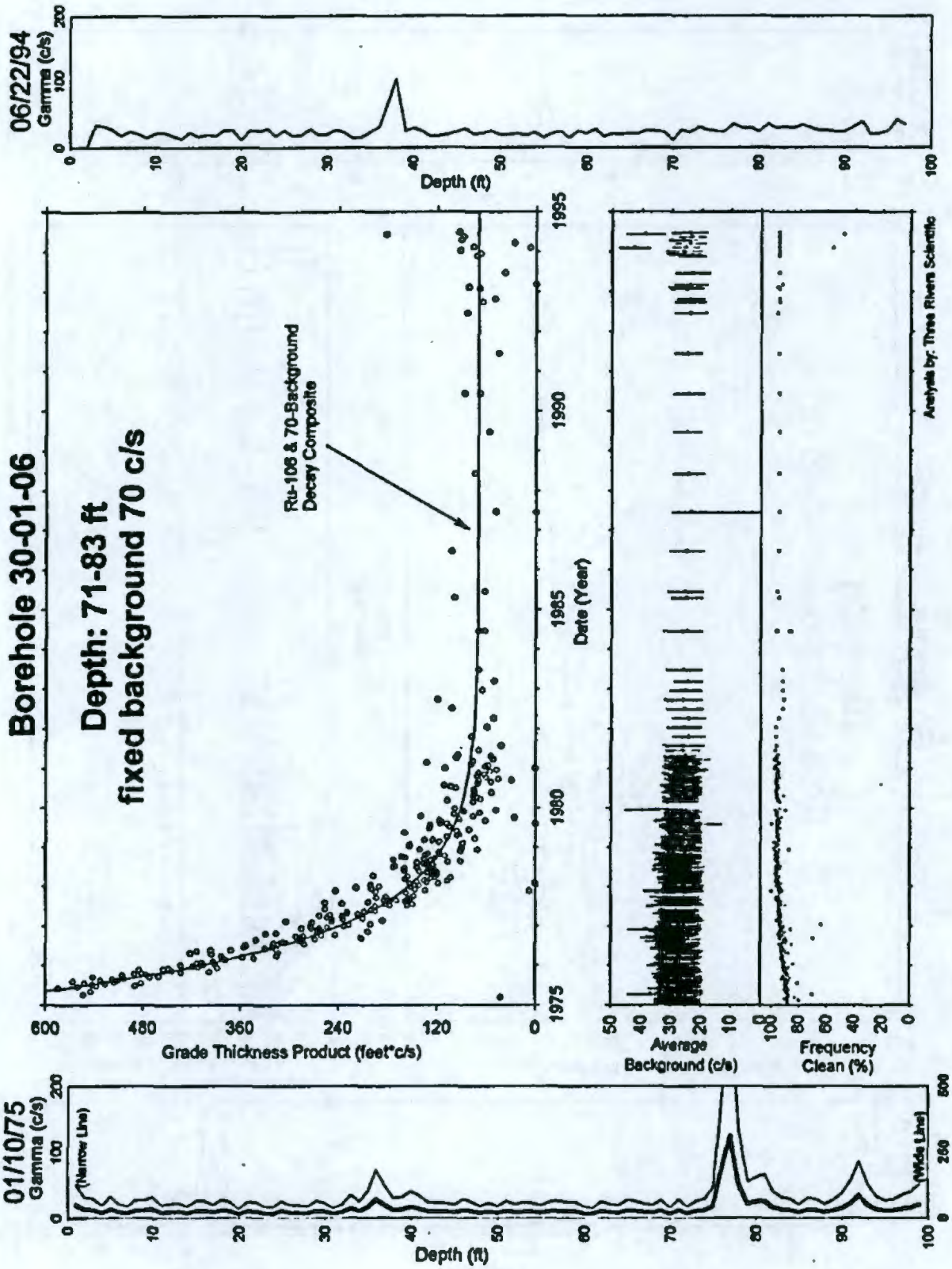
Method Used to Compute Background :	Fixed Background (40-60 ft) for 30-41 ft Zero Background 71-83 & 83-95 ft (fit)
Depth(s) where Contamination Identified in Gross Gamma Surveys :	30-41 ft Unstable Early 71-83 & 83-95 ft Stable
Analyst Name :	R.R. Randall
Company Name :	Three Rivers Scientific

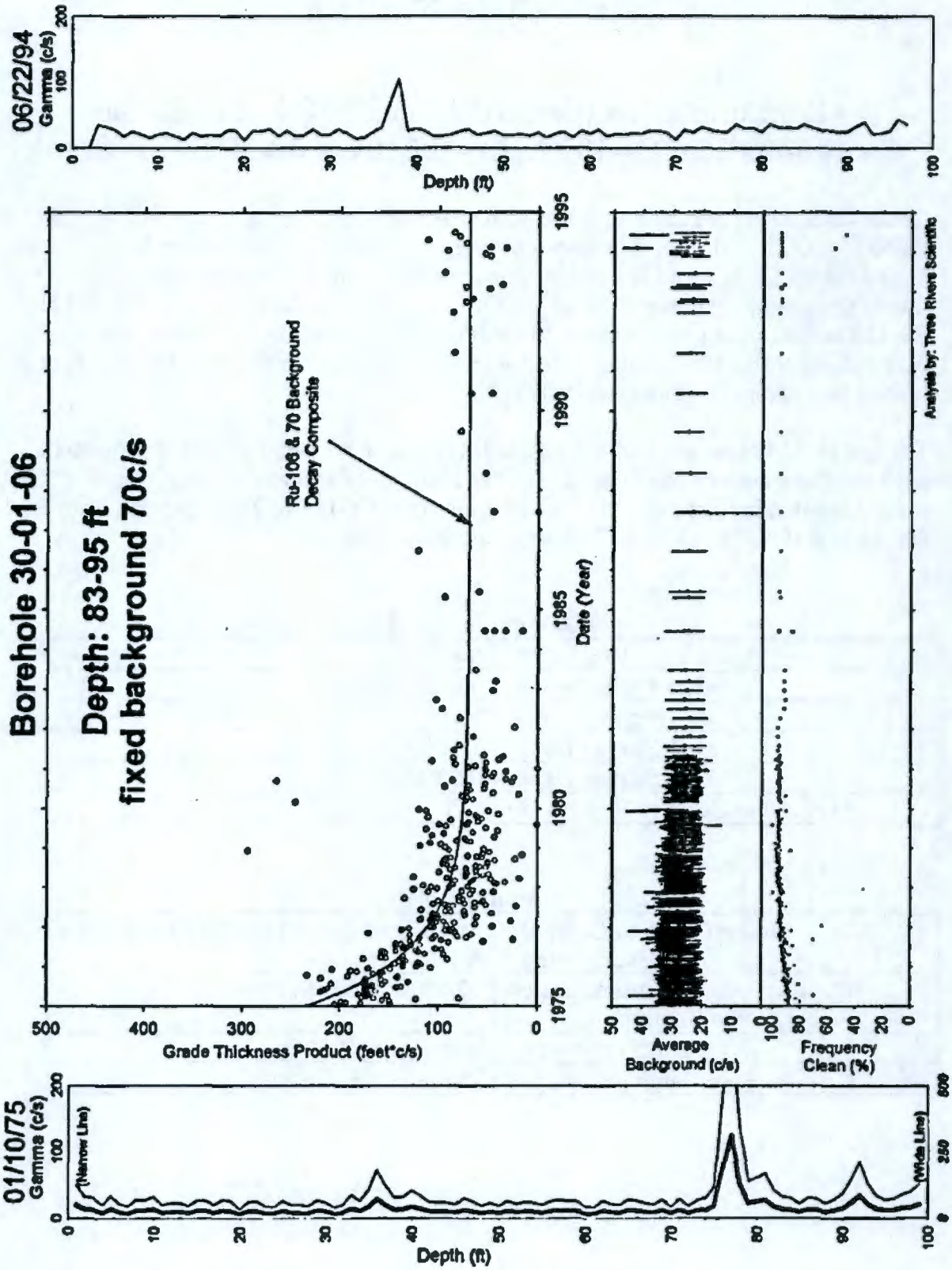
30-01-06 Combination Plot




Borehole 30-01-06
Depth (feet)
0
10
20
30
40
50
60
70
80
90
100
Date (year)
1975
1980
1985
1990
1995
Analysis by: Three Rivers Scientific


06/22/94
Gamma (c/s)
Depth (ft)
Borehole 30-01-06
Depth: 30-41 ft
fixed background (40-60 ft)
Cs-137 Decay Line
Grade Thickness Product (feet*c/s)
Date (Year)
Average Background (c/s)
Frequency Clean (%)
Analysis by: Three Rivers Scientific
01/10/75
Gamma (c/s)
(Narrow Line)
(Wide Line)
Depth (ft)


Borehole 30-01-06
Depth: 71-83 ft
fixed background 70 c/s
Ru-106 & 70-Background
Decay Composite
Grade Thickness Product (feet*c/s)
Date (Year)
Average
Background (c/s)
Frequency
Clean (%)
Analysis by: Three Rivers Scientific
06/22/94
Gamma (c/s)
Depth (ft)
01/10/75
Gamma (c/s)
(Narrow Line)
(Wide Line)
Depth (ft)


06/22/94
Gamma (c/s)
Depth (ft)
Borehole 30-01-06
Depth: 83-95 ft
fixed background 70c/s
Ru-106 & 70 Background
Decay Composite
Grade Thickness Product (feet*c/s)
Date (Year)
Average
Background (c/s)
Frequency
Clean (%)
Analysis by: Three Rivers Scientific
01/10/75
Gamma (c/s)
(Narrow Line)
(Wide Line)
Depth (ft)

Borehole 30-01-09

Contamination (Cs-137) from 20-33 feet is Stable.
Contamination (Cs-137 & Ru-106) from 33-60 feet is Stable.

Grade thickness product over 20 to 33 feet is decreasing consistent with Cs-137 (HPGe identified) decay. The zone category is stable. The HPGe log data analysis showed both Eu-154 and Eu-152 in this interval. This identification may be in error due to the following observations. At 27.5 feet a single observation of Eu-154 and Eu-152 is quoted at greater than 100 pCi/g, with no detection 6 inches above or below this depth. The gamma detector in the borehole would see a single hot spot 6 inches away from the most intense depth.

The grade thickness product over 33 to 60 feet is decreasing at a rate consistent with the least square fit of Cs-137 (HPGe identified) and Ru-106 (hypothesis). The resulting least square ratio of gross gamma from Cs-137 to gross gamma from Ru-106 as of 1/10/1975 is 0.027. The zone category is stable.

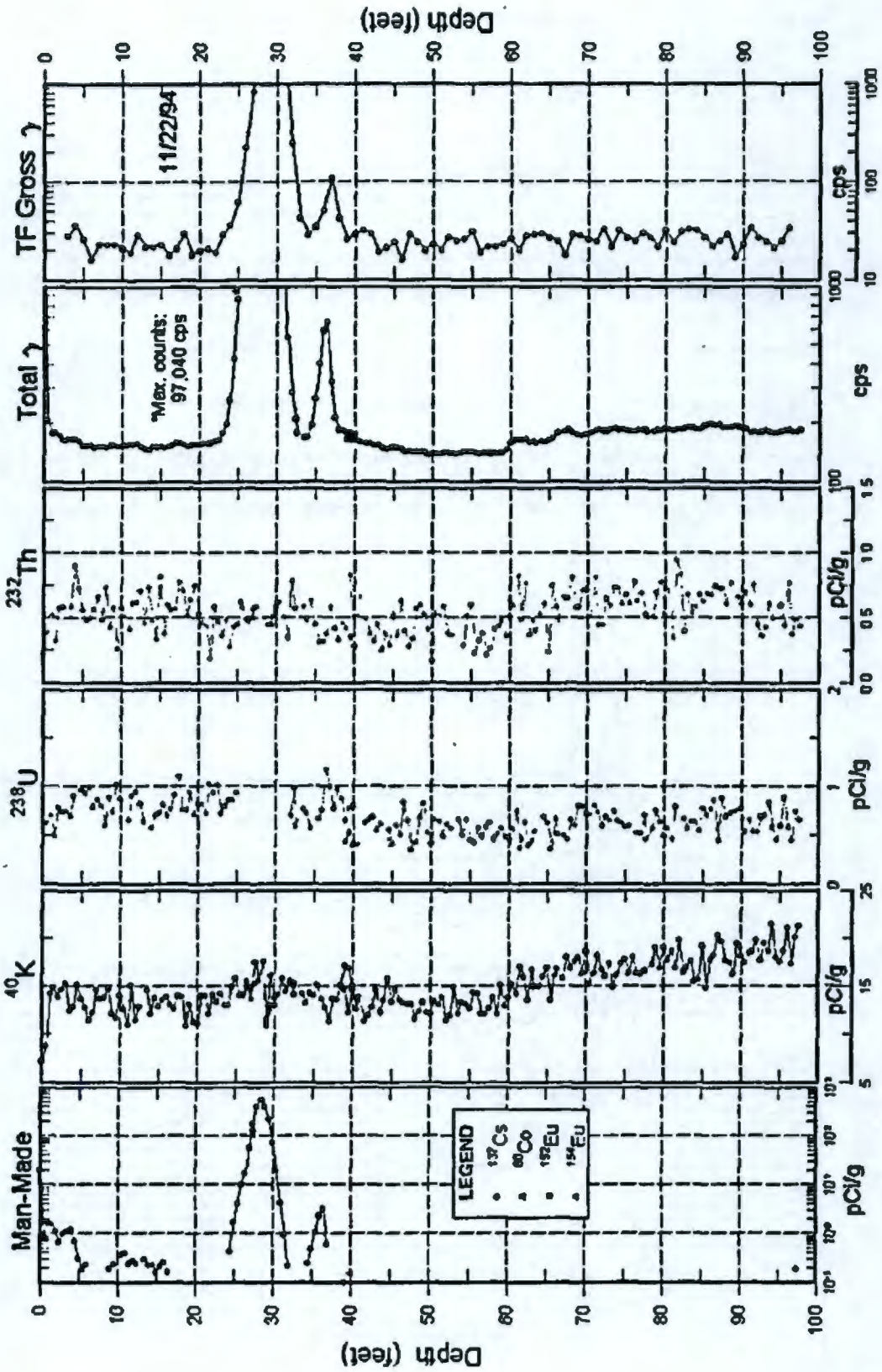
Gross Gamma Survey Information

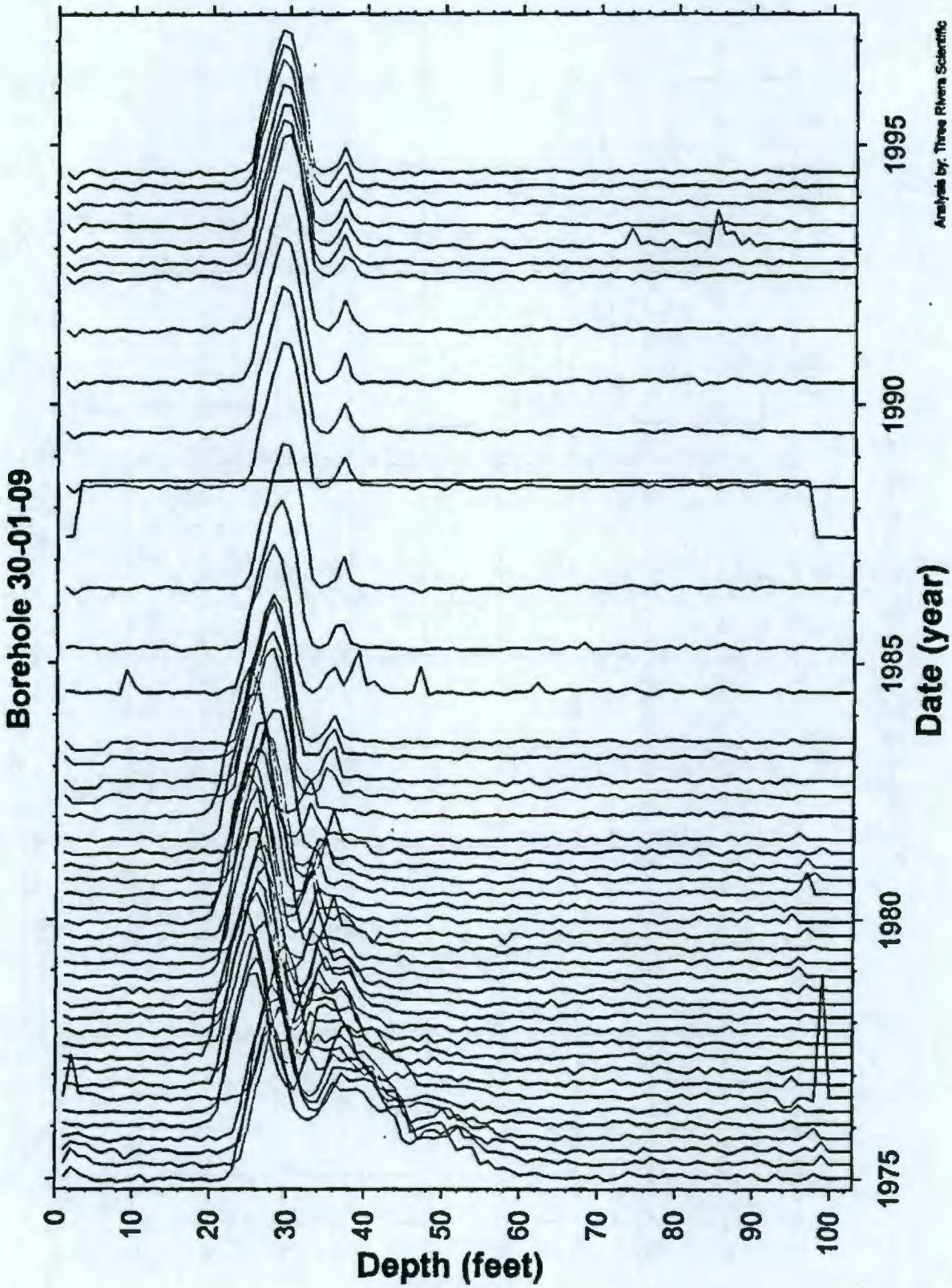
Probe Type Processed :	04: NaI
Other Probe Types :	03: Neutron
Survey Depth :	100 ft
First Survey Date :	1/10/1975
Last Survey Date :	6/22/1994
Number Surveys Processed :	317

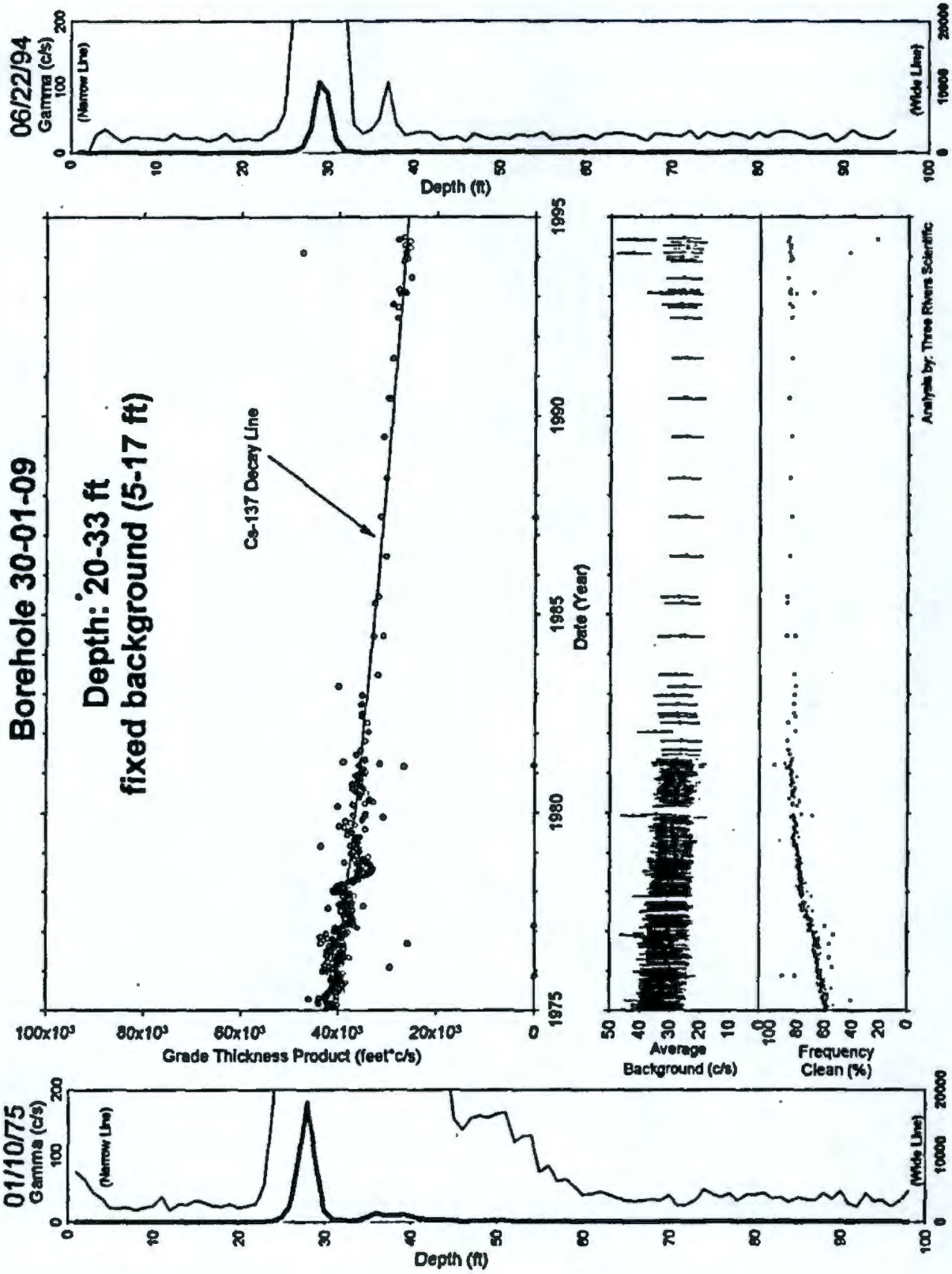
Analysis Notes

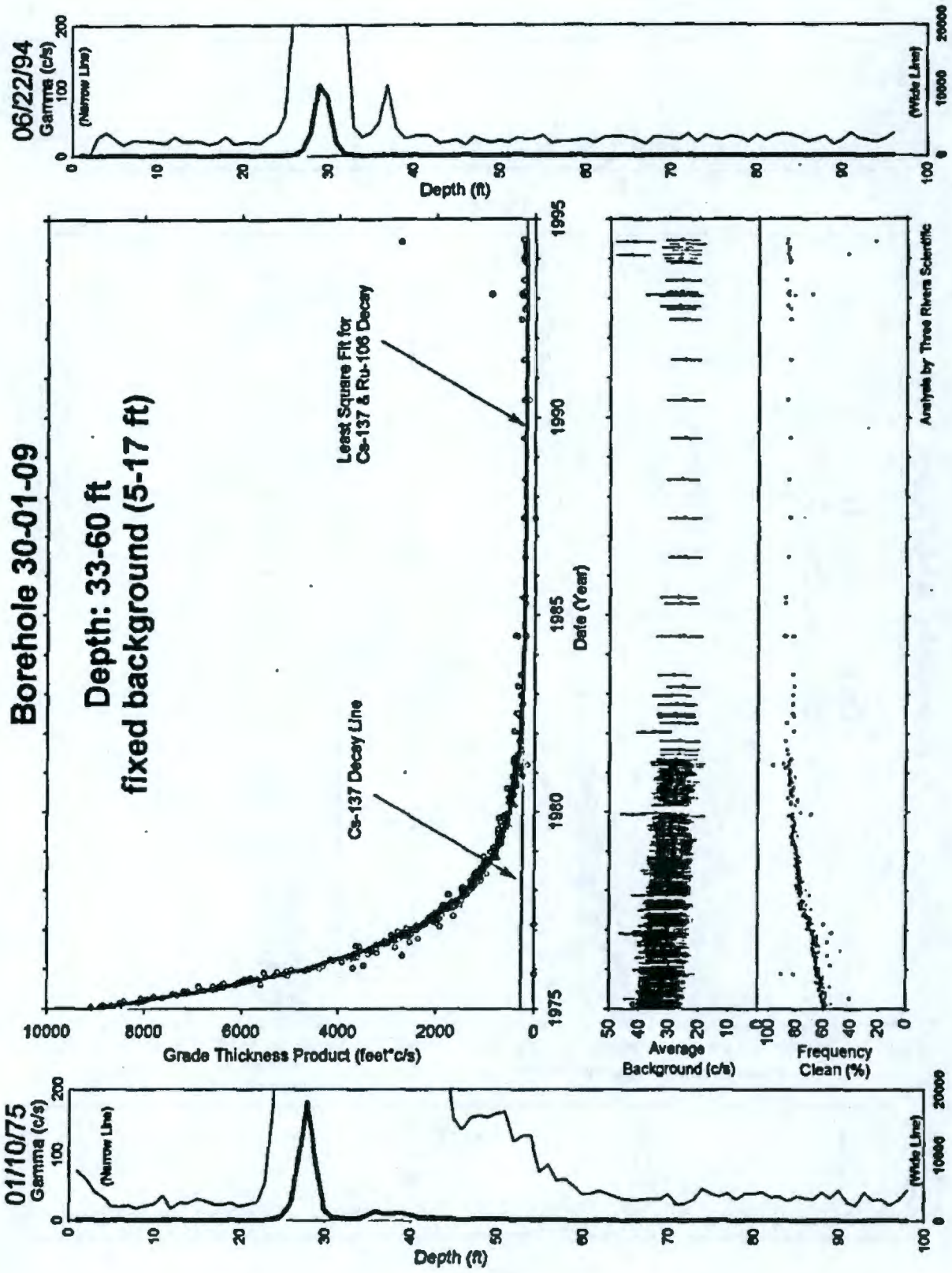
Method Used to Compute Background :	Fixed Background (5-17 ft) for 20-33 & 33-60 ft
Depth(s) where Contamination Identified in Gross Gamma Surveys :	20-33, 33-60 ft Stable
Analyst Name :	R.R. Randall
Company Name :	Three Rivers Scientific

30-01-09 Combination Plot




Borehole 30-01-09
Depth (feet)
0
10
20
30
40
50
60
70
80
90
100
Date (year)
1975
1980
1985
1990
1995
Analysis by: Three Rivers Scientific


Borehole 30-01-09
Depth: 20-33 ft
fixed background (5-17 ft)
Cs-137 Decay Line
Grade Thickness Product (feet*c/s)
Date (Year)
Average Background (c/s)
Frequency Clean (%)
Analysis by: Three Rivers Scientific
06/22/94
Gamma (c/s)
(Narrow Line)
(Wide Line)
Depth (ft)
01/10/75
Gamma (c/s)
(Narrow Line)
(Wide Line)
Depth (ft)


06/22/94
Gamma (c/s)
(Narrow Line)
(Wide Line)
Depth (ft)
Borehole 30-01-09
Depth: 33-60 ft
fixed background (5-17 ft)
Least Square Fit for
Cs-137 & Ru-106 Decay
Cs-137 Decay Line
Grade Thickness Product (feet*c/s)
Date (Year)
Average
Background (c/s)
Frequency
Clean (%)
Analysis by Three Rivers Scientific
01/10/75
Gamma (c/s)
(Narrow Line)
(Wide Line)
Depth (ft)

Borehole 30-01-12

Contamination (Cs-137) from 0-10 feet is Tank Farm Activity. Contamination (Cs-137) from 10-18 feet is Stable.

Grade thickness product over 0 to 10 feet is erratic and highly variable from 1975 to 1984, indicative of tank farm activity. Since 1984, the grade thickness product is consistent with the decay from Cs-137 (HPGe identified).

Grade thickness product over 10 to 18 feet is decreasing consistent with Cs-137 (HPGe identified) decay. The zone category is stable.

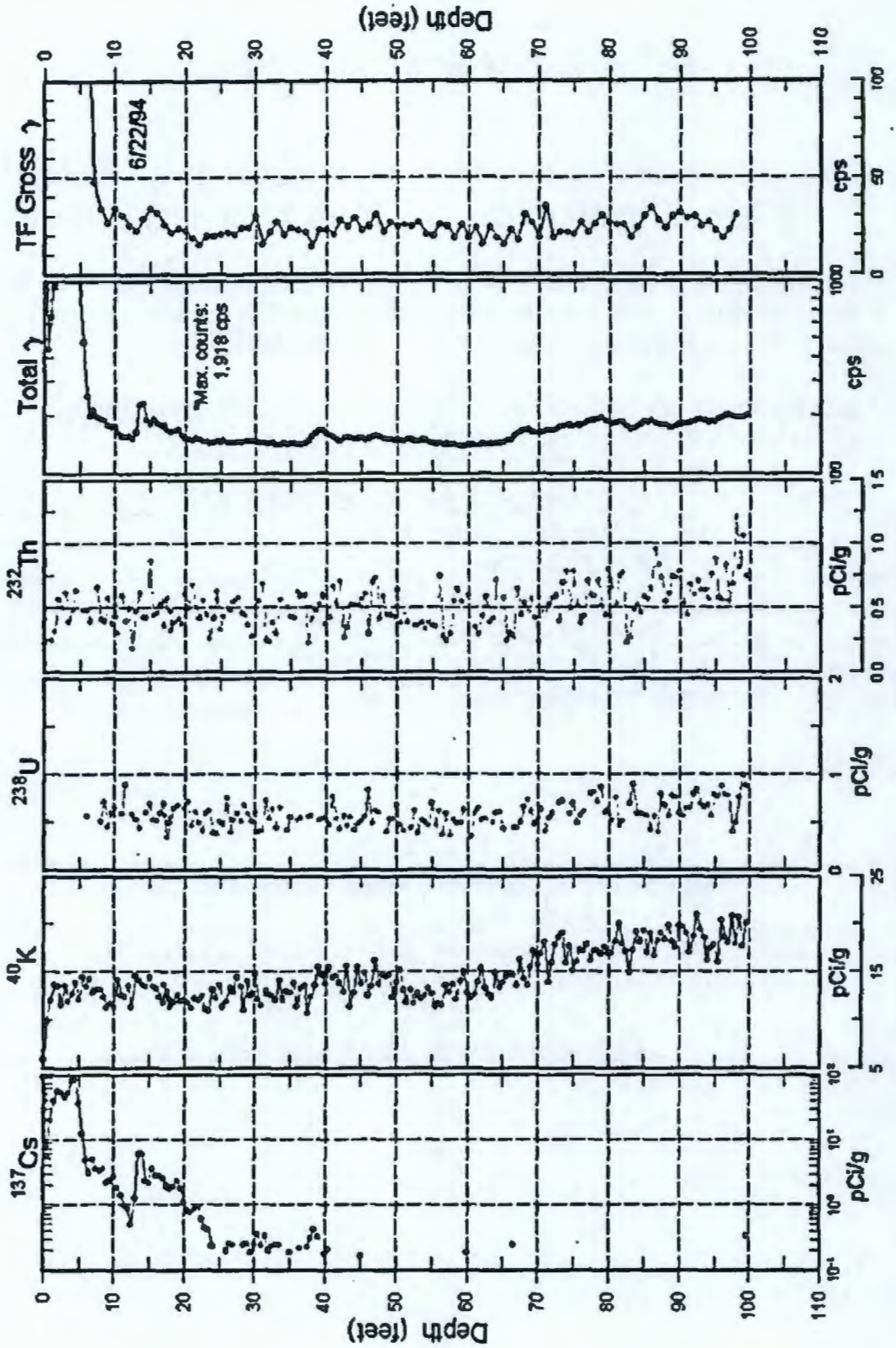
Gross Gamma Survey Information

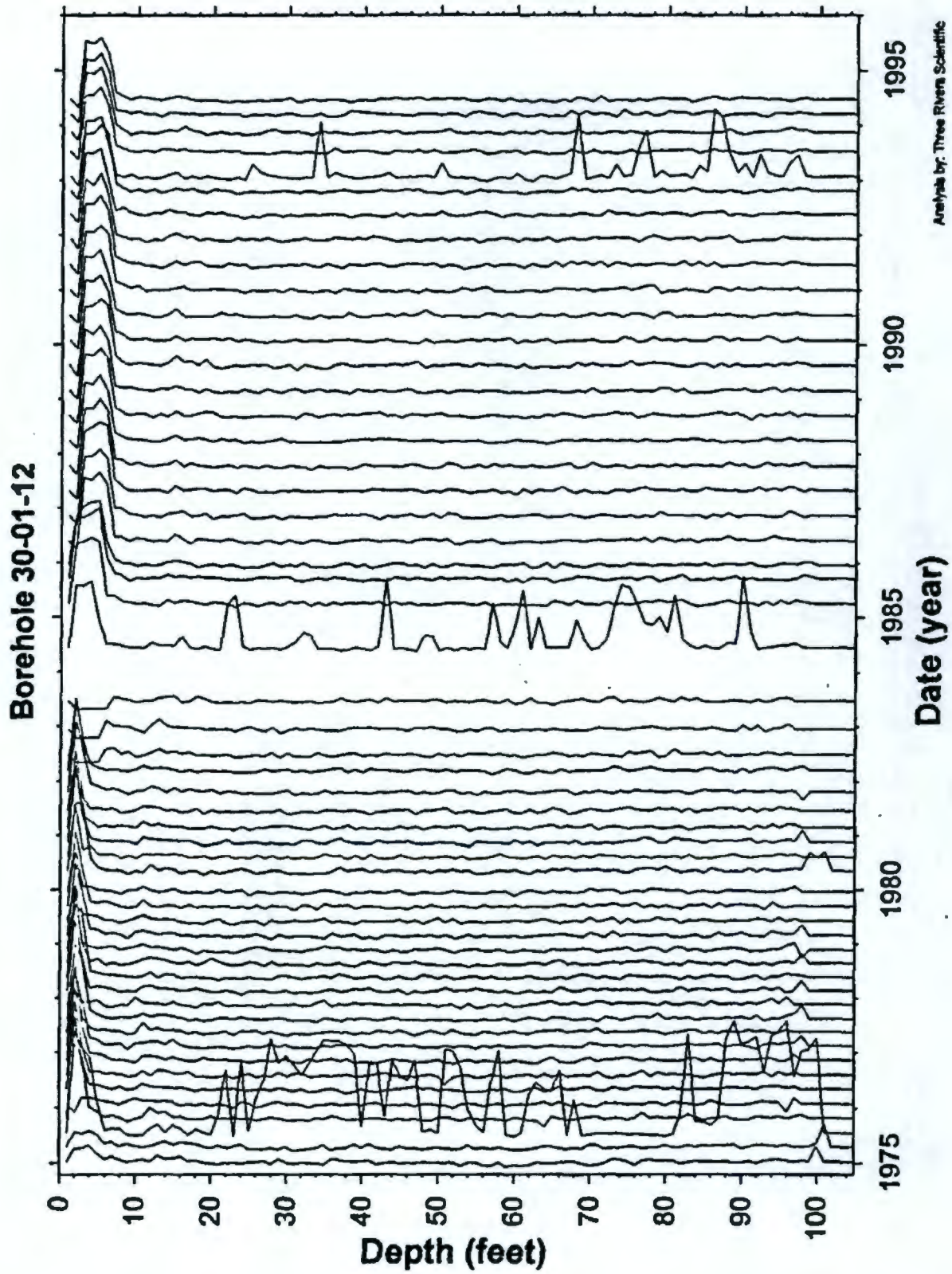
Probe Type Processed :	04: NaI
Other Probe Types :	03: Neutron
Survey Depth :	100 ft
First Survey Date :	1/10/1975
Last Survey Date :	6/22/1994
Number Surveys Processed :	344

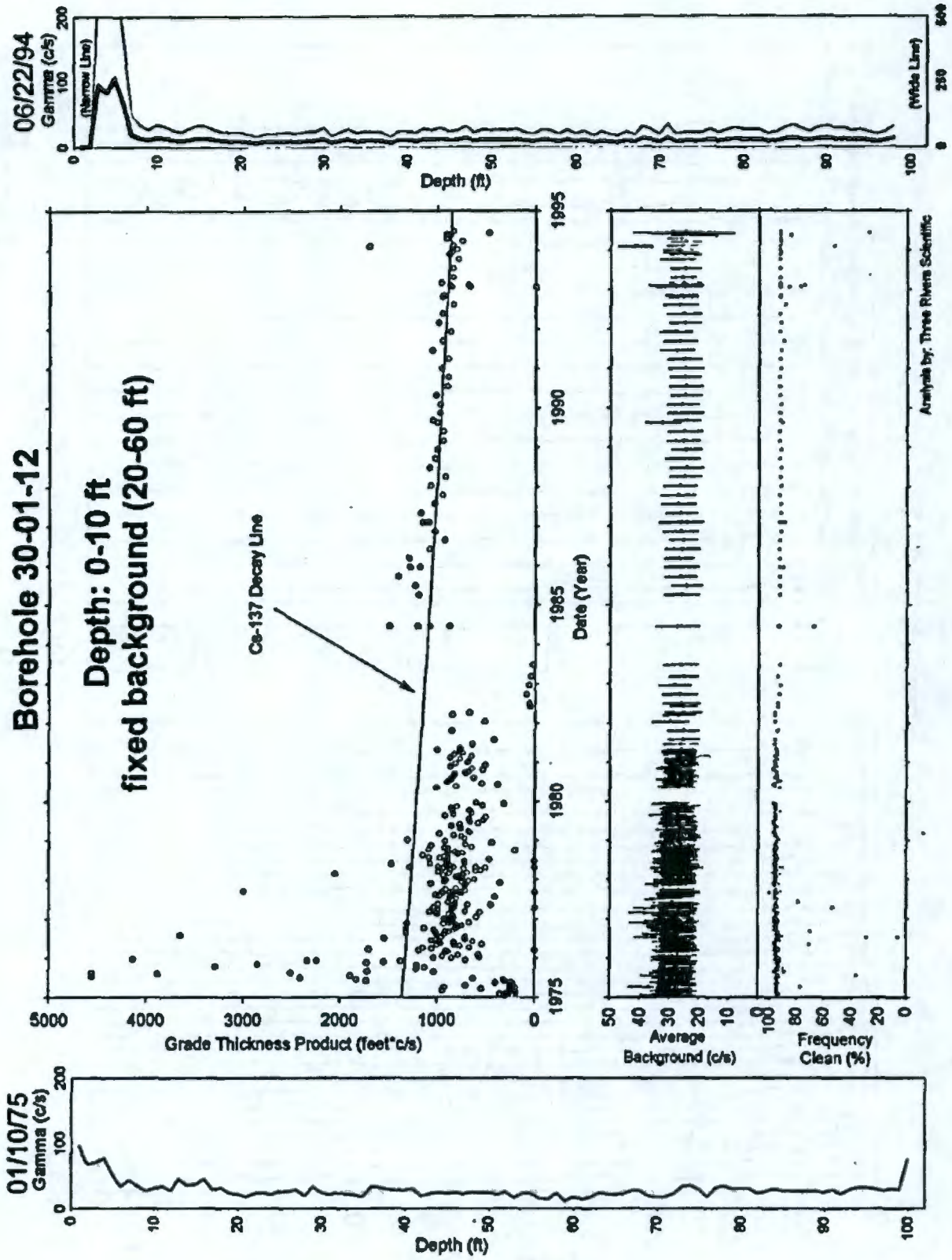
Analysis Notes

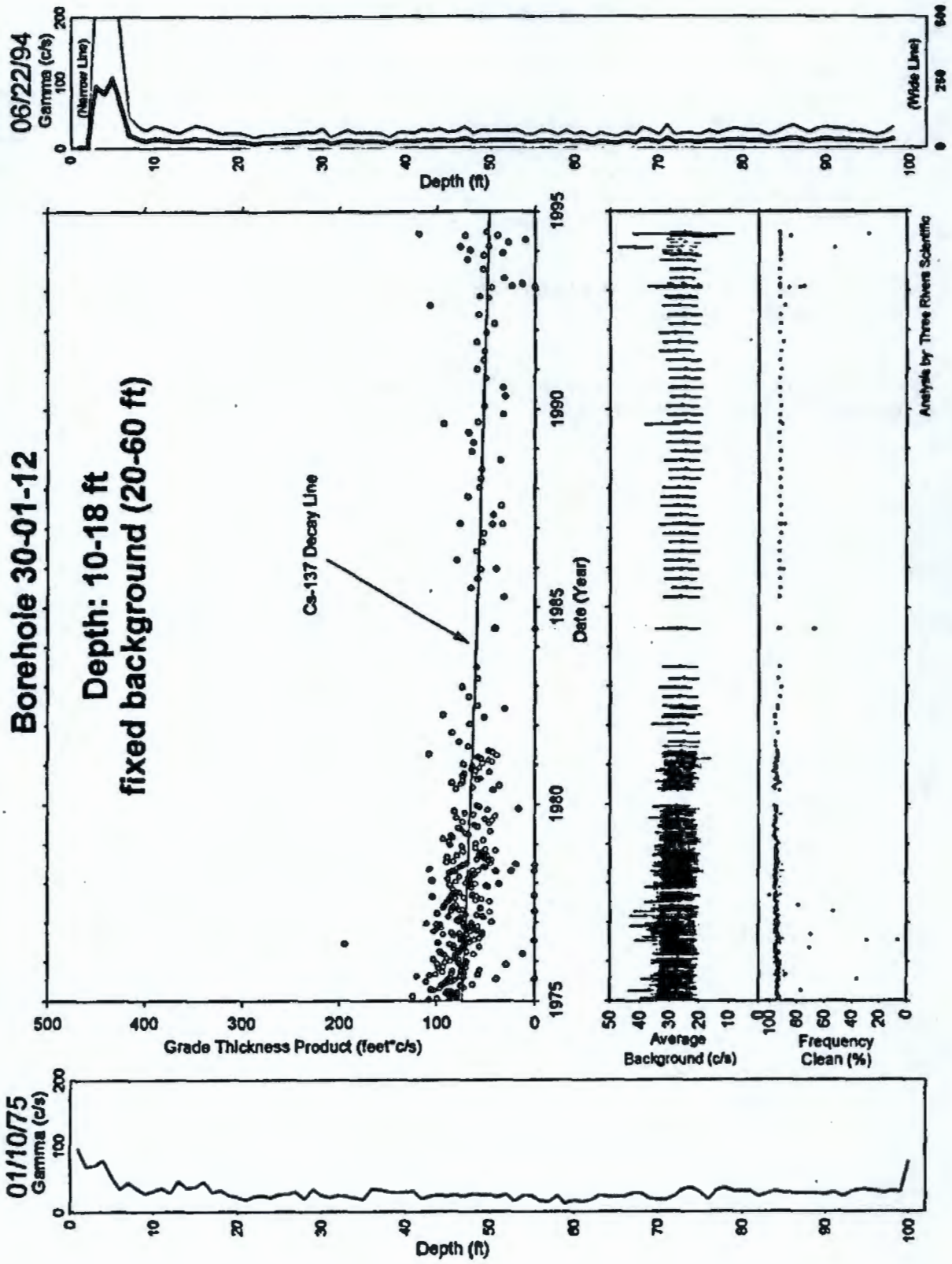
Method Used to Compute Background :	Fixed background (20-60 ft)
Depth(s) where Contamination Identified in Gross Gamma Surveys :	0-10 ft Tank Farm Activity 10-18 ft Stable
Analyst Name :	R.R. Randall
Company Name :	Three Rivers Scientific

30-01-12 Combination Plot




Borehole 30-01-12
Depth (feet)
0
10
20
30
40
50
60
70
80
90
100
Date (year)
1975
1980
1985
1990
1995
Analysis by: Three Rivers Scientific


06/22/94
Gamma (c/s)
(Narrow Line)
(Wide Line)
Depth (ft)
Borehole 30-01-12
Depth: 0-10 ft
fixed background (20-60 ft)
Cs-137 Decay Line
Grade Thickness Product (feet*c/s)
Date (Year)
Average Background (c/s)
Frequency Clean (%)
Analysis by: Three Rivers Scientific
01/10/75
Gamma (c/s)
Depth (ft)


06/22/94
Gamma (c/s)
(Narrow Line)
(Wide Line)
Depth (ft)
Borehole 30-01-12
Depth: 10-18 ft
fixed background (20-60 ft)
Cs-137 Decay Line
Grade Thickness Product (feet*c/s)
Date (Year)
Average Background (c/s)
Frequency Clean (%)
Analysis by: Three Rivers Scientific
01/10/75
Gamma (c/s)
Depth (ft)

Tank C-103

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This section contains the analysis results for vadose zone boreholes (dry wells) associated with the Tank 103 in the "C" Tank Farm.

Special Notes: Borehole 30-03-01 contaminant depth profile changed coincident with well depth change sometime between 1983 and 1984.

Borehole 30-03-01

Contamination (Cs-137) from 0-30 feet is Tank Farm Activity. Contamination (Cs-137) from 40-70 feet is Undetermined. Contamination (C0-60) from 90-125 feet is Unstable.

Grade thickness product over 0 to 30 feet is erratic and highly variable from 1975 to 1986, indicative of tank farm activity. Since 1986, the grade thickness product is consistent with the decay from Cs-137 (HPGe identified).

Grade thickness product over 40 to 70 feet is complicated by the well deepening sometime between July 1982 and January 1984. HPGe log data (near 1994) identified Cs-137 in this depth interval. The grade thickness product demonstrates two distinct characters over time intervals from 1975 to 1981 and from 1984 to 1994, refer to stack plot, just before and after well deepening. Given this abrupt depth character change associated with well deepening, the grade thickness product is computed for two different depth intervals of 42 to 57 feet and 52 to 68 feet; each is only valid for 1975 to mid 1981, and 1984 to 1994, respectively. Over the valid time interval of the grade thickness product for 42-57 feet, the determination of the match with Cs-137 decay is not good from 1975 to 1976. Likewise, the match of grade thickness product with Cs-137 decay over 52-68 feet from 1984 to 1994 is not good from 1984 to 1986. In both cases, the statistical errors make conclusion difficult, thus the classification is undetermined. Note that the depth profile of contaminant changing associated with the well deepening, indicates contaminant may be cause by near borehole drag-down during deepening.

Grade thickness product over 90 to 125 feet is complicated by the well deepening sometime between 1981 and 1984. HPGe log data (near 1994) identified Co-60 in this depth interval. Even ignoring the grade thickness product data before 1984, there is no match with Co-60 decay from 1984 to 1995. There may be a match between Co-60 decay and the grade thickness product from 1990 to 1995, but insufficient monitoring period to make this classification. Thus the interval is unstable.

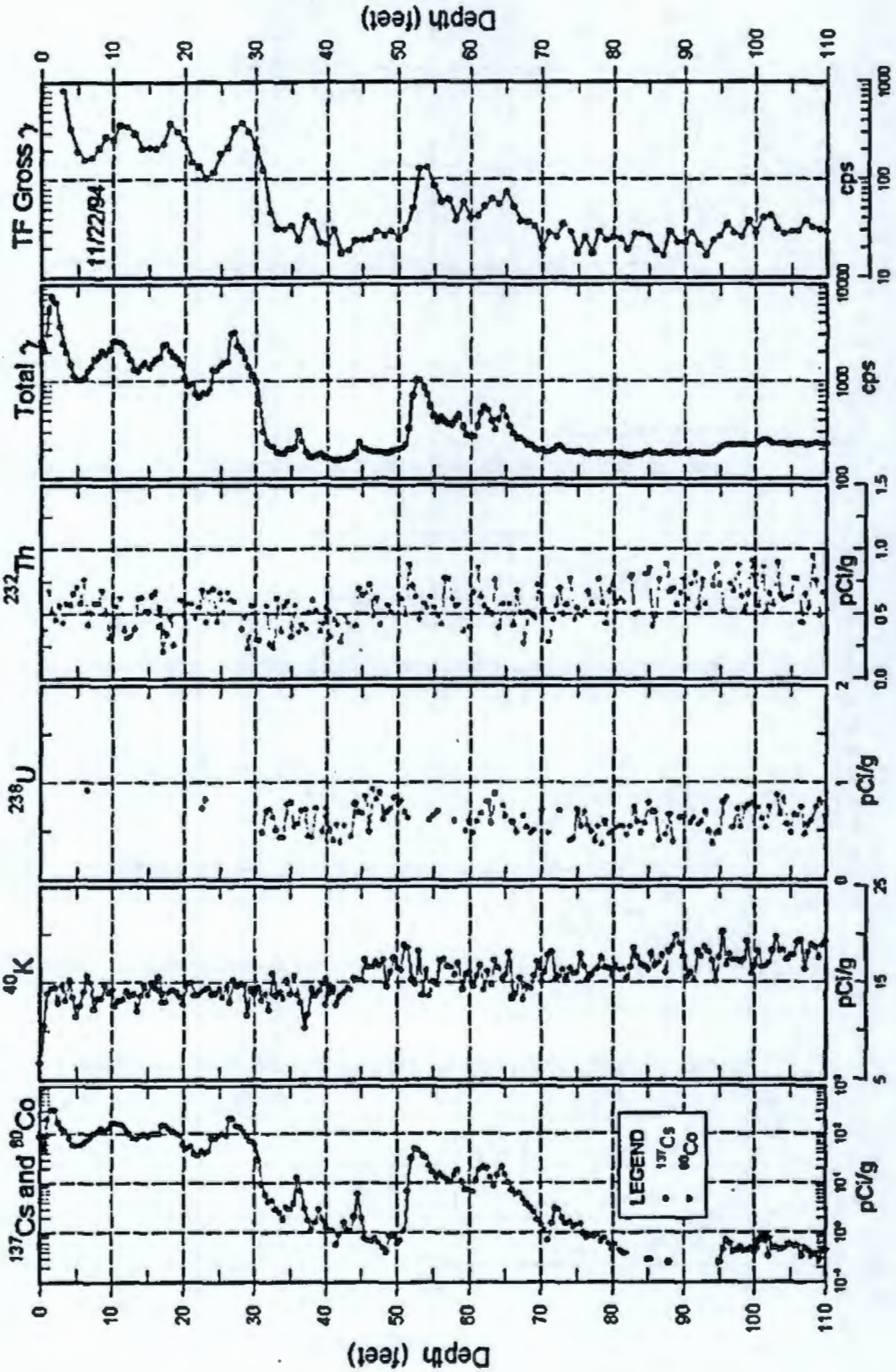
Gross Gamma Survey Information

Probe Type Processed :	04: NaI
Other Probe Types :	03: Neutron
Survey Depth :	100 ft @(<1984), 125 ft (1984-1995)
First Survey Date :	1/10/1975
Last Survey Date :	11/22/1994
Number Surveys Processed :	681

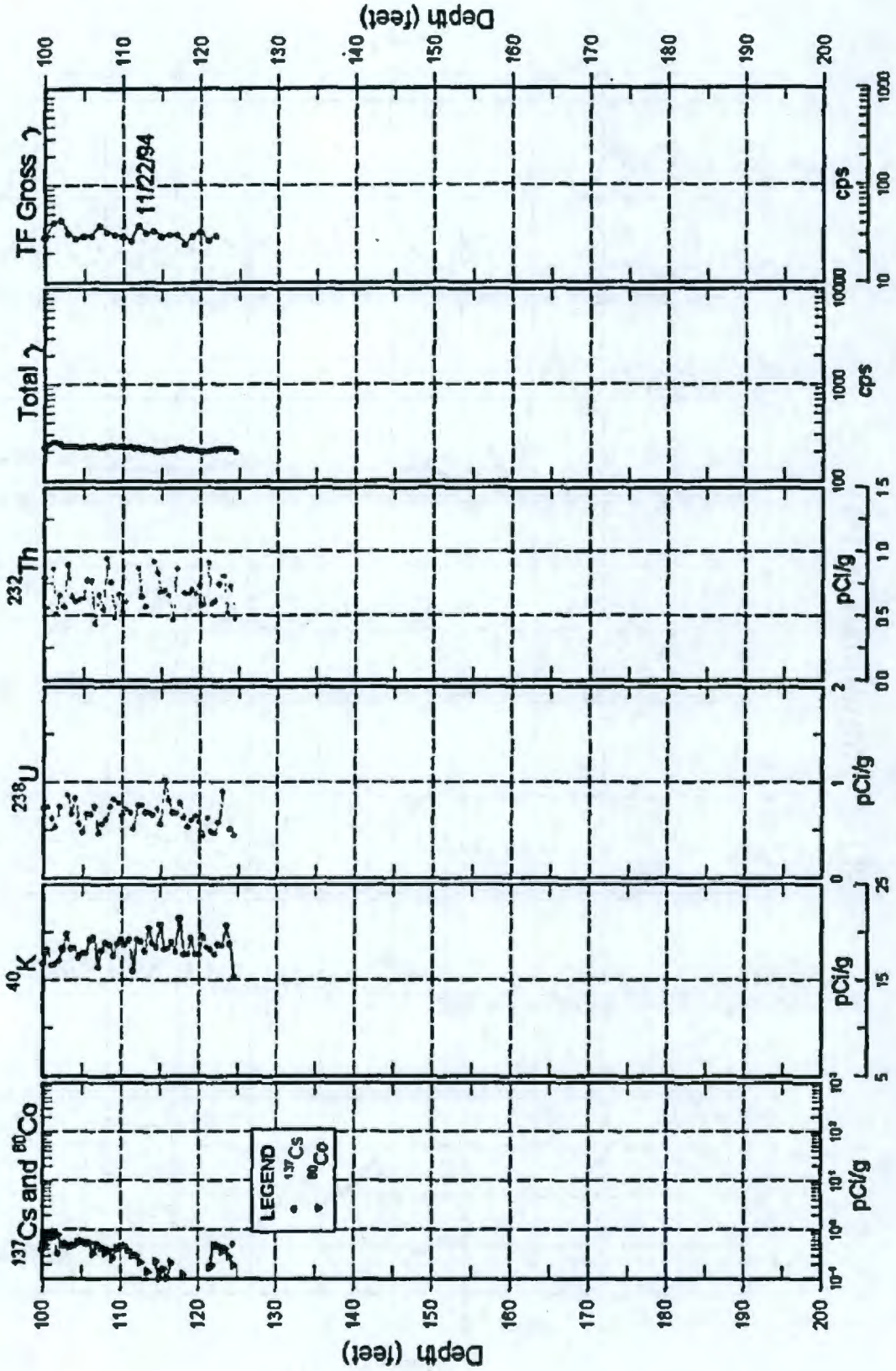
Analysis Notes

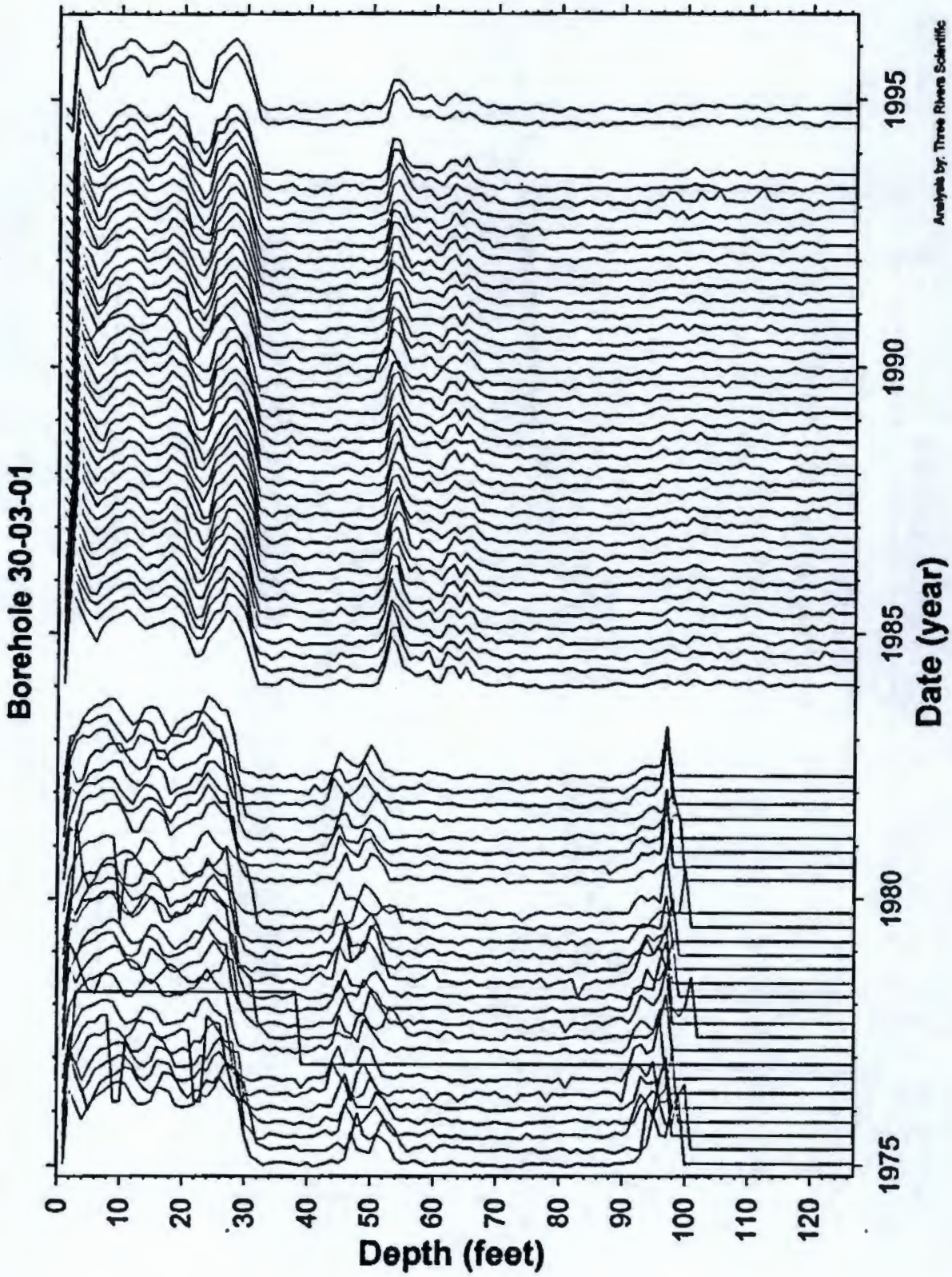
Method Used to Compute Background :	Fixed Background (30-40 ft) for 0-30, 42-57 & 52-68 ft Fixed Background (70-88 ft) for 90-125 ft
Depth(s) where Contamination Identified in Gross Gamma Surveys :	0-30 ft Tank Farm Activity 40-70 ft Undetermined 90-125 ft Unstable
Analyst Name :	R.R. Randall
Company Name :	Three Rivers Scientific

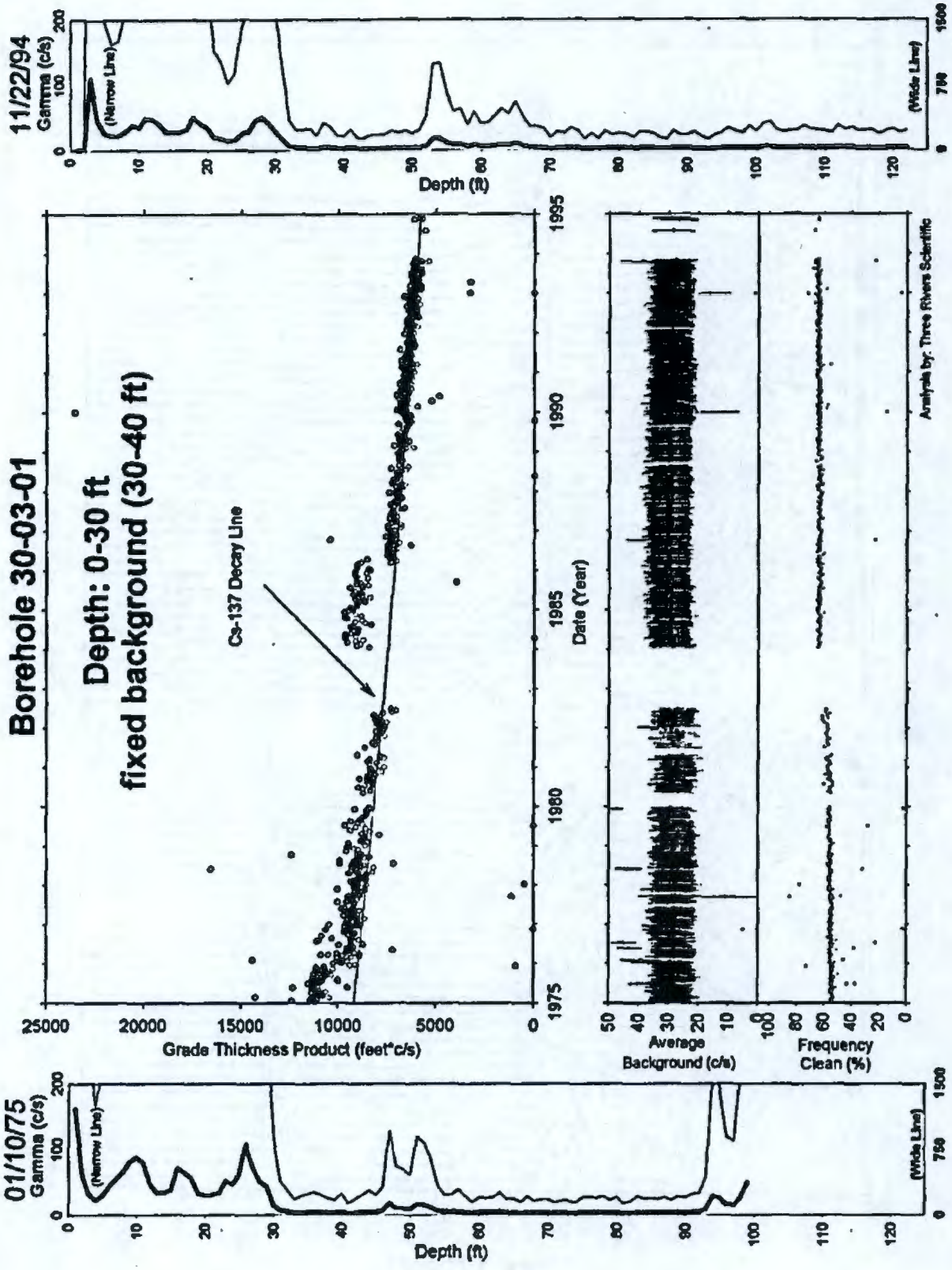
30-03-01 Combination Plot

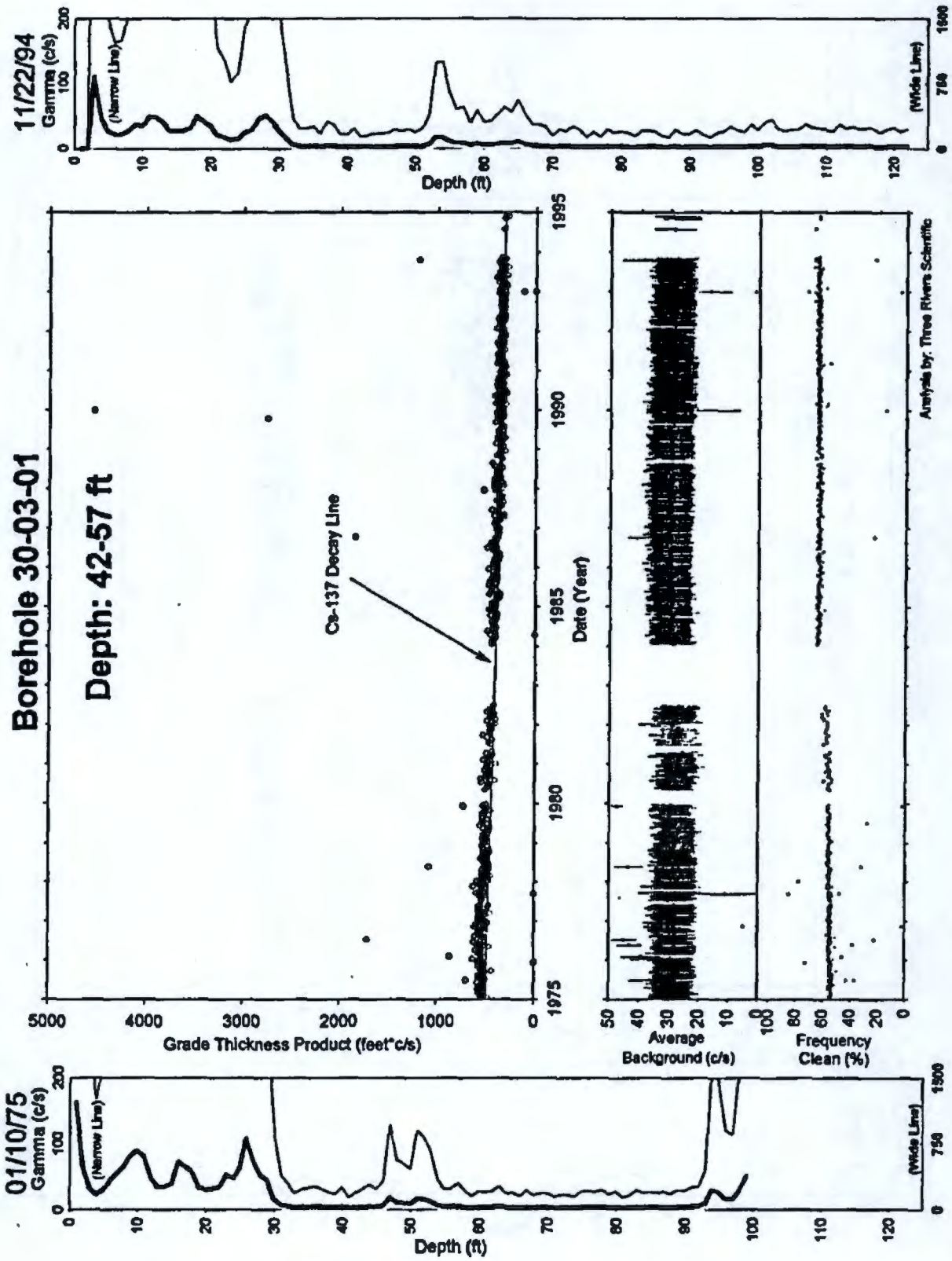


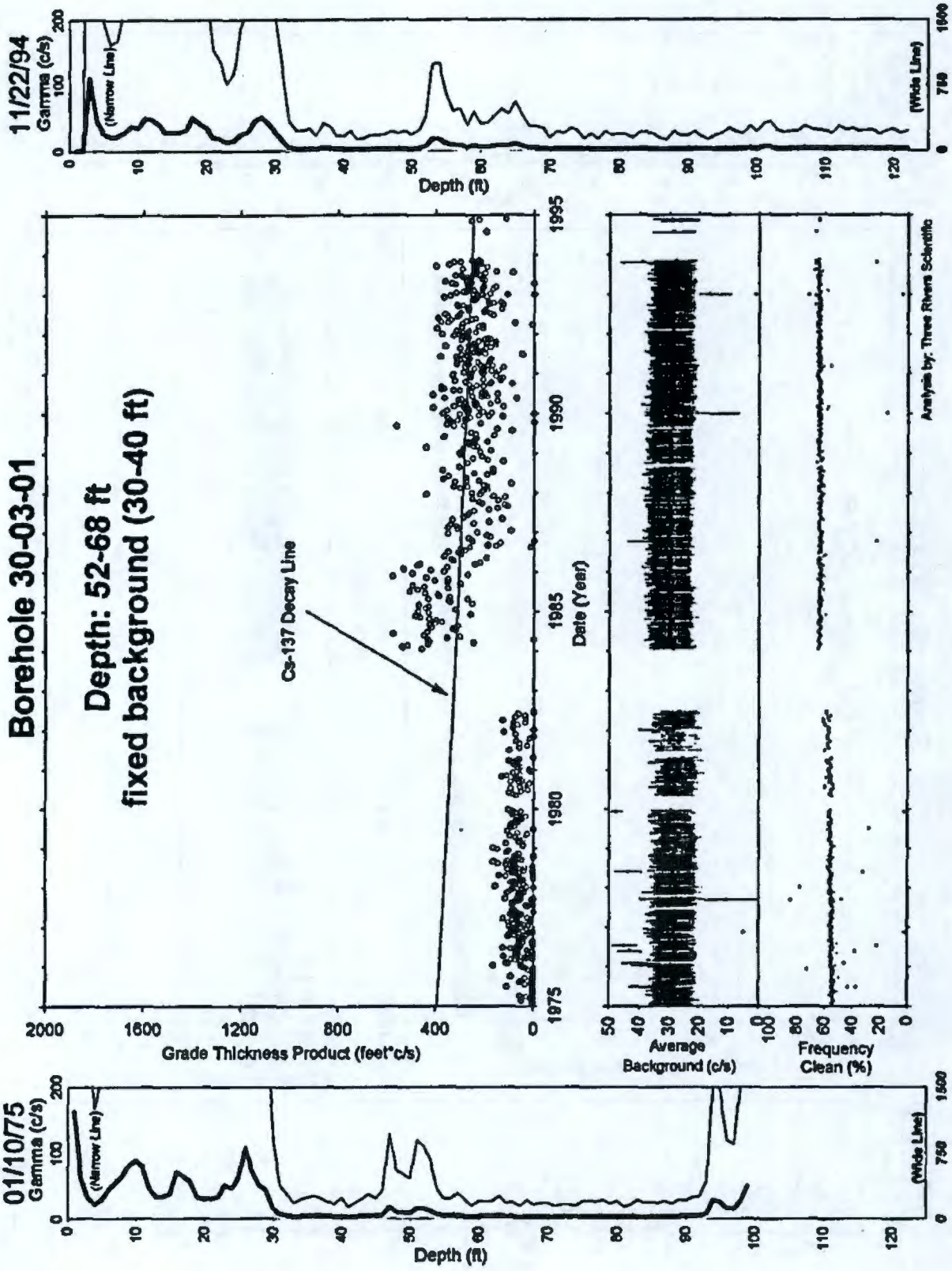
30-03-01 Combination Plot

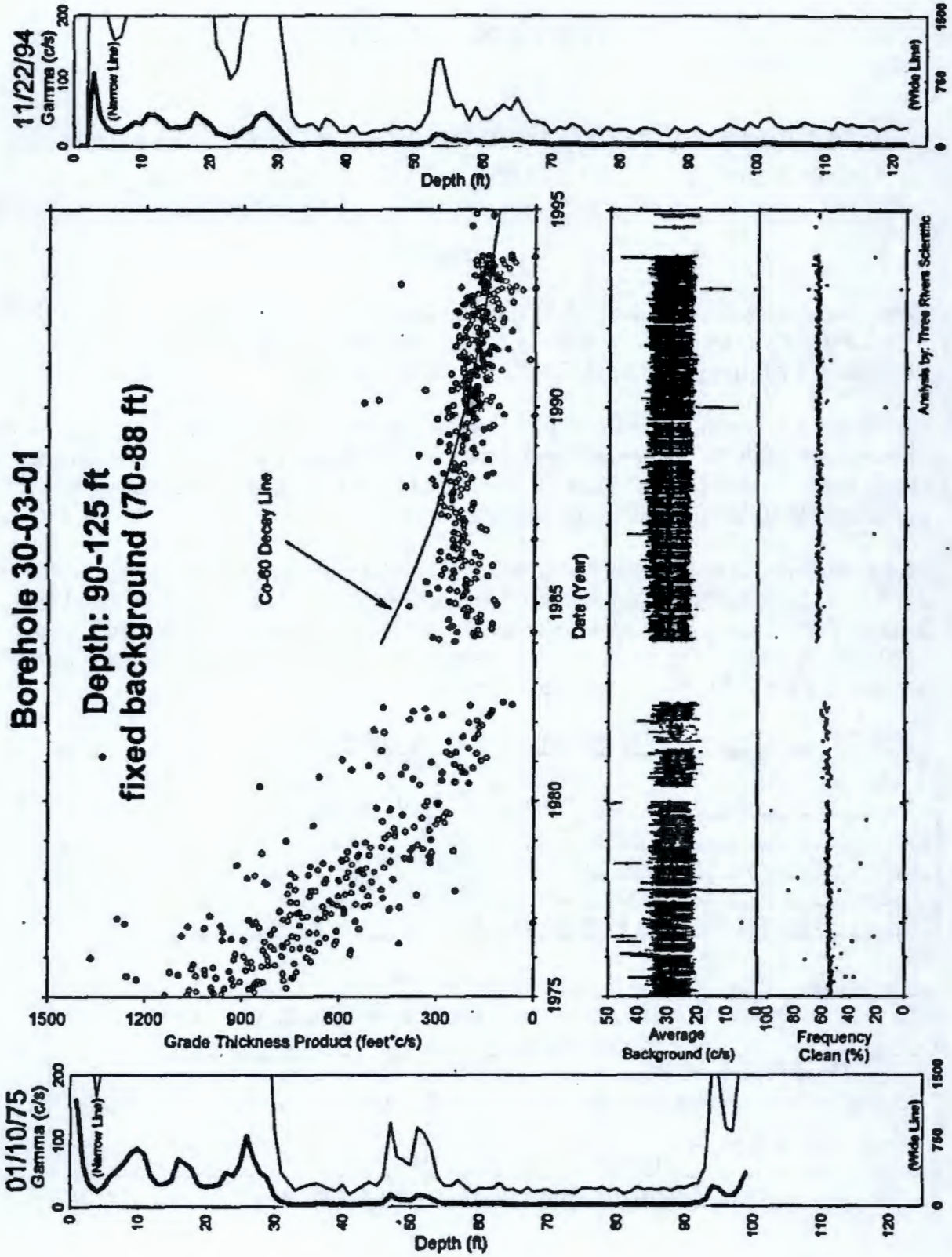



Borehole 30-03-01
Depth (feet)
0
10
20
30
40
50
60
70
80
90
100
110
120
Date (year)
1975
1980
1985
1990
1995
Analysis by: Three Rivers Scientific


Borehole 30-03-01
Depth: 0-30 ft
fixed background (30-40 ft)
11/22/94
Gamma (c/s)
(Narrow Line)
(Wide Line)
Depth (ft)
Cs-137 Decay Line
Grade Thickness Product (feet*c/s)
Date (Year)
Average Background (c/s)
Frequency Clean (%)
Analysis by: Three Rivers Scientific
01/10/75
Gamma (c/s)
(Narrow Line)
(Wide Line)
Depth (ft)


11/22/94
Gamma (c/s)
(Narrow Line)
(Wide Line)
Depth (ft)
Borehole 30-03-01
Depth: 42-57 ft
Cs-137 Decay Line
Grade Thickness Product (feet*c/s)
Date (Year)
Average Background (c/s)
Frequency Clean (%)
Analysis by: Three Rivers Scientific
01/10/75
Gamma (c/s)
(Narrow Line)
(Wide Line)
Depth (ft)


Borehole 30-03-01
Depth: 52-68 ft
fixed background (30-40 ft)
11/22/94
Gamma (c/s)
(Narrow Line)
(Wide Line)
Depth (ft)
Cs-137 Decay Line
Grade Thickness Product (feet*c/s)
Date (Year)
Average Background (c/s)
Frequency Clean (%)
Analysis by: Three Rivers Scientific
01/10/75
Gamma (c/s)
(Narrow Line)
(Wide Line)
Depth (ft)


11/22/94
Gamma (c/s)
(Narrow Line)
(Wide Line)
Depth (ft)
Borehole 30-03-01
Depth: 90-125 ft
fixed background (70-88 ft)
Co-60 Decay Line
Date (Year)
Grade Thickness Product (feet*c/s)
Average Background (c/s)
Frequency Clean (%)
Analysis by: Three Rivers Scientific
01/10/75
Gamma (c/s)
(Narrow Line)
(Wide Line)
Depth (ft)

Borehole 30-03-03

Contamination (Cs-137) from 0-14 feet is Tank Farm Activity. Contamination (Cs-137) from 14-40 feet is Undetermined. Contamination (Co-60 & Ru-106) from 78-100 feet is Unstable Early.

Grade thickness product over 0 to 14 feet is erratic and highly variable from 1975 to 1986, indicative of tank farm activity. Since 1986, the grade thickness product is consistent with the decay from Cs-137 (HPGe identified).

Grade thickness product over 14 to 40 feet is undetermined. The gross gamma over this interval may be influenced by the higher level from 10 to 14 feet coupled with depth control error prior to 1984. From 1984 to 1994 the grade thickness product is consistent with Cs-137 (HPGe identified) decay.

Grade thickness product over 78 to 100 feet is consistent with least square fit for Co-60 (HPGe identified) and Ru-106 (hypothesis) decay after 1978. The resulting least square ratio of gross gamma from Co-60 to gross gamma from Ru-106 as of 1/10/1975 is 0.085. The grade thickness product deviation from the fit prior to 1978 results in a classification of unstable early.

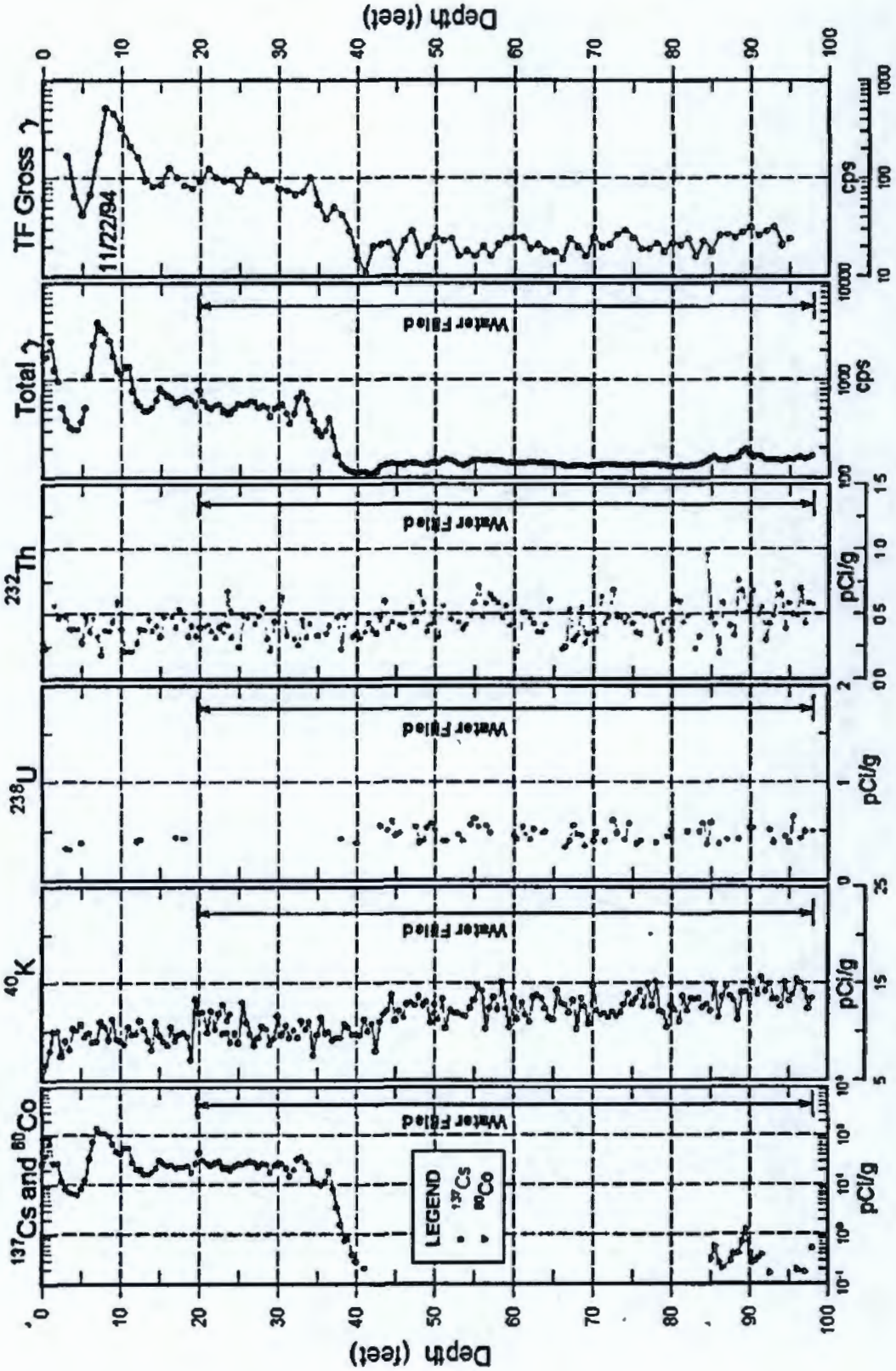
Gross Gamma Survey Information

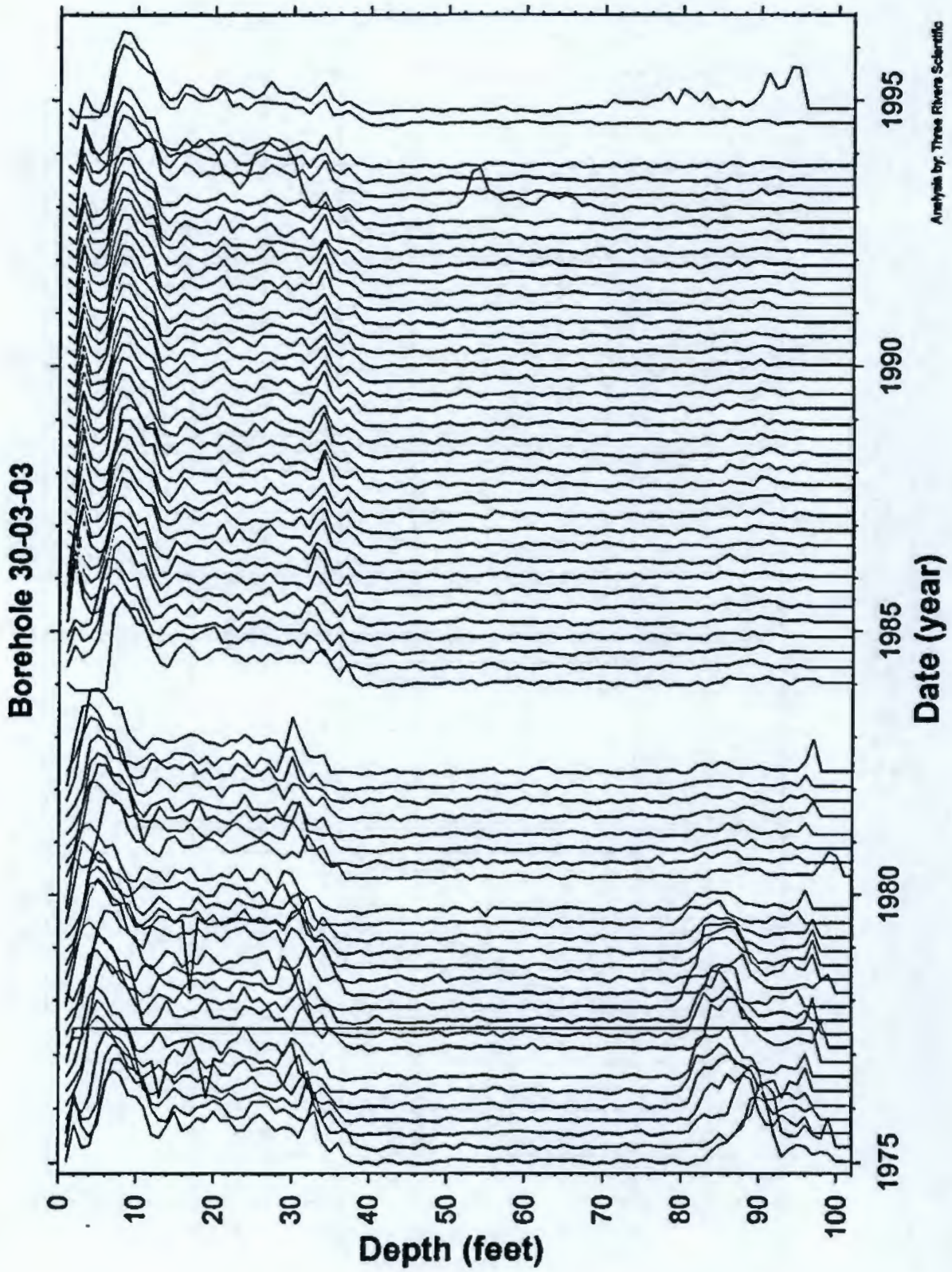
Probe Type Processed :	04: NaI
Other Probe Types :	03: Neutron
Survey Depth :	130 ft
First Survey Date :	1/10/1975
Last Survey Date :	11/22/1994
Number Surveys Processed :	550

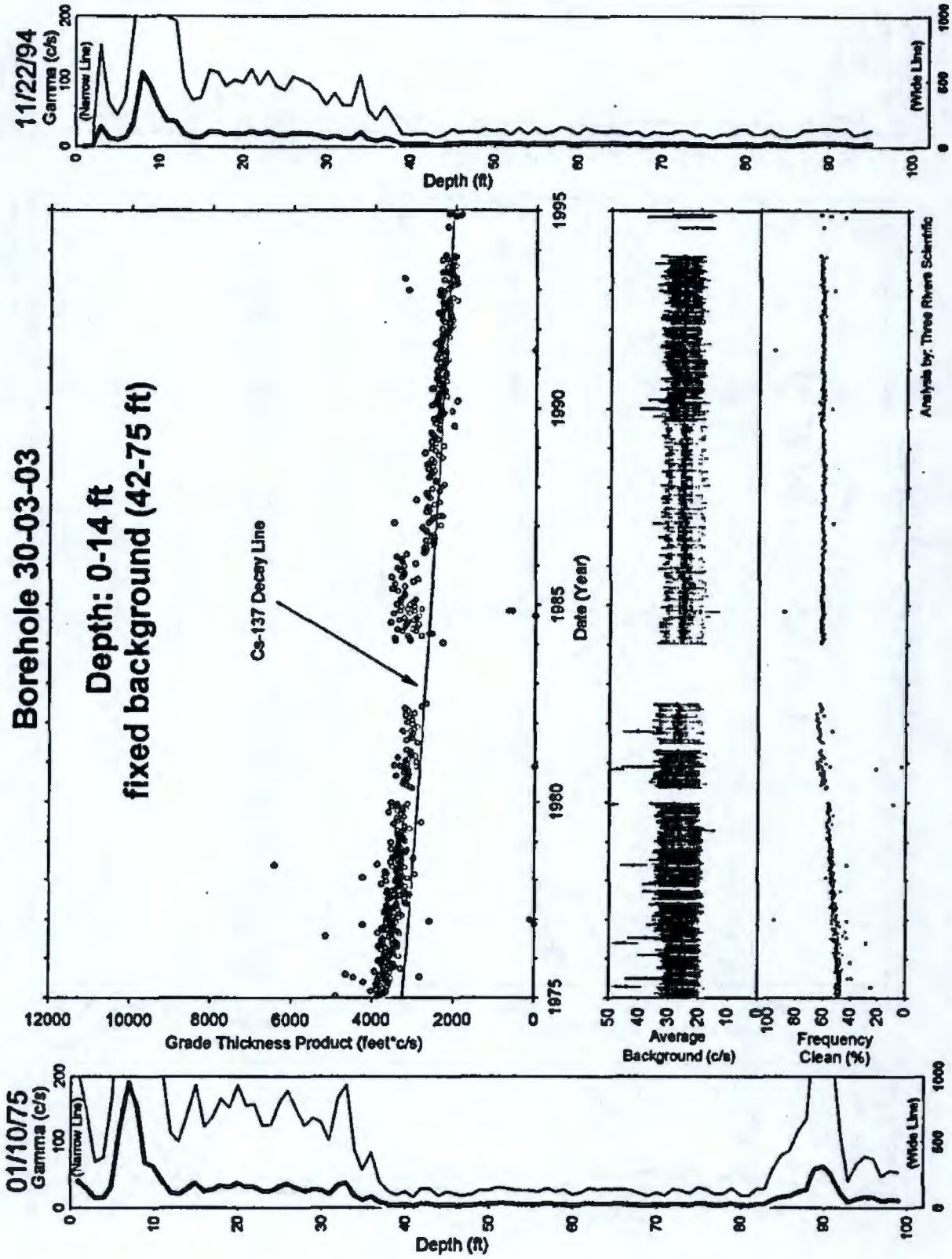
Analysis Notes

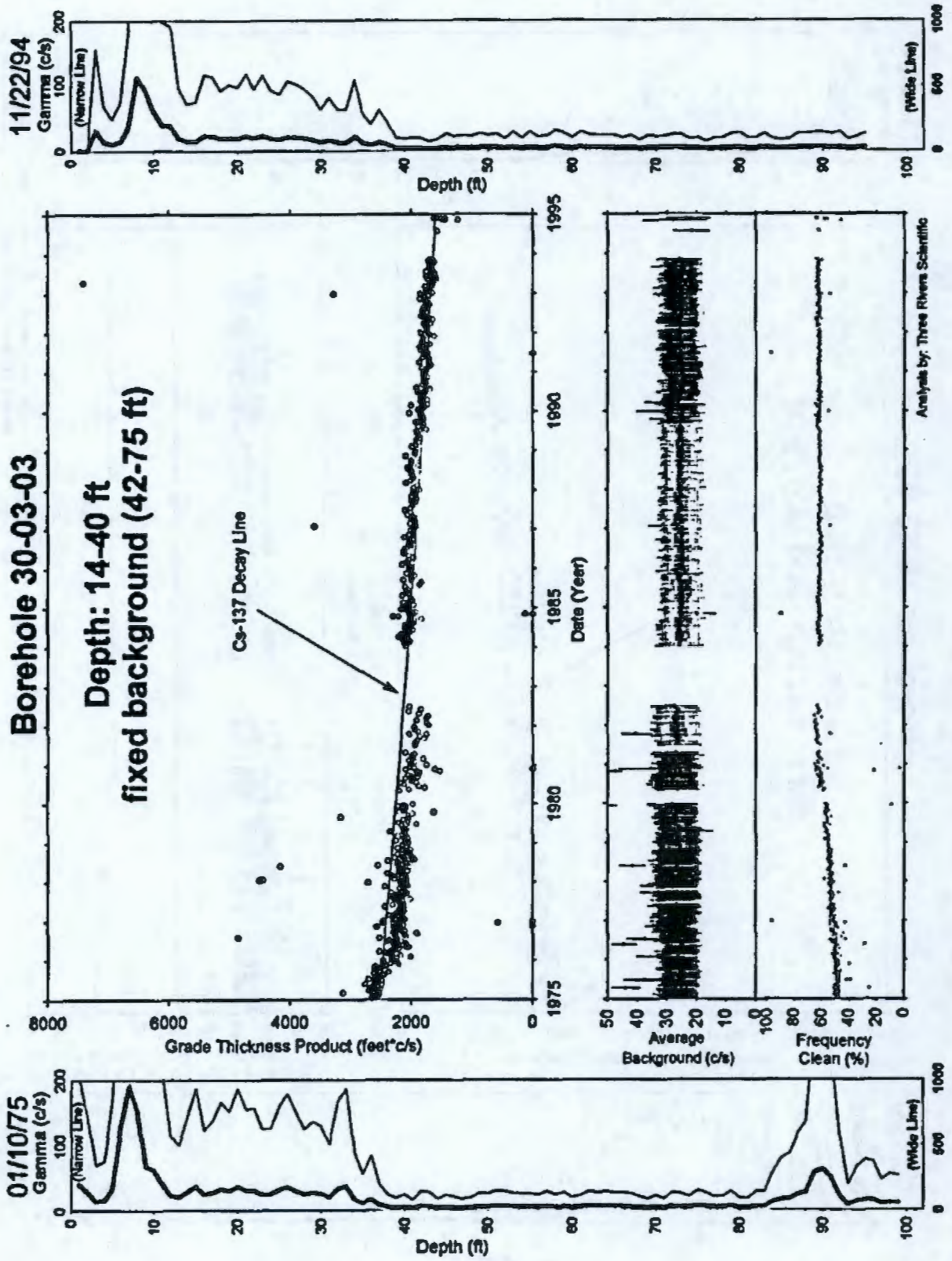
Method Used to Compute Background :	Fixed background (42-75 ft)
Depth(s) where Contamination Identified in Gross Gamma Surveys :	0-14 ft Tank Farm Activity 14-40 ft Undetermined 78-100 ft Unstable Early
Analyst Name :	R.R. Randall
Company Name :	Three Rivers Scientific

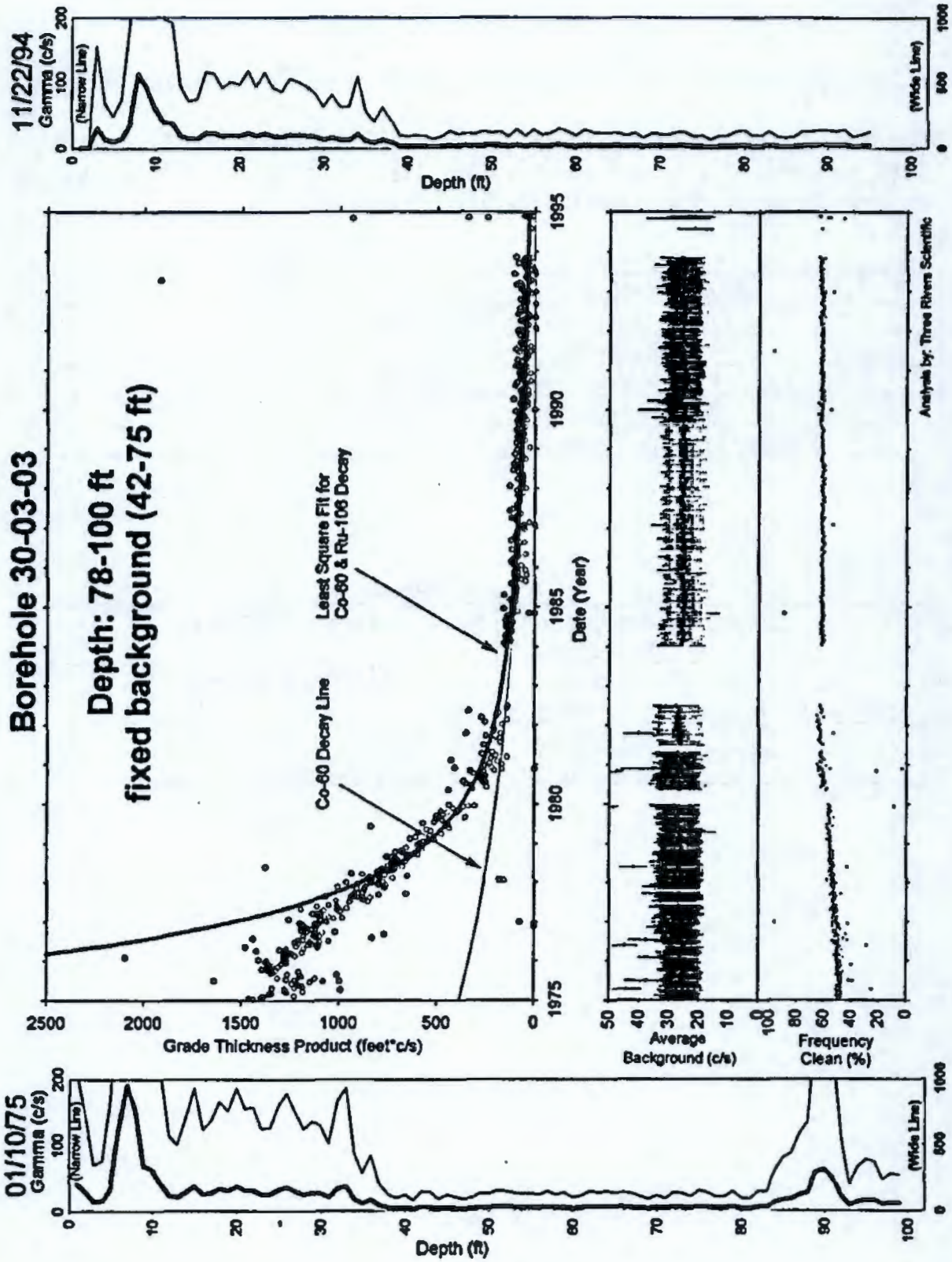
30-03-03 Combination Plot




Borehole 30-03-03
Depth (feet)
0
10
20
30
40
50
60
70
80
90
100
Date (year)
1975
1980
1985
1990
1995
Analysis by: Three Rivers Scientific


11/22/94
Gamma (c/s)
(Narrow Line)
(Wide Line)
Depth (ft)
Borehole 30-03-03
Depth: 0-14 ft
fixed background (42-75 ft)
Cs-137 Decay Line
Grade Thickness Product (feet*c/s)
Date (Year)
Average Background (c/s)
Frequency Clean (%)
Analysis by: Three Rivers Scientific
01/10/75
Gamma (c/s)
(Narrow Line)
(Wide Line)
Depth (ft)


11/22/94
Gamma (c/s)
(Narrow Line)
(Wide Line)
Depth (ft)
Borehole 30-03-03
Depth: 14-40 ft
fixed background (42-75 ft)
Cs-137 Decay Line
Grade Thickness Product (feet*c/s)
Date (Year)
Average
Background (c/s)
Frequency
Clean (%)
Analysis by: Three Rivers Scientific
01/10/75
Gamma (c/s)
(Narrow Line)
(Wide Line)
Depth (ft)


11/22/94
Gamma (c/s)
(Narrow Line)
(Wide Line)
Depth (ft)
Borehole 30-03-03
Depth: 78-100 ft
fixed background (42-75 ft)
Least Square Fit for
Co-60 & Ru-106 Decay
Co-60 Decay Line
Grade Thickness Product (feet*c/s)
Date (Year)
Average
Background (c/s)
Frequency
Clean (%)
Analysis by: Three Rivers Scientific
01/10/75
Gamma (c/s)
(Narrow Line)
(Wide Line)
Depth (ft)

Borehole 30-03-05

Contamination (Cs-137) from 0-20 feet is Tank Farm Activity.

Grade thickness product over 0 to 20 feet is erratic and highly variable from 1975 to 1986, indicative of tank farm activity. Since 1986, the grade thickness product is consistent with the decay from Cs-137 (HPGe identified).

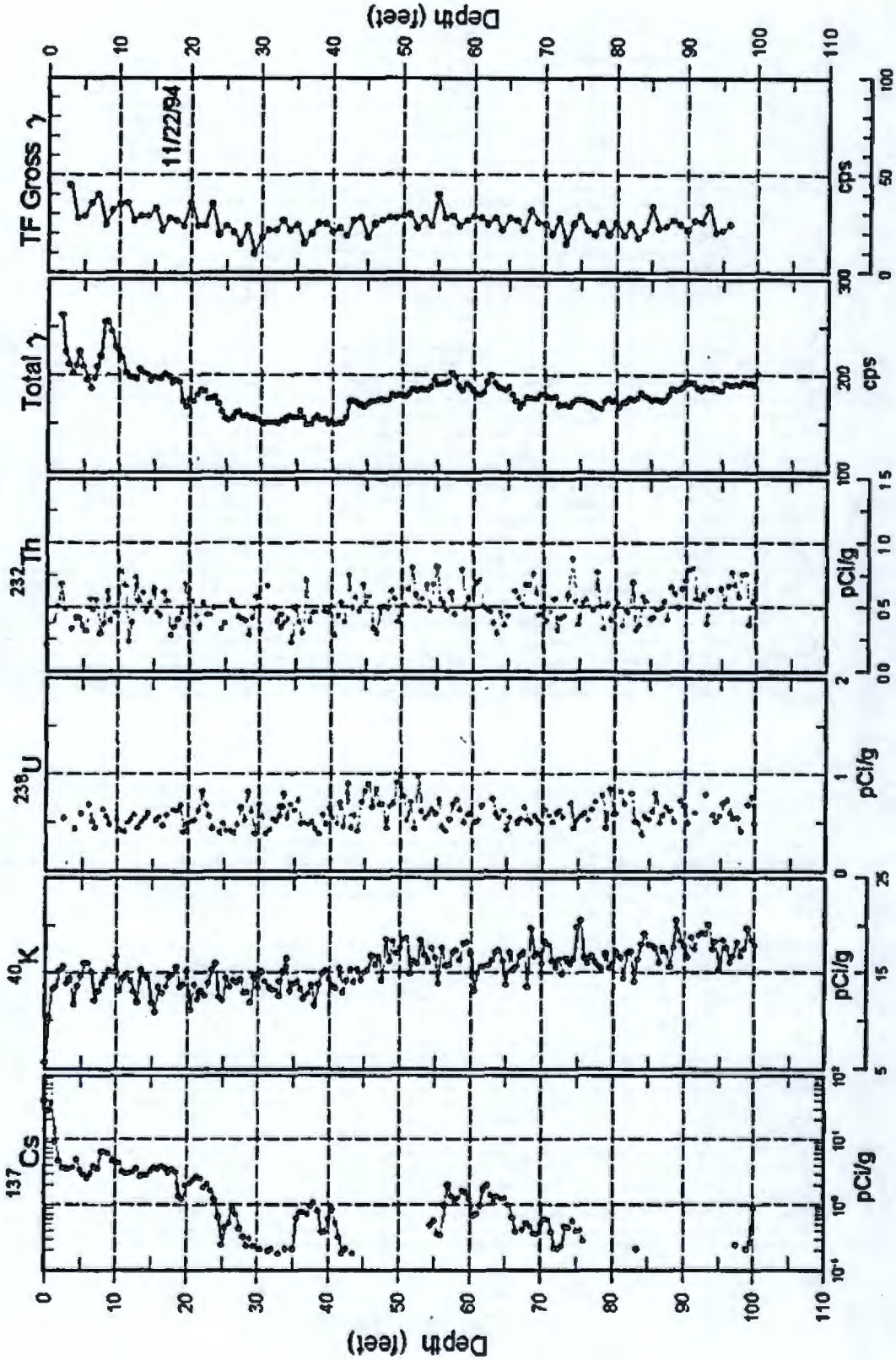
Gross Gamma Survey Information

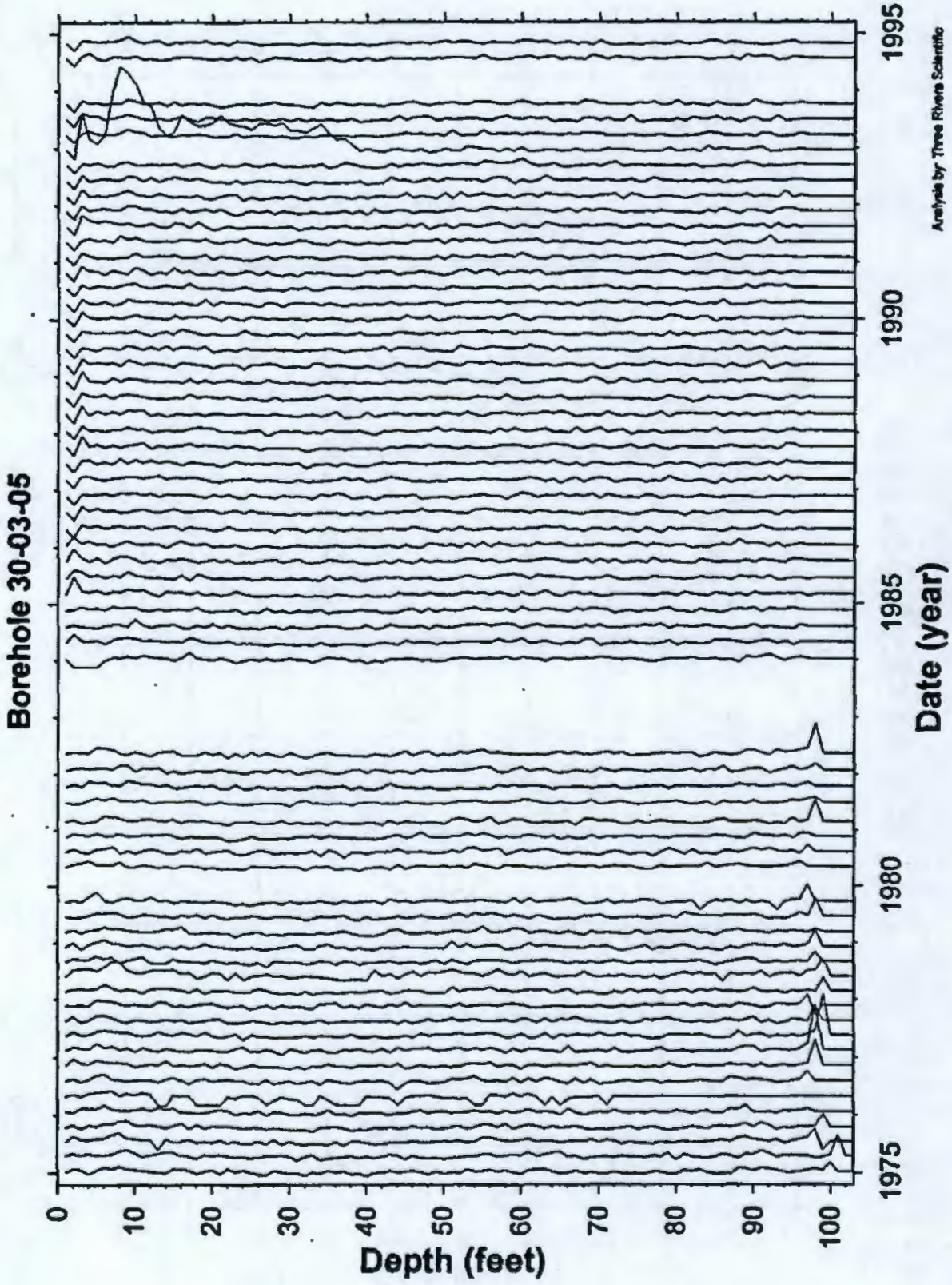
Probe Type Processed :	04: NaI
Other Probe Types :	03: Neutron
Survey Depth :	100 ft
First Survey Date :	1/10/1975
Last Survey Date :	11/22/1994
Number Surveys Processed :	515

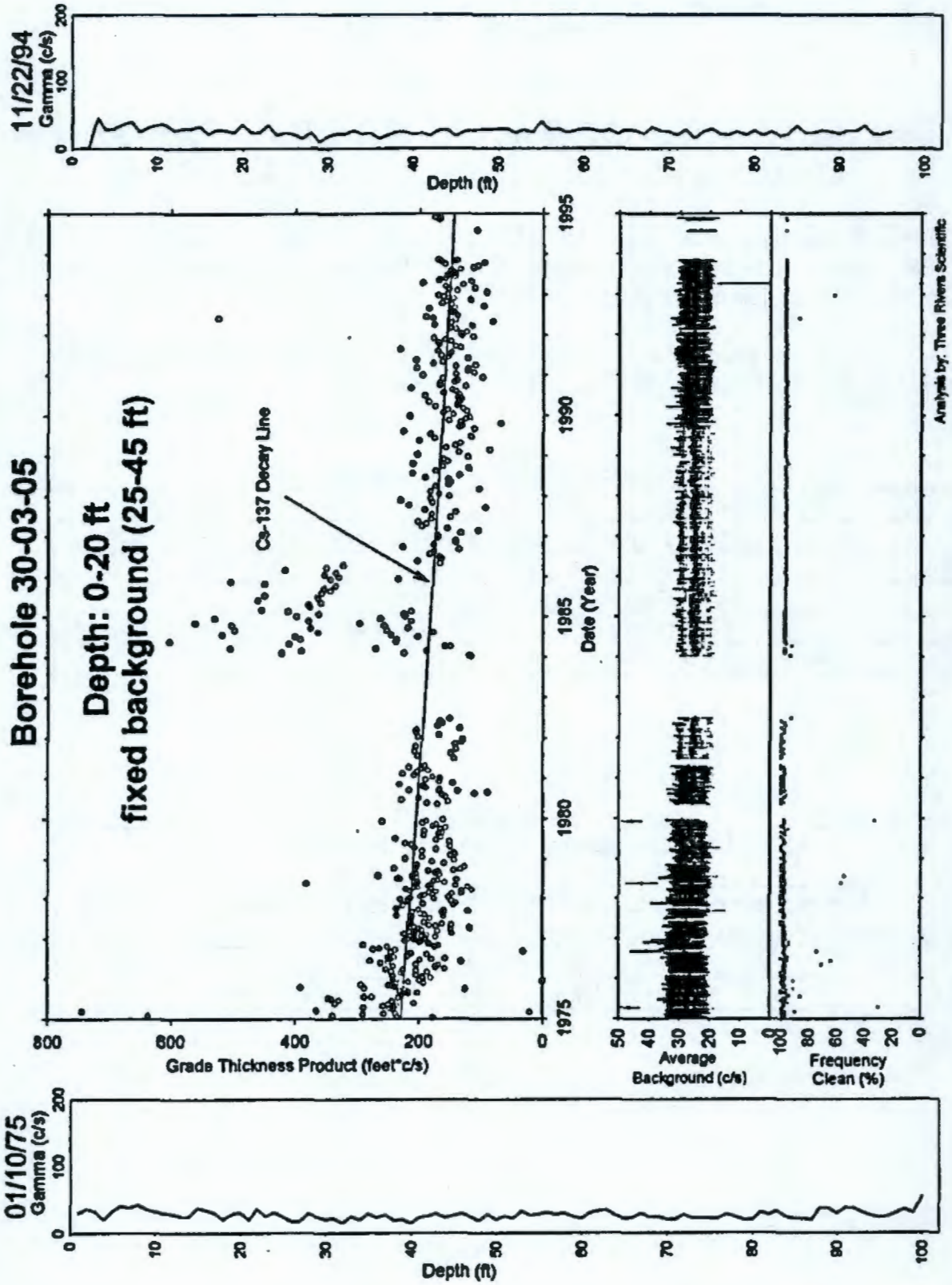
Analysis Notes

Method Used to Compute Background :	Fixed background (25-45 ft)
Depth(s) where Contamination Identified in Gross Gamma Surveys :	0-20 ft Tank Farm Activity
Analyst Name :	R.R. Randall
Company Name :	Three Rivers Scientific

30-03-05 Combination Plot




Borehole 30-03-05
Depth (feet)
0
10
20
30
40
50
60
70
80
90
100
Date (year)
1975
1980
1985
1990
1995
Analysis by Three Rivers Scientific


11/22/94
Gamma (c/s)
Depth (ft)
Borehole 30-03-05
Depth: 0-20 ft
fixed background (25-45 ft)
Cs-137 Decay Line
Grade Thickness Product (feet*c/s)
Date (Year)
Average Background (c/s)
Frequency Clean (%)
Analysis by: Three Rivers Scientific
01/10/75
Gamma (c/s)
Depth (ft)

Borehole 30-03-07

Contamination (Cs-137) from 0-12 feet is Tank Farm Activity. Contamination (Cs-137) from 42-54 feet is Stable.

Grade thickness product over 0 to 12 feet is erratic and highly variable from 1975 to 1986, indicative of tank farm activity. Since 1986, the grade thickness product is consistent with the decay from Cs-137 (HPGe identified).

Grade thickness product over 42 to 54 feet is decreasing consistent with Cs-137 (HPGe identified) decay. The zone category is stable.

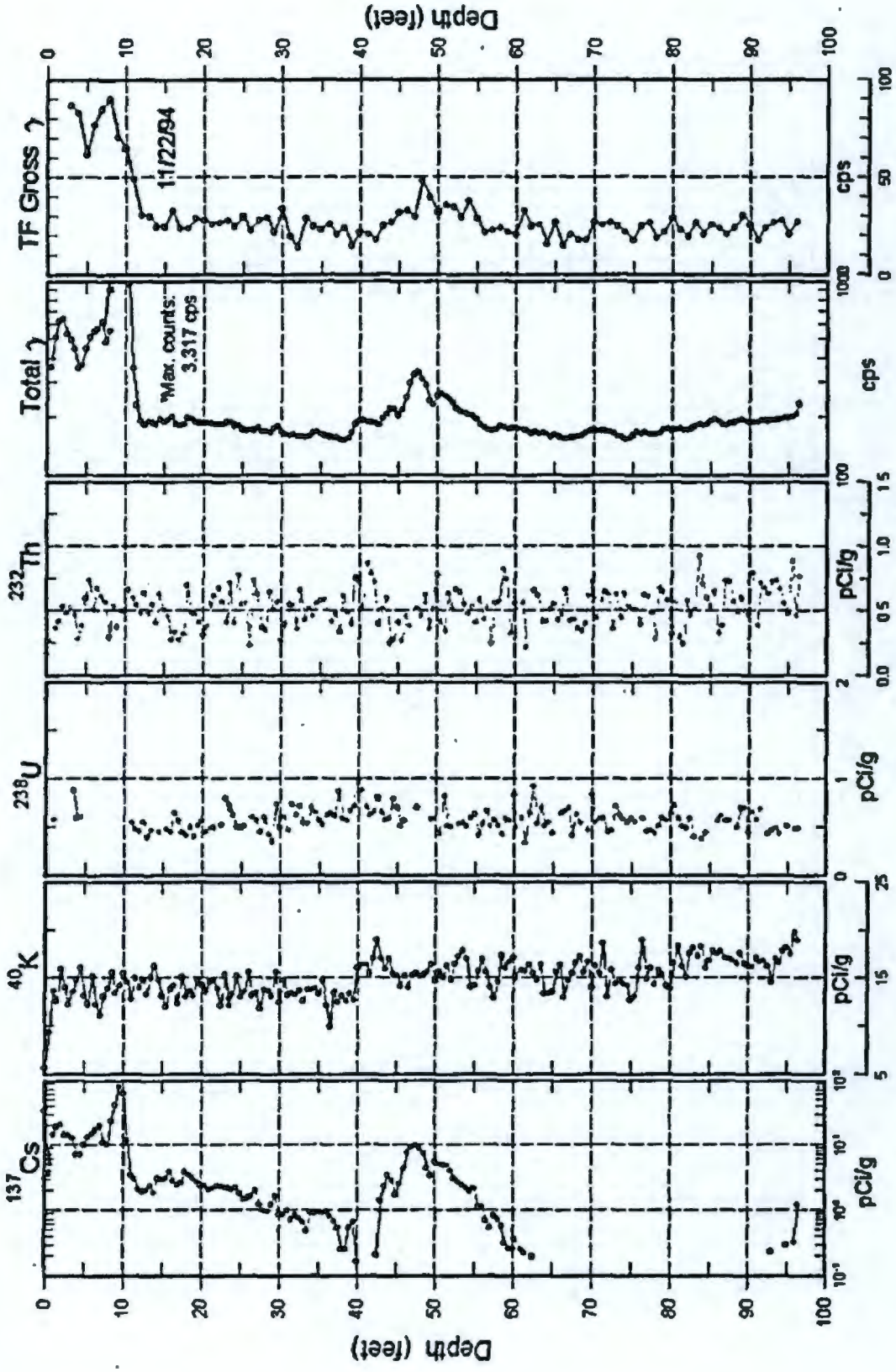
Gross Gamma Survey Information

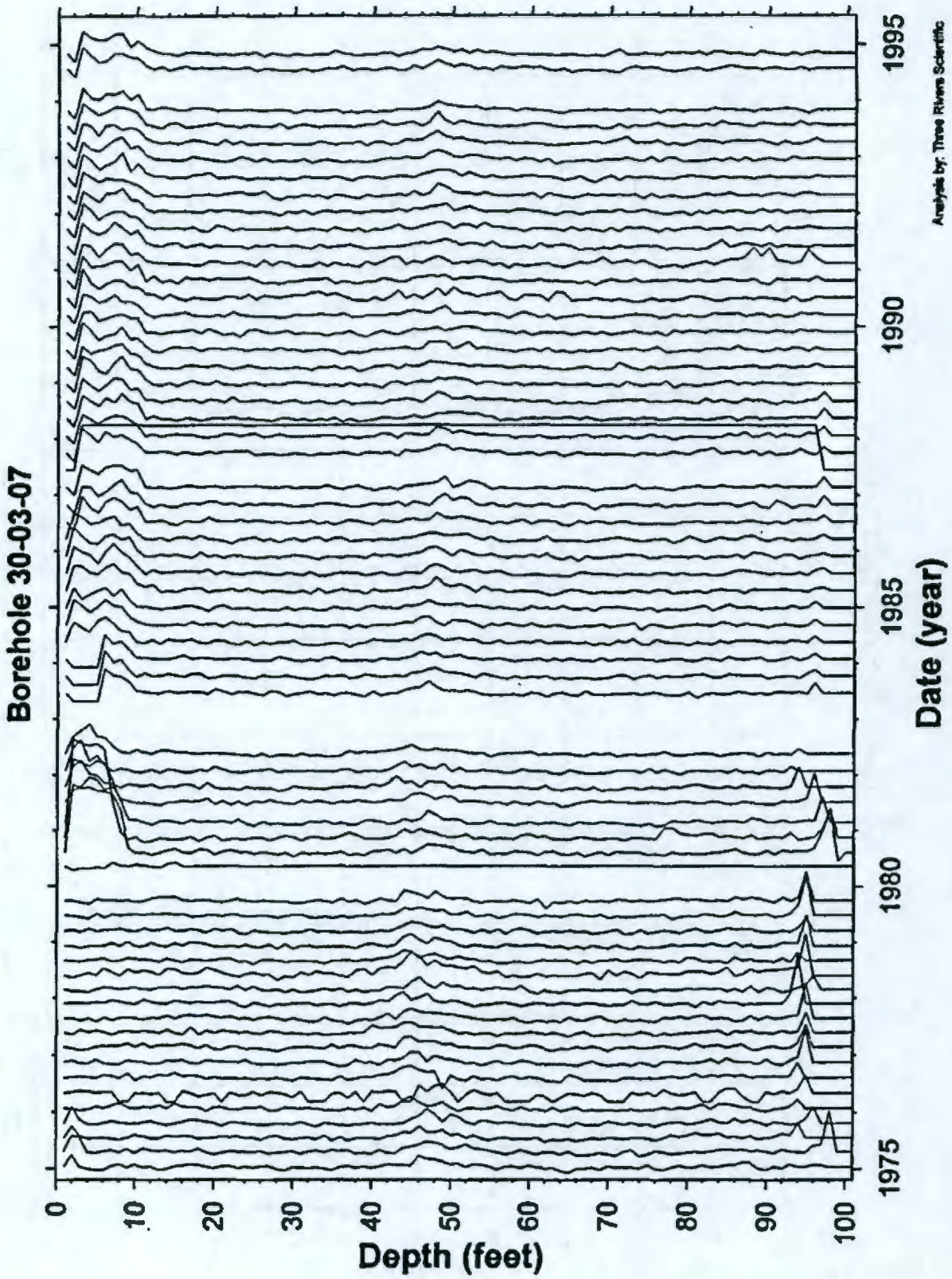
Probe Type Processed :	04: NaI
Other Probe Types :	03: Neutron
Survey Depth :	130 ft
First Survey Date :	1/10/1975
Last Survey Date :	11/22/1994
Number Surveys Processed :	499

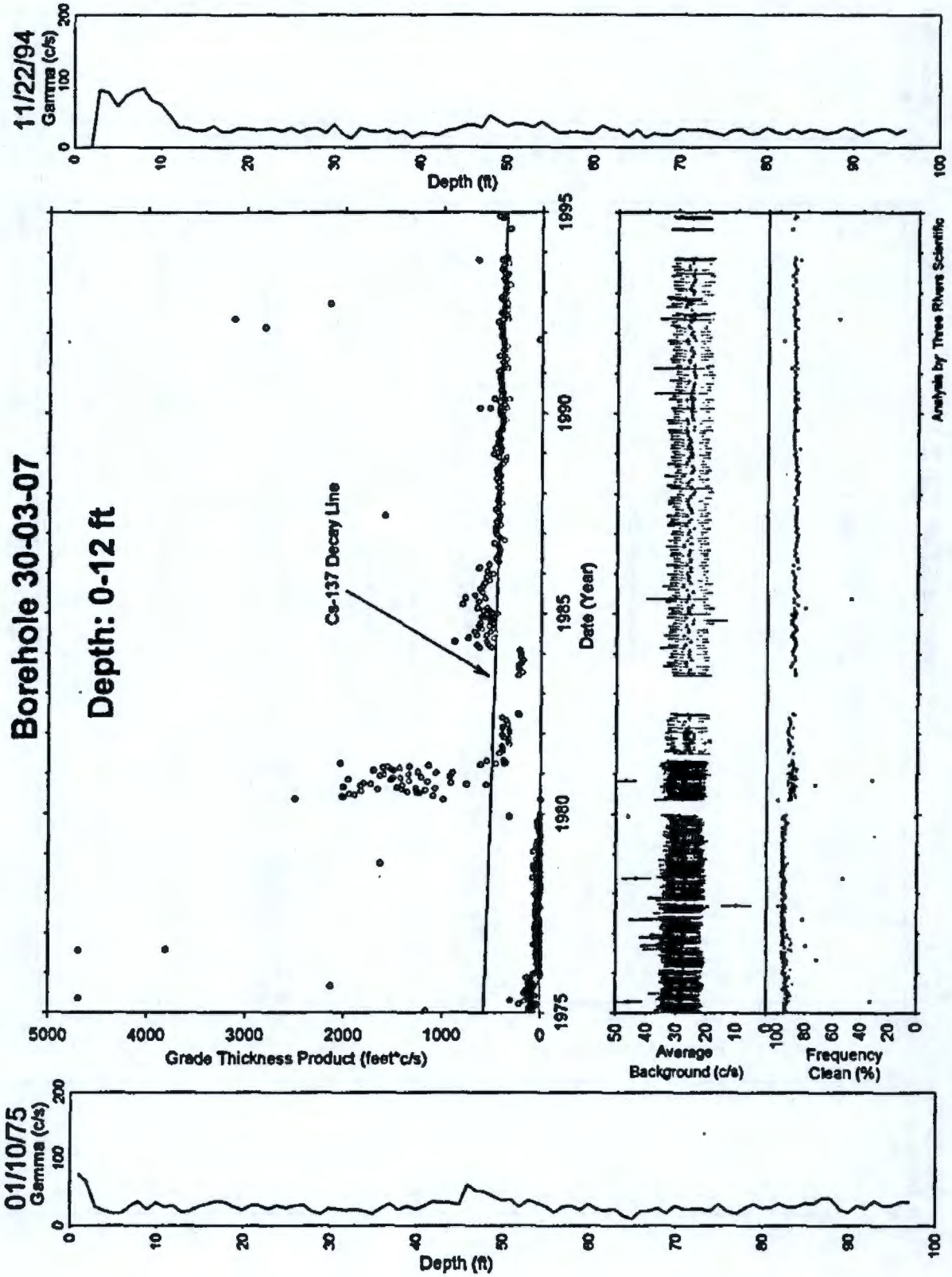
Analysis Notes

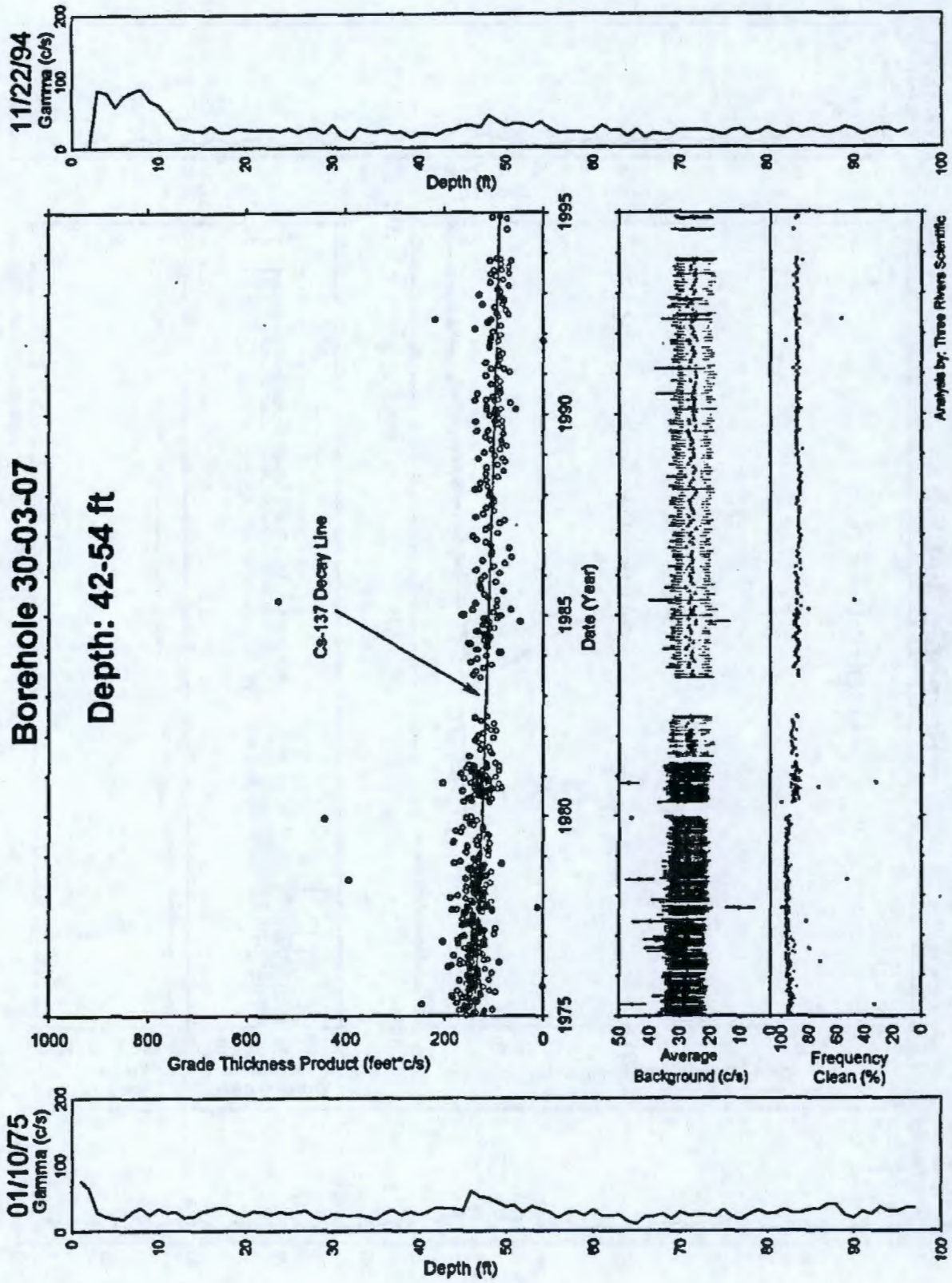
Method Used to Compute Background :	Threshold 0<val<50
Depth(s) where Contamination Identified in Gross Gamma Surveys :	0-12 ft Tank Farm Activity 42-54 ft Stable
Analyst Name :	R.R. Randall
Company Name :	Three Rivers Scientific

30-03-07 Combination Plot




Borehole 30-03-07
Depth (feet)
0
10
20
30
40
50
60
70
80
90
100
Date (year)
1975
1980
1985
1990
1995
Analysis by: Three Rivers Scientific


11/22/94
Gamma (c/s)
Depth (ft)
Borehole 30-03-07
Depth: 0-12 ft
Cs-137 Decay Line
Grade Thickness Product (feet*c/s)
Date (Year)
Average Background (c/s)
Frequency Clean (%)
Analysis by: Three Rivers Scientific
01/10/75
Gamma (c/s)
Depth (ft)


11/22/94
Gamma (c/s)
Depth (ft)
Borehole 30-03-07
Depth: 42-54 ft
Cs-137 Decay Line
Date (Year)
Grade Thickness Product (feet*c/s)
Average Background (c/s)
Frequency Clean (%)
Analysis by: Three Rivers Scientific
01/10/75
Gamma (c/s)
Depth (ft)

Borehole 30-03-09

Contamination (Cs-137) from 0-12 feet is Tank Farm Activity. Contamination (Cs-137) from 40-52 feet is Stable. Contamination (Co-60) from 73-94 feet is Unstable.

