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EG&G
ROCKY FLATS PLANT
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HAZWRAP Evaluation of Operable Unit 4 Interim Measure/Interim Remedial Action Environmental Assessment Decision Document

Steven R. Keith, Program Director
Solar Pond Project
EG&G Rocky Flats, Inc.

The Department of Energy (DOE), Environmental Restoration Major Systems Acquisition Division, is hereby transmitting the "Evaluation of the Rocky Flats Plant OU 4 Solar Evaporation Pond Interim Measures/Interim Remedial Action Environmental Assessment Decision Document". This evaluation was prepared at our request by qualified persons in the HAZWRAP program as an independent review to examine how well the groundwater data was presented in the subject document. We support the reviewers conclusion that the data needs to be presented in a systematic way in the report. These comments should involve some minor changes and be incorporated in the final draft.

If you have any questions please contact me at extension 5952.

Frazer R. Lockhart
Director, Environmental Restoration
Major System Acquisition

Attachment

cc w/Attachment:
A. Ledford, EG&G
R. Ogg, EG&G

cc w/o Attachament:
J. Roberson, AMER, RFFO
S. Howard, SAIC
P. Witherill, SAIC
S. Stiger, EG&G

Evaluation of the Rocky Flats Plant OU4 Solar Evaporation Pond Interim Measures/Interim Remedial Action Environmental Assessment Decision Document

HAZWRAP/ASG

Robert W. Magee
Kathryn A. Walter

1.0 Introduction

This report was prepared at the request of the Rocky Flats Field Office Environmental Restoration program (RFO ER). The purpose of the evaluation was to examine how well the data presented in the *OU4 Solar Evaporation Pond Interim Measures/Interim Remedial Action Environmental Assessment Decision Document* support the conclusions of the document, especially those pertaining to the groundwater flow system. A consistent, defensible conceptual model of the groundwater flow system is critical for designing the compliance well network for post-closure monitoring of the Solar Evaporation Ponds at Operable Unit No. 4 (OU4) to assure that important contaminant migration pathways are monitored. The assurance of adequate monitoring is important for gaining regulatory concurrence on, and public acceptance of, the present closure plan. In addition, the site conceptual model will determine the perception of remaining data gaps and additional work needed to fill those gaps. It will also strongly influence the exposure pathways addressed in the baseline risk assessment (BRA) for the site. The results of the BRA will determine the perceived level of risk related to the site and drive further remedial actions.

Despite the importance of the conceptual model of the saturated flow system, the discussions of it in the decision document are unfocused, and the model is not adequately supported by the data presented. Conclusions regarding the nature of the saturated flow system at OU4 are inconsistent among the various volumes of the decision document (Parts I - VI). Definitions of hydrostratigraphic units vary among the volumes, and hypothesized preferential flow paths are often inconsistent with hydrostatic unit definitions within the same volume. In addition, the data presented do not provide adequate support for the conclusions about the flow system and the existence of preferential flow pathways. In some cases adequate data appear to be available, but are not presented in a systematic way in the report. In other cases, the data either do not exist or appear to support conclusions contrary to those of the report.

Section 2 presents discussions of inconsistencies and deficiencies in the decision document with respect to definition of the saturated flow system model and how they may affect the proposed post-closure monitoring plan and Phase II investigations. It also identifies data gaps and makes specific recommendations about additional data analysis and systematic presentation that would make the conclusions of the decision document more consistent and defensible.

2.0 Saturated Zone Flow Model

2.1 Definition of the Upper Hydrostratigraphic Unit

The following are three definitions of the upper hydrostratigraphic unit (HSU) quoted from the decision document. The first is from Part I of the decision document (Introduction, Section I.4.7.2, p. 1-46). This volume summarizes site characteristics.

"Two HSUs (designated upper and lower units) have been identified at the site. The unconfined groundwater occurs in the upper HSU within the unconsolidated geologic material. The upper HSU includes the Rocky Flats Alluvium, which is present on broad topographic highs, colluvium along the valley slopes, and the valley fill alluvium present in modern stream drainages. ..."

The second definition of the upper HSU is from Part II of the decision document (Phase I Remedial Investigation Report, Section II.5.3.3, p. II.5-14). This section is a description of the saturated flow system in the conceptual model and fate and transport section.

> "The saturated ground water zone immediately underlying the vadose zone at OU4 is termed the upper hydrostratigraphic unit (HSU). This unit is comprised of both Rocky Flats Alluvium and associated soils, and weathered bedrock lithologies. ..."

The third definition is from Part VI of the decision document (OU4 Phase II RI/RFI Work Plan, Section VI.3.3.1, p. VI.3-32), which summarizes groundwater hydraulics.

> "The Upper HSU consists of unconsolidated sediments. In areas where the underlying Arapahoe Formation is sandstone, it is included in the Upper HSU. ..."

The following statement occurs on p. VI.3-33.

> "Common usage equates the Upper HSU, the unconsolidated unit and the alluvial unit. The Lower HSU refers to the bedrock unit, excluding bedrock sands in contact with the Upper HSU.
>
> This description of the hydrogeologic system does not specifically identify the weathered claystones and siltstones of the bedrock as an important water-bearing unit. ... Results of the RCRA monitoring program have shown that the weathered bedrock and the uppermost bedrock sands may act as pathways for contaminant migration. ..."

The apparent confusion about which geologic units should be considered part of the upper HSU is obvious from the discrepancies in the above definitions and occurs throughout the six volumes of the decision document. It makes descriptions of the flow system unnecessarily complicated and confusing and affects perceptions of migration pathways. See the example of the post-closure monitoring plan described below.

