Department of Energy
Washington, DC 20585

FEB 5 1993

Mr. Joseph J. Holonich, Director
Repository Licensing & Quality Assurance
Project Directorate
Division of High-Level Waste Management
Office of Nuclear Material Safety
and Safeguards
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Reference: Ltr, Roberts to Holonich, dtd 12/17/92

Dear Mr. Holonich:

The transmittal of Study Plan 8.3.1.9.2.1, "Natural Resource Assessment of Yucca Mountain, Nye County, Nevada," provides the basis to explicitly address the following Site Characterization Analysis (SCA) open items: Comment 53, Question 14 and Question 15. The administrative record for these open items in Enclosure 1, 2, and 3 consists of: (1) the U.S. Department of Energy's (DOE) December 14, 1990, SCA responses, (2) the U.S. Nuclear Regulatory Commission's July 31, 1991, evaluation of these responses, and (3) an updated response with further explanation or additional information to resolve the open items.

On the basis of the information in Enclosure 1, 2, and 3, DOE regards these three SCA open items as resolved.

If you have any questions, please contact Mr. Chris Einberg of my office at 202-586-8869.

Sincerely,

John P. Roberts
Acting Associate Director for
Systems and Compliance
Office of Civilian Radioactive
Waste Management

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Enclosures:
1. Administrative Record for SCA Comment 53
2. Administrative Record for SCA Question 14
3. Administrative Record for SCA Question 15

cc: w\enclosures
C. Gertz, YMPO
R. Loux, State of Nevada
T. Hickey, Nevada Legislative Commission
M. Baughman, Lincoln County, NV
J. Bingham, Clark County, NV
B. Raper, Nye County, NV
P. Niedzielski-Eichner, Nye County, NV
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J. Pitts, Lincoln County, NV
R. Williams, Lander County, NV
J. Hayes, Esmeralda County, NV
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ENCLOSURE 1

SCA Comment 53 and DOE Response (12/14/92)

NRC Evaluation of DOE Response (7/31/91)

Additional Information Relevant to SCA Comment 53 Open Item

Section 8.3.1.9.1 Study: Natural resource assessment of Yucca Mountain, Nye County, Nevada

COMMENT 53

The program of investigations for natural resources assessment as presented in the SCP appears to be unsatisfactory for consideration of potential natural resources and natural resource models at the site.

BASIS

- This comment addresses concerns expressed in unresolved CDSCP Comments 38 and 39.

- Although conceptual models directed toward natural resource occurrence in tuffs have now been considered in the SCP, alternative resource models to include hosts other than tuffs appear not to be considered. For example, the resource assessment program does not specifically provide for testing structures as potential ore hosts, nor does it provide for testing of possible tactites on the margin of the hypothesized Crater Flat caldera complex.

- The suite of elements selected for analysis in the geochemical sampling program is limited to those commodities known to exist in silicic tuff (p. 8.3.1.9-30) and excludes those elements or commodities associated with resources in tactites (skarn), carbonate and other sedimentary rocks, and possible plutonic rocks that may be present beneath the site.

- Proposed investigations still appear to lack integration with other geological, geophysical, and geochemical investigations and pre-existing data. No geophysical investigations directed toward natural resources assessment and evaluation appear to be considered as recommended in CDSCP Comment 39. Results of geologic/geophysical activities planned for other purposes may provide a portion of the information to delineate areas for more detailed study.

- Drillholes proposed for other tests may not uniformly cover the controlled area and may not be directed at or intersect features favorable to mineralization such as high-angle fault zones, detachment zones, or veins. Drillholes as planned may not be favorably placed or extend to the depth necessary to provide sufficient information to assess resource potential of pre-Cenozoic rocks and volcanic rocks underlying the proposed repository. A large degree of uncertainty exists that vertical drill holes would intersect vertical to near vertical faults or mineralized zones (see Comment 34).

- Mineral and/or hydrocarbon resource potential of pre-Cenozoic rocks cannot be adequately assessed based on surface samples. Drillholes that penetrate the Paleozoic rocks, postulated detachment zone (Scott, 1986), and lowermost volcanic rocks are necessary to test for possible mineral resources in light of gold discoveries and mines near Yucca Mountain associated with low-angle faulting, Paleozoic rocks, and the lower Tram Member of the Crater Flat Tuff (Sterling Mine at Bare Mountain, Bullfrog District, and GEXA gold claims in northern Crater Flat).

