NVO/0410-47 E. Campbell NVO/0410-47

WH ——
E 0

#45

ENVIRONMENTAL SURVEILLANCE REPORT FOR THE NEVADA TEST SITE JULY 1975 THROUGH DECEMBER 1977

REYNOLDS ELECTRICAL & ENGINEERING CO., INC.
LAS VEGAS, NEVADA 89114

JULY 1978

PREPARED FOR
THE U.S. DEPARTMENT OF ENERGY
NEVADA OPERATIONS OFFICE
UNDER CONTRACT NO. EY-76-C-08-0410

NVO/0410-47

NVO/0410-47

ENVIRONMENTAL SURVEILLANCE REPORT FOR THE NEVADA TEST SITE JULY 1975 THROUGH DECEMBER 1977

REYNOLDS ELECTRICAL & ENGINEERING CO., INC.
LAS VEGAS, NEVADA 89114

JULY 1978

Rec'd July 1978

PREPARED FOR
THE U.S. DEPARTMENT OF ENERGY
NEVADA OPERATIONS OFFICE
UNDER CONTRACT NO. EY-76-C-08-0410

ENVIRONMENTAL SURVEILLANCE REPORT

for the

NEVADA TEST SITE

JULY 1975 THROUGH DECEMBER 1977

Compiled by

M. W. Lantz

REYNOLDS ELECTRICAL & ENGINEERING CO., INC.

LAS VEGAS, NEVADA

ABSTRACT

This report documents the environmental surveillance program at the Nevada Test Site as conducted by the Energy Research and Development Administration (ERDA)* onsite radiological safety contractor from July, 1975 through December, 1977. The results and evaluations of measurements of radioactivity in air and water, and ambient gamma exposure rates are presented. Relevancy to ERDA guides is established.

*Became part of the Department of Energy (DOE) on October 3, 1977.

CONTENTS

FIGURES

TABLES

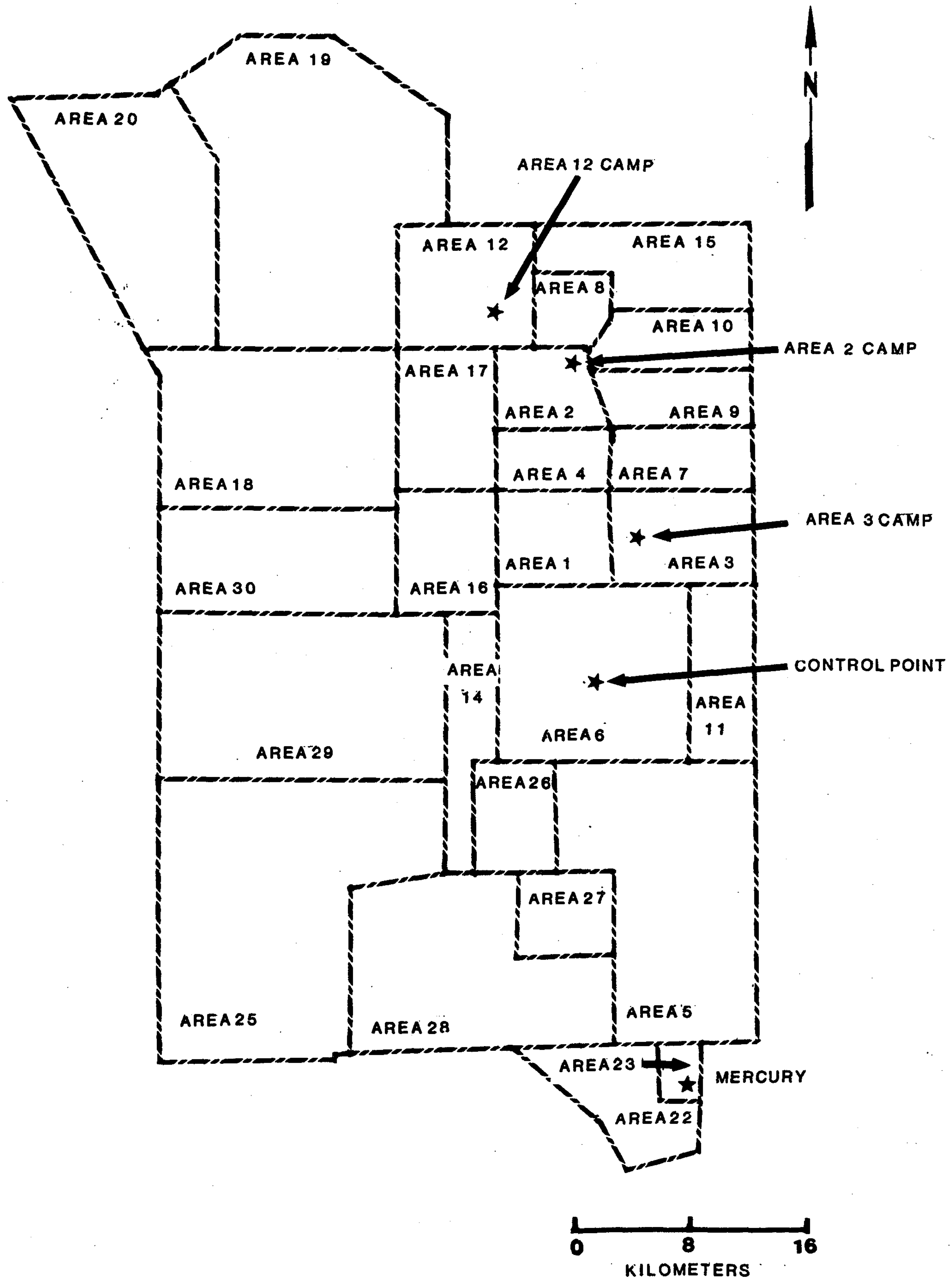
A. INTRODUCTION

This report documents the program conducted at the Nevada Test Site (NTS) for monitoring of radioactivity in the general onsite environment as performed by Reynolds Electrical & Engineering Co., Inc. (REECo) during the Fiscal Years 1976, 1977, and the remainder of the calendar year of 1977. As part of its contract, EY-76-C-08-410, REECo is responsible for providing radiological safety services within the confines of the Test Site. As part of the total program to control, minimize, and document exposure of the working population, an environmental surveillance program has been in effect for a number of years.

The NTS covers an area of 3,711 square kilometers, with terrain and climate conditions typical of the high southwest U. S. region and mountainous area (Figure 1). Temperatures vary from -20°C to 50°C. The area is subject to high winds, dust-laden atmosphere, and low humidity. Elevations range from dry lake beds to rugged mountains as high as 2,300 meters. The NTS has, since 1951, been the primary location for testing the nation's nuclear weapons. Other major projects at the NTS have included nuclear rocket propulsion development and environmental effects studies.

The monitoring program was designed to examine the environment for levels of radioactivity that are of interest in documenting the exposure of NTS workers. The program follows the standards presented in "A Guide for Environmental Radiological Surveillance at ERDA Installations", ERDA 77-24. These standards dictate the following objectives for the protection of the public:

Figure 1. NEVADA TEST SITE



(1) Evaluation of containment of radioactivity onsite.

(2) Detection of rapid changes and evaluation of long-term trends.

(3) Assessment of doses to man from radioactive releases as a result of ERDA operations.

(4) Collection of data bearing on the movement of contaminants released to the environment, with the intent of discovering unknown pathways of exposure.

(5) Maintenance of a data base.

(6) Detection and evaluation of radioactivity from offsite sources.

(7) Demonstration of compliance with applicable regulations and legal requirements concerning releases to the environment.

These objectives are met through the evaluations of the environmental program. A summary of the environmental plan is shown in Table 1. Air and potable water samples are collected at specific areas where personnel may spend significant time apart from the controlled work areas. Additional air sampling stations are located at sites throughout the NTS in support of the testing program. Water sampling of supply wells, open reservoirs, natural springs, contaminated ponds, and sewage ponds is also accomplished. The rate of sampling for each surveillance network is related to potential personnel exposure; i.e., weekly water samples at each cafeteria. Except for removal of a station, inaccessibility of the location, or loss of data, sampling was continuous during this reporting period. A review of all analyses from this sampling program relative to the concentration guides (CG's) is performed daily to insure that potential problems are noted in a timely fashion. Table 2 shows a summary of all laboratory analyses.

In the following environmental report, three periods of interest were evaluated; i.e., FY-1976, FY-1977, and July-December 1977. The third time span was used to initiate subsequent reports by calendar years. All concentrations of radioactivity will be averaged over these periods for comparison to the applicable CG's. Note that the data from FY-1976 has been reported in a prior report, but was included for trend evaluation.

B. SUMMARY OF RESULTS

The results obtained from this environmental monitoring program for the reporting period of July 1975, through December 1977, show that the radioactivity in the NTS environments was low compared to the ERDA guidelines. The maximum average gross beta concentration in air for the entire network was recorded during July-December 1977 (4.1×10^{-13} µCi/cc). This average represents 1.4 percent of the applicable Concentration Guide of 3×10^{-11} µCi/cc as listed in ERDA Manual Chapter 0524, Annex A (assuming Sr-90 to be the most radiotoxic beta emitter present). Airborne radioactivity from foreign atmospheric testing dominated the results of this period. Values up to 8.2×10^{-12} µCi/cc were recorded during the week of September 19 through 26 of that year. Gamma spectroscopy results identified the fission products, ^{131}I, ^{132}I, ^{133}I, ^{132}Te, ^{95}Zr, ^{95}Nb, ^{103}Ru, ^{99}Mo, ^{99m}Tc, ^{139}Ce, ^{141}Ce, ^{144}Ce, ^{140}Ba, ^{140}La. High values were also seen in FY-1977 during the week of October 18 through 25 (up to 1.5×10^{-12} µCi/cc). These increases and even smaller increases in November of that year were due to foreign atmospheric tests. The average gross beta concentration of FY-1977 was higher than FY-1976 because of these results; FY-1976 being a time of minimized source input. Gamma spectral results similar to the above list were seen. During this entire period, no other surveillance system showed conclusive evidence of any fallout-related excesses (i.e., gross beta in water). FY-1976 saw no foreign atmospheric tests, and, as in the remainder of this report period, detected no radioactivity as a result of NTS operations. Gross beta measurements were low and consistent throughout the network, and gamma spectral results showed background. The range of the year's station averages was

1.9×10^{-14} to 3.5×10^{-14} μCi/cc. These values seem to be indicative of a baseline, or background, level of gross beta at NTS because the plots have no upward or downward trend over this time period.

Plutonium-239 concentrations in air were primarily below 10^{-16} μCi/cc as compared with a CG of 6×10^{-14} μCi/cc as listed in ERDA Manual Chapter 0524, Annex A. Two surveillance stations indicated consistently higher plutonium values, and an increased sampling program has been instituted.

The tritium concentrations in air measured at the control station, Building 650 (Mercury), were similar to those found at offsite locations. The highest concentration of HTO was 2.5×10^{-11} μCi/cc. This was during the first week of operation, and all subsequent values were at least a factor of four lower. Most HT measurements were below the minimum detectable limits (MDL). The samples at Sedan Crater demonstrated HTO concentrations on the order of 10^{-11} to 10^{-10} μCi/cc with a high of 3.0×10^{-10} μCi/cc. All HT measurements were below the MDL.

Measurements of radioactivity in the principal NTS water distribution system showed that no release or movement of radionuclides occurred during the reporting period. The results of the gross beta measurements at each sampling location were distinct and consistent, being related only to the natural-occurring radionuclides in the vicinity. Water sampling points with similar origins showed equivalent gross beta concentrations, as expected. The maximum yearly average for the potable water stations was 1.6×10^{-8} μCi/ml at the Area 6 Cafeteria in FY-1977, which is within the CG of 3×10^{-7} μCi/ml as listed in ERDA Manual Chapter 0524, Annex A (assuming Sr-90 to be the most radiotoxic beta emitter present). Water from the natural springs showed gross beta activities comparable to the principal NTS waters, except for the Gold Meadows Spring. It is believed that movement of radionuclides does occur through surface runoff into this spring, but there is no human consumption, and the activity is still within any applicable concentration guides.

^{239}Pu and tritium measurements in water were primarily below the MDL. Tables 7 and 8 list the values above the detection limits in the data of the potable, supply well, natural springs, and open reservoirs. It is suspected that most of these are statistical fluctuations above the MDL, but a small number of tritium values may be valid. No results approached the tritium CG of 3×10^{-3} μCi/ml or the ^{239}Pu CG of 5×10^{-6} μCi/ml.

Measurable amounts of tritium were present in the several contaminated waste ponds. The amounts of effluent released to the environment are calculated on a yearly basis and reported on to ERDA Headquarters in accordance with ERDA Manual Chapter 0513.

C. SAMPLING AND ANALYSIS

1. Air Monitoring

Air sampling units are located at 22 stations on the NTS to measure the radionuclides in the form of particulates and halogens. All placements were primarily chosen to provide monitoring of radioactivity at sites with high occupational factors. Geographical coverage, access, and availability of commercial power were also considered.

The primary sampling units consist of a positive displacement pump pulling air at approximately 100 liters per minute through a 9-centimeter Whatman GF/A filter for particulates, followed by a charcoal cartridge for radioiodines, and mounted on a disposable plastic sample holder. A dry-gas meter is utilized to measure the volume of air displaced over the sampling period which is typically seven days. The total volume sampled is approximately 1000 m^3.

The collected samples are held for about seven days prior to analysis to allow for decay to insignificant levels of natural-occurring radioactive noble gas decay products. Gross beta counting is performed with a gas flow proportional counter (Bickman WIDE BETA II). A nominal MDL, defined as that value for which the relative two-sigma counting error is 100 percent, for the typical parameters involved is 1×10^{-16} μCi/cc. Gamma spectroscopy is accomplished using a germanium detector with an input to 2000 channels which are calibrated at 1 keV per channel from 0 to 2 MeV.

The weekly air samples for a given sampling station are batched on a monthly basis and subjected to a radiochemical analysis for ^{239}Pu. The procedure incorporates an acid dissolution and an ion exchange recovery on a resin bed. Plutonium is deposited by plating on a stainless steel disc. The chemical yield of the plutonium is determined with an internal tracer. Alpha spectroscopy is performed utilizing a solid state surface barrier detector. A nominal MDL for this analysis is 2 X 10^{-17} μCi/cc.

A separate sampler was designed for the collection of airborne tritium (HT) and tritiated water vapor (HTO). It was portable and capable of unattended operation for up to two weeks in desert areas. A small electronic pump draws air into the apparatus at approximately 0.5 liters per minute, and the HTO is removed from the air stream by a silica gel drying column. The dry air then passes through a catalytic converter containing platinum to generate HTO from HT according to the reaction $2H_2 + O_2 \overset{Pt}{\rightarrow} 2H_2O$. The generated vapor is collected on another drying column to which a small volume of distilled water serves as a trap for HTO and makes a supplemental supply of hydrogen unnecessary. Appropriate aliquots of condensed moisture are obtained by heating the silica gel. Counting via liquid scintillation techniques allows for the determination of the HT and HTO activities. A nominal MDL for this analysis is 3 X 10^{-13} μCi/cc.

2. Water Monitoring

Water samples are collected at various frequencies from selected potable water consumption points, supply wells, natural springs, open reservoirs, final effluent ponds and contaminated ponds. Frequency is determined on the basis of potential use and on contamination potential, i.e., potable sources weekly, supply wells monthly, etc. Samples are collected in 1-liter glass containers. All samples are analyzed for gross beta and tritium concentrations, and are screened for gross gamma. Plutonium analyses are performed regularly on a quarterly basis.

A 500-ml aliquot is taken from the original sample for gamma-counting and counted in a Nalgene bottle. A 5-ml sample is aliquoted and subjected to tritium analysis via liquid scintillation. The remainder of the original sample is evaporated to 15 ml, transferred to a stainless steel counting planchet and evaporated to dryness after the addition of a wetting agent. Beta-counting is accomplished as in Section 1. Nominal MDL's are: (1) gross beta, 1 X 10^{-9} μCi/ml; and (2) tritium, 4 X 10^{-7} μCi/ml.

Quarterly, two 1-liter samples are collected and the second is used for plutonium analysis. The radiochemical procedure used is similar to that described in Section 1. As mentioned, alpha spectroscopy is used to measure any ^{239}Pu. The typical MDL for this procedure is 1 X 10^{-11} μCi/ml.

3. Data Treatment

Each set of data obtained from this program undergoes a thorough inspection as to its accuracy. If serious differences are found from the expected value, a review of the field sampling, sample preparation, and processing is done. On the occasions when the problem cannot be resolved by the environmental scientist, a recount or second sample is secured.

All data are plotted on a daily basis or are listed in tabular form. This treatment facilitates the data review and can reveal trends or periodicity in the radioactivity. Environmental data have been found to be log-normally distributed. In order to treat the asymetry, each stations' data are plotted against a logarithmic axis and the averaging plots in each section show geometric means; i.e., the mean $\overline{X}_g$ derived according to the equation:

$$\overline{X}_g = \text{Log}^{-1} \left[\frac{\Sigma \text{Log } X_i}{N} \right]$$

where: X_i = observed values

N = number of observations

Arithmetic means, although severely affected by outliers (suspicious data), are those values compared to the CG's and listed in all tables.

In this program, the value used to check for inaccuracies, trends, or periodicity is the central tendency of the plots. This statistic shows the center of the data file with a strong resistance to outliers and allows the judgement of the analyst to be imposed upon the system. Any suspected radiation excesses will be checked against the station's central tendency and prior measures of dispersion.

Dispersion of the laboratory results is evaluated continuously. Samples are recounted and the percent differences between the original and the second count describes the variance of the counting system. When these checks indicate a problem, the systems are reviewed. The Median Absolute Deviation (M.A.D.) is the statistic used to evaluate new data relative to prior measurements. The M.A.D. is highly resistant to the outliers of environmental data, and has been valuable in the measurement of station-to-station variations and laboratory quality.

D. RADIOACTIVITY IN AIR

The locations at which air was sampled continuously are shown in Figure 2. All stations were sampled over the entire report period except for the Area 20 Dispensary. This location was discontinued in 1976 when power became unavailable.

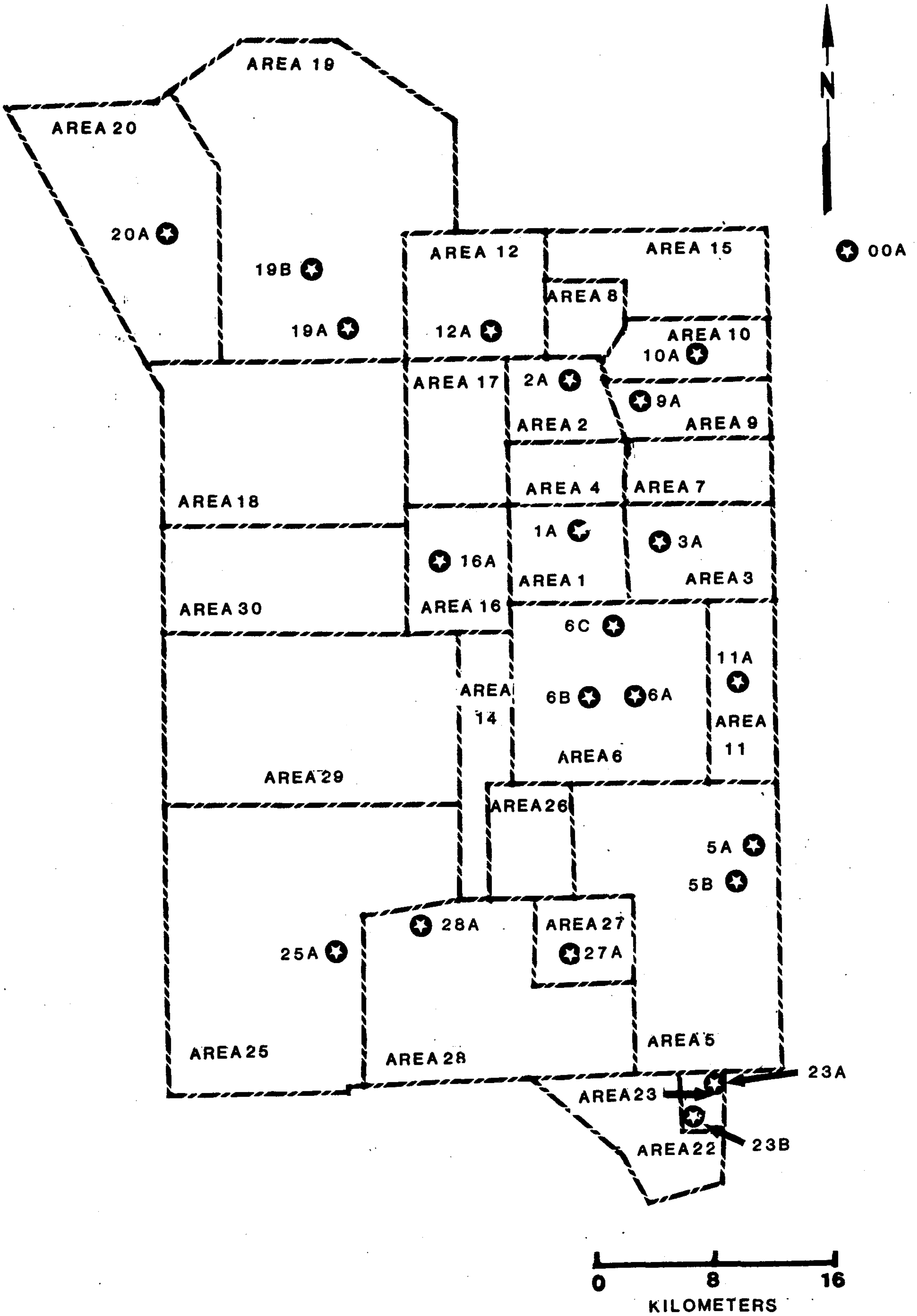
The general trends of the entire air surveillance network are shown in Appendix A for the gross beta and plutonium activity. In the first plot, the twenty-two weekly values were arithmetically averaged to show a smoothed representation of the changes in air radioactivity during the surveillance period. The remaining plots depict the actual measurements at each location during the reporting period. Table 3 lists the averages for each station for gross beta, and Table 4 shows the averages for plutonium.

Measurements of the gross beta concentrations in air are of primary interest. Due to typical beta-counting system characteristics, these measurements provide the most dependable results and are, therefore, used in comparison to other sampling networks.

The network averages for gross beta at the NTS for the primary report periods were:

Year	Average (X 10^{-14} μCi/cc)
July-December 1977	41.0
FY-77	16.8
FY-76	2.5

Figure 2. NTS ENVIRONMENTAL SURVEILLANCE AIR SAMPLING LOCATIONS



The highest average is 1.4 percent of the CG for uncontrolled areas, assuming ^{90}Sr to be the most radiotoxic beta emitter present.

The data from this report can be described by three distinct intervals. The first interval was from July 1975 to September 1976. This was a time of minimized worldwide fallout and resulted in all stations declining to a baseline level of about 2 X 10^{-14} μCi/cc. No radionuclides except for those associated with natural background were detected during this period. It can be seen from Table 3 that the background levels at each location are remarkably consistent for this time span; indicative of the measurement at twenty-two locations of one general atmospheric radioactivity.

The second interval was from October 1976 to September 1977. During this time period, the fallout from two foreign atmospheric tests was the central effect upon the radiation measurements. Airborne radioactivity reached the NTS in early October, and the peak of the activity (∿100 X background) occurred from October 18 to October 25. The gross beta plots show this peak and the subsequent swift decay. A small rise attributed to the second test can be seen in November. The highest value recorded was 1.5 X 10^{-12} μCi/cc at the Area 16 Substation. As can be seen from the plots, the gross beta activity declined to approximately the baseline value by the middle of January 1977. Almost immediately, the measurements began a slow rise, reaching a maximum during April and May of 1977. This secondary peak, called the Tropospheric Fallout, was caused by radioactive particles of small sizes and masses brought down by the weather phenomena associated with that time of the year. The highest value recorded during this period was 7.7 X 10^{-13} μCi/cc at the Area 5 Maintenance Complex. A gradual decline was seen until the end of this interval.

The gamma spectrometry system was used to analyze the samples for specific isotopes, and revealed fission products throughout the interval. Varying concentrations of ^{131}I, ^{132}I, ^{133}I, ^{132}Te, ^{95}Zr, ^{95}Nb, ^{103}Ru, ^{99}Mo, ^{99m}Tc, ^{139}Ce, ^{141}Ce, ^{144}Ce, ^{140}Ba, and ^{140}La were found during the initial phase of this interval. The predominant isotopes detected during the secondary peak were the longer-lived radionuclides:

^{103}Ru (40 days), ^{106}Ru (367 days), ^{95}Zr (65 days),
^{141}Ce (33 days), and ^{144}Ce (285 days).

The third interval was from late September 1977 to the end of this reporting period, December 1977. Another foreign atmospheric test dominated the results of this period. Radioactive debris reached the NTS during the weekend of September 23, 1977. The gross beta activity peaked (∿ 400 X background) in that week and the following week. This peak is demonstrated in the plots, as is the smooth decay in the succeeding months. The highest value recorded was 8.2×10^{-12} μCi/cc at the Building 650 in Area 23. All stations declined through the remainder of the report period, but the cumulative effect of the three tests can be seen in that the lowest gross beta average was still three times the normal background level.

Generally, analyses of the gamma spectrometry data revealed those same radionuclides found after the 1976 tests. Two other isotopes, ^{147}Nd and ^{239}Np, were detected after counting a typical sample for a much longer period of time. Different concentrations were found in this cloud passage, but the ratios of the isotopic activities remained similar.

Plutonium results for most of the air samples were on the order of 10^{-17} μCi/cc. The CG for plutonium in uncontrolled areas is 6 X 10^{-14} μCi/cc. Two stations, the Area 3 Cafeteria and the Area 9, 9-300 Bunker, averaged over 10^{-16} μCi/cc, and the 9-300 Bunker has recorded values approaching the CG. The activity at this location was due to known plutonium fields. Before 1960, several safety experiments spread plutonium throughout Area 9. Decontamination was accomplished by washing roads, blading, windrowing, and oiling the soil, but resuspension of the material has occurred via weathering and disturbance by traffic. The activity detected at the Area 3 cafeteria was due to aboveground nuclear testing conducted in the 1950's in that general area. As additional surveillance, TLD stations have been situated near these locations, and provisions were made to place more air samplers. An evaluation of tritium in the air was begun during 1977 at Building 650 in Area 23 and at Sedan Crater in Area 2. The Area 23 station was considered as a control-type sampler, while Sedan Crater was believed to be one of the higher tritium release points. Table 5 lists the results compiled during the report period.

E. RADIOACTIVITY IN SURFACE AND GROUND WATER

The principal water distribution system on the NTS consists of seventeen supply wells, eight potable water locations, and sixteen open reservoirs. The wells feed directly to many of the reservoirs and the drinking water is pumped from the wells to the points of consumption. While the air surveillance network consisted of twenty-two stations measuring one general atmospheric radioactivity, water stations will only correspond where there is direct "communication" of fluid. This is the critical pathway for the ingestion of waterborne radionuclides, so the system is sampled and evaluated as a special monitoring program. All drinking water is collected weekly to provide a constant check of the end use activity and to allow frequent comparisons to the radioactivity of the water in the wells. This also creates a large data base to evaluate long-term trends or intermittent changes in activity. The supply wells and open reservoirs are collected on a monthly schedule. The identification of any radionuclides above natural background in this system will initiate a closer review of the drinking water.

The other water systems monitored onsite are the natural springs, contaminated ponds, and effluent ponds. The springs and contaminated ponds are sampled monthly, and the effluent ponds are sampled for plutonium analysis on a quarterly basis. Sampling of some waters was discontinued when they were no longer used; i.e., wells in Areas 19 and 20.

1. Supply Wells

Water from the seventeen supply wells is used for a variety of sanitary and industrial uses. Criteria for selection was primarily based on potential use for human consumption. The location of these wells are shown in Figure 3.

Appendix B consists of the plots of each station of the measured gross beta activity with 2σ error bars. An averaging plot is included which shows the trend of the mean of the network throughout the reporting period. The range at each point is also given. Table 6 includes a list of the averages for each location. The highest average recorded was 2.8×10^{-8} μCi/ml at Well 4 during July-December 1977. This is 9.3 percent of the CG assuming ^{90}Sr to be the most radiotoxic beta emitter present. The lowest average gross beta activity for the onsite supply wells was 1.7×10^{-9} μCi/ml at Well U19c during July-December 1977.

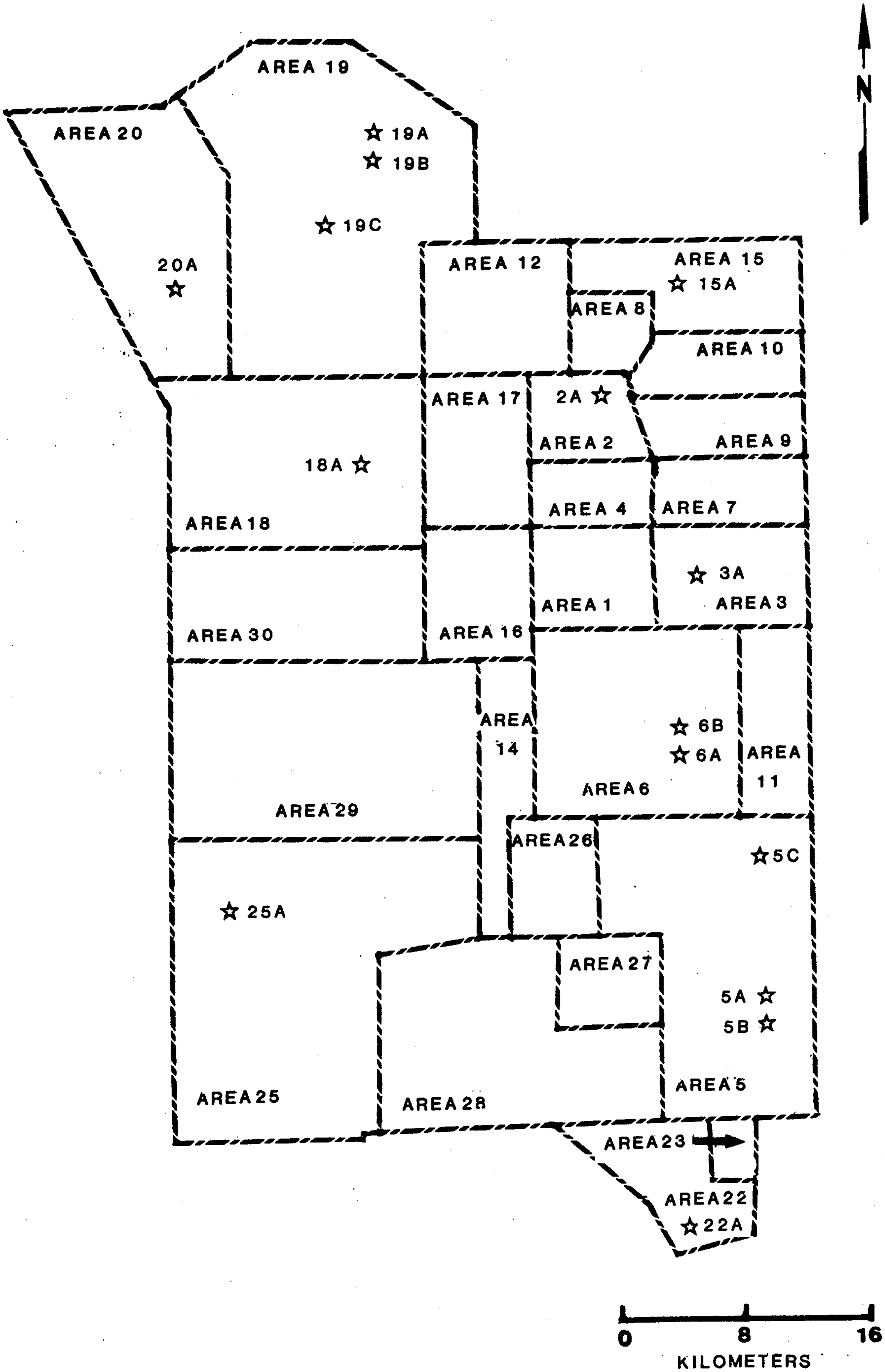
The activities of each well and the entire network appear consistent over the report period. No trends in the plots are discernable and the station averages show minimal changes (<20 percent). The averages of the entire network were:

Year	Mean ($\times 10^{-9}$ μCi/ml)
July-December 1977	10.9
FY-77	10.4
FY-76	9.1

Using the CG for ^{90}Sr as the conservative guide, a comparison with 3×10^{-7} μCi/ml can be made.

Appendix B also includes plots of the network monthly averages for tritium

Figure 3. NTS ENVIRONMENTAL SURVEILLANCE SUPPLY WELLS SAMPLING LOCATIONS



and plutonium. They are basically representations of the detection limits of each system since over 99 percent of the values were less than the limits. All positive values are listed in Tables 7 and 8. In no case was a subsequent value above the detection limit.

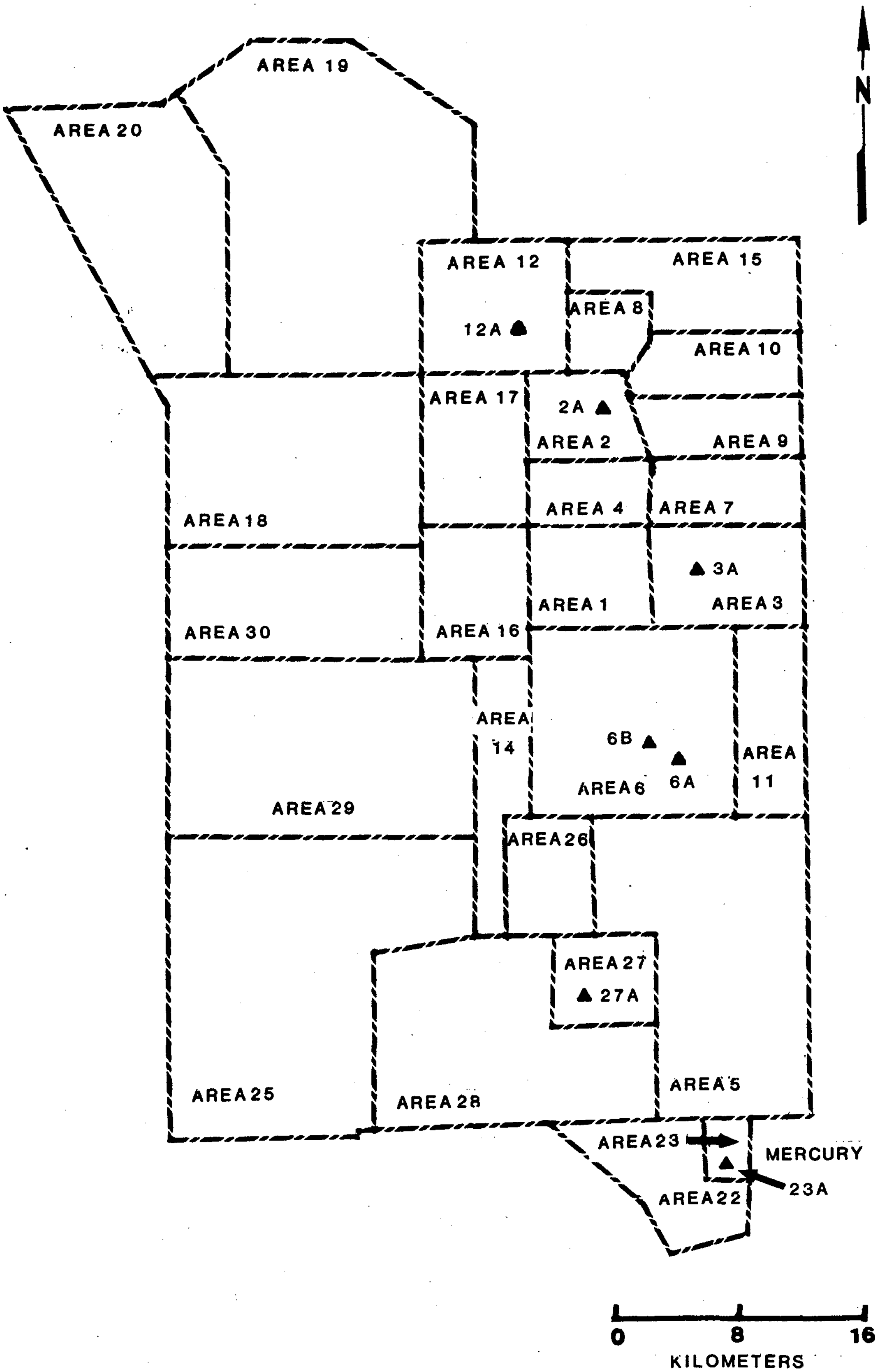
2. Potable Water

As a check on any effect the water distribution system might have on end use activity, eight consumption points were sampled during the reporting period. The location of each station is shown in Figure 4.

Appendix C consists of plots for all stations of the measured gross beta activity with 2σ error bars. An averaging plot is included which shows the trend of the mean of the network throughout the reporting period. The range at each point is also given. Table 6 includes a list of the averages for each location. The highest average recorded was 1.6×10^{-8} μCi/ml at the Area 6 cafeteria during FY-1977. This is 5.3 percent of the CG assuming ^{90}Sr to be the most radiotoxic beta emitter present. The lowest gross activity, excluding Cascade bottled water, was 3.4×10^{-9} μCi/ml at the Area 2 restroom during FY-1977. The Cascade water is demineralized water brought in from offsite and is used as a check of the laboratory system. It is listed because the bottles are stored onsite and are consumed by NTS personnel.

Gross beta measurements at these locations demonstrated that no release or movement of radionuclides occurred in the NTS water system throughout

Figure 4. NTS ENVIRONMENTAL SURVEILLANCE POTABLE WATER SAMPLING LOCATIONS



the report period. No trends in the plots are discernible. The arithmetic mean, geometric mean, and central tendencies were within 10 percent of each other except at the Area 23 and 27 cafeteria, which were both supplied by two distinct wells. Table 9 shows the gross beta activities of these potable water stations along with their suppliers. The differences between each pair were small, as expected, and the values for the Area 23 and 27 cafeterias were, approximately, the combination of the activities of Well 5B and Army Well 1. The low gross beta contents of the Area 2 restroom and Area 12 cafeteria can be seen as a direct consequence of the low natural radioactivity in the water from Well 8.

The average at each location showed minimal change (<15 percent), as did the averages of the entire network. These network averages are shown below:

Year	Mean (X 10^{-9} μCi/ml)
July-December 1977	7.8
FY-77	7.3
FY-76	7.4

These values are well below the CG listed in Section E-1. Appendix C also includes plots of the network averages for tritium and plutonium. As in the case of the supply well data, these plots are primarily representations of the detection limits of each analysis system, since over 99 percent of the values were less than the limits. All positive values are listed in Tables 7 and 8. Two stations revealed tritium concentrations above the detection limit more than once during the reporting period. The station in the Groom Lake area was repeatedly exposed to fallout in the days of the atmospheric tests, and the tritium activity could be real. The Cascade water bottles were stored near the decontamination laundry in Area 6 and tritium contamination was a possibility. A more probably explanation was that these were false positives related to counting statistics.

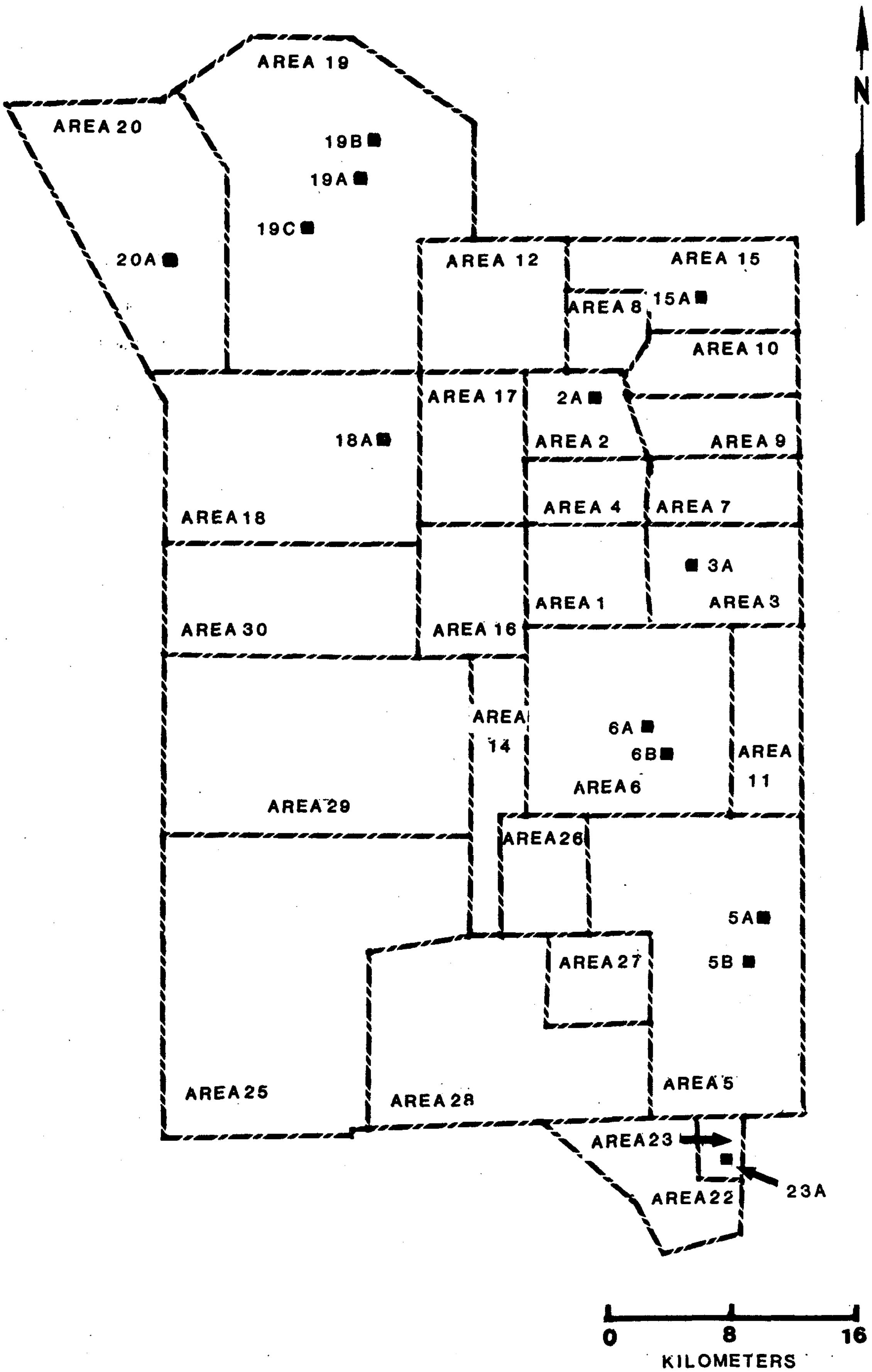
3. Open Reservoirs

Open reservoirs have been established at various locations at the NTS primarily for industrial purposes. Sixteen of these impoundments were sampled during the report period. The locations are shown in Figure 5.

Appendix D consists of the plots of each station of the measured gross beta activity with 2σ error bars. An averaging plot is included which shows the trend of the mean of the network throughout the reporting period. The range at each point is also given. Table 6 includes a list of the averages at each location. The two highest gross beta contents were measured at bodies of water in the Groom Lake area; i.e., the Papoose reservoir and Well 4 reservoir.

Papoose reservoir, which recorded 1.4×10^{-7} µCi/ml during FY-1976, is more properly termed an intermittent desert lake and is not used by man. This area was repeatedly exposed to fallout from early NTS nuclear tests as it was directly in the primary wind patterns; thus, elevated activity would be expected. The lowest gross beta activity appears to be 3.4×10^{-9} µCi/ml at Well Ue19e reservoir during FY-1976.

Figure 5. NTS ENVIRONMENTAL SURVEILLANCE OPEN RESERVOIRS SAMPLING LOCATIONS



The plots of the gross beta activity at these locations showed consistent concentrations throughout the reporting period. Flat trends are seen for the network. The arithmetic mean, geometric means, and central tendencies were within 10 percent of each other. The standard deviation of each data file was higher (over 30 percent) in this system than in the supply wells or drinking water. The larger variation could be caused by real activity changes or, simply, more variable sampling procedures.

Table 10 shows the gross beta activities of the open reservoirs that are supplied by wells, along with the activities of the associated wells. Note that the values are similar, although the reservoirs are consistently higher than the wells. The explanation for this is that these surface waters are open to worldwide fallout and are also more likely to increase in total dissolved solids through evaporation.

The averages at each location, although more variable through time than the other water systems, showed changes usually less than 30 percent through the reporting period. The average for the network for each time period is shown below:

Year	Mean (X 10^{-9} μCi/ml)
July-December 1977	19.4
FY 77	19.6
FY 76	22.0

These values can be compared to the CG listed in Section E-1. Appendix D also includes the plots of the open reservoir network averages for tritium and plutonium. These plots are primarily representations of the detection limits of each system because over 99 percent of the measurements were less than the limits. All positive values are listed in Tables 7 and 8. The values indicate no movement of these radionuclides into this water system.

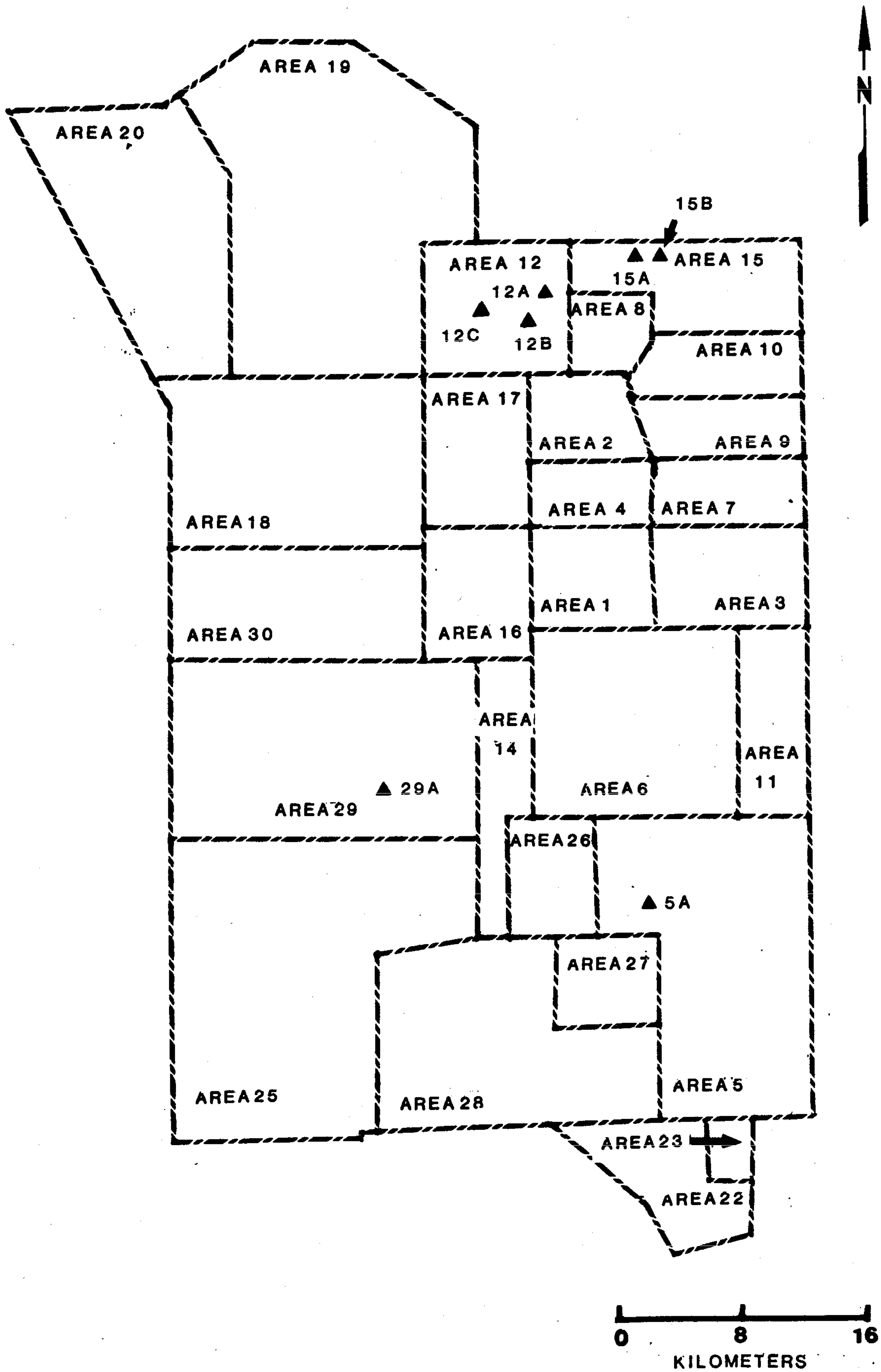
4. Natural Springs

The term "natural springs" was a label given to the spring-supplied pools located within the NTS. Although human consumption is insignificant, wildlife have access to and do use the water. Seven such locations were sampled on a monthly basis and are shown in Figure 6.

Appendix E consists of the plots of all stations of the measured gross beta activity with 2σ error bars. An averaging plot is included which shows the trend of the network mean throughout the reporting period. The range at each point is also given. Table 6 includes a list of the averages at each location. The highest average recorded was 8.4×10^{-8} μCi/ml at Gold Meadows Spring during July-December 1977. This is 28.0 percent of the CG assuming ^{90}Sr to be the most radiotoxic beta emitter present. The lowest beta activity was 5.8×10^{-9} μCi/ml at Oak Butte Spring and Cane Spring during FY-1977.

The most significant gross beta results were found at the Gold Meadows Spring. Highly variable, it is believed that the substantial increases were due to surface runoff of contaminated soils after rains. This region, Area 12, was exposed to fallout from atmospheric tests and the Baneberry release of FY-1971. The other locations showed no significant trends in their plots.