Properly defined the upper HSU should include all geologic units in direct hydraulic communication within the watertable aquifer. There is very good evidence that these units include at least the unconsolidated materials, the weathered bedrock, and the near-surface Arapahoe sandstones. The evidence includes watertable maps, hydrographs, hydraulic conductivity data, vertical hydraulic gradients, seismic refractions results, and the occurrence of contaminants in bedrock. The upper HSU could also include deeper bedrock, but data are insufficient to assess that possibility. The available data, thus, are sufficient to define units belonging to the upper HSU and to identify an important data gap. These data, however, need to more completely analyzed than has been done in the decision document, reinterpreted in some cases, and presented in a more systematic manner to provide the basis for a consistent, defensible definition of the upper HSU.

2.2 Existence of Preferred Migration Pathways

Related to the confusion over the definition of the upper HSU, the decision document discusses flow in the alluvium and the bedrock separately and hypothesizes at least four preferred migration pathways. For example, the following statement is made in the summary to Section II.3.5 (Section II.3.5.5, p. II.3-124) of Part II. This section describes the geological characterization results.

"Based upon the geological investigations within OU4, four potential contaminant pathways were identified. These pathways are the incised bedrock channels which are often filled with material (alluvium Lithofacies 1 and 2) that exhibit a relatively higher value of hydraulic conductivity (~10^{-2} to 10^{-4} cm/sec) than other alluvial or bedrock units, the semi-consolidated "weathered" bedrock zone identified by borehole and refraction seismic data, a sandy lens beneath the area of pond 207-C, and fractures within the bedrock."

2.2.1 Existence of Preferred Flow in Incised Bedrock Channels

Alluvial materials in the bedrock channels are stated to be important preferred groundwater flow pathways throughout the volumes of the decision document, with the exception of Part V, the post-closure monitoring plan, where they are not explicitly considered when siting wells. Fig. 1 shows a conceptual model of flow in the hypothesized bedrock channels as described in the decision document. Fig. 2 shows the inferred locations of the bedrock channels as shown in the decision document.

The first lines of evidence presented in the decision document for preferred flow in the bedrock channels are topographic and stratigraphic. The topography of the top of the bedrock (defined by the alluvium/colluvium-bedrock contact) is interpreted to contain the incised channels. The topography of the bedrock surface is inferred from boring logs and seismic refraction data. However, the existence of the channels is not supported by the borehole and seismic data. First, lithologic control in the critical area, the northern hillside, is very poor and cannot support the detailed top of bedrock contours drawn on decision document figures (e.g., Fig. II.3.5-14). Second, lithologic cross sections presented in the decision document either do not show any evidence of the incised channels at the mapped locations or do not show coarse-grained lithofacies in channels where there may be some evidence of their existence (Fig. 3).

The interpretations of the seismic refraction data presented in decision document Figs. II.3.5-20 to II.3.5-26 do not support the existence of the channels either. First, neither the original seismic data nor a detailed analysis of the data is presented, and the lines are not tied into actual boring logs in the report (only locations are shown). Therefore, the validity of the interpretations cannot be confirmed. In addition, there are indications that the geophone spacing and the methodology for elevation determination may not have produced the resolution necessary to map the detail shown on the seismic interpretations. The discussion in Section II.3.5.4.2 states that vertical accuracy is estimated to be one to two feet and horizontal accuracy is estimated to be five feet. Many of the features mapped, including depressions in the weathered bedrock surface, are of the order of five feet or less. In addition, there are no seismic lines in critical areas on the hillside.

Second, even the interpretations presented do not appear to support the existence of the bedrock channels. For example seismic lines 2, 5, 6, and 7, which are perpendicular to the hypothesized channels, do not show significant relief or indicate large seismic velocity differences at the alluvium-bedrock contact (e.g., Fig. 3 and Fig. 7). They do indicate some relief and large velocity differences at the weathered bedrock-competent bedrock contact, indicating there may be some confusion about where the channels are supposed to be. In any case the evidence provided by the boring logs and seismic data need to be reanalyzed and interpretations carefully checked.

The second line of evidence to support preferred flow in the alluvium in bedrock channels is essentially hydrologic and is based on the contention that alluvial materials in the channels have significantly higher saturated hydraulic conductivities (K) than underlying lithologies (i.e., $K_{alluvium} >> K_{weathered\ bedrock}$). This contention is not well supported by the data. Results of K measurements are presented in the decision document for three different methodologies: insitu BAT™ tests and Guelph permeameter tests, and laboratory determinations from "undisturbed samples". None of these methods can be expected to provide really accurate determinations of K; however, on a relative basis all methods indicate that Ks for alluvial and bedrock materials overlap (Fig. 4 and Fig. 5). The BAT™ data plot separately on Fig. 4, and appear to be anomalously low, indicating that the data from that method may not be comparable to data from other methods. Aquifer test data from OU4 and other Rocky Flats OUs also indicate overlapping K values for alluvium and bedrock, especially for depths less than about 60 feet (Fig. 6).

The decision document claims that Rocky Flats Alluvium Lithofacies 1 and 2 have the highest Ks, and perhaps these could be distinguished from most bedrock Ks. However, the data in the decision document are not presented in such a way that K differences between lithofacies are obvious, and further analysis is necessary to test this claim. Additional problems with the interpretation of K differences between alluvium and bedrock is that the coarse-grained alluvial facies do not appear to occur in the mapped bedrock channels (e.g., Fig. 3), and most of the length of the mapped bedrock channels is on the northern hillside which is underlain by fill and colluvium. It is, thus, not clear that measured K values for the facies of the Rocky Flats Alluvium are relevant to transport pathways on the hillside.