- Information in Chapter 1 and Section 8.3.1.9.2.1 does not reflect recent publications, models, and discoveries (see NRC, 1986 and CDSCP Comment 38; see information in Raney, 1988 and Price, 1988). Reliance has been placed on out-of-date models, parameters (production figures in dollars rather than in tonnage and grade), and references (e.g., McKee, 1979 and Hewitt, 1968).

RECOMMENDATION

Consider and develop a program of planned technical procedures which demonstrate integration and application of geological, geochemical, and geophysical studies in support of the resource assessment investigations, as well as those to be employed in the probability estimation of unidentified resources.

REFERENCES

Hewitt, W.P., 1968, Western Utah, eastern and central Nevada, in Ore Deposits in the United Sates, 1933-1967, Part B: Utah and Nevada, J.D. Ridge ed.: American Institute of Mining Engineers, New York, N.Y., p. 857-885.

McKee, E.H., 1979, Ash-flow sheets and calderas: their genetic relationship to ore deposits in Nevada: Geological Society of America Special Paper 180, p. 205-211.

NRC, 1986, NRC staff comments on the DOE final environmental assessments.

Price, J.G., 1988, Letter to Carl Gertz on review of Raney, 1988, dated October 25, 1988.

Raney, R.G., 1988, Ash-flow sheets and calderas: their relationship to ore deposits in Nevada, by E.H. McKee -- a review of the paper and of its application in an assessment of the resource potential at a proposed high-level waste repository, Yucca Mountain, Nye County, Nevada: document review prepared for the NRC by U.S. Bureau of Mines, FIN D1018.

Scott, R.B., 1986, Extensional tectonics at Yucca Mountain, southern Nevada: Geological Society of America Abstracts with Programs, v. 18, no. 5, p. 411.

RESPONSE

Concerns raised in this comment will be addressed in Study Plan 8.3.1.9.2.1 (Natural Resource Assessment of Yucca Mountain, Nye County, Nevada). An initial preliminary draft of this study plan is currently being reviewed. In general, the study plan will include discussions of rock types to be studied, sampling, geochemical analyses, integrated geological and geophysical activities and mineral deposit models.

REFERENCES:

DOE (U.S. Department of Energy), 1990. Study Plan 8.3.1.9.2.1, Revision 0, Natural Resource Assessment of Yucca Mountain, Nye County, Nevada. Yucca Mountain Site Characterization Project Office, Las Vegas, Nevada. (In Preparation)

Section 8.3.1.9.2 Study: Natural resource assessment of Yucca Mountain, Nye County, Nevada

SCA COMMENT 53

The program of investigations for natural resources assessment as presented in the SCP appears to be unsatisfactory for consideration of potential natural resources and natural resource models at the site.

EVALUATION OF DOE RESPONSE

- DOE indicates that (1) the multiple concerns identified in this comment will be addressed in Study Plan 8.3.1.9.2.1 (Natural Resource Assessment of Yucca Mountain, Nye County, Nevada) and that (2) the study plan is in preparation.

- Based upon DOE's logic diagram for Study Plan 8.3.1.9.2.1 (SCP Figure 8.3.1.9-3, p. 8.3.1.9-22) it is clear that the response to this comment will be dependent upon DOE's completion of not only the above study plan, but numerous supportive studies and investigations.

- Based upon the descriptions of the studies and activities shown on the above logic diagram (SCP Figure 8.3.1.9-3) it is not clear that the concerns raised in this NRC question will be addressed fully.

- Notwithstanding the studies and investigations identified in the logic diagram, DOE indicates (Activity 8.3.1.8.5.2.3, SCP p. 8.3.1.9-35) that even more activities are required to support the Natural Resources Assessment of Yucca Mountain study plan than those indicated on the logic diagram.

- Closure of this comment must await staff evaluations of Study Plan 8.3.1.9.2.1 and other relevant study plans and investigations such as those identified by the staff through its evaluation of Comment 34.

- The NRC staff considers this comment open.

