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TECHNICAL MEMORANDUM NO. 3 TO FINAL PHASE I RFI/RI WORK PLAN ENVIRONMENTAL EVALUATION

ROCKY FLATS PLANT
SOLAR EVAPORATION PONDS
(OPERABLE UNIT NO. 4)

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

EG&G ROCKY FLATS, INC.
ENVIRONMENTAL RESTORATION MANAGEMENT

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TABLE OF CONTENTS

<u>Section</u>	<u>Page</u>
EXECUTIVE SUMMARY	v
1.0 INTRODUCTION	1-1
2.0 APPROACH	2-1
3.0 SITE DESCRIPTION	3-1
3.1 <u>TERRESTRIAL ECOSYSTEMS</u>	3-2
3.2 <u>AQUATIC HABITAT</u>	3-4
3.3 <u>BIOTA</u>	3-4
3.4 <u>WETLANDS</u>	3-5
3.5 <u>SPECIES OF CONCERN AND HABITATS</u>	3-5
4.0 ECOLOGICAL FIELD SURVEYS (STAGE 1 TASKS)	4-1
4.1 <u>SPECIES OF CONCERN COMPLIANCE LIST</u>	4-2
4.2 <u>LITERATURE REVIEW AND CONSULTATIONS</u>	4-2
4.3 <u>HABITAT PRESENCE VERIFICATION</u>	4-3
4.4 <u>ANIMAL SPECIES SURVEYS</u>	4-3
4.5 <u>VEGETATION SURVEYS</u>	4-5
4.6 <u>DOCUMENTATION</u>	4-5
5.0 ECOTOXICOLOGICAL INVESTIGATION (STAGE 2 TASKS)	5-1
5.1 <u>INVESTIGATIVE TASKS</u>	5-1
5.1.1 <u>Conceptual Exposure Model</u>	5-2
5.1.2 <u>Conceptual Biota Transport Model</u>	5-3
5.1.3 <u>Selection of Contaminants of Concern</u>	5-4
5.1.4 <u>Target Taxa</u>	5-5
5.2 <u>FIELD SAMPLING PLAN</u>	5-7
5.2.1 <u>Site Description</u>	5-8
5.2.1.1 Study Site Detail	5-8
5.2.1.2 Reference Site Detail	5-8
5.2.2 <u>Objectives</u>	5-8
5.2.3 <u>Habitat and Taxa Specific Sampling</u>	5-9
5.2.3.1 Terrestrial Sampling	5-10
5.2.3.2 Vegetation	5-10
5.2.3.3 Small Mammals	5-12
5.2.3.4 Large Mammals	5-14
5.2.3.5 Soil Sampling	5-16
5.2.4 <u>Schedule</u>	5-17
5.3 <u>LABORATORY ANALYSIS</u>	5-17
5.4 <u>ECOLOGICAL RISK ASSESSMENT</u>	5-19
5.4.1 <u>Remediation Criteria</u>	5-20
5.4.2 <u>Operable Unit Coordination</u>	5-20
6.0 REFERENCES	6-1

TABLE OF CONTENTS
(continued)

LIST OF TABLES

<u>Table No.</u>	<u>Title</u>
4-1	General List of Species of Concern for the RFP
5-1	Summary of Field Sampling Activities for Terrestrial Biota for OU4
5-2	Field Sampling Schedule 1993 - OU4

TABLE OF CONTENTS
(continued)

LIST OF FIGURES

<u>Figure No.</u>	<u>Title</u>
3-1	OU4 and EE Study Area Boundaries
5-1	Industrial Area Conceptual Exposure Model
5-2	Preliminary Sampling Locations for OU4 Environmental Evaluation

EXECUTIVE SUMMARY

The Solar Evaporation Ponds, Operable Unit No. 4 (OU4) is located mostly within the industrial area at the Rocky Flats Plant (RFP). The Environmental Evaluation for OU4 was to be consolidated with the EE for Operable Unit No. 9 (OU9). However, the work planned for OU9 has been postponed, necessitating this Environmental Evaluation Technical Memorandum (EETM) to address OU4 specifically. The industrial area of RFP has been developed to the point where only fragmented biotic populations and nonfunctional ecosystems, that have originated on bare soil surfaces since construction, currently exist in the area. This EETM has been prepared to describe the Environmental Evaluation (EE) scope with requirements that are proportional to the depleted and newly developing ecosystems under consideration. This EETM is an addendum to the original OU4 EE Work Plan of November 1991, and does not duplicate some of the information there. The small portion of OU4 study area outside the Protected Area (PA) is included with the evaluation for OU6, and has been coordinated with that study.

An initial site visit was conducted in the industrial area in September of 1991 to note the present site conditions, nature and extent of terrestrial and aquatic ecosystems, plant and animal species, and habitats. The land surface at OU4 have been completely altered by construction and operation of the ponds and other surrounding facilities, and ecosystems and habitats are just reestablishing on portions of the study area. There are no natural ecosystems present, although OU4 has some vegetation resulting from a reseeding program and natural reseeding, and colonization by some wide-ranging and hardy animals.

The approach to conducting an ecological risk assessment is being developed with direction from the most recent basic guidelines provided by a framework document (EPA, 1992). This framework suggests a three phase approach of problem formulation, analysis, and risk characterization. Data acquisition and monitoring or field surveys are considered as separate activities to the risk assessment process. This framework will be partially employed in this EE but the activities required will be modified and less comprehensive since area is highly disturbed, and the ecosystems are modified and depleted.

The basic approach to implementation of the OU4 EE field activities during the Phase I RFI/RI is proposed in two stages:

- STAGE 1--Field surveys to determine the site characteristics and the general ecological setting and habitat conditions specifically for target taxa, migratory bird use, and the presence of threatened and endangered species; and

- STAGE 2--Ecotoxicological investigation to determine the potential impacts to onsite biota and for contaminant dispersal via biotic activities from soils within the study area.

