Compilation of Written DOE Comments and EG&G Responses to the Draft Final Hydrogeologic Characterization Report for the Rocky Flats Environmental Technology Site April 10, 1995

COMMENTS FROM SAIC—DENVER

Comment Reference

General

1. This report is an excellent compendium of the hydrogeology at RFETS and provides an extremely thorough site wide reference document. The information summarized and presented in this document is technically sound and well founded. The document is well written, summarizing methods, results and conclusions clearly. For this reason, the few specific comments made below are relatively minor but would add value to the report.

2. Section 7 of this report briefly outlines proposed future research to further study and define the hydrogeology at Rocky Flats. Recognizing that it is important for any research effort to outline and discuss possible data gaps and potential future research needs, the outline of Section 7 does appear academic relative to what is currently known of the nature and extent of contamination at RFETS and the current schedule for the OUs: We recommend that EG&G focus future proposed hydrogeologic research on data gaps and research needs identified by the remedial investigations and feasibility studies or on clearly specified requirements of the site wide programmatic ground water monitoring and protection program. We would be happy to work with EG&G in developing and coordinating this effort.

Specific

(1.) 1. Section 3.1. Briefly summarize methodology. How many met stations are maintained at Rocky Flats and what are the general data logging routines? Is there one official station? Are several stations averaged together? If more than one station is utilized, it would benefit the outside reader and the report to note how well RFETS is monitored and characterized, climatologically, relative to normal climatological monitoring.

The methodologies used for gathering climatologic data are now included in the text.

(2.) 2. Page 3-1, Section 3.1.1. Briefly summarize methodology. Are automatic tipping bucket rain gages used for precip measurements and automatic logging? Any potential data differences which would be caused by

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differences in equipment or methodologies used at RFETS and Stapleton should be briefly noted or mentioned before making comparisons.

The methodologies used for gathering precipitation data are now included in the text.

(3.) 3. Section 3.1.2. Briefly summarize methodology. Mean Daily Temp is officially the average between the daily max and min. I assume that this is what you did for your reported "averages," but given the capabilities of data logging systems and because specific objectives may differ, you should clarify how Mean Daily Temp, Mean Monthly Temps, and Long Term Averages are calculated.

The methodologies used for gathering air temperature data are now included in the text.

(4.) 4. Section 3.1.3. Briefly summarize methodology, i.e., logging routines for wind speed and direction.

The methodologies used for gathering wind pattern data are now included in the text.

(5.) 5. Tables 3-1 through 3-9, 3-11. Most tables don't have units stated or noted.

The noted tables now include units.

(6.) 6. Page 5-10, Section 5.1.6, top of page. Minor edit; Typo: "The audit also made the recommendation to initiate of well maintenance program..."

The text has been corrected.

(7.) 7. Page 6-11, Section 6.2.1.2, second paragraph, first sentence. The reference to Plate 8 should probably be Plate 3 or 4.

The text now refers to Plate 3.

(8.) 8. Plates in General. Why do most all of the Plates show perennial and ephemeral seeps and springs? This is particularly awkward for the saturated thickness maps which show unsaturated zones next to or overlapping ephemeral seeps.

Although seemingly redundant, the seeps and springs were displayed on the groundwater elevation maps of unconsolidated surficial deposits (Plates 1 through 6) because these hydrologic features are important components of the shallow groundwater system. Adding these features

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to the groundwater elevation maps was intended to enhance the reader's understanding of the shallow groundwater flow regime by indicating areas of groundwater discharge. It should be noted that ephemeral seeps may overlap with unsaturated areas during low flow regimes (4th quarter) when groundwater storage is being depleted. However, it is recognized that seeps should not overlap with unsaturated areas during high flow regimes (2nd quarter). These discrepancies on the 2nd quarter maps have been revised accordingly.

(9.) 9. Section 7. See General Comment No. 2. In general, the knowledge of the hydrogeology at RFETS is sufficient for making remedial and regulatory decisions. This is demonstrated by the thoroughness of this report. It is important, therefore, that future hydrogeologic and geochemical research objectives tie closely to research needs and data gaps identified by remedial investigations and feasibility studies. Recognizing that it was not within the scope of this document to provide detailed justification for the identified data gaps outlined in Section 7, the following 2 examples are given to aid EG&G in the development and justification of future objectives.

Although the identified research regarding the Laramie/Fox Hills contacts would be required to detail hydrogeologic water balance for the area, these contacts are fairly deep and have not been identified as important or necessary for making remedial and regulatory decisions at this time. For example, the remedial investigation and risk analysis for OU 11 has recently shown that No Further Action under RCRA/CERCLA will be necessary.