Supplemental Response to SCA Comment 53 Open Item

1) Structures as potential ore hosts; and the testing of tectites on the margin of the hypothesized Crater Flat caldera complex

As described in Section 3.2.1 of Study Plan 8.3.1.9.2.1, the major emphasis of the mineral resource study will be placed on identifying rock types, depositional environments, mineral associations, and tectonic and volcanic settings that are favorable for, or indicative of, the formation of mineral deposits. All existing geologic, geophysical, and geochemical data, as well as new data and field mapping from other site characterization studies (e.g., Study 8.3.1.4.2.1 and 8.3.1.4.2.2), will be used in the evaluation. Particular attention will be given to geophysical boundaries associated with faults and lithologic variations in bedrock. The possible presence of faults, including detachment and thrust faults, and (or) a metamorphic core complex beneath Yucca Mountain and their significance to ore-forming processes will also be evaluated. Maps, cross sections, and other graphic materials will be prepared to portray geologic structure and stratigraphy and the type and extent of identified or inferred zones of alteration and mineralization.

There are no current plans in the integrated drilling program (Activity 8.3.1.4.1.1) for a borehole specifically to test the presence of contact metamorphism around the hypothesized Crater Flat caldera complex. If evidence of contact metamorphism is forthcoming from current mapping near what would be the eastern limb of this hypothetical structure, (Studies 8.3.1.4.2.1, 8.3.1.4.2.2, and 8.3.1.17.4.5), then such evidence can be factored into final siting criteria for presently planned drillholes.

With respect to adequate characterization of near-vertical structural features containing possible mineralization, the penetration of major fault zones to the east of, and within, the potential repository block is accommodated by the amount and type of data that can be acquired directly from underground exposures in the Exploratory Studies Facility. Underground access provides the opportunity to directly sample rocks at the location of vertical discontinuities.

2) Analytical geochemical sampling

Planned analytical testing for samples is expected to provide quantitative and semi-quantitative geochemical data on all of the elements of interest in assessing the mineral potential of Yucca Mountain. As explained in Section 3.1.5 of Study Plan 8.3.1.9.2.1, induction-coupled plasma atomic emission spectroscopy uses a standard analytical package to test 44 elements at moderate to low concentrations.

3) Integration of Study 8.3.1.9.2.1 with other geological, geophysical, and geochemical investigations

Coordination of this study with other, closely related studies in the site characterization program is referenced in sections 2.2, 3.2, 4.0 and 5.0 of Study Plan 8.3.1.9.2.1. Table 5-1 indicates data outputs from 8.3.1.9.2.1 to other studies and data inputs from other studies to 8.3.1.9.2.1, and is especially relevant. With respect to geophysical aspects of the mineral resource study, Section 3.2.1 of Study Plan 8.3.1.9.2.1 explains those geophysical investigations that are specifically part of this study, and how the objectives of this study are impacted by application of geophysical tools and techniques planned for other studies.

4) Assessment of mineral/hydrocarbon potential of pre-Cenozoic rocks

Proposed boreholes G-5, -6, and -7 have been proposed to be drilled to depths that will penetrate the Cenozoic/Paleozoic contact zone (detachment fault?) as well as substantial thicknesses of the Paleozoic strata; pertinent discussions are found in Sections 2.1.2.1, 2.4.2.2, and 3.1.1.1 of Study Plan 8.3.1.9.2.1.

As indicated in Section 3.1.1.1, sampling for geochemical analyses will not be restricted to the volcanic tuffs within the potential repository area, but will include rock types from the surrounding areas. This is particularly so for those areas with potential or suspected mineralization and from prospects, and currently or previously active mines.

With respect to the study of potential petroleum source rocks, outcrop samples of Paleozoic carbonate and clastic rocks will be obtained from adjacent areas such as Bare Mountain, Calico Hills, Bullfrog Hills, and the Mine Mountain-Syncline Ridge area, and possibly from still more distant areas (see Section 2.4.2.2 of Study Plan 8.3.1.9.2.1).

5) Conceptual models

In Section 3.5.1 of Study Plan 8.3.1.9.2.1, it is stated that analog environments of known mineral deposits will be compared with the geological, geochemical, and geophysical characteristics of the potential site area. To the extent possible, analogs will be selected that consist of comparable structures, rock types, and other features which originated under similar geologic conditions in the surrounding regions.