Grade thickness product over 0 to 12 feet is erratic and highly variable from 1975 to 1986, indicative of tank farm activity. Since 1986, the grade thickness product is consistent with the decay from Cs-137 (HPGe identified).

Grade thickness product over 40 to 52 feet is decreasing consistent with Cs-137 (HPGe identified) decay. The zone category is stable.

Grade thickness product over 73 to 94 feet is complex. There is some indication of downward movement from 1985 to 1995, and lateral influx for the depths between 84 to 94 feet. The presence of downward movement alone can generate the classification of unstable. Three grade thickness products were computed and plotted for depth intervals of 73-84, 84-94, and 73-94 feet, in order to examine more closely the possibility of lateral influx. They all show similar character of decline from 1975, with increase from 1985 until 1990. The match of the grade thickness product from 1990 to 1995 is insufficient time period of monitoring to make a classification, thus the category is unstable. Since the entire depth zone grade thickness product (73-94 feet) shows increase from 1985 to 1988, and the stack shows downward movement over this time, the conclusion is both lateral influx and possible downward movement.

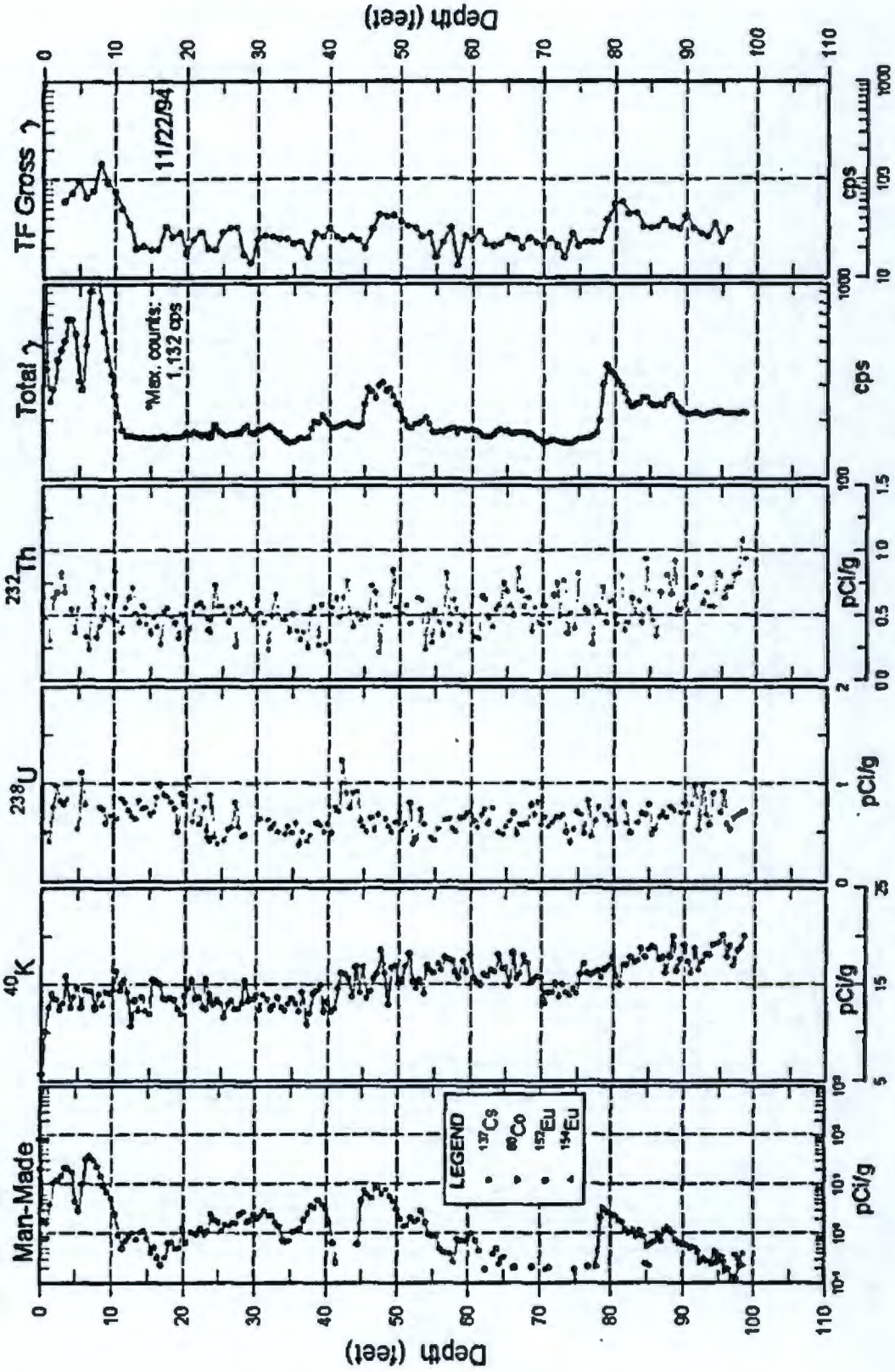
Gross Gamma Survey Information

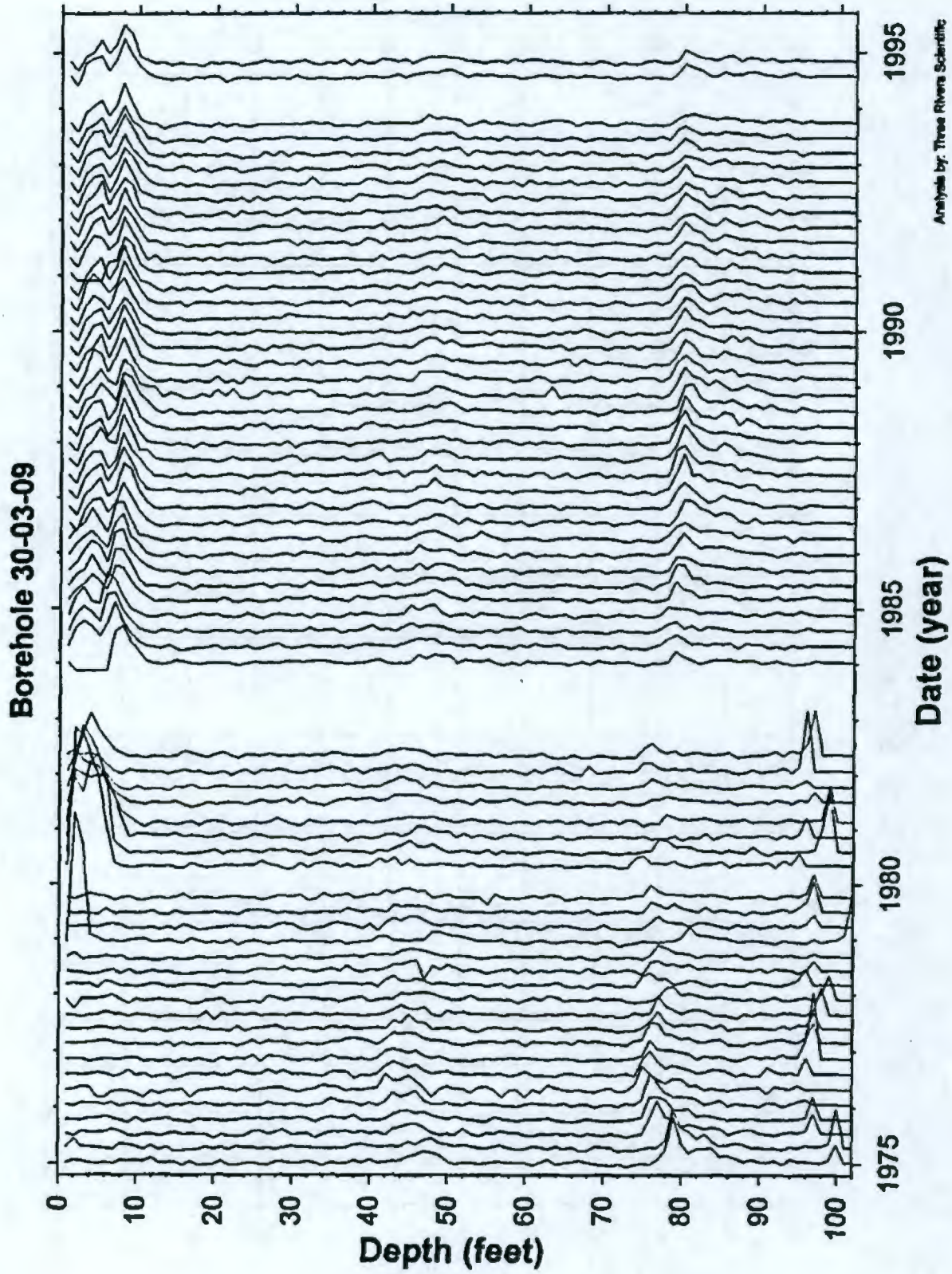
Probe Type Processed :	04: NaI
Other Probe Types :	03: Neutron
Survey Depth :	100 ft
First Survey Date :	1/10/1975
Last Survey Date :	11/22/1994
Number Surveys Processed :	553

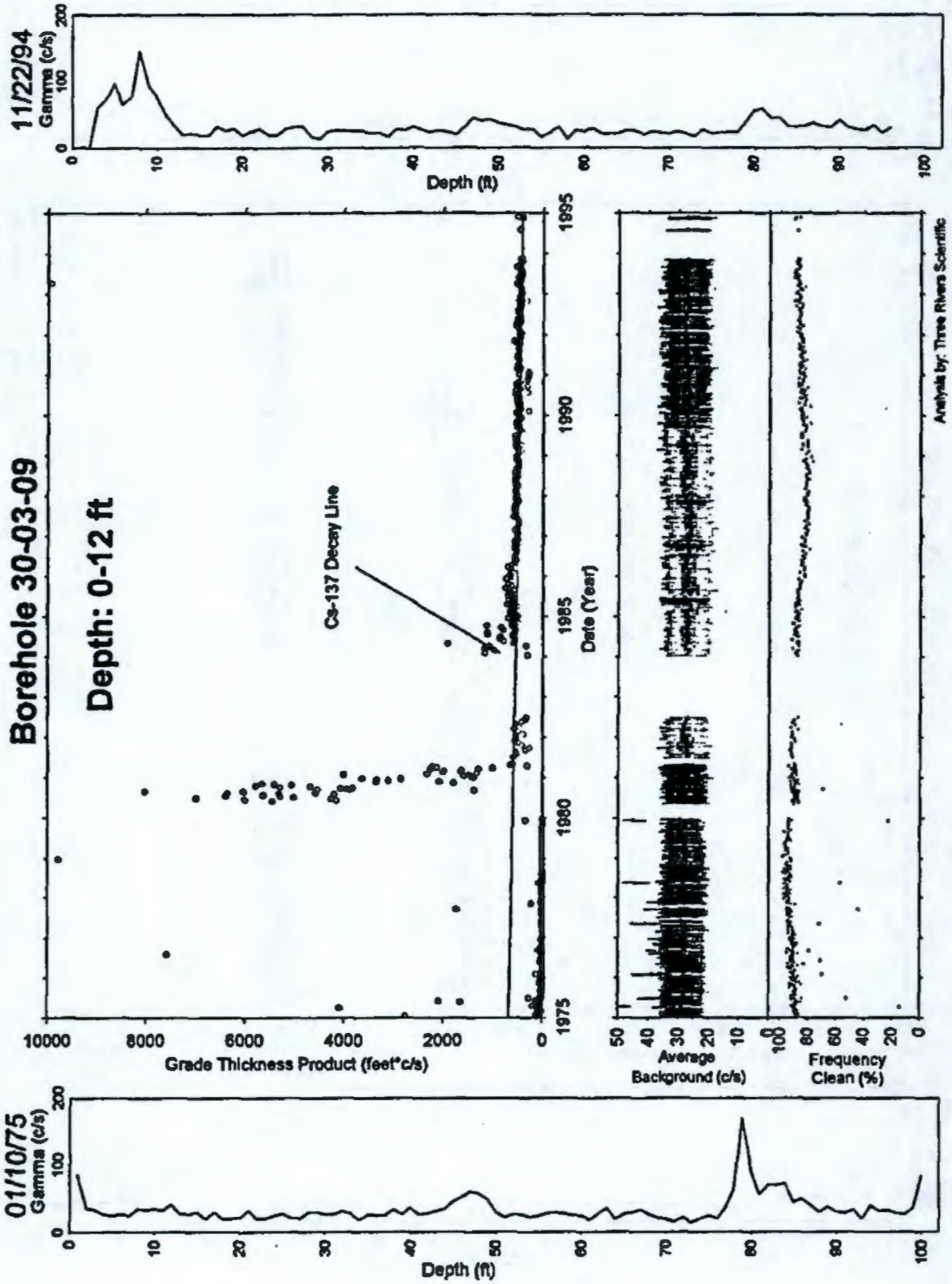
Analysis Notes

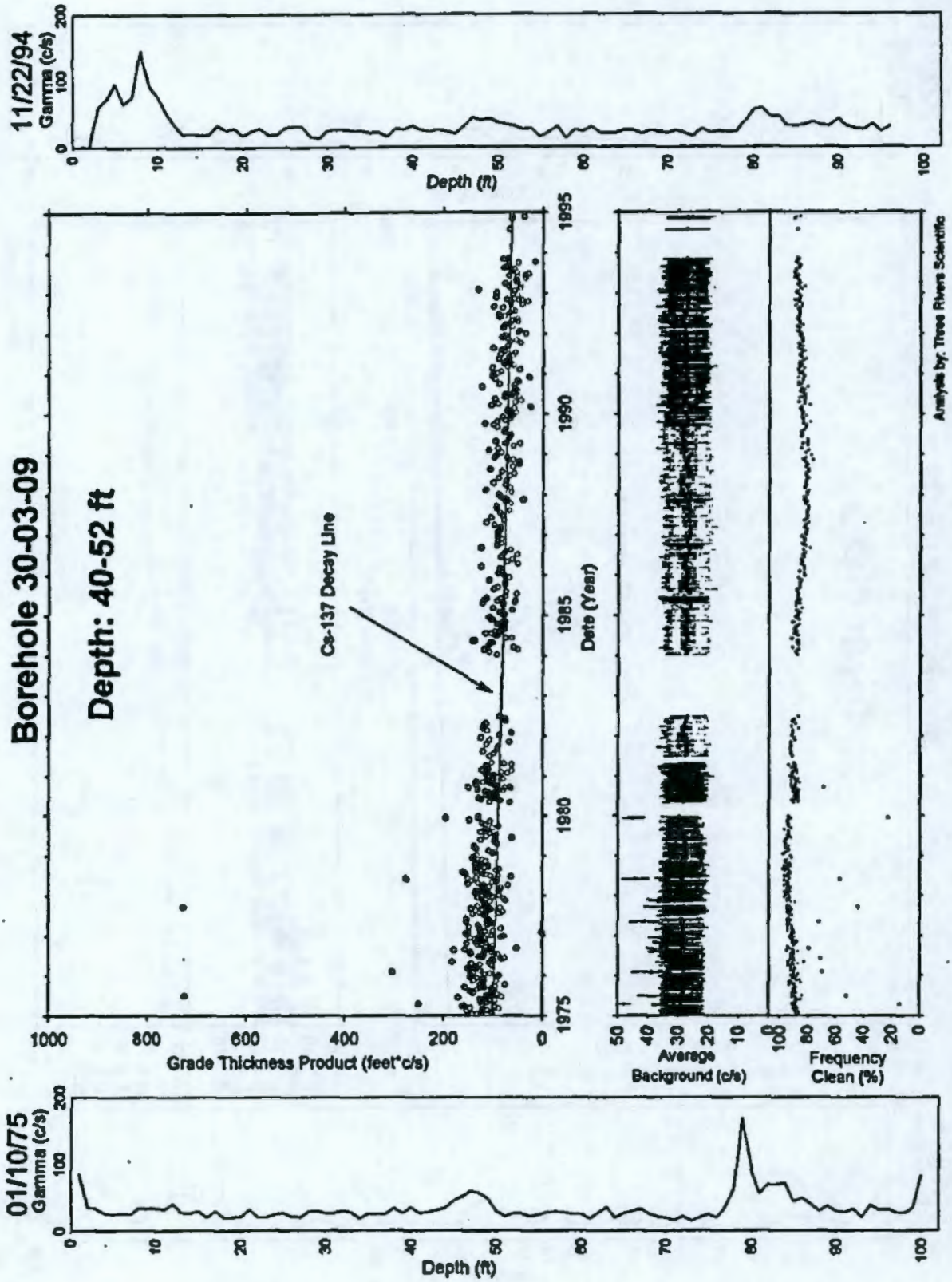
Method Used to Compute Background :	Threshold 0<val<50
Depth(s) where Contamination Identified in Gross Gamma Surveys :	0-12 ft Tank Farm Activity 40-52 ft Stable 73-94 ft Unstable
Analyst Name :	R.R. Randall
Company Name :	Three Rivers Scientific

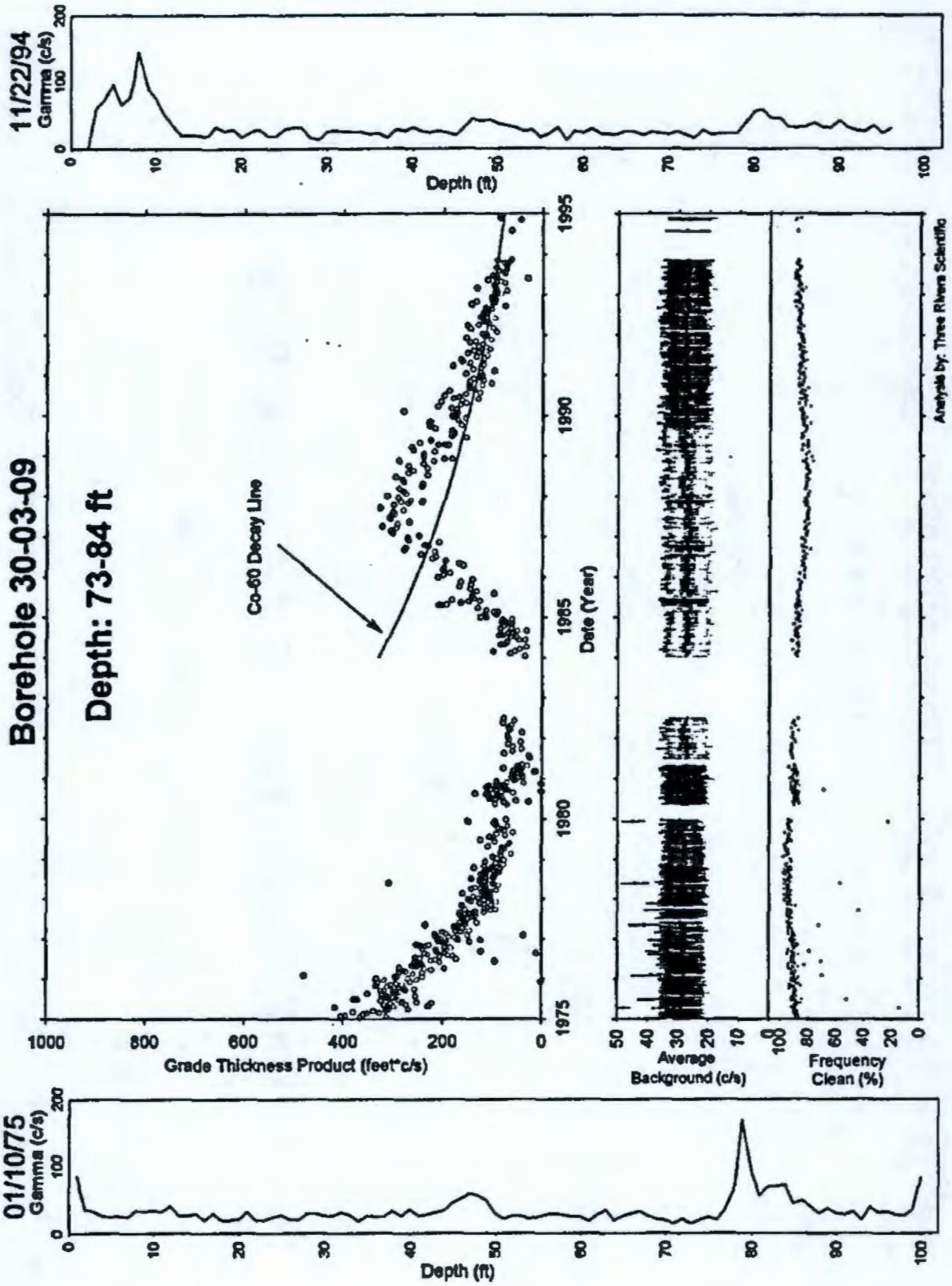
30-03-09 Combination Plot

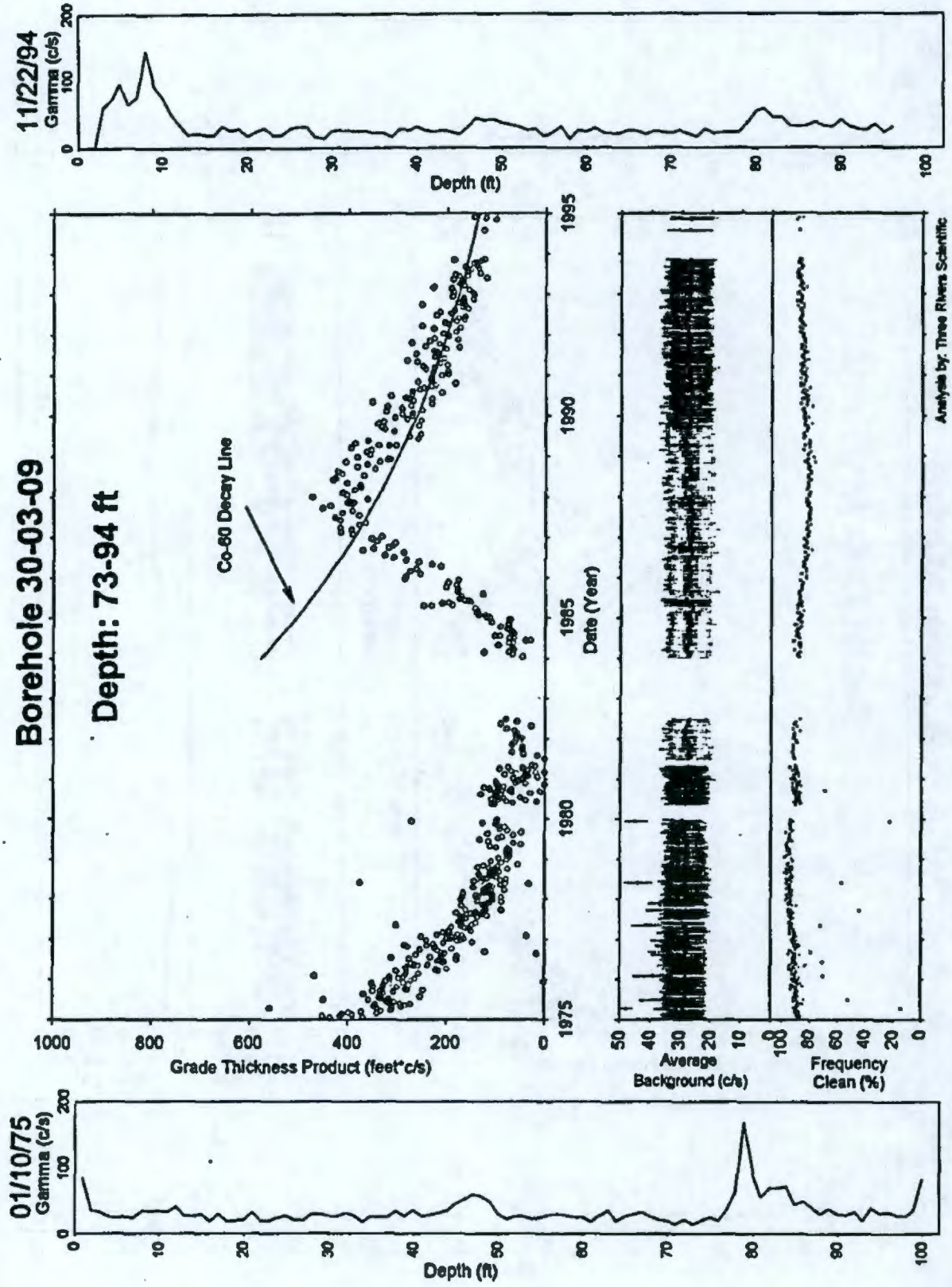


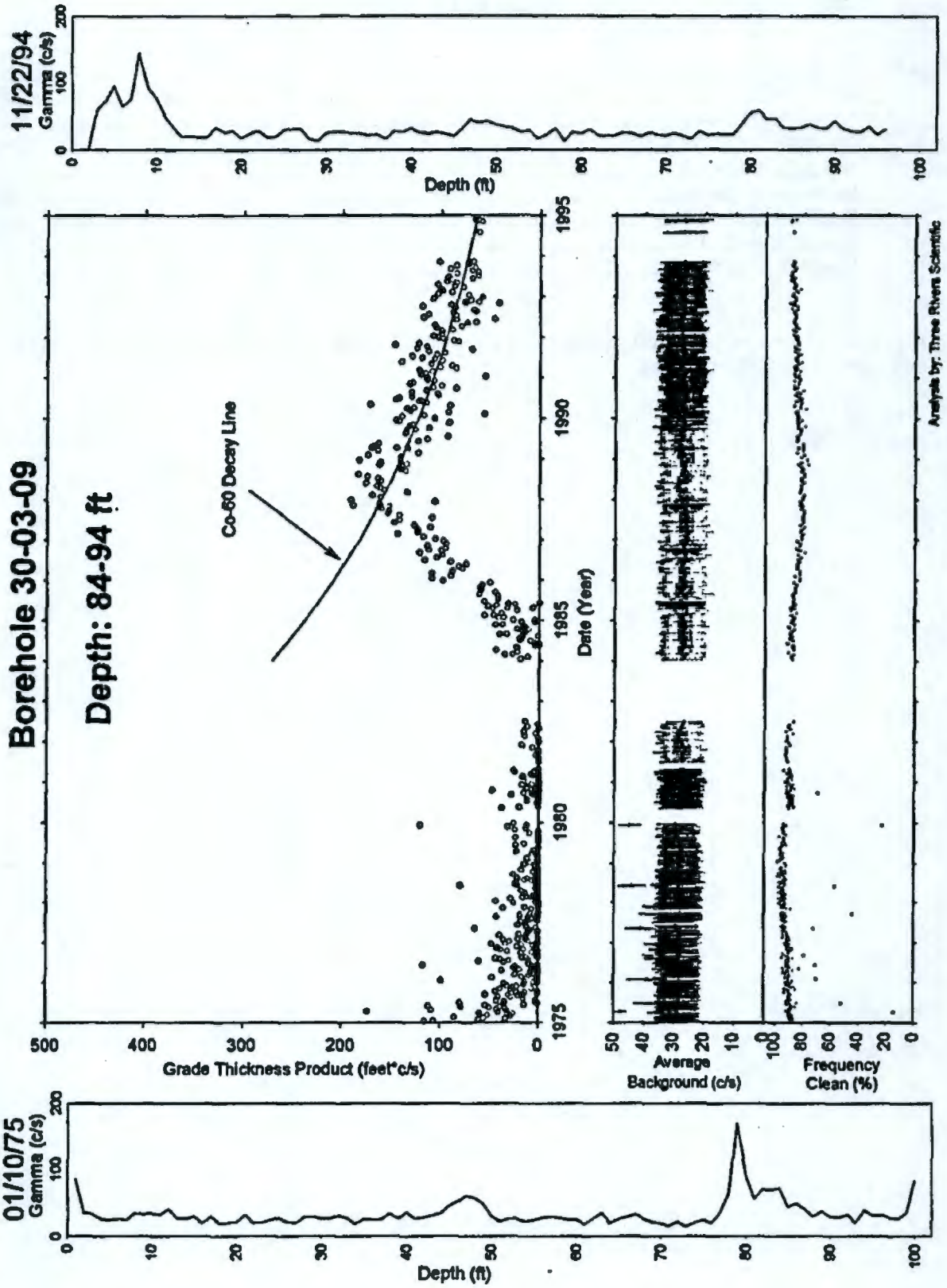

Borehole 30-03-09
Depth (feet)
0
10
20
30
40
50
60
70
80
90
100
Date (year)
1975
1980
1985
1990
1995
Analysis by: Three Rivers Scientific


11/22/94
Gamma (c/s)
Depth (ft)
Borehole 30-03-09
Depth: 0-12 ft
Cs-137 Decay Line
Date (Year)
Grade Thickness Product (feet*c/s)
Average Background (c/s)
Frequency Clean (%)
Analysis by: Three Rivers Scientific
01/10/75
Gamma (c/s)
Depth (ft)


11/22/94
Gamma (c/s)
Depth (ft)
Borehole 30-03-09
Depth: 40-52 ft
Cs-137 Decay Line
Grade Thickness Product (feet*c/s)
Date (Year)
Average Background (c/s)
Frequency Clean (%)
Analysis by: Three Rivers Scientific
01/10/75
Gamma (c/s)
Depth (ft)


Borehole 30-03-09
Depth: 73-84 ft
11/22/94
Gamma (c/s)
Depth (ft)
Co-60 Decay Line
Grade Thickness Product (feet*c/s)
Date (Year)
Average Background (c/s)
Frequency Clean (%)
Analysis by: Three Rivers Scientific
01/10/75
Gamma (c/s)
Depth (ft)


11/22/94
Gamma (c/s)
Depth (ft)
Borehole 30-03-09
Depth: 73-94 ft
Co-60 Decay Line
Grade Thickness Product (feet*c/s)
Date (Year)
Average Background (c/s)
Frequency Clean (%)
Analysis by: Three Rivers Scientific
01/10/75
Gamma (c/s)
Depth (ft)


11/22/94
Gamma (c/s)
Depth (ft)
Borehole 30-03-09
Depth: 84-94 ft
Co-60 Decay Line
Grade Thickness Product (feet*c/s)
Date (Year)
Average Background (c/s)
Frequency Clean (%)
Analysis by: Three Rivers Scientific
01/10/75
Gamma (c/s)
Depth (ft)

Tank C-104

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This section contains the analysis results for vadose zone boreholes (dry wells) associated with the Tank 104 in the "C" Tank Farm.

Special Notes: None

Borehole 30-04-01

Contamination (Cs-137) from 0-8 feet is Tank Farm Activity. Contamination (Cs-137) from 8-22 feet is Undetermined.

Grade thickness product over 0 to 8 feet is erratic and highly variable from 1975 to 1986, indicative of tank farm activity. Since 1986, the grade thickness product is consistent with the decay from Cs-137 (HPGe identified).

Grade thickness product over 8 to 22 feet is undetermined. The gross gamma over this interval may be influenced by the higher level from 0 to 8 feet coupled with depth control error prior to 1986. From 1987 to 1994 the grade thickness product is consistent with Cs-137 (HPGe identified) decay.

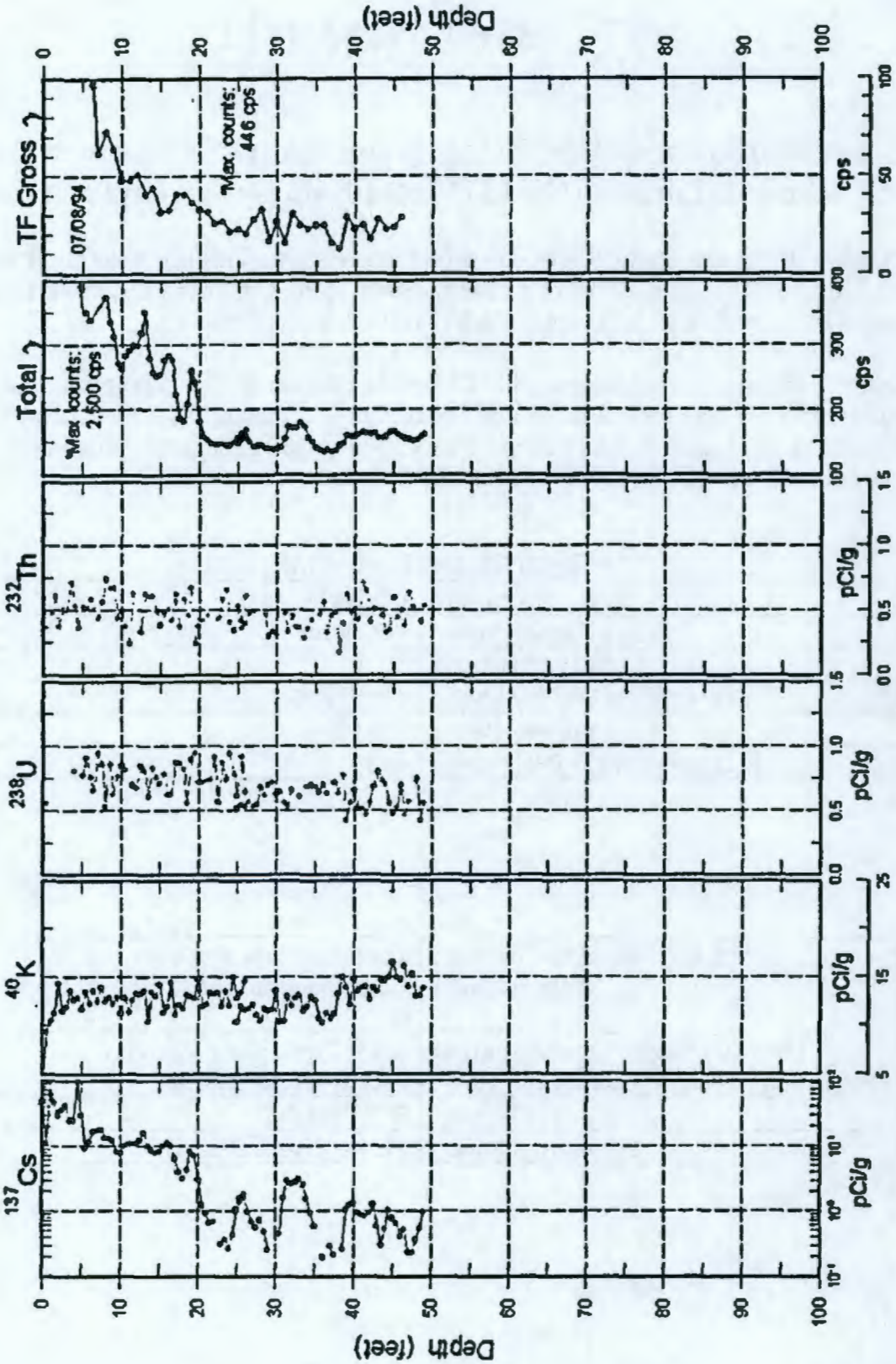
Gross Gamma Survey Information

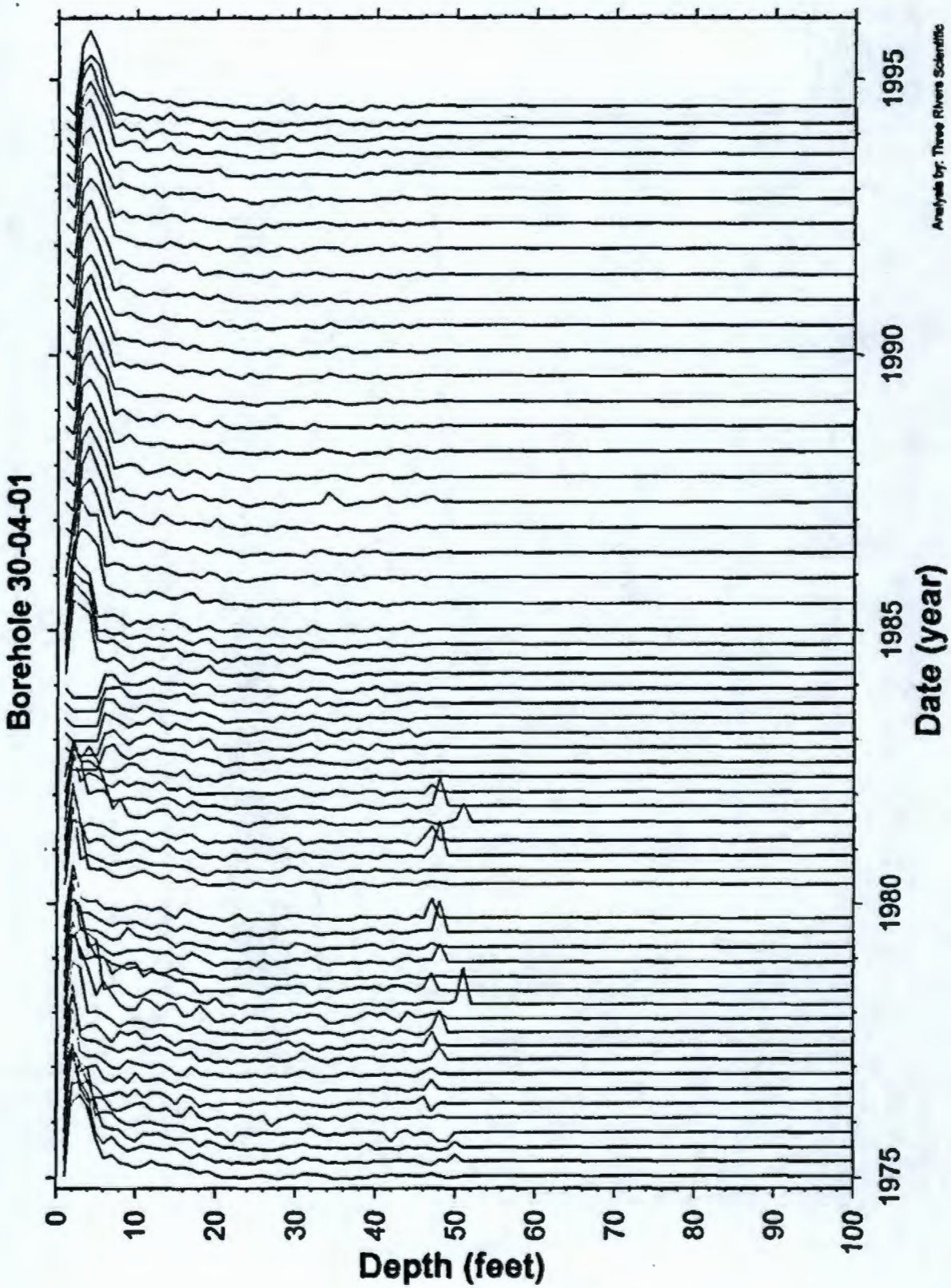
Probe Type Processed :	04: NaI
Other Probe Types :	03: Neutron
Survey Depth :	50 ft
First Survey Date :	1/10/1975
Last Survey Date :	7/8/1994
Number Surveys Processed :	440

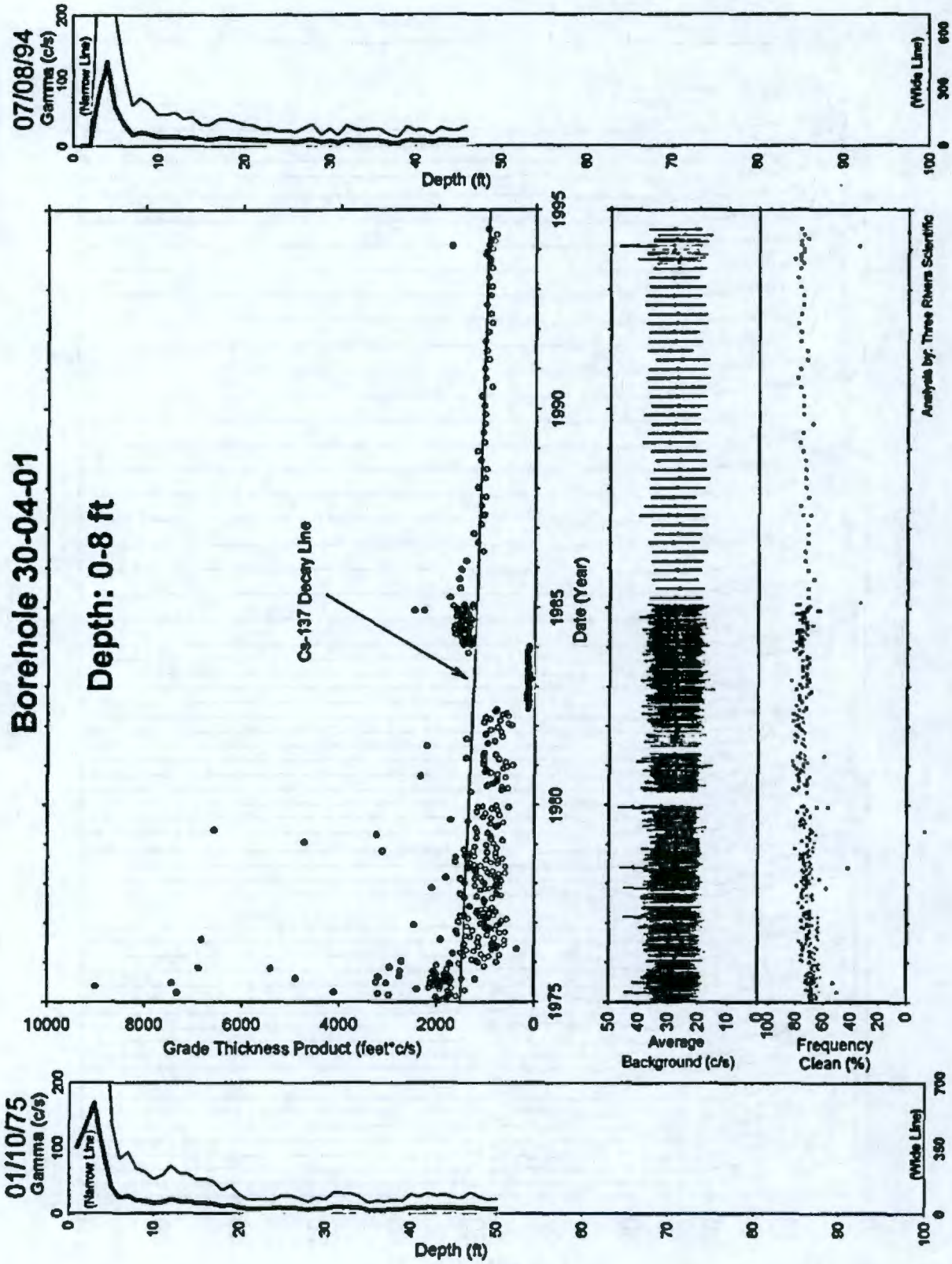
Analysis Notes

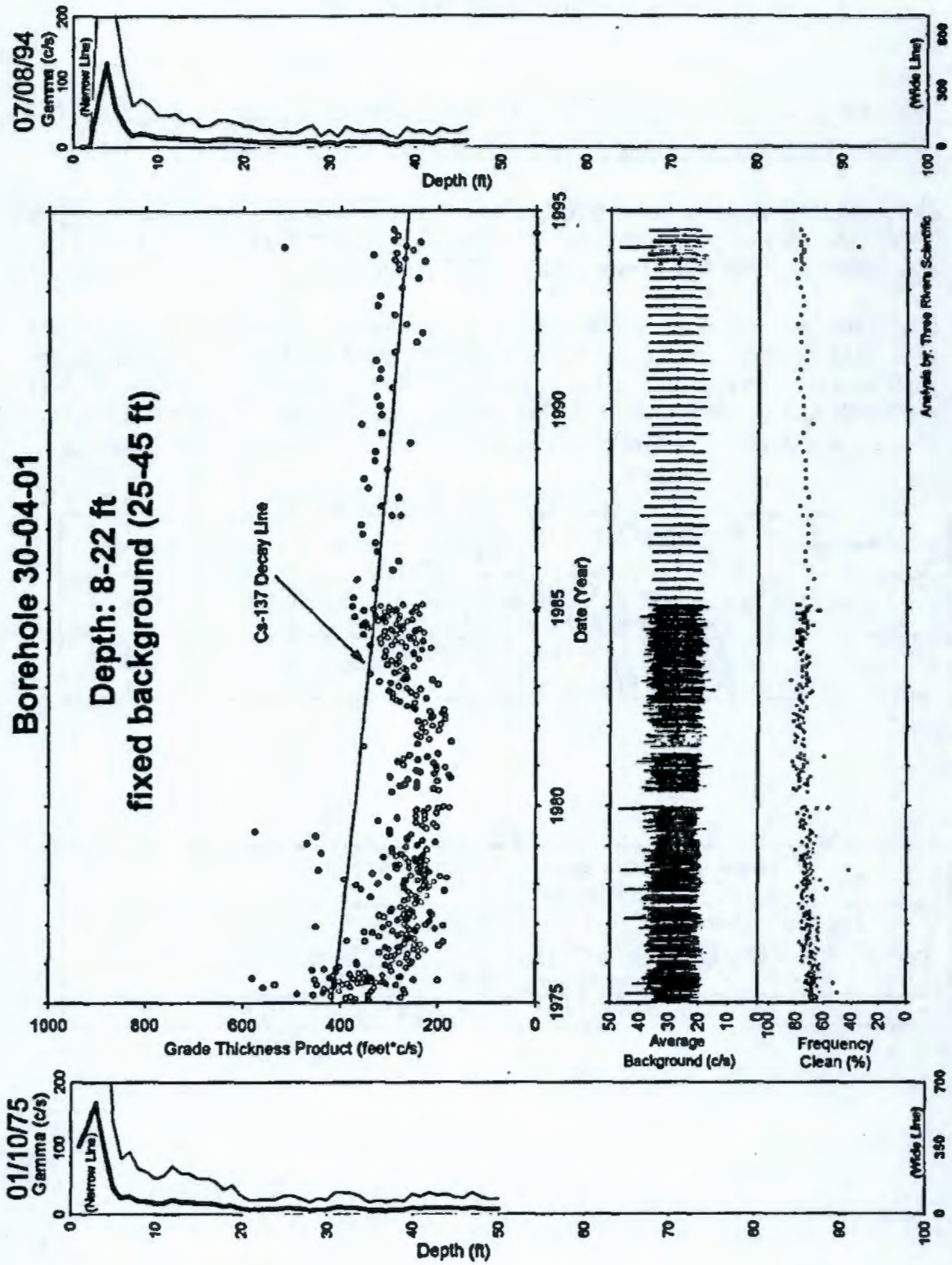
Method Used to Compute Background :	Threshold 0<val<50 for 0-8 ft Fixed background (10-50 ft) for 8-22 ft
Depth(s) where Contamination Identified in Gross Gamma Surveys :	0-8 ft Tank Farm Activity 8-22 ft Undetermined
Analyst Name :	R.R. Randall
Company Name :	Three Rivers Scientific

30-04-01 Combination Plot




Borehole 30-04-01
Depth (feet)
0
10
20
30
40
50
60
70
80
90
100
Date (year)
1975
1980
1985
1990
1995
Analysis by: Three Rivers Scientific


Borehole 30-04-01
Depth: 0-8 ft
07/08/94
Gamma (c/s)
(Narrow Line)
(Wide Line)
Depth (ft)
Cs-137 Decay Line
Grade Thickness Product (feet*c/s)
Date (Year)
Average Background (c/s)
Frequency Clean (%)
Analysis by: Three Rivers Scientific
01/10/75
Gamma (c/s)
(Narrow Line)
(Wide Line)
Depth (ft)


07/08/94
Gamma (c/s)
(Narrow Line)
(Wide Line)
Depth (ft)
Borehole 30-04-01
Depth: 8-22 ft
fixed background (25-45 ft)
Cs-137 Decay Line
Grade Thickness Product (feet*c/s)
Date (Year)
Average Background (c/s)
Frequency Clean (%)
Analysis by: Three Rivers Scientific
01/10/75
Gamma (c/s)
(Narrow Line)
(Wide Line)
Depth (ft)

Borehole 30-04-02

Contamination (Cs-137) from 0-12 feet is Tank Farm Activity. Contamination (Co-60) from 32-60 feet is Unstable Early.

Grade thickness product over 0 to 12 feet is erratic and highly variable from 1975 to 1986, indicative of tank farm activity. Since 1986, the grade thickness product is consistent with the decay from Cs-137 (HPGe identified).

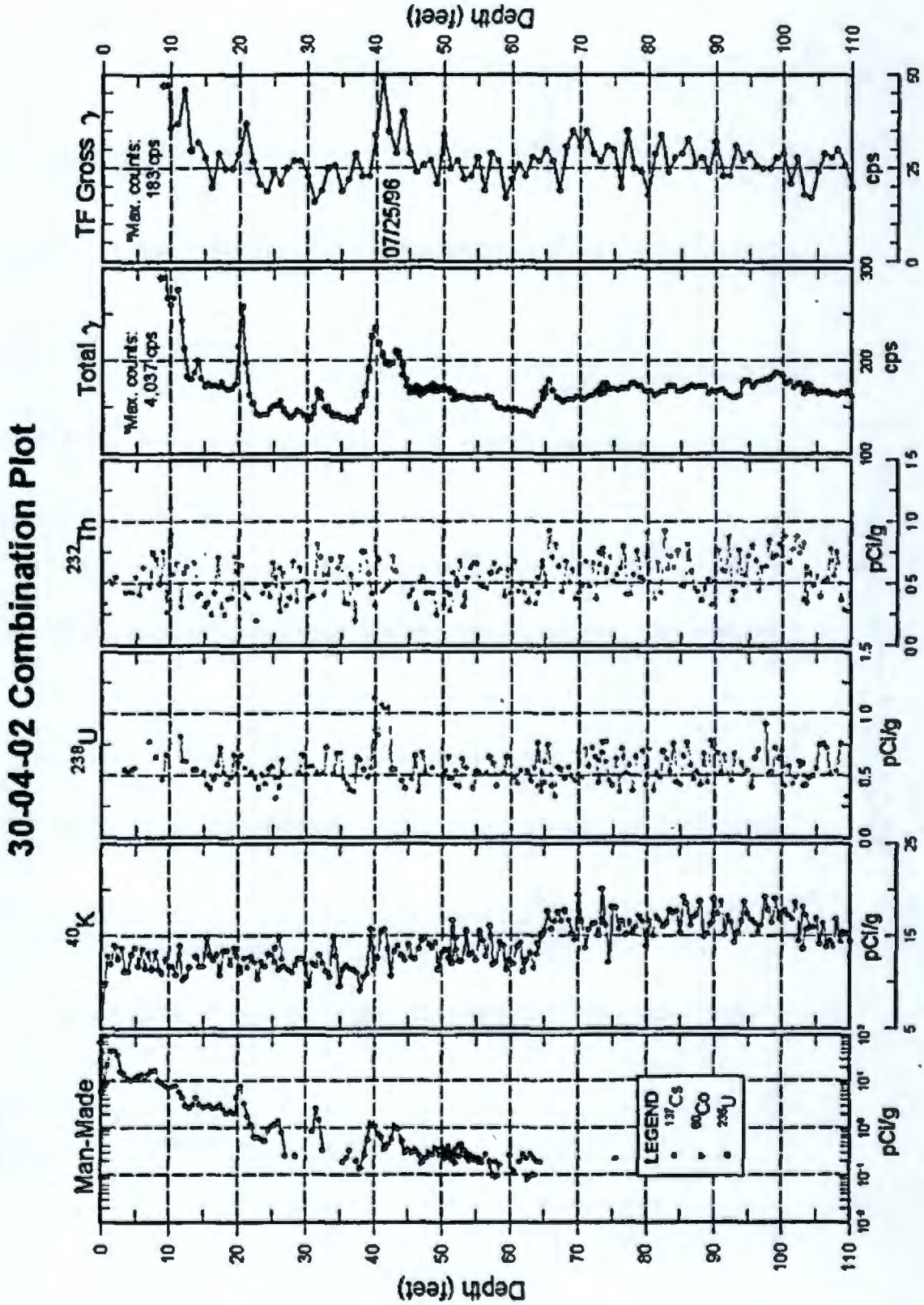
Grade thickness product over 32 to 60 feet both decreases faster than Co-60 (HPGe identified) and occasionally increases from 1975 until 1986. After 1986, the grade thickness product is consistent with Co-60 (HPGe identified) decay. Also, there is some indication of downward movement early (1975 to 1984), but later history is not possible due to such low levels of gross gamma. The category is unstable early.

Gross Gamma Survey Information

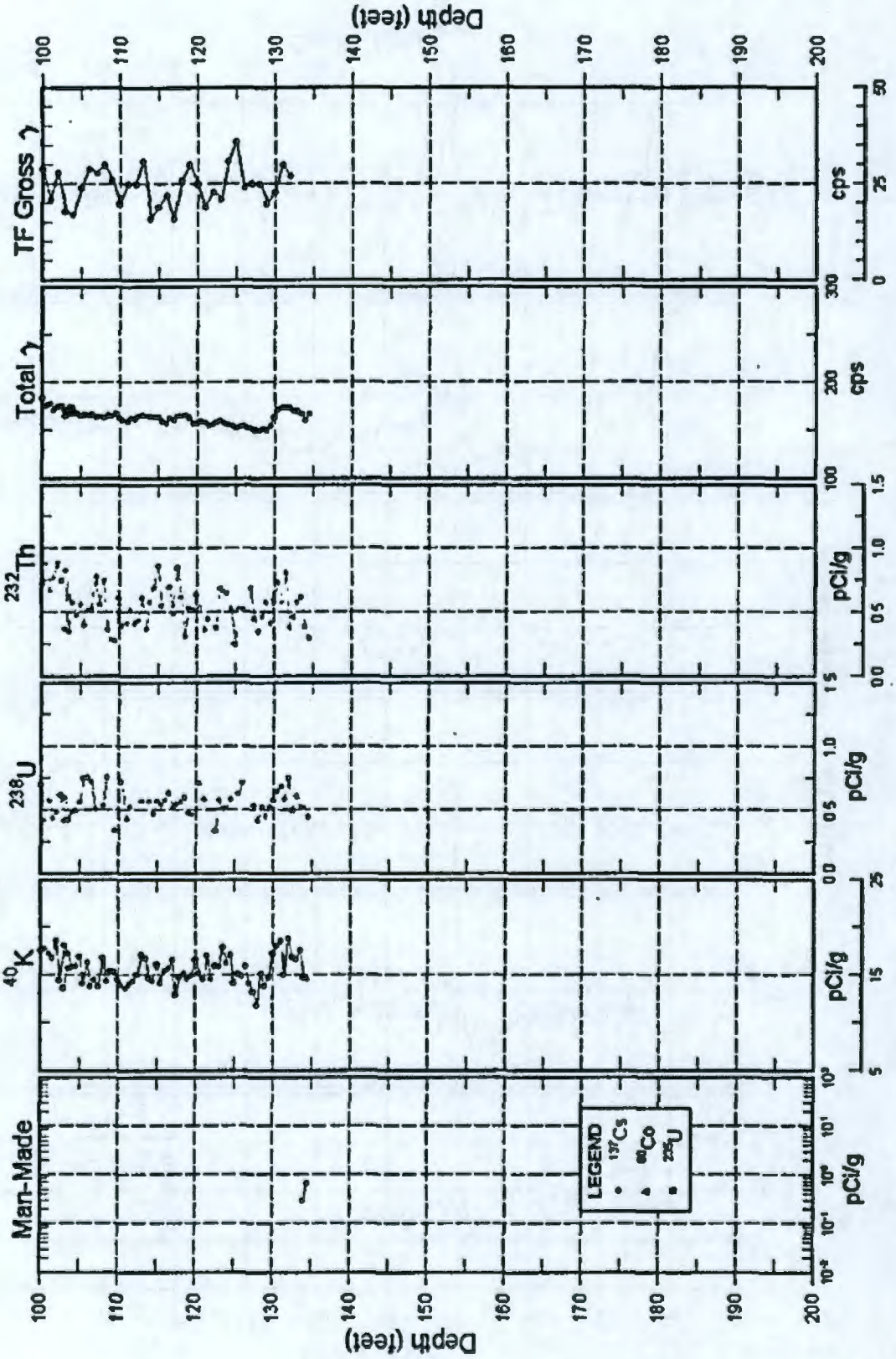
Probe Type Processed :	04: NaI
Other Probe Types :	03: Neutron
Survey Depth :	135 ft
First Survey Date :	1/10/1975
Last Survey Date :	7/8/1994
Number Surveys Processed :	335

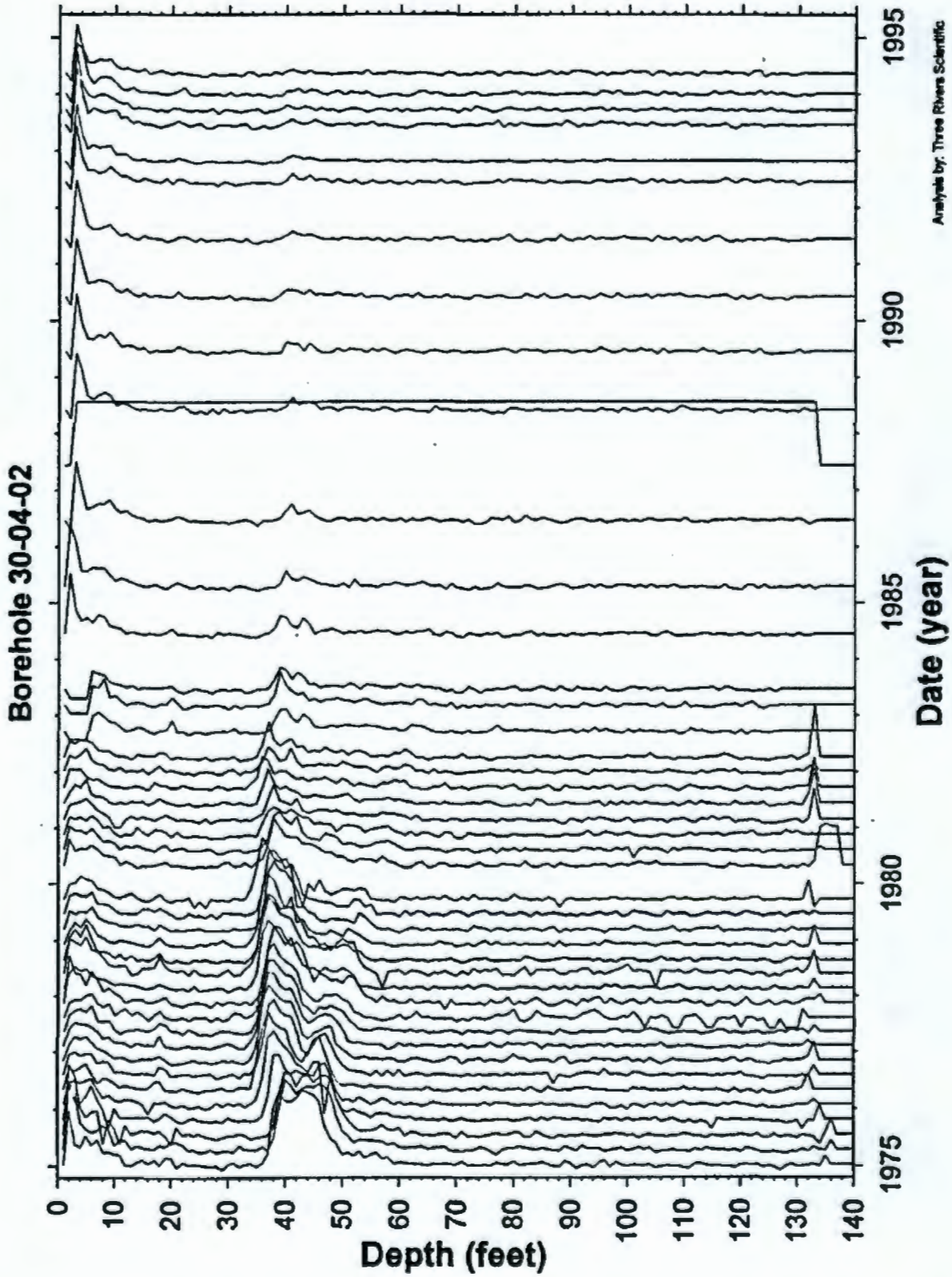
Analysis Notes

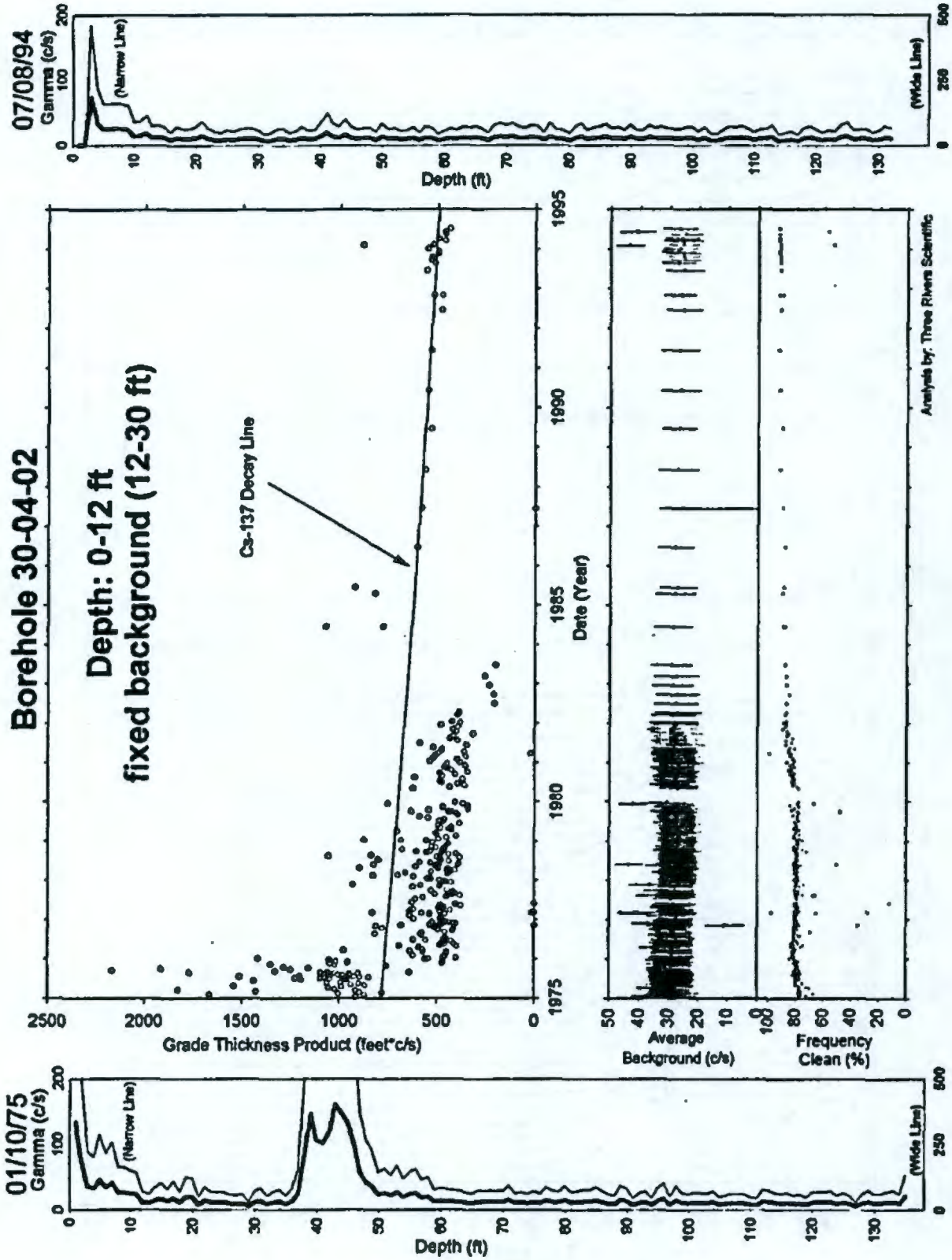
Method Used to Compute Background :	Fixed background (12-30 ft)
Depth(s) where Contamination Identified in Gross Gamma Surveys :	0-12 ft Tank Farm Activity 32-60 ft Unstable Early
Analyst Name :	R.R. Randall
Company Name :	Three Rivers Scientific

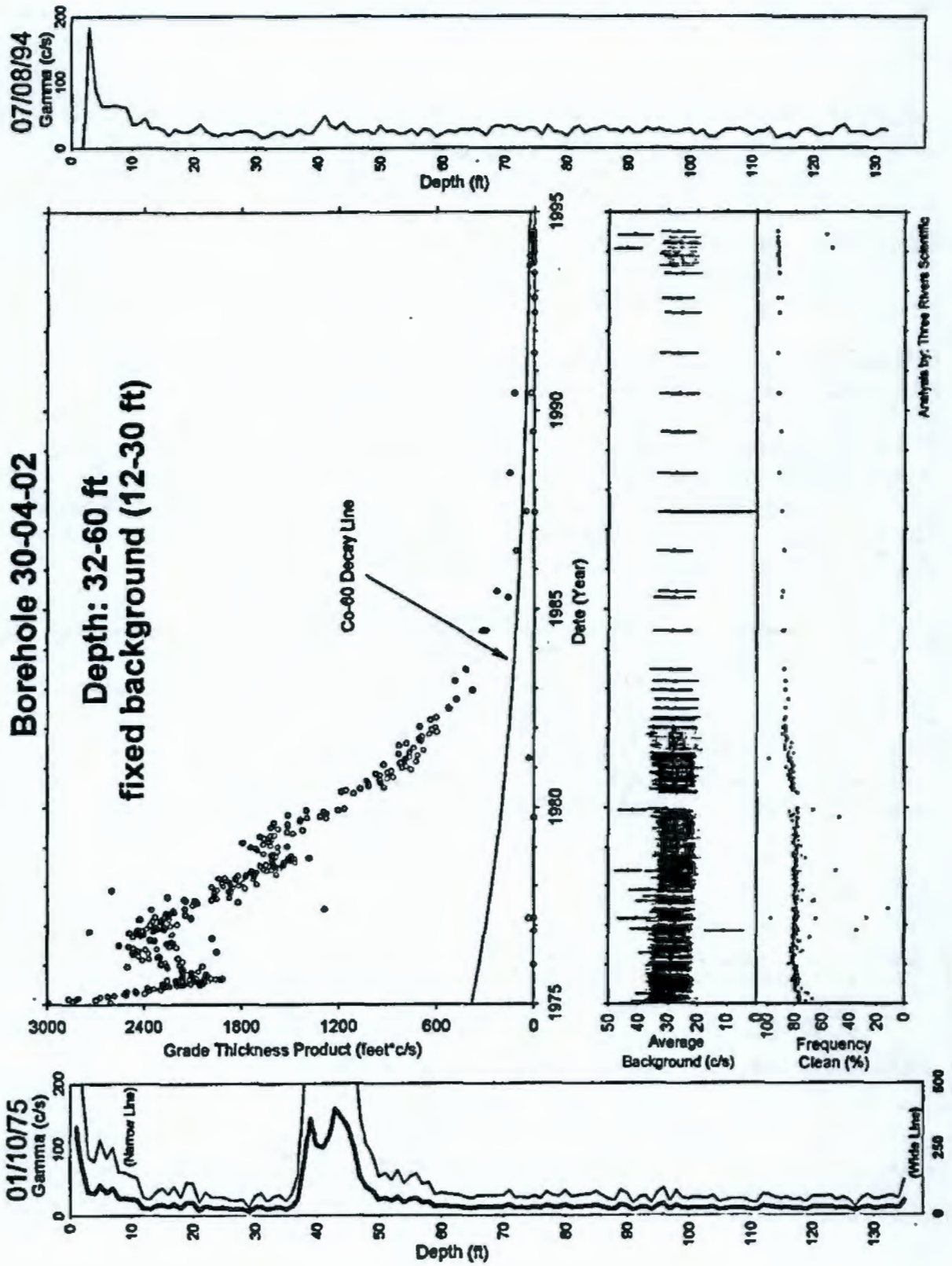

30-04-02 Combination Plot
Man-Made
^{40}K
^{238}U
^{232}Th
Total γ
TF Gross γ
Max. counts: 183 cps
Max. counts: 4,037 cps
07/25/96
LEGEND
^{137}Cs
^{60}Co
^{235}U
pCi/g
cps
Depth (feet)

30-04-02 Combination Plot




Borehole 30-04-02
Depth (feet)
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
Date (year)
1975
1980
1985
1990
1995
Analysis by: Three Rivers Scientific


07/08/94
Gamma (c/s)
(Narrow Line)
(Wide Line)
Depth (ft)
Borehole 30-04-02
Depth: 0-12 ft
fixed background (12-30 ft)
Cs-137 Decay Line
Grade Thickness Product (feet*c/s)
Date (Year)
Average
Background (c/s)
Frequency
Clean (%)
Analysis by: Three Rivers Scientific
01/10/75
Gamma (c/s)
(Narrow Line)
(Wide Line)
Depth (ft)


07/08/94
Gamma (c/s)
Depth (ft)
Borehole 30-04-02
Depth: 32-60 ft
fixed background (12-30 ft)
Co-60 Decay Line
Grade Thickness Product (feet*c/s)
Date (Year)
Average Background (c/s)
Frequency Clean (%)
Analysis by: Three Rivers Scientific
01/10/75
Gamma (c/s)
(Narrow Line)
(Wide Line)
Depth (ft)

Borehole 30-04-03

Contamination (Cs-137) from 0-15 feet is Tank Farm Activity. Contamination (Cs-137) from 16-30 feet is Stable. Contamination (Co-60) from 30-48 feet is Unstable.

Grade thickness product over 0 to 15 feet is erratic and highly variable from 1980 to 1986, indicative of tank farm activity. Since 1986, the grade thickness product is still not consistent with Cs-137 decay (HPGe identified).

Grade thickness product over 16 to 30 feet is decreasing consistent with Cs-137 (HPGe identified) decay. The zone category is stable.

Grade thickness product over 30 to 48 feet is unstable. Indications of downward movement are clouded by the end of depth-data at the bottom of the borehole. Grade thickness product is declining faster than Co-60 (HPGe identified) decay. The zone may be reaching a match with Co-60 decay by 1995, but there is insufficient monitoring period for such a conclusion.

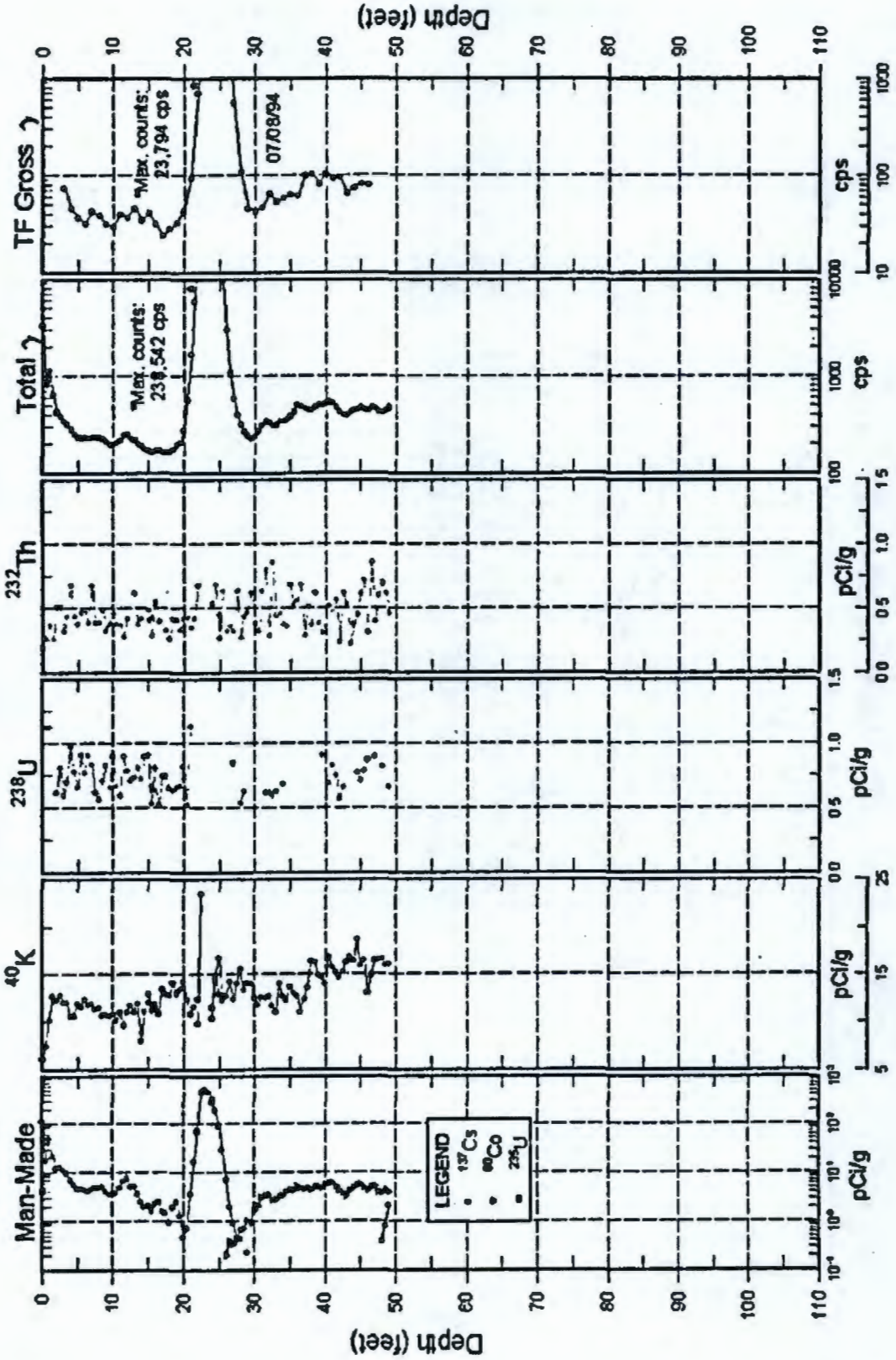
Gross Gamma Survey Information

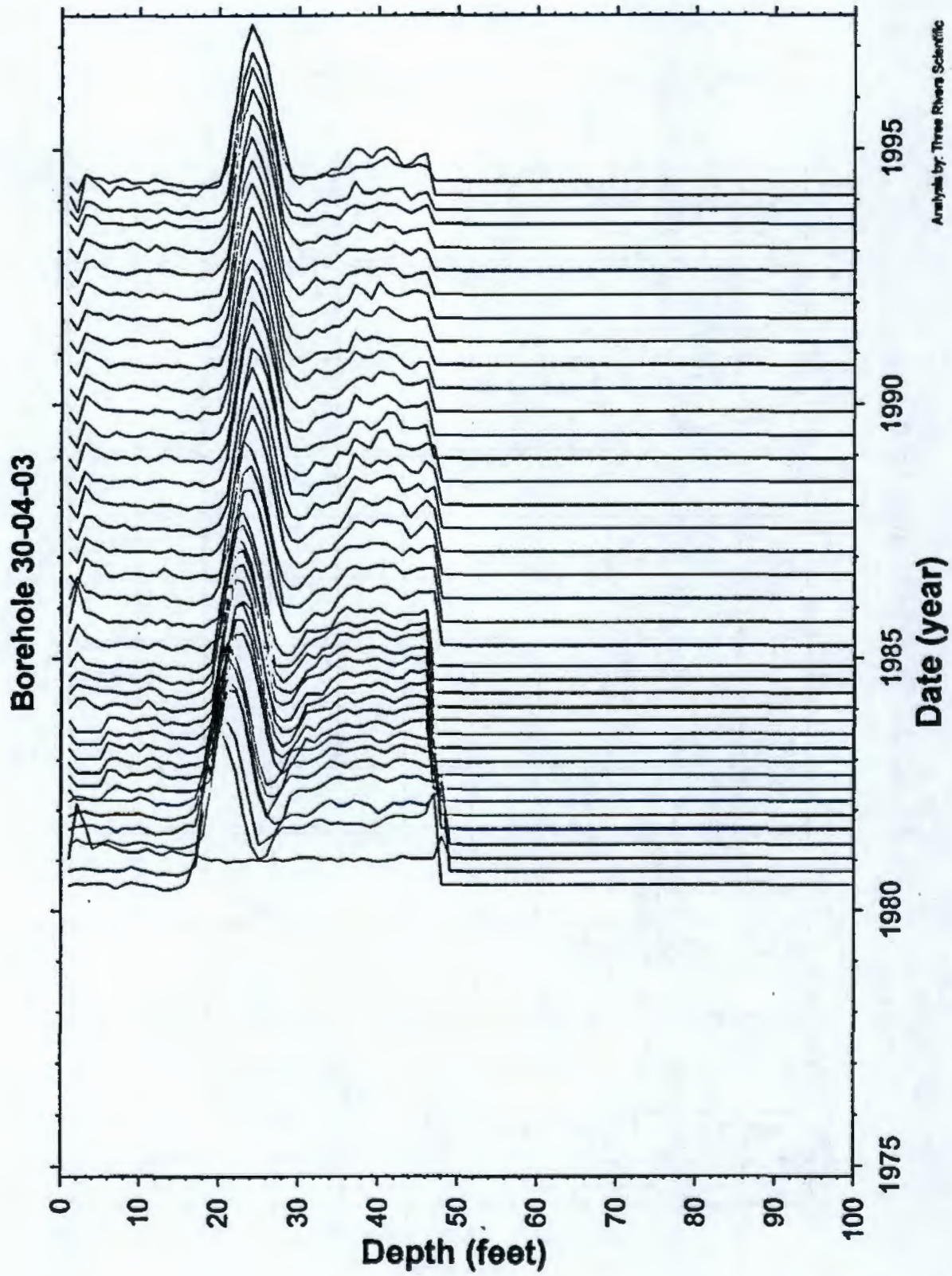
Probe Type Processed :	04: NaI
Other Probe Types :	03: Neutron; 14: Shielded NaI
Survey Depth :	50 ft
First Survey Date :	7/3/1980
Last Survey Date :	7/8/1994
Number Surveys Processed :	195

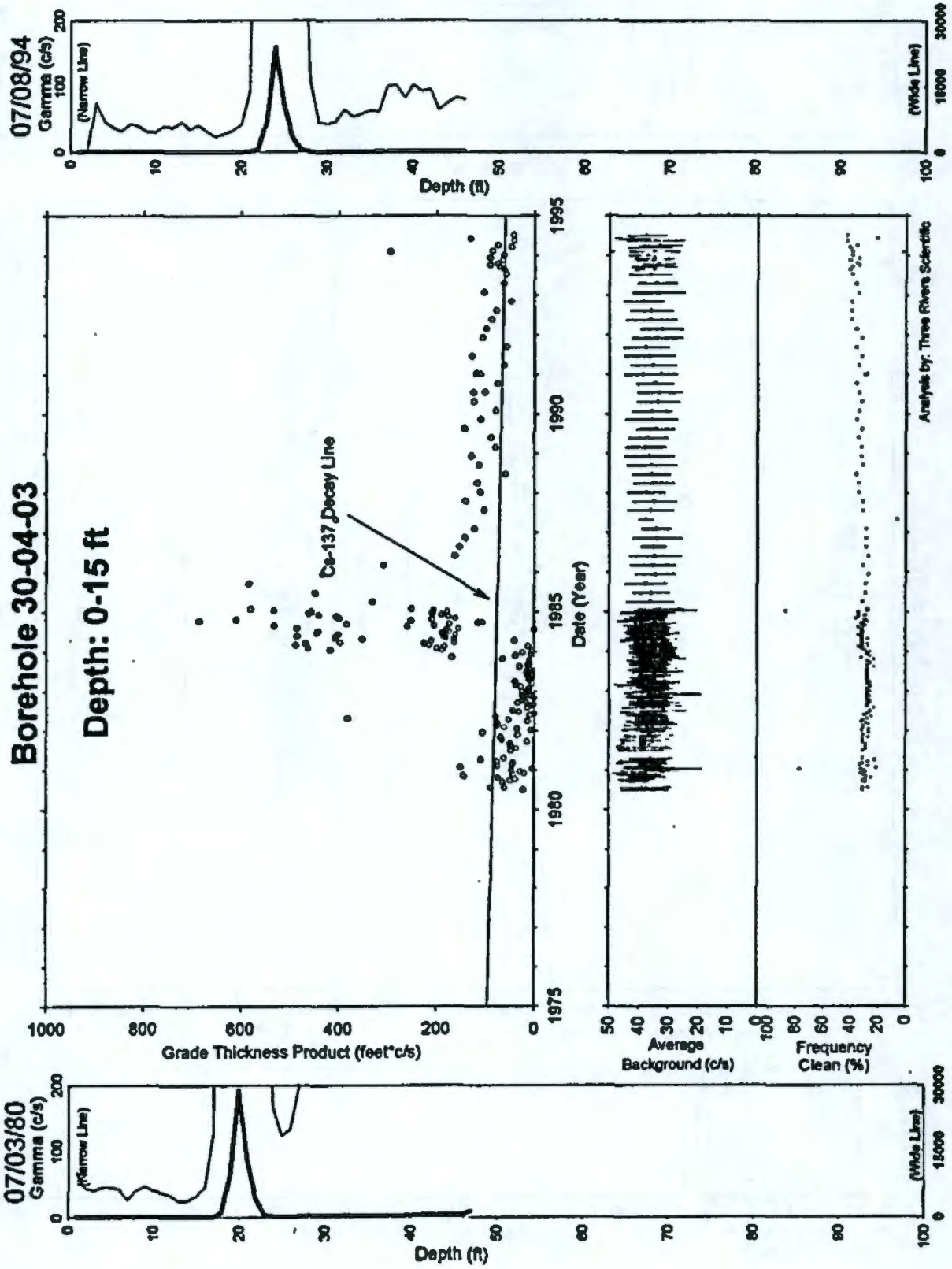
Analysis Notes

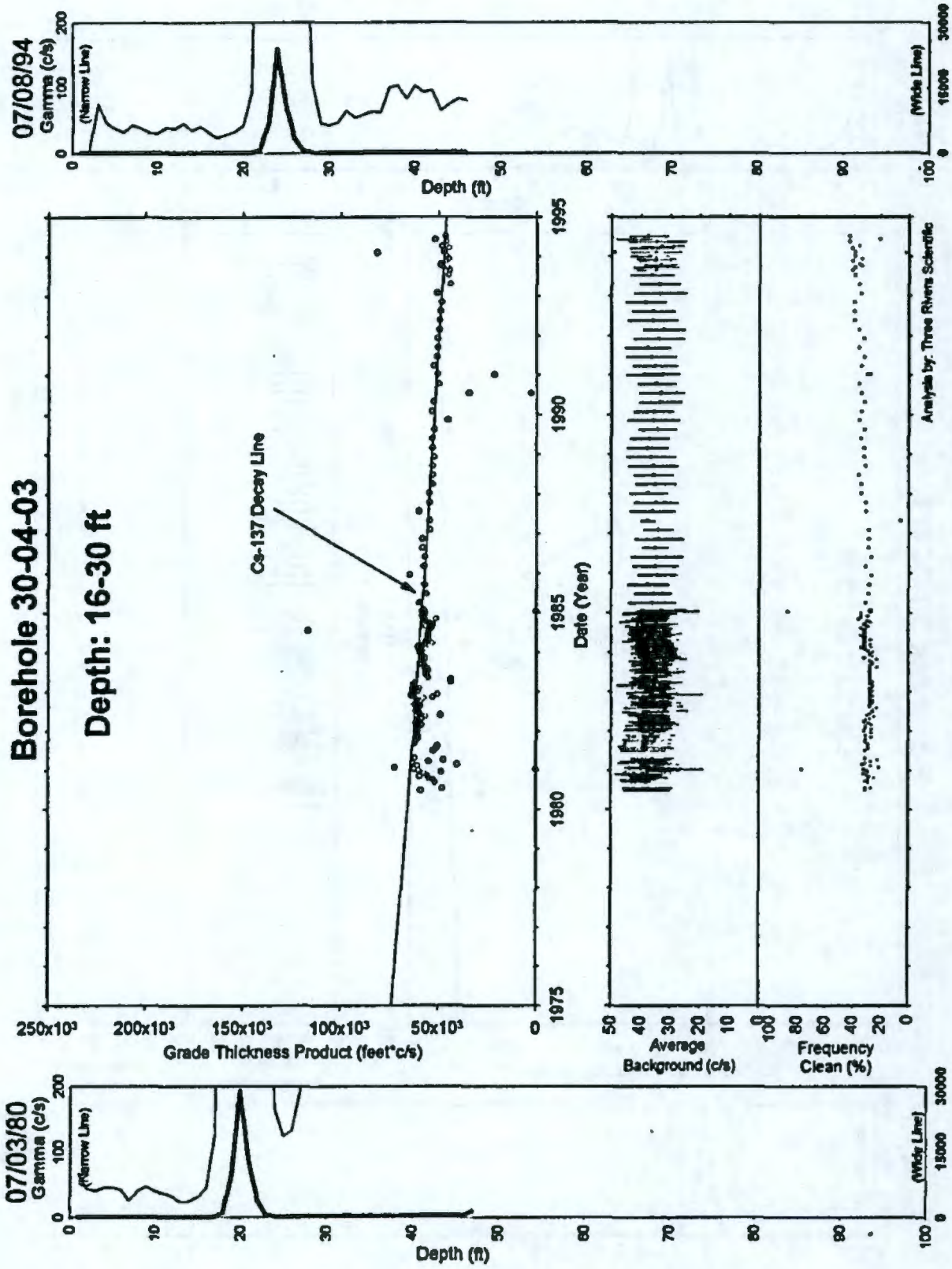
Method Used to Compute Background :	Threshold 0<val<50
Depth(s) where Contamination Identified in Gross Gamma Surveys :	0-15 ft Tank Farm Activity 16-30 ft Stable 30-48 ft Unstable
Analyst Name :	R.R. Randall
Company Name :	Three Rivers Scientific

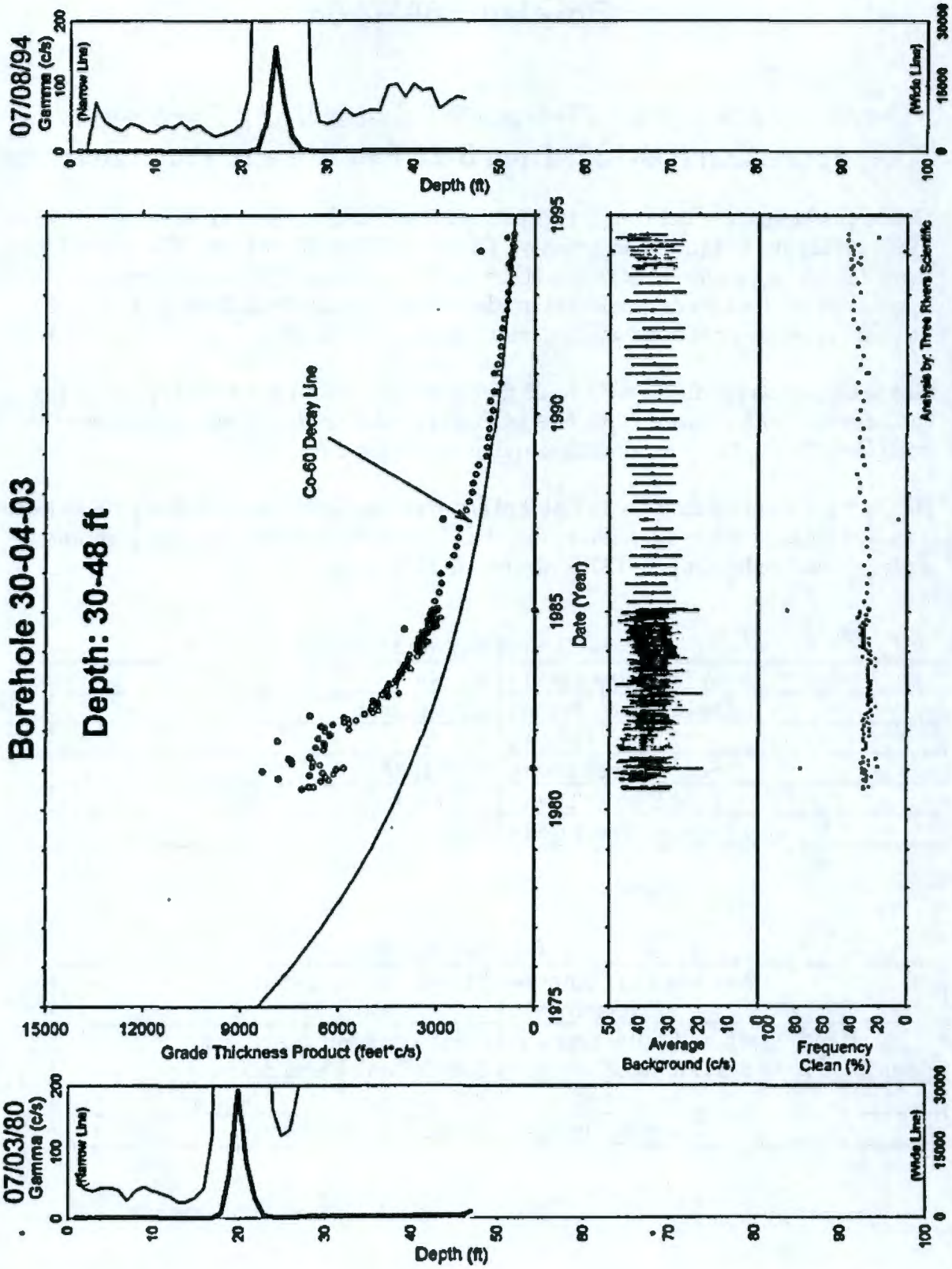
30-04-03 Combination Plot




Borehole 30-04-03
Depth (feet)
0
10
20
30
40
50
60
70
80
90
100
Date (year)
1975
1980
1985
1990
1995
Analysis by: Three Rivers Scientific


Borehole 30-04-03
Depth: 0-15 ft
07/08/94
Gamma (c/s)
(Narrow Line)
(Wide Line)
Depth (ft)
Cs-137 Decay Line
Grade Thickness Product (feet*c/s)
Date (Year)
Average Background (c/s)
Frequency Clean (%)
Analysis by: Three Rivers Scientific
07/03/80
Gamma (c/s)
(Narrow Line)
(Wide Line)
Depth (ft)


07/08/94
Gamma (c/s)
(Narrow Line)
(Wide Line)
Depth (ft)
Borehole 30-04-03
Depth: 16-30 ft
Cs-137 Decay Line
Date (Year)
Grade Thickness Product (feet*c/s)
Average Background (c/s)
Frequency Clean (%)
Analysis by: Three Rivers Scientific
07/03/80
Gamma (c/s)
(Narrow Line)
(Wide Line)
Depth (ft)


Borehole 30-04-03
Depth: 30-48 ft
07/08/94
Gamma (c/s)
(Narrow Line)
(Wide Line)
Depth (ft)
Co-60 Decay Line
Grade Thickness Product (feet*c/s)
Date (Year)
Average Background (c/s)
Frequency Clean (%)
Analysis by: Three Rivers Scientific
07/03/80
Gamma (c/s)
(Narrow Line)
(Wide Line)
Depth (ft)

Borehole 30-04-04

Contamination (Cs-137) from 0-8 feet is Tank Farm Activity.
Contamination (Cs-137) from 8-25 feet is Tank Farm Activity.

Grade thickness product over 0 to 8 feet is erratic and highly variable from 1975 to 1992, indicative of tank farm activity. Cs-137 is HPGe identified. The typical tank farm activity zones for most of the other wells in this tank farm demonstrate apparent match of grade thickness product with Cs-137 decay from 1986 to 1994, but this zone does not show such a match from 1986 to 1994.

Grade thickness product over 8 to 25 feet is erratic from 1975 to 1984, indicating tank farm activity. Since 1984, the grade thickness product is decreasing consistent with Cs-137. Cs-137 was identified using HPGe log data.

HPGe log data identified Cs-137 at 3 pCi/g over the depth interval from 40-60 feet. The historical gross gamma data cannot differentiate between natural gamma activity and the level of Cs-137 contained in this zone.

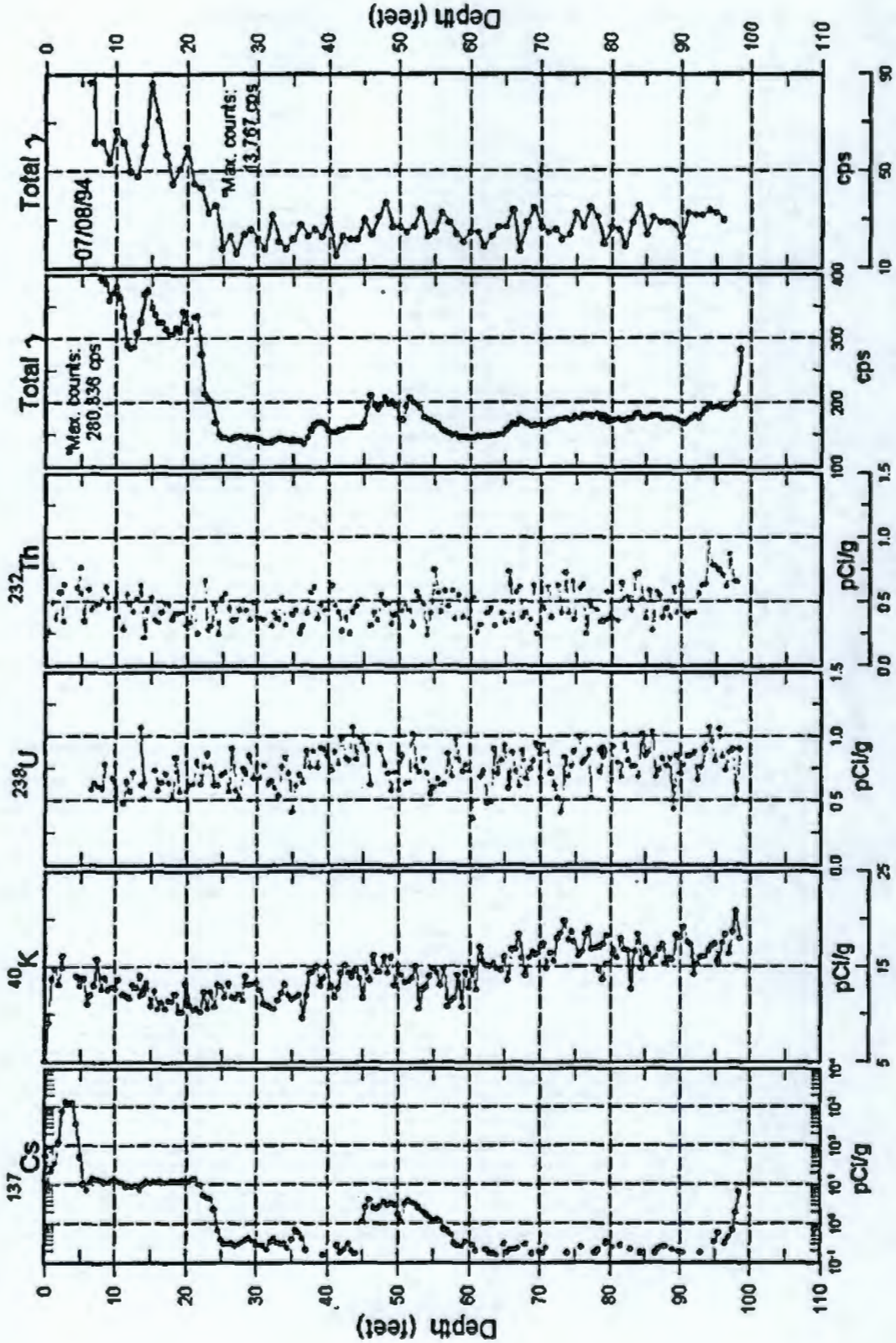
Gross Gamma Survey Information

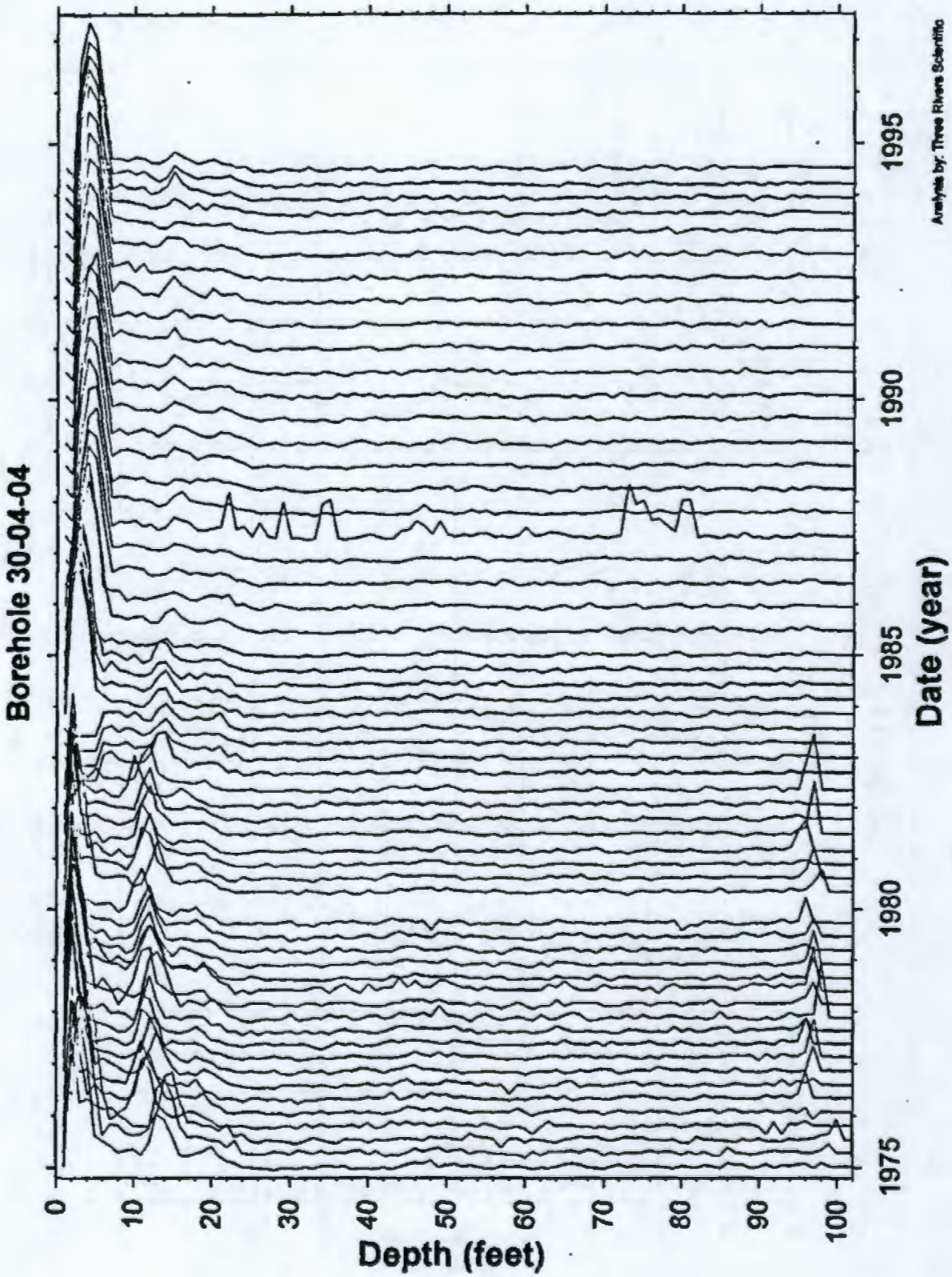
Probe Type Processed :	04: NaI
Other Probe Types :	03: Neutron
Survey Depth :	100 ft
First Survey Date :	1/10/1975
Last Survey Date :	7/8/1994
Number Surveys Processed :	425

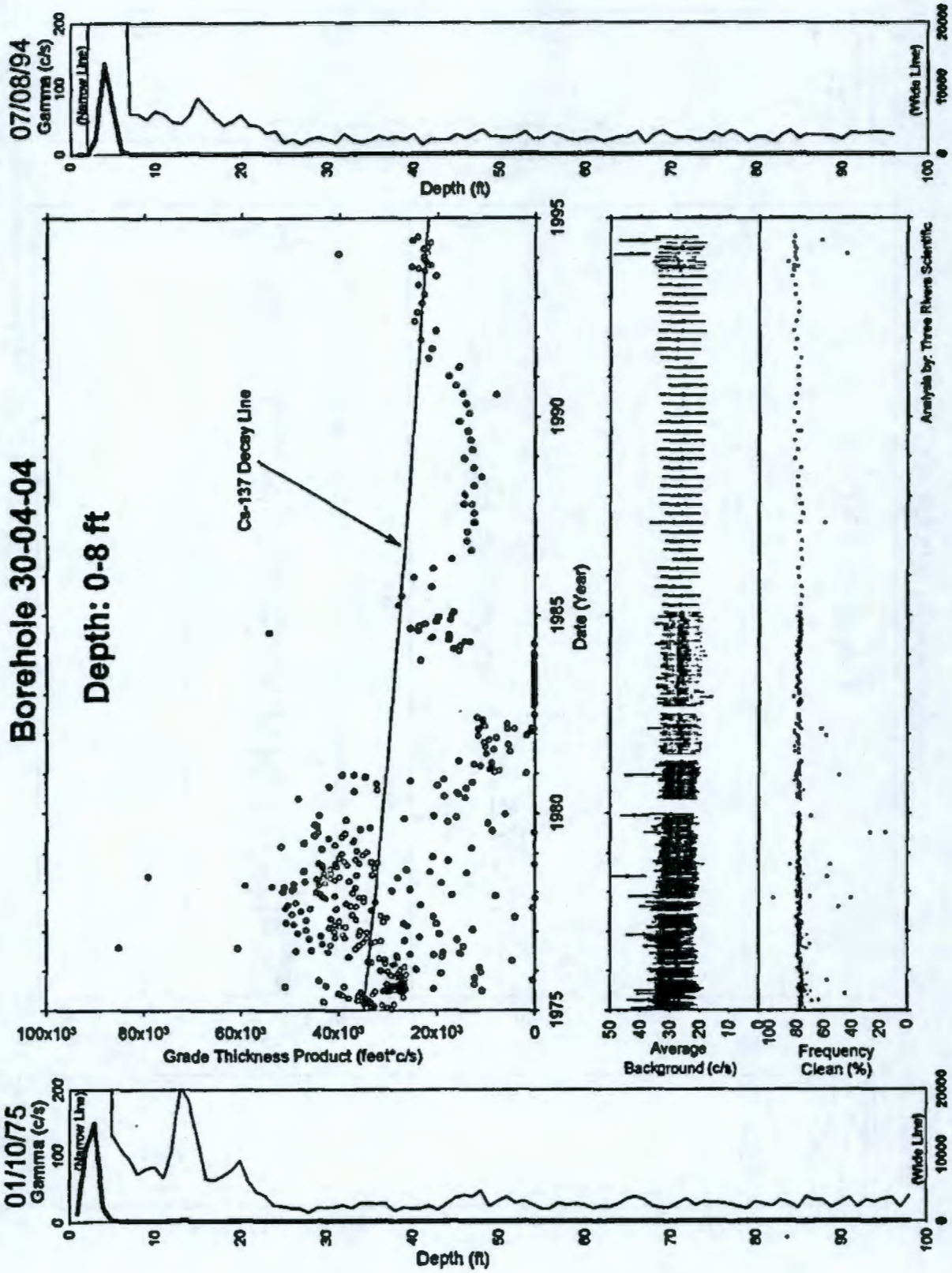
Analysis Notes

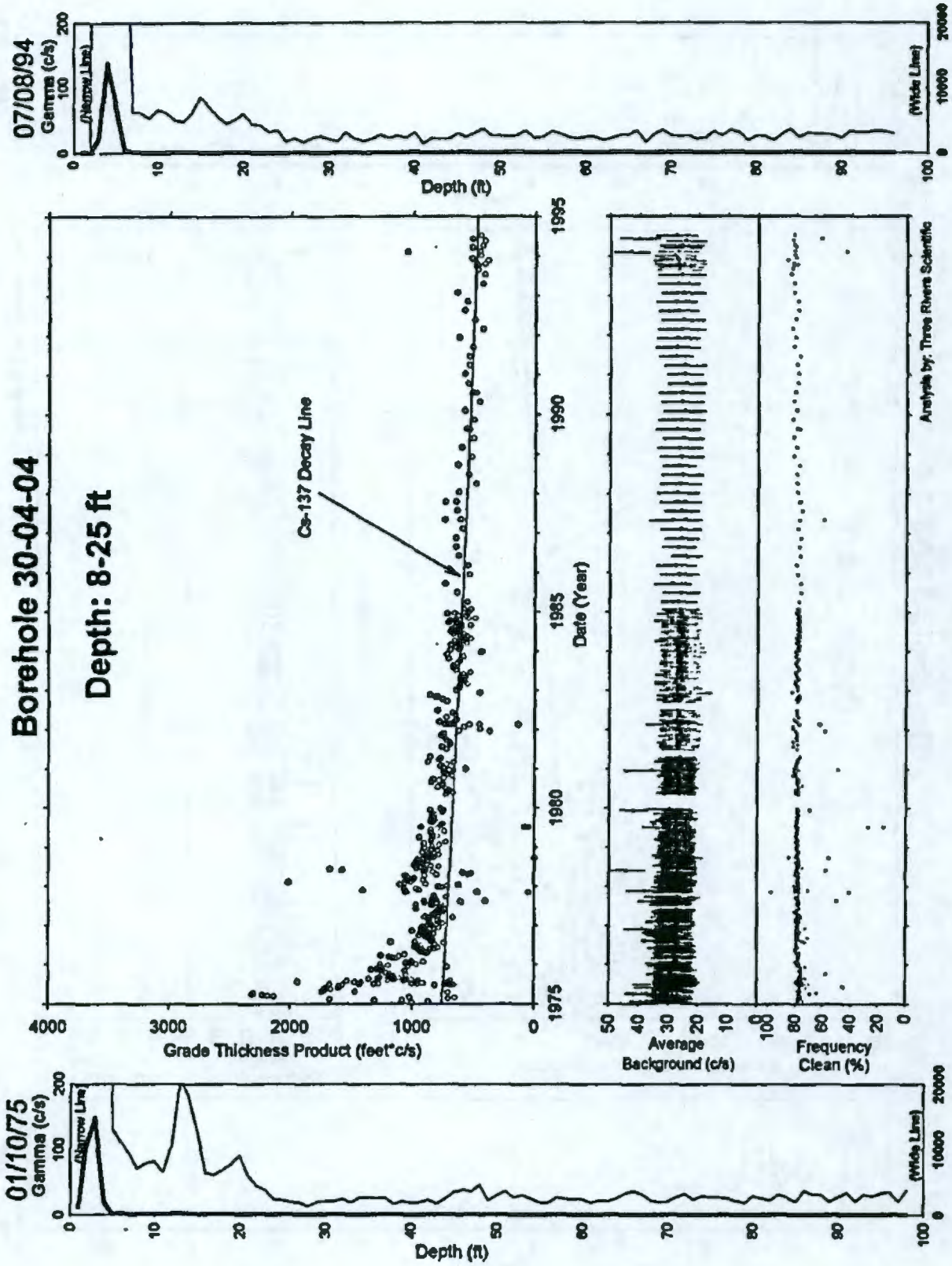
Method Used to Compute Background :	Threshold 0<val<50
Depth(s) where Contamination Identified in Gross Gamma Surveys :	0-8 ft Tank Farm Activity 8-25 ft Tank Farm Activity
Analyst Name :	R.R. Randall
Company Name :	Three Rivers Scientific

30-04-04 Combination Plot




Borehole 30-04-04
Depth (feet)
0
10
20
30
40
50
60
70
80
90
100
Date (year)
1975
1980
1985
1990
1995
Analysis by: Three Rivers Scientific


07/08/94
Gamma (c/s)
(Narrow Line)
(Wide Line)
Depth (ft)
Borehole 30-04-04
Depth: 0-8 ft
Cs-137 Decay Line
Date (Year)
Grade Thickness Product (feet*c/s)
Average Background (c/s)
Frequency Clean (%)
Analysis by: Three Rivers Scientific
01/10/75
Gamma (c/s)
(Narrow Line)
(Wide Line)
Depth (ft)


07/08/94
Gamma (c/s)
(Narrow Line)
(Wide Line)
Depth (ft)
Borehole 30-04-04
Depth: 8-25 ft
Cs-137 Decay Line
Grade Thickness Product (feet*c/s)
Date (Year)
Average Background (c/s)
Frequency Clean (%)
Analysis by: Three Rivers Scientific
01/10/75
Gamma (c/s)
(Narrow Line)
(Wide Line)
Depth (ft)

Borehole 30-04-05

Contamination (Cs-137) from 0-20 feet is Tank Farm Activity.

Grade thickness product over 0 to 20 feet is erratic and highly variable from 1975 to 1986, indicative of tank farm activity. Since 1986, the grade thickness product is consistent with the decay from Cs-137 (HPGe identified).

HPGe log data identified Cs-137 at 3 pCi/g over the depth interval from 45-55 feet. The historical gross gamma data cannot differentiate between natural gamma activity and the level of Cs-137 contained in this zone.

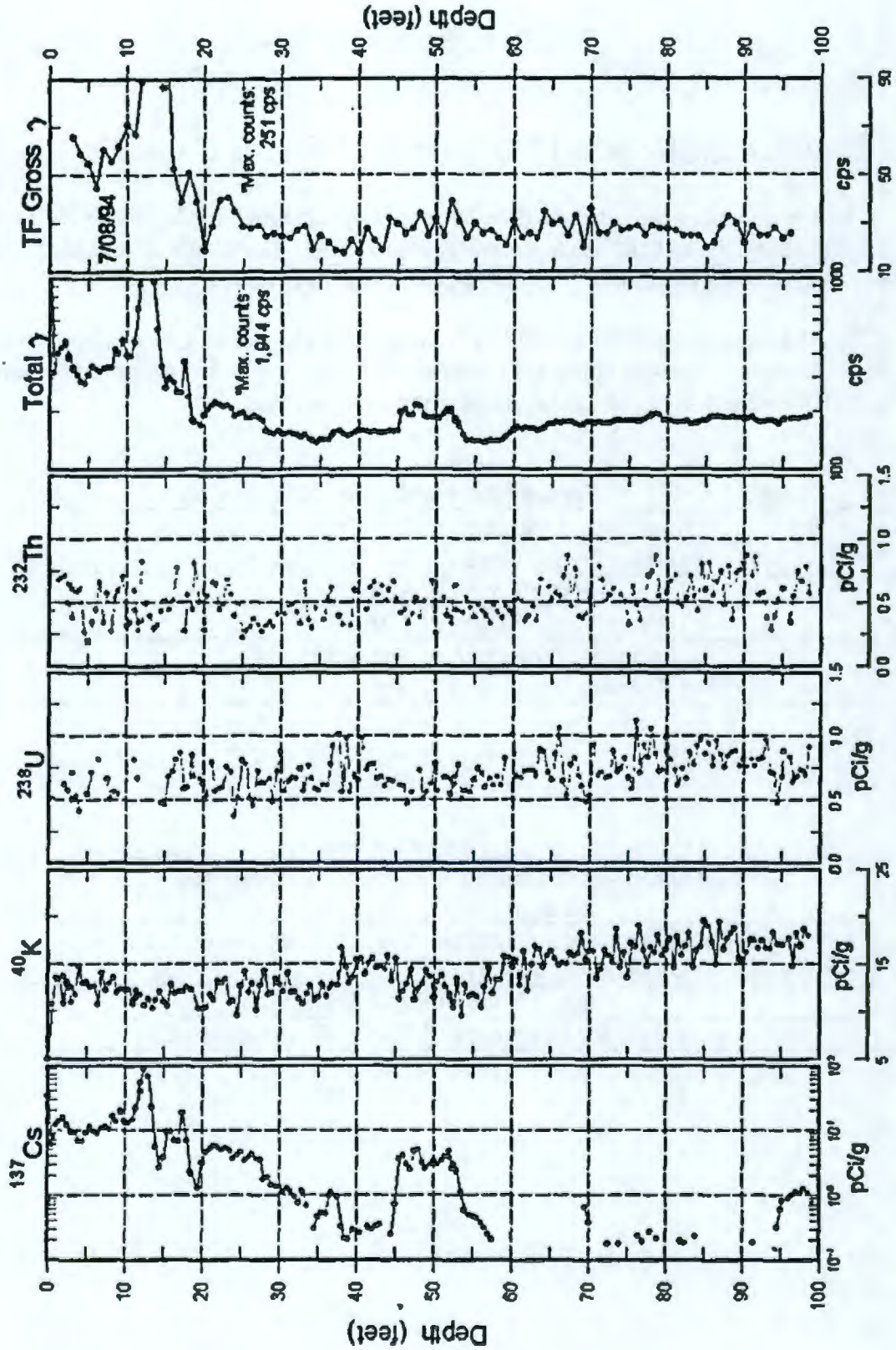
Gross Gamma Survey Information

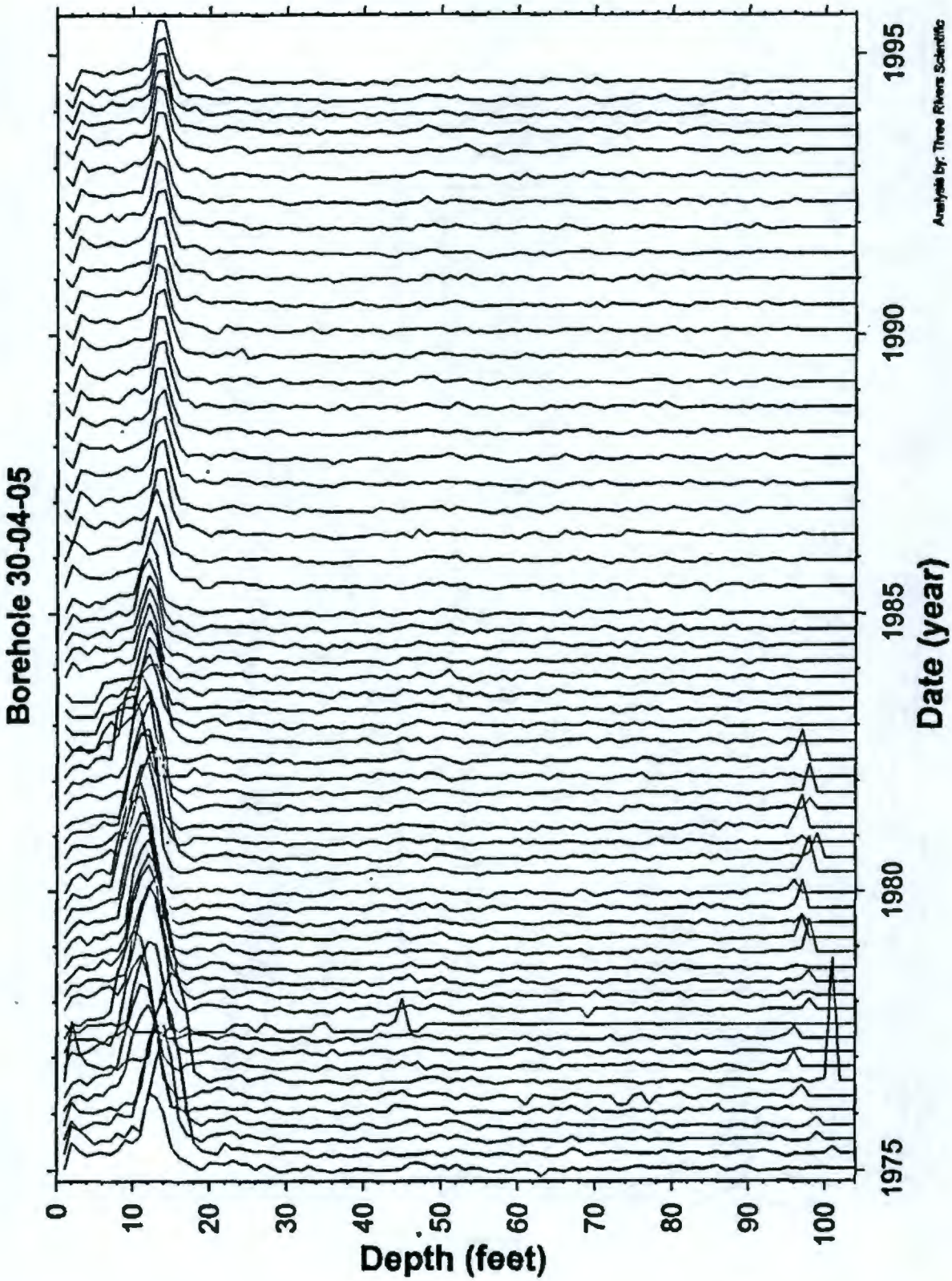
Probe Type Processed :	04: NaI
Other Probe Types :	03: Neutron
Survey Depth :	100 ft
First Survey Date :	1/10/1975
Last Survey Date :	7/8/1994
Number Surveys Processed :	416

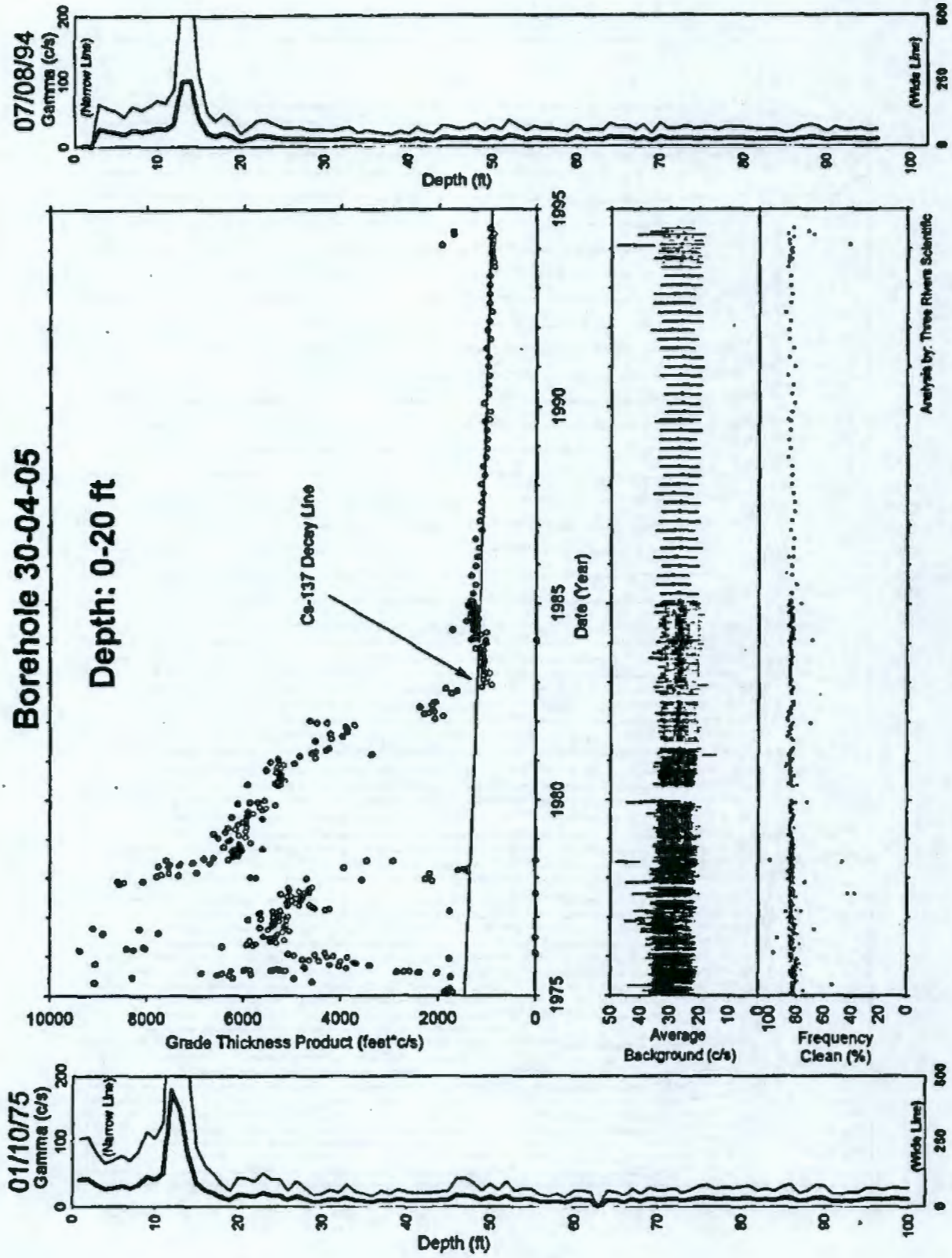
Analysis Notes

Method Used to Compute Background :	Threshold 0<val<50
Depth(s) where Contamination Identified in Gross Gamma Surveys :	0-20 ft Tank Farm Activity
Analyst Name :	R.R. Randall
Company Name :	Three Rivers Scientific

30-04-05 Combination Plot




Borehole 30-04-05
Depth (feet)
0
10
20
30
40
50
60
70
80
90
100
Date (year)
1975
1980
1985
1990
1995
Analysis by: Three Rivers Scientific


07/08/94
Gamma (c/s)
(Narrow Line)
(Wide Line)
Depth (ft)
Borehole 30-04-05
Depth: 0-20 ft
Cs-137 Decay Line
Date (Year)
Grade Thickness Product (feet*c/s)
Average Background (c/s)
Frequency Clean (%)
Analysis by: Three Rivers Scientific
01/10/75
Gamma (c/s)
(Narrow Line)
(Wide Line)
Depth (ft)

Borehole 30-04-08

Contamination (Cs-137) from 0-5 feet is Tank Farm Activity.
Contamination (Cs-137) from 10-26 feet is Stable.
Contamination (Cs-137) from 26-38 feet is Stable.
Contamination (Cs-137) from 38-50 feet is Stable.

Grade thickness product over 0 to 5 feet is erratic and highly variable from 1975 to 1986, indicative of tank farm activity. Since 1986, the historical gross gamma activity cannot distinguish between natural activity and Cs-137 (HPGe identified) contamination.

Grade thickness product over 10 to 26 feet is decreasing consistent with Cs-137 (HPGe identified) decay. The zone category is stable.

Grade thickness product over 26 to 38 feet is decreasing consistent with Cs-137 (HPGe identified) decay. The zone category is stable. Note that the historical gross gamma activity just barely differentiates the activity as higher than natural activity.

Grade thickness product over 38 to 50 feet is decreasing consistent with Cs-137 (HPGe identified) decay. The zone category is stable. Note that the historical gross gamma activity just barely differentiates the activity as higher than natural activity.