Figure 6. NTS ENVIRONMENTAL SURVEILLANCE NATURAL SPRINGS SAMPLING LOCATIONS



The arithmetic averages at each location varied considerably, but the higher variations were usually due to one or two outliers rather than discernable trends in the data. The network averages are shown below:

Year	Mean (X 10^{-9} µCi/ml)
July-December 1977	24.4
FY-77	15.2
FY-76	14.6

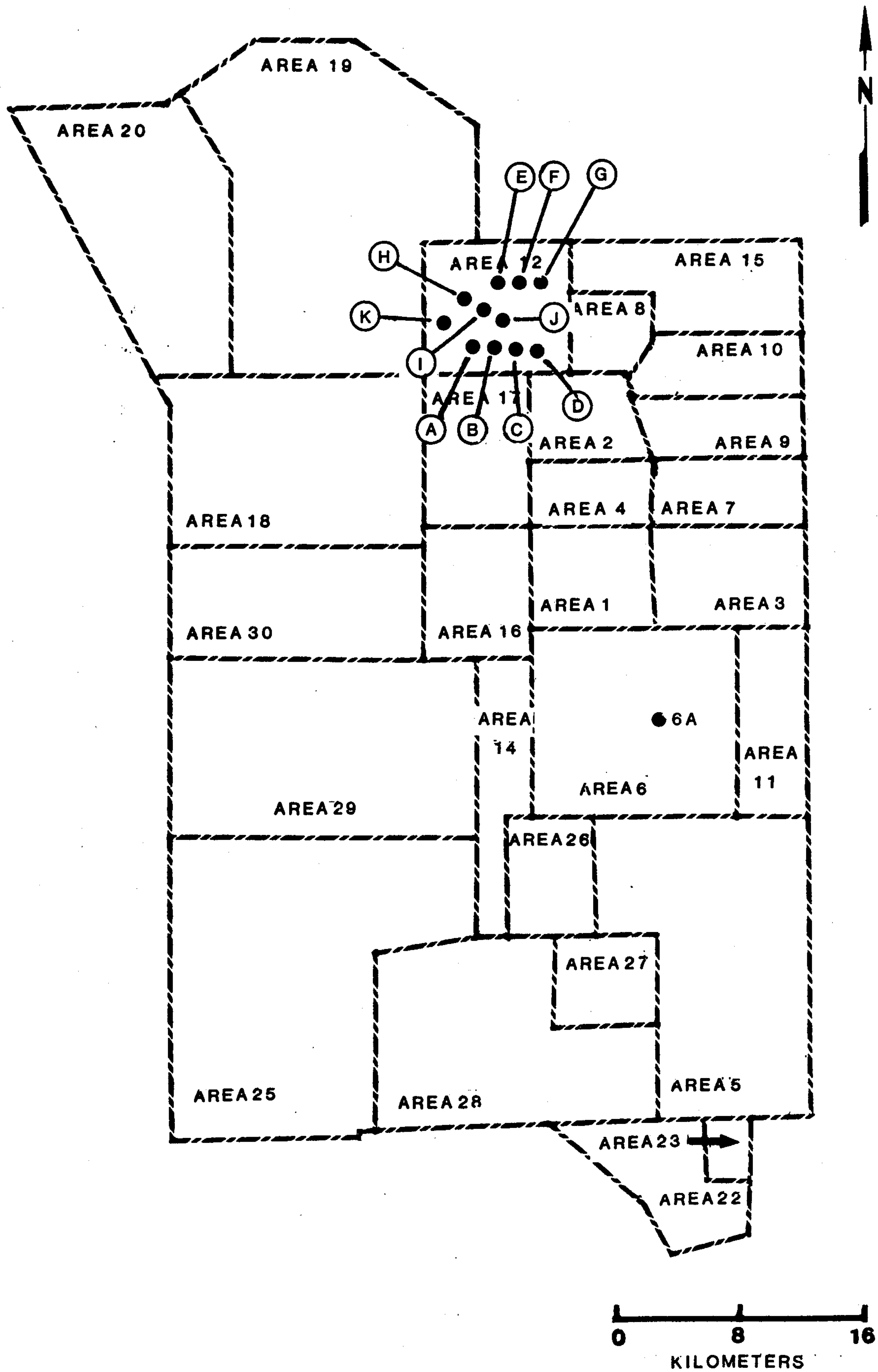
The increase in July-December 1977 was primarily due to the data from the Gold Meadows Spring. Appendix E also includes plots of the network averages for tritium and plutonium. No positive tritium values were found and only one plutonium value was seen above the detection limit (Table 7) during the reporting period. These plots are, therefore, simply representations of the detection limits through time.

5. Contaminated Ponds

Thirteen contaminated ponds are sampled on a monthly basis. The locations are shown in Figure 7. These ponds are impound waters from tunnel test areas, a laboratory waste sump, and a contaminated laundry release point. They are monitored to provide a data base for calculations of any offsite releases, in accordance with DOE Manual 0513. These calculations are reported to DOE Headquarters on an annual basis.

The measured radioactivity of the tunnel ponds corresponds to activities at the tunnels. Seepage from the tunnels and rain will carry contaminated

Figure 7. NTS ENVIRONMENTAL SURVEILLANCE CONTAMINATED PONDS SAMPLING LOCATIONS

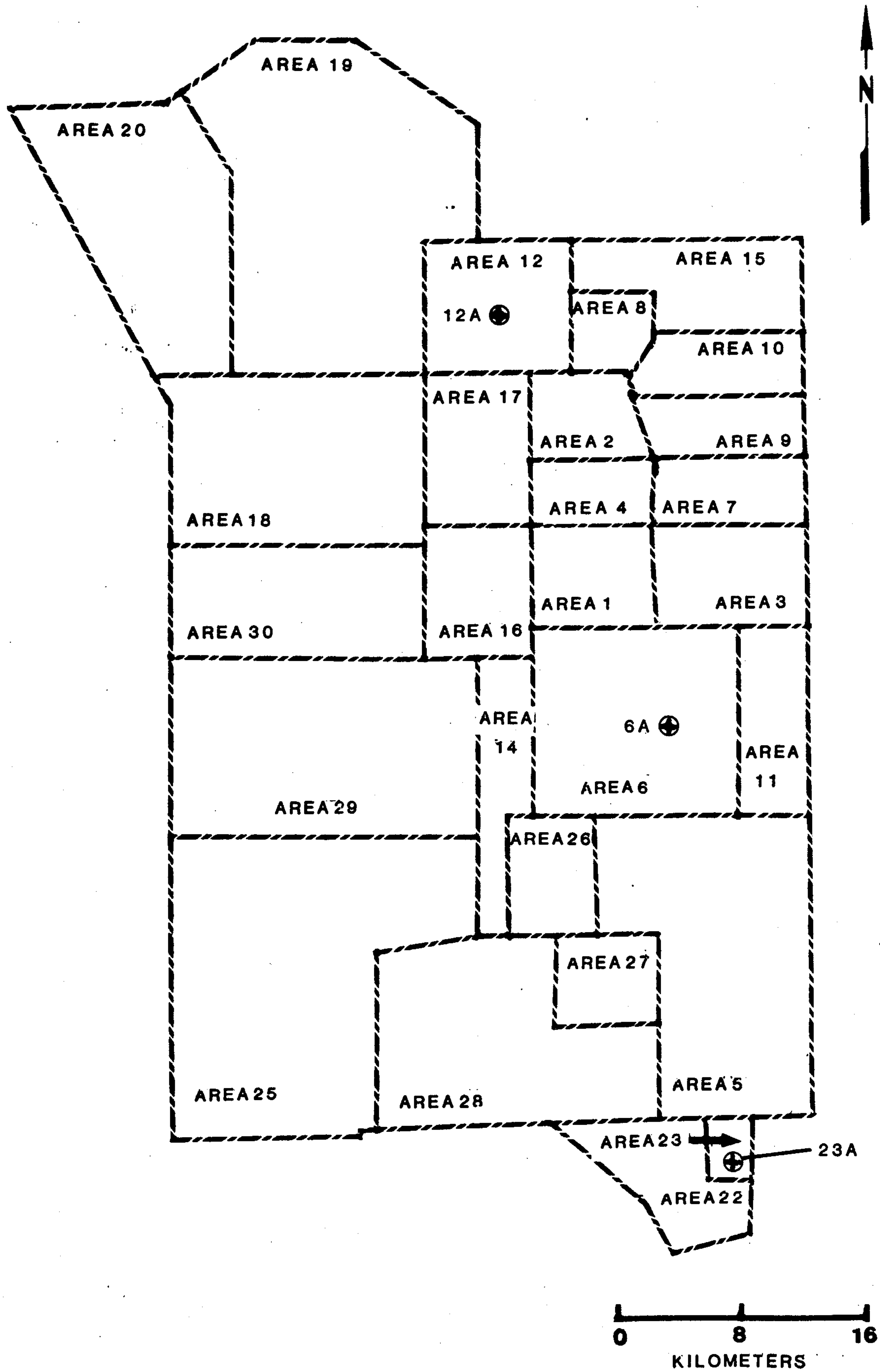


surface water runoff into the ponds causing an increase. Decay of the isotopes in the water will lower the levels, as will any settling in the water. The principal radionuclides detected in the ponds were ^{137}Cs and ^{3}H. Table 11 is a list of the gross beta averages at each location. The plots of Appendix F show the trends of gross beta, plutonium, and tritium. The tritium values in these ponds have not varied much over this reporting period, owing to its long half-life (12.3 years) and containment in water.

6. Effluent Ponds

The four effluent pond sampling locations are shown in Figure 8. These ponds are closed systems which contain both sanitary and radioactive waste for evaporative treatment. Contact with the working population is minimal. The results of the plutonium analyses were all negative.

Figure 8. NTS ENVIRONMENTAL SURVEILLANCE EFFLUENT PONDS SAMPLING LOCATIONS

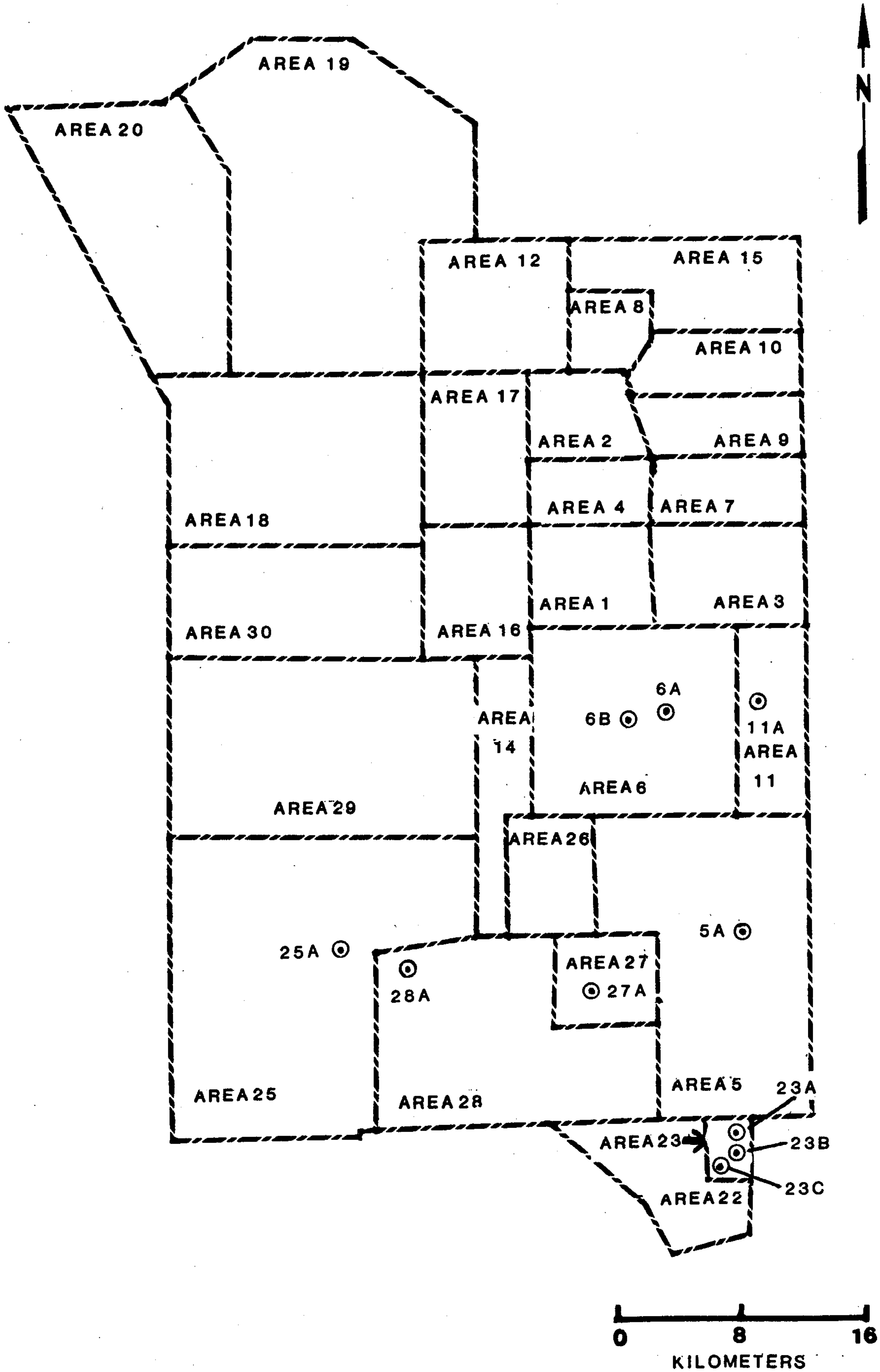


F. AMBIENT GAMMA MONITORING

An ambient gamma monitoring program has been established on the NTS in 1977 using thermoluminescent dosimeters. Ten locations coinciding with air sampling stations were chosen as a preliminary test network (Figure 9). These sites were selected because of their proximity to workers, likelihood of low levels of radiation, and ease of exchange by the field monitor in one day. This led to the use of this small network as a group of control-type stations. This standard network would do the following: (1) detect gamma exposures in excess of natural background whether the excesses are from NTS testing, foreign testing, or other; (2) be a comparison with high-level radioactive stations, such as RADEX areas, which were added later; and (3) be used as a quality control on the TLD equipment.

The dosimeters used are CaF_2:Dy (TLD-200) 1/4" X 1/4" X 0.035" chips from Harshaw Chemical Company. A badge consisting of at least two chips shielded by 0.047"Cd (1030 mg/cm^2) inside a 0.050" black plastic (140 mg/cm^2) holder is placed about one meter above the ground at each location. The dosimeters will detect gamma radiation above an energy cutoff of approximately 70 keV. The known systematic errors of the dosimeter in this application are the minimized detection of lower energy photons and fade of the phosphor's stored energy with time. Previous research indicates that only about 6 percent of the natural radiation background is below 100 keV. For this system, then, a 5 percent increase in the measured value may be appropriate in field determinations. In locations where the spectrum may differ appreciably in the lower energy range, LiF TLD's can be used in conjunction with the CaF_2:Dy TLD's.

Figure 9. NTS AMBIENT GAMMA MONITORING LOCATIONS



These dosimeters, although not preferable for environmental applications because of their low sensitivity, do provide a secondary system that can detect the lower energy photons (the energy response curve is flat to about 10 keV).

Fade in TLD-200 is high when used in elevated temperatures such as the NTS environs. This loss of the phosphor's stored energy is minimized both physically and analytically. After exposure and before readout, the chips are annealed at 115°C for 15 minutes to reduce the high-fade, low temperature traps. Calibration TLD's are stored in a lead pig in order to empirically determine the value of this minimized face (usually less than 10 percent).

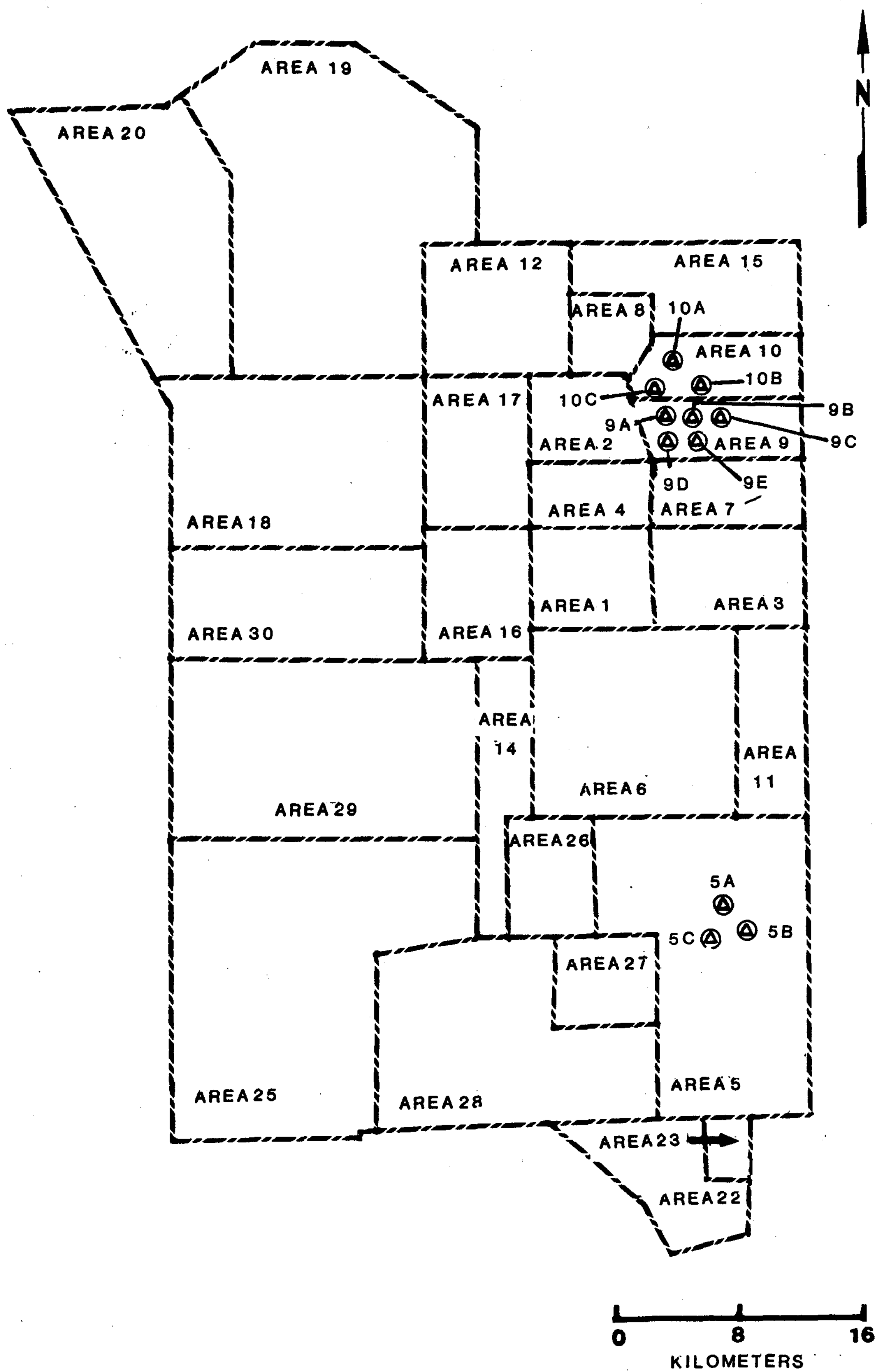
Random errors include dosimeter variance, source calibration, and transit exposure. One method of error analysis is contained in a paper by Burke and Gesell, "Error Analysis of Environmental Radiation Measurements Made with Integrating Detectors," NBS Special Publication 456, pp. 187-198, (1976). For our purposes, a less rigid statistical evaluation is sufficient at this time (Table 14). All analyses will be evaluated as to their compliance with ANSI N545-1975,"American National Standard Performance, Testing, and Procedural Specification for Thermoluminescent Dosimetry (Environmental Applications)."

The data from the first six field cycles are presented in Table 12. Stations 5 and 6, and Stations 8 and 9 are located in the same general area. This was done to check whether or not there were wide variations in exposure rates over small distances throughout the NTS; and, if not, the data would be a duplicate sampling program. The differences between each pair were all less than five percent. Station 3 will not be used in any statistical evaluation because it was found not to be an environmental station (source storage). The remaining nine stations indicate background radiation rates that are comparable to off-site Nevada values; i.e., a range of 0.14 mR/day to 0.40 mR/day.

The data indicates a very precise system. The accuracy of this system was evaluated upon review of results from the Third International Intercomparison of Environmental Dosimeters. This study indicated that the NTS measurements may be systematically low by about ten percent, and this correction is being considered. The variation of the measured values at a single location would suggest that the detection limit of an exposure in excess of natural background would be less than 5 mR in a month-long field cycle. Using the network average as a statistic, an exposure even closer to 1 mR could be detected if it were common to all locations. The nine-station average for each field cycle was 0.246, 0.253, 0.252, 0.277, 0.264, and 0.276 mR/day. Fallout from a foreign atmospheric test reached this area during the fourth field cycle (see Section D). The measured increase in penetrating gamma radiation over the last three cycles may be due to this, but the data is inconclusive; at maximum, the total excess exposure would be less than 2 mR in over 100 days.

Other locations at the NTS were sampled during this reporting period. (Figure 10). The results compiled to date are listed in Table 13. Primary expansion of the gamma monitoring program will be in these areas of elevated exposure rates.

Figure 10. NTS ELEVATED BACKGROUND GAMMA MONITORING LOCATIONS



G. BIBLIOGRAPHY

ANSI N545-1975, *American National Standard; performance, testing and procedural specifications for thermoluminescence dosimetry (environmental applications)*, American National Standards Institute, Inc., New York, New York, 1975.

Burke, Gail De Planque, Thomas F. Gesell and Klaus Becker. "Second International Intercomparison of Environmental Dosimeters under Field and Laboratory Conditions." Paper presented to Tenth Midyear Topical Symposium of the Health Physics Society at Saratoga Springs, New York, October 11-13, 1976. Published by Rensselaer Polytechnic Institute, Troy, New York, pp 555-574.

EMSL-LV-0539-12, *Off-site Environmental Monitoring Report for the Nevada Test Site and Other Test Areas Used for Underground Detonations, January through December, 1976*, Environmental Protection Agency, Las Vegas, Nevada, 1977.

ERDA 77-24, *A Guide for Environmental Radiological Surveillance at ERDA Installations*, Battelle Pacific Northwest Laboratories, Richland, Washington, 1977.

ERDA-1551, *Final Environmental Impact Statement, Nevada Test Site, Nye County, Nevada*, Environmental Research and Development Administration, 1977.

LA-6321-MS, *Environmental Surveillance at Los Alamos during 1975*, Los Alamos Scientific Laboratory, Los Alamos, New Mexico, 1976

Lantz, Michael W., NVO-410-39, *Environmental Surveillance Report for the Nevada Test Site July 1970 through June 1976*, Reynolds Electrical and Engineering Co., Inc., Las Vegas, Nevada, 1978.

NCRP Report No. 50, Environmental Radiation Measurements, National Council on Radiation Protection and Measurements, Washington, D. C., 1976.

Roy, Terry C., *OnSite Environmental Sciences Activities during the Baneberry Event*, NVO-410-29, Reynolds Electrical and Engineering Co., Inc., Las Vegas, Nevada, 1973.

Standard Methods for the Examination of Water and Wastewater, 14th Edition Edited by Arnold E. Greenberg et al, American Public Health Association, Washington, D. C., 1975.

Table 1

SUMMARY OF ENVIRONMENTAL PROGRAM

Sample Type	Description	Collection Frequency	Number of Samples	Analysis
Air	Continuous sampling through Whatman GF/A glass filter and a charcoal cartridge.	Weekly	22	Gamma spectroscopy, gross beta, plutonium (monthly composite)
	Low-volume sampling through a desiccant.	Weekly	2	HT-HTO
Drinking water	2-liter grab sample.	Weekly	8	Gross gamma, gross beta, plutonium (quarterly)
Well water Surface water	2-liter grab sample.	Monthly	51	Gross gamma, gamma spectroscopy*, gross beta, plutonium (quarterly)
Effluent ponds	2-liter sample	Quarterly	4	Plutonium
External gamma radiation levels	CaF_2:Dy and LiF Thermoluminescent Dosimeters	Monthly	21	Total integrated exposure over field cycle

*If gross gamma measurement is above a predetermined level.

Table 2

LABORATORY ANALYTICAL PROCEDURES

Type of Analysis	Type of Sample	Analytical Equipment	Counting Period (Min.)	Analytical Procedures	Sample Size	Detection Limit
Gross Beta	Air	Wide Beta II	20	Place filter on a 5-inch stainless steel planchet	10^9 cc	1 X 10^{-16} µCi/cc
	Water	Wide Beta II	20	Evaporate, transfer residue to a 5-inch stainless steel planchet	1000 ml	1 X 10^{-9} µCi/ml
Gross Gamma	Water	9" X 9" NaI Well crystal	20	Aliquot sample into Nalgene bottle	500 ml	6 X 10^{-8} Ci/ml
Gamma Spectroscopy	Air (particulate)	Ge(Li)	20	Same as beta	10^9 cc	5 X 10^{-15} µCi/cc
	Air (gaseous)	Ge(Li)	20	Place charcoal cartridge in plastic bag	10^9 cc	5 X 10^{-15} µCi/cc
	Water	Ge(Li)	20	Count the planchet after beta analysis	500 ml	1 X 10^{-8} µCi/ml
Tritium	Air	Liquid Scintillation Counter	100	Distill the H_2O and aliquot 5 ml into a scintillation solution	6 X 10^6 cc	3 X 10^{-13} µCi/cc
	Water	Liquid Scintillation Counter	100	Aliquot 5 ml into a scintillation solution	5 ml	4 X 10^{-7} µCi/cc
Plutonium-239	Air	Silicon Semiconductor	333	Filter is ashed and put in solution. Pu is purified by anion exchange resin column, then electrodeposited on a stainless steel disc.	4 X 10^9 cc	2 X 10^{-17} µCi/cc
	Water	Silicon Semiconductor	333	Pu is concentrated with Fe (OH) and purified with anion resin column. Electrodeposited on a stainless steel disc.	1000 ml	1 X 10^{-11} µCi/ml
Direct Gamma Radiation	TLD	Harshaw 2000		Post-anneal at 115°C for 15 minutes. Readout to 270° for 25 seconds.	¼" X ¼" X .035"	5 mR/month

Table 3

AVERAGES OF AIR SURVEILLANCE DATA FOR GROSS BETA

(X 10^{-14} μCi/cc)

Station	1976	1977	July-December 1977
Area 1 Gravel Pit	2.4	16.6	45.6
Area 2 Compound	2.2	16.6	39.4
Area 3 Cafeteria	2.5	16.0	45.1
Area 5 Maintenance Complex	2.8	22.7	54.1
Area 5 Well 5B	3.1	18.1	49.0
Area 6 Yucca Complex	3.5	18.5	49.4
Area 6 CP-2 Complex	2.7	14.1	29.0
Area 6 Well 3 Complex	2.7	17.0	44.3
Area 9 9-300 Bunker	2.6	15.7	45.4
Area 10 Gate 700	1.9	12.3	35.6
Area 11 Gate 293	2.4	16.4	33.2
Area 12 Change House	2.4	16.2	50.1
Area 16 Tunnel Maintenance	2.5	19.0	40.3
Area 19 Echo Peak	2.1	15.7	47.8
Area 19 PM Substation	2.4	17.9	52.6
Area 20 Dispensary	2.4	19.8	--
Area 23 CETO	2.6	16.8	44.5
Area 23 H&N Building	2.3	17.5	48.3
Area 25 Warehouse	2.3	16.8	22.0
Area 27 Dispensary	2.2	14.1	26.3
Area 28 Henre Site	2.5	19.4	42.7
Groom Lake Cafeteria	1.9	12.1	35.0

Table 4

AVERAGES OF AIR SURVEILLANCE DATA FOR PLUTONIUM

($X 10^{-17}$ μCi/cc)

Station	1976	1977	July-December 1977
Area 1 Gravel Pit	3.4	2.7	3.5
Area 2 Compound	2.0	6.5	0.6
Area 3 Cafeteria	11.6	25.5	0.7
Area 3 Maintenance Complex	2.2	2.9	2.6
Area 5 Well 5B	1.6	3.8	0.3
Area 6 Yucca Complex	6.4	6.5	1.0
Area 6 CP-2 Complex	4.3	4.8	1.9
Area 6 Well 3 Complex	6.9	5.3	1.1
Area 9 9-900 Bunker	33.8	25.3	6.3
Area 10 Gate 700	4.1	4.6	0.7
Area 11 Gate 293	3.0	12.1	20.5
Area 12 Change House	3.3	2.1	1.2
Area 16 Tunnel Maintenance	1.8	2.6	11.1
Area 19 Echo Peak	1.3	2.3	1.4
Area 19 PM Substation	1.5	2.3	1.7
Area 20 Dispensary	20.0	5.2	--
Area 23 CETO	9.6	2.9	0.9
Area 23 H&N Building	2.7	2.5	1.1
Area 25 Warehouse	3.0	3.3	0.9
Area 27 Dispensary	3.1	3.1	0.6
Area 28 Henre Site	1.4	7.0	0.9
Groom Lake Cafeteria	3.4	4.4	1.0

Table 5

RESULTS OF TRITIUM IN AIR

(µCi/cc)

Building 650 (Mercury)

Period	HTO	HT
09/23/77 - 09/30/77	2.5E-11	1.8E-12
09/30/77 - 10/06/77	5.2E-12	4.3E-12
10/06/77 - 10/13/77	<3.0E-13	<3.2E-13
10/13/77 - 10/21/77	<3.2E-13	<3.2E-13
10/21/77 - 10/31/77	3.9E-12	4.9E-12
10/31/77 - 11/09/77	<3.0E-13	<3.1E-13
11/09/77 - 11/23/77	3.2E-12	<3.0E-13
11/23/77 - 12/07/77	6.0E-12	<3.0E-13
12/07/77 - 12/16/77	6.2E-12	<3.0E-13
12/16/77 - 12/23/77	<2.8E-13	<3.0E-13
12/23/77 - 12/30/77	<2.9E-13	<3.0E-13

Sedan Crater (Area 10)

Period	HTO	HT
10/05/77 - 10/14/77	3.0E-10	<3.0E-13
10/14/77 - 10/25/77	1.6E-10	<3.4E-13
10/25/77 - 10/31/77	No data - lost in process	
10/31/77 - 11/10/77	4.4E-11	<3.0E-13
11/10/77 - 11/23/77	6.5E-11	<3.3E-13
11/23/77 - 12/07/77	5.3E-11	<3.2E-13
12/07/77 - 12/16/77	2.8E-11	<3.1E-13
12/16/77 - 11/30/77	No data - battery dead	

Table 6

AVERAGES OF WATER SUPPLY DATA FOR GROSS BETA

($X\ 10^{-9}\ \mu Ci/ml$)

Supply Wells	1976	1977	July-December 1977
Area 2 Well 2	6.9	6.9	6.9
Area 3 Well A	9.7	9.9	10.7
Area 5 Well 5B	13.0	13.5	14.5
Area 5 Well 5C	7.7	7.6	8.4
Area 5 Well Ue5c	--	7.9	8.2
Area 6 Well C	16.3	16.6	18.2
Area 6 Well C1	15.9	16.4	18.3
Area 15 Well Ue15d	18.0	17.5	17.2
Area 18 Well 8	4.3	3.5	3.0
Area 19 Well Ue19gs	3.0	--	--
Area 19 Well Ue19e	2.2	--	--
Area 19 Well U19c	1.9	2.0	1.7
Area 20 Well U20a	2.5	--	--
Area 22 Army Well #1	6.4	6.0	6.9
Area 25 Well J13	5.2	6.7	5.2
Groom Lake Well 3	7.3	6.9	8.0
Groom Lake Well 4	24.6	24.5	27.8
Potable Water			
Area 2 Rest Room	3.5	3.4	3.7
Area 3 Cafeteria	9.5	10.0	10.6
Area 6 Cascade	1.3	1.3	1.3
Area 6 Cafeteria	15.6	15.9	15.1
Area 12 Cafeteria	3.7	3.7	3.9
Area 23 Cafeteria	9.0	8.8	9.3
Area 27 Cafeteria	9.4	7.9	10.7
Groom Lake Cafeteria	7.6	7.4	8.2

Supply Wells	1976	1977	July-December 1977
Open Reservoirs			
Area 2 Well 2 Reservoir	8.6	7.0	7.8
Area 3 Well A Reservoir	11.8	11.0	12.1
Area 5 Well 5B Reservoir	15.2	13.9	13.5
Area 5 Well Ue5c Reservoir	--	9.4	9.0
Area 6 Well 3 Reservoir	17.4	17.3	15.4
Area 6 Well C1 Reservoir	16.3	17.8	17.0
Area 15 Well Ue15d Reservoir	17.6	17.2	19.5
Area 18 Camp 17 Reservoir	4.2	5.2	4.1
Area 19 Well Ue19gs Reservoir	3.7	--	--
Area 19 Well Ue19e Reservoir	3.4	--	---
Area 19 Well U19c Reservoir	3.6	6.5	10.8
Area 20 Well U20a Reservoir	5.3	--	--
Area 23 Swimming Pool	36.2	29.9	24.4
Groom Lake Well 4 Reservoir	40.8	39.0	38.5
Groom Lake Papoose Reservoir	138.0	72.9	72.2
Groom Lake Swimming Reservoir	8.1	7.8	8.2
Natural Springs			
Area 5 Cane Spring	7.6	5.8	9.7
Area 12 White Rock Spring	14.5	16.8	18.1
Area 12 Captain Jack Spring	14.6	15.3	22.0
Area 12 Gold Meadows Ponds	37.1	41.7	84.1
Area 15 Oak Butte Spring	8.1	6.2	6.2
Area 15 Tub Spring	6.7	5.8	6.0
Area 29 Topopah Spring	13.7	14.6	--

Table 7

PLUTONIUM VALUES ABOVE DETECTION LIMIT FROM WATER SUPPLY DATA

Water Type	Station	Date	µCi/ml
Supply Wells	Area 5 Well 5B	06-06-76	1.1E-10
Open Reservoirs	Groom Lake Papoose Reservoir	03-21-77	6.2E-11
Natural Springs	Area 12 Captain Jack Spring	09-29-76	7.0E-11

Table 8

TRITIUM VALUES ABOVE DETECTION LIMITS FROM WATER SUPPLY DATA

Water Type	Station	Date	µCi/ml
Supply Wells	Area 3 Well A	09-02-75	2.6E-06
Supply Wells	Area 5 Well 5B	11-08-75	4.4E-07
Supply Wells	Area 15 Well Ue15d	11-13-75	5.8E-07
Supply Wells	Area 18 Well 8	06-03-76	3.6E-07
Supply Wells	Area 19 Well Ue 19gs	09-02-75	4.6E-06
Supply Wells	Area 20 Well U20a	09-02-75	2.6E-06
Supply Wells	Area 25 Well J13	11-09-75	5.0E-07
Supply Wells	Area 19 Well U19c	06-03-76	4.7E-07
Potable Water	Area 2 Rest Room	08-30-76	3.0E-07
Potable Water	Area 6 Cascade	09-08-75	8.3E-07
Potable Water	Area 6 Cascade	04-18-77	6.7E-07
Potable Water	Area 6 Cascade	06-06-77	4.1E-07
Potable Water	Area 27 Cafeteria	06-28-77	6.0E-07
Potable Water	Groom Lake Cafeteria	08-18-75	9.5E-06
Potable Water	Groom Lake Cafeteria	11-10-75	4.2E-06
Potable Water	Groom Lake Cafeteria	08-23-76	4.2E-07
Open Reservoirs	Area 3 Well A Reservoir	11-14-75	1.1E-06
Open Reservoirs	Area 5 Well 5B Reservoir	06-03-75	5.7E-07
Open Reservoirs	Area 5 Well 5B Reservoir	07-02-75	4.2E-06
Open Reservoirs	Area 6 Well C1 Reservoir	04-06-75	6.2E-07
Open Reservoirs	Area 15 Well Ue15d Reservoir	03-09-77	4.4E-07
Open Reservoirs	Area 18 Camp 17 Reservoir	09-08-75	9.6E-06
Open Reservoirs	Area 19 Well U19c Reservoir	05-10-76	3.1E-07

Table 9

COMPARISON OF END USE AND SUPPLY WATER FOR GROSS BETA AVERAGES

(X 10^{-9} μCi/ml)

Station (End Use/Supply)	1976	1977	July-December 1977
Area 2 Rest Room	3.7	3.5	3.5
Area 18 Well 8	3.0	3.5	4.3
Area 3 Cafeteria	10.6	10.0	9.5
Area 3 Well A	10.7	9.9	9.7
Area 6 Cascade	1.3	1.3	1.3
Demineralized Bottled Water	--	--	--
Area 6 Cafeteria	15.1	15.9	15.6
Area 6 Well C	18.2	16.6	16.3
Area 12 Cafeteria	3.9	3.7	3.7
Area 18 Well 8	3.0	3.5	4.3
Area 23 Cafeteria	9.3	8.8	9.0
Area 5 Well 5B/Area 22 Army Well 1	14.5/6.9	13.5/6.0	13.0/6.4
Area 27 Cafeteria	10.7	8.0	9.4
Area 5 Well 5B/Area 22 Army Well 1	14.5/6.9	13.5/6.0	13.0/6.4

Table 10

COMPARISON OF OPEN RESERVOIRS AND SUPPLY WATER FOR GROSS BETA AVERAGES

($\times 10^{-9}$ µCi/ml)

Station (Reservoir/Supply)	1976	1977	July-December 1977
Area 2 Well 2 Reservoir	8.6	7.0	7.8
Area 2 Well 2	6.9	6.9	6.9
Area 3 Well A Reservoir	11.8	11.0	12.1
Area 3 Well A	9.7	9.9	10.7
Area 5 Well 5B Reservoir	15.2	13.9	13.5
Area 5 Well 5B	13.0	13.5	14.5
Area 5 Well Ue5c Reservoir	--	9.4	9.0
Area 5 Well Ue5C	--	7.9	8.2
Area 6 Well C1 Reservoir	16.3	17.8	17.0
Area 6 Well C1	15.9	16.4	18.3
Area 15 Well Ue15d Reservoir	17.6	17.2	19.5
Area 15 Well Ue15d	18.0	17.5	17.2
Area 19 Well Ue19gs Reservoir	3.7	--	--
Area 19 Well Ue19gs	3.0	--	--
Groom Lake Well 4 Reservoir	40.8	39.0	38.5
Groom Lake Well 4	24.6	24.5	27.8

Table 11

AVERAGES OF CONTAMINATED PONDS FOR GROSS BETA

(X 10^{-9} μCi/ml)

Station	1976	1977	July-December 1977
Area 12 Haines Upper	327.0	263.0	188.0
Area 12 Haines #2	228.0	316.0	173.0
Area 12 Haines #3	232.0	269.0	129.0
Area 12 Haines Lower	229.0	254.0	151.0
Area 12 Mint Upper	15.5	30.7	44.9
Area 12 Mint Mid	15.4	27.7	25.1
Area 12 Mint Lower	15.5	36.3	50.3
Area 12 N Upper	57.6	175.0	--
Area 12 N Mid	44.8	212.0	--
Area 12 N Lower	42.8	283.0	--
Area 23 H&S Sump	151.0	25.4	129.0
Area 6 Yucca Decontamination Pond	2380.0	622.0	262.0

Table 12

AMBIENT GAMMA MONITORING RESULTS

EXPOSURE RATE (mR/day)*

Location/Area	Name	05/28/77-06/28/77	06/28/77-08/02/77	08/02/77-09/14/77	09/14/77-10/18/77	10/18/77-11/08/77	11/08/77-01/05/78
1/6	CP-6 Complex	0.200	0.201	0.197	0.210	0.209	0.212
2/6	Yucca Complex	0.266	0.279	0.278	0.309	0.295	0.315
3/11	Gate 293	0.515	0.672	0.355	0.407	0.607	0.431
4/5	Well 5B	0.307	0.298	0.294	0.329	0.318	0.344
5/28	Henre Site	0.317	0.338	0.337	0.361	0.339	0.375
6/25	NRDS Warehouse	0.313	0.332	0.335	0.378	0.352	0.368
7/27	Area 27 Cafe	0.338	0.353	0.359	0.398	0.391	0.378
8/23	H&S Roof, Mercury	0.139	0.147	0.147	0.158	0.150	0.160
9/23	NOAA Station, Mercury	0.140	0.145	0.143	0.158	0.152	0.162
10/23	H&S Room 120,** Mercury	0.193	0.183	0.182	0.189	0.183	0.173

* For μR/hr, multiply by $41.\overline{66}$.
** Moved to Room 129 during November 1977.

Table 13

GAMMA MONITORING RESULTS AT ELEVATED BACKGROUND LOCATIONS

EXPOSURE RATE (mR/day)*

Location	Area	Name	10/14/77 - 11/10/77
1	2	Sedan Visitor's Box	0.713
2	2	Sedan by ^{3}H sampler	0.836
3	2	Sedan S. W. peak	4.45
4	5	Waste Storage Area Gate	0.381
5	5	Waste Storage Area Source Trailer	53.5
6	5	Waste Storage Area Fence by ^{3}H barrels	0.366
7	9	9-300 Bunker (E. of air sampler)	0.428
8	9	9-300 Bunker (at air sampler)	0.399
9	9	9-300 Bunker (W. of air sampler)	0.397
10	9	Crater Fence (1/2 mile S. of 9-300 Bunker)	0.333
11	9	Crater Fence (1/4 mile S. of 9-300 Bunker)	0.333

* For μR/hr, multiply by $41.\overline{66}$.

Table 14

GAMMA MONITORING ERROR ANALYSIS

1. Dosimeter Variations

The measured mean of each station's exposure rate is determined by the average of 3 TLD values. The standard deviation is calculated by:

$$\sigma = \sqrt{\frac{\Sigma x^2 - \frac{(\Sigma x)^2}{n}}{n-1}}$$

An average deviation of the network can be found by adding the calculated deviations and dividing by ten.

1st Field Cycle	2nd Field Cycle	3rd Field Cycle	4th Field Cycle	5th Field Cycle	6th Field Cycle	
4.3%	2.2%	2.3%	2.3%	2.9%	2.7%	AVE ≑ 2.8%

2. Source Calibration Error

This is estimated to ± 10 percent.

3. Transit Exposure Error

The TLD's are annealed approximately one day prior to placement in the field and are usually read the same day as collection. Therefore, the transit exposure is on the order of 0.25 mR (estimated from HUS Building and test site exposure rates). The transit exposure may cause a maximum error of four percent on the low side.

4. Energy Response

As discussed in the text, for a general environmental spectrum, five percent increase should minimize this error; estimate ± 2 percent.

5. Fade

Previous research has indicated TLD fade to be field temperature related. For the third, fourth, and fifth field cycles, a fade of nine percent was determined and corrected. The fades for the first and second field cycles were probably higher (summer) and were estimated at 15 percent. The sixth cycle was estimated to be less than five percent. These estimates could be in error by about five percent.

Total Estimated Error (1σ)

$$\sqrt{(3\%)^2 + (10\%)^2 + (4\%)^2 + (2\%)^2 + (5\%)^2} = 12.4\%$$

APPENDIX A

NTS Environmental Surveillance

Air Sampling Locations and Plots

Several symbols are used in Appendix A to denote the data points. In the first plot, the air network averages, a square represents the geometric mean of all values at that point in time, and the vertical line is the range. The notation (a) depicts significant events that perturb the data; i.e., foreign atmospheric tests.

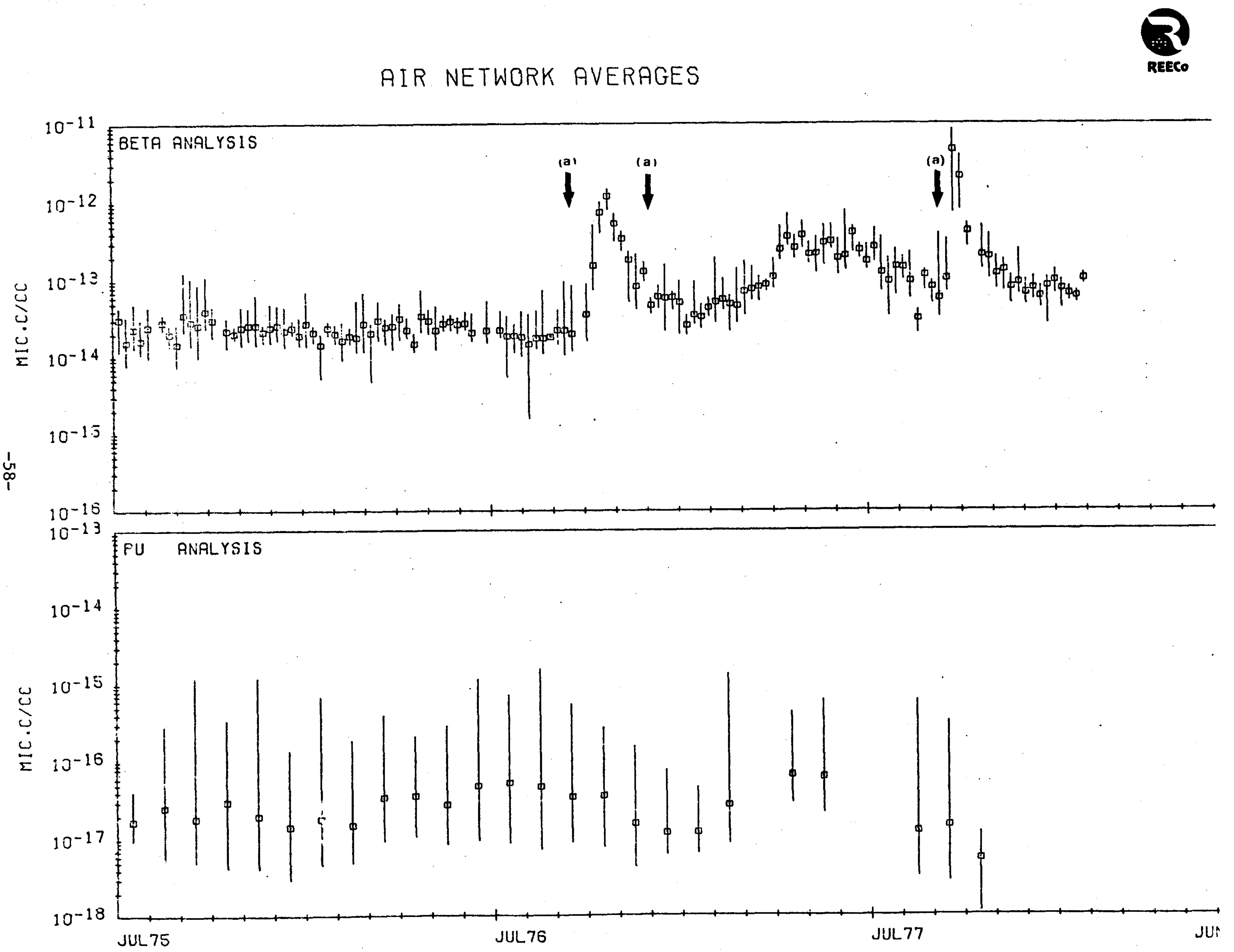
The remaining plots of Appendix A show the gross beta data of each station. The data symbols for the plots are as follows:

Plot #	Symbol
1-4	✖
5-9	◈
10-14	⧗
15-19	○
20-24	★

A two-sigma error bar is also added to the data points, and, in all plots, a delta with the line to the bottom of the plot means below detection limit.