Stage 1 will be conducted for the OU4 study area within the PA zone. Stage 2 will be conducted based on the spatial distribution of contaminants of concern, and the potential for bioaccumulation of contaminants. Ideally, the two stages should be completed sequentially. The two stages will, however, overlap considerably in order to complete the OU4 EE in the short duration proposed. The results will be incorporated into the Phase I RFI/RI report.

The following information is currently understood regarding the OU4 area characteristics. The presence or use of the area by endangered species of plants and animals is not expected because of the lack of habitat. No wetlands have been identified within OU4, although small seepage areas occur on the fill material on the hillside north of the solar ponds. Aquatic ecosystems are lacking within the OU4 study area because of its location at the head of a drainage, and the ponds are non-functional systems. Plants and animals observed and known to be present on the OU4 study area are small in numbers and diversity compared to other Operable Units in the buffer zone. In general, use of the OU4 study area by species of concern is lessened because of the lack of suitable habitat and prey. It is currently anticipated that all survey activities will take place between the beginning of April and the end of July 1993 to coincide with the height of the summer season when there will be the greatest probability of encountering plant and animal species using habitats on or near the study area.

The Stage 1 field surveys will produce three discrete types of documentation, these are:

- A final area habitat survey report;
- A final area biological survey report; and
- A technical report describing the outcome of the vegetation and small mammal investigations; and development of a histopathological database.

The Stage 2 ecotoxicological investigation will be performed during the Phase I RFI/RI investigation. It is anticipated that the ecotoxicological investigation will be conducted as soon as a reasonable list of bioaccumulating and bioconcentrating contaminants of concern (COCs) is compiled for the study area.

The investigative and analysis tasks will consist of:

- Developing a site-specific Conceptual Exposure Model to identify a potential exposure pathway for onsite biota;
- Developing a site-specific Conceptual Biota Transport Model to identify potential biotic off-site transport pathways;
- Selecting site specific COC's using criteria for possibility as stressors;
- Selecting representative target taxa and measurement endpoints (target analytes);
- Directly measuring target analytes within target taxa;
- Conducting histopathological investigations of selected organs and tissues to develop a pathology database; and
- Summarize effects of stressors as related to measurement endpoint.

Because the study area is known to have few ecological attributes at risk within its own boundaries, ecological risk characterization is defined as the probability, first, for biological impacts onsite, and second, biotic vector transport of potentially toxic quantities of bioaccumulating or bioconcentrating contaminants outward from the study area. A chain of logic

for the risk assessment is described in Section 5.4 of this document. Remediation criteria will be developed for contaminants which have a significant probability of impacts or transport. Work by the contractor within the OU4 area will be coordinated with the Human Health Risk Assessment in the Phase I RFI/RI implementation activities. Coordination with adjacent or off-site OU EE activities has been started and will be ongoing with other contractors and EG&G. Information developed for other OUs will be compared with information developed for the OU4 Study Area.

1.0 INTRODUCTION

This Environmental Evaluation Technical Memorandum (EETM) was prepared based on a request from the United States Department of Energy (DOE), Rocky Flats Office that Environmental Evaluation (EE) portions of RFI/RI Work Plans be modified for Operable Units (OUs) within the production areas of the Rocky Flats Plant (US DOE, 1992a). The original Environmental Evaluation Work Plan (EEWP) for OU4 was to be revised for consolidation with the EE for Operable Unit No. 9 (OU9). However, work planned for OU9 has been postponed, necessitating this new EETM to address OU4 specifically. OU4 has a discrete contaminant source in the solar ponds and the associated soil contamination from this source. The initial approach described in this EETM was based on a Technical Memorandum for the EE for OU9 (DOE, 1992). A previous EE Working Document describing the approach for OU4 (DOE, 1993) was revised and incorporated an altered field sampling plan (FSP) to form this EETM. This EETM will be an addendum to the existing EE section of the Solar Evaporation Ponds, Operable Unit 4 (OU4) Phase I RFI/RI Work Plan and form the basis for conducting the OU4 EE. The scope of work in this EETM is to form the plan for implementation of work on OU4.

This EETM for OU4 details the revised plan for the implementation of the EE. The working document includes the following sections:

- SECTION 2.0 APPROACH: A discussion of objectives and tasks (problem formulation);
- SECTION 3.0 SITE DESCRIPTION: A discussion of the site terrestrial ecosystems, aquatic habitats, biota, wetlands, and species of concern;
- SECTION 4.0 ECOLOGICAL FIELD INVESTIGATIONS: A discussion of the biological resource and habitat surveys required for Stage 1 of the EE; and
- SECTION 5.0 ECOTOXICOLOGICAL INVESTIGATIONS: A discussion of all tasks required for Stage 2 of the EE including a Field Sampling Plan.

2.0 APPROACH

The Solar Evaporation Ponds (OU4) is located within the Protected Area of industrial area of the Rocky Flats Plant (RFP). The industrial area of RFP that is inside the OU4 study area, has been disturbed such that only fragmented biotic populations in nonfunctional ecosystems currently exist. Those habitat units or ecosystems that do occur are greatly reduced in size, as are their associated biotic components. Therefore, the EG&G Rocky Flats (EG&G) Risk Assessment Technical Working Group developed a generic EE approach that is proportionately reduced in focus and scope from EEs conducted in areas with viable habitat or ecosystems. In the early planning stages for OU4, an EE was developed that was modeled on the ten-step, full scale ecological risk assessment being conducted for the more robust ecosystems in the buffer zone at RFP. This EETM is a final stage planning document that will address the framework of the ecological risk assessment for the chemical stressors (COC's) as opposed to the physical stressors related to construction and operation of the solar ponds (historical disturbances), effects of biota (the target species), measurement endpoints (the target analytes), and a preliminary conceptual approach to the site specific exposure and effects model and risk assessment characterization. This final planning document will discuss the field sampling plan, data analysis, a more finite conceptual model, and risk characterization.