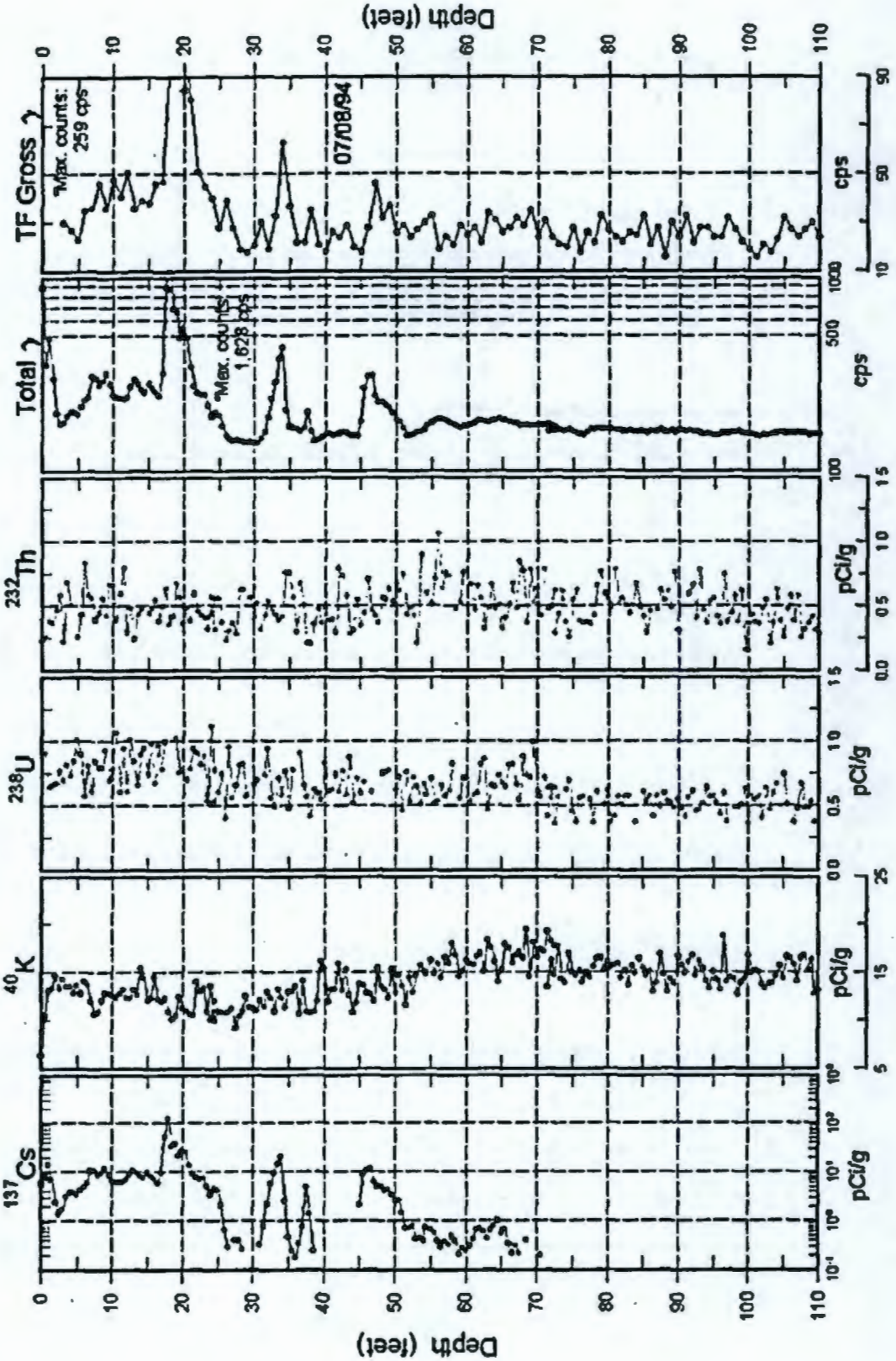
Gross Gamma Survey Information

Probe Type Processed :	04: NaI
Other Probe Types :	03: Neutron
Survey Depth :	145 ft
First Survey Date :	1/10/1975
Last Survey Date :	7/8/1994
Number Surveys Processed :	406

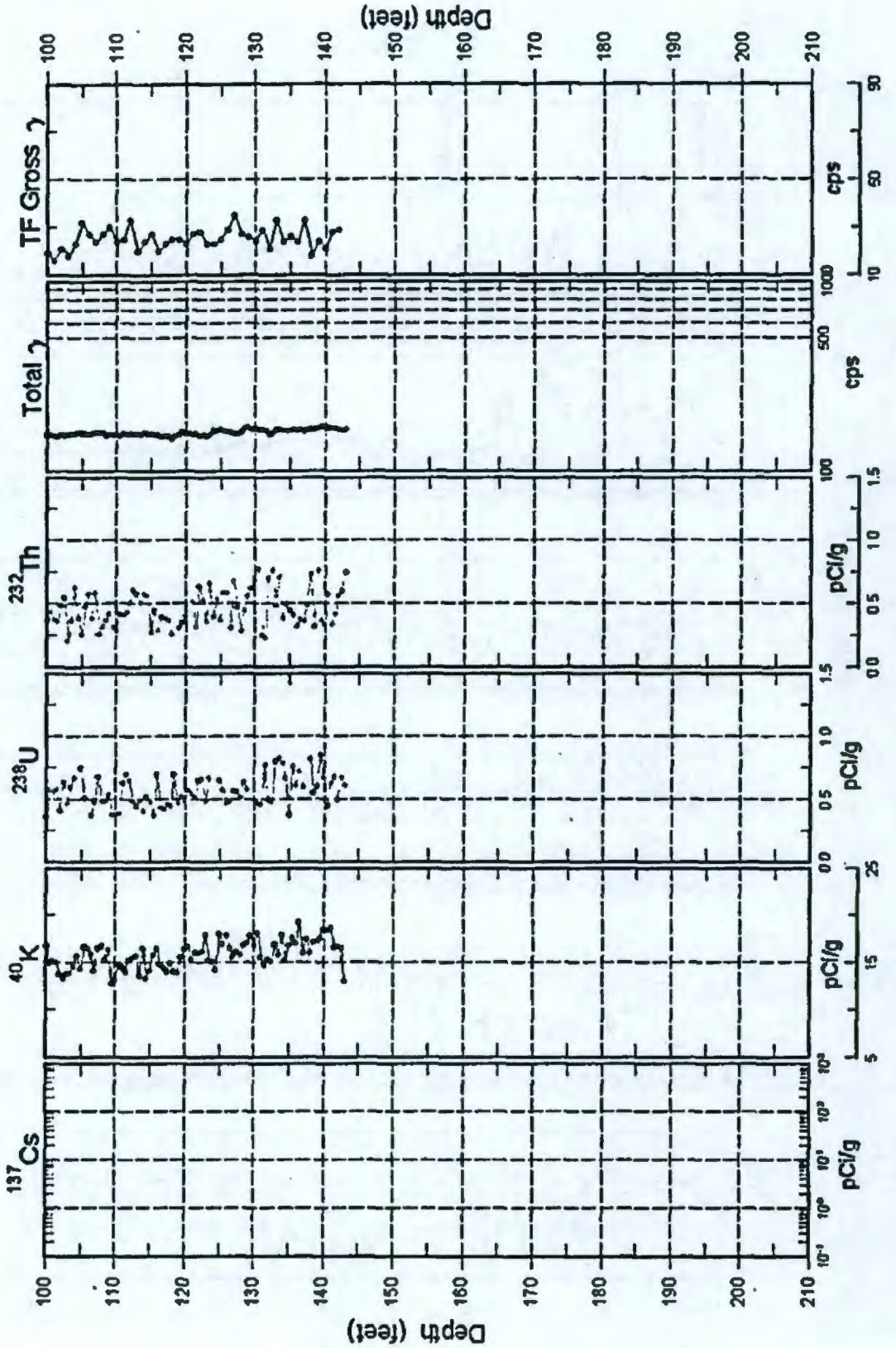
Analysis Notes

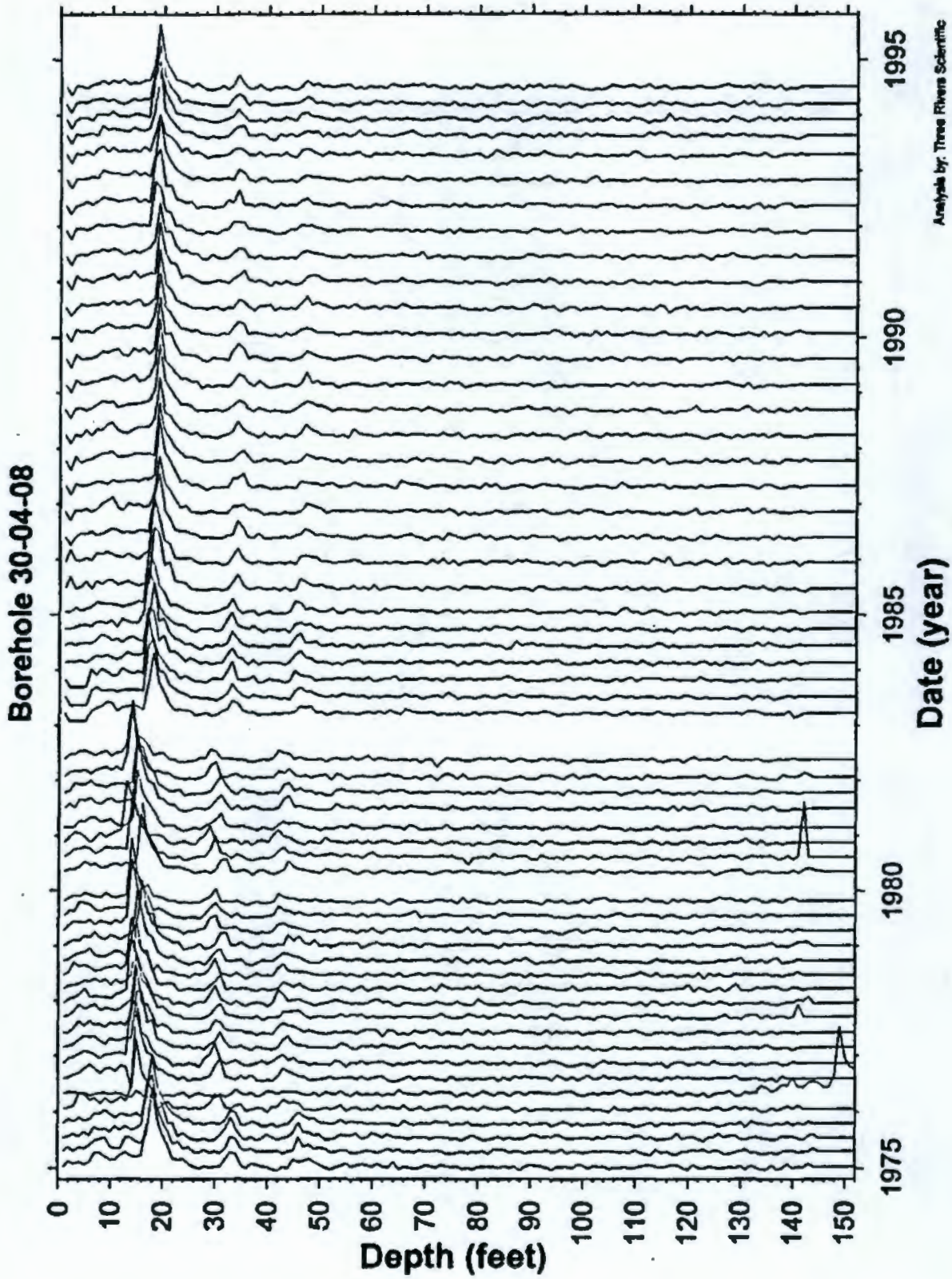
Method Used to Compute Background :	Threshold 0<val<50 for 0-5 & 10-26 ft; Fixed background of 80-130 ft for 26-38 & 38-50 ft
Depth(s) where Contamination Identified in Gross Gamma Surveys :	0-5 ft Tank Farm Activity 10-26, 26-38 & 38-50 ft Stable
Analyst Name :	R.R. Randall
Company Name :	Three Rivers Scientific

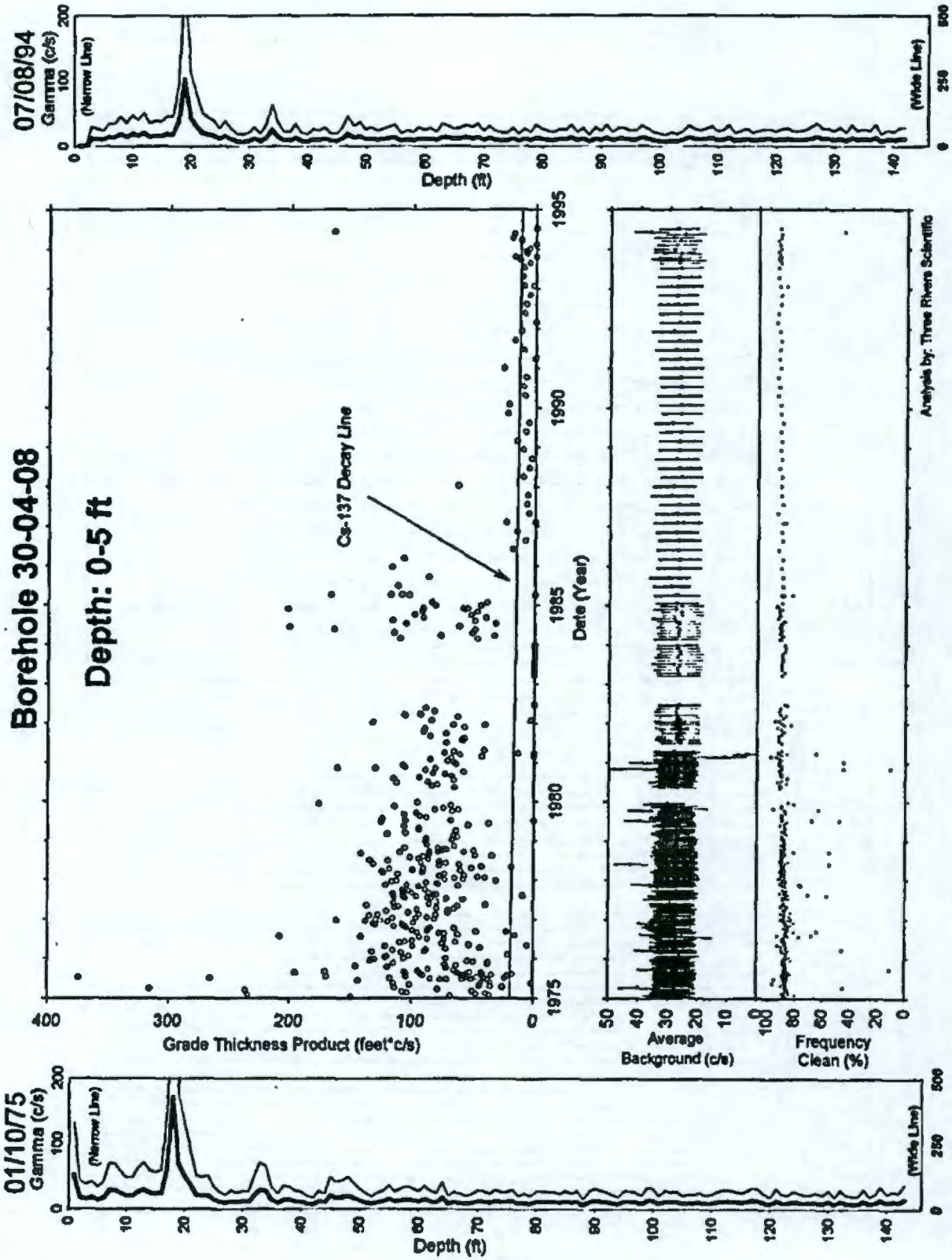
30-04-08 Combination Plot

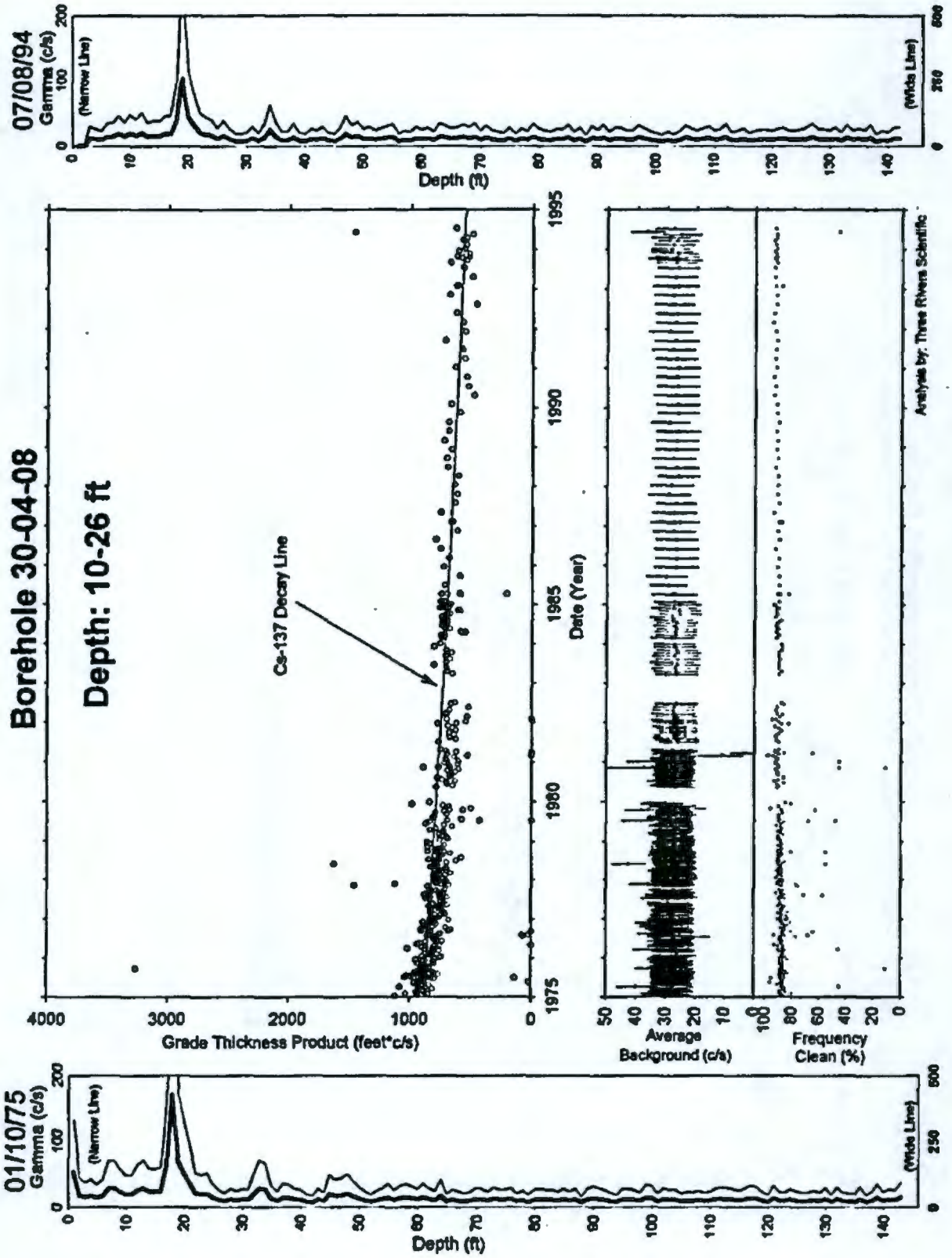


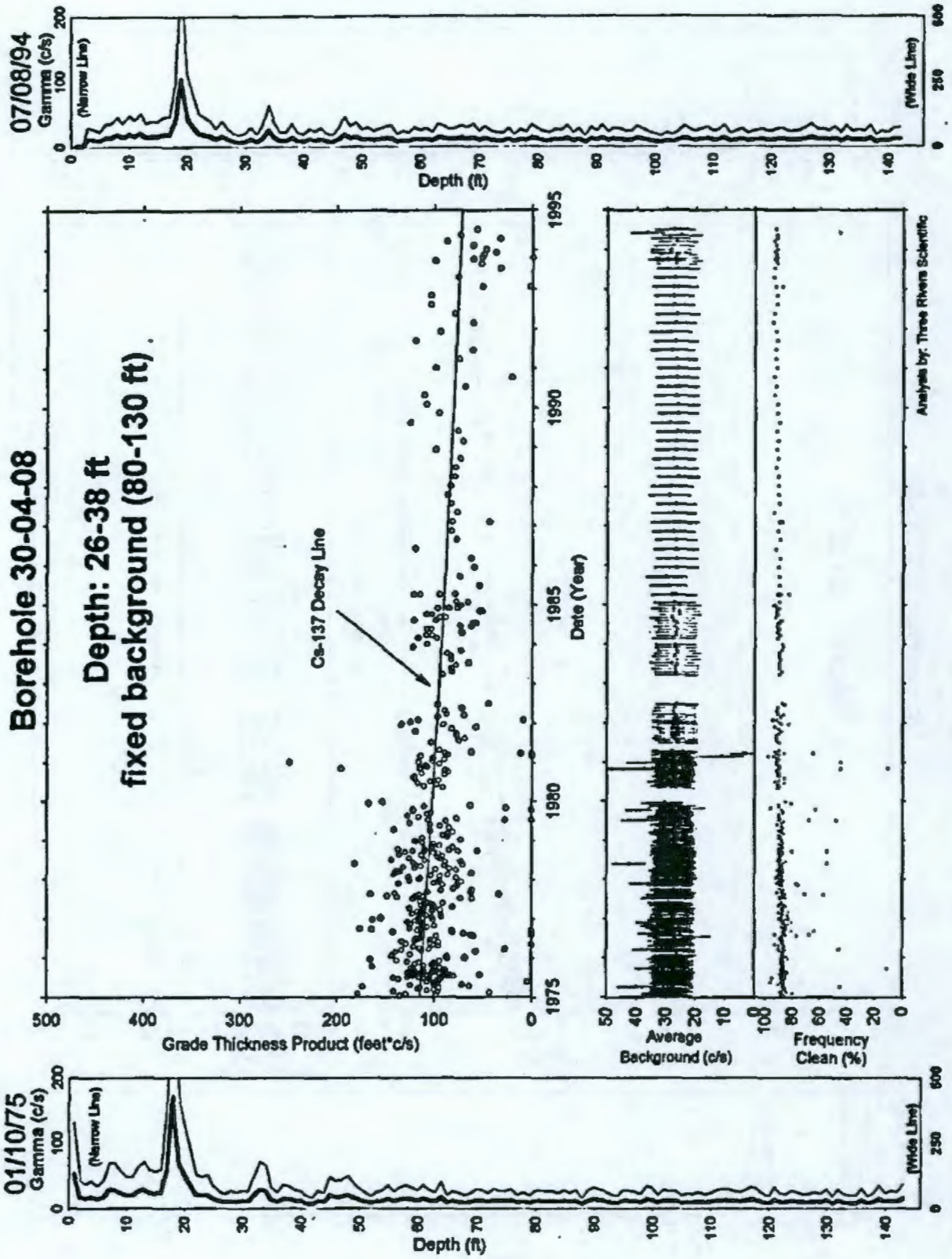
30-04-08 Combination Plot

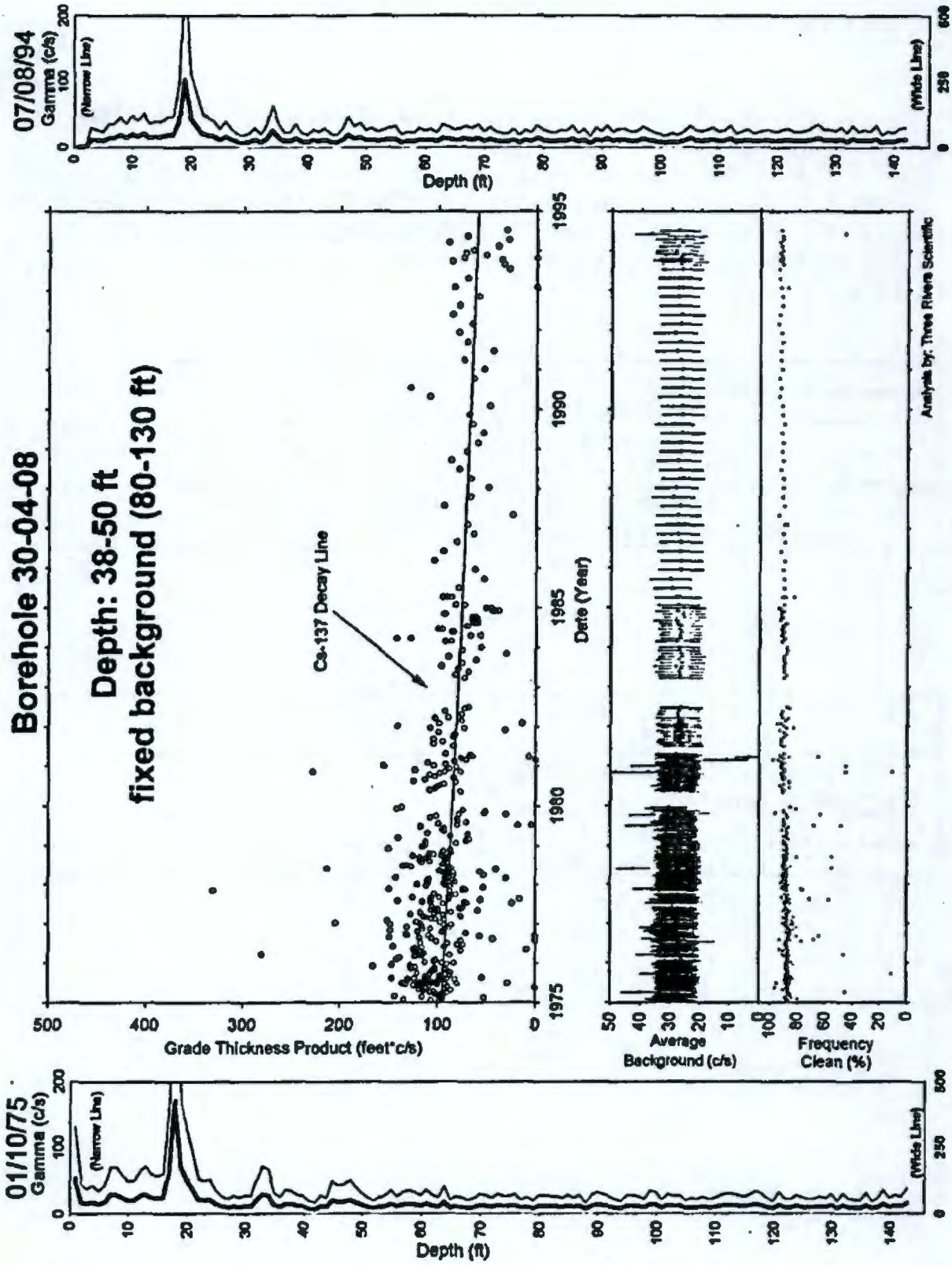



Borehole 30-04-08
Depth (feet)
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
Date (year)
1975
1980
1985
1990
1995
Analysis by: Three Rivers Scientific


07/08/94
Gamma (c/s)
(Narrow Line)
(Wide Line)
Depth (ft)
Borehole 30-04-08
Depth: 0-5 ft
Cs-137 Decay Line
Grade Thickness Product (feet*c/s)
Date (Year)
Average Background (c/s)
Frequency Clean (%)
Analysis by: Three Rivers Scientific
01/10/75
Gamma (c/s)
(Narrow Line)
(Wide Line)
Depth (ft)


07/08/94
Gamma (c/s)
(Narrow Line)
(Wide Line)
Depth (ft)
Borehole 30-04-08
Depth: 10-26 ft
Cs-137 Decay Line
Grade Thickness Product (feet*c/s)
Date (Year)
Average Background (c/s)
Frequency Clean (%)
Analysis by: Three Rivers Scientific
01/10/75
Gamma (c/s)
(Narrow Line)
(Wide Line)
Depth (ft)


07/08/94
Gamma (c/s)
(Narrow Line)
(Wide Line)
Depth (ft)
Borehole 30-04-08
Depth: 26-38 ft
fixed background (80-130 ft)
Cs-137 Decay Line
Date (Year)
Grade Thickness Product (feet*c/s)
Average Background (c/s)
Frequency Clean (%)
Analysis by: Three Rivers Scientific
01/10/75
Gamma (c/s)
(Narrow Line)
(Wide Line)
Depth (ft)


Borehole 30-04-08
Depth: 38-50 ft
fixed background (80-130 ft)
07/08/94
Gamma (c/s)
(Narrow Line)
(Wide Line)
Depth (ft)
Cs-137 Decay Line
Grade Thickness Product (feet*c/s)
Date (Year)
Average Background (c/s)
Frequency Clean (%)
Analysis by: Three Rivers Scientific
01/10/75
Gamma (c/s)
(Narrow Line)
(Wide Line)
Depth (ft)

Borehole 30-04-12

No Gamma Ray Emitting Contamination Identified.

No significant levels of gamma ray contamination are present, based upon gross gamma data, above the survey probe detection threshold between 1975 and 1995 in the vadose zone from 2 to 135 feet. The HPGe logging system detected Cs-137 at 3 pCi/g near the surface (1 feet), and less than 1 pCi/g for the remainder of the logged depths.

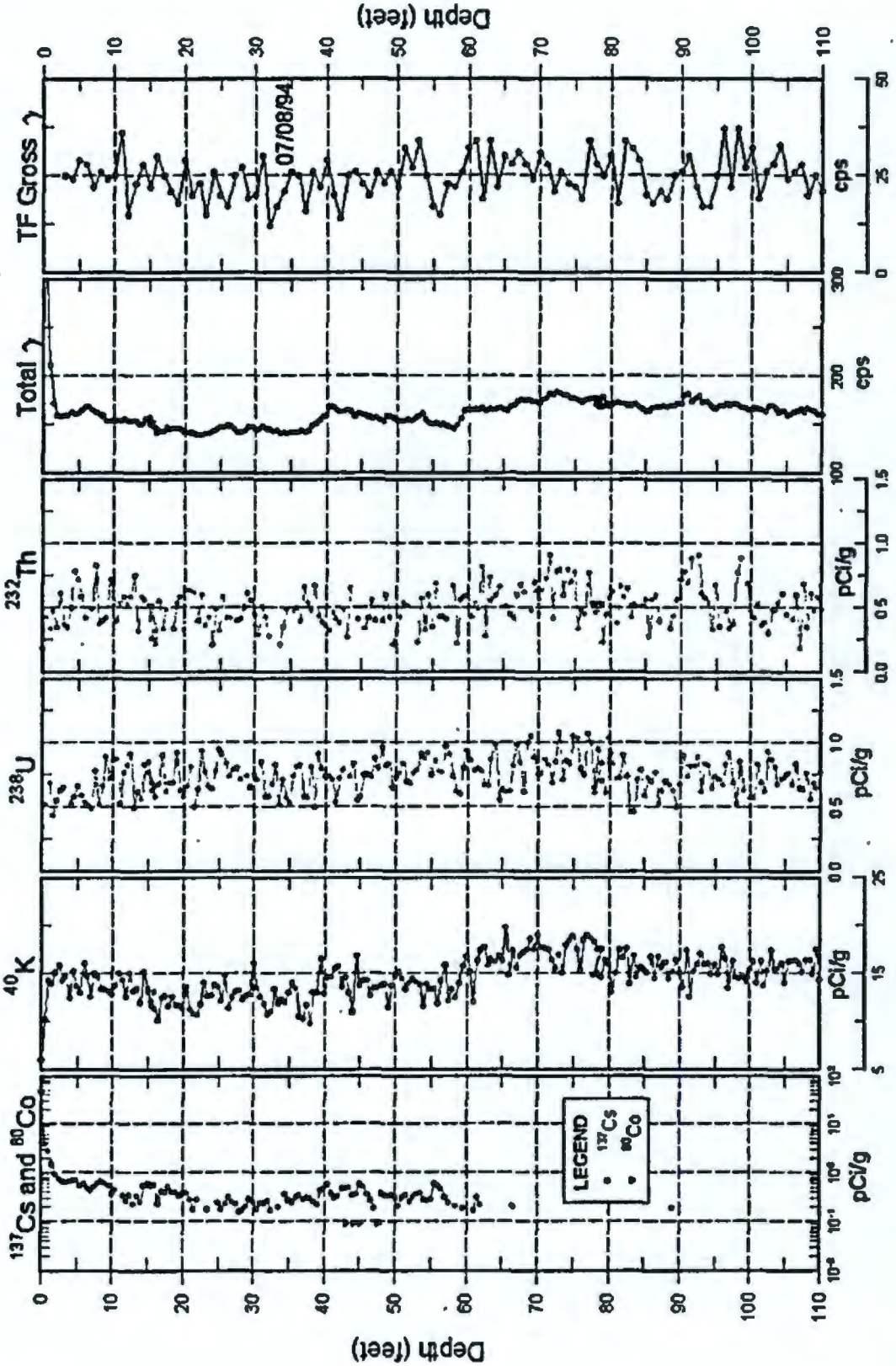
Gross Gamma Survey Information

Probe Type Processed :	04: NaI
Other Probe Types :	03: Neutron
Survey Depth :	135 ft
First Survey Date :	1/10/1975
Last Survey Date :	7/8/1994
Number Surveys Processed :	414

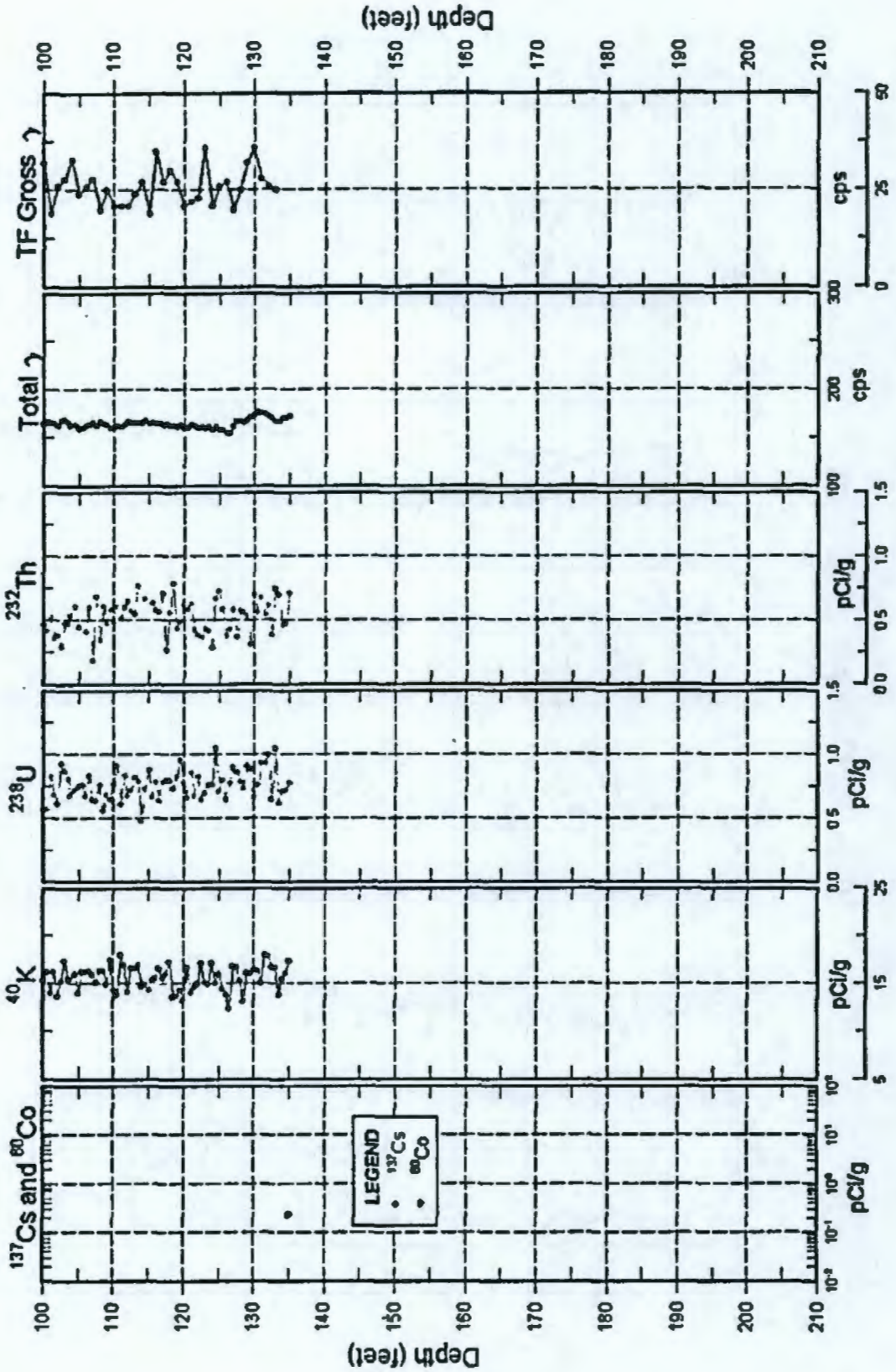
Analysis Notes

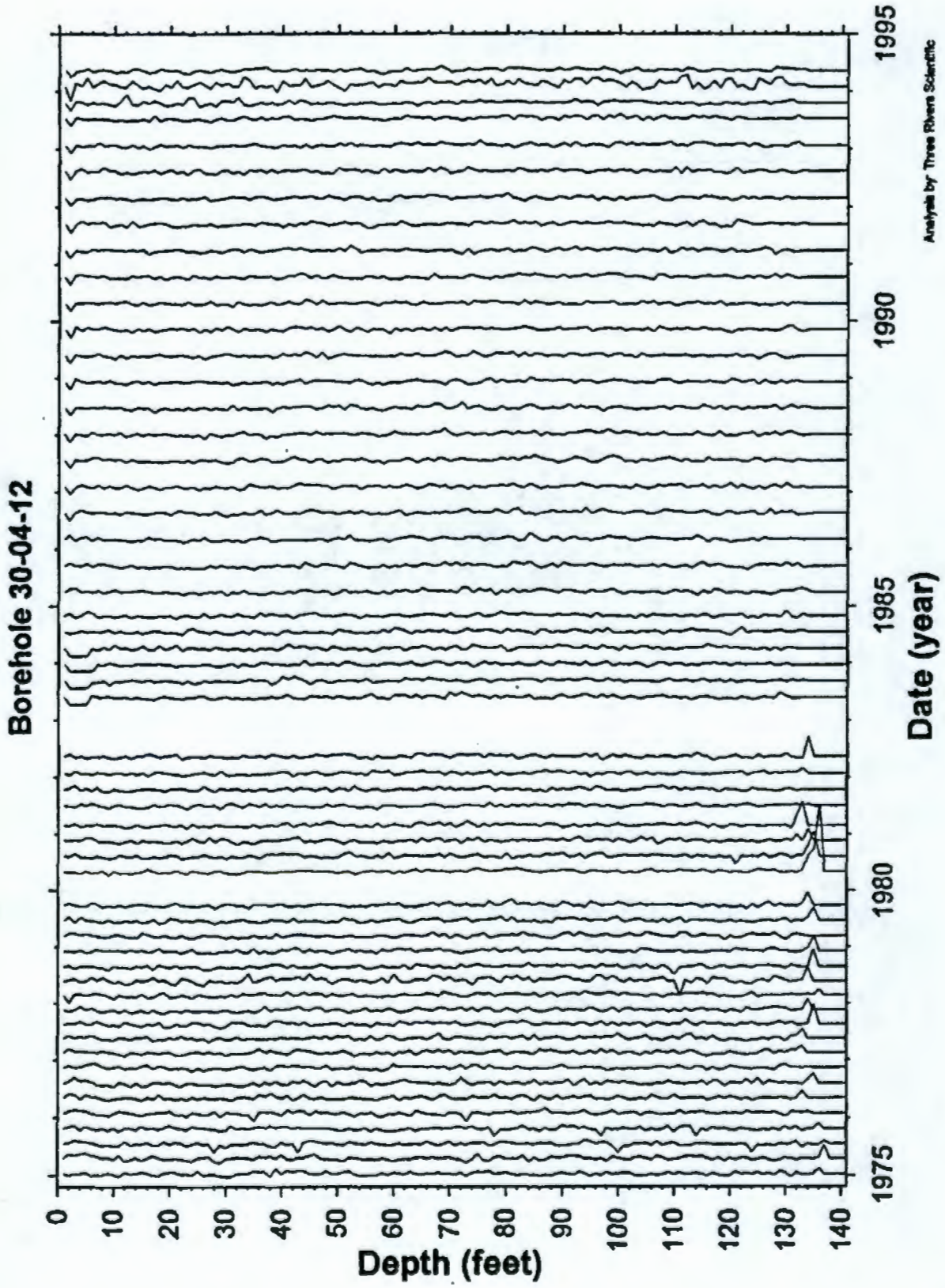
Method Used to Compute Background :	Threshold 0<val<50
Depth(s) where Contamination Identified in Gross Gamma Surveys :	NONE
Analyst Name :	R.R. Randall
Company Name :	Three Rivers Scientific

30-04-12 Combination Plot

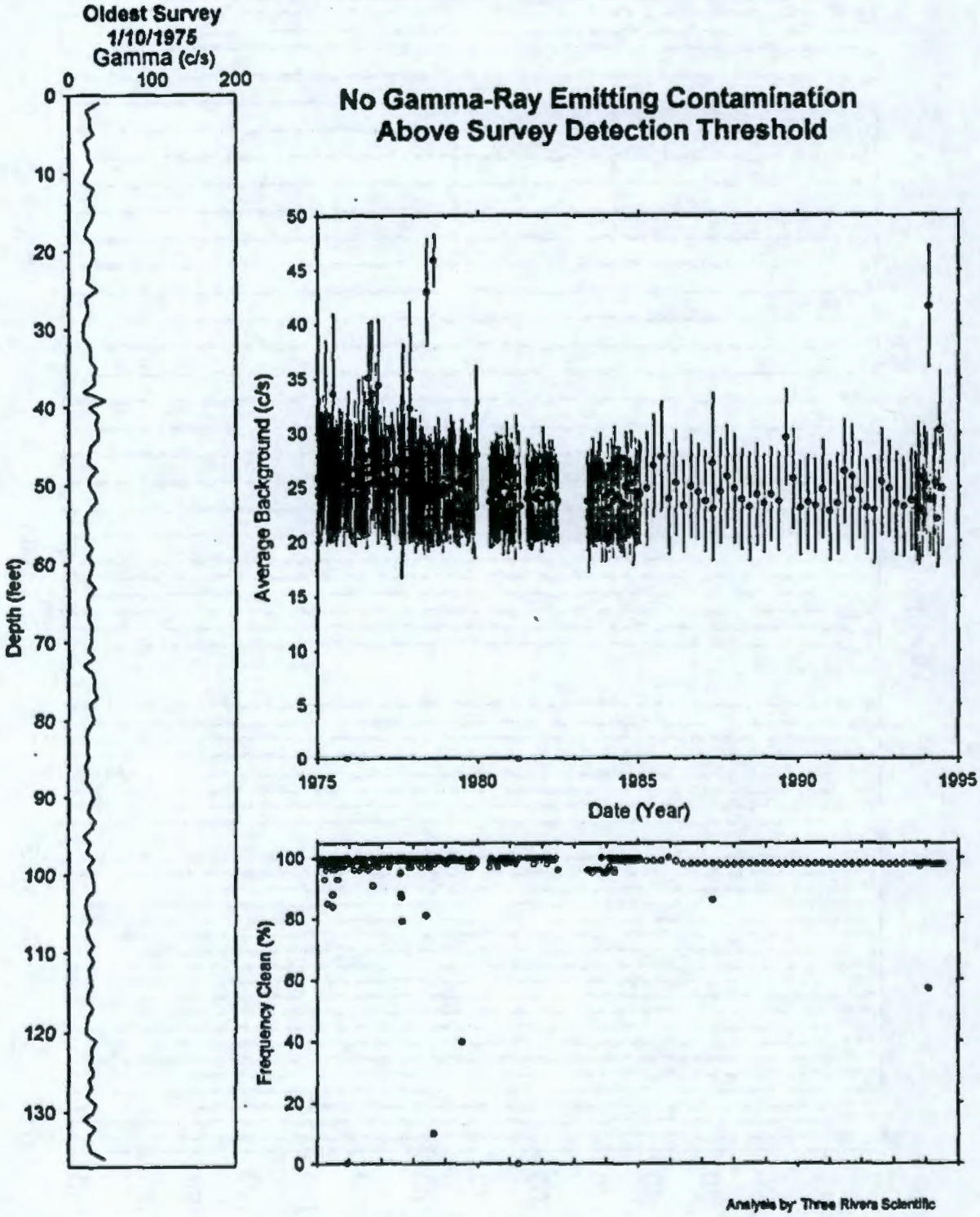


30-04-12 Combination Plot




Borehole 30-04-12
Depth (feet)
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
Date (year)
1975
1980
1985
1990
1995
Analysis by Three Rivers Scientific

Borehole 30-04-12



Tank C-105

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Borehole 30-05-04 190
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Borehole 30-05-07 207
Borehole 30-05-08 213
Borehole 30-05-09 221
Borehole 30-05-10 225

This section contains the analysis results for vadose zone boreholes (dry wells) associated with the Tank 105 in the "C" Tank Farm.

Special Notes: None

Borehole 30-05-02

Contamination (Cs-137) from 0-14 feet is Tank Farm Activity. Contamination (Cs-137) from 14-26 feet is Undetermined. Contamination (Cs-137 & Co-60) from 68-84 feet is Unstable Early.

Grade thickness product over 0 to 14 feet is erratic and highly variable from 1975 to 1997, indicative of tank farm activity. There is no time interval where the grade thickness product is consistent with the decay from Cs-137 (HPGe identified).

Grade thickness product over 14 to 26 feet is undetermined. The gross gamma over this interval may be influenced by the higher level from 0 to 14 feet coupled with depth control error prior to 1986. From 1984 to 1994 the grade thickness product is consistent with Cs-137 (HPGe identified) decay.

Grade thickness product over 68 to 84 feet is consistent with a least square fit for Cs-137 and Co-60 (both HPGe identified) decay after 1977. Before 1977 a systematic increase is observed. The resulting least square fit ratio of gross gamma from Co-60 to gross gamma from Cs-137 as of 7/29/1996 is 1.4. The zone category is unstable early.

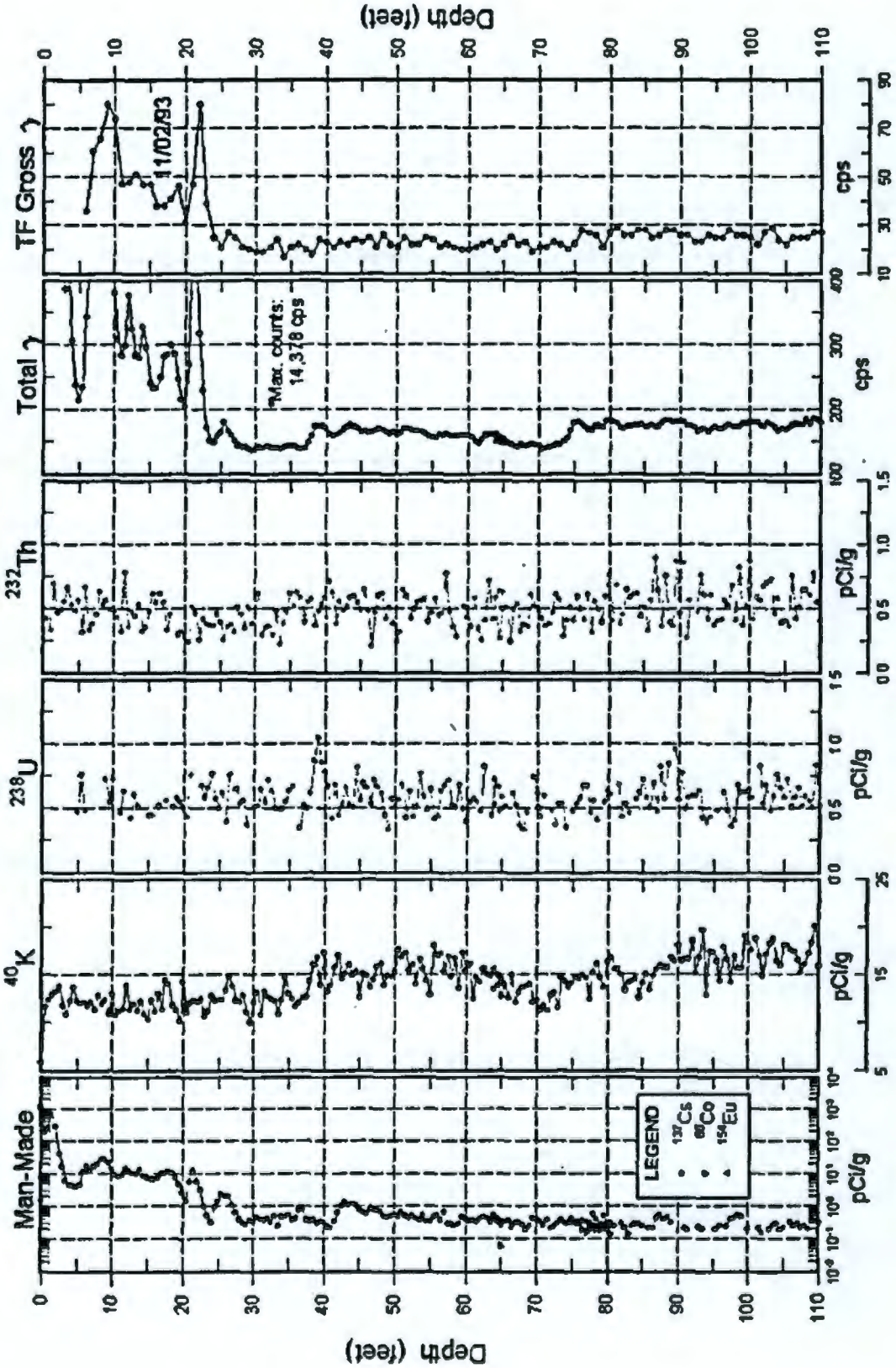
Gross Gamma Survey Information

Probe Type Processed :	04: NaI
Other Probe Types :	03: Neutron
Survey Depth :	130 ft
First Survey Date :	1/10/1975
Last Survey Date :	7/29/1996
Number Surveys Processed :	569

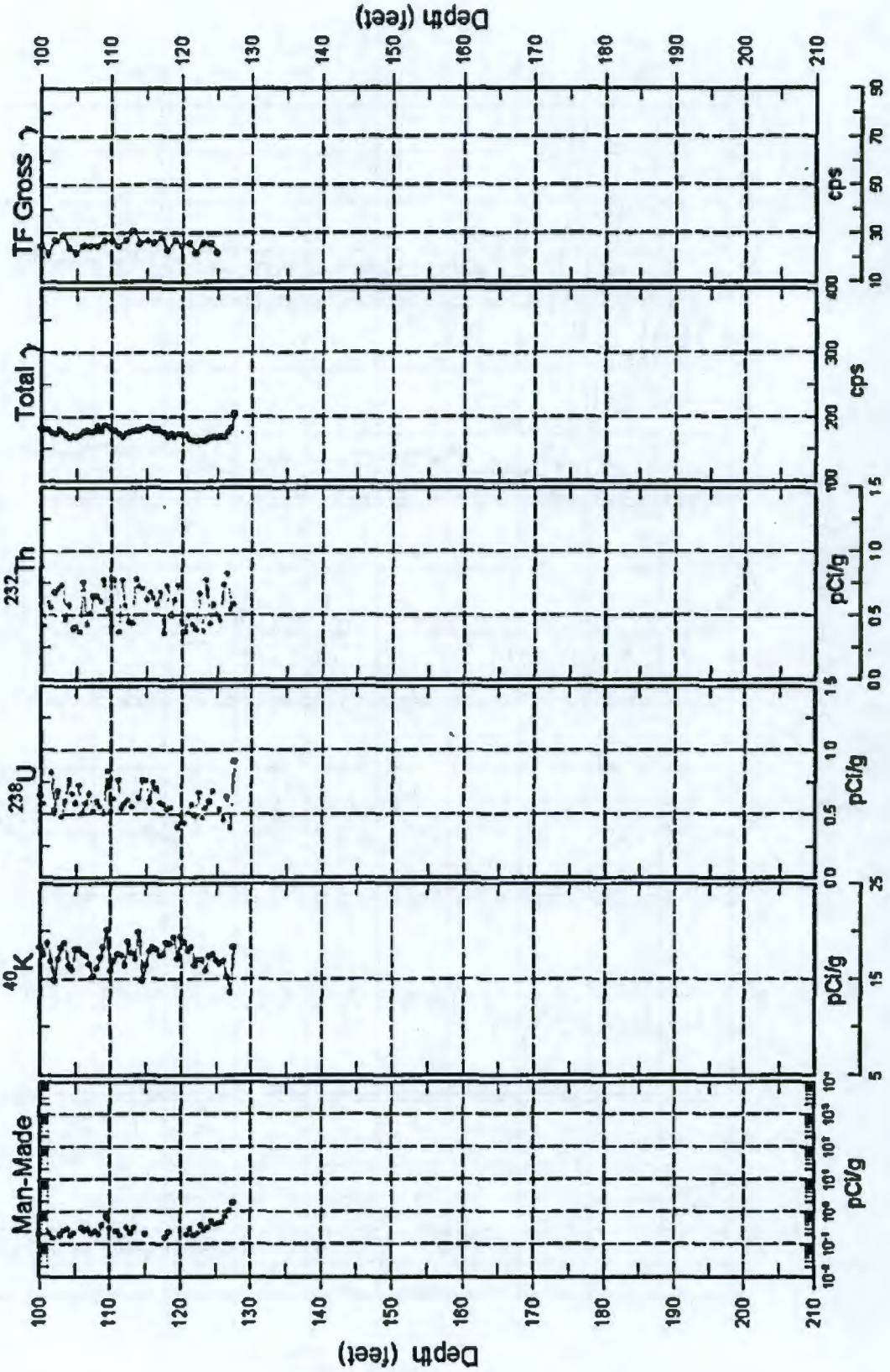
Analysis Notes

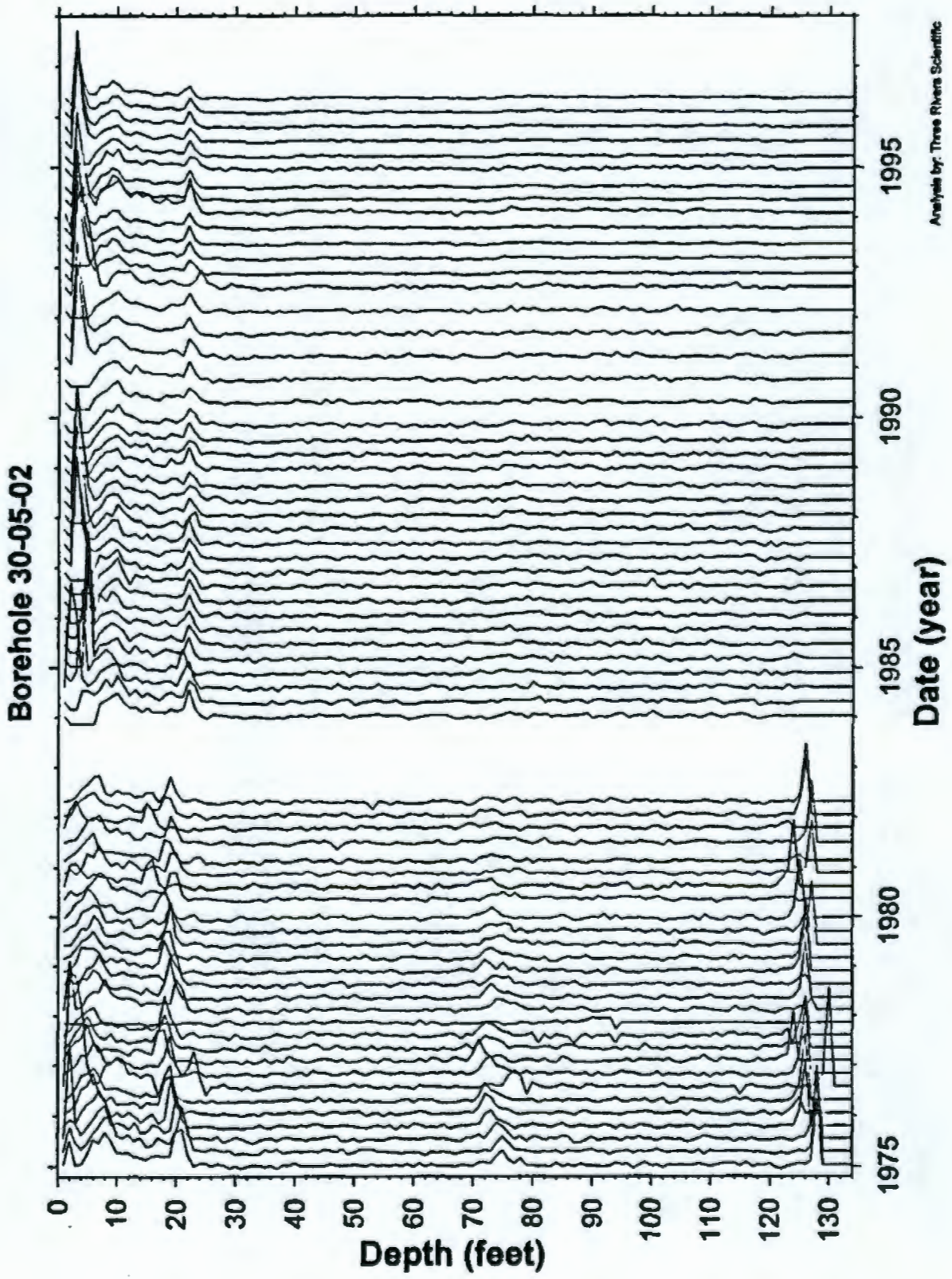
Method Used to Compute Background :	Fixed background (30-40 ft) for 0-14 & 14-26 ft Fixed background (55-68 ft) for 68-84
Depth(s) where Contamination Identified in Gross Gamma Surveys :	0-14 ft Tank Farm Activity 14-26 ft Undetermined 68-84 ft Unstable Early
Analyst Name :	R.R. Randall
Company Name :	Three Rivers Scientific

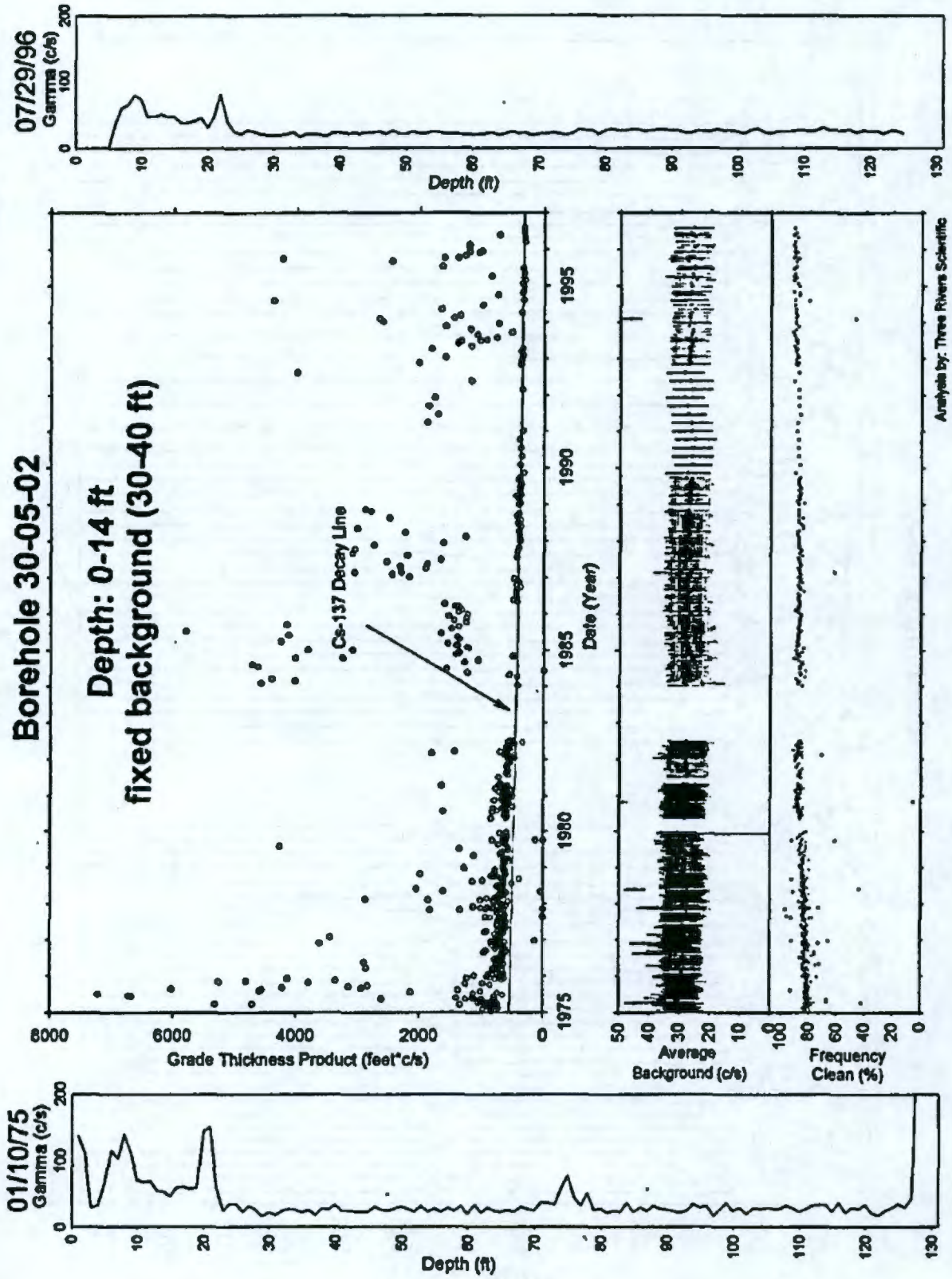
30-05-02 Combination Plot

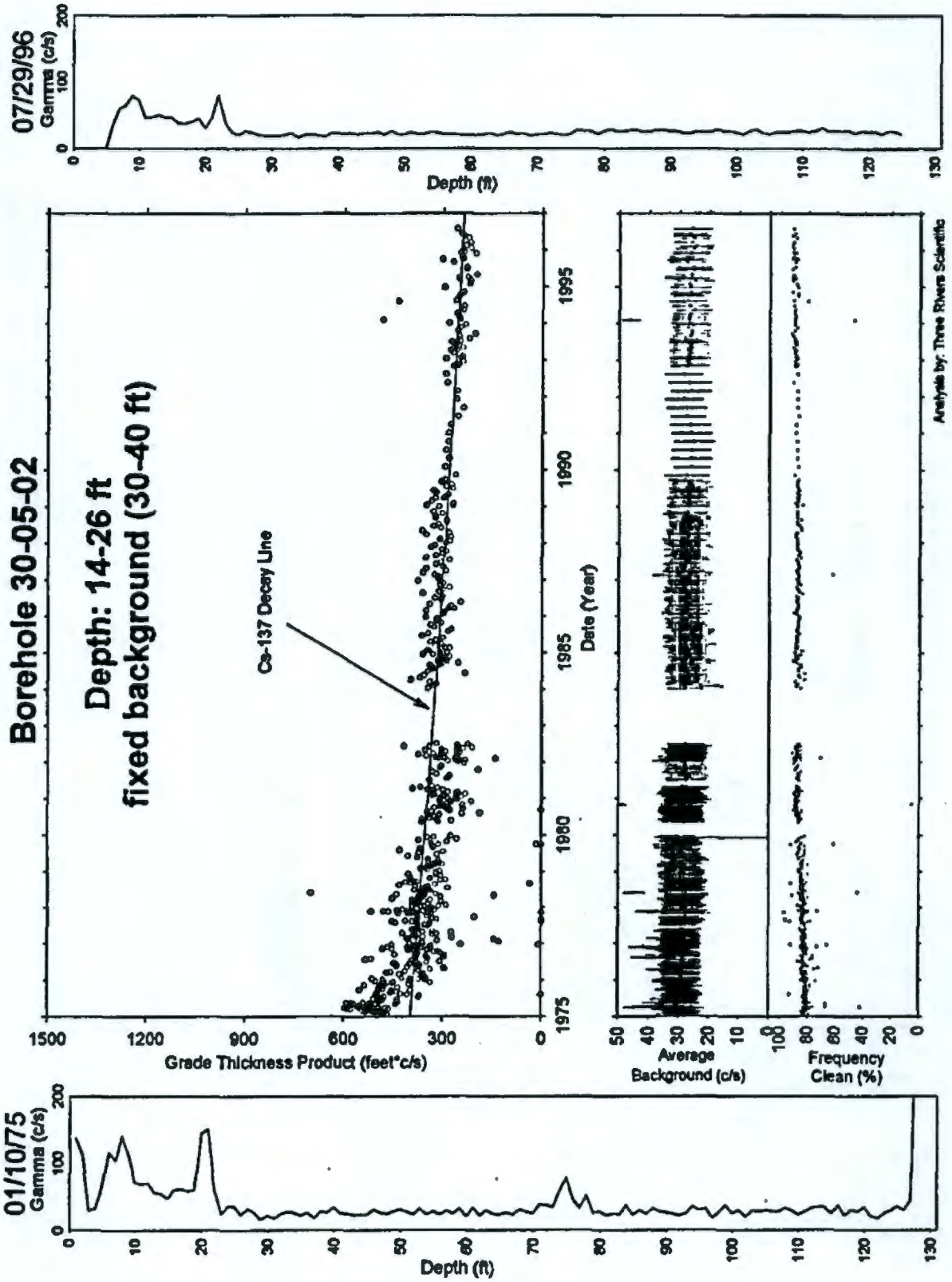


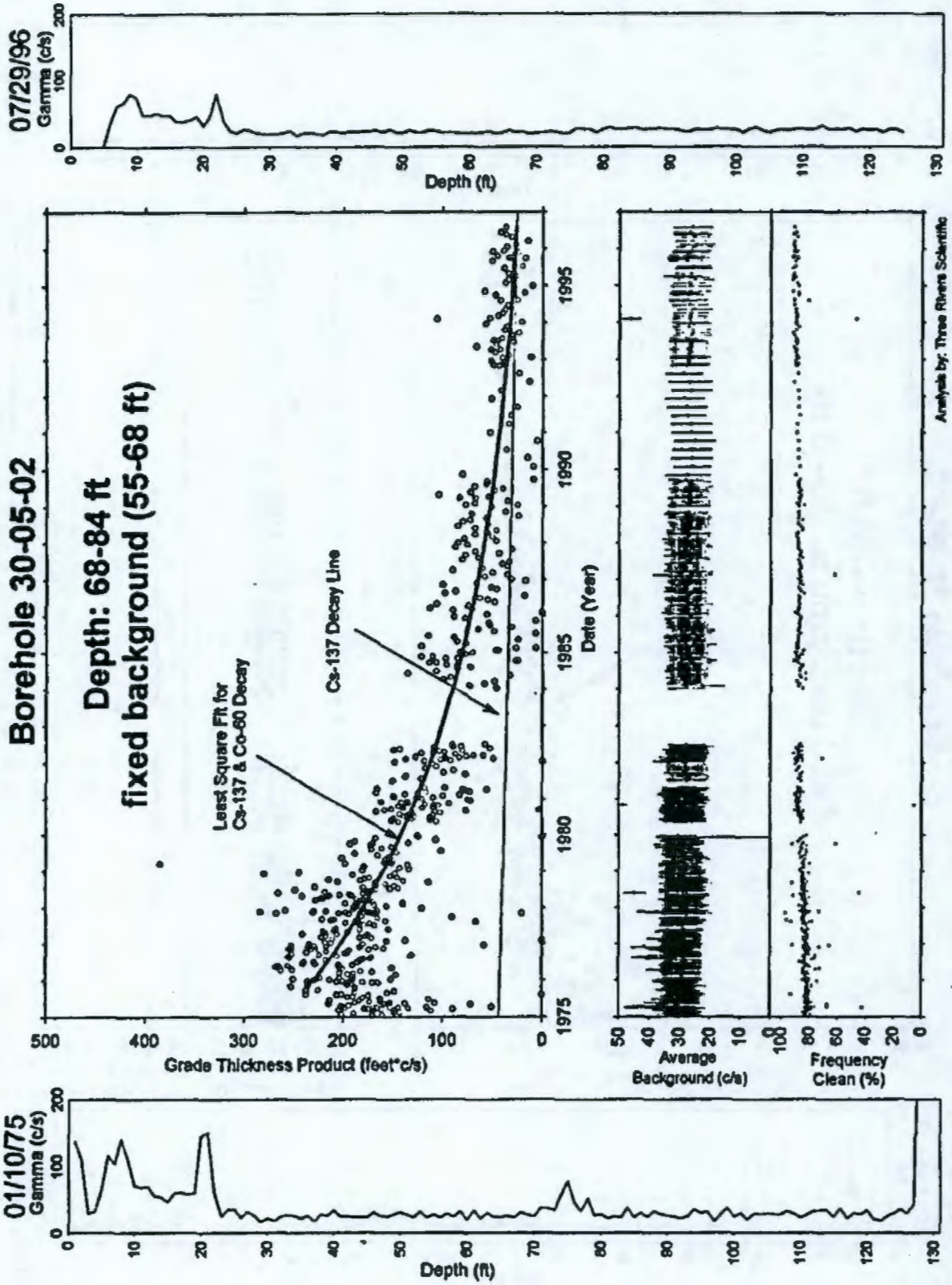
30-05-02 Combination Plot




Borehole 30-05-02
Depth (feet)
0
10
20
30
40
50
60
70
80
90
100
110
120
130
Date (year)
1975
1980
1985
1990
1995
Analysis by: Three Rivers Scientific


07/29/96
Gamma (c/s)
Depth (ft)
Borehole 30-05-02
Depth: 0-14 ft
fixed background (30-40 ft)
Cs-137 Decay Line
Date (Year)
Grade Thickness Product (feet*c/s)
Average Background (c/s)
Frequency Clean (%)
Analysis by: Three Rivers Scientific
01/10/75
Gamma (c/s)
Depth (ft)


07/29/96
Gamma (c/s)
Depth (ft)
Borehole 30-05-02
Depth: 14-26 ft
fixed background (30-40 ft)
Cs-137 Decay Line
Grade Thickness Product (feet*c/s)
Date (Year)
Average Background (c/s)
Frequency Clean (%)
Analysis by: Three Rivers Scientific
01/10/75
Gamma (c/s)
Depth (ft)


07/29/96
Gamma (c/s)
Depth (ft)
Borehole 30-05-02
Depth: 68-84 ft
fixed background (55-68 ft)
Least Square Fit for
Cs-137 & Co-60 Decay
Cs-137 Decay Line
Date (Year)
Grade Thickness Product (feet*c/s)
Average
Background (c/s)
Frequency
Clean (%)
Analysis by: Three Rivers Scientific
01/10/75
Gamma (c/s)
Depth (ft)

Borehole 30-05-03

Contamination (Cs-137) from 0-39 feet is Tank Farm Activity. Contamination (Co-60) from 67-80 feet is Unstable.

Grade thickness product over 0 to 39 feet is erratic and highly variable from 1975 to 1986, indicative of tank farm activity. Since 1986, the grade thickness product is consistent with the decay from Cs-137 (HPGe identified). Computation of sub-zone grade thickness products for this large depth interval would yield the same result for any sub-zone due to depth control errors prior to 1986 and the lack of distinct depth separation of Cs-137 profile from 0 to 39 feet.

Grade thickness product over 67 to 80 feet declines faster than Co-60 (HPGe identified) decay from 1975 to 1980. An increase is observed from 1984 to 1987. A possible match of the grade thickness product and Co-60 decay may exist from 1993 to 1997, but there is insufficient monitoring period to make this classification. The zone is unstable.

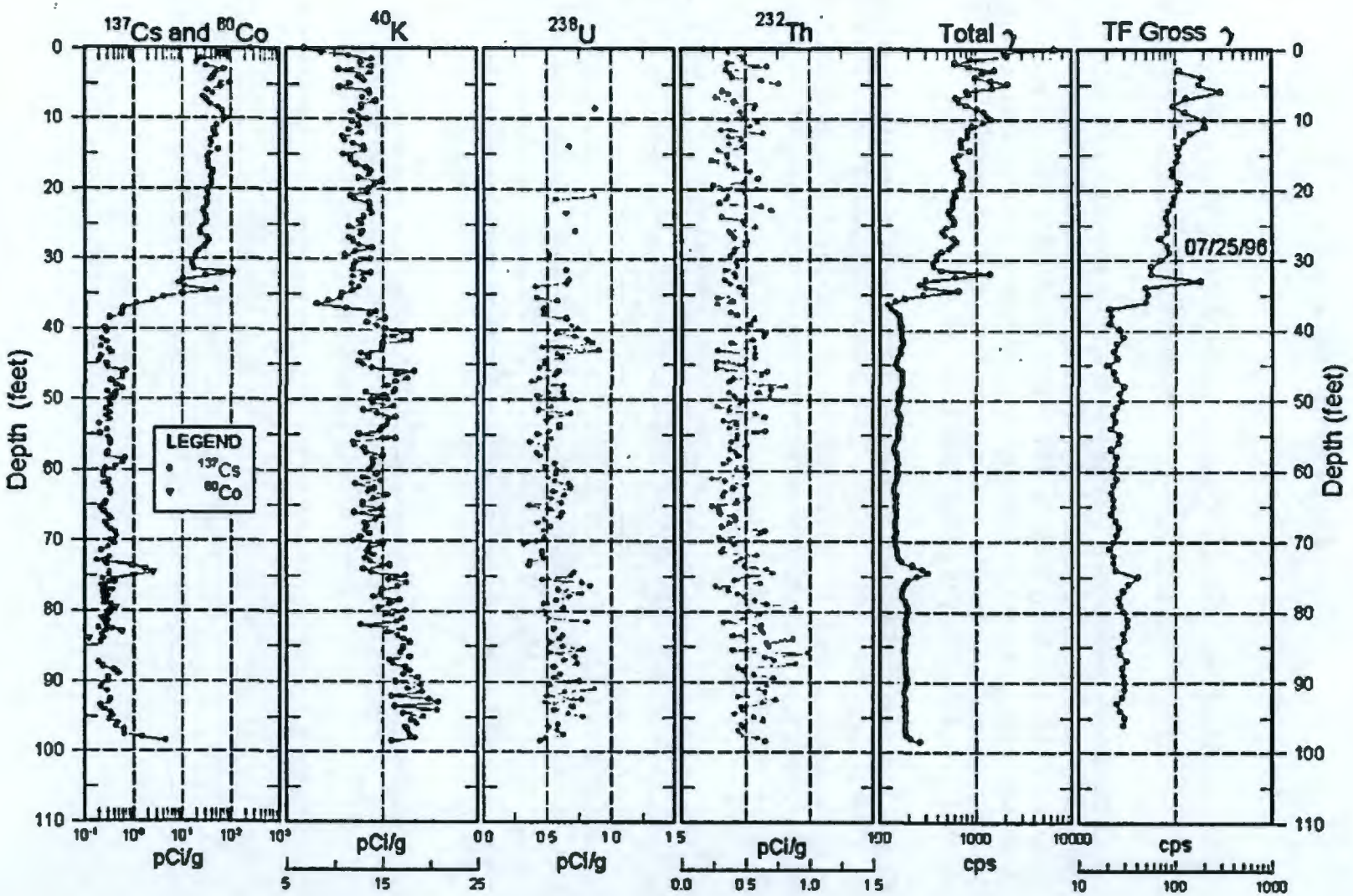
Gross Gamma Survey Information

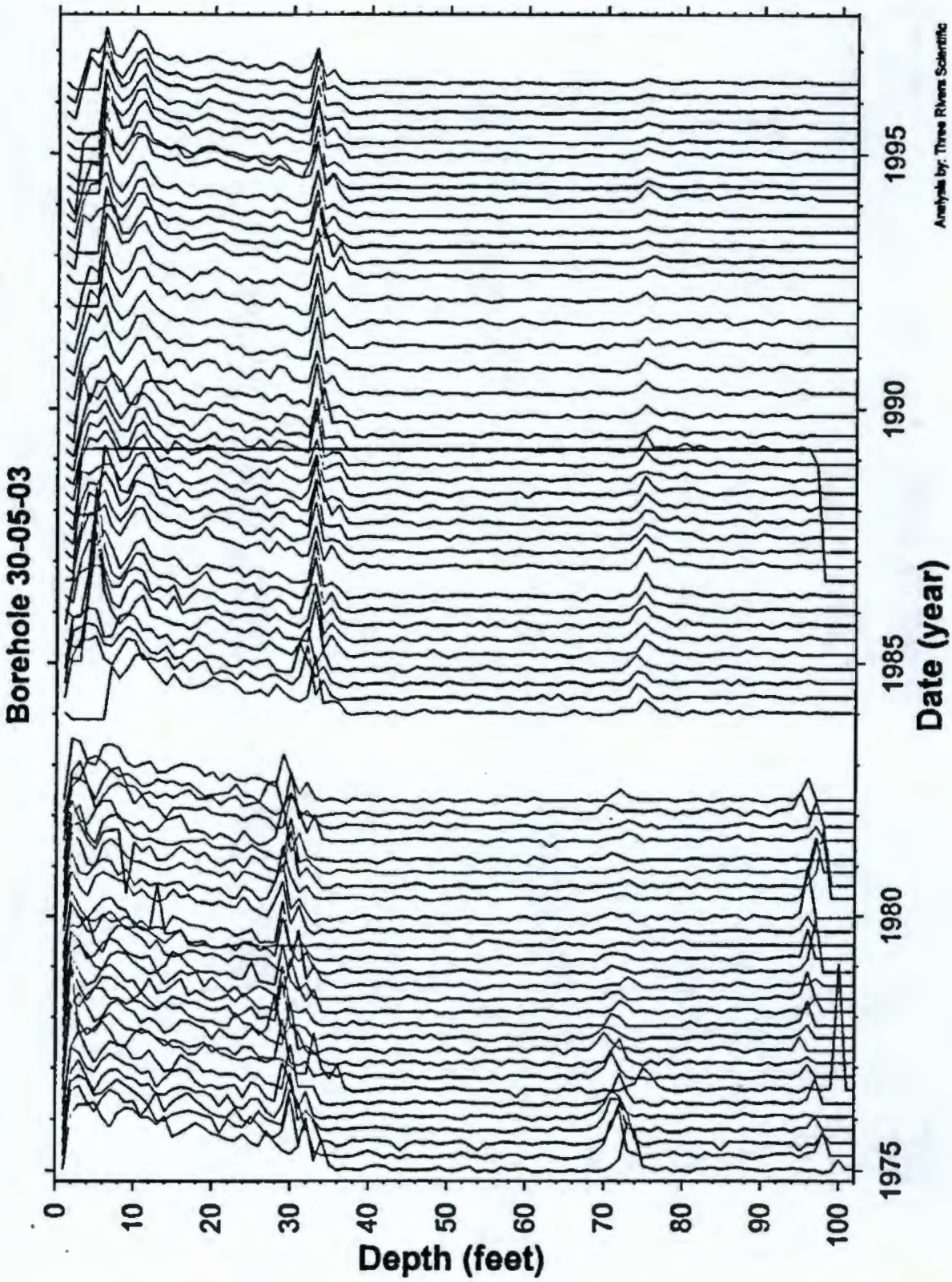
Probe Type Processed :	04: NaI
Other Probe Types :	03: Neutron
Survey Depth :	100 ft
First Survey Date :	1/10/1975
Last Survey Date :	7/25/1996
Number Surveys Processed :	589

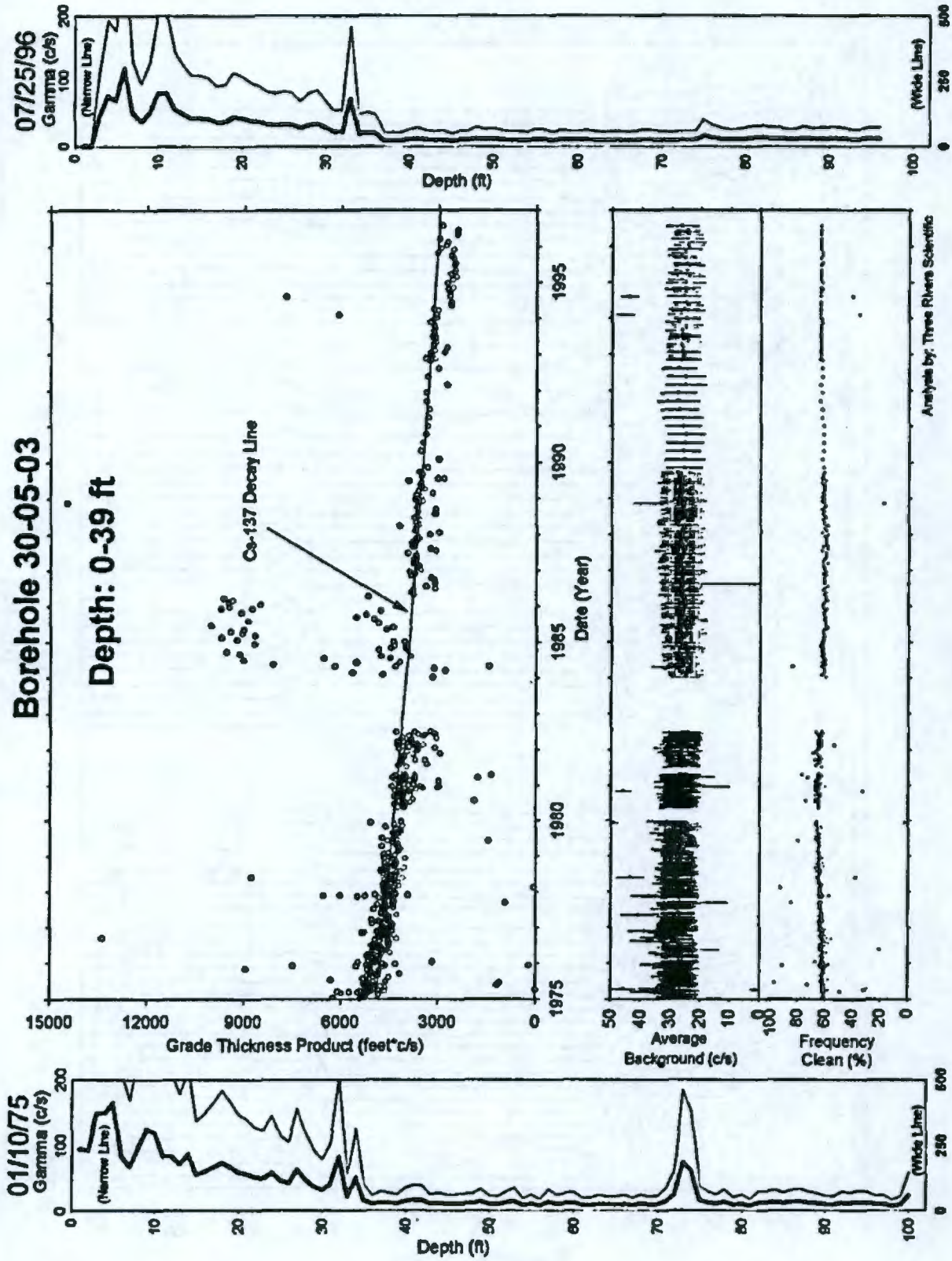
Analysis Notes

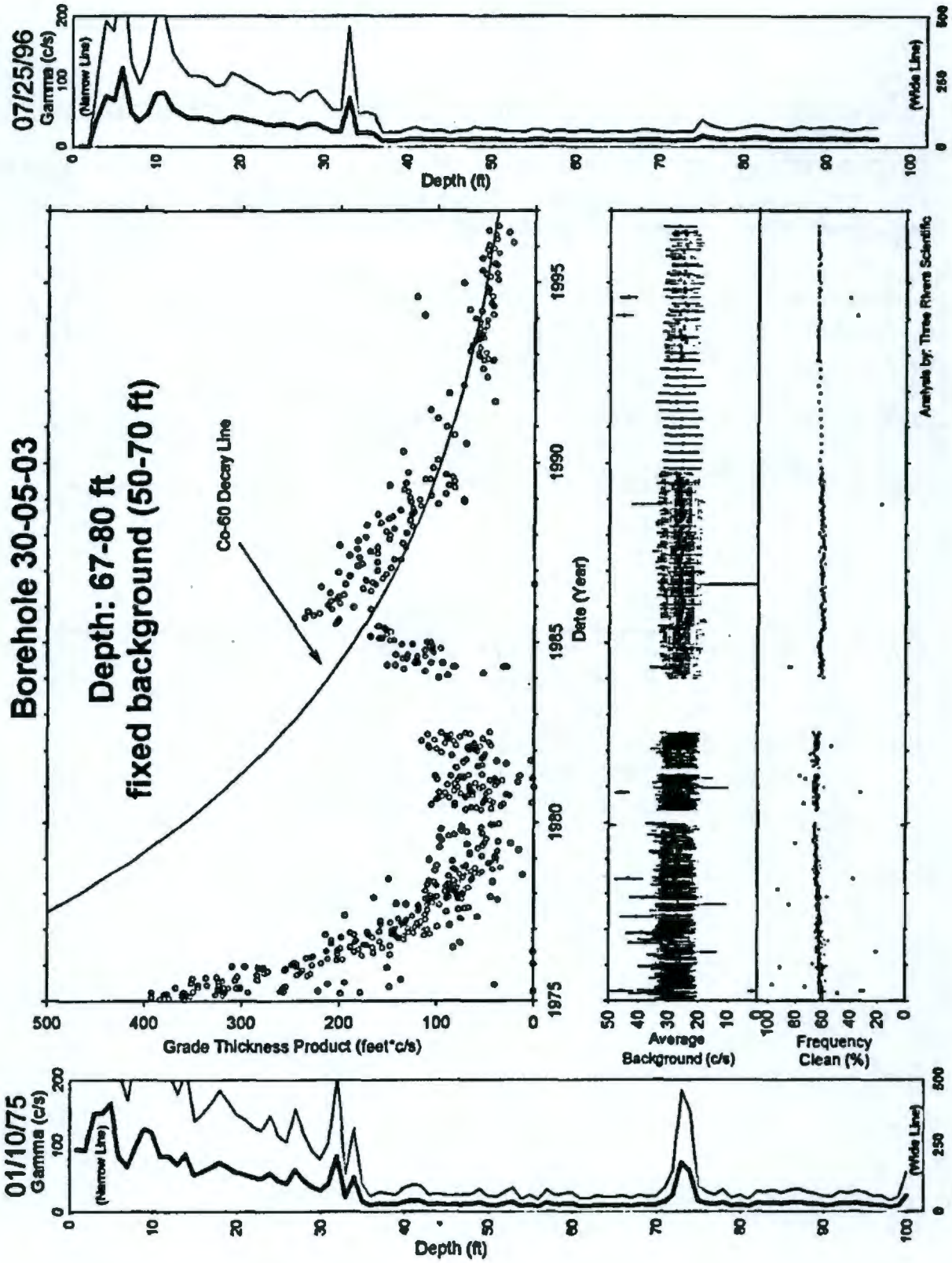
Method Used to Compute Background :	Threshold 0<val<50 for 0-39 ft Fixed background (50-70 ft) for 67-80 ft
Depth(s) where Contamination Identified in Gross Gamma Surveys :	0-39 ft Tank Farm Activity 67-80 ft Unstable
Analyst Name :	R.R. Randall
Company Name :	Three Rivers Scientific

30-05-03 Combination Plot




Borehole 30-05-03
Depth (feet)
0
10
20
30
40
50
60
70
80
90
100
Date (year)
1975
1980
1985
1990
1995
Analysis by: Three Rivers Scientific


07/25/96
Gamma (c/s)
(Narrow Line)
(Wide Line)
Depth (ft)
Borehole 30-05-03
Depth: 0-39 ft
Cs-137 Decay Line
Grade Thickness Product (feet*c/s)
Date (Year)
Average Background (c/s)
Frequency Clean (%)
Analysis by: Three Rivers Scientific
01/10/75
Gamma (c/s)
(Narrow Line)
(Wide Line)
Depth (ft)


07/25/96
Gamma (c/s)
(Narrow Line)
(Wide Line)
Depth (ft)
Borehole 30-05-03
Depth: 67-80 ft
fixed background (50-70 ft)
Co-60 Decay Line
Grade Thickness Product (feet*c/s)
Date (Year)
Average
Background (c/s)
Frequency
Clean (%)
Analysis by: Three Rivers Scientific
01/10/75
Gamma (c/s)
(Narrow Line)
(Wide Line)
Depth (ft)

Borehole 30-05-04

Contamination (Cs-137) from 0-8 feet is Tank Farm Activity.

Grade thickness product over 0 to 8 feet is erratic and highly variable from 1975 to 1986, indicative of tank farm activity. Since 1986, the grade thickness product is consistent with the decay from Cs-137 (HPGe identified).

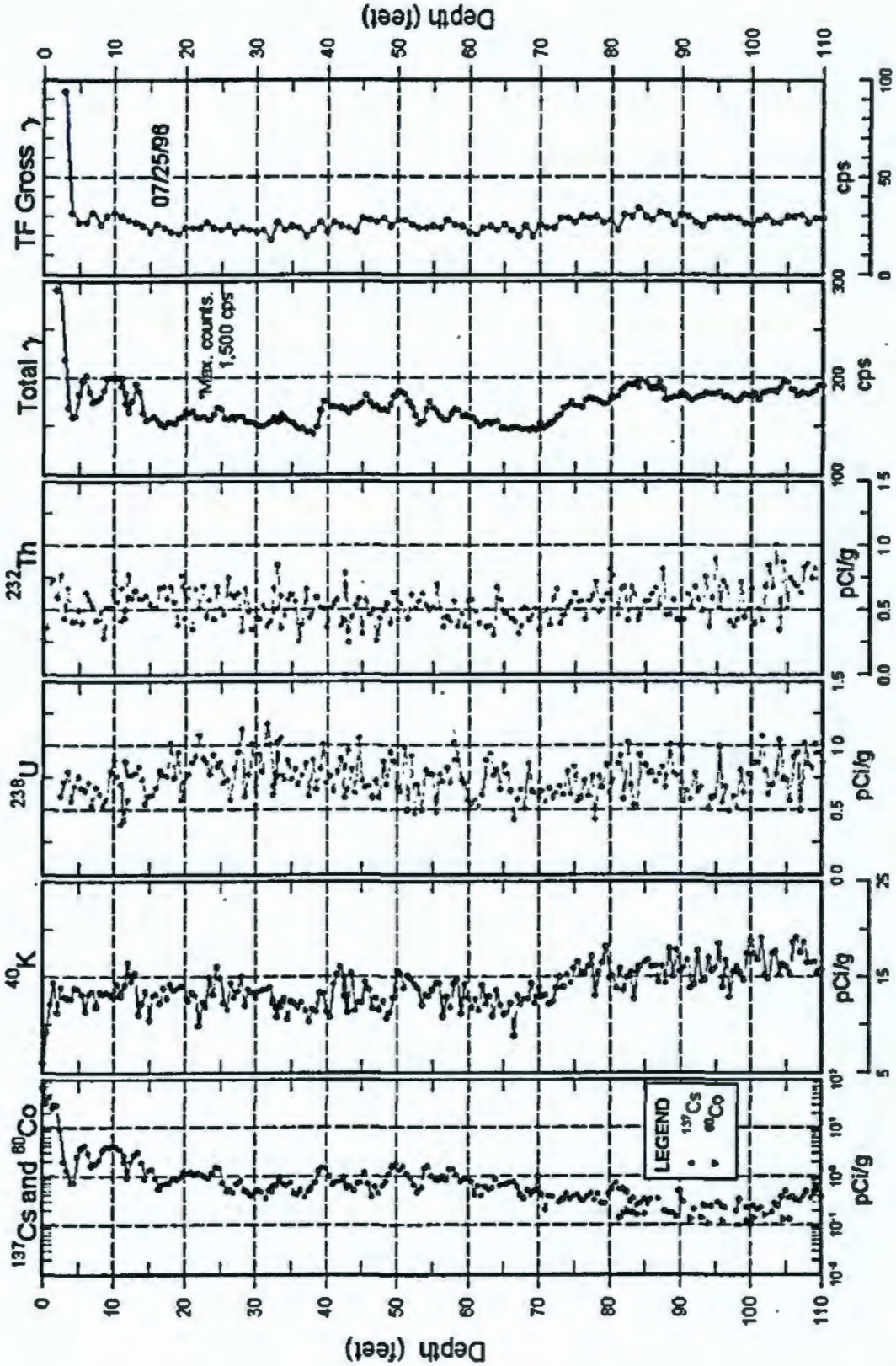
Gross Gamma Survey Information

Probe Type Processed :	04: NaI
Other Probe Types :	03: Neutron
Survey Depth :	120 ft
First Survey Date :	1/10/1975
Last Survey Date :	7/25/1996
Number Surveys Processed :	556

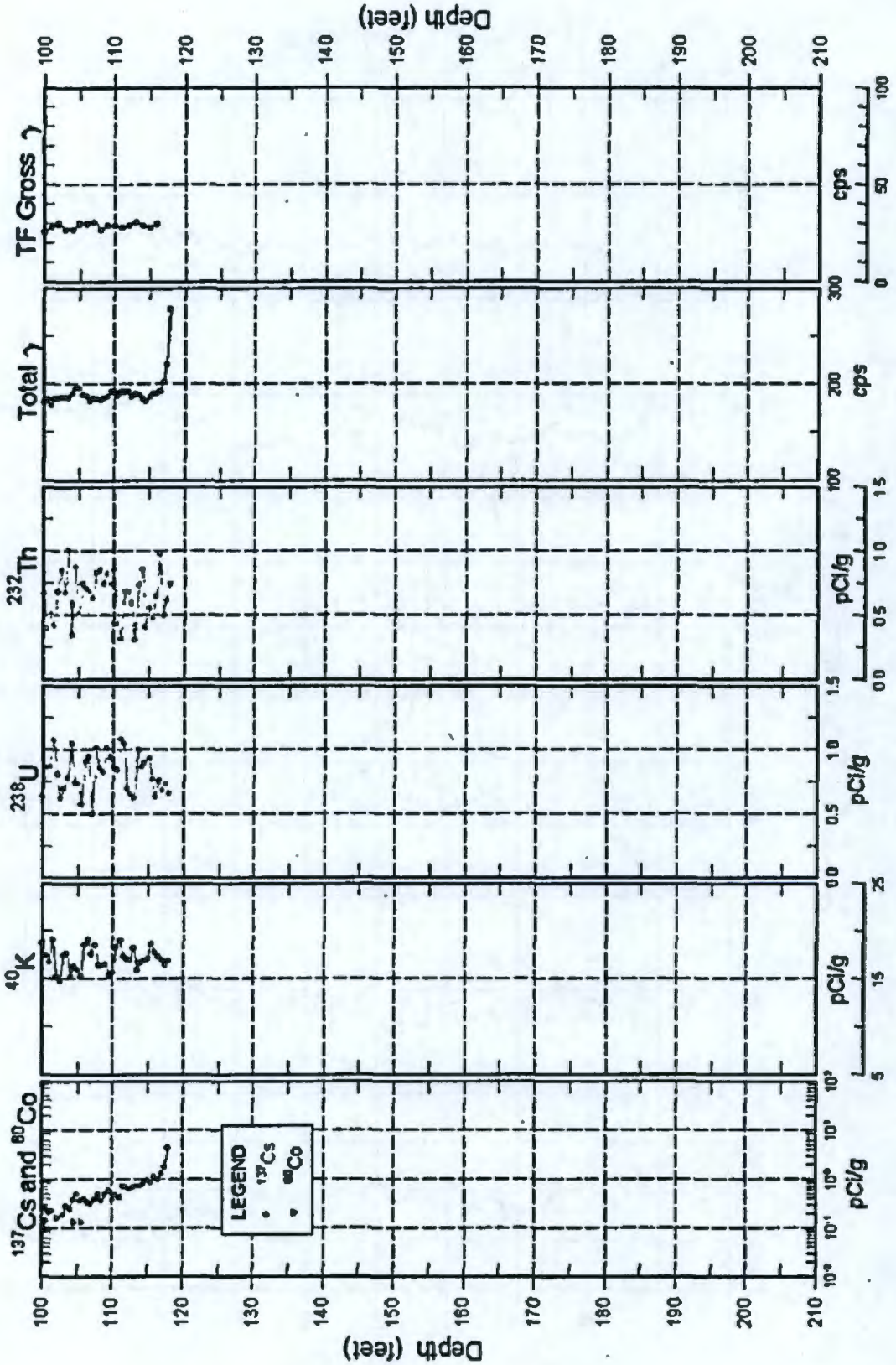
Analysis Notes

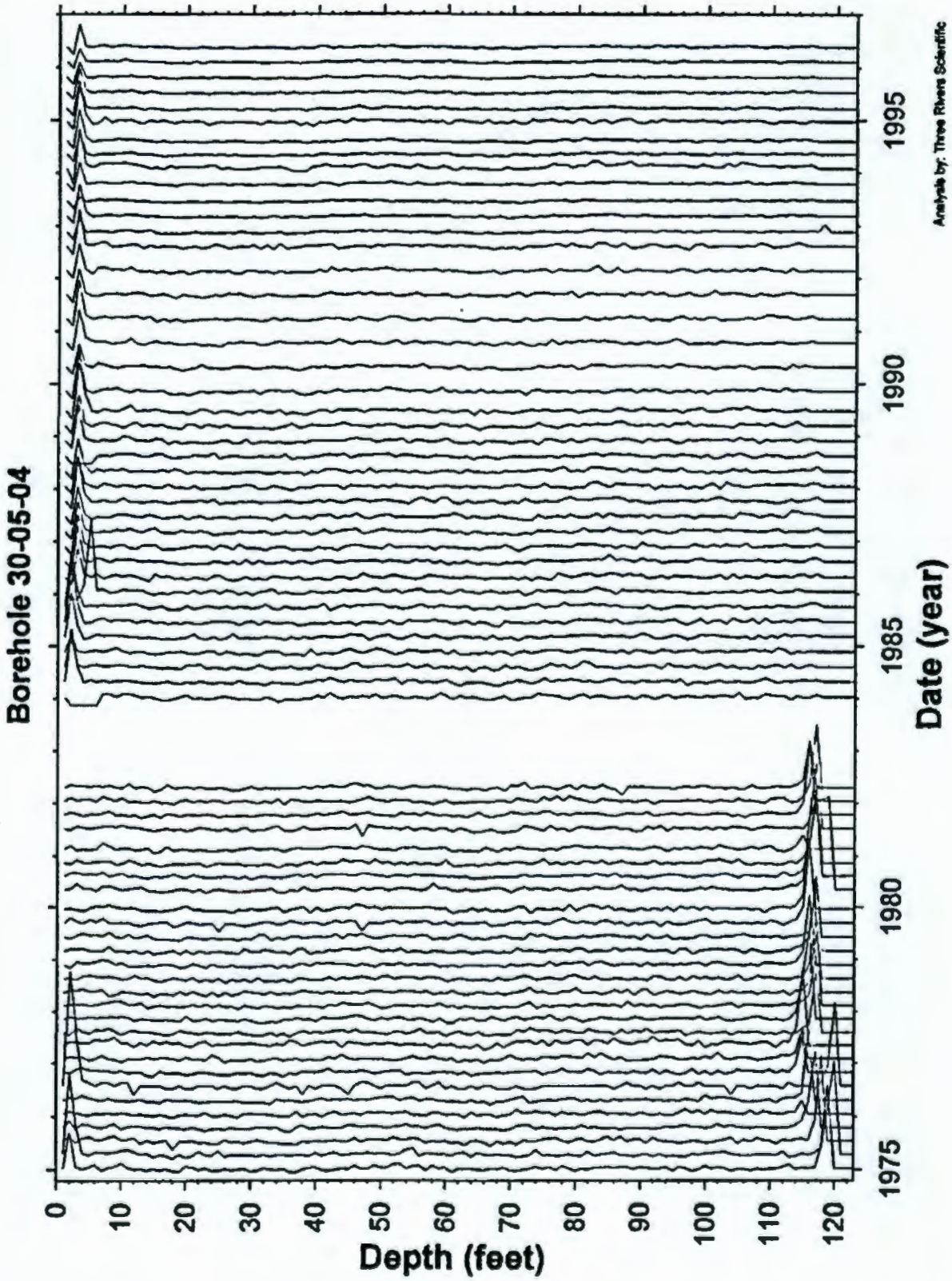
Method Used to Compute Background :	Fixed background (15-38 ft)
Depth(s) where Contamination Identified in Gross Gamma Surveys :	0-8 ft Tank Farm Activity
Analyst Name :	R.R. Randall
Company Name :	Three Rivers Scientific

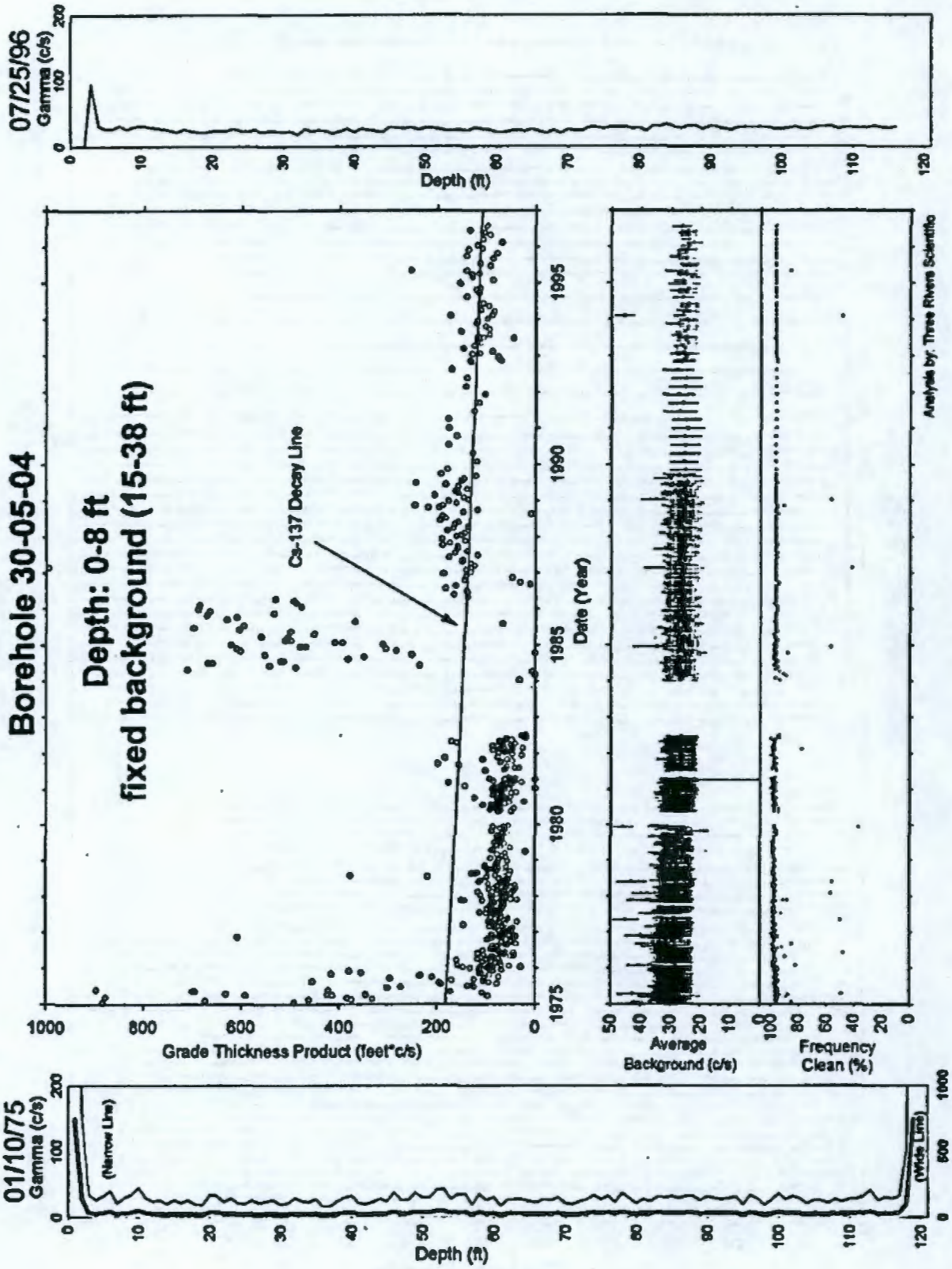
30-05-04 Combination Plot



30-05-04 Combination Plot




Borehole 30-05-04
Depth (feet)
0
10
20
30
40
50
60
70
80
90
100
110
120
Date (year)
1975
1980
1985
1990
1995
Analysis by: Three Rivers Scientific


Borehole 30-05-04
Depth: 0-8 ft
fixed background (15-38 ft)
Cs-137 Decay Line
Grade Thickness Product (feet*c/s)
Date (Year)
Average Background (c/s)
Frequency Clean (%)
Analysis by: Three Rivers Scientific
07/25/96
Gamma (c/s)
Depth (ft)
01/10/75
Gamma (c/s)
(Narrow Lim)
(Wide Lim)
Depth (ft)

Borehole 30-05-05

Contamination (Cs-137) from 0-25 feet is Tank Farm Activity. Contamination (Cs-137) from 40-56 feet is Unstable. Contamination (Cs-137 & Co-60) from 56-84 feet is Undetermined.

Grade thickness product over 0 to 25 feet is erratic and highly variable from 1975 to 1986, indicative of tank farm activity. Since 1986, the grade thickness product is consistent with the decay from Cs-137 (HPGe identified).

Grade thickness product over 40 to 56 feet is not consistent with Cs-137 (HPGe identified) decay. This interval has low gross gamma compared to the zone just below from 56 to 84 feet. Depth control errors before 1986 make a classification over the time period 1975 to 1984 unclear; however, since 1986 the grade thickness product is still not consistent with Cs-137 decay. From 1994 to 1997 the apparent match of grade thickness product and Cs-137 decay does not occur over a statistically significant period to make a classification of stable, thus the category is unstable.

Grade thickness product over 56 to 84 feet is undetermined. The gross gamma over this interval may be influenced by the gross gamma from 40 to 56 feet coupled with depth control error prior to 1986, thus the deviation prior to 1986 has unknown cause. From 1986 to 1994 the grade thickness product is consistent with a least square fit of Cs-137 and Co-60 (HPGe identified) decay. The resulting least square fit ratio of gross gamma from Co-60 to gross gamma from Cs-137 as of 7/25/1996 is 0.065.

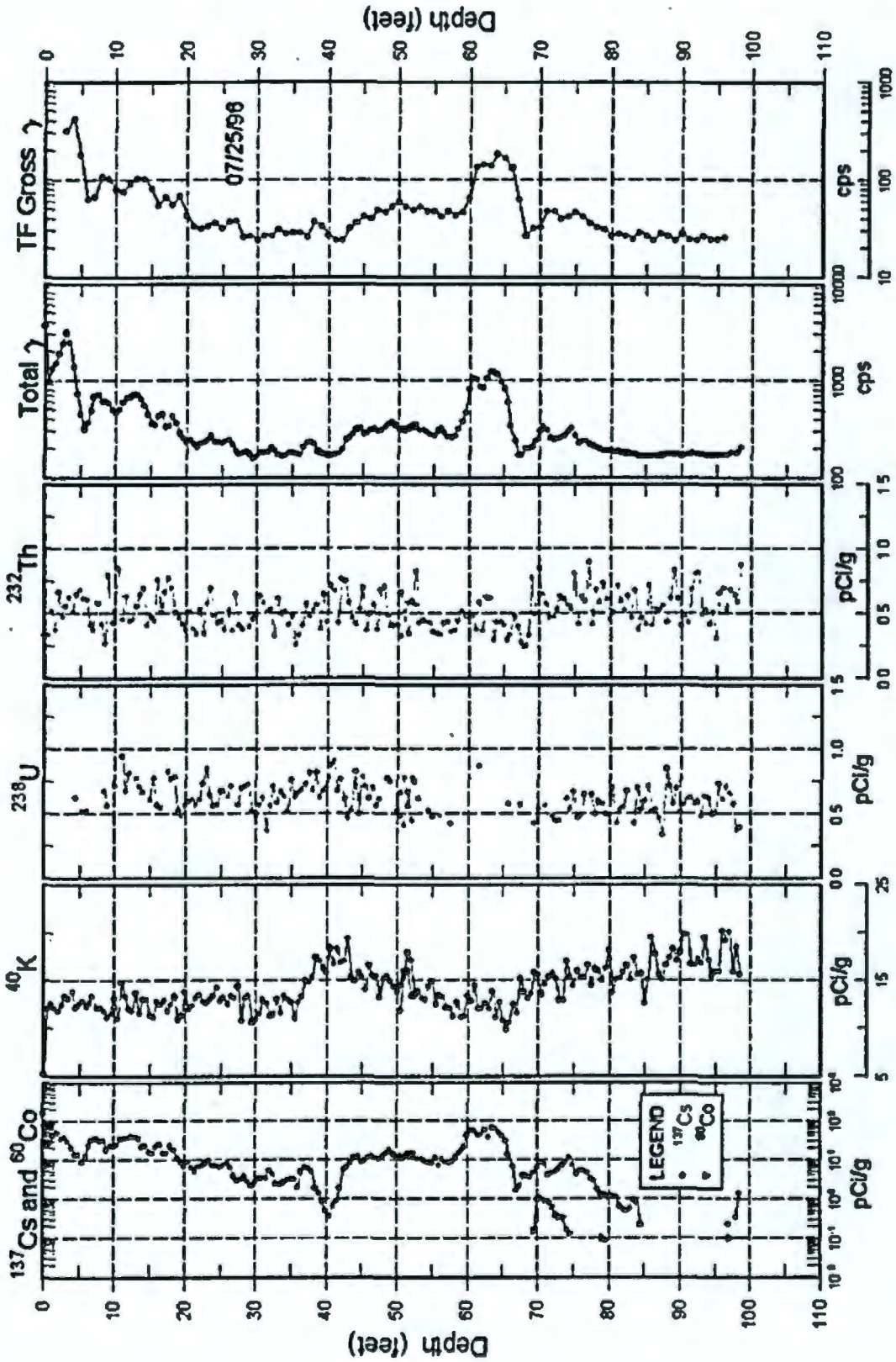
Gross Gamma Survey Information

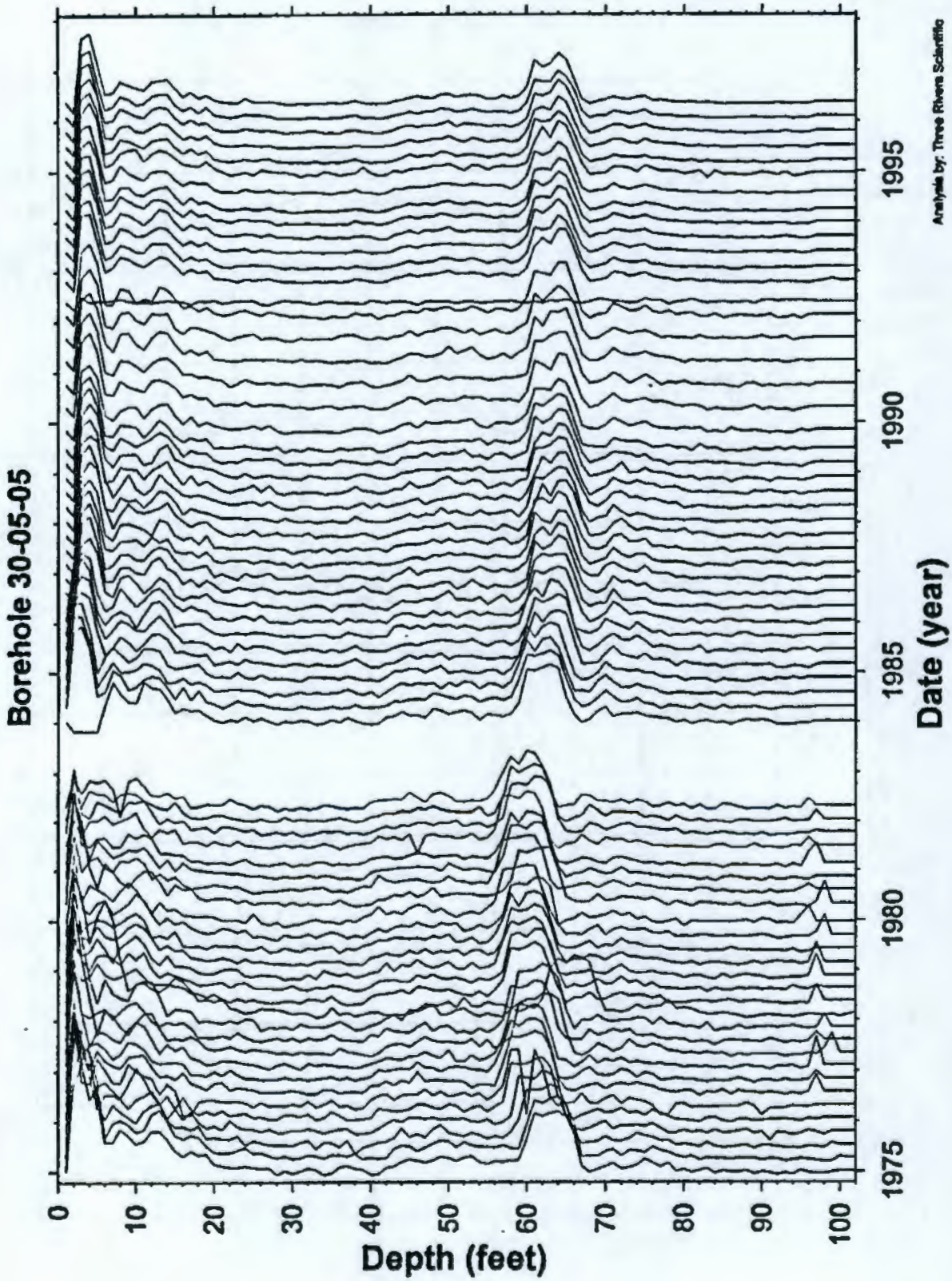
Probe Type Processed :	04: NaI
Other Probe Types :	03: Neutron
Survey Depth :	100 ft
First Survey Date :	1/10/1975
Last Survey Date :	7/25/1996
Number Surveys Processed :	526

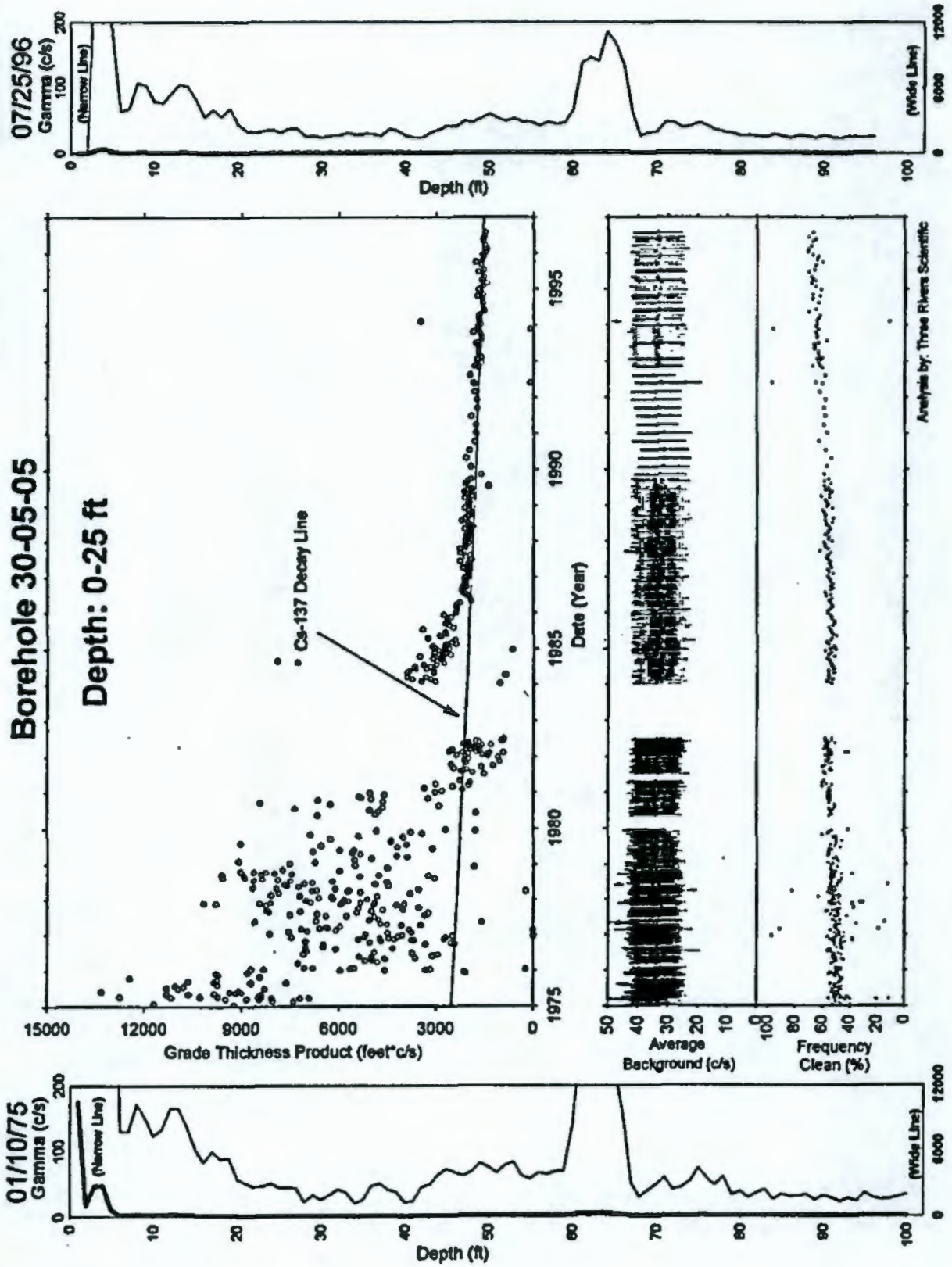
Analysis Notes

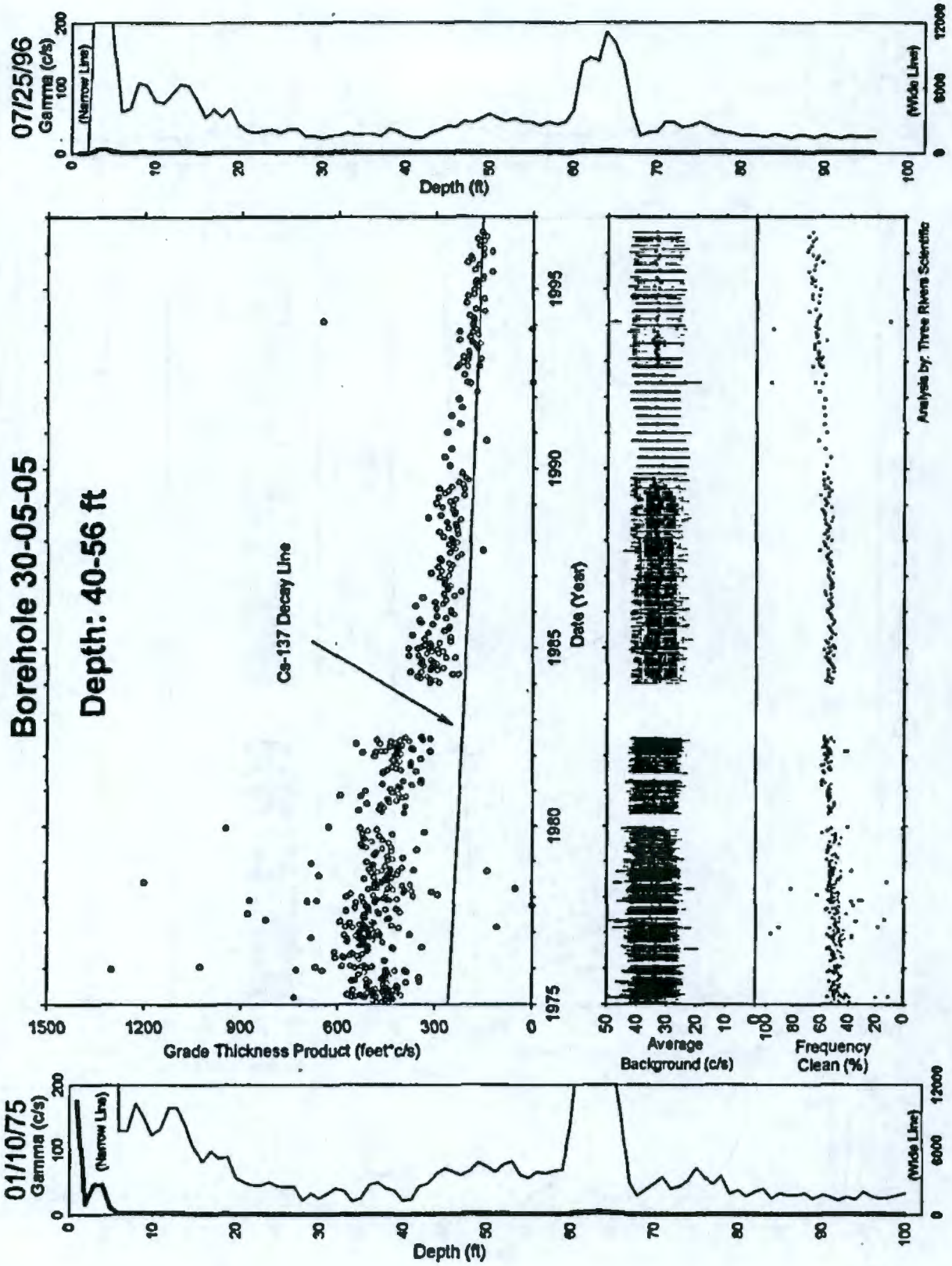
Method Used to Compute Background :	Threshold 0<val<50
Depth(s) where Contamination Identified in Gross Gamma Surveys :	0-25 ft Tank Farm Activity 40-56 ft Unstable 56-84 ft Undetermined
Analyst Name :	R.R. Randall
Company Name :	Three Rivers Scientific

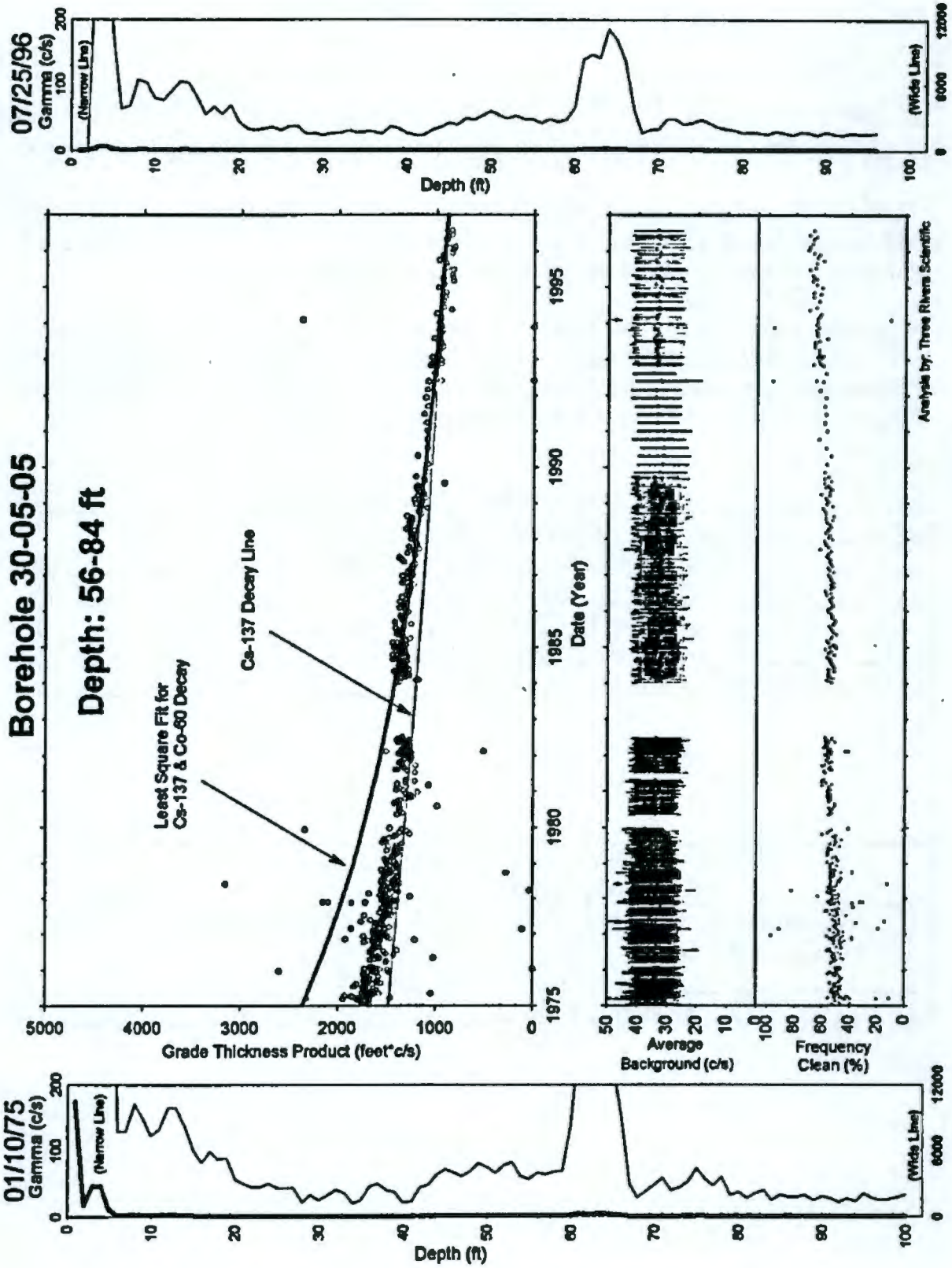
30-05-05 Combination Plot




Borehole 30-05-05
Depth (feet)
0
10
20
30
40
50
60
70
80
90
100
Date (year)
1975
1980
1985
1990
1995
Analysis by: Three Rivers Scientific


07/25/96
Gamma (c/s)
(Narrow Line)
(Wide Line)
Depth (ft)
Borehole 30-05-05
Depth: 0-25 ft
Cs-137 Decay Line
Grade Thickness Product (feet*c/s)
Date (Year)
Average Background (c/s)
Frequency Clean (%)
Analysis by: Three Rivers Scientific
01/10/75
Gamma (c/s)
(Narrow Line)
(Wide Line)
Depth (ft)


07/25/96
Gamma (c/s)
(Narrow Line)
(Wide Line)
Depth (ft)
Borehole 30-05-05
Depth: 40-56 ft
Cs-137 Decay Line
Grade Thickness Product (feet*c/s)
Date (Year)
Average Background (c/s)
Frequency Clean (%)
Analysis by: Three Rivers Scientific
01/10/75
Gamma (c/s)
(Narrow Line)
(Wide Line)
Depth (ft)


07/25/96
Gamma (c/s)
(Narrow Line)
(Wide Line)
Depth (ft)
Borehole 30-05-05
Depth: 56-84 ft
Least Square Fit for
Cs-137 & Co-60 Decay
Cs-137 Decay Line
Grade Thickness Product (feet*c/s)
Date (Year)
Average
Background (c/s)
Frequency
Clean (%)
Analysis by: Three Rivers Scientific
01/10/75
Gamma (c/s)
(Narrow Line)
(Wide Line)
Depth (ft)

Borehole 30-05-06

Contamination (Cs-137) from 0-15 feet is Tank Farm Activity. Contamination (Cs-137 & Ru-106) from 40-53 feet is Stable.

Grade thickness product over 0 to 15 feet is erratic and highly variable from 1975 to 1986, indicative of tank farm activity. Since 1986, the grade thickness product is consistent with the decay from Cs-137 (HPGe identified).

The grade thickness product over 40 to 53 feet is decreasing at a rate consistent with the least square fit of Cs-137 (HPGe identified) and Ru-106 (hypothesis). The resulting least square ratio of gross gamma from Cs-137 to gross gamma from Ru-106 as of 1/10/1975 is 0.135. The zone category is stable.

