FINAL DRAFT
TECHNICAL MEMORANDUM NO. 1

ADDENDUM TO FINAL PHASE I RFI/RI WORK PLAN

Revised Network Design -- Field Sampling Plan

Rocky Flats Plant
Woman Creek Priority Drainage

(Operable Unit No. 5)

EG&G ROCKY FLATS, INC.
P.O. Box 464
Golden, Colorado 80402-0464

Prepared for:

U.S. DEPARTMENT OF ENERGY
Rocky Flats Plant
Golden, Colorado

Revised Draft: July 24, 1992
Final Draft: August 14, 1992

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Prepared by: ADVANCED SCIENCES, INC.
405 Urban Street, #401
Lakewood, CO 80228

Prepared on Behalf of: EG&G ROCKY FLATS, INC.
P.O. Box 464
Golden, Colorado 80402-0464

Prepared for: U.S. DEPARTMENT OF ENERGY
Rocky Flats Plant
Golden, Colorado

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ASI Project No. 9208.15.01.02

Mr. Ed Mast
EG&G Rocky Flats, Inc.
Environmental Management (EM)
Surface Water Division (SWD)
Building 080
P.O. Box 464
Golden, CO 80402-0464

August 14, 1992

Subject: Submittal, Final Draft Technical Memorandum No. 1, Revised Network Design, Field Sampling Plan, Rocky Flats Plant, Woman Creek Priority Drainage (Operable Unit No. 5)
ASI Project No. 9208.15.01.02

Dear Mr. Mast:

As discussed in meetings with you, me, and various ASI, EG&G, and DOE staff, attached is a final draft of the subject Technical Memorandum (TM). This reflects guidance and advisory discussions with your Messrs. Rick Roberts, Ralph Lindberg, Barry Roberts, and Greg Wetherbee, Ms. Leslie Dunstan, Ms. Sharon Andrews, and Ms. Rebecca Hoagland. To the extent possible, review comments of Ms. Hoagland, Ms. Andrews, Mr. Wetherbee, Ms. Jen Pepe, and Mr. Greg Litus, were considered in this final draft. Consensus was apparent to limit the TM to a rationale description and specific recommendations regarding modifications to the field sampling plan (FSP). Detailed data tabulations and numerous graphical time-series plots which were in the revised draft TM now have been shifted to the IAG-driven Data-Summary Report, which also is to be submitted to the regulatory agencies and is provided herewith only in preliminary draft form.

We have appreciated the continued assistance from EG&G staff in this critical endeavor. The intent of this final draft TM is to provide a document appropriate for a draft submittal to the U.S. Environmental Protection Agency and to the Colorado Department of Health.

Give Dr. Kunkel or me a call if you have questions or need additional information at this time. Please note that I will be on vacation during the August 10-17 period.

Reviewed by:____________________
James R. Burnell, Ph.D.
Denver Office Manager

Yours truly,

Timothy D. Steele, Ph.D.
Director, Water Resources Department

James R. Kunkel, Ph.D., P.E.
Senior Principal Engineer

File: 9208.15 (Subtask 01.02)

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1.0 INTRODUCTION

1.1 BACKGROUND AND PURPOSE

A field sampling plan (FSP) has been proposed as part of the Final Phase I RFI/RI Work Plan for the Woman Creek Priority Drainage (Operable Unit No. 5) (USDOE, 1992a). Generally, conditions or priority needs may change, and this Technical Memorandum (TM) was requested to review and evaluate certain aspects of the FSP.

1.2 OU5 PHASE-I RFI/RI OBJECTIVES

The currently applicable Interagency Agreement (IAG) (State of Colorado and others, 1991) stipulates that each identified operable unit (OU) at the Rocky Flats Plant, including OU5, shall proceed through a phased series of field and other related technical investigations to characterize the applicable OU. To date, a number of OUs are proceeding with planned Phase-I field investigations, in response to an overall environmental restoration (ER) program designed to investigate and clean up contaminated sites at the Rocky Flats Plant, one among several DOE facilities. The execution of the OU5 Work Plan (USDOE, 1992a) constitutes part of a second of five activities within the ER program to "include planning and implementation of sampling programs to delineate the magnitude and extent of contamination at specific sites, evaluate potential contaminant migration pathways, and perform baseline risk assessments" (USDOE, 1992a, p. 1-2). Also, reference is made to the preliminary site-characterization description contained in the OU5 Work Plan document (USDOE, 1992a, Section 2.0).

1.3 PRIMARY AND SECONDARY TM OBJECTIVES

This TM is to review and evaluate applicable parts of the FSP dealing with C-pond, stream (Woman Creek and tributaries), and the South Interceptor Ditch (SID) as currently proposed in the OU5 Final Phase I RFI/RI Work Plan (USDOE, 1992a). The primary objective of this effort is to provide documentation in support of or in revision to the current version of the FSP. Aspects to be considered in this effort are to include (EG&G, 1992h):

- elimination of redundant sampling sites,
- changes in the number or in the location or sampling sites,

- changes in the frequency or scheduling of both water- and sediment-related sampling surveys, and

- application (to the extent possible) of existing sitewide, Clean Water Act compliance (NPDES), operational (routine), and event-related data to fulfill information needs in lieu of additional data acquisition as specified in the FSP in fulfillment of the Interagency Agreement (IAG).

This TM has been prepared on behalf of EG&G Rocky Flats, Inc. and the U.S. Department of Energy (USDOE) for submittal to the USEPA and Colorado Department of Health (CDH). The information contained in this TM is to provide the technical rationale for any proposed changes in the OU5 Work Plan's FSP as currently applicable. Primary focus was placed on C-Pond sampling aspects, and secondary emphasis was placed on evaluating aspects of the stream (Woman Creek and tributaries) and SID sampling surveys.

2.0 DATA-SOURCE COMPILATION

In developing the technical rationale for FSP changes, use was made of a number of data sources and data types. Certain available data were summarized in the OU5 Work Plan (USDOE, 1992a, Appendices D and E). It would appear that the primary data source for the OU5 Work Plan was EG&G's Rocky Flats Environmental Database System (RFEDS), an extensive database system operated and maintained by EG&G Rocky Flats, Inc. However, other supplementary data sources were sought out and obtained during the investigative part of this compilation; relevant aspects of these are included in this TM. It should be noted that most of these data sources in general have not had the benefit of rigorous quality-assurance/quality-control (QA/QC) review protocols (EG&G, 1990a; 1990c).

2.1 POND WATER QUALITY

This aspect of C-Pond water-quality monitoring is of primary concern to this TM. Various data sources involving C-Pond water-quality data will be discussed in this section. During the course of this data-source compilation, it was apparent that quite useful data were available from other sources within EG&G-ER/SWD.

2.1.1 Sitewide Water-Monitoring Data

The bulk of the sitewide monitoring program has involved sampling streams, seeps, and springs throughout the RFP area (see Section 2.3). However, selective water-quality data collection has occurred involving the C-ponds, with results entered into RFEDS. Such data were included in the accompanying assessment of water-quality data (ASI, 1992b), and results are highlighted in Section 3.1 below. Please note the previously-cited concern regarding lack of rigorous QA/QC review protocols being applied to these data.

2.1.2 CWA Compliance (NPDES) and Operational Monitoring Data

EG&G (1992a) provides a detailed overview of CWA compliance monitoring, which includes NPDES-related aspects. Operational monitoring program components have been widely varying, relative to sample scheduling and variables analyzed. Many of the resultant data from these latter components have not been included in the computerized RFEDS database and thus are available principally in hardcopy form from EG&G staff who are knowledgeable in the collection of such data for operational purposes. Please note the previously-cited concern regarding lack of rigorous QA/QC review protocols being applied to these data.

2.1.3 Toxicity Testing

In June 1989, an initial biomonitoring survey using the whole-effluent-toxicity (WET) test methodology was conducted in Pond C-2. Indicator aquatic species used in this test were fathead minnows and the *Ceriodaphnia dubia.* Beginning in January 1990, monthly biomonitoring surveys (April and November 1990 surveys were not made) have been conducted by EG&G personnel in Pond C-2 and for Pond C-2 discharges (when applicable). Except for the results of one survey, where sample contamination is suspected, conditions in Pond C-2 were judged to be non-toxic, based upon the remaining survey results for these indicator species. Presumedly, similar WET-test surveys have been conducted for Pond C-1; however, results for both C-Ponds are pending further evaluation, and a report giving these results is scheduled for completion on/about September 1992. To the extent possible, concurrent sampling was attempted for the toxicity-testing results and water-quality data; however, coordination of these separate field investigations was not always possible.

2.1.4 Other Sources

Two additional sources of water-quality data were useful. As part of a RFP plutonium (Pu) study of several impoundments conducted by investigators from Colorado State University (CSU) (Johnson and others, 1974), water samples were taken at Pond C-1 for each of six surveys. Up to 12 sampling sites areally across this impoundment were included in each survey. One-liter samples were composited from samples collected from the surface, one-half depth, and full depth at a given location (Appendix E, Section E-4). Sample collection and processing procedures are described in Johnson and others (1974). As a second miscellaneous data source, approximately six months of field data were collected for Pond C-2 during the latter half of 1990. These data included numerous measures at various depths below the impoundment surface (Appendix Table E-1). No standardized, rigorous QA/QC protocols were known to be applied to these resultant data.

2.2 POND BOTTOM SEDIMENTS

The first known field investigation of pond-sediment chemical characterization applicable to this TM was a RFP study conducted by CSU investigators on several RFP ponds, including Pond C-1

(Johnson and others, 1974). Pu-239,240 was used as the indicator variable in this study. Water samples also were collected for this study. Water and sediment samples were analyzed for samples collected for 6 surveys conducted between May 1971 and August 1973. Detailed sediment-core sampling was conducted in April 1974 for Pond C-1. Specific selected results of this study are described below (Section 3.1.2).

During May 1992, ponds C-1 and C-2 were sampled by EG&G-contractor field personnel for the purpose of further characterizing bottom-sediment chemistry for radionuclides (Pu, U, and Am), trace metals, and various organic compounds. Bottom sediments were sampled near the outlet works of each pond; the top 6-in of sediment were sampled using an Eckman-dredge sampler. Only selected analyses are available to date, and these preliminary data are undergoing further review and evaluation by EG&G-ER/SWD staff.

For historical-data comparison purposes, several other offsite impoundment bottom-sediment chemistry surveys are cited in ASI (1991c, p. 32). However, results of these studies have not been included in this TM.

2.3 STREAM/DITCH (SID) SW AND SED SITES

Initial water-quality and bottom-sediment chemistry characterization of selected surface-water sites in the Woman Creek drainage basin was reported by Rockwell International (1986) as part of the RFP RCRA Part B permit application. Beginning in 1990, a sitewide monitoring program was implemented, which included a series of surface-water (SW) and sediment (SED) monitoring sites within the Woman Creek drainage basin (EG&G, 1991b; 1992a). Many of these sites had data useful for preliminary site characterization of the OU5 area (USDOE, 1992a, Section 2.0 and Appendices D and E). The SW and SED sites used for evaluation of available data for this TM are indicated on Figure 1 and are listed in Table 2.

The most recent overview of the sitewide surface-water and sediment monitoring plan is that provided by EG&G Rocky Flats, Inc. (1992c). However, reductions and modifications in this sitewide monitoring program have taken place (EG&G, 1991c; 1991d). In essence, monitoring-program reductions can be summarized as follows, relative to the sitewide program:

- Prior to October 1991, a sitewide network was in operation involving 108 surface-water (SW) sites and 38 sediment (SED) sites (EG&G, 1991b). Samples were collected monthly; however, analyses of organic constituents (priority pollutants) and sampling of bottom sediments were to be completed on a quarterly schedule.

- Between October 1991 and March 1992, the number of monitoring sites in the sitewide network was reduced from 108 SW sites and 38 SED sites down to 80 SW sites and 24 SED sites (EG&G, 1992c). A quarterly sampling and analysis frequency was given for both categories of sites.

- Beginning April 1992, the sitewide network has been reduced further to 30 SW sites (30 existing and 2 new) and 33 SED (19 existing and 14 new) sites associated with OU5 monitoring (EG&G, 1991d; 1992a, Table 5). However, The several OU5-related additional (new) surface-water and sediment monitoring sites are to be implemented at that time of executing the FSP for the RFI/RI. It is assumed that the quarterly sampling scheduling imposed for the previous monitoring-network modification would continue to apply for the Phase I RFI/RI surface-water and sediment characterization. Of particular concern in this TM are (1) continued data-collection justification for the existing specified sites and (2) rationale for the specified additional (new) monitoring sites specified for the OU5 RFI/RI characterization (see Section 3.0).

2.4 OTHER POND/STREAM-HYDROLOGY CONSIDERATIONS

Other pond/stream-hydrology considerations relevant to the data assessment, modeling, and risk assessment aspects of OU5 include: (1) the morphology of Ponds C-1 and C-2; (2) water/sediment interactions in hillslope, stream channel, and pond areas; (3) artificial water controls; (4) biology/limnology of streams and ponds; and (5) a water balance of the system including pond discharges, streamflows, and gains from and losses to the alluvial aquifer. Each of these five considerations is defined below relative to the data sources.

2.4.1 Pond Morphology

Pond C-1 is an on-channel pond built in 1955 to provide temporary holding and to provide monitoring of Woman Creek waters and waters discharged from former Ponds 6, 7, and 8 (USDOE, 1992d). Ponds 6, 7 and 8 no longer exist and have never received an alpha-numeric designation. These ponds were located adjacent to Woman Creek and received water treatment plant backwash (Pond 6), steam condensate from Building 881 cooling towers and perhaps sewage lift station overflows (Pond 7), and Building 881 cooling tower overflow/blowdown (Pond 8). Pond 8 included two ponds: 8-North and 8-South. Because Pond C-1 historically had received waters from Ponds 6, 7 and 8, all potential contaminants in these former ponds were also conveyed into Pond C-1 and hence to reaches of Woman Creek downstream from Pond C-1. Additionally, Ponds 6, 7, and 8 have been designated as part of OU16 and hence are not designated at all as part of OU5, although they clearly are located physically in the OU5 area.

Pond C-2 was built in 1979 to store runoff collected by the South Interceptor Ditch (SID) from the south side of the RFP. Pond C-2 has been impacted by several release occurrences since its construction (USDOE, 1992d).

The morphology of both Ponds C-1 and C-2, since their construction, has been related to sediment accumulations which have reduced their storage capacity (USDOE, 1992c, Appendix 4). Pond C-1 had an estimated storage capacity at the spillway crest of approximately 6.1 acre-feet at the time of construction. In 1992, this spillway-crest storage capacity has decreased to approximately 5.2 acre-feet, or a volume reduction of approximately 15 percent (EG&G, 1992a). Minor impacts on pond morphology (primarily affecting Pond C-1, but perhaps also Pond C-2 for larger storms) also could occur if development takes place in the Coal Creek basin and irrigation water continues to discharge into Woman Creek from the Kinnear and Smart 2 Ditches. This would mean that additional sediment might enter either of these ponds. Pond C-2 had a spillway storage capacity of approximately 71 acre-feet at construction. In 1992 this capacity had decreased to 70 acre-feet, or a reduction of approximately 1 percent (EG&G, 1992a). The relatively small storage reduction in Pond C-2 appears reasonable, because the pond is off-channel and only 14 years old. It is anticipated that this morphology will continue into the future, especially if additional development takes place on site or in the upper Woman Creek drainage basin. The surface-water contaminant modeling (see Section 4.2.2) will use the most recent elevation-capacity curves for Ponds C-1 and C-2.

2.4.2 Water/Sediment Interactions

Water/sediment geochemical interactions occur as precipitation and runoff erode surface soils, as water flows in open channels and streams, and within ponds. These processes will be modeled, to the extent possible, using the HSPF model for assessing the surface-water contaminant impacts (Section 4.2.2). This model, however, cannot model the water/sediment physical/chemical/biological interactions in the ponds. These processes are very complex and cannot be modeled in detail. However, model calibration may be able to take into account some effects of these complex interactions, based upon fitting the model outputs to pond discharge water-quality data. Potential release of contaminants from sediments can be deduced from the bottom sediment-quality data available for both Woman Creek and the C-series ponds (See Section 3.1.2).

2.4.3 Artificial Controls

The Woman Creek drainage basin has several artificial water controls. These include the SID which intercepts runoff and routes this runoff to Pond C-2. This runoff would normally flow into Woman Creek or would percolate into the underlying subsurface materials of the basin . Ponds C-1 and C-2 themselves are artificial water-control structures which temporarily store water and, in the case of Pond C-2, may export water from the Woman Creek basin to the Walnut Creek basin. The Woman Creek diversion dam routes all Woman Creek flows less than about the 100-year flood peak, around Pond C-2 (Figure 1). Irrigation inputs to Woman Creek from the Kinnear Ditch and Smart 2 Ditch are artificial water controls which divert water from the Coal Creek basin into the Woman Creek basin (ASI, 1990). The 881 Hillside French drain also may be classified as an artificial water control which changes the ground-water flow from the 881 Hillside to Woman Creek.

2.4.4 Biology/Limnology

Biological and limnological data on the C-series ponds are not available, except for some limited

WET-test results (Section 2.1.3). Basic water-quality and sediment-quality data for the C-series ponds generally do not include a full suite of nutrient (nitrogen and phosphorus) species. Exceptions involve the availability of nitrate data for Pond C-2 for CWA compliance monitoring (daily during discharge) and monthly data for N and P indicator species for DOE Order 5400.1 C-Pond characterization (Table 1). Therefore, little can be deduced about plankton populations through modelling until data are available to compare with the modeling results. Biological data in Woman Creek and in the C-ponds, in terms of identification of aquatic species (plankton, periphyton in ponds, fish, benthic invertebrates) and of toxicity testing, are expected to be available as part of recently-completed OU1 field investigations (USDOE, 1992e).

2.4.5 Water Balance

Water balances have been done for Ponds C-1 and C-2 by EG&G. These water-balance estimates have not been published but are available through EG&G-ER/SWD. Stream-reach gain/loss studies along Woman Creek, Mower Ditch, and selected tributaries, have been done, and interim study results are discussed in Section 4.1.

3.0 DATA ASSESSMENT

The primary purpose of this section is document results of our assessment of the various available C-Pond data sources (both water-quality and bottom-sediment aspects). Secondarily, readily available results of SW and SED site data for the Woman Creek watershed and the South Interceptor Ditch (SID) will be discussed briefly. The intent of this evaluation is to assess whether information obtained from the existing data is sufficient, given the scope and intent of the Phase I RFI/RI site characterization. In cases where existing historical data have provided information of sufficient quality and quantity for purposes of the OU5 RFI/RI, additional data needs for this purpose can be limited to the particular modeling or characterization applications, to provide efficient and cost-effective continued data collection for OU5. The data-qualification caveat regarding general lack of QA/QC review protocols should be kept in mind in evaluating the indicated data-assessment results, details of which are provided in an accompanying Data-Summary Report (ASI, 1992b).

3.1 C-POND DATA

A detailed evaluation was made of the various C-Pond data sources outlined previously. Preliminary results of the Pond C-2 toxicity testing were mentioned in Section 2.1.3; more detailed information is not available at this time regarding this critical investigation. However, it is expected that results of the toxicity data evaluation will be available for purposes of the Phase I RFI/RI characterization.

3.1.1 Water-Quality Characteristics

Various data time-series plots and statistical summaries of the basic data were made for purposes of a critical evaluation of existing available data for both Ponds C-1 and C-2. Results of this evaluation are discussed in the following paragraphs and detailed in the Data Summary Report (ASI, 1992b).

Pond C-1. The Pond C-1 water-quality characterization is supported by the data provided in Appendices A, C, E, and F of ASI, 1992b. From these basic data, two sets of water-quality time-series plots have been generated (Figures 2 and 4, selected plots only; see ASI, 1992b) and associated statistical summaries are given in Tables 3 and 5. Table 7 gives a summary of the priority pollutants found above detection limits in Pond C-1.

Pond C-2. In a similar manner, the Pond C-2 water-quality characterization is supported by the data provided in ASI (1992b, Appendices B, D, E, and F). From these basic data, three sets of water-quality time-series plots have been generated (Figures 3, 5 and 6, selected plots only; see ASI, 1992b) and associated statistical summaries are given in Tables 4 and 6. Table 8 gives a summary of the priority pollutants found above detection limits in Pond C-2.

3.1.2 Bottom-Sediment Chemistry

Up to 22 sampling sites were used in the RFP study of Pu concentrations by CSU in sediments of Pond C-1 (Johnson and others, 1974). Results of the six surveys are depicted by areal data patterns (ASI, 1992b, Appendix Section E-4, Figures 45 through 50). Relatively higher Pu-concentrations were apparent towards the eastern (deeper) part of the impoundment for several surveys; the highest Pu concentration (79 pCi/g) noted for the July 16, 1971 survey was an order of magnitude greater than most of the areal sediment-survey results. The time series of average sediment and water Pu concentrations showed no distinct seasonal pattern nor any longer-term trend over that period.