The industrial area has no pristine ecological attributes at risk within its own boundaries. Therefore, ecological risk is viewed in a different context than other, non-industrial area OUs. Ecological risk in the OU4 context is the probability for biological impacts and/or biotic vector transport of potentially toxic quantities of bioaccumulating contaminants outward from the industrial area.

The current approach to conducting an EE within this industrial portion of the RFP was originally developed and submitted to the agencies in a Technical Memorandum (TM) for OU9 (DOE, 1992b). OU9 encompasses the entire 400 acre industrial area and overlaps portions of the OU4 study area inside the PA. The OU9 EE, however, has been postponed and cannot be relied upon to provide data for OU4. Therefore, this EETM has been prepared to present the approach to be taken for OU4. Portions of this OU4 document and EE approach are adapted directly from the TM for OU9. The EE conducted for Operable Unit 6 (OU6) was coordinated with that

contractor to sample the area of overlap outside the PA that is contiguous to Walnut Creek. This sampling was coordinated in 1992, and results from this study will be available to OU4. The OU4 EE will provide information only in the area north of the PA influenced by OU4 contaminants.

The framework for conducting the ecological risk assessment at OU4 is also based on recent guidelines developed by EPA (US EPA 1992), but is less comprehensive. The framework proposed consists of three major phases; 1 - problem formulation (establish goals, breadth, and focus, with a conceptual model as the final product), 2 - analysis (exposure and effects of stressors), and 3 - risk characterization (integrates the exposure and effects profiles for an estimate of risks). Stressors for OU4 are limited to chemical contaminants, and do not include physical factors of the ponds or management and control during use. Data acquisition and field surveys are considered important companion activities to the three phases.

The basic approach to conducting the monitoring surveys for an EE within the industrial area during the Phase I investigation consists of two stages that focus on source materials and soils:

Stage 1

Conduct field surveys to determine the general ecological setting and habitat conditions specifically for target taxa, migratory bird use, and the presence of threatened and endangered species.

Stage 2

Conduct an ecotoxicological investigation to determine the potential impacts to onsite biota and to assess contaminant dispersion from soils via biotic activities.

Stage 1 will be conducted for the entire extent of OU4, and results will be incorporated into the Phase I RFI/RI report. Stage 2 will depend on the spatial distribution of chemical stressors, the Contaminants of Concern (COCs) and the potential for bioaccumulation of contaminants as determined in Stage 1. Results will also be incorporated into the Phase I RFI/RI report. Activities for these two stages will overlap considerably so the EE can be completed in the short

time frame proposed. Additional environmental and biotic impact studies may be conducted during the subsequent Phase II investigation of water, air, and migration pathways.

During the analysis phase of the investigation in Stage 2, the results of the contaminant testing will be used to characterize exposure as a dose to the biotic components. This dose will then be used to determine or estimate ecological effects on plant or animal populations rather than ecosystem functions, and to determine the probability of biotic vectors for contaminant transport off-site. The risk characterization will be a two part exercise of (1) estimating the probability of injury to the small biotic populations on site, and (2) estimating the probability of biotic transport and exposure to off-site components. The ecological significance of these predicted impacts will be interpreted for actions or recommendations based on types and magnitude of effects. The results and conclusions of the ecological risk assessment will be evaluated for uncertainty, and the degree of confidence provided in qualitative or quantitative terms.

The general tasks and Data Quality Objectives (DQOs) for the ecological risk assessment for OU4 are the same as those stated in the TM for OU9 (DOE, 1992b) and are as follows:

- Qualitatively describe the ecological setting of the study area with specific reference to target taxa, endangered species and migratory bird habitat concerns;
- Define contaminants that are of concern to biota using a COC selection criteria specifically tailored for the study area and the list of contaminants identified during scoping and documented by the Phase I abiotic sampling program;
- Identify specific exposure points, transport media, and exposure point concentrations potentially available to biota;
- Identify mechanisms and pathways for uptake of COCs by biota;
- Empirically determine through tissue analysis whether uptake of contaminants has occurred in selected biota collected within the study area;
- Identify mechanisms and pathways for biotic transport of COCs beyond the boundaries of the study area; and
- Summarize the assumptions, uncertainties, and qualifications appropriate to the overall process of exposure assessment and contamination characterization.

The preliminary considerations for planning the specific ecological risk assessment tasks involved discussions with EG&G, and a determination of the approach to EEs within the industrial area at RFP. The general framework and tasks are elaborated in this TM by incorporation of a Field Sampling Plan (FSP) to accomplish the habitat and biota surveys (Stage 1) and the ecotoxicological investigations (Stage 2) during the planning Phase I RFI/RI. The general tasks consist of:

- Data review and consultation for determining stressors and types of ecosystems at risk;
- Develop site specific conceptual exposure model;
- Select COCs, target taxa and analytes;
- Develop a transport model to identify potential pathways for exposure and determine potential ecological effects;
- Conduct field investigations for site characterization and endpoint measurements;
- Analyze data for extrapolation and causal relationships; and
- Prepare environmental evaluation reports.

3.0 SITE DESCRIPTION

OU4 encompasses the Solar Ponds, consisting of five surface impoundments, and their area of influence. The five ponds presently in existence are Pond 207A, the largest pond; Ponds 207B-North, Center, and South, the smaller ponds to the east of Pond 207A; and Pond 207C which is approximately equal in size to the individual B series ponds and is west of Pond 207A. The Solar Ponds have historically been the recipients of industrial and hazardous waste stream products produced at the Rocky Flats Plant. Materials placed in the ponds consisted of low-level radioactive process wastes containing nitrates and neutralized acidic wastes, and additional wastes such as sanitary sewage sludge, metals, acids, and chromium and cyanide solutions. Although the ponds were lined, it is known that some leakage into the ground around and underneath the ponds has occurred. An Interceptor Trench System (ITS) was constructed downgradient of the ponds to control the migration of nitrate-containing groundwater and surface water from the ponds. The water collected in the ITS was routinely pumped back into the ponds. Currently, pipelines and holding tanks are being constructed to hold water from the ITS. Once completed, no additional water will be added to the Solar Ponds, and they will be remediated to prevent movement of contaminants in sediments.