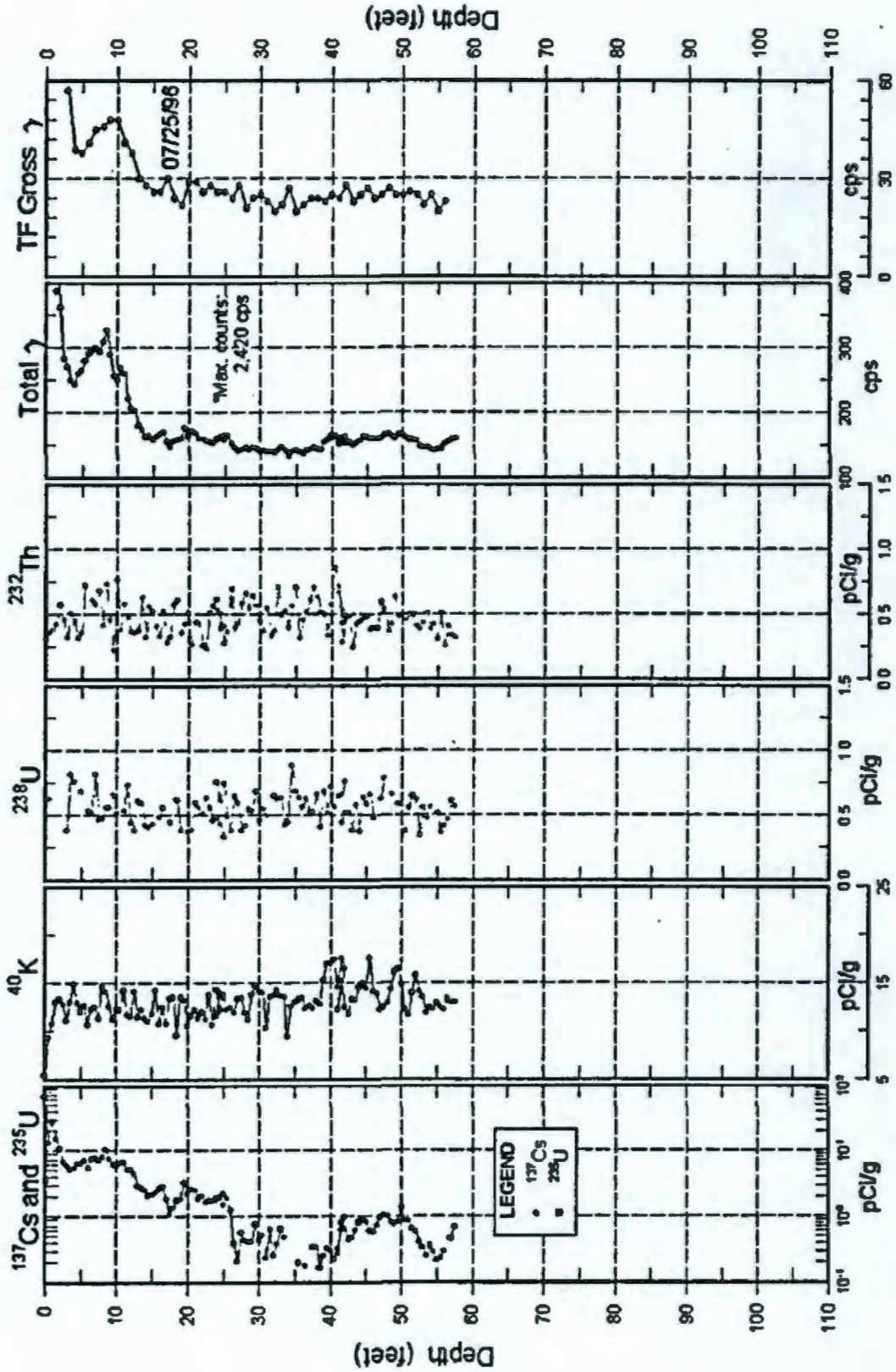
Gross Gamma Survey Information

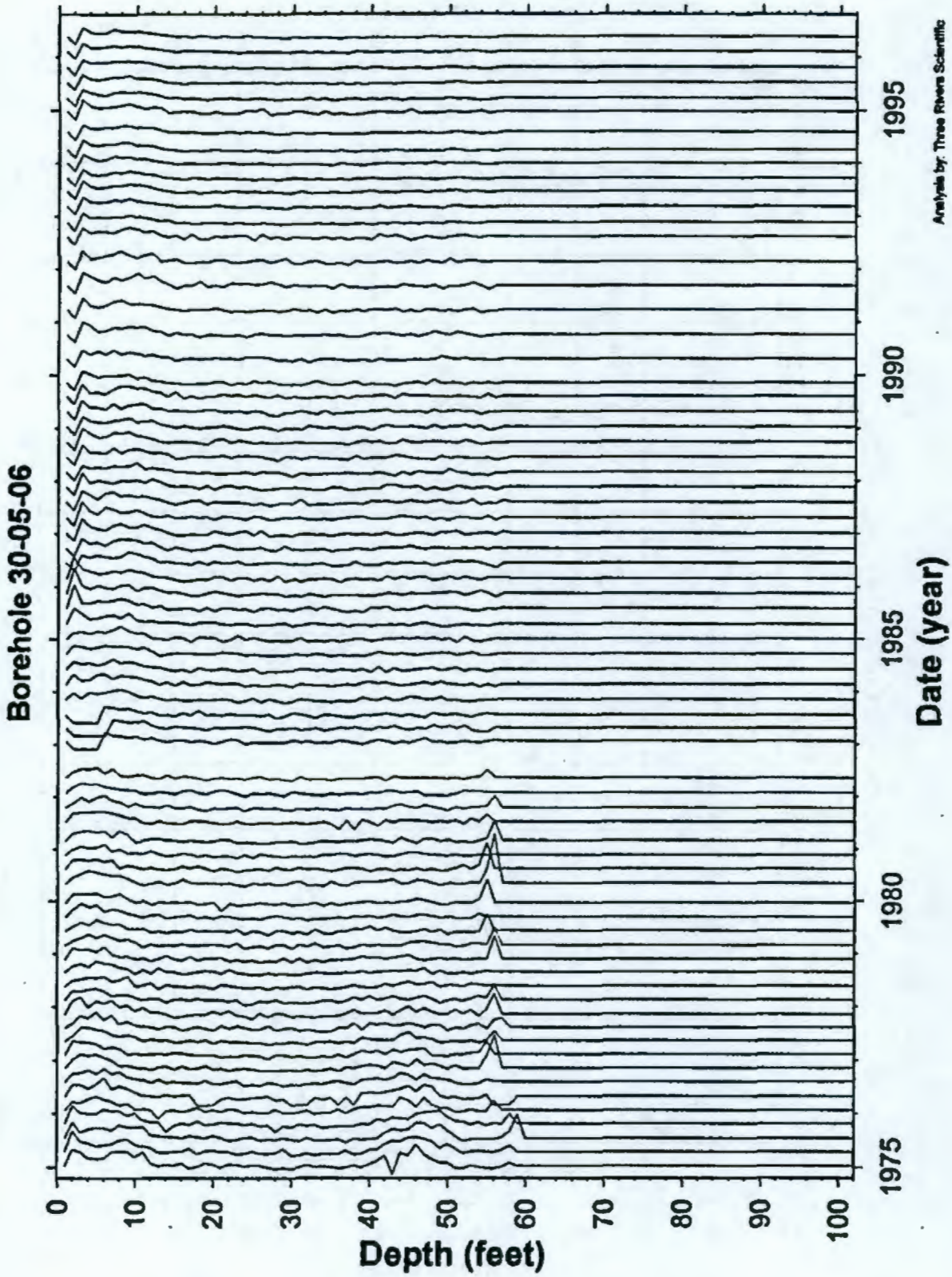
Probe Type Processed :	04: NaI
Other Probe Types :	03: Neutron
Survey Depth :	60 ft
First Survey Date :	1/10/1975
Last Survey Date :	7/25/1996
Number Surveys Processed :	537

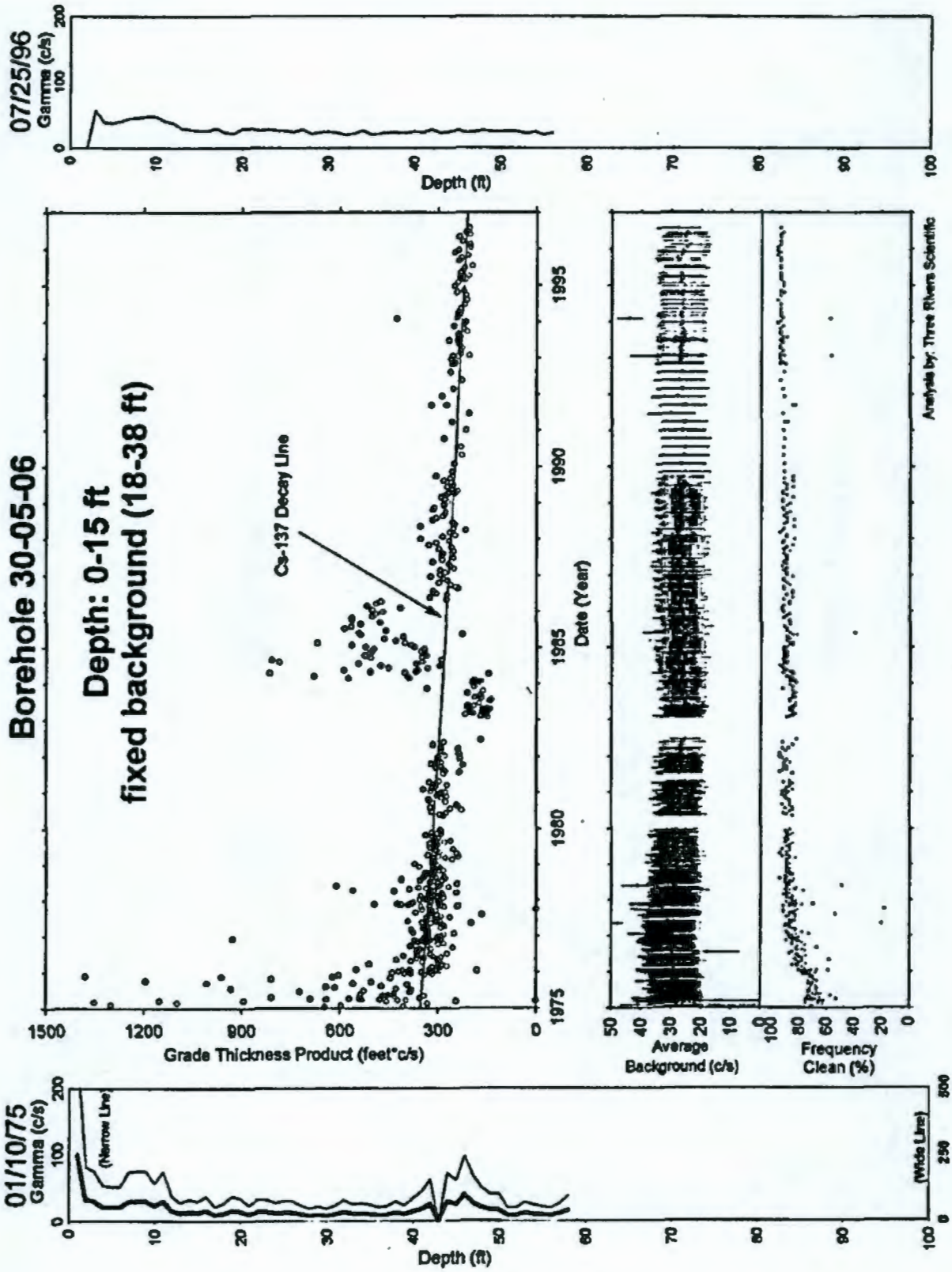
Analysis Notes

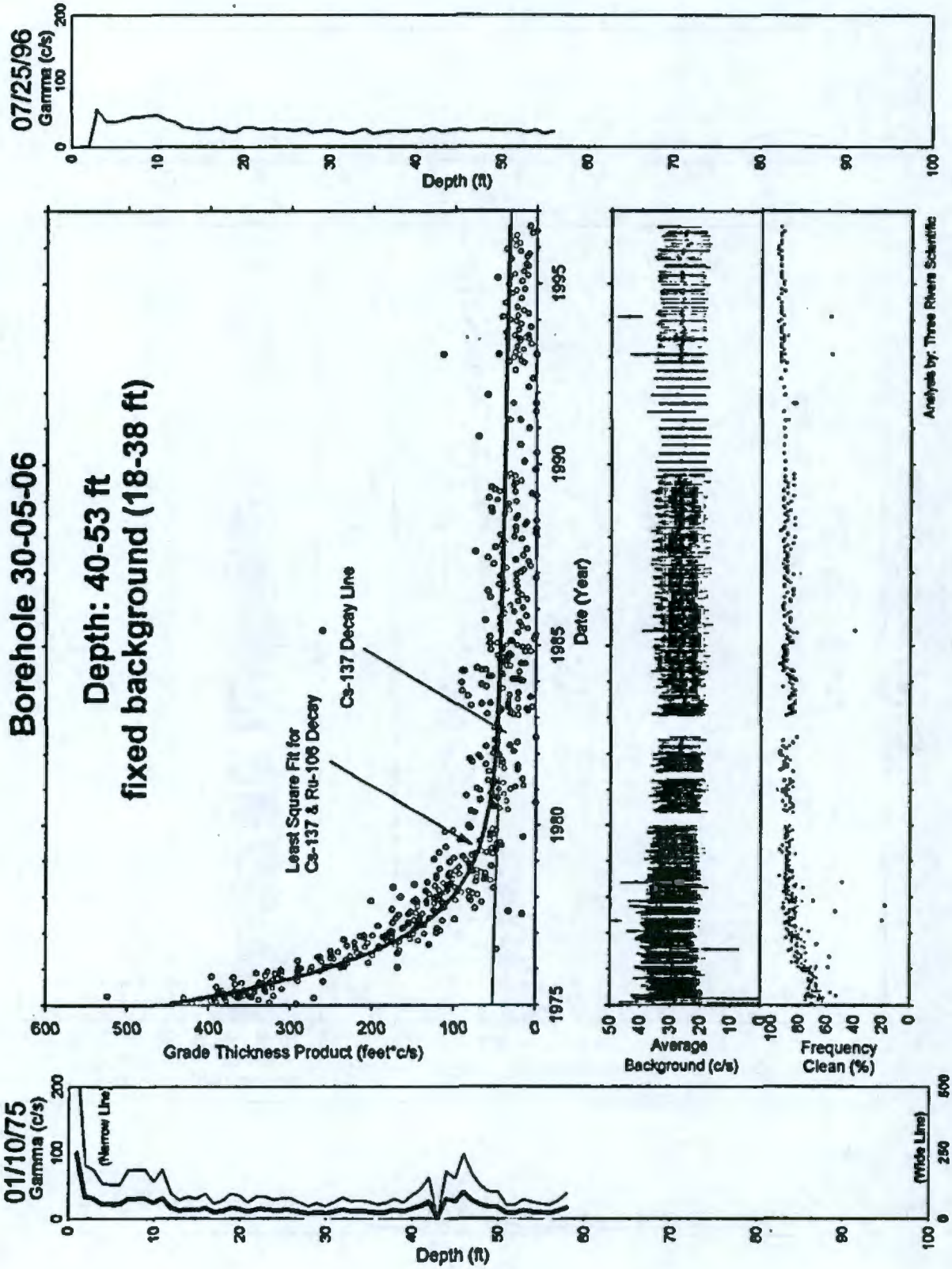
Method Used to Compute Background :	Fixed background (18-38 ft)
Depth(s) where Contamination Identified in Gross Gamma Surveys :	0-15 ft Tank Farm Activity 40-53 ft Stable
Analyst Name :	R.R. Randall
Company Name :	Three Rivers Scientific

30-05-06 Combination Plot




Borehole 30-05-06
Depth (feet)
0
10
20
30
40
50
60
70
80
90
100
Date (year)
1975
1980
1985
1990
1995
Analysis by: Three Rivers Scientific


Borehole 30-05-06
Depth: 0-15 ft
fixed background (18-38 ft)
Cs-137 Decay Line
Grade Thickness Product (feet*c/s)
Date (Year)
Average Background (c/s)
Frequency Clean (%)
Analysis by: Three Rivers Scientific
07/25/96
Gamma (c/s)
Depth (ft)
01/10/75
Gamma (c/s)
(Narrow Line)
(Wide Line)
Depth (ft)


Borehole 30-05-06
Depth: 40-53 ft
fixed background (18-38 ft)
07/25/96
Gamma (c/s)
Depth (ft)
Least Square Fit for
Cs-137 & Ru-106 Decay
Cs-137 Decay Line
Grade Thickness Product (feet*c/s)
Date (Year)
Average
Background (c/s)
Frequency
Clean (%)
Analysis by: Three Rivers Scientific
01/10/75
Gamma (c/s)
(Narrow Line)
(Wide Line)
Depth (ft)

Borehole 30-05-07

Contamination (Cs-137) from 30-45 feet is Stable. Contamination (Cs-137) from 45-66 feet is Undetermined.

Grade thickness product over 30 to 45 feet is decreasing consistent with Cs-137 (HPGe identified) decay from 1983 through 1997. Indication of difference from 1980 through 1983, for the Red GM probe data is a result of equipment differences before 1984. The zone category is stable.

The HPGe log data was analyzed and Eu-154 was reported in this interval (30-45 feet). This identification may be in error due to the following observations. At 32.5 feet a single observation of Eu-154 is quoted at near 100 pCi/g, with no detection 6 inches above or below this depth. The gamma detector in the borehole would see a single hot spot 6 inches away from the most intense depth.

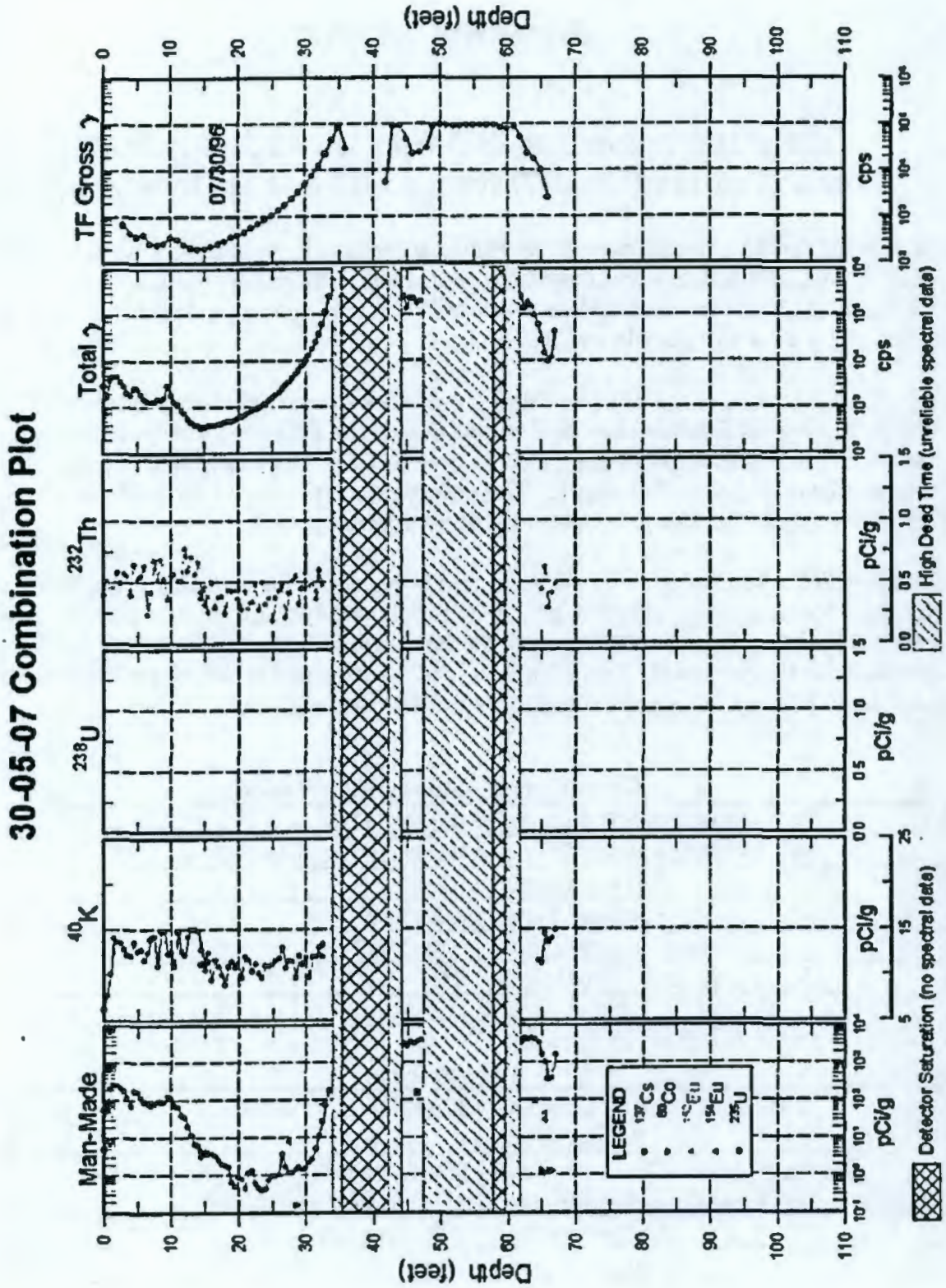
Grade thickness product over 45 to 66 feet is not valid for Red GM probe data prior to 1984. From 1984 to 1988 the grade thickness product does not match the HPGe identified decay; however, the measurement error is large for the grade thickness product for this interval. From 1988 to 1997, the grade thickness product matches the Cs-137 decay. The zone category is undetermined.

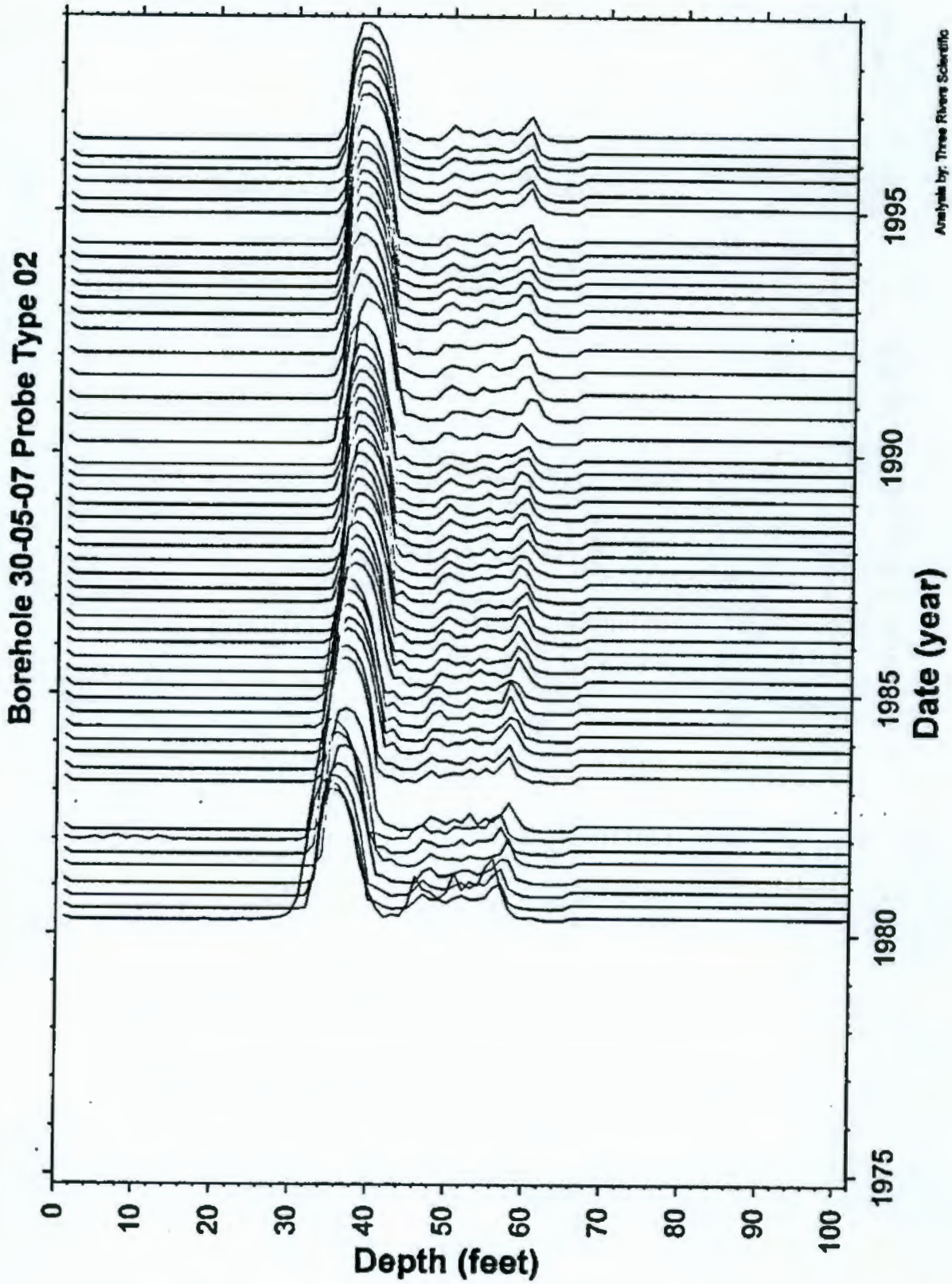
Gross Gamma Survey Information

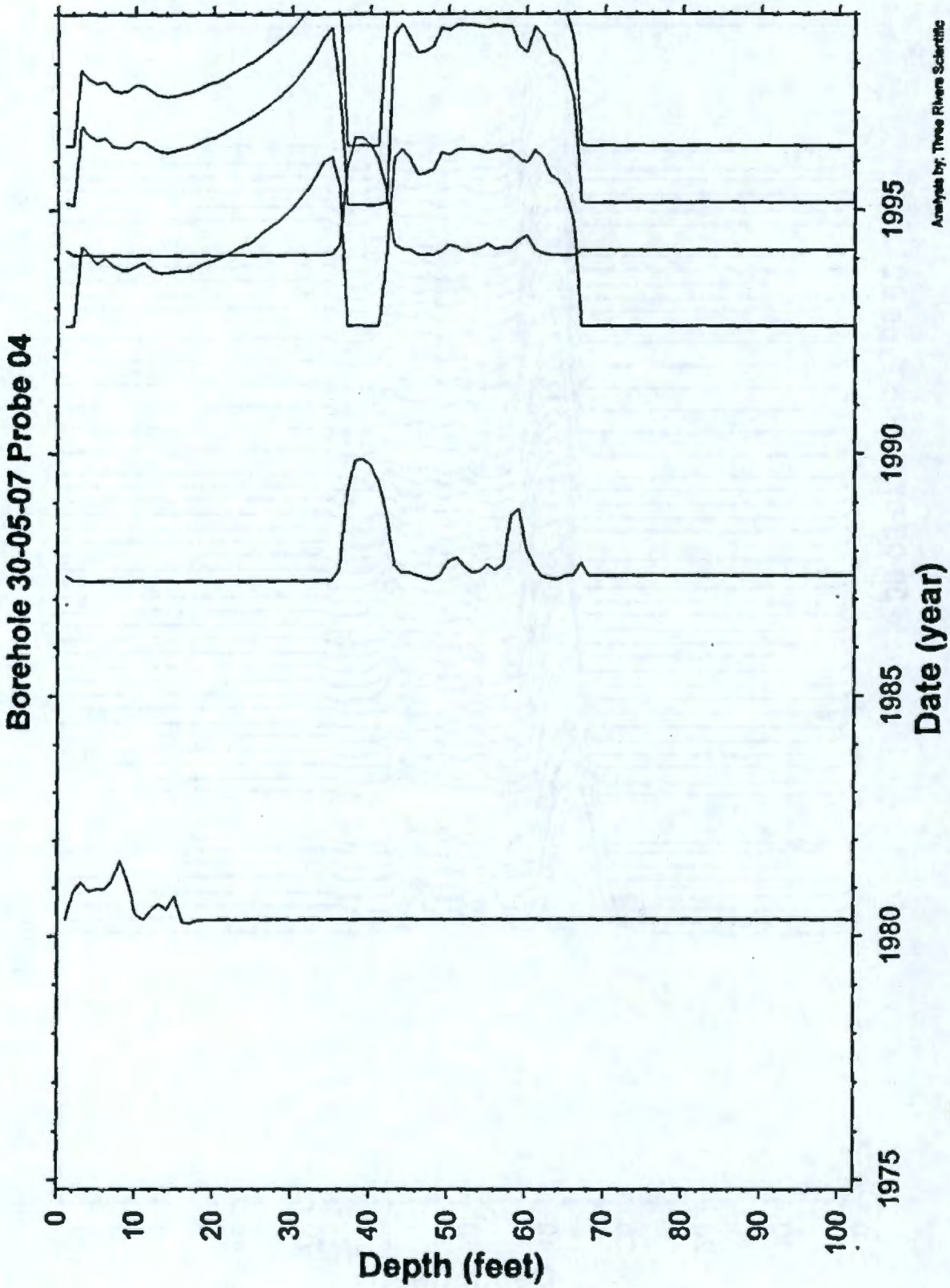
Probe Type Processed :	02: Red GM
Other Probe Types :	04: NaI; 03:Neutron
Survey Depth :	67 ft
First Survey Date :	5/5/1980
Last Survey Date :	7/25/1996
Number Surveys Processed :	319

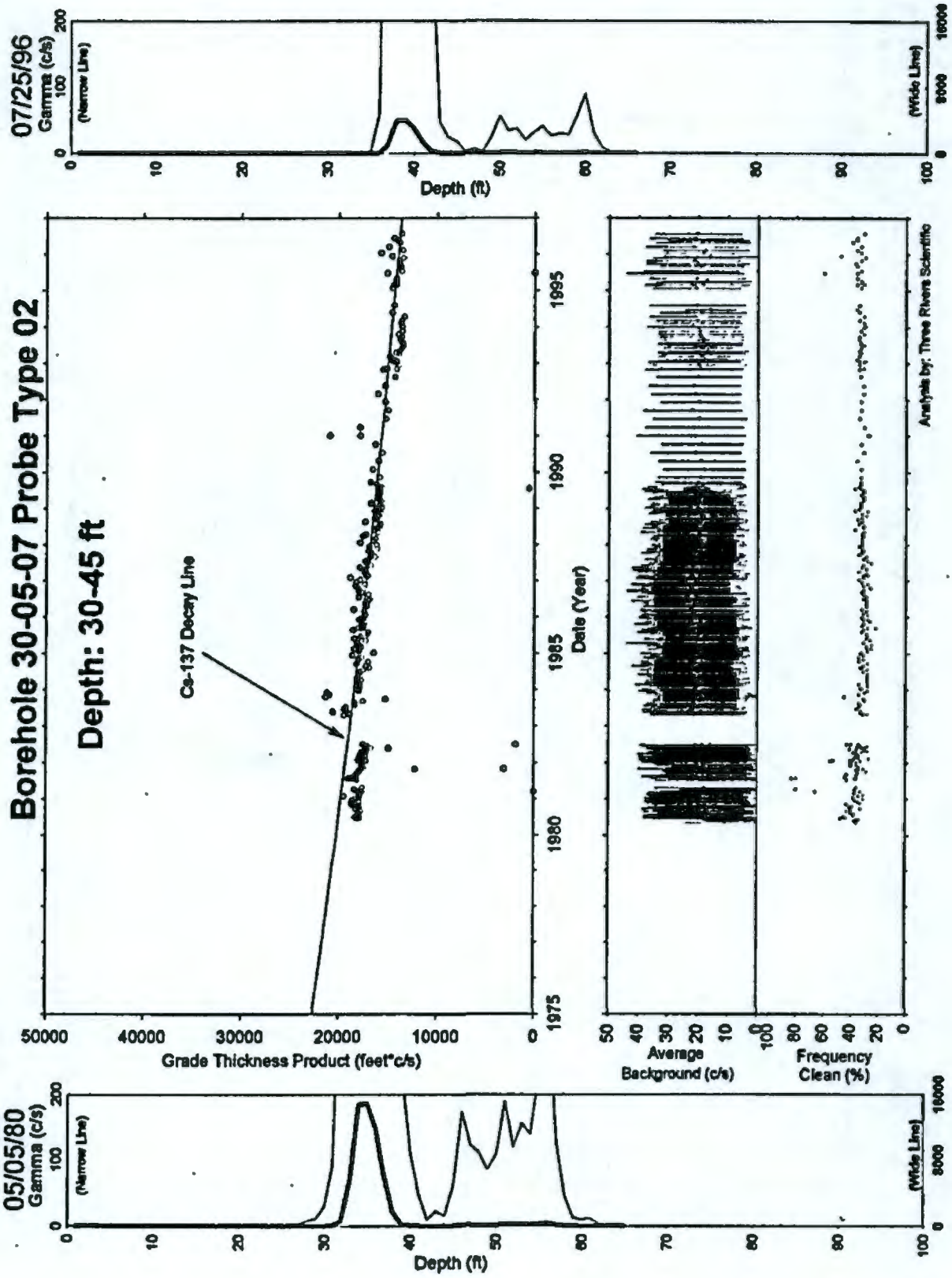
Analysis Notes

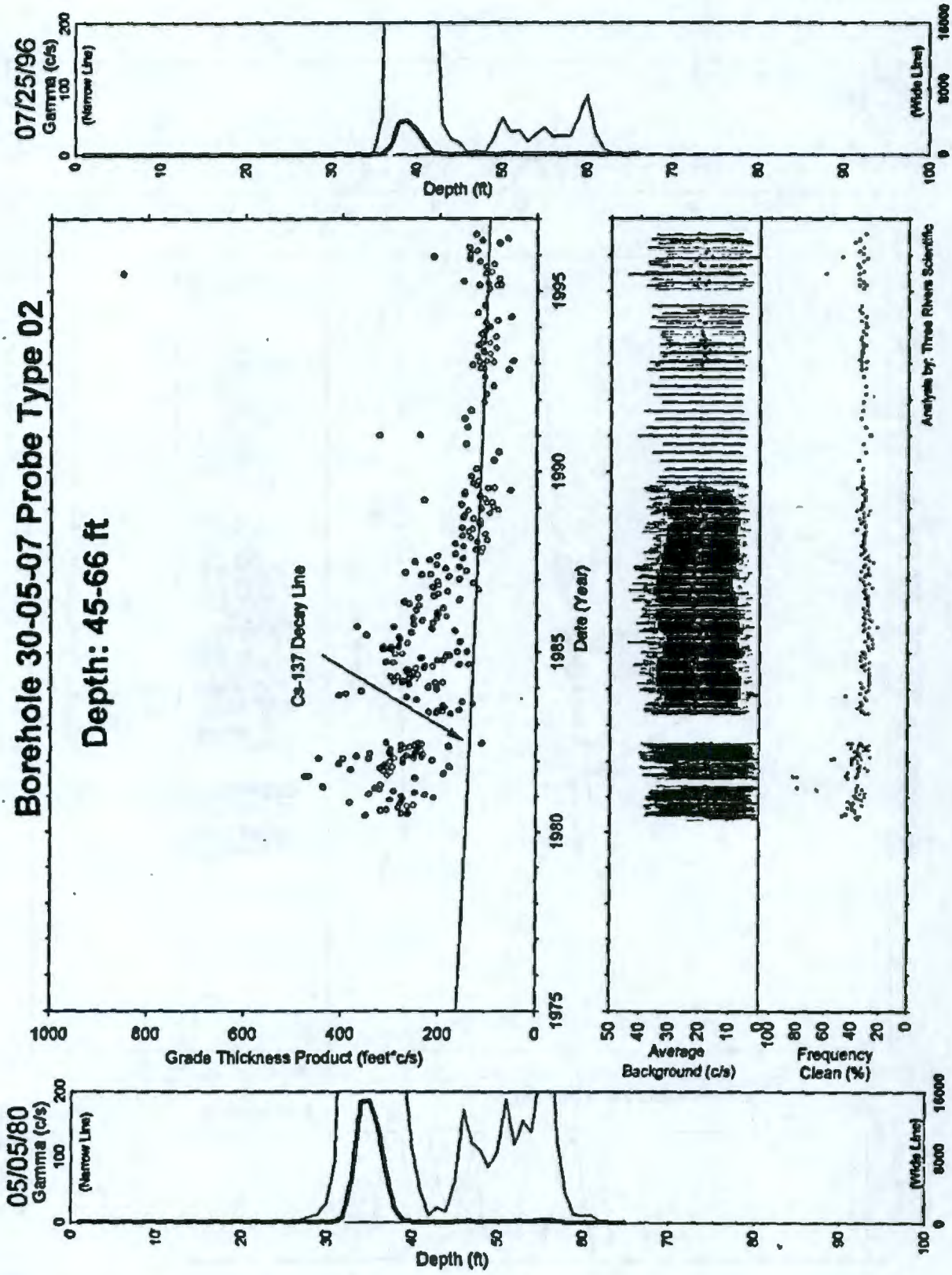
Method Used to Compute Background :	Threshold 0<val<50
Depth(s) where Contamination Identified in Gross Gamma Surveys :	20-45 ft Stable 45-66 ft Undetermined
Analyst Name :	R.R. Randall
Company Name :	Three Rivers Scientific


30-05-07 Combination Plot
Man-Made
^{40}K
^{238}U
^{232}Th
Total γ
TF Gross γ
07/30/96
Depth (feet)
pCi/g
cps
LEGEND
^{137}Cs
^{60}Co
^{154}Eu
^{235}U
Detector Saturation (no spectral data)
High Dead Time (unreliable spectral data)


Borehole 30-05-07 Probe Type 02
Depth (feet)
0
10
20
30
40
50
60
70
80
90
100
Date (year)
1975
1980
1985
1990
1995
Analysis by: Three Rivers Scientific


Borehole 30-05-07 Probe 04
Depth (feet)
0
10
20
30
40
50
60
70
80
90
100
Date (year)
1975
1980
1985
1990
1995
Analysis by: Three Rivers Scientific


Borehole 30-05-07 Probe Type 02
Depth: 30-45 ft
07/25/96
Gamma (c/s)
(Narrow Line)
(Wide Line)
Depth (ft)
Cs-137 Decay Line
Grade Thickness Product (feet*c/s)
Date (Year)
Average Background (c/s)
Frequency Clean (%)
Analysis by: Three Rivers Scientific
05/05/80
Gamma (c/s)
(Narrow Line)
(Wide Line)
Depth (ft)


Borehole 30-05-07 Probe Type 02
Depth: 45-66 ft
07/25/96
Gamma (c/s)
(Narrow Line)
(Wide Line)
Depth (ft)
Cs-137 Decay Line
Grade Thickness Product (feet*c/s)
Date (Year)
Average Background (c/s)
Frequency Clean (%)
Analysis by: Three Rivers Scientific
05/05/80
Gamma (c/s)
(Narrow Line)
(Wide Line)
Depth (ft)

Borehole 30-05-08

Contamination (Cs-137) from 0-11 feet is Tank Farm Activity. Contamination (Cs-137, Eu-154, & Co-60) from 11-26 feet is Undetermined. Contamination (Cs-137 & Co-60) from 26-53 feet is Undetermined.

Grade thickness product over 0 to 11 feet is erratic and highly variable from 1975 to 1986, indicative of tank farm activity. Since 1986, the grade thickness product is consistent with the decay from Cs-137 (HPGe identified).

Grade thickness product over 11 to 26 feet is affected by depth control errors prior to 1986, which clouds classification with a match of Cs-137, Eu-154, and Co-60 (all HPGe identified). Since 1986, there is consistent match of the grade thickness product and the least square fit for the three radionuclides. The least square fit ratio of gross contribution from Cs-137:Eu-154:Co-60 is 2950:5201:50 as of 12/10/99. The classification is undetermined due to interference before 1986.

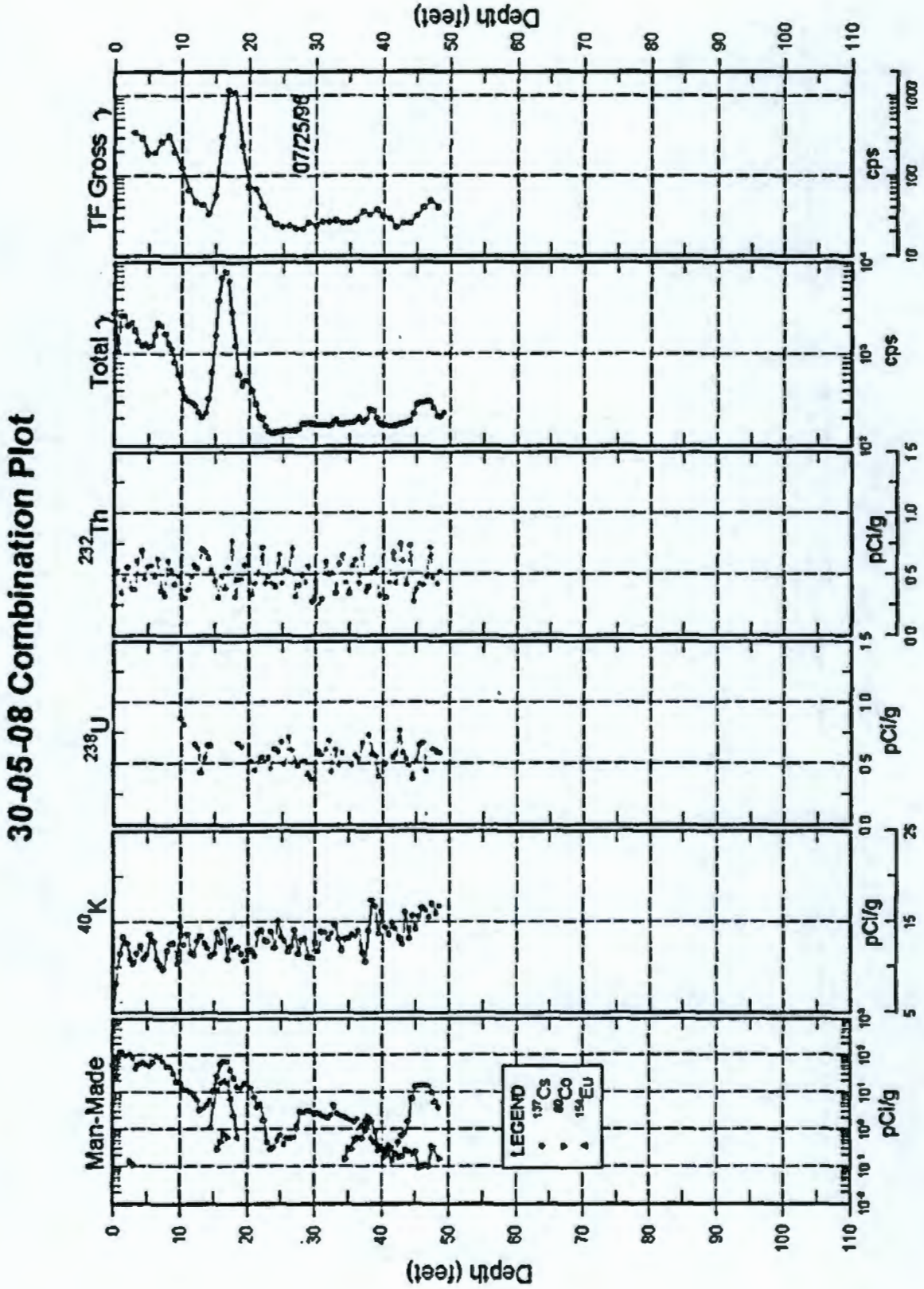
Grade thickness product over 26 to 53 feet is complex, thus the normal plot presentation for the grade thickness product and a second plot in semi-log format. The grade thickness product from 1975 to 1995 shows a conventional two component exponential decay with one rapid and the other slower. However, the decay rates of the observed grade thickness product are not representative of the radionuclides HPGe identified of Cs-137 and Co-60. The Co-60 decay rate is shown in the red line for reference and clearly is much slower than the observed grade thickness product from about 1982 to 1995. From 1982 to 1995, the grade thickness product matches a decay half-life of 2.6 years. Note that Na-22 has a half-life of 2.6 years, but this isotope was not HPGe identified. A rapid decay radionuclide may go undetected by the HPGe logged in 1997 (old RLS HPGe logged in 1993) due to decay to low levels, while a historical gross gamma may identify such rapid decay. Ru-106 is one example of this effect. Alternatively, the Co-60 HPGe identified may have moved out of this zone with an exponential character that seems to match 2.6 year half-life. Given this level of complication and the lack of any reason to expect Na-22, the zone is classified undetermined.

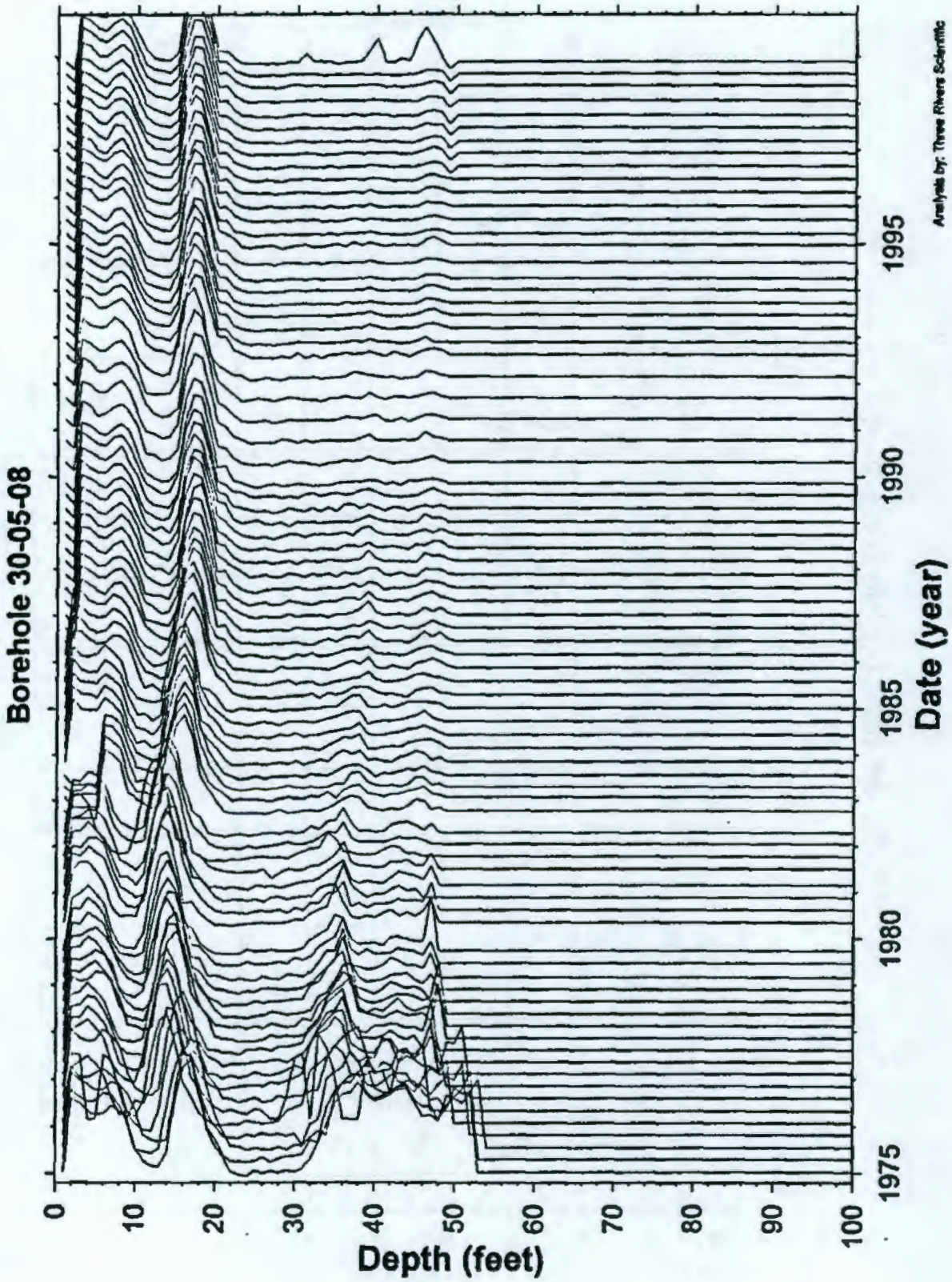
Gross Gamma Survey Information

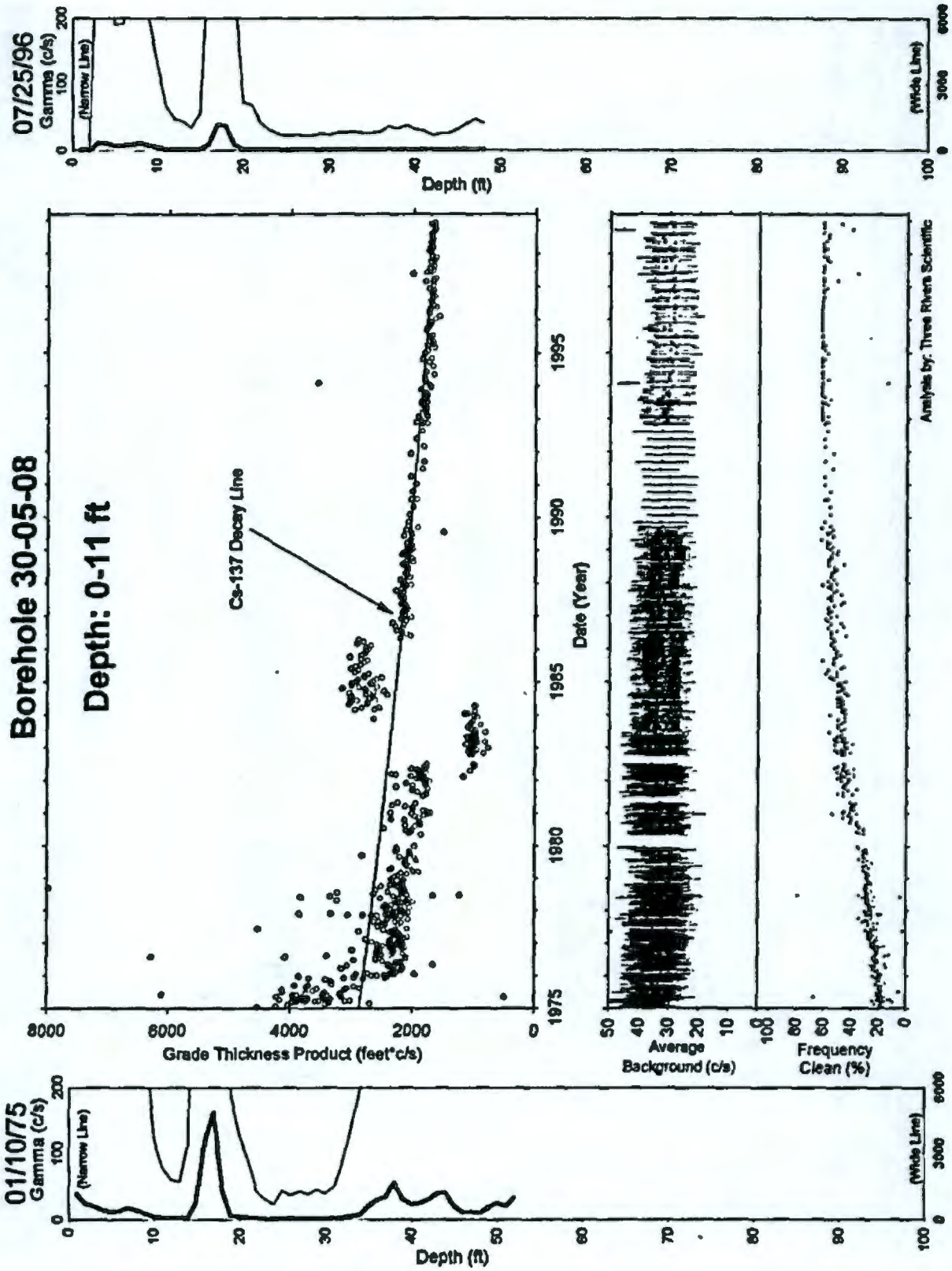
Probe Type Processed :	04: NaI
Other Probe Types :	03: Neutron
Survey Depth :	50 ft
First Survey Date :	1/10/1975
Last Survey Date :	12/10/1998
Number Surveys Processed :	594

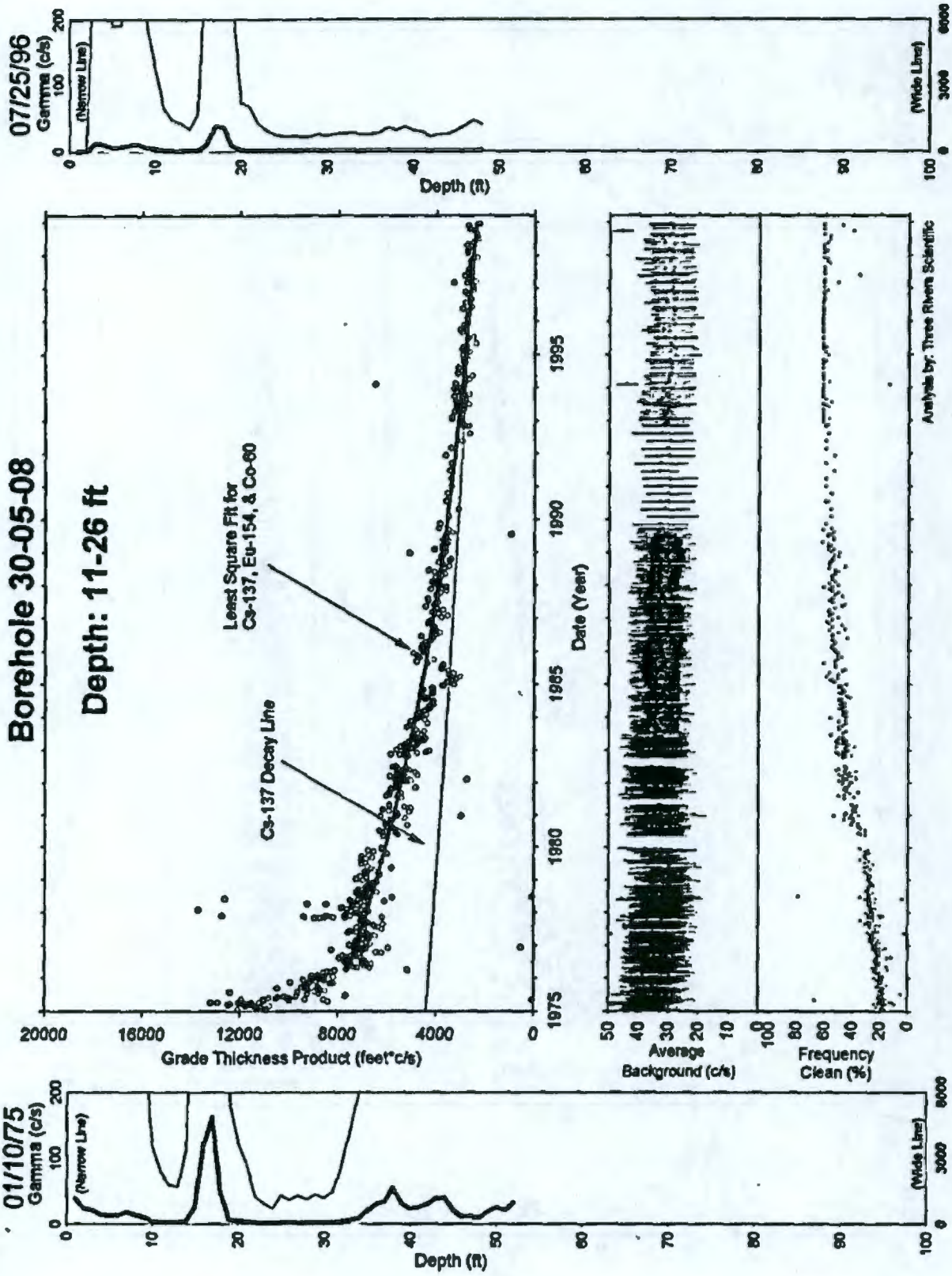
Analysis Notes

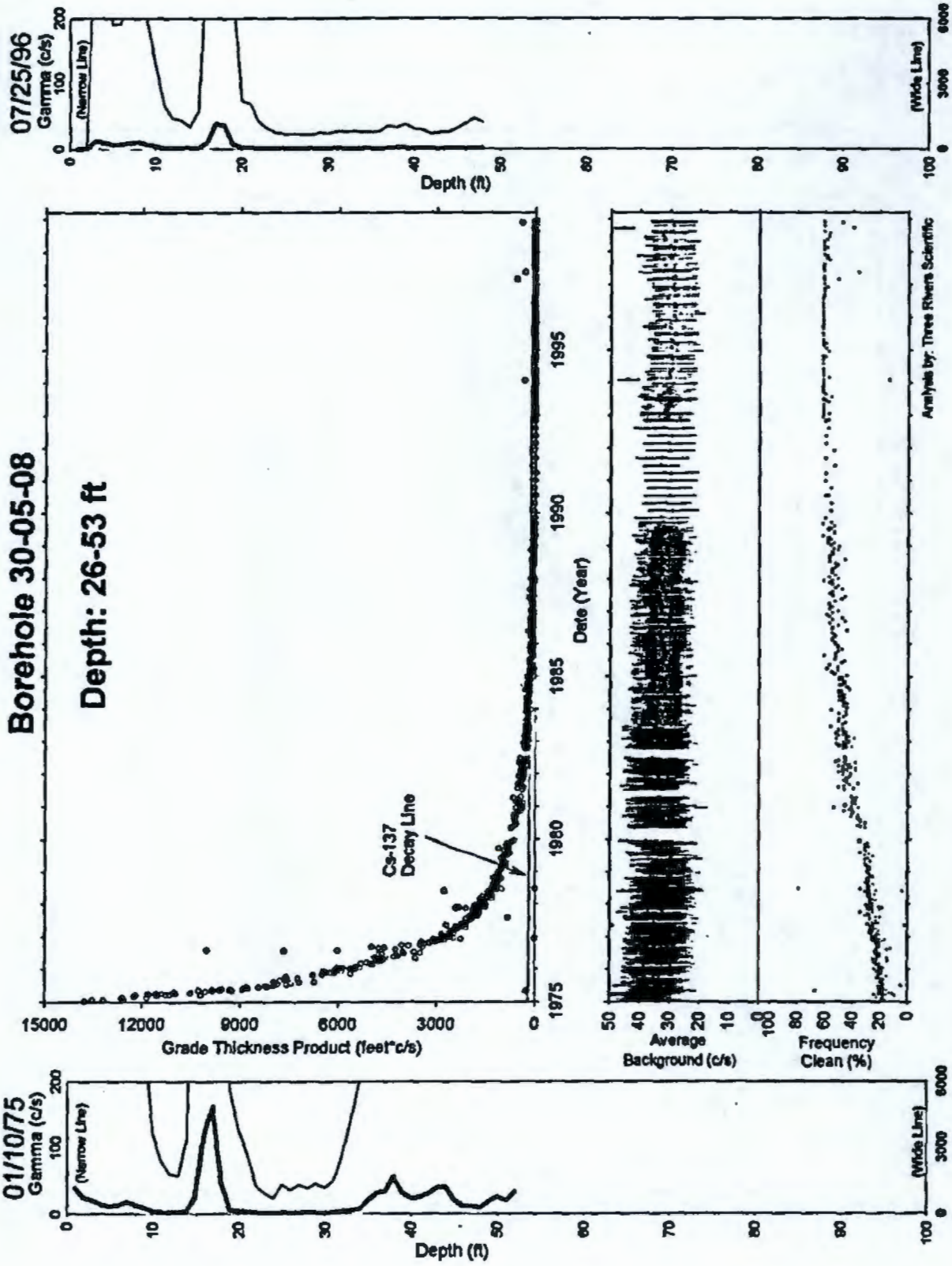
Method Used to Compute Background :	Threshold 0<val<50
Depth(s) where Contamination Identified in Gross Gamma Surveys :	0-11 ft Tank Farm Activity 11-26 & 26-53 ft Undetermined
Analyst Name :	R.R. Randall
Company Name :	Three Rivers Scientific

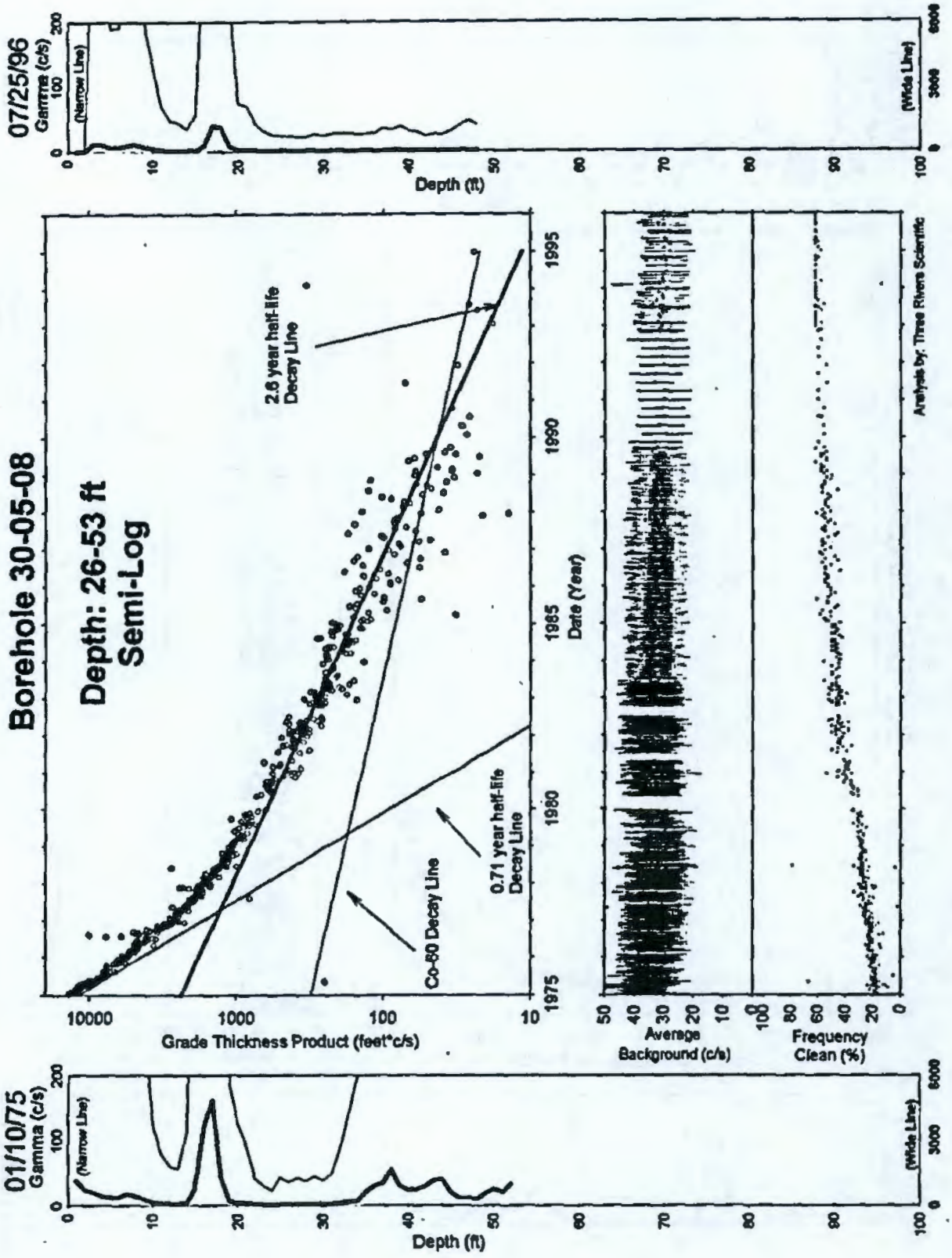

30-05-08 Combination Plot
Man-Made
^{40}K
^{238}U
^{232}Th
Total γ
TF Gross γ
07/25/96
LEGEND
^{137}Cs
^{60}Co
^{154}Eu
pCi/g
cps
Depth (feet)


Borehole 30-05-08
Depth (feet)
0
10
20
30
40
50
60
70
80
90
100
Date (year)
1975
1980
1985
1990
1995
Analysis by: Three Rivers Scientific


07/25/96
Gamma (c/s)
(Narrow Line)
(Wide Line)
Depth (ft)
Borehole 30-05-08
Depth: 0-11 ft
Cs-137 Decay Line
Grade Thickness Product (feet*c/s)
Date (Year)
Average Background (c/s)
Frequency Clean (%)
Analysis by: Three Rivers Scientific
01/10/75
Gamma (c/s)
(Narrow Line)
(Wide Line)
Depth (ft)


07/25/96
Gamma (c/s)
(Narrow Line)
(Wide Line)
Depth (ft)
Borehole 30-05-08
Depth: 11-26 ft
Least Square Fit for
Cs-137, Eu-154, & Co-60
Cs-137 Decay Line
Grade Thickness Product (feet*c/s)
Date (Year)
Average
Background (c/s)
Frequency
Clean (%)
Analysis by: Three Rivers Scientific
01/10/75
Gamma (c/s)
(Narrow Line)
(Wide Line)
Depth (ft)


07/25/96
Gamma (c/s)
(Narrow Line)
(Wide Line)
Depth (ft)
Borehole 30-05-08
Depth: 26-53 ft
Cs-137
Decay Line
Grade Thickness Product (feet*c/s)
Date (Year)
Average
Background (c/s)
Frequency
Clean (%)
Analysis by: Three Rivers Scientific
01/10/75
Gamma (c/s)
(Narrow Line)
(Wide Line)
Depth (ft)


07/25/96
Gamma (c/s)
(Narrow Line)
(Wide Line)
Depth (ft)
Borehole 30-05-08
Depth: 26-53 ft
Semi-Log
2.6 year half-life
Decay Line
0.71 year half-life
Decay Line
Co-60 Decay Line
Grade Thickness Product (feet*c/s)
Date (Year)
Average
Background (c/s)
Frequency
Clean (%)
Analysis by: Three Rivers Scientific
01/10/75
Gamma (c/s)
(Narrow Line)
(Wide Line)
Depth (ft)

Borehole 30-05-09

Contamination (Cs-137) from 0-8 feet is Tank Farm Activity.

Grade thickness product over 0 to 8 feet is erratic and highly variable from 1975 to 1986, indicative of tank farm activity. Since 1986, the grade thickness product is consistent with the decay from Cs-137 (HPGe identified).

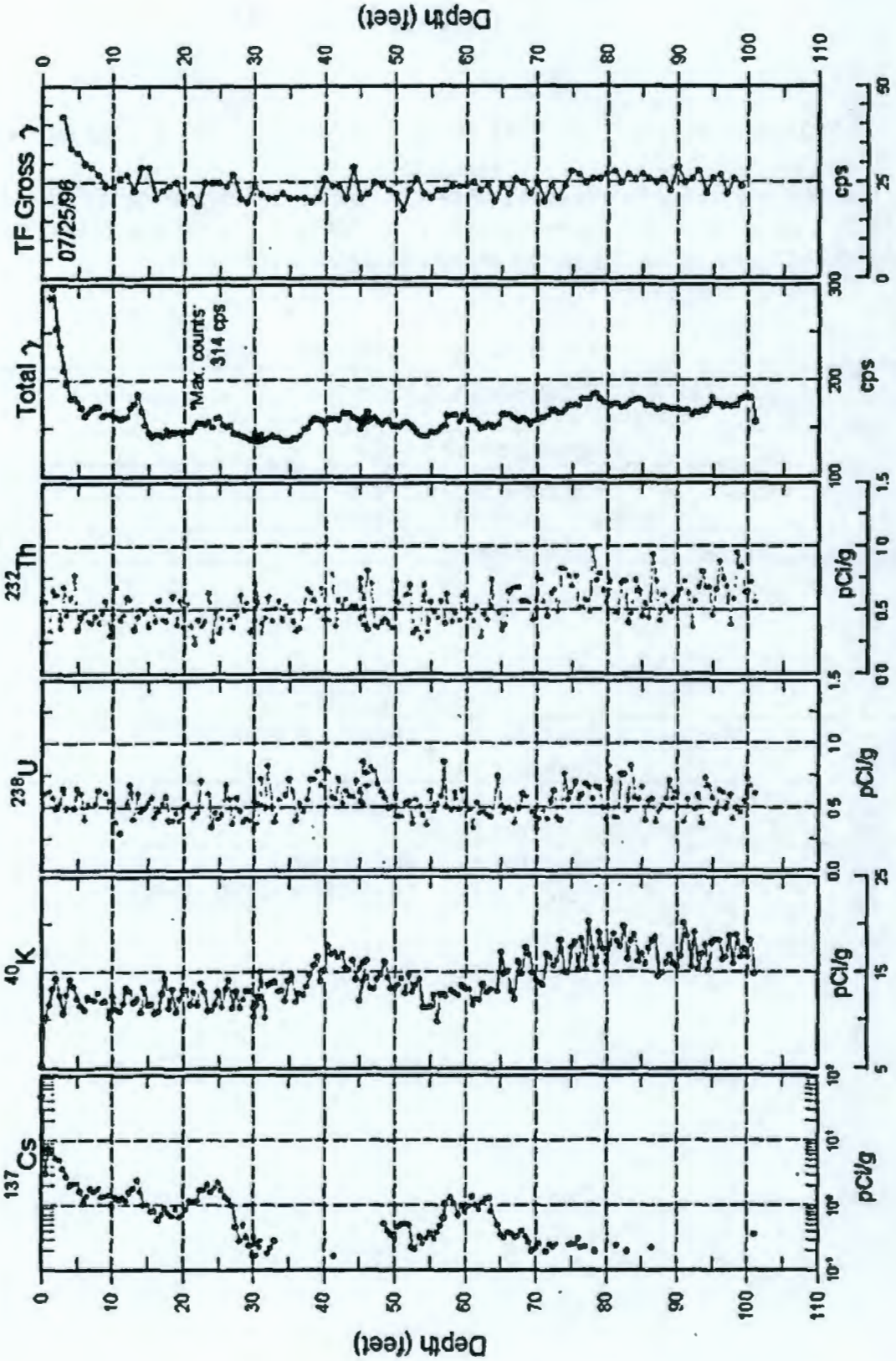
Gross Gamma Survey Information

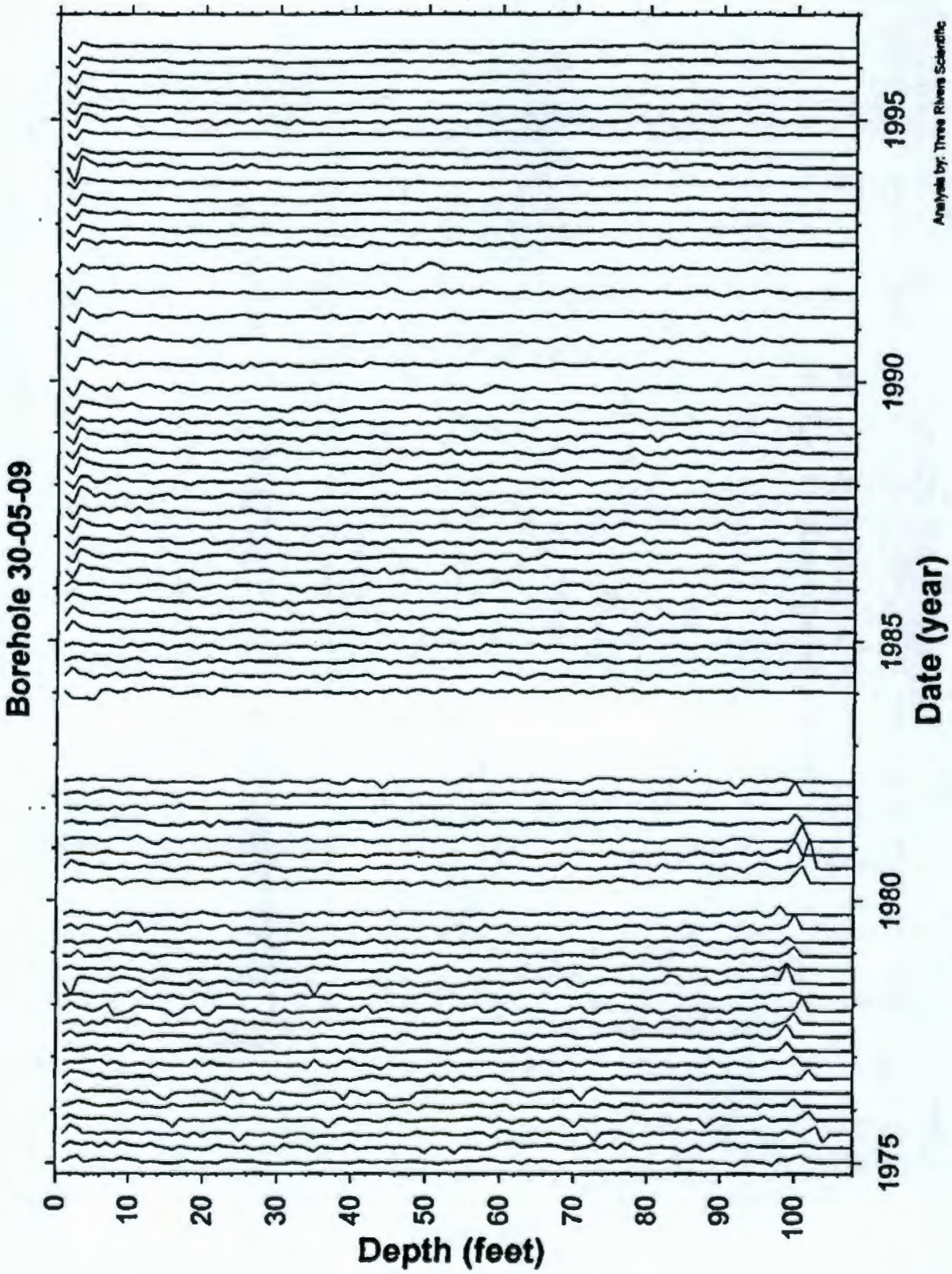
Probe Type Processed :	04: NaI
Other Probe Types :	03: Neutron
Survey Depth :	100 ft
First Survey Date :	1/10/1975
Last Survey Date :	7/25/1996
Number Surveys Processed :	513

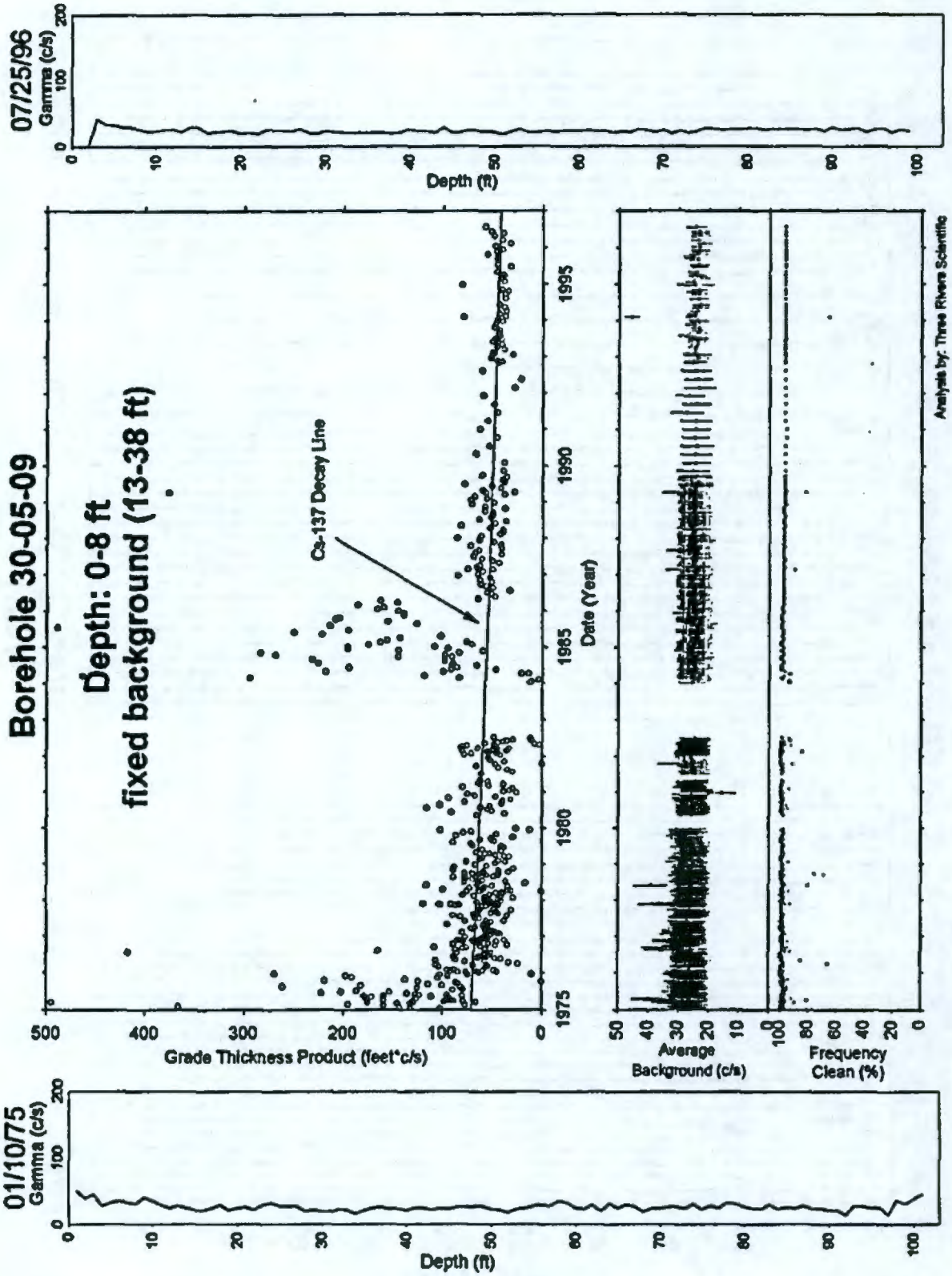
Analysis Notes

Method Used to Compute Background :	Fixed Background 13-38 ft
Depth(s) where Contamination Identified in Gross Gamma Surveys :	0-8 ft Tank Farm Activity
Analyst Name :	R.R. Randall
Company Name :	Three Rivers Scientific

30-05-09 Combination Plot




Borehole 30-05-09
Depth (feet)
0
10
20
30
40
50
60
70
80
90
100
Date (year)
1975
1980
1985
1990
1995
Analysis by: Three Rivers Scientific


Borehole 30-05-09
Depth: 0-8 ft
fixed background (13-38 ft)
07/25/96
Gamma (c/s)
Depth (ft)
Cs-137 Decay Line
Grade Thickness Product (feet*c/s)
Date (Year)
Average Background (c/s)
Frequency Clean (%)
Analysis by: Three Rivers Scientific
01/10/75
Gamma (c/s)
Depth (ft)

Borehole 30-05-10

Contamination (Cs-137) from 0-17 feet is Tank Farm Activity. Contamination (Cs-137, Co-60 & Ru-106) from 17-35 feet is Unstable Early.

Grade thickness product over 0 to 17 feet is erratic and highly variable from 1975 to 1986, indicative of tank farm activity. Since 1986, the grade thickness product may be consistent with the decay from Cs-137 (HPGe identified); however, the gross gamma levels are too low to make a clear classification.

Grade thickness product over 17 to 35 feet increases from 1975 to 1976, and after 1976 is consistent with a least square fit for Cs-137, Co-60 (both HPGe identified), and Ru-106 (hypothesis) decay. The resulting least square ratio of gross gamma Co-60:Cs-137:Ru-106 as of 1/10/1975 is 265:26:420. The category is unstable early.

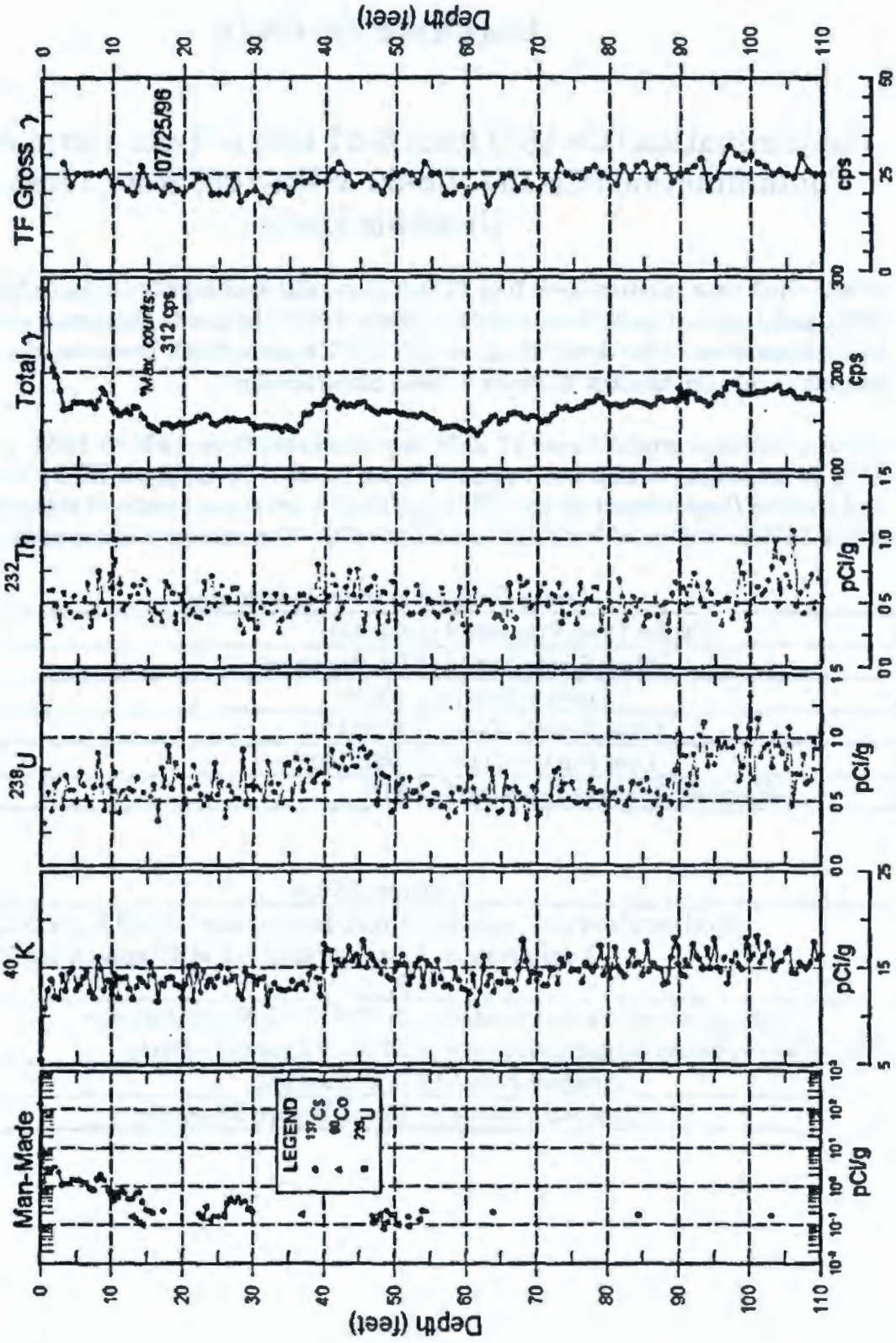
Gross Gamma Survey Information

Probe Type Processed :	04: NaI
Other Probe Types :	03: Neutron
Survey Depth :	135 ft
First Survey Date :	1/10/1975
Last Survey Date :	7/25/1996
Number Surveys Processed :	513

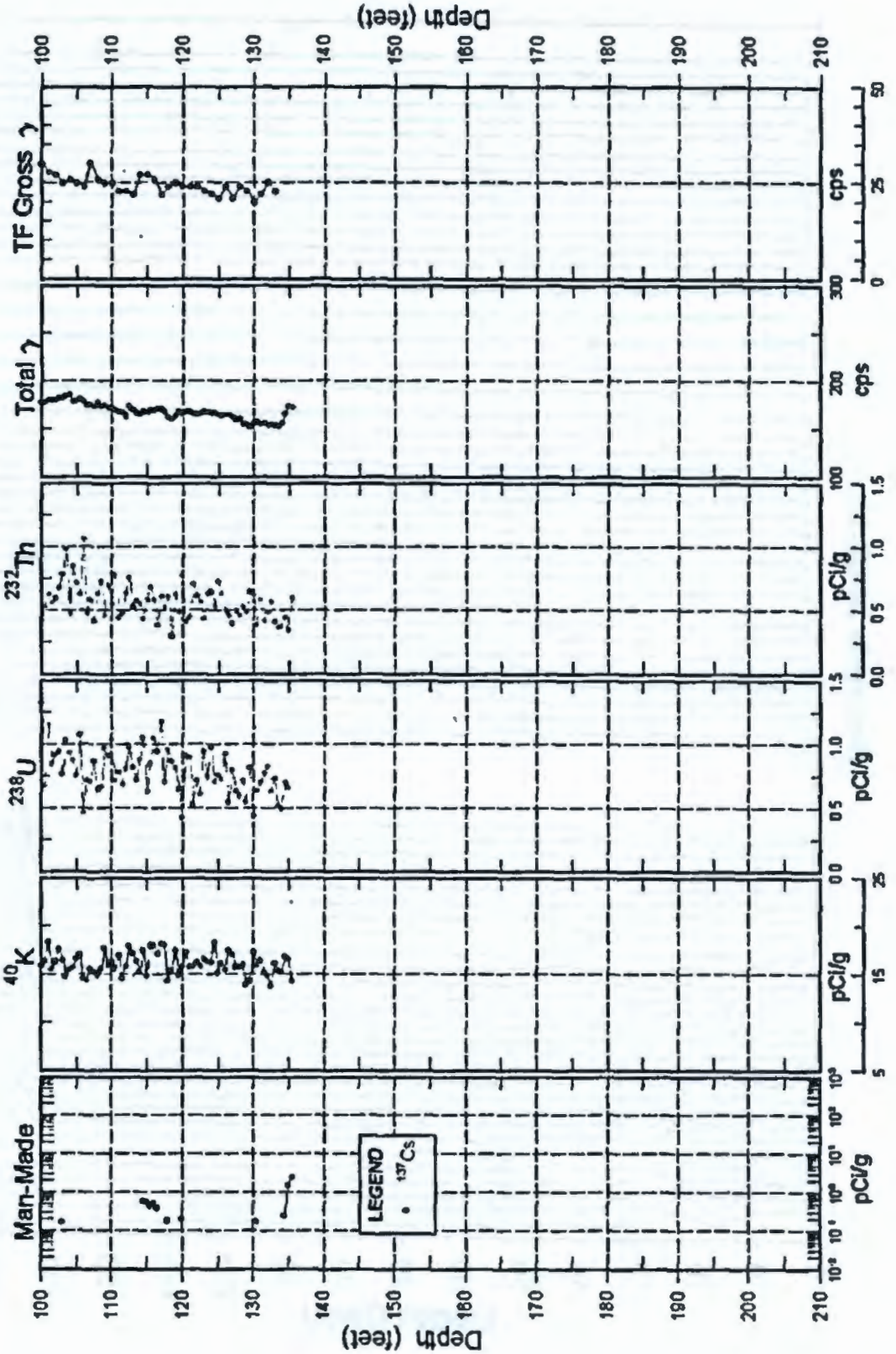
Analysis Notes

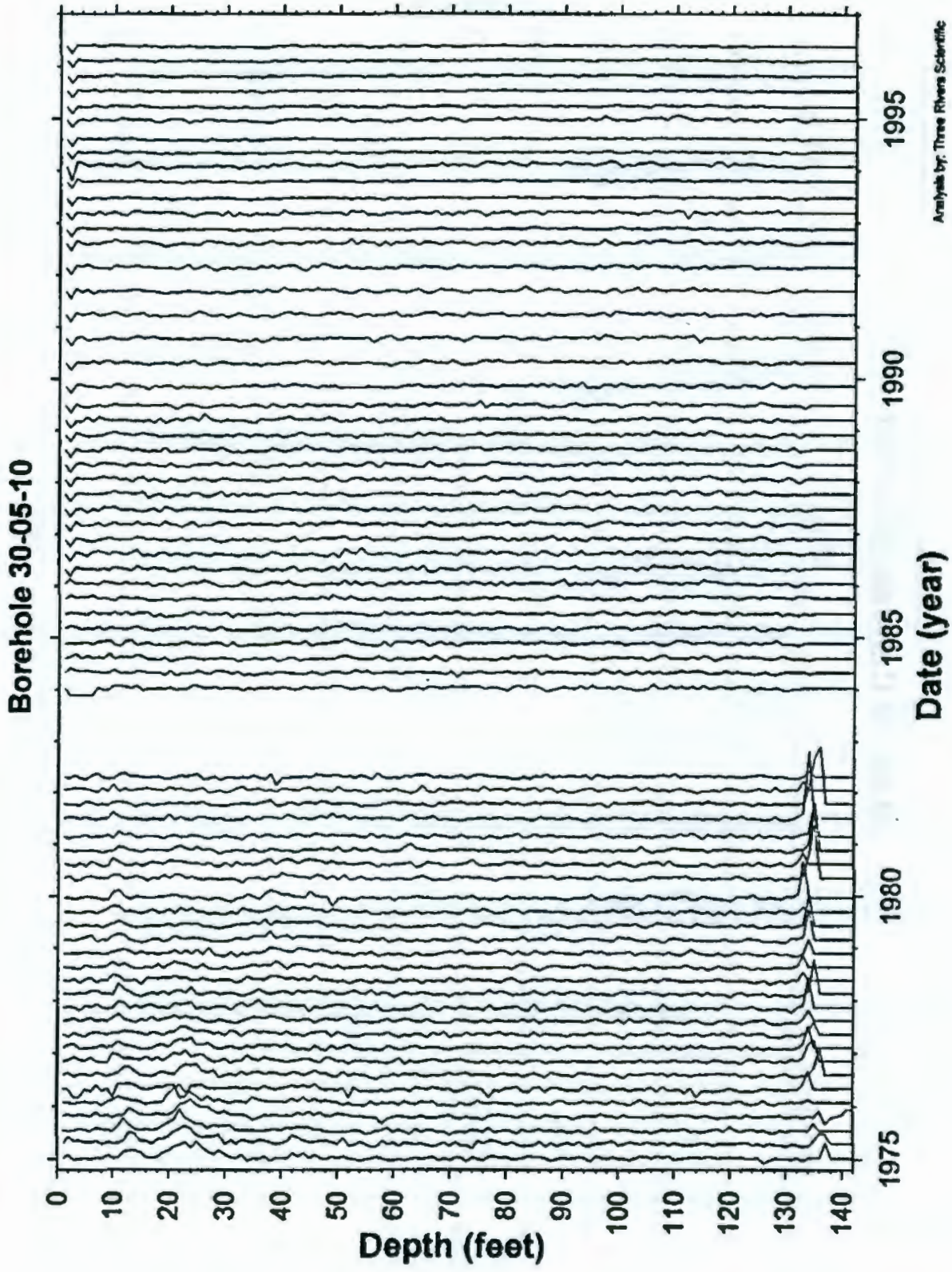
Method Used to Compute Background :	Fixed Background 35-49 ft for 0-17 ft Background set at 20 cps/1ft for 17-35 ft
Depth(s) where Contamination Identified in Gross Gamma Surveys :	0-17 ft Tank Farm Activity 17-35 ft Unstable Early
Analyst Name :	R.R. Randall
Company Name :	Three Rivers Scientific

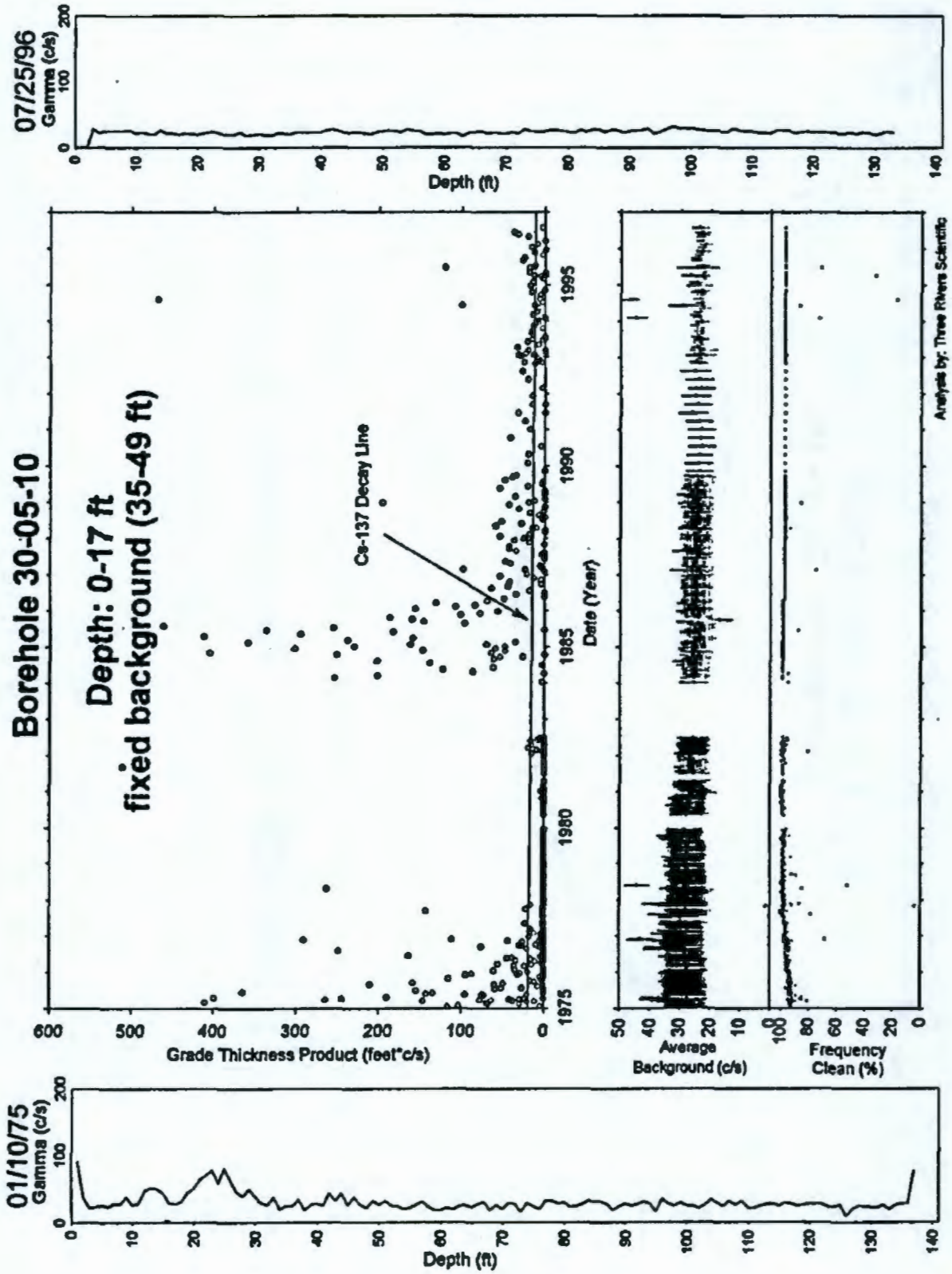
30-05-10 Combination Plot

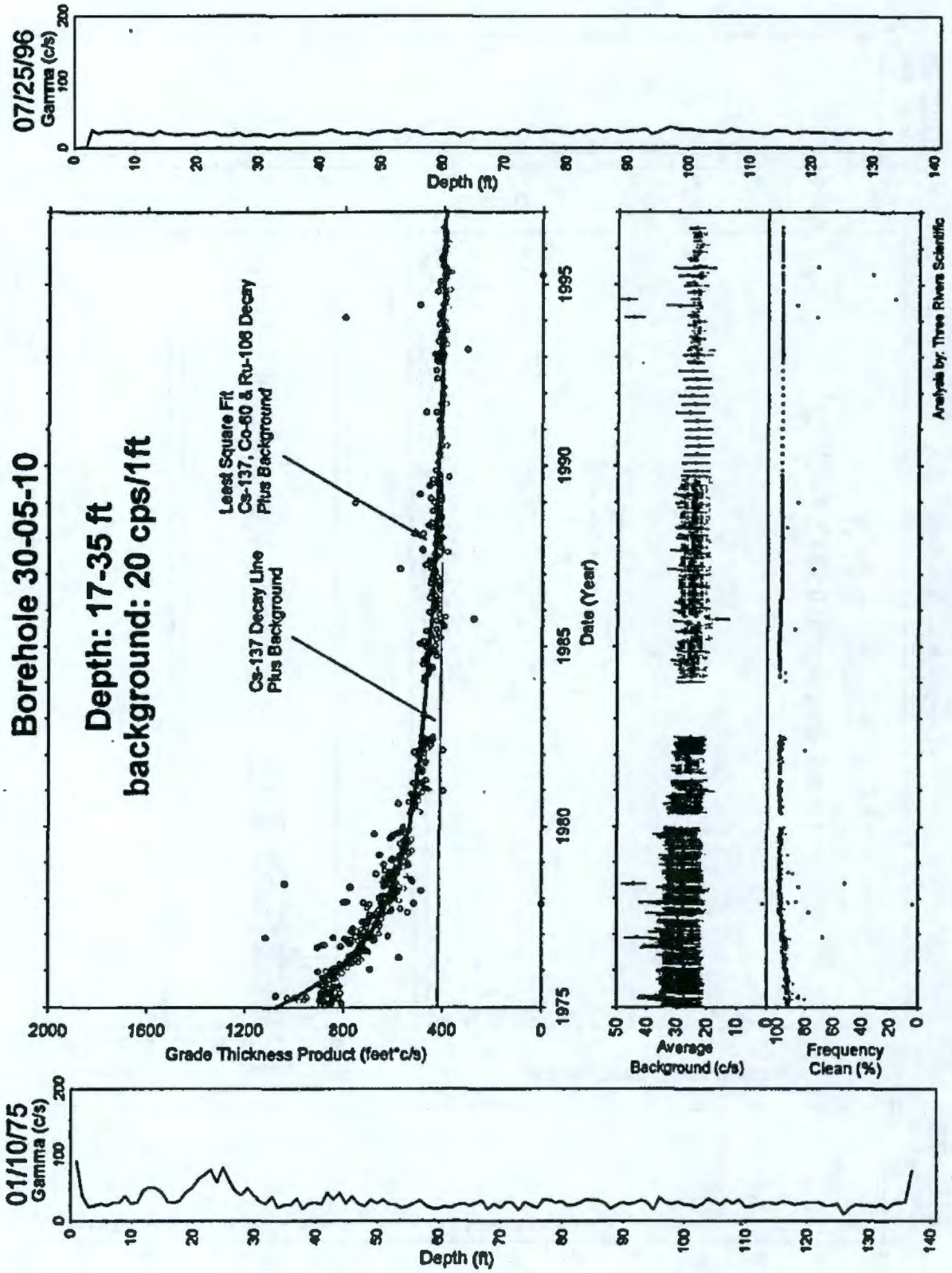


30-05-10 Combination Plot




Borehole 30-05-10
Depth (feet)
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
Date (year)
1975
1980
1985
1990
1995
Analysis by: Three Rivers Scientific


07/25/96
Gamma (c/s)
Depth (ft)
Borehole 30-05-10
Depth: 0-17 ft
fixed background (35-49 ft)
Cs-137 Decay Line
Date (Year)
Grade Thickness Product (feet*c/s)
Average Background (c/s)
Frequency Clean (%)
Analysis by: Three Rivers Scientific
01/10/75
Gamma (c/s)
Depth (ft)


07/25/96
Gamma (c/s)
Depth (ft)
Borehole 30-05-10
Depth: 17-35 ft
background: 20 cps/1ft
Least Square Fit
Cs-137, Co-60 & Ru-106 Decay
Plus Background
Cs-137 Decay Line
Plus Background
Grade Thickness Product (feet*c/s)
Date (Year)
Average
Background (c/s)
Frequency
Clean (%)
Analysis by: Three Rivers Scientific
01/10/75
Gamma (c/s)
Depth (ft)

Tank C-106

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Borehole 30-06-12 257

This section contains the analysis results for vadose zone boreholes (dry wells) associated with the Tank 106 in the "C" Tank Farm.

Special Notes: None

Borehole 30-06-02

Contamination (Cs-137) from 0-16 feet is Tank Farm Activity.

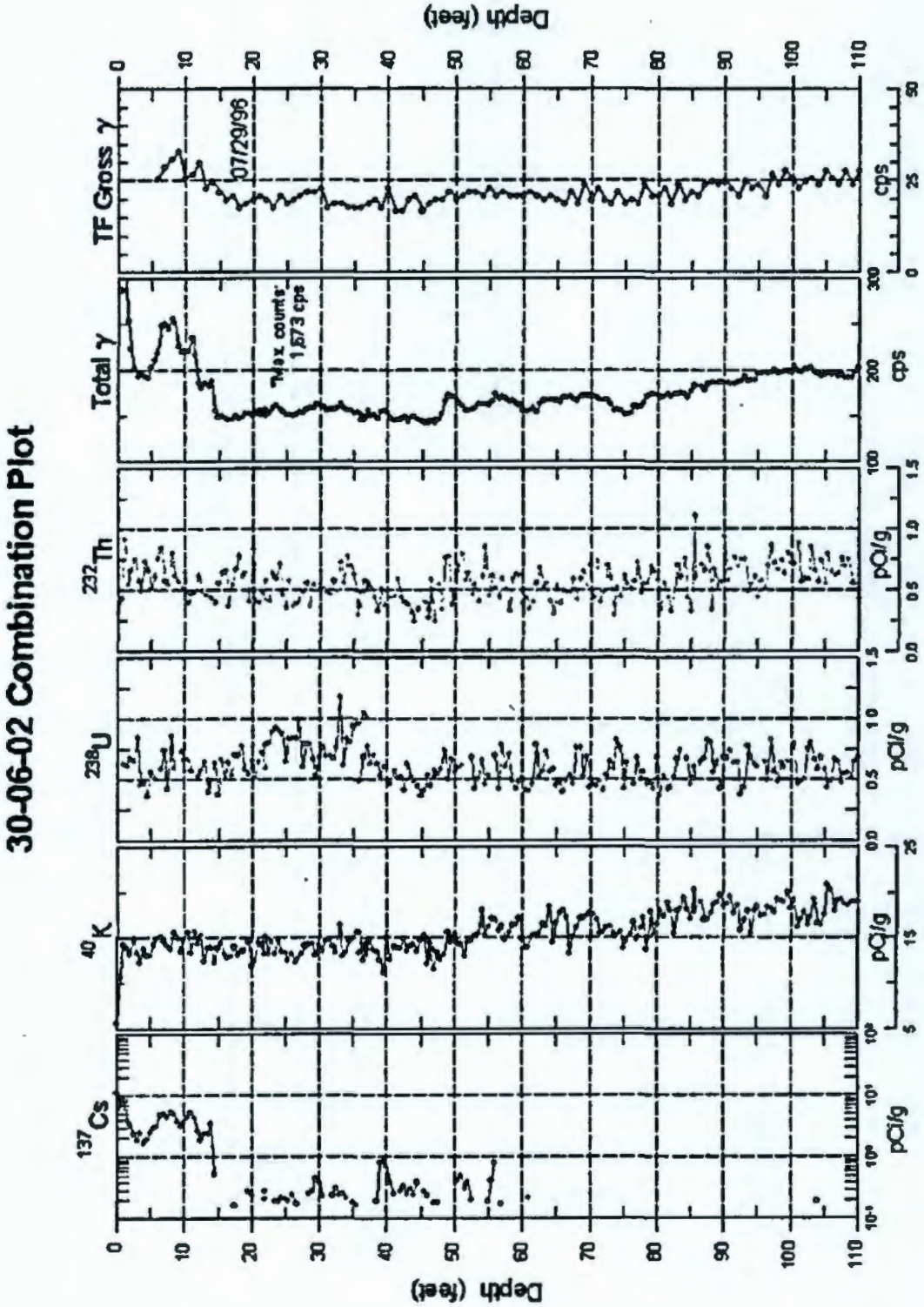
Grade thickness product over 0 to 16 feet is variable and erratic from 1975 to 1986, indicative of tank farm activity. Since 1986, the grade thickness product is consistent with the decay of Cs-137 (HPGe identified). The concentration of Cs-137 is up to 10 pCi/g from the surface to 15 feet and is less than 1 pCi/g from 15 to 60 feet.

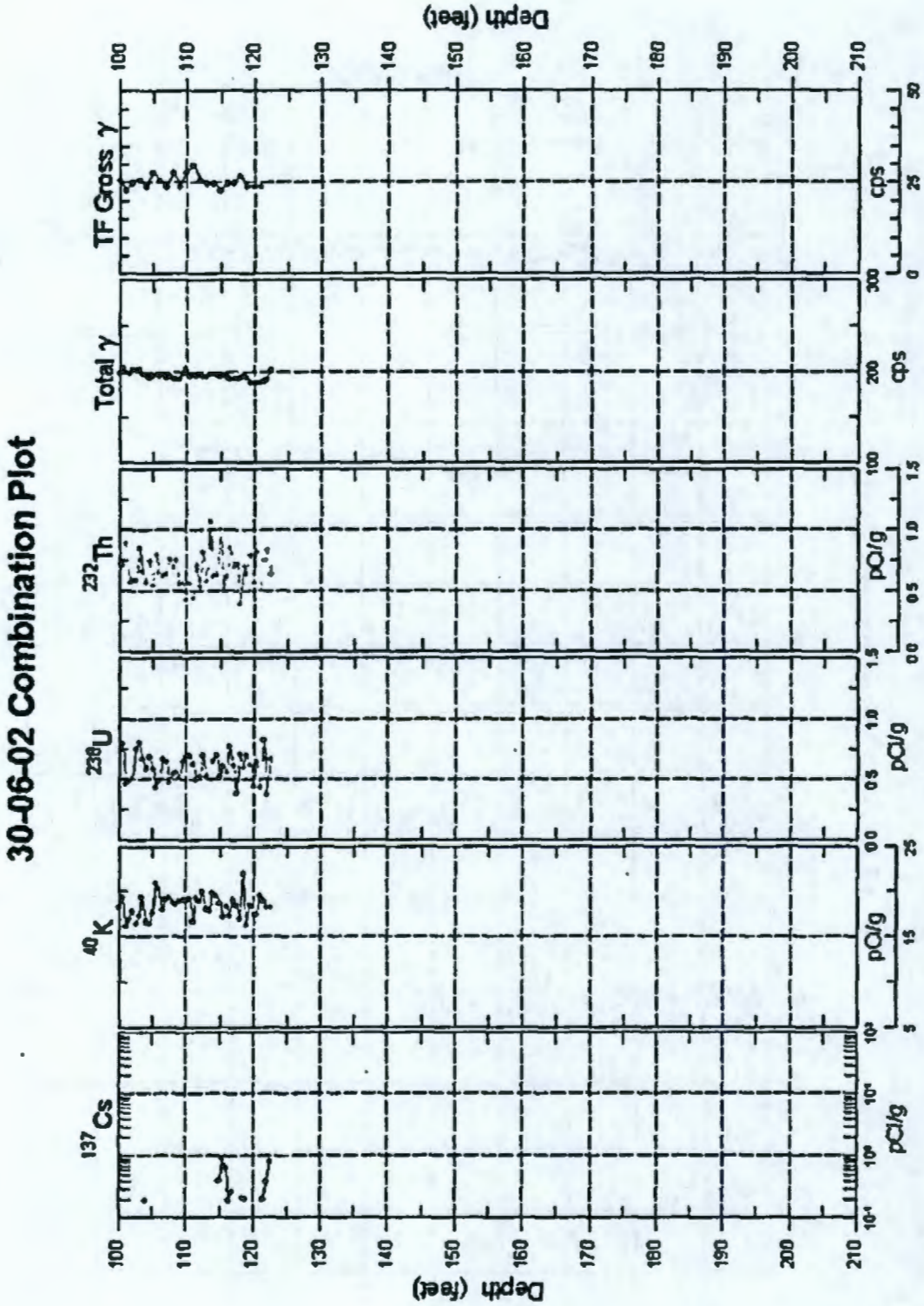
Gross Gamma Survey Information

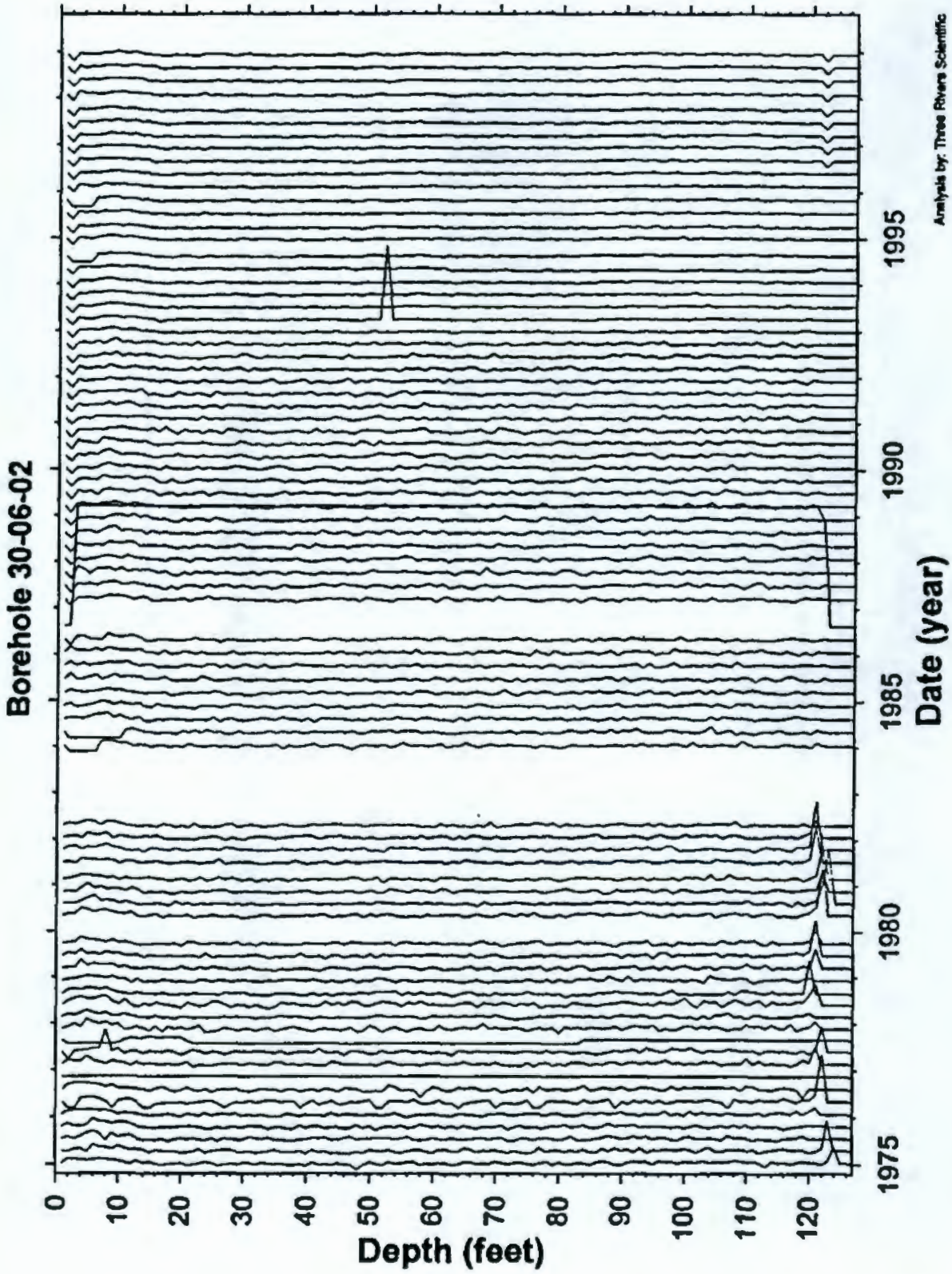
Probe Type Processed :	04: NaI
Other Probe Types :	03: Neutron
Survey Depth :	123 ft
First Survey Date :	1/10/1975
Last Survey Date :	1/29/1999
Number Surveys Processed :	631

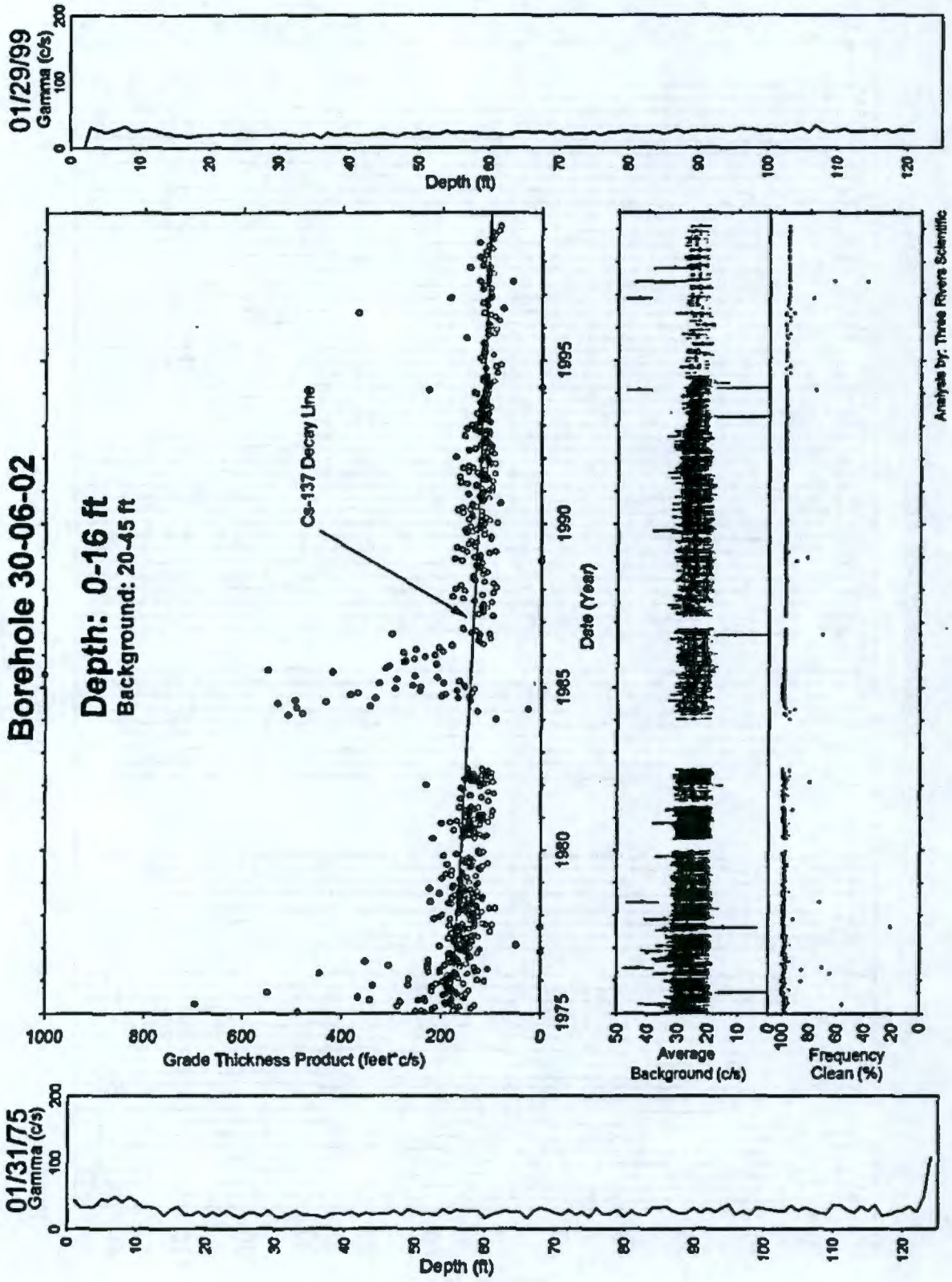
Analysis Notes

Method Used to Compute Background :	Fixed background (20-45ft)
Depth(s) where Contamination Identified in Gross Gamma Surveys :	0-16 ft Tank Farm Activity
Analyst Name :	R.K. Price
Company Name :	Three Rivers Scientific


30-06-02 Combination Plot
TF Gross γ
07/29/96
Total γ
Max counts: 1,573 cps
232Th
238U
40K
137Cs
cps
pCi/g
Depth (feet)


30-06-02 Combination Plot
TF Gross γ
Total γ
232Th
238U
40K
137Cs
Depth (feet)
cps
pCi/g


Borehole 30-06-02
Depth (feet)
0
10
20
30
40
50
60
70
80
90
100
110
120
Date (year)
1975
1980
1985
1990
1995
Analysis by: Three Rivers Scientific


01/29/99
Gamma (c/s)
Depth (ft)
Borehole 30-06-02
Depth: 0-16 ft
Background: 20-45 ft
Cs-137 Decay Line
Grade Thickness Product (feet*c/s)
Date (Year)
Average Background (c/s)
Frequency Clean (%)
Analysis by: Three Rivers Scientific
01/31/75
Gamma (c/s)
Depth (ft)

Borehole 30-06-03

Contamination (Cs-137) from 0-10 feet is Tank Farm Activity.

Grade thickness product over 0 to 10 feet is erratic and highly variable, indicative of tank farm activity. The HPGe survey identified Cs-137 in the borehole from the surface to 75 feet with concentrations up to 100 pCi/g at 1 ft. The second highest concentrations are up to 10 pCi/g from 2 to 45 feet. The gross gamma surveillance logs identified only the upper contamination (0 to 10 feet).

The HPGe survey identified a thin zone of Cs-137 at 27 ft with a concentration of 10 pCi/g. No grade thickness product plot was presented for this zone because the zones activity is below the detection threshold of the tank farm surveillance logs.

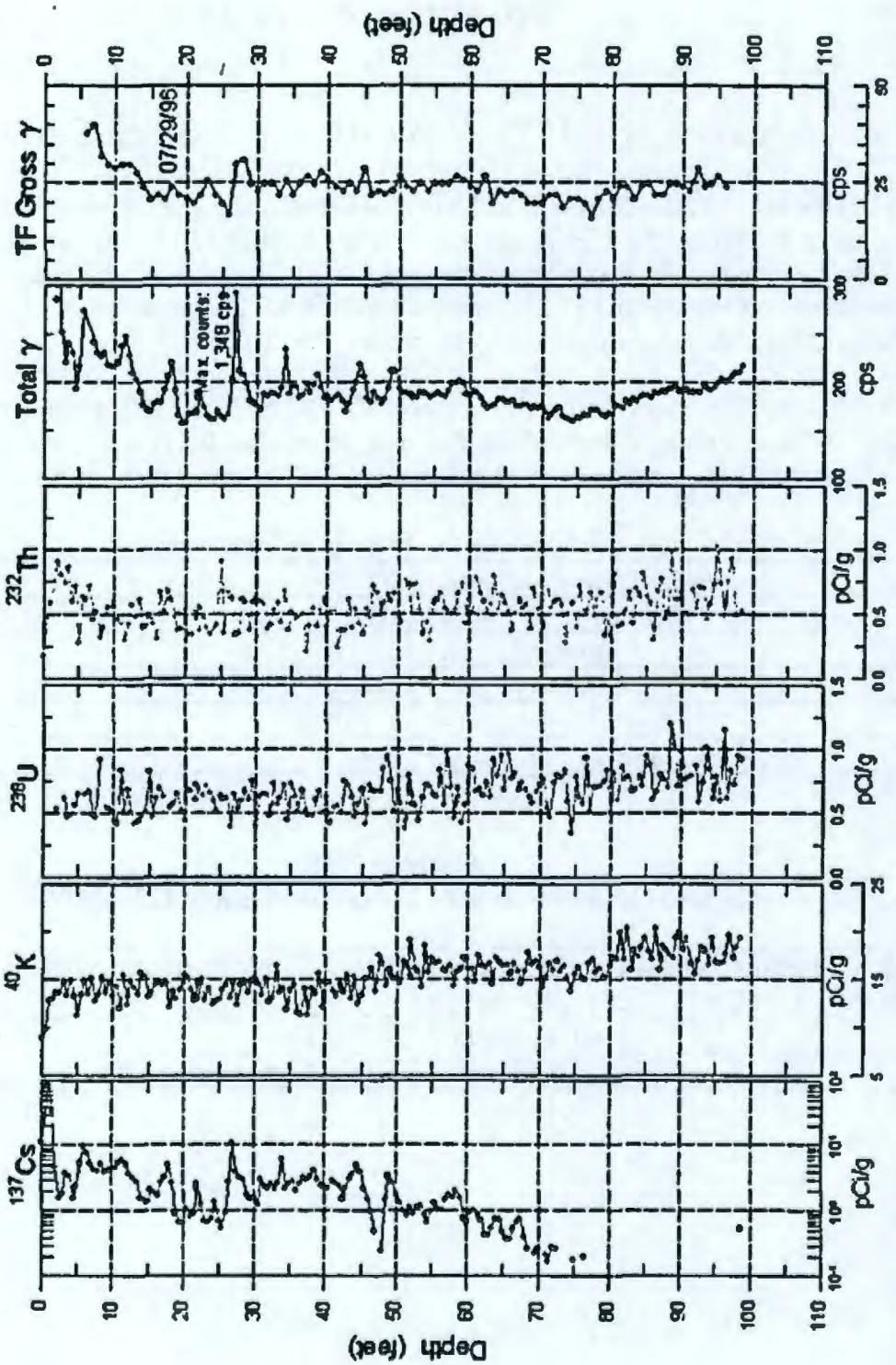
Gross Gamma Survey Information

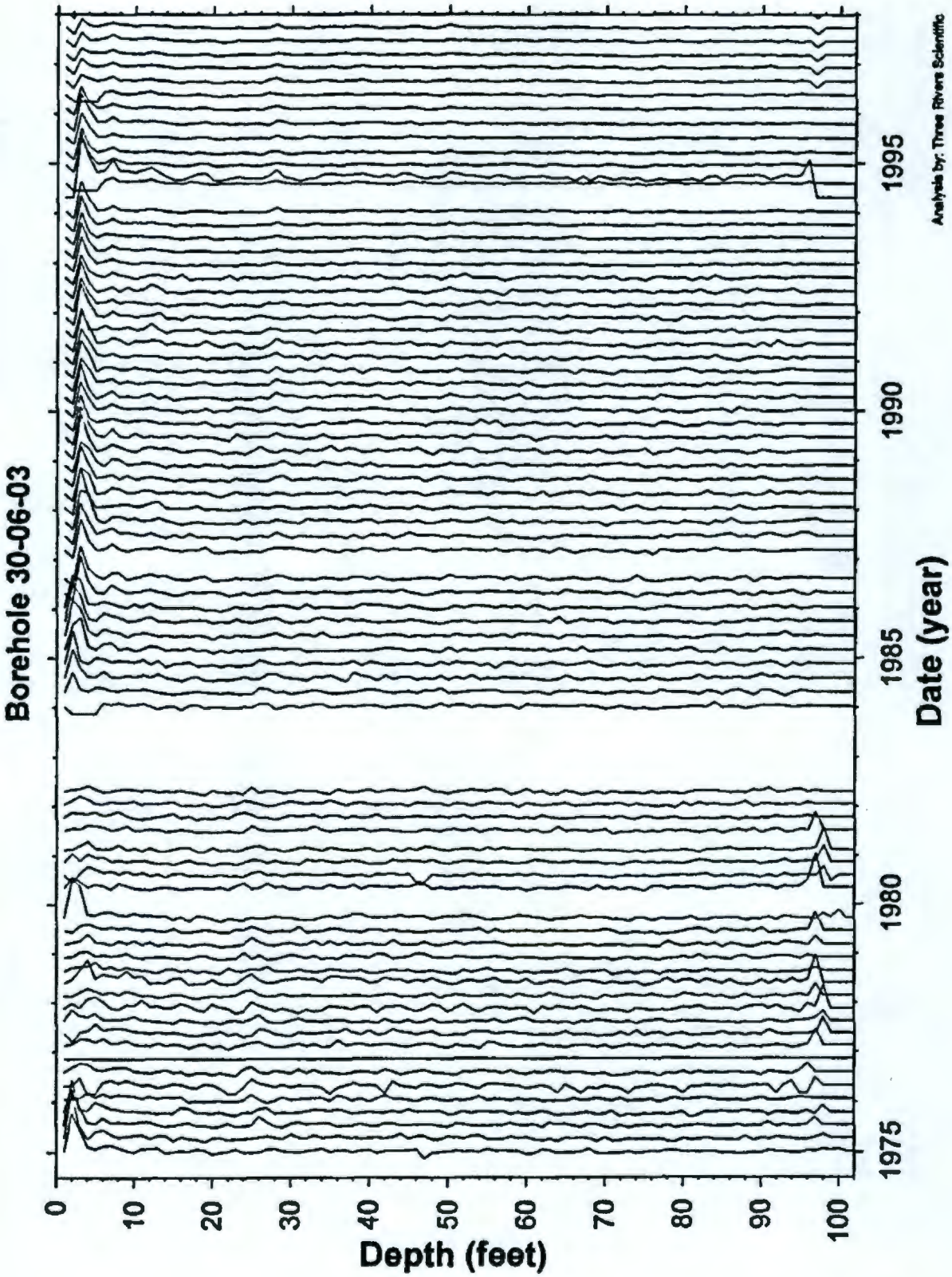
Probe Type Processed :	04: NaI
Other Probe Types :	03: Neutron
Survey Depth :	100 ft
First Survey Date :	1/10/1975
Last Survey Date :	1/29/1999
Number Surveys Processed :	666

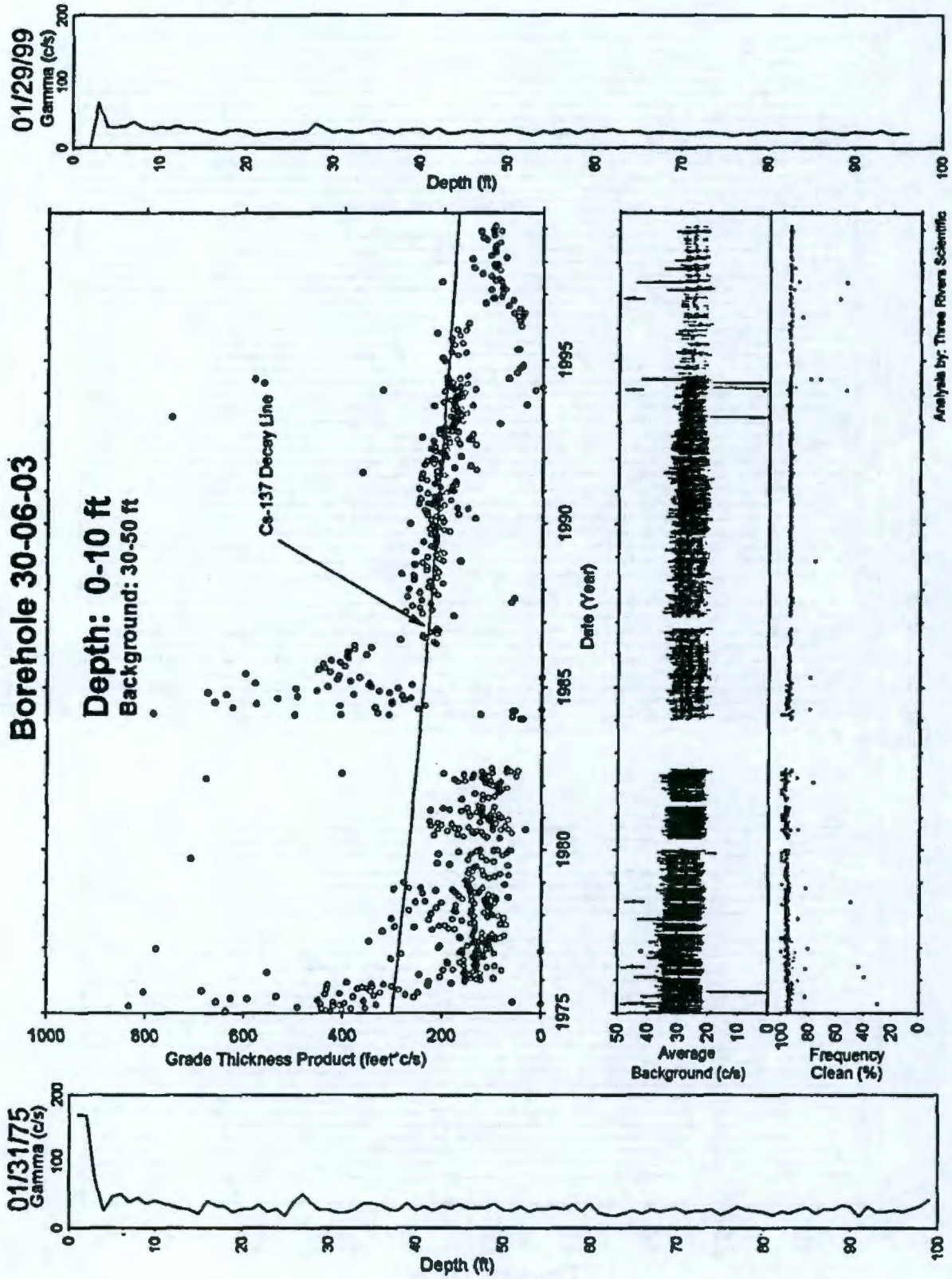
Analysis Notes

Method Used to Compute Background :	Fixed background (30-50ft)
Depth(s) where Contamination Identified in Gross Gamma Surveys :	0-10 ft Tank Farm Activity
Analyst Name :	R.K. Price
Company Name :	Three Rivers Scientific

30-06-03 Combination Plot




Borehole 30-06-03
Depth (feet)
0
10
20
30
40
50
60
70
80
90
100
Date (year)
1975
1980
1985
1990
1995
Analysis by: Three Rivers Scientific


01/29/99
Gamma (c/s)
Depth (ft)
Borehole 30-06-03
Depth: 0-10 ft
Background: 30-50 ft
Cs-137 Decay Line
Date (Year)
Grade Thickness Product (feet*c/s)
Average Background (c/s)
Frequency Clean (%)
Analysis by: Three Rivers Scientific
01/31/75
Gamma (c/s)
Depth (ft)

Borehole 30-06-04

Contamination (Cs-137) from 0-16 feet is Tank Farm Activity. Contamination (Cs-137) from 16-32 feet is Stable.