At this time, OU 3 has not identified ground water contamination or a future risk to ground water which justified the development of a Remedial Action Objective and further study of ground water contaminant transport. OU 3, OU 5 and OU 6 have not identified the need for the detailed study of potential offsite contaminant transport in ground water in the pond drainages. No contaminated LHSU ground water has been identified east of OU 2, and no LHSU plumes or sources have been identified which have warranted further investigation for making remedial and regulatory decisions at this time.

Comment acknowledged.

COMMENTS FROM SANDI DOTY, SAIC—DENVER

Objectives

(10.) 1. The objectives are presented in Section 1.2 entitled "Purpose and Scope" in the third sentence which states that "The report describes previous

hydrogeologic studies performed at Rocky Flats, the hydrogeologic setting of the site, regional hydrogeology, the hydrogeology of the Rocky Flats site, innovative groundwater field methods used at the site, and recommendations for additional groundwater studies."

(11.) 2. In general, these objectives are clear; however, I do not understand the difference between "the hydrogeologic setting of the site" and "the hydrogeology of the Rocky Flats site." After reading Sections 3 and 6, it appears that Section 3 would be better entitled "the environmental setting of the Rocky Flats site" to avoid the confusion. Also, I question the reference to "innovative groundwater field methods." Section 5 describes the groundwater monitoring program but I don't see anything that is "innovative."

Agreed. Section 3.0 "The Hydrogeologic Setting of the Rocky Flats Site and Surrounding Areas" has been changed to "The Environmental Setting of the Rocky Flats Site and Surrounding Areas." The reference to "innovative groundwater field methods" has been changed to "sitewide groundwater program activities."

(12.) 3. In Section 1.2, second paragraph, fifth bullet — Isn't the Groundwater Geochemistry Report Volume III?

The reference to the Groundwater Geochemistry Report, Volume III, has been corrected.

Parameters/Equations

(13.) 1. Parameters such as hydraulic conductivity, transmissivity, recharge, specific yield, etc. As presented in Section 4 seem reasonable from an outsiders point of view. I would have to go back to the sources of data as referenced to question the appropriateness of the values presented.

It is beyond the scope of this report to include hydraulic conductivity, transmissivity, recharge, specific yield, etc., values for other aquifers for comparison purposes.

(14.) 2. In section 6 on page 6-17, the definition of "kurtosis" is presented and then the values are categorized as "between two and four indicates normally peaked (mesokurtic) data; less than two indicates flat (platykurtic) data; and greater than four indicates highly peaked (leptokurtic) data." In the same paragraph, the text goes on to describe the Rocky Flats Alluvium as having a kurtosis of 12.7, which it says is mesokurtic but by definition should be leptokurtic since it's value is greater than 4. Likewise, on page 6-18,

paragraph 4, the text describes the colluvium as having a kurtosis value of 5.63 then states that it is mesokurtic instead of leptokurtic.

The text now indicates that the Rocky Flats Alluvium hydraulic conductivity data and the colluvium hydraulic conductivity data are leptokurtic.

(15.) 3. Referring to Figure 6-8, the only upward gradient measured was at monitoring location 38. A discussion of why this occurs should be included in the text.

Section 6.2.2.4, Discharge, includes an explanation for the upward hydraulic gradient observed at monitoring location 38.

(16.) 4. Referring to Figure 6-11, many of the potentiometric surface contours indicate that there is flow into the unsaturated areas which seems wrong. One example of the problem is the area to the south below the "5970" contour symbol.

The equipotential lines in Figure 6-11 were based on actual field observations and were contoured using sound hydrologic principles. The equipotential lines in or near OU1 and OU4 indicate that groundwater flows in the downgradient direction toward unsaturated areas. This suggests that the French drains in OUs and 1 and 4 are functioning properly.

Conclusions

(17.) 1. Conclusion and/or summary sections are included in the report at the end of Section 6.2 (Upper Hydrostratigraphic Unit); Section 6.4 (UHSU/LHSU Interactions) and Section 6.5 (Surface-Water/Groundwater Interactions). Why is there no conclusion and/or summary section at the end of Section 6.3 (Lower Hydrostratigraphic Unit)?

A new subsection, 6.3.6, Summary, is now included at the end of Section 6.3, Lower Hydrostratigraphic Unit.

(18.) 2. In general, the conclusions and recommendations seem reasonable from an outsiders point of view. The recommendation on page 7-1 to investigate the hydrogeologic significance of fault and fracture flow is a huge undertaking and it is surprising to me that it would be proposed so late in the process of characterizing the site.

The above recommendation is based on an investigation of faulting at the Rocky Flats site that was conducted in 1994 as part of the Seismic

Investigation Program, which was conducted under the Sitewide Evaluation Program.