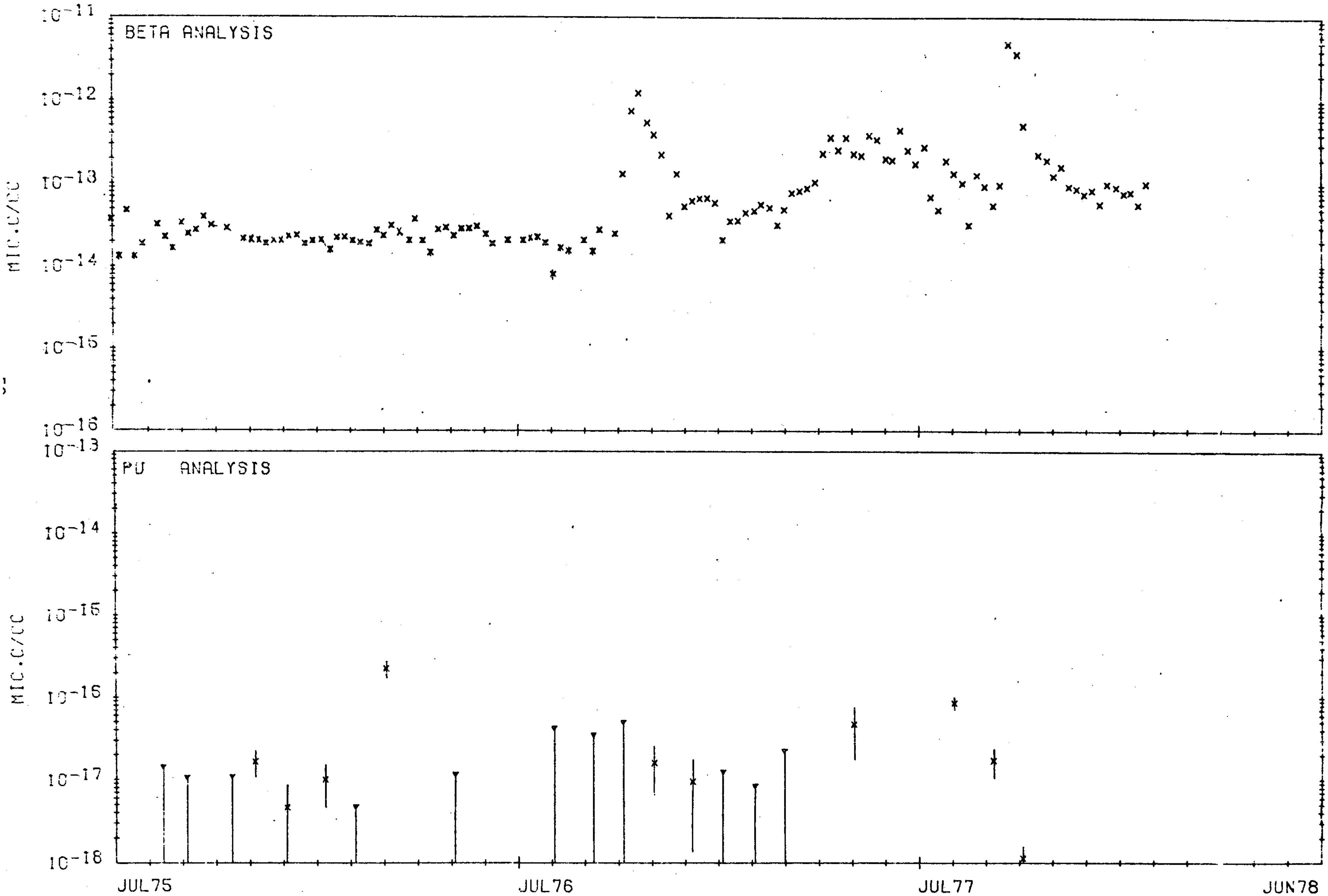
NTS ENVIRONMENTAL SURVEILLANCE AIR SAMPLING LOCATIONS

Number	Location	Map Code (Figure 2)
1	Area 1 Gravel Pit	1A
2	Area 2 Compound	2A
3	Area 3 Cafeteria	3A
4	Area 5 Maintenance Complex	5A
5	Area 5 Well 5B	5B
7	Area 6 Yucca Complex	6A
8	Area 6 CP-2 Complex	6B
9	Area 6 Well 3 Complex	6C
10	Area 9 9-300 Bunker	9A
11	Area 10 Gate 700	10A
12	Area 11 Gate 293	11A
13	Area 12 Changehouse	12A
14	Area 16 Tunnel Maintenance	16A
16	Area 19 Echo Peak	19A
17	Area 19 PM Substation	19B
18	Area 20 Dispensary	20A
19	Area 23 CETO	23A
20	Area 23 H&S Building	23B
21	Area 25	25A
22	Area 27 Dispensary	27A
23	Area 28 Project Henre	28A
24	East of Groom Lake Cafeteria	00A

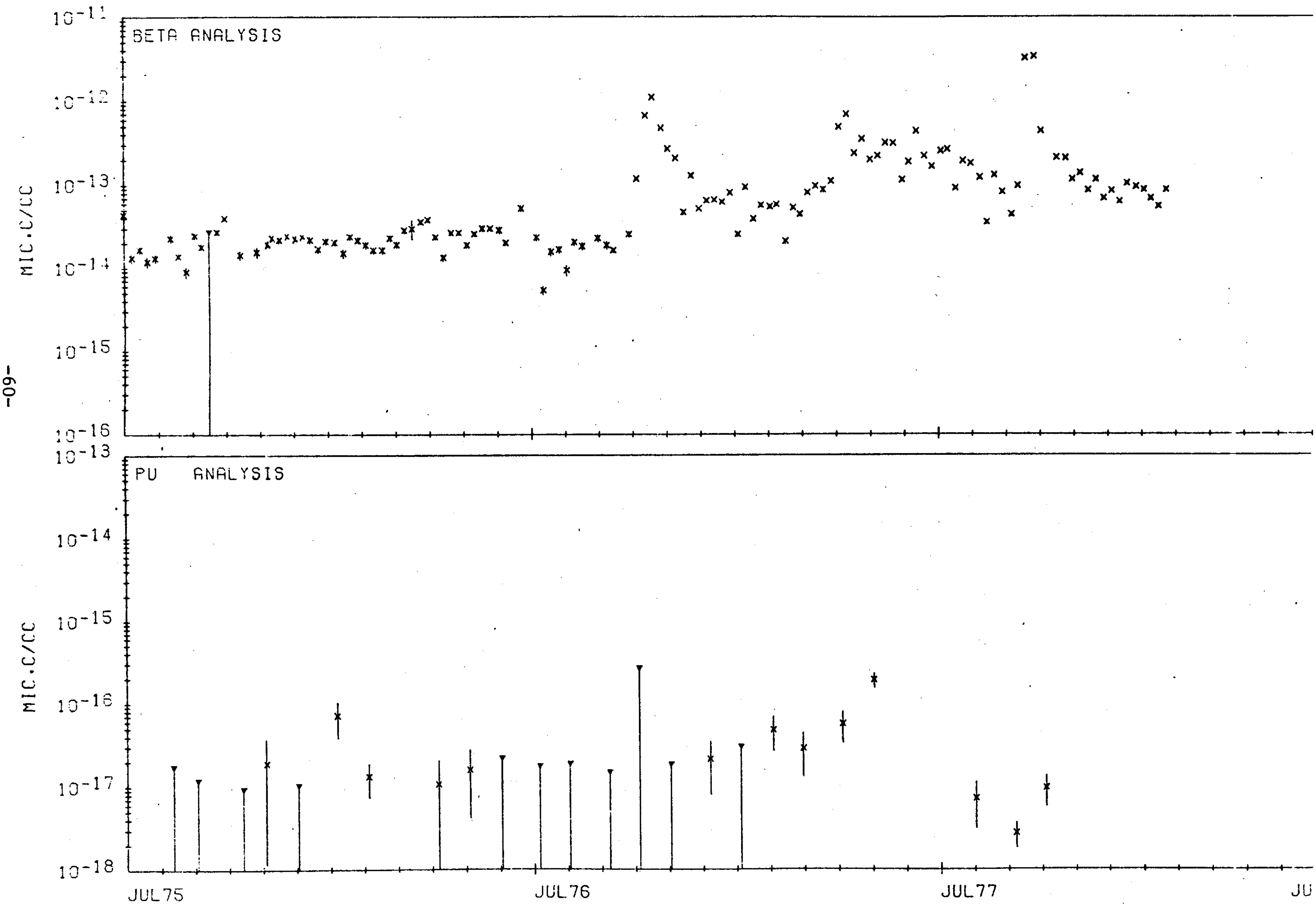


REECo
AIR NETWORK AVERAGES
BETA ANALYSIS
(a)
(a)
(a)
MIC.C/CC
10-11
10-12
10-13
10-14
10-15
10-16
PU ANALYSIS
10-13
10-14
10-15
10-16
10-17
10-18
JUL75
JUL76
JUL77

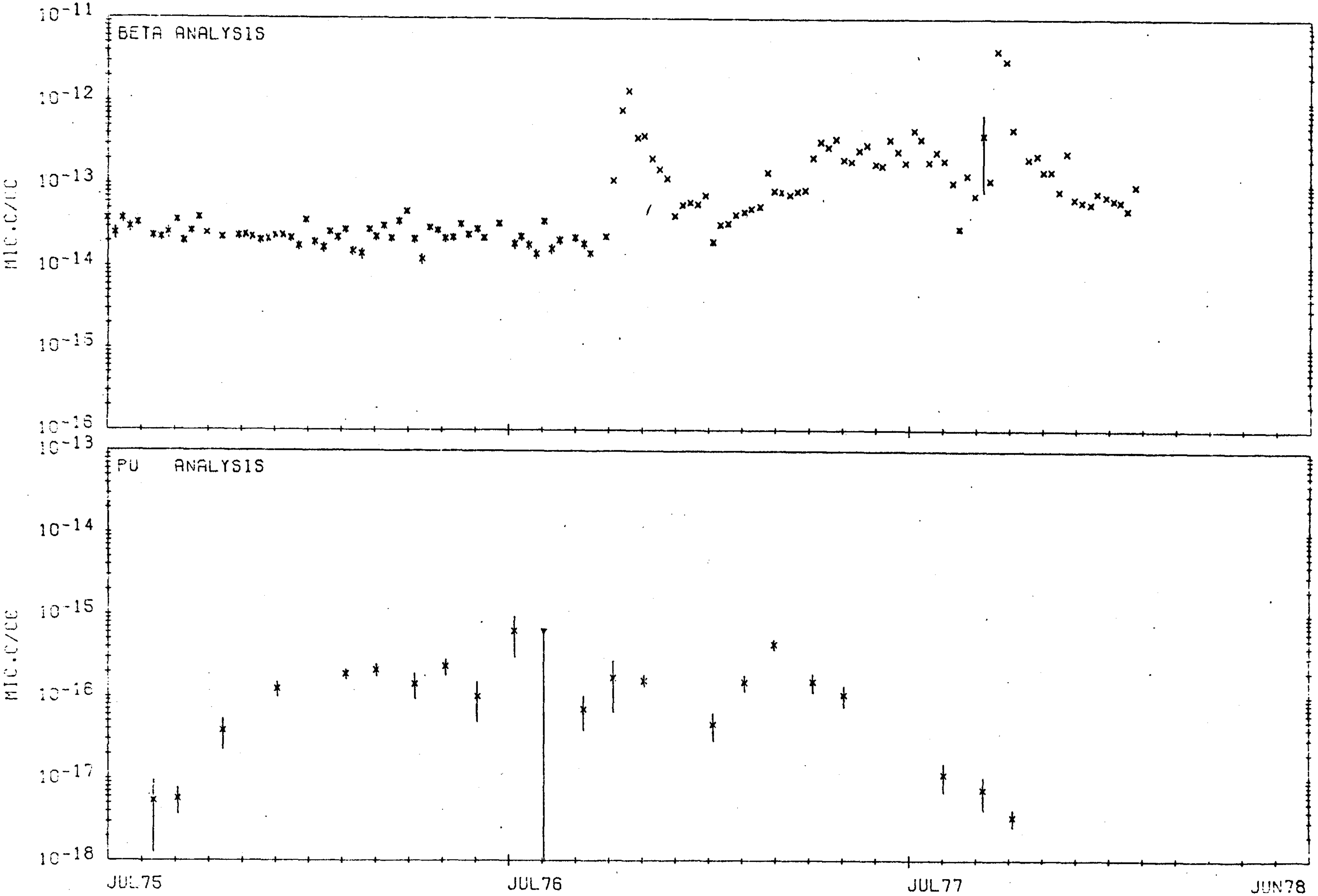
AIR SAMPLING STATION NUMBER 1



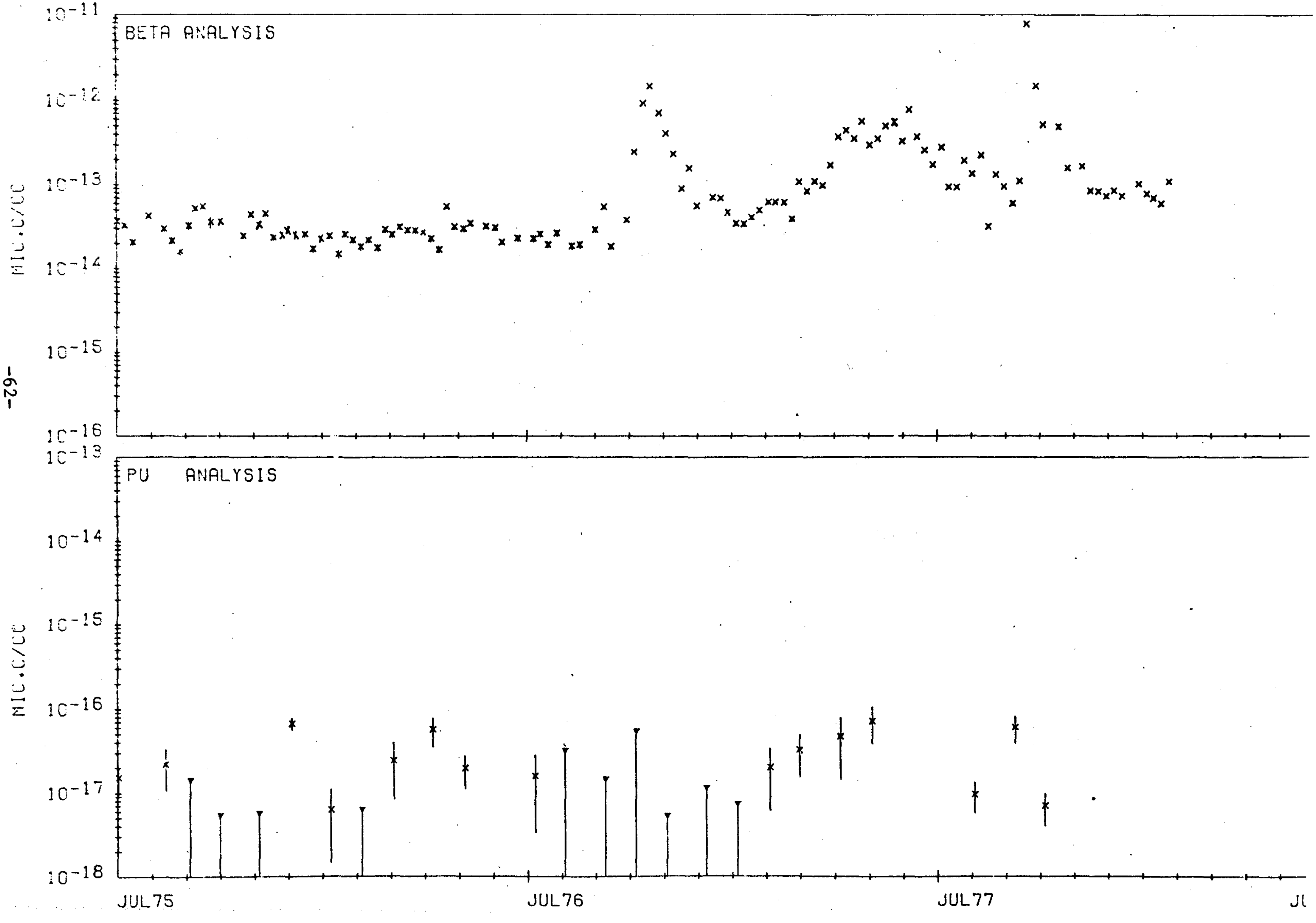
AIR SAMPLING STATION NUMBER 2



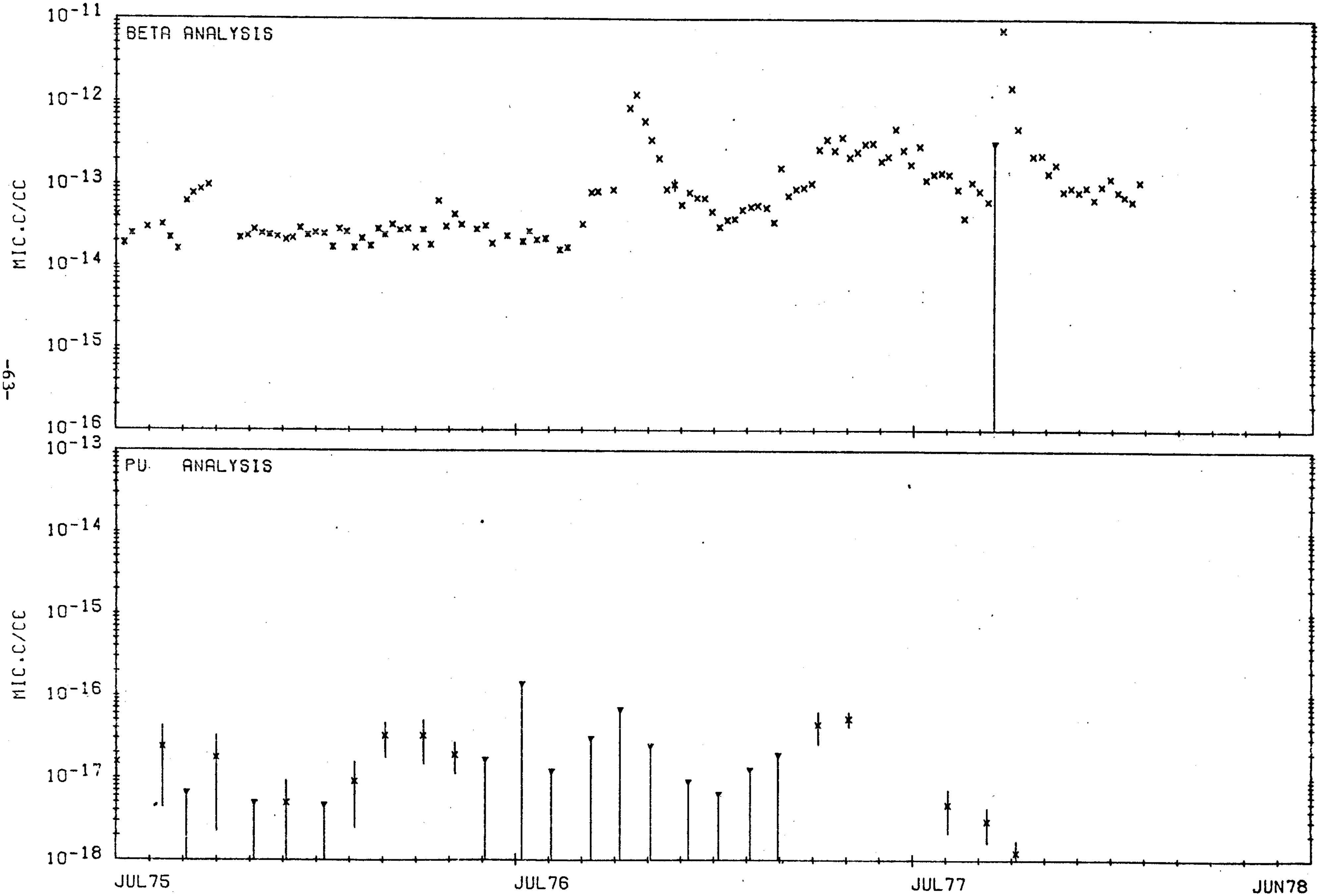
AIR SAMPLING STATION NUMBER 3



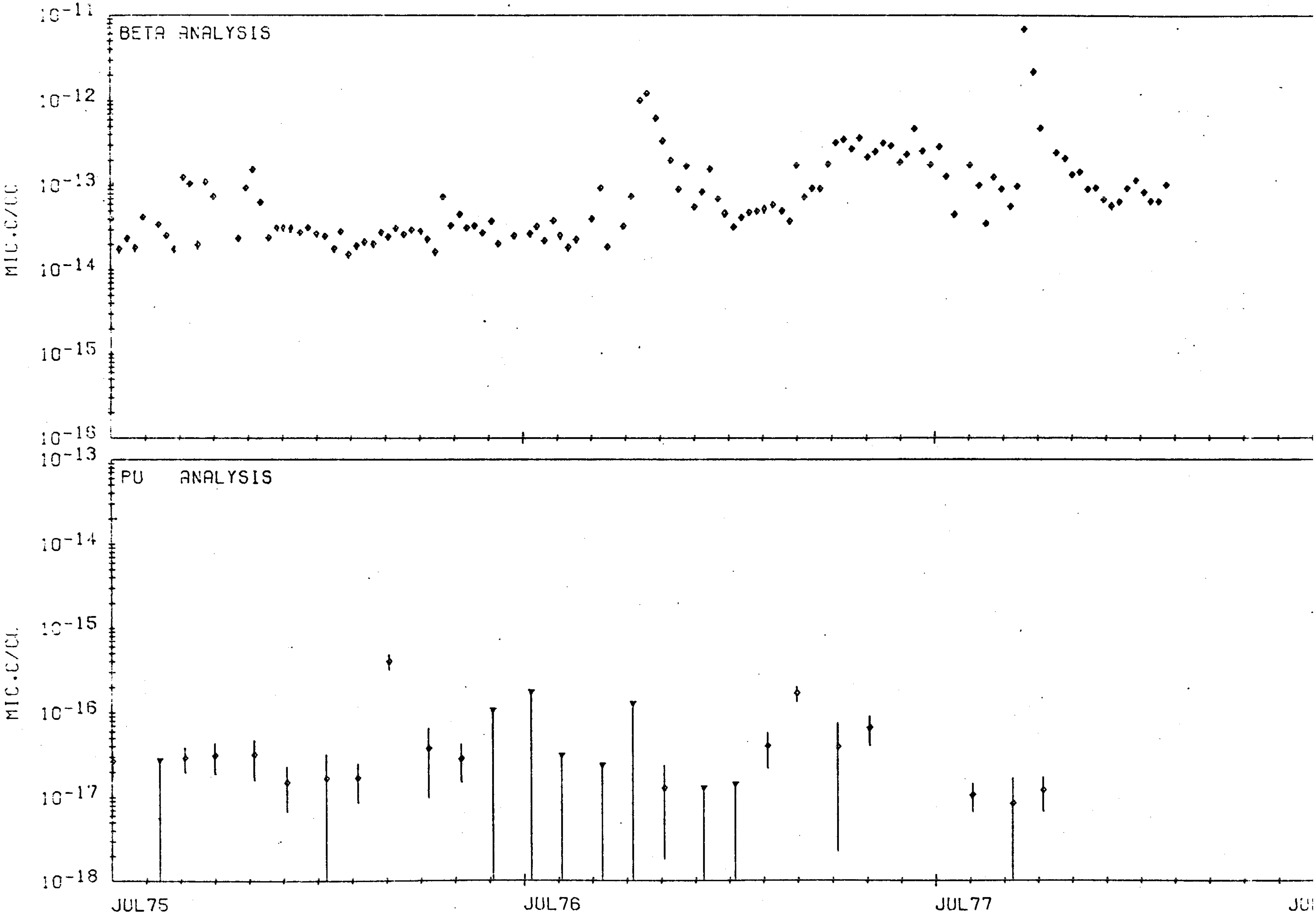
AIR SAMPLING STATION NUMBER 4

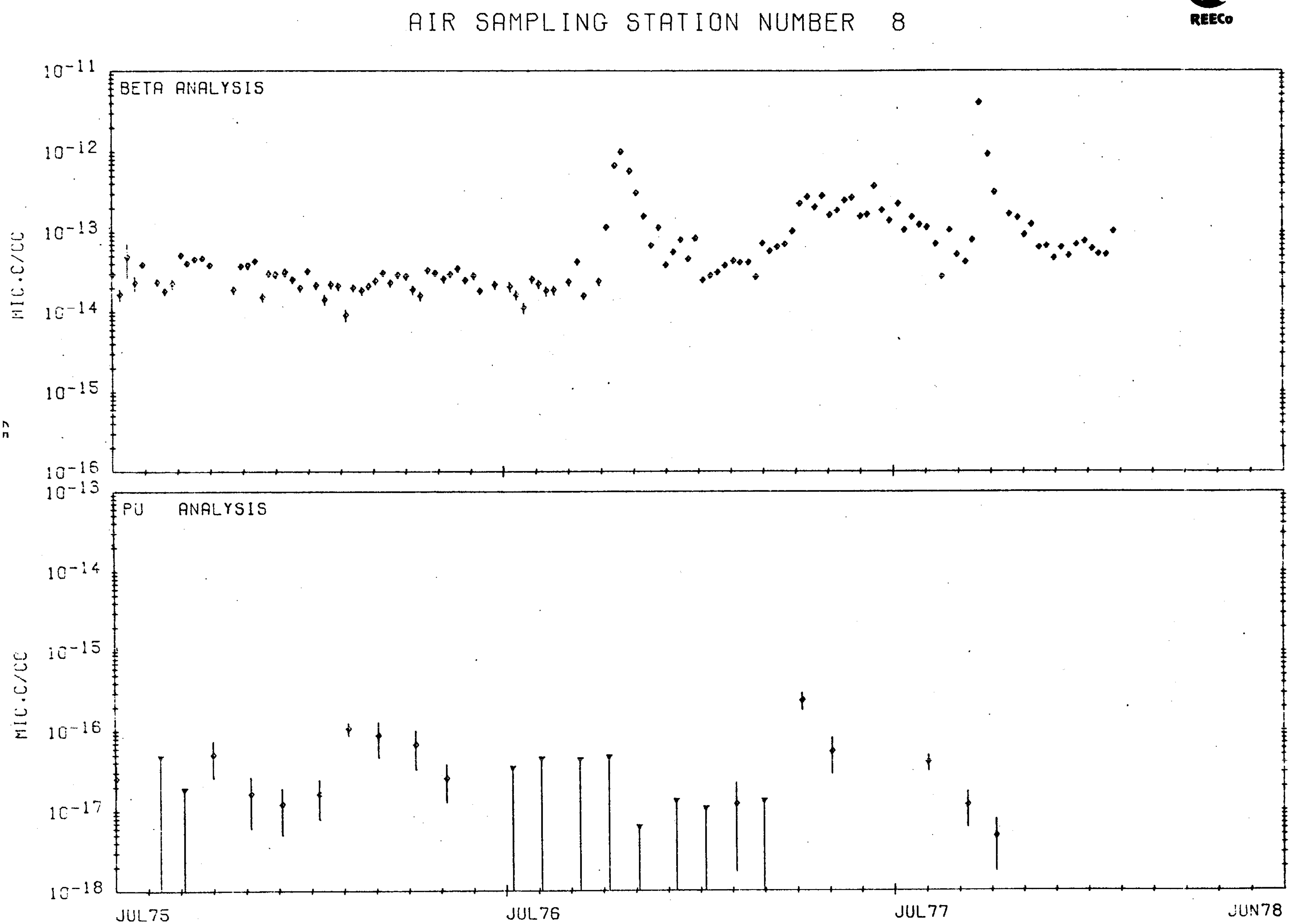


AIR SAMPLING STATION NUMBER 5



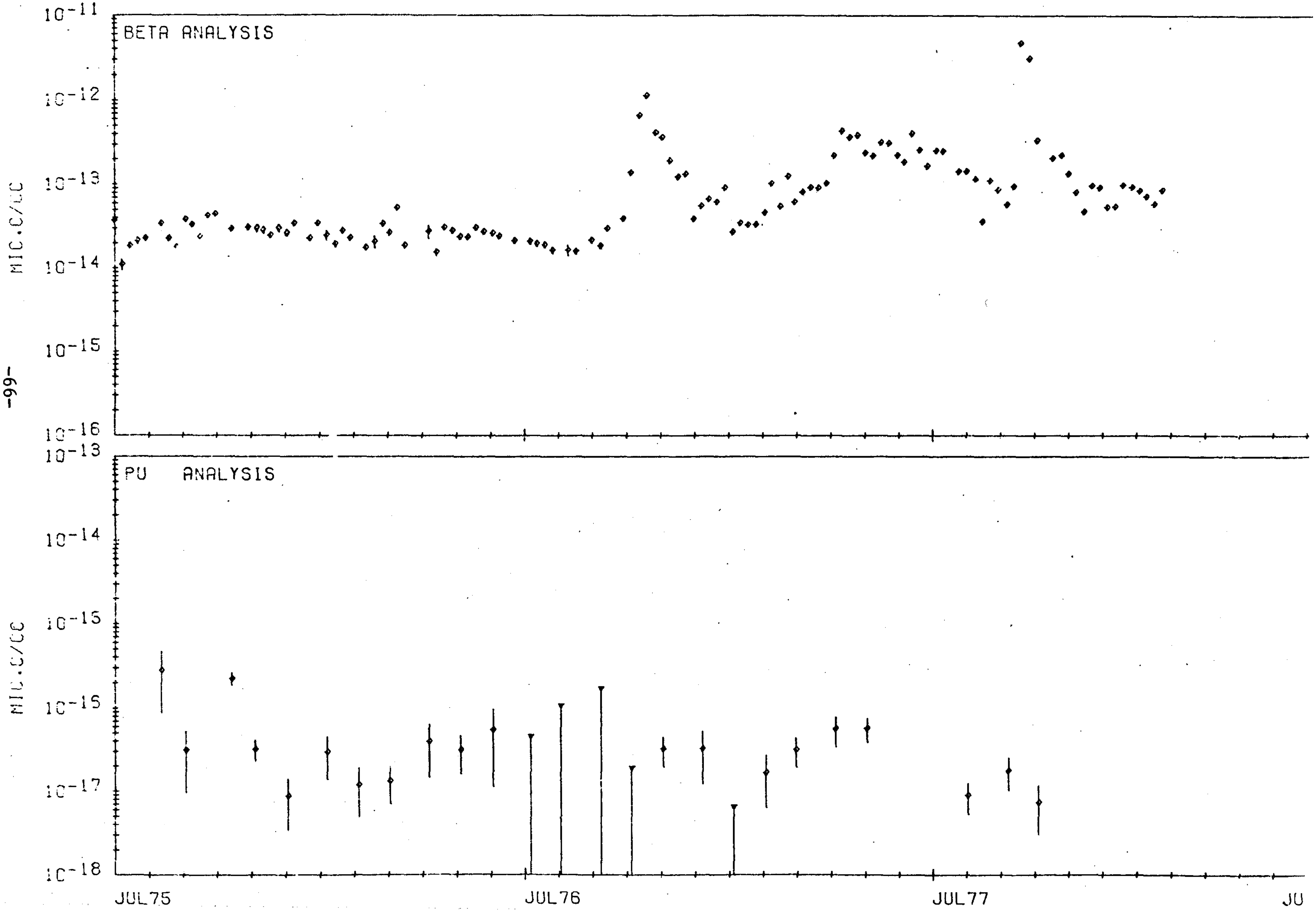
AIR SAMPLING STATION NUMBER 7



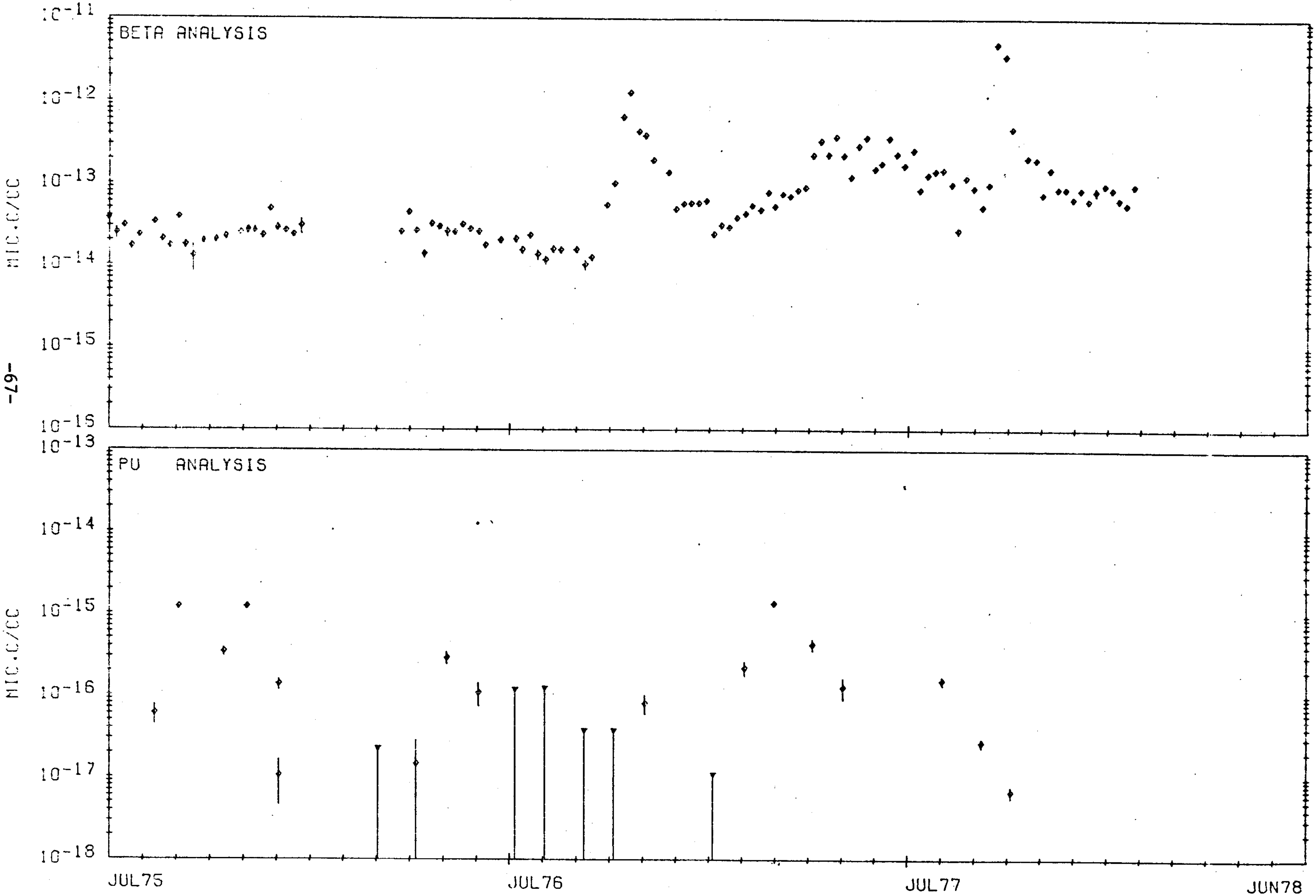


AIR SAMPLING STATION NUMBER 8
BETA ANALYSIS
PU ANALYSIS
MIC.C/CC
10^-11
10^-12
10^-13
10^-14
10^-15
10^-16
10^-17
10^-18
JUL75
JUL76
JUL77
JUN78