An initial site visit were conducted in the industrial area between in September 1991 to observe site conditions, nature and extent of terrestrial and aquatic ecosystems, plant and animal species, and habitats. An addition site visit was conducted in January 1993. The initial site visits determined the extent of the ecosystems and habitats present on the site, and the relationship of the OU4 study area to other OUs. A habitat map was provided in the original EE Work Plan (DOE 1991). No systematic assessment of vegetation cover or animal species was conducted during the initial site visits. Observations were made on the vegetation and the presence or signs of animals. The following comments are based on observations made during the initial site visits and general information from other reports. Habitats in the study area were identified in accord with the Standard Operating Procedure (SOP) EE.11 (EG&G, 1992).

Overlap of the OU4 study area exists with Operable Units 6 and 9, and the extent to which they overlap has been determined. The study area boundaries for OU4 are determined by existing

roads in the area. The northern boundary is the perimeter road outside the security fenced area, the boundary east and northeast of the ponds is distinguished by an access road, the southern boundary extends to the paved road south of the ponds, and the western boundary is formed by the dirt road just west of Pond 207C. No sampling is planned for the area outside the perimeter fence. The study area boundary is shown in Figure 3-1. The study area overlaps the OU9 study area in the PA, and the OU6 study area to the north outside the PA security fence. Environmental samples have been taken from the OU4 area north of the EE study area as part of the OU6 EE work.

The ecosystems and habitats at OU4 have been highly altered by construction and operation of the ponds and other surrounding facilities. There are no natural ecosystems present, although OU4 has some vegetation established by reseeding and natural seeding, and some wide ranging and hardy animals. The following sections contain brief descriptions based on initial site visits and general information taken from other reports.

3.1 TERRESTRIAL ECOSYSTEMS

The terrestrial ecosystems are highly modified and in the first stages of revegetation by plants and invasion by smaller animals. Weedy vegetation has established on and around the ponds on bare soil, in adjacent level construction fill and in cracks in liners. The fill slope to the north of the ponds has a grass/weed vegetation with small marshy areas around two seeps. Arthropods and other invertebrates were observed on plants, and birds occasionally visit the site. Small mammals such as deermice are expected. Cottontails were seen and scat from either a fox or a coyote was observed. There are no wetlands in the OU4 study area, but the study area does contain the two small seeps and marshy areas. Aquatic ecosystems are lacking on the OU4 study area which is at the head of a drainage and there are no streams or natural bodies of water. The ponds cannot be considered as aquatic ecosystems due to use and management practices and the lack of viable aquatic organisms and food webs. Algae mats grow seasonally on the ponds and were observed on Pond 207B-North during the site visit in September 1991. The areas north and east of the ponds are the drainages of Walnut Creek which include both terrestrial and aquatic ecosystems. These could potentially be impacted by contaminants from OU4. North Walnut

Creek is a separate operable unit (OU6) and the EE sampling has been coordinated with the OU4 EE.

Habitats in the area were identified according to SOP EE.11 - Identification of Habitat Types, and a map is included in the EE Work Plan in Phase I RFI/RI Work Plan . Habitats at OU4 and the study area are greatly influenced by the construction and use of the ponds, and are all disturbed habitat types. The main habitat not covered by ponds, roads and buildings on OU4 is disturbance/barren land areas with a few areas of the cheatgrass/weedy forbs habitat. Although there is open water at present in the Solar Ponds as impoundment type habitats, this open water has little aquatic biota and is being evaporated and not replaced. The open water is not expected to be present by the time this EE is implemented. Waterfowl have been reported to land on the ponds. Use of these ponds at the present time by waterfowl or amphibians is unlikely due to draining and closure activities. The OU4 study area includes the fill slope north of the ponds and the ITS area which has a mixed grassland complex of seeded and adventive plant species, and small areas of short marsh around seeps.

The biotic species observed and known to be present in OU4 are small in numbers and diversity compared to the rest of RFP and the surrounding area. This lack of numbers and diversity is due to the large bare areas, fragmentation and small areal extent of plant communities, and security fencing which limits access. Plant species are primarily grasses and weedy forbs in the first stages of establishment and succession with no shrubs or trees. Animal species are those adapted to disturbances or are wide-ranging, mobile, and able to penetrate the fencing. The higher trophic levels of consumer and predators are few, and those species which are present are in small numbers or are occasional visitors to the OU4 area, not restricted to the ecosystems at OU4. Much of OU4 is inside the PA with security fencing to control access. Due to the lack of habitat, the presence or use of the OU4 study area by endangered species of plants and animals is not expected.

The weedy species found at most sites in the industrial area included: kochia (*Kochia scoparia*), yellow sweet clover (*Melilotus officinalis*), white sweet clover, (*Melilotus albus*), knot weed (*Polygonum sp.*), daisy fleabane (*Erigeron strigosus*), scorpionweed (*Phacelia heterophylla*),

Russian knapweed (*Centaurea repens*), woody plantain (*Plantago sp.*), Canada thistle (*Cirsium arvense*), musk thistle (*Carduus nutans*), peppergrass (*Lepidium sp.*), bindweed (*Convolvulus arvensis*), ragweed (*Ambrosia sp.*), sunflower (*Helianthus sp.*), common mullein (*Verbascum thapsus*), verbena (*Verbena bracteata*), toadflax (*Linaria dalmatica*), ragwort (*Senecio sp.*), dock (*Rumex sp.*), common St. John wort (*Hypericum perforatum*), salsify (*Tragopogon dubius*), quackgrass (*Agropyron repens*), filaree (*Erodium cicutarium*), yucca (*Yucca glauca*), buffalograss (*Buchloe dactyloides*), and prickly lettuce (*Lactuca serriola*). These species often formed an ecotone between asphalt areas and better developed habitats.