3.2 STREAM/DITCH (S/D) SW AND SED DATA

A source of initial basinwide characterization data at several surface-water locations in the Woman Creek drainage basin is given in Rockwell International (1986). The OU5 Phase I RFI/RI Work Plan (USDOE, 1992a) contains two appendices statistically summarizing data on sediment chemistry and water-quality characteristics. This latter data-summary source was the primary means of evaluating adequacy of the existing data for surface-water site characterization. However, consideration was given to the most recent proposed changes in the RFP sitewide surface-water monitoring program (EG&G, 1992a). Selected results are given in a series of tables in ASI (1992b, Appendix G).

4.0 MODELING/RISK-ASSESSMENT IMPACTS

Included in the evaluation of the rationale for additional needs in surface-water and sediment data are considerations of a number of related hydrologic factors. Aspects of these factors are discussed in the following subsections.

4.1 GROUND-WATER/SURFACE-WATER INTERACTIONS

EG&G (1992d), with assistance of staff of Colorado State University (CSU), has completed several months of gain/loss measurements in Woman Creek from the western boundary of the RFP to Indiana Street. These gain/loss measurements have been summarized in a preliminary manner into discrete subreaches of Woman Creek. Between August 1991 and March 1992, five gain/loss studies were done on up to 17 subreaches of Woman Creek. Of these subreaches, approximately 11 were gaining water and 6 were losing water on the average over the limited period of field surveys. The variability in gain or loss within any given reach, or in Woman Creek as a whole, is highly seasonal and dependent upon both surface-water and ground-water conditions, both at the time of measurement and from previous antecedent hydrologic conditions such as precipitation, air temperature, vegetative cover, and soil moisture.

4.2 MODELING APPLICATIONS

4.2.1 Ground-Water Solute-Transport Modeling

Ground-water solute-transport modeling will serve two purposes identified in the OU5 Work Plan (USDOE, 1992a): (1) to characterize the general ground-water flow regime within and adjacent to OU5; and (2) to provide insight into potential ground-water contaminant pathways within and adjacent to OU5.

To characterize the general ground-water flow regime within and adjacent to the IHSSs, ground-water flow modeling will be conducted at an appropriate scale. This flow modeling will initially consist of a single modeling project designed to include the IHSSs within OU5 and integrate consistently with site-wide ground-water flow modeling. The initial flow modeling will be used to construct flow paths from the IHSSs and to determine requirements for more detailed flow and transport modeling. Detailed flow and transport modeling will be done at the IHSS level as necessary.

The initial ground-water flow modeling will consist of a single finite-difference model designed to include the IHSSs within OU5 and to extend far enough eastward so that ground-water flow lines from all IHSSs reach a stream within the boundary of the model. MODFLOW or an equivalent finite-difference flow model will be used for the modeling. A two-layer deformed grid is the likely configuration, with the upper layer representing surficial materials and the lower layer representing underlying bedrock. This configuration may be adjusted if necessary to integrate with site-wide groundwater flow modeling and the surface-water model so that ground-water/surface-water interactions may be modeled, if possible. Particle tracking will be used to construct the flow paths from the IHSSs and to determine the requirements for more detailed flow modeling. Sensitivity analyses will not be done on the initial modeling effort, because its purpose is to help define the ground-water flow system for more detailed modeling as described below.

Detailed flow and transport modeling will be done at the IHSS level (individual or clusters) as appropriate. Where necessary, telescoped solute transport models will be developed for individual IHSSs or cluster groups of IHSSs. The expected modeling procedure involves the use of MT3D or equivalent for simulating transport in the ground-water system. Because few data are available for the vadose zone, it is anticipated a one-dimensional analytical solute transport model will be appropriate for simulating contaminant movement through the vadose zone to provide input to the ground-water model. The surface-water model will provide quantitative estimates of the amounts of water which may have to be considered in the vadose zone. In addition, if contaminants are found to be leaving the IHSS-modeled areas via subsurface flows into Woman Creek, a one dimensional analytical model will be used, if necessary, to simulate the transport in underflow beyond the boundaries of the telescoped IHSS models. All solute transport models used will include dispersion, adsorption, and decay. Models will be adjusted until their results are consistent with available data on contaminant concentrations in wells near the IHSSs. Sensitivity analyses will be done as part of the detailed ground-water flow and transport modeling and will be used as information inputs to Section 4.3 (Risk Assessment).

4.2.2 Surface-Water Contaminant Modeling

To characterize the general surface-water system of OU5, a regional scale surface-water flow and transport model will be developed. This model will include the Woman Creek segments located onsite at RFP. The model will use both stream-reach and pond modules to simulate the total Woman Creek surface-water system. The regional model may be expanded to include off-site segments as necessary. Where required, IHSS-specific flow and transport models will be developed and integrated to the regional scale model. Data collected during surface-water and sediment sampling, including background sampling, will be used to characterize Woman Creek, the South Interceptor Ditch (SID), and the C-Series ponds.

The purpose of the regional surface-water flow and transport model will be to assess the water quality of Woman Creek over its various segments under a range of flow rates and to assess the potential surface-water contaminant pathways. Flow in Woman Creek can be attributed to ground water, storm runoff from both rainfall and snowmelt, and inflows from irrigation diversions through the Smart 2 and Kinnear Ditches. Each of these sources will be included in the flow and transport model. Because the flows in Woman Creek are generally small, the Hydrological Simulation Program-Fortran (HSPF) model, a one-dimensional steady-state or dynamic model will be used (Johnson and others, 1980). HSPF permits simulation of branching, one-dimensional stream/reservoir systems, with ground-water simulation and pond simulation also. The model is capable of simulating water and sediment budgets, water temperature, dissolved oxygen, biochemical oxygen demand (BOD), organic-nitrogen, ammonia-nitrogen, nitrate-nitrogen, organic-phosphorus, dissolved-phosphorus, pesticides, pH, CO_2, total inorganic carbon, alkalinity, plankton populations, arbitrary nonconservative constituents using a first-order decay function, and conservative constituents. However, the modeling application will focus only on selected water-quality and sediment-related variables of concern at OU5. The proposed approach to HSPF modeling for (1) various segments in Woman Creek on the RFP site; (2) integration of ponds on

Woman Creek to simulate the complete Woman Creek system; (3) IHSS-specific flow and transport models, where necessary; and (4) ground-water/surface-water interactions are discussed in the following paragraphs.

Because the HSPF model requires some data, such as inputs for modeling stream temperature, to be hourly or bi-hourly when the data are often available only as daily totals (such as solar radiation), preprocessing of such data must be done on order to correctly simulate the physical processes occurring (such as the rising and setting of the sun related to daily solar radiation). these types of preprocessing tasks require large amounts of time for each time series. Therefore, a limited number of time series will be used to reduce this set-up time.

Modeling Woman Creek Segments. Several physical, as well as water-quality segments, are present in the Woman Creek basin in the vicinity of the RFP. Water-quality segments have been established by the Colorado Department of Health's (CDHs) Water Quality Control Division. These stream segments are: (1) Segment 4 which includes Ponds C-1 (on-channel) and the main stem of Woman Creek upstream from Standley Lake; and (2) Segment 5 which includes Pond C-2, an off-channel pond (for peak discharges less than the 100-yr flood).

In addition to these water-quality stream segments, there are some physical segments which will help determine the structure of the simulation model. The Kinnear Ditch diverts water from Coal Creek and discharges it into Woman Creek at the western RFP boundary. The quality of Coal Creek water may differ from that of Woman Creek. This water-quality difference will be taken into account in the model. The Smart 2 Ditch diverts water from the Smart Ditch downstream from Rocky Flats (Smart) Lake into Woman Creek. The source of Smart Ditch water also is Coal Creek. The impacts of Rocky Flats Lake on the water quality of the Smart 2 Ditch water is unknown and no data on this quality are known to exist. If Smart 2 Ditch water-quality data are available, this aspect will be included in the model. The SID intercepts runoff from the south side of the controlled area of the RFP and diverts it to Pond C-2. The locations and configuration of these various diversion structures are given in ASI (1990, Figure 2).

A third segment of Woman Creek is runoff from the RFP areas not diverted to Pond C-2 by the SID. Much of the RFP storm runoff from the south site of the plant site is diverted by the SID to Pond C-2. A fourth segment of Woman Creek is downstream from Pond C-1. Existing water-quality data from historical Woman Creek monitoring will aid in assessing the impacts of Pond C-1 and these data will be used to calibrate the model. The segment of Woman Creek downstream from Pond C-2 also may have different water-quality inputs, because releases from Pond C-2 periodically are discharged to Woman Creek. The water quality of Woman Creek at the eastern RFP boundary at Indiana Street will be predicted by the model, based upon upstream inputs. The Woman Creek water quality in each physical stream segment will be compared to historical data and CDH in-stream standards for that segment. Ground-water flows and identified seeps and springs and their associated water quantity and quality, from the RFEDS data base, also will be used to calibrate the model.

Integration of Pond Models. HSPF has an internal module for predicting the water quality of ponds. Results of the modeling will be compared to actual available field and laboratory data (in the RFEDS data base and other sources) and will be used to calibrate the model to simulate pond outflow water quality. In this way, the complete hydrologic (surface-water) Woman Creek system will be modeled.

Individual IHSS Modeling. To the extent possible using existing water-quality data from the RFEDS data base, the impacts of individual IHSSs or clusters of IHSSs will be included in the model using input elements. Sediment discharge from segments may be an important aspect of the IHSSs and will be modeled in this study. Both ground-water and surface-water aspects of the IHSSs will be used, if existing data are available for individual IHSSs or can be estimated from existing upstream and downstream data. The impacts on Woman Creek water quality will be assessed, if possible, assuming that the individual IHSS water quality is improved due to remediation within an individual IHSS.

Ground-Water/Surface-Water Interactions. Ground-water/surface-water interactions can be modeled using HSPF. The amount of water lost from the stream or entering the stream, along with its water-quality attributes can be simulated by the model. These interactions will be verified using data collected as described in Section 4.1 above.

The HSPF modeling will be done by assuming that adequate flow and water-quality data are available to calibrate the model. Long-term flow data on Woman Creek over a large range of flow conditions are generally not available. The calibrated model will be used to predict water quality in Woman Creek, Ponds C-1 and C-2, and the alluvial ground-water system for a low-flow and high flow period in a typical dry, average, and wet year if enough data exist to adequately represent these flow scenarios. Model water temperature, dissolved oxygen, nitrate, one nonconservative and one conservative tracer will be modeled. The nonconservative tracer can be a radionuclide, if a first-order decay is assumed.

Results of the modeling will be presented as plots of the water-quality constituent of interest versus distance along Woman Creek. This will help assess the critical points of water quality concern along the Creek from its headwaters to Indiana Street. As indicated above, six scenarios will be modeled if enough existing data are available. Sensitivity analyses will be done as part of the surface-water modeling and be used as input to Section 4.3, RISK ASSESSMENT.

4.3 RISK ASSESSMENT

4.3.1 Contaminant Identification

Data Collection. The methods used for sampling radiological and/or hazardous constituents will be evaluated to determine suitability of the sampling program to meet the model parameter needs. Data will be collected based upon the field sampling plans which will be reviewed by the risk assessor. The data collection phase will include the following activities to be performed in support of the Public Health Baseline Risk Assessment (PHBRA):

- Existing data will be reviewed using the Guidance for Data Useability in Risk Assessment (USEPA, 1990).

- Model-parameter needs will be reviewed and verified to be included in the field sampling plan (FSP) applicable to OU5.

- Background data will be collected in suitable areas representing naturally occurring environmental site conditions.

- Preliminary Exposure Assessments will be conducted for each individual IHSS (or IHSS cluster, as appropriate), focusing on the dominant contaminants and exposure pathways.

- The overall sampling strategy will be evaluated to verify that all pathways are covered by a statistically acceptable set of sample locations.

- Radiological analysis will be specified to include detection systems capable of adequately distinguishing a contaminant from background and/or fallout from offsite tests.

- During the data collection phase, the risk assessor will be available for consultation on any field variance.

Data Evaluation. The data evaluation phase will incorporate all of the elements of the OU1 Baseline Health Risk Assessment Plan plus additional screening criteria as approved by EPA/CDH on OU1. The selection of contaminants of concern (COCs) will be based on the protocol established in OU1 unless otherwise directed. It will be assumed that 15 COCs will be the maximum number of COCs to be modeled.

A technical memorandum describing the method for selecting COCs results, and conclusions will be part of this task. Validated data will be used if available; unvalidated data also may be used, in order to maintain the IAG schedule and overall intent.

4.3.2 Exposure Assessment

Exposure assessments are performed using scenarios that define the conditions of exposure to contaminants at a site. An exposure scenario defines (quantitatively) the human populations that may be exposed, the frequencies and durations of exposure, the pathways of exposure (e.g., inhalation, drinking water, or dermal contact with soil), and the levels of contaminants in the air, water, or soil that contact the population through the exposure pathways.

Pathway analysis and exposure assessment are directly impacted by the assumed category of land use. The PHBRA will require an evaluation of both current and future land uses. The categories of land use to be evaluated as part of this assessment include:

- Agricultural;
- Residential;
- Commercial/Industrial; and
- Recreational/Research

Each category has a suite of unique parameters associated with it including assumed population densities, lifestyles, and eating habits.

In 1989, there were 2,201,340 people living within 50 miles of the Rocky Flats Plant (EG&G, 1990). It is projected that this number will grow steadily to 3,119,309 by the year 2010. Currently, and in future predictions, approximately 14 percent of these inhabitants live within 10 miles of the site (EG&G, 1990b). It is assumed that none of the land use categories can be eliminated based on these projections.

Once potentially exposed populations and exposure scenarios have been identified and characterized, exposure pathways can be traced from the site to receptor locations. Each exposure pathway describes a mechanism by which a hypothetical receptor is exposed to chemicals originating from the site.

Measured or estimated concentrations of COCs in soil, air and water will be provided as part of this Work Plan. All ground-water, surface-water and air modeling required by the risk assessment task will be performed herein and be approved by the Risk Assessment Manager. This includes modeling concentrations in each media at each receptor location. The estimated concentrations of COCs in each medium will be used to estimate the intake and resulting health risk to the receptor.

In order to support the uncertainty analysis, it is assumed that all groundwater, surface water and air modeling required by the uncertainty analysis task will be performed. This includes an extensive parameter sensitivity analysis which generates a distribution function around the central tendency factor for each modeled media concentration at each receptor location.

Human exposure is expressed in terms of intake and defined as the amount of a chemical substance taken into the body per unit body weight per unit time. Intake rates will be calculated separately for exposures to chemicals in each environmental medium via soil, air, groundwater, surface water, and food. Then, for each exposed population, intake rates are summed for oral, inhalation, and dermal exposure routes. If dermal exposure is determined to be significant, it is summed with oral exposure. Intakes are typically expressed in units of milligram of substance per kilogram of body weight per day (mg/kg/day).

The following assumptions and calculations are used to estimate intake in humans from exposure to chemicals present in soil, air, groundwater and surface water. The magnitude of exposure to chemicals is influenced by frequency and duration of contact with these media. Also, the age of the potentially exposed individual will influence the extent of contact with these chemicals. There are three categories of parameters used to estimate intake:

- Chemical-related parameters (exposure concentrations)

- Characteristics of the exposed population (contact rate, frequency and duration of exposure, inhalation rate, soil ingestion rate, drinking water consumption rate, skin surface area, and body weight); and

- Averaging time.

The models will be evaluated by EG&G's Risk Assessment Manager on the basis of both technical and management objectives. Models in each discipline will be evaluated with regard to a range of technical criteria applicable to each. However, to screen appropriate models the following four criteria will be used for all disciplines:

- The selected model(s) should be capable of simulating, with or without minor adaptation, the transport processes and site conditions existing at OU5 and surrounding areas.

- The models should be capable of accomplishing the study objectives. They should have the appropriate degree of sophistication, neither too simplistic and approximate nor too complex and elaborate, requiring extensive input data for calibration and implementation which may be hard to obtain.

- The model should have been tested and validated for application in situations similar to that at the Rocky Flats Plant site.

- The model code and documentation should be complete and have undergone adequate peer review.

A technical memorandum will be prepared as specified in the IAG. This memorandum will describe the present, future, potential and reasonable use exposure scenarios with a description of the assumptions made and the use of data. The memo will be submitted to EG&G/DOE-RFO for one round of comment response prior to submittal to CDH/EPA.

4.3.3 Toxicity Assessment

Health risks from all routes of exposure will be characterized by combining the radiological and chemical intake information with numerical indicators of toxicity. These health-protective toxicity criteria are obtained through EPA-developed reference doses (RfDs) or slope factors (SFs)(USEPA, 1990). If no health-based toxicity criteria are available for a particular chemical, a health-protective number in the toxicity assessment task will be developed using procedures identical to those used for developing RfDs.

The baseline risk assessment will include a toxicological profile for each chemical detected at the site. These profiles will discuss:

- Acute and chronic toxic effects of these chemicals in humans;
- Environmental fate and transport (e.g., degradation process, products, mobility within each medium, and potential means of transport from one medium to another);
- Applicable or relevant and appropriate requirements (ARARs), maximum contaminant levels (MCLs), and other health-protective criteria for each chemical.

In accordance with EPA guidance, the preferred numerical indicators of toxicity will be the EPA-derived RfDs. RfDs for chemicals considered in the risk assessment will be obtained from the EPA's Integrated Risk Information System (IRIS) database. The RfD is based on the assumption that thresholds exist for certain non-carcinogenic toxic effects such as cellular necrosis, but may not exist for other toxic effects such as cancer. In general, the RfD is an estimate (with uncertainty spanning perhaps an order of magnitude) of a daily exposure to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious effects during a lifetime of exposure.

4.3.4 Risk Characterization

Risk characterization involves estimating the magnitude of the potential adverse effects under study and presents summary judgements of the nature of the threats to public health. Characterization of risks involves combining the results of the exposure and toxicity assessments to provide numerical estimates of health risk. These estimates are comparisons of exposure levels with appropriate RfDs or estimates of lifetime cancer risk with a particular intake. Risk characterization also considers the nature and weight of evidence supporting these risk estimates and the magnitude of uncertainty surrounding those estimates. Results of this task will be presented in the public health evaluation (PHE) report.

<u>Quantify Risks From Each Contaminant</u>. The health risks from each contaminant may be calculated using two methods: one to determine carcinogenic effects and another for noncarcinogenic effects.

Carcinogenic Effects. The following calculations are used to obtain numerical estimates of lifetime cancer risks:

$$RISK = INTAKE \times SF$$

where:

RISK	=	potential cancer risk adjusted for lifetime exposure (unitless)
SF	=	cancer potency slope $(mg/kg/day)^{-1}$
INTAKE	=	chemical intake (mg/kg/day)

Additionally, the committed effective dose equivalent (CEDE) will be calculated for receptors potentially exposed to radionuclides.

Noncarcinogenic Effects. Health risks associated with exposure to noncarcinogenic compounds will be evaluated by calculating a hazard index. The hazard index is the ratio of the intake rate to the RfD, as follows:

$$HI = INTAKE/RfD$$

where:

HI	=	Hazard index
INTAKE	=	Chemical intake (mg/kg/day)
RfD	=	Reference Dose (mg/kg/day)

Quantify Risks From Multiple Contaminants. The summed carcinogenic and noncarcinogenic effects for multiple contaminants can be calculated using the following two methods.

Carcinogenic Effects. Cancer risks will be summed across all carcinogens considered in the risk assessment using the following equation:

$$RISK_T = \Sigma RISK_i$$

where:

$RISK_T$	=	the total cancer risk, expressed as a unitless probability; and
$RISK_i$	=	the risk estimate for the i-th substance.

Noncarcinogenic Effects. Hazard indices will be summed for those chemicals known to produce similar adverse effects in the same target organ using the following equation:

$$HI = \sum \frac{E_i}{RfD_i}$$

where:

HI	=	Hazard Index

E_i = exposure level (intake) for the i^{th} toxicant
RfD_i = reference dose for the i^{th} toxicant
E and RfD are expressed in the same units and represent the same exposure period.

Limitations on the application of this procedure are discussed in the Risk Assessment Guidance for Superfund (RAGS)(EPA, 1989).

4.3.5 Uncertainty Analysis

The quantification of uncertainty is an important component of the risk assessment. There are four stages of analysis applied in the risk assessment that can introduce uncertainties:

- data collection and evaluation,
- exposure assessment
- toxicity assessment
- risk characterization

The uncertainty analysis characterizes the propagated uncertainty in public health risk through the pathways and contaminants which dominate the risk in each credible scenario. These uncertainties are driven by uncertainty in the chemical and radiological monitoring data, the transport models used to estimate concentrations at receptor locations, receptor intake parameters, and the toxicity values used to characterize risk. Additionally, uncertainties are introduced in the risk assessment when exposures to several substances across multiple pathways are summed.

The goal of the uncertainty analysis is to quantify the uncertainty in the final risk characterization estimates. Initially, the key site-related variables and assumptions that contribute most to the uncertainty will be identified. The risk characterization used in the risk assessments may not be fully probabilistic estimates of risk but conditional estimates given a considerable number of assumptions about exposure and toxicity. Where possible, quantitative techniques to estimate uncertainty will be applied (e.g., parameter imprecision analyses to evaluate model predictions). Assumptions and uncertainties inherent in the risk assessment will be fully specified in order to place the risk estimates in the proper perspective. The goal will be to use and analyze site data in such a way that results can be presented as estimated probability distributions. The overall uncertainty for the risk assessment will be estimated by the total resultant variance propagated through the pathways which dominate the risk.