ENCLOSURE 2

SCA Question 14 and DOE Response (12/14/92)

NRC Evaluation of DOE Response (7/31/91)

Additional Information Relevant to SCA Question 14 Open Item

Section 8.3.1.9 Human Intrusion

Section 1.6.1 Drilling and Excavation History

QUESTION 14

The SCP does not appear to consider historical records of claims and/or leases in its evaluation of previous drilling or excavation at Yucca Mountain. What consideration has been given to historical maps and claim and lease information in establishing the position that "no further investigation of previous drilling or mining is needed" (p. 1-213) in the proposed repository area?

BASIS

o The statement that "all known drilling within 10 km of the perimeter drift outline has been under the control of either the Nevada Test Site Office or the Nuclear Rocket Development Station" (p. 1-213) is misleading. The crest of Yucca Mountain and the area to the west of the mountain are not under the control of those two entities.

o Excavation and/or drilling may have occurred in the Yucca Mountain area prior to the withdrawal of the land to the east of the mountain crest for establishment of the NTS in the 1940s.

o An early 1900s map of Nevada (Clason Map Company, 1906) shows a possible mining area on the east flank of Yucca Mountain.

o Mapping or surface inspection may not delineate relatively inconspicuous surface disturbances (e.g., drilling).

RECOMMENDATION

Prior to the evaluation that "no further investigation of previous drilling or mining is needed" at the Yucca Mountain site, a thorough search of historical information pertinent to the evaluation should be made.

REFERENCES

Clason Map Company, 1906, Map of Nevada and the southeastern portion of California, Denver, Colorado.

RESPONSE

In a preliminary draft of Study Plan 8.3.1.9.2.1 (Natural Resource Assessment of Yucca Mountain, Nye County, Nevada,) the geochemical, geological, and geophysical activities will include sampling, analyses, and investigations of areas surrounding Yucca Mountain, including: 1) Areas with potential or suspected mineralization; 2) prospects; and 3) currently or previously active mines. This evaluation will include an assessment of pertinent historical information.

REFERENCES:

DOE (U.S. Department of Energy), 1990. Study Plan 8.3.1.9.2.1, Revision 0, Natural Resource Assessment of Yucca Mountain, Nye County, Nevada. Yucca Mountain Site Characterization Project Office, Las Vegas, Nevada. (In Preparation)

Natural Resource Assessment of Yucca Mountain, Nye County, Nevada, YMP-xxxx, SP 8.3.1.9.2.1, Rxx, [status/date]

Section 8.3.1.9 Human Intrusion

Section 1.6.1 Drilling and Excavation History

SCA QUESTION 14

The SCP does not appear to consider historical records of claims and/or leases in its evaluation of previous drilling or excavation at Yucca Mountain. What consideration has been given to historical maps and claim and lease information in establishing the position that "no further investigation of previous drilling or mining is needed" (p. 1-213) in the proposed repository area?

EVALUATION OF DOE RESPONSE

- DOE indicates that the natural resources assessment program, Study Plan 8.3.1.9.2.1 (Natural resource assessment of Yucca Mountain, Nye County, Nevada), now in preliminary draft stage, will respond to this question by addressing pertinent historical information, including prospects and currently or previously active mines.

- Based upon DOE's logic diagram for Study Plan 8.3.1.9.2.1 (SCP Figure 8.3.1.9-3, p. 8.3.1.9-22), and upon DOE's indications (Activity 8.3.1.8.5.2.3, SCP p. 8.3.1.9-35) that even more activities are required to support the natural resources assessment of Yucca Mountain study plan than those indicated on the logic diagram, it is clear that the response to this question will be dependent upon DOE's completion of not only the above study plan, but numerous supportive studies, investigations, and technical procedures.

- The response did not provide any new information specifically addressing the bases of this question.

- Closure of this question must await NRC staff evaluation of Study Plan 8.3.1.9.2.1 and other relevant study plans.

- The NRC staff considers this question open.

Additional Information Relevant to SCA Question 14 Open Item

1) Use of historical data

By direct statements and strong inference in Sections 3.1.1.1 and 3.2 of Study Plan 8.3.1.9.2.1, data bearing on all currently or previously active mines and prospects in and surrounding the potential site area will be evaluated during the course of the mineral resource studies; all available information bearing on past mineral exploration and development activities will be utilized. See, for example, Bergquist and McKee (1991).