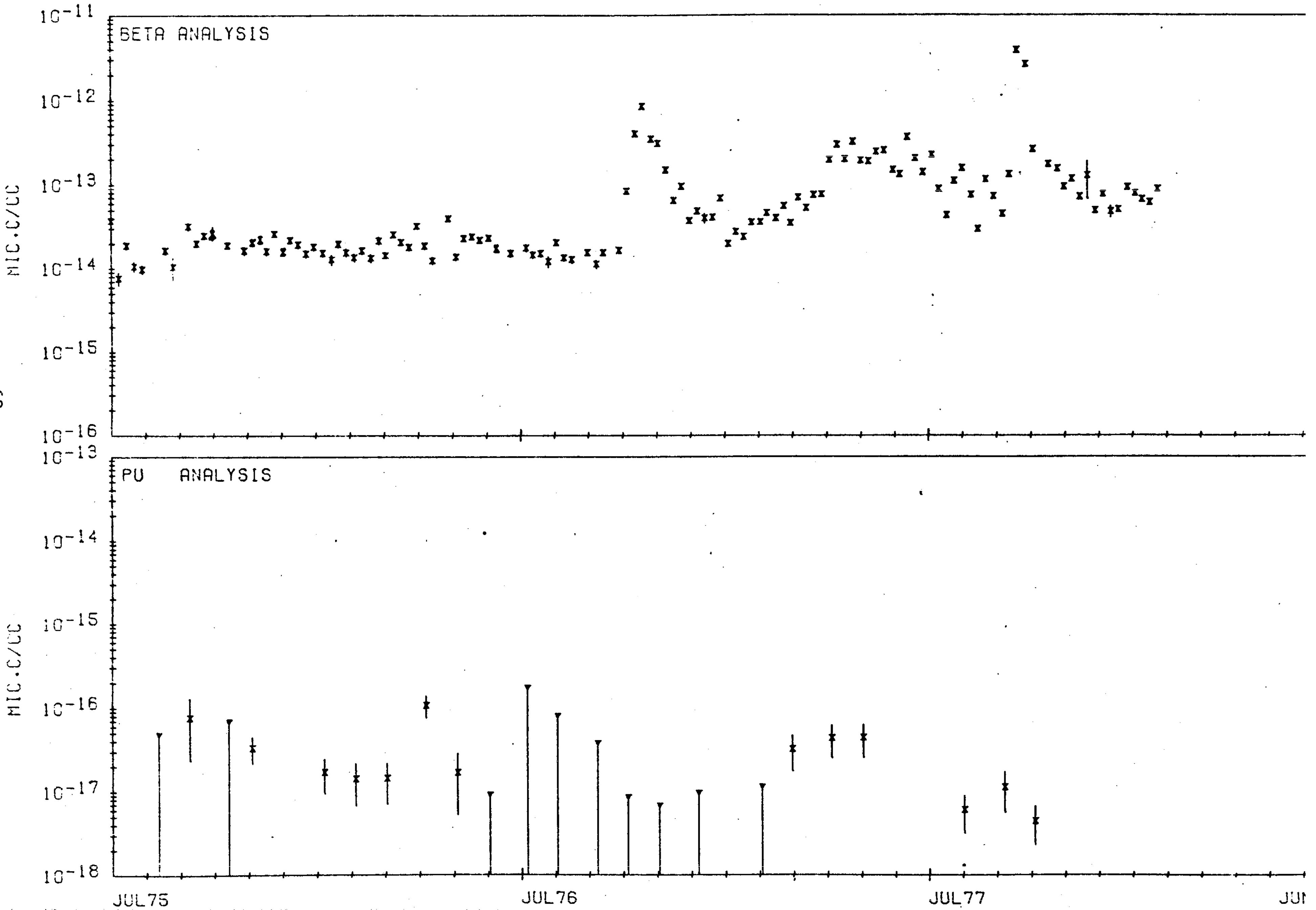
AIR SAMPLING STATION NUMBER 9



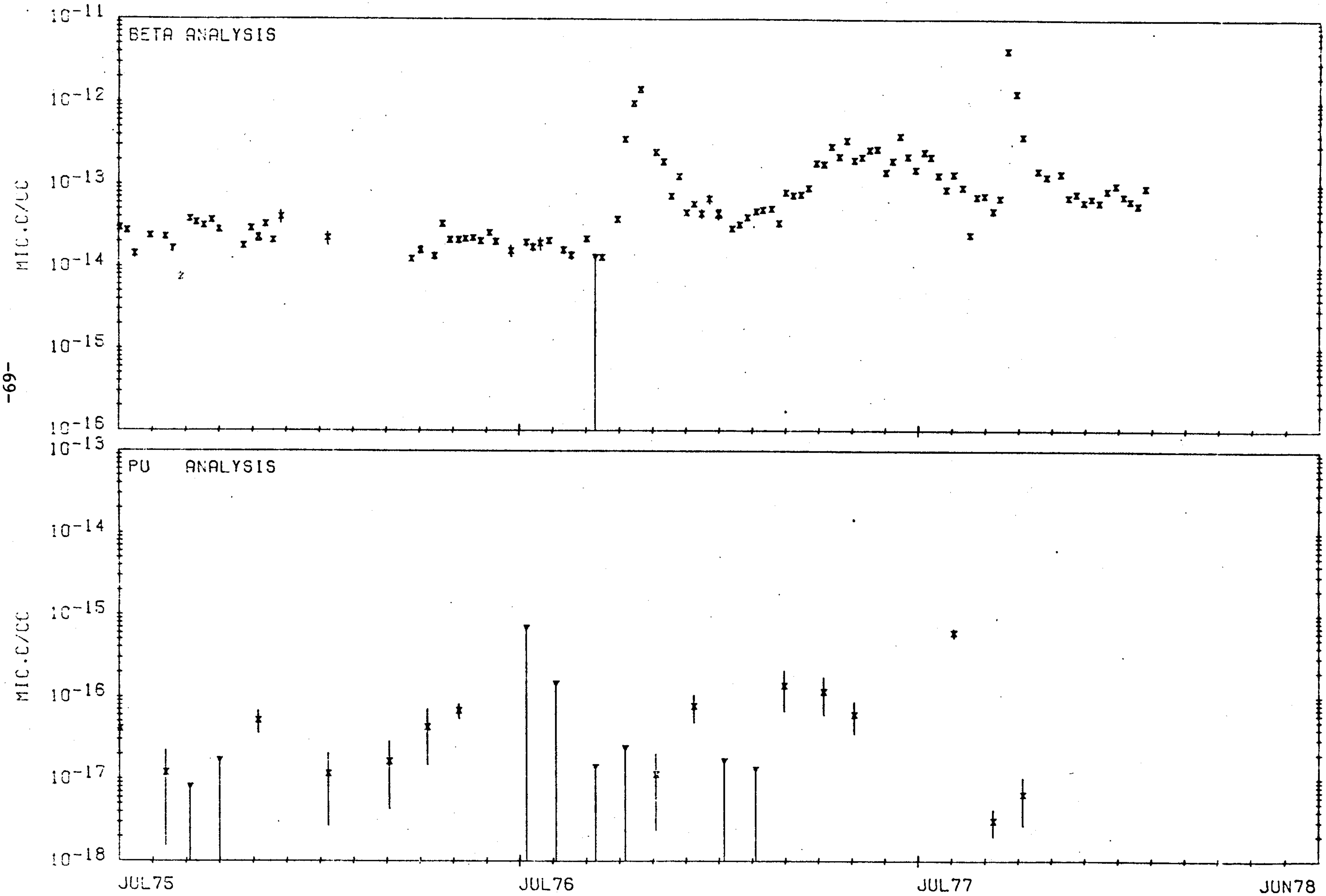
AIR SAMPLING STATION NUMBER 10



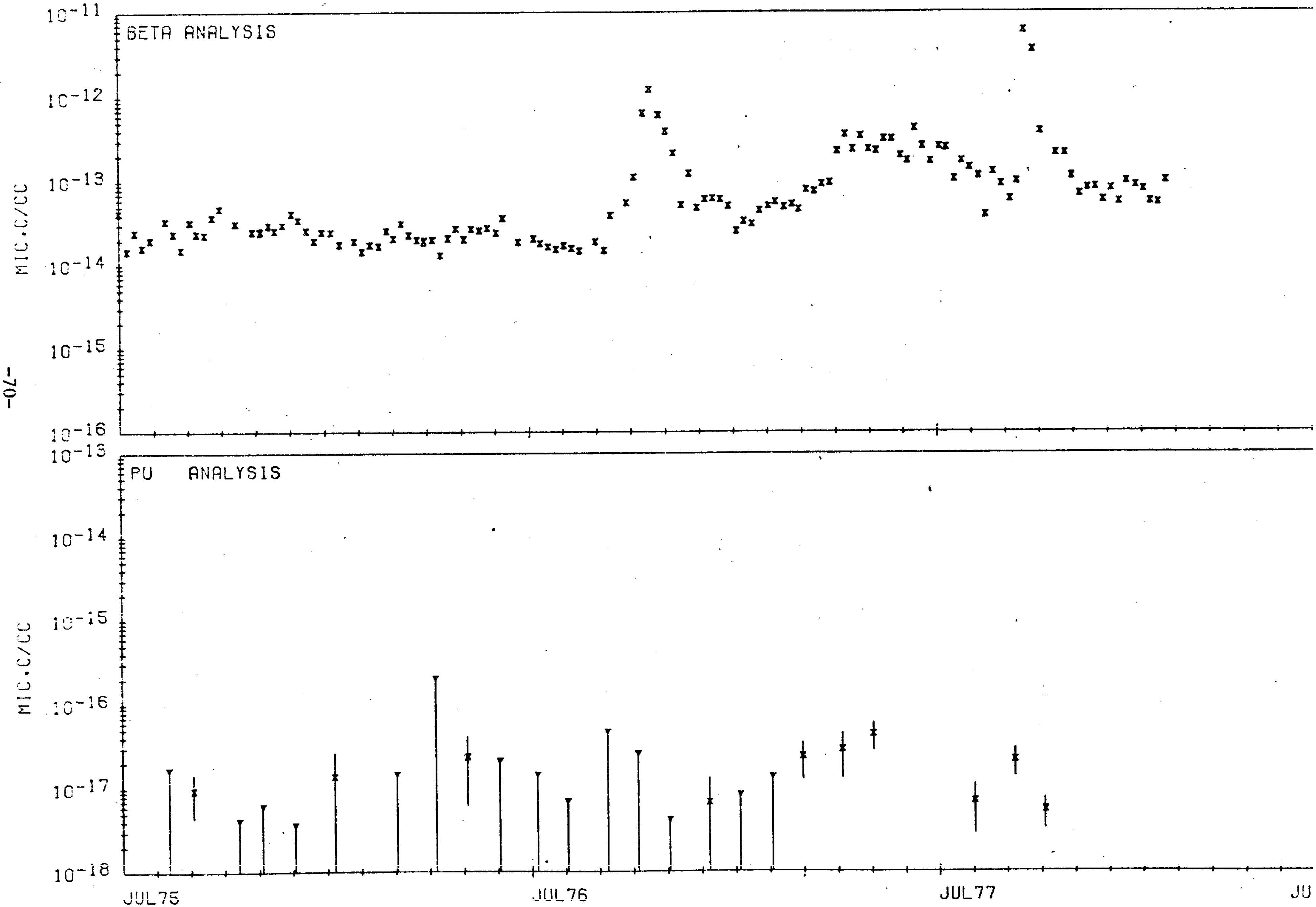
AIR SAMPLING STATION NUMBER 11



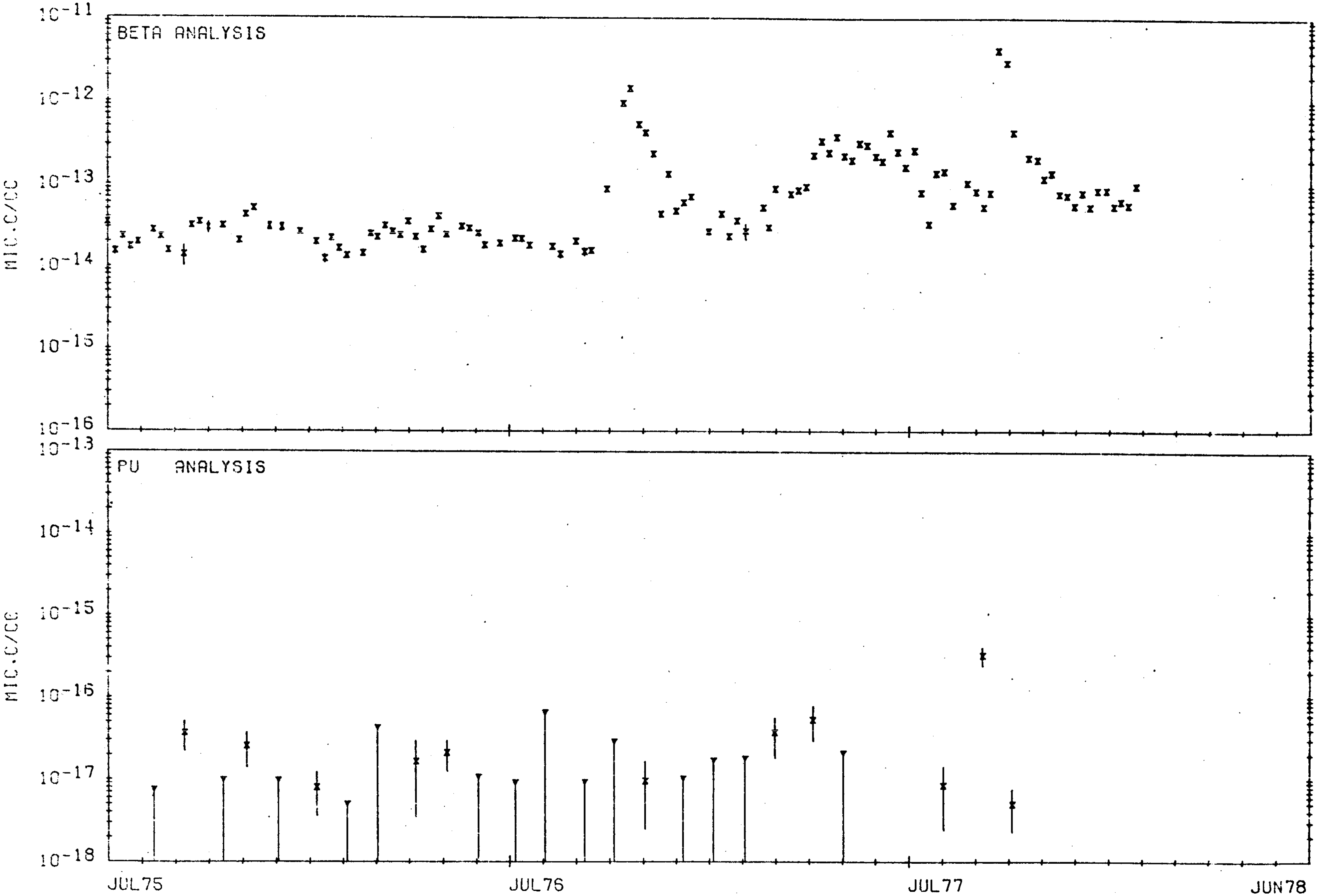
AIR SAMPLING STATION NUMBER 12

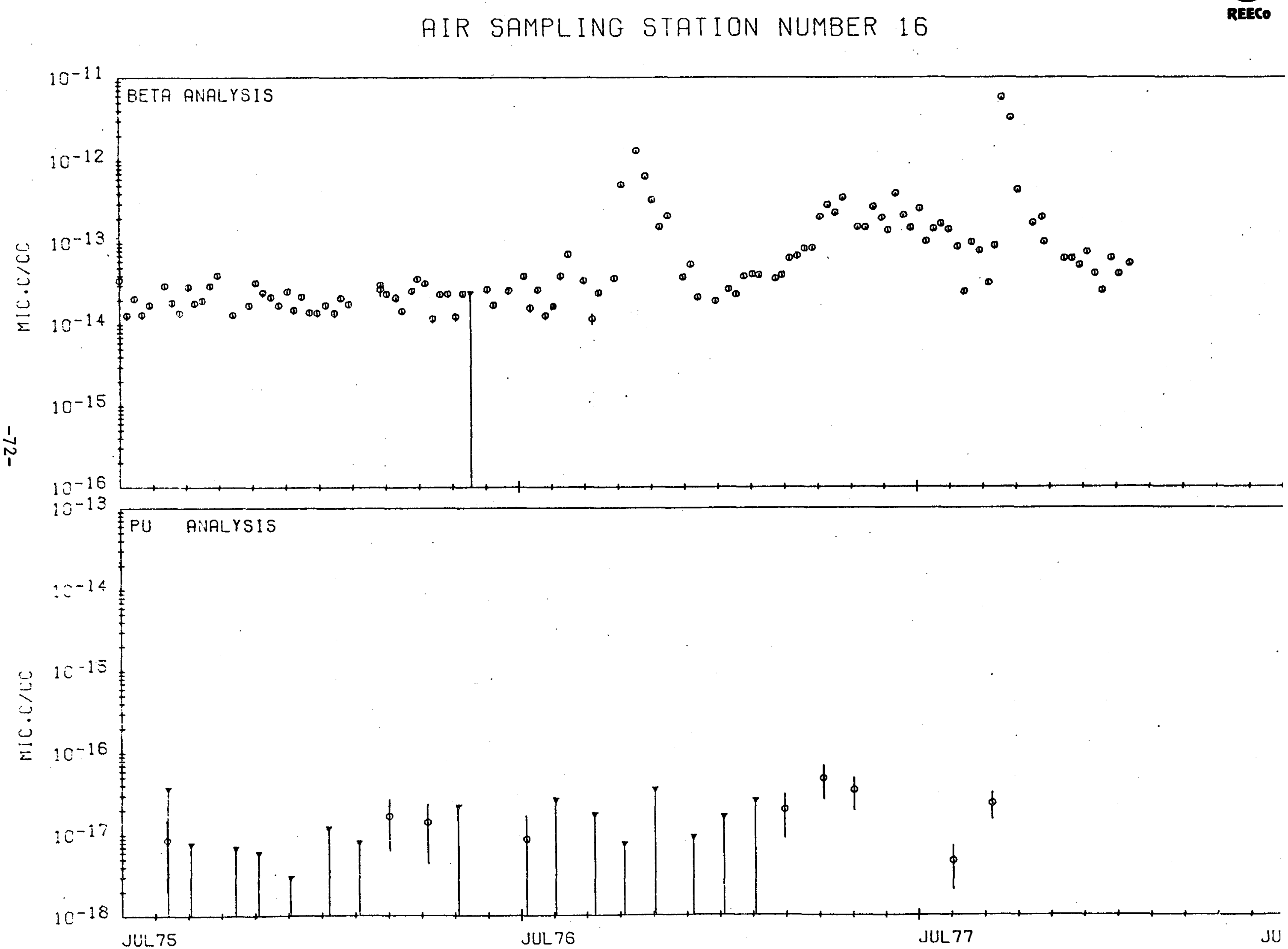


AIR SAMPLING STATION NUMBER 13

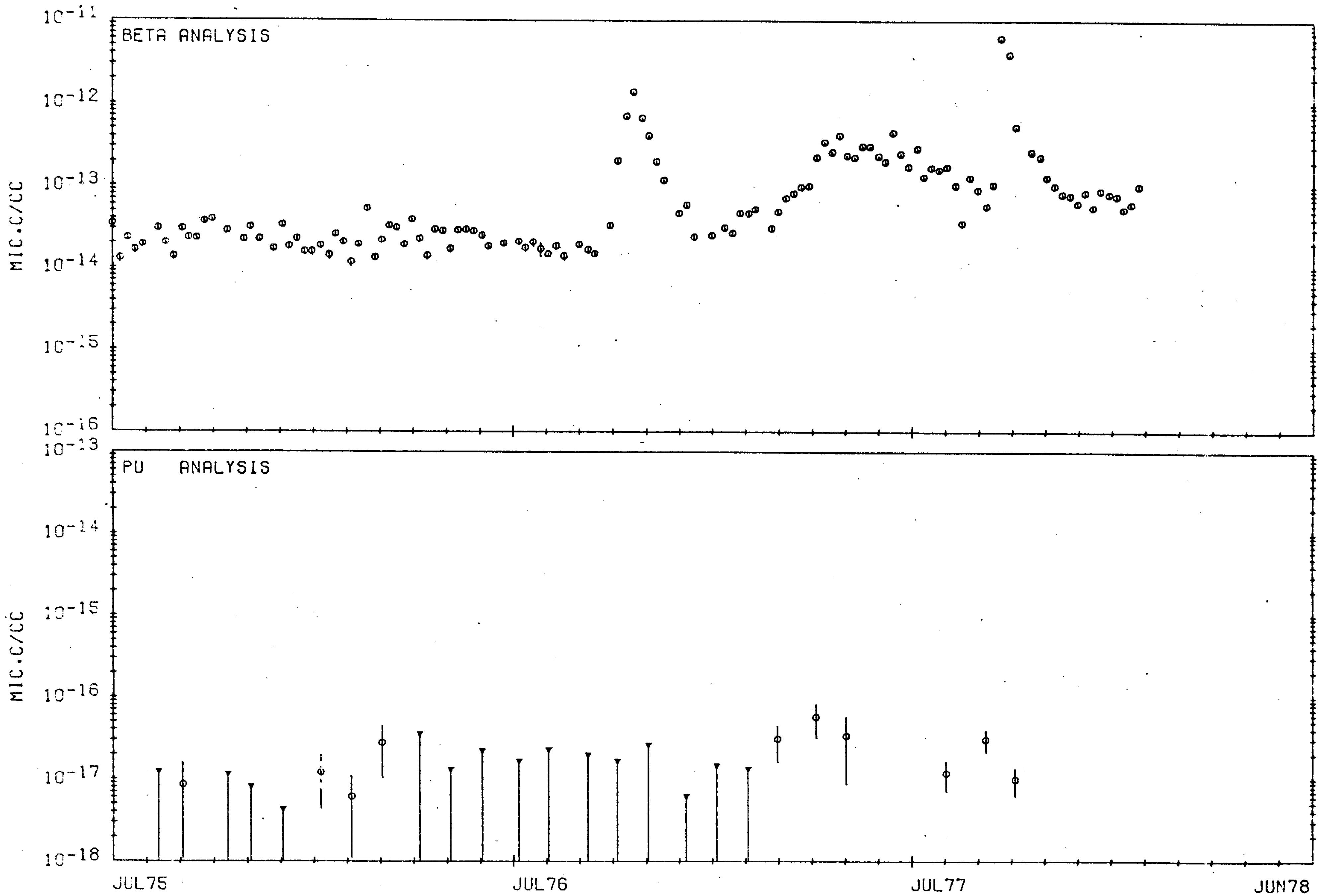


AIR SAMPLING STATION NUMBER 14

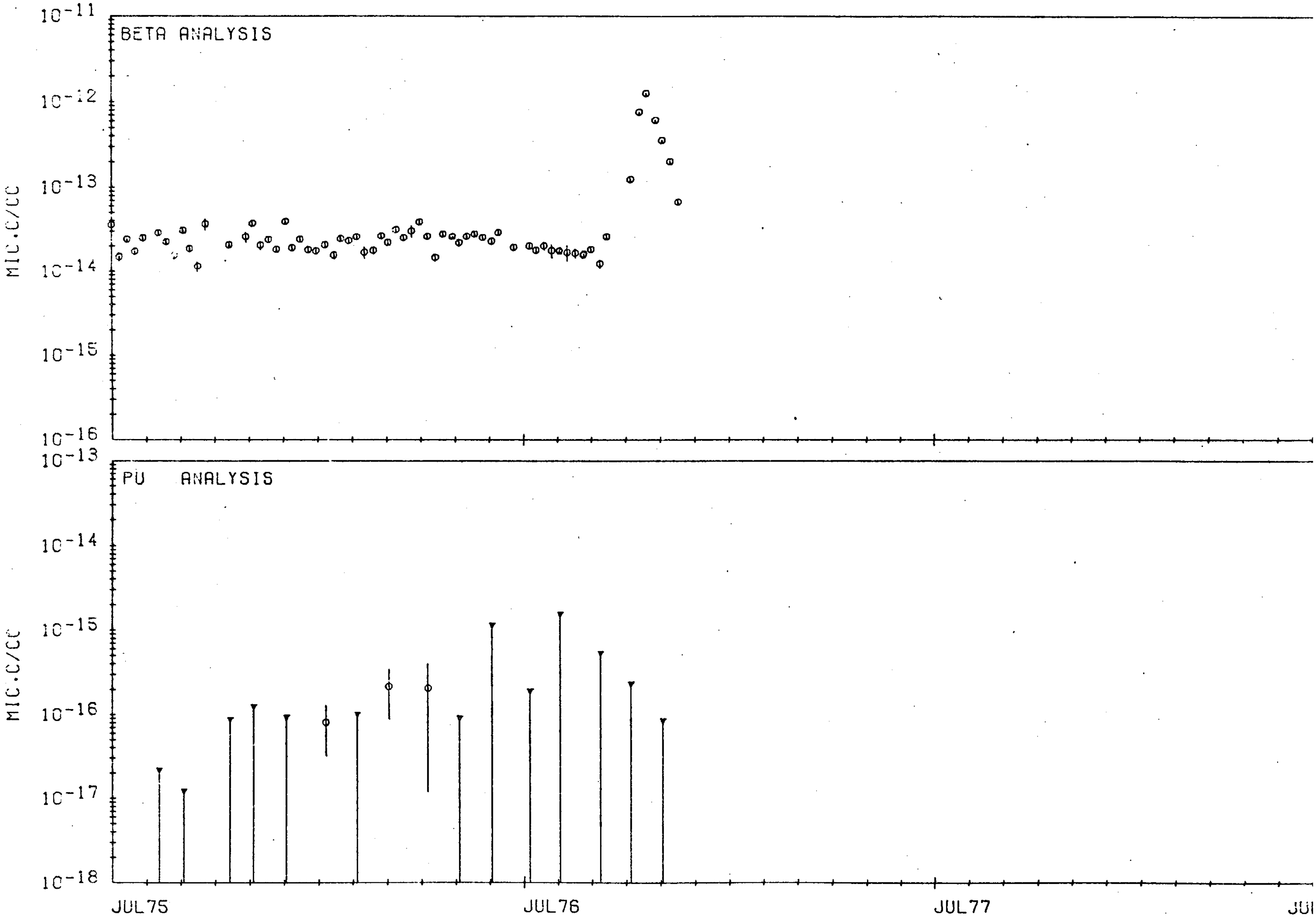



AIR SAMPLING STATION NUMBER 16
BETA ANALYSIS
PU ANALYSIS
MIC.C/CC
MIC.C/CC
10^-11
10^-12
10^-13
10^-14
10^-15
10^-16
10^-13
10^-14
10^-15
10^-16
10^-17
10^-18
JUL75
JUL76
JUL77
JU

AIR SAMPLING STATION NUMBER 17

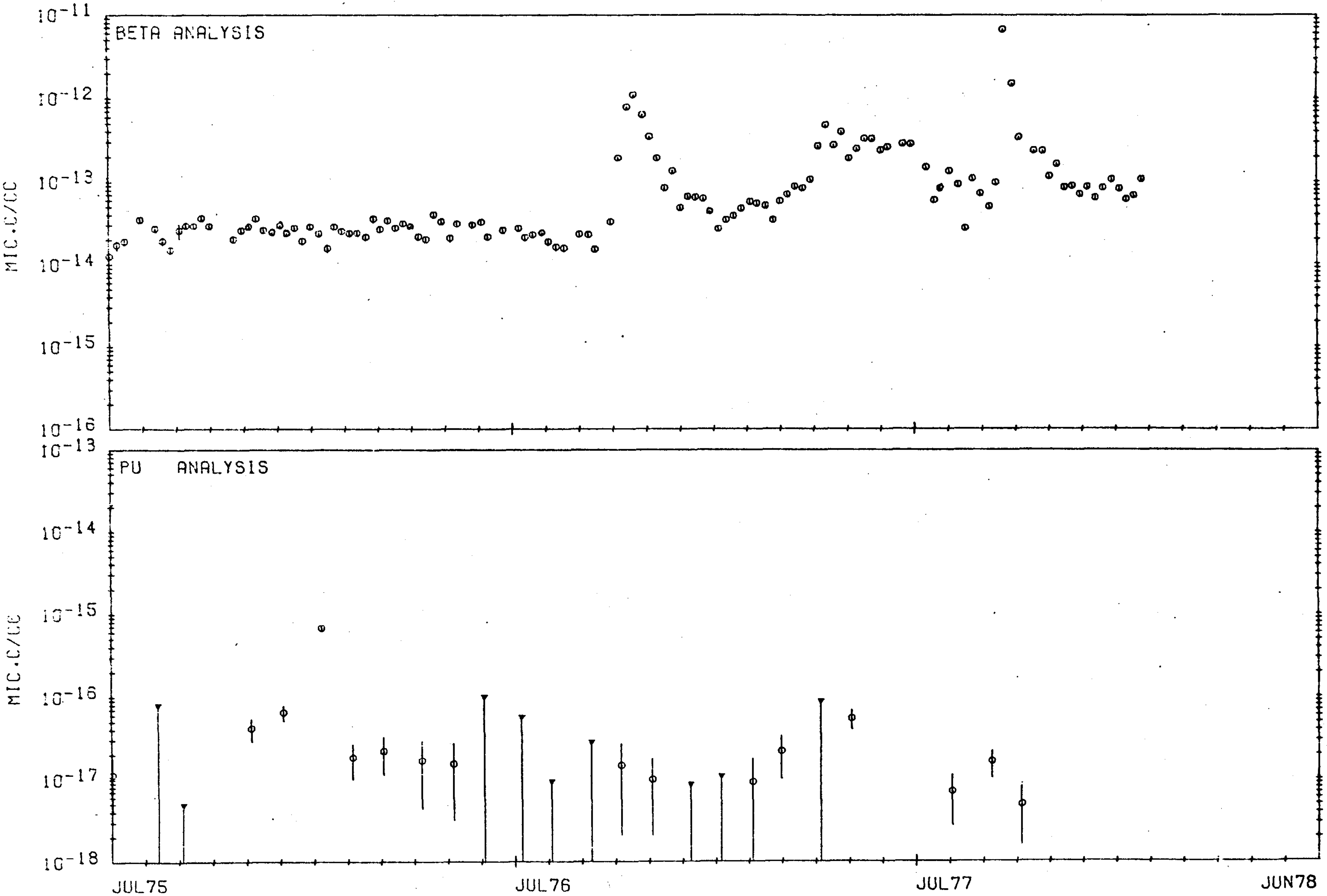


AIR SAMPLING STATION NUMBER 18

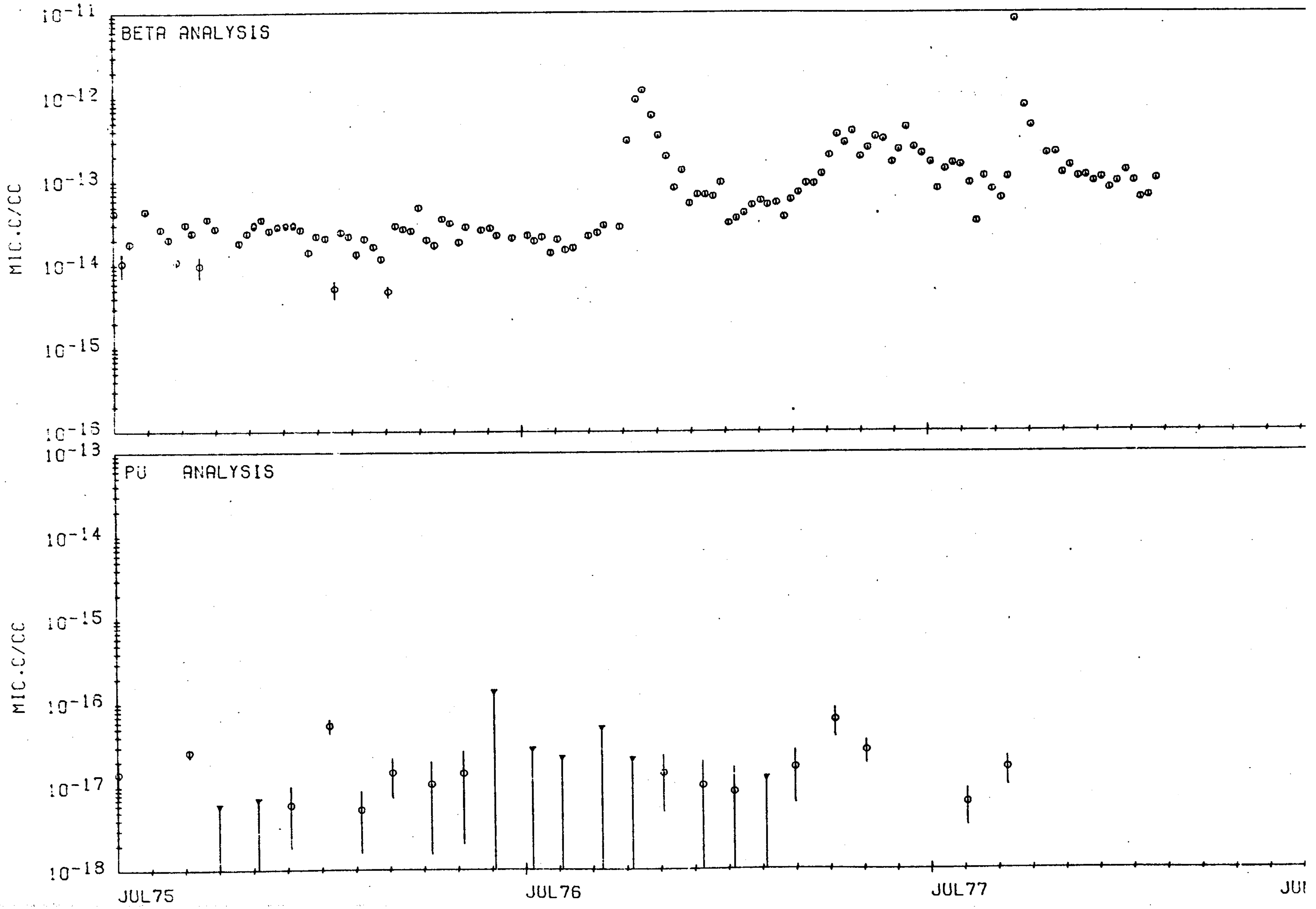


REECo

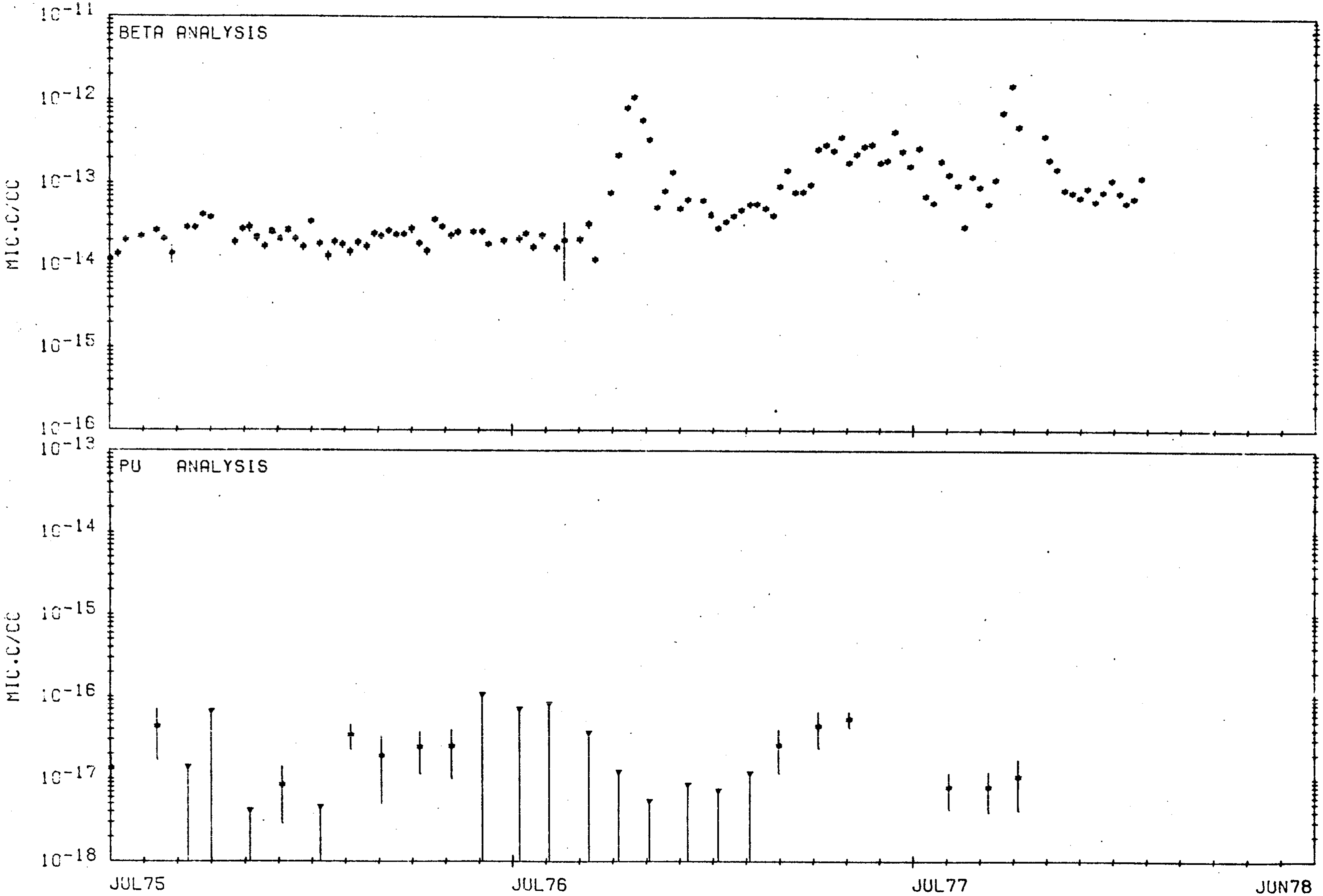
AIR SAMPLING STATION NUMBER 19

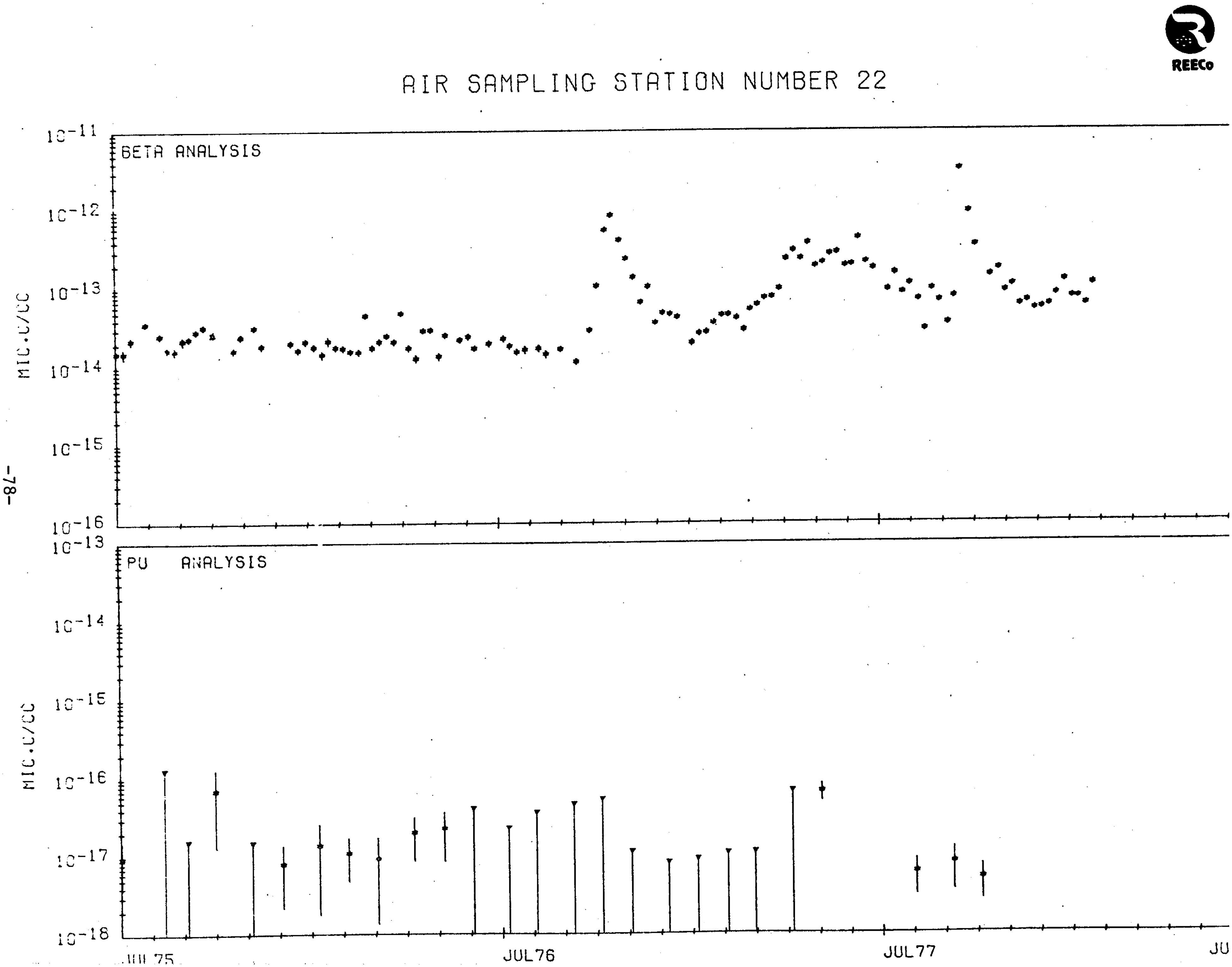


AIR SAMPLING STATION NUMBER 20

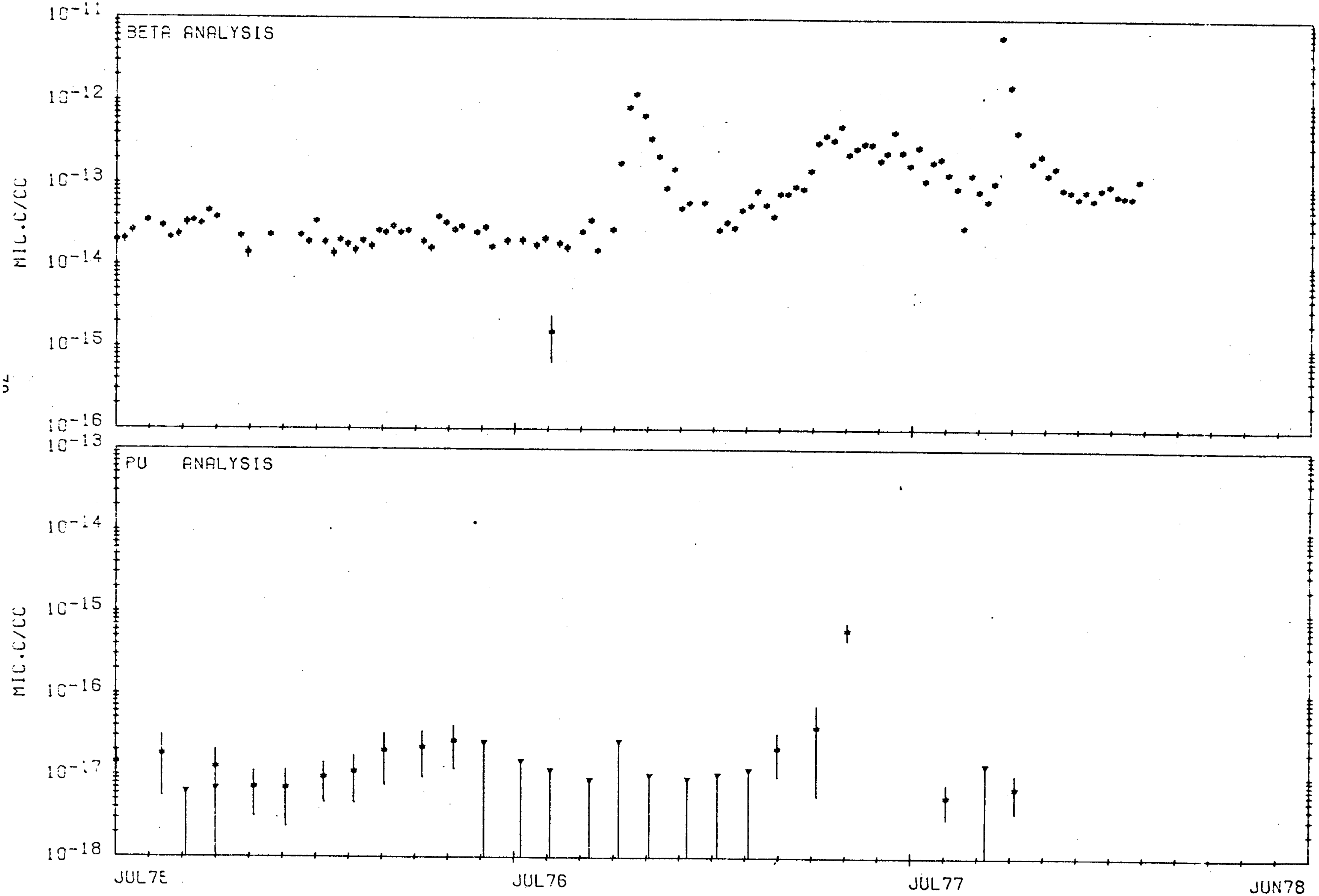


AIR SAMPLING STATION NUMBER 21

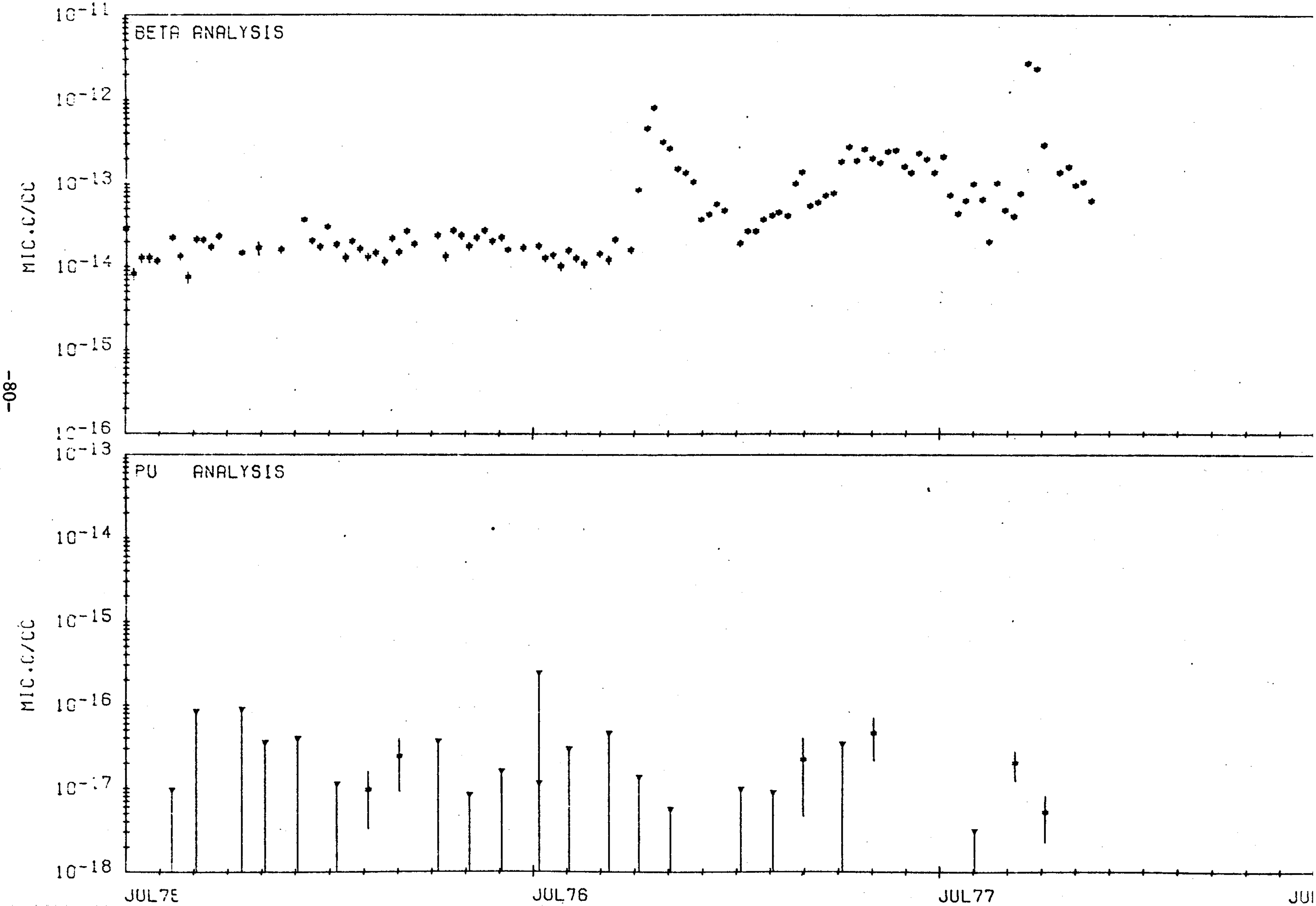



REECo
AIR SAMPLING STATION NUMBER 22
BETA ANALYSIS
PU ANALYSIS
MIC.C/CC
10^{-11}
10^{-12}
10^{-13}
10^{-14}
10^{-15}
10^{-16}
10^{-17}
10^{-18}
JUL75
JUL76
JUL77
JU

AIR SAMPLING STATION NUMBER 23



AIR SAMPLING STATION NUMBER 24



APPENDIX B

NTS Environmental Surveillance

Supply Wells Locations and Plots

Several symbols are used in Appendix B to denote the data points. In the first two pages of plots, the supply well network averages, a square represents the geometric mean of all values at that point in time, and the vertical line is the range.

The remaining plots of Appendix B show the gross beta data of each station. The data symbols for the plots are as follows:

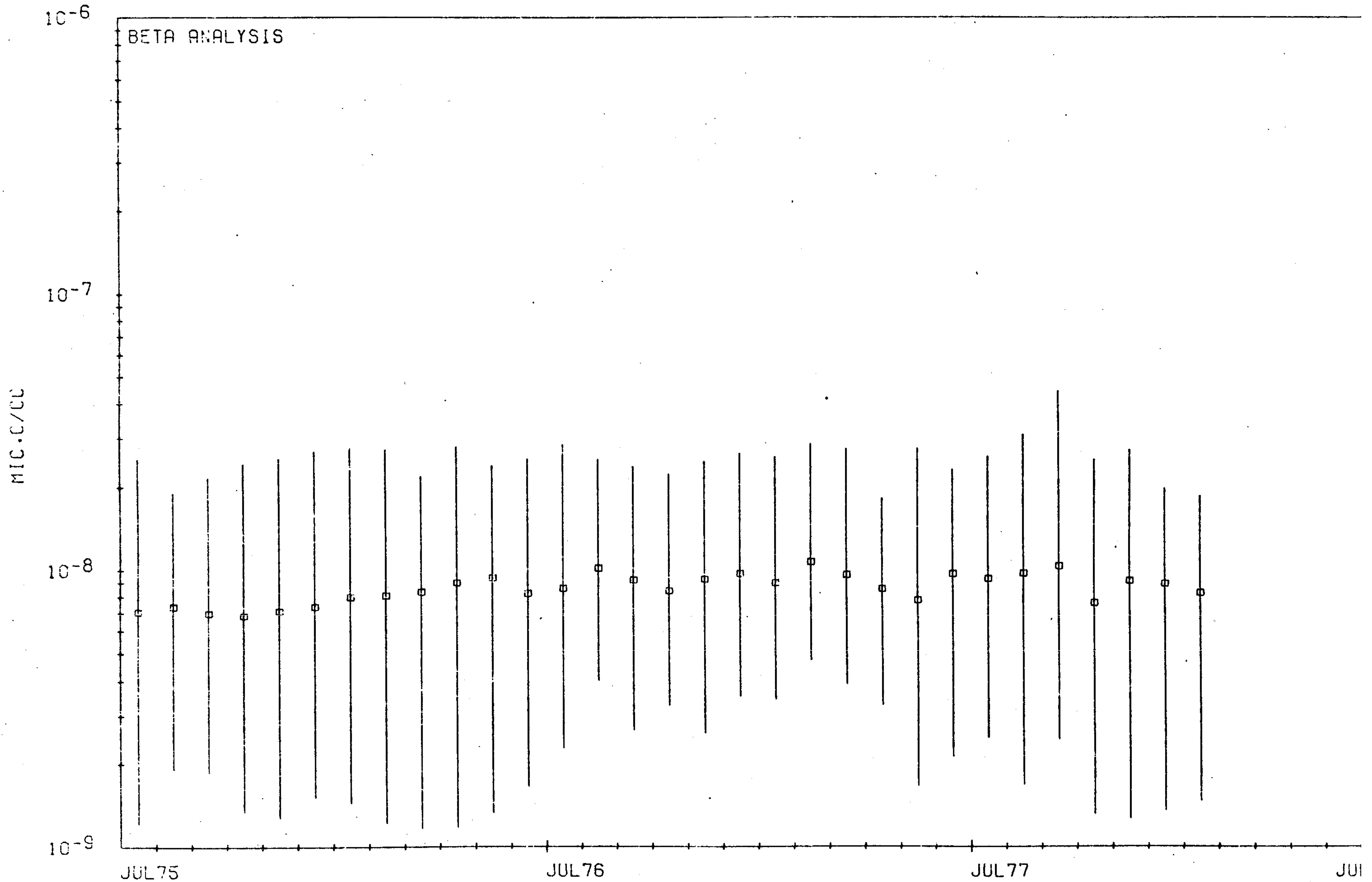
Plot #	Symbol
1-10	✖
11-18	◇

A two-sigma error bar is also added to the data points, and, in all plots, a delta with the line to the bottom of the plot means below detection limit.

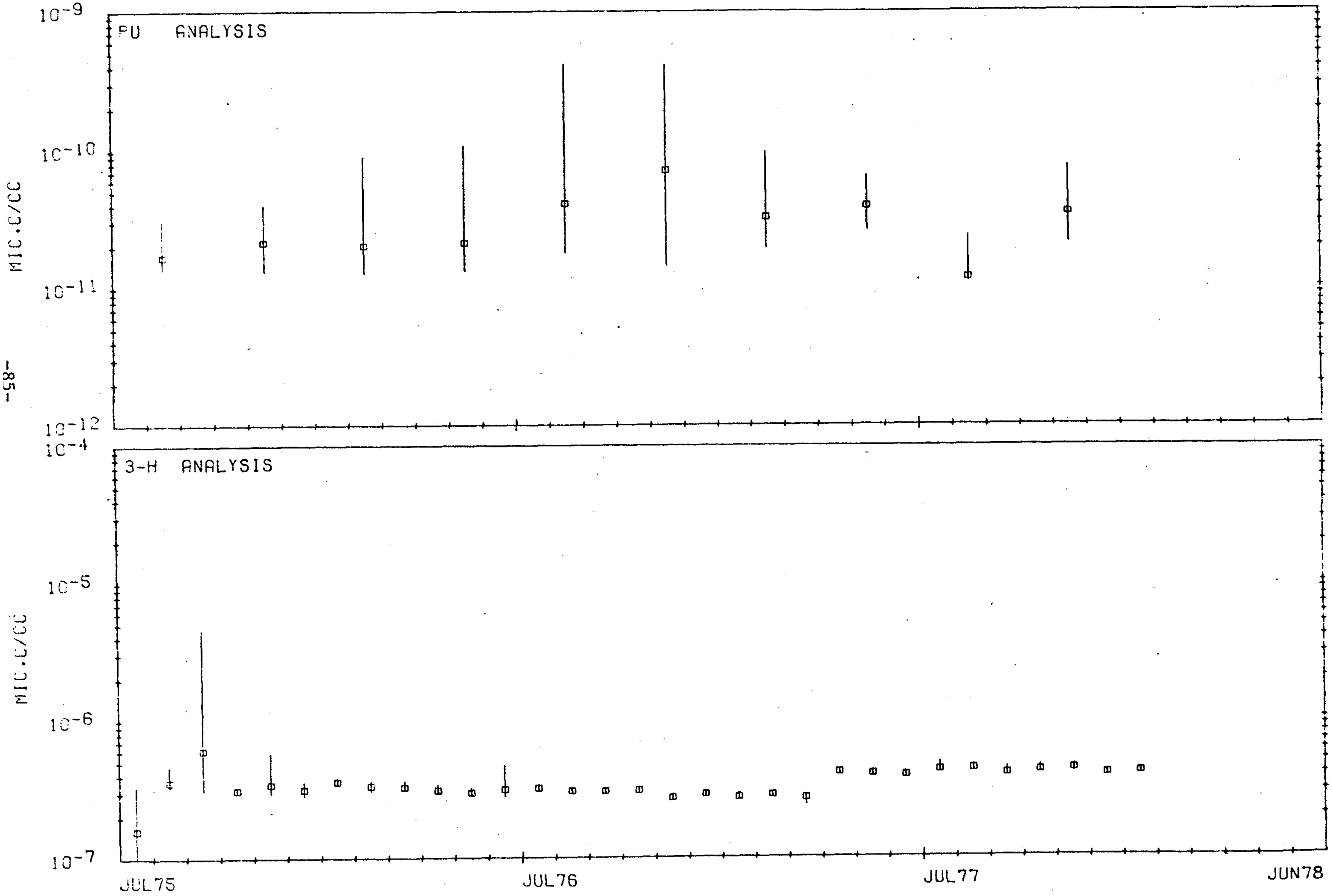
NTS ENVIRONMENTAL SURVEILLANCE
SUPPLY WELLS SAMPLING LOCATIONS

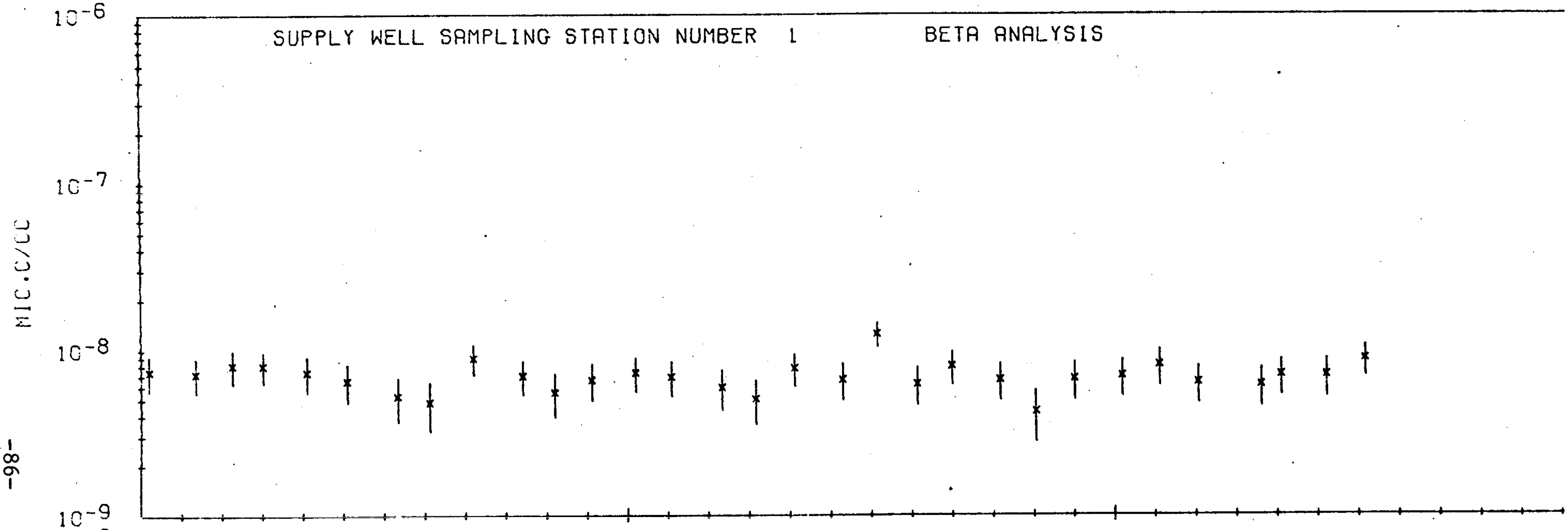
Number	Location	Map Code (Figure 3)
1	Area 2 Well 2	2A
2	Area 3 Well A	3A
3	Area 5 Well 5B	5A
4	Area 5 Well 5C	5B
5	Area 5 Well Ue5c	5C
6	Area 6 Well C	6A
7	Area 6 Well C1	6B
8	Area 15 Well Ue15d	15A
9	Area 18 Well 8	18A
10	Area 19 Well Ue19gs	19A
11	Area 19 Well Ue19e	19B
12	Area 20 Well U20a	20A
13	Area 22 Army Well #1	22A
15	Area 25 Well J13	25A
16	Groom Lake Well 3	00A
17	Groom Lake Well 4	00B
18	Area 19 Well U19c	19c