Meadow sideslopes were found to contain smooth brome (*Bromus inermis*), Japanese brome (*Bromus japonicus*), redtop (*Agrostis stolonifera*), crested wheatgrass (*Agropyron cristatum*), curlycup gumweed (*Grindelia squarrosa*), and velvety gaura (*Gaura parviflora*). Dry upland areas within the industrial area contained smooth brome, Junegrass (*Koeleria pyramidata*), foxtail (*Setaria viridis*), western wheatgrass (*Agropyron smithii*), as well as some of the more weedy species such as toadflax, mullein, al'ysum (*Allysum sp.*), plantago, sunflower, goatsbeard, dandelion (*Taraxacum officinale*), daisy fleabane, and geranium (*Geranium caespitosum*). Plantings adjacent to several of the buildings included horticultural varieties of juniper (*Juniperus virginiana*) and spruce trees.

3.2 AQUATIC HABITAT

Aquatic ecosystems are lacking within the OU4 and the industrial area due to its location at the head of a drainage. There are no streams or natural bodies of water in OU4. To the north and east of the OU4 study area are the drainages of North and South Walnut Creek. Both these drainages have terrestrial and/or aquatic ecosystems that could be impacted by contaminants migrating from OU4. Two small marshy seeps with cattails were observed just to the northwest outside the OU4 study area.

3.3 BIOTA

Plant and animal species observed and known to be present on the OU4 study area are small in numbers and diversity compared to the buffer zone. Restricted numbers of individuals and reduced diversity are a result of the large amount of surface and space occupied by the industrial

facilities, bare areas, and intense management for weeds and insects. Plant species are weedy forbs and hardy grasses with no shrubs or trees, other than planted landscape trees. Animal species are those adapted to disturbed or industrially developed areas or are wide ranging and highly mobile. The higher trophic levels of consumers and predators are few, and those species present are in small numbers and are occasional visitors not restricted to the poorly developed habitats in OU4.

Flying over the industrial area, and occasionally perched on structures within it, were a number of bird species: barn swallow (*Hirundo rustica*), house finch (*Carpodacus mexicanus*), vesper sparrow (*Pooecetes gramineus*), western meadowlark (*Sturnella neglecta*), American robin (*Turdus migratorius*), western kingbird (*Tyrannus verticalis*), Say's phoebe (*Sayornis saya*), house sparrow (*Passer domesticus*), common grackle (*Quiscalus quiscula*), starling (*Sturnus vulgaris*), raven (*Corvus corax*), killdeer (*Charadrius vociferus*), common nighthawk (*Chordeiles minor*). Bees, damselflies, dragonflies, and grasshoppers were observed in the area, as were a gartersnake (*Thamnophis sirtalis*) and desert cottontails (*Syivilagus audubonii*).

3.4 WETLANDS

Wetlands do not exist within OU4, but have been identified west of OU4 on the slopes below the 700 series buildings and in the upper reaches of Walnut Creek outside the study area. These wetlands occur mostly as isolated seeps that support hydrophytic vegetation species, including broad leaf cattail (*Typha latifolia*), baltic rush (*Juncus balticus*), and various bulrushes (*Scripus spp.*).

3.5 SPECIES OF CONCERN AND HABITAT UTILIZATION

The potential species of concern and habitats used in OU4 are discussed in the OU9 TM (DOE, 1992b). The rest of this section describes the species of concern and habitats, based on the OU9 TM, and is included since the same species of concern will occasionally visit the OU4 study area. In general, use of the OU4 study area or the industrial area by species of concern is not expected due to lack of suitable habitat and/or prey. Studies performed to date have not identified any threatened plant or animal species at RFP. Endangered animal species potentially present in or near Rocky Flats include the black-footed ferret (*Mustela nigripes*), two subspecies of peregrine

falcon (*Falco peregrinus tundris* and *F. p. tanatum*) and bald eagle (*Haliaeetus leucocephalus*). Black-footed ferrets are not known to occur in the vicinity of Rocky Flats, although there are historical reports of their presence in the Denver area. Their critical habitat is primarily associated with colonies of their major food item, prairie dogs. There are no colonies within the OU4 study area, although two small black-tailed prairie dog colonies are located about 1500 meters northeast and 2000 meters east of OU4 and encompass about 10 and 5 hectares, respectively. Each colony contained fewer than 40 individuals. Ferrets may be associated with prairie dog colonies above a certain size; however, given the small size of these colonies, it is extremely unlikely that *M. nigripes* is present.

Bald eagles occur occasionally in the RFP area, primarily as irregular visitors during the winter or migration seasons. This eagle is primarily a winter resident around lakes and rivers, and the closest known nesting pair is located at Barr Lake, 40 km east of RFP. Although RFP lacks suitable bald eagle nesting habitat, this species has been observed flying over the northeast quadrant of the buffer zone and one pair has been observed feeding regularly at Great Western Reservoir, approximately 0.9 km east of RFP. A nesting pair have been noted to be establishing a nest northwest of Standley Reservoir during the winter 1992/1993. None have been observed to roost or hunt on RFP, but have been observed hunting in proximity to the industrial area which includes OU4.

Peregrine falcons may occur as migrants. Two individuals of this species were observed at RFP in early fall: one flying from west to east near the west gate, the other perched on a powerline near Pond B-5 attempting to capture a killdeer inbound to Pond B-5. The Peregrine Falcon Recovery Plan discourages land-use practices and development which may adversely alter the character of the hunting habitat or prey base within a 10-mile radius of a nesting cliff. As there are two such cliffs within five and seven miles of RFP, the entire plant site is within the area of protection of potential foraging habitat. However, no nesting activities have been observed at RFP and no nesting or foraging activities have been observed on or in proximity to OU4. In 1991, a pair was reported as nesting approximately 10 km to the northwest of RFP. It is possible that the hunting territory of the nesting peregrines will include Rocky Flats, although suitable habitat and prey are lacking at OU4.