2.2.2 Other Preferred Flow Paths

The definition of the other preferred flow pathways does not appear to be very meaningful based on available data. The pathways are defined as the weathered bedrock, the uppermost Aprapahoe sandstone, and fractures within the bedrock. As discussed under definition of the upper HSU above, the evidence is very good that the weathered bedrock and the Aprapahoe sandstone are in direct hydraulic communication with the alluvium and with each other when they are physically juxtaposed. There is some evidence provided by oxidized fractures within the bedrock that fractured bedrock is in hydraulic communication with the other units. Consequently, as discussed above, the data indicate that the alluvium, the weathered bedrock, and the Arapahoe sandstone should be considered one hydrologic unit. Contrary to the impression created by mapping alluvial and weathered bedrock contours separately, as is done in the figures in Section II.3 of Part II, the elevation of the watertable is simply gravity controlled and is independent of geologic unit.

Possible evidence for the existence of preferred flow paths is the occurrence of seeps along the northern hillside. These seeps are not adequately considered in the decision document. Section III.5 cross sections do not clearly indicate the contact at which these seeps occur. It may be very useful to review available data to attempt to determine the origin of the seeps. The extent of communication with the fractured bedrock needs to be investigated further via hydrographs, deeper borings, monitoring wells, and aquifer testing.

2.3 Relationship of Conceptual Flow Model to Post-Closure Monitoring and Phase II Investigations

The post-closure monitoring plan does not appear to be based on a consistent definition of the upper HSU or on the four preferred migration pathways proposed in Part II of the decision document. The post-closure monitoring plan defines the upper HSU as the unconsolidated material and the weathered bedrock, but then describes wells as alluvial, weathered bedrock, and upper HSU, as if these were three separate hydrologic units. In addition, it does not discuss the possible existence of preferred migration pathways and specifically does not propose wells in mapped bedrock channels, the uppermost Arapahoe sandstone or in bedrock below the weathered zone (Fig. 7). Thus, the monitoring plan does not appear to have taken into account the conclusions of the Phase I Remedial Investigation Report. As discussed above, these particular conclusions are not necessarily correct; however, to be defensible the post-closure monitoring plan needs be based on some clearly definable conceptual model that is supported by data.

The locations and depths of proposed Phase II monitor wells should reflect the conceptual flow model and identified data gaps. Part VI (Phase II Work Plan) describes the locations of 11 new alluvial wells and 17 new weathered bedrock wells. Preliminary review indicates that siting of the wells appears to be related primarily to spatial coverage of the area, although a statement is made that if bedrock channels are found at least one well will be sited in each. The plan separates wells into alluvial and weathered bedrock with no recognition that both belong to the upper HSU. One obvious deficiency in the investigation is the lack of proposed wells in the bedrock underlying the weathered zone, although fractured bedrock has been identified as a flow pathway.

Few details about proposed slug tests and pump tests are given. For example, no locations are provided for the slug tests. From the descriptions of the pump tests it is not clear that they will provide critical data on hydraulic communication between units. For example, no tests are proposed for bedrock below the weathered zone. It would be useful to analyze the locations of proposed monitoring wells and the design of aquifer tests in more detail in relation to valid flow models and identified data gaps.