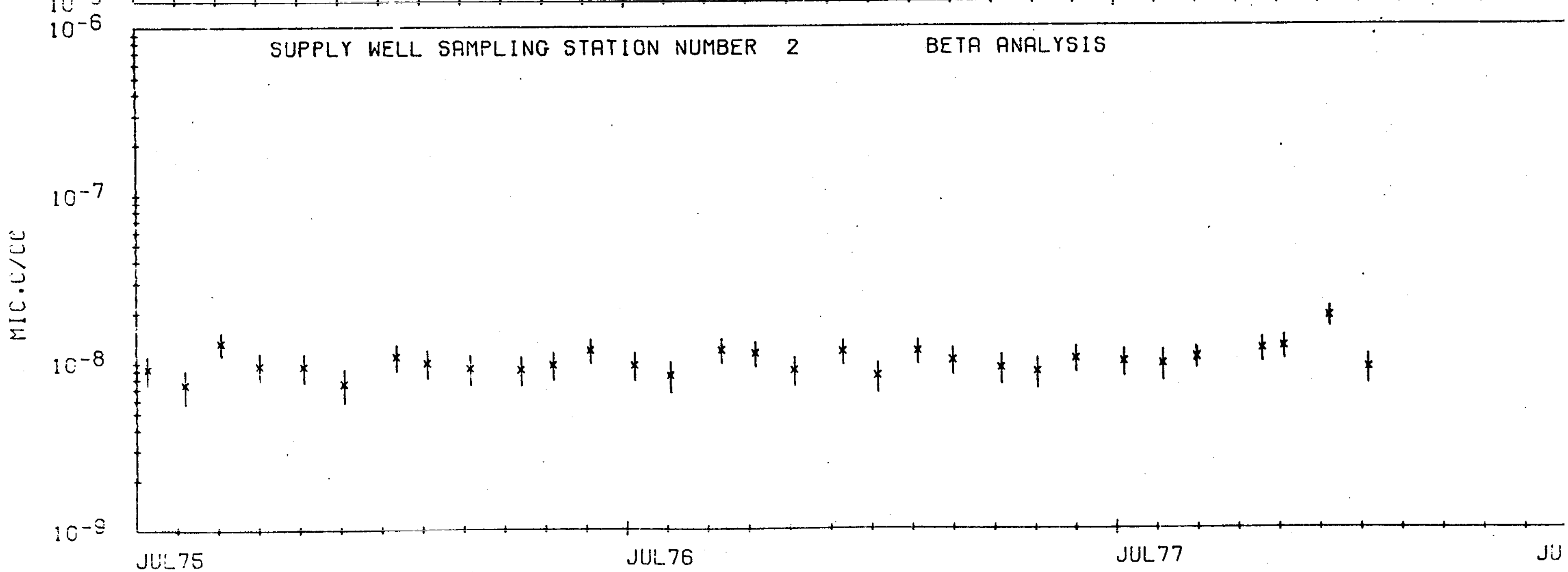
SUPPLY WELL NETWORK AVERAGES

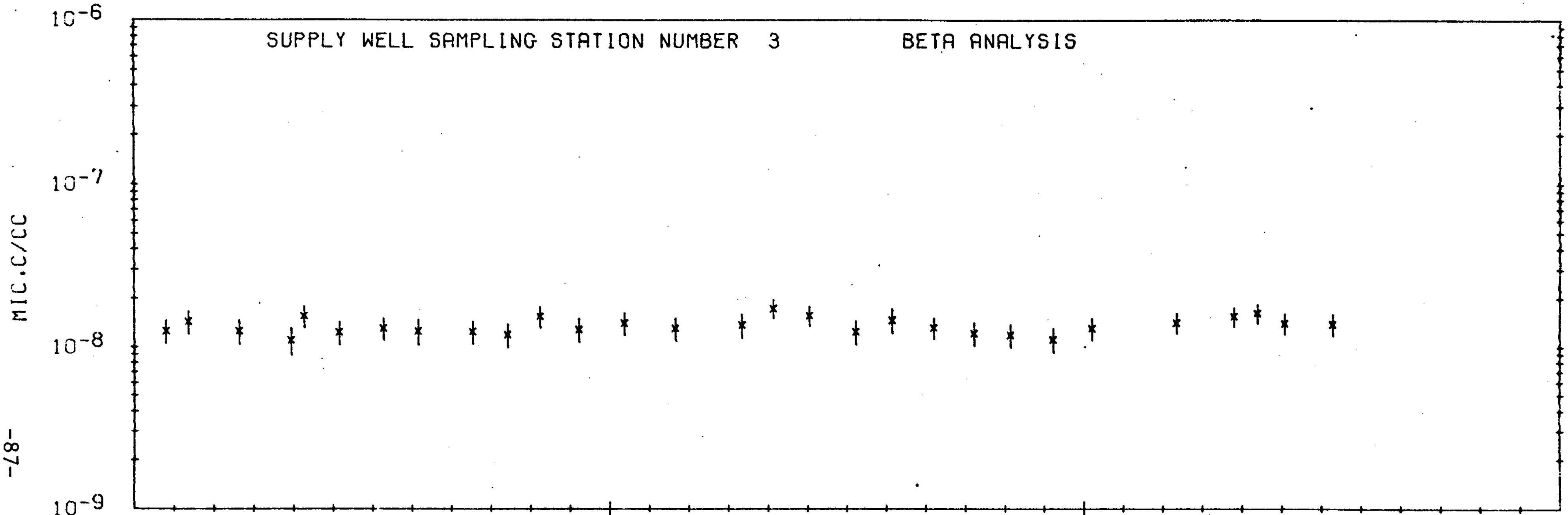


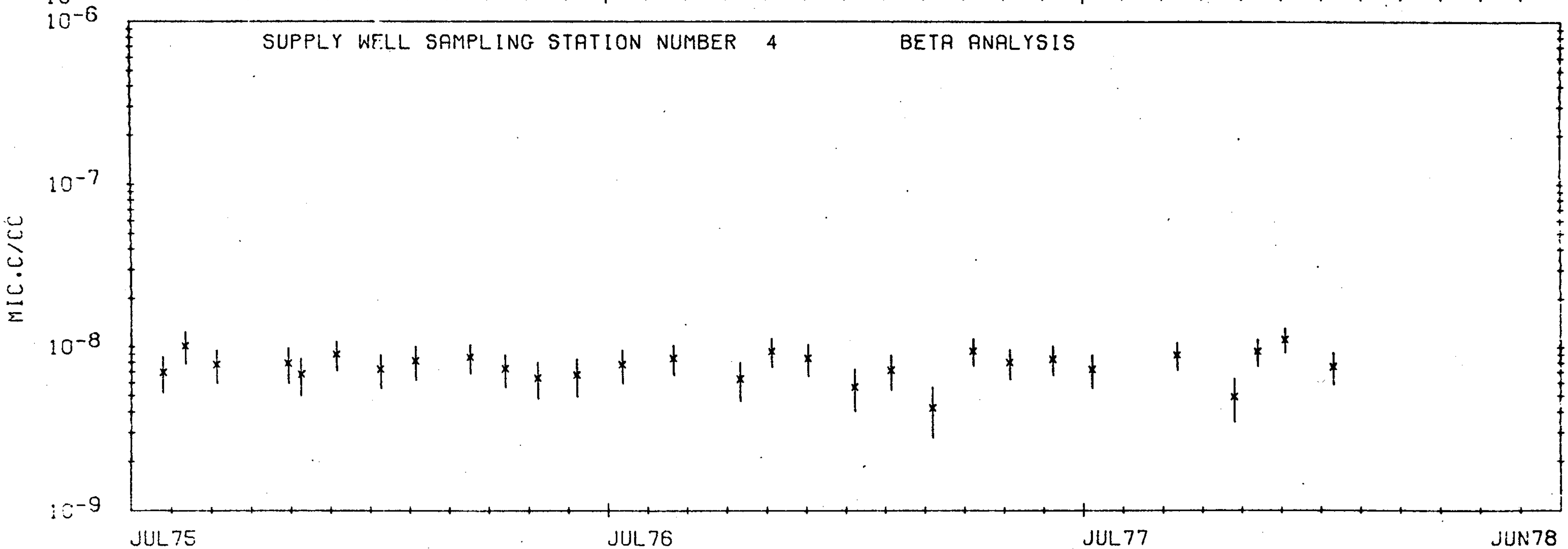
SUPPLY WELL NETWORK AVERAGES

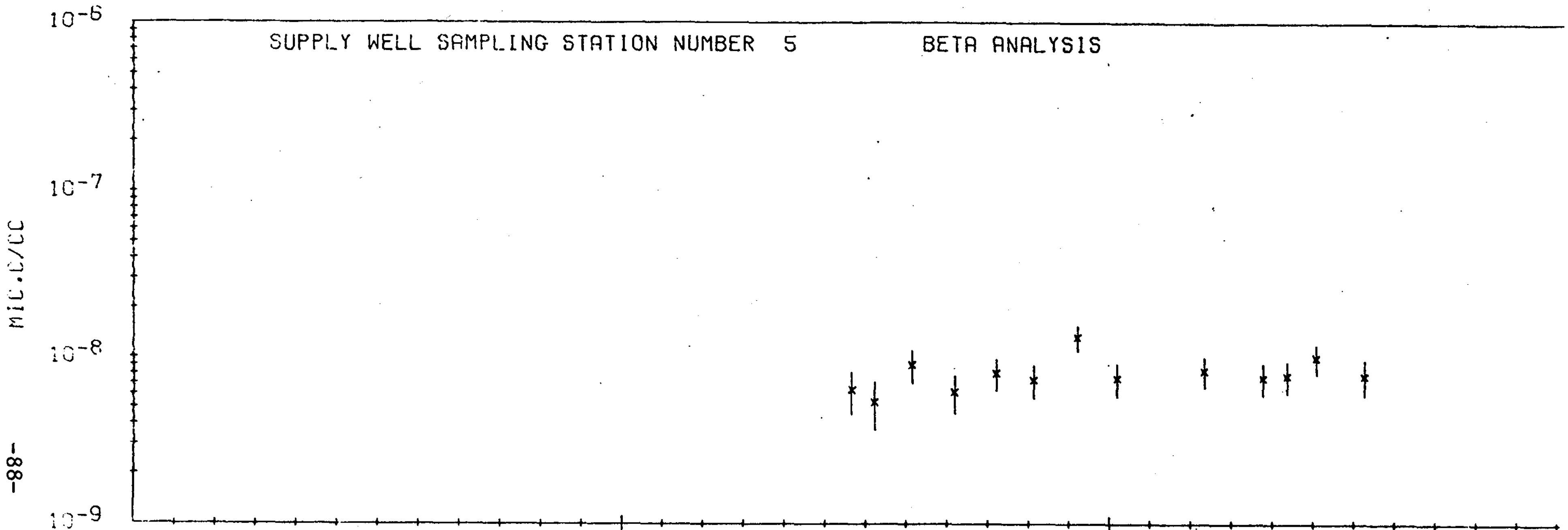


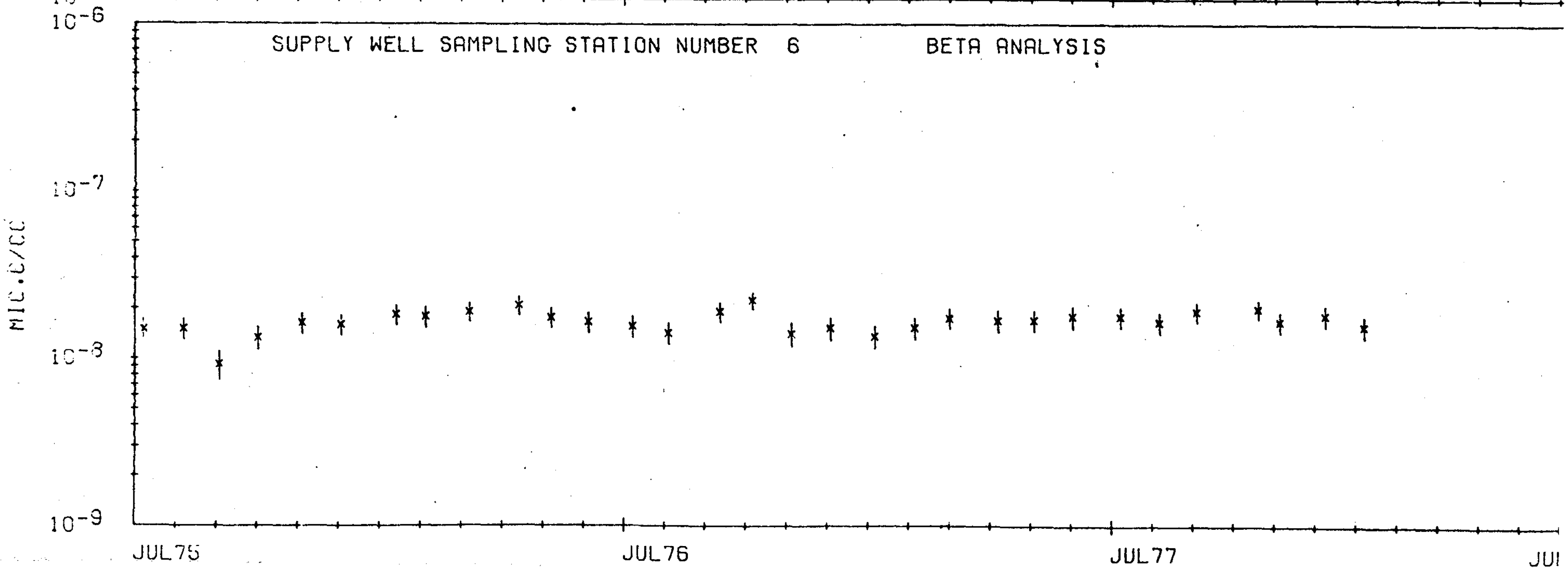

SUPPLY WELL SAMPLING STATION NUMBER 1
BETA ANALYSIS
MIC.C/CC
10^-6
10^-7
10^-8
10^-9

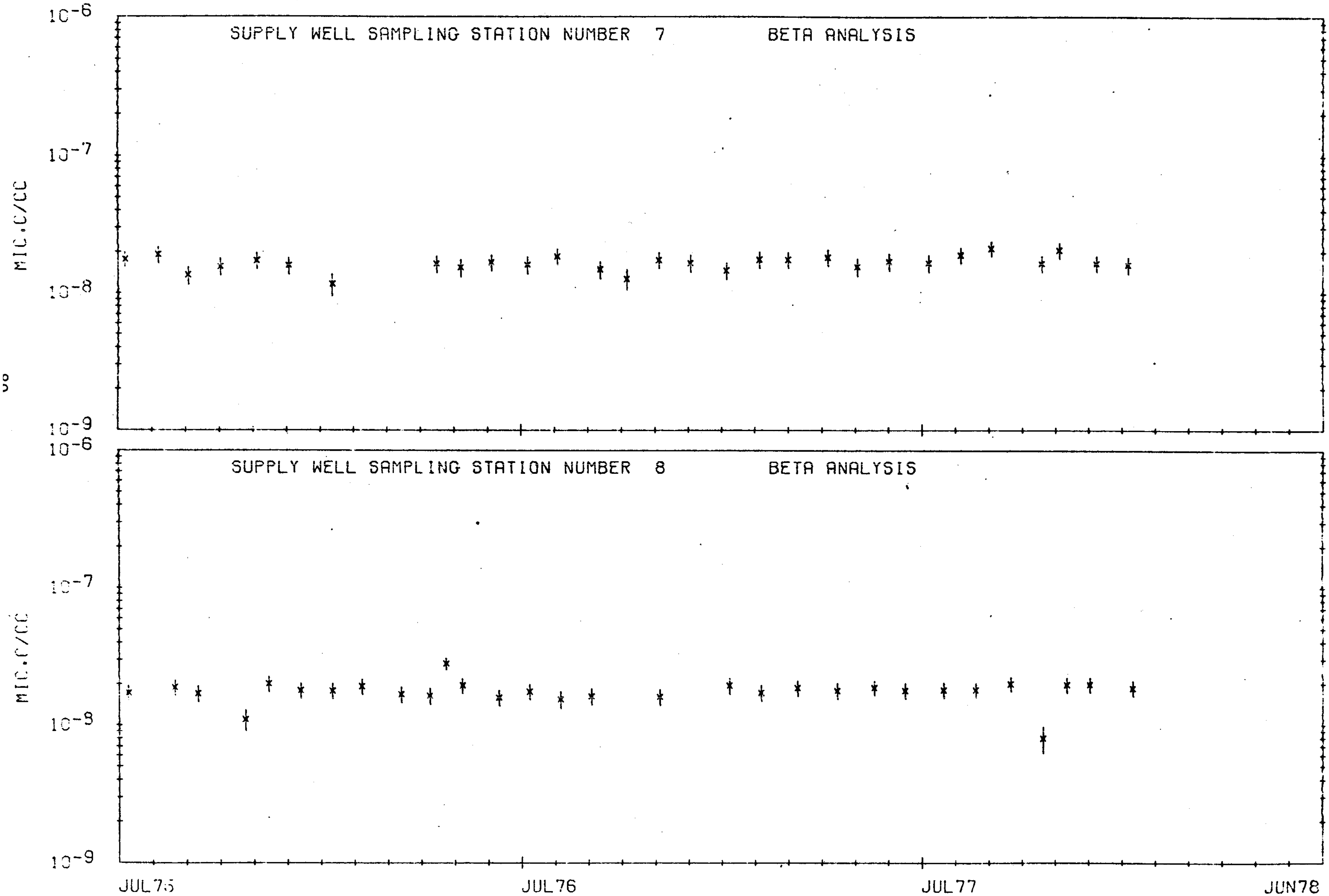

SUPPLY WELL SAMPLING STATION NUMBER 2
BETA ANALYSIS
MIC.C/CC
10^-6
10^-7
10^-8
10^-9
JUL75
JUL76
JUL77


SUPPLY WELL SAMPLING STATION NUMBER 3
BETA ANALYSIS
MIC.C/CC
10^{-6}
10^{-7}
10^{-8}
10^{-9}

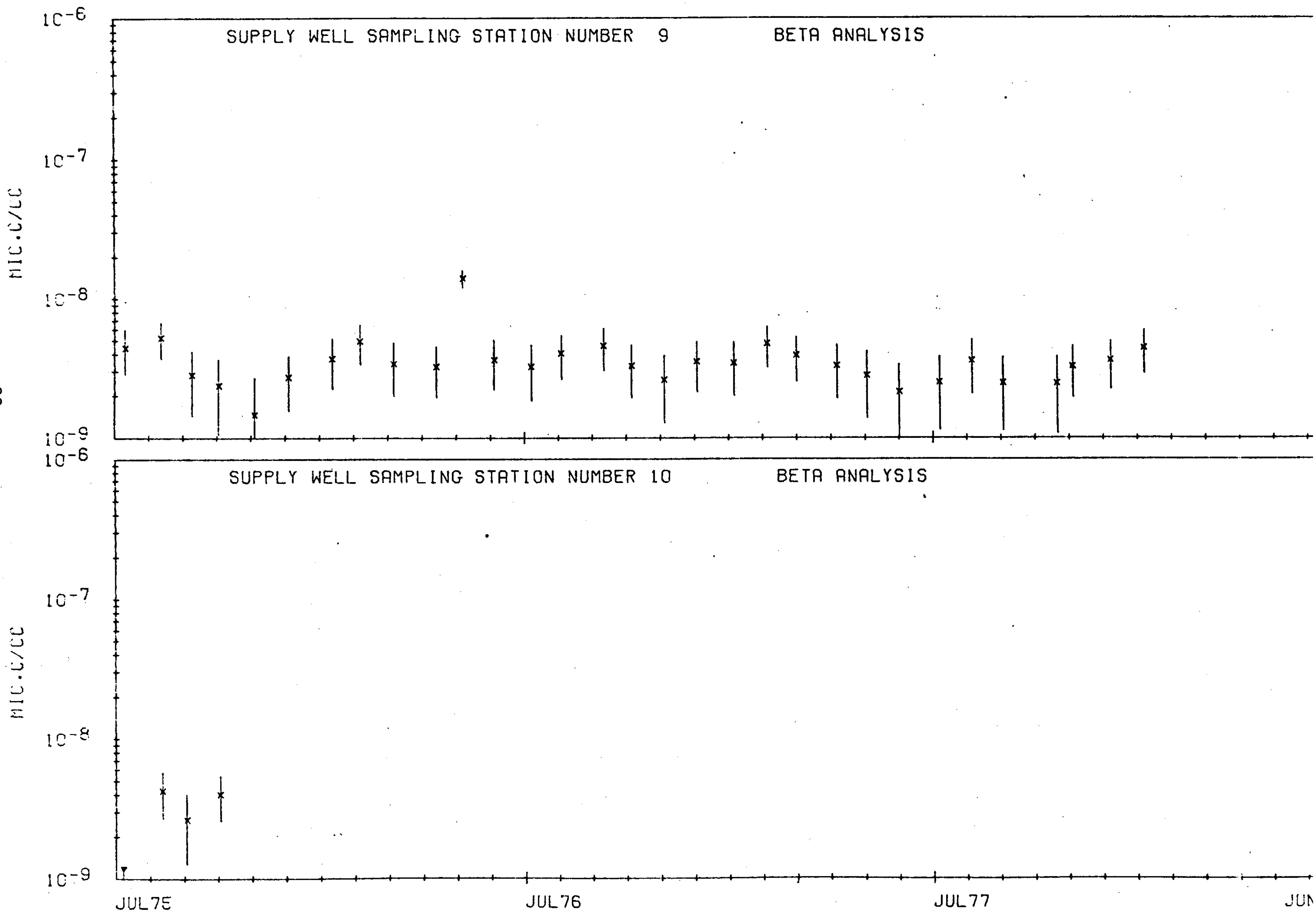

SUPPLY WELL SAMPLING STATION NUMBER 4
BETA ANALYSIS
MIC.C/CC
10^{-6}
10^{-7}
10^{-8}
10^{-9}
JUL75
JUL76
JUL77
JUN78

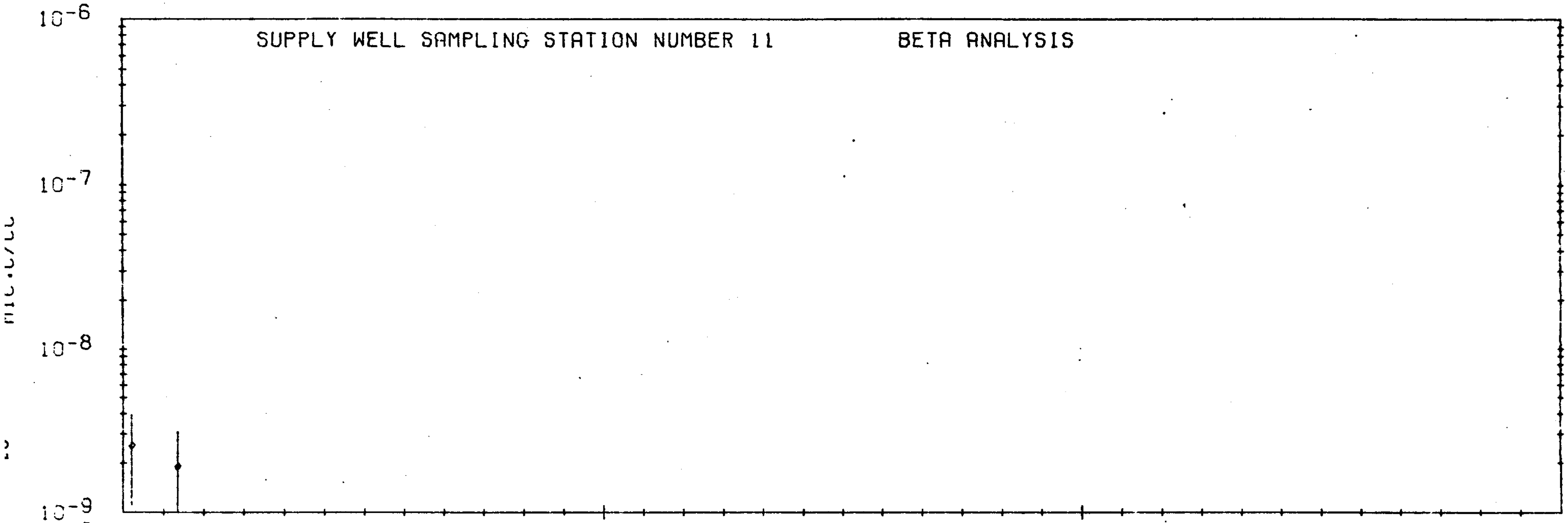

SUPPLY WELL SAMPLING STATION NUMBER 5
BETA ANALYSIS
MIC.C/CC
10^{-6}
10^{-7}
10^{-8}
10^{-9}

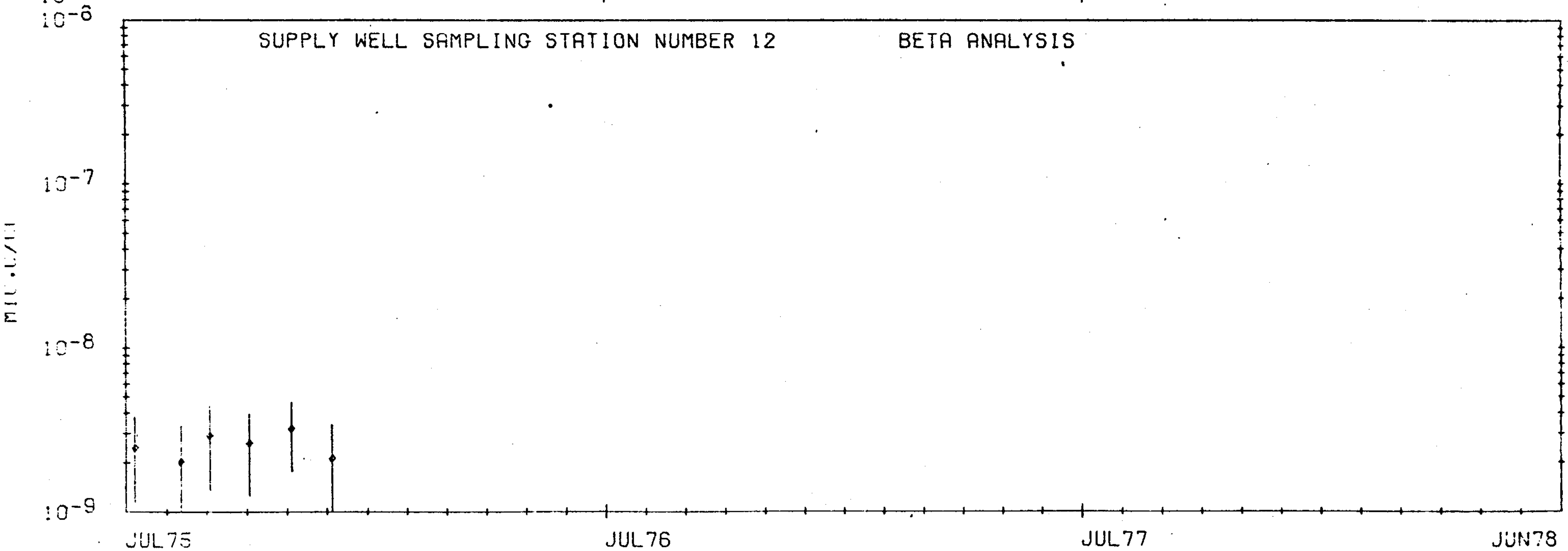

SUPPLY WELL SAMPLING STATION NUMBER 6
BETA ANALYSIS
MIC.C/CC
10^{-6}
10^{-7}
10^{-8}
10^{-9}
JUL75
JUL76
JUL77
JUL

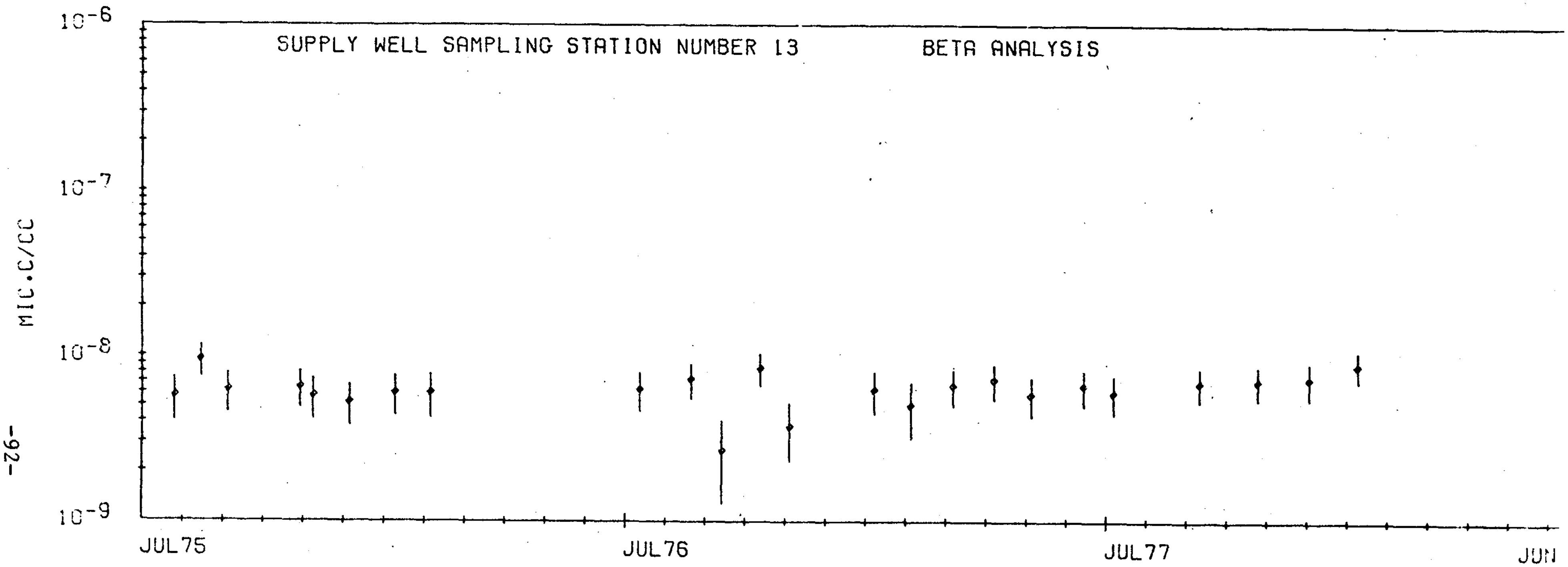


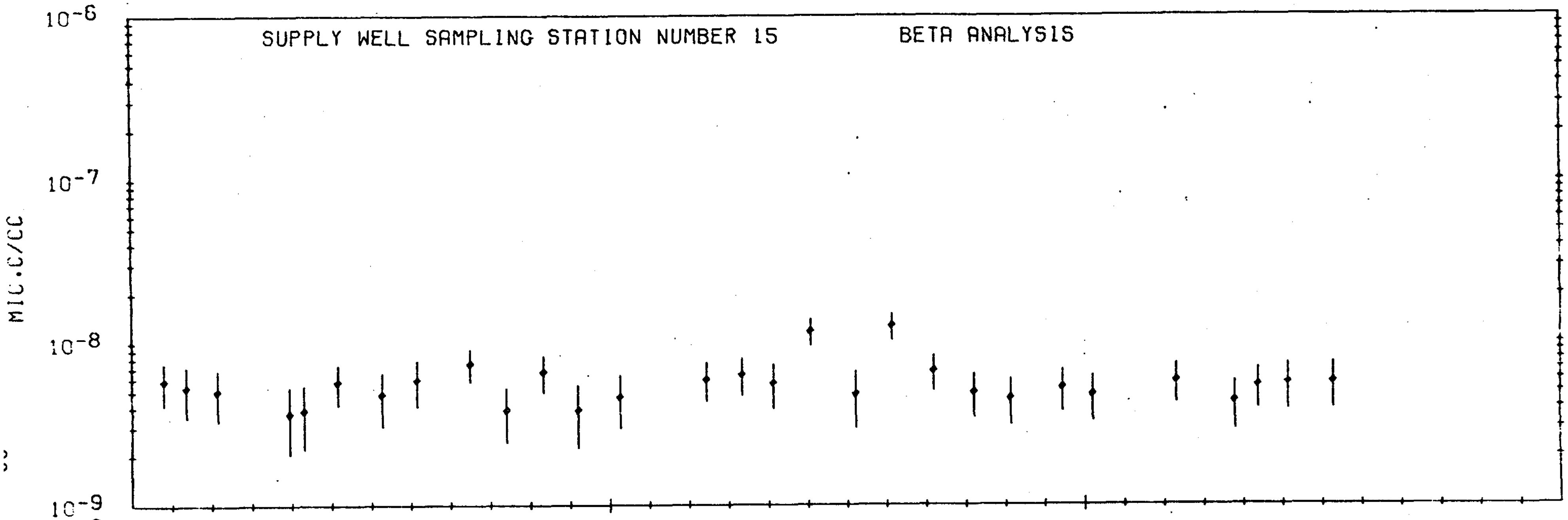
SUPPLY WELL SAMPLING STATION NUMBER 7
BETA ANALYSIS
SUPPLY WELL SAMPLING STATION NUMBER 8
BETA ANALYSIS
MIC.C/CC
10^-6
10^-7
10^-8
10^-9
JUL75
JUL76
JUL77
JUN78


SUPPLY WELL SAMPLING STATION NUMBER 9
BETA ANALYSIS
SUPPLY WELL SAMPLING STATION NUMBER 10
BETA ANALYSIS
MIC.C/CC
MIC.C/CC
10^{-6}
10^{-7}
10^{-8}
10^{-9}
JUL75
JUL76
JUL77

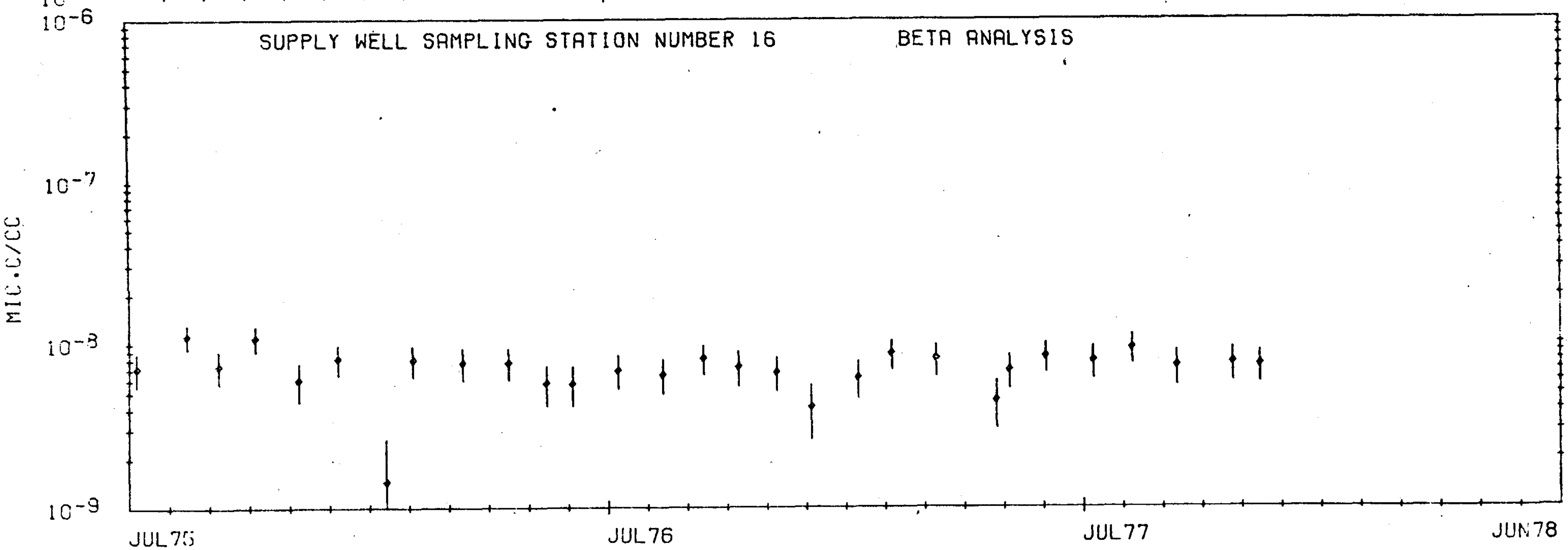

SUPPLY WELL SAMPLING STATION NUMBER 11 BETA ANALYSIS
10⁻⁶
10⁻⁷
10⁻⁸
10⁻⁹


SUPPLY WELL SAMPLING STATION NUMBER 12 BETA ANALYSIS
10⁻⁶
10⁻⁷
10⁻⁸
10⁻⁹
JUL75
JUL76
JUL77
JUN78

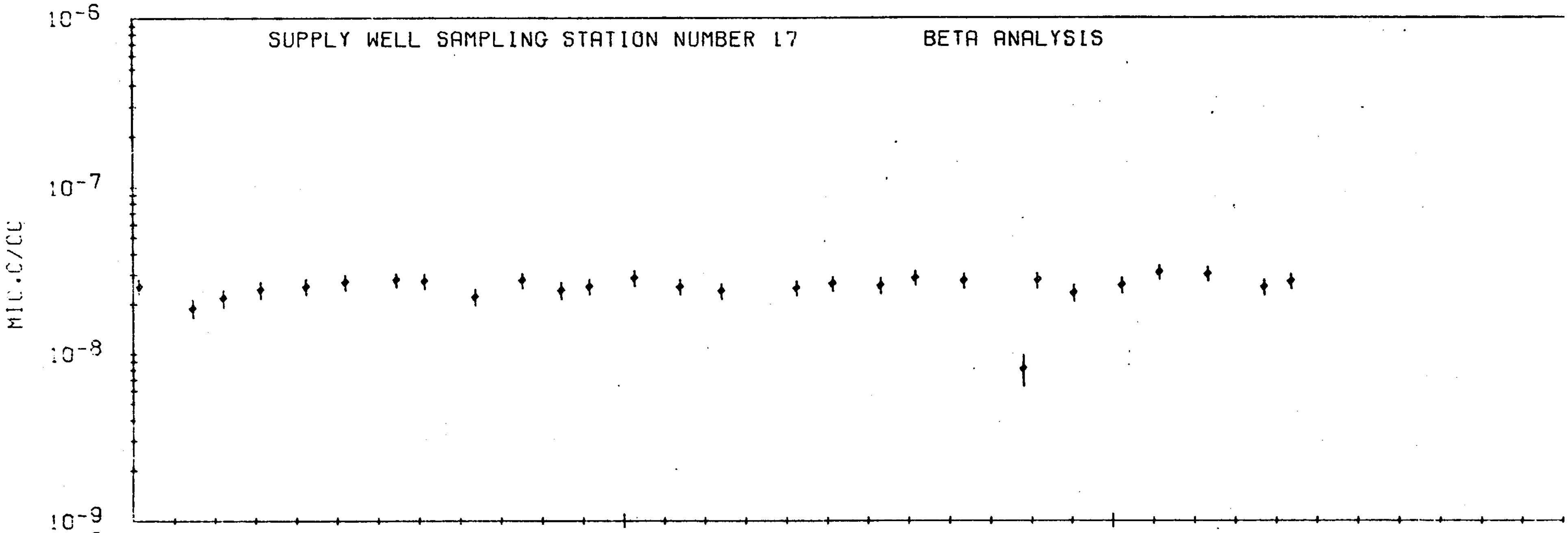

SUPPLY WELL SAMPLING STATION NUMBER 13
BETA ANALYSIS
MIC.C/CC
10^-6
10^-7
10^-8
10^-9
JUL75
JUL76
JUL77
JUN

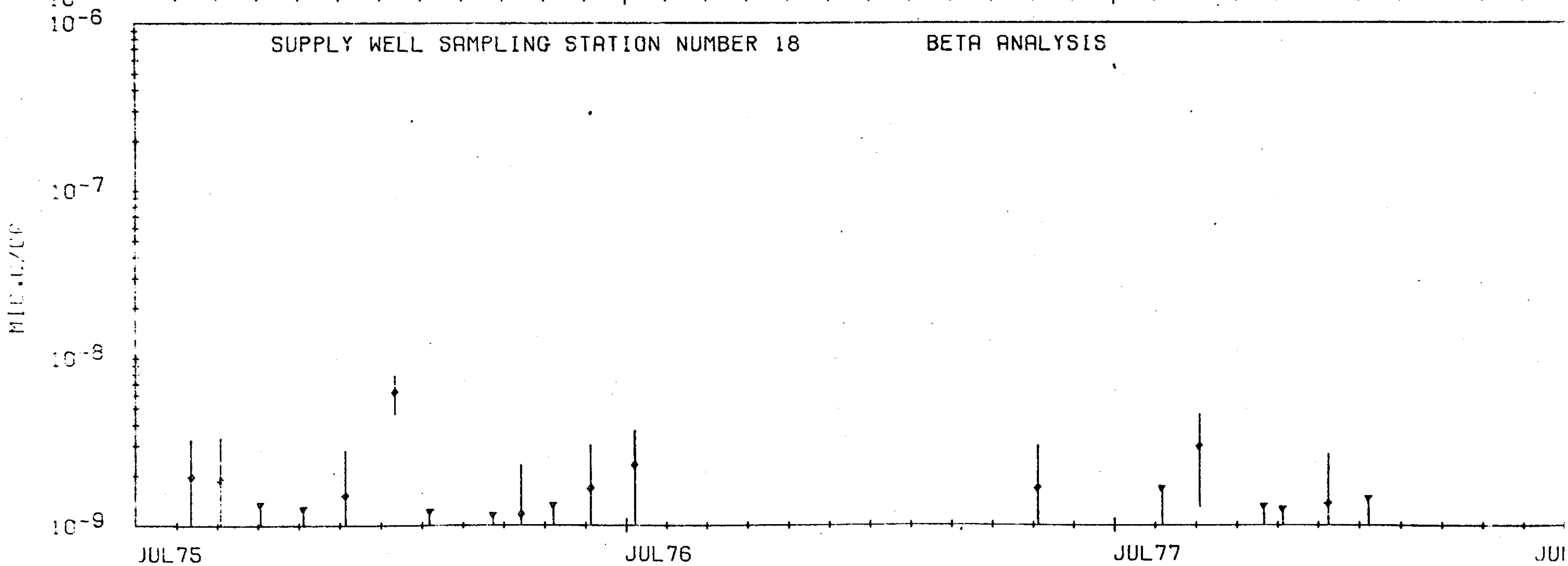


SUPPLY WELL SAMPLING STATION NUMBER 15
BETA ANALYSIS
MIC.C/CC
10^{-6}
10^{-7}
10^{-8}
10^{-9}



SUPPLY WELL SAMPLING STATION NUMBER 16
BETA ANALYSIS
MIC.C/CC
10^{-6}
10^{-7}
10^{-8}
10^{-9}
JUL75
JUL76
JUL77
JUN78


SUPPLY WELL SAMPLING STATION NUMBER 17
BETA ANALYSIS
MIC.C/CC
10^{-6}
10^{-7}
10^{-8}
10^{-9}


SUPPLY WELL SAMPLING STATION NUMBER 18
BETA ANALYSIS
MIC.C/CC
10^{-6}
10^{-7}
10^{-8}
10^{-9}
JUL75
JUL76
JUL77

APPENDIX C

NTS Environmental Surveillance

Potable Water Locations and Plots

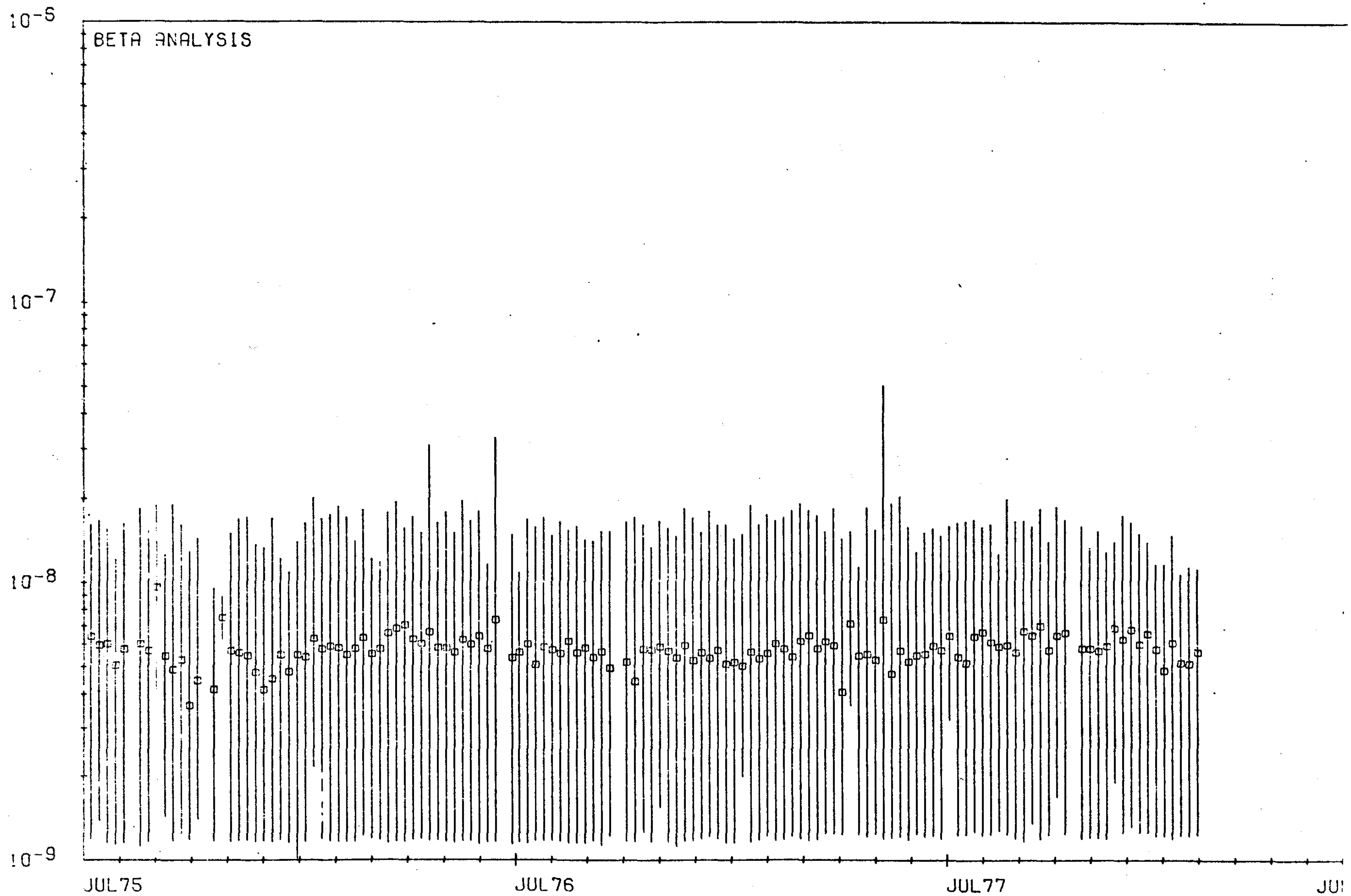
In the first two pages of plots in Appendix C, the potable water network averages, a square is used to represent the geometric mean of all values at that point in time, and the vertical line is the range.

The remaining plots show the gross beta data of each station utilizing the symbol, ✖, as the data point. A two-sigma error bar is also added to the data points, and, in all plots, a delta with a line to the bottom of the plot means below detection limit.

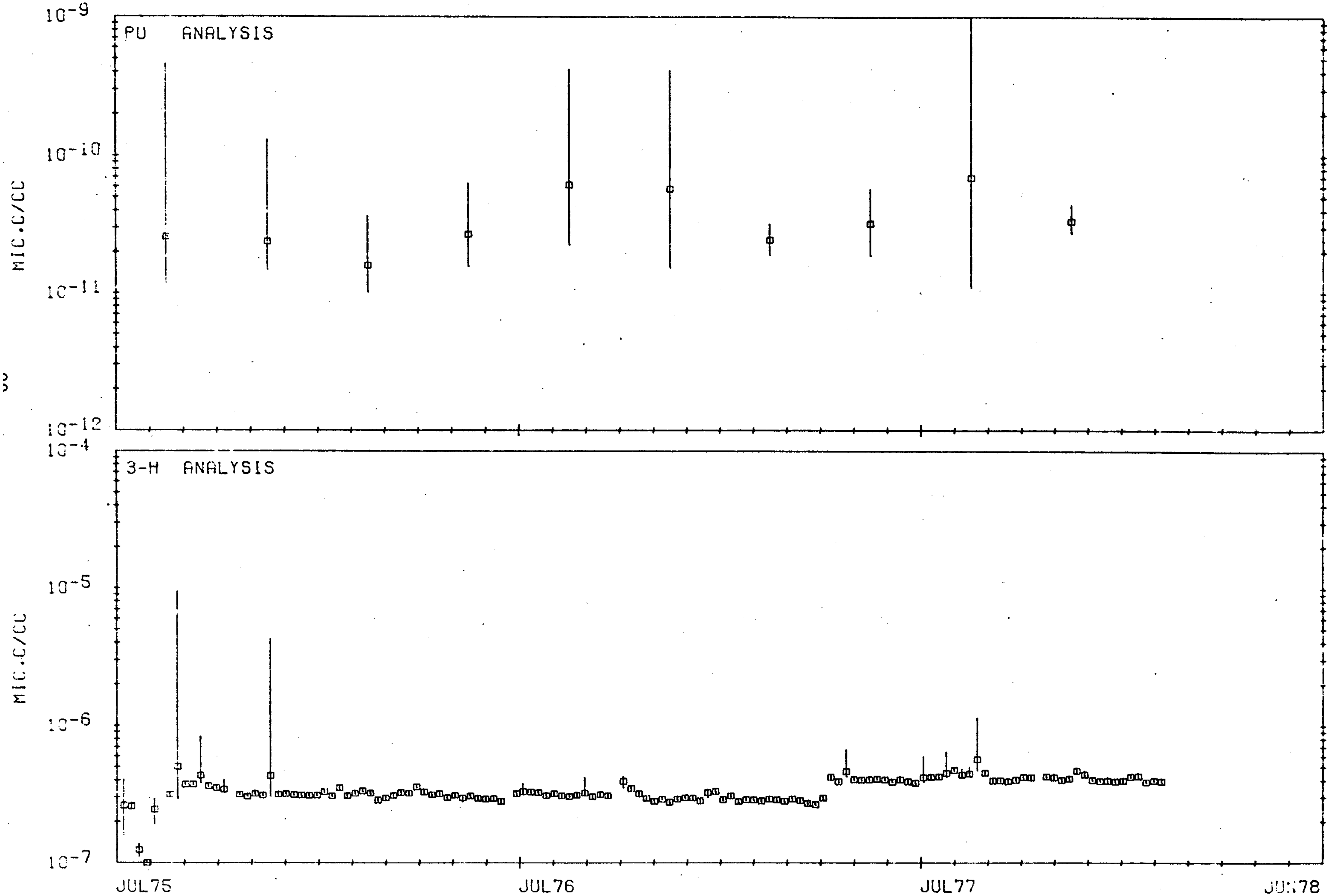
NTS ENVIRONMENTAL SURVEILLANCE
POTABLE WATER SAMPLING LOCATIONS

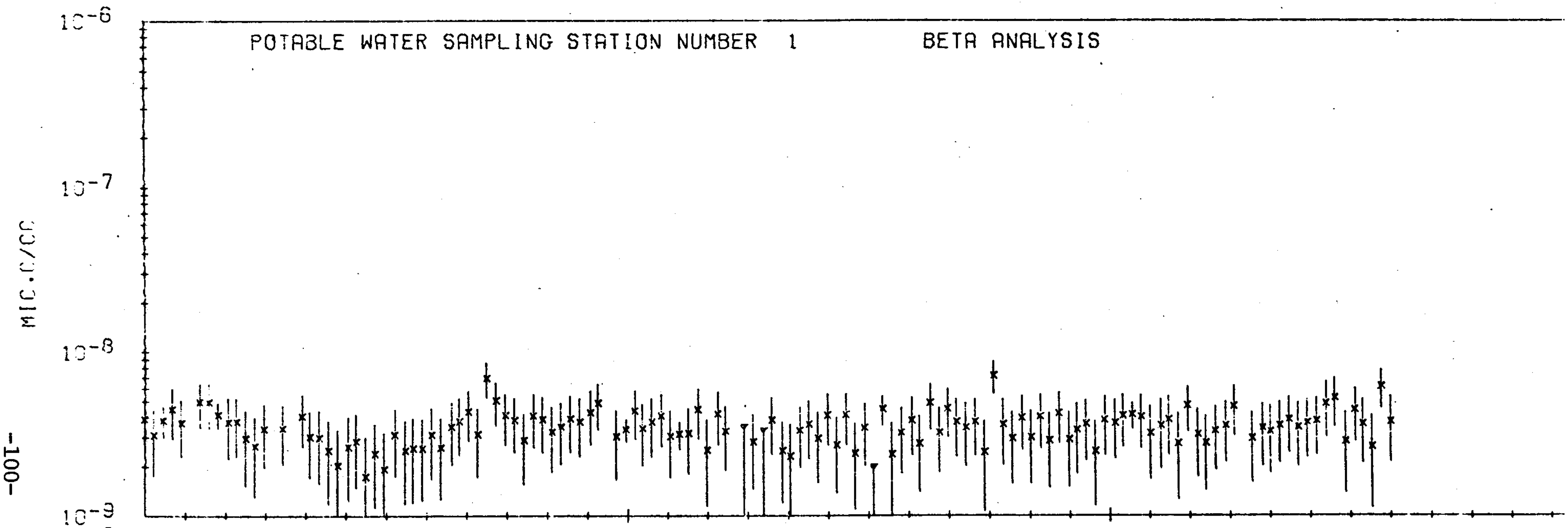
Number	Location	Map Code (Figure 4)
1	Area 2 Men's Rest Room	2A
2	Area 3 Cafeteria	3A
3	Area 6 Cascade	6A
4	Area 6 Cafeteria	6B
5	Area 12 Cafeteria	12A
7	Area 23 Cafeteria	23A
8	Area 27 Cafeteria	27A
9	Groom Lake Cafeteria	00A