Other federal candidate animal species that are potentially present in the study area include the Preble's meadow jumping mouse (*Zapus hudsonius preblei*), ferruginous hawk (*Buteo regalis*), Swainson's hawk (*Buteo swainsonii*), and swift fox (*Vulpes velox*). The Preble's mouse, ferruginous hawk, and Swainson's hawk have been documented at RFP. A program to determine the habitat and numbers of *Z. h. preblei* was conducted in the summer season of 1992, and results of this study will determine trapping on OU4 for the Preble's mouse, if necessary.

Ferruginous hawks were observed adjacent to the industrial area in winter, spring, and early summer 1990-91. A juvenile male was resident in the vicinity for a six week period in late spring and early summer 1991; nesting was not documented. This individual was observed hunting primarily in the riparian zone of Woman Creek and along the 881 Hillside, directly south of the industrial area. Most observations of this species have been in association with prairie dog colonies southeast of RFP. A pair of Swainson's hawks attempted to nest in early June 1991 in a cottonwood about 2000 meters southeast of the industrial area. The nest was abandoned for unknown reasons in early July 1991. During this period, members of the pair were not observed hunting in the vicinity of RFP, although other observations of this species have been documented infrequently and widely on the RFP site.

Only one endangered plant species, the Diluvium (or Ute) Lady's Tresses (*Spiranthes diluvialis*) is potentially present in or near Rocky Flats. An intensive survey for this species on the entire RFP site was conducted during the 1992 field season. No plants of this species were observed on the RFP site or in the drainages to the east on OU3, the off-site operable unit. The nearest populations of the plant have been found along Clear Creek in Jefferson County to the south and near South Boulder Creek in Boulder County to the north of RFP.

Other federal candidate or state species of concern plants that are potentially present at RFP are the Colorado butterfly plant (*Gaura neomexicana var. coloradensis*), forktip threeawn (*Aristida basiramea*), and toothcup (*Rotala ramosior*). The forktip threeawn was reported along Woman Creek in 1973 and, in 1991, just south of the west access road entering Rocky Flats, growing on gravel scars bordering an old roadway, 500 meters west of the industrial area. This gravel habitat can apparently support the species when other plants are absent and adequate moisture can

accumulate. Given these habitat preferences, it is possible that this species will be found in the industrial area, although none have been observed there. Appropriate habitat for the Colorado butterfly plant includes the transition zone between wetland bottoms and the drier uplands associated with wet meadow habitat. The toothcup was reported in a temporary pool approximately 6 km east of Boulder. Given a lack of suitable habitat for these species in the industrial area, there is little probability that they will occur in or near OU4.

4.0 ECOLOGICAL FIELD SURVEYS (STAGE 1 TASKS)

The ecological field surveys will consist of the habitat and biota surveys focusing on those biotic components that could be impacted or accumulate contaminants and act as vectors for contaminant dispersal. Data from earlier studies will be reviewed to make some initial estimations for Conceptual Exposure and Transport Models, as well as bioaccumulating COCs. Data derived from Stage 1 field surveys will be used to refine the models and the list of COCs.

All surveys will take place between the beginning of April and the end of July 1993 (the "study period"), to coincide with the height of the summer season when there will be the greatest probability of encountering plant and animal species using habitats on or near the study area. These investigations will cover the entire OU4 study area and the results obtained will be available for the preparation of RFI/RI reports for other OUs.

These biological resource and habitat surveys will provide the following information:

- A more comprehensive view of the types and areal extent of habitat within the study area and vicinity;
- A determination as to the presence or absence of migratory and raptor bird species, including passerine species;
- A determination as to the foraging, breeding, or nesting habitat for migratory, passerine, and raptor bird species;
- A determination as to the presence or absence of species of concern for which habitat exists;
- Data on the species, numbers, and movement patterns of small mammals living in or near the study area; and
- Data on the histopathology of selected tissues from small mammals and vegetation in or near the study area.

All references to methodologies used for ecological surveys at RFP are specified in the Standard Operating Procedures (SOP) Manual: Volume 5.0, Ecology (EG&G, 1992). These SOPs have been approved for use on Comprehensive Environmental Response Compensation and Liability Act (CERCLA)/Resource Conservation Reauthorization Act (RCRA) investigations by the

Environmental Protection Agency (EPA), Colorado Department of Health (CDH), the U.S. Fish and Wildlife Service, and the Colorado Division of Wildlife (CDOW). Specific aspects of the surveys are discussed in the following sections.

4.1 SPECIES OF CONCERN COMPLIANCE LIST

Table 4-1 lists all of the species of concern (SOC), both federal and state, that may be present at RFP. Field surveys will focus on these species. Species not marked in this table have been screened from consideration at this time due to a lack of suitable habitat, although some may be brought back into consideration if surveys reveal the presence of suitable habitat.

4.2 LITERATURE REVIEW AND CONSULTATIONS

A comprehensive literature review was performed as part of the RFP baseline biological inventory program. This literature review involved surveying available pertinent documents and data to provide a synoptic background description of the wildlife and vegetation resources on site. Information extracted during this process was summarized in the form of an annotated bibliography that will be used to support interpretation of survey results. A recent report (EG&G, 1991b) provides a broad picture of potential SOC at RFP and contains a literature review for those species, which include migratory bird species. The Species of Concern List developed for OU9 (DOE, 1992b) is shown in Table 4-1.