OU 4 IM/IRA CONCEPTUAL MODEL OF FLOW IN INCISED BEDROCK CHANNELS

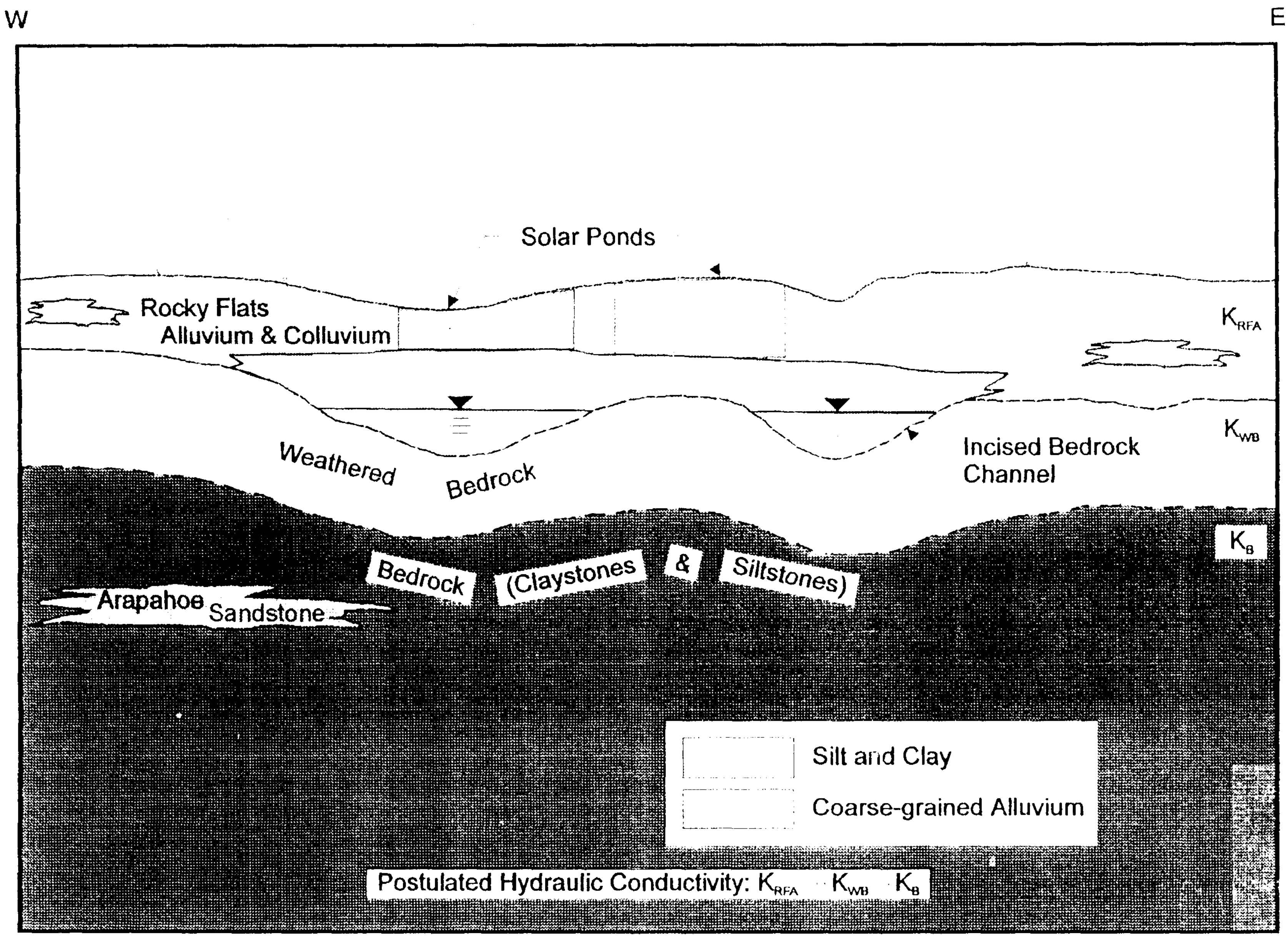

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Figure 1

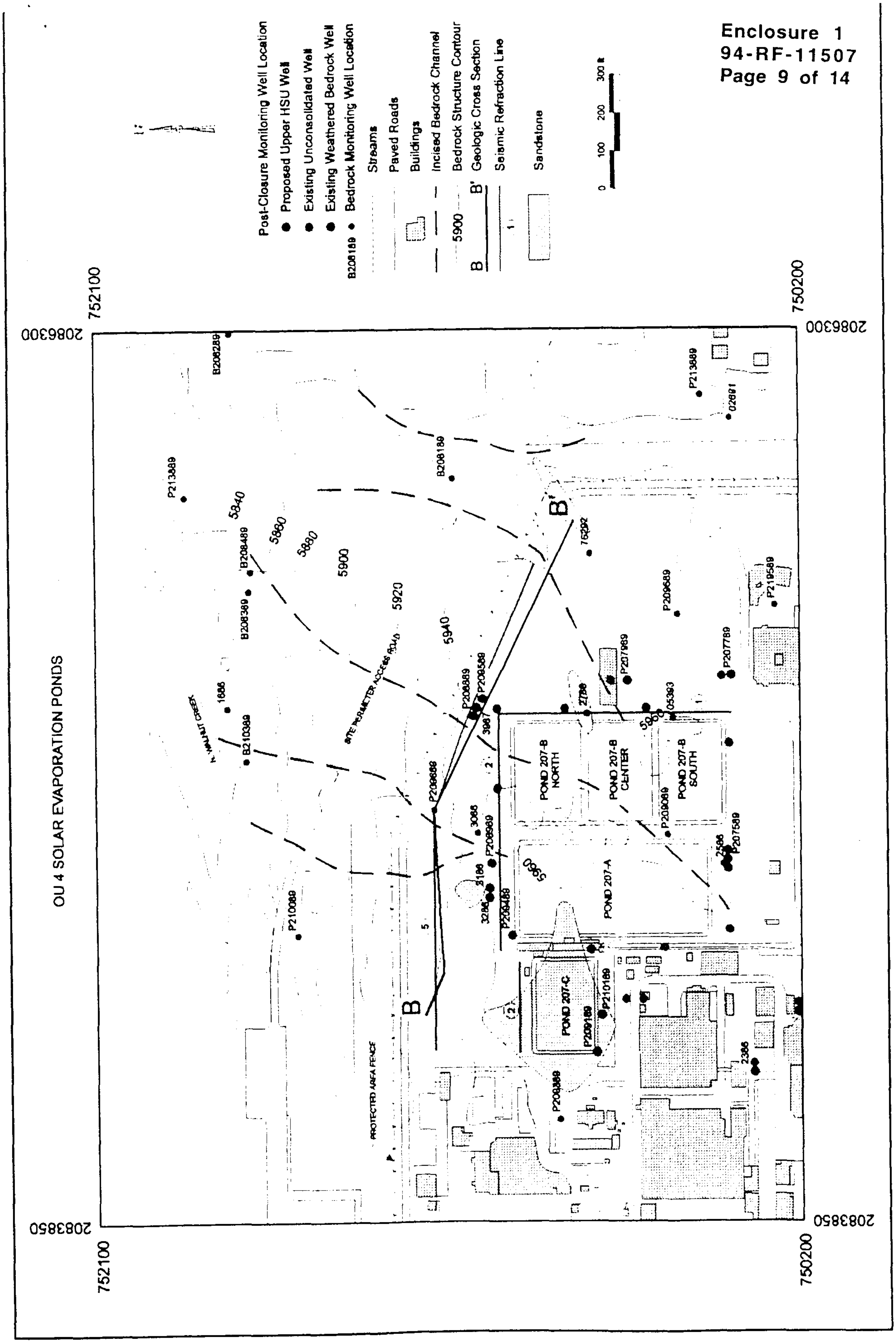
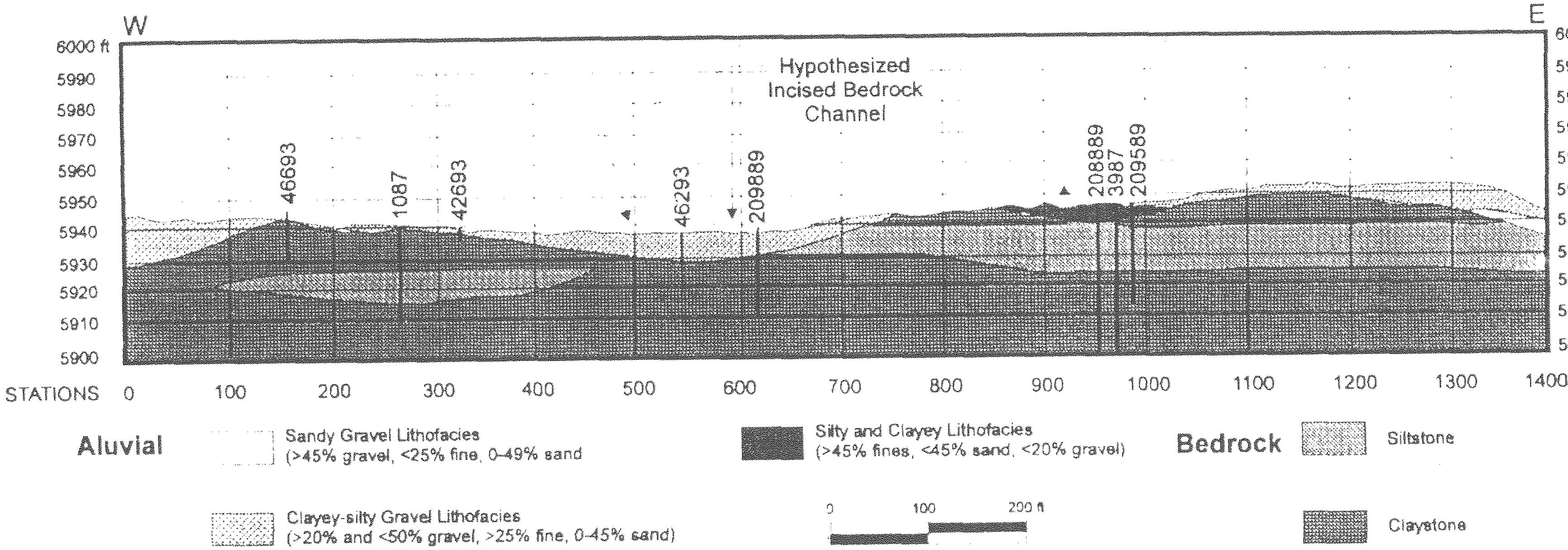
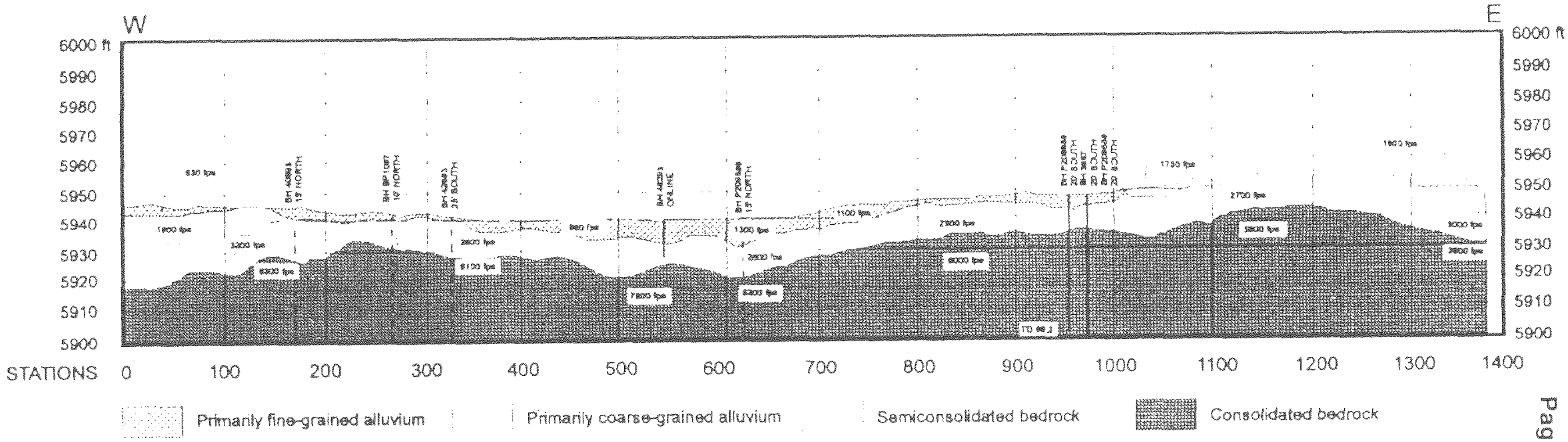

OU 4 SOLAR EVAPORATION PONDS
Post-Closure Monitoring Well Location
Proposed Upper HSU Well
Existing Unconsolidated Well
Existing Weathered Bedrock Well
B208189 Bedrock Monitoring Well Location
Streams
Paved Roads
Buildings
Incised Bedrock Channel
5900 Bedrock Structure Contour
B B' Geologic Cross Section
Seismic Refraction Line
Sandstone
0 100 200 300 ft
752100
2086300
2083850
750200
POND 207-B NORTH
POND 207-B CENTER
POND 207-B SOUTH
POND 207-A
POND 207-C
N. WALNUT CREEK
SITE PERIMETER ACCESS ROAD
PROTECTED AREA FENCE
5840
5860
5880
5900
5920
5940
5960
B
B'
P213389
B208289
B208189
B208489
B208389
B210389
P210089
P213889
P209689
P219589
P207989
P207789
P209889
P209589
P209689
P209089
P207589
P208989
P208489
P210189
P209189
P208889