The review and selection of appropriate uncertainty analysis methods will be focused on providing an overall approach that would provide a quantitative result. To assess the uncertainty introduced into the risk assessment by each of the categories described above, methodologies or approaches for determining the uncertainty for each category will be selected. These are discussed in the following sections.

Data Collection and Evaluation. Variability in observed concentrations is due to sampling design and implementation, laboratory analysis, seasonality, and natural variation. The key issue in optimizing the usability of the data is to quantify these uncertainties in the risk assessment. Uncertainty introduced from sample collection and analysis is quantifiable by calculating the variance in the analytical results within OU5. After identification of the contaminant(s) which dominate(s) the risk for each credible pathway, a concentration distribution will be calculated along with the mean concentration and variance. The resulting variance accounts for the uncertainty introduced by sampling, analysis, seasonality, and natural variation.

Exposure Assessment. The largest measure of uncertainty in the exposure assessment is associated with: (1) characterizing transport, dispersion, and transformation of COCs in the environment; (2) establishing exposure settings; and (3) deriving estimates of subchronic and chronic intake. The ultimate effect of this process is the generation of a range of estimates for intake at a given exposure point.

A statistical sampling method (Monte Carlo, latin hypercube, or similar method) will be used for quantitative modeling of uncertainty, if available information is judged to be adequate to support this approach. The product of this subtask will be semiquantitative or quantitative estimates of the uncertainty associated with exposure concentrations predicted by the air dispersion and transport models applied during the exposure assessment.

5.0 RECOMMENDED REVISIONS, OU5 PHASE-I FIELD SAMPLING PLAN

This section provides specific details of recommended modifications to the field sampling plan (FSP) for Phase-I RFI/RI investigations for OU5, as originally proposed by USDOE (1992a). The primary and secondary objectives stated previously are reflected in the recommendations that follow.

5.1 C-Pond Components

5.1.1 Spatial Water-Column Sampling

This subsection addresses concerns of spatial variability of conditions in the C-ponds. Based upon available data in the cases of the C-ponds and upon experience with monitoring-data results for larger impoundments, no multiple areal sampling or compositing from multiple water-depth intervals are necessary (see Sections 2.4.1 and 3.3.1; also, ASI, 1992b, Appendix Tables A-1, B-1, and E-1). In order to provide continuity with historical data, water-quality sampling procedures for these impoundments should be continued for the CWA compliance and other operational (routine) purposes still applicable (see Table 1). Resultant analyses for these regulatory-compliance samples will be used for the Final OU5 RFI/RI C-pond characterization without the need for additional data collection.

5.1.2 Bottom Sediments

The recent bottom-sediment characterization sampling program in the C-ponds conducted by an EG&G contractor under the direction of EG&G should provide useful information to further characterize bottom-sediment chemical conditions in these impoundments. Minimal historical data on C-Pond bottom sediments are available. Only a preliminary evaluation has been made to date of results of EG&G's May 1992 sampling survey (see Section 2.2). It is concluded that further bottom-sediment characterization of the C-Ponds is needed for the Phase I OU5 RFI/RI. A selective sampling program for the C-Ponds is proposed to provide additional information of use to the hydrologic-modeling and risk-assessment aspects of the OU5 Phase I RFI/RI.

Field components of this C-pond sampling survey, scheduled for late August or early September 1992, are as follows:

- A hand-corer or gravity-corer sampler (USEPA, 1987) would be used at five (5) locations in Pond C-1 (within 5 feet of the inlet, from the bank presently below the waterline, from the bank above high waterline, and two samples from the deepest part of the pond), and five (5) locations in Pond C-2 (within 5 feet of the SID inlet, from the bank presently below waterline, from the bank above high waterline, and two samples from the deepest part of the pond).

- It would be attempted to obtained relatively undisturbed sediment core samples at each of the above specified locations. However, if bottom sediments do not lend themselves to maintaining layering integrity (after 3 attempts at any given location), then a mixed sample would be obtained for use in the bottom-sediment characterization.

- Analyses on resultant C-pond bottom-sediment samples (anticipated to total 10 in number of locations and multiple for sites for at which core samples are obtained), extractable analyses on the bottom sediments would consist of the following: radionuclides (gross alpha, gross beta, Pu-239/240, U-233/234/235/238, tritium, Sr-89/90, Cs-137 and Am-241; along with beryllium, chromium, Hazardous Substance List (HSL) metals, HSL volatiles, *HSL semi-volatiles, and total nitrate* (State of Colorado and others, 1991).

- For core samples, parts of bottom-sediment cores at 6-in intervals would be separated for analyses of the constituents specified above.

After results of this survey are evaluated, additional data needs may be identified subsequently for risk-assessment or hydrologic-modeling purposes. Therefore, an additional bottom-sediment survey may be required prior to spring snowmelt runoff (generally judged to occur in late March or early April 1993). Survey-design considerations are anticipated to follow the components described above for the late-August, early-September 1992 survey.

5.1.3 Frequency/Scheduling of Samples and Field Measurements/Laboratory Analyses

C-pond data of additional benefit to OU5 Phase I RFI/RI characterization will be collected through currently scheduled and ongoing regulatory-compliance programs for environmental protection. Assuming that all concerns regarding temporal variability have not been covered by available historical data, data available as recently as possible will be evaluated and incorporated in the OU5 Phase I RFI/RI characterization. Also, consideration in this characterization will be given to presently known hydrologic-modeling and risk-assessment data-input needs (WBSs 1003 and 1005, ASI, 1992), as discussed in Sections 4.2 and 4.3.

5.1.4 Suites of Chemical Constituents

In the case of C-pond characterization, application of the designated suites of field measurements and laboratory chemical analyses for ongoing regulatory and operational purposes should be *sufficient as indicated in Section* 5.1.2 above. However, continued consideration will be given to identified indicator variables required for hydrologic-modeling or risk-assessment data-input needs (WBSs 1003 and 1005, ASI, 1992), as discussed in Sections 4.2 and 4.3.

5.1.5 Toxicity Testing

Further information should be extracted from the ongoing WET-test program currently underway for the C-ponds (Sharon Ford, EG&G-ER/SWD, written commun., July 15, 1992, see Section 2.1.3). At this time, no field investigations in additional to this program will be needed for OU5 Phase I C-pond characterization.

5.2 STREAM/DITCH (SID) SW AND SED SITES

This aspect is of secondary priority relative to the primary objective and data-assessment scope of this TM, which focuses on an evaluation of the C-pond data-collection programs. Selective observations and recommendations have made in the case of stream or SID (SW) and associated sediment (SED) monitoring-site operations. This evaluation and subsequent recommended continuing or new monitoring activities are based upon a preliminary assessment of existing data and identified conclusions and recommendations regarding the historical and current monitoring program (USDOE, 1992a; EG&G, 1991d; 1992a).

In order to further assess the ground-water/surface-water interactions, the EG&G (1992d) gain/loss data collection program in Woman Creek is assumed to be continuing. Additionally, alluvial ground-water levels near the stream should be measured at locations consistent with those used for the surface-water gain/loss measurements. This can be done by using temporary shallow wellpoints or perforated pipe driven into the alluvium at the edge of Woman Creek. It is envisioned that the wellpoints or pipe would consist of between 3/4-in and 1-1/2-in diameter galvanized pipe driven into the alluvium. Figure 7 shows the proposed locations of these shallow alluvial monitoring points. Because of the difficulty of installing driven pipes into cobbly materials, the number and location of the monitoring locations shown on Figure 7 may vary. Only water levels would be measured in these pipes. In addition to pipes along Woman Creek to establish if the alluvial water levels are above or below the stream bottom, three additional lines of pipe would be installed perpendicular to Woman Creek (Figure 7). These three lines of pipe would include (1) a line from Woman Creek north toward the ash pits; (2) a line from Woman Creek north to the SID near Antelope Spring; and (3) a line from Woman Creek north to the SID between Pond C-1 and Pond C-2 diversion (Figure 7). These lines would help establish if a continuous ground-water connection exists between Woman Creek and these locations. Each wellpoint or pipe would be surveyed to establish its reference elevation relative to the stream channel bottom and/or water surface. The water-level elevation in each well point and in Woman Creek would be measured monthly at the time of the gain/loss study. These shallow alluvial well data would confirm if the surface water measurements are occurring in or near a gaining or losing reach based upon ground-water measurements. These data would be used to help calibrate both the ground-water and surface-water models and provide an assessment of the potential for contaminants to move between the shallow ground-water and surface-water systems.

5.2.1 Stream/Ditch Water Quality

<u>OU5-Related SW Monitoring Sites</u>. It is assumed that identified continuing sitewide operations of OU5-related SW sites, generally as recommended in EG&G (1992a) will be adhered to. Of specific concern in the evaluation for this TM are the sites indicated in Figure 8. It is recommended that three sites (SW028, SW035, and SW041) be reactivated as part of a synoptic surveys along with currently active event-related sites (Figures 1 and 8), if these have been discontinued as inferred in EG&G (1991d), for OU5 Phase I RFI/RI characterization purposes. These sites are to be sampled synoptically (that is, concurrently) with runoff-event sampling occurring at other SW sites in the Woman Creek drainage (EG&G, 1992c, and see below). Site SW028 will provide continuing water-quality characterization of any occurring extreme-event inflows over the Woman Creek diversion into Pond C-2. Site SW035 would provide continuing water-quality characterization along the SID generally downstream from IHSS 115 (old landfill) and upstream from the 881 Hillside area (USDOE, 1992a). Site SW-41 would provide continuing water-quality characterization of inflows of this tributary to Woman Creek; a stream possibly impacted by a disturbed area to the south.

Six additional sites required by the IAG also will be implemented during synoptic event-related surveys. **[details to follow, see Greg Wetherbee's notes]**

The remaining 10 SW sites as indicated in Figure 8 will continue to provide useful information for OU5 characterization, including anticipated hydrologic-modelling and risk-assessment needs. Of particular use in the hydrologic modelling will be resultant data from continuation of stream/ditch event-related monitoring, specifically, involving sites SW107 (GS05) and SW127 (GS06), site SW029 (GS07) just downstream from Pond C-1, site SW027 (stormwater NPDES) near the outflow of the SID to Pond C-2, and either site SW002 (GS02) on Mower Ditch or site

SW001 (GS01) on Woman Creek (dry nearly all the time) near the downstream eastern-RFP boundary (ASI, 1991c; EG&G, 1992b). The potential for sediment transport in Woman Creek from IHSS areas is greatest during snowmelt or storm-related runoff. Contaminant mass-balance calculations and loadings will be evaluated, using discharge records and water-quality samples for event-related flows.

Sampling-Survey Scheduling. For SW sites not currently included in continuing sitewide monitoring (EG&G, 1992c; Figure 8), event-related surveys at approximate quarterly intervals are recommended for about the intervals of August 1992, November 1992, February 1993, and May 1993 (or as scheduled for applicable sitewide sites), to provide current data for OU5 characterization.

Water-Quality Variables. For SW sites not currently included in continuing sitewide monitoring (EG&G 1992c; Figure 8), suites of variables as described in EG&G (1991d, Table 6) should be analyzed, with the following recommendations:

- Continue the quarterly schedule for radiochemical and trace-metals/major-cations analytes.
- Schedule the organic analytes only for the low-flow late-summer or early-fall event-related survey (tentatively scheduled above for August 1992).
- Measurement of other analytes might occur in subsequent phases of the OU5 RFI/RI work, only if warranted by detailed review of available historical data (in general, existing characterization for these variables will be sufficient for purposes of the OU5 Phase I RFI/RI characterization).

5.2.2 Stream/Ditch Bottom-Sediment Chemistry

OU5-Related SED Monitoring Sites. For the designated SED sites (Figure 8), a single (late-August/early-September 1992) survey is recommended during low-flow late-summer or early-fall 1992.

Sediment-Chemistry Variables. Suites of analyses should be consistent in general with those outlined in EG&G (1991d, Table 6), with the following modifications:

- Use total organic carbon as an indicator organic analyte, and omit detailed organic-compound (GC/MS) analyses.
- Include trace metals as specified in this reference table.

5.3 SUMMARY OF RECOMMENDED FIELD SAMPLING PLAN (FSP) REVISIONS

In summary, the OU5 Phase-I RFI/RI FSP revisions consist of the following items:

- No water-quality C-pond multiple areal sampling or compositing from multiple water-depth intervals is judged necessary. Ongoing regulatory and operations programs will be sufficient to supply information for C-pond analyses relative to frequency, scheduling, and chemical constituents.

- A single bottom-sediment sampling survey is proposed for both Pond C-1 and Pond C-2 during the late-summer/early-autumn period to provide additional information.

- The existing WET-test program underway for the C-ponds will be sufficient to provide toxicity data.

- Ground-water/surface-water interaction data collection currently ongoing by EG&G and CSU should be augmented by several lines of wellpoints or driven pipes to measure the elevation of the shallow alluvial water table near Woman Creek to confirm gaining and losing reaches.

- Existing surface-water (SW) and sediment (SED) sites (9 SW sites and 4 SED sites) on Woman Creek and its tributaries in OU5 will be sampled for the OU5 work. Additionally, inactivated sites SW041, SW028, SED017, and SED026 on Woman Creek and its tributaries in OU5 should be sampled synoptically during quarterly event-related flows at active SW sites. One new sediment site will be initiated at SW032 on Woman Creek downstream from the Antelope Springs tributary during a low-flow synoptic survey. Sites SW027 and SED025 on the SID should be sampled and site SW035 sampled synoptically during event-related runoff. A new sediment site will be sampled at SW035 during a low-flow synoptic survey.

- One aspect of the OU5 surface-water data-collection network is its ability to monitor the impacts of storm runoff using a series of existing SW sites (SW107, SW127, SW029, SW027, and SW002). Most of the sediment transport from IHSSs occurs during precipitation events (either rainfall or snowmelt). The OU5 investigations will assess, in some detail, the impacts of runoff, providing a comparison between storm-related water-quality concentrations and low-flow water-quality concentrations.

- Sample collection for SW sites shown in Figure 8 will be synoptic and concurrent with event-related runoff (approximately quarterly).

- Water-quality variables for SW sites will be consistent with those currently being collected.
- Sediment-quality variables during a single low-flow survey for SED sites will include those currently being collected with the addition of a new site at SW035.

6.0 REFERENCES

Advanced Sciences, Inc., 1990, Water-Yield and Water-Quality Study of Walnut Creek and Woman Creek Watersheds, Rocky Flats Plant Site: Task 4 of the Zero-Offsite Water-Discharge Study, Prepared for EG&G Rocky Flats, Inc, Golden, Colorado, EG&G Job No. 401009, BOA Contract BA72429PB, Rev. 4, Purchase Order No. BA76637GS, ASI Project No. 9208.0105, September 18, 28 p., 4 figures, 6 tables, and Appendices A through E.

Advanced Sciences, Inc., 1991a, Surface-Water and Ground-Water Rights Study in the Vicinity of Rocky Flats Plant: Task 14 of the Zero-Offsite Water-Discharge Study, Prepared for EG&G Rocky Flats, Inc, Golden, Colorado, EG&G Job No. 986804, BOA Contract BA72429PB, Rev. 4, Purchase Order No. BA76637GS, ASI Project No. 9208.0114, May 21, 62 p., 8 figures, 18 tables, and Plate I.

Advanced Sciences, Inc., 1991b, Rainfall-Runoff Relationships Study, Rocky Flats Plant Site: Task 5 of the Zero-Offsite Water-Discharge Study, Prepared for EG&G Rocky Flats, Inc, Golden, Colorado, EG&G Job No. 401009, BOA Contract BA72429PB, Rev. 4, Purchase Order No. BA76637GS, ASI Project No. 9208.0105, June 18, 17 p., 9 figures, and Appendix A (17 p.).

Advanced Sciences, Inc., 1991c, Non-Point Source Assessment and Storm-Sewer Infiltration/Inflow and Exfiltration Study, Rocky Flats Plant Site: Tasks 2 and 3 of the Zero-Offsite Water-Discharge Study, Prepared for EG&G Rocky Flats, Inc, Golden, Colorado, EG&G Job No. 401009, BOA Contract BA72429PB, Rev. 3, Purchase Order No. BA73394PB, ASI Project Nos. 9208.0102 and 9208.0103, September 30, 66 p., 15 figures, 10 tables, and Appendices A through G.

Advanced Sciences, Inc., 1992a, Implementation of Phase I RFI/RI Work Plan, Woman Creek Drainage, Operable Unit No. 5: Request for Proposal BA 220329 - DBC-093-92, Prepared for EG&G Rocky Flats, Inc., P.O. Box 464, Golden, CO 80402-0464, May 15, 41 p., Appendices A and B.

Advanced Sciences, Inc., 1992b, Water-Quality and Bottom-Sediment Chemistry Data Assessment, Rocky Flats Plant, Woman Creek Priority Drainage (Operable Unit No. 5): Data-Summary Report for Final Phase I RFI/RI Work Plan, Prepared for EG&G Rocky Flats, Inc., P.O. Box 464, Golden, CO 80402-0464, August 14 (preliminary draft), __ p., 6 figures, 8 tables, and Appendices A through G.

CDM Federal Programs Corporation, 1987, Data Quality Objectives for Remedial Response Activities - Development Process: Report EPA/540/G-87/003 (OSWER Directive 9355.0-7B), 7611 Little River Turnpike, Suite 104, Annandale, VA 22003, EPA Contract No. 68-01-6939, Prepared for U.S. Environmental Protection Agency, Office of Emergency and Remedial Response and Office of Waste Programs Enforcement, Office of Solid Waste and Emergency Response, Washington, D.C., March, 5 sections and Appendices A through H.

State of Colorado, U.S. Environmental Protection Agency (USEPA), and U.S. Department of Energy (USDOE), 1991, Rocky Flats Interagency Agreement: Federal Facility Agreement and Consent Order, CERCLA-VIII-91-03, RCRA (3008(h))-VIII-91-07, State of Colorado Docket Number 91-01-22-01, January 22, 5 chapters and Appendices 1 through 4.

Demayo, Adrian, Davis, A. R., and Forbes, M. A., 1978, Forms of Metals in Water: Environment Canada, Scientific Series No. 87, Inland Waters Directorate, Water Quality Branch, Ottawa, Canada, 24 p.

EG&G Rocky Flats, Inc., 1990a, Rocky Flats Plat Site-Wide Quality Assurance Project Plan for CERCLA Remedial Investigations/Feasibility Studies and RCRA Facility Investigations/Corrective Measures Studies Activities: Environmental Restoration Program, Rocky Flats Plant, U.S. Department of Energy, Golden, Colorado, 148 p., Appendices A through C.

EG&G Rocky Flats, Inc., 1990b, 1989 Population, Economic and Land Use Data Base for Rocky Flats Plant: Report prepared for the U. S. Department of Energy, August, 105 p., Appendices A through C.

EG&G Rocky Flats, Inc., 1990c, General Radiochemistry and Routine Analytical Services Protocol (GRRASP): Scope of Work, Environmental Restoration Program, Rocky Flats Plant, U.S. Department of Energy, Golden, Colorado, ___ p.

EG&G Rocky Flats, Inc., 1991a, Rocky Flats Plant Site Environmental Report for 1990: Prepared for the U.S. Department of Energy under Control Contract No. DE-AC04-90DP62349, RFP-ENV-90, 210 p.

EG&G Rocky Flats, Inc., 1991b, Surface-Water and Sediment Monitoring Plan: Prepared by S.M. Stoller Corporation on Behalf of EG&G Rocky Flats, Inc., P.O. Box 464, Golden, CO 80402, Environmental Management Department, February 15, 81 p., 5 figures, 10 figures, and 2 plates.

EG&G Rocky Flats, Inc., 1991c, Evaluation of Surface Water Quality for Rocky Flats Plant Terminal Ponds A-4, B-5, and C-2: Environmental Management Department, CWAD-100-91, Prepared for U.S. Department of Energy, Rocky Flats Plant, Golden, Colorado, August 15, 53 p.

EG&G Rocky Flats, Inc., 1991d, Evaluation of the Rocky Flats Surface-Water Monitoring Programs: Environmental Management Department, Surface Water Division, September 16, 41 p., 2 figures, and 7 plates.

EG&G Rocky Flats, Inc., 1992a, Evaluation of the Rocky Flats Surface-Water and Sediment Monitoring Programs: Environmental Management Department, Surface Water Division, January 22, 30 p., 7 tables, 7 plates and Appendix A (see EG&G Rocky Flats, Inc., 1991c above).

EG&G Rocky Flats, Inc., 1992b, Final Work Plan for Event-Related Surface-Water Monitoring and Sediment Characterization: Rocky Flats Plant, P.O. Box 464, Golden, CO 80402, Environmental Management Department, February 10, 56 p.

EG&G Rocky Flats, Inc., 1992c, Final Surface-Water and Sediment Monitoring Plan: Rocky Flats Plant, P.O. Box 464, Golden, CO 80402, Environmental Management Department, February 24, 36 p. and Appendix A (2 plates).

EG&G Rocky Flats, Inc., 1992d (draft), Groundwater/Surface Water Interaction Study at Rocky Flats: Compiled by Randy Fydors (Colorado State University) and Andis Berzins (EG&G-EM/SWD), February 26, 17 p. and Appendices A through C.