EG&G has discussed the potential occurrence of *Spiranthes diluvialis*, *Aristida basiramea*, *Zapus hudsonius preblei*, *Gaura neomexicana*, and other SOC with Dr. Fred Harrington who served as Field Supervisor for the sitewide biological baseline studies and for the OU1 EE. In addition, EG&G has had Dr. David Buckner (ESCO Associates) conduct surveys specifically for *Spiranthes diluvialis* and/or its habitat. Dr. Buckner is a locally recognized expert in the life history and habitat preferences of this particular species, and has done similar work for the Army Corps of Engineers and the U.S. Fish and Wildlife Service. EG&G may also call upon the services of Dr. Jim Fitzgerald, a mammalogist at the University of Northern Colorado, who can provide guidance with regard to the life history, habitat preferences, and trapping requirements of *Zapus hudsonius preblei*. Dr. Robert Stoecker conducted trapping surveys for this species on the RFP and OU3 during the summer of 1992 field season, and the results of this trapping will

guide additional trapping efforts. Colorado State University has collected extensive data on the bioconcentrations of radionuclide contaminants, but little work has been done on the pathological impacts. Previous studies will be reviewed during the Stage 1 work to identify means for predicting such impacts.

4.3 HABITAT PRESENCE VERIFICATION

This task will involve a comprehensive survey and mapping of types and extent of habitats, particularly habitats that could support species of special concern such as migratory birds. Habitat types in the study area were briefly described in Section 3.3, based on the initial site assessment in September 1991. At that time, four habitat types were observed. A more recent RFP vegetation map details a total of seven habitat types within the industrial area. During Stage 1, a more accurate assessment of the types and areal extent of habitat within the study area will be undertaken. Habitats in the study area will be identified and verified in accordance with SOP EE.11. Survey results will be used to validate or correct the RFP vegetation map, and to guide the conduct of other survey efforts. These surveys will result in an updated map of the study area for habitat and vegetation types and a comparability table.

Bird surveys will only be performed if existence of suitable migratory bird or raptor foraging habitat is verified within the study area. Similarly, plant species surveys will only be performed if the existence of either (a) suitable species of concern habitat, or (b) specifically, suitable *Spiranthes diluvialis* habitat is verified within the study area. Soil series will not be mapped because of the heavily disturbed nature of the soil surface within the study area.

4.4 ANIMAL SPECIES SURVEYS

During Stage 1, general field surveys will be conducted to collect data on terrestrial wildlife in the study area. Objectives for this general work are to describe existing wildlife and habitats in the area; develop food web models, including contributions from vegetation; identify potential contaminant pathways through trophic levels; identify target taxa for collection and tissue analysis during Stage 2; and provide a general description of the community.

Qualitative methods will be employed by observational surveys (according to SOP EE.7) to determine which bird species are present, their number, their general behavior, and the habitat in which they were observed. Special attention will be given to the presence and/or use of habitats by raptors and migratory birds, including waterfowl and passerine species. Opportunistic observations of bird nests and raptor use will also be recorded. Bird species in the study area will be surveyed in accordance with SOP EE.7. If initial qualitative surveys suggest that use of the study area by birds is substantial for habitat use, foraging or breeding, quantitative sampling methods may also be employed for density and population numbers.

The presence or absence of small mammals (primarily cricetine or microtine rodents) and one larger mammal (cottontail rabbit) population, will be surveyed throughout the study area. Feral domestic house cats currently use the site, and will be evaluated for recapture and histopathological studies. Mark-recapture or other population assessment methods will be employed to gain an understanding of their population characteristics and movement patterns. Small mammals in the study area will be live-trapped in accordance with SOP EE.6, and larger mammals trapped in accordance with SOP EE.5. Trap grids will be established, at stations within the study area congruent with those intended for later ecotoxicological work, using rat-sized Sherman non-collapsible live traps (25 x 8 x 8 centimeters). Grid size and length of trapping sessions may vary at each station. Captured animals will be marked and released, and capture locations noted. This information will be used during Stage 2 to guide ecotoxicological sampling efforts. Preble's meadow jumping mouse surveys will not be conducted within the study due to a lack of potential habitat for this species.

Any mammals or tissue samples collected by accidental trap death or found intact and fresh during the habitat surveys will be either used to initiate histopathological investigations of selected organs and tissues in order to develop a pathology database, or appropriately preserved for use in ecotoxicological investigations for analysis of the target analyte list presented in Section 5.1.3.

4.5 VEGETATION SURVEYS

The objectives of the vegetation survey are to assess the extent, quality, and structure of habitat available to migratory bird species and small mammals. In addition, this survey program may provide data for description of site vegetation characteristics, determination of impacts to plant communities, identification of potential exposure pathways from contaminant releases to higher trophic level receptors, selection of target taxa for contaminant analysis during Stage 2, and identification of any protected plant species or habitats. Qualitative methods will be employed to determine plant species present by community type, as well as data on abiotic features. Terrestrial vegetation in the study area will be surveyed in accordance with SOP EE.10. If initial qualitative surveys suggest that terrestrial vegetation communities in the study area are more complex for species diversity or productivity than expected for early vegetation succession, quantitative sampling methods may also be employed during Phase I for site characterization.

Qualitative sampling will involve compiling a comprehensive species list for each identified community type by traversing all appropriate portions of the study area at least twice during the early growing season, and describing abiotic features, such as substrate, topography, and soil moisture, that could influence composition and structure. The releve method (also known as the sample-stand or species-list method) will be used since the area is too limited for linear cover transects.

Observations made during the initial site survey revealed that vegetation had become established on the hillside immediately north of the ponds. Seeps have occurred historically on the hillside. The vegetation on the hillside north of the ponds will be typed and characterized for plant species cover and composition. The methods for vegetation analysis will follow the procedures described in SOP EE.10. The hillside will be evaluated for the vegetation units and habitats to be sampled for cover and production.