COMMENTS FROM TIM STEELE, B&A—DENVER

General Comments

General Comments. This document constitutes a quite comprehensive compendium and analysis of both regional and sitewide hydrogeologic characterizations relevant to the RFETS. Plates 6 (sitewide areal contouring of depths to water) and 8 (locations of seeps) of the document exemplify the useful products resulting from this study. Although the information on Plate 8 also is contained on Plate 6, this reviewer judges the redundancy to be justified. In general, use of the relevant literature is excellent (several updated reports, such as 1994 versions of GPMPP and WER, might be incorporated into the final report). The document in general is well written and contains detailed graphic and tabular support materials. The appendices serve as a valuable resource for future work and reference to information and data involving this critical aspect of the RFETS water-resources environment.

(19.) 1. Several multiple-author reference citations in the text and on figures are given inconsistently as "and others" and *et al.*; this reviewer suggests the use of "and others." At least one reference is in error [see p. 6.4, first line of Section 6.1.3; EG&G (1991b) and not (1991c) for Geological Characterization Report]. In cases where tables, figures, or plates of cited reports are referenced (for example, see p. 6-12, third line of first full paragraph), it is recommended that the reference be given first and the specific table/figure/plate citation second. This avoids confusion with tables/figures/plates contained in this document. On p. 6-24, second full paragraph, line 6, DOE (1993f) is a nonexistent reference citation; should it not rather be DOE (1994f)? For single-source/multiple-year reference, this reviewer suggests use of ";" rather than "and" to separate years (examples: p. 4-18, Section 4.6, first paragraph, line 3; p. 6-30, near bottom). On p. 6-30, is DOE 1994j, which is nonexistent in Section 8, meant to be DOE (1994i)? On p. 6-31, reference EG&G (1994j) does not exist in Section 8. On pp. 6-53/54, the Woman Creek I/E Study would be referenced as EG&G (1993j) and not EG&G (1993a).

The text has been changed where appropriate. However, with regard to single-source/multiple-year references, the citation format follows format used for all three volumes of the Sitewide Geoscience Characterization Study and has been retained for consistency among the reports.

(20.) 2. References to several regulations (for example, see p. 6-2, 40 CFR and 42 USC) should be included as reference citations (Section 8).

References have been added.

(21.) 3. Both the terms hydraulic conductivity (Section 4, p. 4-14 and elsewhere) and permeability (Section 6.0, p. 6-2, 6-38, and elsewhere) both are used; this reviewer suggests sole use of the former term.

Hydraulic conductivity and permeability are not synonymous terms. Hydraulic conductivity is a coefficient of proportionality describing the rate or velocity at which water moves through a porous medium; whereas, permeability is a property of the porous medium that pertains to the relative ease with which a porous medium can transmit a liquid. Within the report, hydraulic conductivity is generally used in specific terms such as when actual groundwater flow rates are discussed; permeability is typically used in a more general sense describing the permeable nature of the aquifer material.

(22.) 4. Watch the occurrence of split verbs (examples: pp. 6-11 and 6-14), which should be discouraged, and split infinitives are taboo (p. 6-3). The term "although" or "whereas" is grammatically correct and preferred over "while", which is grammatically incorrect [for examples of each: (1) p. 6-6, first full paragraph, third line from bottom; (2) p. 6-12, line 5 of the first full paragraph]. When "whereas" is used as a conjunction, it is preceded by a semicolon and followed by a comma, as follows: ";whereas,". "Use" is preferred to "utilize"; "parts" to "portions" (which refer to food). Is the verb "to desaturate" valid (pp. 6-11 and 6-12)? This reviewer has not heard of it before.

Text has been changed as indicated. "Desaturates" has been changed to "removes groundwater from."

(23.) 5. The occurrence of units of relatively low hydraulic conductivity (permeability) can minimize flow/leakage or contamination; however, this reviewer doubts that these units can prevent these phenomenon (for examples, see pp. 6-2 through 6-4).

Changes have been made as indicated.

(24.) 6. A blend of metric units, English units, and dual (metric/English) units are used in this document; can some consensus and consistency on this issue be achieved by EG&G and DOE?

A conversion table has been added following the List of Acronyms and Abbreviations.

(25.) 7. Capitalization consistency is needed, as per the following examples: (1) Groundwater Monitoring Program (see pp. 5-7 and 5-9), (2) Present Landfill (see p. 6-12).

Changes have been made as indicated.

(26.) 8. Throughout the document, selected OUs (namely: 1, 2, 4, 5, 6, 7, 8, and 11) are referred to (see, for example, pp. 6-57/58); areal extents of cited OUs would be helpful to be included on a map included in this report.