The quoted statement from SCP p. 1-213 "No further investigation of previous drilling or mining is needed", is not an accurate portrayal of the work that is being conducted. Evidence germane to the mineral resources assessment study is able to be gathered in ongoing and future work as part of several surface mapping activities (e.g. 8.3.1.4.2.2.1, 8.3.1.4.2.1.1, 8.3.1.5.1.4.2, and 8.3.1.17.4.5.2). These mapping activities use U.S. Geological Survey technical procedure GP-01 "Geologic Mapping". In Section 4.5.1 of GP-01, revision 2, the following criteria are to be met in producing all general purpose geologic maps, "4) [the plotting of all] mines, prospects, quarries, wells, trenches, test pits, and drill holes".

2) Coordination with other studies using previous drillhole data

As indicated in Sections 2.1.1.1, 2.3, 3.2.1, Figure 5-1 and Table 5-1 of Study Plan 8.3.1.9.2.1, there will be close coordination and sharing of information between the mineral resource study and numerous other studies in the site characterization program. This includes the use of all pertinent geological, geophysical, and geochemical data resulting from studies of previous drilling in the study area. Table 5-1 is especially relevant for indicating the outputs from study 8.3.1.9.2.1 to other studies and the data inputs from other studies to 8.3.1.9.2.1.

REFERENCE

Bergquist, J.R. and E.H. KcKee, 1991. Mines, Prospects, and Mineral Occurrences in Esmeralda and Nye Counties, Nevada, Near Yucca Mountain. U.S. Geological Survey Administrative Report to the U.S. Department of Energy Yucca Mountain Project.

Provided to NRC via letter (Roberts to Holonich, dtd., 6/19/92)

ENCLOSURE 3

SCA Question 15 and DOE Response (12/14/92)

NRC Evaluation of DOE Response (7/31/91)

Additional Information Relevant to SCA Question 15 Open Item

Section 8.3.1.9.2.1 Study: Natural resource assessment of Yucca Mountain, Nye County, Nevada

QUESTION 15

What is the basis for SCP statements with respect to resource exploration and mineral resource potential? The following statements are inconsistent and/or fail to consider or integrate alternative information.

BASIS

o The conclusion that "on the basis of currently available data and regional comparisons, the mineral resource potential of the site is considered low" (p. 8.3.1.9-31) is not justified in the SCP. It appears to be in error, because the site's mineral resource potential may be perceived as high. For example, Yucca Mountain is surrounded by mineralized areas such as Bare Mountain, Wahmonie, and Calico Hills (NRC, 1986) and is in proximity to faults, breccia zones, and veins and overlies zones that may host resources (e.g., Tram Member of the Crater Flat Tuff).

o The statement that it is "standard practice to exclude evaluation of mineral resources below 1 km" (p. 1-258) is without merit. There are precedents in the literature for resource exploration at depths greater than 1 km (Mining Ann, Rev., 1987). Deposits at depth, whether large tonnage or high-grade or not, may be economic at higher, but reasonable, values (i.e., $1,000/oz gold is not inconceivable; gold prices reached $800/oz in 1980).

o The SCP (p. 1-258) states that evaluation of hypothetical resources in the Paleozoic rocks cannot be accomplished due to the "constraints" of depth. However, on page 1-280 it is stated, "Exploration for precious metals in a deeply buried Paleozoic terrain, such as at Yucca Mountain, cannot be dismissed."

RECOMMENDATION

Resolve inconsistencies and consider and integrate alternative information that may be relevant to the program to address the potential for mineral resources at the proposed HLW site.

REFERENCES

Mining Annual Review, 1987, Mining Journal, London, p. 389.

RESPONSE

A recently prepared study plan for Study Plan 8.3.1.9.2.1 (Natural Resource Assessment of Yucca Mountain, Nye County, Nevada), states the following:

1. Modeling will be undertaken to provide probabilistic, quantitative estimates of the mineral endowment of the area by considering both discovered and undiscovered mineral resources, including resources that may not be presently economic.

2. The only types of mineral deposits eliminated from serious consideration are those types involving geologic conditions not present in the Yucca Mountain area (e.g., conditions favoring massive sulfide or Bushveld-type deposits) and those resources whose concentrations, based on geochemical analyses, are found to be present in no more than average crustal abundances.