EG&G Rocky Flats, Inc., 1992e, Pond and Reservoir Bottom Sediment Sampling: Standard Operating Procedure Manual No. 5-21000-OPS-SW.17, Environmental Management Department Operations Procedure Manual (Not Related to Plant Safety), Draft, __ p. and Appendices __ and __.

EG&G Rocky Flats, Inc., 1992f, Definition of Scope for Operable Unit Nos. 5 and 6 (OU5 and OU6) Technical Memoranda: Letter JEE-0377-92 dated June 5, 2 p.

EG&G Rocky Flats, Inc., 1992g, Transmittal of the Draft OU5 and OU6 Technical Memorandum Number 2 (1?): Letter MBA-0451-92 dated June 23, 1 p. with attachments.

EG&G Rocky Flats, Inc., 1992h, Modification to the SOW for Request for Proposal BA220329 - DBC-093-92, Advanced Sciences, Inc. (ASI), Implementation of Phase I RFI/RI Work Plan, Woman Creek Drainage, Operable Unit No. 5: Memorandum from Ed Mast, EG&G-EM/RPD to C. Lopez, EG&G-Contracts dated July 2, 1 p.

EG&G Rocky Flats, Inc., 1992i, Suspended Sediment Sampling: Standard Operating Procedure 5-21000-OPS-SW.14, Revision 0, Draft B, Environmental Management Department Operations Procedure Manual (Not Related to Plant Safety), Draft, 8 p. and Appendices 1 and 2.

Henry, R. L., 1986, Trends Observed in Rocky Flats Surface Water Monitoring: Rockwell International, Environmental Analysis and Control, Report 100384, April 15, 7 p. and 28 figures.

Johnson, R. C., Imhoff, J.C. and Davis, H.H., 1980, Users Manual for Hydrological Simulation Program-Fortran (HSPF): Prepared by Hydrocomp Incorporated, EPA-600/9-80-015, 667 p.

Johnson, J.E., Svalberg, Sharon, and Paine, Donald, 1974, The Study of Plutonium in Aquatic Systems of the Rocky Flats Environs: Final Technical Report, Colorado State University, Department of Animal Sciences and the Department of Radiology and Radiation Biology, Fort Collins, Colorado 80521, Prepared for Dow Chemical Company, Rocky Flats Division, Golden, Colorado 80303, Contract No. 41493-F, for the Period January 1, 1971, to June 1, 1974, 186 p.

Moran, R.E., 1990, Environmental Constituents in the Rocky Flats Area - Non-Facility Related Sources Pertinent to Water Quality: Completion Report Prepared by Moran and Associates, Inc., Prepared for Advanced Sciences, Inc. on Behalf of EG&G Rocky Flats, Inc., Appendix E of ASI (1991c) Tasks 02/03 ZOWD Study Report, December 10, 14 p., 1 figure, and 4 tables.

Paine, Donald, 1980, Plutonium in Rocky Flats Freshwater Systems: in Hanson, W.C. (ed.), Transuranic Elements in the Environment, Published by the Technical Information Center/U.S. Department of Energy, DOE-TIC-22800, pp. 644-658.

Rockwell International, 1986, Resource Conservation and Recovery Act Part B-Operating Permit Application for U.S.D.O.E.-Rocky Flats Plant Hazardous & Radioactive Mixed Wastes: Permit No. CO7890010526, 28 November, Volume VI, Section E Ground-Water Monitoring and Protection.

Sanders, T.G., Ward, R.C., Loftis, J.C., Steele, T.D., Adrian, D.D. and Yevjevich, V., 1983, Design of Networks for Monitoring Water Quality: Water Resources Publications, Littleton, Colorado, 328 p.

Steele, T.D. and Doerfer, J.T., 1983, Bottom-Sediment Chemistry and Water Quality of the South Platte River in the Denver Metropolitan Area, Colorado: International Symposium on Urban Hydrology, Hydraulics, and Sediment Control, University of Kentucky, Lexington, Kentucky, July 25-28, pp. 195-205.

U.S. Department of Energy (USDOE), 1992a, Final Phase I RFI/RI Work Plan, Rocky Flats Plant, Woman Creek Priority Drainage (Operable Unit No. 5): Rocky Flats Plant, Golden, Colorado, Environmental Restoration Program, February, Volume I - Text (12 sections), Volume II -Appendices A through E (Manual 21100-WP-OU 05.1), Prepared by Weston on behalf of EG&G Rocky Flats, Inc., August, Revision 1 (updates August 1991).

U.S. Department of Energy (USDOE), 1992b, Stage 1 Implementation of OU5 and OU6 Surface Water and Sediment Sampling: Memorandum from F. R. Lockhart to Erich Evered dated March 3, 2 p.

U.S. Department of Energy (USDOE), 1992c, Draft Technical Memorandum 1 - Revision to Final Phase I RFI/RI Work Plan, Surface-Water and Sediment Sampling and Analysis Plan - Rocky Flats Plant, Woman Creek Priority Drainage (Operable Unit Number 5) and Walnut Creek Priority Drainage (Operable Unit Number 6): Prepared by EG&G Rocky Flats, Inc., Environmental Restoration Program, June, 45 p. and Appendices 1 through 7.

U. S. Department of Energy (USDOE), 1992d, Historical Release Report for the Rocky Flats Plant: Volume I - Text, June.

U. S. Department of Energy (USDOE), 1992e, Baseline Vegetation and Wildlife Study Report, Rocky Flats Plant: Prepared by EBASCO and subcontractors on behalf of EG&G Rocky Flats, Inc., August 14 (draft), in process.

U.S. Environmental Protection Agency (USEPA), 1987, A Compendium of Superfund Field Operations Methods: Office of Emergency and Remedial Response, EPA/540/P-87/001 (OSWER Directive 9355.0-14), December, 619 p. (available from U.S. Department of Commerce, NTIS PB88-181557).

U.S. Environmental Protection Agency (USEPA), 1989, Risk Assessment Guidance for Superfund (RADS), Volume I - Human Health Evaluation Manual (Part A): Office of Emergency and Remedial Response, EPA/540/1-89/002, December.

U.S. Environmental Protection Agency (USEPA), 1990, Guidance for Data Useability in Risk Assessment: Office of Emergency and Remedial Response, EPA-540/G-90/008, October, 216 p.

U.S. Environmental Protection Agency (USEPA), 1991, NPDES Federal Facility Compliance Agreement FFCA-CWA-90-1: NPDES Permit No. CO-0001333, March 25, __ p.

Table 1
Summary of Rocky Flats Pond Monitoring Programs

Program	Location	Analytes	Frequency	Reason	Justification
Effluent Treatment	GAC Treatment Pond C-2	Volatiles	Weekly During Treatment	Process Control	BMP, AIP Attach A A-3 & DOE 5400.1
		Total Suspended Solids	Weekly During Treatment	Process Control	BMP, AIP Attach A A-3 & DOE 5400.1
		Total Dissolved Solids	Weekly During Treatment	Process Control	BMP, AIP Attach A A-3 & DOE 5400.1
		Chloride	Weekly During Treatment	Process Control	BMP, AIP Attach A A-3 & DOE 5400.1
		Fluoride	Weekly During Treatment	Process Control	BMP, AIP Attach A A-3 & DOE 5400.1
		Sulfate	Weekly During Treatment	Process Control	BMP, AIP Attach A A-3 & DOE 5400.1
		Carbonate/Bicarbonate	Weekly During Treatment	Process Control	BMP, AIP Attach A A-3 & DOE 5400.1
		Chromium	Weekly During Treatment	Process Control	BMP, AIP Attach A A-3 & DOE 5400.1
		Orthophosphate	Weekly During Treatment	Process Control	BMP, AIP Attach A A-3 & DOE 5400.1
		Nitrate	Weekly During Treatment	Process Control	BMP, AIP Attach A A-3 & DOE 5400.1
		Gross Alpha/Beta(t)	Weekly During Treatment	Process Control	BMP, AIP Attach A A-3 & DOE 5400.1
		Pu,Am,U,Sr,Cs,Ra (t)	Weekly During Treatment	Process Control	BMP, AIP Attach A A-3 & DOE 5400.1
		Tritium	Weekly During Treatment	Process Control	BMP, AIP Attach A A-3 & DOE 5400.1
		Triazine Herbicides	Weekly During Treatment	Process Control	BMP, AIP Attach A A-3 & DOE 5400.1
Pond Charaterization (Discontinued)	Pond C-1 Raw Water Pond C-2 Raw Water	Chloride	Monthly	Legal Exhibit Development	CWQCC, DOE Order 5400.1
		Fluoride	Monthly	Legal Exhibit Development	CWQCC, DOE Order 5400.1
		Sulfate	Monthly	Legal Exhibit Development	CWQCC, DOE Order 5400.1
		Carbonate/Biocarbonate	Monthly	Legal Exhibit Development	CWQCC, DOE Order 5400.1
		Chromium IV	Monthly	Legal Exhibit Development	CWQCC, DOE Order 5400.1
		Orthophosphate	Monthly	Legal Exhibit Development	CWQCC, DOE Order 5400.1
		Nitrite	Monthly	Legal Exhibit Development	CWQCC, DOE Order 5400.1
		Nitrite/Nitrate	Monthly	Legal Exhibit Development	CWQCC, DOE Order 5400.1
		Ammonia	Monthly	Legal Exhibit Development	CWQCC, DOE Order 5400.1
		Total Phosphorous	Monthly	Legal Exhibit Development	CWQCC, DOE Order 5400.1
		Sulfide	Monthly	Legal Exhibit Development	CWQCC, DOE Order 5400.1
		Microtoxicity	Monthly	Legal Exhibit Development	CWQCC, DOE Order 5400.1
		Cyanide	Monthly	Legal Exhibit Development	CWQCC, DOE Order 5400.1
		Dioxin (613)	Monthly	Legal Exhibit Development	CWQCC, DOE Order 5400.1
		HSL Metals (t)	Monthly	Legal Exhibit Development	CWQCC, DOE Order 5400.1
		HSL Metals (d)	Monthly	Legal Exhibit Development	CWQCC, DOE Order 5400.1
		Total Organic Carbon	Monthly	Legal Exhibit Development	CWQCC, DOE Order 5400.1
		Dissolved Organic Carbon	Monthly	Legal Exhibit Development	CWQCC, DOE Order 5400.1
		Rad Screen	Monthly	Legal Exhibit Development	Required by Offsite Labs
		Gross Alpha/Beta (t)	Monthly	Legal Exhibit Development	CWQCC, DOE Order 5400.1
		Pu,U,Am,Sr,Cs,Ra,Np,Th (t)	Monthly	Legal Exhibit Development	CWQCC, DOE Order 5400.1
		Gross Alpha/Beta (d)	Monthly	Legal Exhibit Development	CWQCC, DOE Order 5400.1
		Pu,U,Am,Sr,Cs,Ra,Np,Th (d)	Monthly	Legal Exhibit Development	CWQCC, DOE Order 5400.1
		Tritium	Monthly	Legal Exhibit Development	CWQCC, DOE Order 5400.1

[Comp=Composite; BMP=Best Management Practice; DOE5400.1, DOE5400.1, DOE5400.5=DOE Order 5400.5; AIP=Agreement in Principle; Mon=Monday; Wed=Wednesday; Fri=Friday; WET=Whole Effluent Toxicity; Pu=Plutonium; U=Uranium; Am=Americium; Sr=Stontium; Cs=Cesium; Ra=Radium; HSL=Hazardous Substance List; (t)=total; (d)=dissolved; BNA=Base-Neutral-Acid; PAH=Polyaromatic; PCB=Polychlorinated Biphenyls; Herb=Herbicides; Np=Neptunium; Th=Thorium; (624)=EPA analytical method 624; (502.2)=EPA analytical method 502.2; (625)=EPA analytical method 625; (608)=EPA analytical method 608; (615)=EPA analytical method 615; CWQCC=Colorado Water Quality Control Commission]

Source: Extraction from USDOE (1992c, Table 1).

Table 1
Summary of Rocky Flats Pond Monitoring Programs

Program	Location	Analytes	Frequency	Reason	Justification
Effluent Surveillance	Pond C-1 Effluent	Gross Alpha/Beta	Daily	Surveillance	BMP/DOE5400.1 ChIV 5a(1)(d&f)
		Flowrate	Daily	Surveillance	BMP/DOE5400.1 ChIV 5a(1)(d&f)
		Pu, U, Am	Weekly Comp.	Surveillance	BMP/DOE5400.1 ChIV 5a(1)(d&f)
		Tritium	Weekly Comp.	Surveillance	BMP/DOE5400.1 ChIV 5a(1)(d&f)
		HSL Metals	Quarterly	Surveillance	BMP/DOE5400.1 ChIV 5a(1)(d&f)
Effluent Surveillance	Pond C-2 Effluent	Gross Alpha/Beta	Daily During Discharge	Surveillance	BMP/DOE5400.1 ChIV 5a(1)(c&f)
		Nitrate	Daily During Discharge	Surveillance	BMP/DOE5400.1 ChIV 5a(1)(c&f)
		ph	Daily During Discharge	Surveillance	BMP/DOE5400.1 ChIV 5a(1)(c&f)
		WET	Quarterly Dur. Discharge	Compliance	FFCA page 5
		Suspended Solids	Daily During Discharge	Surveillance	BMP/DOE5400.1 ChIV 5a(1)(c&f)
		Nonvolatile Suspended Solids	Daily During Discharge	Compliance	NPDES page 13
		Tritium	Daily During Discharge	Surveillance	BMP/DOE5400.1 ChIV 5a(1)(c&f)
		WET	Monthly	Surveillance	BMP/DOE5400.1 ChIV 5a(1)(c&f)
		Pu, U, Am	Daily Comp. During Discharge	Surveillance	BMP/DOE5400.1 ChIV 5a(1)(c&f)
		Total Chromium	Monthly During Discharge	Compliance	FFCA page 4
Predischarge Surveillance	Pond C-2	Total Suspended Solids	Daily, Predischarge Split	Surveillance	AIP Attach A, A-3 & DOE 5400.1
		Gross Alpha/Beta	Daily, Predischarge Split	Surveillance	ChapIV 5b(1)(c)
		Nitrate/Nitrite	MWF, Predischarge Split	Compliance	FFCA page 4
		Ammonia	MWF, Predischarge Split	Surveillance	ChapIV 5b(1)(c)
		Volatiles	Weekly Predischarge Split	Surveillance	AIP Attach A, A-3 & DOE 5400.1
		Total Dissolved Solids	Weekly Predischarge Split	Surveillance	ChapIV 5b(1)(c)
		Chloride	Weekly Predischarge Split	Surveillance	AIP Attach A, A-3 & DOE 5400.1
		Fluoride	Weekly Predischarge Split	Surveillance	ChapIV 5b(1)(c)
		Sulfate	Weekly Predischarge Split	Surveillance	AIP Attach A, A-3 & DOE 5400.1
		Carbonate/Bicarbonate	Weekly Predischarge Split	Surveillance	ChapIV 5b(1)(c)
		Chromium VI	Weekly Predischarge Split	Surveillance	AIP Attach A, A-3 & DOE 5400.1
		Orthophosphate	Weekly Predischarge Split	Surveillance	ChapIV 5b(1)(c)
		Nitrate	Weekly Predischarge Split	Surveillance	AIP Attach A, A-3 & DOE 5400.1
		Triazine Herbicides	Weekly Predischarge Split	Surveillance	ChapIV 5b(1)(c)
		Tritium	Weekly Predischarge Split	Surveillance	AIP Attach A, A-3 & DOE 5400.1
		Pu, U, Am, Sr, Cs, Ra	Weekly Predischarge Split	Surveillance	ChapIV 5b(1)(c)

Table 2

Woman Creek Drainage Surface-Water and Sediment Monitoring-Site Descriptions

Surface Water Site[1)]	Sediment Site[1)]	Programmatic Driver(s)	Site Monitors Runoff from These OU5 IHSSs
SW-107	SED-16	B, C, D	Upstream from OU5
SW-40	--	B, C	133.1, 133.4, 133.5, 133.6
SW-127	--	B, C, D	Upstream from OU5
SW-41	SED-17	B, C	Surface Disturbance South of Ash Pits
SW-39	SED-14	B, C	133.1, 133.3, 133.4, 133.5,133.6, Surface Disturbance South of Ash Pits
SW-33	--	B, C	115, 133.1, 133.2, 133.3, 133.4, 133.5, 133.6, 196, Surface Disturbance South of Ash Pits
SW-34	--	B, C	None
SW-32	--	B, C	Same as SW-33
SW-C1	--	B, E	115, 133.1, 133.2, 133.3, 133.4, 133.5, 133.6, 142.10, 196, SE-1601.2, Surface Disturbance South of Ash Pits, Surface Disturbance West of IHSS 209
SW-29	SED-27	B, C	Same as SW-C2
SW-28	SED-26	B, C	Same as SW-C2 plus 209
SW-27	SED-25	A, B	115, SE-1600, SE-1601.1, Surface Disturbance East of Landfill
SW-C2	--	B, E, F	142.11 (except during 100-yr flood or large when all IHSSs contribute)
SW-26	SED-24	B, C	All IHSSs in OU5 (except 142.11 unless Pond C-2 is discharging)

1) Locations are shown on Figure 1.
2) A = Critical station for support of NPDES-related activities; B = Operable unit RI/FS and RI/CMS; C = General site characterization under DOE Order 5400.1; D = Storm-event monitoring under DOE Order 5400.1; E = Federal Facility Compliance Agreement (FFCA); F = Agreement in Principle (AIP).

Adapted from: EG&G (1991, Table 4).

Table 3

Pond C-1 Sitewide (RFEDS) Water-Quality Data, Statistical Summary

FIELD MEASUREMENTS

Variable	No. of Analyses	Mean	Std. Deviation	Maximum	Minimum
SC (uS/cm)	20	389.90	63.06	460.00	165.00
TEMP (deg C)	19	16.58	8.49	29.25	0.00
DO (mg/L)	16	8.36	3.16	14.80	4.20
pH (std. units)	20	8.02	0.41	8.83	7.18
ALK (mg/L)	10	148.17	42.81	185.00	34.00

RADIONUCLIDE ANALYSES

Variable (pCi/L)	No. of Analyses	Mean	Std. Deviation	Maximum	Minimum
GROSS ALPHA DIS	5	0.795	0.646	1.377	0.019
GROSS ALPHA TOT	4	1.860	1.697	4.200	0.210
GROSS BETA DIS	6	4.412	2.843	9.600	2.219
GROSS BETA TOT	5	6.381	4.564	12.000	2.624
PLUTONIUM 239/240 DIS	6	0.002	0.001	0.003	0.000
PLUTONIUM 239/240 TOT	6	0.006	0.004	0.014	0.002
URANIUM 233,-234 DIS	6	0.959	0.446	1.800	0.540
URANIUM 233,-234 TOT	6	0.797	0.331	1.100	0.390
URANIUM 235 DIS	6	0.109	0.180	0.470	0.000
URANIUM 235 TOT	6	0.070	0.025	0.098	0.033
URANIUM 238 DIS	6	0.744	0.673	2.100	0.350
URANIUM 238 TOT	6	0.599	0.255	0.880	0.260
AMERICIUM-241 DIS	4	0.008	0.014	0.029	0.000
AMERICIUM-241 TOT	4	0.008	0.011	0.023	0.001
CESIUM-137 DIS	5	0.128	0.262	0.440	-0.140
CESIUM-137 TOT	5	0.261	0.463	0.920	-0.260
CURIUM-244 DIS	3	0.008	0.014	0.024	-0.001
CURIUM-244 TOT	3	0.009	0.013	0.024	0.001
NEPTUNIUM-237 DIS	1	-0.019	N/A	-0.019	-0.019
NEPTUNIUM-237 TOT	1	-0.009	N/A	-0.009	-0.009
STRONTIUM-89,90 DIS	5	0.405	0.211	0.700	0.120
STRONTIUM-89,90 TOT	5	0.377	0.151	0.530	0.130
THORIUM-230 DIS	2	0.034	0.021	0.048	0.019
THORIUM-230 TOT	1	-0.013	N/A	-0.013	-0.013
THORIUM-232 DIS	2	-0.013	0.018	0.000	-0.026
THORIUM-232 TOT	1	0.028	N/A	0.028	0.028
TRITIUM DIS	3	208.733	80.606	301.800	161.100
TRITIUM TOT	2	187.500	201.525	330.000	45.000

TRACE-METALS AND MAJOR-CATIONS ANALYSES

Variable (ug/L)	No. of Analyses	Mean	Std. Deviation	Maximum	Minimum
ALUMINUM DIS	2	75.90	45.40	108.00	43.80
ALUMINUM TOT	4	612.75	297.14	1040.00	410.00
ANTIMONY DIS	3	27.27	14.17	42.20	14.00
ANTIMONY TOT	4	612.75	297.14	1040.00	410.00
ARSENIC DIS	2	1.45	0.78	2.00	0.90
ARSENIC TOT	4	1.95	1.46	4.00	0.90
BARIUM DIS	3	96.20	11.97	110.00	88.60
BARIUM TOT	4	93.83	23.99	120.00	62.00
BERYLLIUM DIS	3	0.70	0.26	1.00	0.50
BERYLLIUM TOT	4	0.78	0.26	1.00	0.50
CADMIUM DIS	2	3.95	0.92	4.60	3.30
CADMIUM TOT	1	4.60	N/A	4.60	4.60
CALCIUM DIS	3	48000.00	800.00	48800.00	47200.00