A map outlining operable unit boundaries and locations at the Rocky Flats site has been included as Figure 1-2. Text on page 1-2 references the new figure.

(27.) 9. The methodology narrative introducing the "Plates" report volume is quite useful. In general, the consistency in scales and in areal extent for various map plates should be appreciated. One notable exception involved Plates 7 and 22; despite differing areal extents, it was judged that a compatible scale (either 1:2400 or 1:2640) for both would have been preferred. What is the status of Plate 21 (locations of permitted wells; not available for this review)? Will its scale and areal extent be comparable with Plate 21 (aquifer-test location map)?

The Plate 7 scale was changed to 1:2640 and is now compatible with Plate 22. Plate 21 is included in the final report. The aerial extent of Plate 21 is much larger than that of Plate 20. In order to maintain the detailed features of these two maps, the map scales will have to be slightly different.

Specific

(28.) 1. What is the significance of the area delineated in Figure 1-1. It is quite irregular in shape.

The irregular outline of Denver has been deleted from Figure 1-1.

(29.) 2. The review of previous hydrogeologic studies (Section 2 and Appendix A) appeared comprehensive and should be of continuing use for reference purposes.

Comment acknowledged.

(30.) 3. In the lead-in to Section 3, clarification should be made on how this Section complements Sections 4 and 6. This Section more appropriately should be entitled "Hydrologic Setting....". If accepted, this change also applies to Section 1.2 (p. 1.2, line 5 in first paragraph). The average annual precipitation for Rocky Flats should be made consistent: "nearly 15.5 inches" (p. 3-1) versus "approximately 16 inches" (p. 6-14).

The introductory paragraph for Section 3 now includes references to its usefulness in Sections 4 and 6. The section title was not changed. The references to the average annual precipitation are now consistent in the text.

(31.) 4. The variable precision of data values in Section 3 tables were inconsistent and did not appear reasonable (specifically, monthly temperatures to hundredths). Why are Stapleton Airport data for the latter half of 1993 still not available (Table 3-5)? Why are several missing years indicated on Table 3-8? Are the tabular wind-direction results on the bottom of Table 3-10 identical with those given graphically in Figure 3-3? Why are no long-term average relative-humidity and solar values provided (Table 3-11)? Table 3-13 indicates an average relative humidity of nearly 46 percent (multiyear period of record); cannot this apply to Table 3-11? Cannot the pan-evaporation results for Denver be updated (Table 3-12)?

The tables in Section 3 have been edited; temperature values are now reported to the nearest degree. No data are available from Stapleton Airport for the latter half of 1993. All available long-term average winter temperatures at Rocky Flats are reported in Table 3-8. The tabular wind-direction results on the bottom of Table 3-10 are identical with those given graphically in Figure 3-3. The long-term average relative-humidity value is now included in Table 3-11; the long-term average solar total value is not available for the Rocky Flats site. More recent (post-1960) pan evaporation results for Denver are not available.

(32.) 5. Section 4 contains many useful details. See minor editorial or unit-consistency comments noted in the text copy. At this bottom of p. 4-19, what is the cause of the "major groundwater trough"? On the lower half of p. 4-21, the towns of Frederick and Platteville should be located on some map. References are made to EG&G (1993c) (1993 Well Evaluation Report); cannot the final document be used (EG&G, 1994a), thereby

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replacing the earlier draft-final reference citation? The Denver-Basin-aquifer water-quality characterizations provide useful comparisons to Rocky Flats localized conditions (Section 6). The sources for Tables 4-1 and 4-3 should be given. Table 4-2 should be cross-referenced with Plate 21 (missing). Can the coordinates for the "Northwest Subregional Boundary" be given for general reference purposes?

Agreed. The appropriate revisions to the text, tables, and figures have been incorporated.

(33.) 6. Section 5.1.4, The installation/active well/piezometer descriptions given on pp. 5-4 through 5-7 in many instances appear to be inconsistent with either Table 5-1 or Appendix B or both. This need for consistency carries over to the recently updated 1994 GPMPP (see earlier review comments 15 and 16 dated December 12, 1994, regarding the 1994 GPMPP). What was reconciled there should be reflected here, as applicable. Are wells listed chronologically in Appendix B? If not so, what is the rationale for sequencing of these wells. Are the TH-series wells (ending with 92) listed on page 1 of Table B-1 old (pre-1986) or recent (1992)? Why are not the 13 piezometers installed in 1994 not given in Table B-1? Why are 29 monitoring wells (MWs) identified with a "94" ID-ending; whereas, Table 5-1 indicated that 28 wells were installs during 1994? (See text for other examples of discrepancies.)