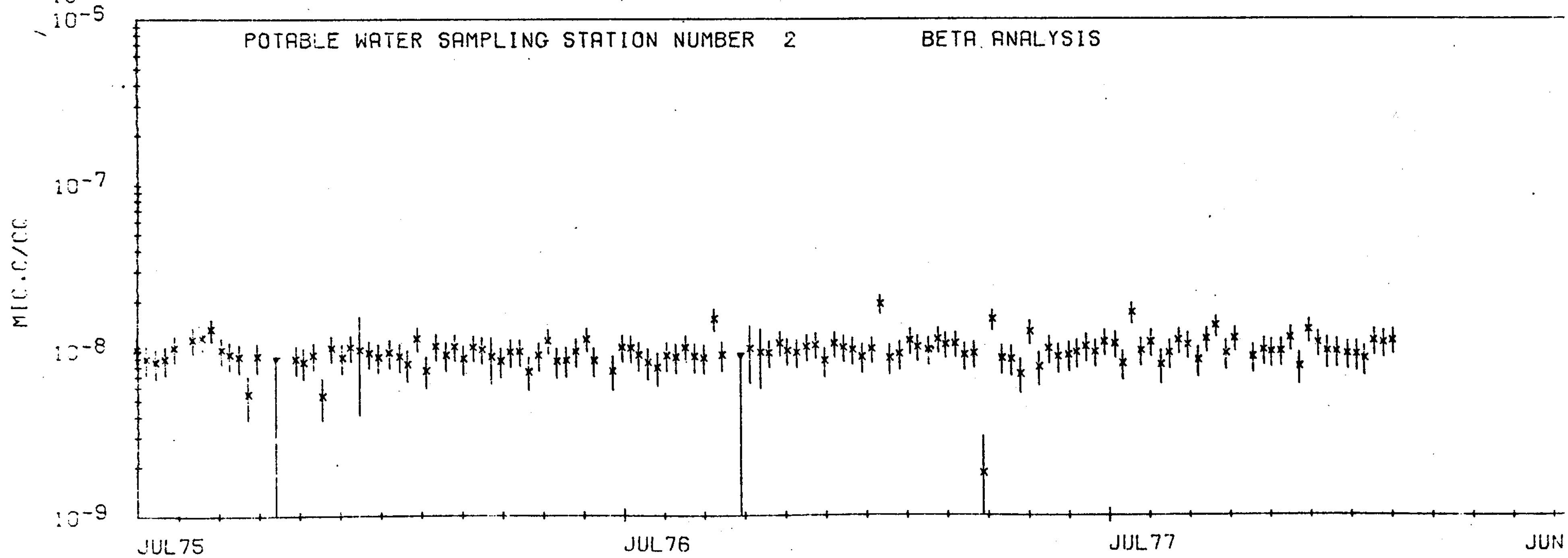
POTABLE WATER NETWORK AVERAGES



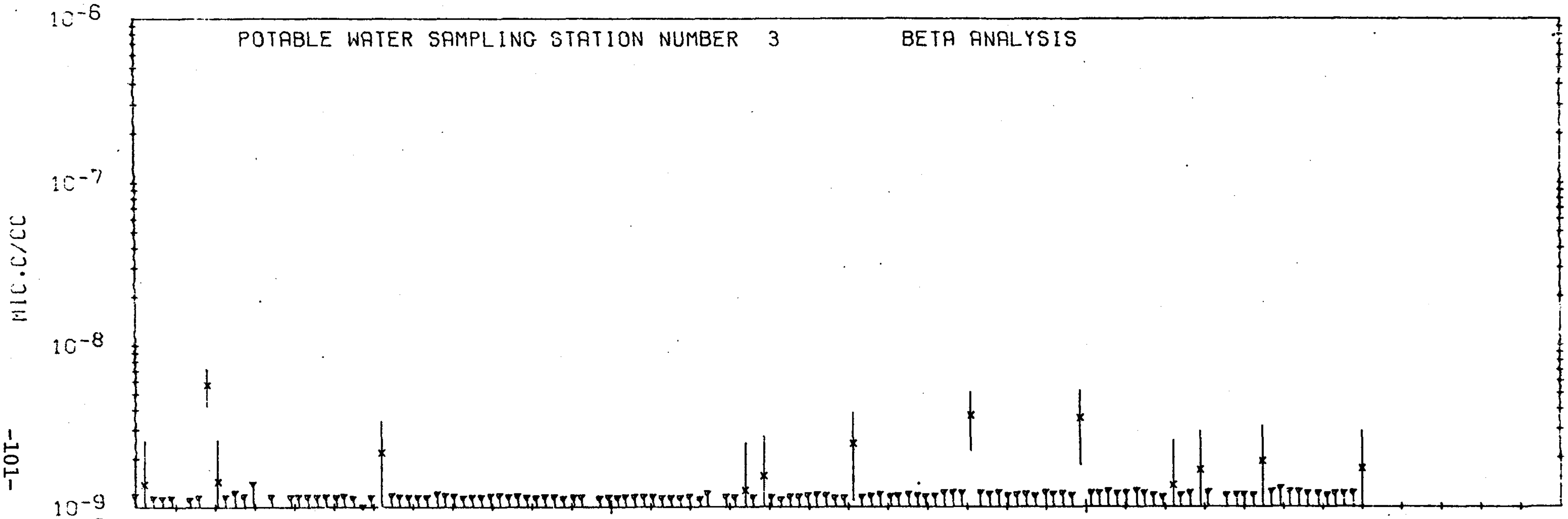
POTABLE WATER NETWORK AVERAGES

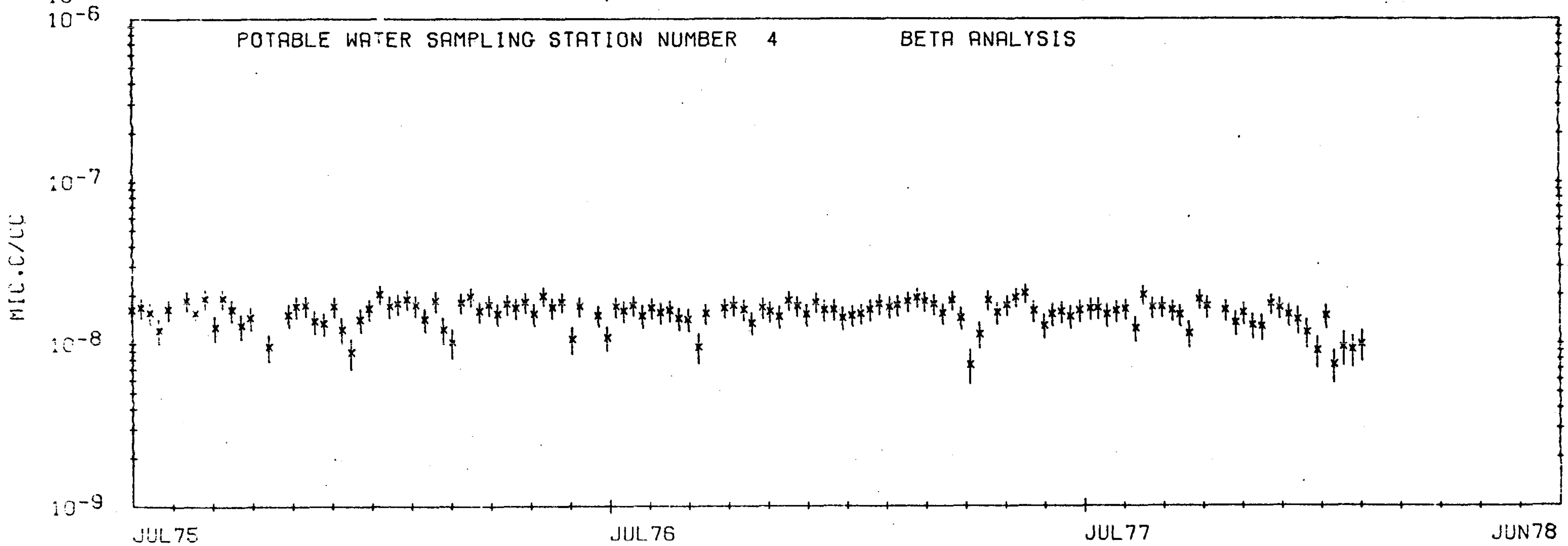


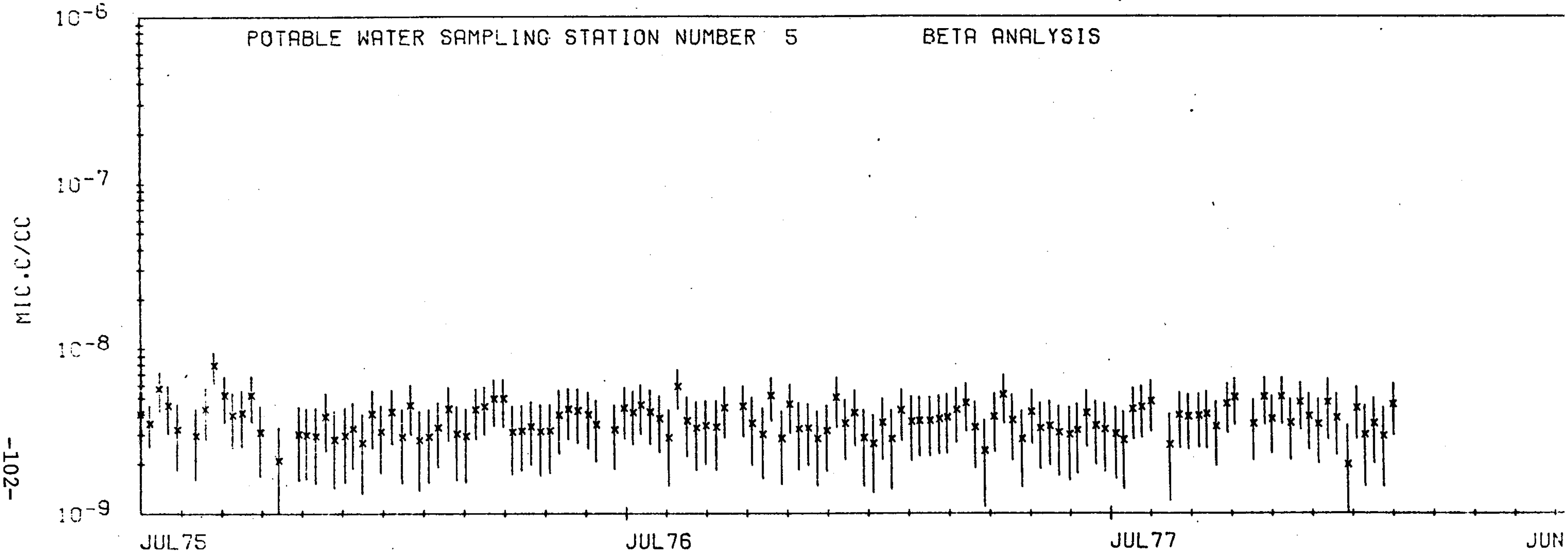

POTABLE WATER SAMPLING STATION NUMBER 1
BETA ANALYSIS
MIC.C/CC
10⁻⁶
10⁻⁷
10⁻⁸
10⁻⁹

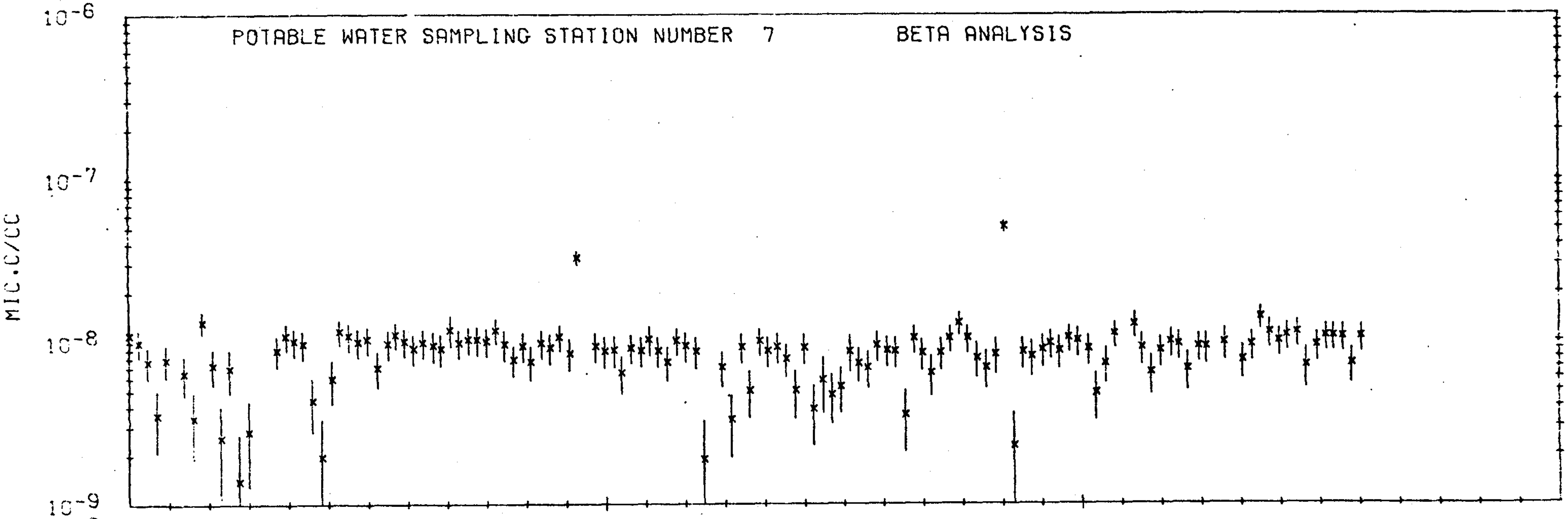

POTABLE WATER SAMPLING STATION NUMBER 2
BETA ANALYSIS
MIC.C/CC
10⁻⁶
10⁻⁷
10⁻⁸
10⁻⁹
JUL75
JUL76
JUL77
JUN

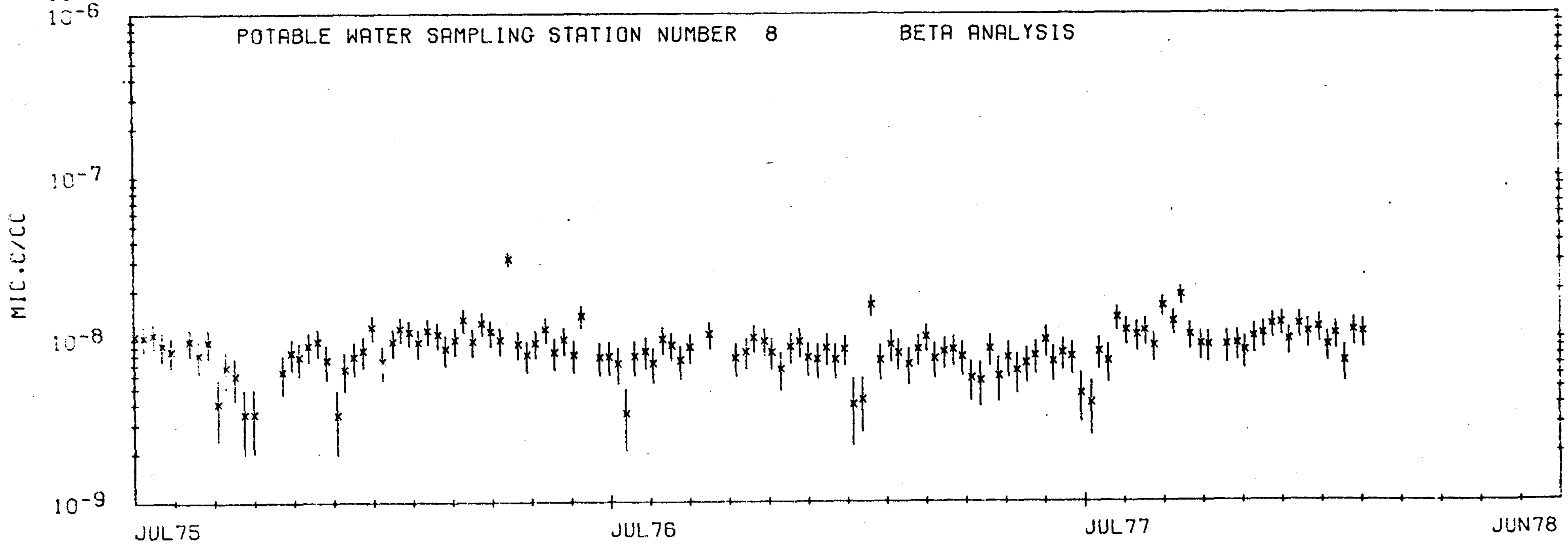
REECo

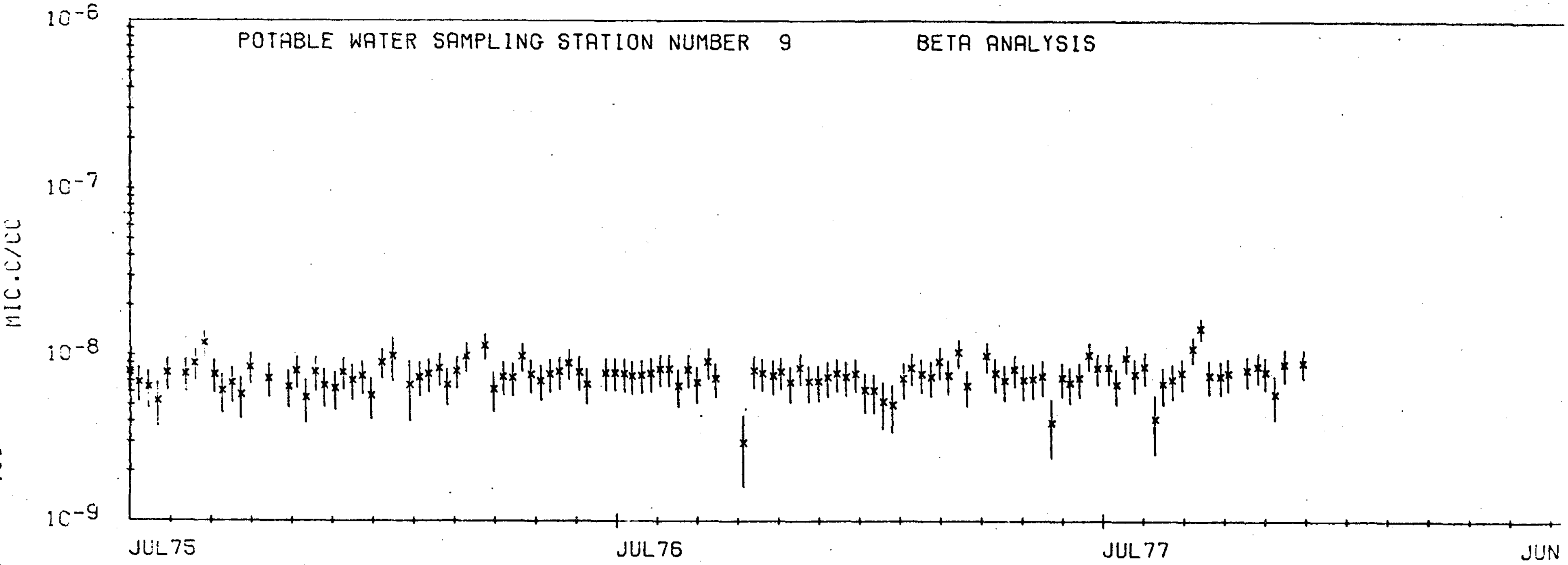

POTABLE WATER SAMPLING STATION NUMBER 3
BETA ANALYSIS
MIC.C/CC
10-6
10-7
10-8
10-9


POTABLE WATER SAMPLING STATION NUMBER 4
BETA ANALYSIS
MIC.C/CC
10-6
10-7
10-8
10-9
JUL75
JUL76
JUL77
JUN78


POTABLE WATER SAMPLING STATION NUMBER 5
BETA ANALYSIS
MIC.C/CC
10^{-6}
10^{-7}
10^{-8}
10^{-9}
JUL75
JUL76
JUL77
JUN


POTABLE WATER SAMPLING STATION NUMBER 7
BETA ANALYSIS
MIC.C/CC
10^{-6}
10^{-7}
10^{-8}
10^{-9}


POTABLE WATER SAMPLING STATION NUMBER 8
BETA ANALYSIS
MIC.C/CC
10^{-6}
10^{-7}
10^{-8}
10^{-9}
JUL75
JUL76
JUL77
JUN78


POTABLE WATER SAMPLING STATION NUMBER 9
BETA ANALYSIS
10^{-6}
10^{-7}
10^{-8}
10^{-9}
MIC.C/CC
JUL75
JUL76
JUL77
JUN

APPENDIX D

NTS Environmental Surveillance

Open Reservoirs Locations and Plots

Several symbols are used in Appendix D to denote the data points. In the first two pages of plots, the open reservoir network averages, a square represents the geometric mean of all values at that point in time, and the vertical line is the range. The remaining plots of Appendix E show the gross beta data of each station. The data symbols for the plots are as follows:

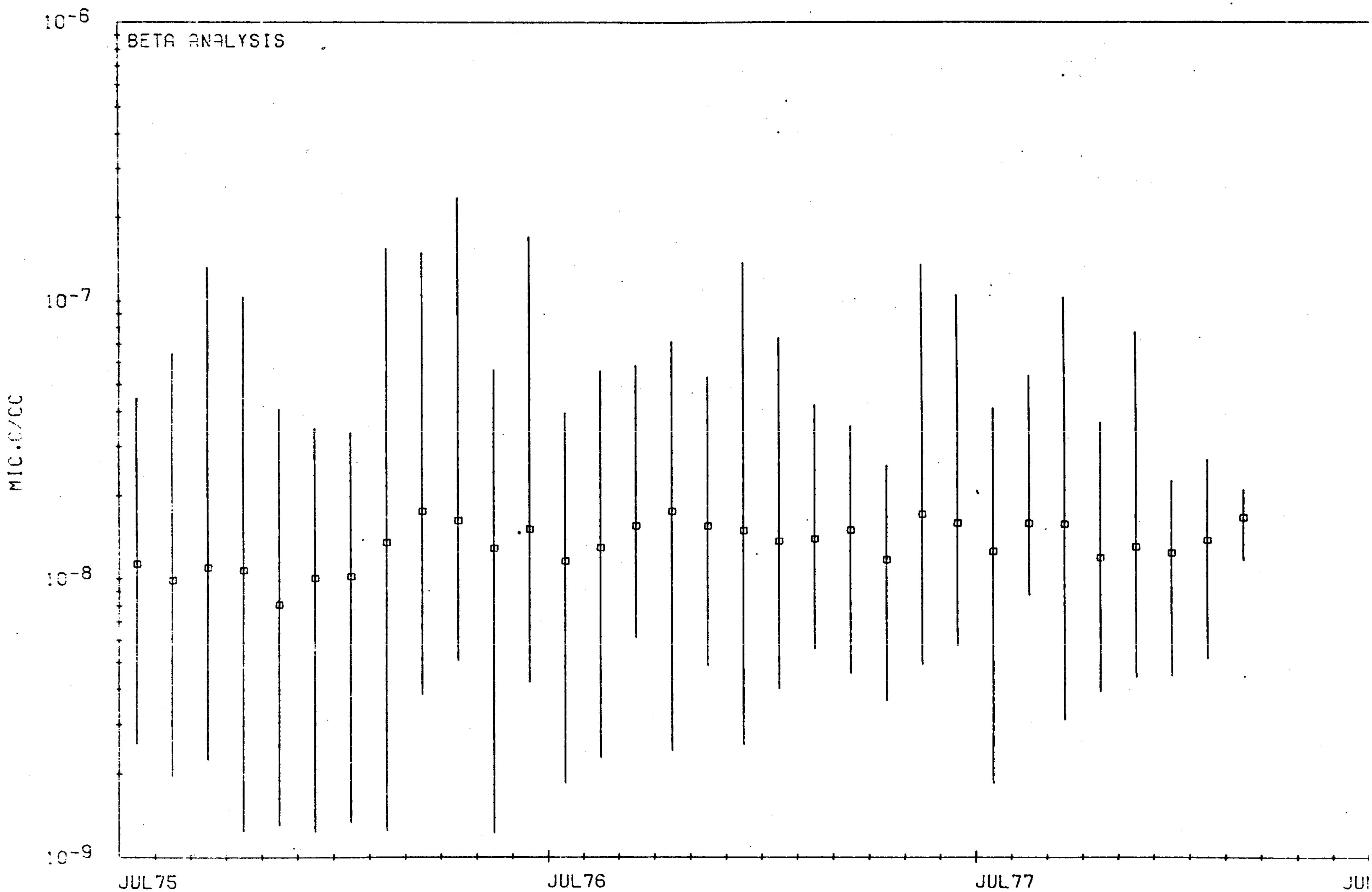
Plot #	Symbol
1-10	✖
11-16	◇

A two-sigma error bar is also added to the data points, and, in all plots, a delta with the line to the bottom of the plot means below detection limit.

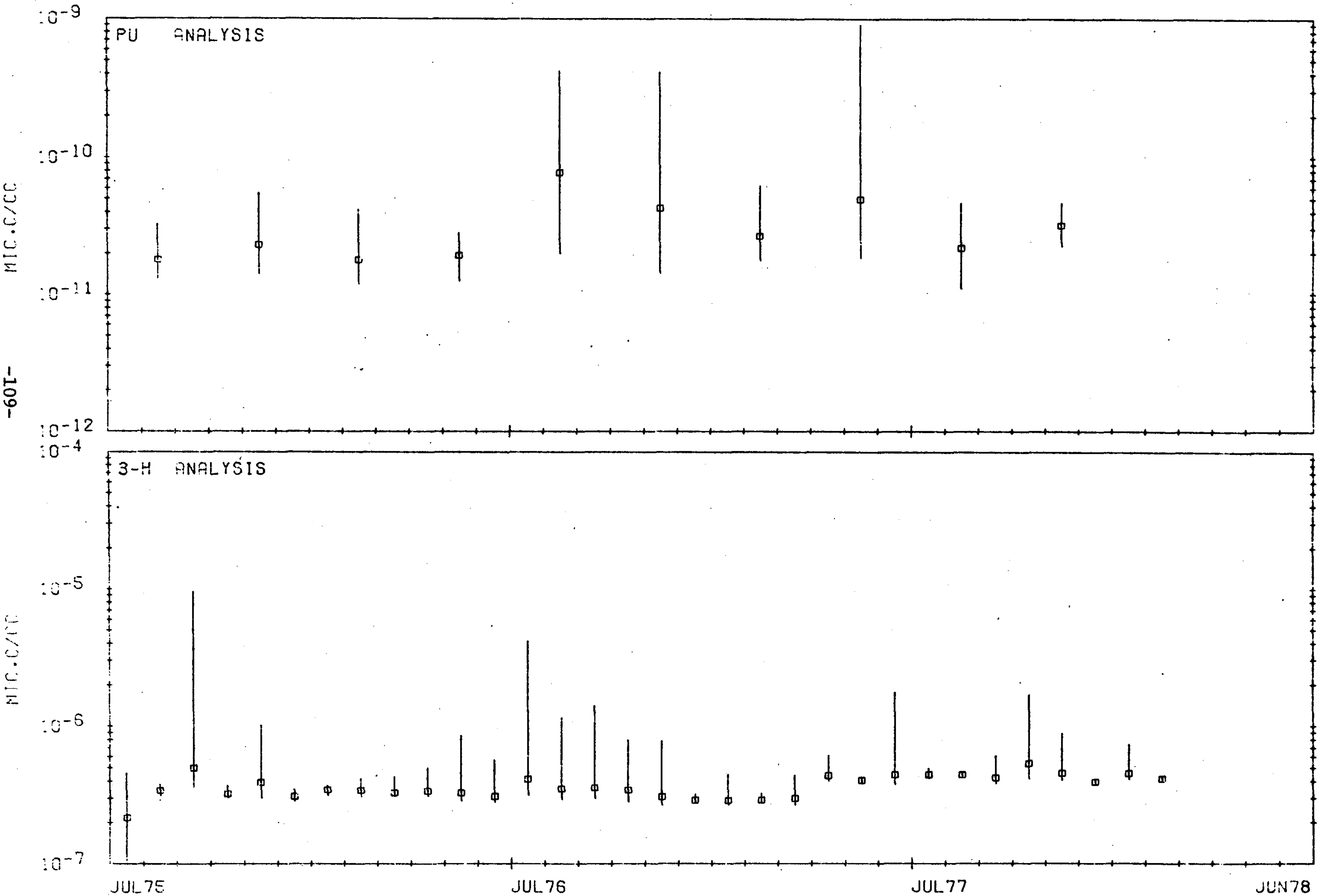
NTS ENVIRONMENTAL SURVEILLANCE
OPEN RESERVOIRS SAMPLING LOCATIONS

Number	Location	Map Code (Figure 5)
1	Area 2 Well 2 Reservoir	2A
2	Area 3 Well A Reservoir	3A
3	Area 5 Well 5B Reservoir	5A
4	Area 5 Well Ue5c Reservoir	5B
5	Area 6 Well 3 Reservoir	6A
6	Area 6 Well C1 Reservoir	6B
7	Area 15 Well Ue15d Reservoir	15A
8	Area 18 Camp 17 Reservoir	18A
9	Area 19 Well Ue19gs Reservoir	19A
10	Area 19 Well Ue19e Reservoir	19B
11	Area 20 Well U20a Reservoir	20A
12	Area 23 Swimming Pool	23A
13	Groom Lake Well 4 Reservoir	00A
14	Groom Lake Papoose Reservoir	00B
15	Groom Lake Swimming Reservoir	00C
16	Area 19 Well U19c Reservoir	19c

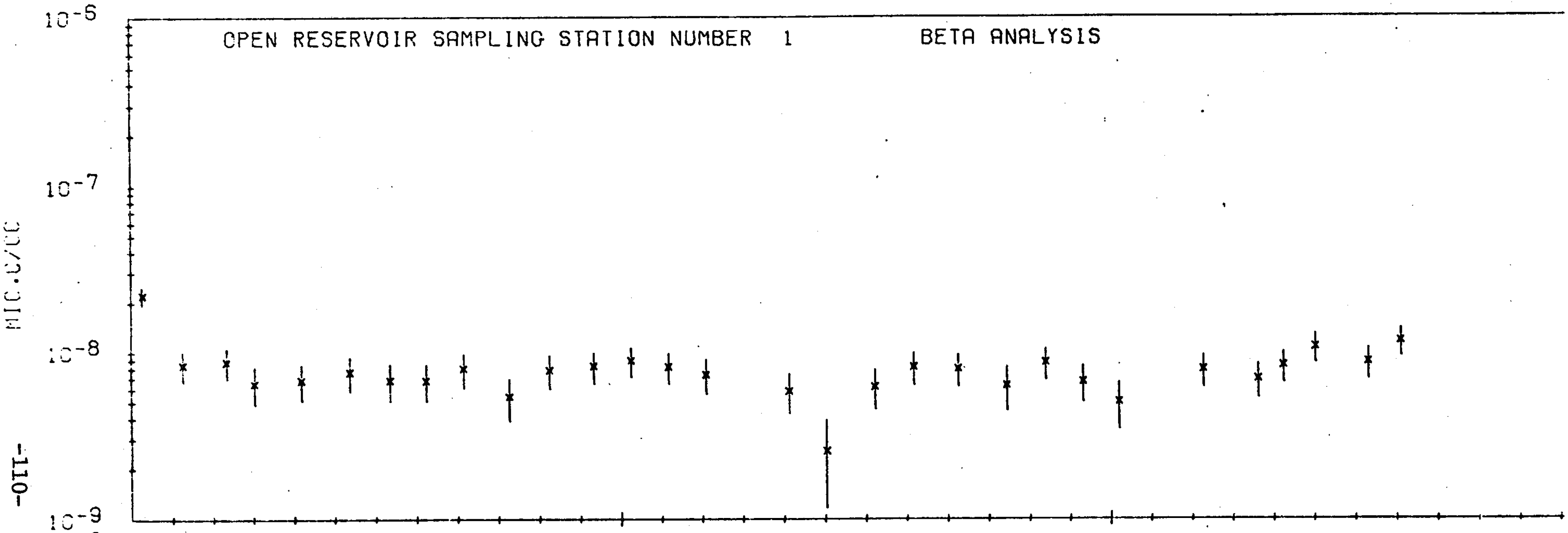
OPEN RESERVOIR NETWORK AVERAGES

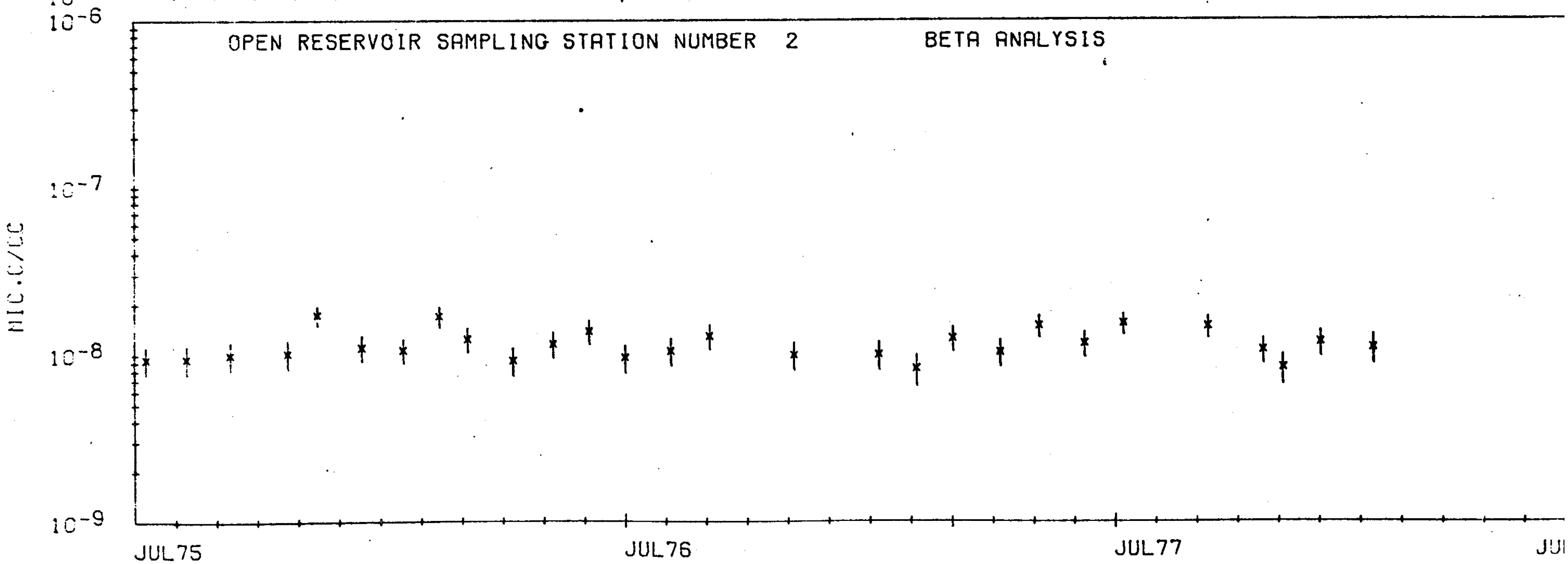


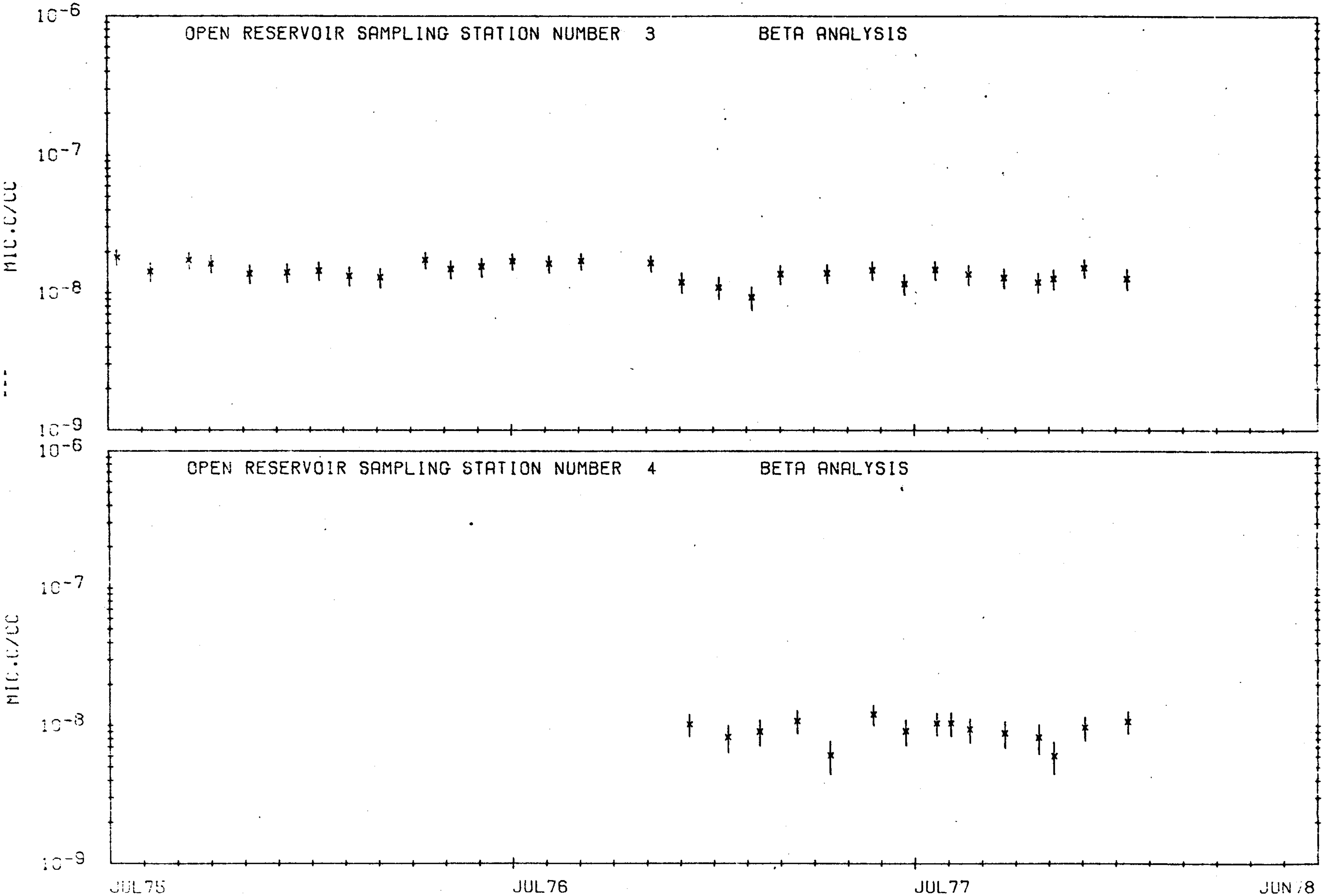
OPEN RESERVOIR NETWORK AVERAGES

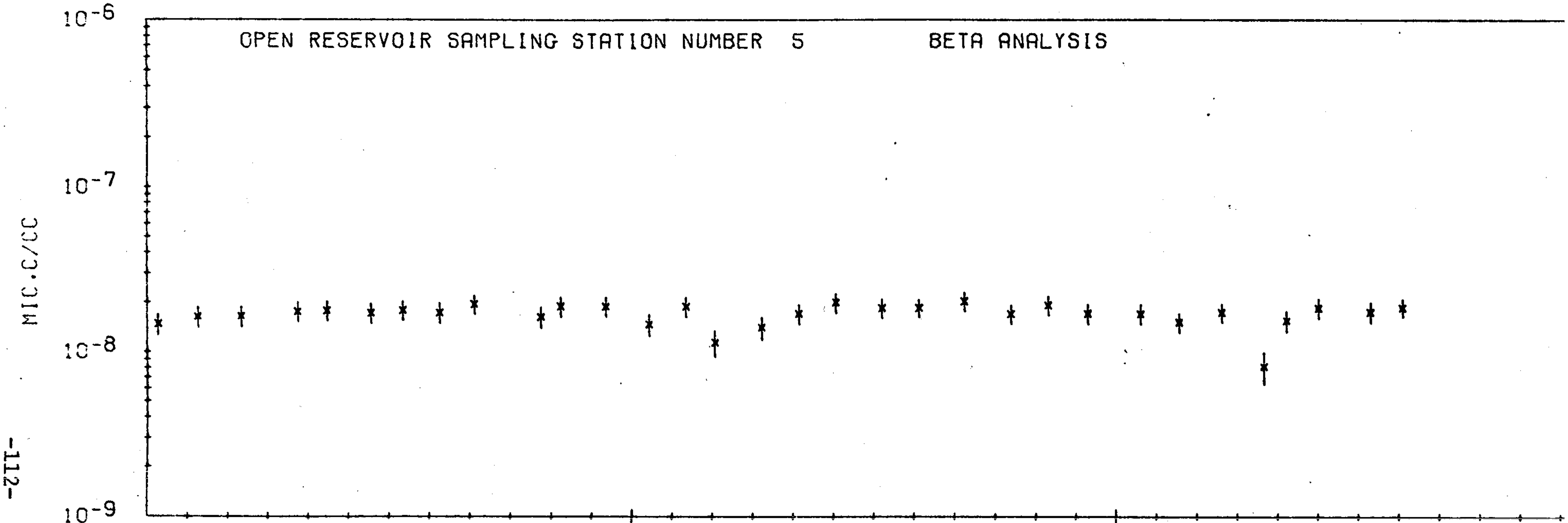


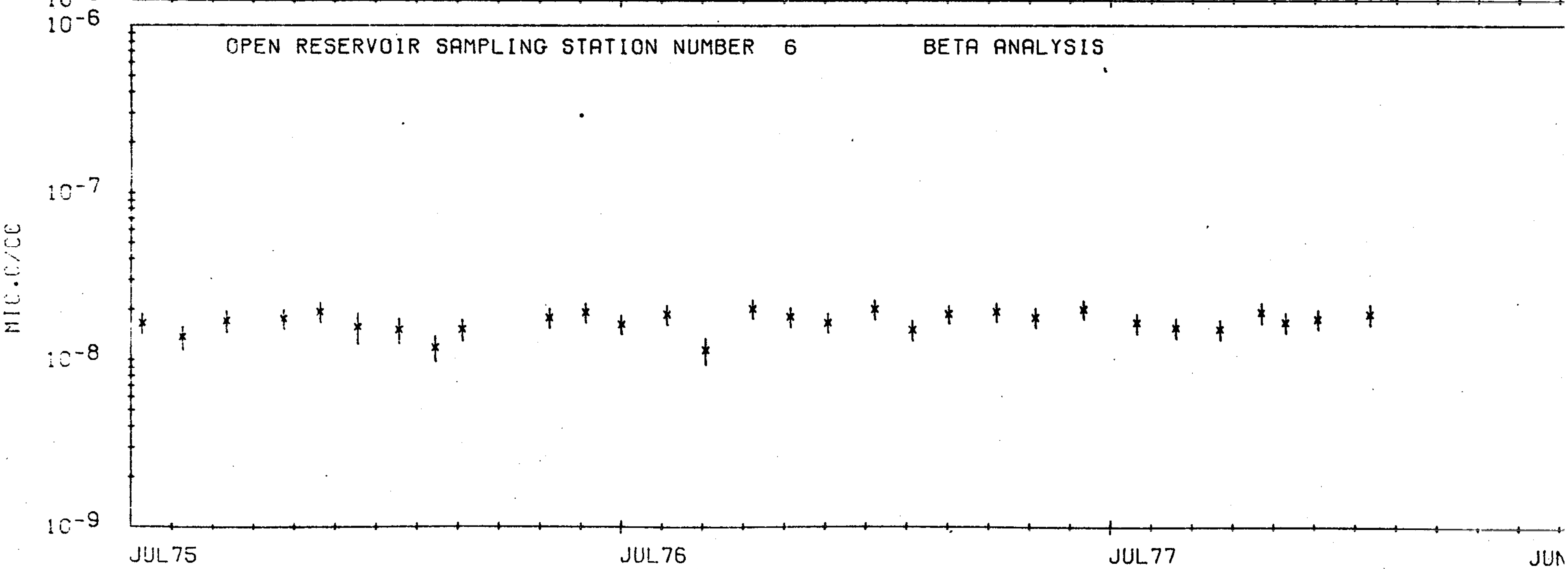
REECo


OPEN RESERVOIR SAMPLING STATION NUMBER 1
BETA ANALYSIS
MIC.C/CC
10^{-6}
10^{-7}
10^{-8}
10^{-9}

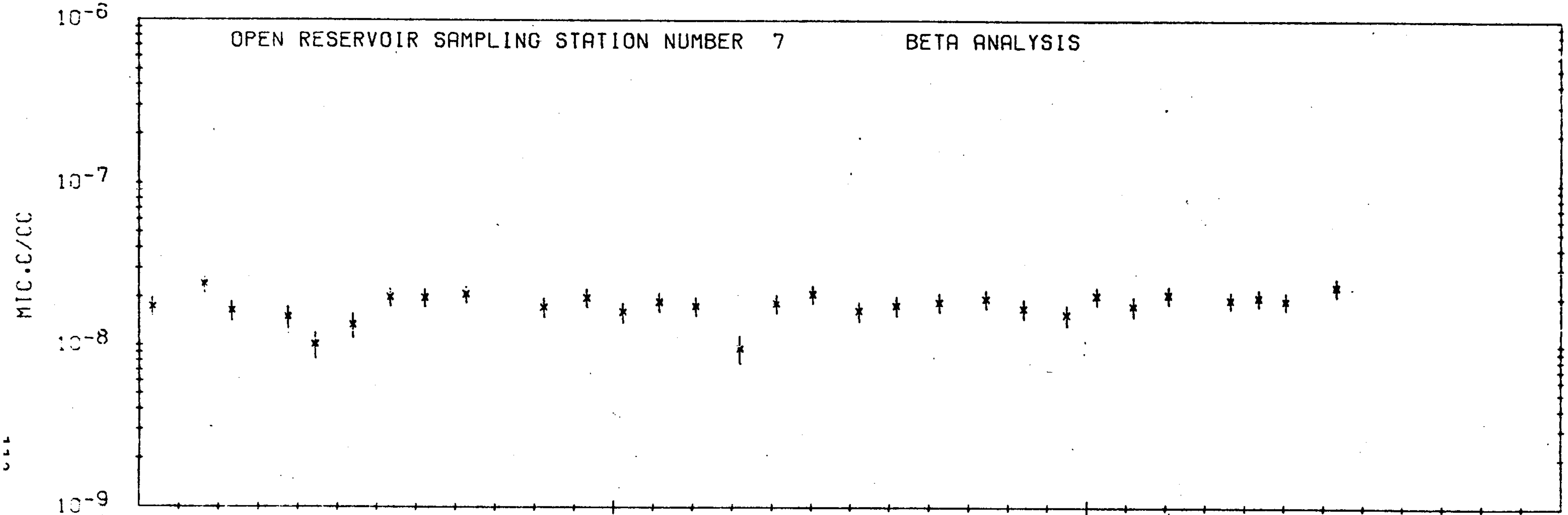

OPEN RESERVOIR SAMPLING STATION NUMBER 2
BETA ANALYSIS
MIC.C/CC
10^{-6}
10^{-7}
10^{-8}
10^{-9}
JUL75
JUL76
JUL77

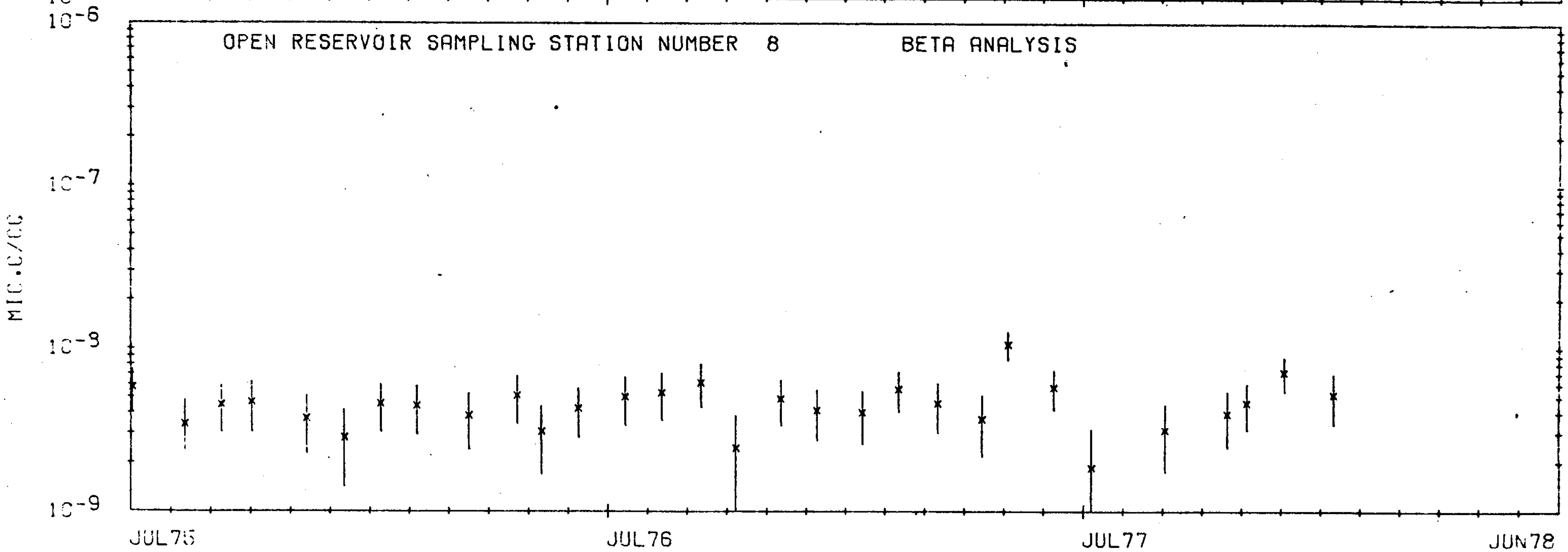

OPEN RESERVOIR SAMPLING STATION NUMBER 3
BETA ANALYSIS
OPEN RESERVOIR SAMPLING STATION NUMBER 4
BETA ANALYSIS
MIC.C/CC
10⁻⁶
10⁻⁷
10⁻⁸
10⁻⁹
JUL75
JUL76
JUL77
JUN78