Table 3

Pond C-1 Sitewide (RFEDS) Water-Quality Data, Statistical Summary

CALCIUM TOT	4	44575.00	5766.79	48500.00	36000.00
CESIUM DIS	3	350.00	259.81	500.00	50.00
CESIUM TOT	4	275.00	259.81	500.00	50.00
CHROMIUM DIS	3	3.87	1.76	5.50	2.00
CHROMIUM TOT	4	3.48	1.64	5.50	2.00
COBALT DIS	3	4.30	2.72	7.30	2.00
COBALT TOT	4	3.73	2.50	7.30	2.00
COPPER DIS	3	4.63	2.35	6.50	2.00
COPPER TOT	3	4.37	1.23	5.40	3.00
IRON DIS	3	29.70	20.97	46.80	6.30
IRON TOT	4	987.50	225.74	1230.00	690.00
LEAD DIS	3	29.70	20.97	46.80	6.30
LEAD TOT	4	2.98	1.89	5.40	1.20
LITHIUM DIS	3	8.23	1.76	10.20	6.80
LITHIUM TOT	4	6.70	2.12	8.40	3.90
MAGNESIUM DIS	3	9570.00	923.42	10200.00	8510.00
MAGNESIUM TOT	4	9235.00	947.05	10100.00	8300.00
MANGANESE DIS	3	99.73	12.37	114.00	92.00
MANGANESE TOT	4	155.00	71.30	240.00	70.00
MERCURY DIS	3	0.20	0.00	0.20	0.20
MERCURY TOT	4	0.20	0.00	0.20	0.20
MOLYBDENUM DIS	3	6.57	3.09	10.00	4.00
MOLYBDENUM TOT	4	5.68	3.09	10.00	3.00
NICKEL DIS	3	10.13	4.87	14.70	5.00
NICKEL TOT	4	8.60	5.02	14.70	4.00
POTASSIUM DIS	3	2003.33	126.62	2100.00	1860.00
POTASSIUM TOT	4	1905.00	427.12	2300.00	1300.00
SELENIUM DIS	3	2.13	1.62	4.00	1.20
SELENIUM TOT	4	2.68	1.53	4.00	1.20
SILICON DIS	5	5962.00	1517.42	7670.00	3700.00
SILICON TOT	4	6582.50	1925.99	8950.00	4370.00
SILVER DIS	3	5.60	1.04	6.80	5.00
SILVER TOT	4	4.70	1.99	6.80	2.00
SODIUM DIS	3	24466.67	3716.63	27000.00	20200.00
SODIUM TOT	4	23725.00	2927.31	26400.00	20500.00
STRONTIUM DIS	3	251.67	17.56	270.00	235.00
STRONTIUM TOT	4	247.25	14.31	260.00	230.00
THALLIUM DIS	2	1.50	0.14	1.60	1.40
THALLIUM TOT	4	2.50	1.23	4.00	1.40
TIN DIS	3	21.57	15.13	38.90	11.00
TIN TOT	4	19.43	13.08	38.90	11.00
VANADIUM DIS	3	4.73	2.40	6.50	2.00
VANADIUM TOT	4	4.53	2.00	6.50	2.00
ZINC DIS	3	4.67	2.72	7.20	1.80
ZINC TOT	4	6.18	0.90	7.20	5.00

MISCELLANEOUS ANALYSES

Variable (mg/L)	No. of Analyses	Mean	Std. Deviation	Maximum	Minimum
AMMONIA	9	428.89	263.51	840.00	200.00
BICARBONATE AS $CaCO_3$	8	145262.50	45222.72	194000.00	46100.00
CARBONATE AS $CaCO_3$	9	10388.89	1166.67	13500.00	10000.00
CHLORIDE	9	25600.00	4118.86	32200.00	20100.00
CYANIDE (ug/L)	9	13.33	5.00	20.00	10.00
DISSOLVED ORGANIC CARBON	6	5166.67	1169.05	7000.00	4000.00
FLUORIDE, SOLUBLE	9	451.11	37.90	500.00	400.00
HEXAVALENT CHROMIUM	5	18.00	4.47	20.00	10.00
NITRATE/NITRITE	9	104.44	13.33	140.00	100.00
NITRITE	9	20.00	0.00	20.00	20.00
OIL AND GREASE	9	6000.00	574.46	6600.00	5100.00
ORTHOPHOSPHATE	9	50.67	2.00	56.00	50.00
PHOSPHORUS	8	51.00	1.85	54.00	50.00

Table 3

Pond C-1 Sitewide (RFEDS) Water-Quality Data, Statistical Summary

SULFATE	9	21100.00	8207.16	32400.00	9200.00
SULFIDE	9	942.22	256.99	1200.00	280.00
TOTAL DISSOLVED SOLIDS	9	245333.33	24103.94	284000.00	204000.00
TOTAL ORGANIC CARBON	6	7166.67	2857.74	12000.00	4000.00
TOTAL SUSPENDED SOLIDS	9	14222.22	7293.45	28000.00	5000.00

Source: Appendix A

Table 4
Pond C-2 Sitewide (RFEDS) Water-Quality Data, Statistical Summary

FIELD MEASUREMENTS

Variable	No. of Analyses	Mean	Std. Deviation	Maximum	Minimum
SC (uS/cm)	294	534.94	90.69	733.00	235.00
TEMP (deg C)	291	12.42	5.93	35.50	1.00
DO (mg/L)	248	5.34	4.62	17.00	0.00
pH (std. units)	301	8.35	0.50	10.28	6.60
ALK (mg/L)	125	173.22	32.33	295.00	107.60

RADIONUCLIDE ANALYSES

Variable (pCi/L)	No. of Analyses	Mean	Std. Deviation	Maximum	Minimum
GROSS ALPHA DIS	61	3.36	2.06	9.45	0.24
GROSS ALPHA TOT	163	4.46	1.90	9.00	0.13
GROSS BETA DIS	57	7.26	1.64	15.25	3.52
GROSS BETA TOT	162	7.05	1.39	14.17	0.45
PLUTONIUM 239/240 DIS	32	0.01	0.00	0.02	0.00
PLUTONIUM 239/240 TOT	26	0.02	0.02	0.07	-0.00
URANIUM 233,-234 DIS	34	1.27	0.50	3.03	0.28
URANIUM 233,-234 TOT	19	1.29	0.77	2.63	0.25
URANIUM 235 DIS	68	0.76	0.76	3.22	0.00
URANIUM 235 TOT	38	0.92	1.13	4.06	0.00
URANIUM 238 DIS	30	0.51	1.31	2.08	0.00
URANIUM 238 TOT	19	1.71	1.15	4.06	0.32
AMERICIUM-241 DIS	31	0.01	0.01	0.04	-0.01
AMERICIUM-241 TOT	15	0.08	0.26	1.03	-0.00
CESIUM-137 DIS	38	-0	0	0	-0
CESIUM-137 TOT	23	0.03	0.14	0.40	-0.22
CERIUM-244 DIS	5	0.01	0.01	0.02	-0.00
CERIUM-244 TOT	3	0.03	0.05	0.09	-0.00
TRITIUM DIS	20	86.48	104.82	370.00	-145.00
TRITIUM TOT	7	7928.57	2507.13	13000.00	5000.00

TRACE-METALS AND MAJOR-CATIONS ANALYSES

Variable (ug/L)	No. of Analyses	Mean	Std. Deviation	Maximum	Minimum
ALUMINUM DIS	52	32.94	36.53	200.00	10.00
ALUMINUM TOT	15	488.42	1038.56	4180.00	14.00
ANTIMONY DIS	48	22.63	12.01	60.00	6.00
ANTIMONY TOT	16	27.38	12.81	60.00	8.00
ARSENIC DIS	49	2.84	1.38	10.00	1.20
ARSENIC TOT	16	2.84	2.01	10.00	1.00
BARIUM DIS	50	6257.15	13520.47	61000.00	9.00
BARIUM TOT	16	85.60	33.37	202.00	49.00
BERYLLIUM DIS	49	1.11	0.62	5.00	0.60
BERYLLIUM TOT	17	1.21	0.98	5.00	0.60
CADMIUM DIS	39	2.91	0.92	5.00	1.00
CADMIUM TOT	13	3.45	0.97	5.00	2.00
CALCIUM DIS	50	40346.00	13086.22	108000.00	26000.00
CALCIUM TOT	15	44840.00	19088.51	109000.00	26500.00
CESIUM DIS	40	184.39	248.14	1000.00	5.00
CESIUM TOT	1644	4201.58	12479.19	108000.00	0.10
CHROMIUM DIS	48	4.48	2.18	10.00	2.00
CHROMIUM TOT	16	5.11	2.49	10.00	2.00
COBALT DIS	48	5.43	7.23	50.00	2.00
COBALT TOT	16	8.51	11.82	50.00	2.00
COPPER DIS	48	6.98	5.11	25.00	2.00
COPPER TOT	16	6.69	5.51	25.00	2.00
IRON DIS	50	24.14	30.56	124.00	3.00
IRON TOT	16	500.59	853.79	3430.00	21.50
LEAD DIS	49	1.80	1.20	6.20	0.40
LEAD TOT	16	6.83	17.76	73.00	0.60
LITHIUM DIS	37	54.11	135.24	500.00	7.40

Table 4
Pond C-2 Sitewide (RFEDS) Water-Quality Data, Statistical Summary

LITHIUM TOT	13	93.48	182.11	500.00	8.30
MAGNESIUM DIS	50	14980.00	1742.86	19000.00	11000.00
MAGNESIUM TOT	16	14587.50	2372.31	17000.00	7700.00
MANGANESE DIS	48	97.98	149.74	730.00	1.00
MANGANESE TOT	16	209.79	320.12	1000.00	3.30
MERCURY DIS	48	0.21	0.07	0.60	0.10
MERCURY TOT	16	0.21	0.08	0.50	0.10
MOLYBDENUM DIS	36	95.53	277.11	1000.00	2.00
MOLYBDENUM TOT	13	173.29	367.74	1000.00	3.80
NICKEL DIS	48	9.36	7.69	40.00	3.00
NICKEL TOT	16	12.31	9.86	40.00	4.00
POTASSIUM DIS	50	6192.60	817.98	7900.00	4510.00
POTASSIUM TOT	16	6475.63	1765.27	12000.00	4900.00
SELENIUM DIS	48	2.83	1.52	8.90	1.00
SELENIUM TOT	16	2.87	2.16	10.20	1.00
SILICON TOT	18	*2010*	*970.2948006*	4000	808
SILVER DIS	48	3.64	1.47	10.00	2.00
SILVER TOT	15	4.47	1.76	10.00	3.00
SODIUM DIS	50	51646.00	7615.11	63200.00	27800.00
SODIUM TOT	16	49812.50	10077.95	61000.00	27600.00
STRONTIUM DIS	38	368.92	121.76	1000.00	277.00
STRONTIUM TOT	14	386.21	188.16	1000.00	220.00
THALLIUM DIS	49	4.67	5.07	15.00	0.90
THALLIUM TOT	16	4.93	5.22	15.00	1.00
TIN DIS	37	182.41	547.73	2000.00	7.00
TIN TOT	13	328.92	742.01	2000.00	11.00
VANADIUM DIS	48	4.68	6.84	50.00	2.00
VANADIUM TOT	15	7.96	11.95	50.00	2.00
ZINC DIS	48	11.44	25.83	179.00	2.00
ZINC TOT	16	606.25	994.30	3100.00	100.00

MISCELLANEOUS ANALYSES

Variable (mg/L)	No. of Analyses	Mean	Std. Deviation	Maximum	Minimum
ALKALINITY AS CACO3	53	123924.53	78734.18	210000.00	10000.00
AMMONIA	61	1266.64	2058.63	14000.00	15.00
BICARBONATE	36	172944.44	26625.38	210000.00	102000.00
BICARBONATE AS CACO3	23	154043.48	28718.82	210000.00	107000.00
CARBONATE AS CACO3	37	9756.76	1479.59	10000.00	1000.00
CHLORIDE	55	49236.36	6283.32	61000.00	33000.00
CHROMIUM VI	45	10.89	3.58	30.00	10.00
CYANIDE	9	8.87	4.61	16.30	0.02
DISSOLVED ORGANIC CARBON	15	7933.33	1437.59	11000.00	5000.00
FLUORIDE	54	670.37	90.34	800.00	500.00
NITRATE	49	13.67	13.18	100.00	10.00
NITRATE/NITRITE	64	267.50	546.53	3100.00	10.00
NITRITE	58	0.02	0.02	0.14	0.01
OIL AND GREASE	16	8368.75	5498.33	21000.00	5000.00
ORTHOPHOSPHATE	30	43.43	42.16	160.00	10.00
PHOSPHATE	39	0.05	0.05	0.17	0.01
PHOSPHORUS	23	0.12	0.13	0.54	0.01
SILICA, DISSOLVED	3	3203.00	3015.17	6000.00	9.00
SODIUM NITRATE	2	50.00	0.00	50.00	50.00
SULFATE	54	41333.33	13868.66	80000.00	10000.00
SULFIDE	18	2.91	2.00	10.00	1.00
TOTAL ALKALINITY	22	154227.27	29380.80	210000.00	107000.00
TOTAL DISSOLVED SOLIDS	53	403773.58	80959.31	522000.00	150000.00
TOTAL ORGANIC CARBON	14	13071.43	4358.268635	22000	7000
TOTAL SUSPENDED SOLIDS	197	13583.76	9349.74	43000.00	2000.00

Source: Appendix B

Table 5

Pond C-1, Operational Data, Statistical Summary

RADIONUCLIDE ANALYSES

Variable (pCi/L)	No. of Analyses	Mean	Std. Deviation	Maximum	Minimum
ALPHA (pCi/L)	393	1.85	0.82	6.00	-0.10
BETA (pCi/L)	393	3.12	1.17	10.00	-0.60
PLUTONIUM 238	181	0.00	0.02	0.16	-0.02
PLUTONIUM 239/240	192	0.01	0.03	0.23	-0.03
URANIUM 233,-234	196	0.70	0.57	5.00	-0.04
URANIUM 238	193	0.48	0.27	1.28	-0.03
AMERICIUM-241	192	0.01	0.02	0.11	-0.02

TRACE-METALS AND MAJOR-CATIONS ANALYSES

Variable (ug/L)	No. of Analyses	Mean	Std. Deviation	Maximum	Minimum
ALUMINUM	5	467.80	238.55	653.00	106.00
ANTIMONY	5	0.00	0.00	0.00	0.00
ARSENIC	5	0.00	0.00	0.00	0.00
BARIUM	5	94.26	21.42	132.00	78.60
BERYLLIUM	5	0.00	0.00	0.00	0.00
CADMIUM	5	0.00	0.00	0.00	0.00
CALCIUM	5	47460.00	6883.53	56500.00	41000.00
CHROMIUM	5	0.00	0.00	0.00	0.00
COBALT	5	1.76	2.41	4.40	0.00
COPPER	5	0.00	0.00	0.00	0.00
IRON	5	761.80	426.24	1110.00	123.00
LEAD	5	0.00	0.00	0.00	0.00
MAGNESIUM	5	9212.00	895.95	10800.00	8630.00
MANGANESE	5	141.76	104.47	300.00	28.70
MOLYBDENUM	5	0.00	0.00	0.00	0.00
NICKEL	5	0.00	0.00	0.00	0.00
POTASSIUM	5	1332.00	798.57	1970.00	0.00
SELENIUM	5	0.46	1.03	2.30	0.00
SILVER	5	1.04	2.33	5.20	0.00
SODIUM	5	23900.00	1707.34	25300.00	21400.00
STRONTIUM	5	257.20	24.45	299.00	240.00
THALLIUM	5	0.00	0.00	0.00	0.00
VANADIUM	5	1.16	2.59	5.80	0.00
ZINC	5	8.66	8.80	23.50	0.00

* All zero values were analyses under detection limit.

FIELD/RADIONUCLIDE INDICATOR ANALYSES

Variable	No. of Analyses	Mean	Std. Deviation	Maximum	Minimum
TEMP (C)	378	9.40	6.61	26.50	-1.60
pH (std. units)	378	7.91	0.49	9.23	6.52
DO (mg/L)	122	10.02	1.60	14.10	3.60
TOTAL P (mg/L)	14	0.10	0.03	0.16	0.04
NITRATE (mg/L)	14	0.03	0.02	0.07	0.02
NVSS (mg/L)	1	8.70	N/A	8.70	8.70

Source: Appendix C

Table 6

Pond C-2 CWA Compliance (NPDES) and Operational Data, Statistical Summary

RADIONUCLIDE ANALYSES

Variable (pCi/L)	No. of Analyses	Mean	Std. Deviation	Maximum	Minimum
ALPHA	73	2.58	1.11	6.00	0.40
BETA	73	7.05	1.48	10.00	0.30
PLUTONIUM 238	50	0.00	0.01	0.04	-0.02
PLUTONIUM 239/240	61	0.04	0.11	0.85	-0.01
URANIUM 233,-234	66	1.13	0.46	2.36	0.42
URANIUM 238	66	1.42	0.67	2.95	0.51
AMERICIUM-241	68	0.02	0.07	0.51	-0.03

TRACE-METALS AND MAJOR-CATIONS ANALYSES

Variable (ug/L)	No. of Analyses	Mean	Std. Deviation	Maximum	Minimum
ALUMINUM	70	430.78	726.75	5030.00	73.80
ANTIMONY	70	0.00	0.00	0.00	0.00
ARSENIC	70	0.00	0.00	0.00	0.00
BARIUM	70	89.20	13.63	122.00	36.70
BERYLLIUM	70	0.09	0.38	2.50	0.00
CADMIUM	70	0.13	0.78	4.90	0.00
CALCIUM	70	44365.71	7947.76	55600.00	15600.00
CHROMIUM	70	0.91	2.46	10.60	0.00
COBALT	70	0.26	0.98	4.70	0.00
COPPER	70	1.03	2.37	9.50	0.00
IRON	70	490.87	521.90	3390.00	59.70
LEAD	70	0.00	0.00	0.00	0.00
MAGNESIUM	70	13864.71	2254.73	17300.00	3960.00
MANGANESE	70	294.14	278.08	931.00	26.20
MOLYBDENUM	70	0.12	1.04	8.70	0.00
NICKEL	70	0.61	3.06	20.60	0.00
POTASSIUM	70	5385.43	947.55	7730.00	3040.00
SELENIUM	70	0.64	5.35	44.80	0.00
SILVER	70	0.00	0.00	0.00	0.00
SODIUM	70	46342.86	8390.72	62200.00	17400.00
STRONTIUM	70	344.27	50.24	428.00	125.00
THALLIUM	70	0.00	0.00	0.00	0.00
VANADIUM	70	0.60	2.31	12.20	0.00
ZINC	70	19.81	28.94	228.00	0.00

* All zero values were analyses under detection limit.