Discrepancies exist between Table 5-1 and Table B-1 because both tables offer a snapshot in time of the groundwater monitoring program at Rocky Flats. Table 5-1 refers to the status of wells and piezometers as of 3rd Quarter 1994 (refer to footnote in Table B-1). Table B-1 differs slightly from Table 5-1 by including not only installed wells but also proposed wells. Some recent wells without survey coordinates may be excluded from this table. This is footnoted in Table B-1.

The rationale for sequencing wells and piezometers is based on the prefix code followed by a suffix code that designates the year of installation (refer to Section 5.1.1). The TH-series piezometers were installed in 1992.

(34.) 7. On p. 6-3, include reference citations to the annual RCRA reports (Rockwell International, 1986b?; 1988?; EG&G, 1992c; 1993d). Should not in addition the 1993 RCRA report be included (EG&G, 1994b)?

The Annual RCRA Groundwater Monitoring Reports for the Rocky Flats site for 1986, 1988, 1991, and 1992 are cited and referenced. The 1993 Annual RCRA Report was included as a reference.

(35.) 8. Regarding the conceptualized hydrostratigraphic cross-section for OU2 (Figure 6-1); it would be helpful for the reader to have the general areal location indicated on a Rocky Flats site map.

A new figure illustrating the IHSS boundaries color coded by OU is now included as Figure 1-2.

(36.) 9. The compiled hydraulic data (Appendix G) are quite useful. Specifically, Table G-1 summarizes results to date (1994) and carefully references the data source and configuration for each test. Regarding Figure G-5, are these flow-path locations consistent with those discussed in the companion Geochemical Characterization Study (EG&G, 1995b)? Any inconsistencies or discrepancies on this issue should be noted. Is there any rationale for comparative results for contoured sitewide potentiometric-surface maps for unconsolidated surficial deposits (Plates 1 and 2) and for localized weathered-bedrock areas (Figure G-6 for Solar Ponds area and Figure G-7 for Present Landfill area)? Discussion on this latter issue might be helpful (realizing that these aspects are segregated into Sections 6.1.2 and 6.2.2). However, they both comprise the UHSU, and interrelationship discussion is judged relevant.

The flow paths chosen for the seepage velocity calculations have a distinctly different purpose than those chosen for the Groundwater Geochemistry Report. The purpose of the flow paths presented in Figure G-5 is to demonstrate the sitewide variation in seepage velocities in saturated surficial deposits. Therefore, these flow paths are not consistent with those identified in the Groundwater Geochemistry Report which were used to demonstrate the variation in geochemistry in the downgradient direction. The methodologies and objectives of each are clearly explained in the text of both volumes and are clearly self explanatory. However, in order to minimize confusion, a qualifying statement explaining the difference between the two flow paths will be incorporated into the text (p. G-4).

As discussed in Section 6.2.2, the potentiometric surfaces of the unconsolidated surficial deposits and weathered bedrock are compared. This discussion is warranted because both these units compose the UHSU and are generally in hydraulic connection as indicated by the available hydraulic and geochemical data (refer to Sections 6.1 and 6.2).

(37.) 10. At the bottom of p. 6-18, box-and-whisker plots were introduced only briefly. Given their applicability to evaluating outliers, can any more details be given for the indicated results?

Agreed. A general discussion of the outliers identified in the box-and-whisker plots has been added (refer to Sections 6.2.1, 6.2.2, and 6.3.5).

(38.) 11. On pp. 6-26 and 6-41, this reviewer (knowing enough statistics to be dangerous) understands being "skewed" but was snowed by the terms "platykurtic," "mesokurtic," and "leptokurtic" (obviously, dealing with kurtosis characteristics). Can some explanations be provided? P. 6-28 (line 3 from top) refers to Table G-9, which is nonexistent (refer to Figure G-9 or Table 6-8?). ON p. G-7, top line (Appendix G), is not Table G-8 (not Table G-7) being referred to?

The terms platykurtic, mesokurtic, and leptokurtic are now included in the glossary. The reference to Table G-9 has been changed to Table G-8 on page 6-28, and the reference to Table G-7 on page G-7 has been changed to Table G-8.

(39.) 12. On p. 6-27 (first full paragraph, line 3), Figure G-12 (rather than Figure 6-12) is being referred to. Do results of the Geochemical Characterization Study (Volume III) corroborate statements made in this paragraph?

Figure reference has been changed. Statements in this paragraph are based on physical data. Geochemical data have not been studied for evidence of transport mechanisms in the different hydrogeologic regimes. This is a subject for possible future study.