OPEN RESERVOIR SAMPLING STATION NUMBER 5 BETA ANALYSIS
MIC.C/CC
10-6
10-7
10-8
10-9

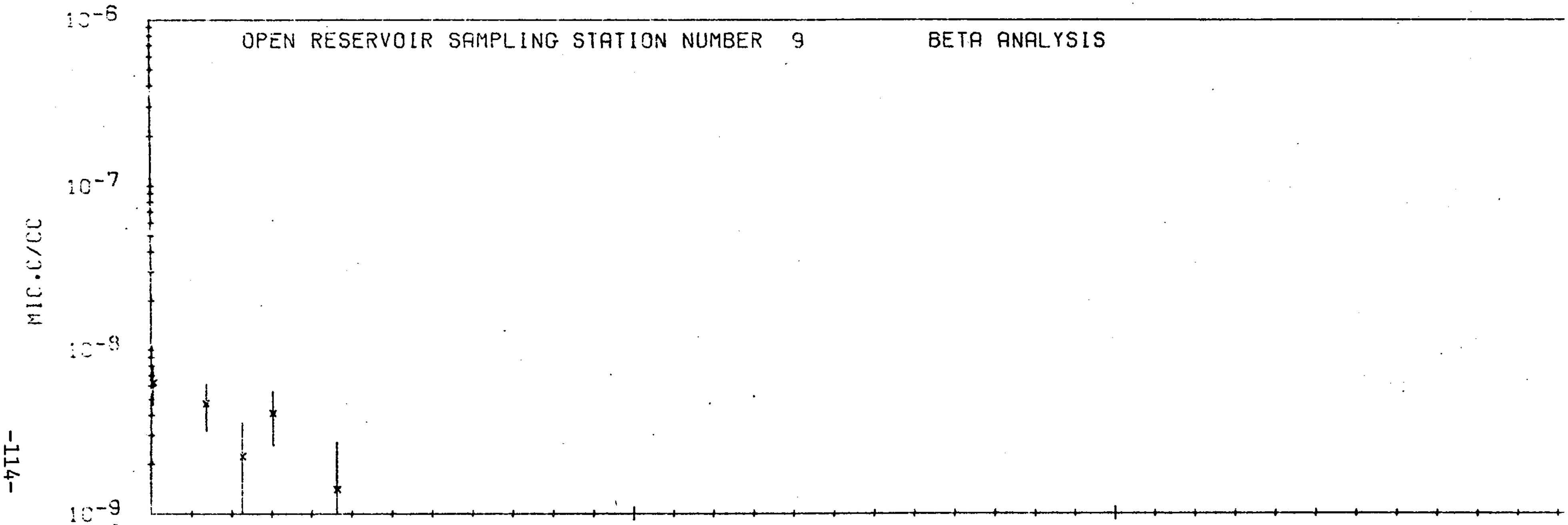

OPEN RESERVOIR SAMPLING STATION NUMBER 6 BETA ANALYSIS
MIC.C/CC
10-6
10-7
10-8
10-9
JUL75
JUL76
JUL77
JUN

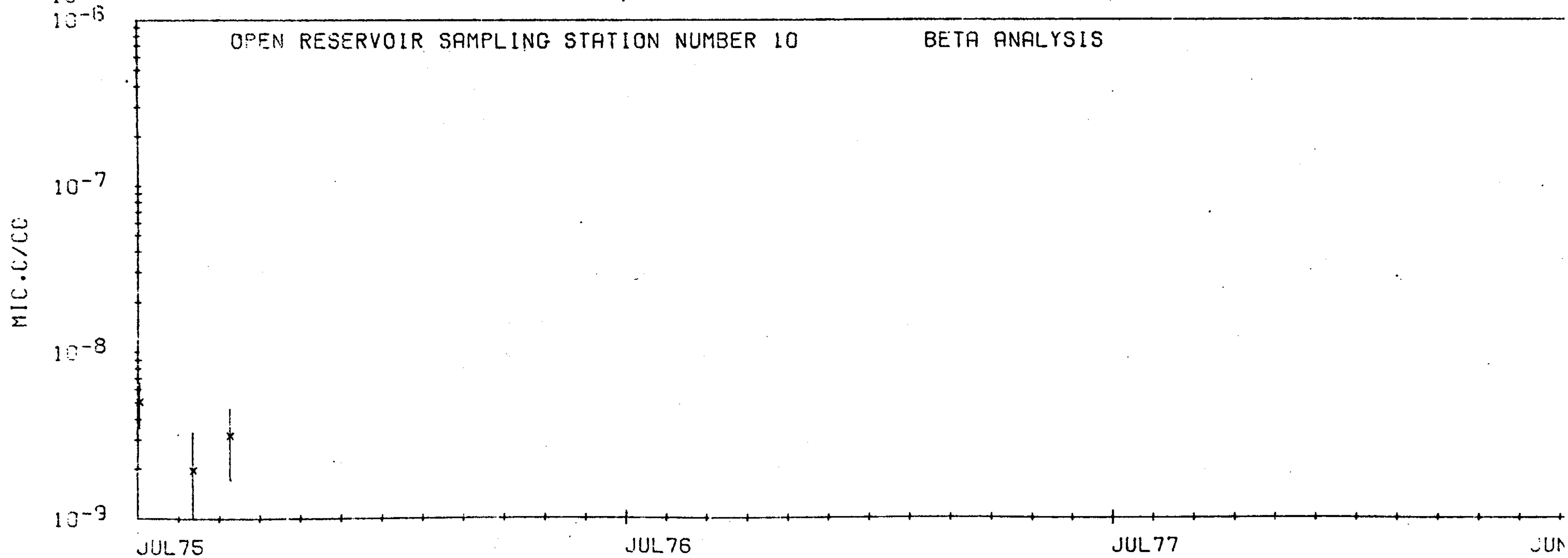
REECo

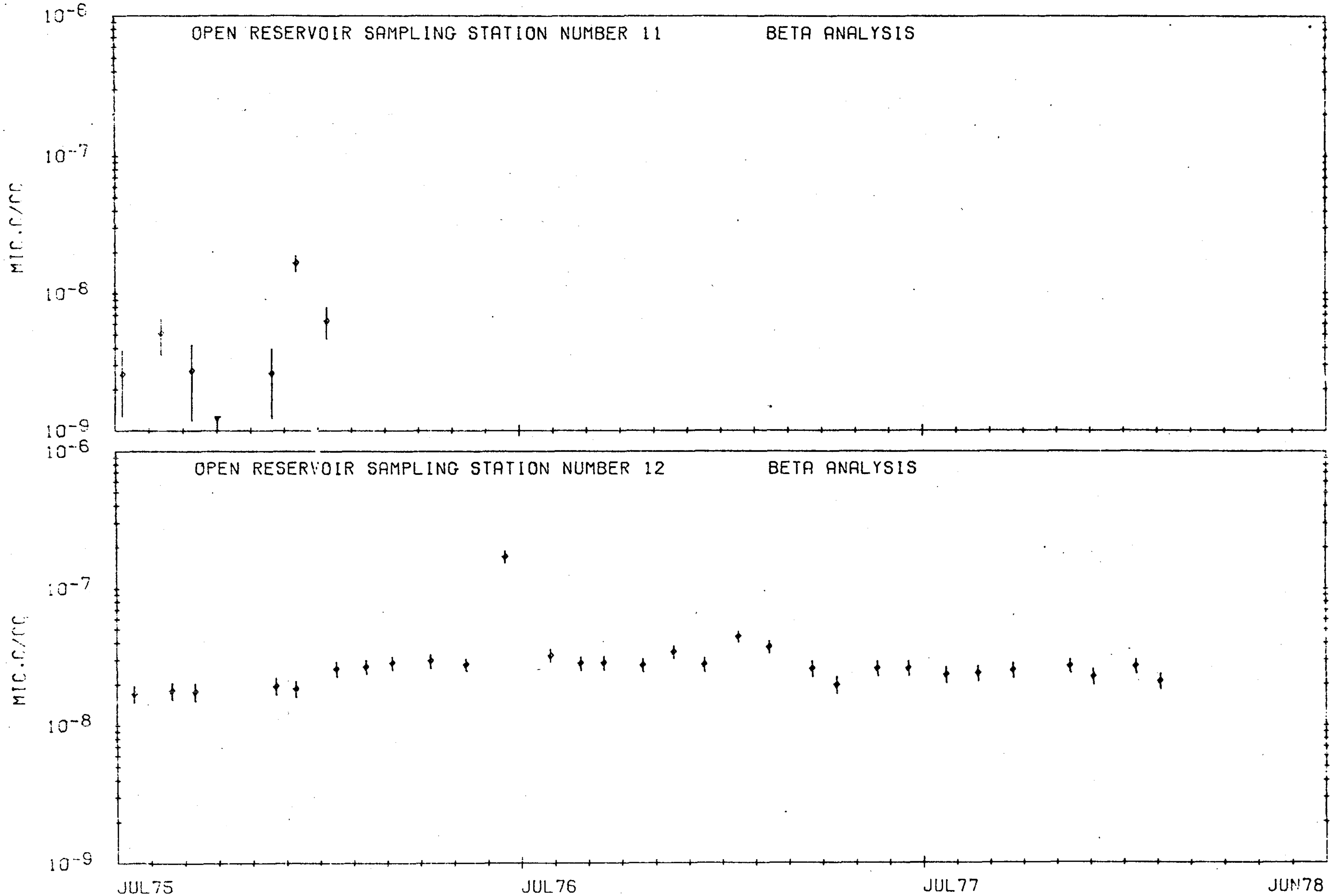

OPEN RESERVOIR SAMPLING STATION NUMBER 7
BETA ANALYSIS
MIC.C/CC
10-6
10-7
10-8
10-9


OPEN RESERVOIR SAMPLING STATION NUMBER 8
BETA ANALYSIS
MIC.C/CC
10-6
10-7
10-8
10-9
JUL75
JUL76
JUL77
JUN78

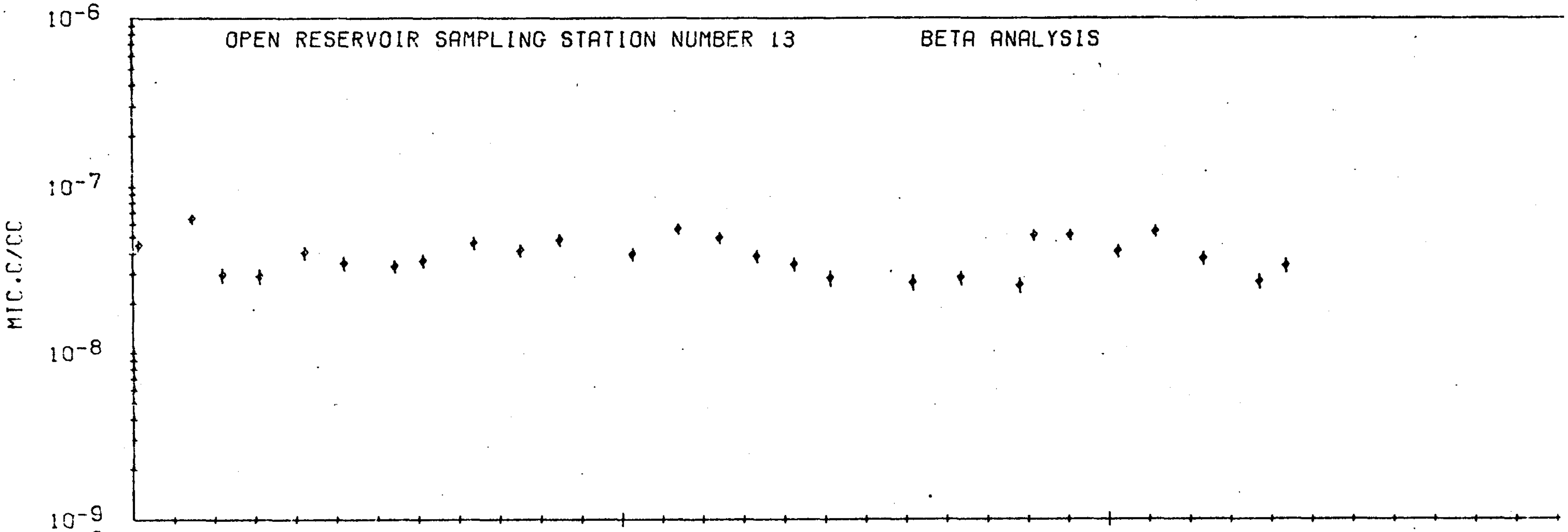
REECo

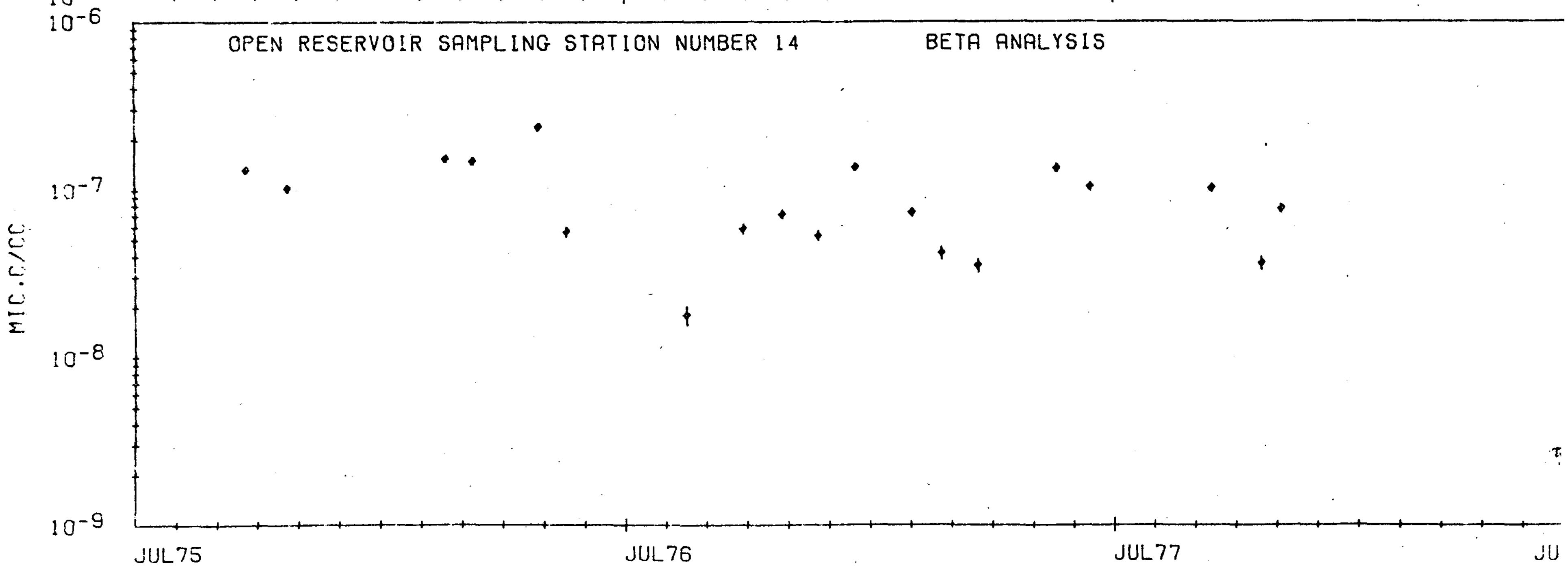

OPEN RESERVOIR SAMPLING STATION NUMBER 9
BETA ANALYSIS
MIC.C/CC
10-6
10-7
10-8
10-9


OPEN RESERVOIR SAMPLING STATION NUMBER 10
BETA ANALYSIS
MIC.C/CC
10-6
10-7
10-8
10-9
JUL75
JUL76
JUL77
JUN

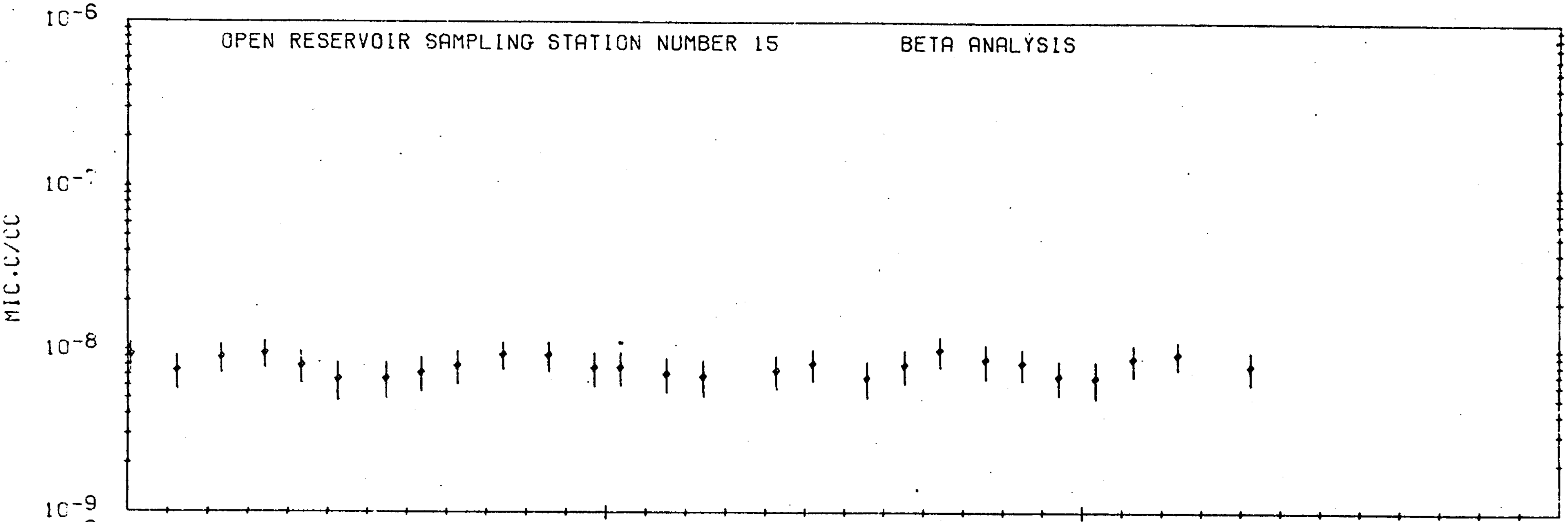


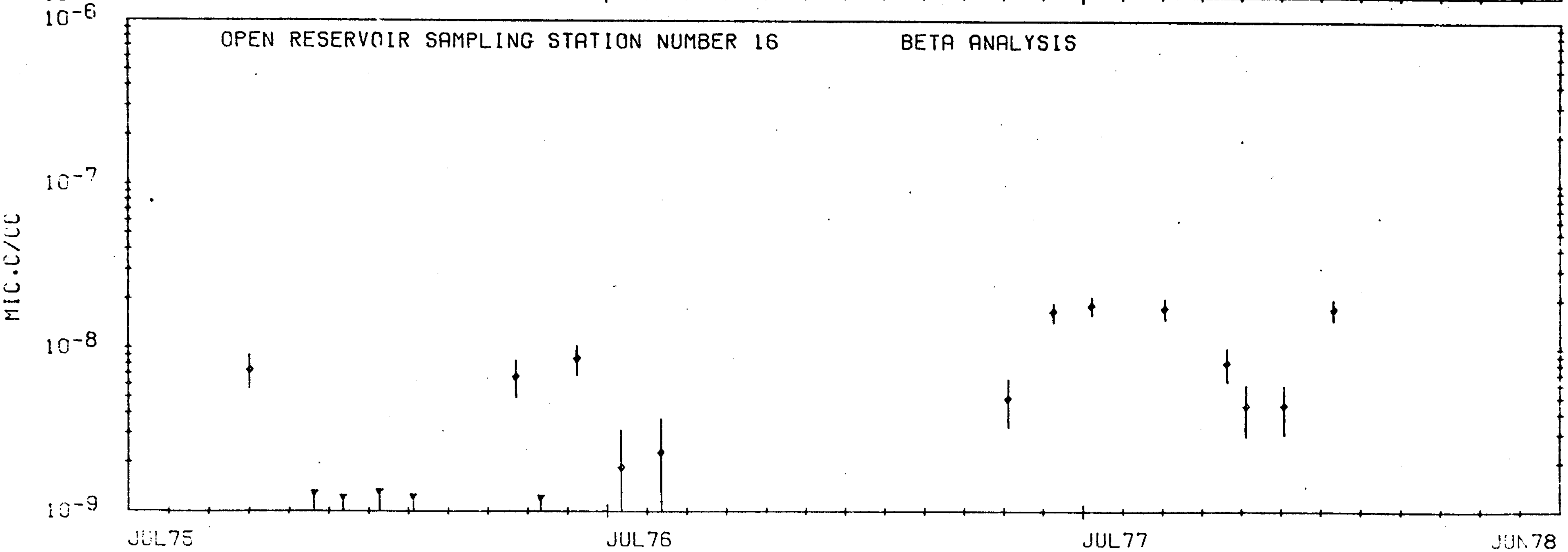
OPEN RESERVOIR SAMPLING STATION NUMBER 11
BETA ANALYSIS
OPEN RESERVOIR SAMPLING STATION NUMBER 12
BETA ANALYSIS
MIC.C/CC
10⁻⁶
10⁻⁷
10⁻⁸
10⁻⁹
JUL75
JUL76
JUL77
JUN78


OPEN RESERVOIR SAMPLING STATION NUMBER 13
BETA ANALYSIS
MIC.C/CC
10^-6
10^-7
10^-8
10^-9


OPEN RESERVOIR SAMPLING STATION NUMBER 14
BETA ANALYSIS
MIC.C/CC
10^-6
10^-7
10^-8
10^-9
JUL75
JUL76
JUL77
JU

REECo


OPEN RESERVOIR SAMPLING STATION NUMBER 15
BETA ANALYSIS
MIC.C/CC
10^-6
10^-7
10^-8
10^-9


OPEN RESERVOIR SAMPLING STATION NUMBER 16
BETA ANALYSIS
MIC.C/CC
10^-6
10^-7
10^-8
10^-9
JUL75
JUL76
JUL77
JUN78

APPENDIX E

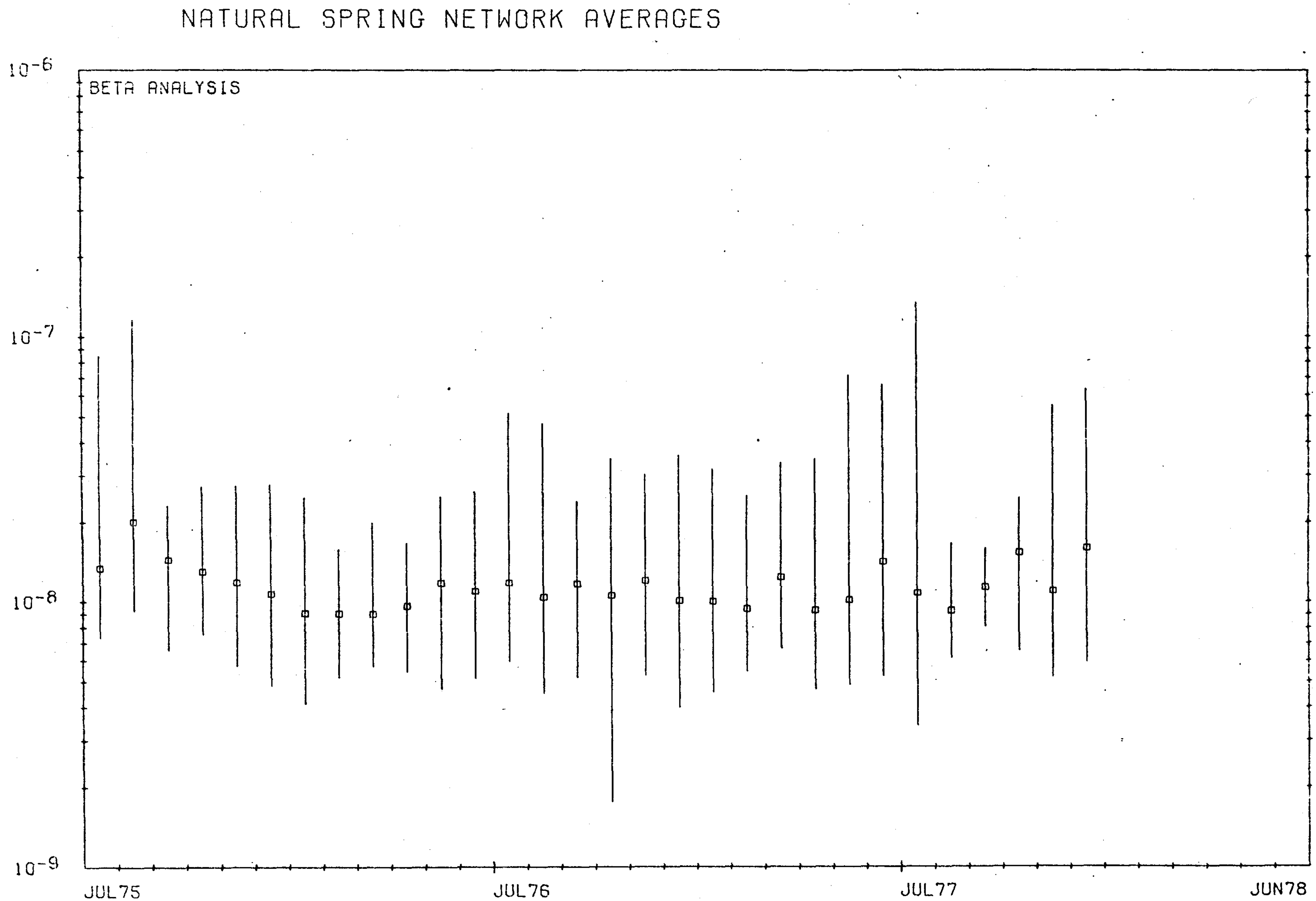
NTS Environmental Surveillance

Natural Springs Locations and Plots

In the first two pages of plots in Appendix E, the natural springs network averages, a square is used to represent the geometric mean of all values at that point in time, and the vertical line is the range. The remaining plots show the gross beta data of each station utilizing the symbol, ✖, as the data point. A two-sigma error bar is also added to the data points, and, in all plots, a delta with a line to the bottom of the plot means below detection limit.

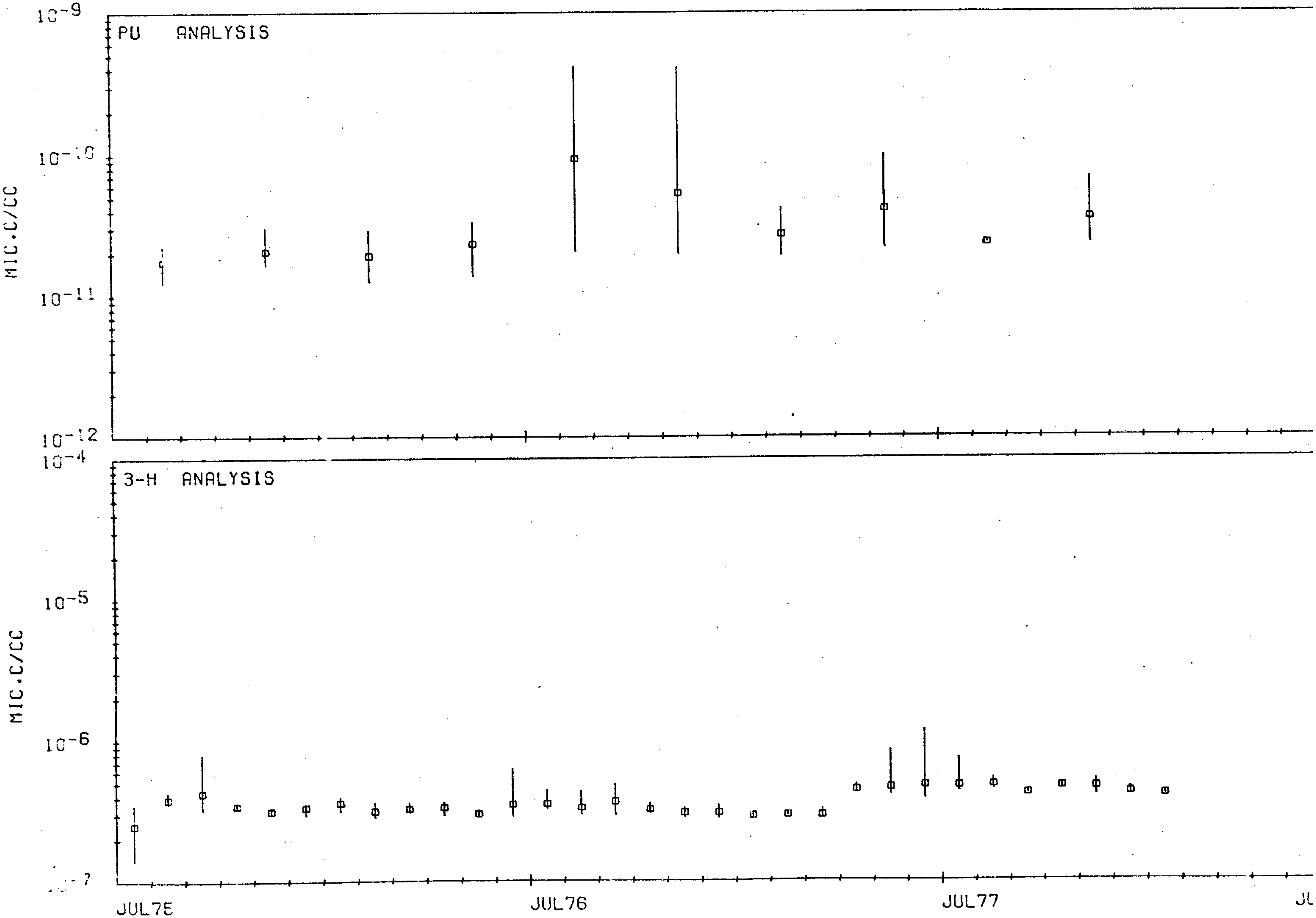
NTS ENVIRONMENTAL SURVEILLANCE
NATURAL SPRINGS SAMPLING LOCATIONS

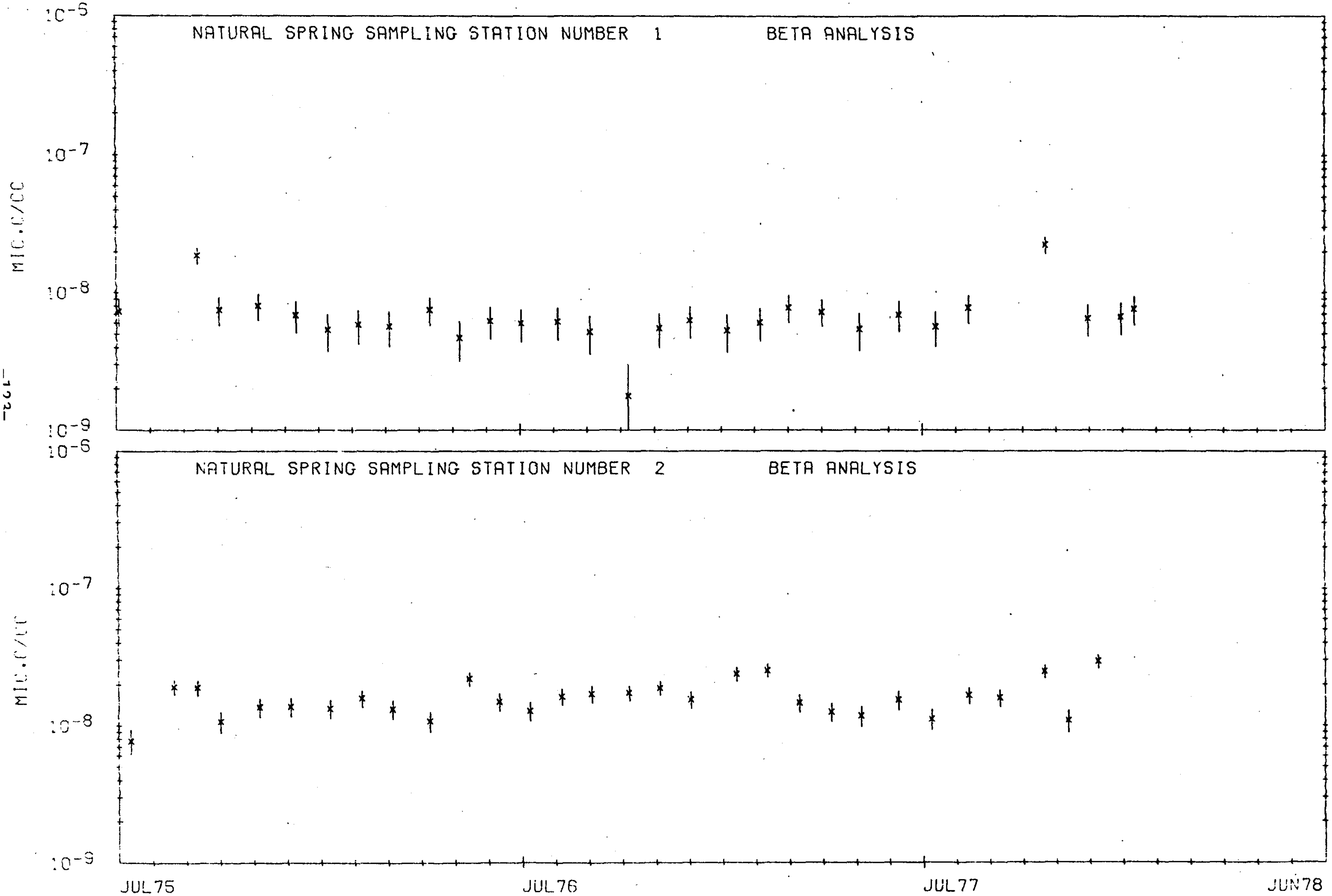
Number	Location	Map Code (Figure 6)
1	Area 5 Cane Springs	5A
2	Area 12 White Rock Spring	12A
3	Area 12 Captain Jack Spring	12B
4	Area 12 Gold Meadows Pond	12C
5	Area 15 Oak Butte Spring	15A
6	Area 15 Tub Spring	15B
7	Area 29 Topopah Spring	29A

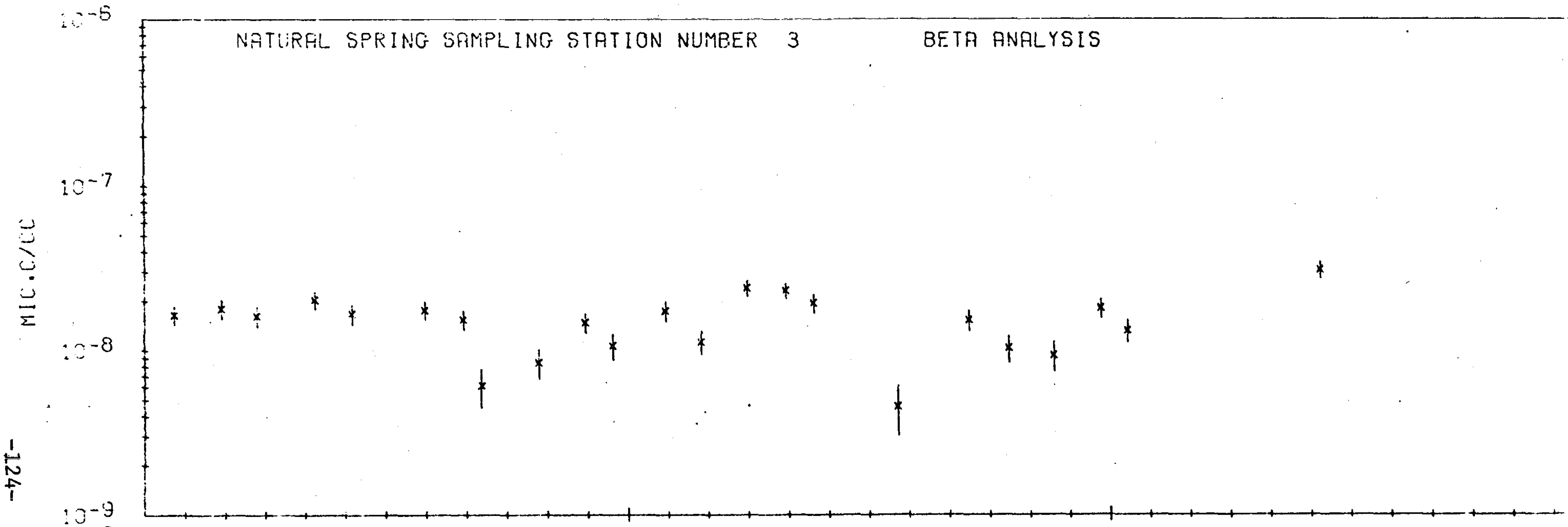


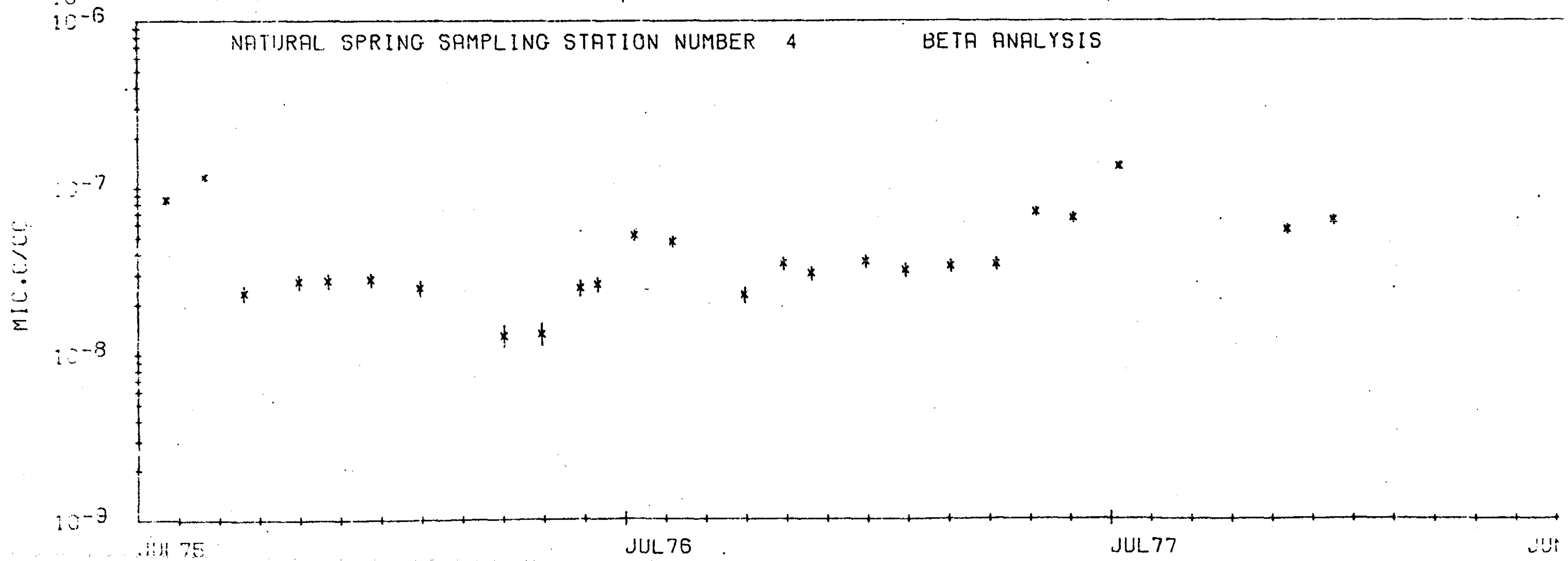
NATURAL SPRING NETWORK AVERAGES
BETA ANALYSIS
10^{-6}
10^{-7}
10^{-8}
10^{-9}
MIC.C/CC
JUL75
JUL76
JUL77
JUN78

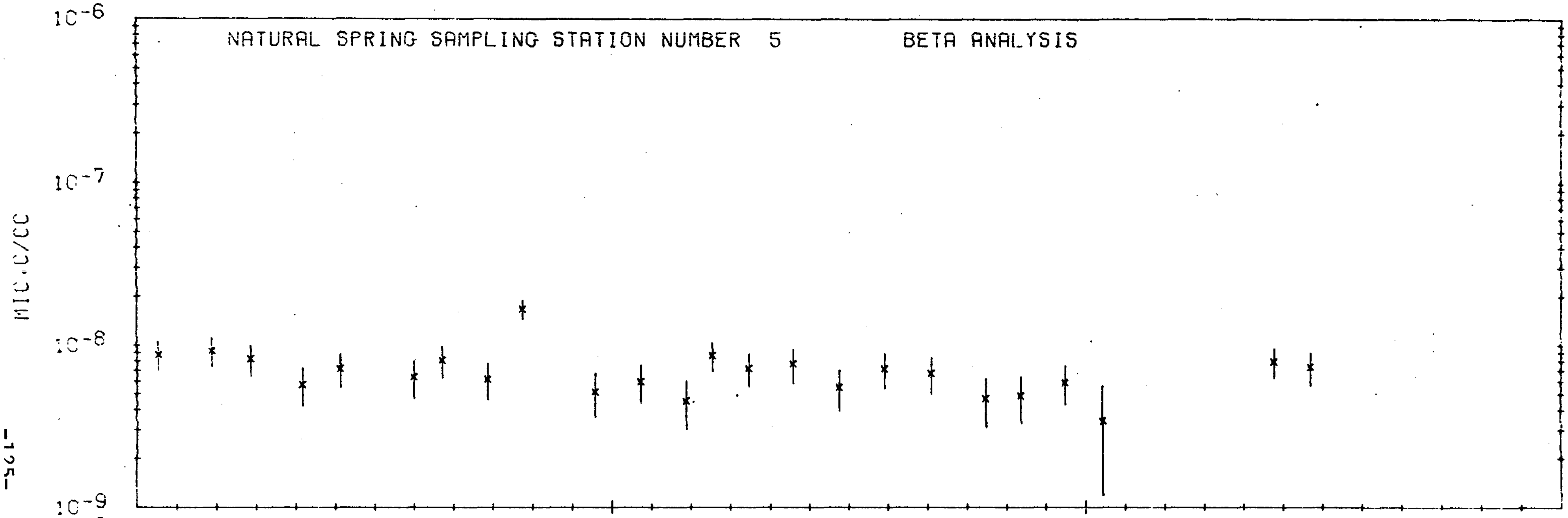
NATURAL SPRING NETWORK AVERAGES



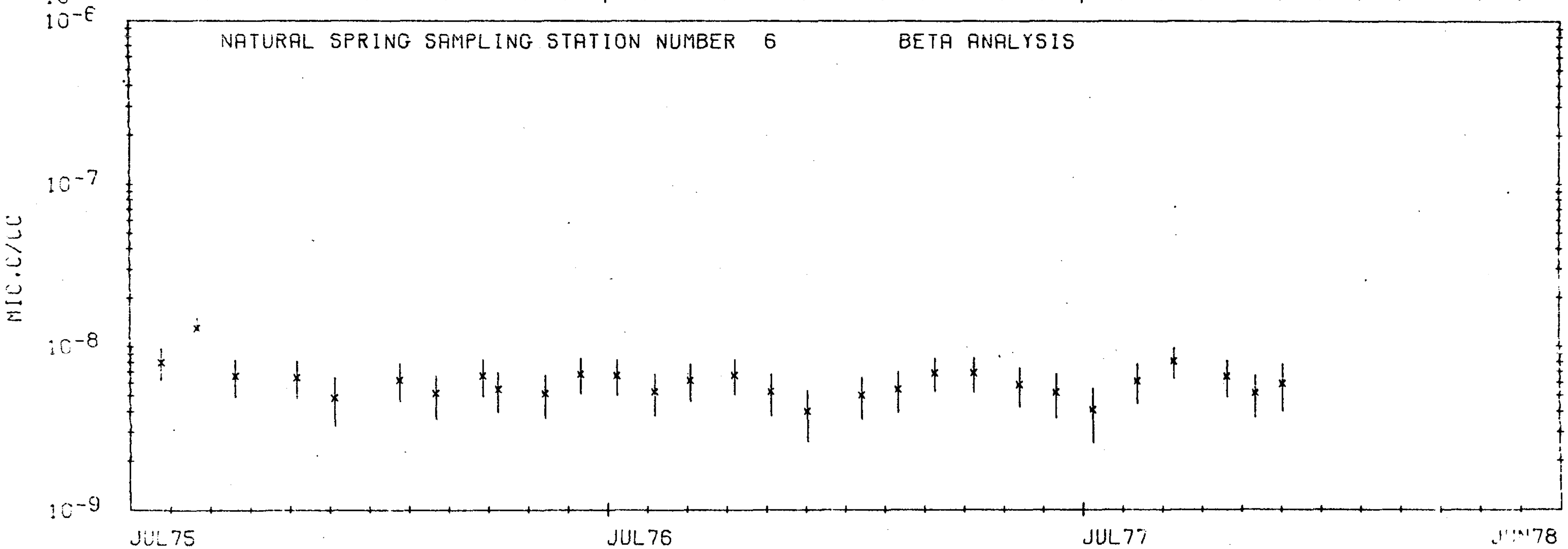

NATURAL SPRING SAMPLING STATION NUMBER 1
BETA ANALYSIS
MIC.C/CC
10-6
10-7
10-8
10-9
NATURAL SPRING SAMPLING STATION NUMBER 2
BETA ANALYSIS
MIC.C/CC
10-6
10-7
10-8
10-9
JUL75
JUL76
JUL77
JUN78


NATURAL SPRING SAMPLING STATION NUMBER 3
BETA ANALYSIS
MIC.C/CC
10^-6
10^-7
10^-8
10^-9

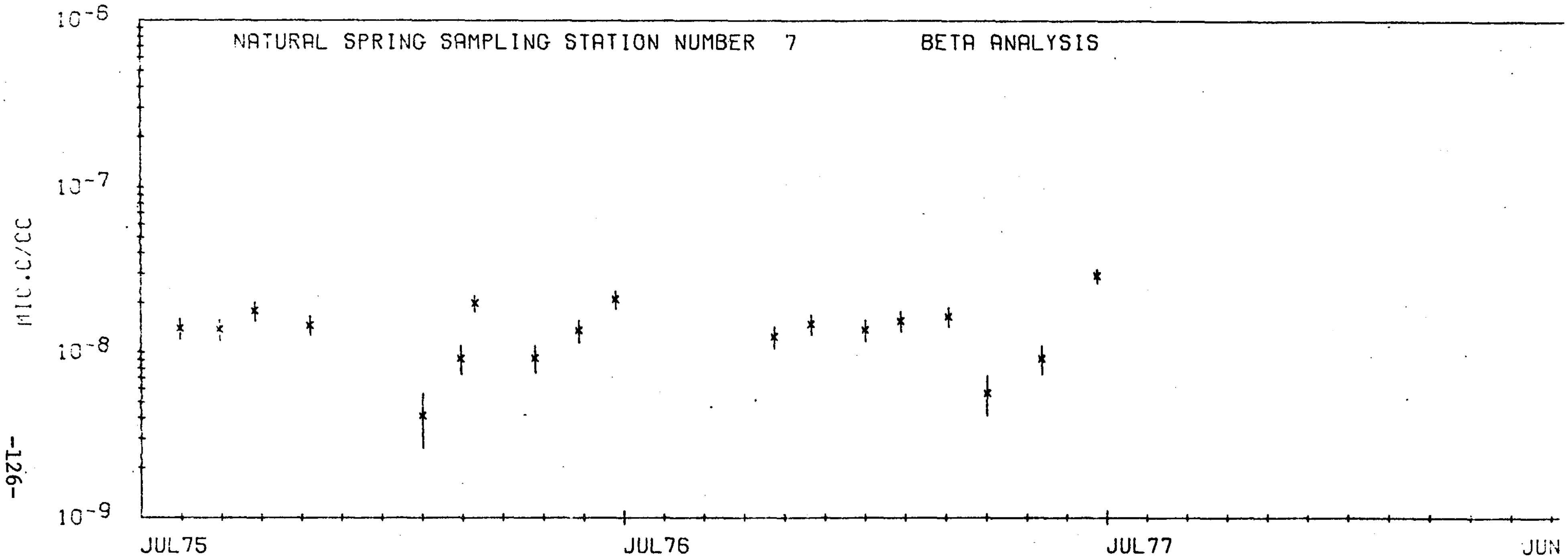

NATURAL SPRING SAMPLING STATION NUMBER 4
BETA ANALYSIS
MIC.C/CC
10^-6
10^-7
10^-8
10^-9
JUL76
JUL77



NATURAL SPRING SAMPLING STATION NUMBER 5 BETA ANALYSIS
MIC.C/CC
10⁻⁶
10⁻⁷
10⁻⁸
10⁻⁹



NATURAL SPRING SAMPLING STATION NUMBER 6 BETA ANALYSIS
MIC.C/CC
10⁻⁶
10⁻⁷
10⁻⁸
10⁻⁹
JUL75
JUL76
JUL77
JUN78


NATURAL SPRING SAMPLING STATION NUMBER 7
BETA ANALYSIS
10^-6
10^-7
10^-8
10^-9
MIC.C/CC
JUL75
JUL76
JUL77
JUN

APPENDIX F

NTS Environmental Surveillance

Contaminated Ponds Locations and Plots

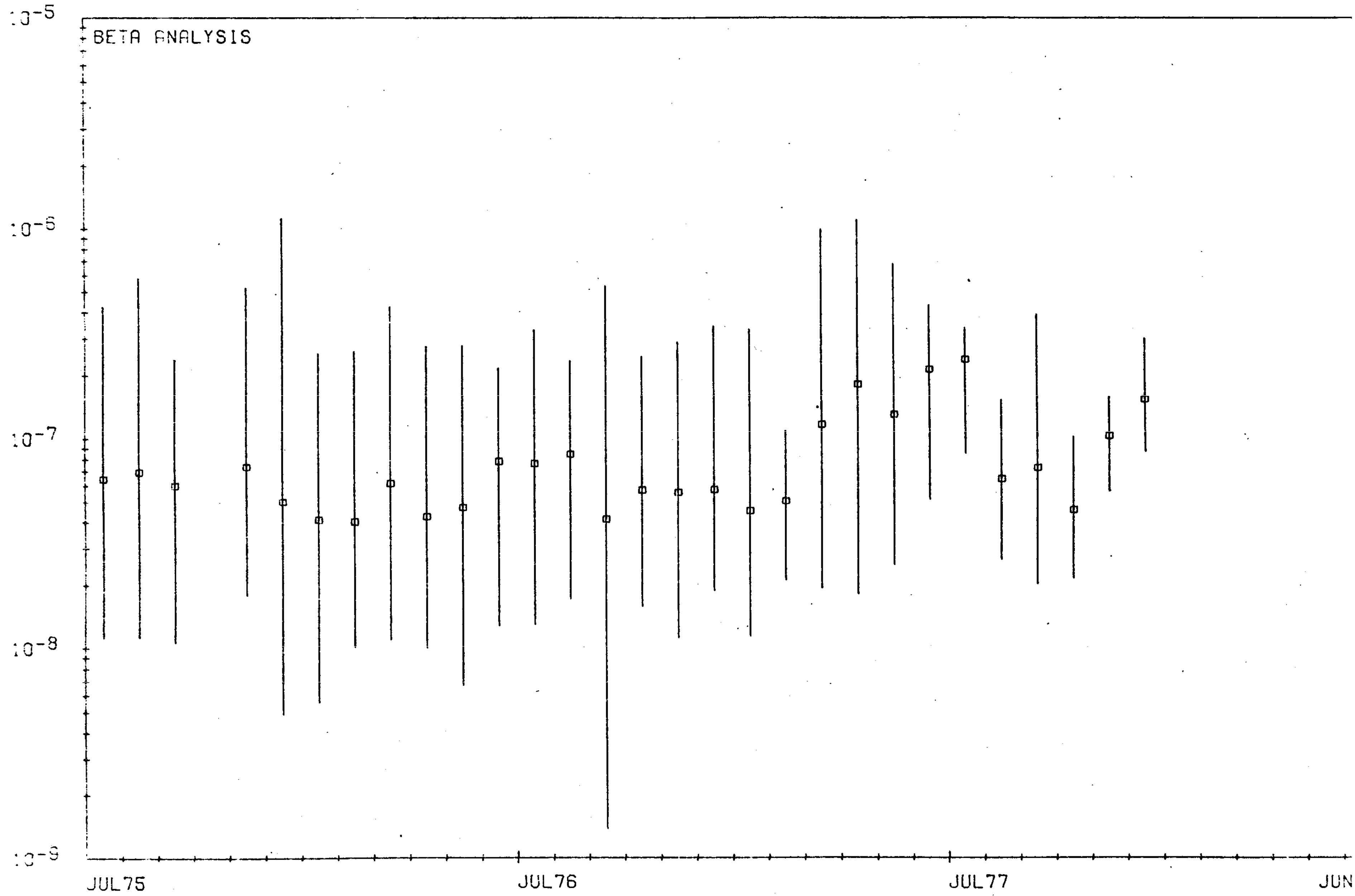
In the first two pages of plots in Appendix F, the contaminated pond network averages, a square is used to represent the geometric mean of all values at that point in time, and the vertical line is the range.

The remaining plots show the gross beta data of each station utilizing the symbol, ✖, as the data point. A two-sigma error bar is also added to the data points, and, in all plots, a delta with a line to the bottom of the plot means below detection limit.