FIELD/MISCELLANEOUS ANALYSES

Variable (mg/L)	No. of Analyses	Mean	Std. Deviation	Maximum	Minimum
TEMPERATURE (C)	70	11.13	7.31	24.90	0.70
pH (std. units)	70	8.21	0.33	8.68	7.25
DO	17	9.65	2.25	13.50	6.10
NITRATE	66	0.05	0.08	0.34	0.00
HARDNESS	64	173.36	34.29	217.00	0.00
SUSPENDED SOLIDS	57	24.07	30.30	211.00	0.00
AMMONIA	1	<.03	N/A	<.03	<.03
TOTAL DISOLVED SOLIDS	65	308.26	69.09	407.00	1.00
BIOLOGICAL OXYGEN DEMAND	1	6.80	N/A	6.80	6.80
TOTAL CHROMIUM	61	0.01	0.00	0.01	0.01
NON-VOLATILE SUSPENDED SOLIDS	65	9.32	12.62	67.00	0.00

Source: Appendix D

Table 7

Pond C-1 Summary of Priority Pollutants Above Detection Limits

Sample Date	Chemical	Result	Unit
04-Sep-91	ACETONE	21.0	UG/L
02-Dec-91	ACETONE	45.0	UG/L
19-Dec-91	ACETONE	45.0	UG/L
04-Sep-91	METHYLENE CHLORIDE	7.0	UG/L
09-Oct-91	METHYLENE CHLORIDE	18.0	UG/L
19-Dec-91	METHYLENE CHLORIDE	18.0	UG/L

Table 8

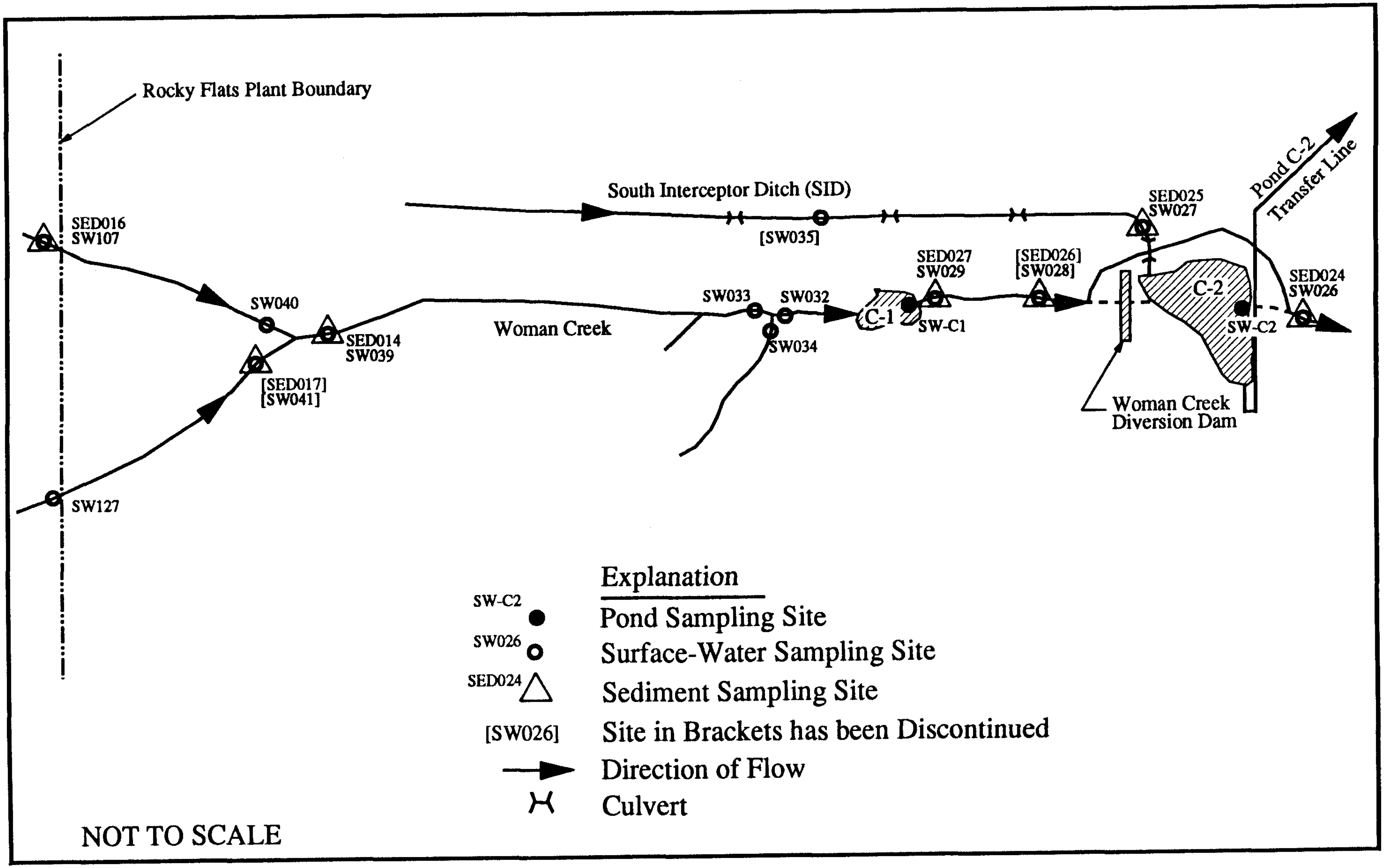
Pond C-2 Summary of Priority Pollutants Above Detection Limits

Smpl Date	Chemical	Result	Unit
11-Sep-90	AMETRYN	0.18	UG/L
29-Mar-90	ATRAZINE	0.57	UG/L
03-May-90	ATRAZINE	0.14	UG/L
03-May-90	ATRAZINE	0.23	UG/L
10-May-90	ATRAZINE	0.14	UG/L
10-May-90	ATRAZINE	0.22	UG/L
15-May-90	ATRAZINE	130.00	UG/L
15-May-90	ATRAZINE	190.00	UG/L
22-May-90	ATRAZINE	0.23	UG/L
14-Jun-90	ATRAZINE	0.21	UG/L
25-Jun-90	ATRAZINE	0.21	UG/L
05-Jul-90	ATRAZINE	0.17	UG/L
26-Jul-90	ATRAZINE	0.30	UG/L
31-Jul-90	ATRAZINE	0.20	UG/L
08-Aug-90	ATRAZINE	0.24	UG/L
15-Aug-90	ATRAZINE	0.25	UG/L
22-Aug-90	ATRAZINE	0.30	UG/L
31-Aug-90	ATRAZINE	0.18	UG/L
05-Sep-90	ATRAZINE	0.20	UG/L
11-Sep-90	ATRAZINE	0.15	UG/L
17-Sep-90	ATRAZINE	0.16	UG/L
27-Sep-90	ATRAZINE	0.15	UG/L
02-Oct-90	ATRAZINE	0.17	UG/L
11-Oct-90	ATRAZINE	0.17	UG/L
24-Oct-90	ATRAZINE	1.00	UG/L
31-Oct-90	ATRAZINE	0.29	UG/L
08-Nov-90	ATRAZINE	700.00	UG/L
13-Nov-90	ATRAZINE	0.40	UG/L
20-Nov-90	ATRAZINE	0.33	UG/L
27-Nov-90	ATRAZINE	0.41	UG/L
05-Dec-90	ATRAZINE	0.23	UG/L
18-Dec-90	ATRAZINE	0.32	UG/L
18-Dec-90	ATRAZINE	320.00	UG/L
02-Jan-91	ATRAZINE	0.42	UG/L
18-Mar-91	ATRAZINE	0.31	UG/L
22-Apr-91	ATRAZINE	0.25	UG/L
29-Apr-91	ATRAZINE	0.61	UG/L
20-May-91	ATRAZINE	0.38	UG/L
17-Jun-91	ATRAZINE	0.29	UG/L
24-Jun-91	ATRAZINE	0.33	UG/L
01-Jul-91	ATRAZINE	0.15	UG/L
17-Jul-91	ATRAZINE	0.16	UG/L
05-Aug-91	ATRAZINE	0.18	UG/L
14-Aug-91	ATRAZINE	0.77	UG/L
21-Aug-91	ATRAZINE	0.17	UG/L
28-Aug-91	ATRAZINE	0.56	UG/L
01-Oct-91	ATRAZINE	0.36	UG/L
11-Sep-90	CYANAZINE	0.30	UG/L
11-Sep-90	PROMETON	0.09	UG/L
11-Sep-90	PROMETRYN	0.18	UG/L
11-Sep-90	PROPAZINE	0.09	UG/L
11-Sep-90	SIMAZINE	0.18	UG/L
20-Nov-90	SIMAZINE	0.10	UG/L
11-Sep-90	SIMETRYN	0.21	UG/L
11-Sep-90	TERBUTHYLAZINE	0.09	UG/L
12-Apr-90	1,1,1-TRICHLOROETHANE	7	UG/L
07-Apr-90	ACETONE	20	UG/L
20-May-91	ACETONE	12	UG/L
30-Sep-91	ACETONE	16	UG/L
01-Oct-91	ACETONE	10	UG/L
14-Jun-90	CARBON TETRACHLORIDE	10	UG/L
31-Mar-90	METHYLENE CHLORIDE	5	UG/L
03-Apr-90	METHYLENE CHLORIDE	5	UG/L
07-Apr-90	METHYLENE CHLORIDE	12	UG/L
09-Apr-90	METHYLENE CHLORIDE	5	UG/L
09-Apr-90	METHYLENE CHLORIDE	5	UG/L
10-Apr-90	METHYLENE CHLORIDE	5	UG/L
11-Apr-90	METHYLENE CHLORIDE	6	UG/L
29-May-90	METHYLENE CHLORIDE	10	UG/L
26-Jul-90	METHYLENE CHLORIDE	8.1	UG/L
12-Apr-90	TETRACHLOROETHENE	13	UG/L
03-May-90	TOLUENE	6	UG/L
03-May-90	TOLUENE	5	UG/L
03-May-90	TOTAL XYLENES	6	UG/L

Table 8

Pond C-2 Summary of Priority Pollutants Above Detection Limits

Smpl Date	Chemical	Result	Unit
03-May-90	TOTAL XYLENES	5	UG/L
12-Apr-90	TRICHLOROETHENE	15	UG/L
31-Aug-90	BIS(2-ETHYLHEXYL)PHTHALATE	13	UG/L
13-Nov-90	BIS(2-ETHYLHEXYL)PHTHALATE	44	UG/L
05-Dec-90	BIS(2-ETHYLHEXYL)PHTHALATE	11	UG/L
29-May-91	BIS(2-ETHYLHEXYL)PHTHALATE	23	UG/L
14-Oct-91	1,1,1-TRICHLOROETHANE	0.4	UG/L



Historical and Existing Surface-Water Monitoring Sites
Woman Creek Drainage Basin

ADVANCED SCIENCES, INC.

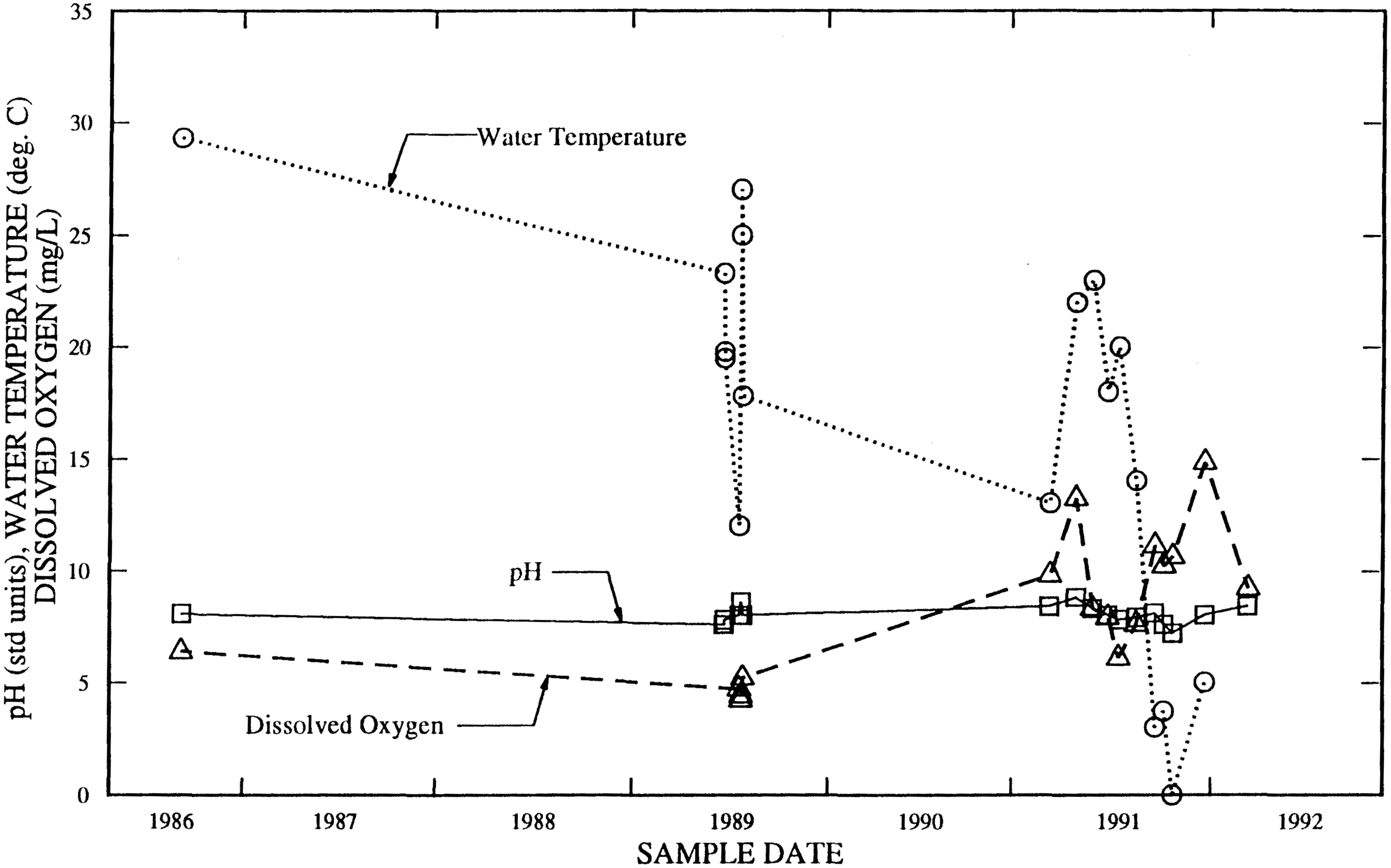
ROCKY FLATS PLANT OU 5 RFI/RI
WOMAN CREEK PRIORITY DRAINAGE

ASI Project No. 9208.15

FIGURE 1

STATUS: 8/14/92

FILE: FIG1-H&E.DRW



TIME-SERIES PLOTS, POND C-1 RFEDS DATA

pH, WATER TEMPERATURE AND DISSOLVED OXYGEN CONCENTRATIONS

ADVANCED SCIENCES, INC.

ROCKY FLATS PLANT OU 5 RFI/RI

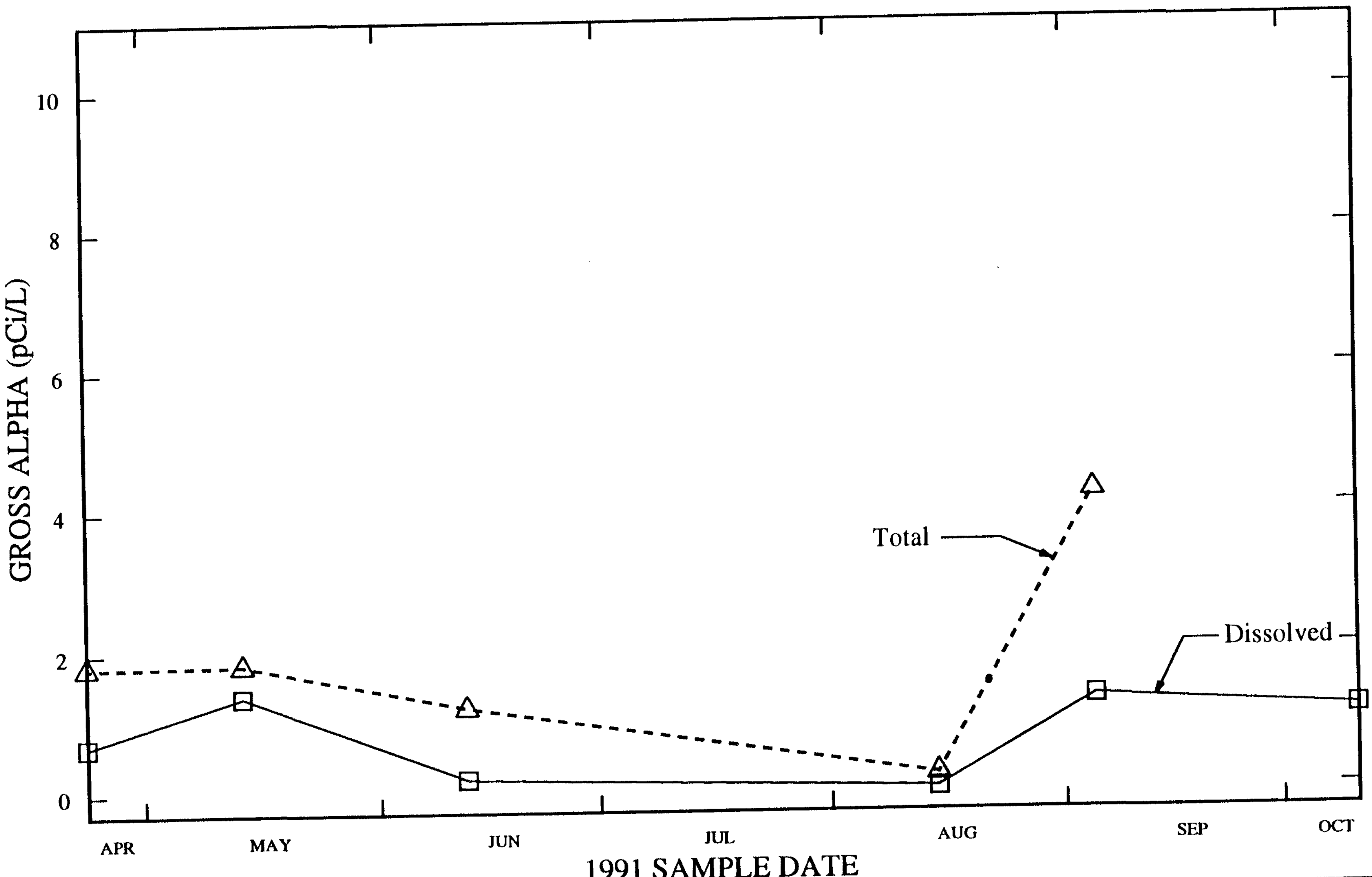
WOMAN CREEK PRIORITY DRAINAGE

ASI PROJECT NO. 9208.15

FIGURE 2A

FILE: FIG2A.DRW

STATUS: 8/10/92



TIME-SERIES PLOTS, POND C-1 RFEDS DATA
DISSOLVED AND TOTAL GROSS ALPHA CONCENTRATIONS

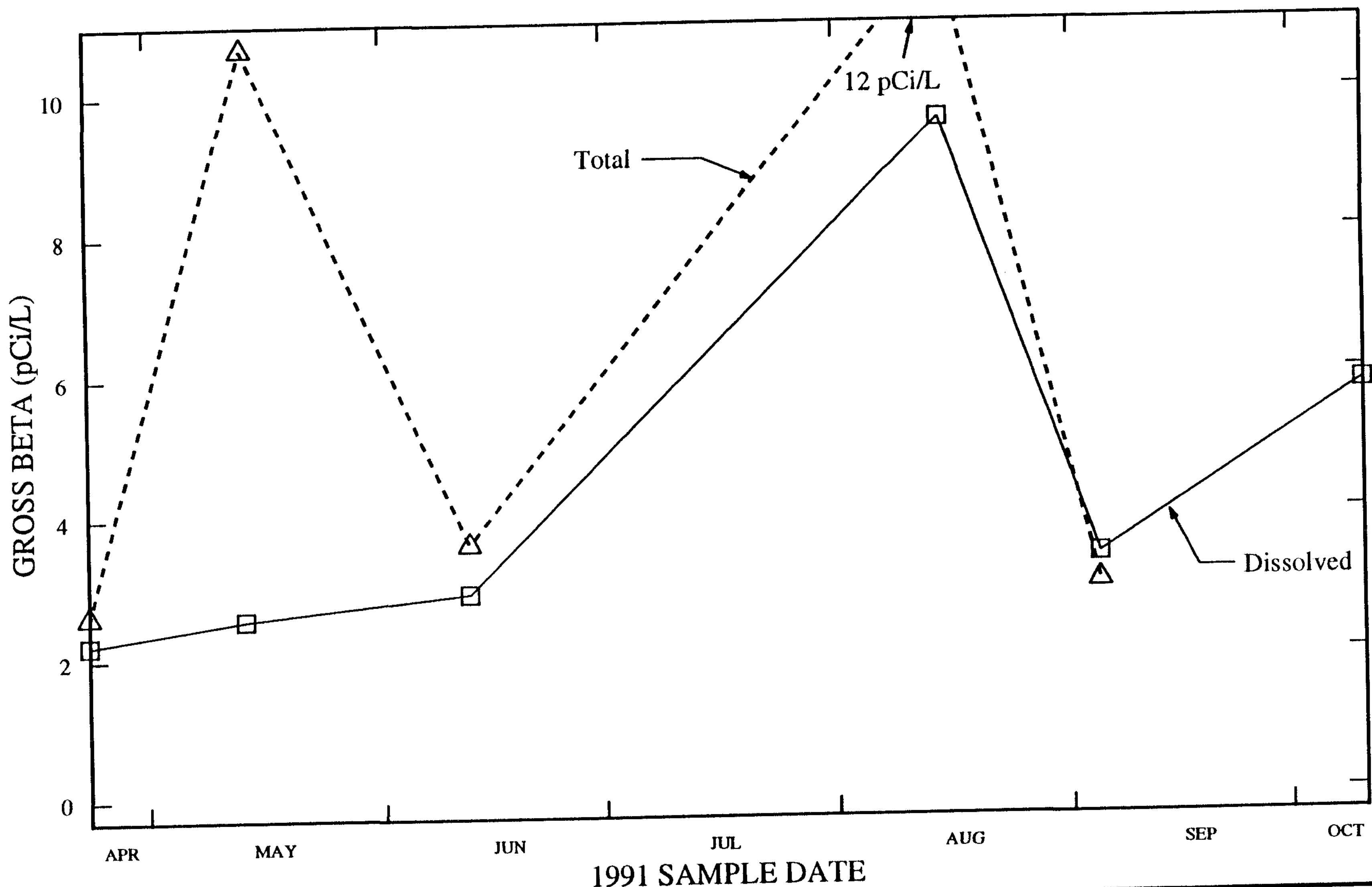
ADVANCED SCIENCES, INC.