Figure 2

GEOLOGICAL CROSS SECTION (Modified from Cross Section B-B', OU4 IM/IRA Decision Document)



GEOLOGICAL INTERPRETATIONS OF SEISMIC REFRACTION DATA LINE 5 (OU4 IM/IRA Decision Document)



ASG383-B001

Figure 3

HYDRAULIC CONDUCTIVITY BY METHODOLOGY (OU4)

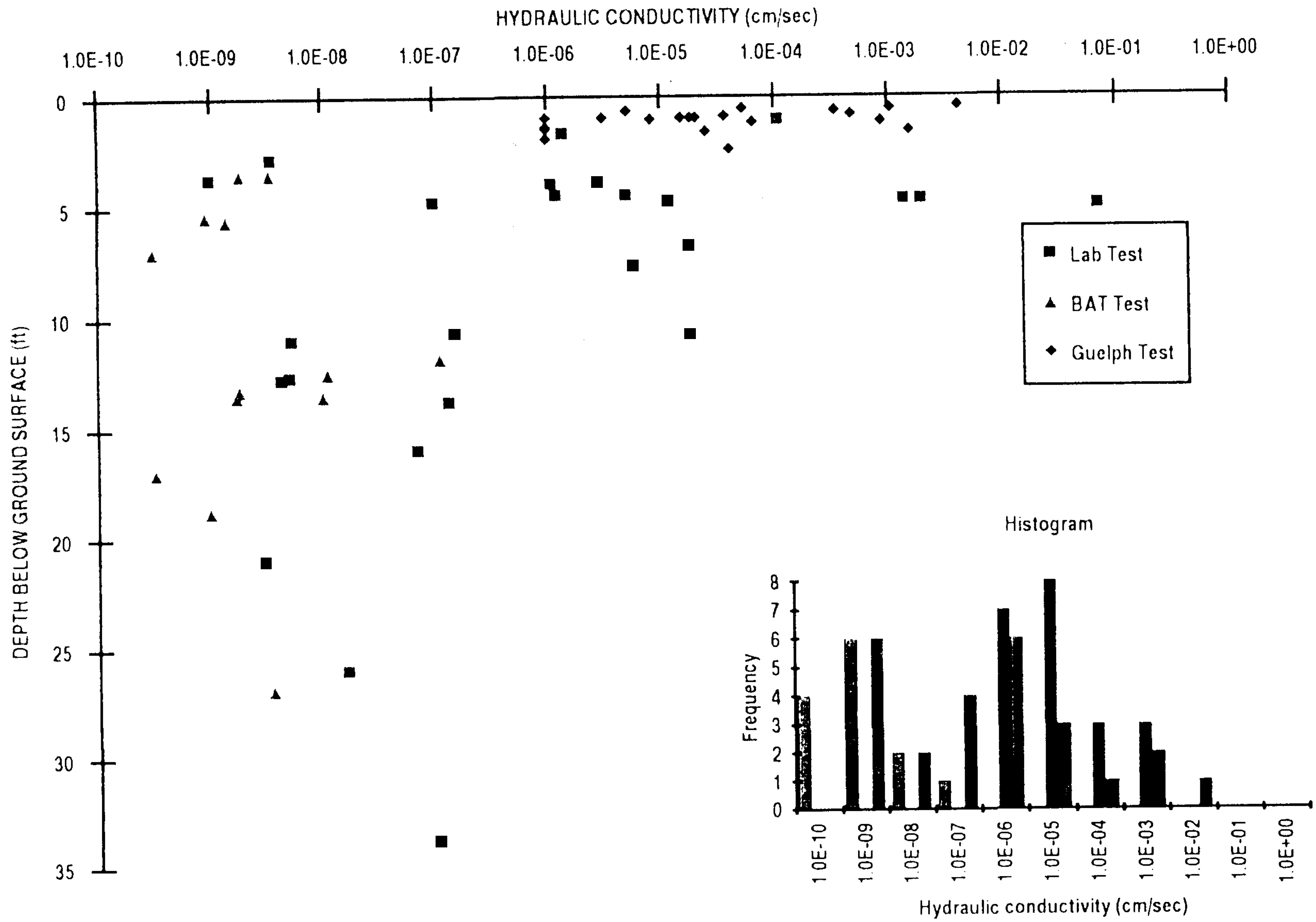


Figure 4

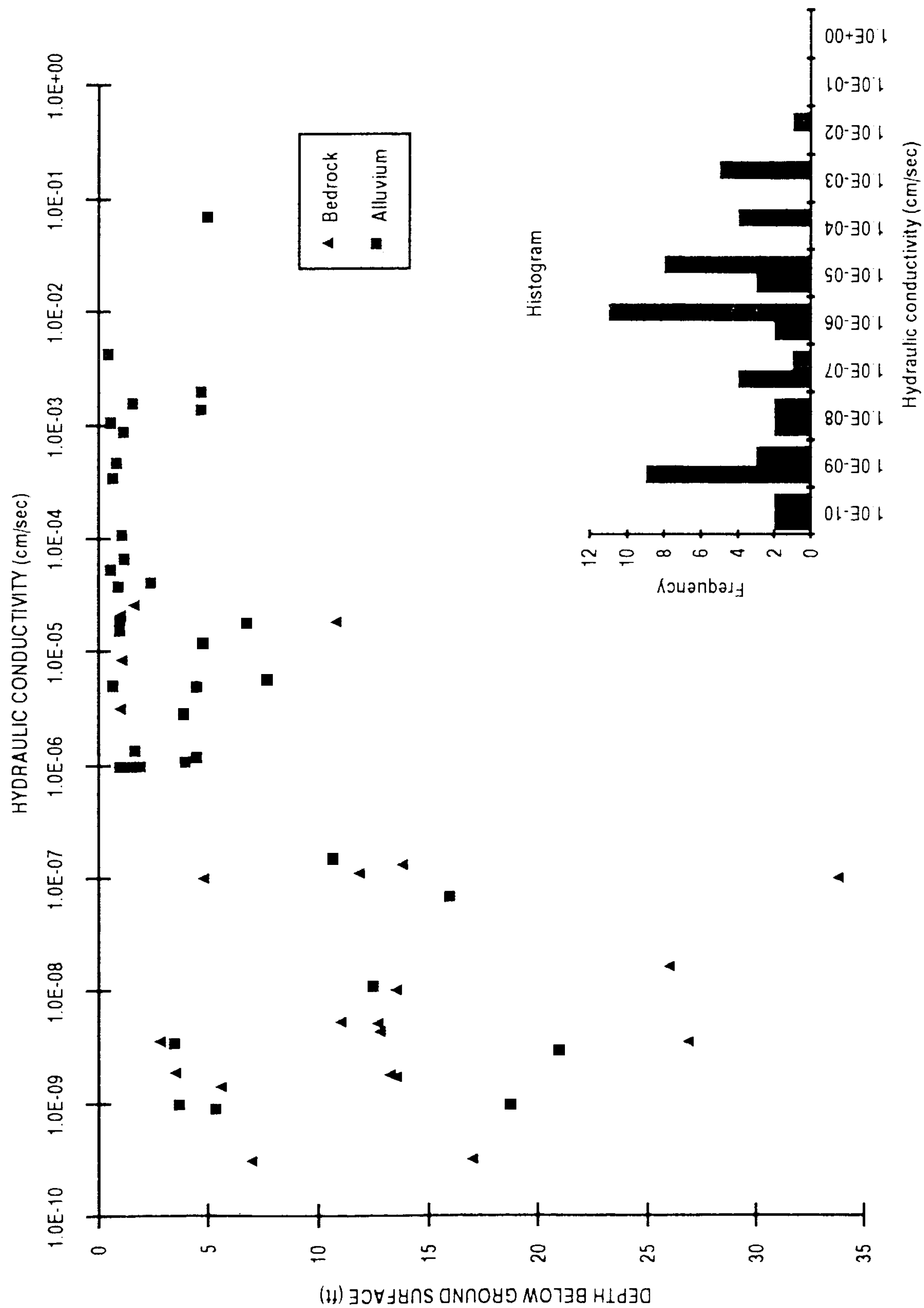

HYDRAULIC CONDUCTIVITY (cm/sec)
1.0E-10
1.0E-09
1.0E-08
1.0E-07
1.0E-06
1.0E-05
1.0E-04
1.0E-03
1.0E-02
1.0E-01
1.0E+00
0
5
10
15
20
25
30
35
DEPTH BELOW GROUND SURFACE (ft)
Bedrock
Alluvium
Histogram
Frequency
12
10
8
6
4
2
0
1.0E-10
1.0E-09
1.0E-08
1.0E-07
1.0E-06
1.0E-05
1.0E-04
1.0E-03
1.0E-02
1.0E-01
1.0E+00
Hydraulic conductivity (cm/sec)