(40.) 13. Are the aquifer test results (Plate 20 and Appendix H) cross-referenced sufficiently? In a random check, this reviewer could not locate well 0887BR on Plate 20; also, some of the leading zeros in well Ids may be missing from the well-location map (Plate 20). Careful scrutiny was conducted regarding a review of the available aquifer tests database (p. H-1), include re-analyses, as needed (Appendix Table G-1). This review was conducted in a technically sound and comprehensive manner, and Appendix H contains many quite useful pumping/bailer-recovery and slug test results for current use as well as for future consideration. Were any multiple tests conducted for the same well location?

Aquifer test results (Plate 21 and Appendix H) were cross-referenced, missing wells were located, and well IDs were corrected. Some multiple tests were conducted on the same well and are included in Table G-1.

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(41.) 14. This reviewer suggests that well-cluster hydrographs (Appendix D) be identified by sequence number (D-1, D-2, etc.) (see example citations on p. 6-28). For well-cluster 45 (as an example, others could be noted), a few "extraneous" water-level readings (outliers?) occur in the Appendix D hydrograph.

Comment was considered and rejected. Referenced hydrograph was evaluated and left unchanged.

(42.) 15. On the bottom of p. 6-43, well-cluster 53 (and not 35 as indicated) is being referred to (see following page and appropriate Appendix D hydrographs).

Changes have been made as indicated.

(43.) 16. The situation of limited UHSU/LHSU hydraulic connection (that is, interaction) is stated several times in not so many different ways (see, for example, pp. 6-44 and 6-48, although the latter is in a summary). This and other redundant aspects could use some "tightening up." In some respects, a circular argument is indicated; these units are not so defined, because of the condition of no or minimal hydraulic connection or interaction?

Agreed. Section 6.4 has been slightly revised to minimize some of the redundancy and to better define the hydraulic interactions between the UHSU and LHSU.

(44.) 17. Regarding seasonal water-level fluctuations (pp. 6-53/54/59), Appendix C includes a large number of groundwater hydrographs. Cannot the text be more specific in this citation. Again, as discussed previously in the case of Appendix D (see ES-14), it would help to identify these by sequence numbers (C-1, C-2, etc.)

The text adequately discusses seasonal water-level fluctuations. The hydrographs in Appendix C have been arranged in a logical order. Hydrographs for specific wells are easily located if the well identification number is known.

(45.) 18. On p. 6-58 (the last line of Section 6.5.6), the EG&G reference citations appear to be incorrect: (1) 1991e is an SOP, and (2) 1992e is nonexistent in Section 8.

References have been changed to DOE 1992 and DOE 1993, respectively.

(46.) 19. In Section 9, the glossary might include statistical terms (see comment #S-11): kurtosis, skewness, platykurtic, mesokurtic, and leptokurtic.

These terms are now included in the glossary.

References

(47.) 1. A couple of citations need to be completed: Bouwer and Rice (p. 8-1); and Hvorslev (p. 8-6).

Citations have been completed.

(48.) 2. This reviewer's recommendation is that personal communications not be included in reference citations: Grigsby, p. 8-6; Lovseth and Robson, p. 8-7; and Smith, p. 8-8. Rather, these should be indicated in the report text, including affiliation (EG&G/USGS) and month and day of the "communication". Is not Rob Smith citing himself (as one who co-authored this document)? The referenced Illsley (1976) letter to Lackey might more appropriately be cited only in the text as a "written commun.," again giving affiliation, month and day.

For simplicity in the text, the personal communications references have been retained in the reference section.

(49.) 3. Regarding the 1993 WER, is not EG&G (1993c) merely a draft-final version of EG&G (1994a)? Assuming that the basic information content is the same; this reviewer recommends omitting the former in preference to the latter.

The reference to the draft final document has been deleted.

(50.) 4. Some authorship acronyms need to be spelled out, for clarification and consistency: (1) cite as EG&G (EG&G Rocky Flats, Inc.); (2) cite as EPA (U.S. Environmental Protection Agency); and (3) cite as ERDA (Energy Research and Development Administration).

Changes have been made to Section 8.

(51.) 5. The ASI (1990), Merrick & Company (1991), a few Rockwell International, and many other EG&G references would benefit by adding information such as: Prepared for whom? Month (and day, if available) of final report? Number of pages or sections?

References are sufficient as presented.

(52.) 6. For consistency, some book titles need to be italicized; see, for example, Mitsch and Gosselink (1986; Fetter (1988); Davis and DeWiest (1966); and Barbour and others (1987). Ditto for technical journals: see, for example, Abriola and Pinder (1982); Jamieson and Steams (1982). Again, for consistency, USGS should be shown in reference citations as U.S. Geological Survey (see, for example, Malde (1955); Hung (1954).