ROCKY FLATS PLANT OU 5 RFI/RI
WOMAN CREEK PRIORITY DRAINAGE

ASI PROJECT NO. 9208.15
FIGURE 2C

STATUS: 8/11/92

FILE: FIG2C.DRW



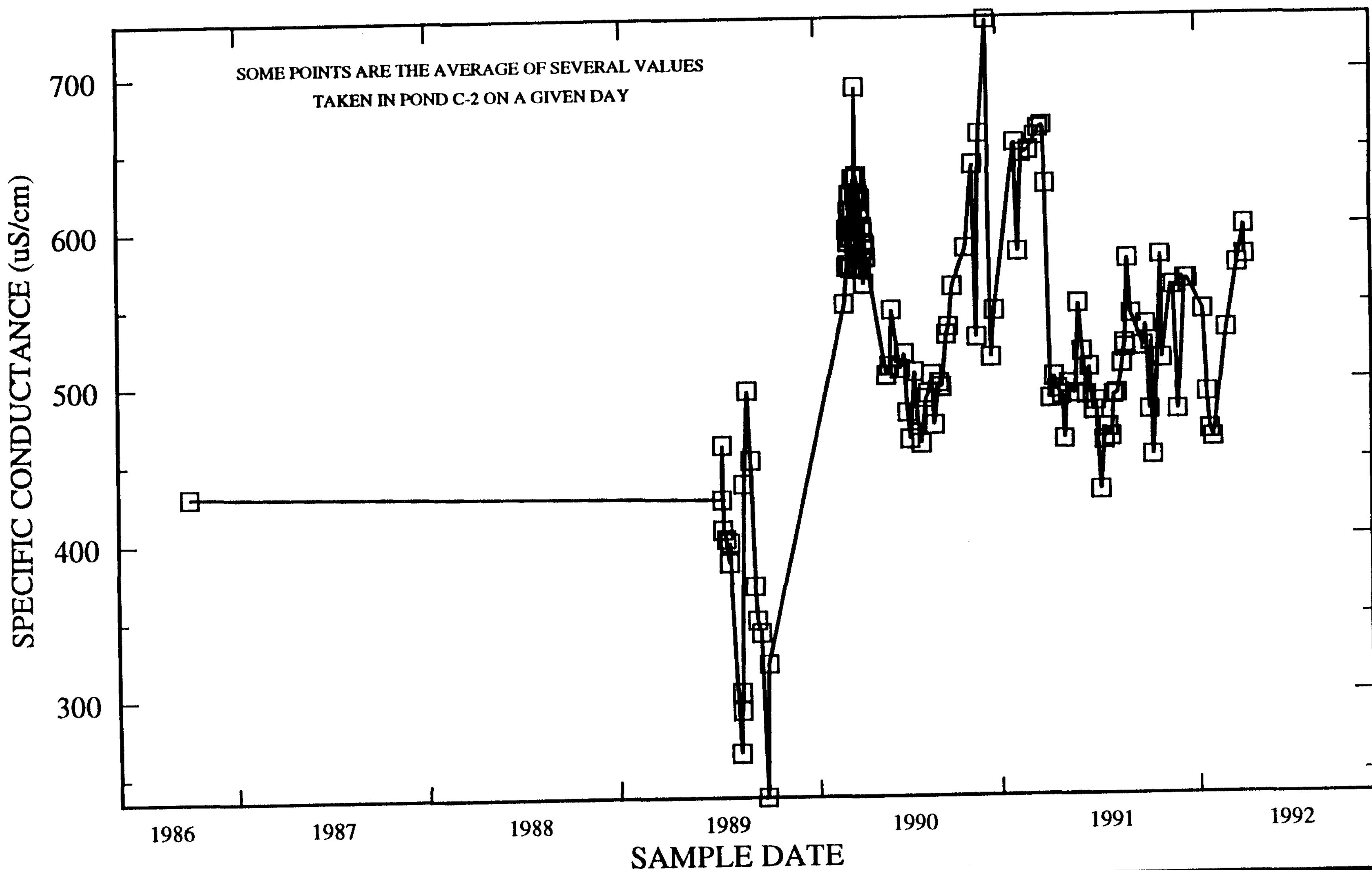
TIME-SERIES PLOTS, POND C-1 RFEDS DATA
DISSOLVED AND TOTAL GROSS BETA CONCENTRATIONS

ADVANCED SCIENCES, INC.

ROCKY FLATS PLANT OU 5 RFI/RI
WOMAN CREEK PRIORITY DRAINAGE

ASI PROJECT NO. 9208.15
FIGURE 2D
STATUS: 8/11/92

FILE: FIG2D.DRW



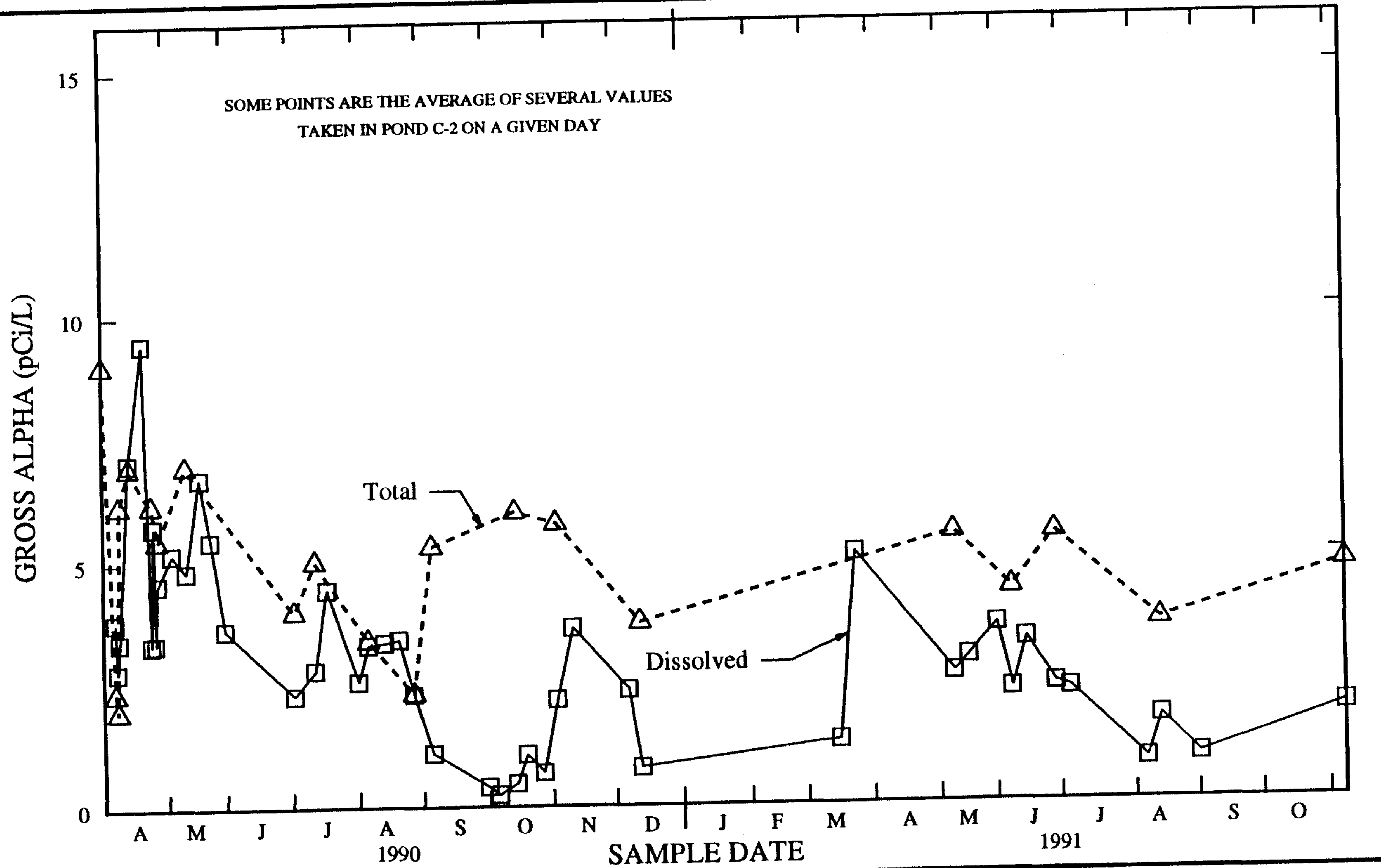
TIME-SERIES PLOTS, POND C-2 RFEDS DATA
SPECIFIC CONDUCTANCE CONCENTRATION

ADVANCED SCIENCES, INC.

ROCKY FLATS PLANT OU 5 RFI/RI
WOMAN CREEK PRIORITY DRAINAGE

ASI PROJECT NO. 9208.15
FIGURE 3B
STATUS: 8/10/92

FILE: FIG3B.DRW



TIME-SERIES PLOTS, POND C-2 RFEDS DATA
DISSOLVED AND TOTAL GROSS ALPHA CONCENTRATIONS

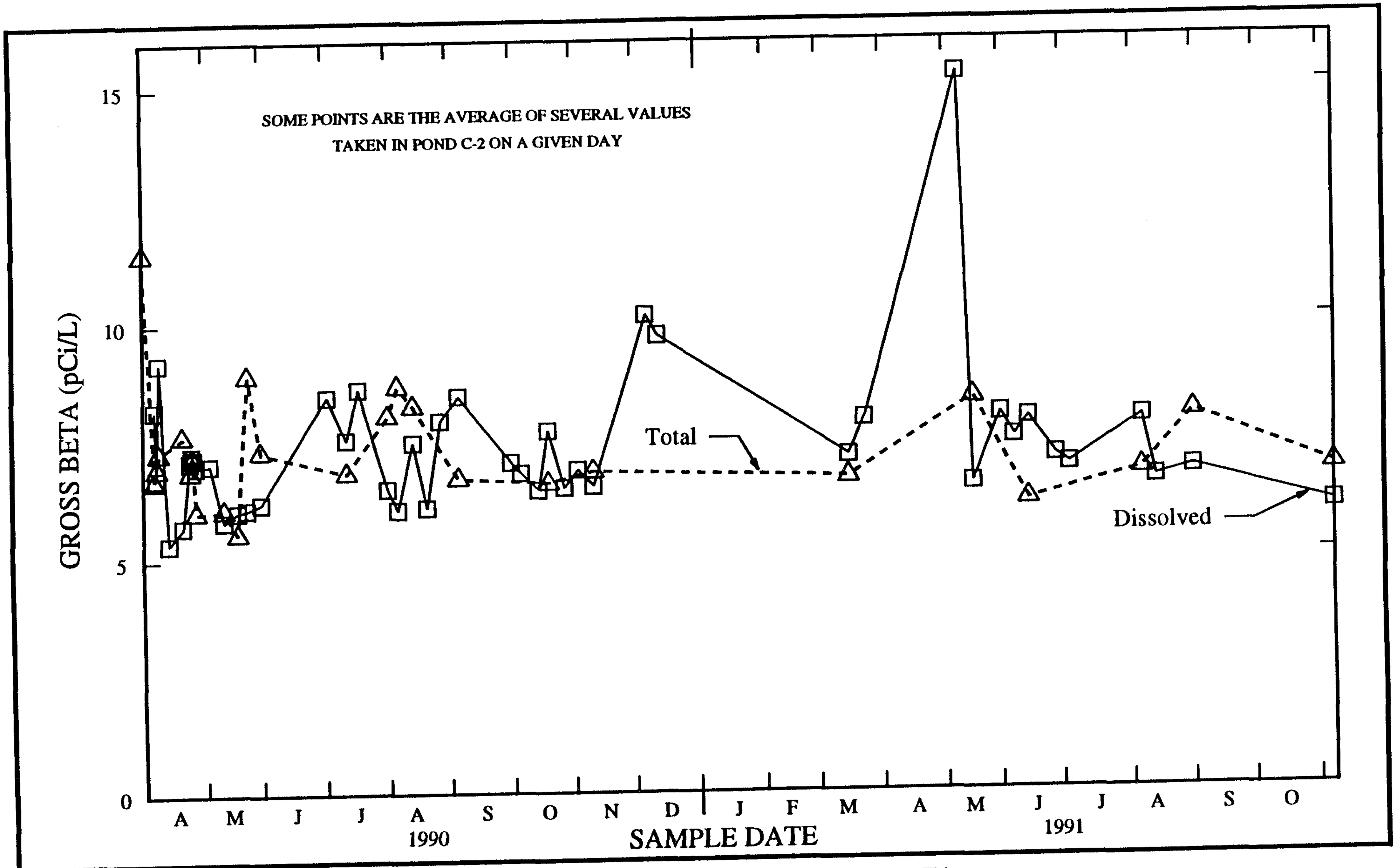
ADVANCED SCIENCES, INC.

ROCKY FLATS PLANT OU 5 RFI/RI
WOMAN CREEK PRIORITY DRAINAGE

ASI PROJECT NO. 9208.15
FIGURE 3G

STATUS: 8/11/92

FILE: FIG3G.DRW



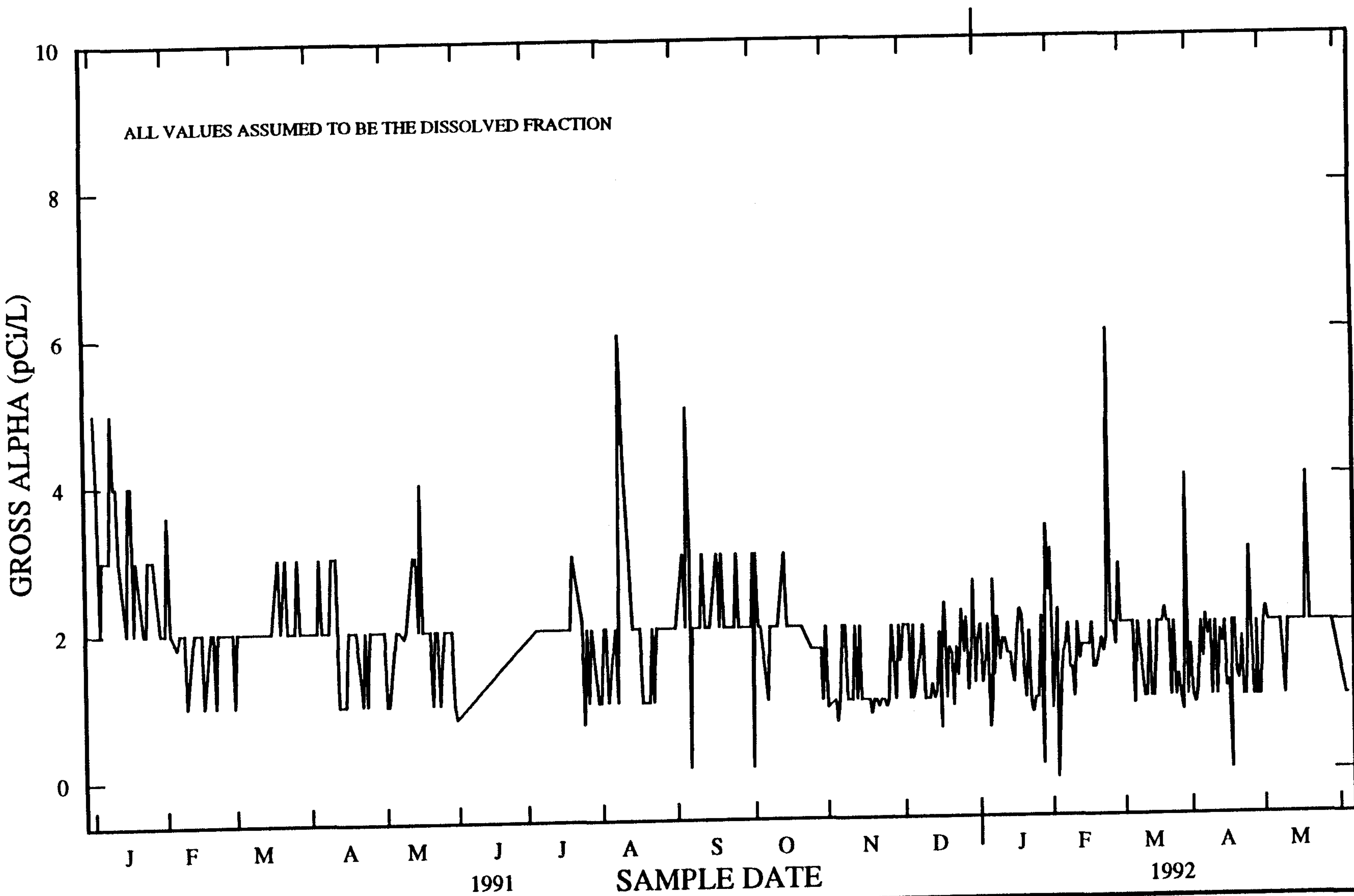
TIME-SERIES PLOTS, POND C-2 RFEDS DATA
DISSOLVED AND TOTAL GROSS BETA CONCENTRATIONS

ADVANCED SCIENCES, INC.

ROCKY FLATS PLANT OU 5 RFI/RI
WOMAN CREEK PRIORITY DRAINAGE

ASI PROJECT NO. 9208.15
FIGURE 3H
STATUS: 8/11/92

FILE: FIG3H.DRW



TIME-SERIES PLOTS, POND C-1 OPERATIONAL DATA

GROSS ALPHA CONCENTRATIONS

ADVANCED SCIENCES, INC.