Grade thickness product over 0 to 16 feet is variable and erratic from 1984 to 1986, indicative of tank farm activity. Since 1986, the grade thickness product is consistent with the decay of Cs-137 (HPGe identified).

Grade thickness product over 16 to 32 feet is decreasing consistent with Cs-137 (HPGe identified) since 1984, and is somewhat erratic before 1984. Since the small amount of erratic nature before 1984 could be caused by depth control errors, the zone is classified stable.

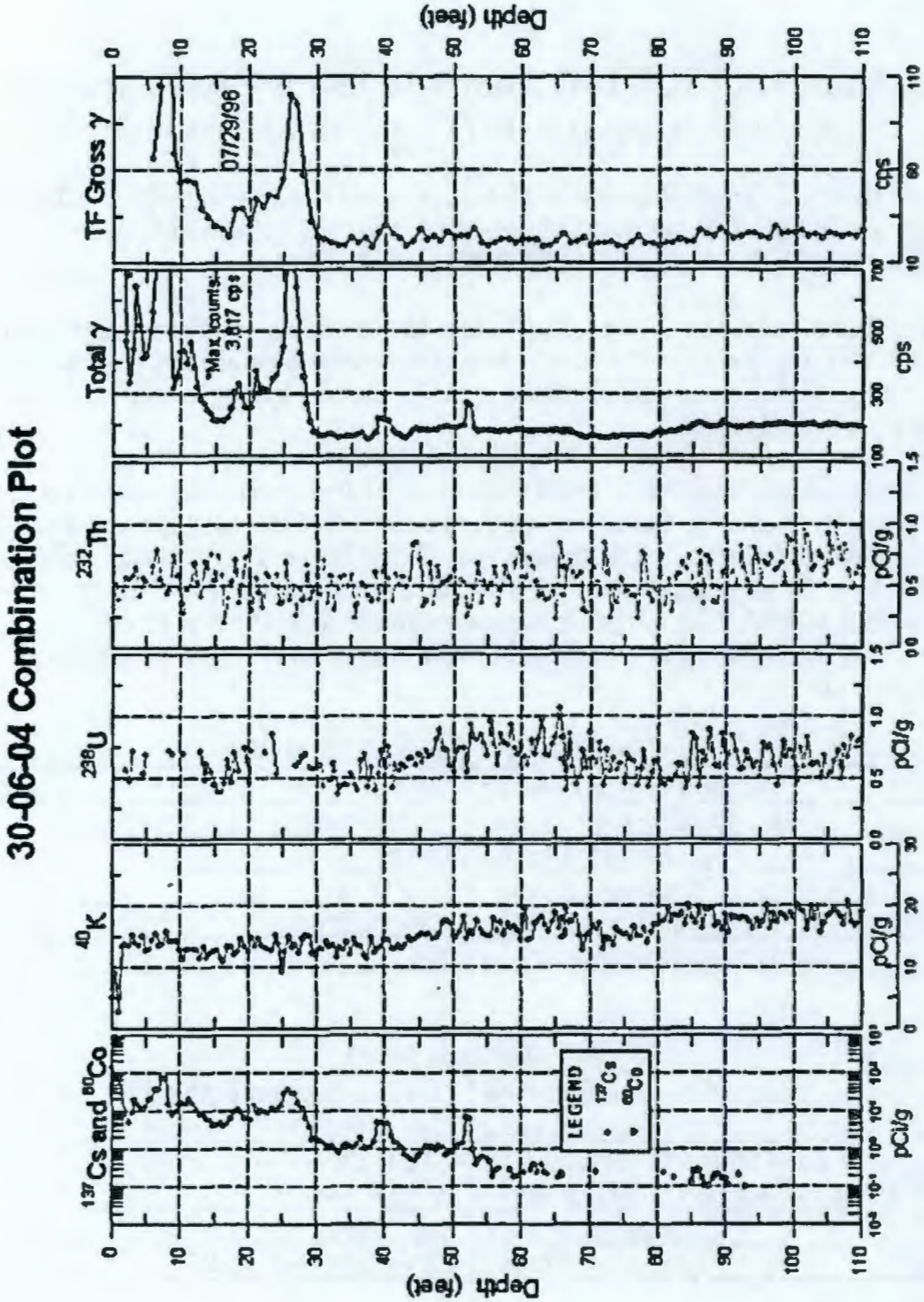
The HPGe survey identified Co-60 from 85 to 91 feet at concentrations up to 0.3 pCi/g and there was no indication on the stack plot of elevated activity in this interval even in the early (1975) surveys. The HPGe survey was run February 1997. A Co-60 concentration of 5.6 pCi/g on January 1975 would decay to 0.3 pCi/g on February 1997. The 5.6 pCi/g concentration is near the non detect limit for the tank farm logging system which could explain why no elevated activity is shown in the stack plot.

Gross Gamma Survey Information

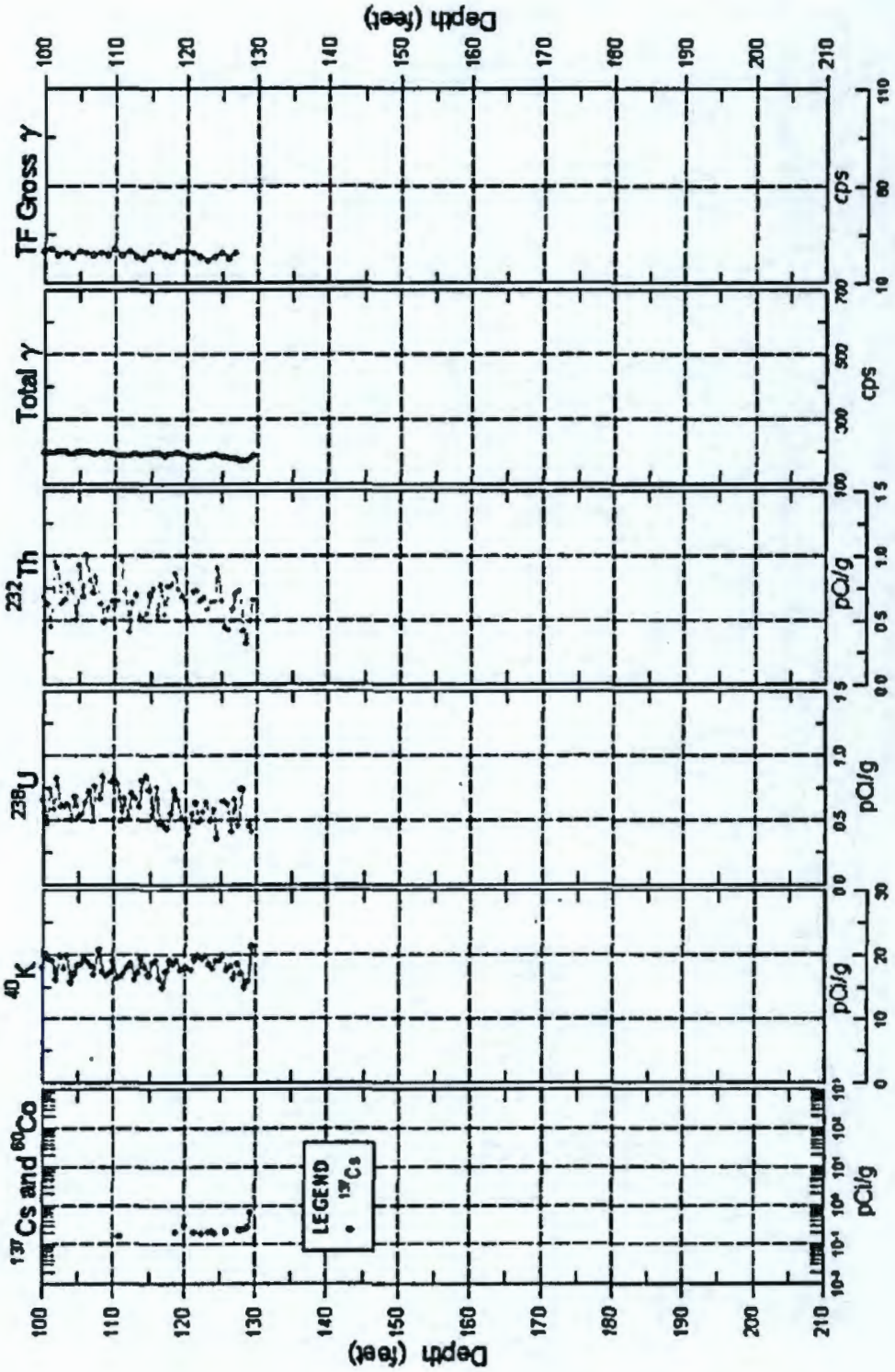
Probe Type Processed :	04: NaI
Other Probe Types :	03: Neutron
Survey Depth :	130 ft
First Survey Date :	1/10/1975
Last Survey Date :	1/30/1999
Number Surveys Processed :	657

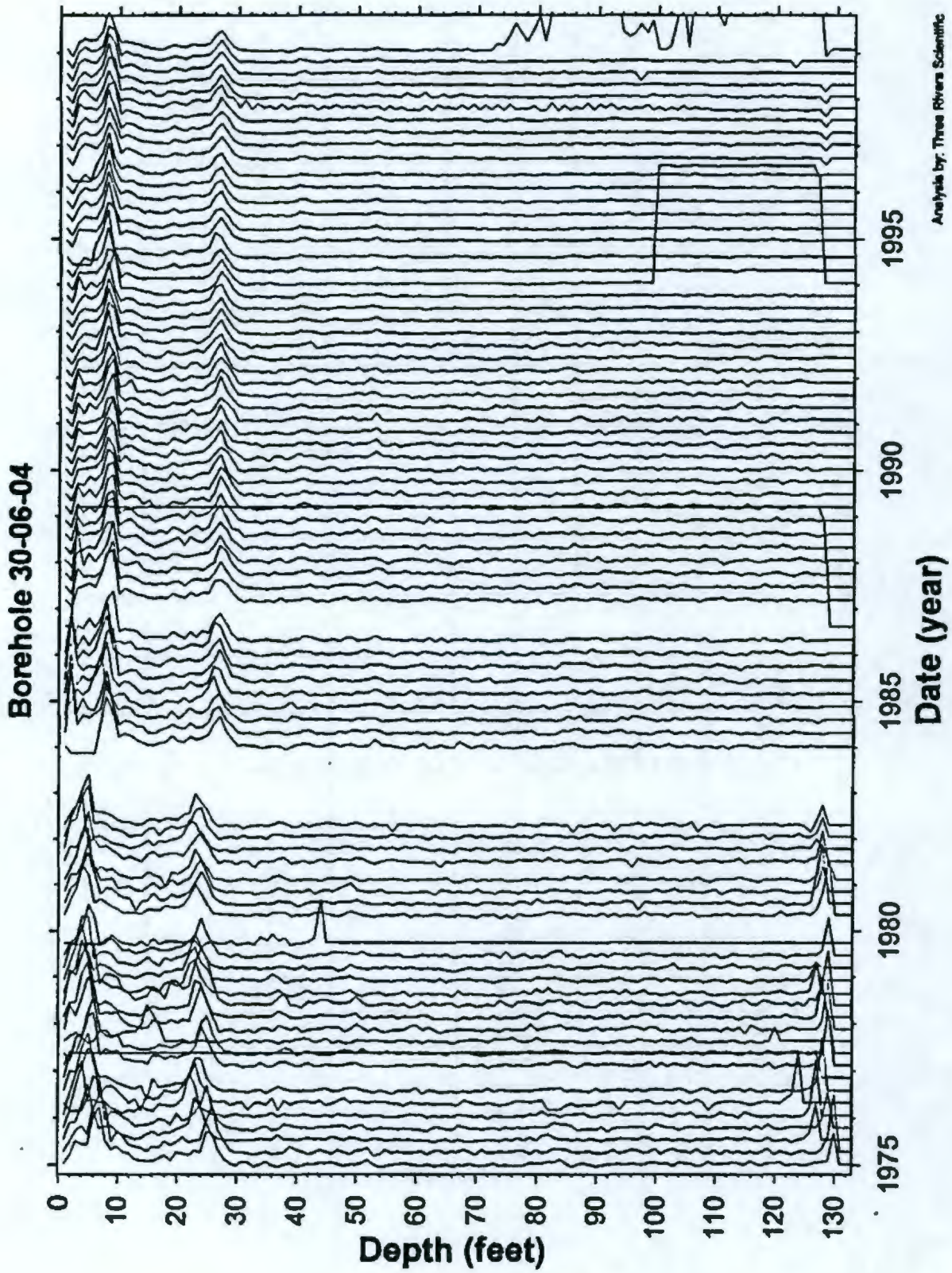
Analysis Notes

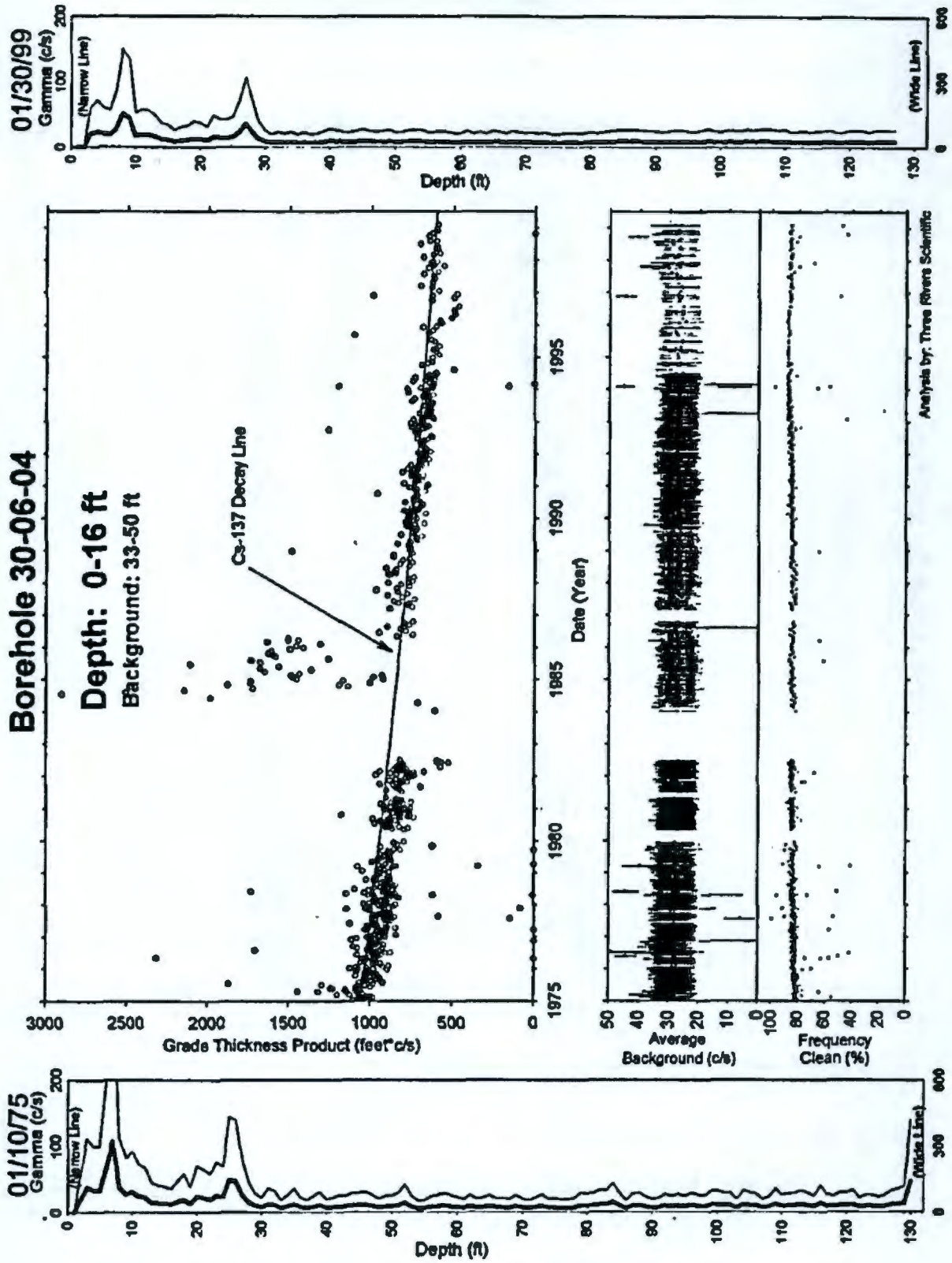
Method Used to Compute Background :	Fixed background (33-50ft)
Depth(s) where Contamination Identified in Gross Gamma Surveys :	0-16 ft Tank Farm Activity 16-32 ft Stable
Analyst Name :	R.K. Price
Company Name :	Three Rivers Scientific

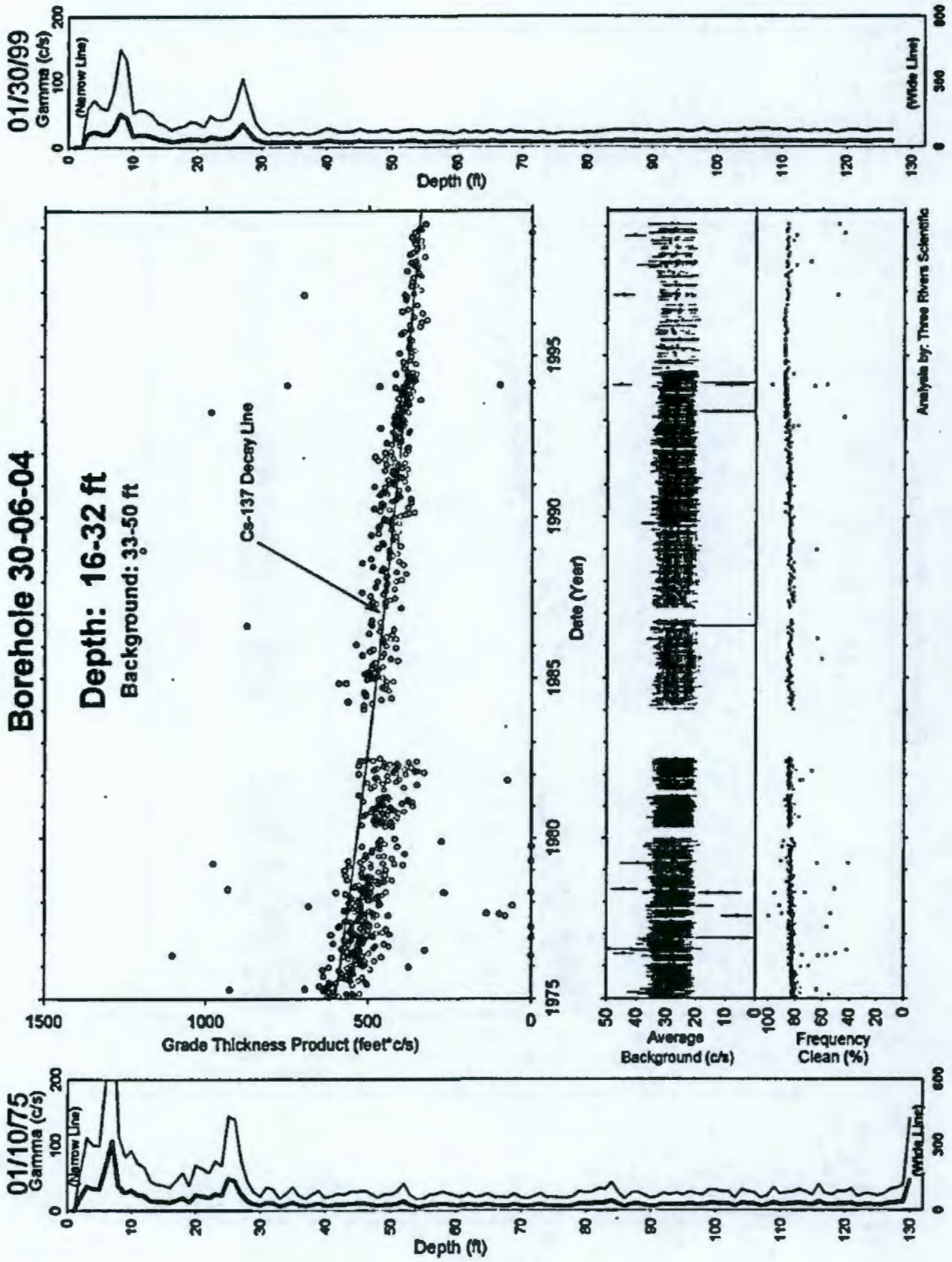

30-06-04 Combination Plot
TF Gross γ
07/29/96
cps
Total γ
*Max counts: 3,617 cps
cps
232Th
pCi/g
238U
pCi/g
40K
pCi/g
137Cs and 60Co
pCi/g
LEGEND
137Cs
60Co
Depth (feet)
Depth (feet)

30-06-04 Combination Plot




Borehole 30-06-04
Depth (feet)
0
10
20
30
40
50
60
70
80
90
100
110
120
130
Date (year)
1975
1980
1985
1990
1995
Analysis by: Three Rivers Scientific


01/30/99
Gamma (c/s)
(Narrow Line)
(Wide Line)
Depth (ft)
Borehole 30-06-04
Depth: 0-16 ft
Background: 33-50 ft
Cs-137 Decay Line
Grade Thickness Product (feet*c/s)
Date (Year)
Average Background (c/s)
Frequency Clean (%)
Analysis by: Three Rivers Scientific
01/10/75
Gamma (c/s)
(Narrow Line)
(Wide Line)
Depth (ft)


01/30/99
Gamma (c/s)
(Narrow Line)
(Wide Line)
Depth (ft)
Borehole 30-06-04
Depth: 16-32 ft
Background: 33-50 ft
Cs-137 Decay Line
Grade Thickness Product (feet*c/s)
Date (Year)
Average Background (c/s)
Frequency Clean (%)
Analysis by: Three Rivers Scientific
01/10/75
Gamma (c/s)
(Narrow Line)
(Wide Line)
Depth (ft)

Borehole 30-06-09

Contamination (Cs-137) from 0-16 feet is Tank Farm Activity.

Grade thickness product over 0 to 16 feet is variable and erratic, indicative of tank farm activity. The HPGe survey identified Cs-137 from the surface to the bottom of the borehole with concentrations up to 20 pCi/g between 0 and 15 feet. Trace amounts of Co-60 were detected by the HPGe survey at concentrations less than 0.2 pCi/g at 27 and 75 feet.

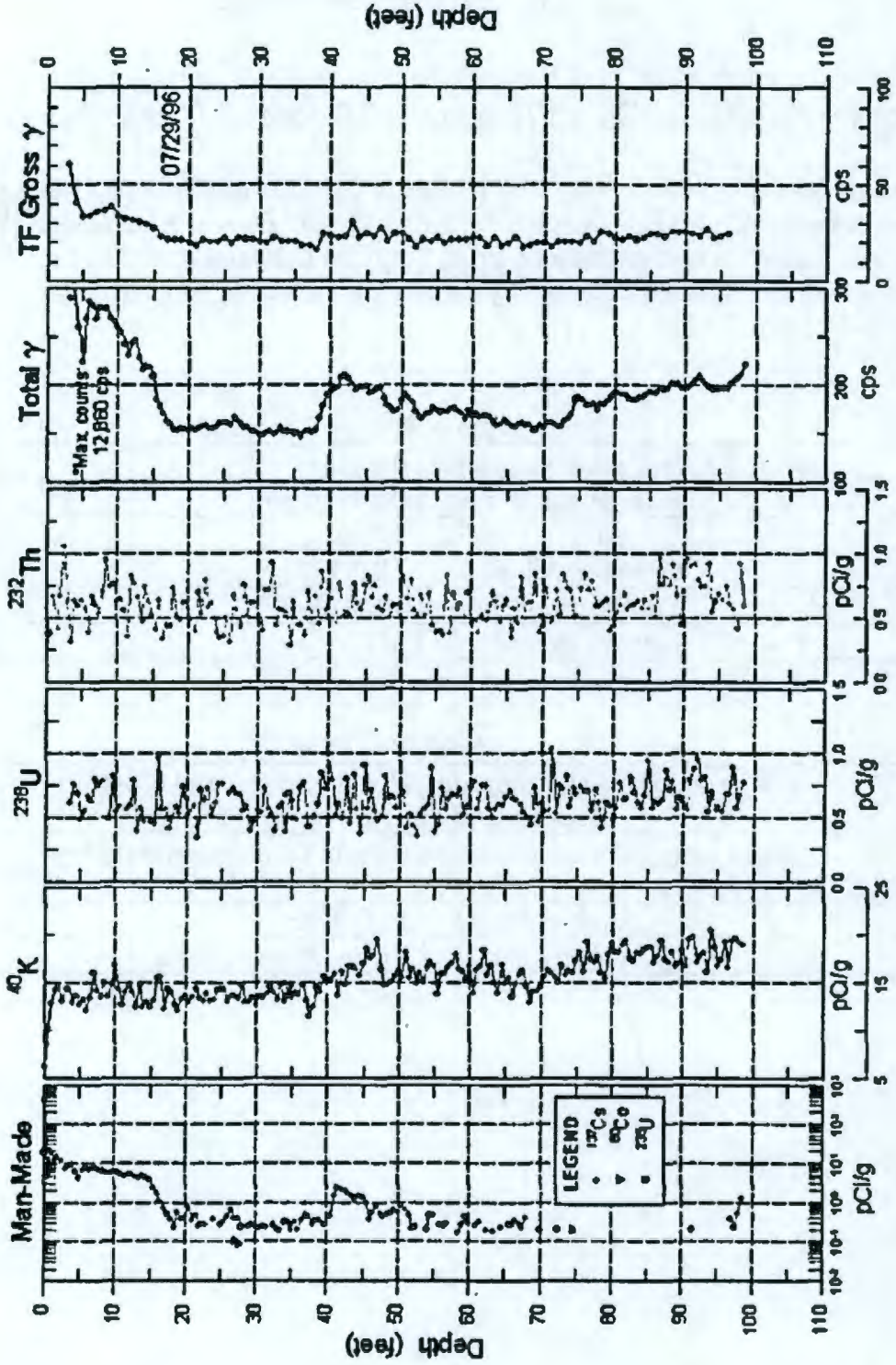
Gross Gamma Survey Information

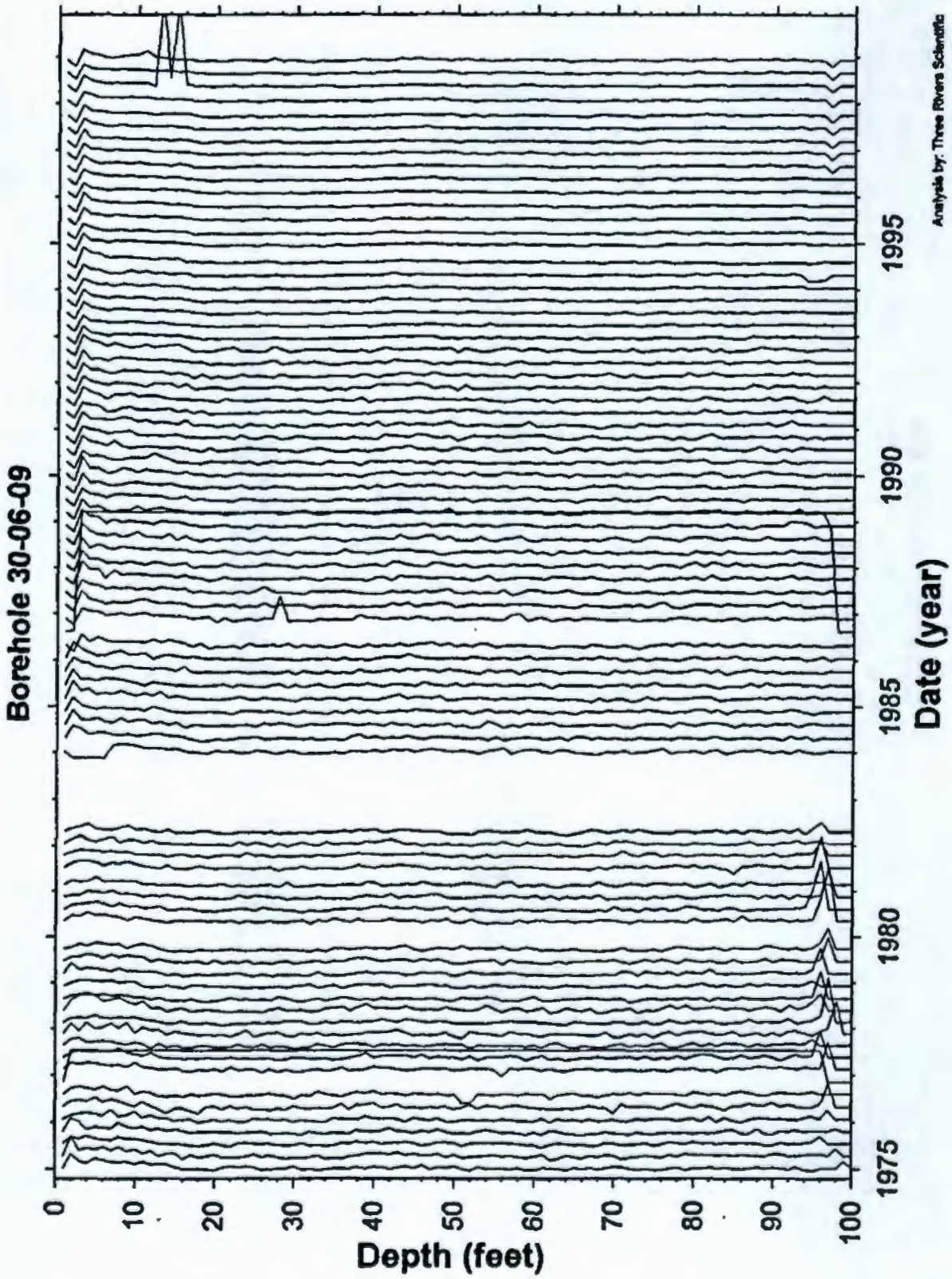
Probe Type Processed :	04: NaI
Other Probe Types :	03: Neutron
Survey Depth :	100 ft
First Survey Date :	1/10/1975
Last Survey Date :	1/29/1999
Number Surveys Processed :	657

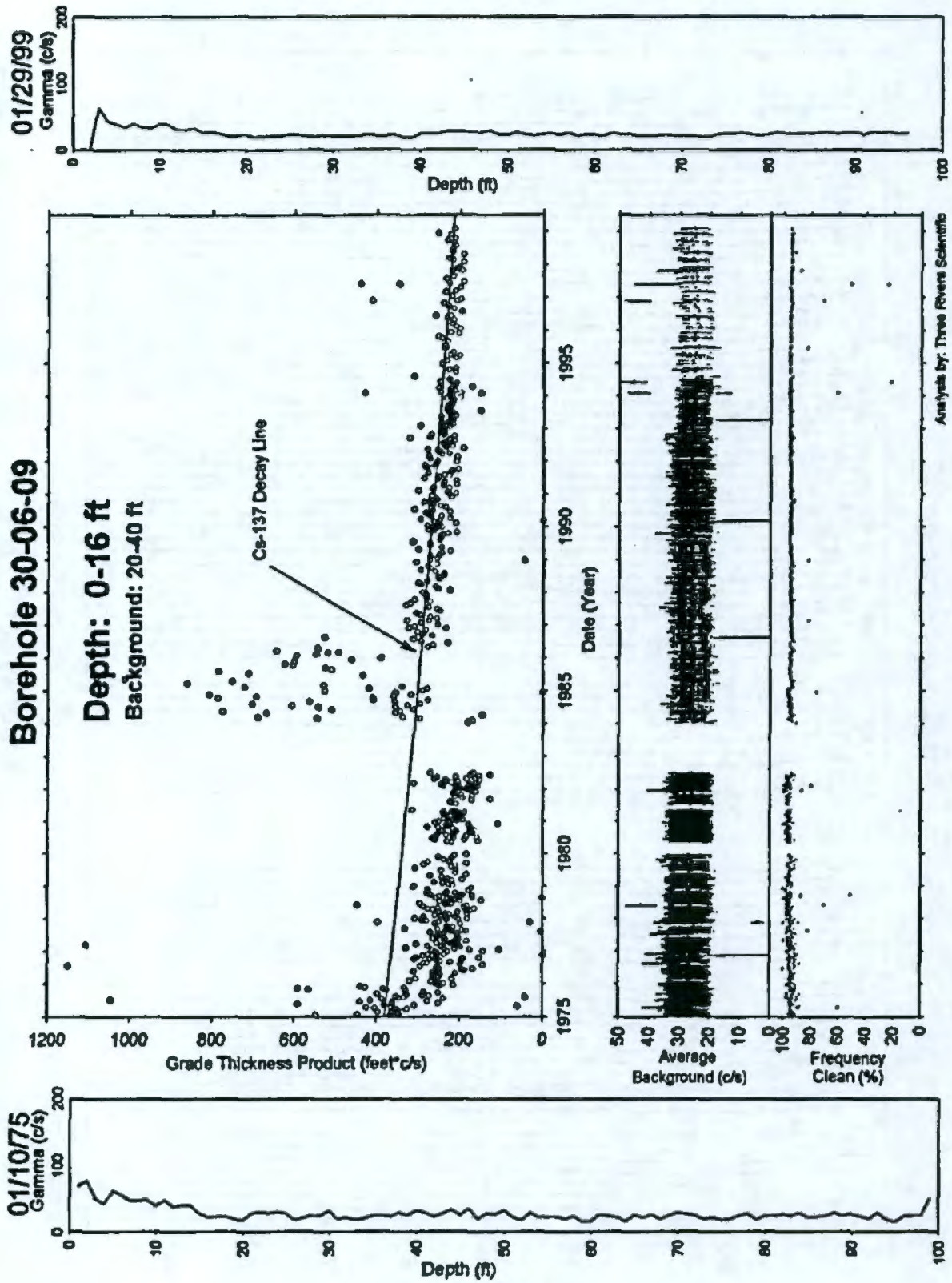
Analysis Notes

Method Used to Compute Background :	Fixed background (20-40ft)
Depth(s) where Contamination Identified in Gross Gamma Surveys :	0-16 ft Tank Farm Activity
Analyst Name :	R.K. Price
Company Name :	Three Rivers Scientific

30-06-09 Combination Plot




Borehole 30-06-09
Depth (feet)
0
10
20
30
40
50
60
70
80
90
100
Date (year)
1975
1980
1985
1990
1995
Analysis by: Three Rivers Scientific


01/29/99
Gamma (c/s)
Depth (ft)
Borehole 30-06-09
Depth: 0-16 ft
Background: 20-40 ft
Cs-137 Decay Line
Grade Thickness Product (feet*c/s)
Date (Year)
Average Background (c/s)
Frequency Clean (%)
Analysis by: Three Rivers Scientific
01/10/75
Gamma (c/s)
Depth (ft)

Borehole 30-06-10

Contamination (Cs-137) from 0-10 feet is Tank Farm Activity. Contamination (Co-60) from 86-115 feet is Unstable.

Grade thickness product over 0 to 10 feet is variable and erratic from 1975 to 1986, indicative of tank farm activity. Since 1986, the grade thickness product is consistent with the decay of Cs-137 (HPGe identified).

Grade thickness product over 86 to 115 feet shows a low level of increasing contamination beginning in 1985. Careful review of the stack plot also shows an increase in activity in the depth zone beginning in 1985. The HPGe survey identified Co-60 in the zone at concentration of 1 pCi/g. The decay line for Co-60 does not match the trend of the grade thickness product, indicating an unstable zone.

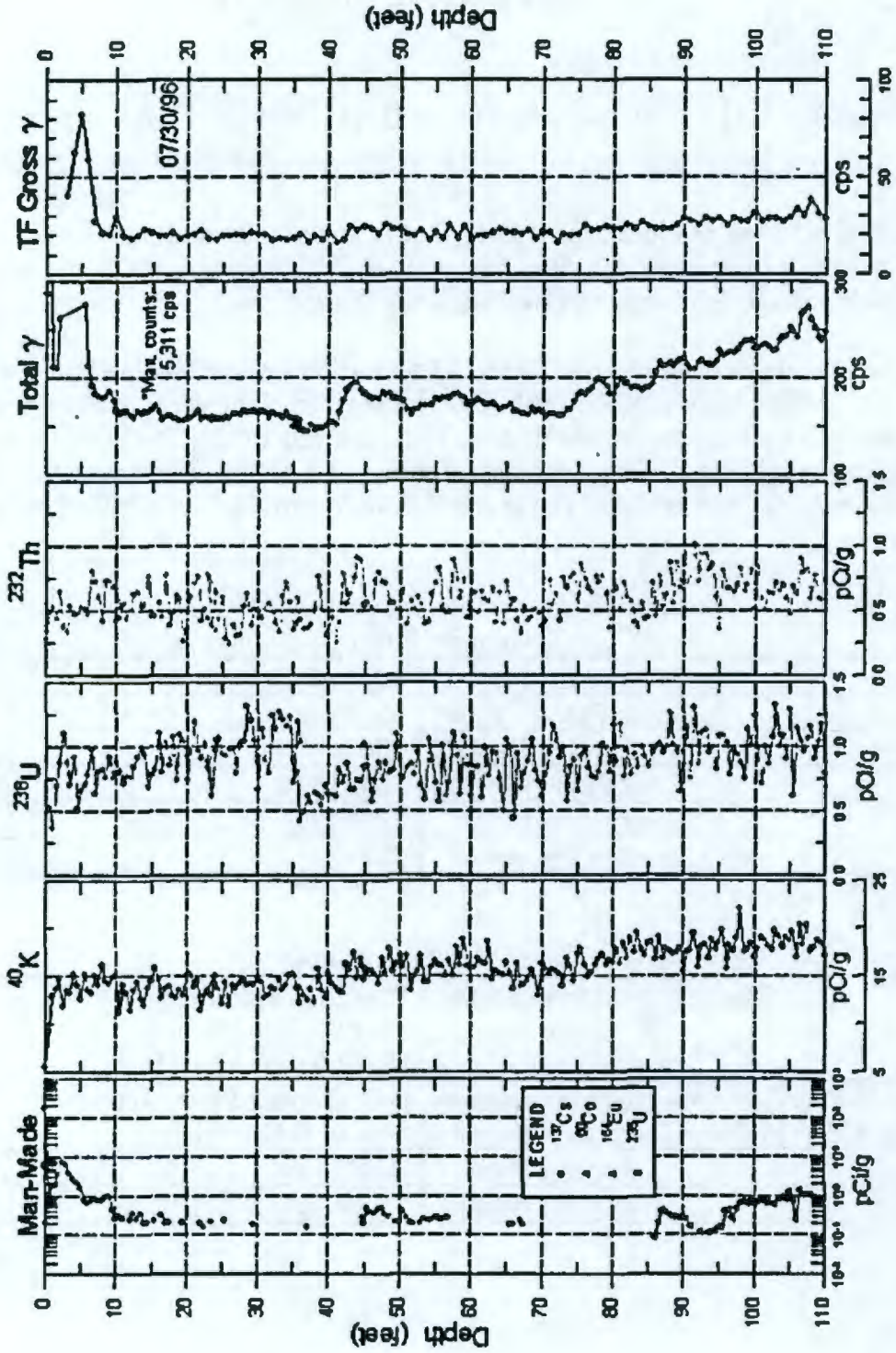
Gross Gamma Survey Information

Probe Type Processed :	04: NaI
Other Probe Types :	03: Neutron
Survey Depth :	130 ft
First Survey Date :	1/10/1975
Last Survey Date :	1/30/1999
Number Surveys Processed :	657

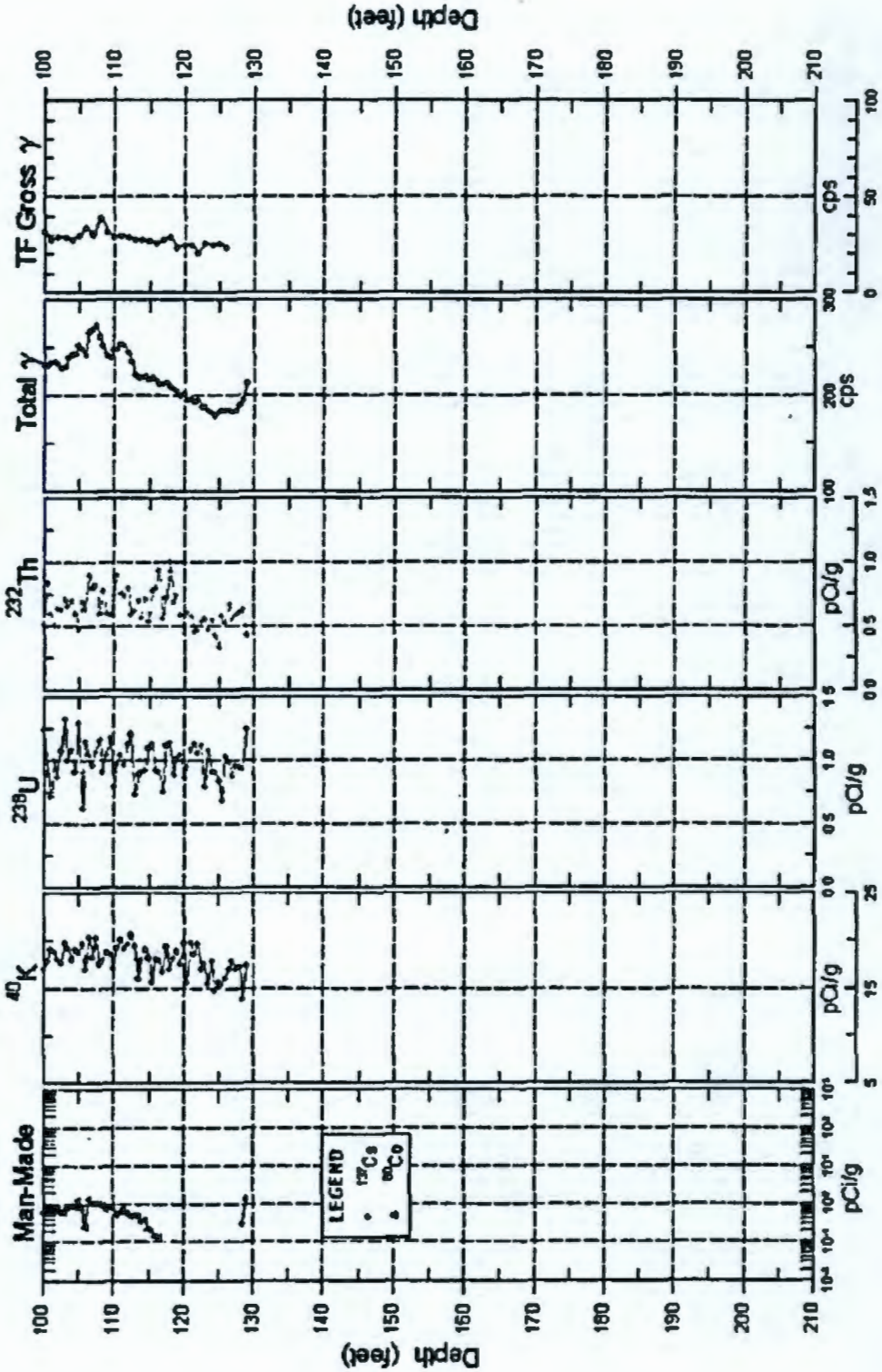
Analysis Notes

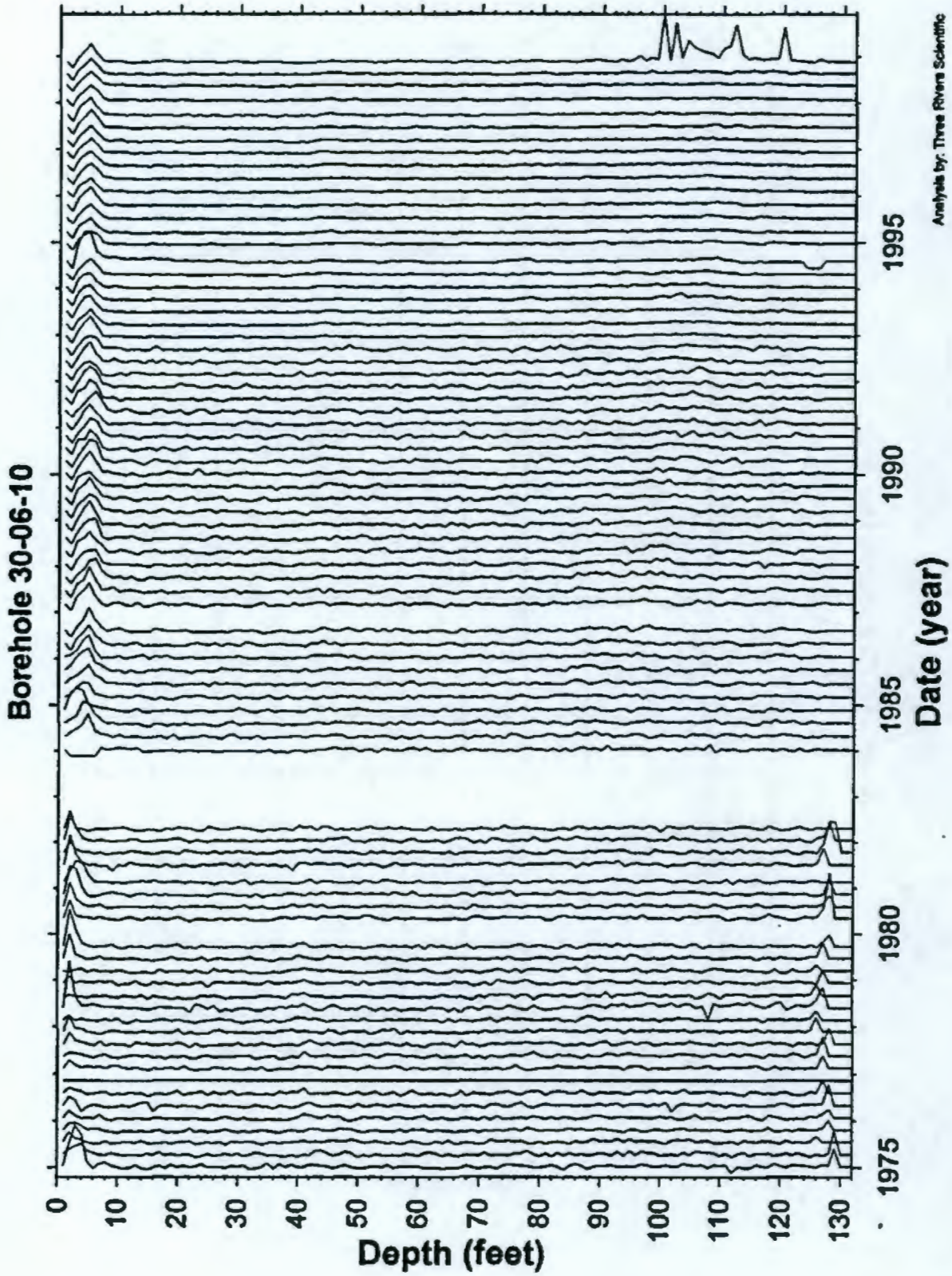
Method Used to Compute Background :	Fixed background: 20-40 ft; zone 0-10 ft 58-80 ft; zone 86-115 ft
Depth(s) where Contamination Identified in Gross Gamma Surveys :	0-10 ft Tank Farm Activity 86-115 ft Unstable
Analyst Name :	R.K. Price
Company Name :	Three Rivers Scientific

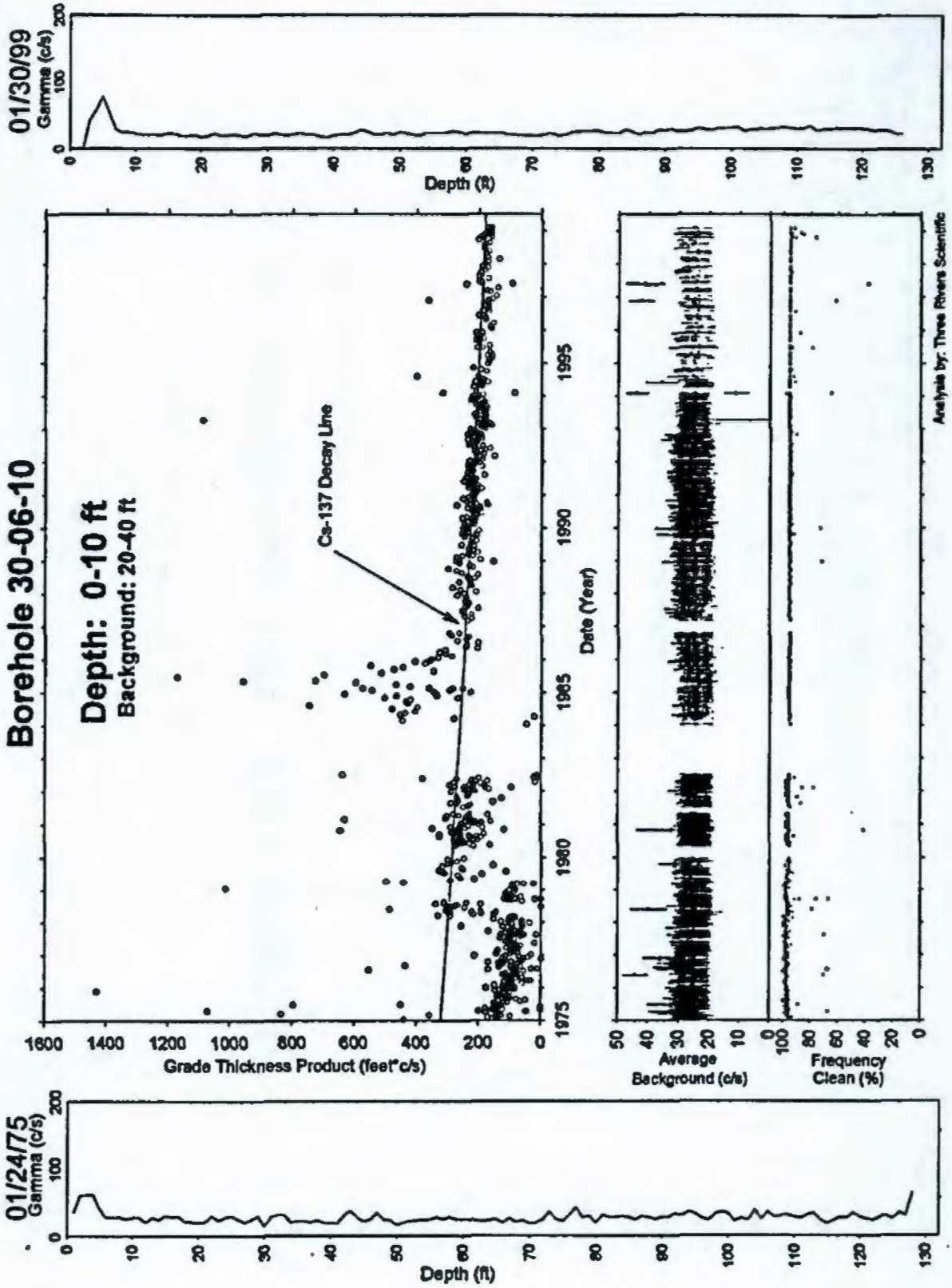
30-06-10 Combination Plot

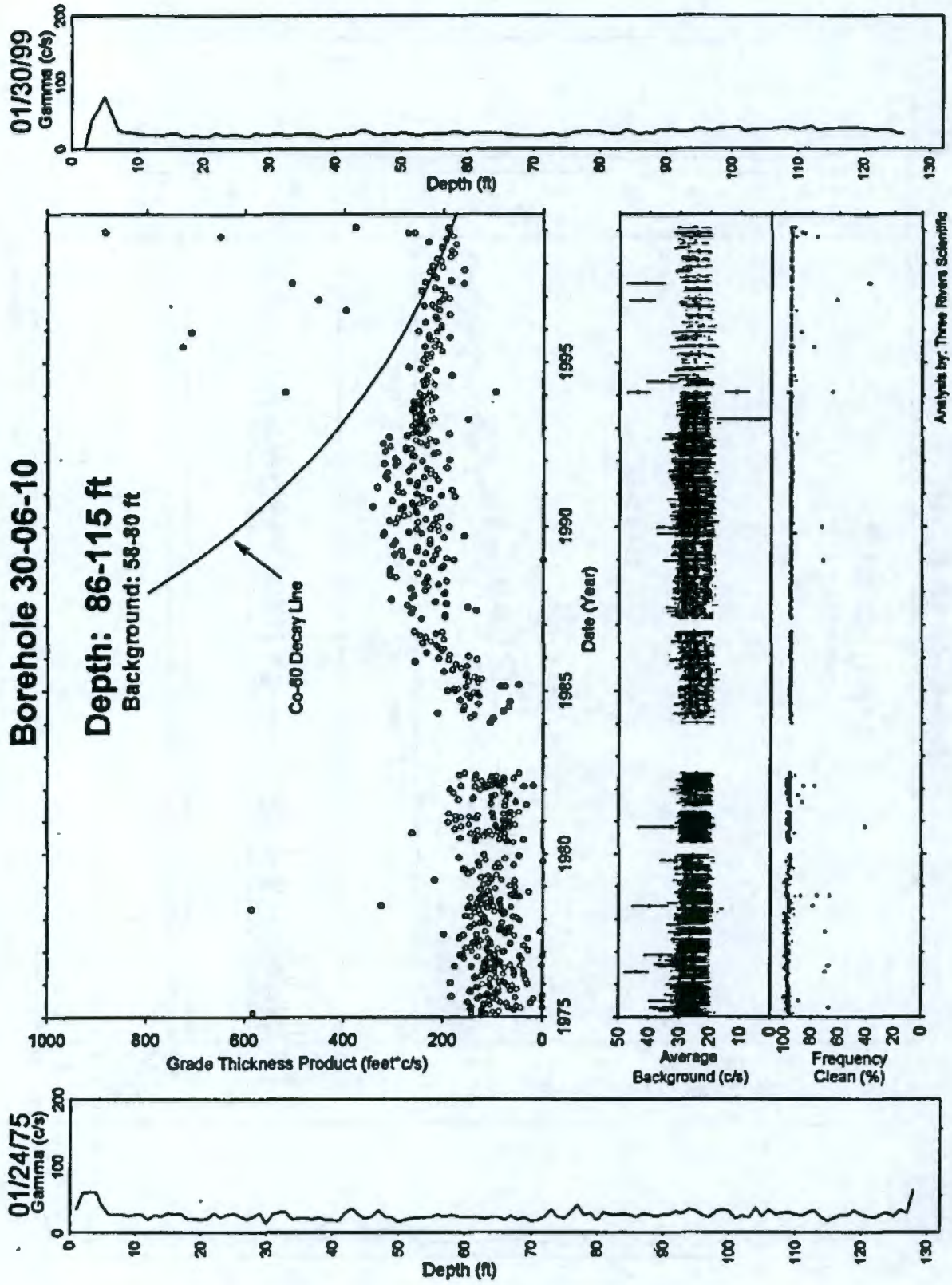


30-06-10 Combination Plot




Borehole 30-06-10
Depth (feet)
0
10
20
30
40
50
60
70
80
90
100
110
120
130
Date (year)
1975
1980
1985
1990
1995
Analysis by: Three Rivers Scientific


01/30/99
Gamma (c/s)
Depth (ft)
Borehole 30-06-10
Depth: 0-10 ft
Background: 20-40 ft
Cs-137 Decay Line
Grade Thickness Product (feet*c/s)
Date (Year)
Average Background (c/s)
Frequency Clean (%)
Analysis by: Three Rivers Scientific
01/24/75
Gamma (c/s)
Depth (ft)


01/30/99
Gamma (c/s)
Depth (ft)
Borehole 30-06-10
Depth: 86-115 ft
Background: 58-80 ft
Co-60 Decay Line
Grade Thickness Product (feet*c/s)
Date (Year)
Average Background (c/s)
Frequency Clean (%)
Analysis by: Three Rivers Scientific
01/24/75
Gamma (c/s)
Depth (ft)

Borehole 30-06-12

Contamination (Cs-137) from 0-14 feet is Tank Farm Activity. Contamination (Cs-137 & Co-60) from 14-26 feet is Unstable Early.

Grade thickness product over 0 to 14 feet is variable and erratic, indicative of tank farm activity. A Cs-137 (HPGe identified) decay line is shown on the grade thickness plot.

Grade thickness product over 14 to 26 feet shows an abrupt activity increase in 1978 then decreases consistent with a least square fit for the decay of Cs-137 and Co-60 (both HPGe identified). The ratio of Cs-137 to Co-60 on 1/2000 is 79:10. The zone is categorized as unstable early.

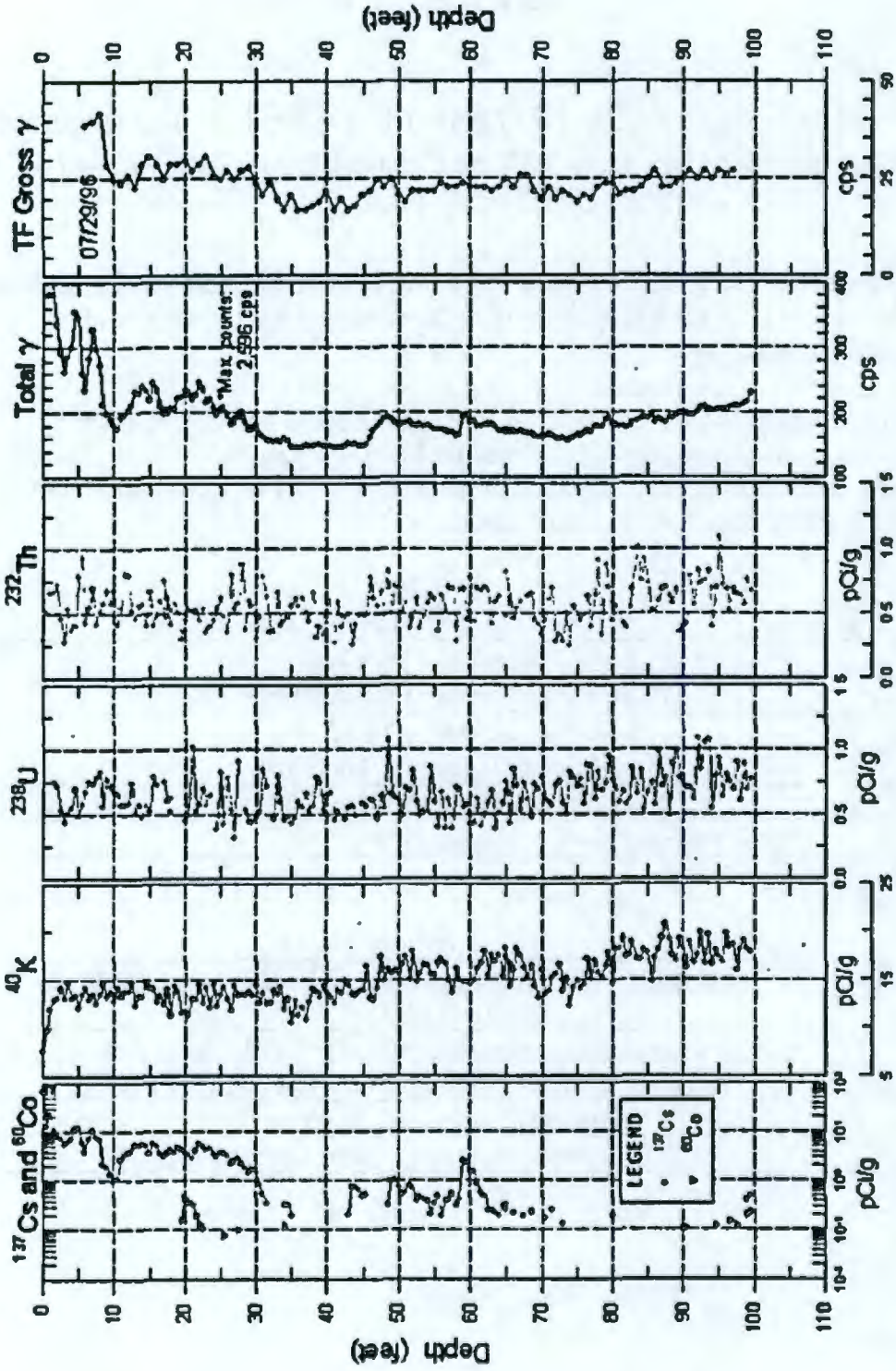
Gross Gamma Survey Information

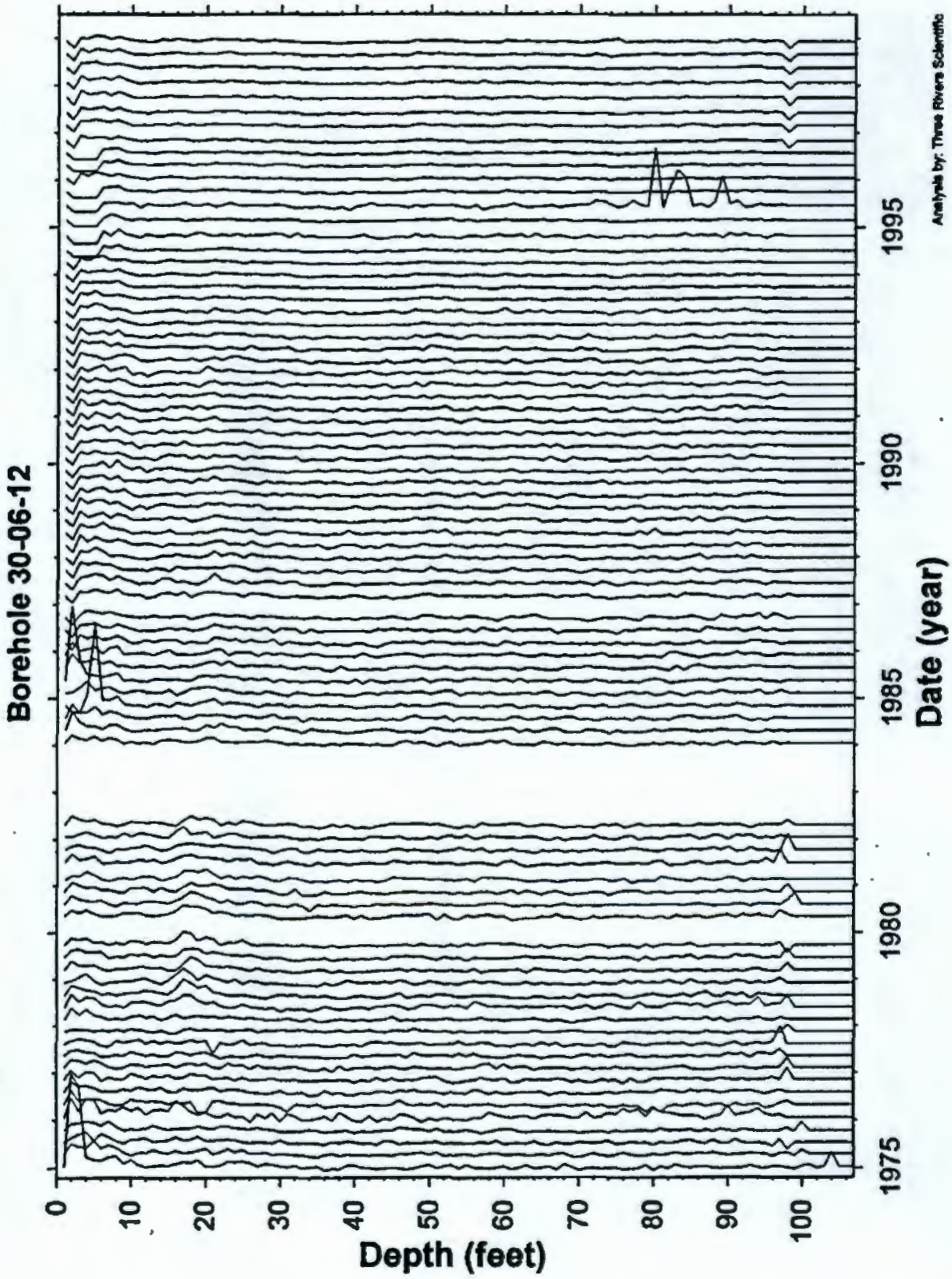
Probe Type Processed :	04: NaI
Other Probe Types :	03: Neutron
Survey Depth :	100 ft
First Survey Date :	1/10/1975
Last Survey Date :	1/20/1999
Number Surveys Processed :	802

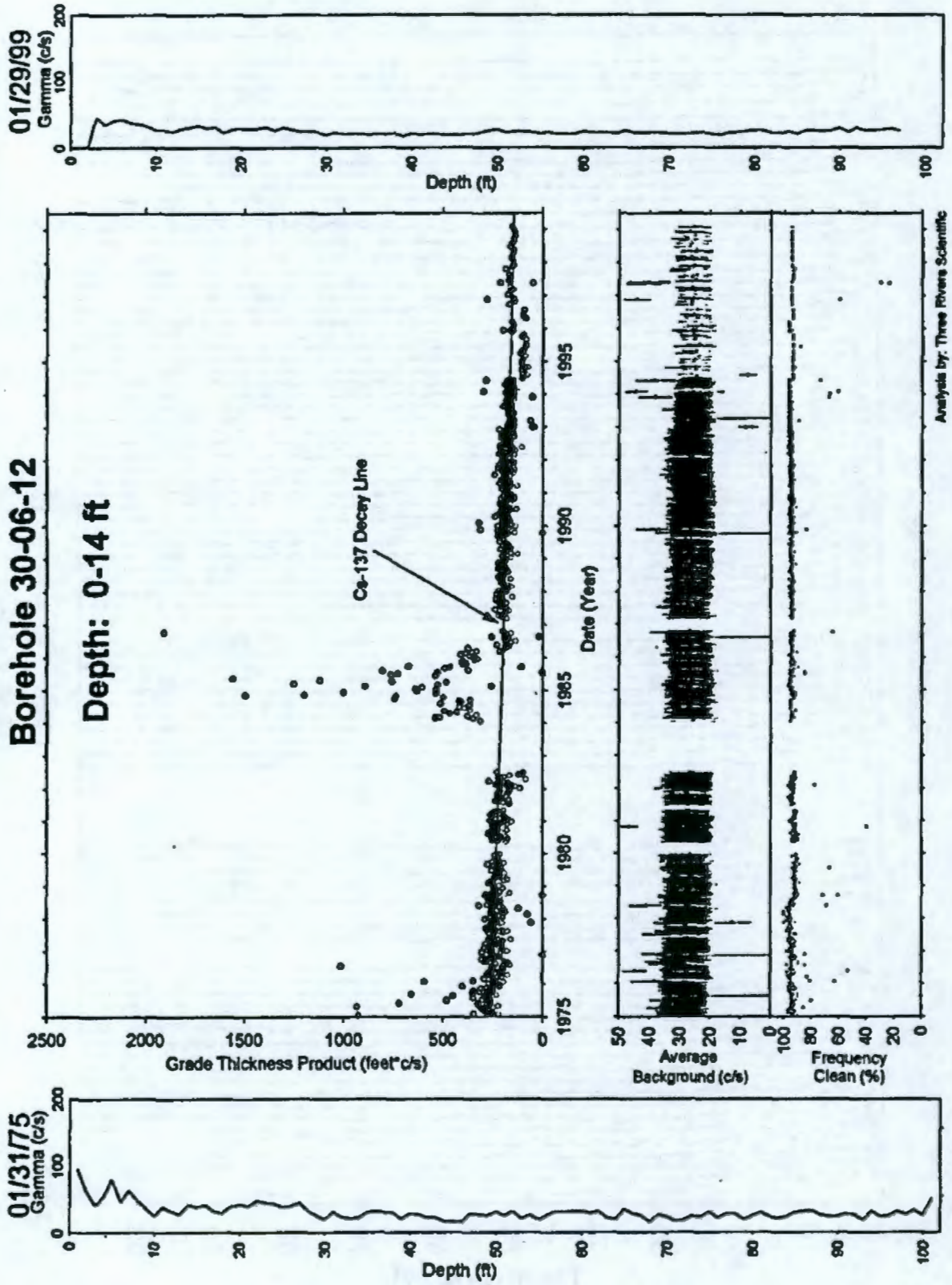
Analysis Notes

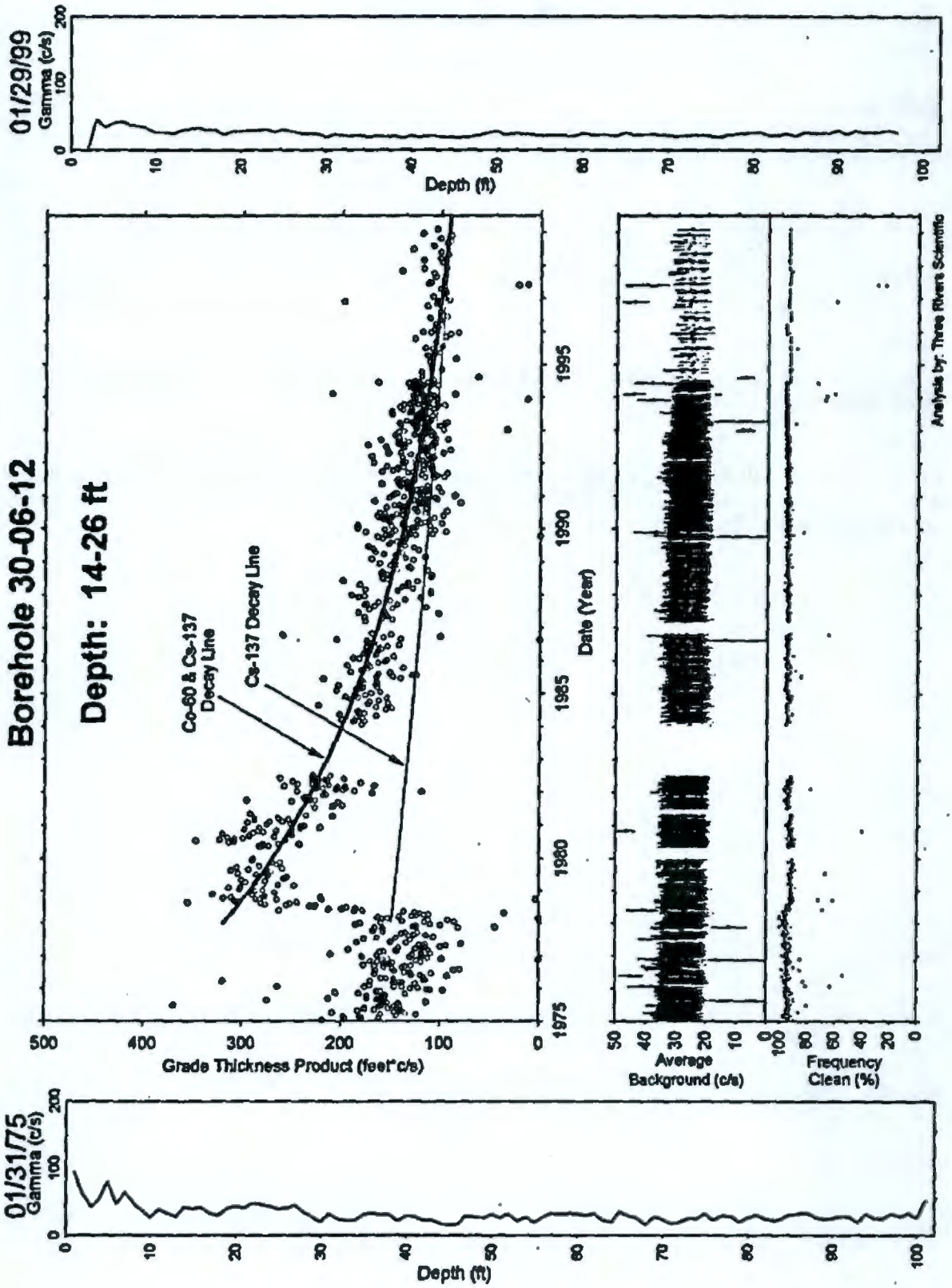
Method Used to Compute Background :	Fixed background: 30-50 ft
Depth(s) where Contamination Identified in Gross Gamma Surveys :	0-14 ft Tank Farm Activity 14-26 ft Unstable Earlly
Analyst Name :	R.K. Price
Company Name :	Three Rivers Scientific

30-06-12 Combination Plot




Borehole 30-06-12
Depth (feet)
0
10
20
30
40
50
60
70
80
90
100
Date (year)
1975
1980
1985
1990
1995
Analysis by: Three Rivers Scientific


01/29/99
Gamma (c/s)
Depth (ft)
Borehole 30-06-12
Depth: 0-14 ft
Cs-137 Decay Line
Grade Thickness Product (feet*c/s)
Date (Year)
Average Background (c/s)
Frequency Clean (%)
Analysis by: Three Rivers Scientific
01/31/75
Gamma (c/s)
Depth (ft)


01/29/99
Gamma (c/s)
Depth (ft)
Borehole 30-06-12
Depth: 14-26 ft
Co-60 & Cs-137 Decay Line
Cs-137 Decay Line
Grade Thickness Product (feet*c/s)
Date (Year)
Average Background (c/s)
Frequency Clean (%)
Analysis by: Three Rivers Scientific
01/31/75
Gamma (c/s)
Depth (ft)

Tank C-107

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This section contains the analysis results for vadose zone boreholes (dry wells) associated with the Tank 107 in the "C" Tank Farm.

Special Notes: Borehole 30-07-05 has high gross for the level of Cs-137 reported with the HPGe log data. This indicates the possibility of either a remote Cs-137 source, or the presence of a strong beta only source, (such as Sr-90).

Borehole 30-07-01

Contamination (Cs-137) from 0-14 feet is Stable.

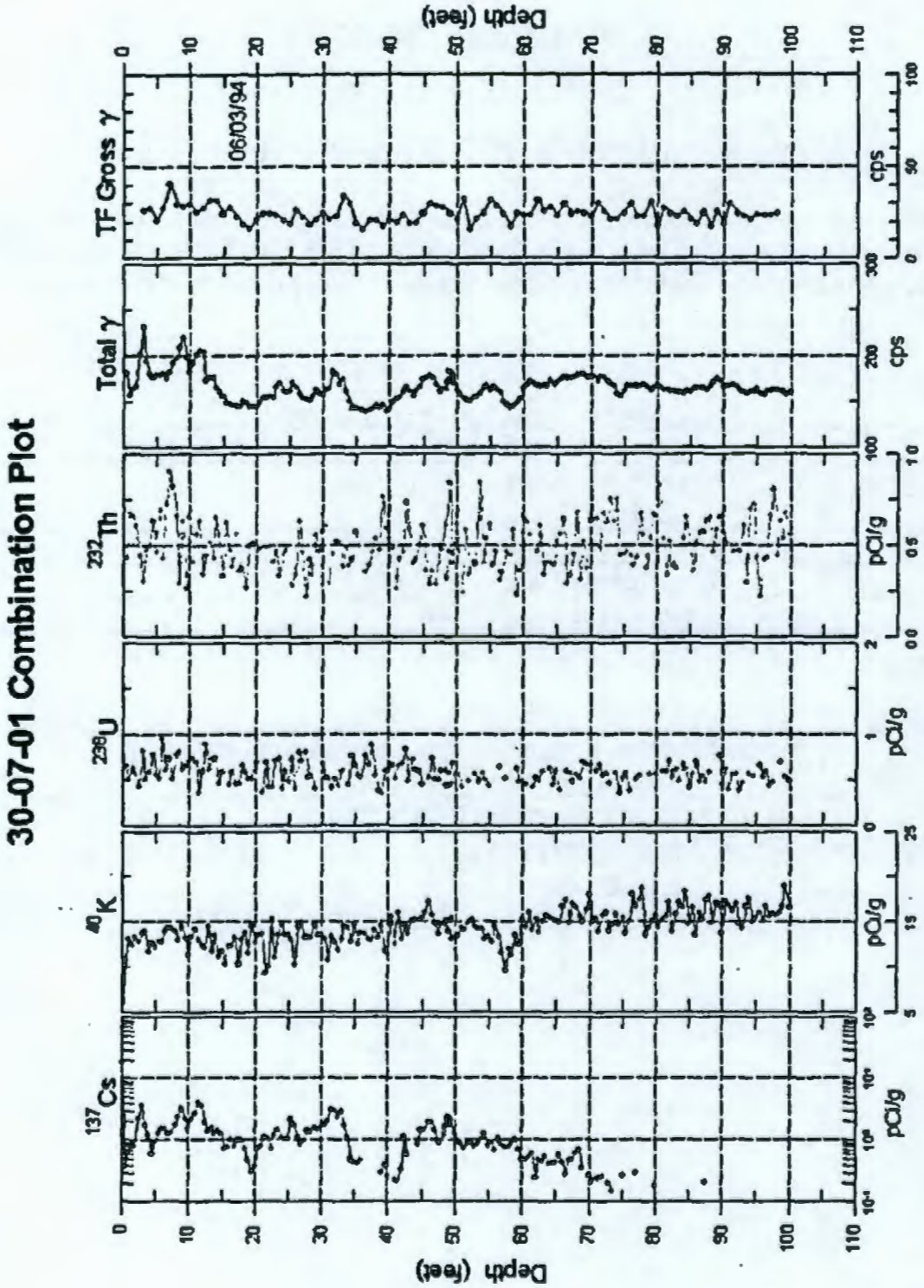
Grade thickness product over 0 to 14 feet is decreasing consistent with logging practices at the top and bottom of a borehole and with Cs-137 (HPGe identified) decay. Any observed variance is within the statistical precision of the data in this interval.

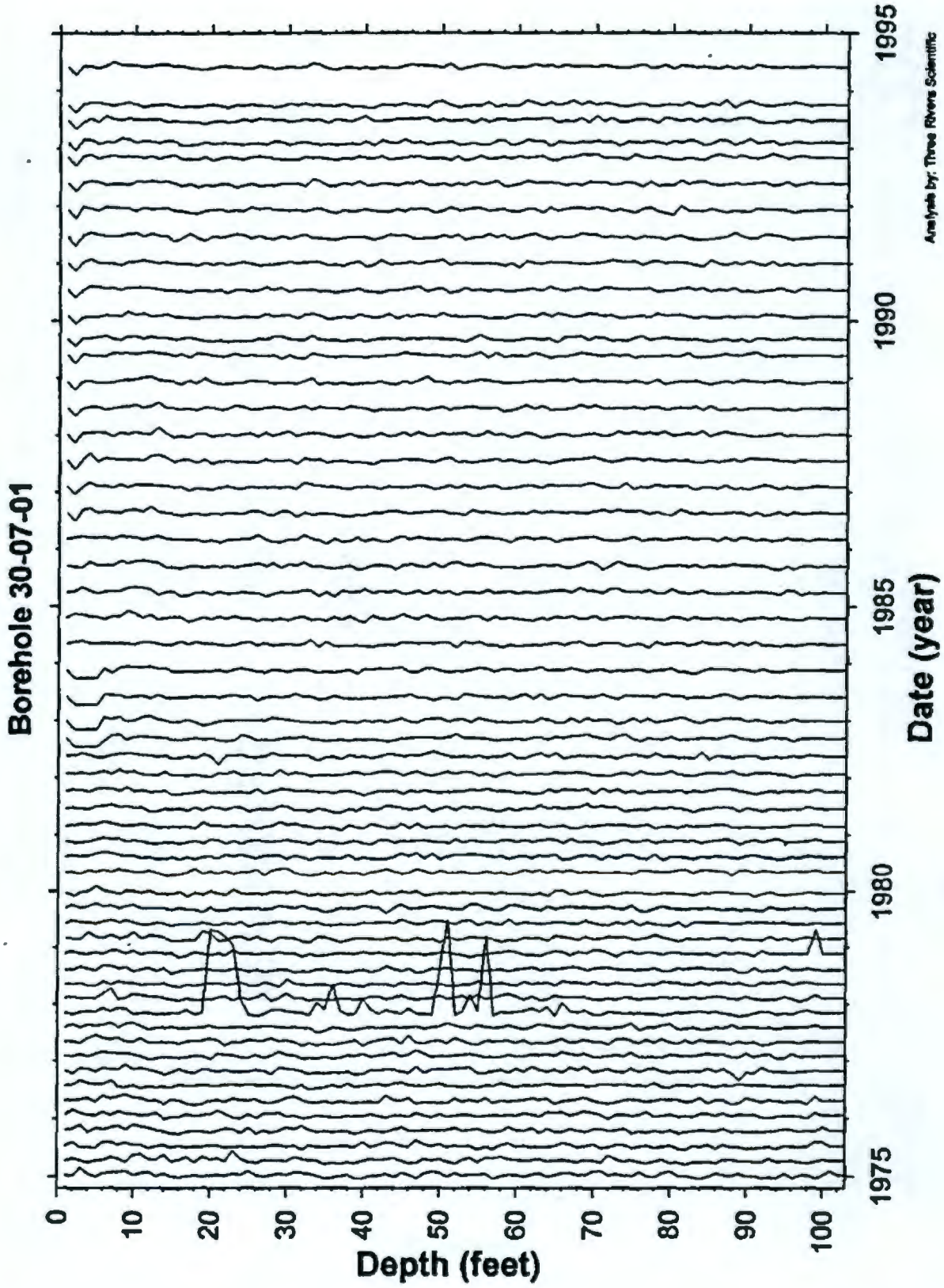
Gross Gamma Survey Information

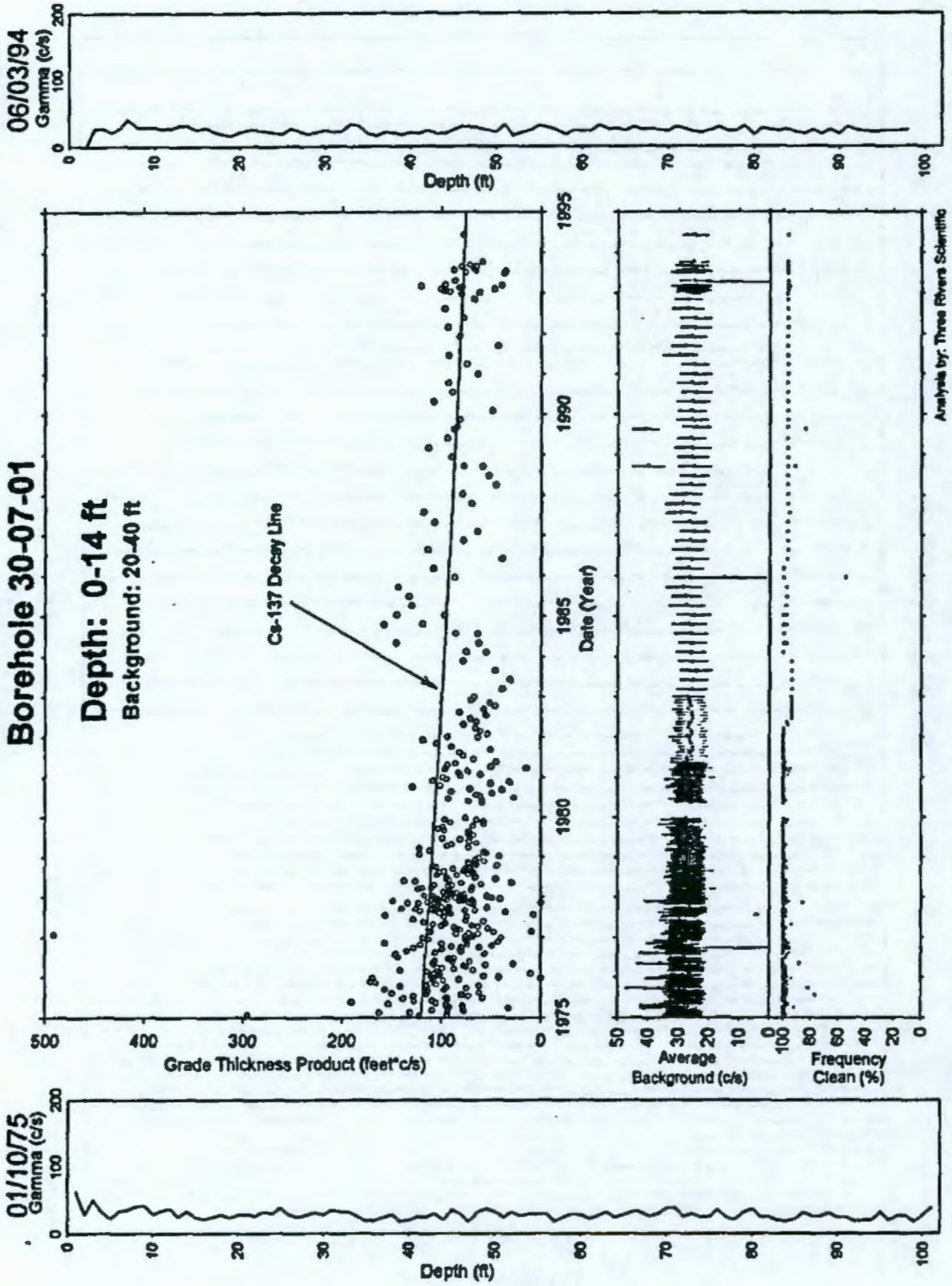
Probe Type Processed :	04: NaI
Other Probe Types :	03: Neutron
Survey Depth :	100 ft
First Survey Date :	1/10/1975
Last Survey Date :	6/03/1994
Number Surveys Processed :	380

Analysis Notes

Method Used to Compute Background :	Fixed background (20-40ft)
Depth(s) where Contamination Identified in Gross Gamma Surveys :	0-14 ft Stable
Analyst Name :	R.K. Price
Company Name :	Three Rivers Scientific


30-07-01 Combination Plot
TF Gross γ
06/03/94
Total γ
232Th
238U
40K
137Cs
cps
pCi/g
Depth (feet)


Borehole 30-07-01
Depth (feet)
0
10
20
30
40
50
60
70
80
90
100
Date (year)
1975
1980
1985
1990
1995
Analysis by: Three Rivers Scientific


06/03/94
Gamma (c/s)
Depth (ft)
Borehole 30-07-01
Depth: 0-14 ft
Background: 20-40 ft
Cs-137 Decay Line
Grade Thickness Product (feet*c/s)
Date (Year)
Average Background (c/s)
Frequency Clean (%)
Analysis by: Three Rivers Scientific
01/10/75
Gamma (c/s)
Depth (ft)

Borehole 30-07-02

No Gamma Ray Emitting Contamination Identified.

No significant levels of gamma ray contamination are present, based upon gross gamma data, above the survey probe detection threshold between 1975 and 1994 in the vadose zone from 2 to 100 feet. The HPGe logging system detected Cs-137 at up to 6 pCi/g from the surface to 32 feet with the maximum occurring at 27 ft.

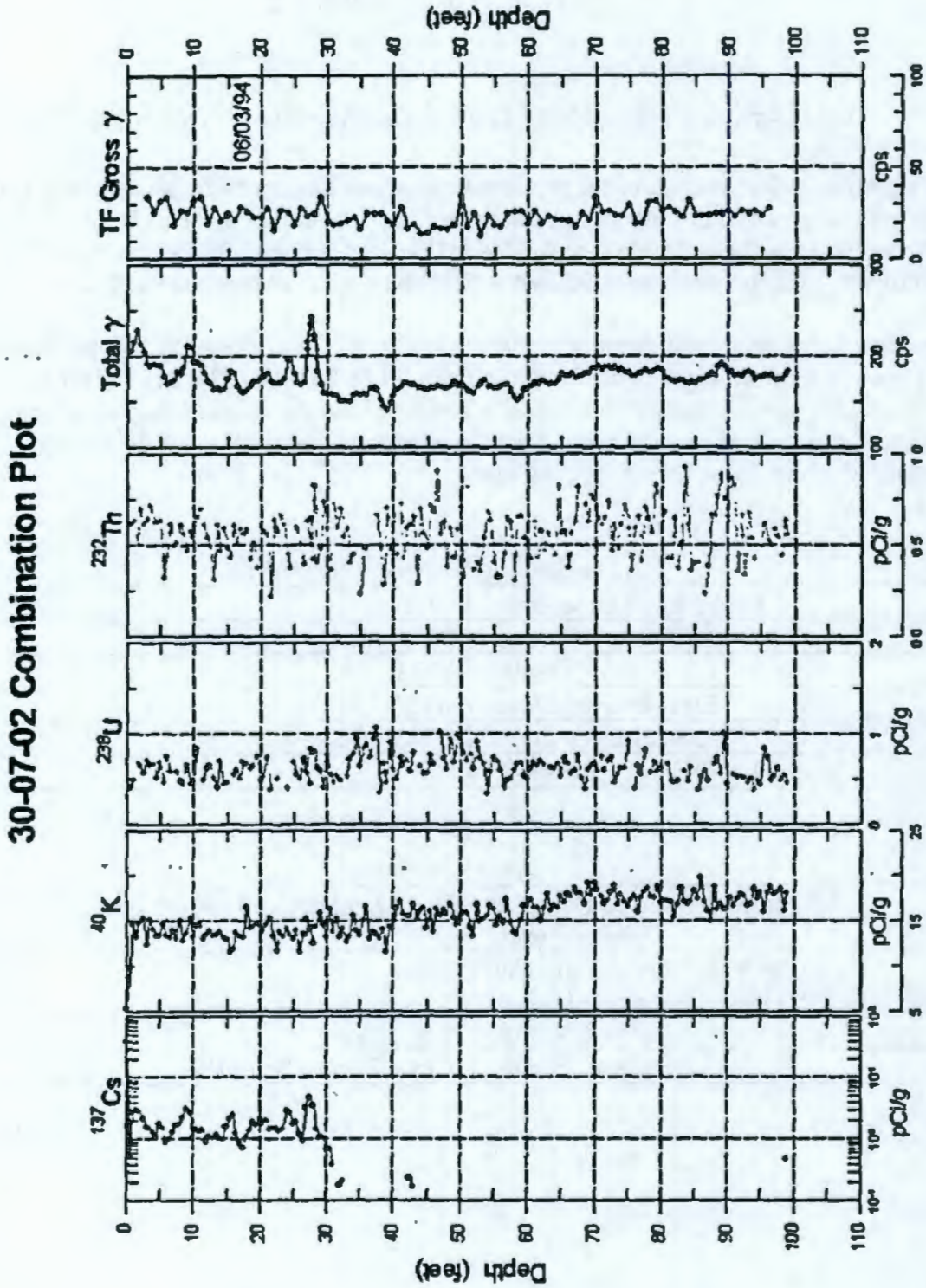
The stack plot and total gamma curve from the HPGe survey both identified a small increase in gamma activity in the zone from 24 to 28 feet. The grade thickness product plot (not included) confirmed a low level zone with no significant variations during the monitoring time period and is less than the minimum detection threshold of the tank farms logging system.

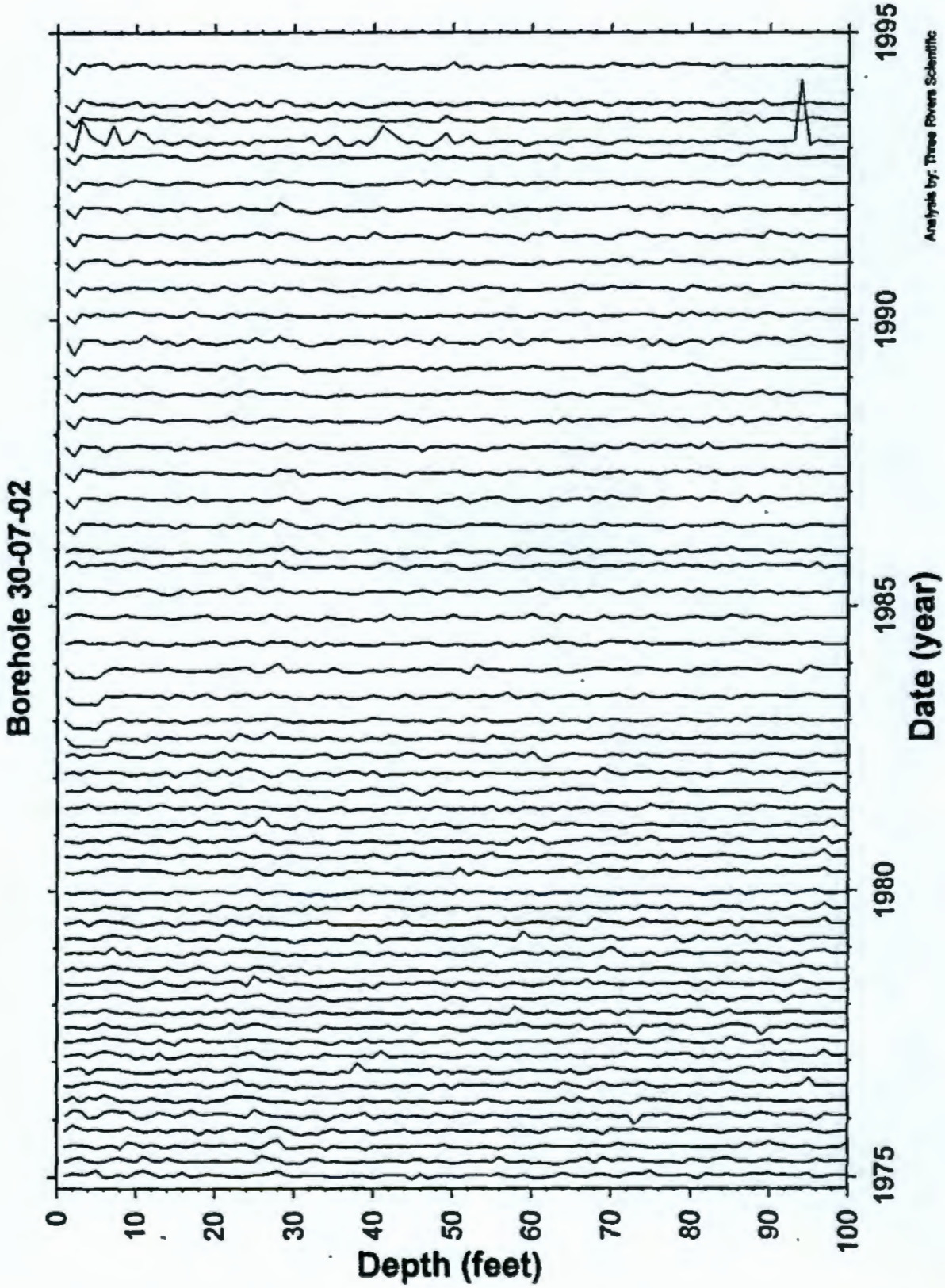
Gross Gamma Survey Information

Probe Type Processed :	04: NaI
Other Probe Types :	03: Neutron
Survey Depth :	100 ft
First Survey Date :	1/10/1975
Last Survey Date :	6/03/1994
Number Surveys Processed :	385

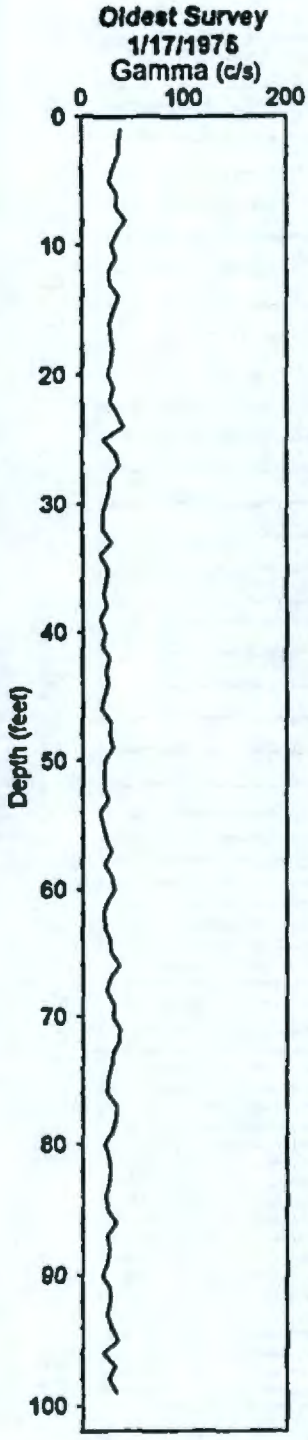
Analysis Notes

Method Used to Compute Background :	Fixed background (34-45 ft)
Depth(s) where Contamination Identified in Gross Gamma Surveys :	None
Analyst Name :	R.K. Price
Company Name :	Three Rivers Scientific

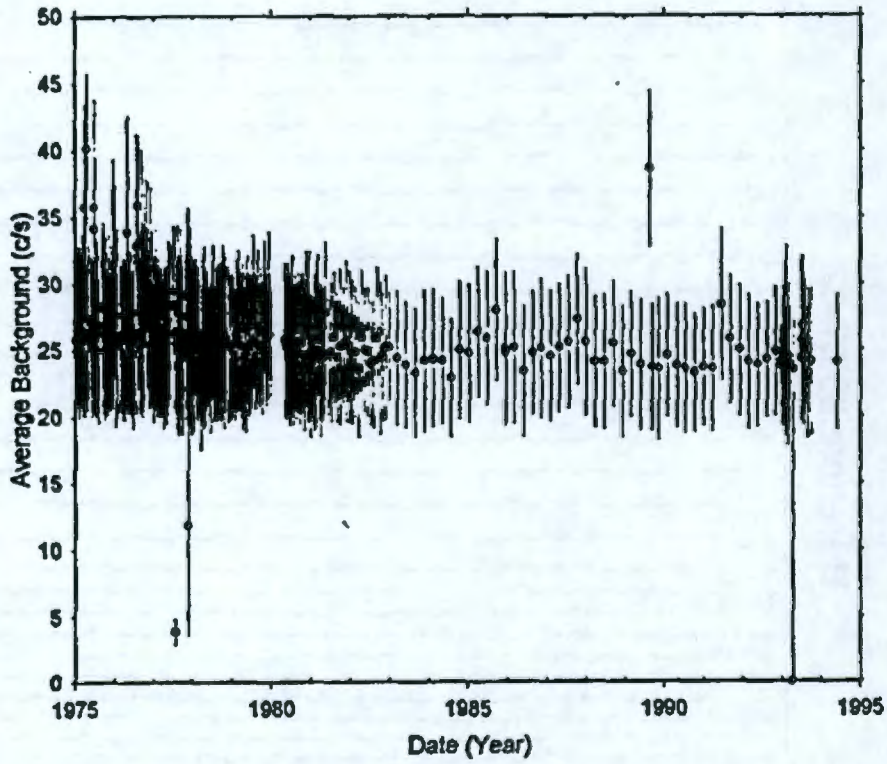

30-07-02 Combination Plot
TF Gross γ
06/03/94
Total γ
232Th
238U
40K
137Cs
cps
pCi/g
Depth (feet)

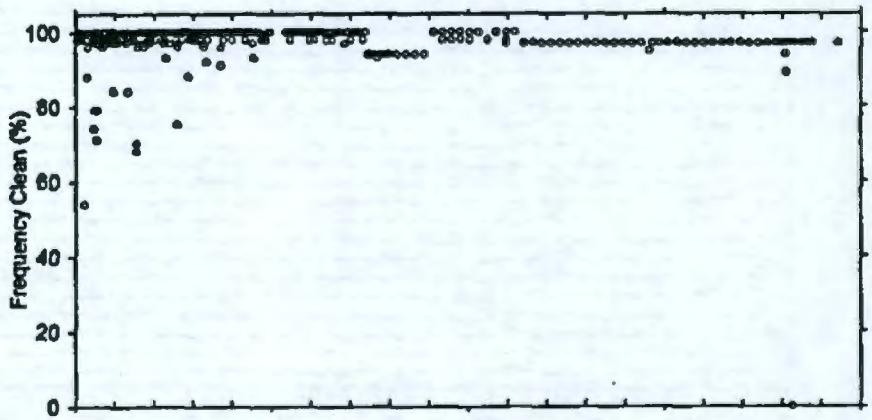

Borehole 30-07-02
Depth (feet)
0
10
20
30
40
50
60
70
80
90
100
Date (year)
1975
1980
1985
1990
1995
Analysis by: Three Rivers Scientific

Borehole 30-07-02



No Gamma-Ray Emitting Contamination Above Survey Detection Threshold





Analysis by: Three Rivers Scientific

Borehole 30-07-05

Contamination (Cs-137) from 0-8 feet is Tank Farm Activity.

Grade thickness product over 0 to 8 feet is variable and erratic from 1975 to 1986, indicative of tank farm activity. Since 1986, the grade thickness product is consistent with the decay of Cs-137 (HPGe identified).

The concentration of Cs-137 between 1 and 4 feet is low relative to the gross gamma activity. This indicates the presence of a strong remote Cs-137 source or the presence of a strong beta only emitter (such as Sr-90).

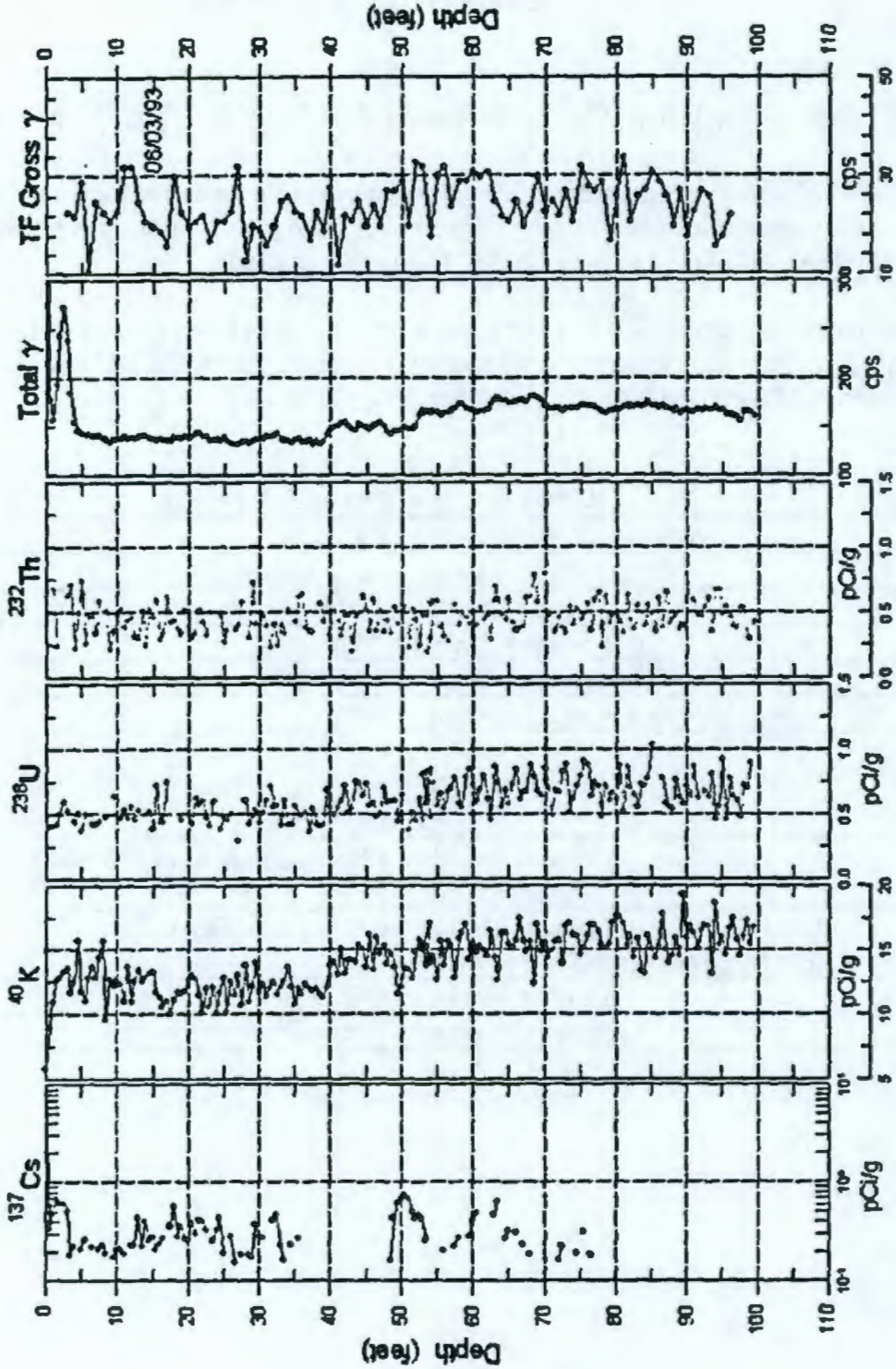
Gross Gamma Survey Information

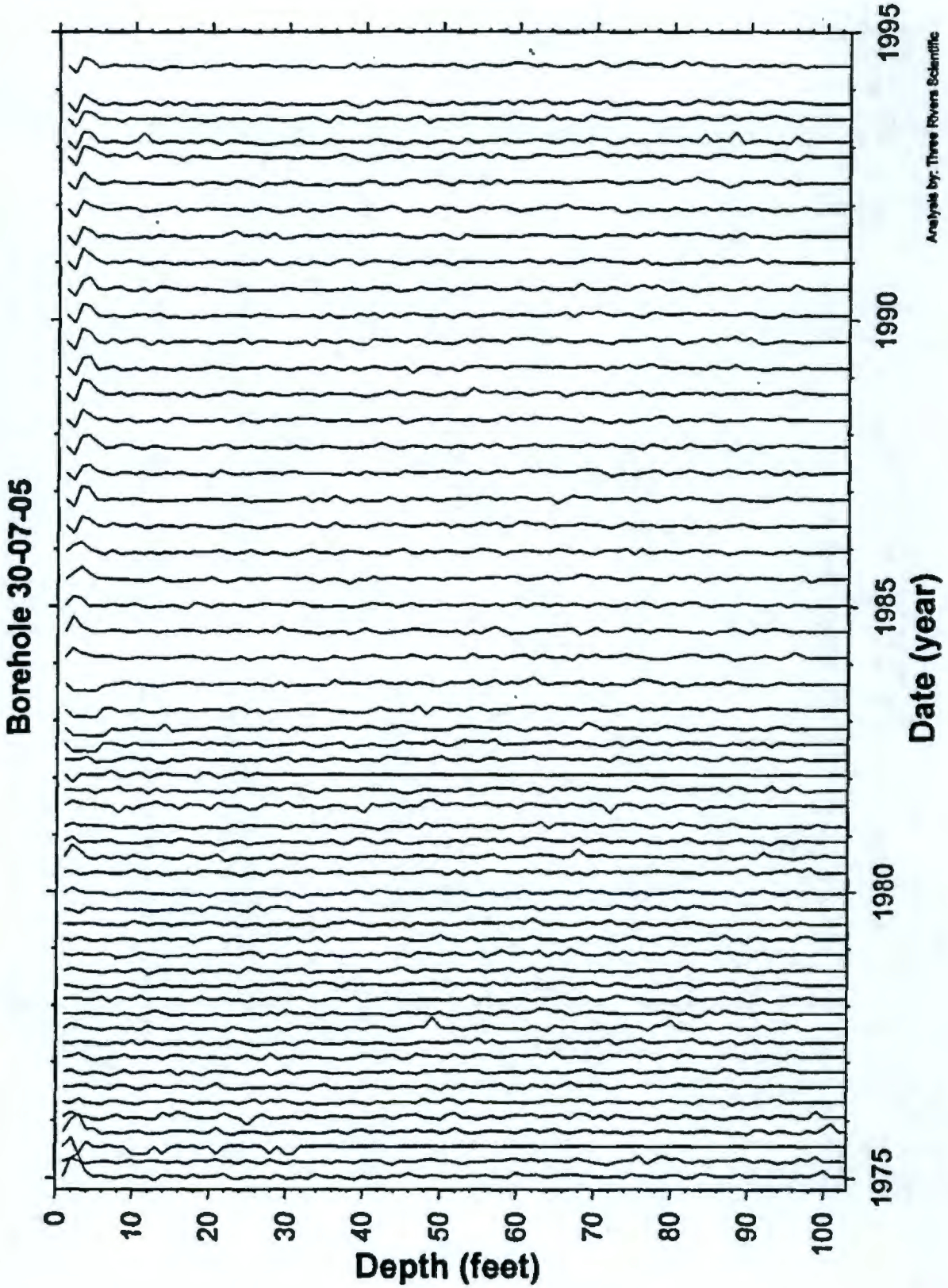
Probe Type Processed :	04: NaI
Other Probe Types :	03: Neutron
Survey Depth :	100 ft
First Survey Date :	1/10/1975
Last Survey Date :	6/30/1994
Number Surveys Processed :	398

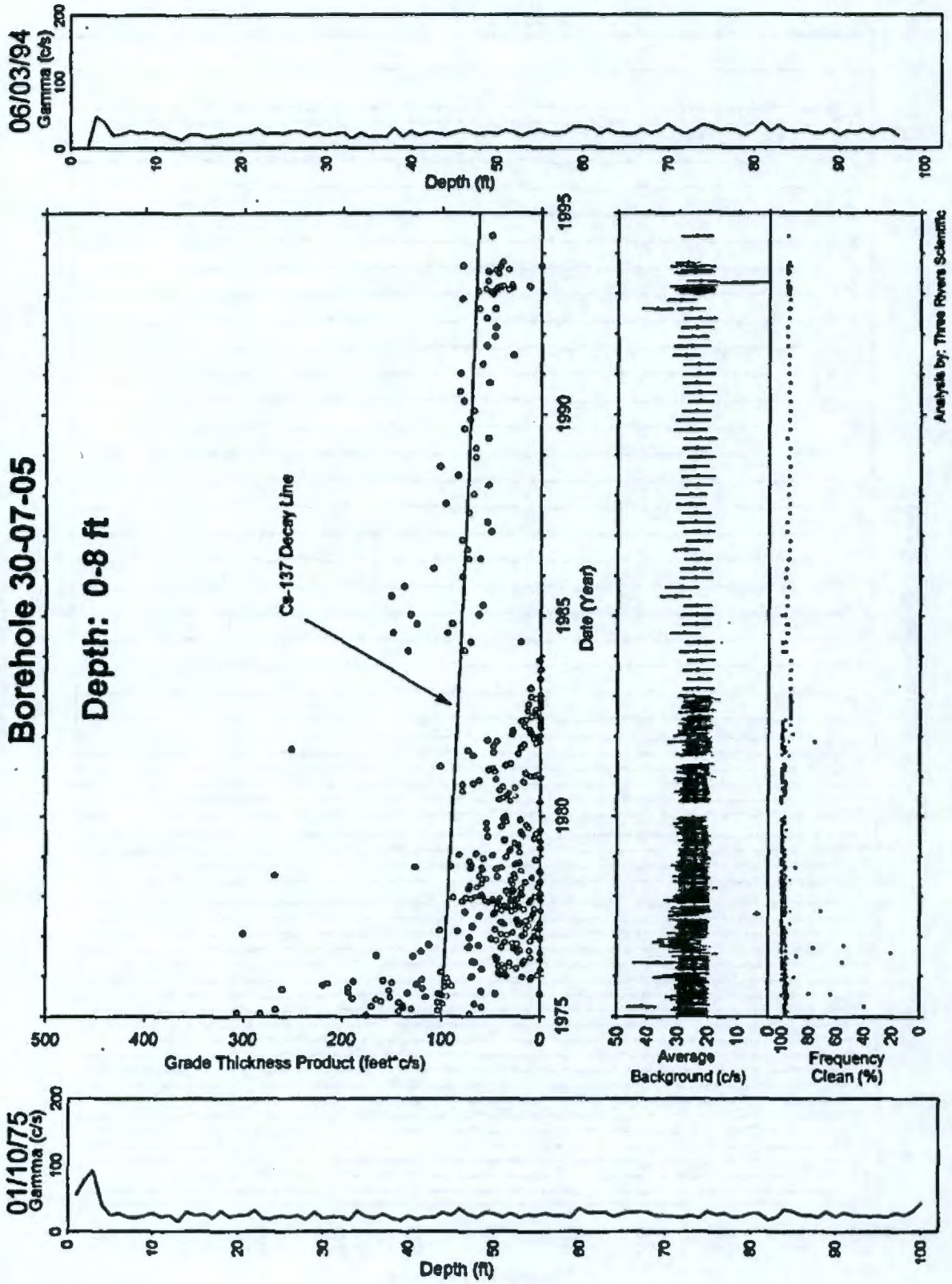
Analysis Notes

Method Used to Compute Background :	Fixed background (10-40ft)
Depth(s) where Contamination Identified in Gross Gamma Surveys :	0-8 ft Tank Farm Activity
Analyst Name :	R.K. Price
Company Name :	Three Rivers Scientific

30-07-05 Combination Plot




Borehole 30-07-05
Depth (feet)
0
10
20
30
40
50
60
70
80
90
100
Date (year)
1975
1980
1985
1990
1995
Analysis by: Three Rivers Scientific


06/03/94
Gamma (c/s)
Depth (ft)
Borehole 30-07-05
Depth: 0-8 ft
Cs-137 Decay Line
Date (Year)
Grade Thickness Product (feet*c/s)
Average Background (c/s)
Frequency Clean (%)
Analysis by: Three Rivers Scientific
01/10/75
Gamma (c/s)
Depth (ft)

Borehole 30-07-07

No Gamma Ray Emitting Contamination Identified.

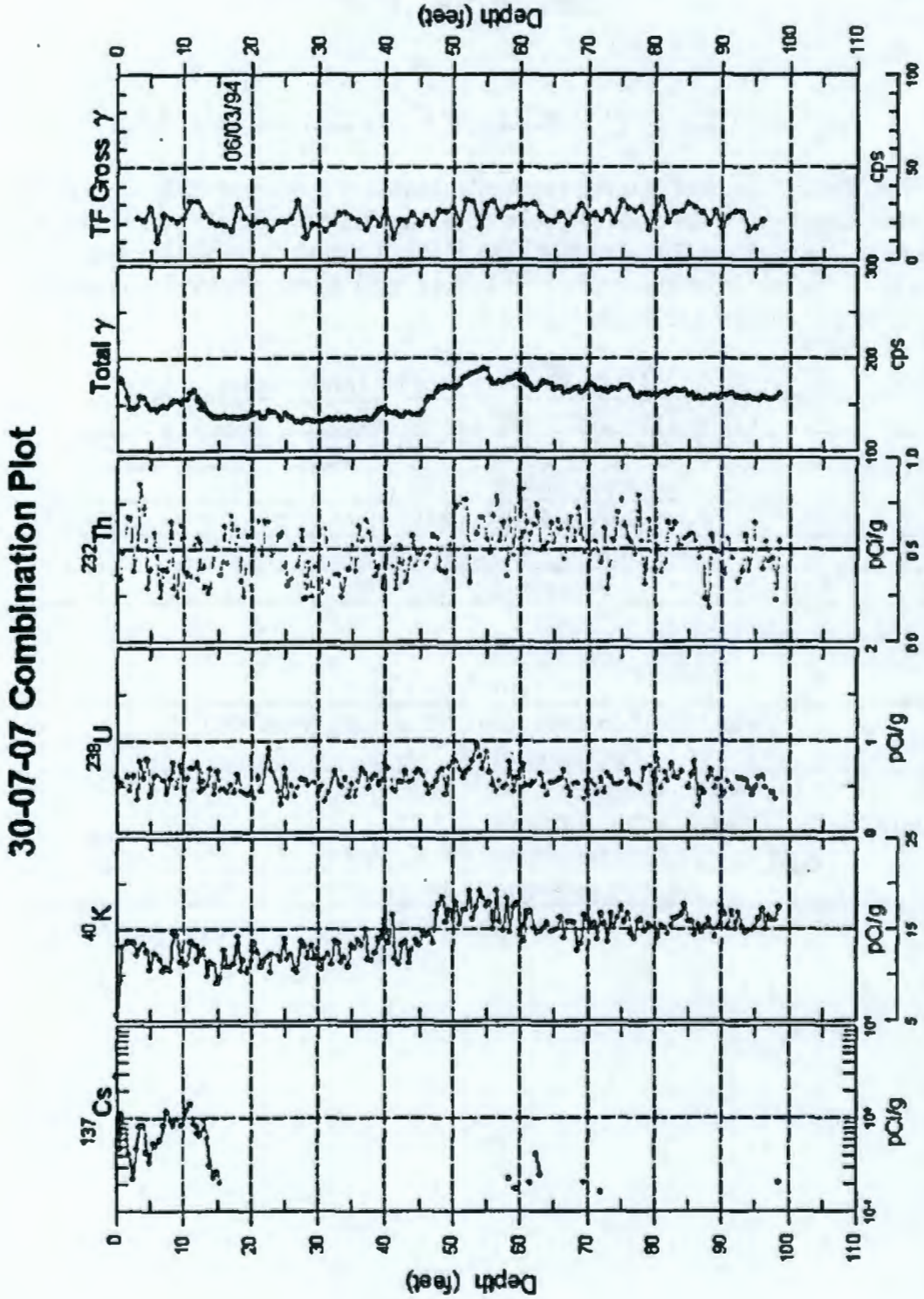
No significant levels of gamma ray contamination are present, based upon gross gamma data, above the survey probe detection threshold between 1975 and 1994 in the vadose zone from 2 to 100 feet. The HPGe logging system detected Cs-137 at less than 2 pCi/g from the surface to 16 feet, and no other detection greater than 0.5 pCi/g for the remainder of the logged depths.

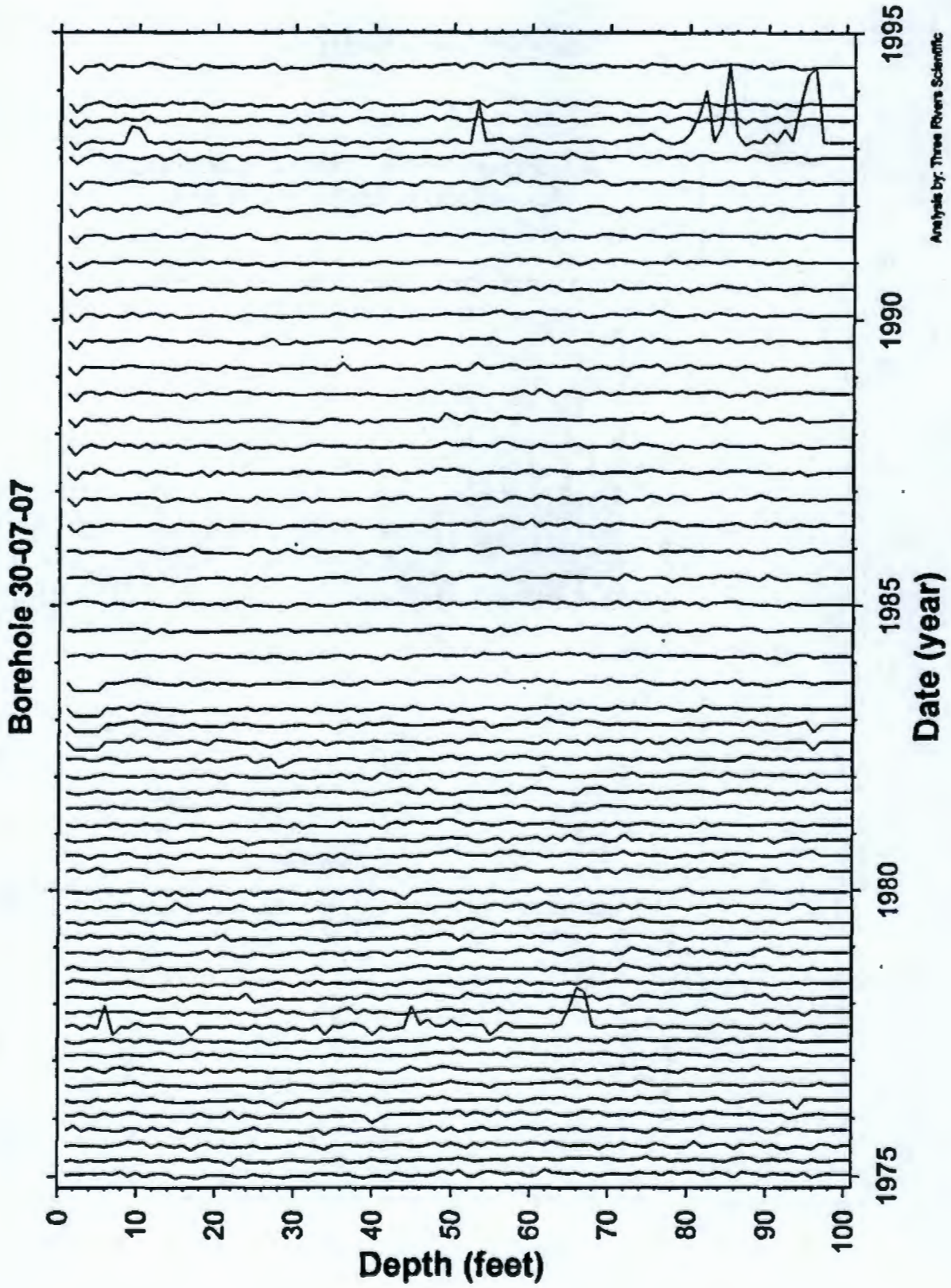
Gross Gamma Survey Information

Probe Type Processed :	04: NaI
Other Probe Types :	03: Neutron
Survey Depth :	100 ft
First Survey Date :	1/10/1975
Last Survey Date :	6/03/1994
Number Surveys Processed :	390

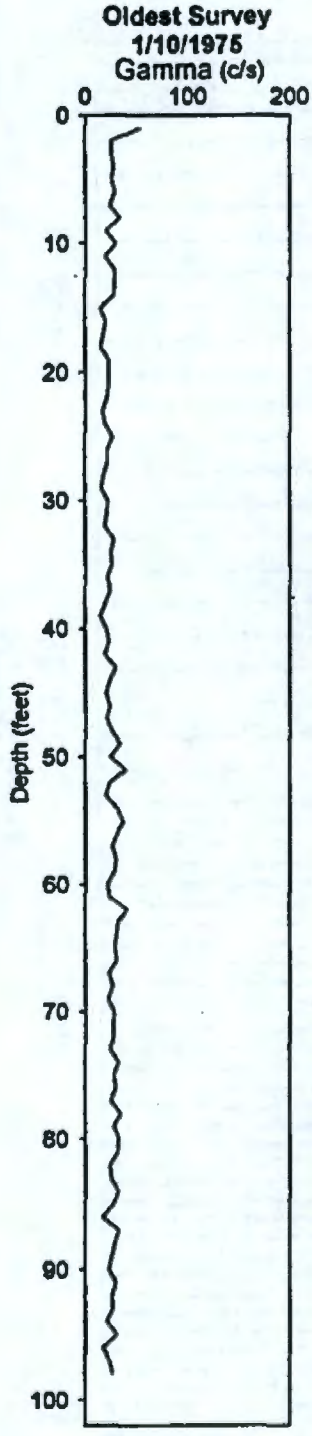
Analysis Notes

Method Used to Compute Background :	Threshold 0<val<50
Depth(s) where Contamination Identified in Gross Gamma Surveys :	NONE
Analyst Name :	R.K. Price
Company Name :	Three Rivers Scientific

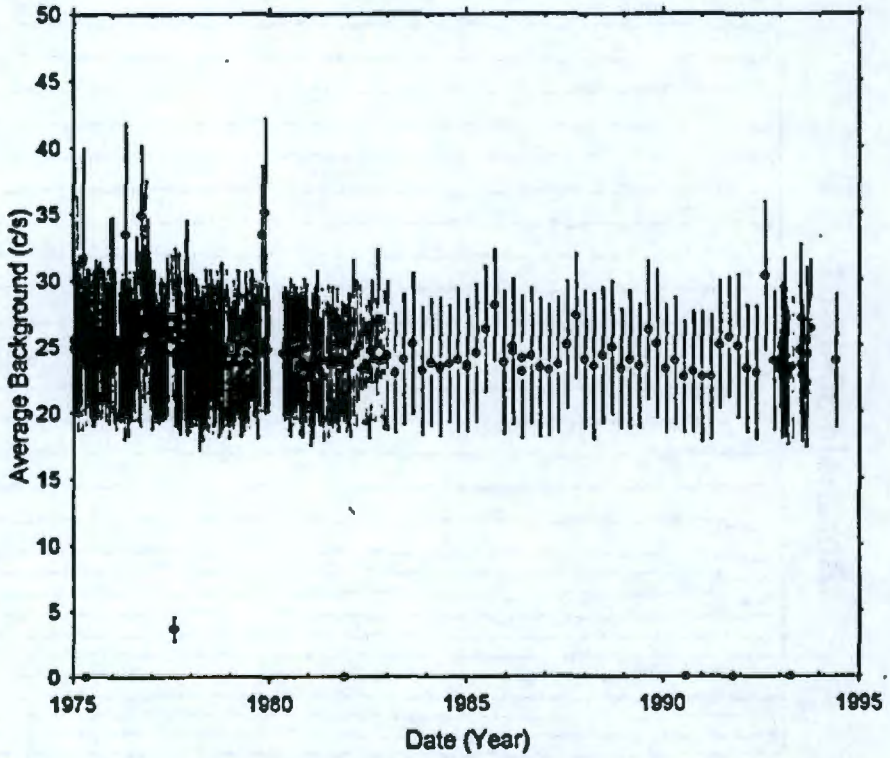

30-07-07 Combination Plot
TF Gross γ
06/03/94
Total γ
232Th
238U
40K
137Cs
Depth (feet)
cps
pCi/g

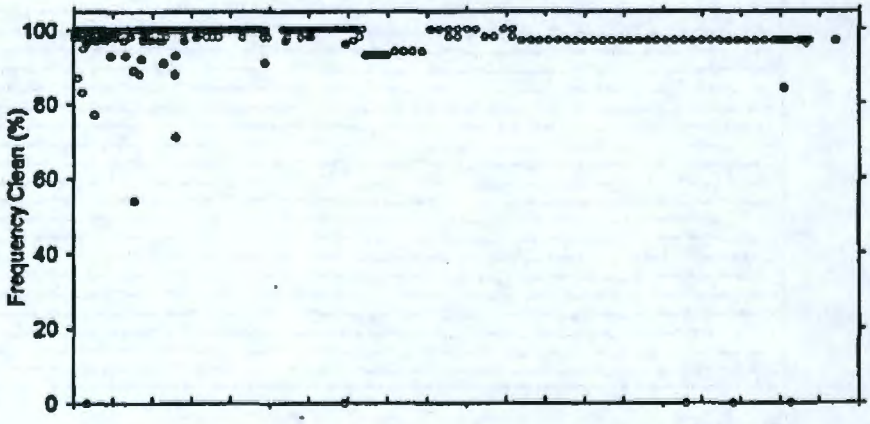

Borehole 30-07-07
Depth (feet)
0
10
20
30
40
50
60
70
80
90
100
Date (year)
1975
1980
1985
1990
1995
Analysis by: Three Rivers Scientific

Borehole 30-07-07



No Gamma-Ray Emitting Contamination Above Survey Detection Threshold





Analysis by: Three Rivers Scientific

Borehole 30-07-08

No Gamma Ray Emitting Contamination Identified.