Changes have been made as indicated.

(53.) 7. Should not DOE (1991b) in text (p. 6-5) be DOE (1991), as given in Section 8? Should not DOE (1993a) in Sections 8 and 6.2.1.2 (p. 6-11) be DOE (1993) (referenced throughout Section 6)? There are not multiple DOE references for either the years 1991 or 1993.

Changes have been made as indicated.

COMMENTS FROM GREG LITUS

General Comments

(54.) 1. This document is a very good assessment of all the site-wide and specific hydrologic information available for Rocky Flats. The document is well written and organized and is generally thorough.

Comment acknowledged.

(55.) 2. The site hydrogeologic setting of Rocky Flats is adequately described by focusing on the facility and the data collected here. The comparative data presented in Section 3 does not provide any added value to the assessment of Rocky Flats.

Comparative data from Stapleton are presented to show that general climatological trends at RFETS are similar to those at a station in the same area. In addition, Stapleton has a longer, more complete record.

(56.) 3. Section 4, Regional Hydrogeology, is not definitively tied to Rocky Flats. There needs to be a clear connection between the extensive discussion on off-site hydrogeology and Rocky Flats. Otherwise, the reader is left wondering why information on the Dawson Formation even included. A focus on the importance of Rocky Flats within the regional system may lead to a reduction in some of the extraneous information presented in this section.

The introductory paragraph for Section 4, Regional Hydrogeology, adequately describes the purpose of the section and indicates that an

understanding of the regional setting is essential in understanding the local (Rocky Flats) setting.

Specific

(57.) 1. Section 2. Reports that were not reviewed for this document, and especially reports that cannot be located should not be included in the references.

Appendix A is a comprehensive bibliography of documents and reports pertaining to Rocky Flats hydrogeology; references used in writing this report are included in Section 8. These are two separate reference lists that serve different purposes. Reports that were not used or reviewed for use in the document and reports that could not be located were not included in Section 8.

Since the method and results of the literature search is presented is such detail, gaps in the search stand out. DOE publications from the national laboratories may be a source of additional information that was not researched. In addition, the reference section only includes two journal articles. I find it hard to believe that a thorough literature review does not include a significant base of information from the peer reviewed literature.

The literature search that was conducted as part of this report was thorough and focused on references pertaining to the hydrogeology of the Rocky Flats site and vicinity. DOE publications from the national laboratories were not researched because these were thought to be unlikely sources of information on Rocky Flats hydrogeology. Further, a peer-reviewed literature search was conducted. This search yielded only two journal articles pertaining to Rocky Flats hydrogeology; these are included in Appendix A.

(58.) 2. Section 3.1.1. I do not believe that the comparison to Stapleton Airport is relevant to this report. The fact that complete 1993 data is not available for a 1995 report further questions the merits of this comparison.

Comparison of Stapleton Airport climatological data to Rocky Flats climatological data is relevant to this report because the airport data provide the best regional database and show the regional trends. More data are available from the Stapleton Airport station. The data are included in this report to supplement the Rocky Flats data.

(59.) 3. Section 3.2. A draft version of the U.S. Army Corp of Engineers, Rocky Flats Plant Wetlands Mapping and Resource Study was available in the summer of 1994. That document is currently final and is the most

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comprehensive delineation of wetlands on the site. The absence of the information contained in the Corp study is a serious deficiency in this report.

The final version of the Corps Wetlands Mapping and Resource Study was issued in December 1994 followed by a final ARCINFO version of the wetlands map in late February 1995. While we agree that the report contains information relevant to the hydrogeology of the site, this information was received too late to be incorporated effectively into the Hydrogeologic Characterization Report. References to the report have been added to the text in areas related to vegetation and seepage.

(60.) 4. Section 4.1.1, second paragraph. This comment supports the general comment #3. Without a clear discussion of the relationship between Rocky Flats and the regional hydrogeology, the information presented in this section is misleading. I do not believe that conditions in the Denver Formation 7 miles to the southeast has any relationship to Rocky Flats. The text leads the reader to believe that there is some connection. If there is a connection, it should be clearly described.

See comment reference 56.

(61.) 5. Description of specific hydrogeologic conditions as far away as Greeley do not add any value to this report. This type of information should be critically reviewed for removal from the report.

See comment reference 56.

(62.) 6. Section 6.1, second paragraph. This paragraph should be removed. While the general settings at these sites may be similar, the specific hydrogeologic conditions are in no way similar to Rocky Flats.

The paragraph has been removed from the text.

(63.) 7. Page 6-14, last paragraph. Rocky Flats Lake and the clay pits are not part of Rocky Flats. The connection between water control modifications west of the facility and Rocky Plats groundwater should be clearly explained.