Figure 5

PLANT - WIDE HYDRAULIC CONDUCTIVITY BY LITHOLOGY

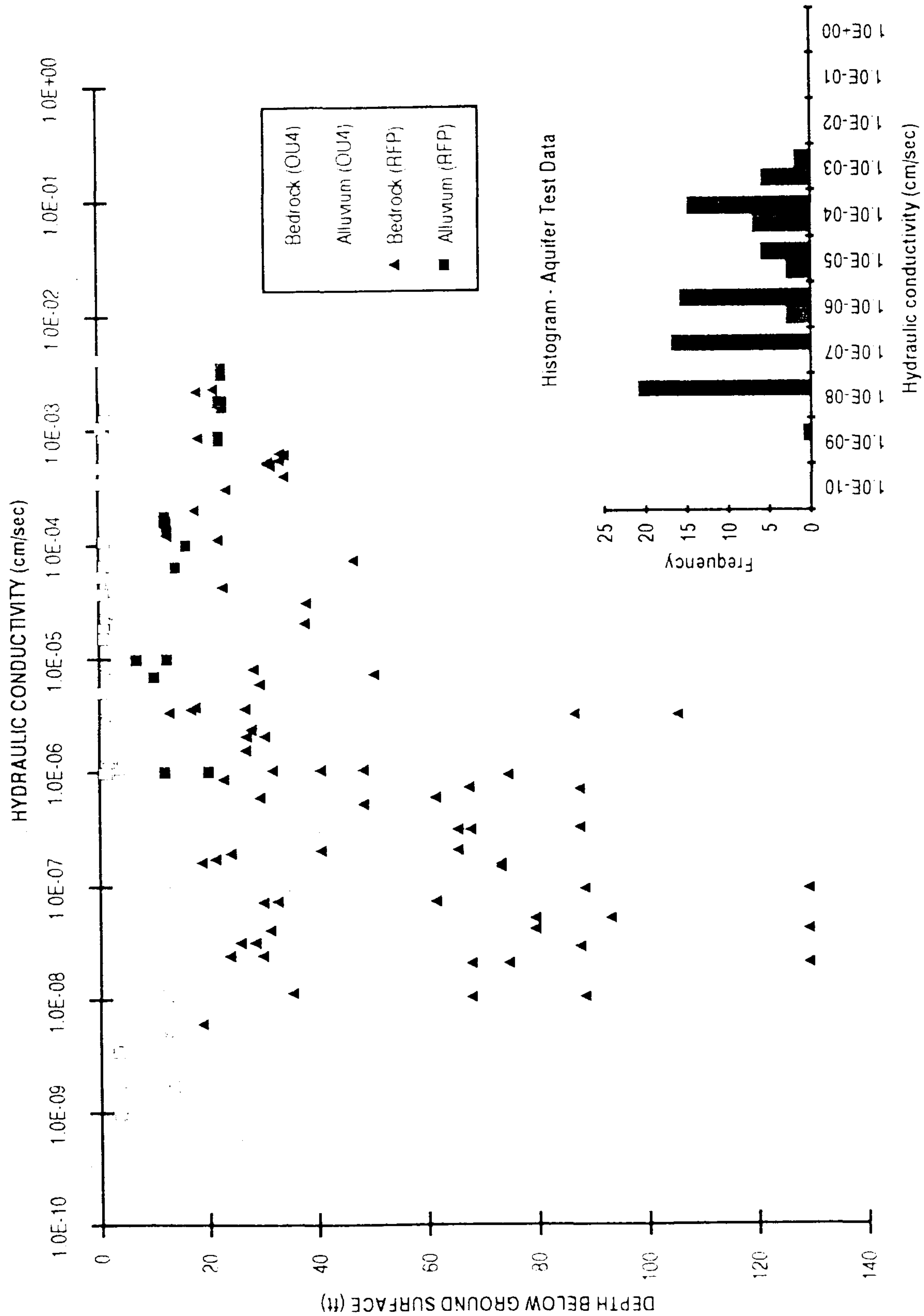


Figure 6

POST-CLOSURE MONITORING WELLS ALONG SEISMIC SECTION FOR LINE 2
(Modified from OU4 M/IRA Decision Document)

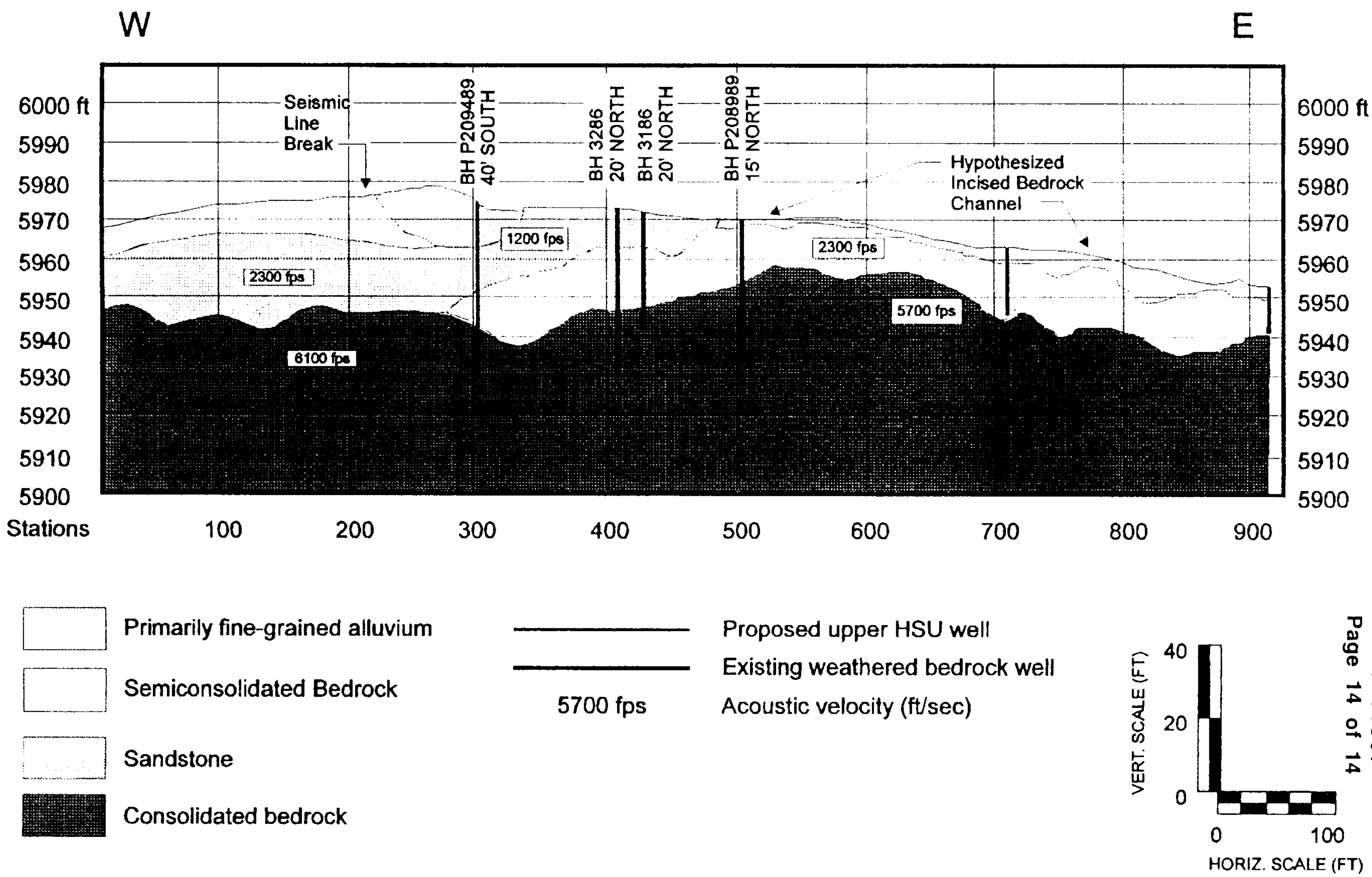


Figure 7