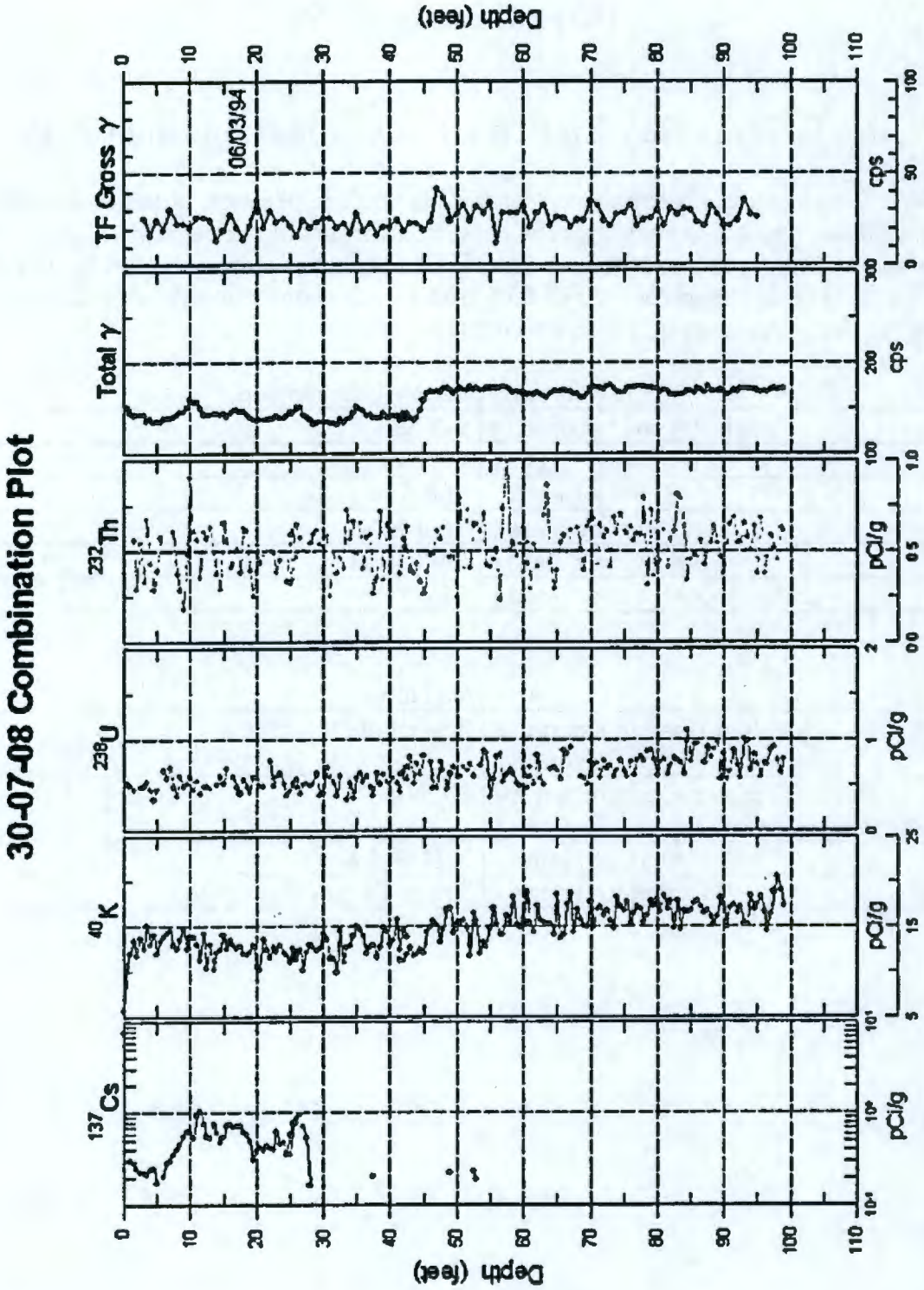
No significant levels of gamma ray contamination are present, based upon gross gamma data, above the survey probe detection threshold between 1975 and 1994 in the vadose zone from 2 to 100 feet. The HPGe logging system detected Cs-137 at 1 pCi/g or less from the surface to 28 feet, and no other detection greater than 0.5 pCi/g for the remainder of the logged depths.

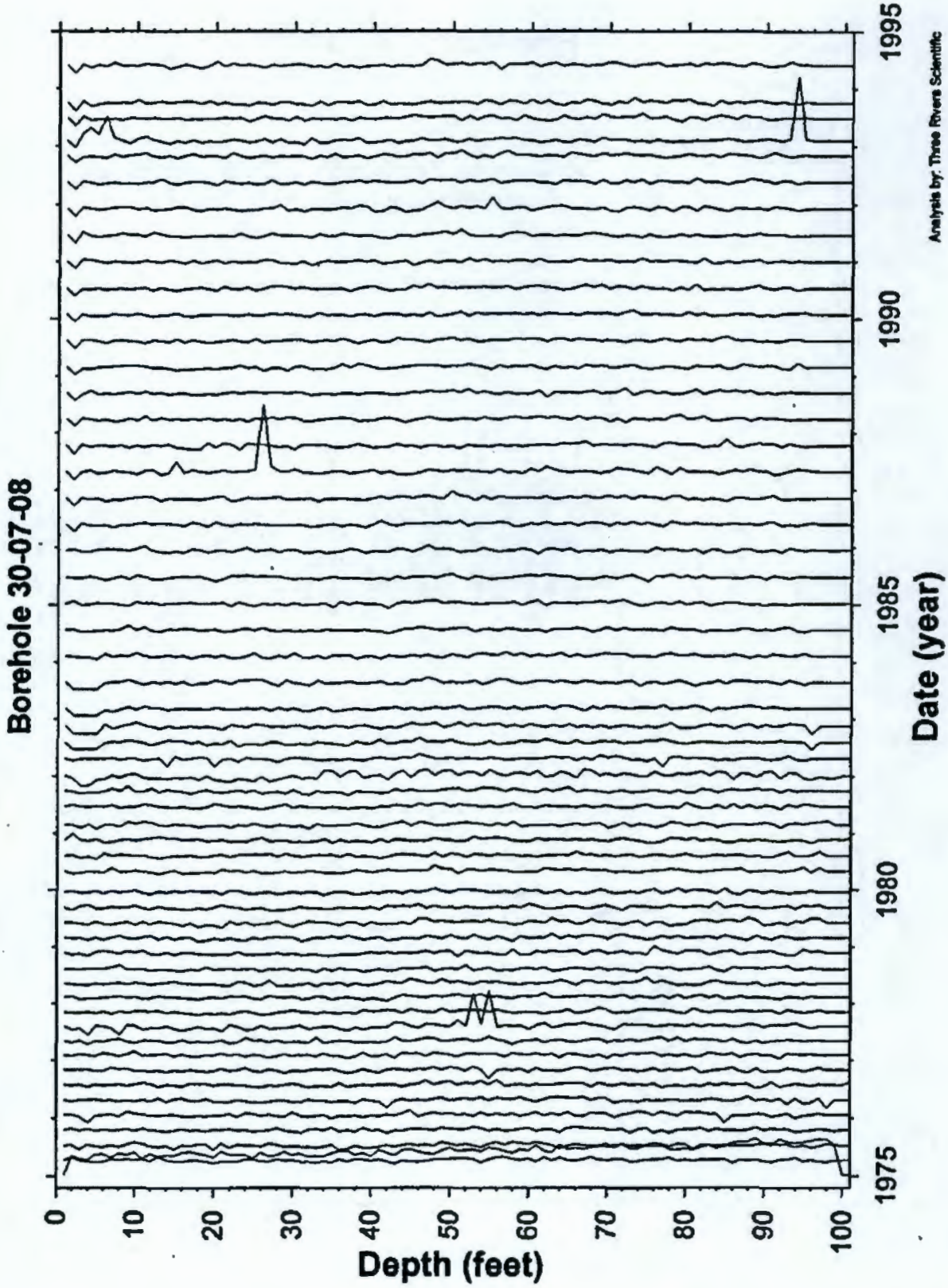
Gross Gamma Survey Information

Probe Type Processed :	04: NaI
Other Probe Types :	03: Neutron
Survey Depth :	100 ft
First Survey Date :	1/10/1975
Last Survey Date :	6/03/1994
Number Surveys Processed :	387

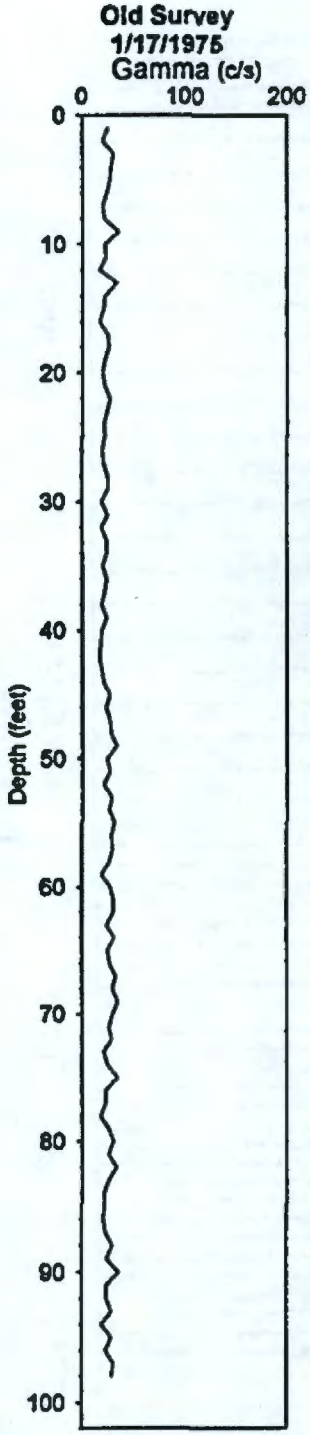
Analysis Notes

Method Used to Compute Background :	Threshold 0<val<50
Depth(s) where Contamination Identified in Gross Gamma Surveys :	NONE
Analyst Name :	R.K. Price
Company Name :	Three Rivers Scientific

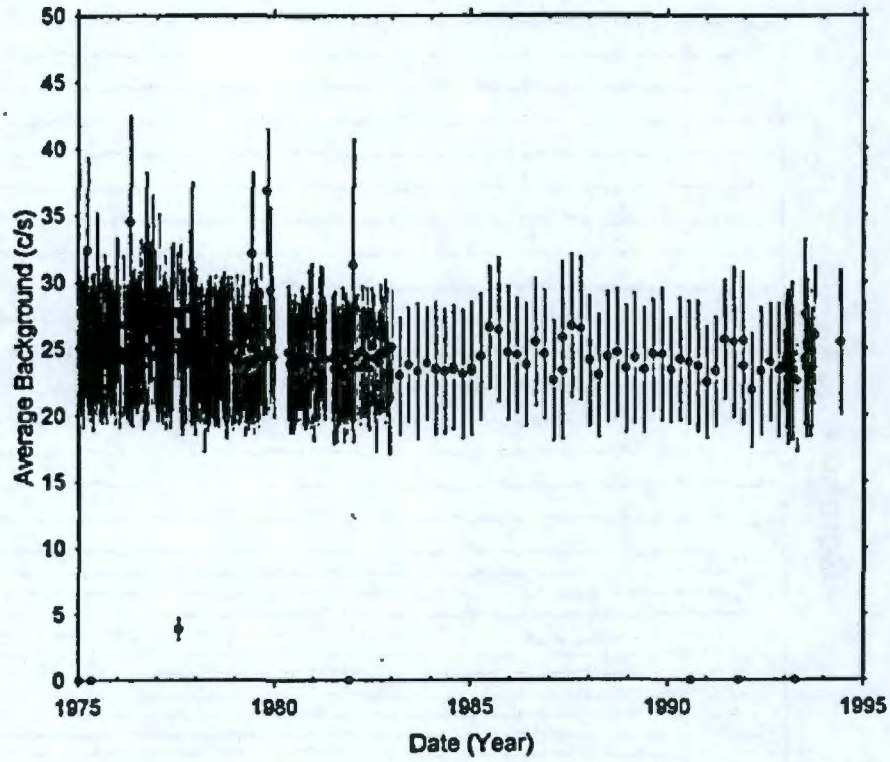

30-07-08 Combination Plot
TF Gross γ
06/03/94
Total γ
232Th
238U
40K
137Cs
cps
pCi/g
Depth (feet)

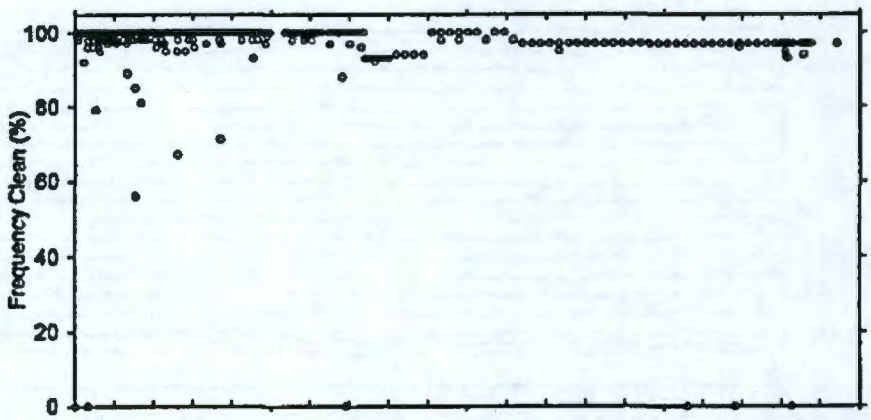

Borehole 30-07-08
Depth (feet)
0
10
20
30
40
50
60
70
80
90
100
Date (year)
1975
1980
1985
1990
1995
Analysis by: Three Rivers Scientific

Borehole 30-07-08



No Gamma-Ray Emitting Contamination Above Survey Detection Threshold





Analysis by: Three Rivers Scientific

Borehole 30-07-10

No Gamma Ray Emitting Contamination Identified.

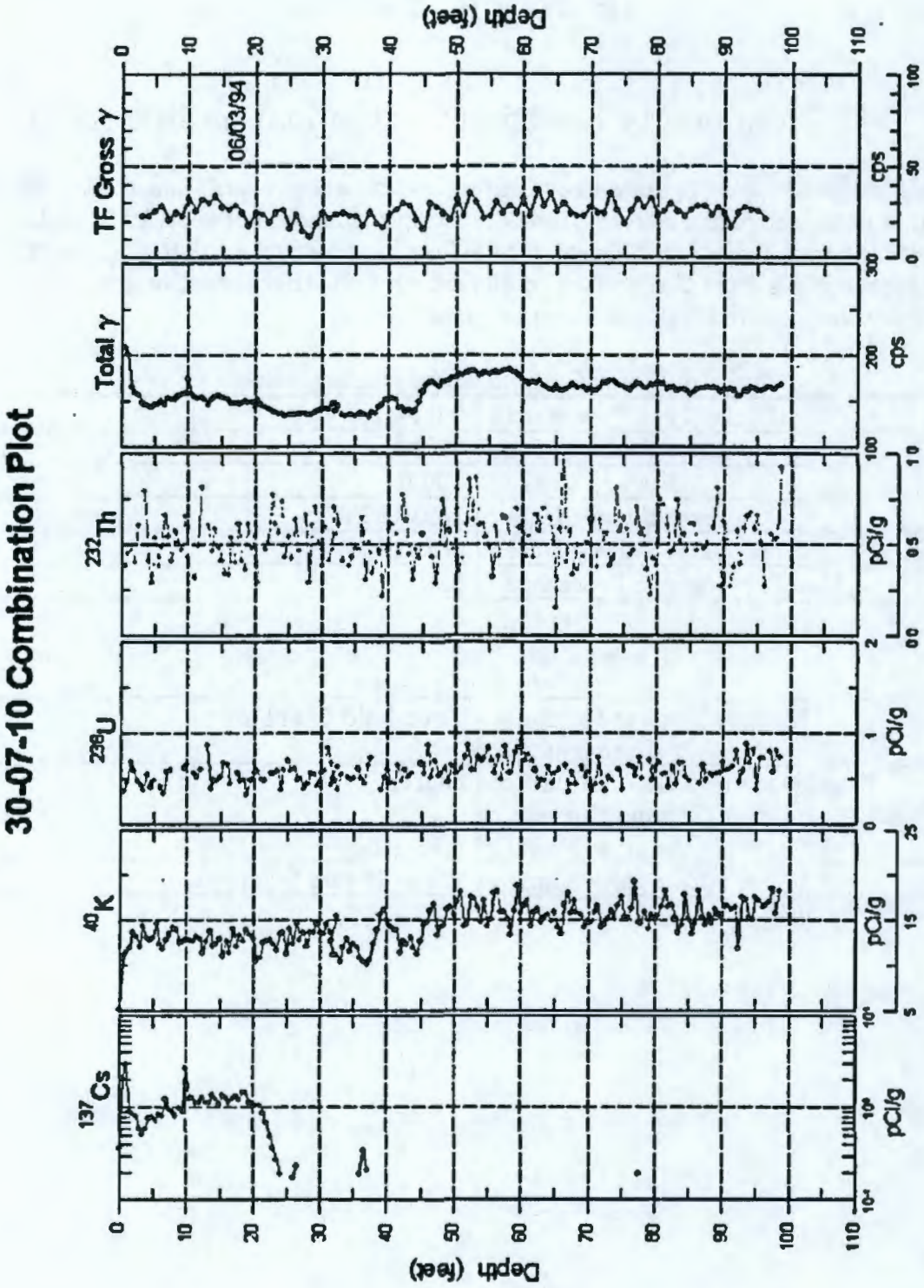
No significant levels of gamma ray contamination are present, based upon gross gamma data, above the survey probe detection threshold between 1975 and 1994 in the vadose zone from 2 to 100 feet. The HPGe logging system detected Cs-137 at less than 3 pCi/g from the surface to 25 feet, and no other detection greater than 0.5 pCi/g for the remainder of the logged depths.

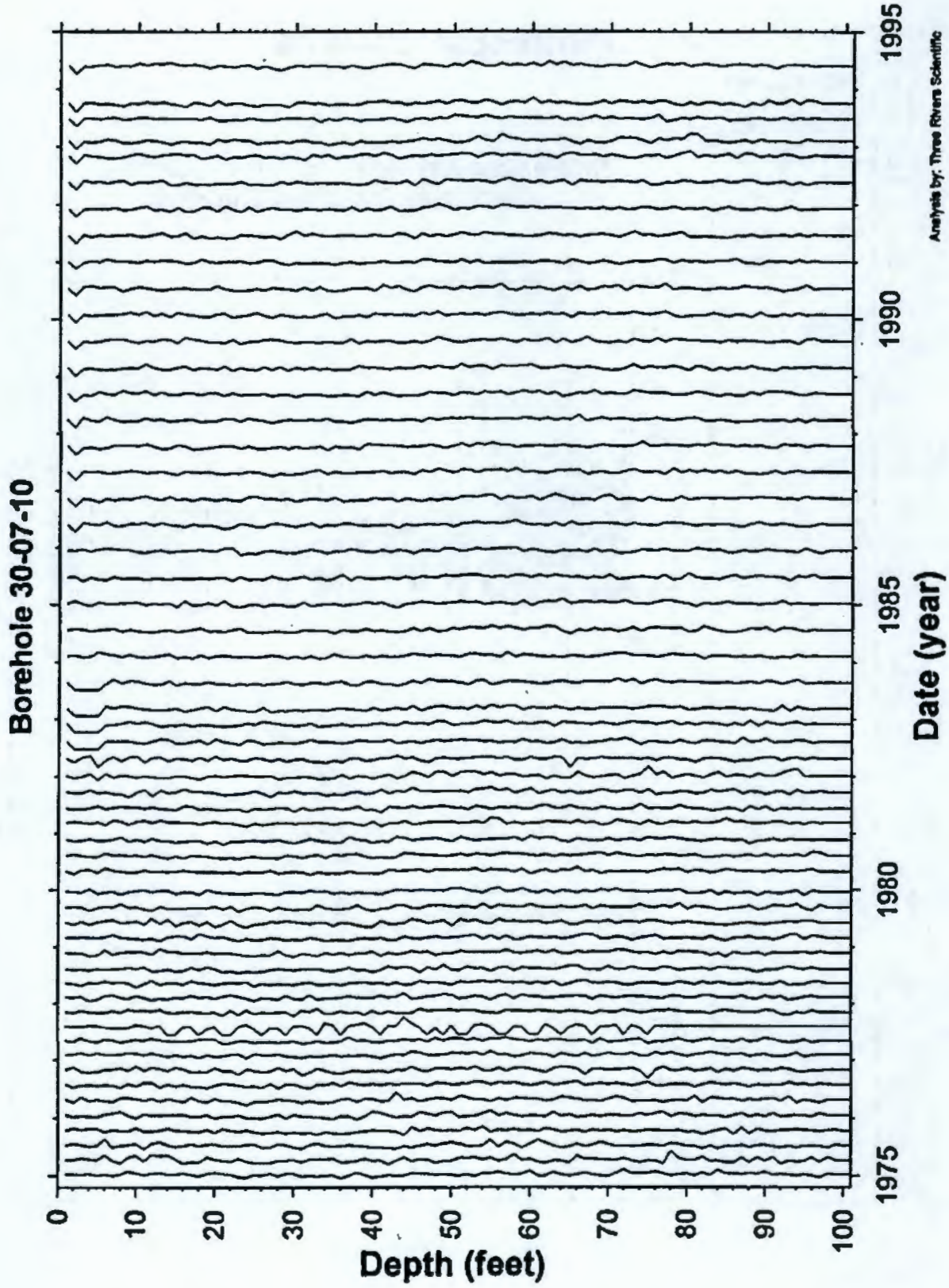
Gross Gamma Survey Information

Probe Type Processed :	04: NaI
Other Probe Types :	03: Neutron
Survey Depth :	100 ft
First Survey Date :	1/10/1975
Last Survey Date :	6/03/1994
Number Surveys Processed :	390

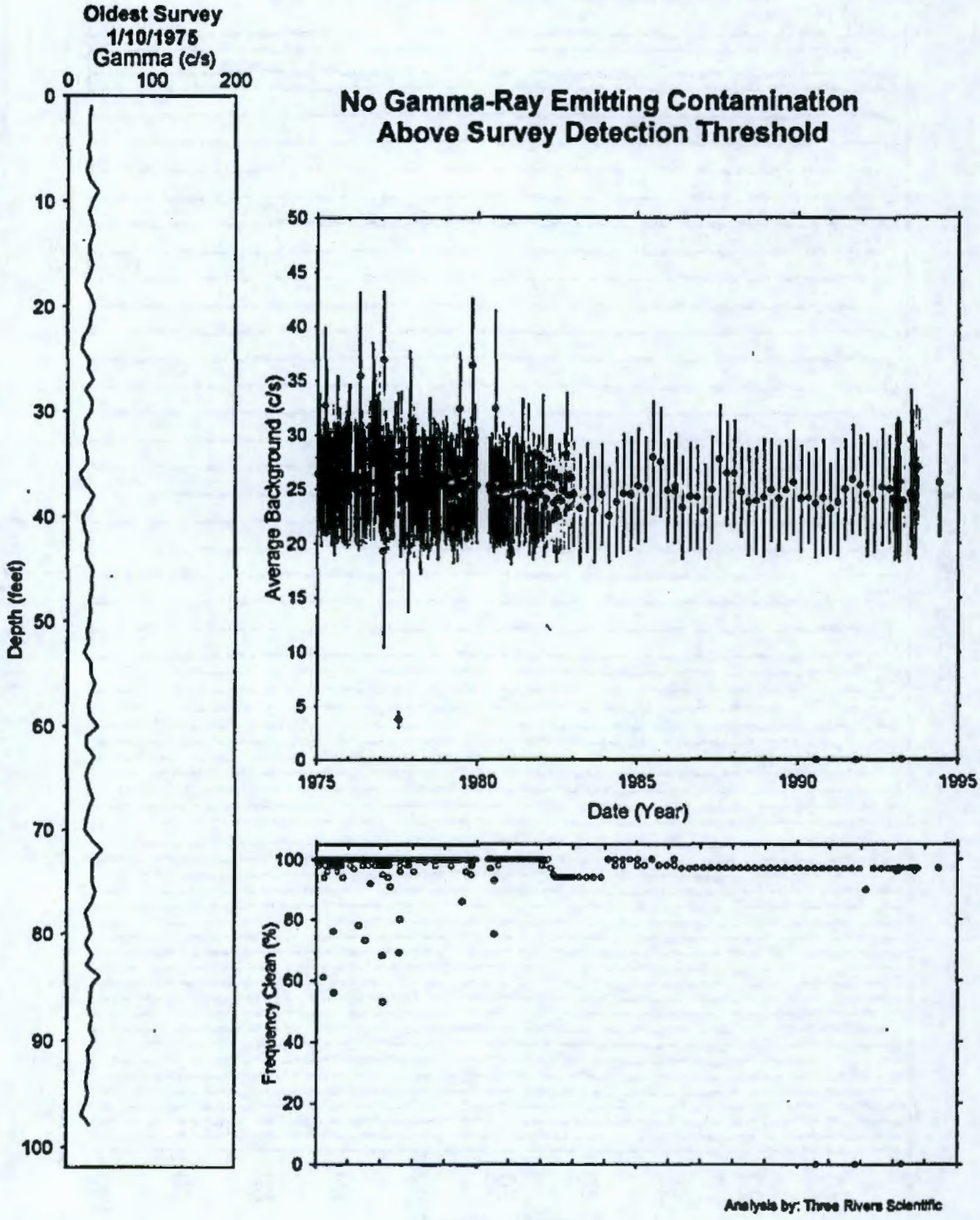
Analysis Notes

Method Used to Compute Background :	Threshold 0<val<50
Depth(s) where Contamination Identified in Gross Gamma Surveys :	NONE
Analyst Name :	R.K. Price
Company Name :	Three Rivers Scientific


30-07-10 Combination Plot
TF Gross γ
06/03/94
Total γ
232Th
238U
40K
137Cs
Depth (feet)
cps
pCi/g


Borehole 30-07-10
Depth (feet)
0
10
20
30
40
50
60
70
80
90
100
Date (year)
1975
1980
1985
1990
1995
Analysis by: Three Rivers Scientific

Borehole 30-07-10



Borehole 30-07-11

Contamination (Cs-137) from 0-10 feet is Tank Farm Activity.

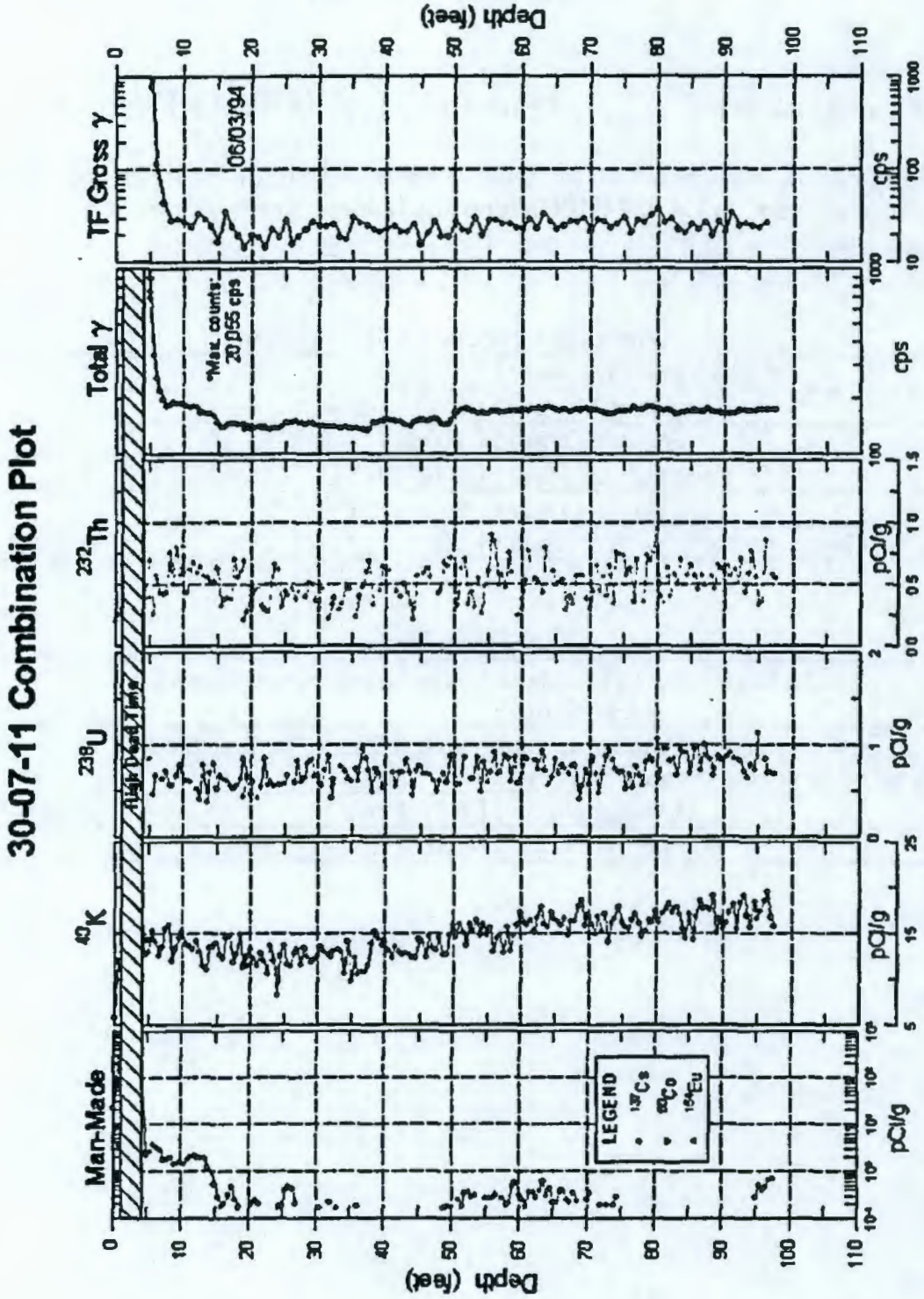
Grade thickness product over 0 to 10 feet erratic and highly variable, indicative of tank farm activity. A Cs-137 (HPGe identified) decay line is shown on the grade thickness plot.

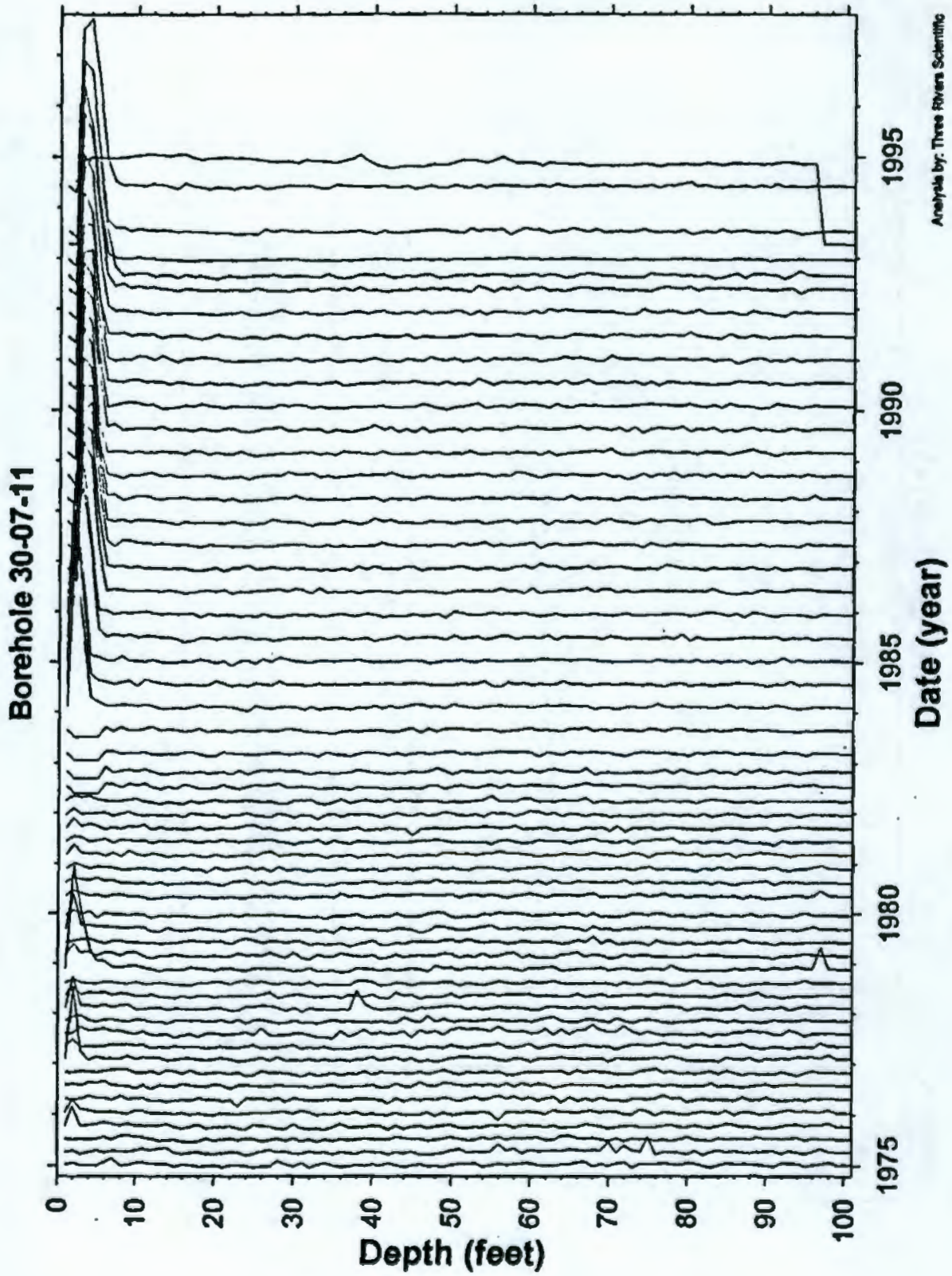
Gross Gamma Survey Information

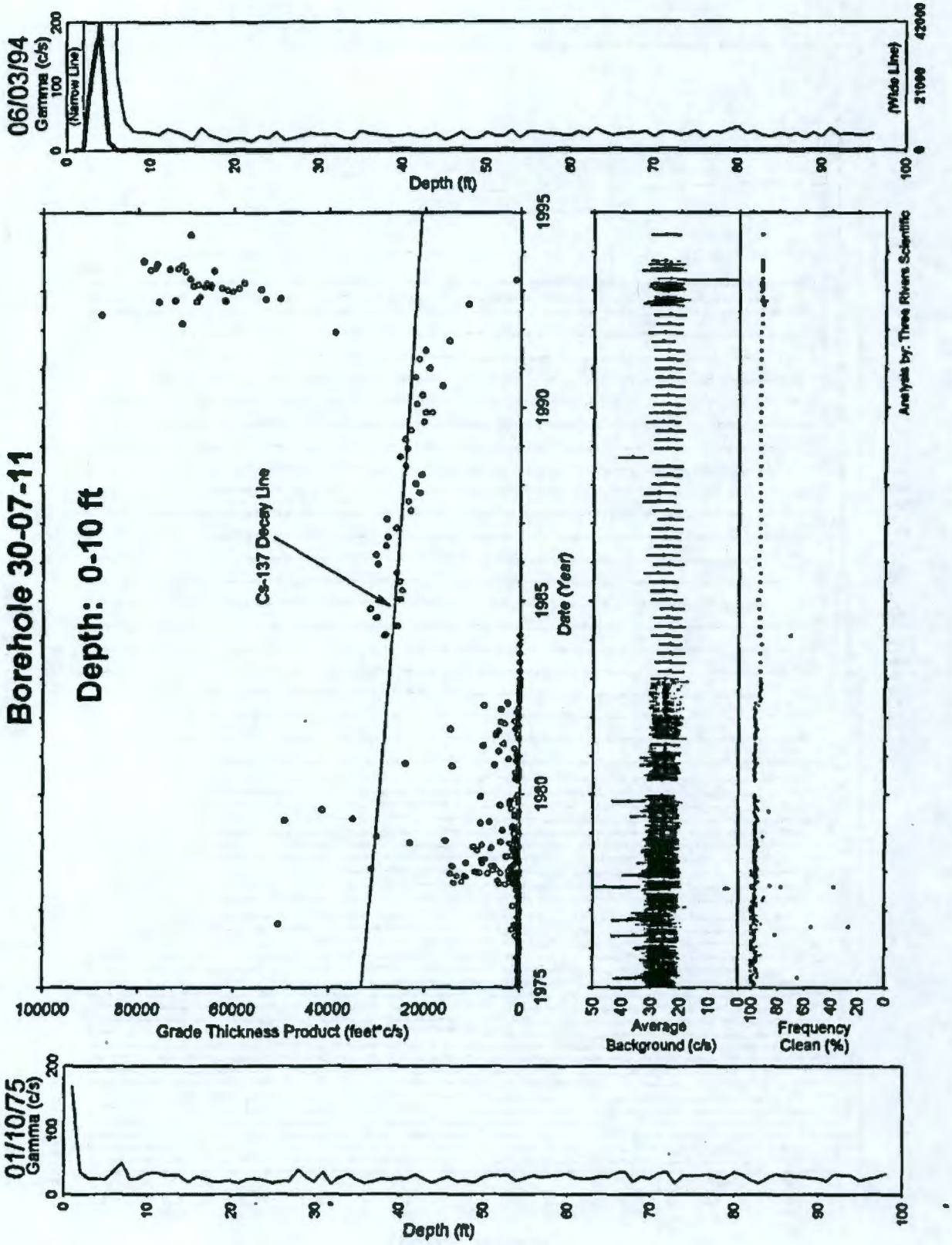
Probe Type Processed :	04: NaI
Other Probe Types :	03: Neutron
Survey Depth :	100 ft
First Survey Date :	1/10/1975
Last Survey Date :	6/03/1994
Number Surveys Processed :	403

Analysis Notes

Method Used to Compute Background :	Fixed background (20-40ft)
Depth(s) where Contamination Identified in Gross Gamma Surveys :	0-10 ft Tank Farm Activity
Analyst Name :	R.K. Price
Company Name :	Three Rivers Scientific


30-07-11 Combination Plot
Man-Made
^{40}K
^{238}U
^{232}Th
Total γ
TF Gross γ
Depth (feet)
pCi/g
cps
06/03/94
*Max. counts: 20,055 cps
LEGEND
^{137}Cs
^{60}Co
^{154}Eu


Borehole 30-07-11
Depth (feet)
0
10
20
30
40
50
60
70
80
90
100
Date (year)
1975
1980
1985
1990
1995
Analysis by: Three Rivers Scientific


06/03/94
Gamma (c/s)
(Narrow Line)
(Wide Line)
Depth (ft)
Borehole 30-07-11
Depth: 0-10 ft
Cs-137 Decay Line
Date (Year)
Grade Thickness Product (feet*c/s)
Average Background (c/s)
Frequency Clean (%)
Analysis by: Three Rivers Scientific
01/10/75
Gamma (c/s)
Depth (ft)

Tank C-108

Table of Contents

Tank C-108 291
Borehole 30-08-02 292
Borehole 30-08-03 300
Borehole 30-08-12 304

This section contains the analysis results for vadose zone boreholes (dry wells) associated with the Tank 108 in the "C" Tank Farm.

Special Notes: None

Borehole 30-08-02

Contamination (Cs-137) from 0-6 feet is Tank Farm Activity.
Contamination (Cs-137) from 13-28 feet is Tank Farm Activity.
Contamination (Co-60) from 46-55 feet is Unstable.
Contamination (Co-60) from 55-84 feet is Unstable.

Grade thickness product over 0-14 and 13-28 feet are variable and highly erratic, indicative of tank farm activity. A Cs-137 (HPGe identified) decay line is shown on the grade thickness plot as a reference. The HPGe survey identified Eu-154 at low levels (less than 1/30th the concentration of Cs-137) in the contamination zones. The Eu-154 contamination, although unusual for near surface contamination does not influence the assigned category.

The stack plot shows two contamination zones in the lower portion of the borehole. The contamination zone at 52 feet remains at a constant depth for the duration of the tank farm logs, which may indicate a spreading horizon in the subsurface sediments. Low frequency logging from 1983 to 1989 for a mobile contaminant (Co-60) inhibits a stable classification in the latter years.

The lower contamination zone (55 to 84 ft) shows on the stack plot that the contamination moved down through the sediments from 55 to 75 feet during the ten years of surveillance monitoring (about 2 ft per year). The decrease in the grade thickness product for both zones does not fit either the HPGe identified contaminants (Co-60 and Cs-137) or the contaminants combined with Ru-106 (hypothesis), implying migrating contamination. A Co-60 decay line is shown on the plots as a reference.

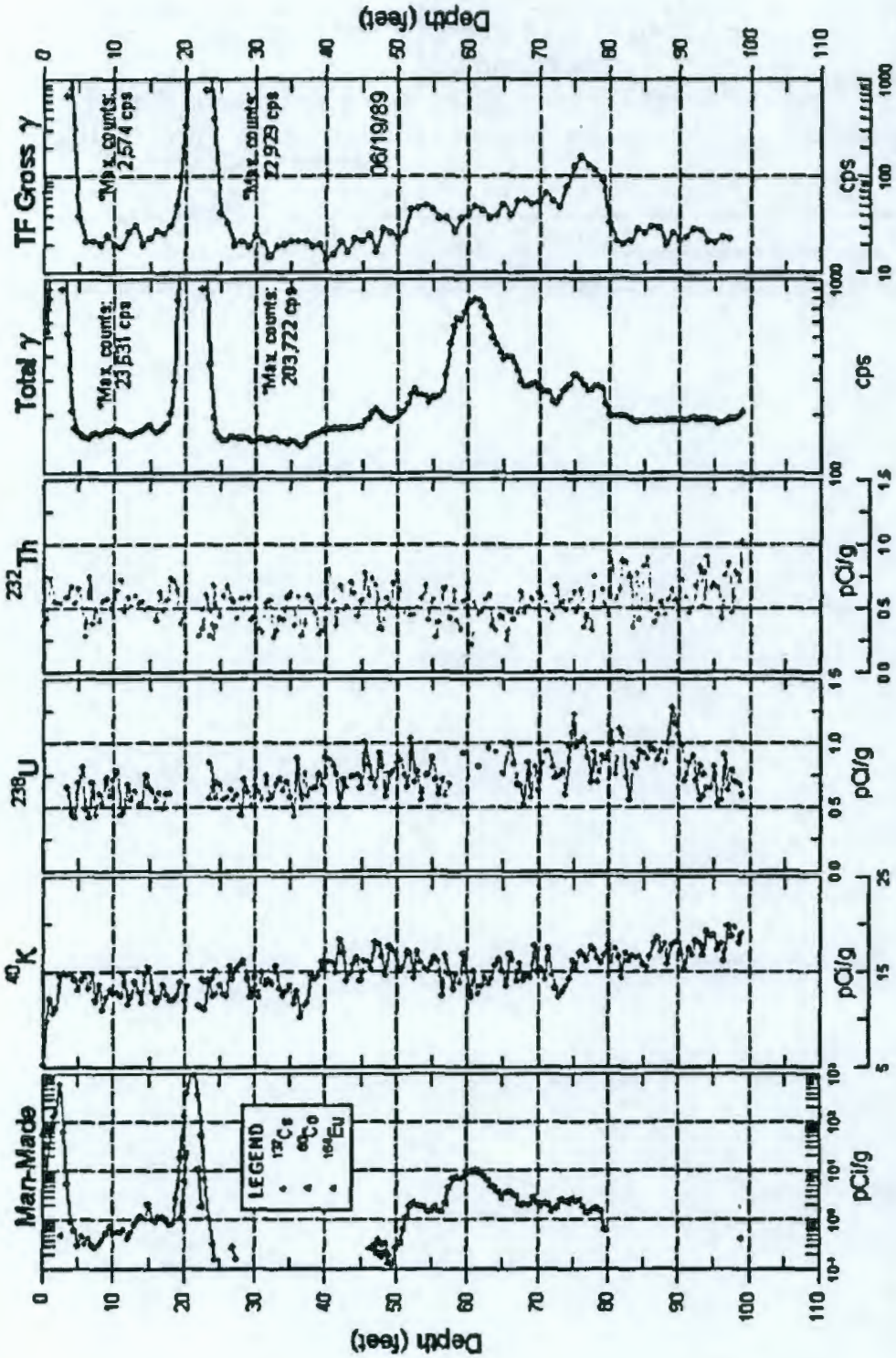
Gross Gamma Survey Information

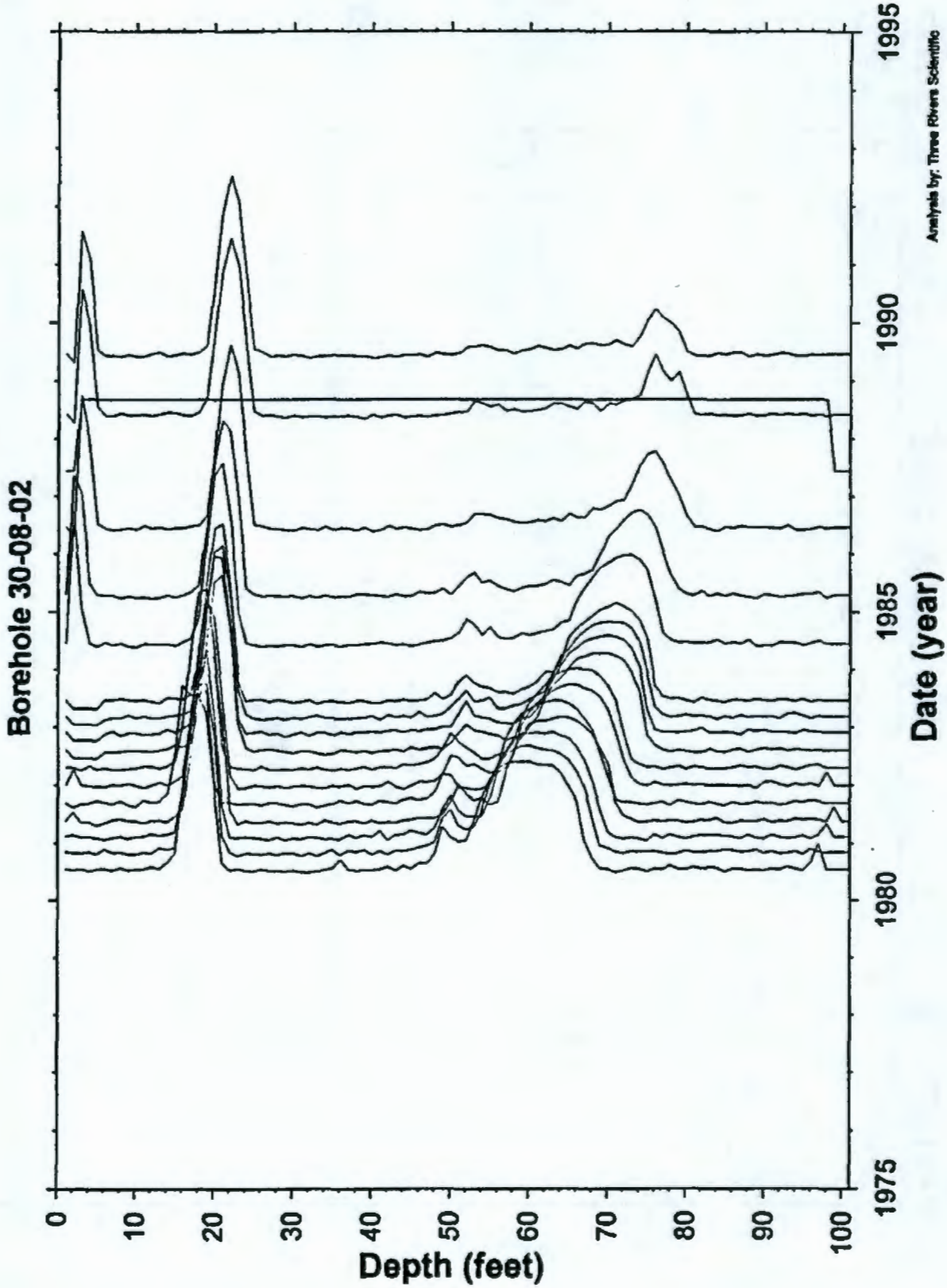
Probe Type Processed :	04: NaI
Other Probe Types :	03: Neutron
Survey Depth :	100 ft
First Survey Date :	7/24/1980
Last Survey Date :	6/19/1989
Number Surveys Processed :	68

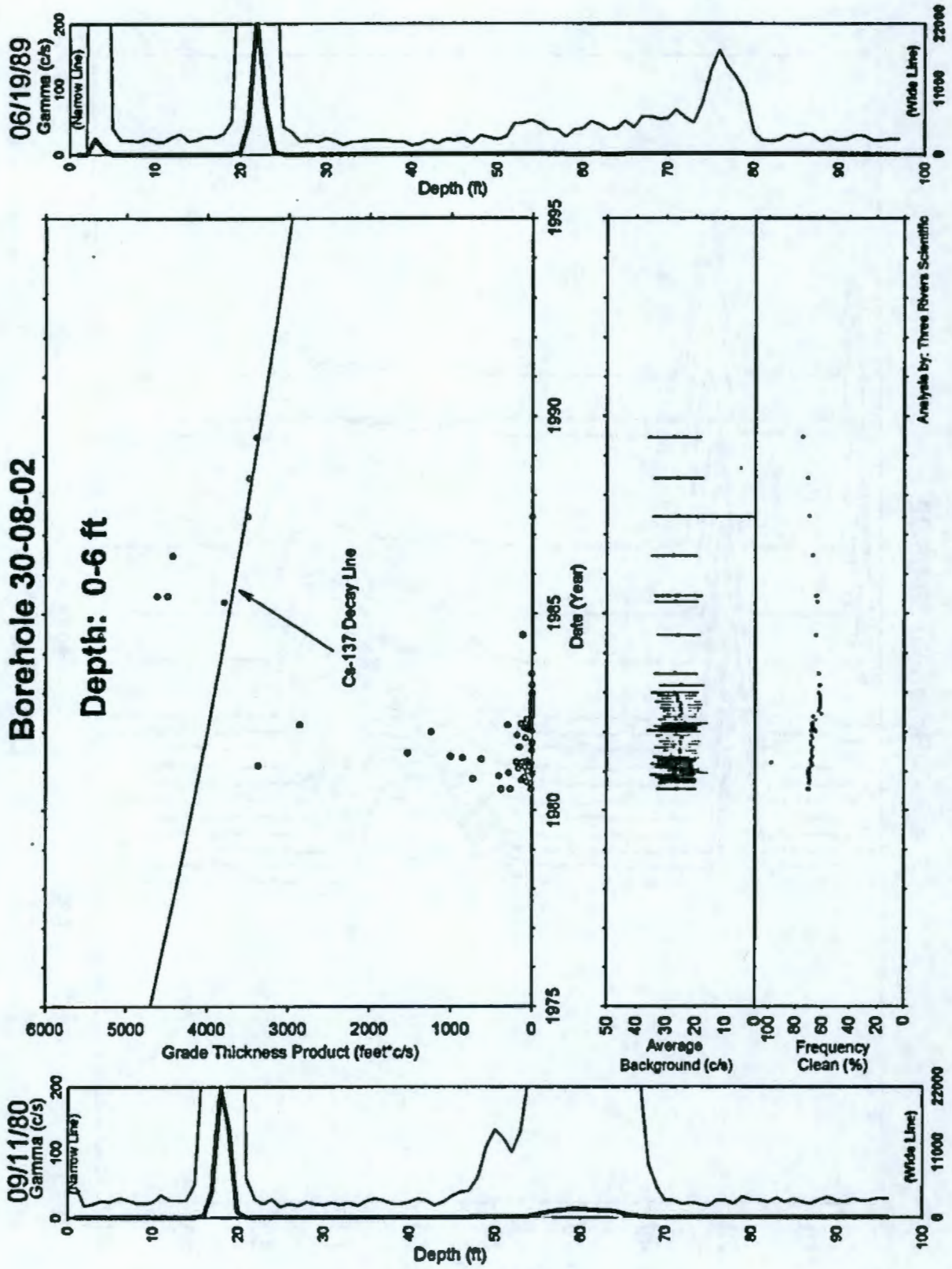
Analysis Notes

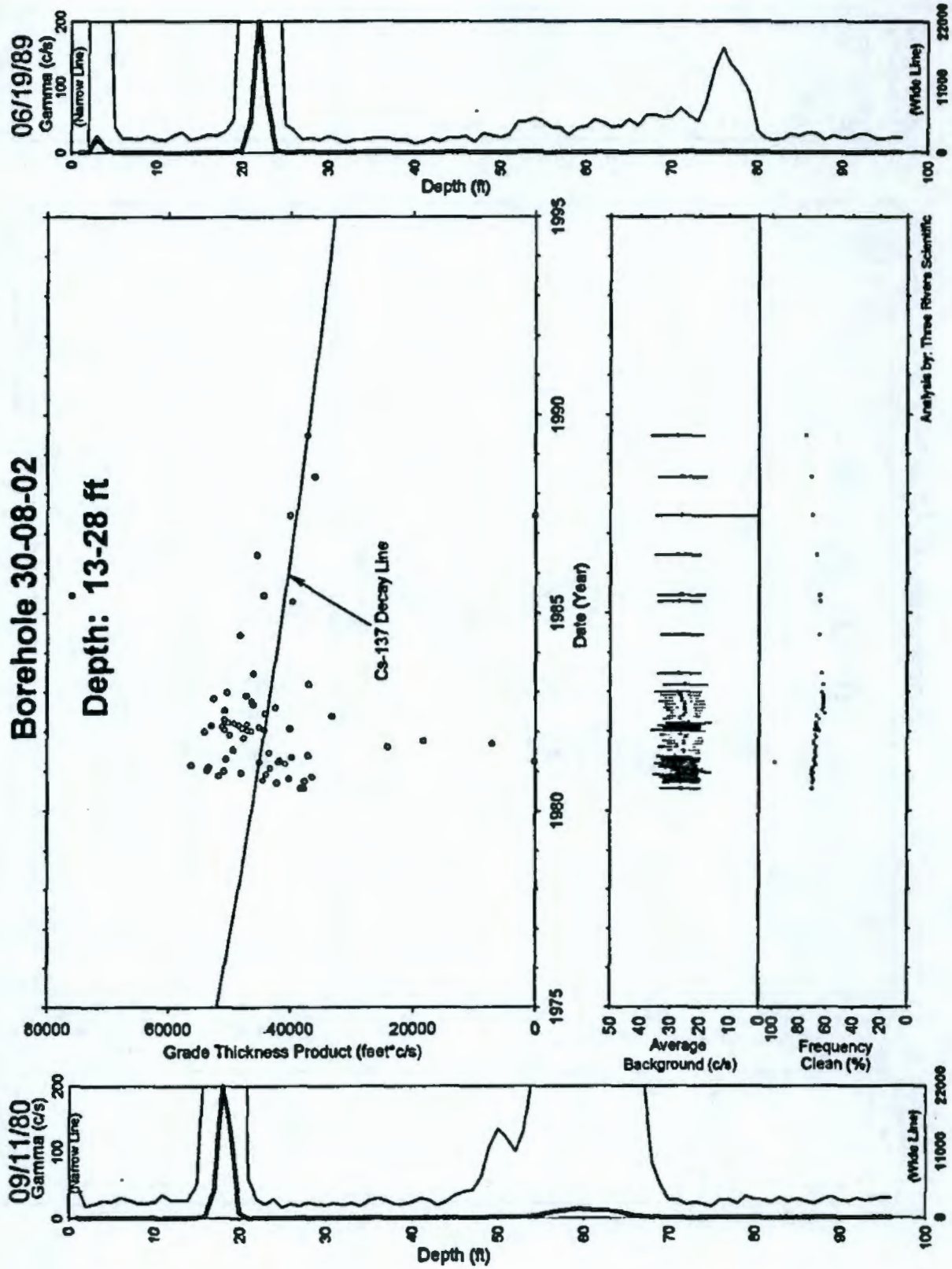
Method Used to Compute Background :	Fixed background: 28-48 ft
Depth(s) where Contamination Identified in Gross Gamma Surveys :	0-6 ft Tank Farm Activity 13-28 ft Tank Farm Activity 46-55 ft Unstable 55-84 ft Unstable
Analyst Name :	R.K. Price
Company Name :	Three Rivers Scientific

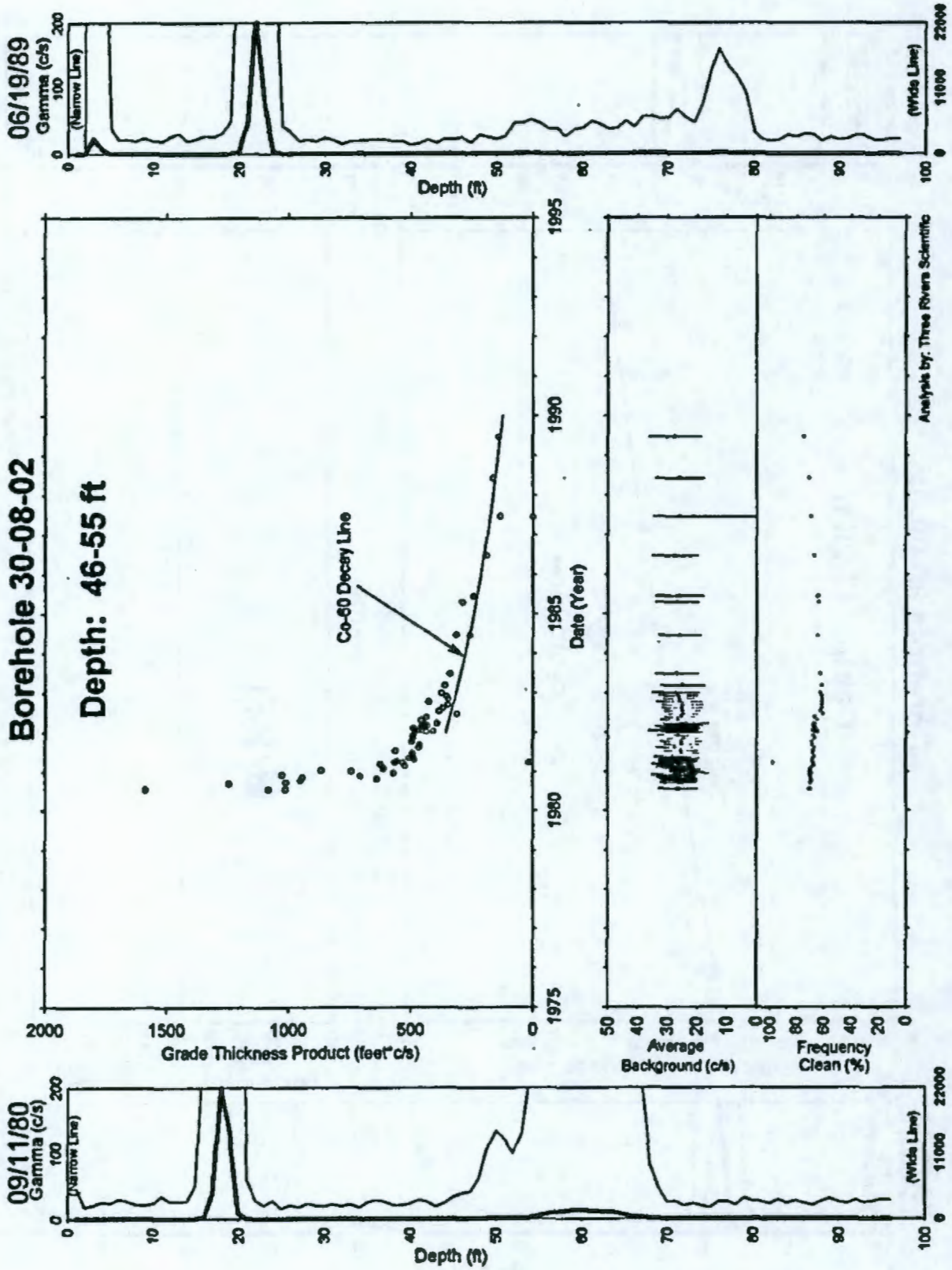
30-08-02 Combination Plot

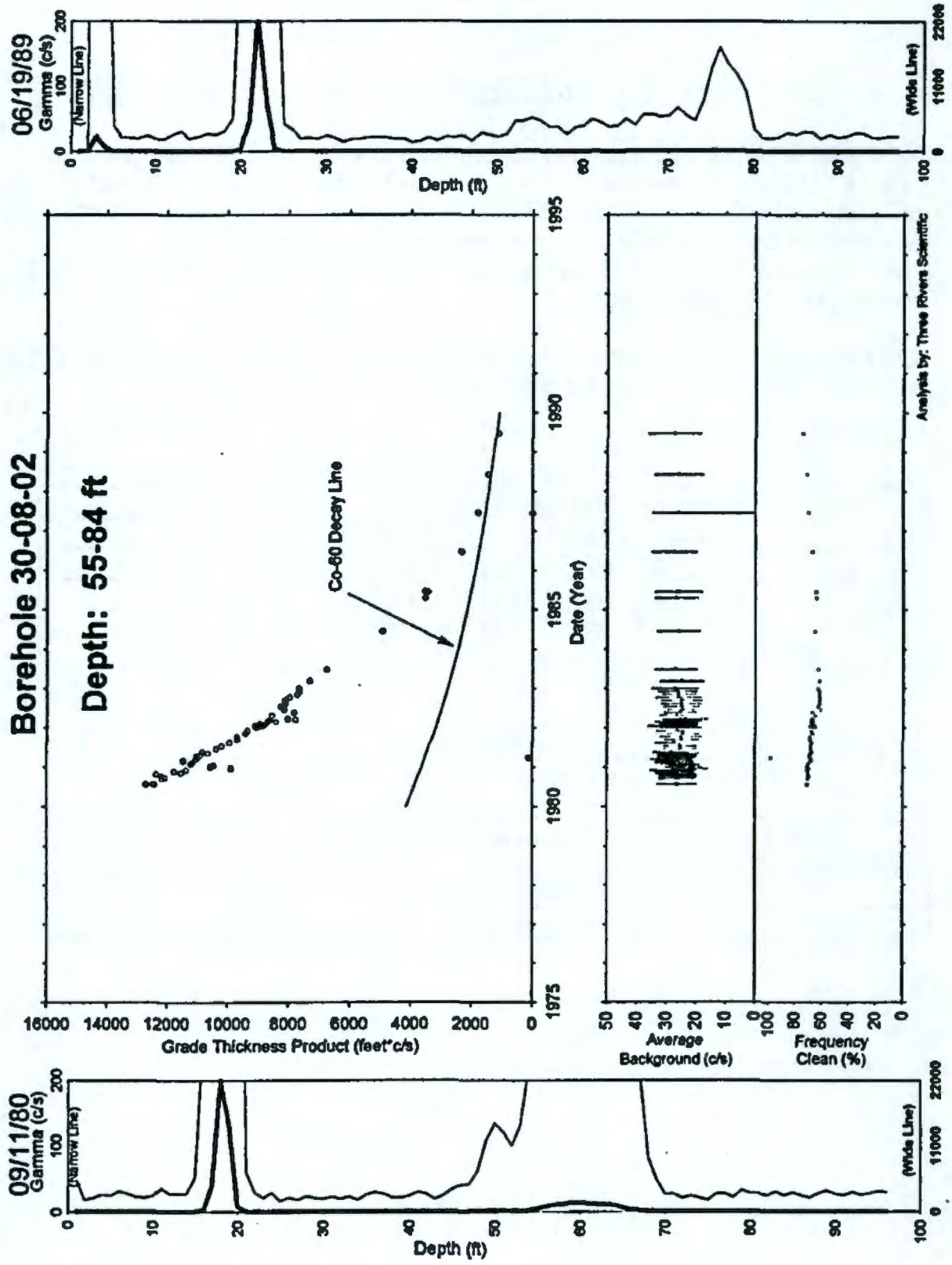



Borehole 30-08-02
Depth (feet)
0
10
20
30
40
50
60
70
80
90
100
Date (year)
1975
1980
1985
1990
1995
Analysis by: Three Rivers Scientific


06/19/89
Gamma (c/s)
(Narrow Line)
(Wide Line)
Depth (ft)
Borehole 30-08-02
Depth: 0-6 ft
Cs-137 Decay Line
Grade Thickness Product (feet*c/s)
Date (Year)
Average Background (c/s)
Frequency Clean (%)
Analysis by: Three Rivers Scientific
09/11/80
Gamma (c/s)
(Narrow Line)
(Wide Line)
Depth (ft)


06/19/89
Gamma (c/s)
(Narrow Line)
(Wide Line)
Depth (ft)
Borehole 30-08-02
Depth: 13-28 ft
Cs-137 Decay Line
Date (Year)
Grade Thickness Product (feet*c/s)
Average Background (c/s)
Frequency Clean (%)
Analysis by: Three Rivers Scientific
09/11/80
Gamma (c/s)
(Narrow Line)
(Wide Line)
Depth (ft)


Borehole 30-08-02
Depth: 46-55 ft
06/19/89
Gamma (c/s)
(Narrow Line)
(Wide Line)
Depth (ft)
Co-60 Decay Line
Grade Thickness Product (feet*c/s)
Date (Year)
Average Background (c/s)
Frequency Clean (%)
Analysis by: Three Rivers Scientific
09/11/80
Gamma (c/s)
(Narrow Line)
(Wide Line)
Depth (ft)


Borehole 30-08-02
Depth: 55-84 ft
06/19/89
Gamma (c/s)
(Narrow Line)
(Wide Line)
Depth (ft)
Co-60 Decay Line
Grade Thickness Product (feet*c/s)
Date (Year)
Average Background (c/s)
Frequency Clean (%)
Analysis by: Three Rivers Scientific
09/11/80
Gamma (c/s)
(Narrow Line)
(Wide Line)
Depth (ft)

Borehole 30-08-03

No Gamma Ray Emitting Contamination Identified.

No significant levels of gamma ray contamination are present, based upon gross gamma data, above the survey probe detection threshold between 1975 and 1994 in the vadose zone from 2 to 50 feet. The HPGe logging system detected Cs-137 for the full borehole depth with the maximum concentration occurring at the surface (0 ft) and bottom of the borehole at greater than 5 pCi/g. The concentration between 2 and 49 feet is less than 1 pCi/g.

The stack plot indicates that the borehole may have been 58 feet deep in 1975. The logs after 1984 have a maximum depth of 50 feet.

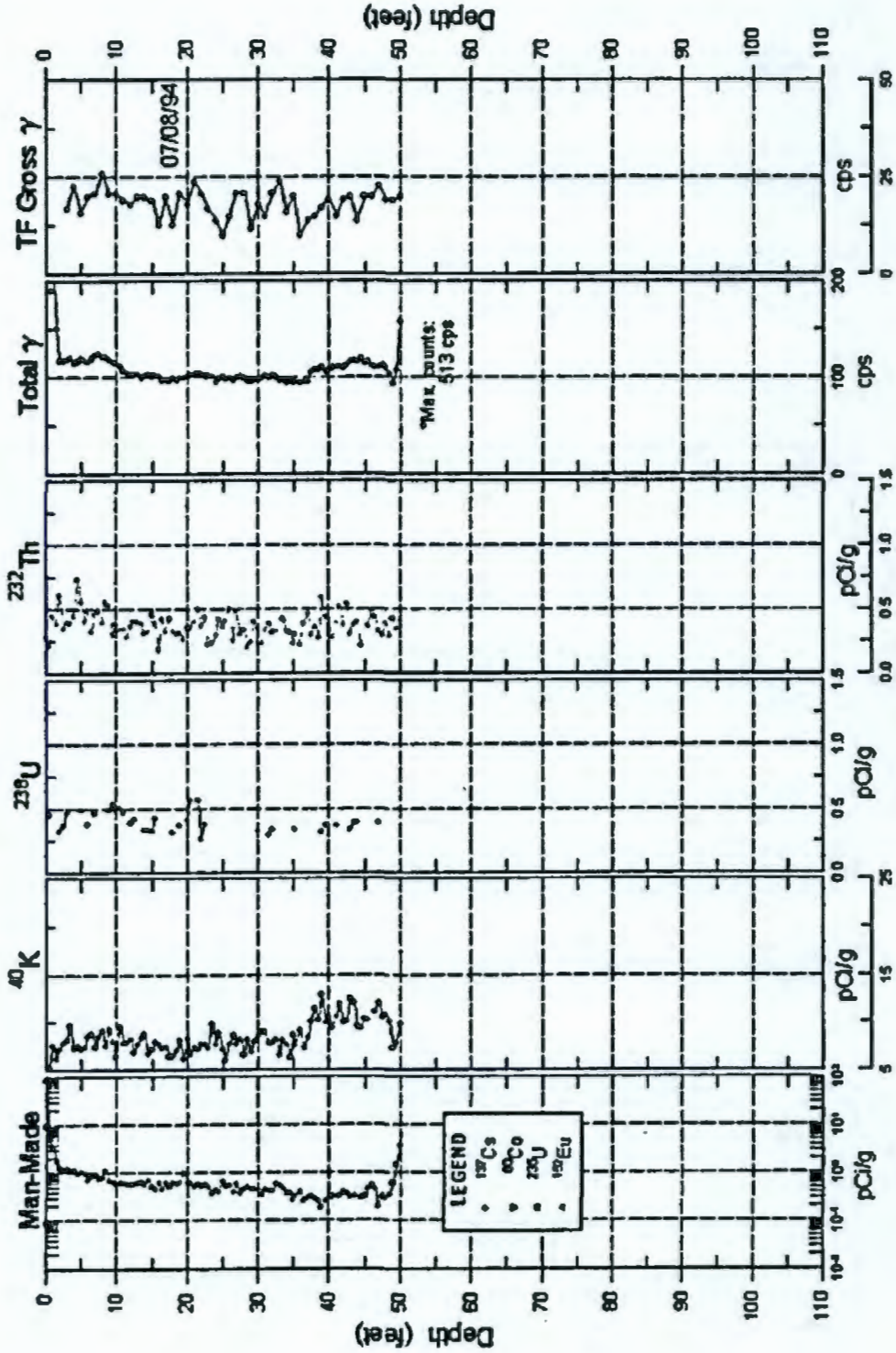
Gross Gamma Survey Information

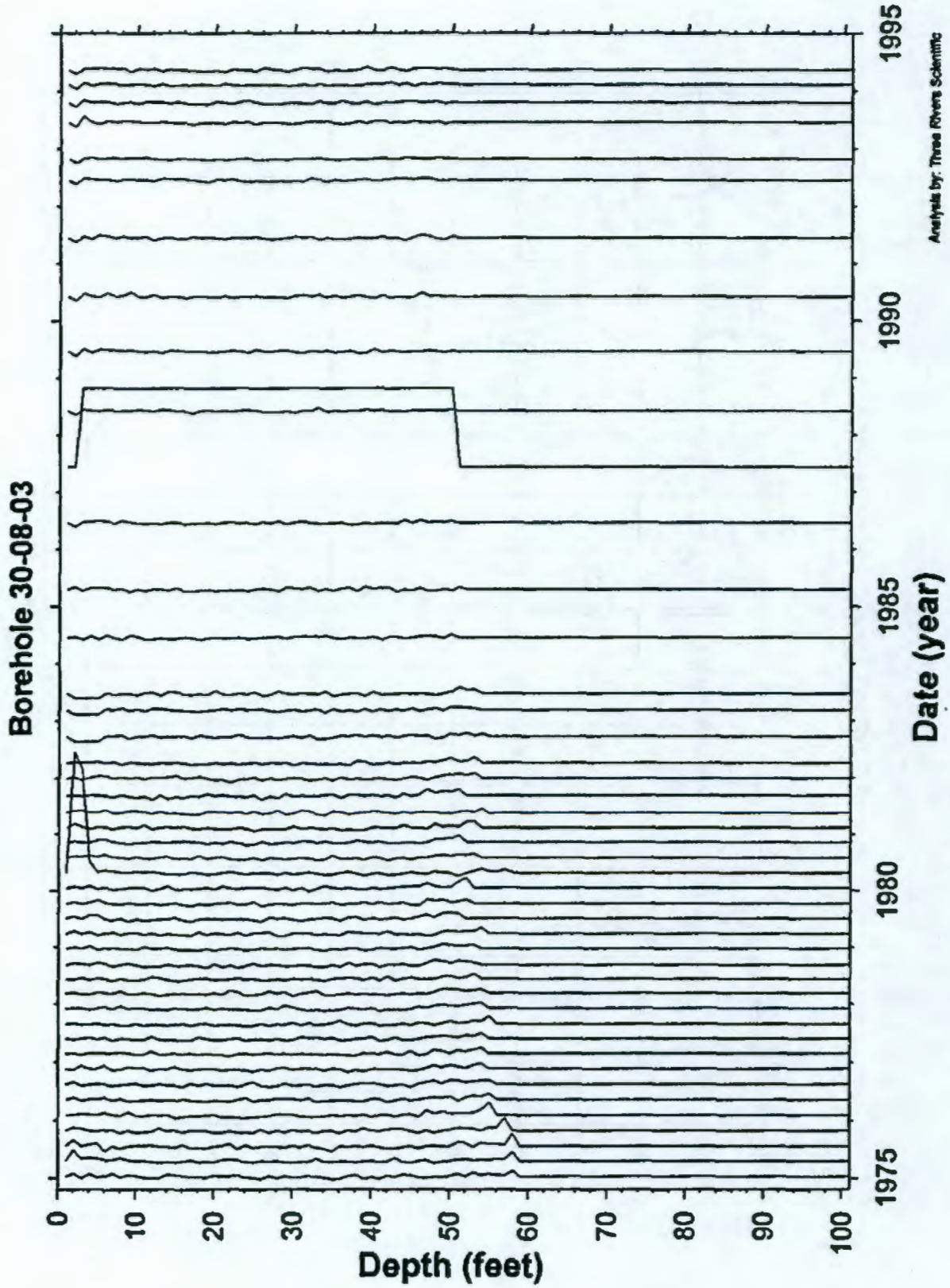
Probe Type Processed :	04: NaI
Other Probe Types :	03: Neutron
Survey Depth :	55 ft
First Survey Date :	1/10/1975
Last Survey Date :	7/08/1994
Number Surveys Processed :	317

Analysis Notes

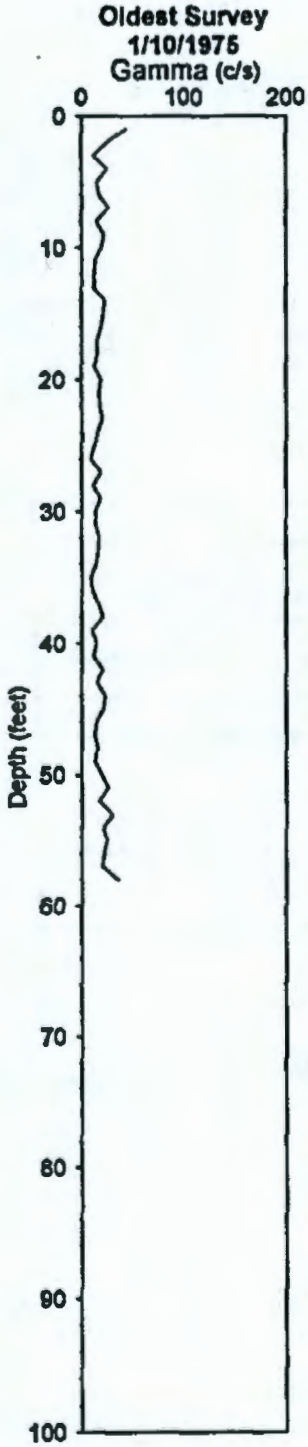
Method Used to Compute Background :	Threshold 0<val<50
Depth(s) where Contamination Identified in Gross Gamma Surveys :	NONE
Analyst Name :	R.K. Price
Company Name :	Three Rivers Scientific

30-08-03 Combination Plot

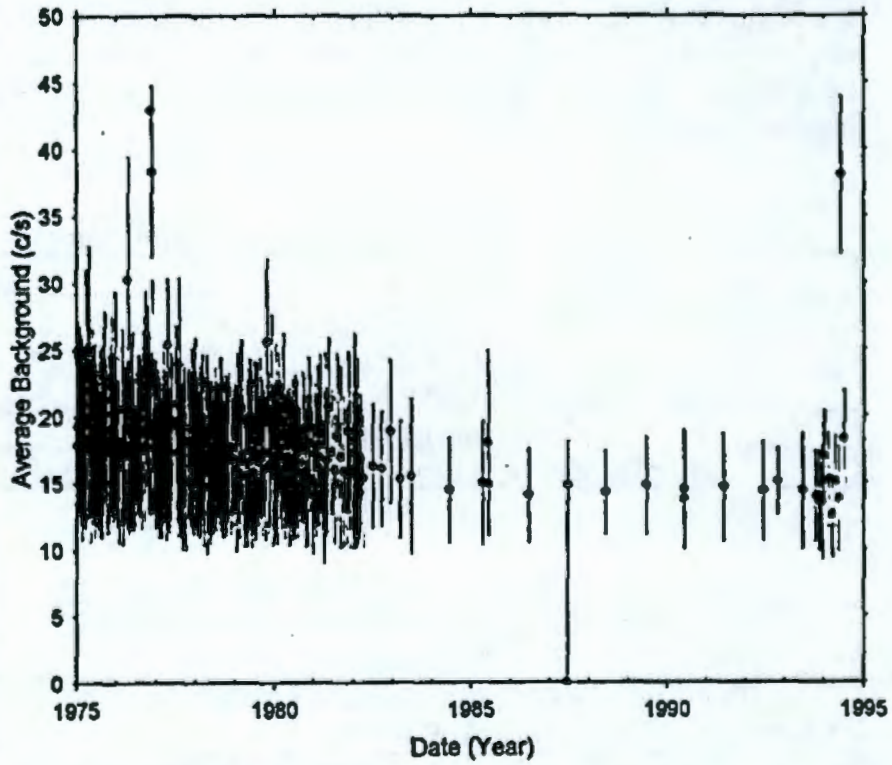


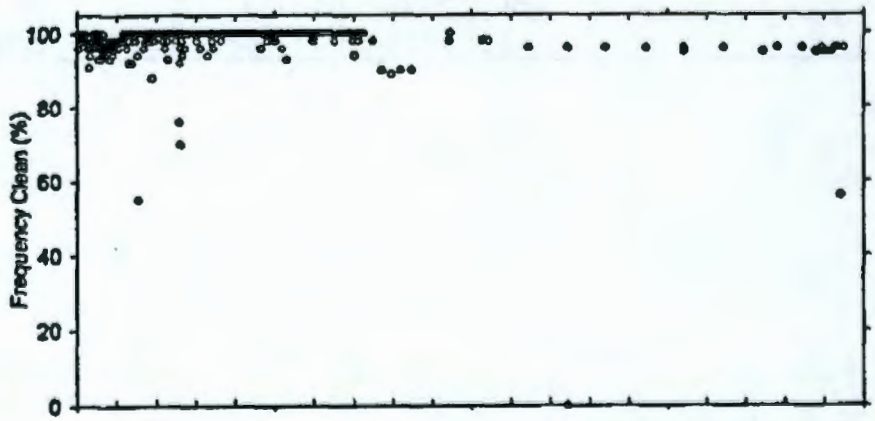

Borehole 30-08-03
Depth (feet)
0
10
20
30
40
50
60
70
80
90
100
Date (year)
1975
1980
1985
1990
1995
Analysis by: Three Rivers Scientific

Borehole 30-08-03



No Gamma-Ray Emitting Contamination Above Survey Detection Threshold





Analysis by: Three Rivers Scientific

Borehole 30-08-12

No Gamma Ray Emitting Contamination Identified.

No significant levels of gamma ray contamination are present, based on gross gamma data, above the survey probe detection threshold between 1975 and 1994 in the vadose zone from 2 to 100 feet. The HPGe logging system detected Cs-137 for much of borehole depth (0-37 and 47-73 ft) at concentrations less than 5 pCi/g. The concentrations of Cs-137 were not clearly identified in either the HPGe total gamma log or the tank farms stack plots. The grade thickness product plots (not included) confirmed the low level zones had no significant variations during the monitoring time period and are less than the minimum detection threshold of the tank farms logging system.

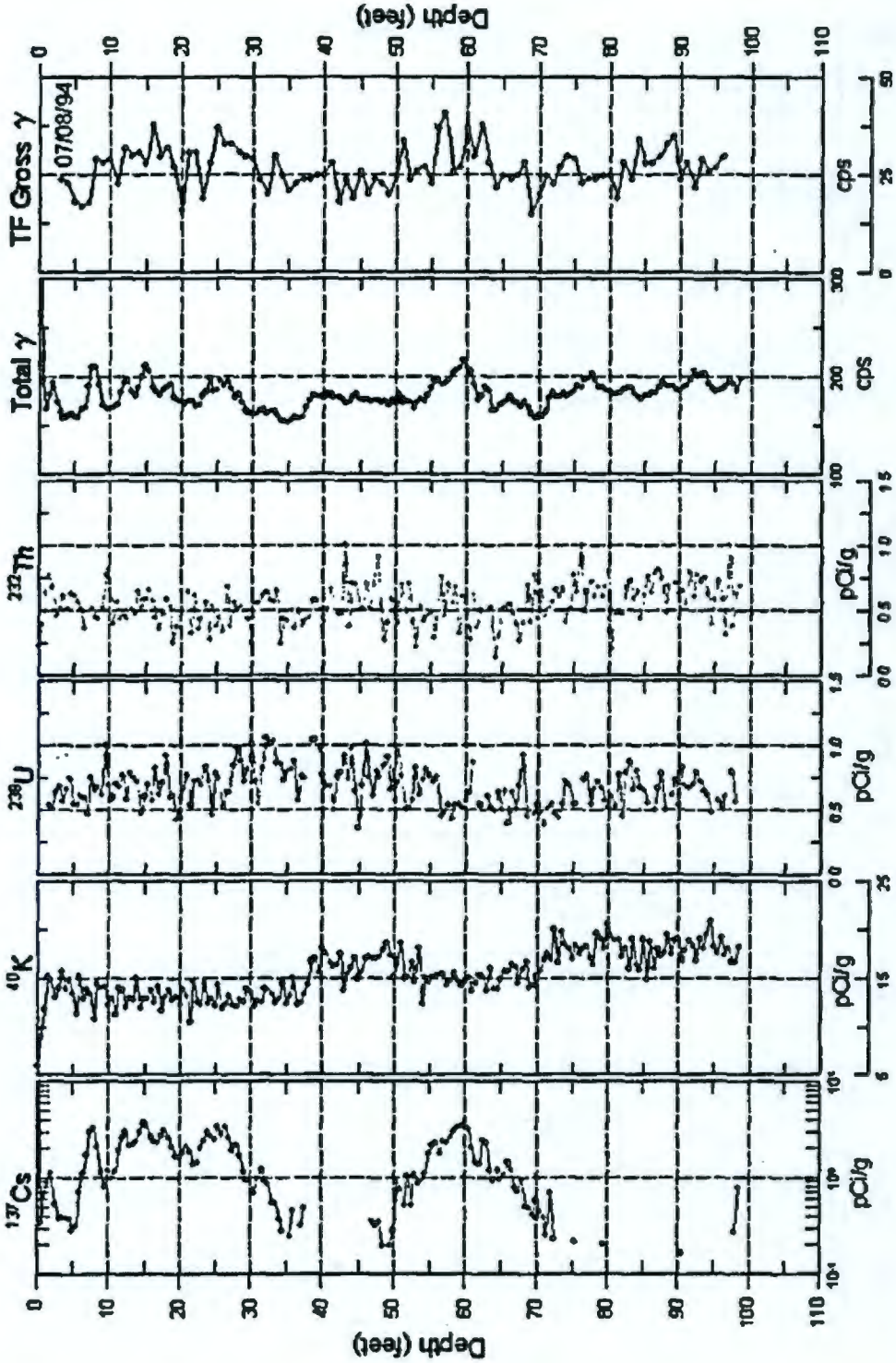
Gross Gamma Survey Information

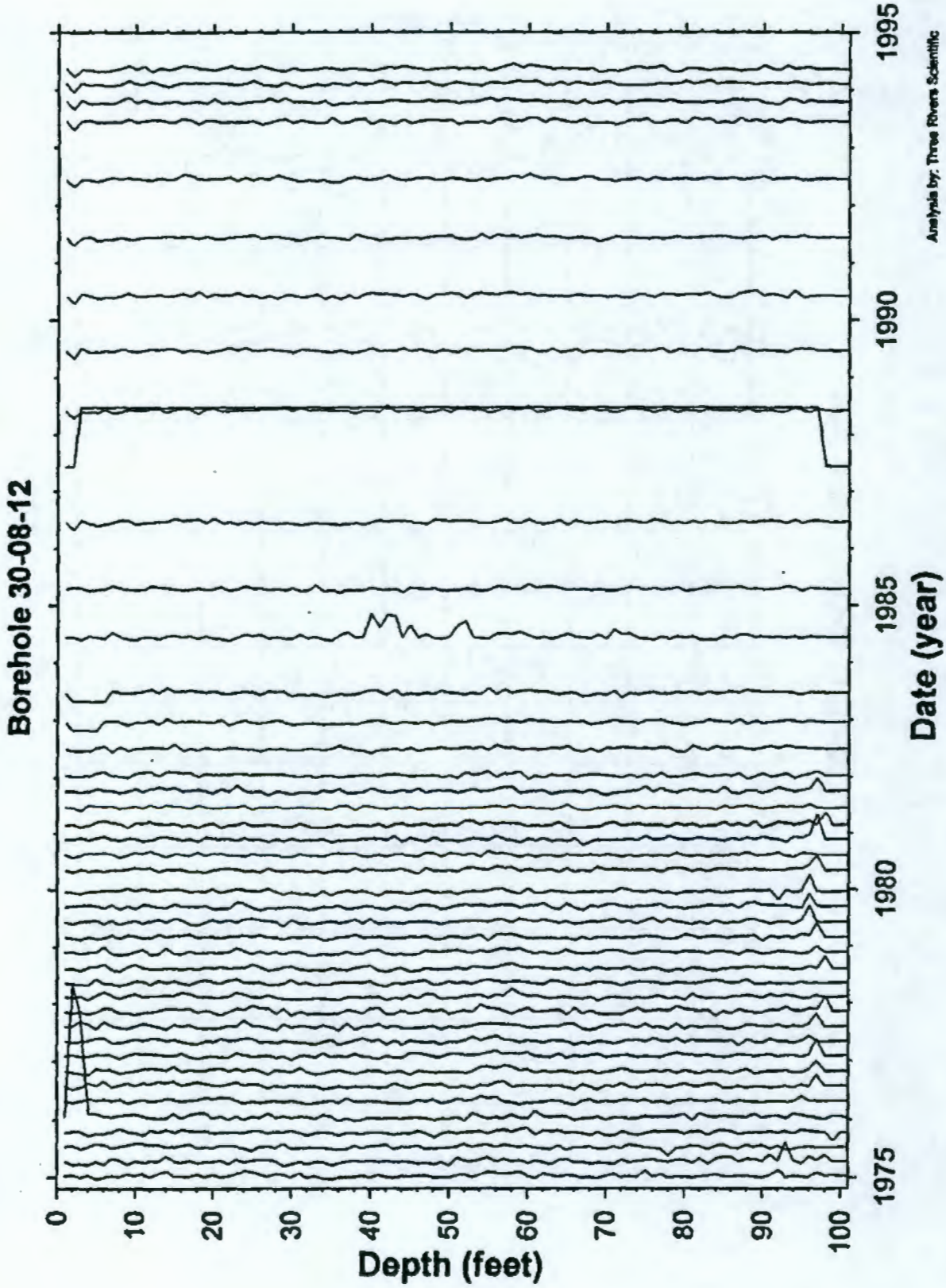
Probe Type Processed :	04: NaI
Other Probe Types :	03: Neutron
Survey Depth :	100 ft
First Survey Date :	1/10/1975
Last Survey Date :	7/08/1994
Number Surveys Processed :	299

Analysis Notes

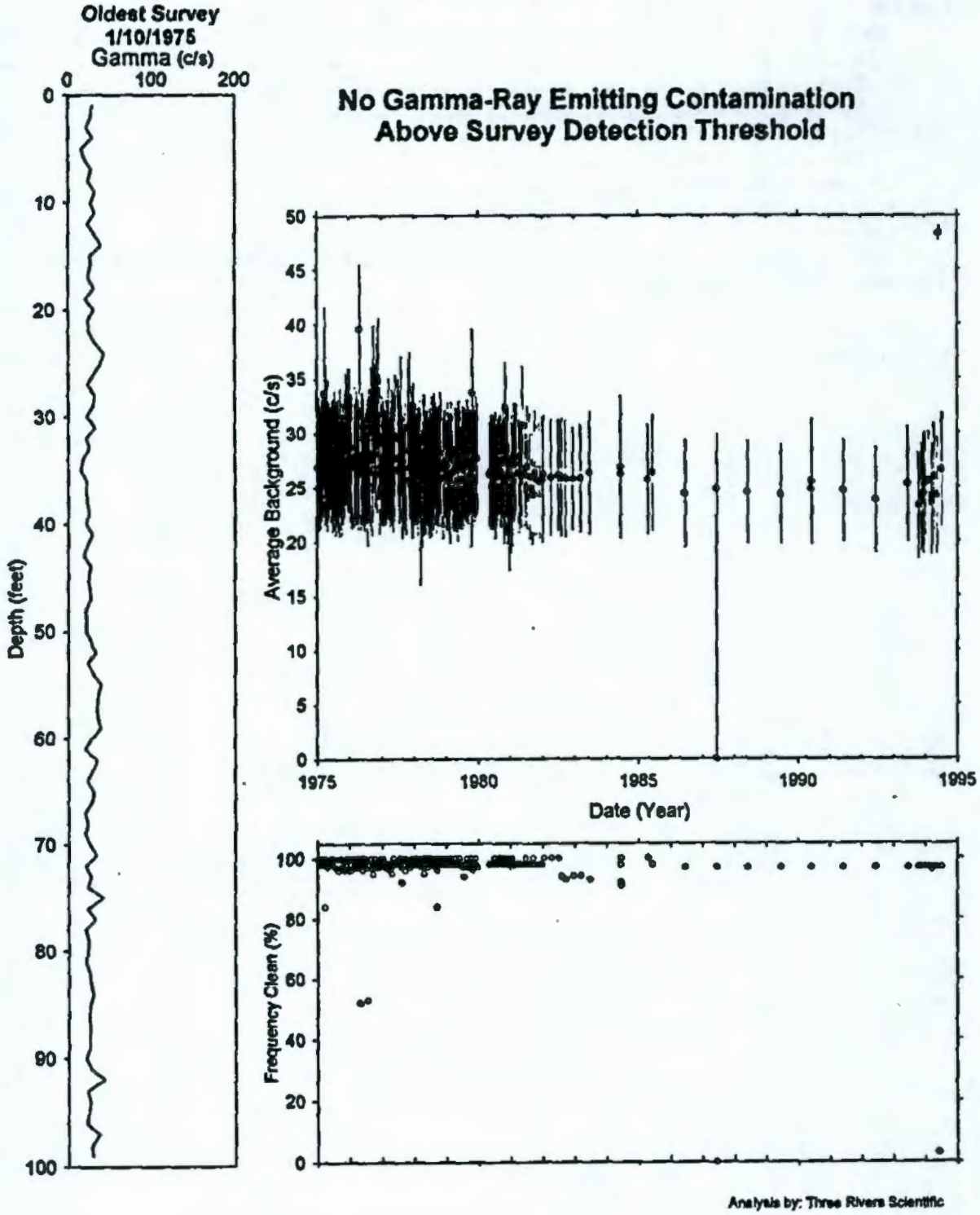
Method Used to Compute Background :	Fixed background (30-50 ft)
Depth(s) where Contamination Identified in Gross Gamma Surveys :	None
Analyst Name :	R.K. Price
Company Name :	Three Rivers Scientific

30-08-12 Combination Plot




Borehole 30-08-12
Depth (feet)
0
10
20
30
40
50
60
70
80
90
100
Date (year)
1975
1980
1985
1990
1995
Analysis by: Three Rivers Scientific

Borehole 30-08-12



Tank C-109

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This section contains the analysis results for vadose zone boreholes (dry wells) associated with the Tank 109 in the "C" Tank Farm.

Special Notes: None

Borehole 30-09-01

Contamination (Cs-137, Co-60, & Ru-102) from 88-100 feet is Unstable Early.

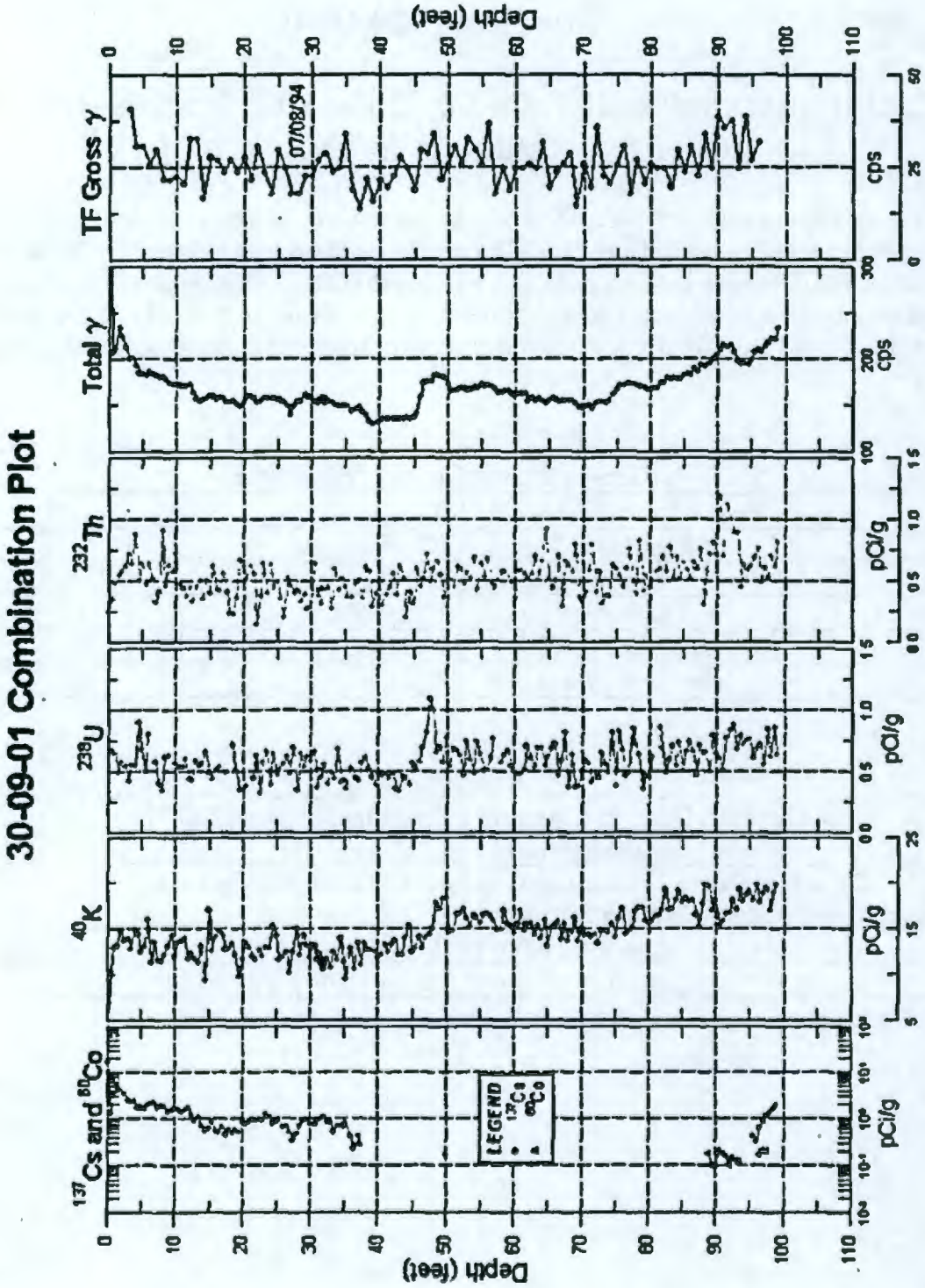
Grade thickness product over 88 to 100 feet shows an abrupt increase in 1976 then a rapid decrease to activity that is slightly lower than was present in 1975. The high rate of decrease in the grade thickness product in 1976 is possibly migrating contamination and does not match a least square fit of Cs-137, Co-60 (both HPGe identified) and Ru-102 (hypothesis) decay. The zone is categorized as unstable early.

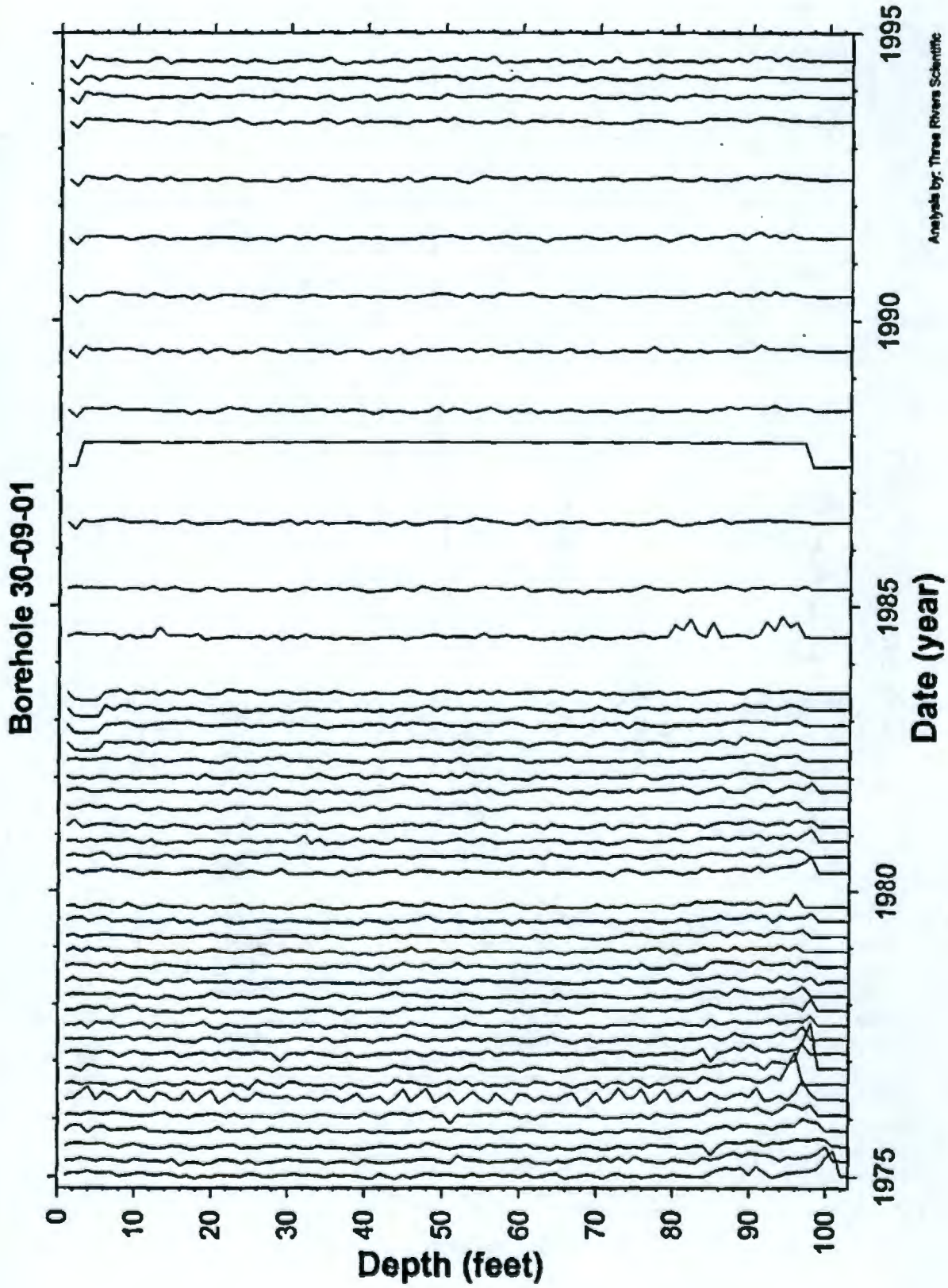
Gross Gamma Survey Information

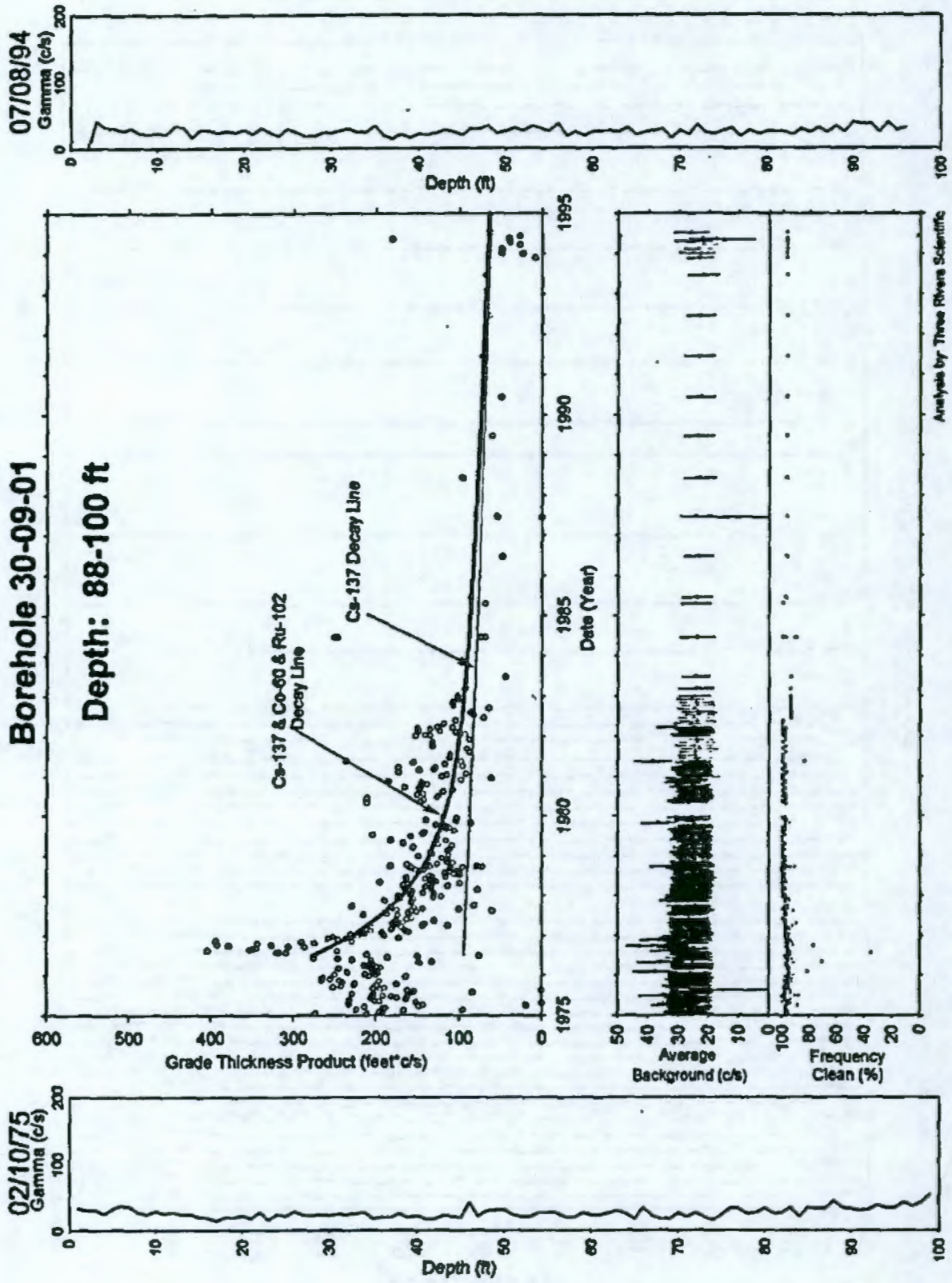
Probe Type Processed :	04: NaI
Other Probe Types :	03: Neutron
Survey Depth :	100 ft
First Survey Date :	1/10/1975
Last Survey Date :	7/08/1994
Number Surveys Processed :	316

Analysis Notes

Method Used to Compute Background :	Fixed background (50-70ft)
Depth(s) where Contamination Identified in Gross Gamma Surveys :	88-100 ft Unstable Early
Analyst Name :	R.K. Price
Company Name :	Three Rivers Scientific


30-09-01 Combination Plot
TF Gross γ
07/08/94
cps
Total γ
cps
232Th
pCi/g
238U
pCi/g
40K
pCi/g
137Cs and 60Co
pCi/g
LEGEND
137Cs
60Co
Depth (feet)
Depth (feet)


Borehole 30-09-01
Depth (feet)
0
10
20
30
40
50
60
70
80
90
100
Date (year)
1975
1980
1985
1990
1995
Analysis by: Three Rivers Scientific


Borehole 30-09-01
Depth: 88-100 ft
07/08/94
Gamma (c/s)
Depth (ft)
Cs-137 Decay Line
Cs-137 & Co-60 & Ru-102 Decay Line
Grade Thickness Product (feet*c/s)
Date (Year)
Average Background (c/s)
Frequency Clean (%)
Analysis by Three Rivers Scientific
02/10/75
Gamma (c/s)
Depth (ft)

Borehole 30-09-02

Contamination (Co-60) from 40-58 feet is Unstable.
Contamination (Co-60) from 82-100 feet is Stable.

Grade thickness product over 40 to 58 feet shows two times where activity increased (1980 and 1983-1984). The grade thickness product is decreasing consistent with Co-60 (HPGe identified) decay after 1985. The zone is unstable because, the stack plot shows that the contamination moved two feet lower in the ten year time period from 1984 to 1994. Tracking the movement of the contamination to lower depths can not be performed for logs prior to 1984 because depth control was compromised by the manual operation of the logging equipment.

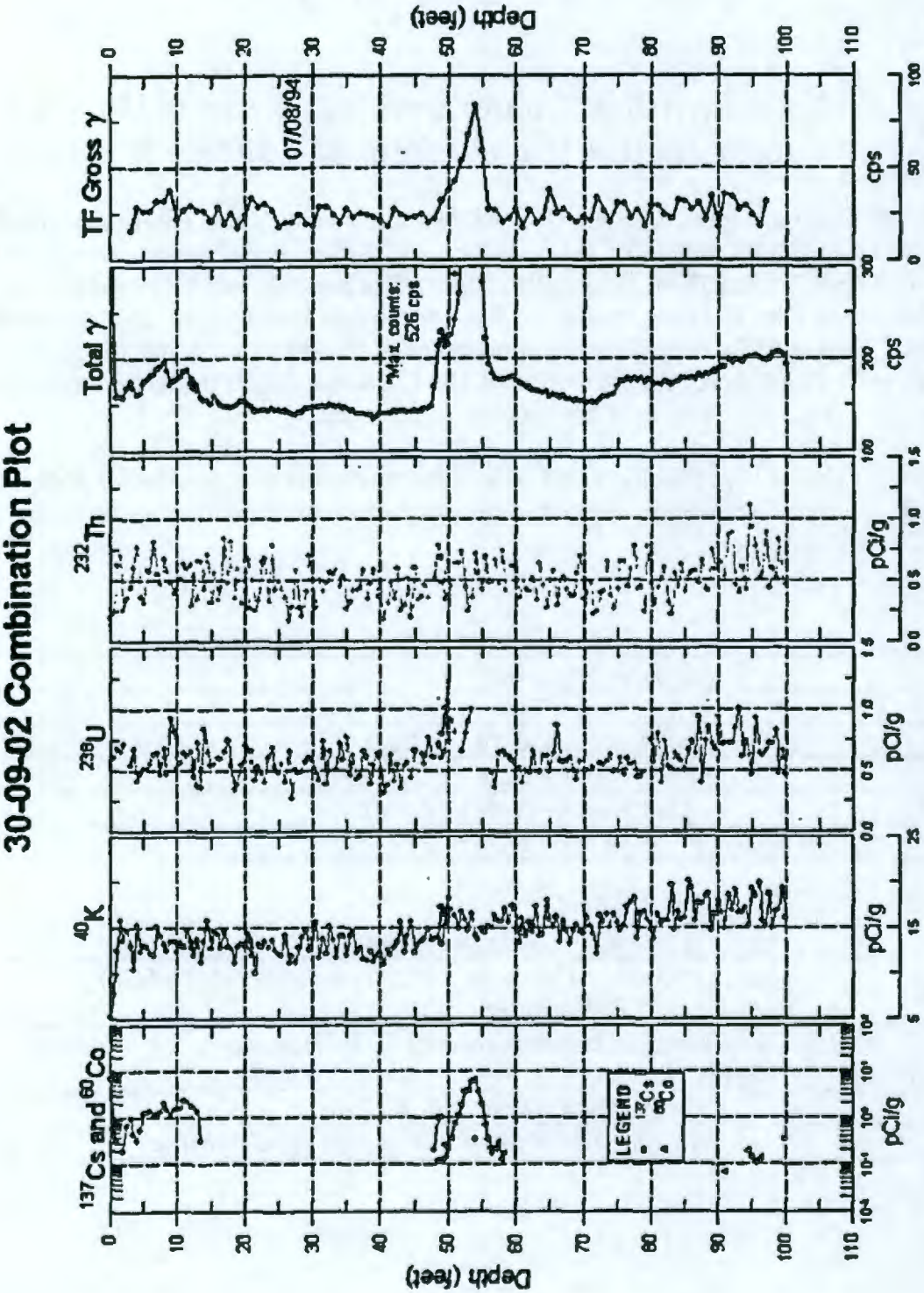
Grade thickness product over 82 to 100 feet is decreasing consistent with Co-60 (HPGe identified) decay. Any observed variances are within the statistical precision of the log data.

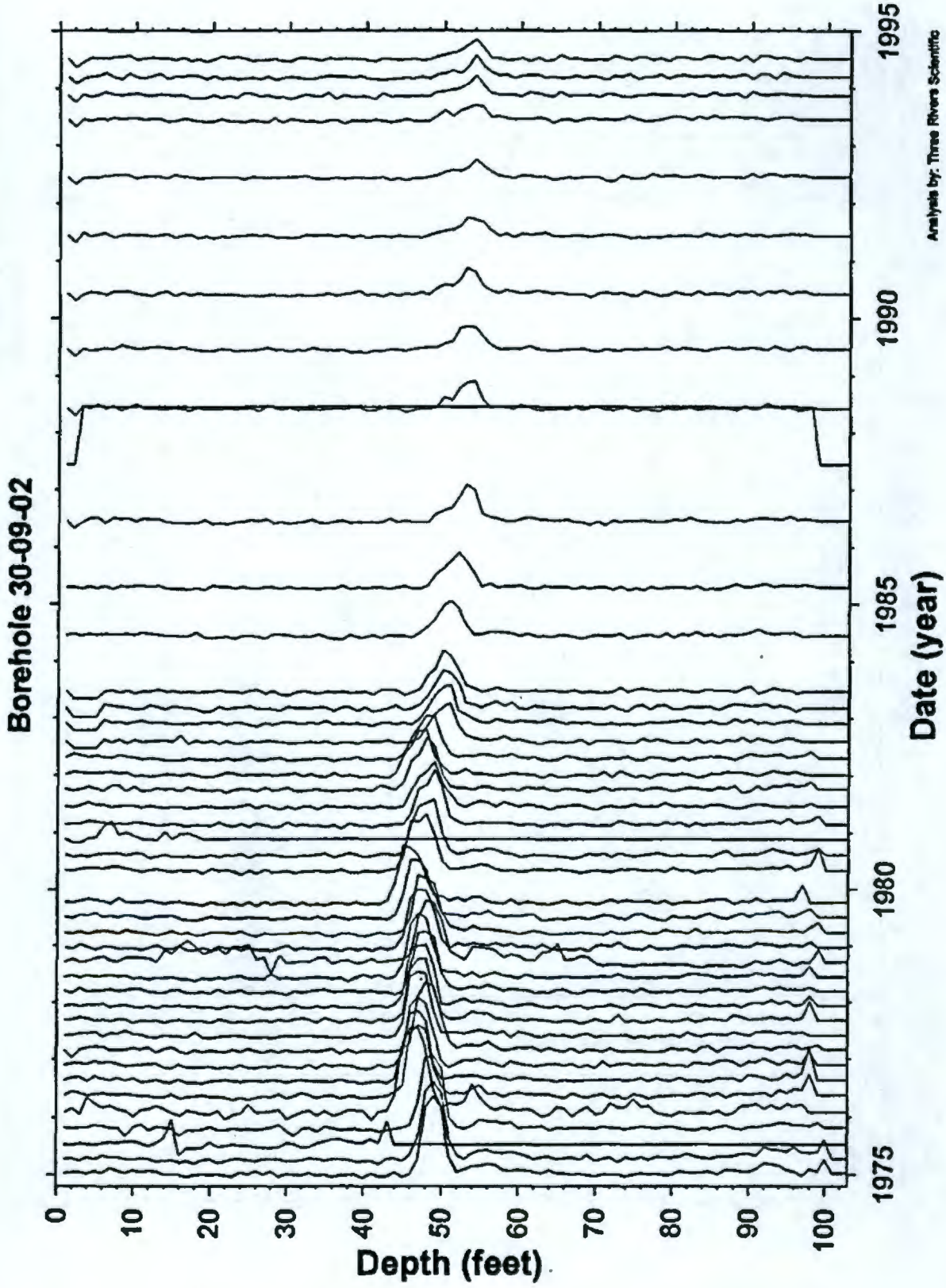
Gross Gamma Survey Information

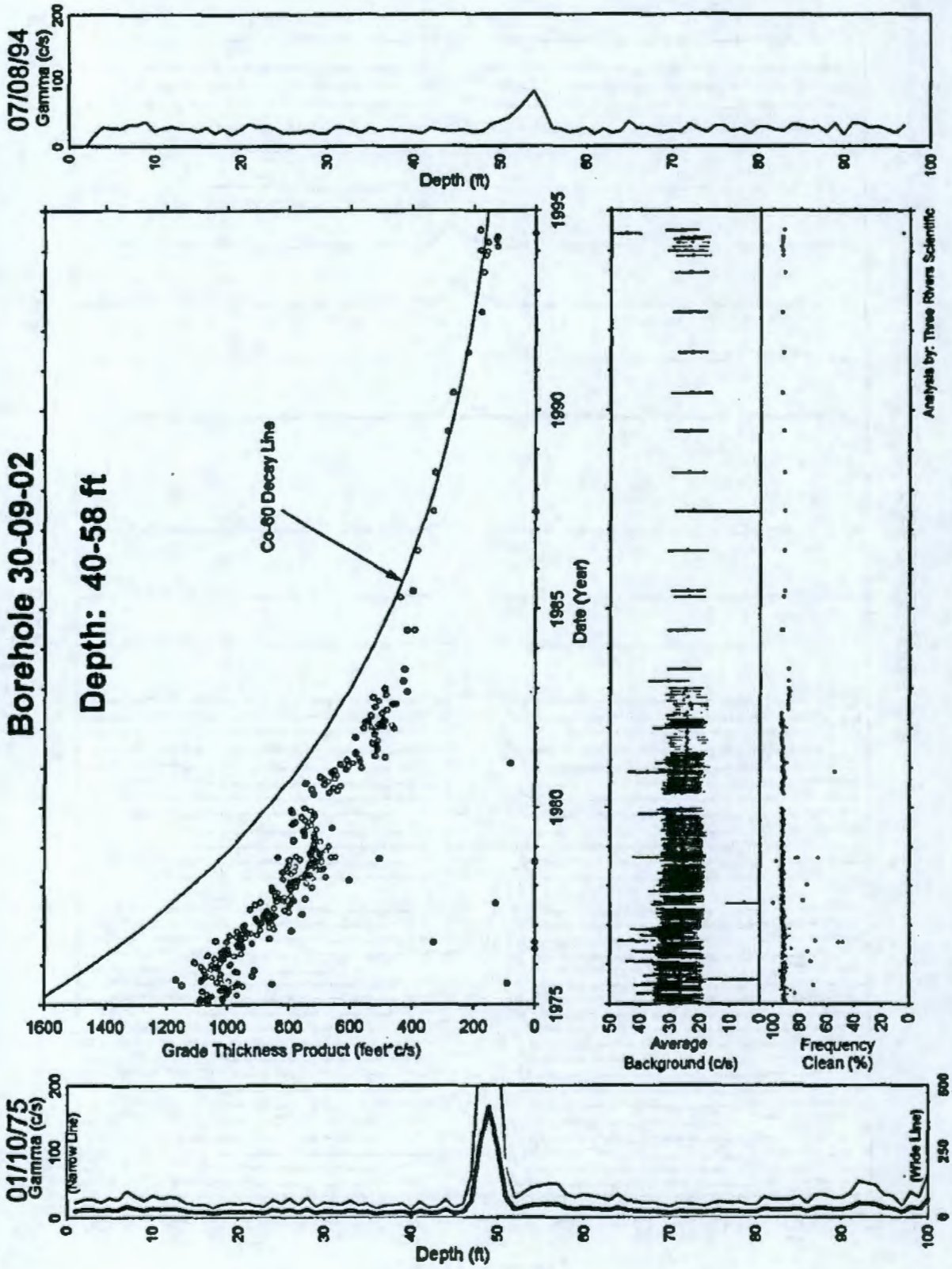
Probe Type Processed :	04: NaI
Other Probe Types :	03: Neutron
Survey Depth :	100 ft
First Survey Date :	1/10/1975
Last Survey Date :	7/08/1994
Number Surveys Processed :	312

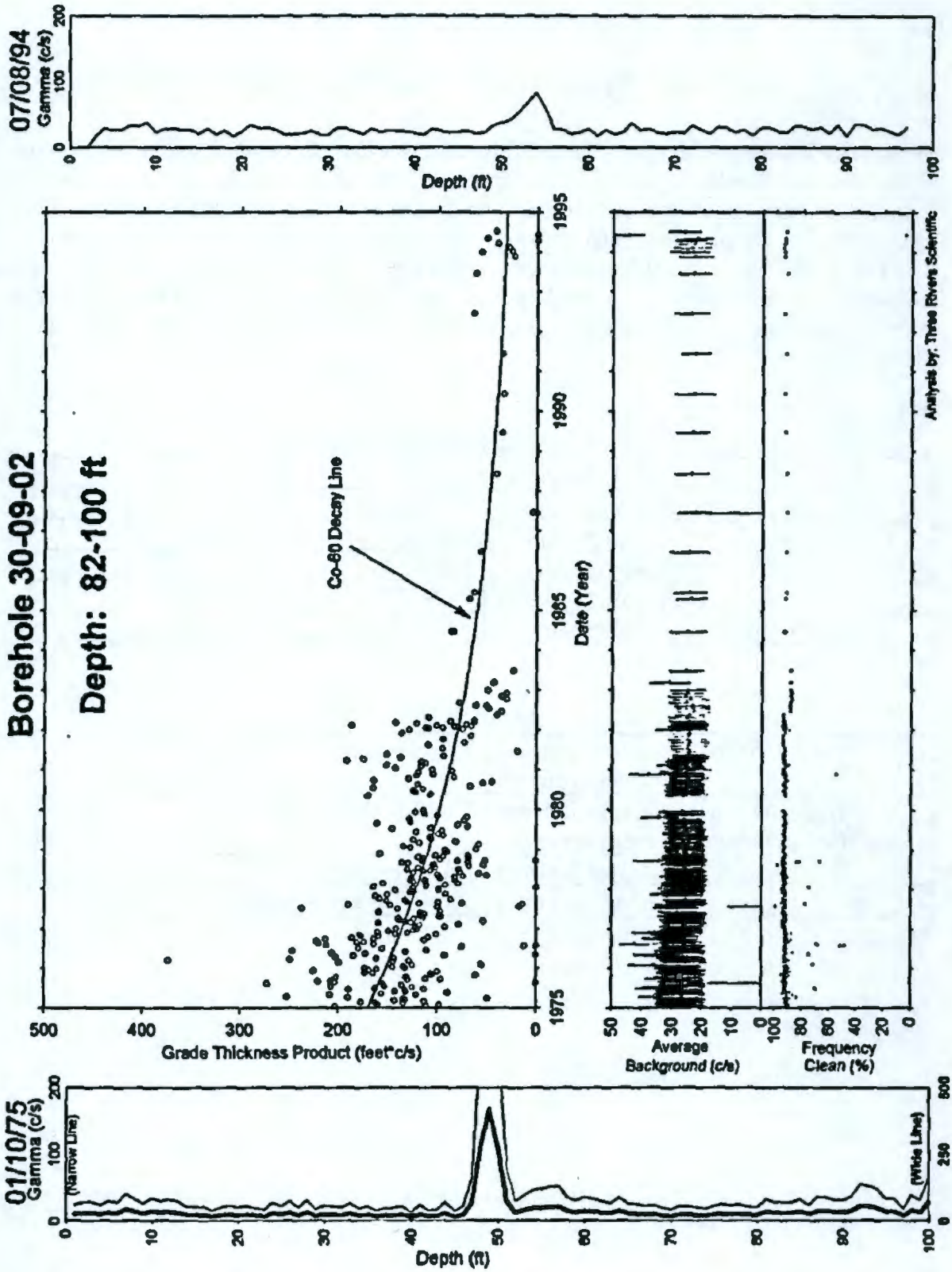
Analysis Notes

Method Used to Compute Background :	Fixed background (58-82ft)
Depth(s) where Contamination Identified in Gross Gamma Surveys :	40-58 ft Unstable 82-100 ft Stable
Analyst Name :	R.K. Price
Company Name :	Three Rivers Scientific


30-09-02 Combination Plot
TF Gross γ
07/08/94
Total γ
Max counts: 526 cps
232Th
238U
40K
137Cs and 60Co
LEGEND
137Cs
60Co
Depth (feet)
cps
pCi/g


Borehole 30-09-02
Depth (feet)
0
10
20
30
40
50
60
70
80
90
100
Date (year)
1975
1980
1985
1990
1995
Analysis by: Three Rivers Scientific


07/08/94
Gamma (c/s)
Depth (ft)
Borehole 30-09-02
Depth: 40-58 ft
Co-60 Decay Line
Grade Thickness Product (feet*c/s)
Date (Year)
Average Background (c/s)
Frequency Clean (%)
Analysis by: Three Rivers Scientific
01/10/75
Gamma (c/s)
(Narrow Line)
(Wide Line)
Depth (ft)


Borehole 30-09-02
Depth: 82-100 ft
07/08/94
Gamma (c/s)
Depth (ft)
Co-60 Decay Line
Grade Thickness Product (feet*c/s)
Date (Year)
Average Background (c/s)
Frequency Clean (%)
Analysis by: Three Rivers Scientific
01/10/75
Gamma (c/s)
(Narrow Line)
(Wide Line)
Depth (ft)

Borehole 30-09-06

Contamination (Co-60) from 72-88 feet is Unstable Early.