ROCKY FLATS PLANT OU 5 RFI/RI

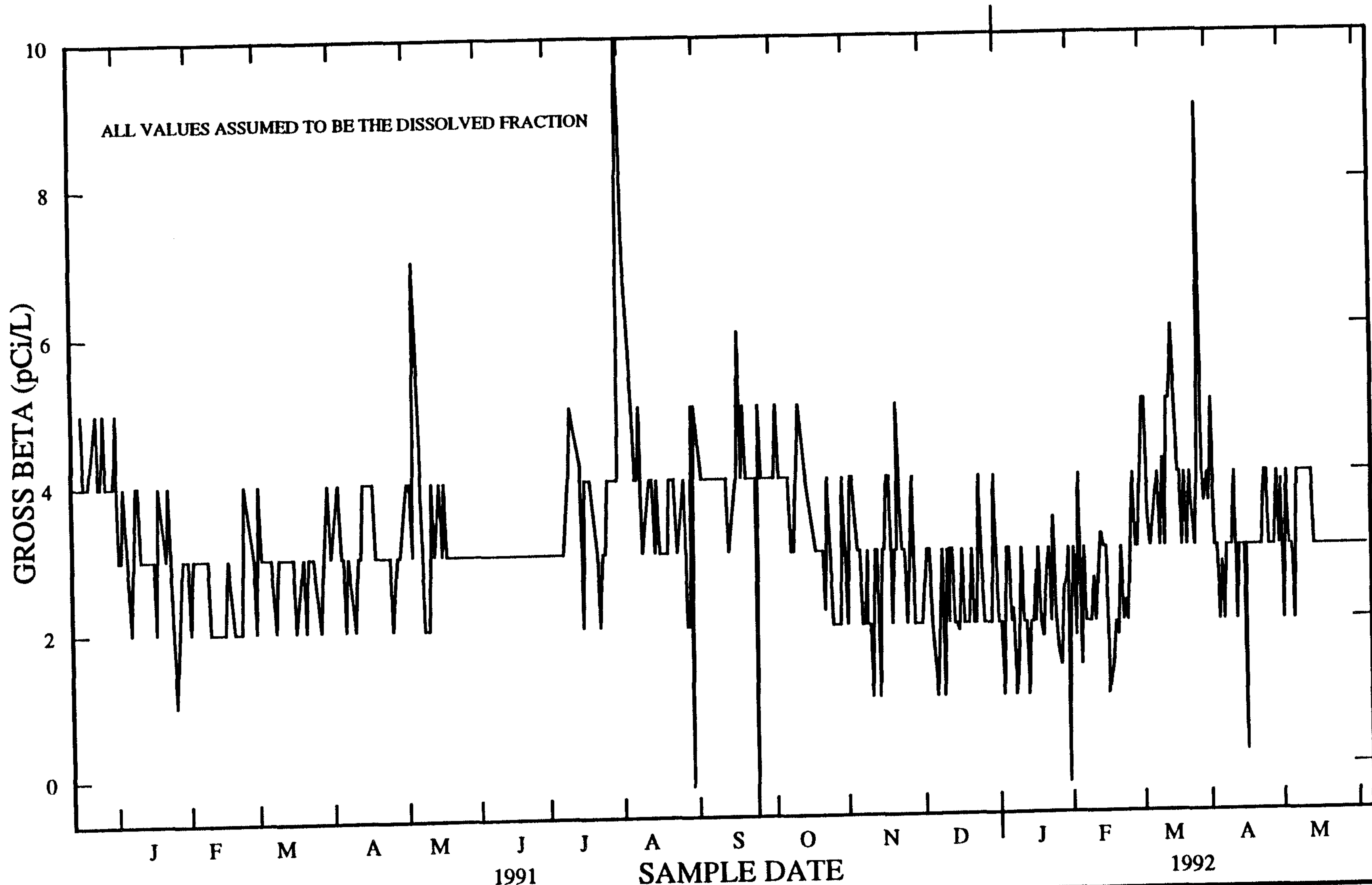
WOMAN CREEK PRIORITY DRAINAGE

ASI PROJECT NO. 9208.15

FIGURE 4A

STATUS: 8/13/92

FILE: FIG4A.DRW



TIME-SERIES PLOTS, POND C-1 OPERATIONAL DATA
GROSS BETA CONCENTRATIONS

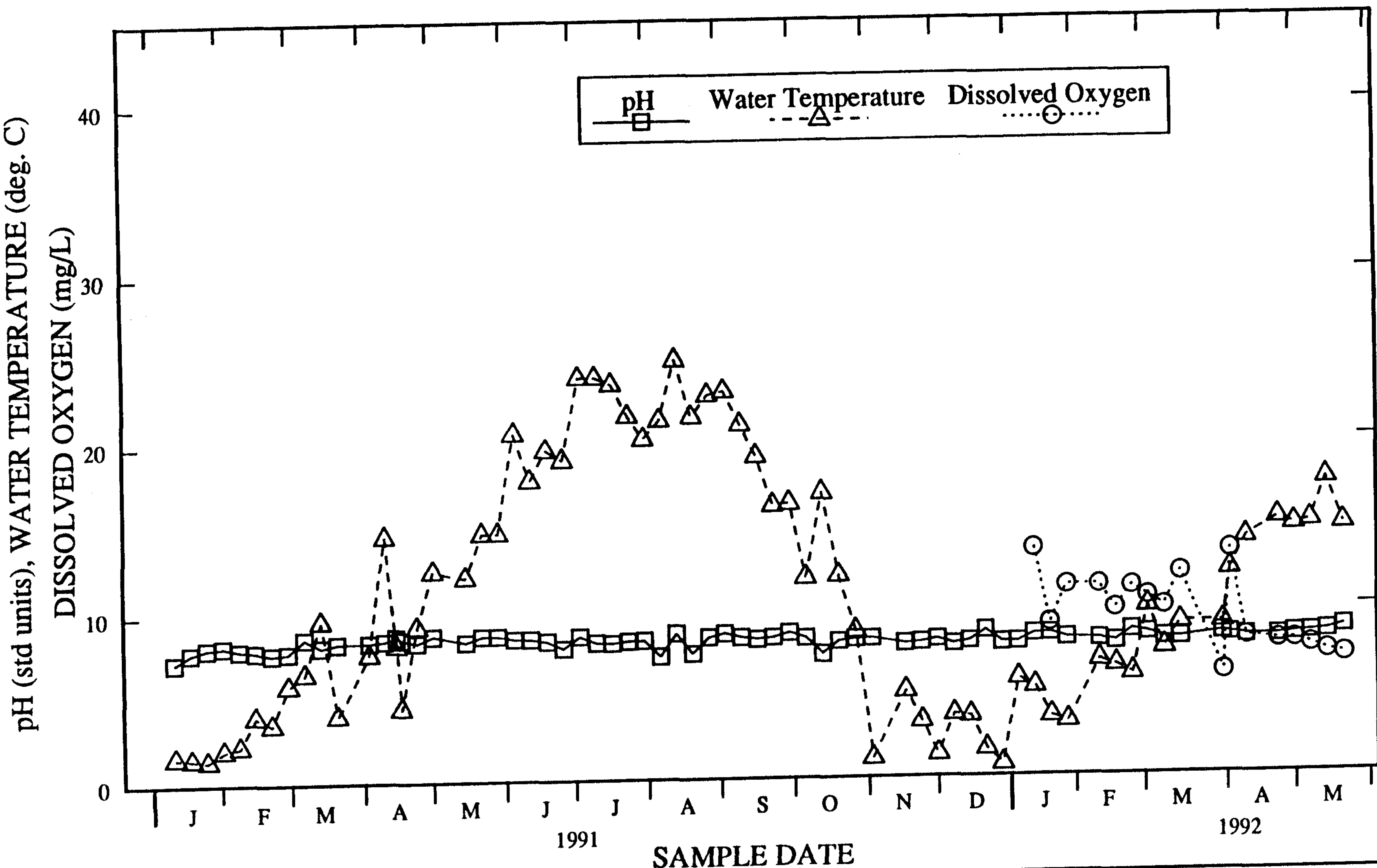
ADVANCED SCIENCES, INC.

ROCKY FLATS PLANT OU 5 RFI/RI
WOMAN CREEK PRIORITY DRAINAGE

ASI PROJECT NO. 9208.15
FIGURE 4B

STATUS: 8/13/92

FILE: FIG4B.DRW



TIME-SERIES PLOTS, POND C-2 CWA COMPLIANCE DATA
pH, TEMPERATURE and DISSOLVED OXYGEN CONCENTRATIONS

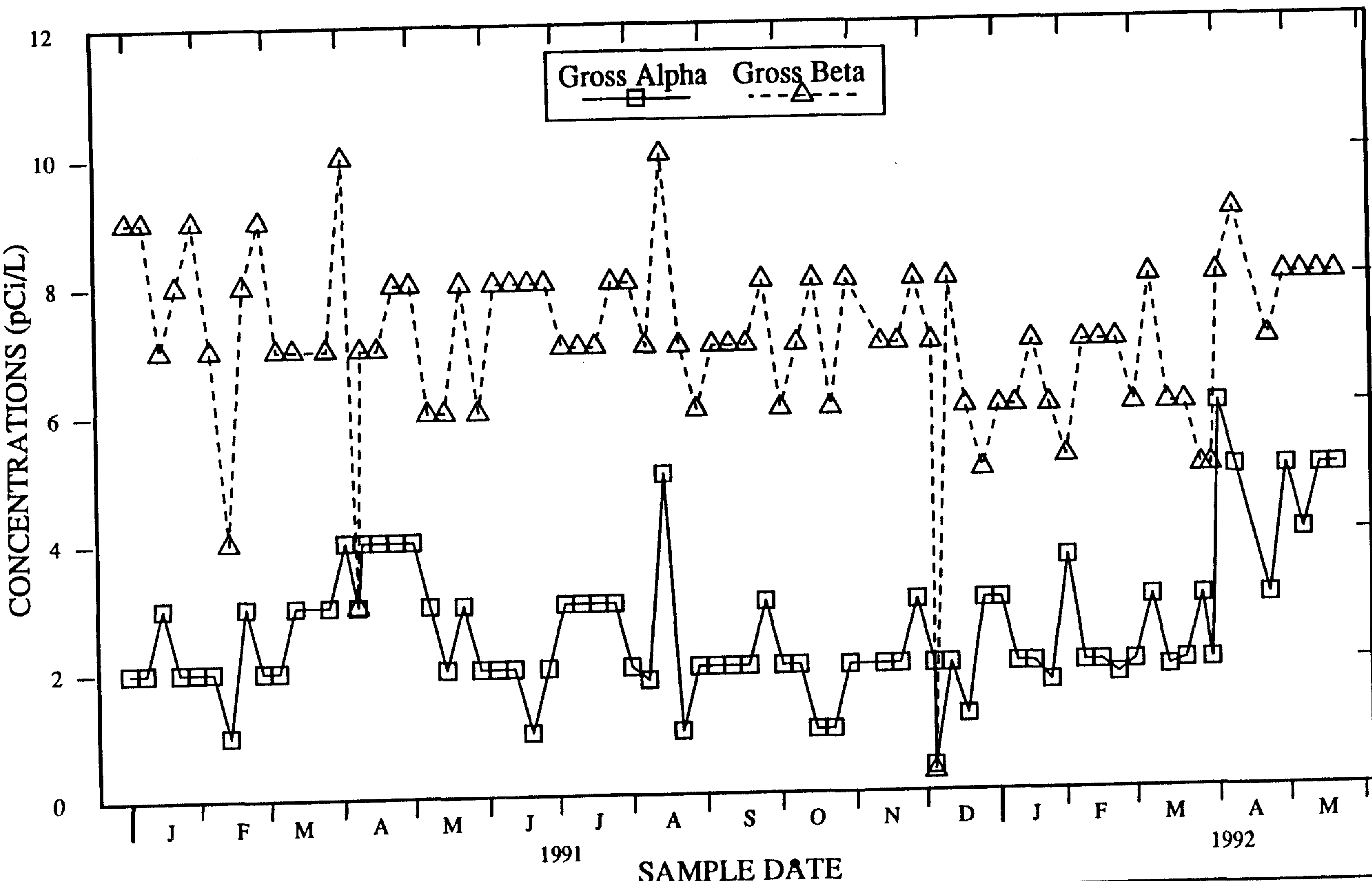
ADVANCED SCIENCES, INC.

ROCKY FLATS PLANT OU 5 RFI/RI
WOMAN CREEK PRIORITY DRAINAGE

ASI PROJECT NO. 9208.15
FIGURE 5H

STATUS: 8/13/92

FILE: FIG-5H.DRW



TIME-SERIES PLOTS, POND C-2 CWA COMPLIANCE DATA
GROSS ALPHA and GROSS BETA CONCENTRATIONS

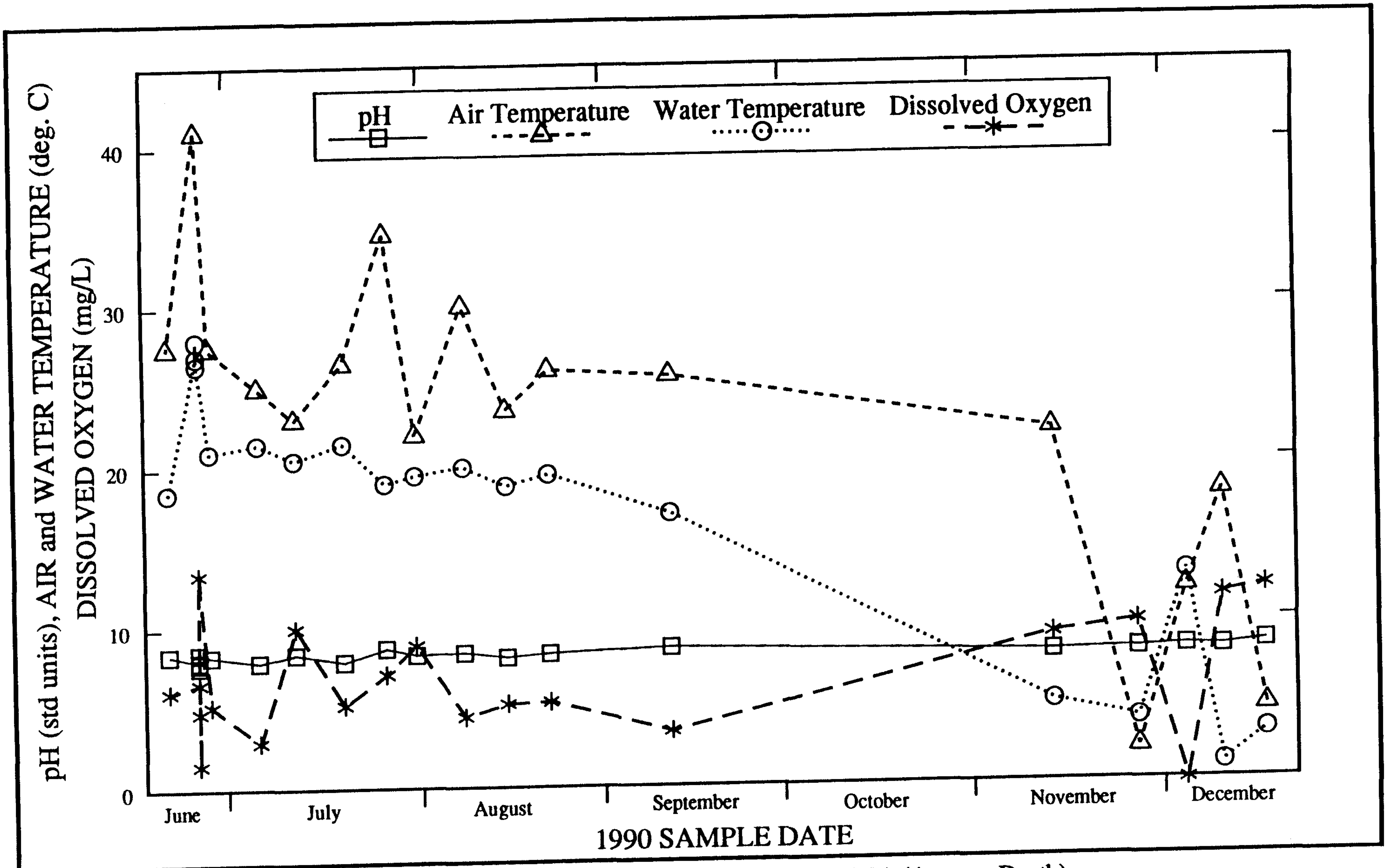
ADVANCED SCIENCES, INC.

ROCKY FLATS PLANT OU 5 RFI/RI
WOMAN CREEK PRIORITY DRAINAGE

ASI PROJECT NO. 9208.15
FIGURE 5G

STATUS: 8/13/92

FILE: FIG-5G.DRW



TIME-SERIES PLOTS, POND C-2 HYDRO LAB DATA (Average Depth)
pH, TEMPERATURE and DISSOLVED OXYGEN CONCENTRATIONS

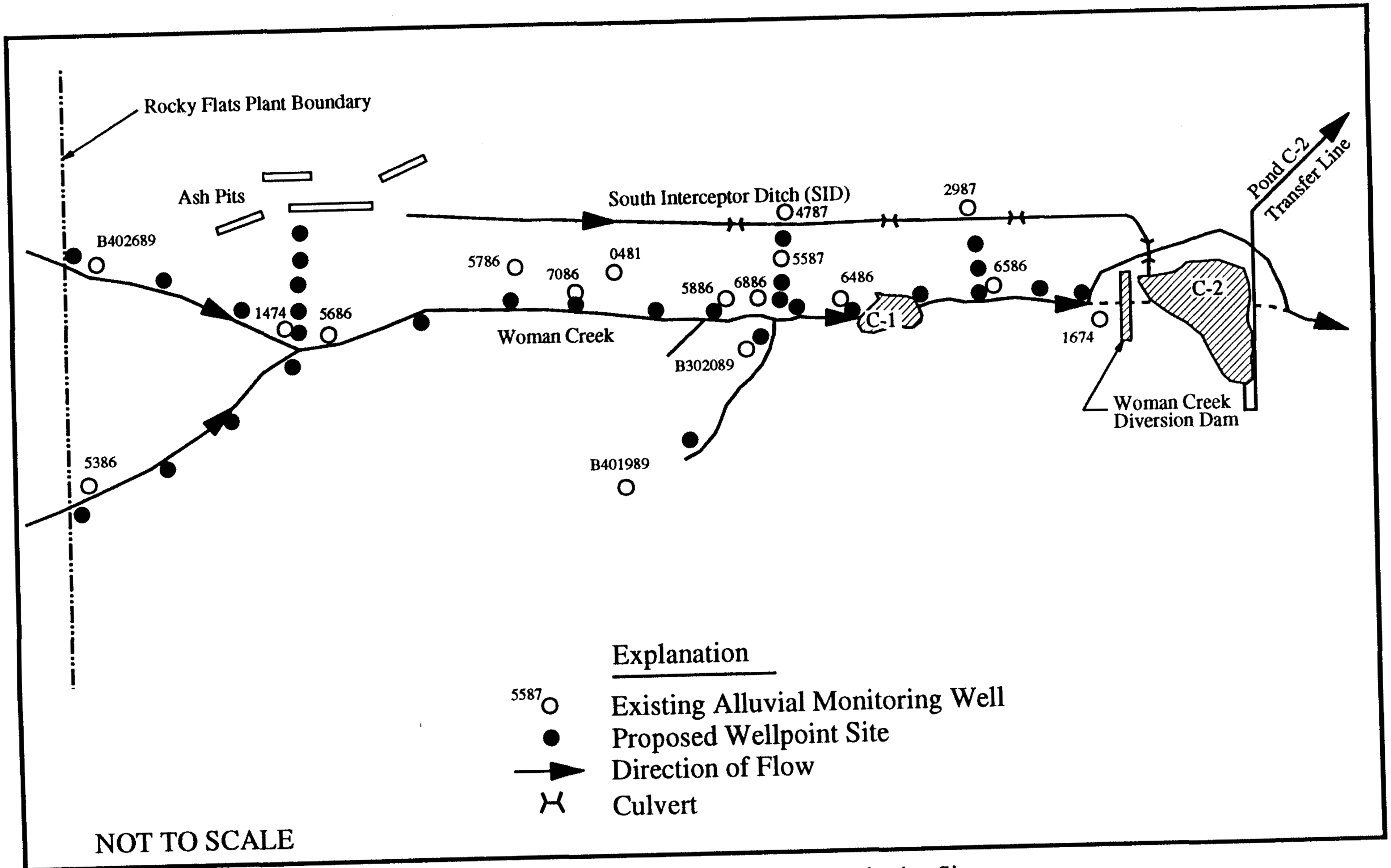
ADVANCED SCIENCES, INC.

ROCKY FLATS PLANT OU 5 RFI/RI
WOMAN CREEK PRIORITY DRAINAGE

ASI PROJECT NO. 9208.15
FIGURE 6A

STATUS: 8/11/92

FILE: FIG-6A.DRW



Proposed Location of Shallow Wellpoint Monitoring Sites
Woman Creek Drainage Basin

ADVANCED SCIENCES, INC.

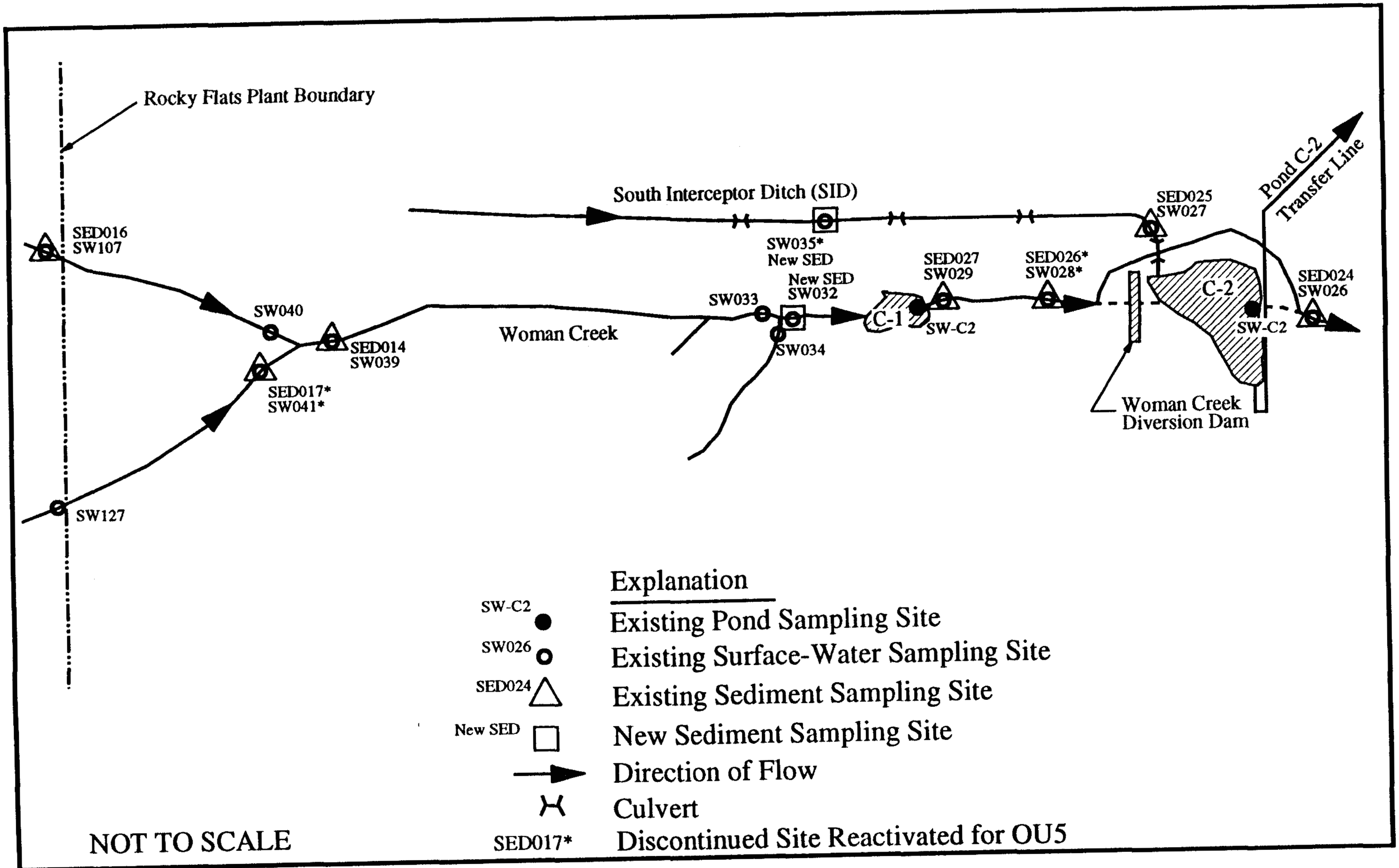
ROCKY FLATS PLANT OU 5 RFI/RI
WOMAN CREEK PRIORITY DRAINAGE

ASI Project No. 9208.15

FIGURE 7

STATUS: 8/06/92

FILE: FIG7-PTS.DRW



FSP-Related Surface-Water Monitoring Sites
Woman Creek Drainage Basin

ADVANCED SCIENCES, INC.

ROCKY FLATS PLANT OU 5 RFI/RI
WOMAN CREEK PRIORITY DRAINAGE

ASI Project No. 9208.15
FIGURE 8
STATUS: 8/06/92

FILE: FIG8-FSP.DRW