NTS ENVIRONMENTAL SURVEILLANCE
CONTAMINATED PONDS SAMPLING LOCATIONS

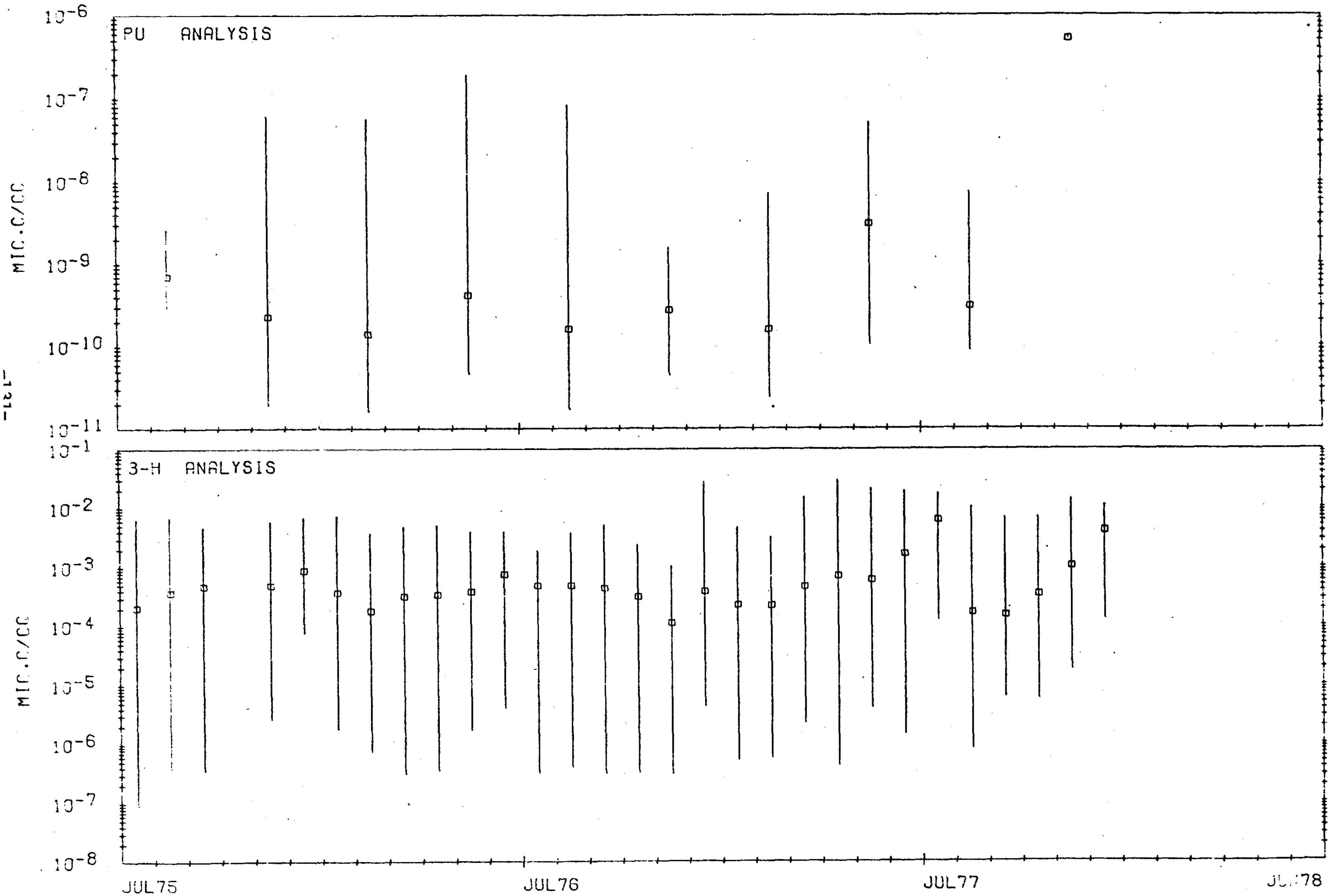
Number	Location	Map Code (Figure 7)
1	Area 12 Haines Upper	A
2	Area 12 Haines #2	B
3	Area 12 Haines #3	C
4	Area 12 Haines Lower	D
5	Area 12 Mint Upper	E
6	Area 12 Mint Mid	F
7	Area 12 Mint Lower	G
8	Area 12 N Upper	H
9	Area 12 N Mid	I
10	Area 12 N Lower	J
11	Area 12 G Tunnel	K
12	Area 12 H&S Sump	23A
13	Area 6 Yucca Decontamination Pond	6A

CONTAMINATED POND NETWORK AVERAGES

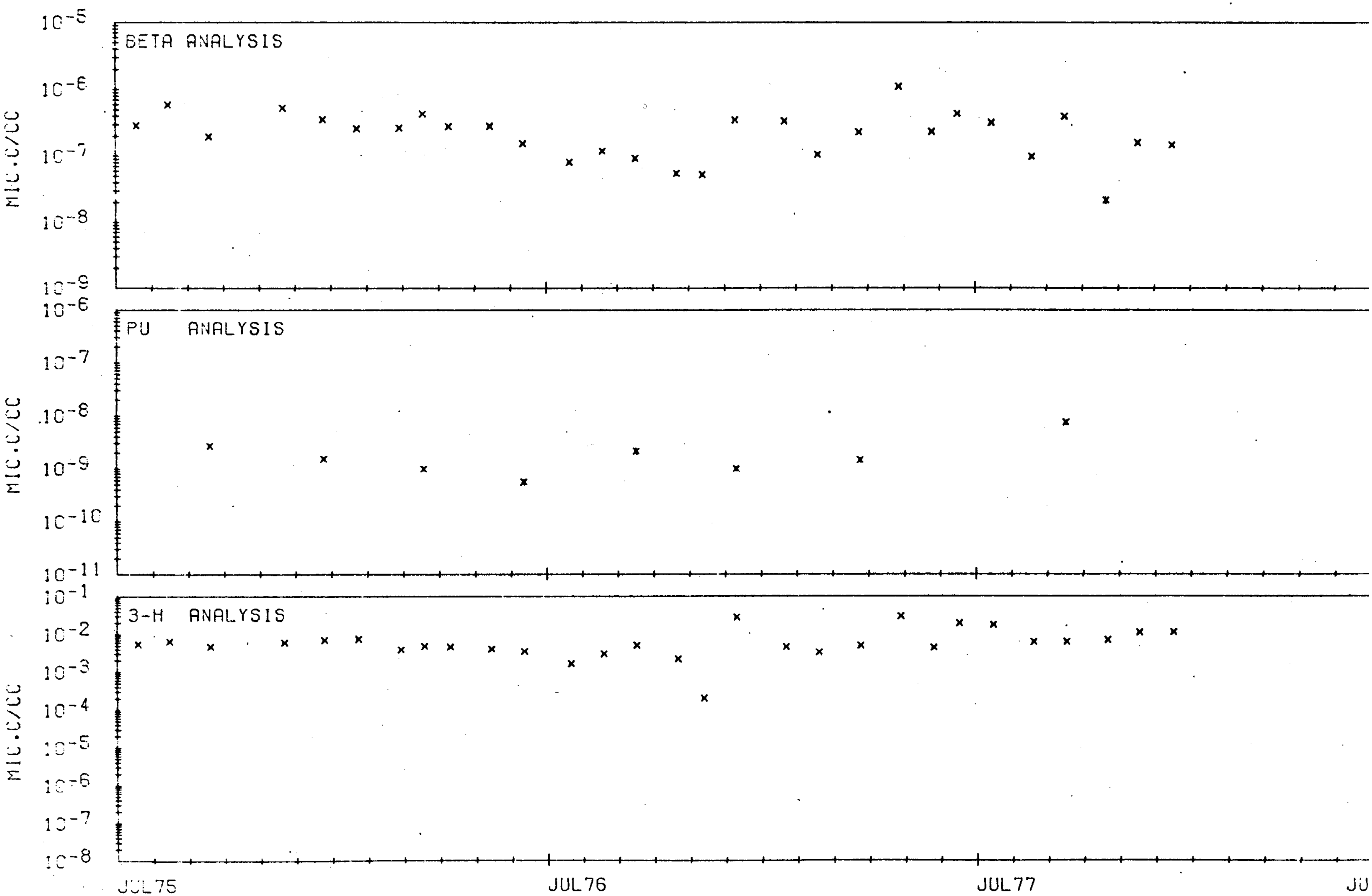


REECo

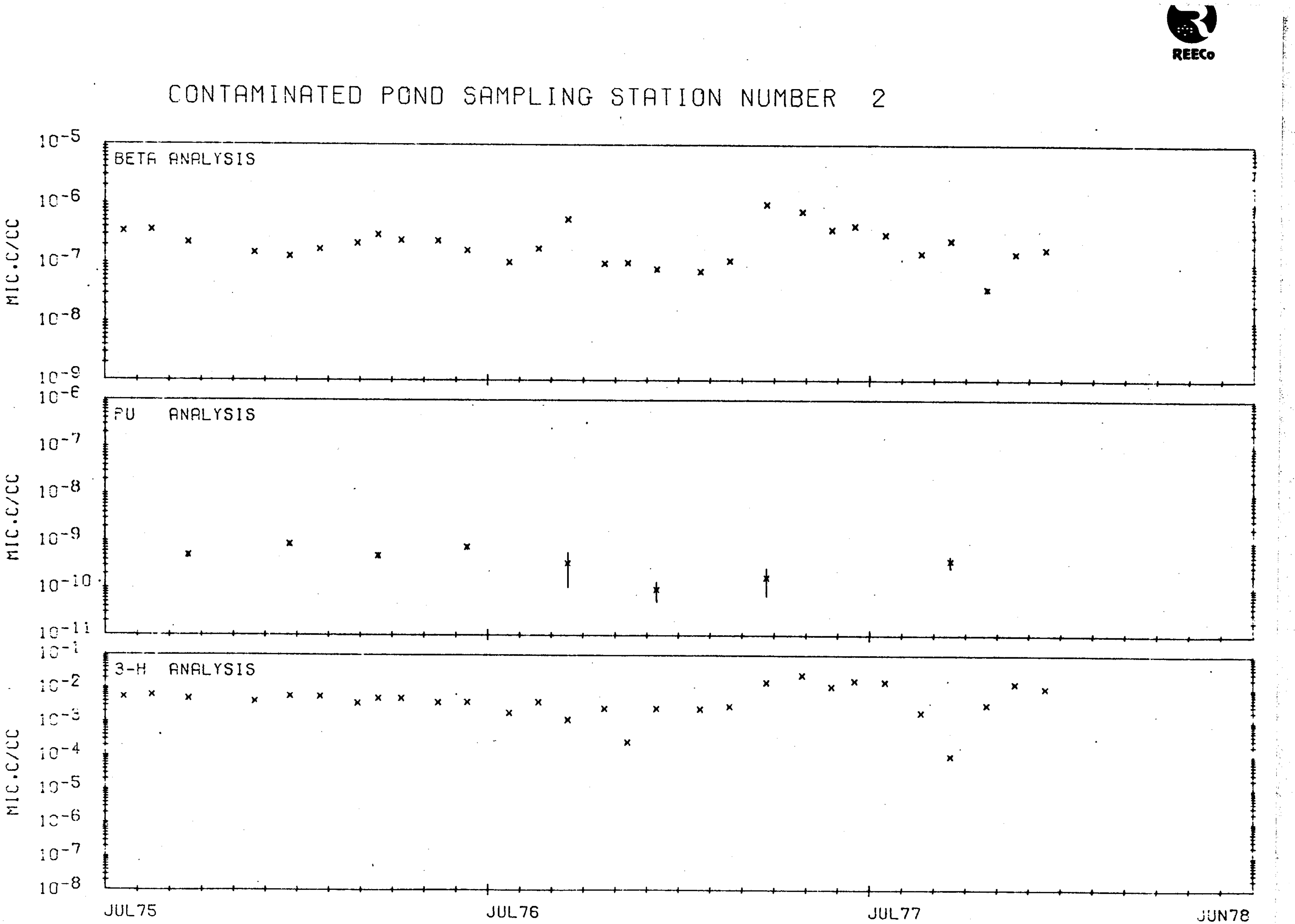
CONTAMINATED POND NETWORK AVERAGES

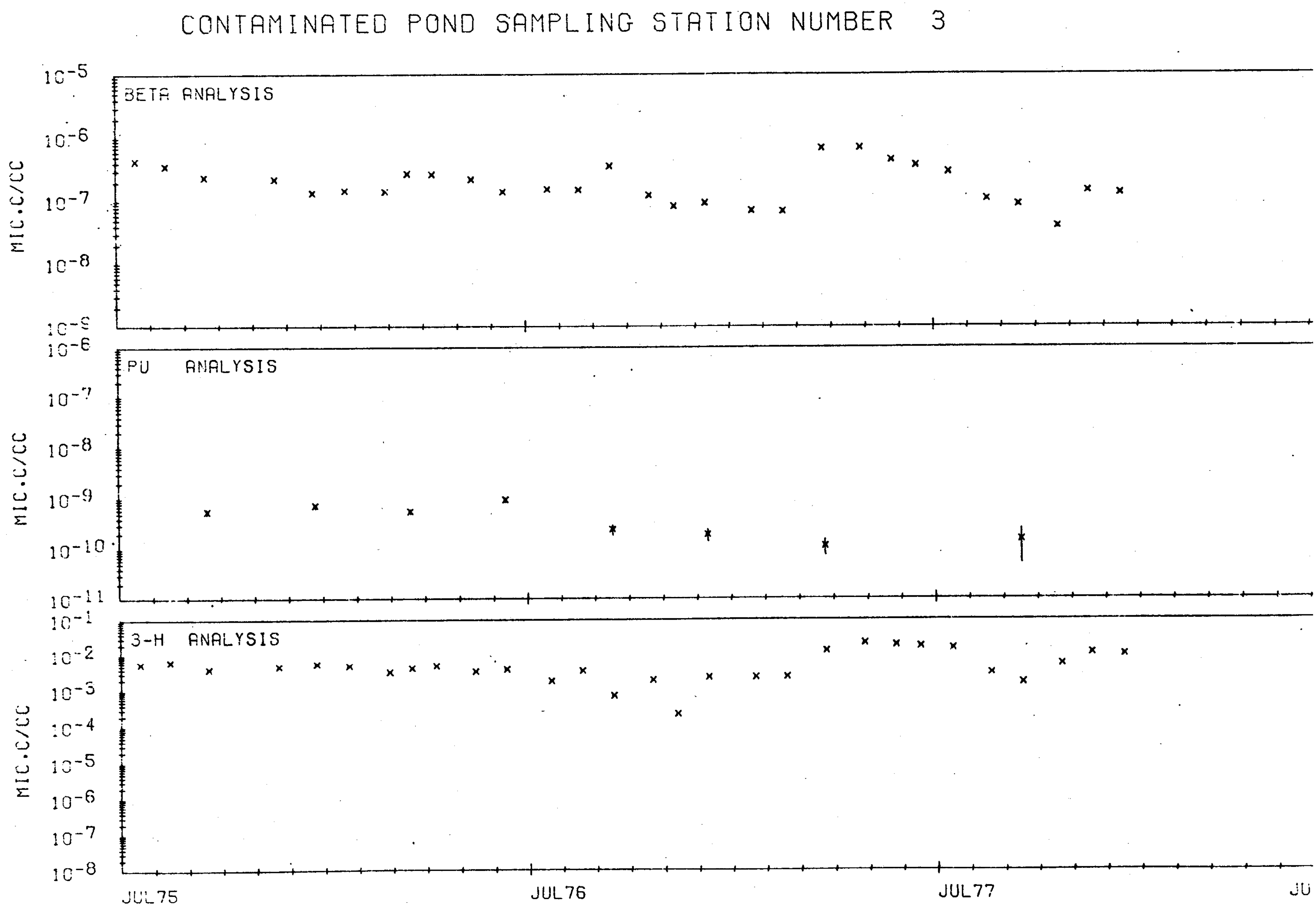


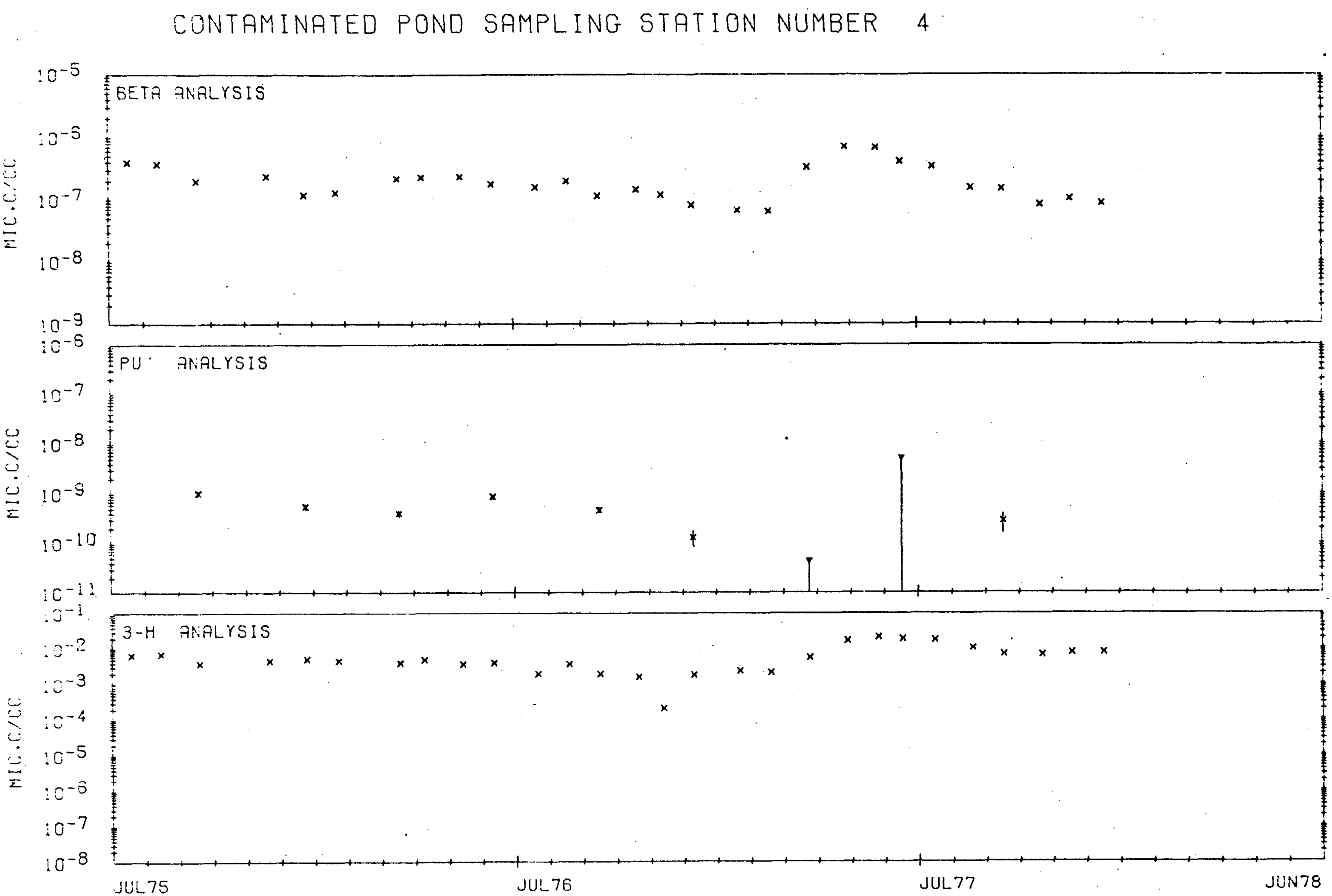
CONTAMINATED POND SAMPLING STATION NUMBER 1



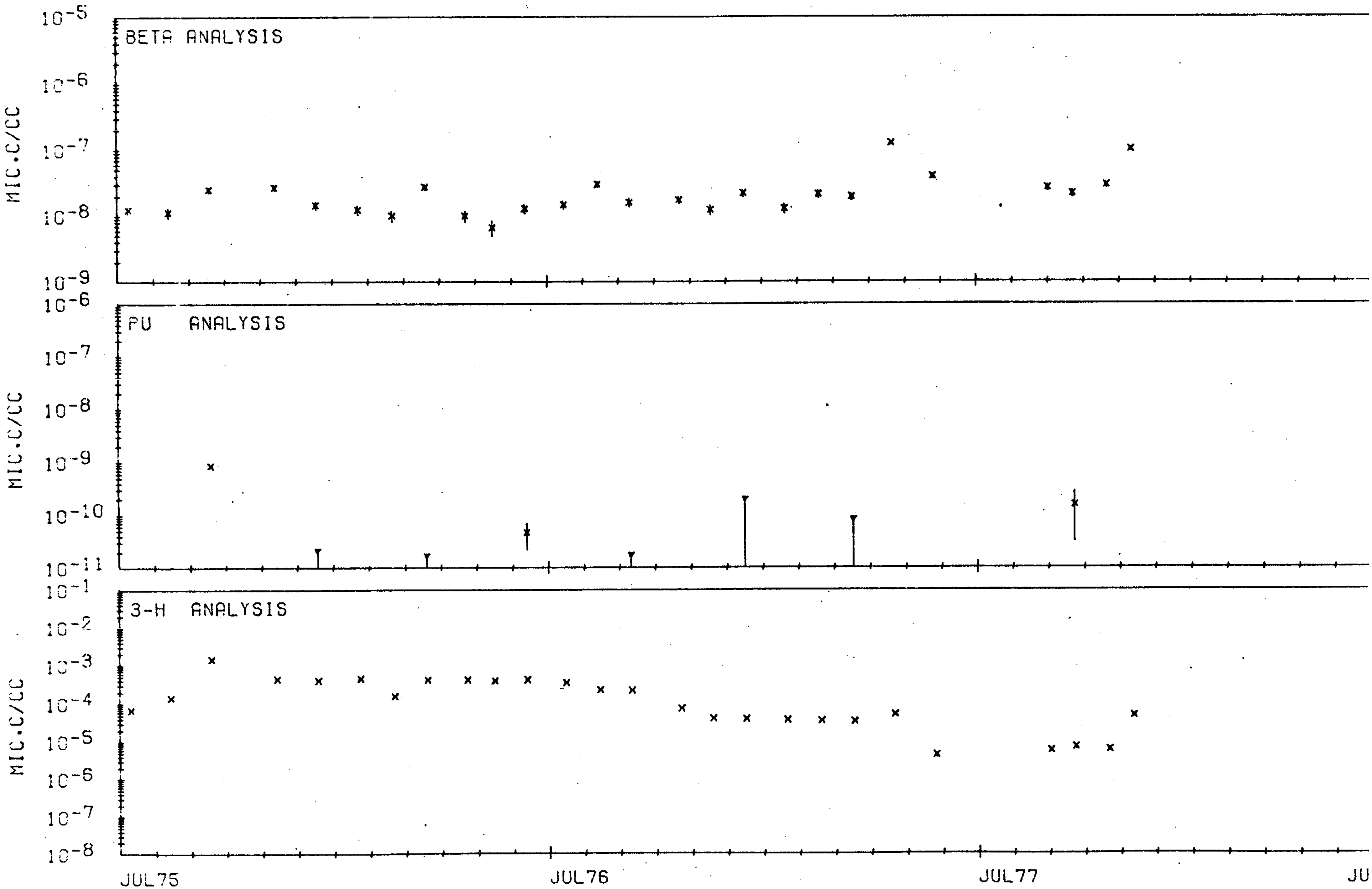
CONTAMINATED POND SAMPLING STATION NUMBER 2



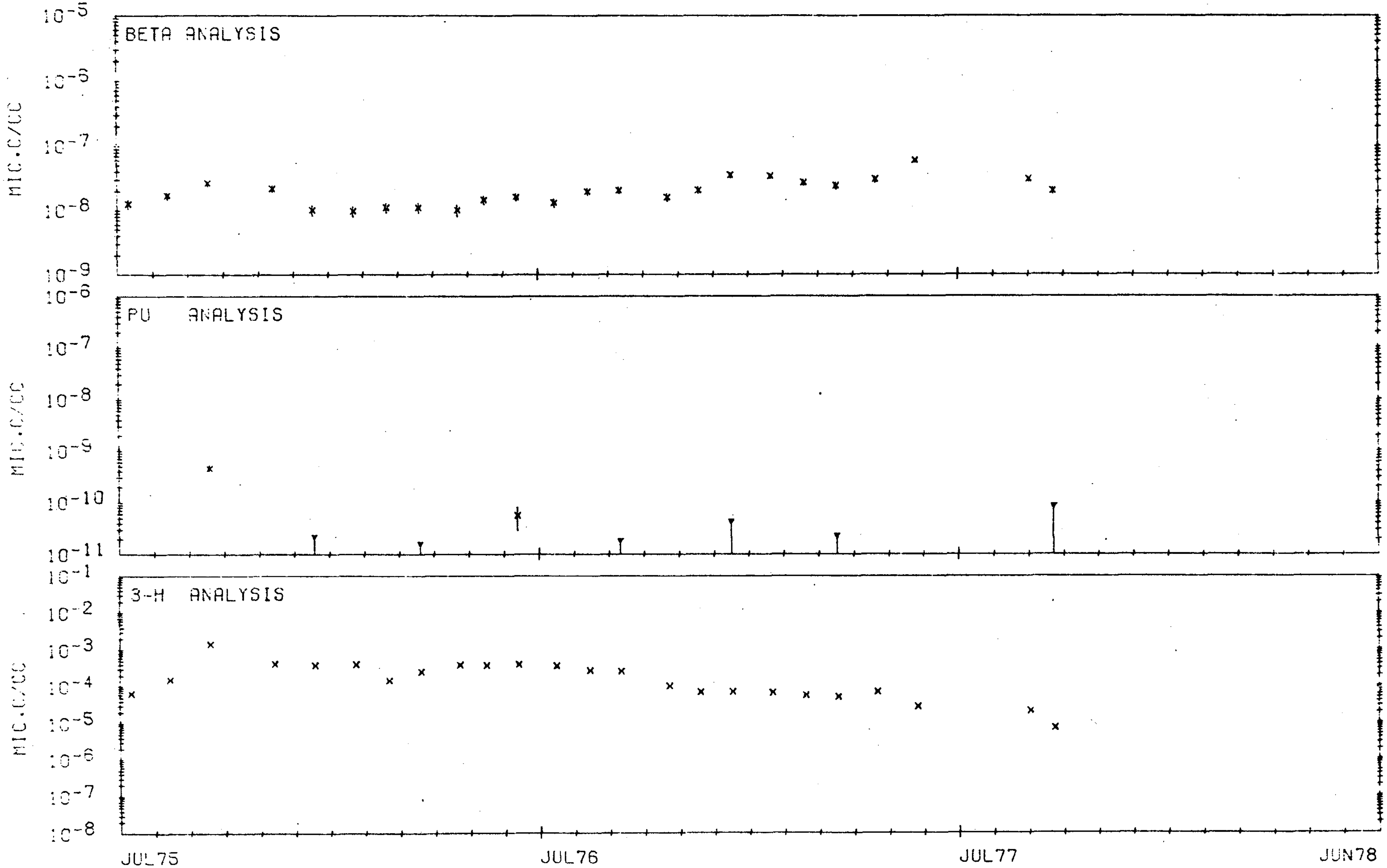

CONTAMINATED POND SAMPLING STATION NUMBER 3
BETA ANALYSIS
PU ANALYSIS
3-H ANALYSIS
MIC.C/CC
10^-5
10^-6
10^-7
10^-8
10^-9
10^-10
10^-11
10^-1
10^-2
10^-3
10^-4
JUL75
JUL76
JUL77


REECo
CONTAMINATED POND SAMPLING STATION NUMBER 4
BETA ANALYSIS
PU ANALYSIS
3-H ANALYSIS
MIC.C/CC
10-5
10-6
10-7
10-8
10-9
10-10
10-11
10-1
10-2
10-3
10-4
JUL75
JUL76
JUL77
JUN78

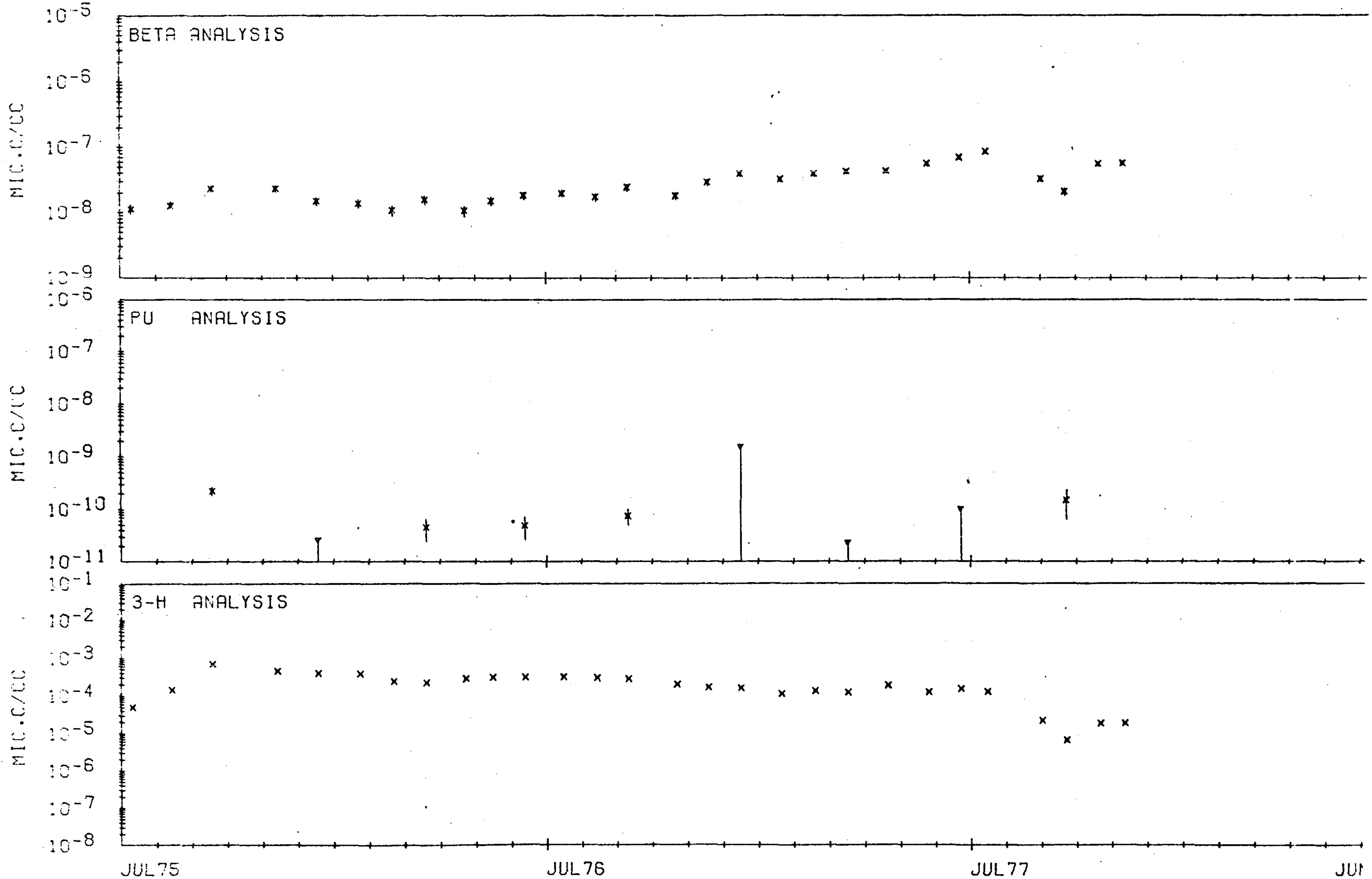
CONTAMINATED POND SAMPLING STATION NUMBER 5



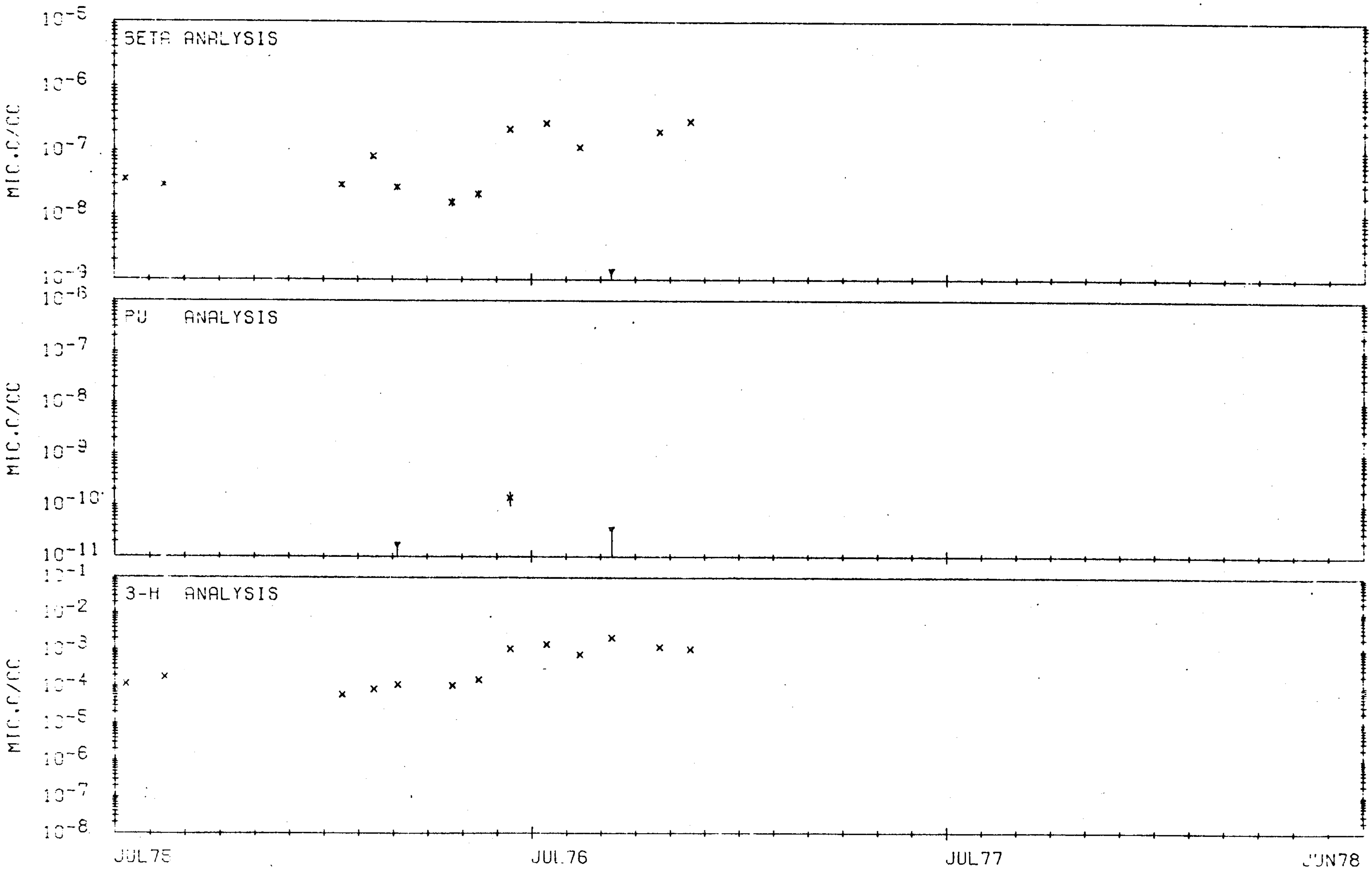
CONTAMINATED POND SAMPLING STATION NUMBER 6



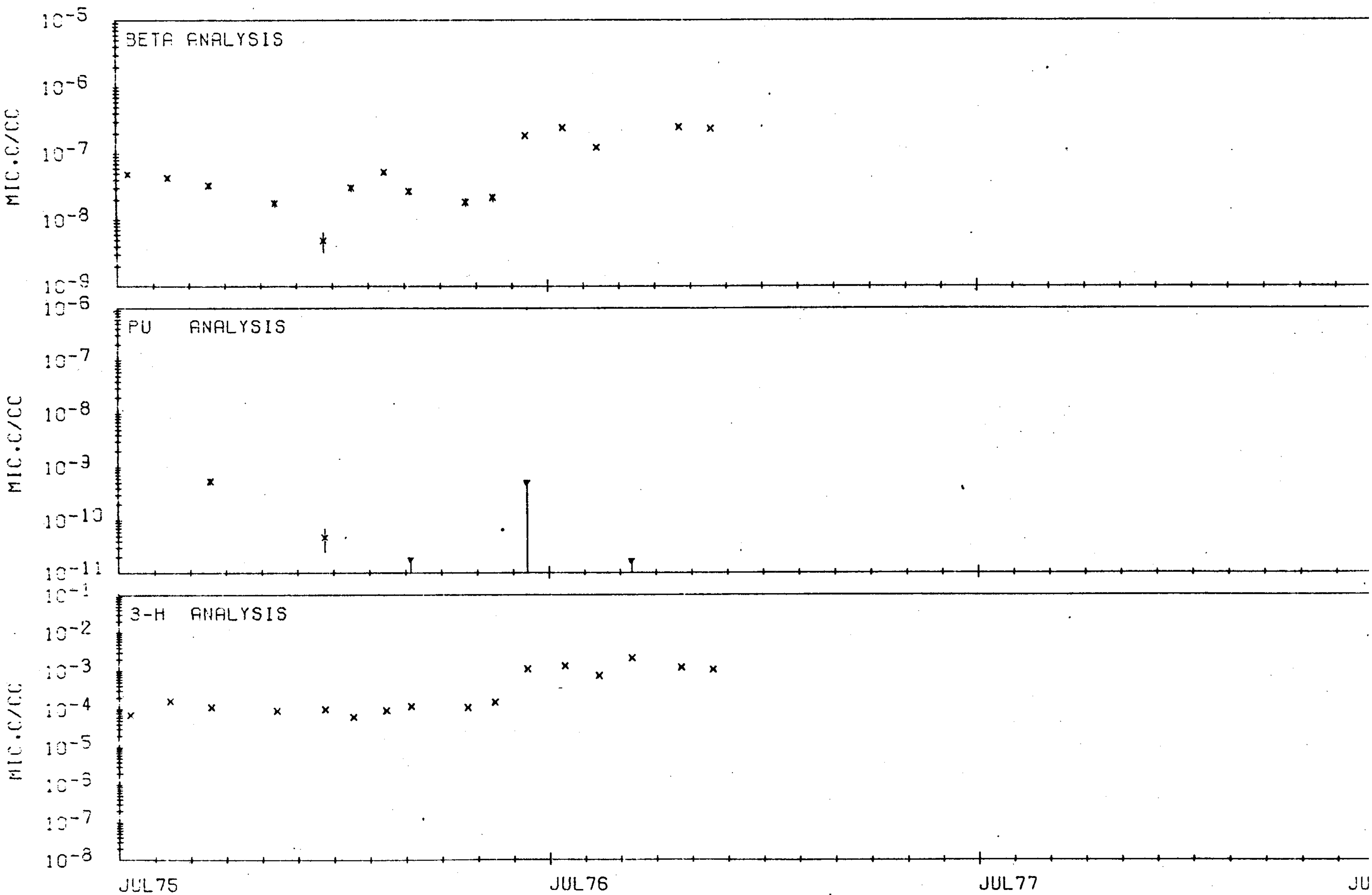
CONTAMINATED POND SAMPLING STATION NUMBER 7



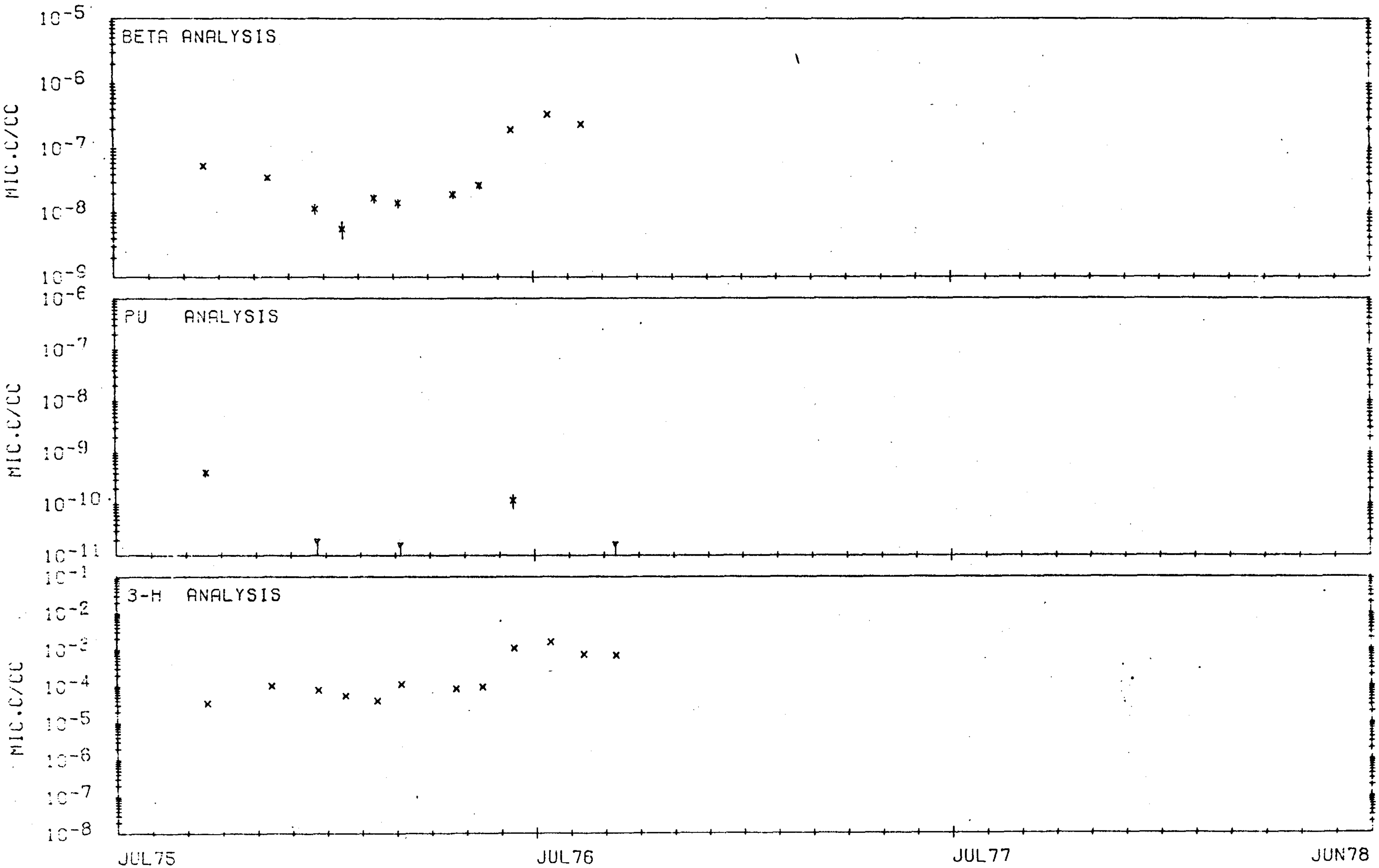
CONTAMINATED POND SAMPLING STATION NUMBER 8



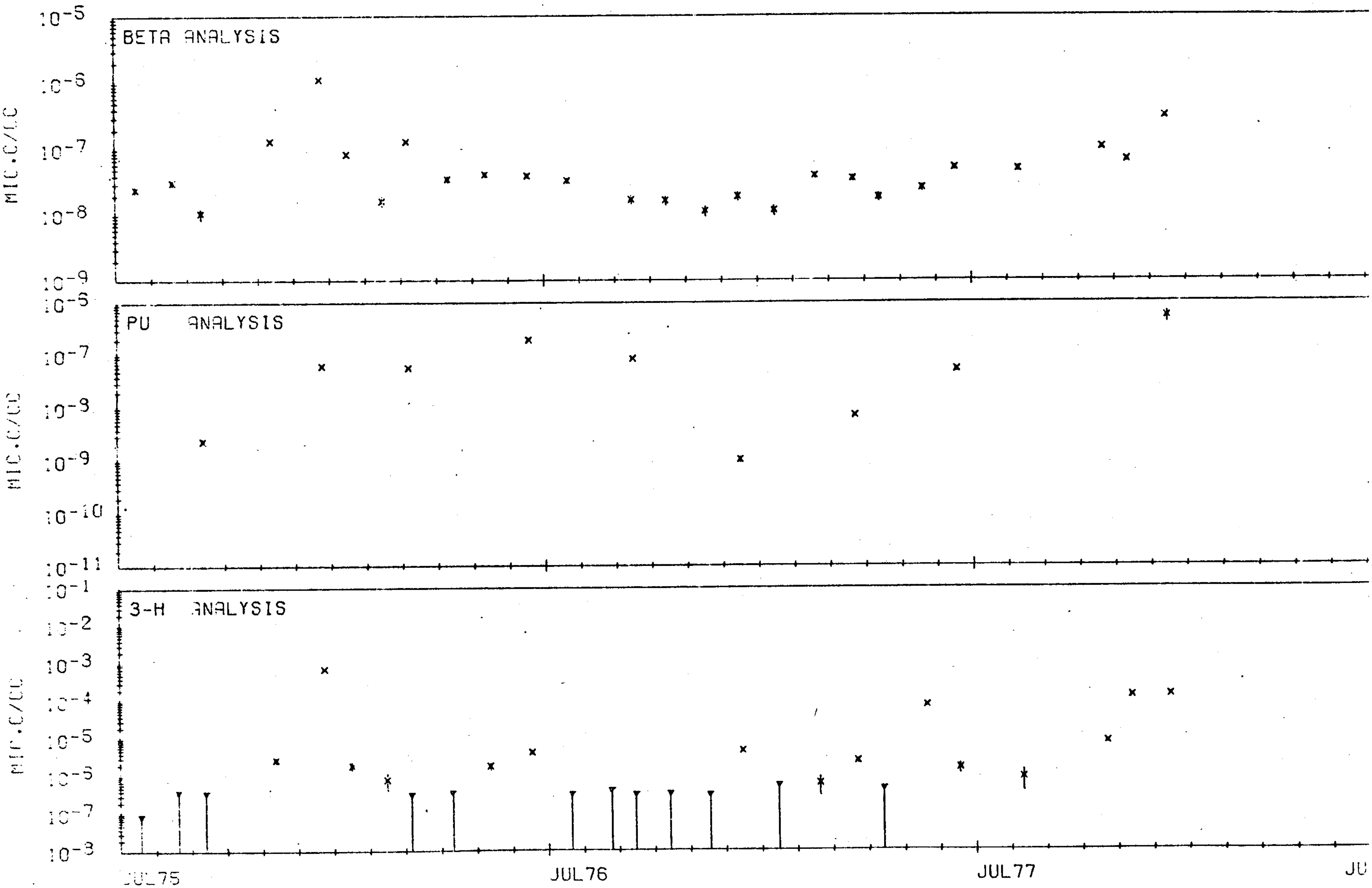
CONTAMINATED POND SAMPLING STATION NUMBER 9



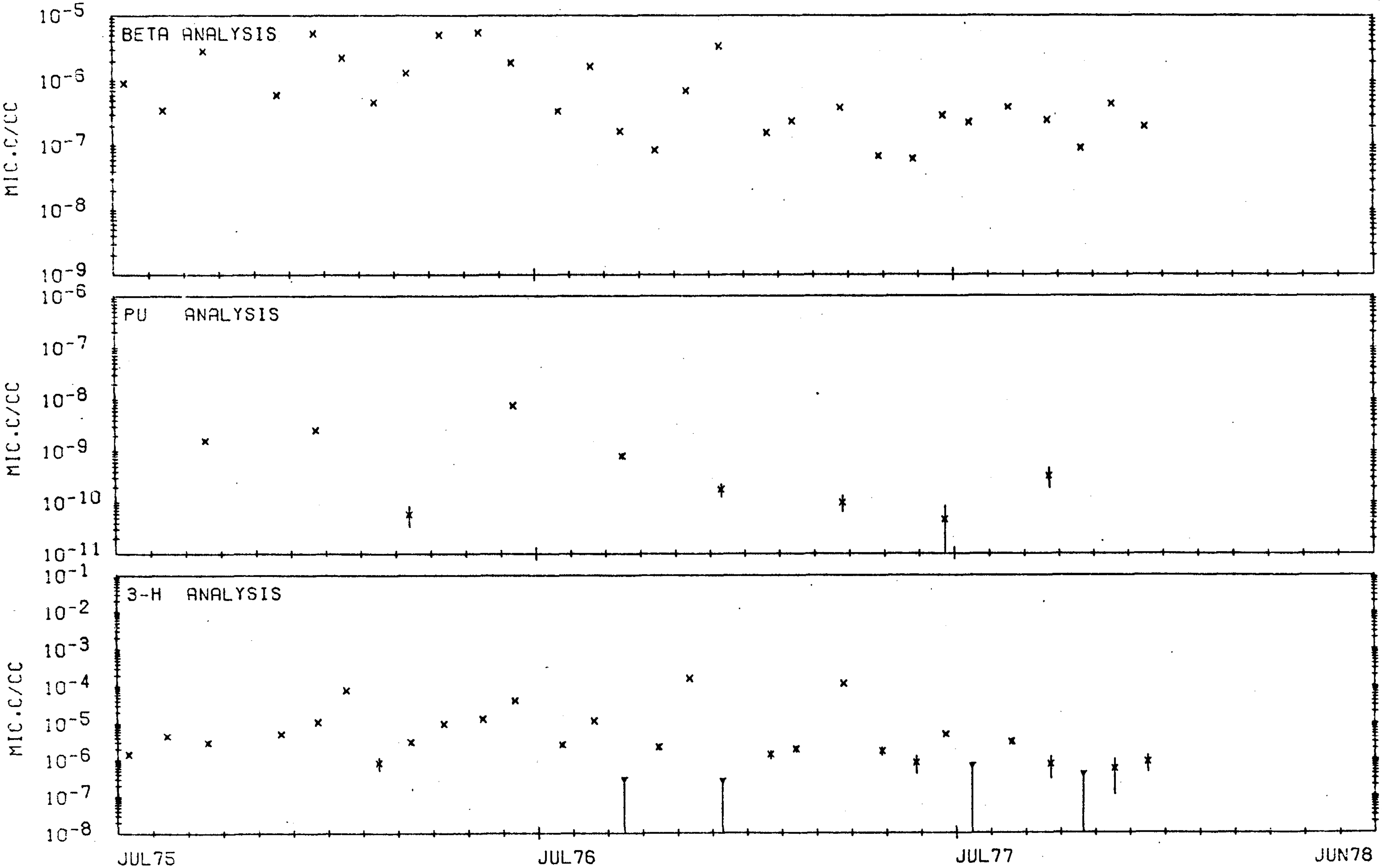
CONTAMINATED POND SAMPLING STATION NUMBER 10



CONTAMINATED POND SAMPLING STATION NUMBER 12



CONTAMINATED POND SAMPLING STATION NUMBER 13



DISTRIBUTION

M. E. Gates, Manager, DOE/NV
T. E. Wade, Deputy Manager, DOE/NV
D. G. Jackson, OPA, DOE/NV
R. W. Newman, AMO DOE/NV
B. W. Church, DOE/NV (2)
R. R. Loux, DOE/NV (2)
A. J. Whitman, DOE/NV
E. M. Douthett, DOE/NV
E. D. Campbell, DOE/NV
P. K. Fitzsimmons, DOE/NV
H. Hollister DOES, DOE/HQ
Major General J. K. Bratton, MA, DOE/HQ
J. R. Liverman, A/AS for Environment, DOE/HQ
E. Rippeon, Library, DOE/HQ (2)
USDOE TIC, Oak Ridge, TN (27)
T. H. Blankenship, DOE/NV
P. J. Mudra, DOE/NV
P. B. Dunaway, DOE/NV
K. M. Oswald, LLL, Mercury, NV
J. E. Dummer, LASL, Los Alamos, NV
G. E. Tucker, SL, Albuquerque, NM
R. L. Wagner, LLL, Livermore, CA
H. F. Mueller, WSNSO/NOAA, Las Vegas, NV
G. B. Morgan, EPA/EMSL, Las Vegas, NV
Librarian, EG&G, Las Vegas, NV
Technical Library, REECo, Mercury, NV (2)
A. Perge, Office of Nuclear Waste Management, DOE/HQ (3)
Technical Library, DOE/NV (3)