Grade thickness product over 72 to 88 feet shows that the activity rapidly increased from 1980 to 1984 then decreased by one half from 1984 to 1986. After 1986 the grade thickness product decrease was consistent with Co-60 (HPGe identified) decay. The stack plot shows that the contamination moved two feet lower from 1984 to 1986. Tracking the movement of the contamination to lower depths can not be performed for logs prior to 1984 because depth control was compromised by the manual operation of the logging equipment. The zone is categorized as unstable early.

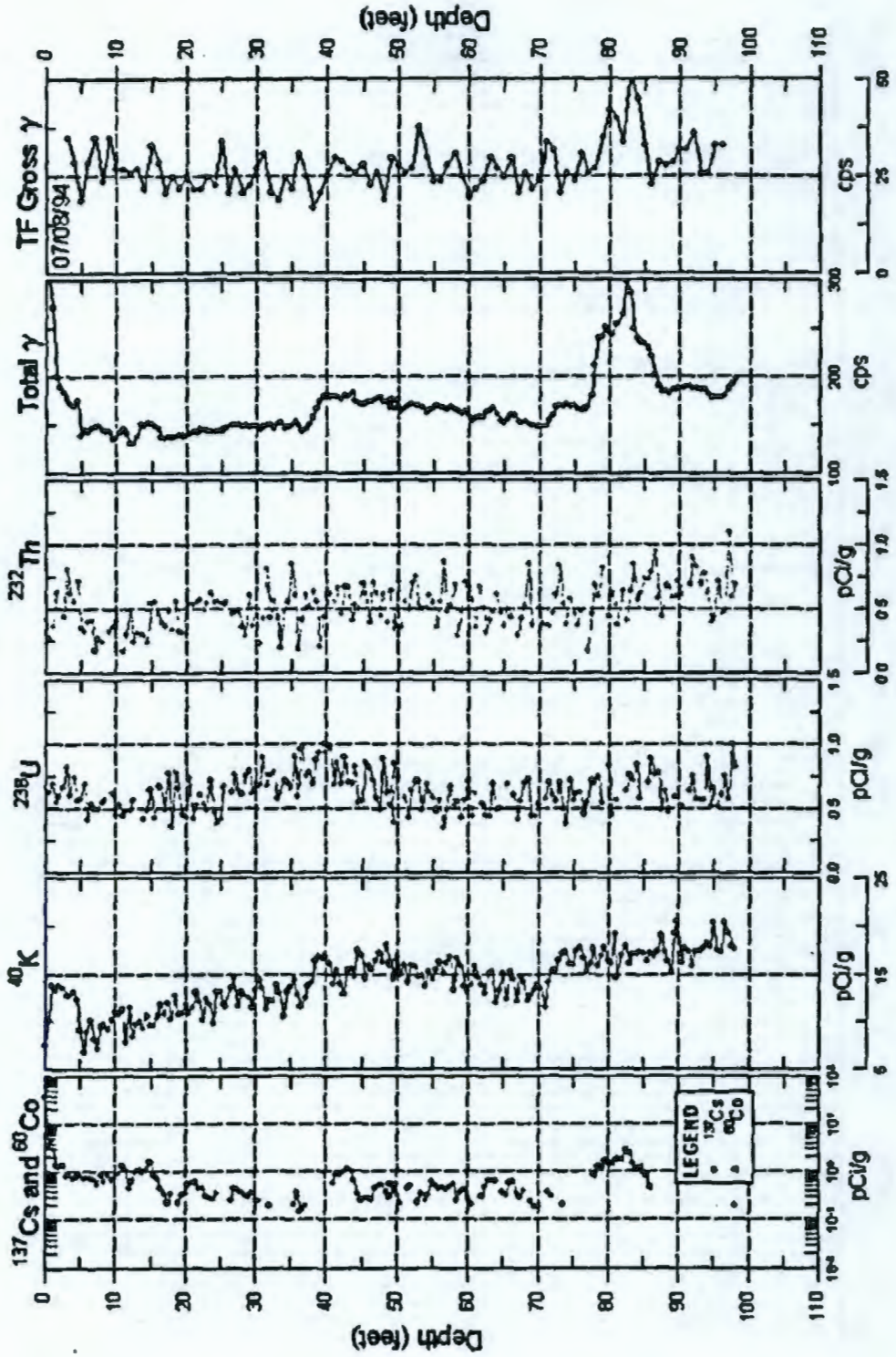
Gross Gamma Survey Information

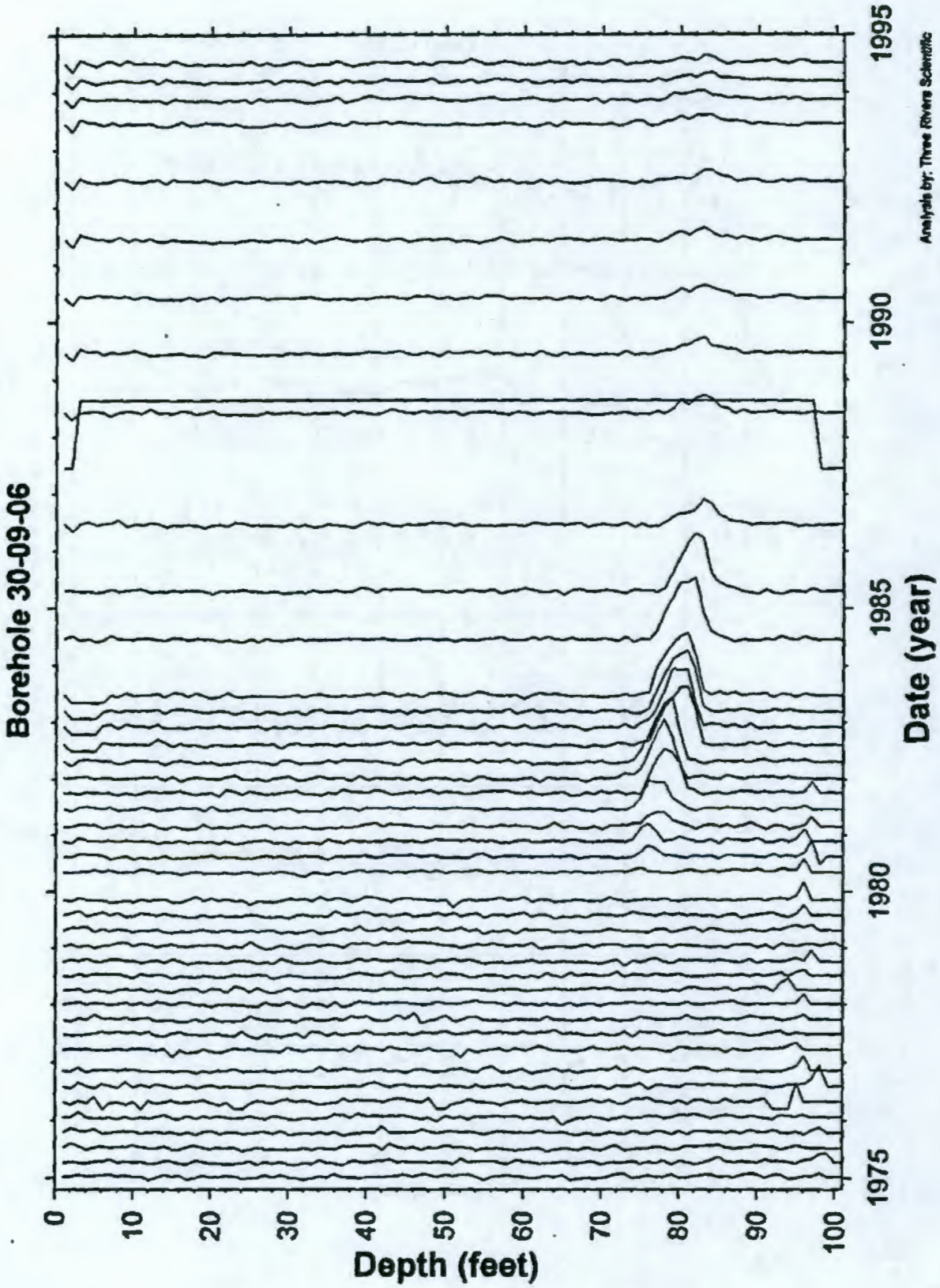
Probe Type Processed :	04: NaI
Other Probe Types :	03: Neutron
Survey Depth :	100 ft
First Survey Date :	1/10/1975
Last Survey Date :	7/08/1994
Number Surveys Processed :	320

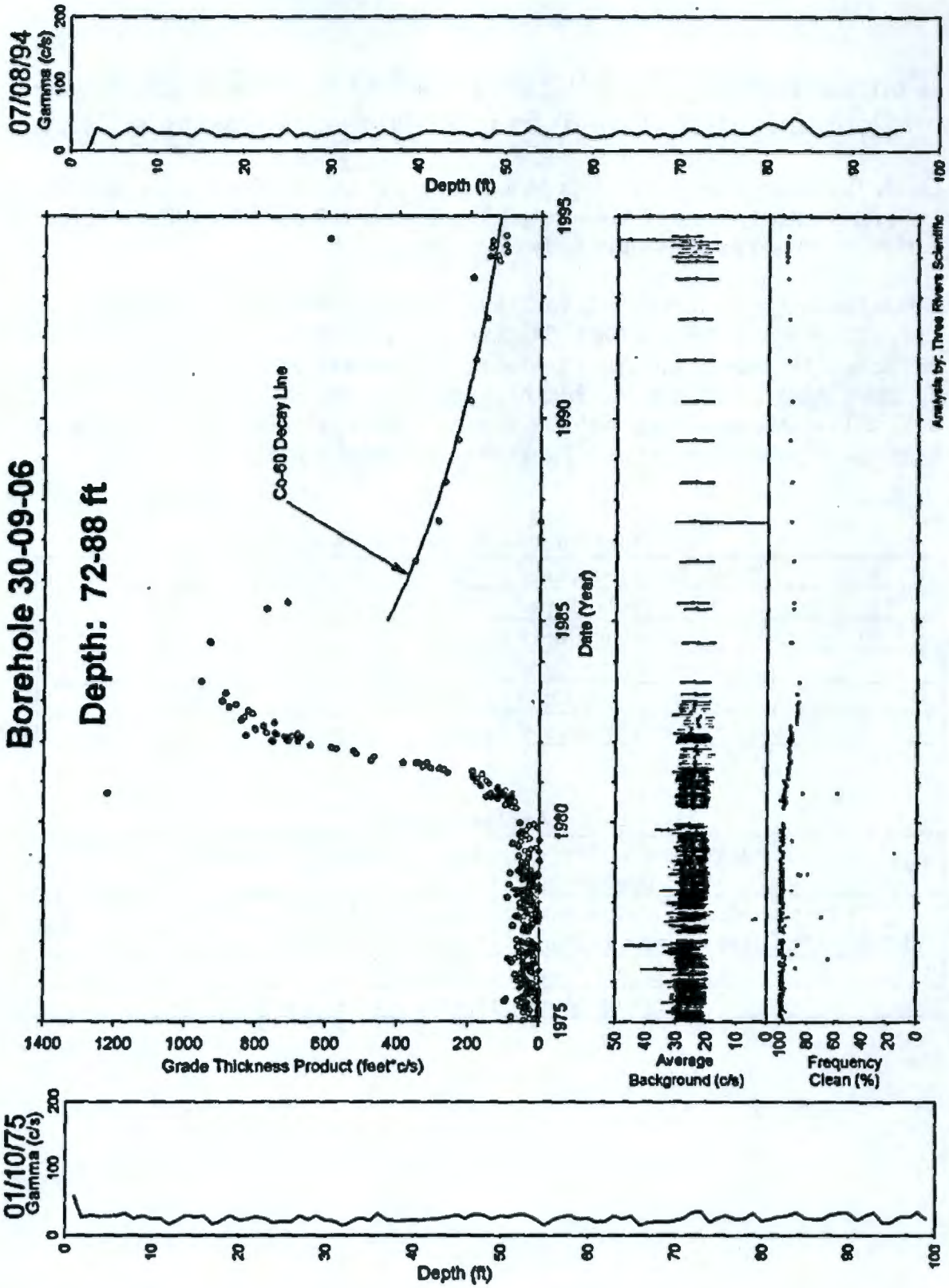
Analysis Notes

Method Used to Compute Background :	Fixed background (40-70ft)
Depth(s) where Contamination Identified in Gross Gamma Surveys :	72-88 ft Unstable Early
Analyst Name :	R.K. Price
Company Name :	Three Rivers Scientific

30-09-06 Combination Plot




Borehole 30-09-06
Depth (feet)
0
10
20
30
40
50
60
70
80
90
100
Date (year)
1975
1980
1985
1990
1995
Analysis by: Three Rivers Scientific


07/08/94
Gamma (c/s)
Depth (ft)
Borehole 30-09-06
Depth: 72-88 ft
Co-60 Decay Line
Date (Year)
Grade Thickness Product (feet*c/s)
Average Background (c/s)
Frequency Clean (%)
Analysis by: Three Rivers Scientific
01/10/75
Gamma (c/s)
Depth (ft)

Borehole 30-09-07

Contamination (Cs-137) from 0-14 feet is Tank Farm Activity. Contamination (Co-60) from 72-90 feet is Unstable Early.

Grade thickness product over 0 to 14 feet is erratic and highly variable, indicative of tank farm activity. The HPGe survey identified Cs-137 up to 15 pCi/g from the surface to 10 feet and intermittently from 10 to 35 feet.

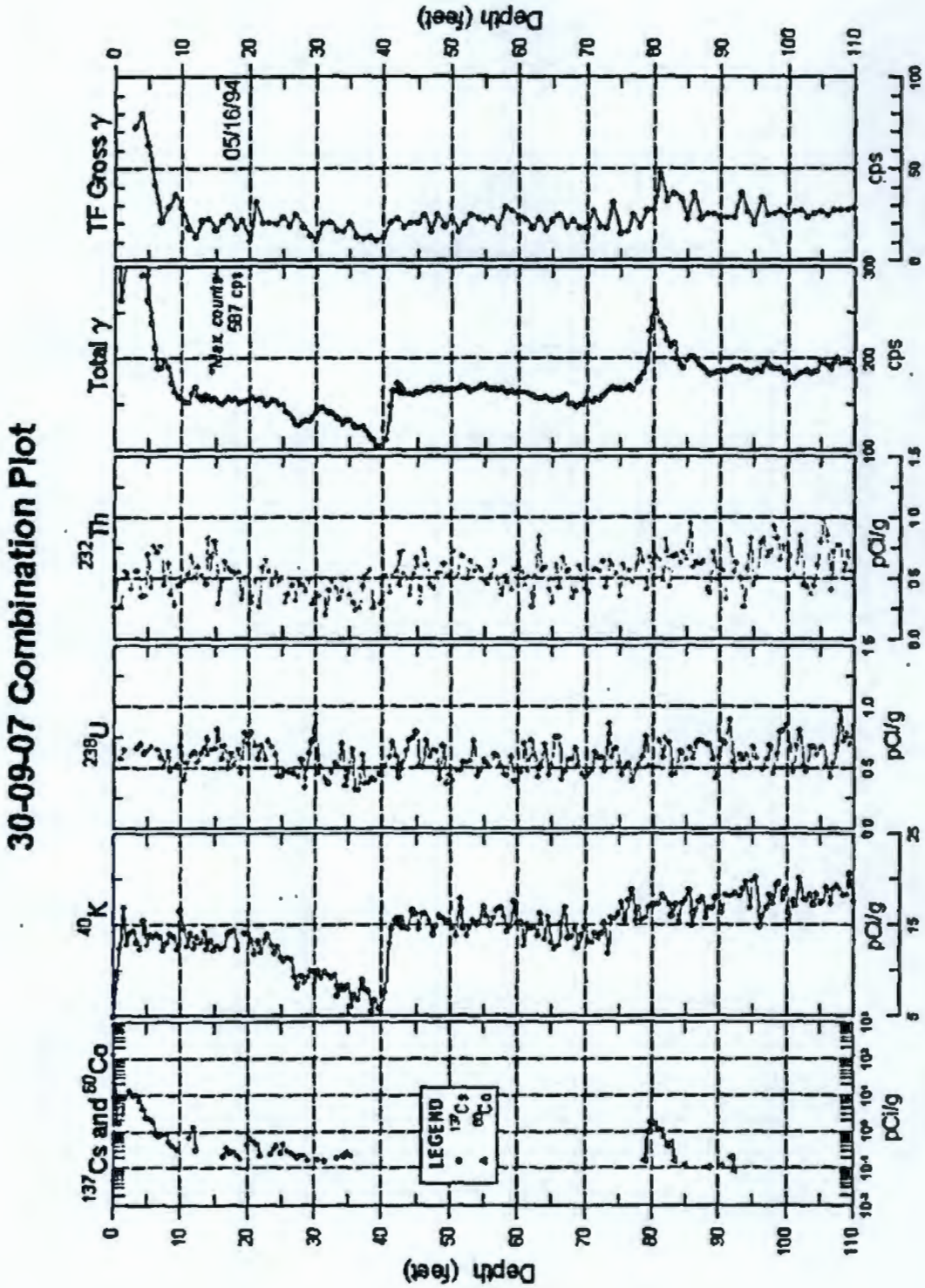
Grade thickness product over 72 to 90 feet shows a rapid decrease in activity from the first surveys in 1982 to 1987. The low monitoring frequency (annual) for the majority of the surveillance time period makes analysis of the tank farm logs difficult. After 1987 the grade thickness product is decreasing, consistent with Co-60 (HPGe identified) decay, within statistical precision typical of the tank farms logging equipment. The zone is categorized as unstable early.

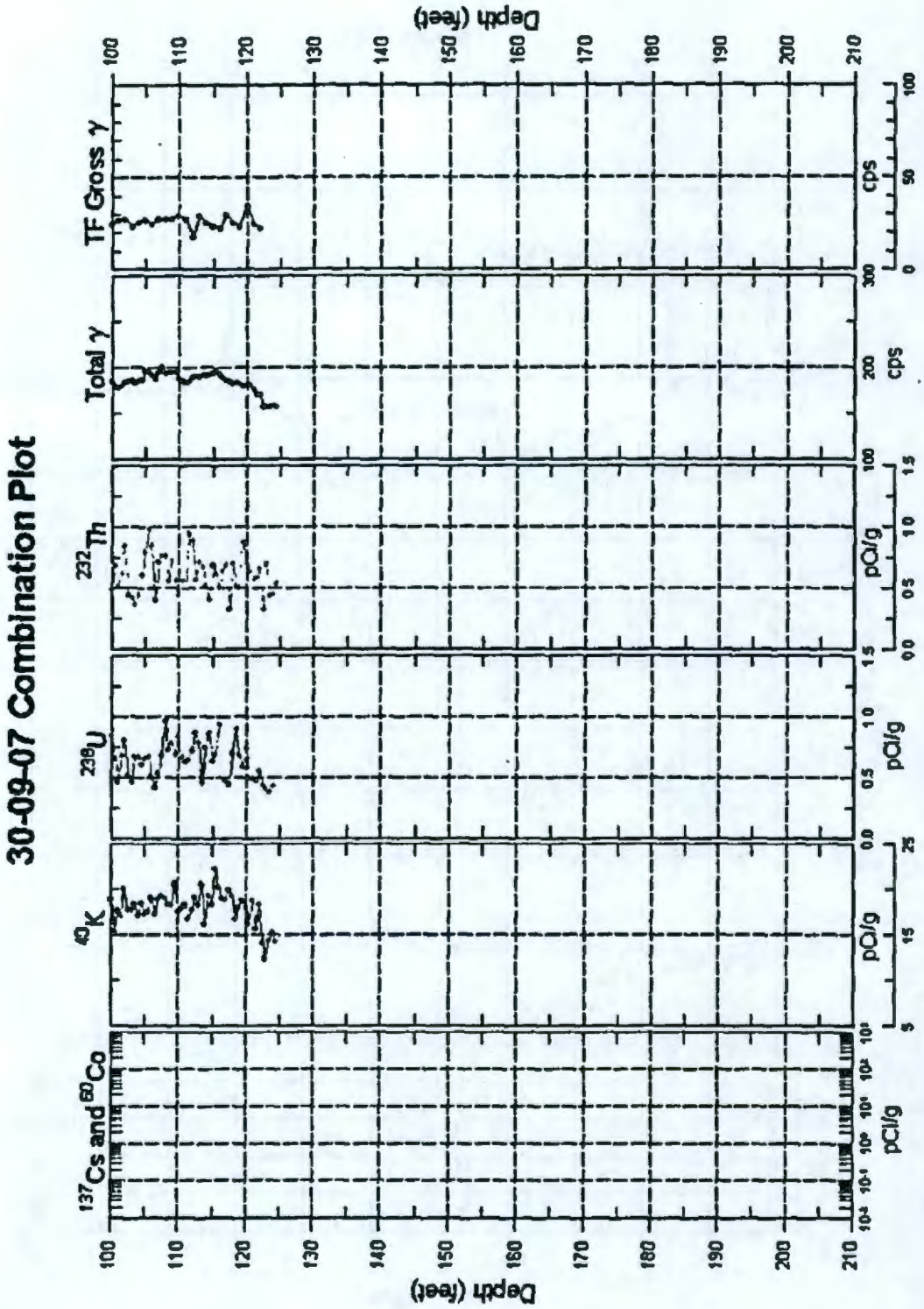
Gross Gamma Survey Information

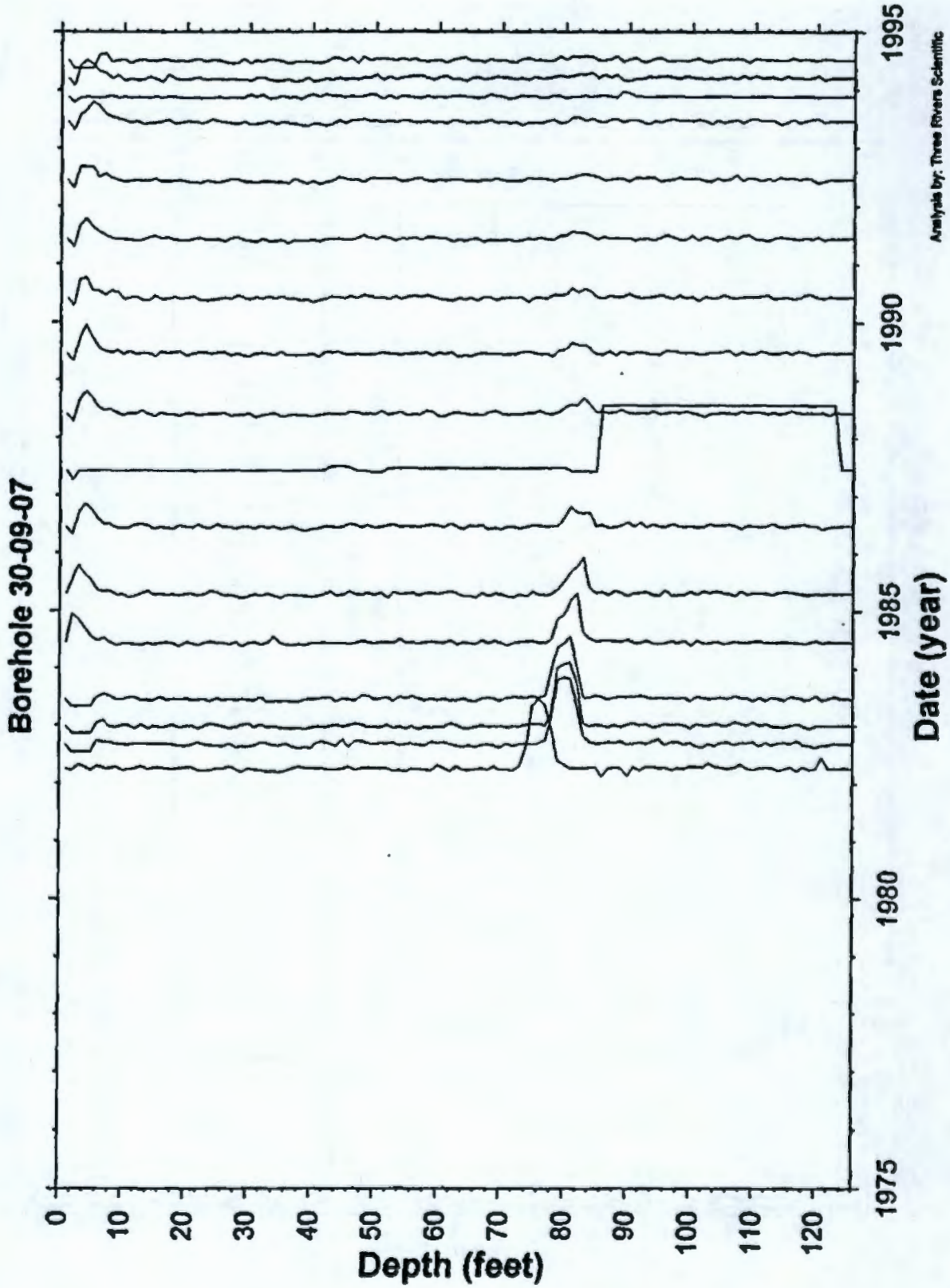
Probe Type Processed :	04: NaI
Other Probe Types :	03: Neutron
Survey Depth :	125 ft
First Survey Date :	4/08/1982
Last Survey Date :	7/08/1994
Number Surveys Processed :	45

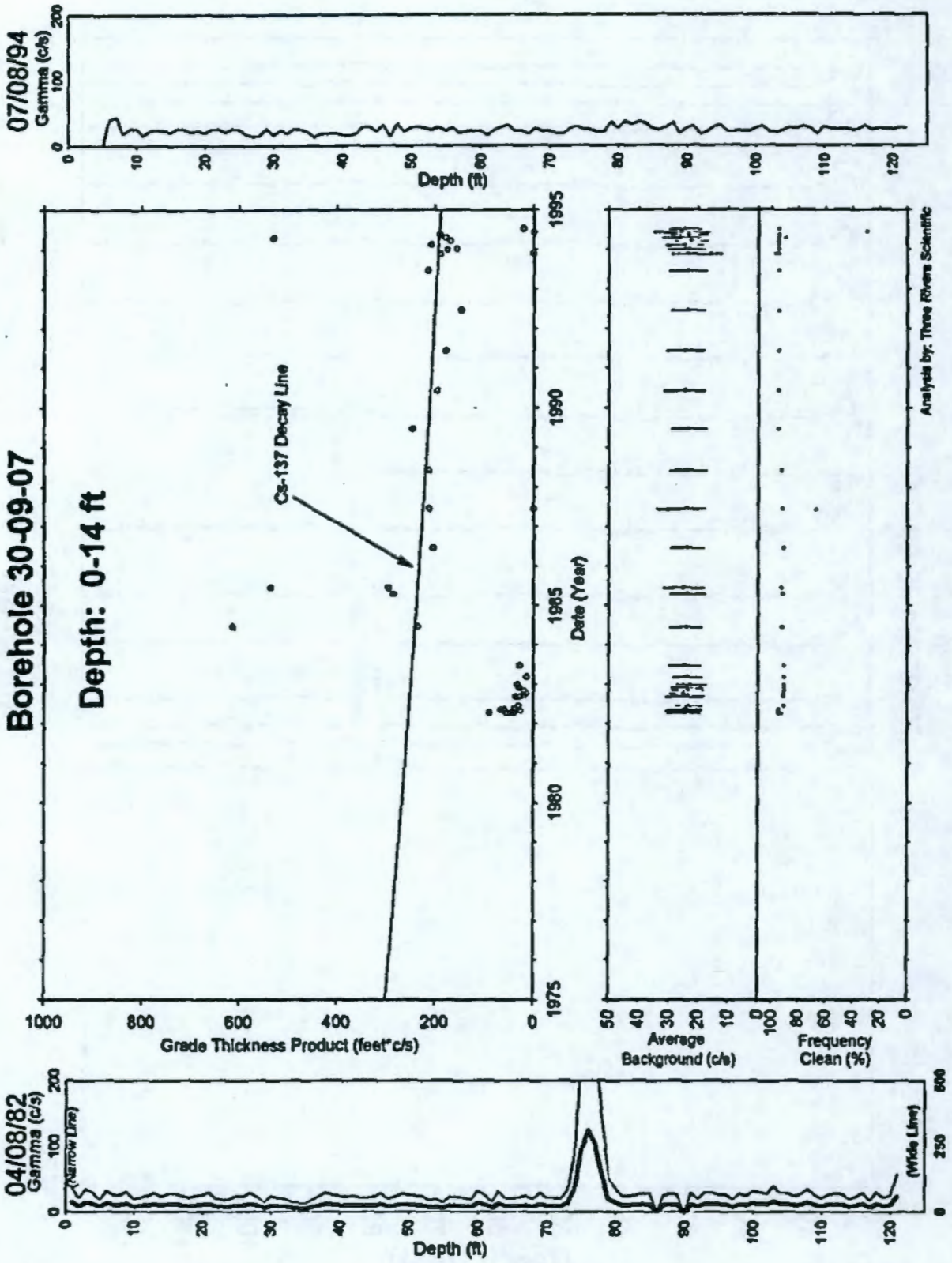
Analysis Notes

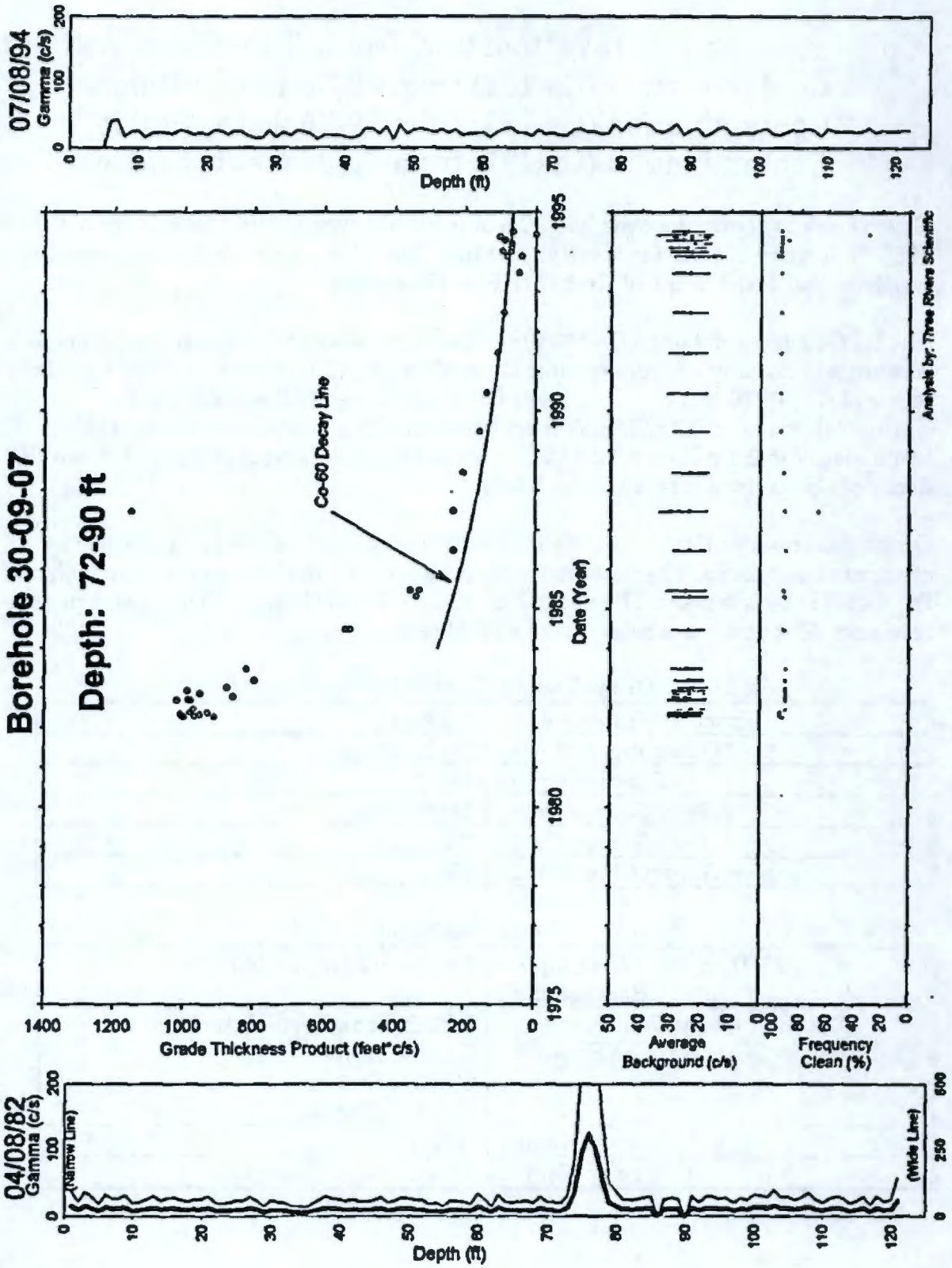
Method Used to Compute Background :	Fixed background (42-70ft)
Depth(s) where Contamination Identified in Gross Gamma Surveys :	0-14 ft Tank Farm Activity 72-90 ft Unstable Early
Analyst Name :	R.K. Price
Company Name :	Three Rivers Scientific


30-09-07 Combination Plot
TF Gross γ
05/16/94
Total γ
Max counts
587 cps
232Th
238U
40K
137Cs and 60Co
LEGEND
137Cs
60Co
cps
pCi/g
Depth (feet)


30-09-07 Combination Plot
^{137}Cs and ^{60}Co
^{40}K
^{238}U
^{232}Th
Total γ
TF Gross γ
pCi/g
cps
Depth (feet)


Borehole 30-09-07
Depth (feet)
0
10
20
30
40
50
60
70
80
90
100
110
120
Date (year)
1975
1980
1985
1990
1995
Analysis by: Three Rivers Scientific


Borehole 30-09-07
Depth: 0-14 ft
07/08/94
Gamma (c/s)
Depth (ft)
Cs-137 Decay Line
Date (Year)
Grade Thickness Product (feet*c/s)
Average Background (c/s)
Frequency Clean (%)
Analysis by: Three Rivers Scientific
04/08/82
Gamma (c/s)
(Narrow Line)
(Wide Line)
Depth (ft)


07/08/94
Gamma (c/s)
Depth (ft)
Borehole 30-09-07
Depth: 72-90 ft
Co-60 Decay Line
Grade Thickness Product (feet*c/s)
Date (Year)
Average Background (c/s)
Frequency Clean (%)
Analysis by: Three Rivers Scientific
04/08/82
Gamma (c/s)
(Narrow Line)
(Wide Line)
Depth (ft)

Borehole 30-09-10

Contamination (Cs-137) from 0-20 feet is Tank Farm Activity.
Contamination (Cs-137) from 20-38 feet is Stable.
Contamination (Cs-137) from 50-70 feet is Stable.
Contamination (Cs-137) from 70-94 feet is Stable.

Grade thickness product over 0 to 20 feet is highly erratic and variable from 1975 to 1986, indicative of tank farm activity. Since 1986, the grade thickness product is consistent with the decay of Cs-137 (HPGe identified).

The HPGe survey detected Cs-137 almost continuously through out the borehole at concentrations ranging from greater than 100 pCi/g (3 ft) to near 1 pCi/g with low levels of Co-60 (70-100 ft). Co-60 was detected between 52 and 98 feet at concentrations near 0.1 pCi/g. A concentration of 3.1 pCi/g of Co-60 on 1/1/1975 would decay to 0.1 pCi/g on 12/31/2000. Thus the tank farm logs would not see the decay of Co-60 since it is less than MDL.

Grade thickness products over 20-38, 50-70, and 70-94 feet are low level contamination zones. The observed variances are within the statistical precision of the data in the intervals. The decay line of Cs-137 (HPGe identified) is shown as a reference. The zones are categorized as stable.

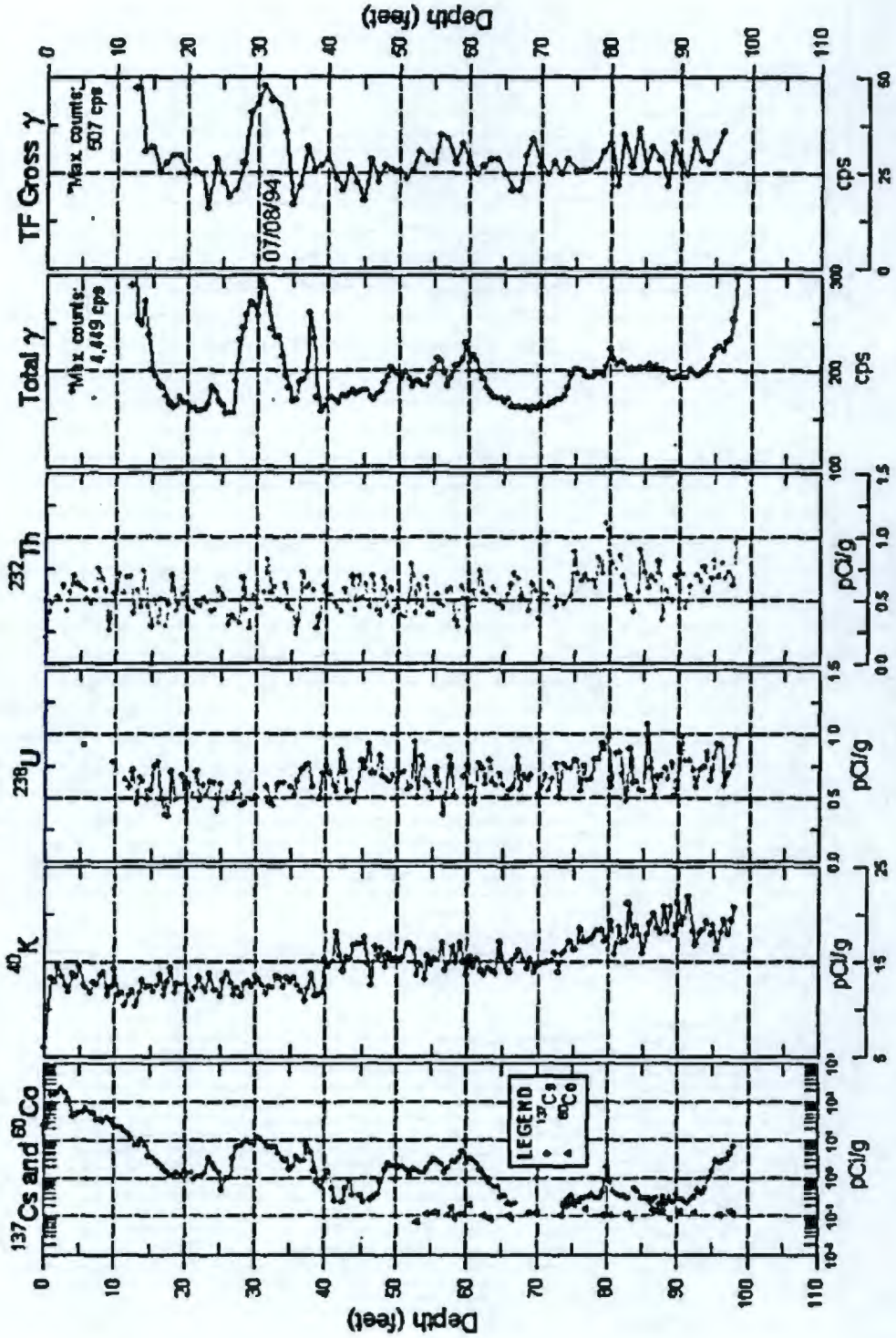
Gross Gamma Survey Information

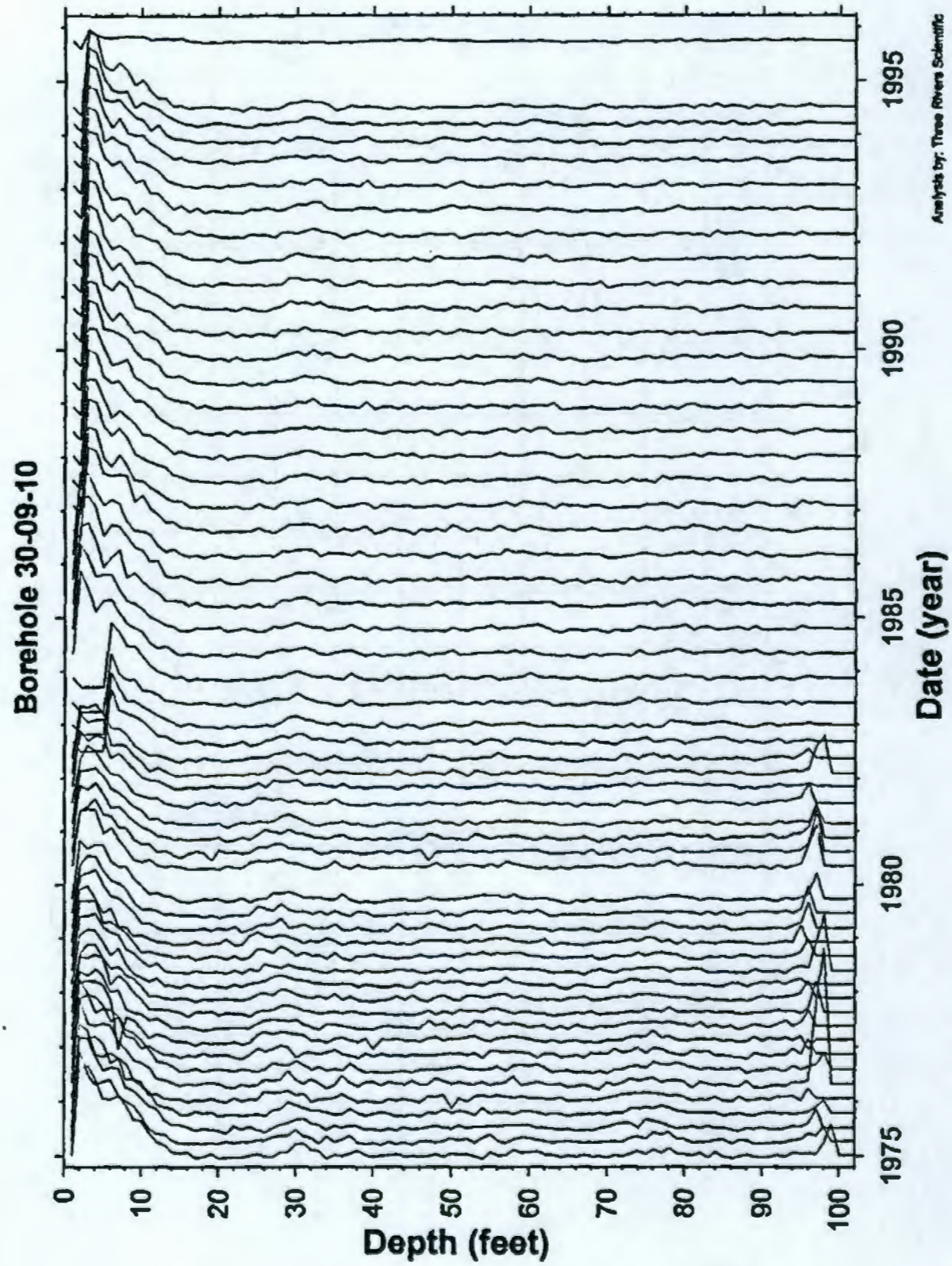
Probe Type Processed :	04: NaI
Other Probe Types :	03: Neutron
Survey Depth :	100 ft
First Survey Date :	1/10/1975
Last Survey Date :	9/27/1995
Number Surveys Processed :	360

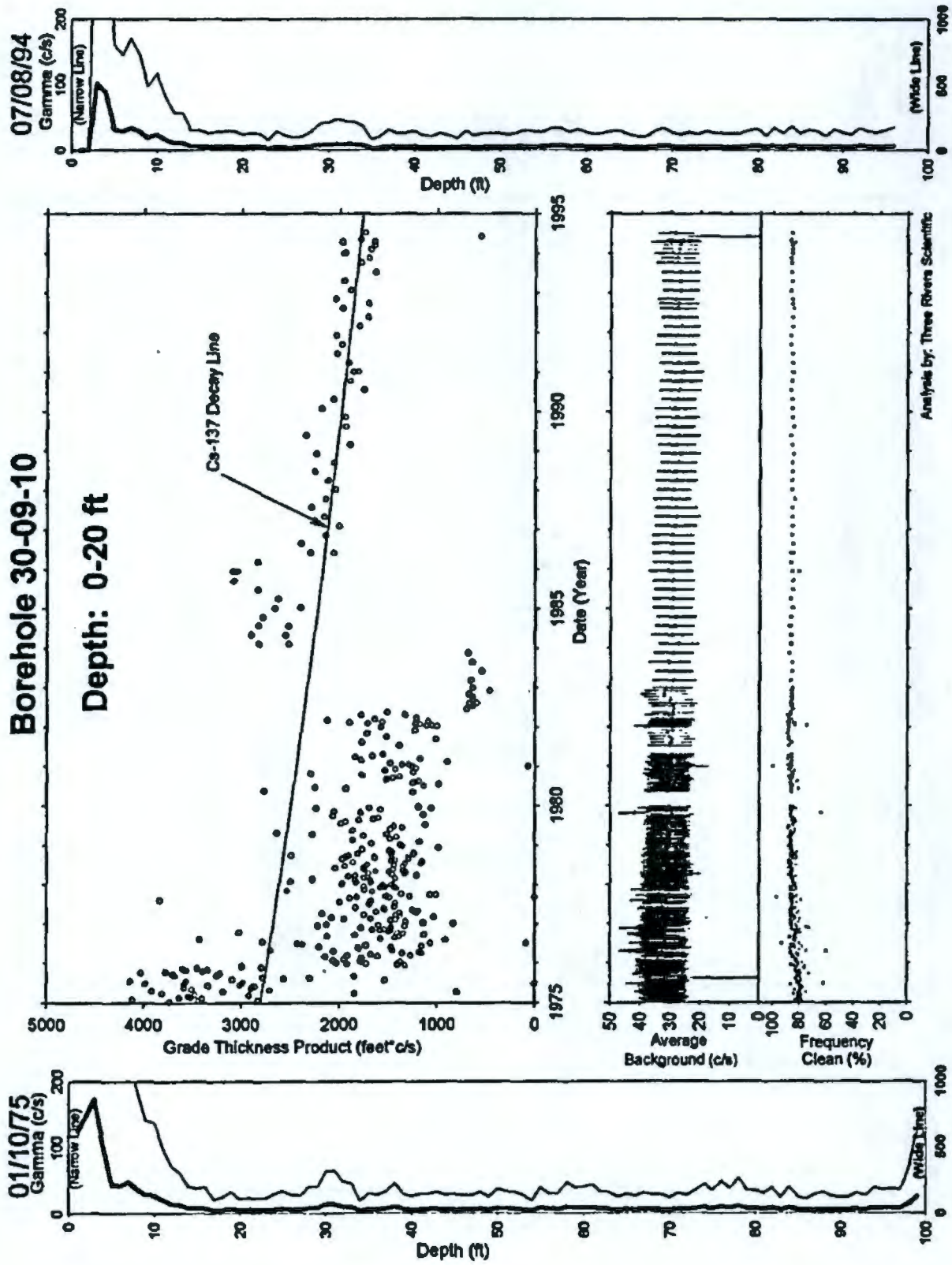
Analysis Notes

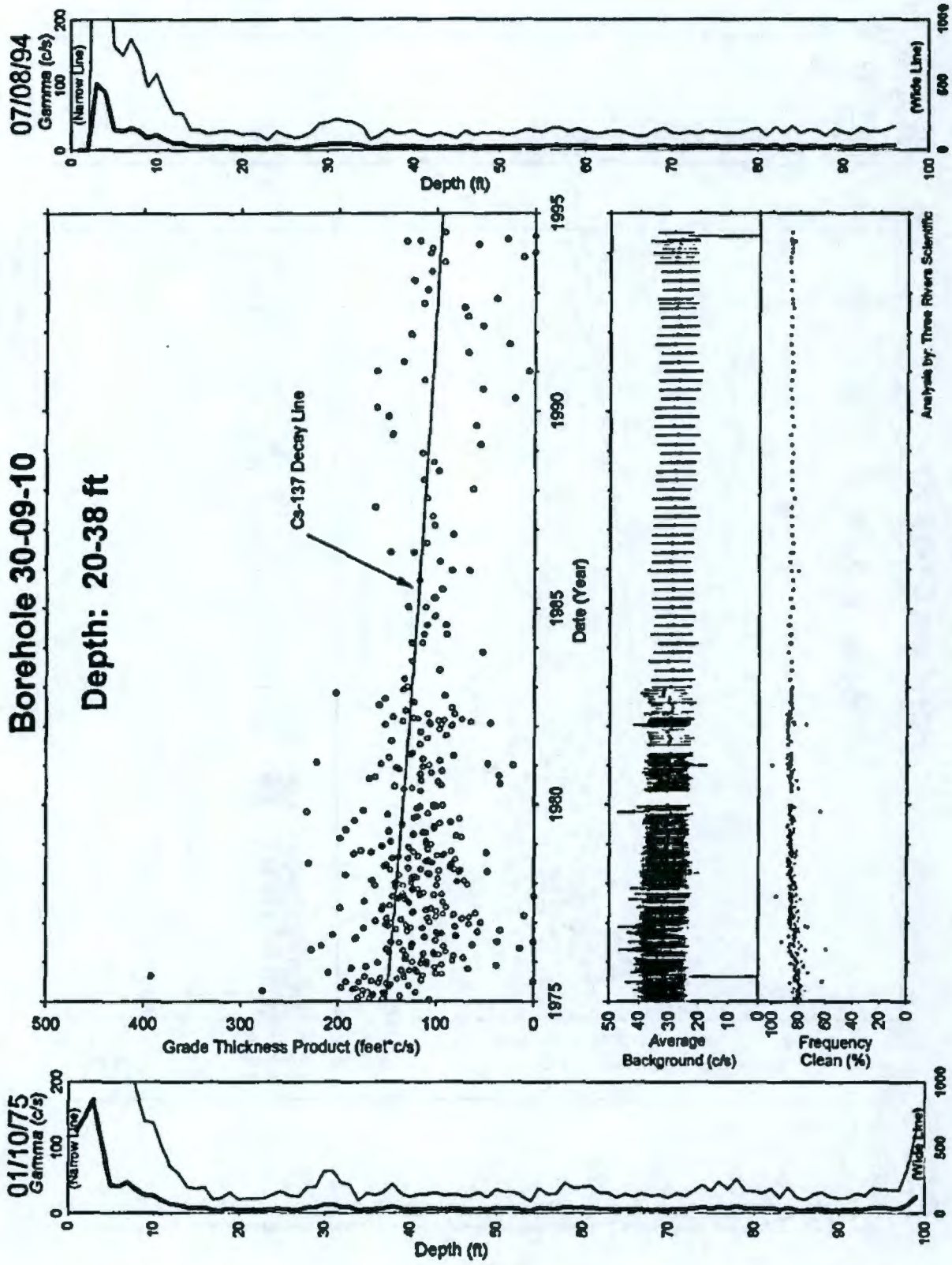
Method Used to Compute Background :	Fixed background (40-50ft)
Depth(s) where Contamination Identified in Gross Gamma Surveys :	0-20 ft Tank Farm Activity 20-38 ft Stable 50-70 ft Stable 70-94 ft Stable
Analyst Name :	R.K. Price
Company Name :	Three Rivers Scientific

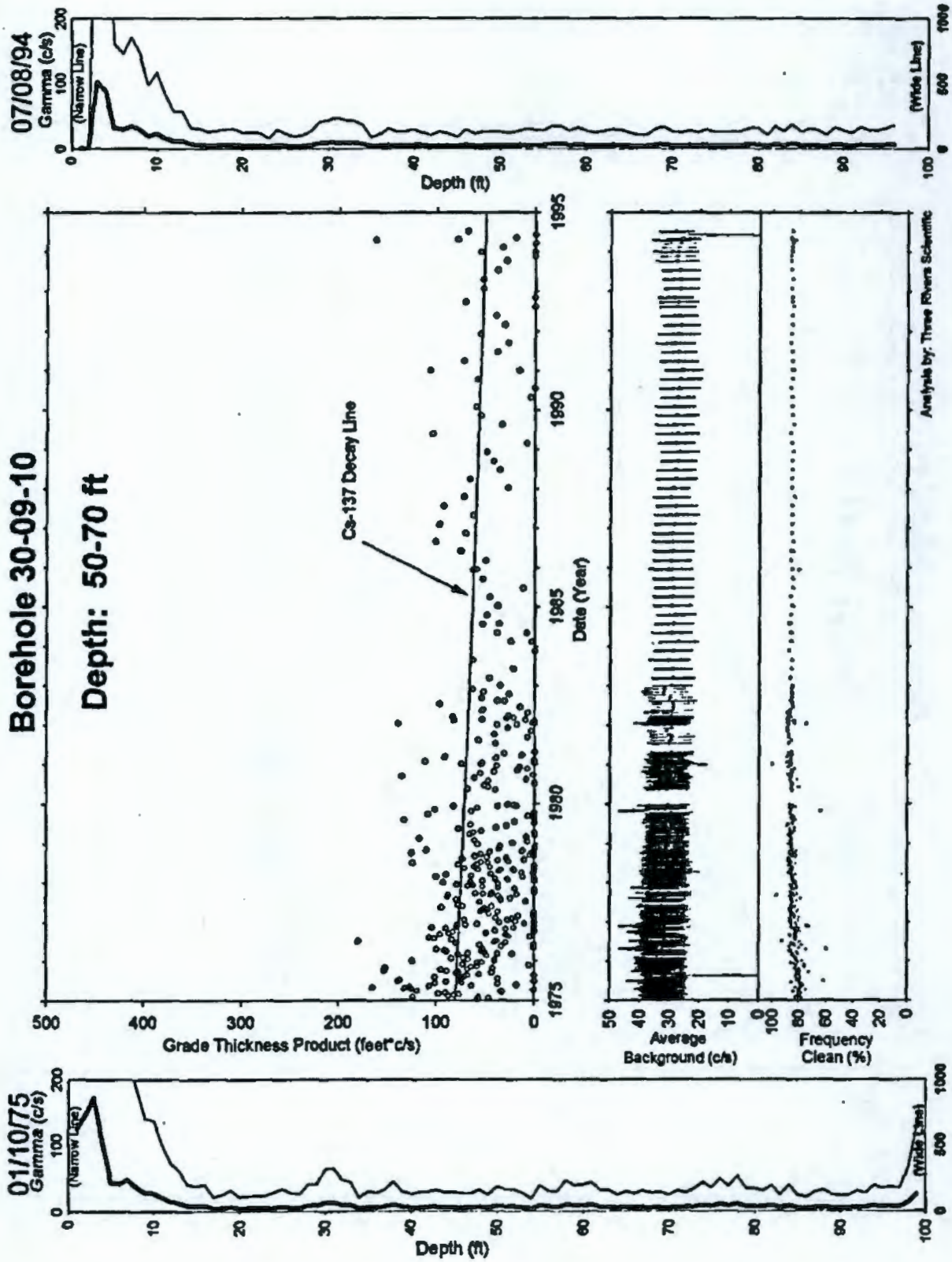
30-09-10 Combination Plot

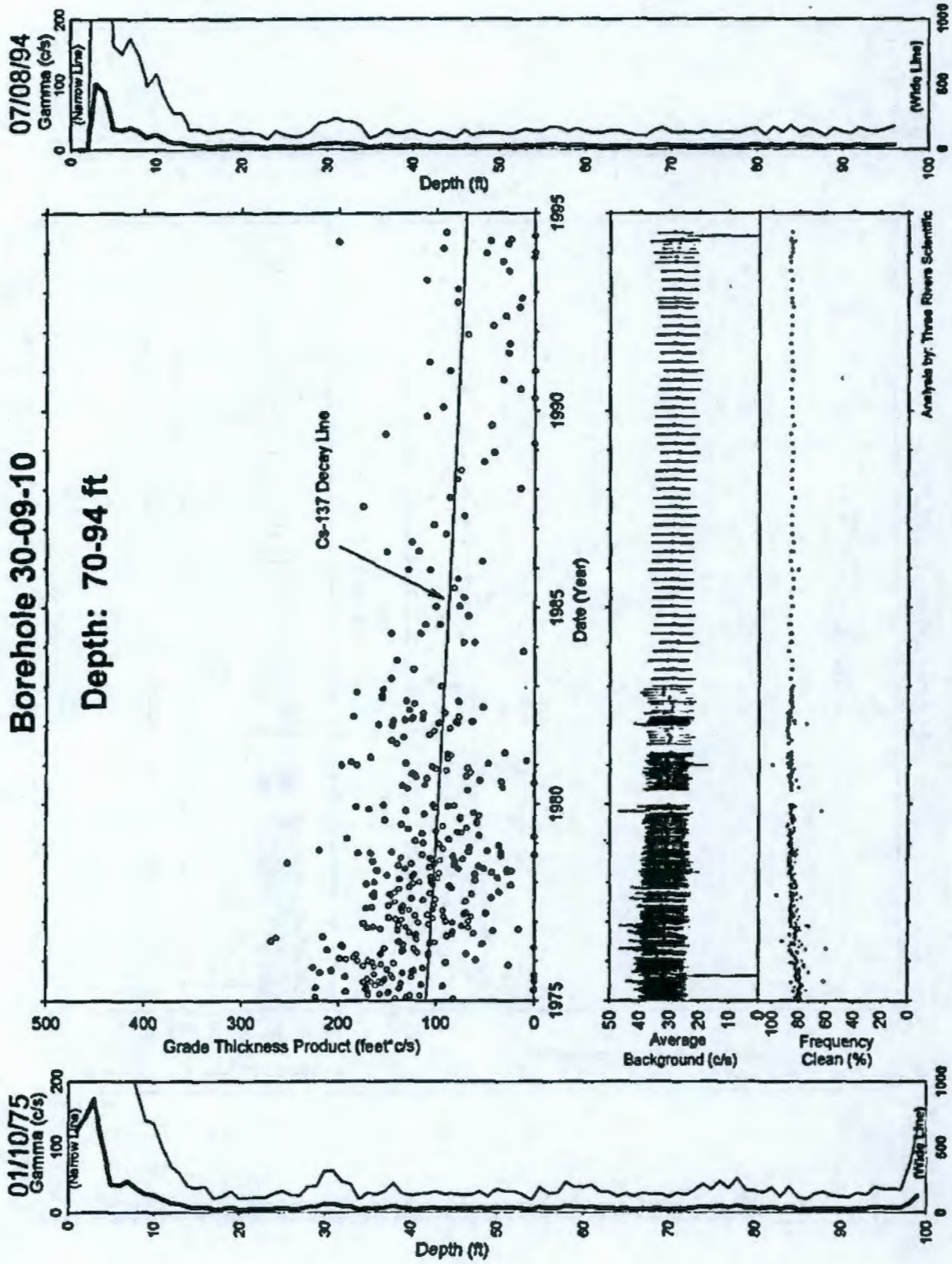



Borehole 30-09-10
Depth (feet)
0
10
20
30
40
50
60
70
80
90
100
Date (year)
1975
1980
1985
1990
1995
Analysis by: Three Rivers Scientific


07/08/94
Gamma (c/s)
(Narrow Line)
(Wide Line)
Depth (ft)
Borehole 30-09-10
Depth: 0-20 ft
Cs-137 Decay Line
Date (Year)
Grade Thickness Product (feet*c/s)
Average Background (c/s)
Frequency Clean (%)
Analysis by: Three Rivers Scientific
01/10/75
Gamma (c/s)
(Narrow Line)
(Wide Line)
Depth (ft)


Borehole 30-09-10
Depth: 20-38 ft
07/08/94
Gamma (c/s)
(Narrow Line)
(Wide Line)
Depth (ft)
Cs-137 Decay Line
Grade Thickness Product (feet*c/s)
Date (Year)
Average Background (c/s)
Frequency Clean (%)
Analysis by: Three Rivers Scientific
01/10/75
Gamma (c/s)
(Narrow Line)
(Wide Line)
Depth (ft)


Borehole 30-09-10
Depth: 50-70 ft
07/08/94
Gamma (c/s)
(Narrow Line)
(Wide Line)
Depth (ft)
Cs-137 Decay Line
Date (Year)
Grade Thickness Product (feet*c/s)
Average Background (c/s)
Frequency Clean (%)
Analysis by: Three Rivers Scientific
01/10/75
Gamma (c/s)
(Narrow Line)
(Wide Line)
Depth (ft)


Borehole 30-09-10
Depth: 70-94 ft
07/08/94
Gamma (c/s)
(Narrow Line)
(Wide Line)
Depth (ft)
Cs-137 Decay Line
Date (Year)
Grade Thickness Product (feet*c/s)
Average Background (c/s)
Frequency Clean (%)
Analysis by: Three Rivers Scientific
01/10/75
Gamma (c/s)
(Narrow Line)
(Wide Line)
Depth (ft)

Borehole 30-09-11

No Gamma Ray Emitting Contamination Identified.

No significant levels of gamma ray contamination are present, based upon gross gamma data, above the survey probe detection threshold between 1975 and 1994 in the vadose zone from 2 to 100 feet.

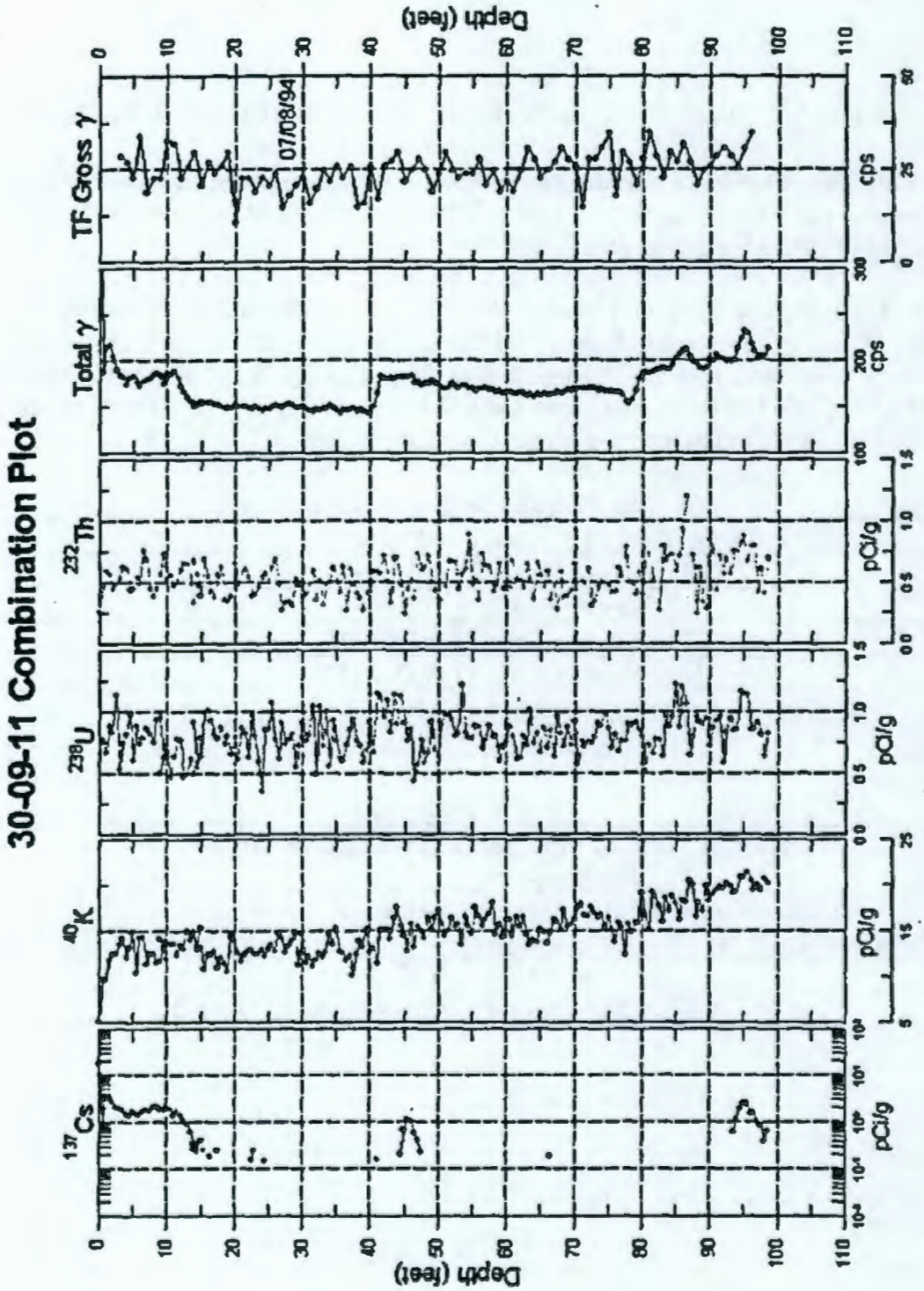
The HPGe logging system detected Cs-137 in three zones in the borehole. The first zone, from the surface to 16 feet, had Cs-137 levels up to 4 pCi/g. The second zone, from 44 to 48 feet, had Cs-137 levels less than 2 pCi/g. The third zone, at the bottom of the borehole (93 to 99 feet), had Cs-137 levels at 2 pCi/g. All three zones contain Cs-137 at levels below gross gamma detection threshold.

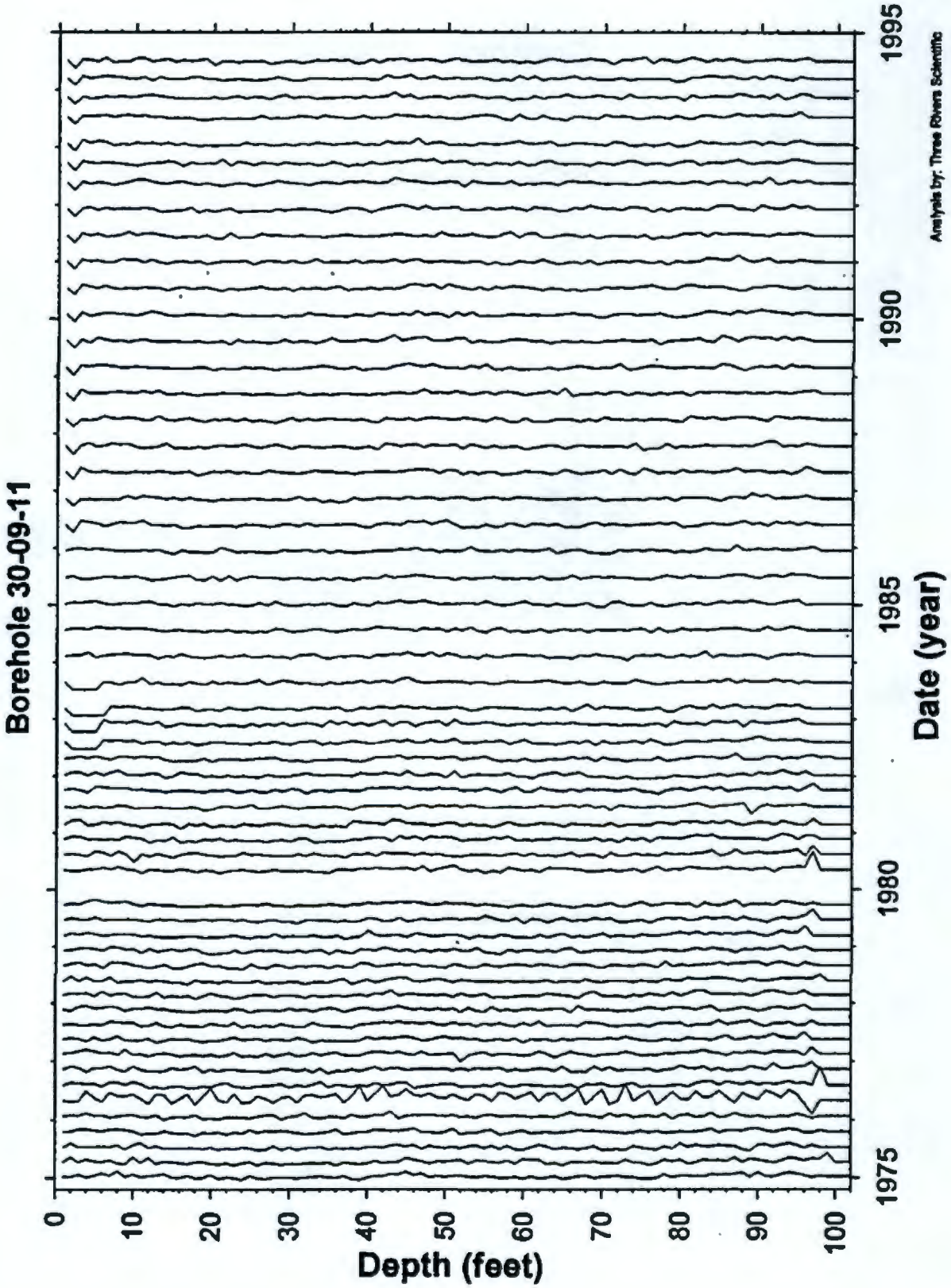
Gross Gamma Survey Information

Probe Type Processed :	04: NaI
Other Probe Types :	03: Neutron
Survey Depth :	100 ft
First Survey Date :	1/10/1975
Last Survey Date :	6/03/1994
Number Surveys Processed :	349

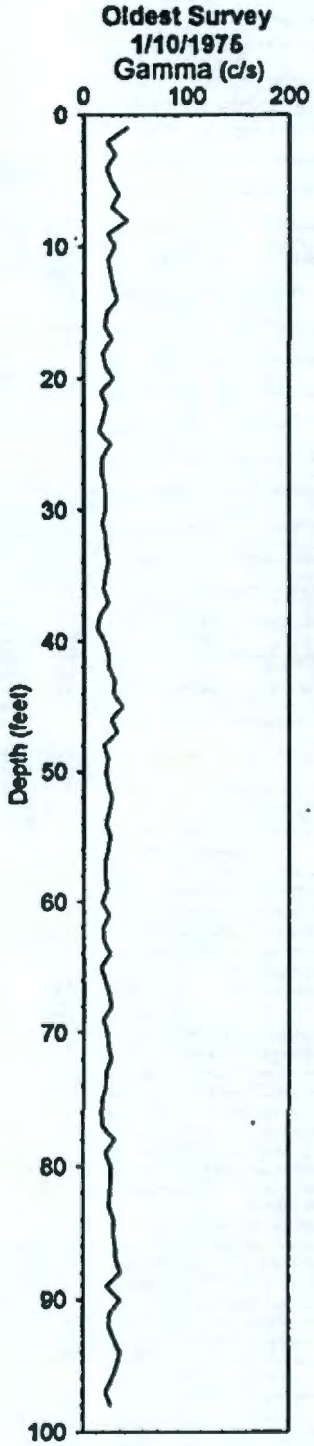
Analysis Notes

Method Used to Compute Background :	Threshold 0<val<50
Depth(s) where Contamination Identified in Gross Gamma Surveys :	NONE
Analyst Name :	R.K. Price
Company Name :	Three Rivers Scientific

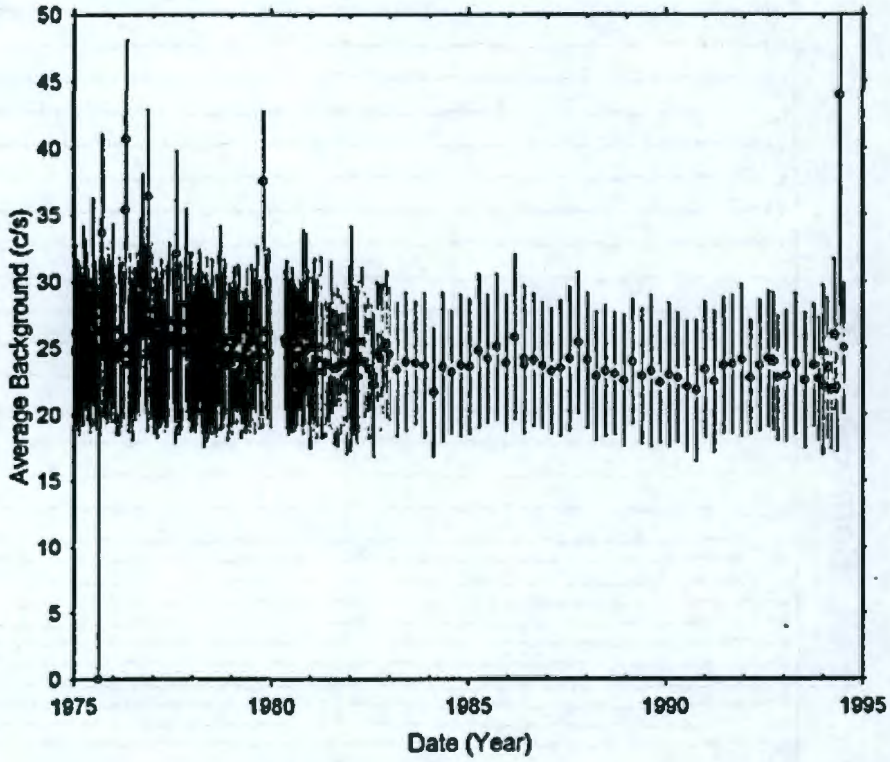

30-09-11 Combination Plot
TF Gross γ
07/08/94
cps
Total γ
cps
232Th
pCi/g
238U
pCi/g
40K
pCi/g
137Cs
pCi/g
Depth (feet)
Depth (feet)

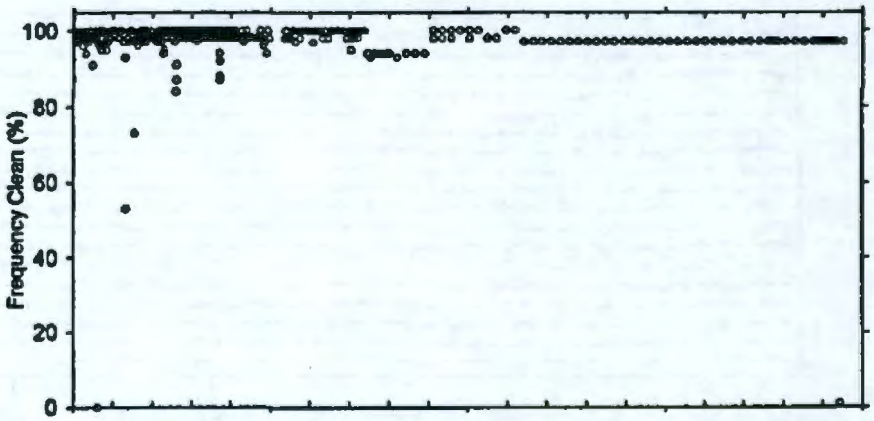

Borehole 30-09-11
Depth (feet)
0
10
20
30
40
50
60
70
80
90
100
Date (year)
1975
1980
1985
1990
1995
Analysis by: Three Rivers Scientific

Borehole 30-09-11



No Gamma-Ray Emitting Contamination Above Survey Detection Threshold





Analysis by: Three Rivers Scientific

Tank C-110

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Tank C-110 339
Borehole 30-10-01 340
Borehole 30-10-02 344
Borehole 30-10-09 348
Borehole 30-10-11 352

This section contains the analysis results for vadose zone boreholes (dry wells) associated with the Tank 110 in the "C" Tank Farm.

Special Notes: Borehole 30-10-02 has slightly high gross activity for the level of Cs-137 reported with the HPGe log data. This indicates the possibility of either a remote Cs-137 source, or the presence of a strong beta only source, (such as Sr-90).

Borehole 30-10-01

No Gamma Ray Emitting Contamination Identified.

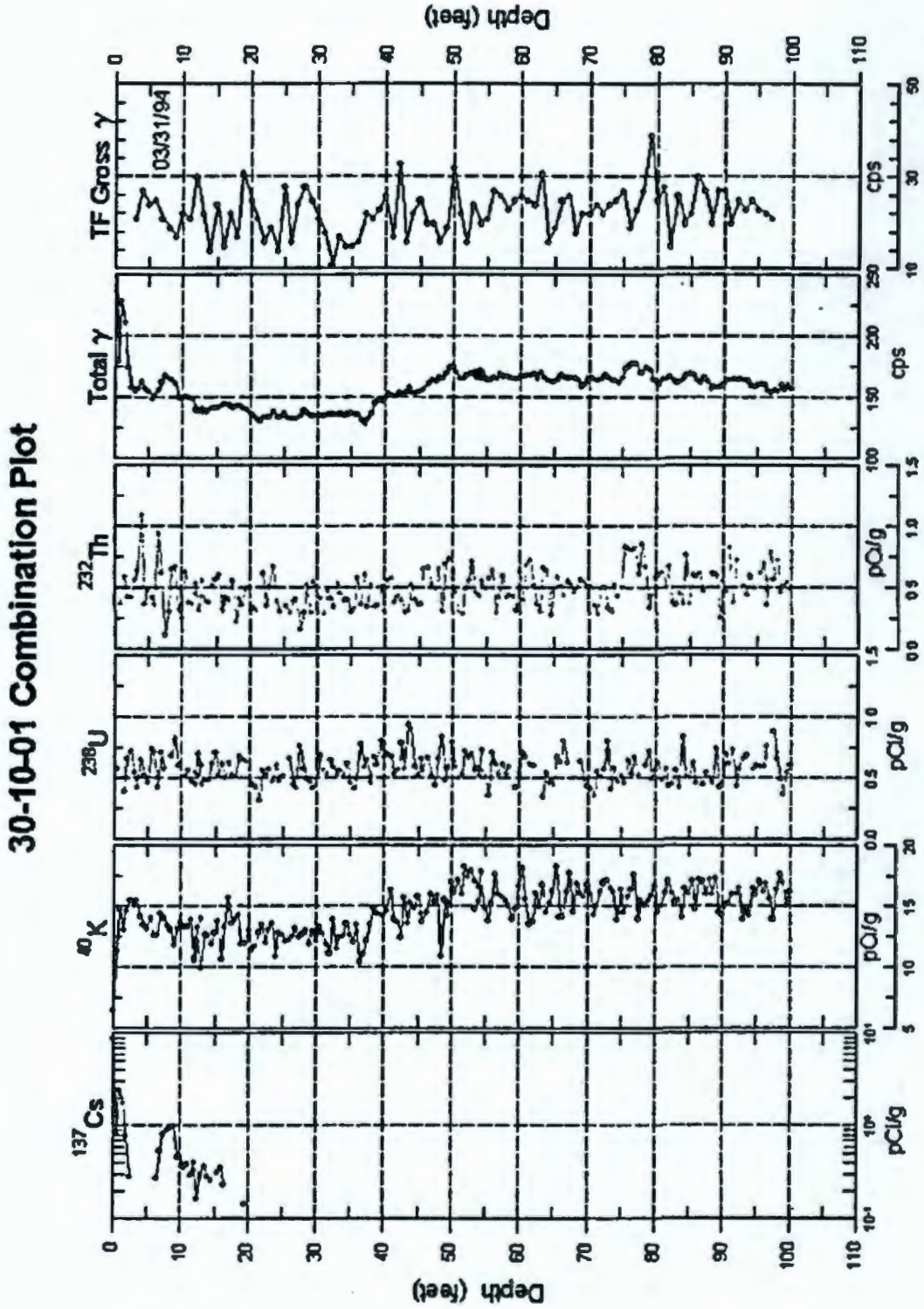
No significant levels of gamma ray contamination are present, based upon gross gamma data, above the survey probe detection threshold between 1975 and 1994 in the vadose zone from 2 to 100 feet. The HPGe logging system detected Cs-137 in two zones in the borehole near the surface. The first zone from the surface to 2 feet had the highest amount of Cs-137 at the surface, 9 pCi/g. The second zone from 6 to 17 feet had Cs-137 levels near 1 pCi/g or less.

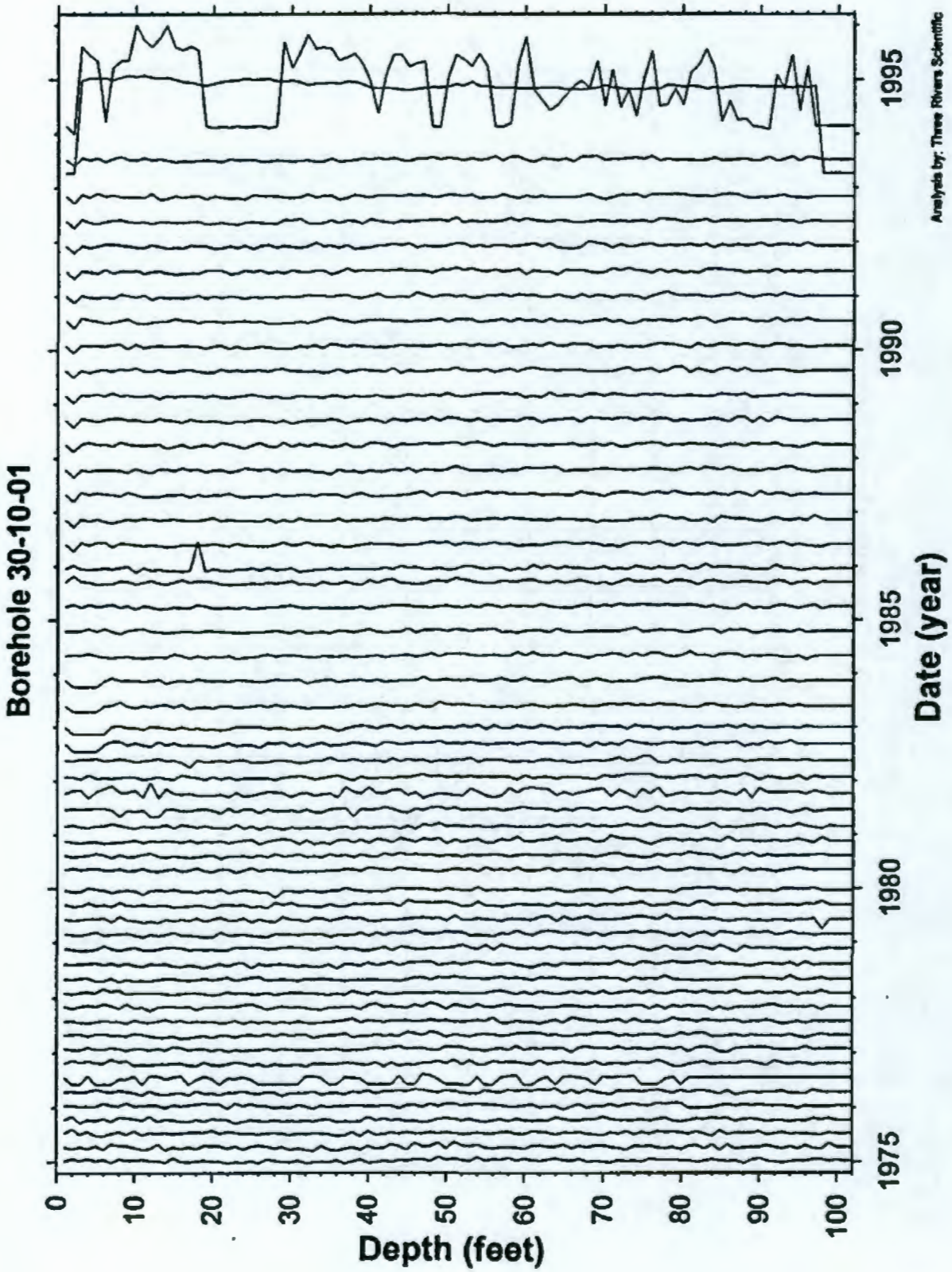
Gross Gamma Survey Information

Probe Type Processed :	04: NaI
Other Probe Types :	03: Neutron
Survey Depth :	100 ft
First Survey Date :	1/10/1975
Last Survey Date :	3/31/1994
Number Surveys Processed :	333

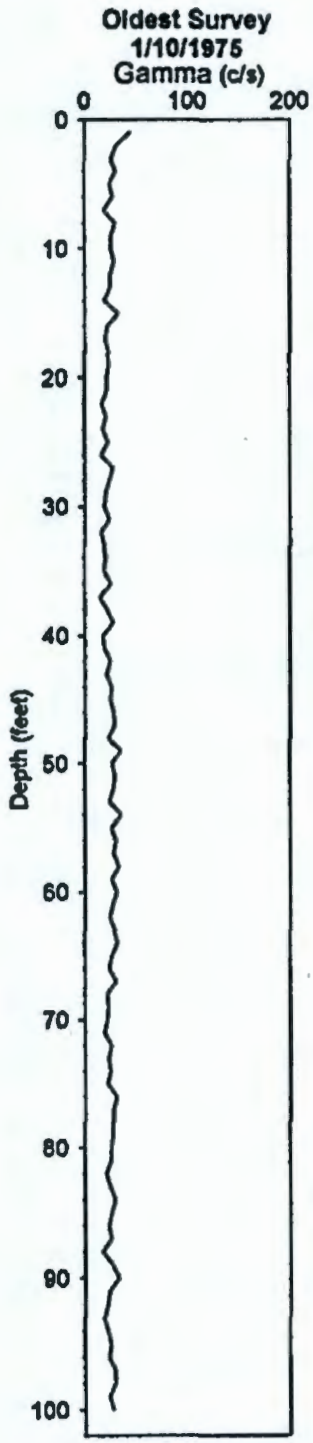
Analysis Notes

Method Used to Compute Background :	Threshold 0<val<50
Depth(s) where Contamination Identified in Gross Gamma Surveys :	NONE
Analyst Name :	R.K. Price
Company Name :	Three Rivers Scientific

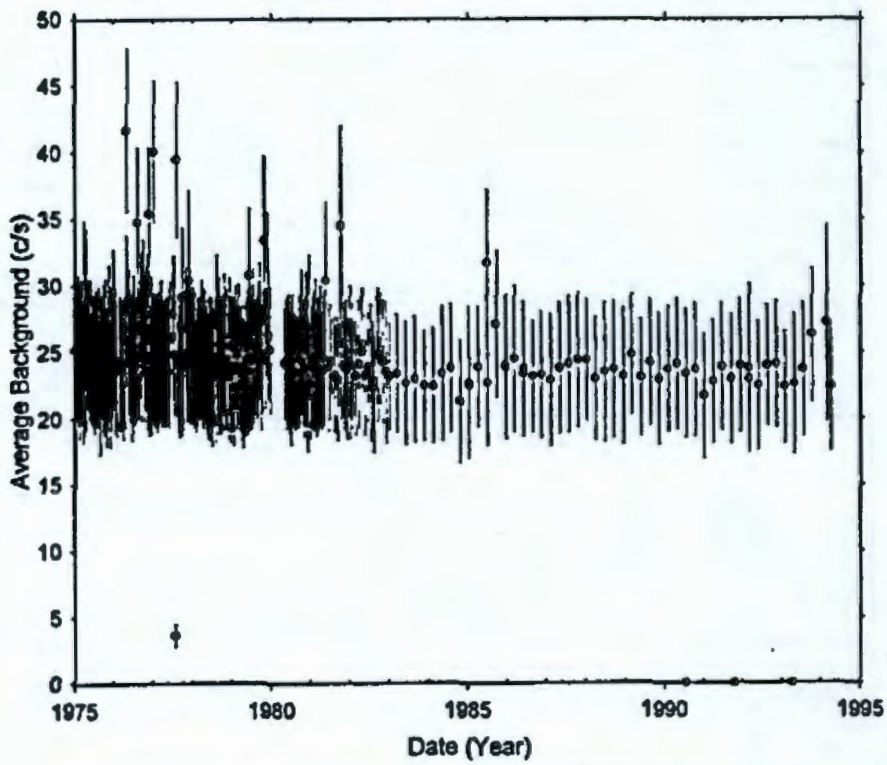

30-10-01 Combination Plot
TF Gross γ
03/31/94
Total γ
232Th
238U
40K
137Cs
cps
pCi/g
Depth (feet)

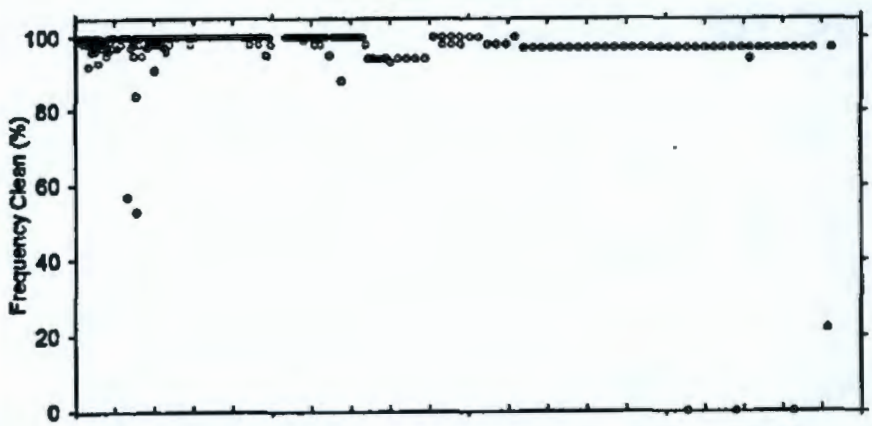

Borehole 30-10-01
Depth (feet)
0
10
20
30
40
50
60
70
80
90
100
Date (year)
1975
1980
1985
1990
1995
Analysis by: Three Rivers Scientific

Borehole 30-10-01



No Gamma-Ray Emitting Contamination Above Survey Detection Threshold





Analysis by: Three Rivers Scientific

Borehole 30-10-02

Contamination (Cs-137) from 42-50 feet is Stable.

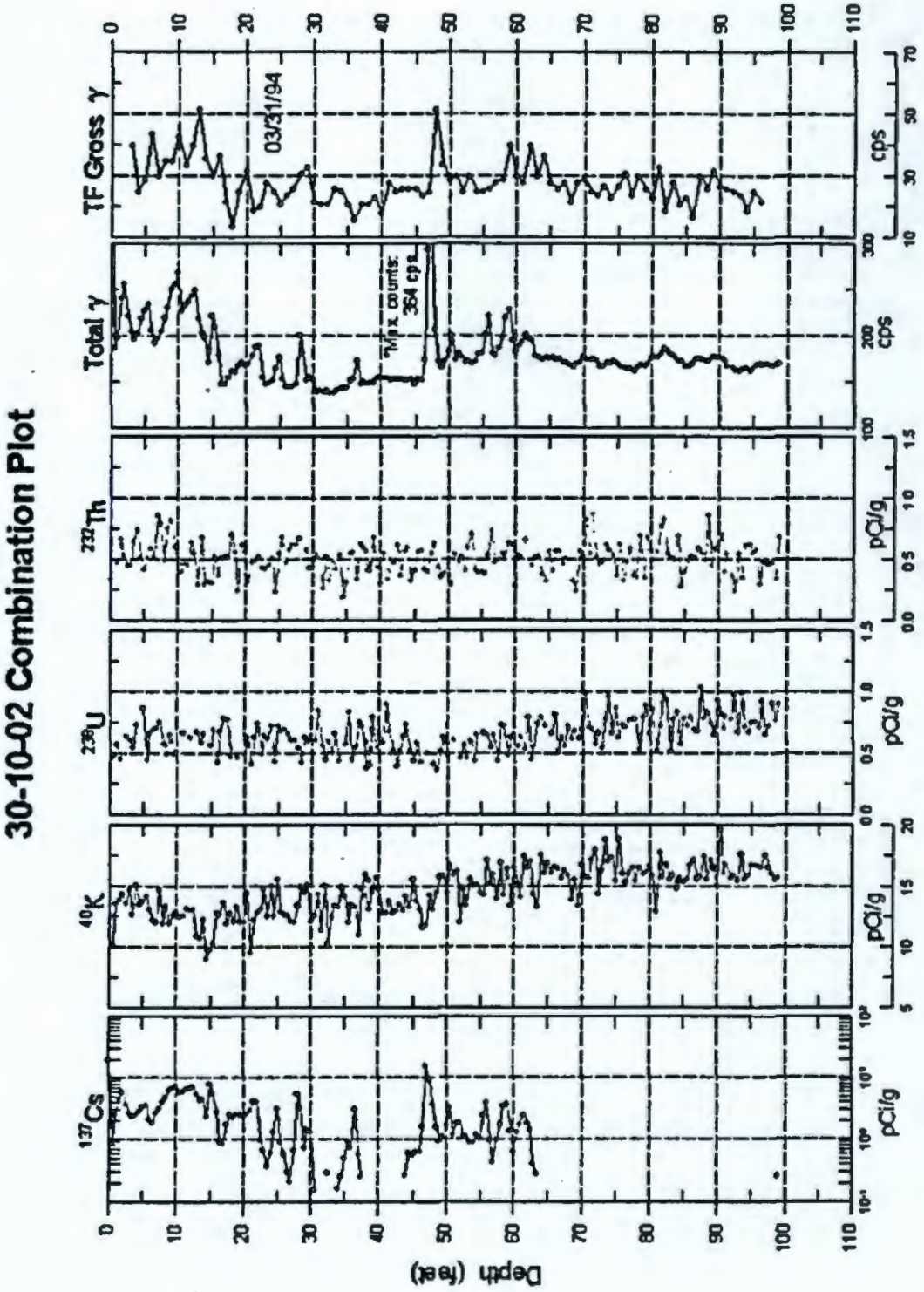
Grade thickness product over 42 to 50 feet is decreasing consistent with Cs-137 (HPGe identified) decay. The magnitude of gross count rate is slightly higher than normal for the observed level of Cs-137, which may indicate either strong beta emitter with the Cs-137, or that the Cs-137 source is remote to the borehole.

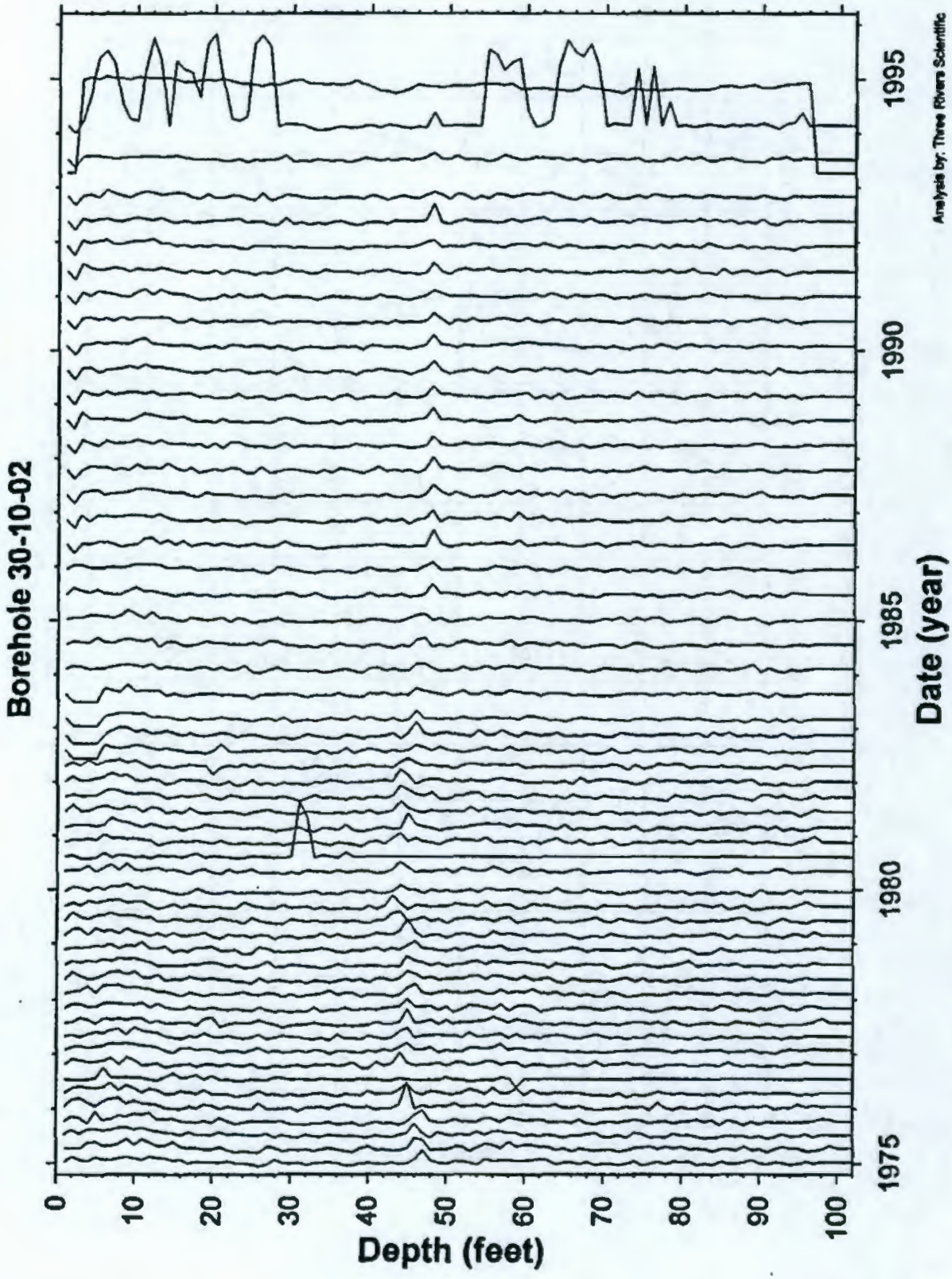
Gross Gamma Survey Information

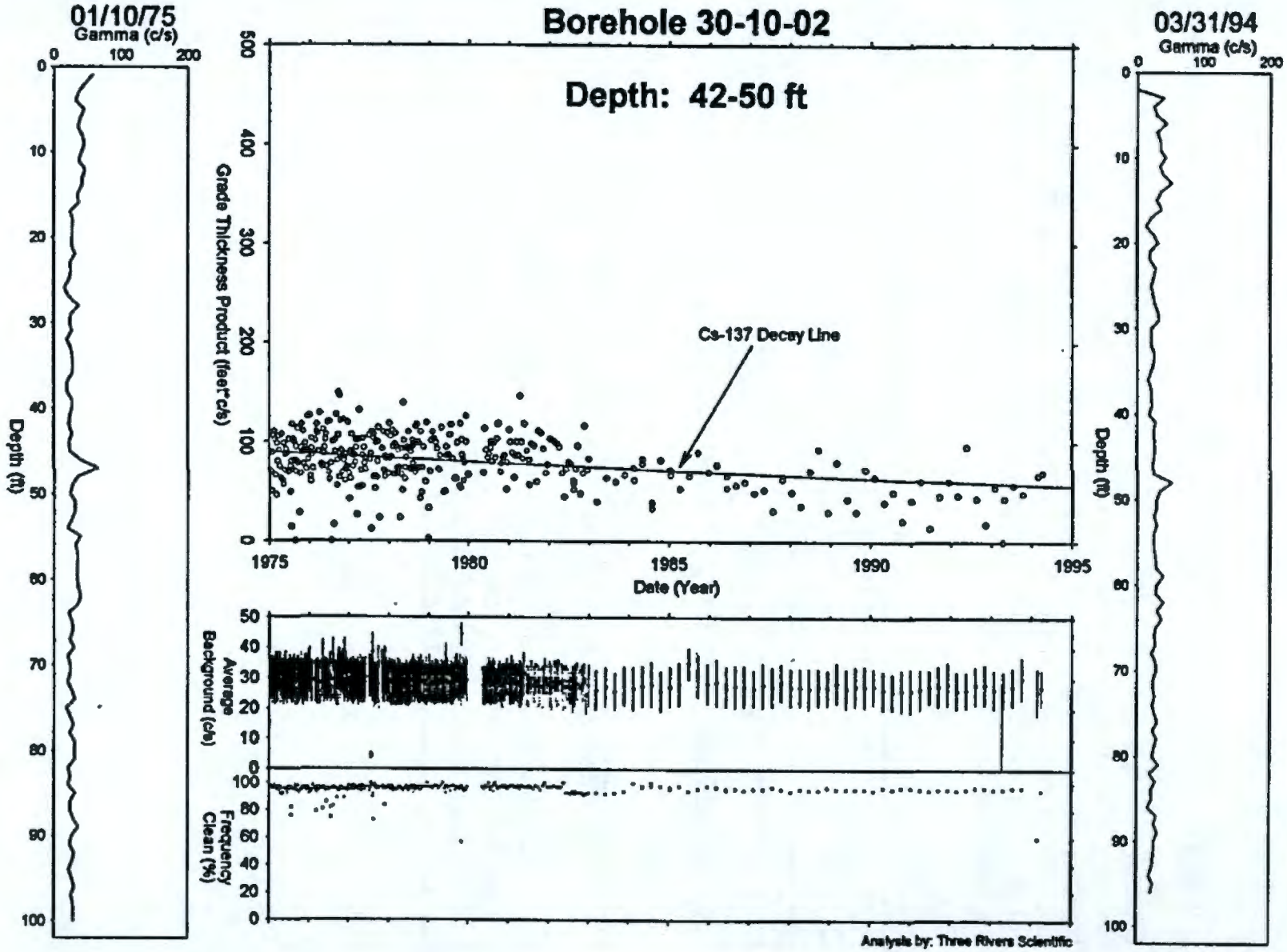
Probe Type Processed :	04: NaI
Other Probe Types :	03: Neutron
Survey Depth :	100 ft
First Survey Date :	1/10/1975
Last Survey Date :	3/31/1994
Number Surveys Processed :	357

Analysis Notes

Method Used to Compute Background :	Fixed background (30-41ft)
Depth(s) where Contamination Identified in Gross Gamma Surveys :	42-50 ft Stable
Analyst Name :	R.K. Price
Company Name :	Three Rivers Scientific


30-10-02 Combination Plot
TF Gross γ
03/31/94
Total γ
Max counts:
354 cps
232Th
238U
40K
137Cs
cps
pCi/g
Depth (feet)


Borehole 30-10-02
Depth (feet)
0
10
20
30
40
50
60
70
80
90
100
Date (year)
1975
1980
1985
1990
1995
Analysis by: Three Rivers Scientific


Borehole 30-10-02
Depth: 42-50 ft
01/10/75
Gamma (c/s)
Depth (ft)
03/31/94
Gamma (c/s)
Depth (ft)
Grade Thickness Product (feet*c/s)
Cs-137 Decay Line
Date (Year)
Average Background (c/s)
Frequency Clean (%)
Analysis by: Three Rivers Scientific

Borehole 30-10-09

Contamination (Ru-106) from 40-60 feet is Unstable Early.

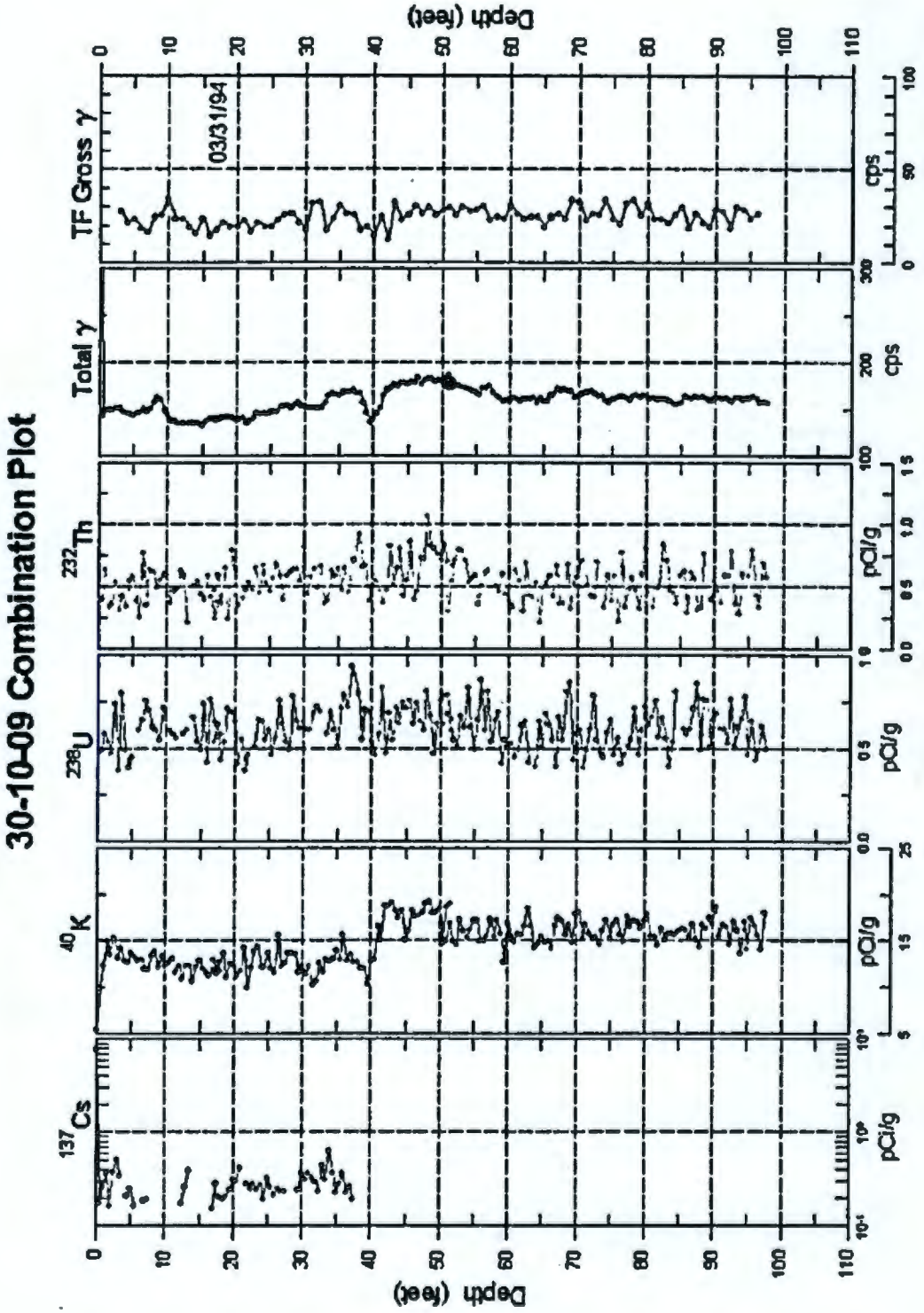
Grade thickness product over 40 to 60 feet is decreasing at a rate that is faster than the decay of Ru-106 (hypothesis). The half life of Ru-106 is 1.02 years. The grade thickness product shows a short time period from 1978 to 1980 with no significant change before the contaminant decreased to background levels. The gross gamma survey logs from 1981 to the last survey in 1994 show a clean borehole. The zone is categorized as unstable early.

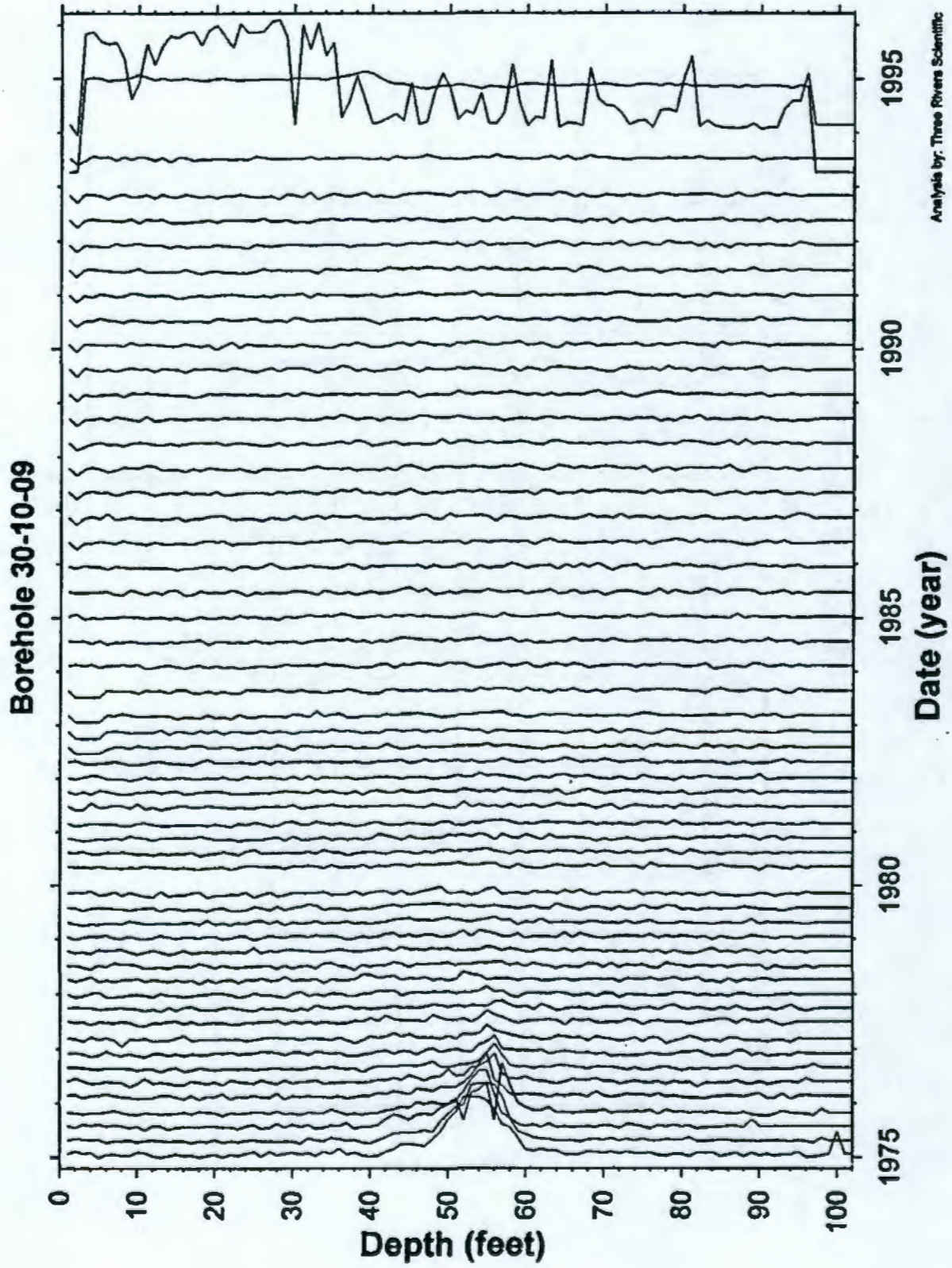
Gross Gamma Survey Information

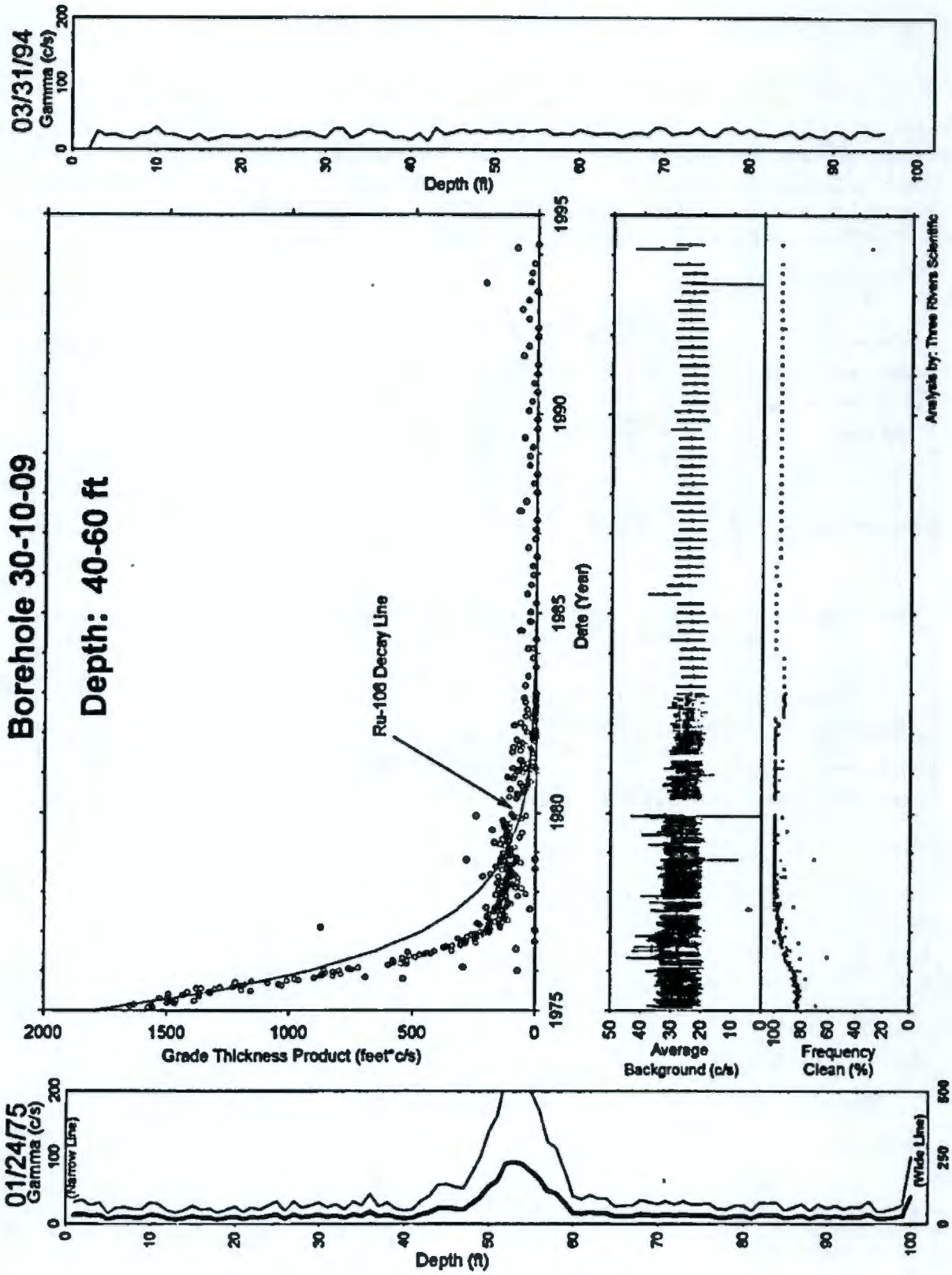
Probe Type Processed :	04: NaI
Other Probe Types :	03: Neutron
Survey Depth :	100 ft
First Survey Date :	1/24/1975
Last Survey Date :	3/31/1994
Number Surveys Processed :	354

Analysis Notes

Method Used to Compute Background :	Fixed background (60-80ft)
Depth(s) where Contamination Identified in Gross Gamma Surveys :	40-60 ft Unstable Early
Analyst Name :	R.K. Price
Company Name :	Three Rivers Scientific


30-10-09 Combination Plot
TF Gross γ
03/31/94
Total γ
232Th
238U
40K
137Cs
cps
pCi/g
Depth (feet)


Borehole 30-10-09
Depth (feet)
0
10
20
30
40
50
60
70
80
90
100
Date (year)
1975
1980
1985
1990
1995
Analysis by: Three Rivers Scientific


Borehole 30-10-09
Depth: 40-60 ft
03/31/94
Gamma (c/s)
Depth (ft)
Ru-106 Decay Line
Grade Thickness Product (feet*c/s)
Date (Year)
Average Background (c/s)
Frequency Clean (%)
Analysis by: Three Rivers Scientific
01/24/75
Gamma (c/s)
(Narrow Line)
(Wide Line)
Depth (ft)

Borehole 30-10-11

No Gamma Ray Emitting Contamination Identified.

No significant levels of gamma ray contamination are present, based upon gross gamma data, above the survey probe detection threshold between 1975 and 1994 in the vadose zone from 2 to 100 feet. The HPGe logging system detected Cs-137 at up to 6 pCi/g from the surface to 4 feet, and no other detection for the remainder of the logged depths.

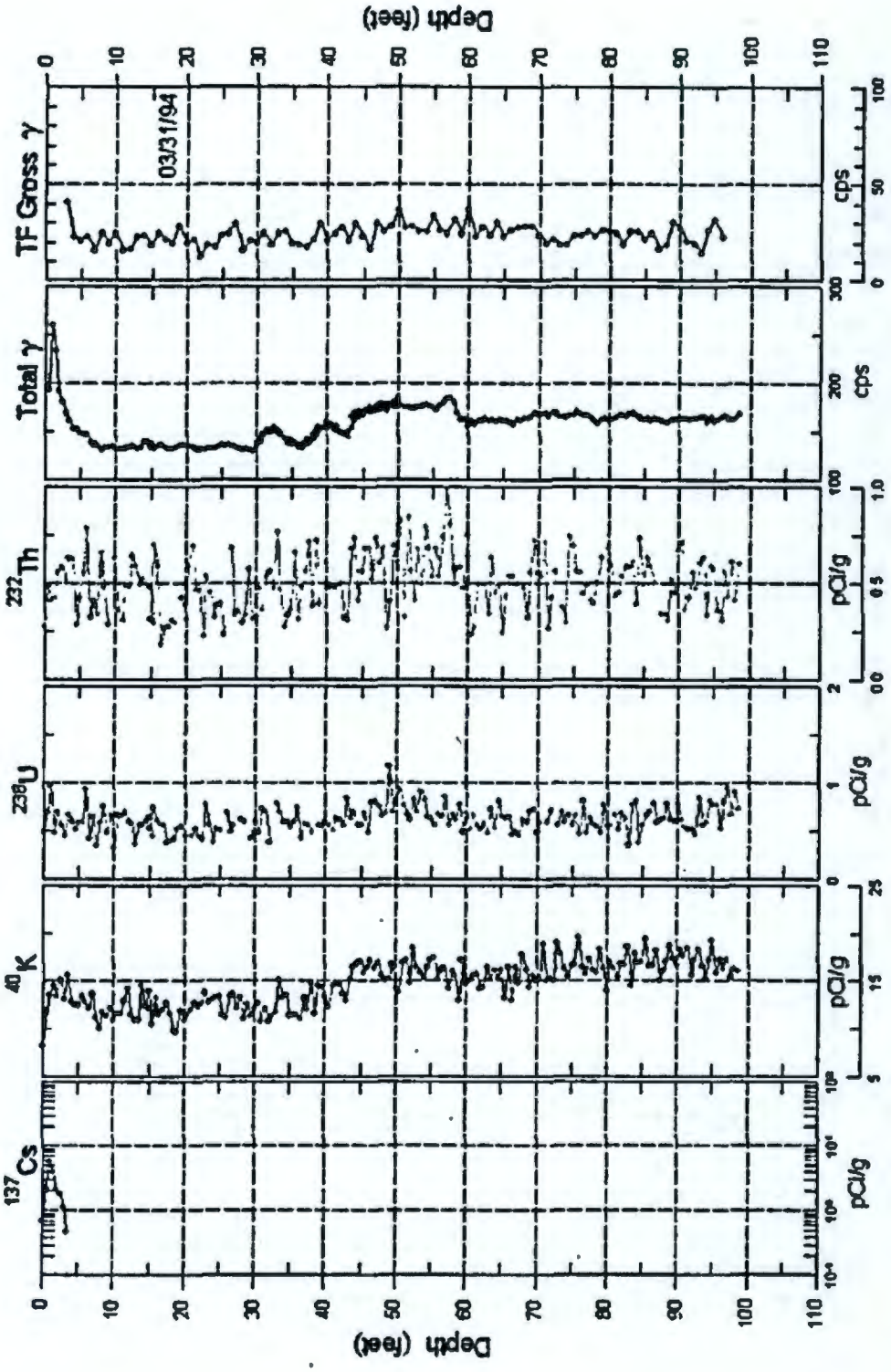
Gross Gamma Survey Information

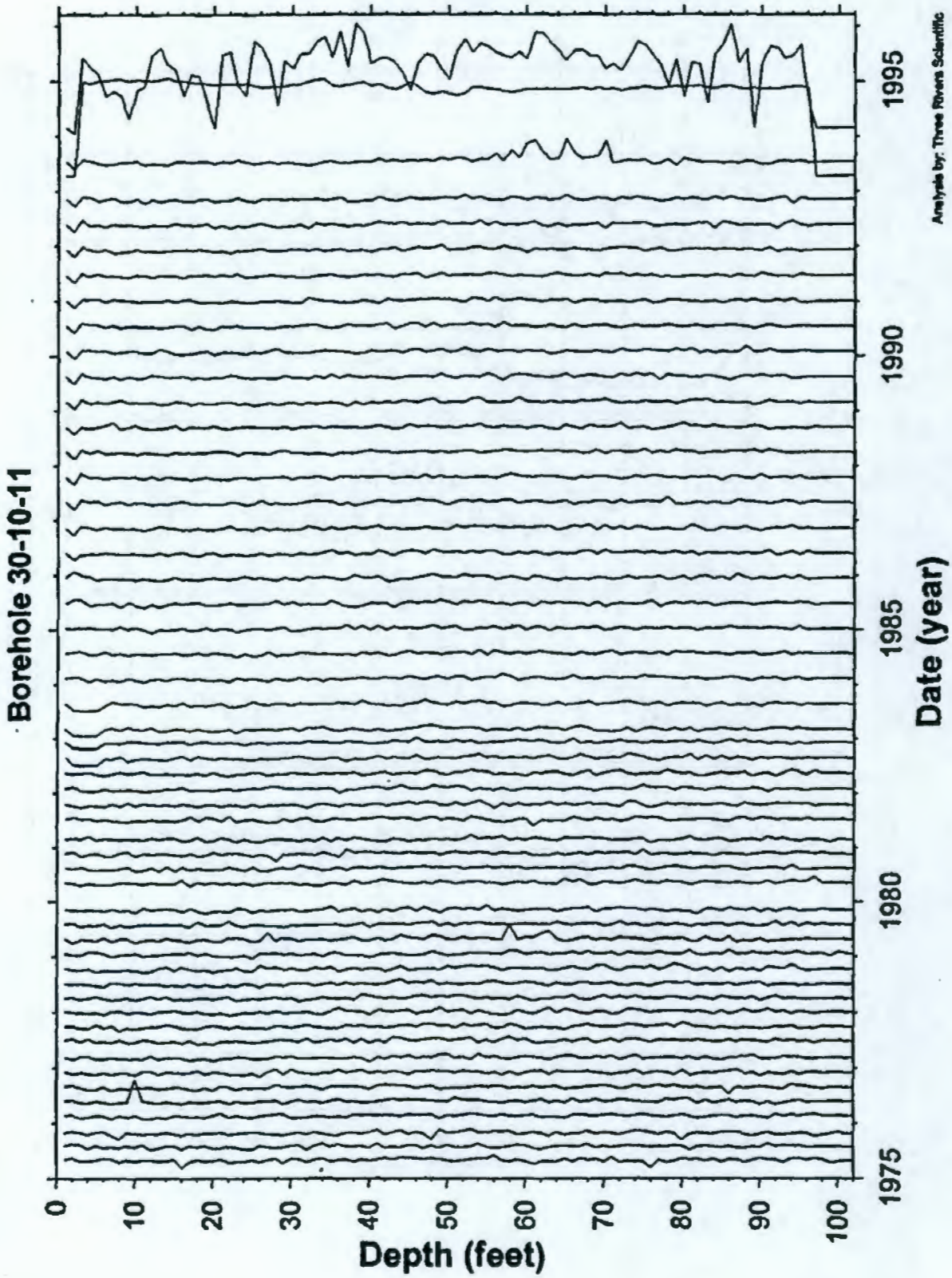
Probe Type Processed :	04: NaI
Other Probe Types :	03: Neutron
Survey Depth :	100 ft
First Survey Date :	5/02/1975
Last Survey Date :	3/31/1994
Number Surveys Processed :	336

Analysis Notes

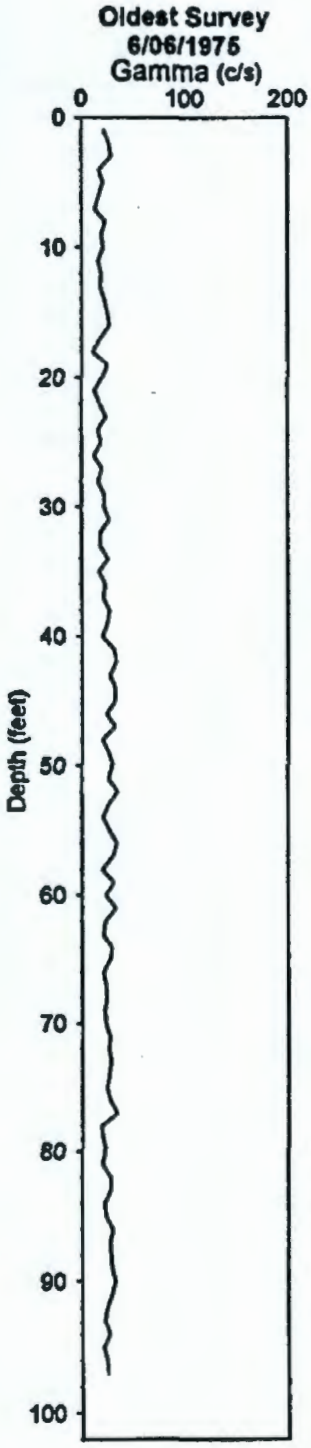
Method Used to Compute Background :	Threshold 0<val<50
Depth(s) where Contamination Identified in Gross Gamma Surveys :	NONE
Analyst Name :	R.K. Price
Company Name :	Three Rivers Scientific

30-10-11 Combination Plot

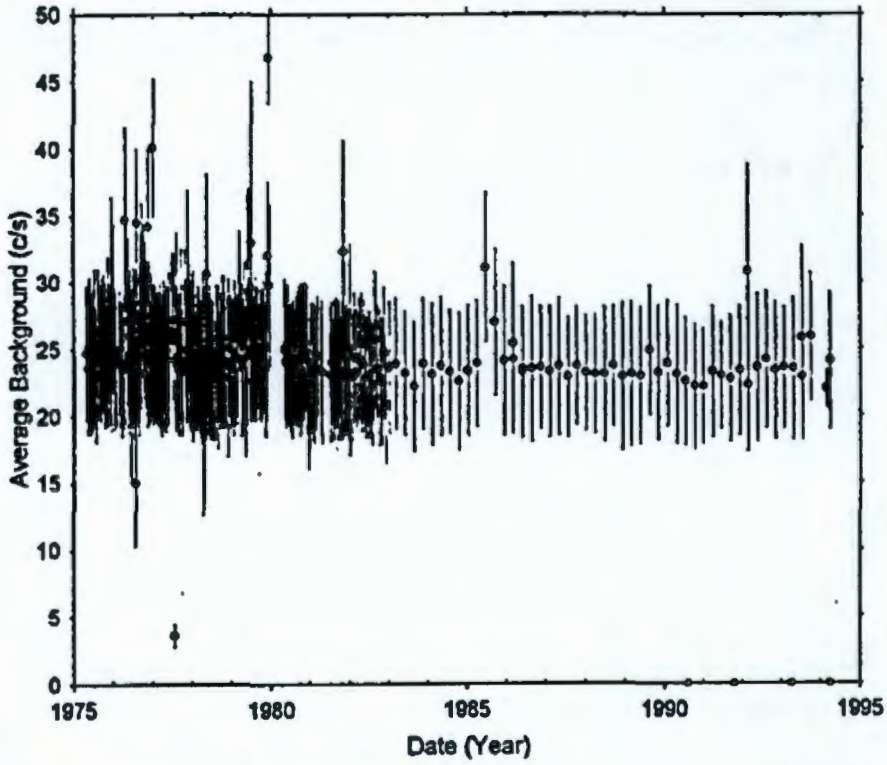


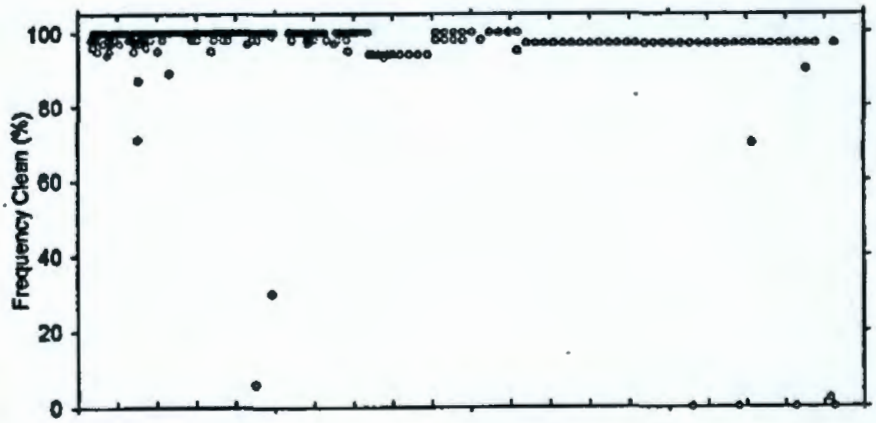

Borehole 30-10-11
Depth (feet)
0
10
20
30
40
50
60
70
80
90
100
Date (year)
1975
1980
1985
1990
1995
Analysis by: Three Rivers Scientific

Borehole 30-10-11



No Gamma-Ray Emitting Contamination Above Survey Detection Threshold





Analysis by: Three Rivers Scientific

Tank C-111

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Borehole 30-11-06 365
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This section contains the analysis results for vadose zone boreholes (dry wells) associated with the Tank 111 in the "C" Tank Farm.