Depth is not treated as a limiting factor in these considerations.

REFERENCE:

DOE (U.S. Department of Energy), 1990. Study Plan 8.3.1.9.2.1, Revision 0, Natural Resource Assessment of Yucca Mountain, Nye County, Nevada. Yucca Mountain Site Characterization Project Office, Las Vegas, Nevada. (In Preparation)

Section 8.3.1.9.2.1 Study: Natural resource assessment of Yucca Mountain, Nye County, Nevada

SCA QUESTION 15

What is the basis for SCP statements with respect to resource exploration and mineral resource potential? The following statements are inconsistent and/or fail to consider or integrate alternative information.

EVALUATION OF DOE RESPONSE

- DOE indicates that Study Plan 8.3.1.9.2.1 (Natural resource assessment of Yucca Mountain, Nye County, Nevada), now in preliminary draft stage, will respond to this question by addressing (1) appropriate modeling wherein both discovered and undiscovered mineral resources, including those that may not be presently economic, will be considered and (2) by not restricting DOE's mineral resource evaluations to within one kilometer of the earth's surface.

- Based upon DOE's logic diagram for Study Plan 8.3.1.9.2.1 (SCP Figure 8.3.1.9-3, p. 8.3.1.9-22), and upon DOE's indications (Activity 8.3.1.8.5.2.3, SCP p. 8.3.1.9-35) that even more activities are required to support the natural resources assessment of Yucca Mountain study plan than those indicated on the logic diagram, it is clear that the response to this question will be dependent upon DOE's completion of not only the above study plan, but numerous supportive activities, investigations, and technical procedures.

- The response provided no new information addressing the first basis point for this question, which questioned the SCP conclusion that "on the basis of currently available data and regional comparisons, the mineral resource potential of the site is considered low."

- Closure of this question must await NRC staff evaluation of Study Plan 8.3.1.9.2.1 and other relevant study plans.

- The NRC staff considers this question open.

Additional Information Relevant to SCA Question 15 Open Item

1) Program for assessing natural resources in Study 8.3.1.9.2.1

The SCP statement (p. 8.3.1.9-31), "on the basis of currently available data and regional comparisons, the mineral resource potential of the site is considered low", is based on the fact that there is no known field evidence of ore mineralization at Yucca Mountain. Such is the basis for the SCP statement (see also Study Plan 8.3.1.9.2.1, Section 3.2.5, p. 3-8). The DOE also understands the basis of the NRC staff's perception.

The objective of Study Plan 8.3.1.9.2.1 is to conduct a broadly based, comprehensive, and objective program for assessing the natural resource potential of the Yucca Mountain area. All pertinent geologic factors will be taken into account (including Yucca Mountain's proximity to other mineralized areas and the presence of faults and other potentially mineralized zones -- see, for example, Section 3.2.1), and no assumptions are being made in advance of the planned studies as to the nature of the evidence that will be found with regard to the presence or absence of mineral deposits. The quotation from SCP p. 1-258, that it is "standard practice to exclude evaluation of mineral resources below 1 km", is a common operational standard for the industry, but it is not meant to be a statement expressing a limitation for the DOE's natural resources assessment. There are geophysical techniques planned to be employed that will provide data regarding mineral resource potential at depths exceeding 1 km. Section 3.2.5 of Study Plan 8.3.1.9.2.1 identifies these techniques. These techniques would be in addition to the proposed drillholes G-5 -6, and -7 that would penetrate the Paleozoic-Tertiary contact.

The depth "constraint" (SCP p. 1-258) is not really a constraint but, as stated above, is more of an operational standard or practice. The statement on SCP p. 1-280 is true, it cannot be "dismissed". The statement forms part of the basis for conducting the natural resource assessment study.

2) Coordination with other SCP supporting activities

As indicated in sections 2.1.1.1, 2.3, 3.2.1, Figure 5-1 and Table 5-1 of Study Plan 8.3.1.9.2.1, there will be close coordination and sharing of information between the mineral resource study and numerous other studies in the site characterization program. This includes the use of all pertinent geological, geophysical, and geochemical data resulting from studies of previous drilling in the study area. Table 5-1 is especially relevant for indicating the outputs from study 8.3.1.9.2.1 to other studies and the data inputs from other studies to 8.3.1.9.2.1.