The text has been changed to say that Rocky Flats Lake and the clay pit are not part of the Rocky Flats site but that they are upgradient of the site and do provide recharge to the UHSU.

(64.) 8. Section 6.2.1.4, third paragraph. A seep between B1 and OU2 is mentioned in the text and shown on Plate 8. However, the wetland delineation performed by the Corp does not show any seep in this area. I am not familiar with any seep in this area but the current snow conditions preclude a "ground

truthing" of this location. This is an excellent example of the contradiction between the work performed by the Corp and this report.

The references to seepage above Pond B-2 are erroneous and have been changed to Pond B-1. Contradictions between the Corps study and report text and Plate 9 (formerly Plate 8), such as the seepage area between Pond B-2 and OU2, are known to exist but cannot be resolved fully using the current database. These discrepancies result partially from the different methods used to construct the maps and partially from differences in mapping objectives. It must be remembered that the purpose of the Corps report and map was to identify and classify wetlands which, while encompassing the majority of seepage areas, does not directly coincide with the purpose of a seep map. For example, there are many wetland areas delineated in the Corps work that are not seeps (i.e., riverine, lacustrine and certain palustrine wetlands). Conversely, the Corps wetlands study apparently omits some well-known and hydrologically important seepage areas, including all seeps uphill of the SID on the OU1 and OU2 hillsides, the OU4 seeps, various small seeps downhill of the SID between Ponds C-1 and C-2, and other small seeps in the Walnut Creek drainage, to name a few. Resolution of these discrepancies is out-of-scope under the current hydrogeologic report contract but will be addressed under the scope of the Seepage Characterization project (an edited version of the Corps wetlands map will be produced specifically for seepage locations).

(65.) 9. Page 6-46, first paragraph. This estimated movement of contamination is based on typical modeling assumptions that are not representative of actual field conditions. The seepage velocity estimates mean very little unless empirical data can support the results. I recommend expanding this section to look at actual contaminant data that will either support or reject the velocity estimate.

The seepage velocity estimate was based on actual field observations. The vertical saturated hydraulic conductivity value (geometric mean) was obtained from measured permeameter tests (refer to p. 6-45, 4th paragraph, and Table G-3). The hydraulic gradient of 1.00 (ft/ft) was calculated from observed potentiometric data at Well Cluster #42 (Table D-1). The effective porosity value of 0.10 is within the range of Rocky Flats site-specific values for bedrock (0.10 to 0.15) as reported by Hurr (1976). These data represent a conservative estimate of the downward movement of contaminants into the LHSU, which provides the reader with a conceptual understanding of the effectiveness of the LHSU as a hydraulic barrier to vertical flow. Given the context in which the estimated seepage velocity was presented, a more detailed discussion of observed well concentrations is not warranted.

(66.) 10. Page 6-46, last equation. Add the superscript for tritium.

Changes have been made as indicated.

(67.) 11. Section 6.5.6, second paragraph. This discussion on seep flow does not address the complexity of the seep complexes that exist at Rocky Flats. The discussion is limited to an interpretation of excess water in the seep complexes and does not consider the role of vegetation in seep water consumption. For example, many of the seeps do flow in the fall as soon as the plant communities become dormant and excess water is no longer transpired by the vegetation. Summer seep flows, while less than in the spring, are still significant but do not produce excess water that can be measured easily.

Information regarding the role of vegetation in seep water consumption has been incorporated into the text.

(68.) 12. Plate 8. This map is not consistent with the wetland delineation performed by the Corp. The Corp performed a detailed survey of the entire facility and produced a definitive inventory of all the wetlands based on vegetation type. The locations and extent of these wetlands were mapped using a portable GPS data logger. For these reasons I believe that Corp's work should be used as the primary reference on seep locations and type. Any discrepancies on Plate 8 should be adjusted to reflect the Corp wetland delineation. I cannot overemphasize the importance of improving Plate 8 to the quality of the Corp work. In fact, Plate 8 should be replaced by the composite wetland delineation map that is available on ArcInfo.

It is agreed that seepage boundaries for slope wetlands in the Corps map are more accurately defined than in Plate 9 (formerly Plate 8). However, this advantage is offset by the problems associated with the wetlands map described in comment reference 64. Plate 9 was developed specifically to locate known and probable seep areas related to groundwater discharge. As the Corps map technically defines wetland areas rather than seeps and omits several important seepage areas, Plate 9 has been retained in the report as the best available seep map, despite any shortcomings created by uncertainties related to the definition of individual seep boundaries. Again, this problem will be resolved with the development of a new sitewide seep map under the Seepage Characterization project.