Special Notes: None

Borehole 30-11-01

No Gamma Ray Emitting Contamination Identified.

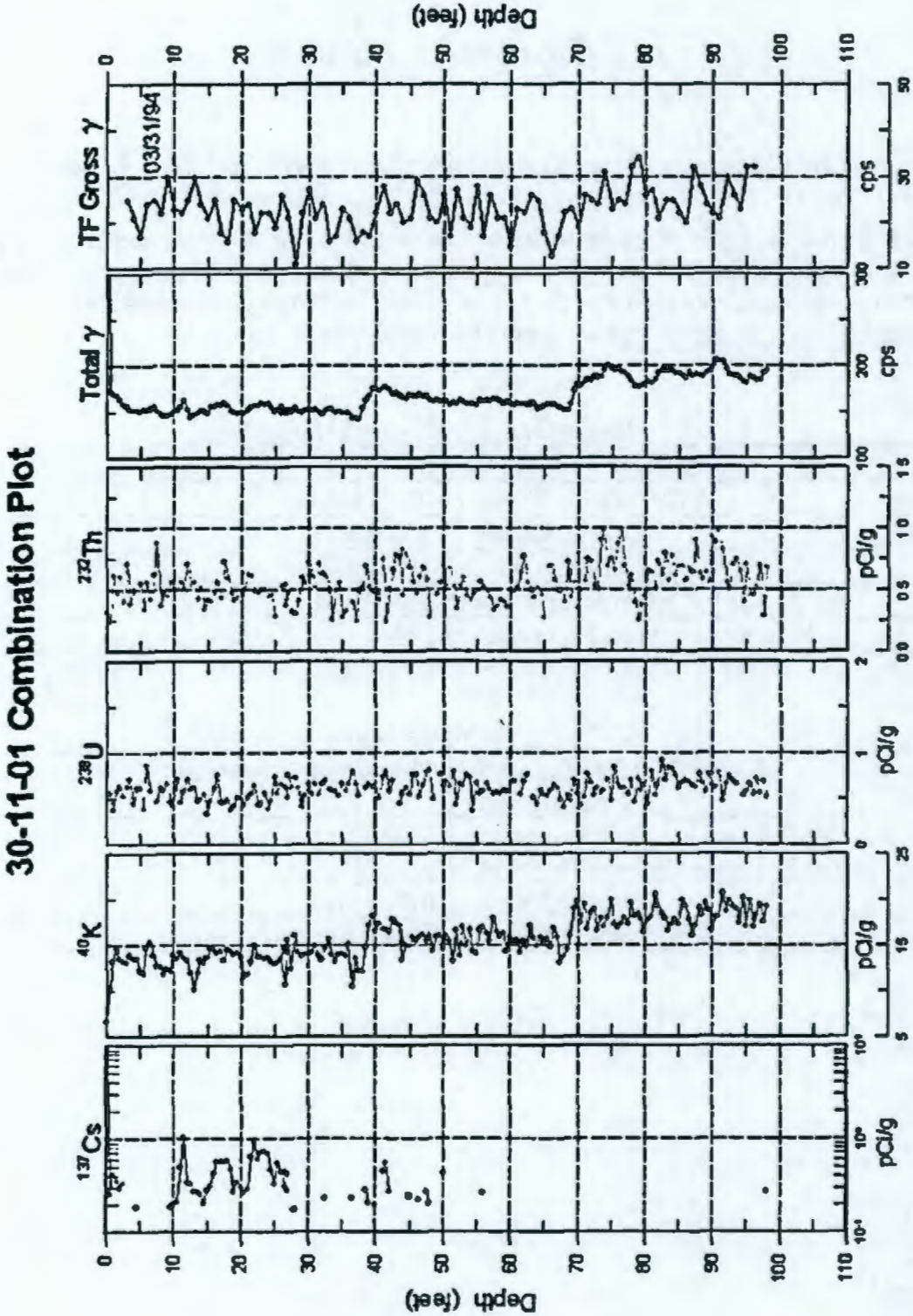
No significant levels of gamma ray contamination are present, based upon gross gamma data, above the survey probe detection threshold between 1975 and 1994 in the vadose zone from 2 to 100 feet. The HPGe logging system detected Cs-137 intermittently at up to 1 pCi/g from the surface to 56 feet.

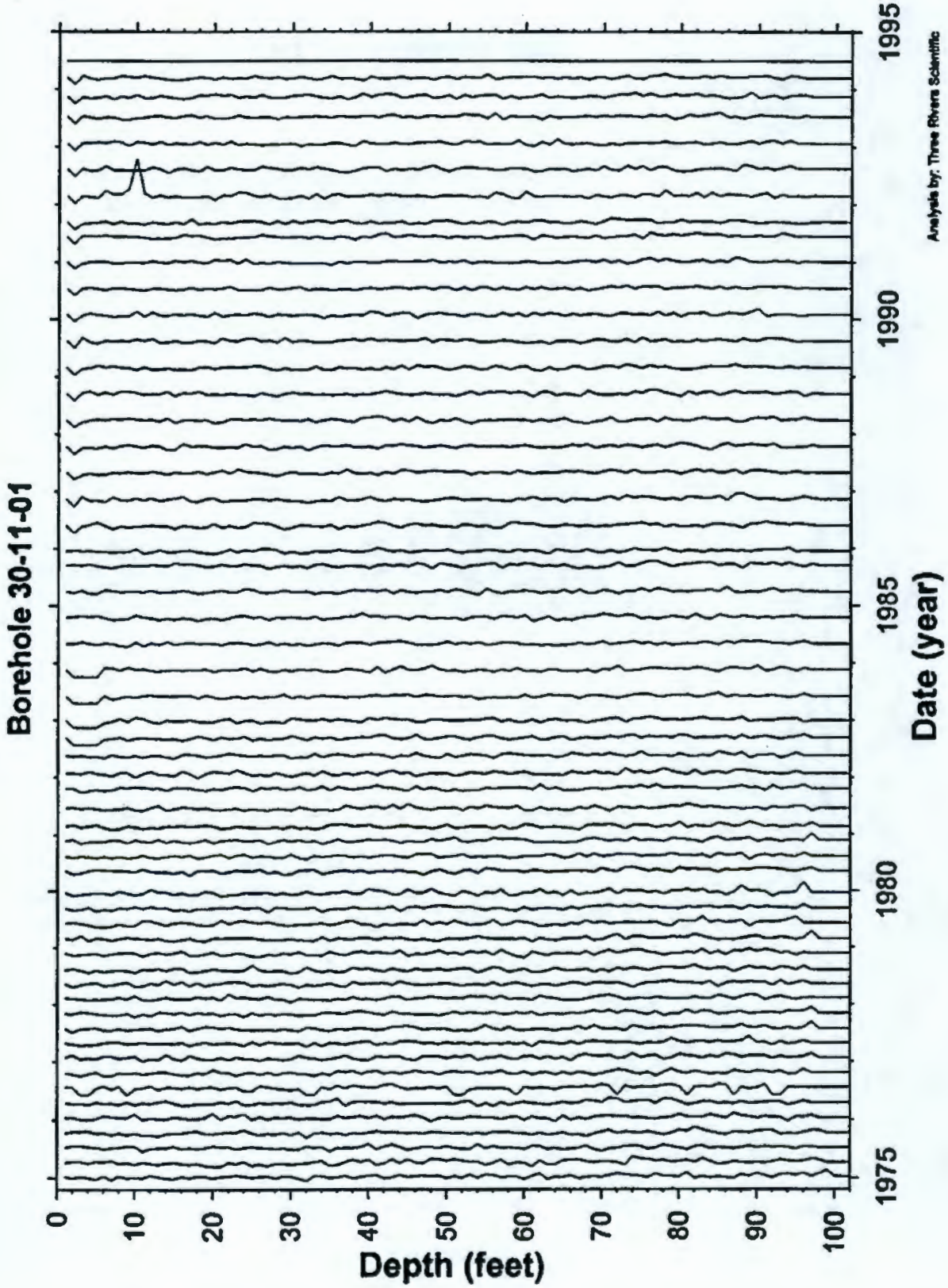
Gross Gamma Survey Information

Probe Type Processed :	04: NaI
Other Probe Types :	03: Neutron
Survey Depth :	100 ft
First Survey Date :	1/10/1975
Last Survey Date :	7/01/1994
Number Surveys Processed :	345

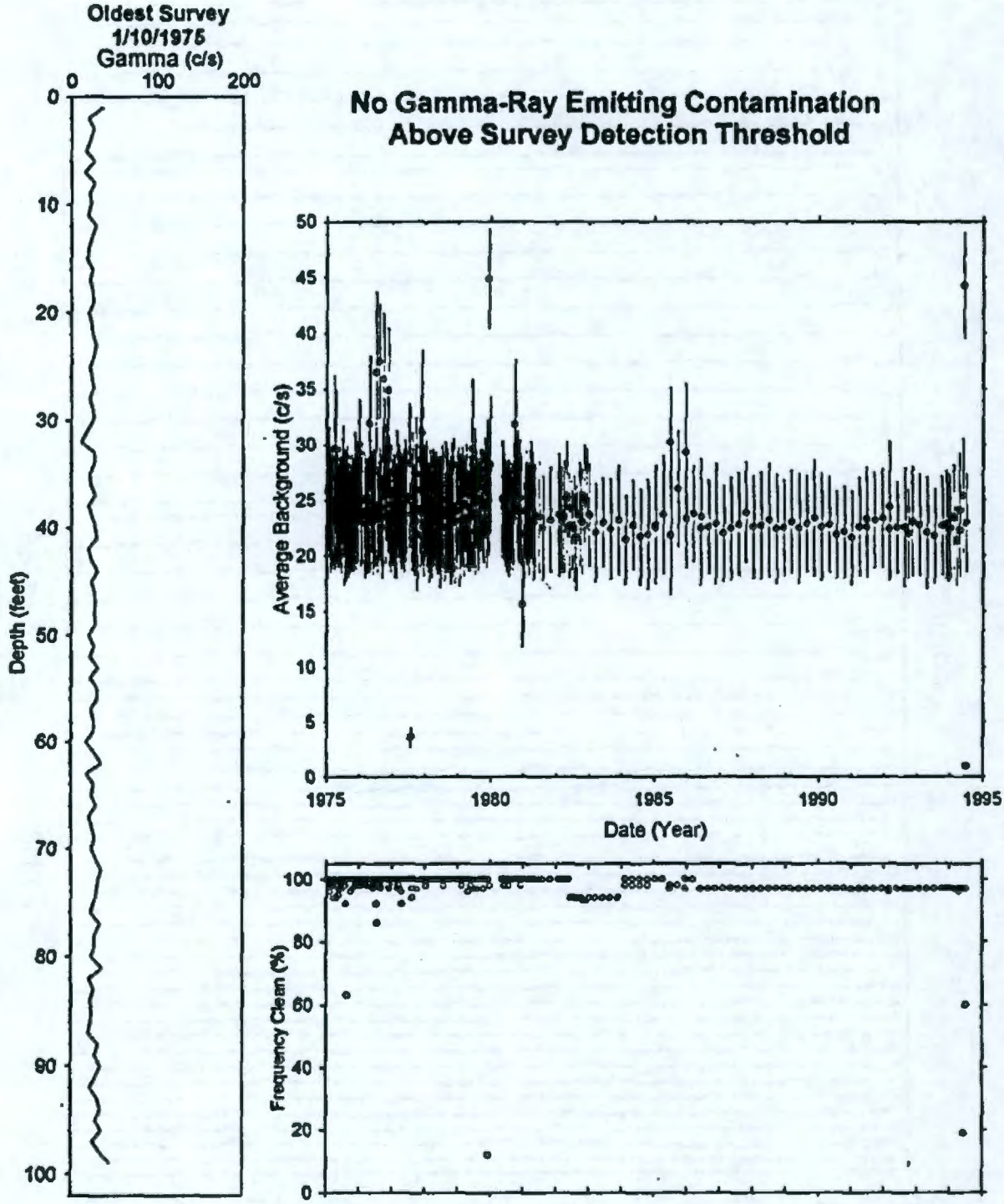
Analysis Notes

Method Used to Compute Background :	Threshold 0<val<50
Depth(s) where Contamination Identified in Gross Gamma Surveys :	NONE
Analyst Name :	R.K. Price
Company Name :	Three Rivers Scientific


30-11-01 Combination Plot
TF Gross γ
03/31/94
Total γ
232Th
238U
40K
137Cs
cps
pCi/g
Depth (feet)


Borehole 30-11-01
Depth (feet)
0
10
20
30
40
50
60
70
80
90
100
Date (year)
1975
1980
1985
1990
1995
Analysis by: Three Rivers Scientific

Borehole 30-11-01



Analysis by: Three Rivers Scientific

Borehole 30-11-05

No Gamma Ray Emitting Contamination Identified.

No significant levels of gamma ray contamination are present, based upon gross gamma data, above the survey probe detection threshold between 1975 and 1994 in the vadose zone from 2 to 100 feet. The HPGe logging system detected Cs-137 at up to 2 pCi/g from the surface to 5 feet, and no other detection greater than 0.5 pCi/g for the remainder of the logged depths.

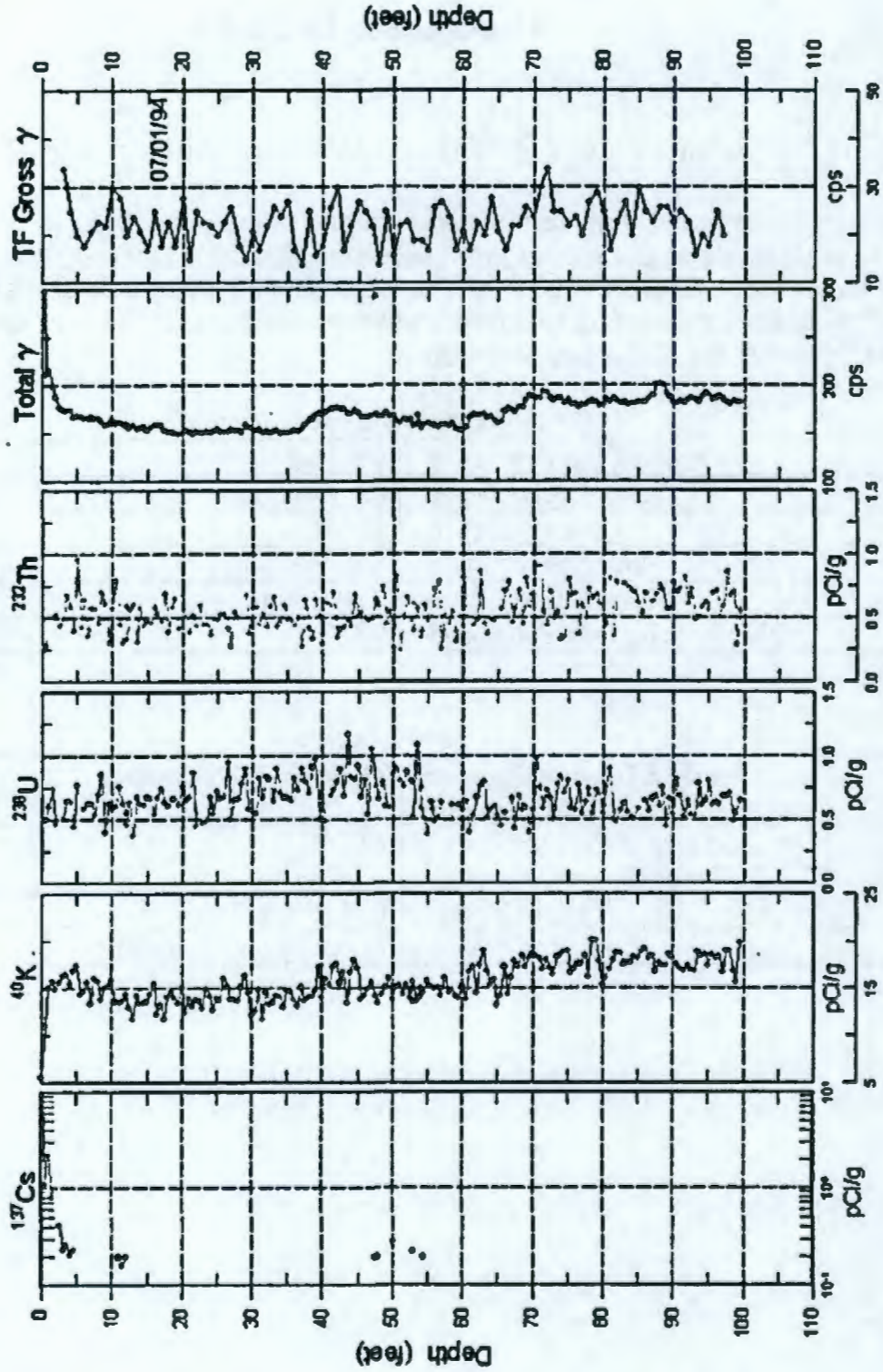
Gross Gamma Survey Information

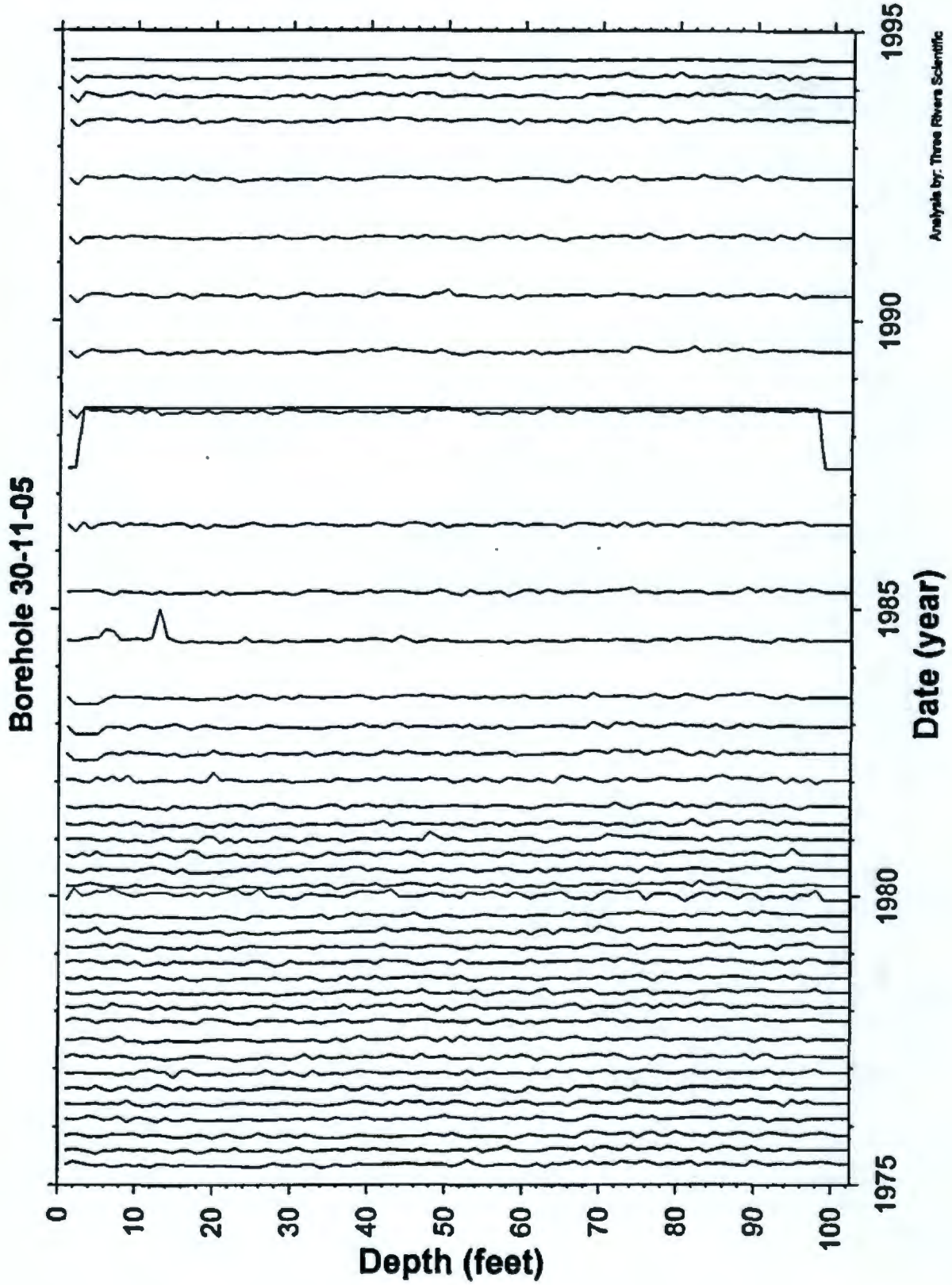
Probe Type Processed :	04: NaI
Other Probe Types :	03: Neutron
Survey Depth :	100 ft
First Survey Date :	5/09/1975
Last Survey Date :	7/01/1994
Number Surveys Processed :	277

Analysis Notes

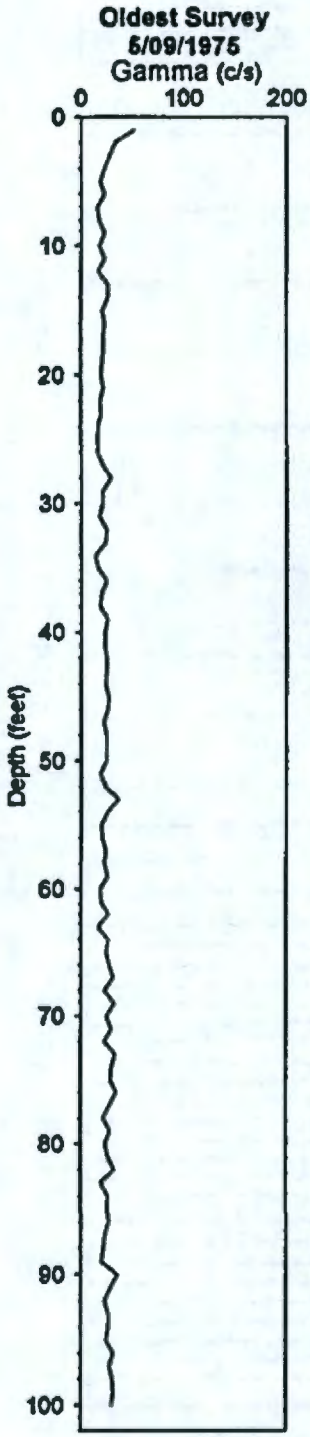
Method Used to Compute Background :	Threshold 0<val<50
Depth(s) where Contamination Identified in Gross Gamma Surveys :	NONE
Analyst Name :	R.K. Price
Company Name :	Three Rivers Scientific

30-11-05 Combination Plot

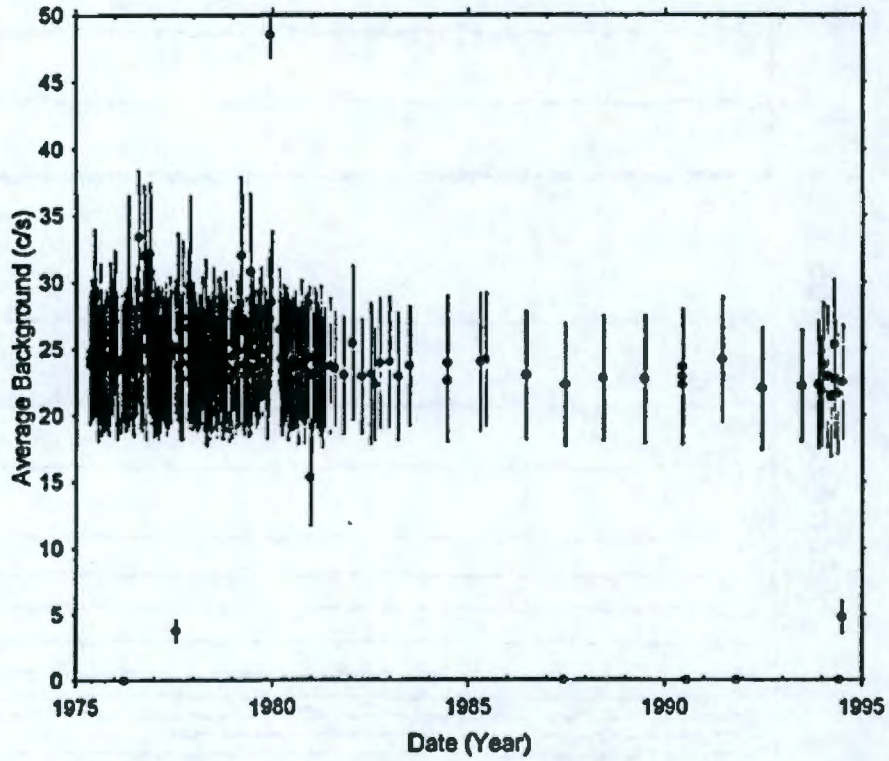


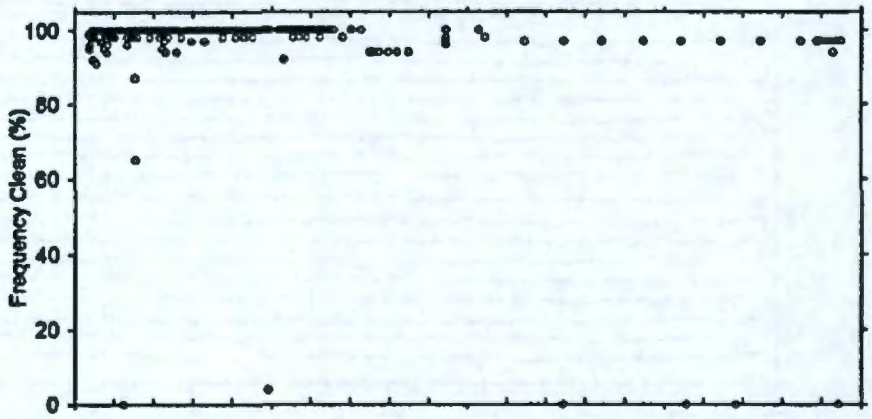

Borehole 30-11-05
Depth (feet)
0
10
20
30
40
50
60
70
80
90
100
Date (year)
1975
1980
1985
1990
1995
Analysis by: Three Rivers Scientific

Borehole 30-11-05



No Gamma-Ray Emitting Contamination Above Survey Detection Threshold





Analysis by: Three Rivers Scientific

Borehole 30-11-06

No Gamma Ray Emitting Contamination Identified.

No significant levels of gamma ray contamination are present, based upon gross gamma data, above the survey probe detection threshold between 1975 and 1994 in the vadose zone from 2 to 100 feet. The HPGe logging system detected Cs-137 from the surface to 40 feet. The maximum concentrations are: 7 pCi/g at 1 feet and 5 pCi/g at 11 feet. These levels are below the threshold of the gross gamma surveillance system.

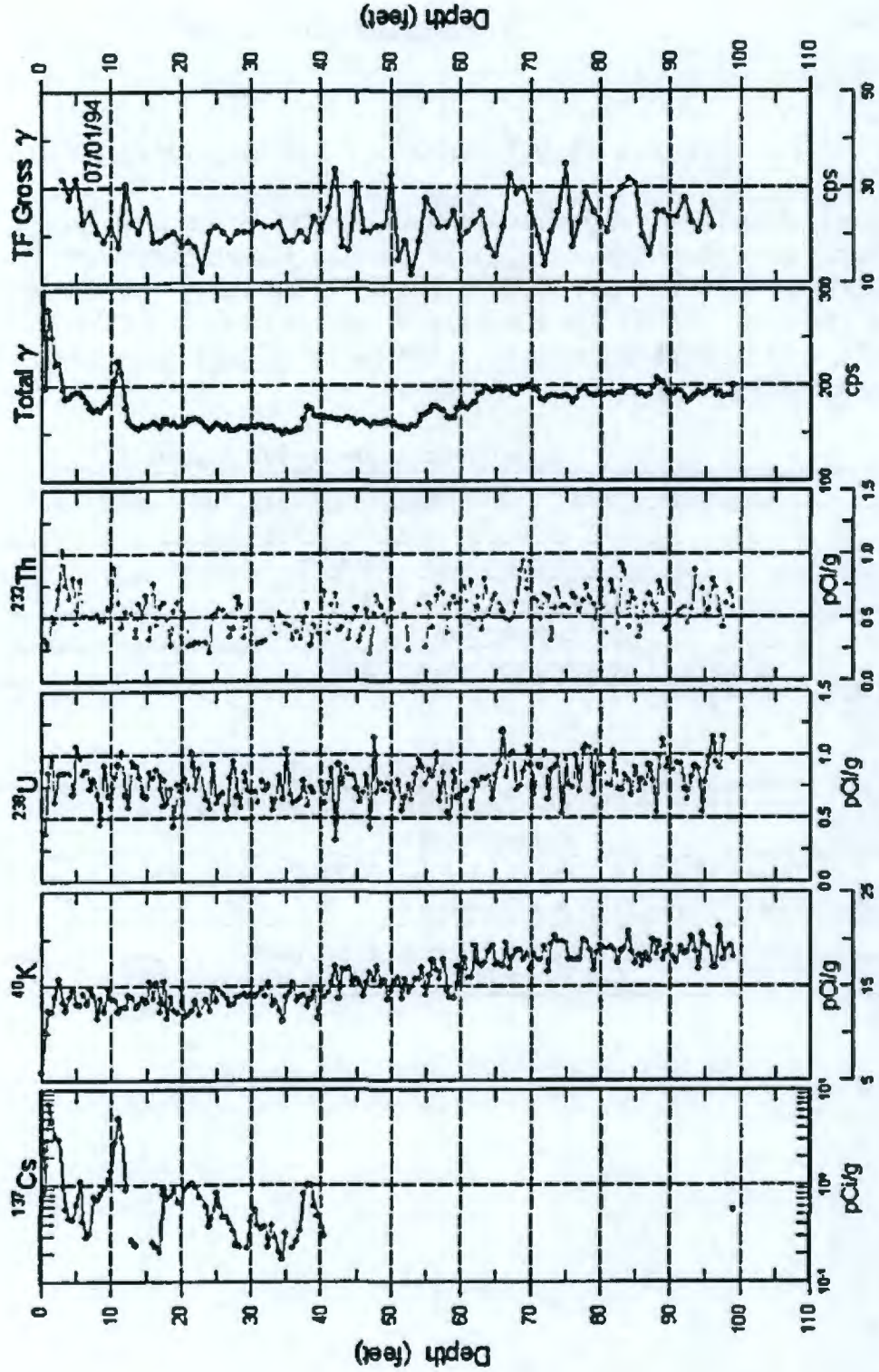
Gross Gamma Survey Information

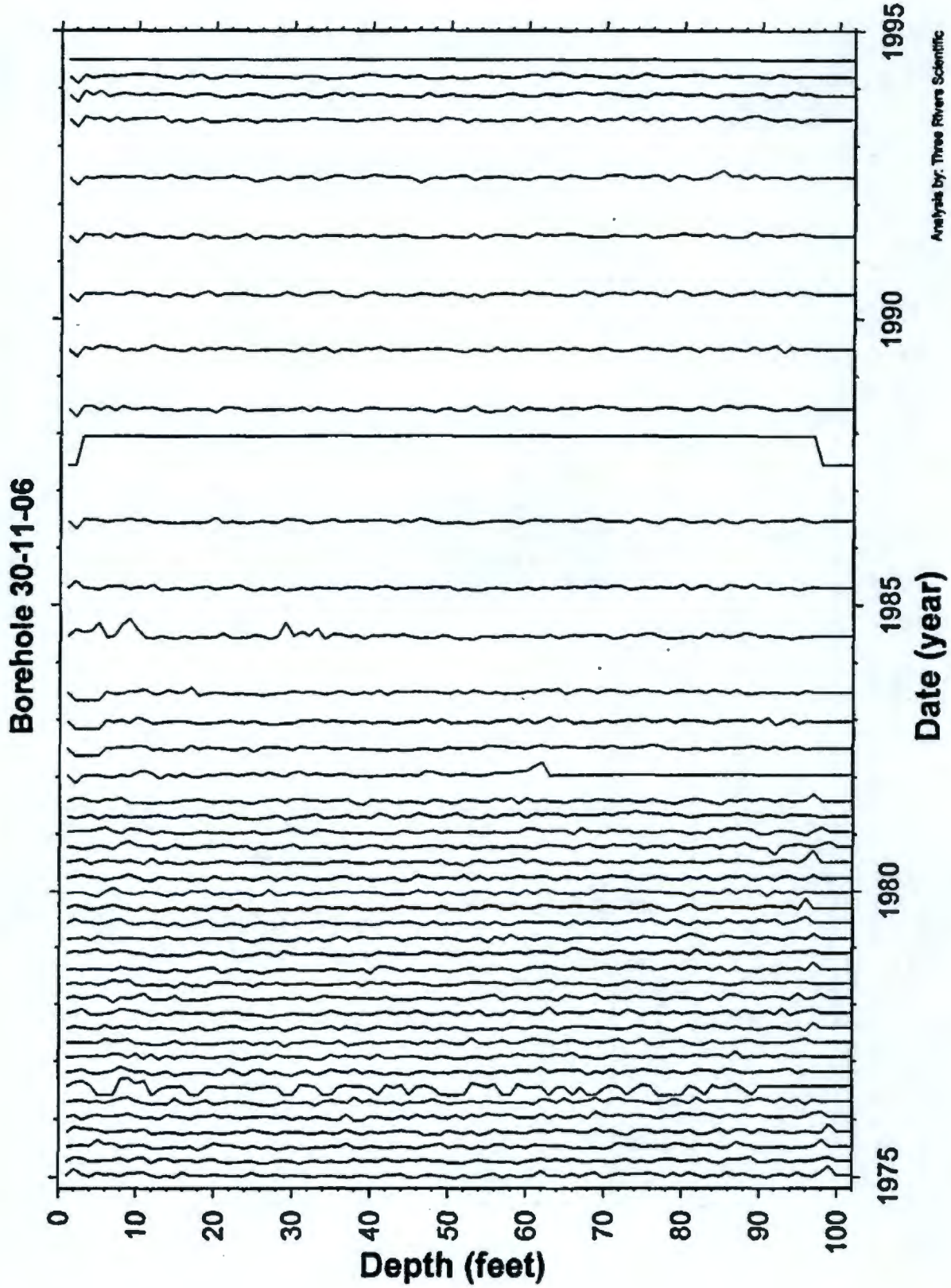
Probe Type Processed :	04: NaI
Other Probe Types :	03: Neutron
Survey Depth :	100 ft
First Survey Date :	1/10/1975
Last Survey Date :	7/01/1994
Number Surveys Processed :	298

Analysis Notes

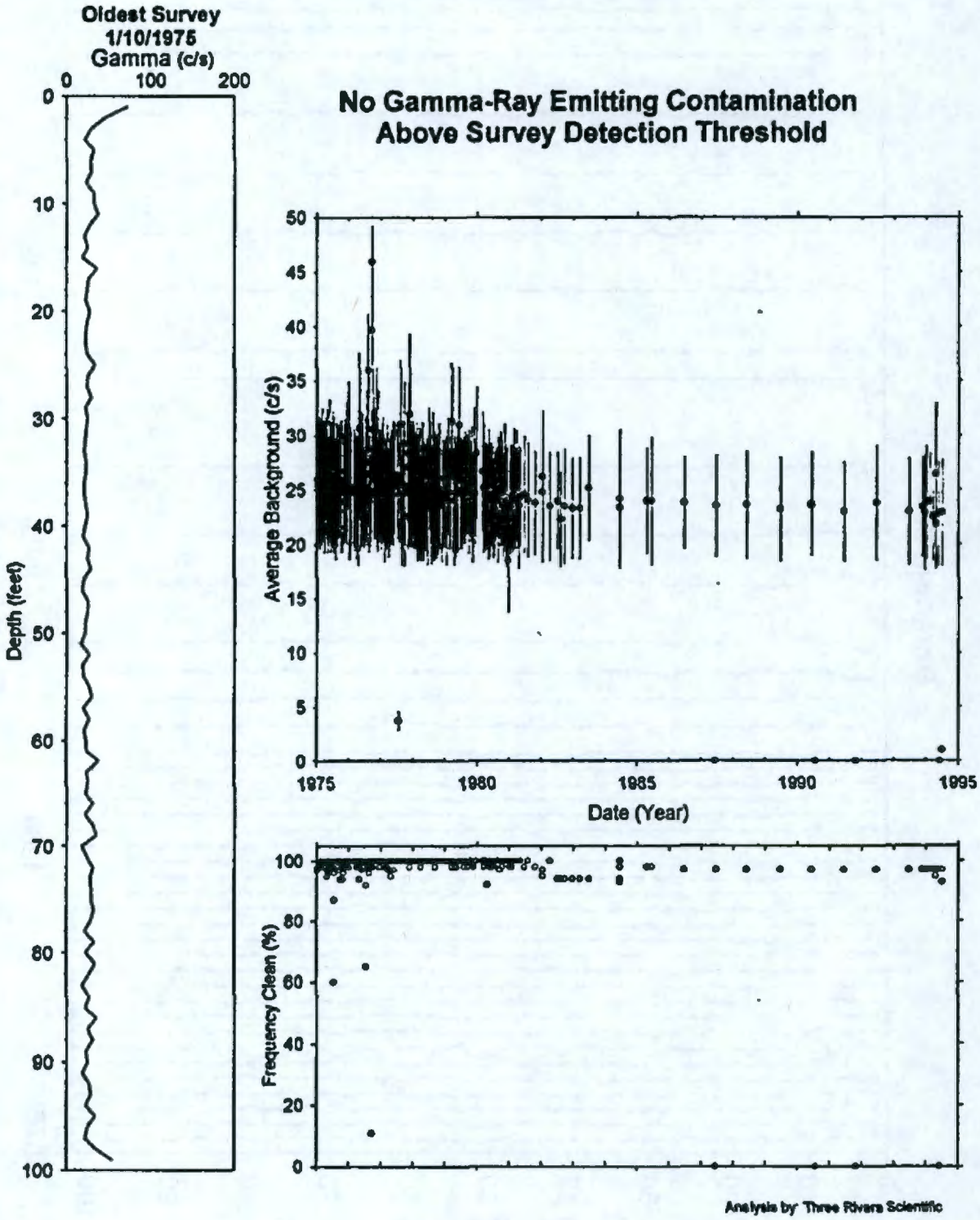
Method Used to Compute Background :	Threshold 0<val<50
Depth(s) where Contamination Identified in Gross Gamma Surveys :	NONE
Analyst Name :	R.K. Price
Company Name :	Three Rivers Scientific

30-11-06 Combination Plot




Borehole 30-11-06
Depth (feet)
0
10
20
30
40
50
60
70
80
90
100
Date (year)
1975
1980
1985
1990
1995
Analysis by: Three Rivers Scientific

Borehole 30-11-06



Borehole 30-11-09

No Gamma Ray Emitting Contamination Identified.

No significant levels of gamma ray contamination are present, based upon gross gamma data, above the survey probe detection threshold between 1975 and 1994 in the vadose zone from 2 to 100 feet. The HPGe logging system detected Cs-137 at 9 pCi/g at the surface, less than 1 pCi/g from 1 to 15 feet, and no other detection for the remainder of the logged depths.

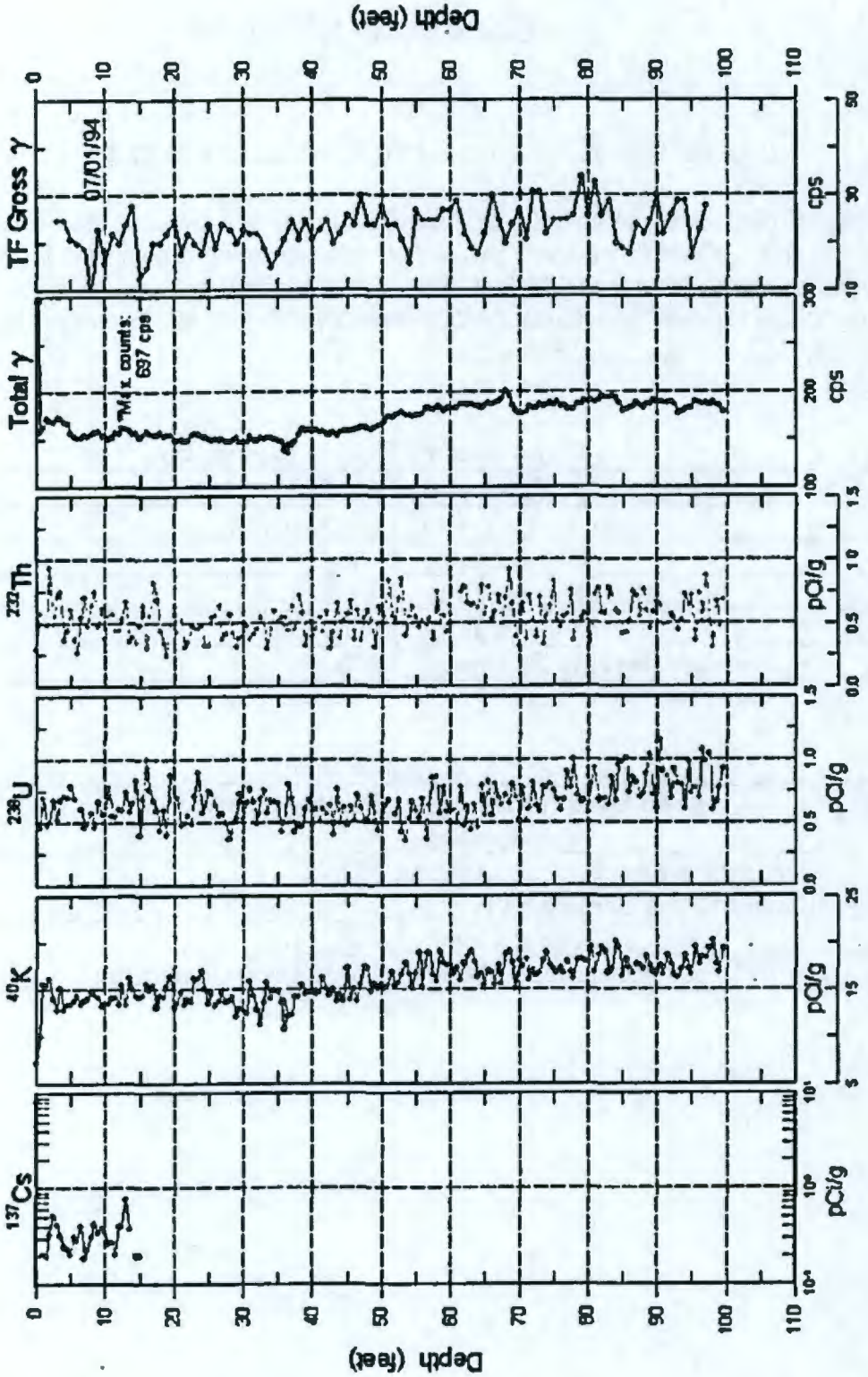
Gross Gamma Survey Information

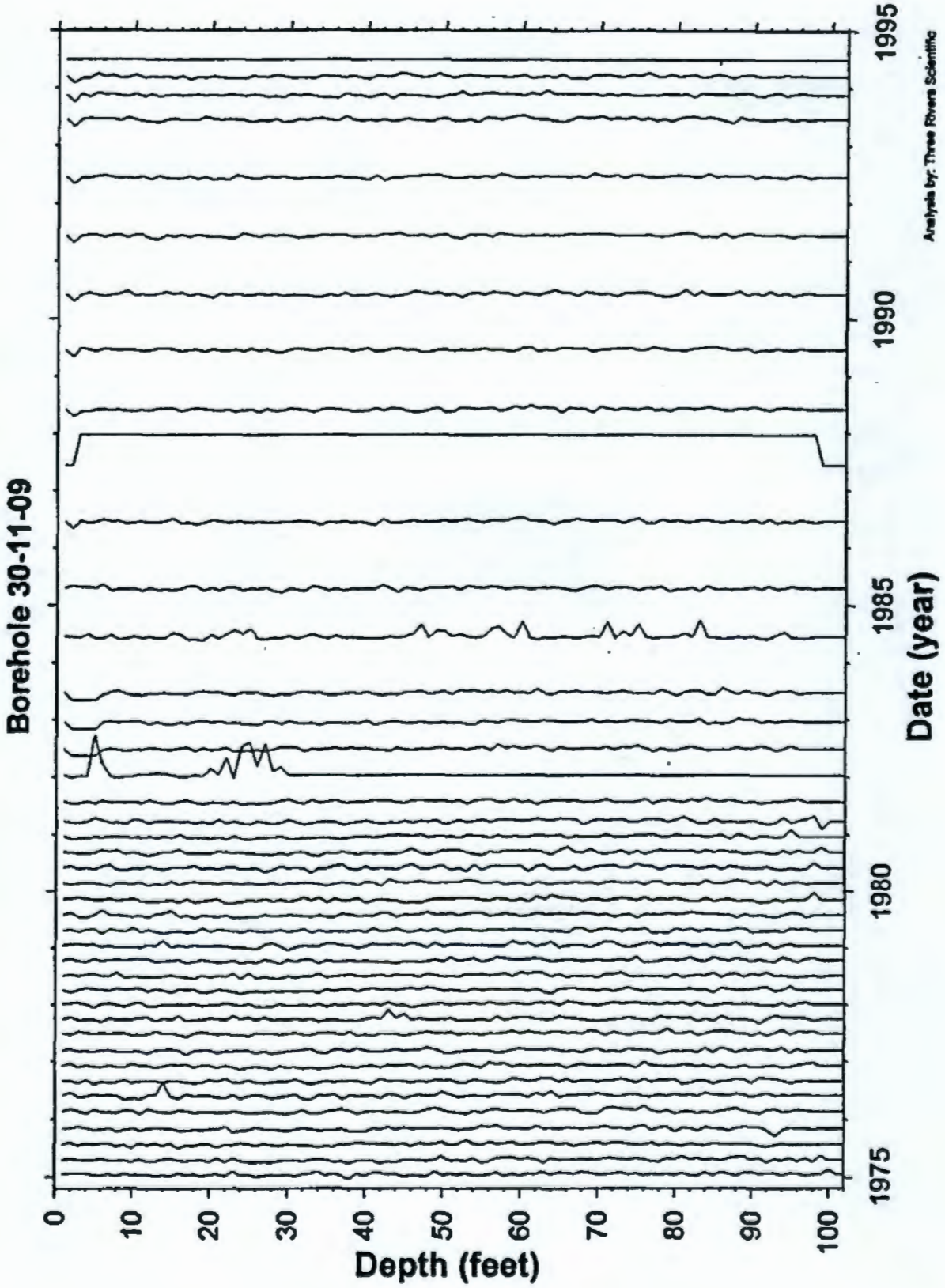
Probe Type Processed :	04: NaI
Other Probe Types :	03: Neutron
Survey Depth :	100 ft
First Survey Date :	1/17/1975
Last Survey Date :	7/01/1994
Number Surveys Processed :	305

Analysis Notes

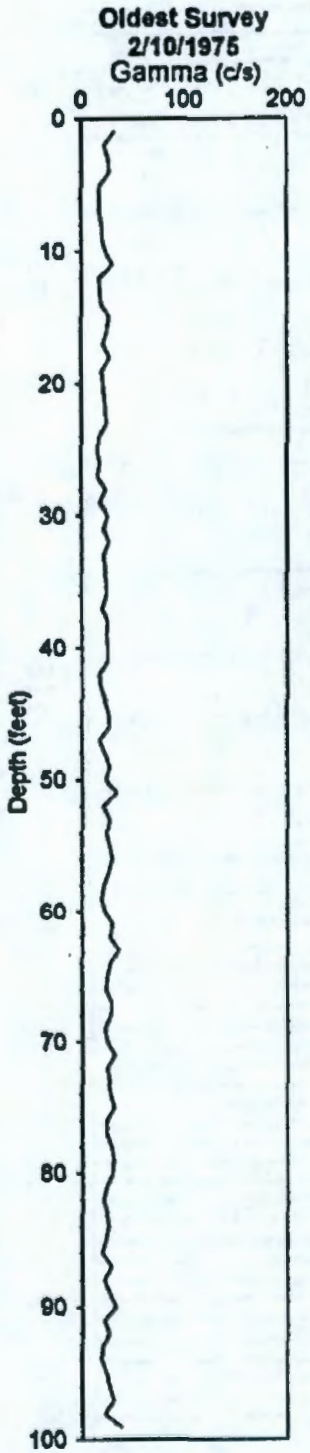
Method Used to Compute Background :	Threshold 0<val<50
Depth(s) where Contamination Identified in Gross Gamma Surveys :	NONE
Analyst Name :	R.K. Price
Company Name :	Three Rivers Scientific

30-11-09 Combination Plot

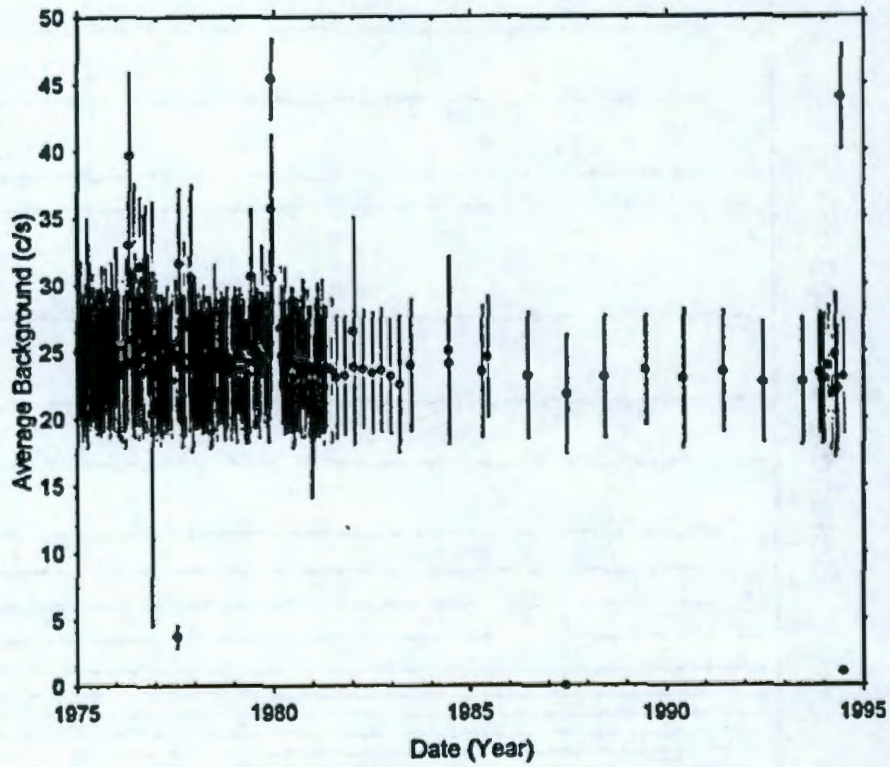


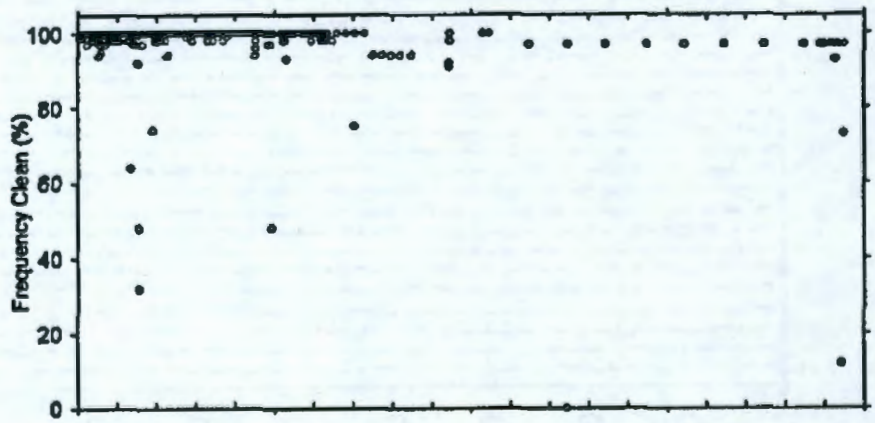

Borehole 30-11-09
Depth (feet)
0
10
20
30
40
50
60
70
80
90
100
Date (year)
1975
1980
1985
1990
1995
Analysis by: Three Rivers Scientific

Borehole 30-11-09



No Gamma-Ray Emitting Contamination Above Survey Detection Threshold





Analysis by: Three Rivers Scientific

Borehole 30-11-11

No Gamma Ray Emitting Contamination Identified.

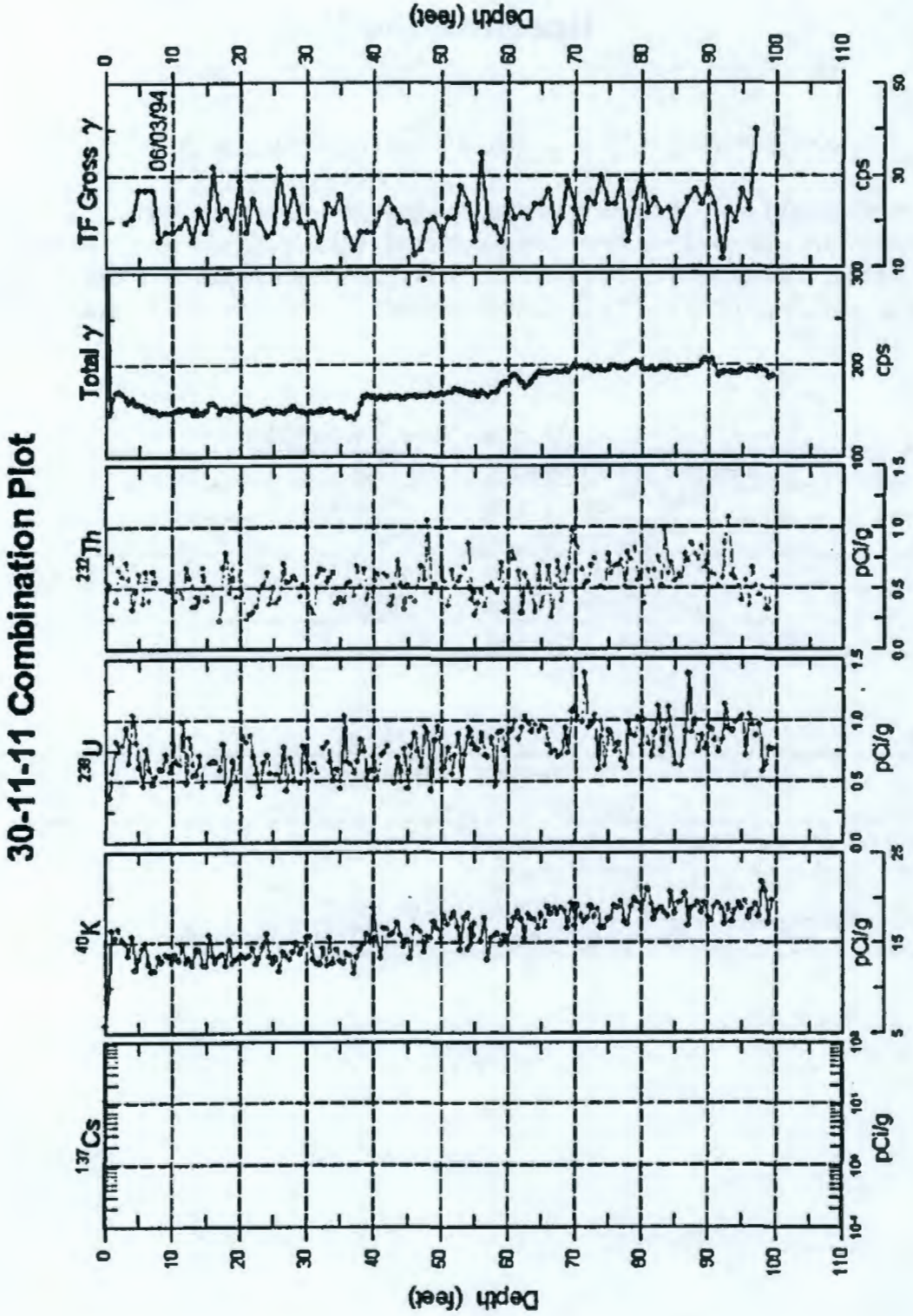
No significant levels of gamma ray contamination are present, based upon gross gamma data, above the survey probe detection threshold between 1975 and 1994 in the vadose zone from 2 to 100 feet. The HPGe logging system detected Cs-137 only at the surface (0 feet) at 10 pCi/g, and no other detection for the remainder of the logged depths.

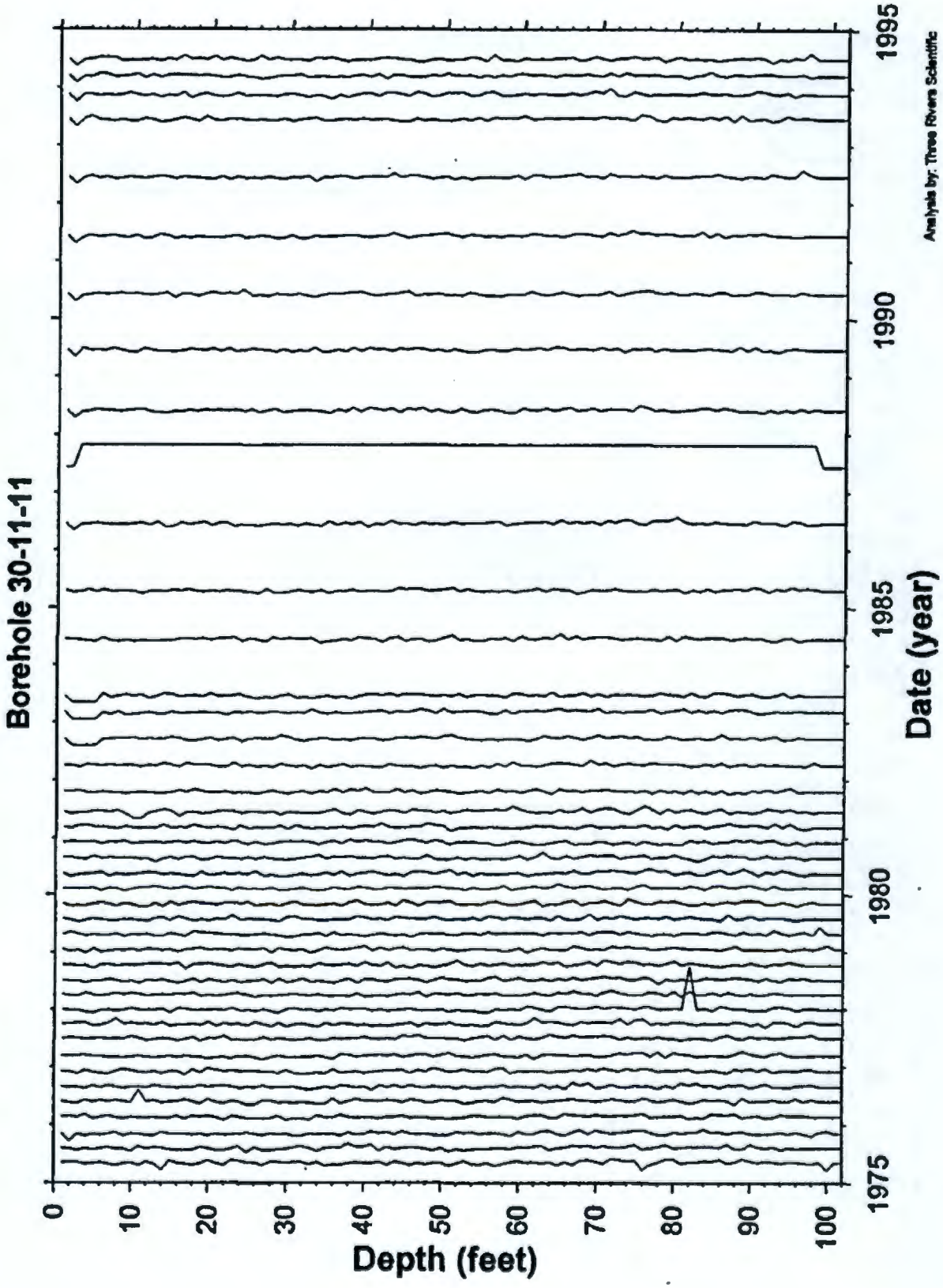
Gross Gamma Survey Information

Probe Type Processed :	04: NaI
Other Probe Types :	03: Neutron
Survey Depth :	100 ft
First Survey Date :	5/09/1975
Last Survey Date :	6/30/1994
Number Surveys Processed :	280

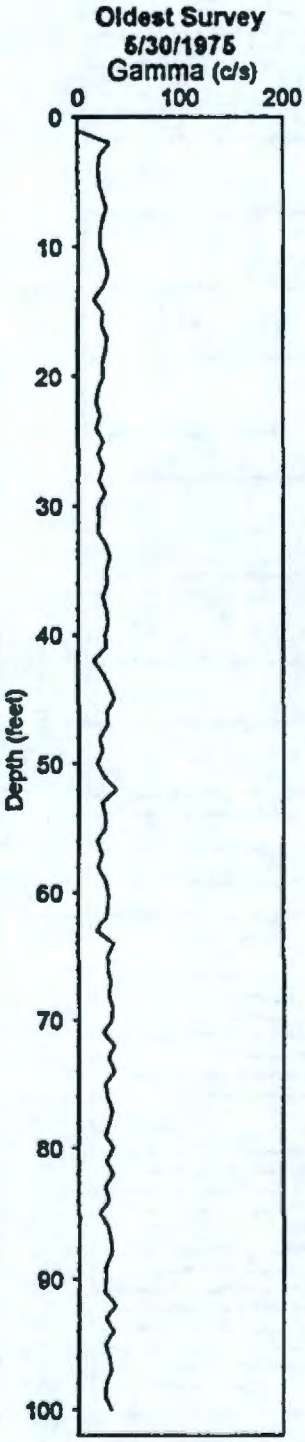
Analysis Notes

Method Used to Compute Background :	Threshold 0<val<50
Depth(s) where Contamination Identified in Gross Gamma Surveys :	NONE
Analyst Name :	R.K. Price
Company Name :	Three Rivers Scientific

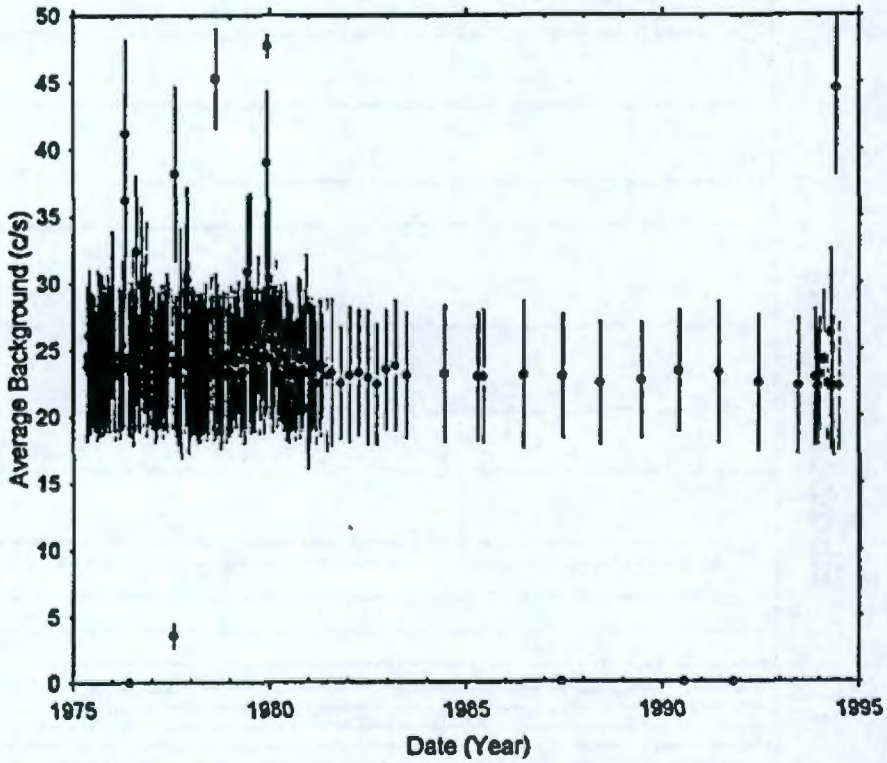

30-11-11 Combination Plot
TF Gross γ
06/03/94
cps
Total γ
cps
232Th
pCi/g
238U
pCi/g
40K
pCi/g
137Cs
pCi/g
Depth (feet)
Depth (feet)

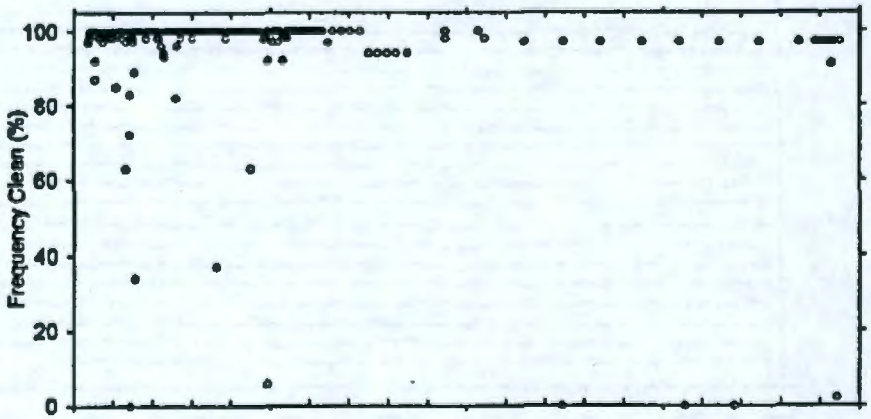

Borehole 30-11-11
Depth (feet)
0
10
20
30
40
50
60
70
80
90
100
Date (year)
1975
1980
1985
1990
1995
Analysis by: Three Rivers Scientific

Borehole 30-11-11



No Gamma-Ray Emitting Contamination Above Survey Detection Threshold





Analysis by: Three Rivers Scientific

Tank C-112

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This section contains the analysis results for vadose zone boreholes (dry wells) associated with the Tank 112 in the "C" Tank Farm.

Special Notes: None

Borehole 30-12-01

Contamination (Co-60 & Ru-106) from 38-48 feet is Unstable Early.

Grade thickness product over 38 to 48 feet shows a rapid increase of gross gamma activity in 1978. The grade thickness product from mid 1978 is decreasing at a rate consistent with a least square fit for the decay of Co-60 (HPGe identified) and Ru-106 (hypothesis). The decay fit to the grade thickness product is acceptable but not great. The GTP is consistently below the decay fit beyond 1988. The ratio of Ru-106 to Co-60 on 1/1978 is 161:52. The zone is categorized as unstable early.

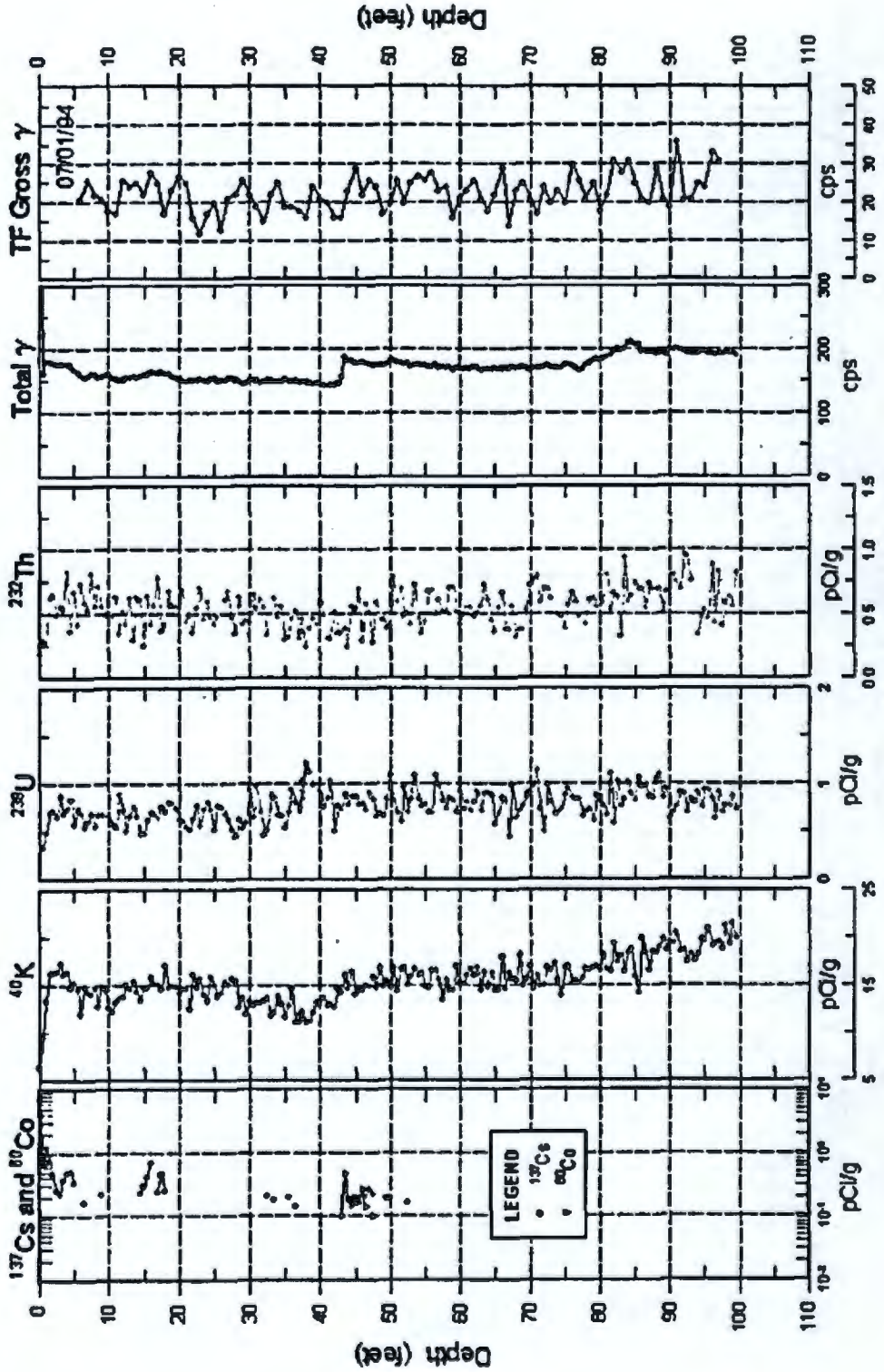
Gross Gamma Survey Information

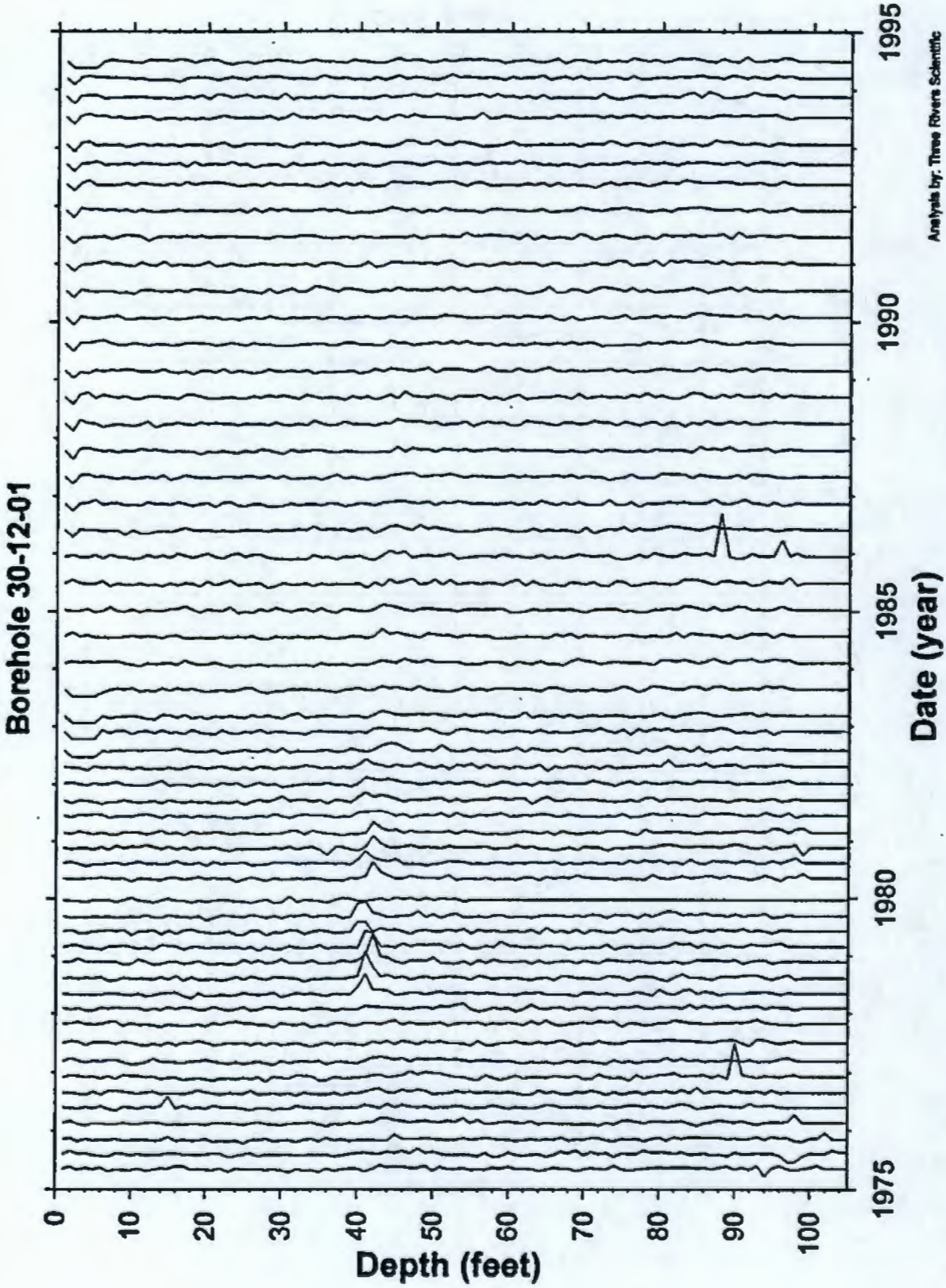
Probe Type Processed :	04: NaI
Other Probe Types :	03: Neutron
Survey Depth :	100 ft
First Survey Date :	5/09/1975
Last Survey Date :	7/01/1994
Number Surveys Processed :	384

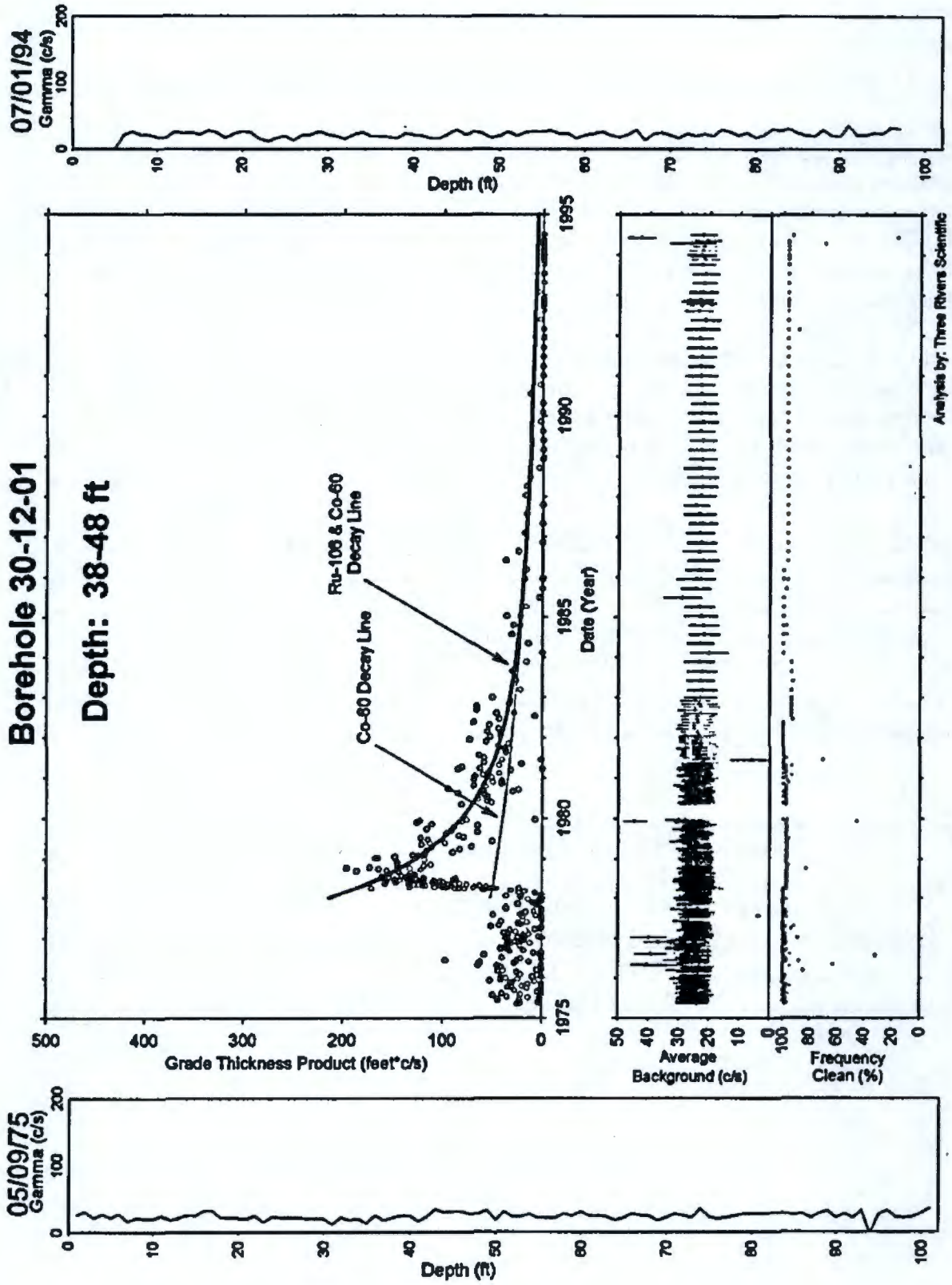
Analysis Notes

Method Used to Compute Background :	Fixed background (48-70ft)
Depth(s) where Contamination Identified in Gross Gamma Surveys :	38-48 ft Unstable Early
Analyst Name :	R.K. Price
Company Name :	Three Rivers Scientific

30-12-01 Combination Plot




Borehole 30-12-01
Depth (feet)
0
10
20
30
40
50
60
70
80
90
100
Date (year)
1975
1980
1985
1990
1995
Analysis by: Three Rivers Scientific


07/01/94
Gamma (c/s)
Depth (ft)
Borehole 30-12-01
Depth: 38-48 ft
Ru-106 & Co-60 Decay Line
Co-60 Decay Line
Grade Thickness Product (feet*c/s)
Date (Year)
Average Background (c/s)
Frequency Clean (%)
Analysis by: Three Rivers Scientific
05/09/75
Gamma (c/s)
Depth (ft)

Borehole 30-12-03

No Gamma Ray Emitting Contamination Identified.

No significant levels of gamma ray contamination are present, based on gross gamma data, above the survey probe detection threshold between 1975 and 1994 in the vadose zone from 2 to 100 feet. The HPGe logging system detected Cs-137 up to 6 pCi/g from the surface to 8 feet and intermittently for the reminder of the borehole at concentrations less than 1 pCi/g. The HPGe survey encountered water in the borehole at 40 feet.

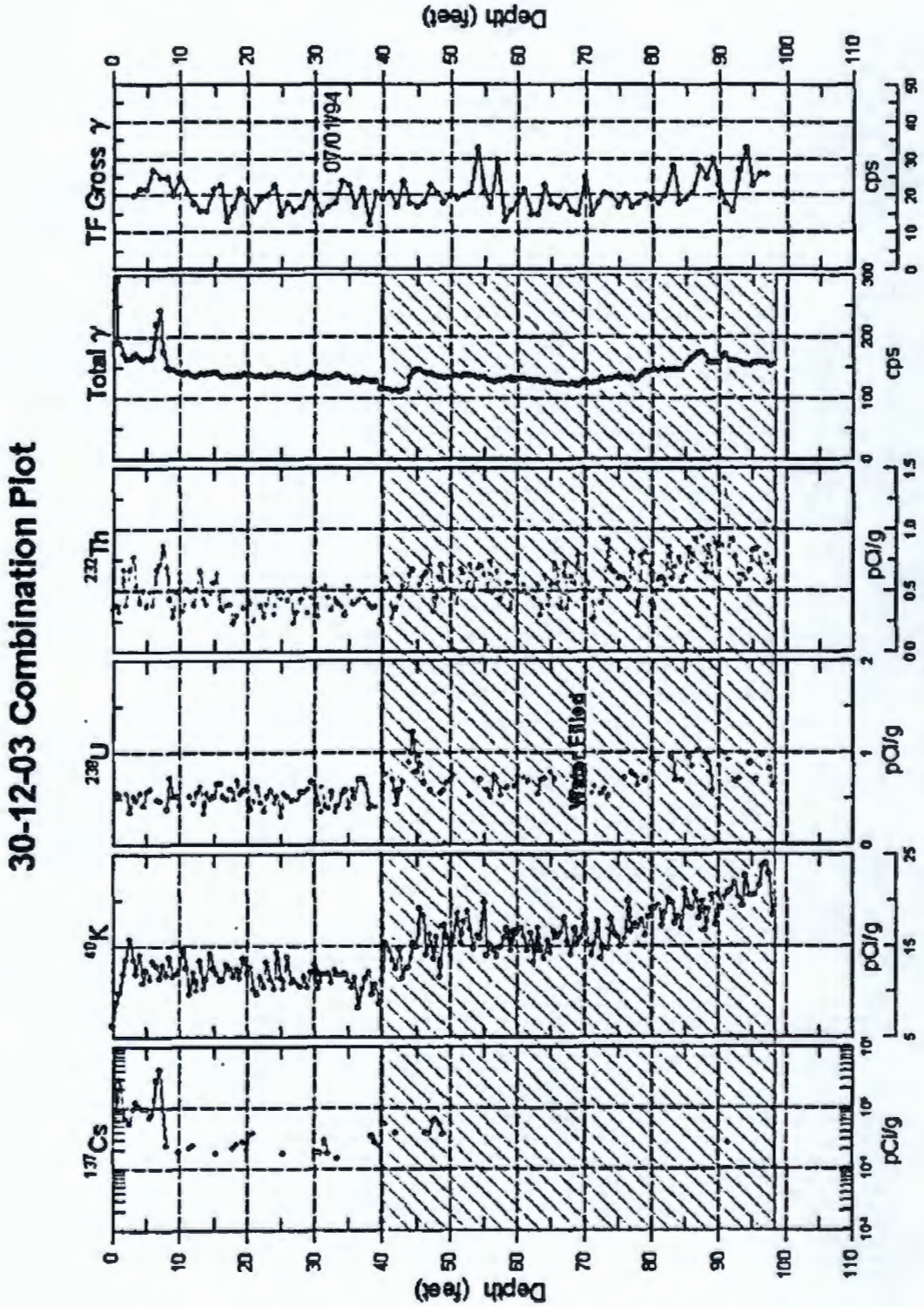
The stack plot and total gamma curve from the HPGe survey both identified a small increase in the gamma activity above 10 feet. The grade thickness product plot (not included) confirmed a low level zone with no significant variations during the monitoring time period and is less than the minimum detection threshold of the tank farm logging system.

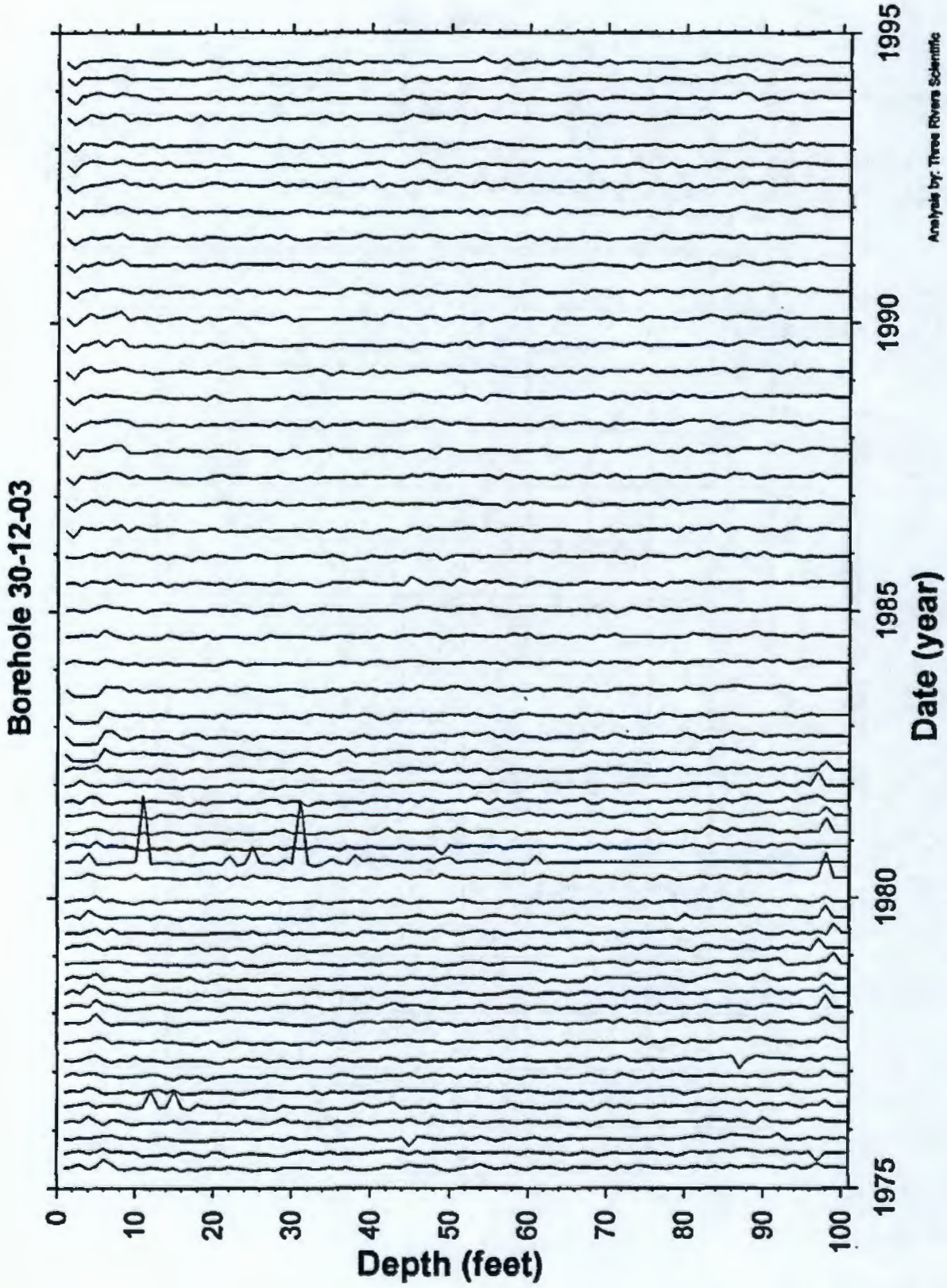
Gross Gamma Survey Information

Probe Type Processed :	04: NaI
Other Probe Types :	03: Neutron
Survey Depth :	100 ft
First Survey Date :	5/09/1975
Last Survey Date :	7/01/1994
Number Surveys Processed :	348

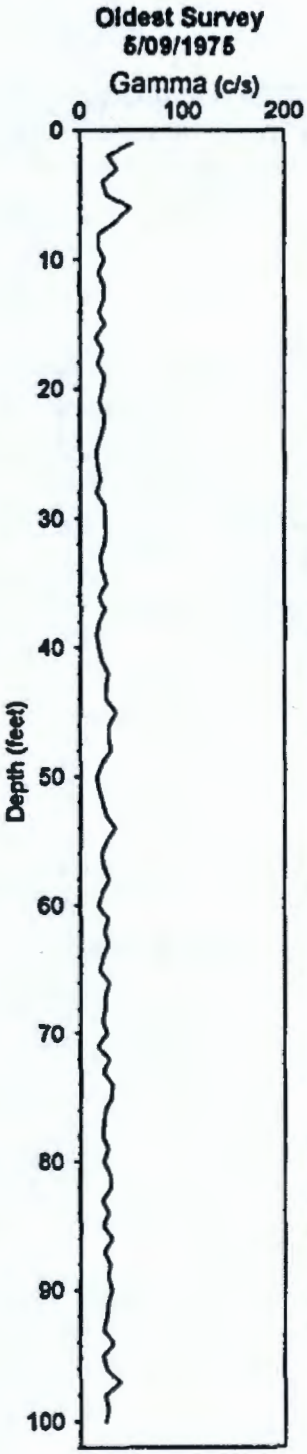
Analysis Notes

Method Used to Compute Background :	Fixed background (20-40ft)
Depth(s) where Contamination Identified in Gross Gamma Surveys :	None
Analyst Name :	R.K. Price
Company Name :	Three Rivers Scientific

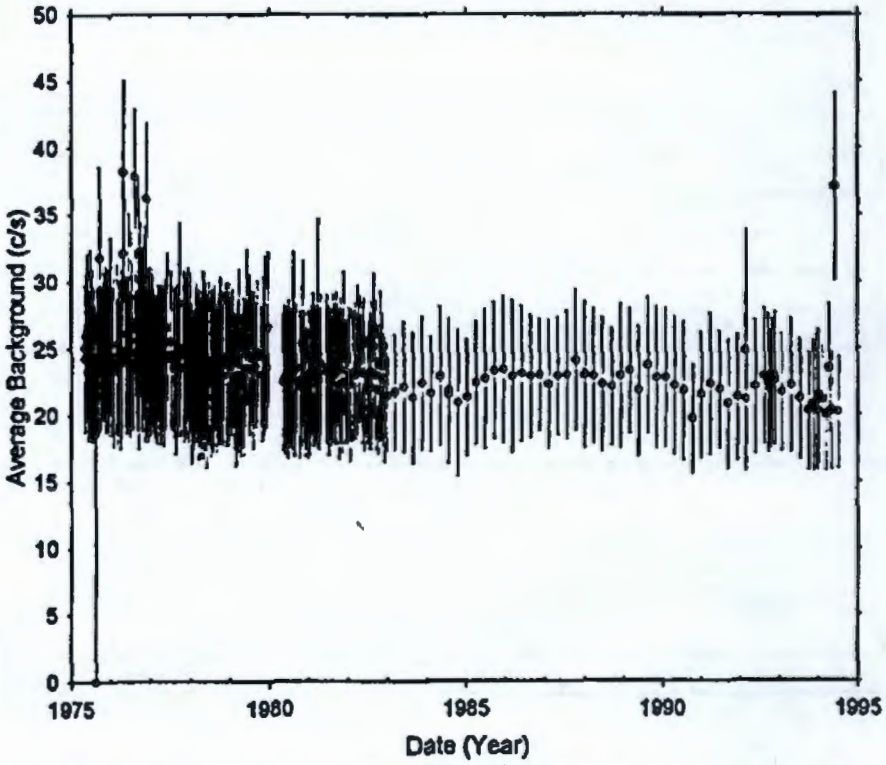

30-12-03 Combination Plot
TF Gross γ
07/01/94
Total γ
232Th
238U
Water Filled
40K
137Cs
cps
pCi/g
Depth (feet)

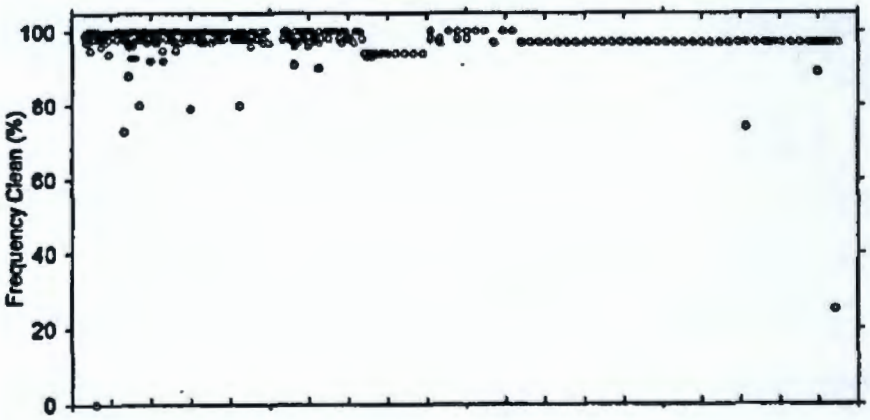

Borehole 30-12-03
Depth (feet)
0
10
20
30
40
50
60
70
80
90
100
Date (year)
1975
1980
1985
1990
1995
Analysis by: Three Rivers Scientific

Borehole 30-12-03



No Gamma-Ray Emitting Contamination Above Survey Detection Threshold





Analysis by: Three Rivers Scientific

Borehole 30-12-09

No Gamma Ray Emitting Contamination Identified.

No significant levels of gamma ray contamination are present, based upon gross gamma data, above the survey probe detection threshold between 1975 and 1994 in the vadose zone from 2 to 100 feet. The HPGe logging system detected Cs-137 at 6 pCi/g at the surface (0 feet) then less than 0.5 pCi/g intermittently from 1 to 16 feet, and no other detection for the remainder of the logged depths.

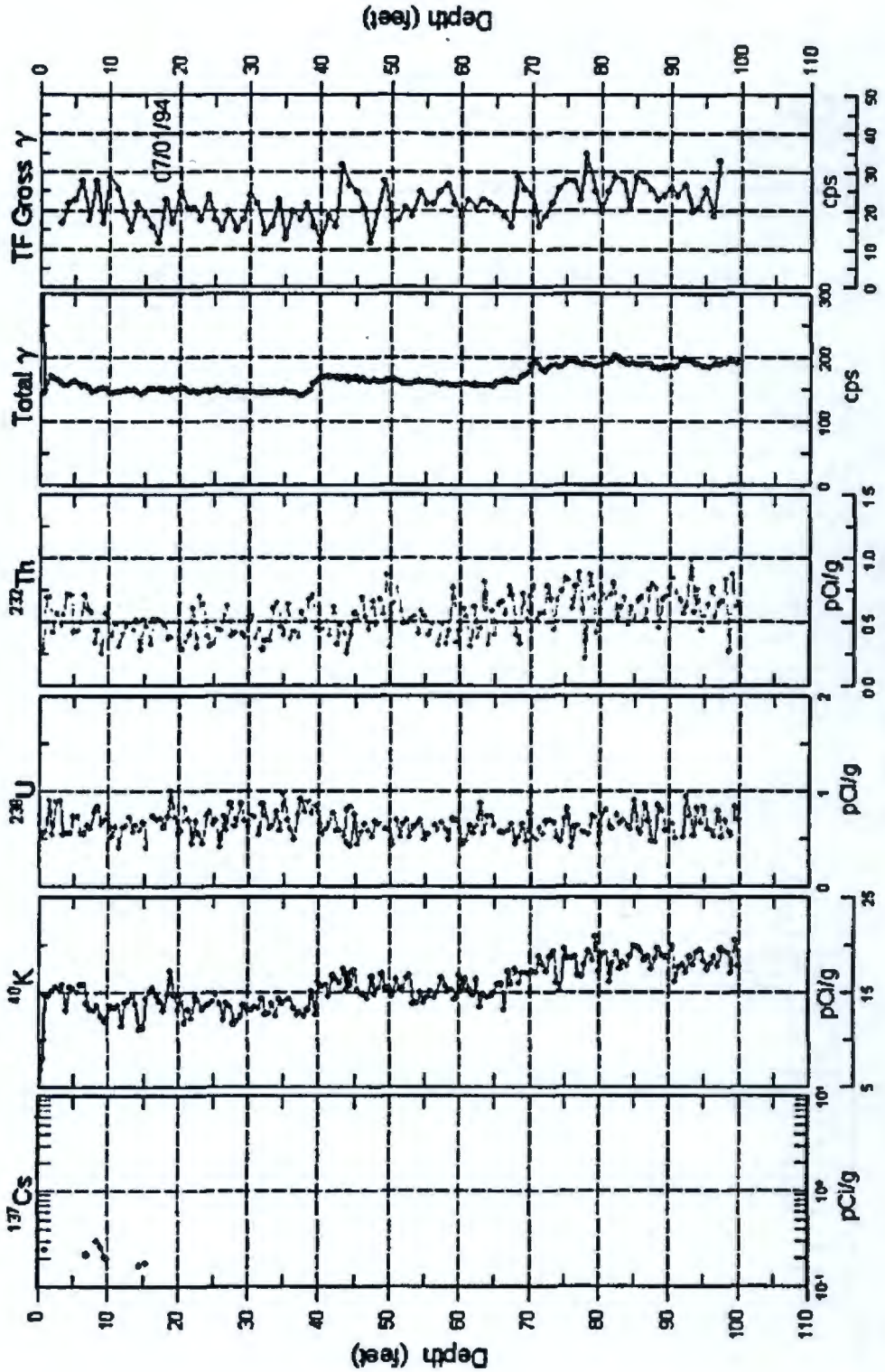
Gross Gamma Survey Information

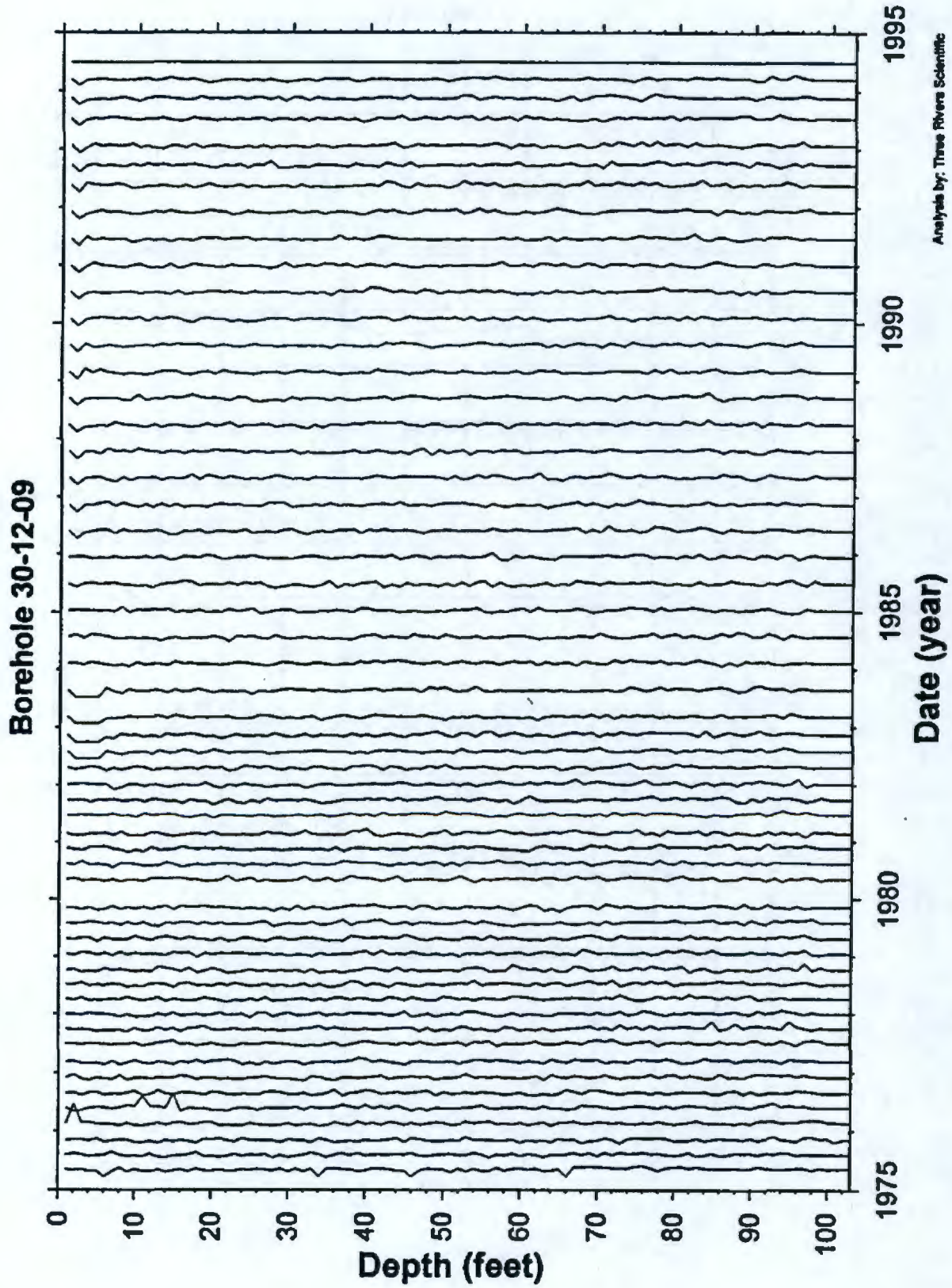
Probe Type Processed :	04: NaI
Other Probe Types :	03: Neutron
Survey Depth :	100 ft
First Survey Date :	5/09/1975
Last Survey Date :	7/01/1994
Number Surveys Processed :	340

Analysis Notes

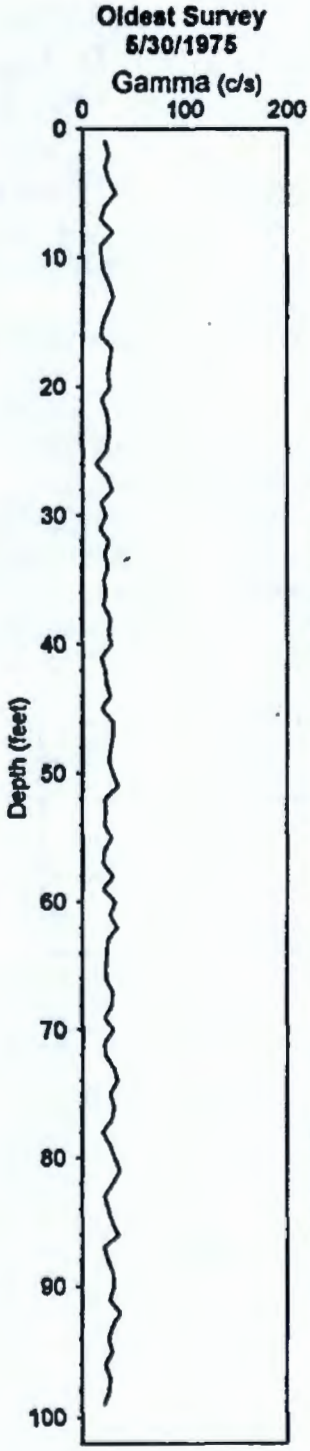
Method Used to Compute Background :	Threshold 0<val<50
Depth(s) where Contamination Identified in Gross Gamma Surveys :	NONE
Analyst Name :	R.K. Price
Company Name :	Three Rivers Scientific

30-12-09 Combination Plot

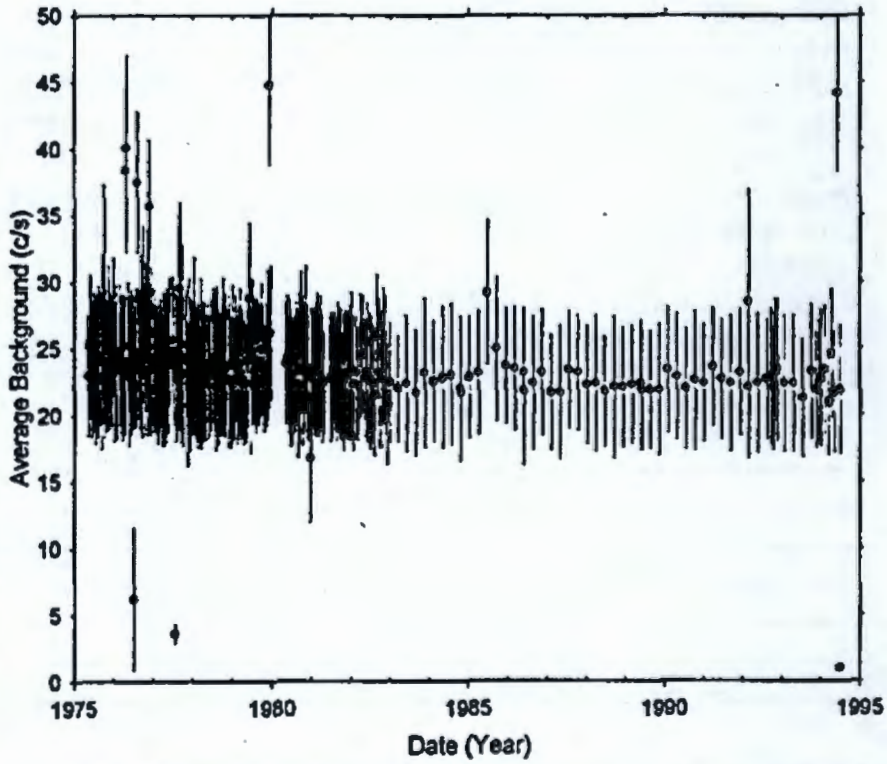



Borehole 30-12-09
Depth (feet)
0
10
20
30
40
50
60
70
80
90
100
Date (year)
1975
1980
1985
1990
1995
Analysis by: Three Rivers Scientific

Borehole 30-12-09



No Gamma-Ray Emitting Contamination Above Survey Detection Threshold



Analysis by: Three Rivers Scientific

Borehole 30-12-13

Contamination (Cs-137) from 0-20 feet is Tank Farm Activity. Contamination (Co-60 & Cs-137 & Ru-106) from 20-50 feet is Stable.

Grade thickness product over 0 to 20 feet shows variations in gamma activity level. The maximum activity in the Cs-137 zone (HPGe identified) did not exceed the linear range of the tank farm gross gamma probe. The zone is thin with the highest activity occurring at 10 feet. The shallow contamination zone is above the underground tank and may be associated with a buried transfer line. The variations in grade thickness product are indicative of tank farm activity.

Grade thickness produce over 20 to 50 feet is decreasing at a rate consistent with a least square fit for the decay of Co-60, Cs-137 (both HPGe identified) and Ru-106 (hypothesis). The ratios of Co-60, Cs-137, and Ru-106 (1/1978) are 767:14:1093. The HPGe survey also identified Eu-154 in the thin zone at 37 feet which has a half life of 8.5 years. The half life of Eu-154 is between the least square fit isotopes of Cs-137 (30.17 yr), Co-60 (5.27 yr), and Ru-106 (1.02 yr) and was not required for the fit.

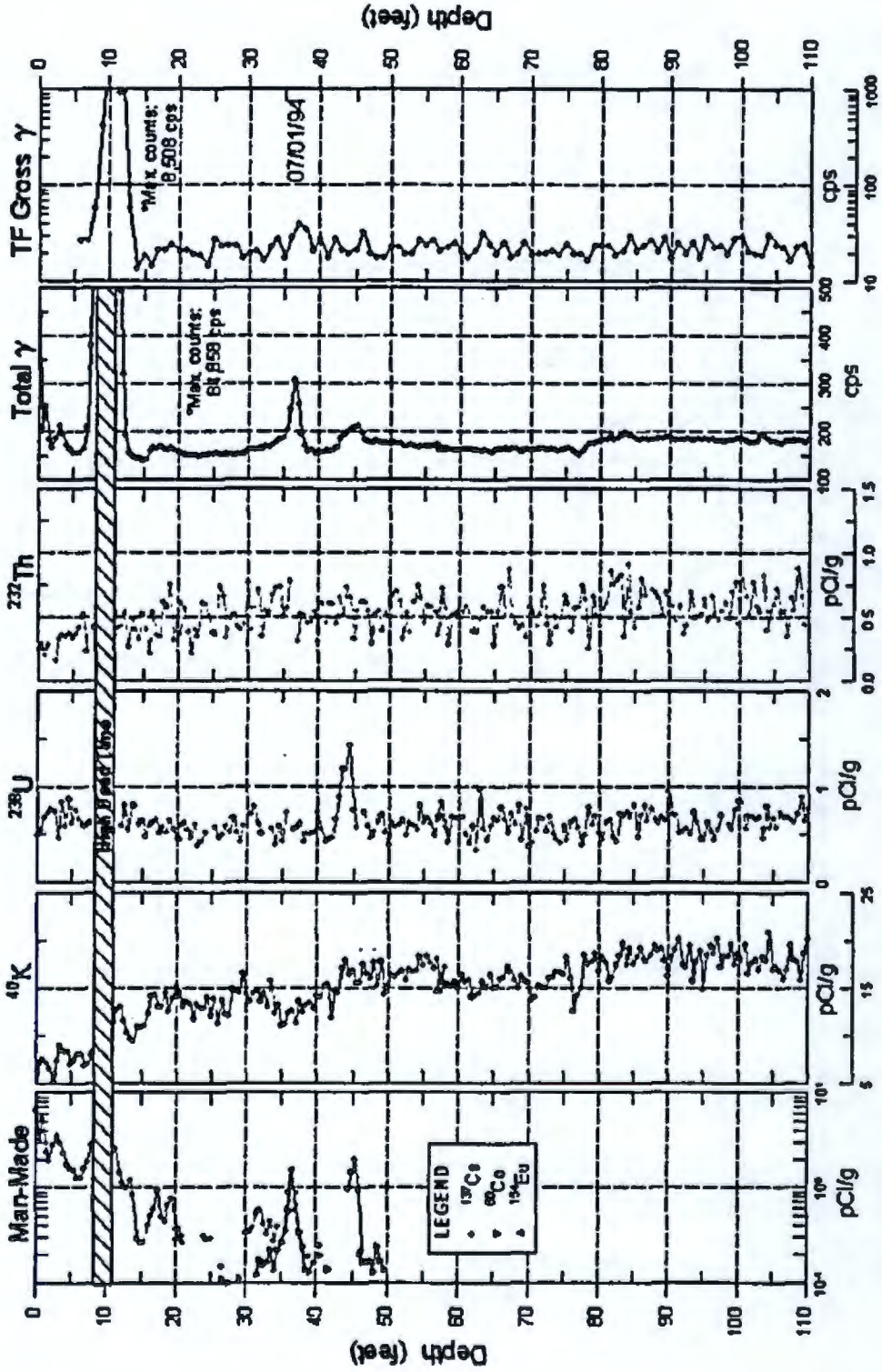
Gross Gamma Survey Information

Probe Type Processed :	04: NaI
Other Probe Types :	03: Neutron
Survey Depth :	120 ft
First Survey Date :	5/03/1978
Last Survey Date :	7/01/1994
Number Surveys Processed :	211

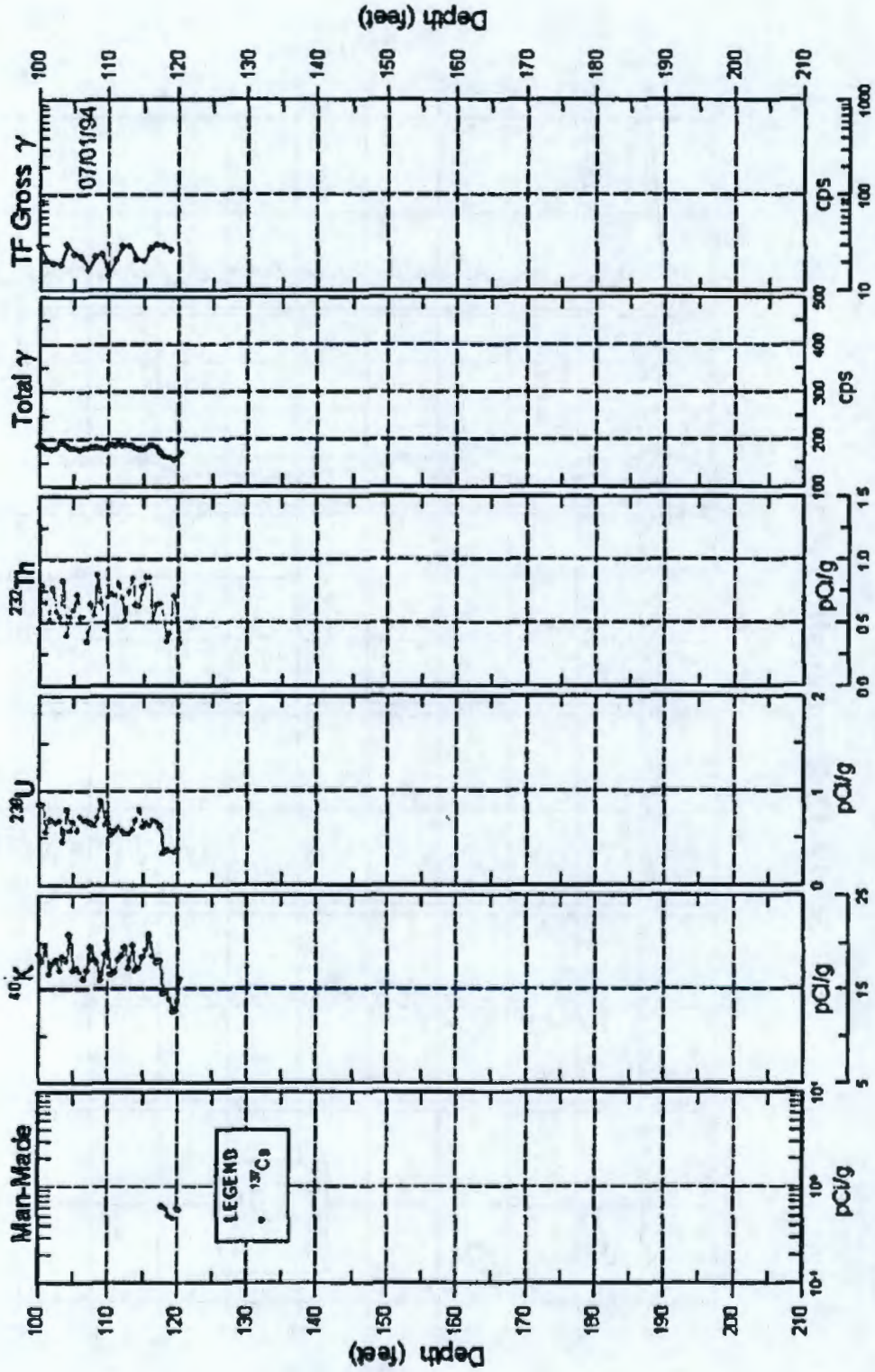
Analysis Notes

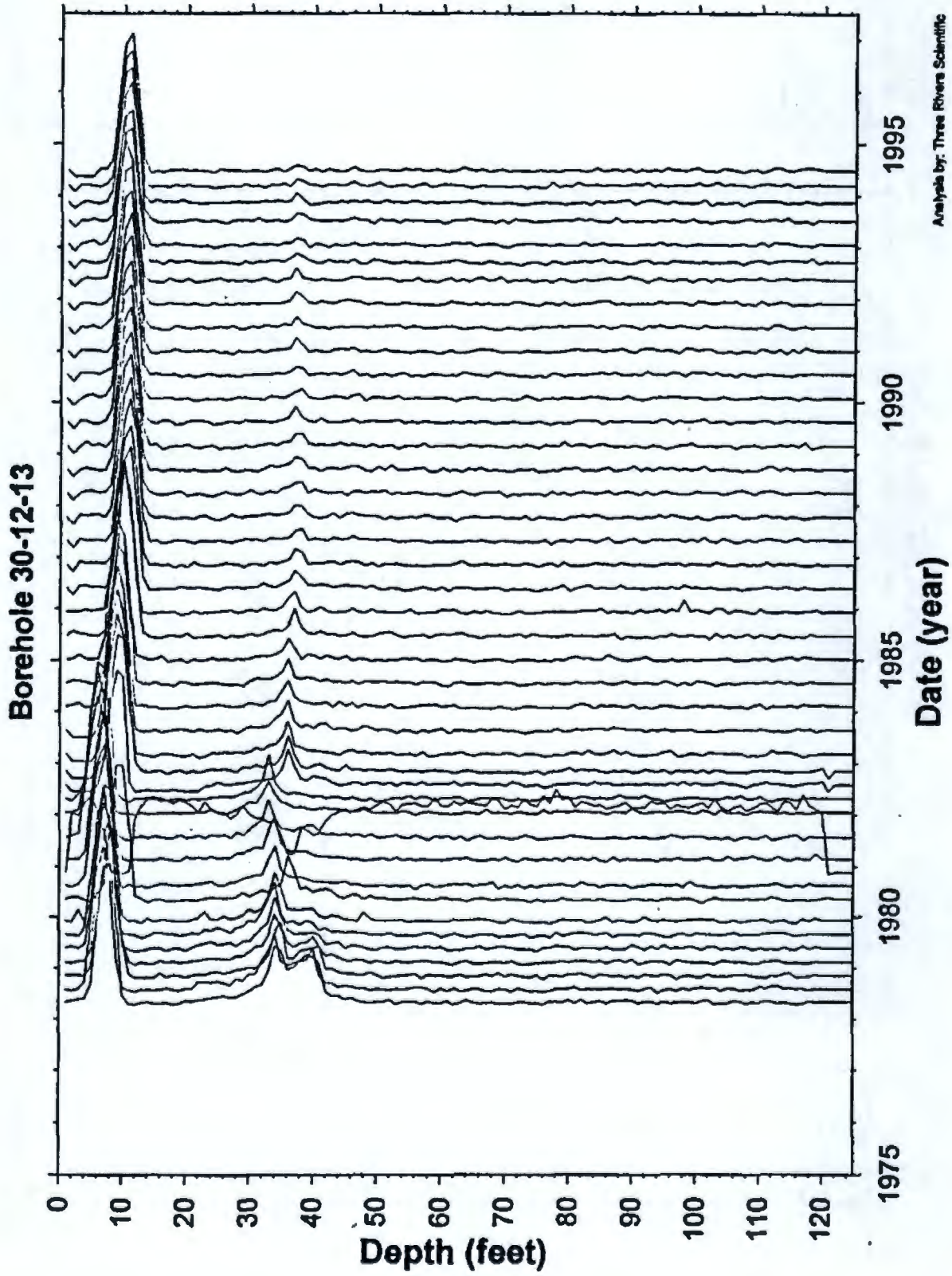
Method Used to Compute Background :	Fixed background (50-75ft)
Depth(s) where Contamination Identified in Gross Gamma Surveys :	0-20 ft Tank Farm Activity 20-50 ft Stable
Analyst Name :	R.K. Price
Company Name :	Three Rivers Scientific

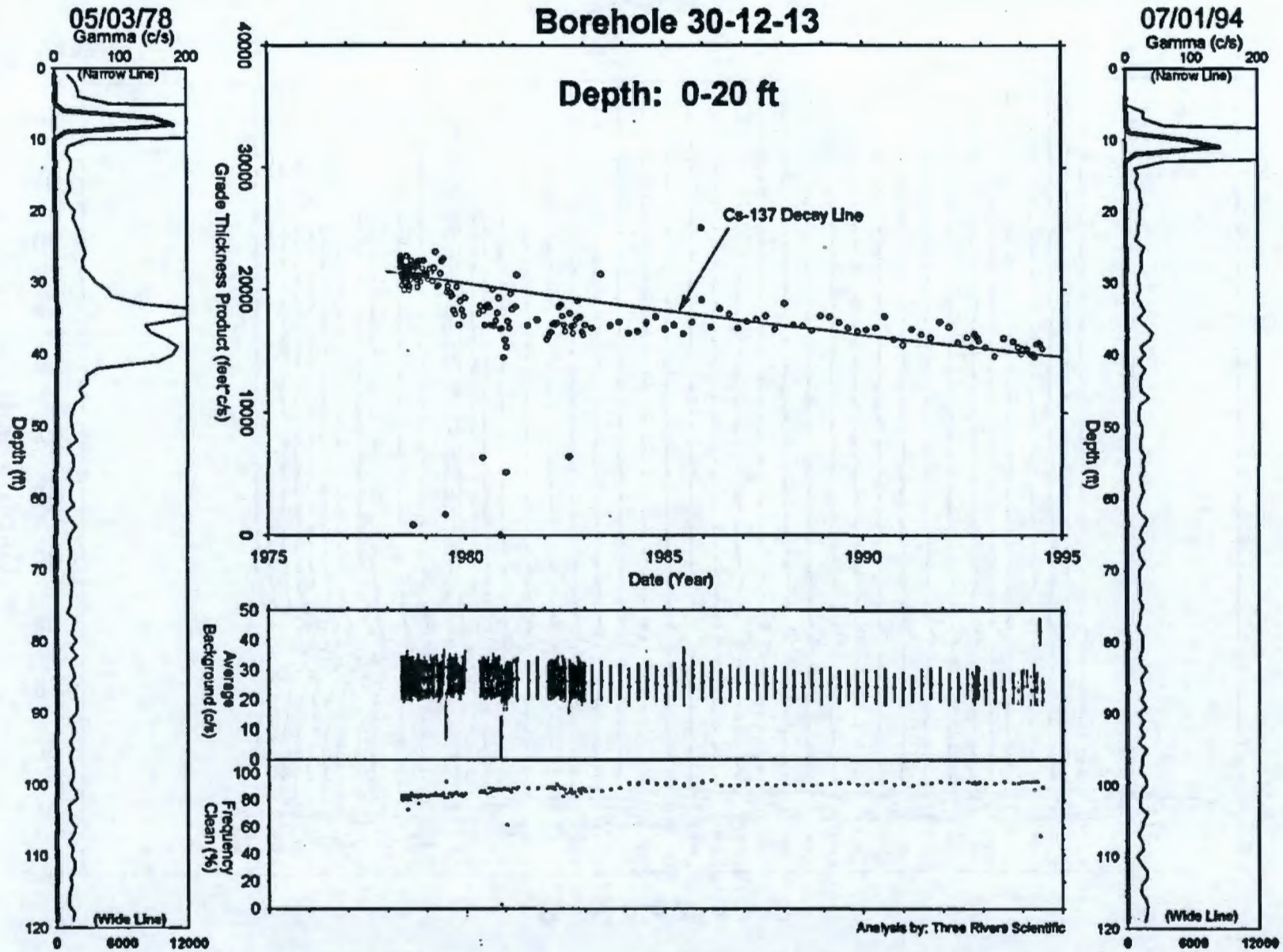
30-12-13 Combination Plot



30-12-13 Combination Plot




Borehole 30-12-13
Depth (feet)
0
10
20
30
40
50
60
70
80
90
100
110
120
Date (year)
1975
1980
1985
1990
1995
Analysis by: Three Rivers Scientific


Borehole 30-12-13
Depth: 0-20 ft
05/03/78
Gamma (c/s)
(Narrow Line)
(Wide Line)
Depth (ft)
07/01/94
Gamma (c/s)
(Narrow Line)
(Wide Line)
Depth (ft)
Grade Thickness Product (feet*c/s)
Cs-137 Decay Line
Date (Year)
Average Background (c/s)
Frequency Clean (%)
Analysis by: Three Rivers Scientific