4.6 DOCUMENTATION

The Stage 1 EE effort will produce three discrete reports to support the environmental evaluation: (1) a final OU4 habitat survey report, (2) a final OU4 biological survey report (if there is habitat suitable for threatened and endangered species within the study area), which will ensure

compliance with the informal consultation requirements of the Endangered Species Act, and (3) a technical report describing both the outcome of the vegetation and small mammal investigations and development of histopathological information. These reports will comprise the EE portion of the baseline risk assessment in the Phase I RFI/RI report.

The habitat survey report will discuss the findings of the field survey work relative to the presence or absence of migratory bird or raptor species and/or the habitat required for their foraging, breeding, or nesting activities. Should such species or habitat be present within or near the study area, an analysis of potential impacts resulting from site characterization activities will be presented. Where appropriate, the discussion will include possible benefits or losses to wildlife associated with site characterization activities, possible conservation measures, and conclusions. The information contained therein will be used, if appropriate, for preparation of future mitigation reports analyzing potential impacts from proposed site remediation activities such as pond closure and cleanup.

The biological survey report will discuss the findings of the field survey work relative to the presence or absence of compliance listed species (Table 4-1) and the habitat required for their foraging, breeding, or nesting activities. Should such species or habitat be present within or near the study area, an analysis of potential direct, indirect, or cumulative impacts resulting from site characterization activities will be presented. This analysis will conclude with a determination of the impact of site characterization activities on compliance-listed species. The presence of a federal threatened or endangered species within or near the study area will also trigger the mandatory consultation process with the U.S. Fish and Wildlife Service as stipulated by 50 CFR 402 and 3-21000-ADM-NEPA.12, Identification and Reporting of Threatened and Endangered and Special Concern Species. The information contained therein will be available for preparation of future mitigation reports analyzing potential impacts resulting from proposed site remediation activities.

The technical report is intended as a brief description of the results obtained from vegetation, small mammal, and cottontail rabbit qualitative surveys and live trapping and mark-recapture survey, if conducted. Information will be collected on histopathological effects of COCs at the

concentrations estimated in animal and plant tissue. Information contained in this memorandum will provide a basis for design and modification of proposed Stage 2 ecotoxicological investigations.

5.0 ECOTOXICOLOGICAL INVESTIGATION (STAGE 2 TASKS)

Stage 2 ecotoxicological tasks may be performed during either Phase I or Phase II of an RFI/RI investigation. Stage 2 tasks discussed here will be conducted during the Phase I RFI/RI for OU4. An ecotoxicological investigation will be conducted as soon as a reasonable list of COCs is compiled for the study area as a result of Stage 1 based on site characterization. Soil characterization data will be analyzed to determine the need and extent of tissue sampling, and for the need for additional sampling of soil parameters for ecological significance. Ecotoxicological investigations to be performed at the OU4 study area will be significantly less complex than those performed in more ecologically robust OUs. A guiding assumption for the study area is that few, if any, contaminant susceptible ecological attributes will exist within the study area. The study area will be treated as a potential source for contaminants, rather than as a point of impact for contaminants. Therefore, investigations proposed for the OU4 study area will focus on determining the potential for biotic uptake and transport of contaminants from the study area into adjacent watersheds, drainages, or operable units.

5.1 INVESTIGATIVE TASKS

Investigative tasks will consist of:

- Finalizing COCs as chemical stressors;
- Finalizing a site-specific Conceptual Exposure Model to identify potential exposure pathways for on-site biota;
- Finalizing a site-specific Conceptual Biota Transport Model to identify potential biotic off-site transport pathways;
- Selecting representative target taxa;
- Directly measuring target analytes within target taxa as measurement endpoints; and
- Conducting histopathological investigations of selected organs and tissues to develop a pathology database.

5.1.1 Conceptual Exposure Model

The biota-specific model shown in Figure 5-1 was developed as a general conceptual exposure model for use in industrial areas at RFP (DOE, 1992b). It will be used to qualitatively identify the actual or potential pathways by which various biological receptors at or near the study area might be exposed to site-related chemicals or radionuclides. It will help to focus the search for potentially exposed habitats or taxa within the study area. The model identifies the following five mandatory elements for a valid exposure pathway; (1) chemical/radionuclide source, (2) mechanism of release to the environment, (3) environmental transport medium for the released chemical/radionuclide, (4) point of potential biological contact with the contaminated medium, and (5) biological uptake mechanism and absorption, or dose, at the point of exposure.

Surficial soil samples will be of prime importance for determining source contaminants for on-site biota. The uppermost layer is a major source of nutrients and contaminant uptake for on-site vegetation. It is also a potential source for contaminants ingested by soil dwelling animals and invertebrates and their predators. Soil samples from all depths are related to surface water and groundwater regimes. Fluids moving through soils can leach contaminants, transport them through available flow paths, and deposit them in downgradient environments. Contamination in soil and groundwater at a depth of greater than 6 feet, the maximum depth of burrowing animals and plant root penetration in a disturbed site, will not be considered as affecting biota. Contamination at depths greater than 6 feet may be considered if other RFI/RI studies suggest a mechanism for it to contact burrowing animals and plant roots.

Surface water from the study area flows north and east toward North Walnut and South Walnut Creeks. Surface water drainage and runoff is collected from buildings and roads by water collection and diversion structures (drains and ditches) that run into a series of detention ponds along these creeks. Once impounded in these ponds, the water is treated and released. Surface water and sediment samples are collected on a regular basis as part of ongoing sitewide investigations.

Groundwater generally flows to the east of the study area in two connected groundwater systems. In the surficial materials, groundwater flow diverges in two directions: northeast toward North

Walnut Creek and east-southeast toward South Walnut Creek. In weathered bedrock, the groundwater also flows to the northeast and southeast. These flows are influenced by topography, facilities construction and grading, seasonal recharge, and the surface of the bedrock. Inorganic constituents and radionuclides have been measured in the soil in the vicinity of the Solar Evaporation Ponds. The groundwater has been found to contain some VOCs, elevated total dissolved solids and nitrates, and some radionuclides. The Solar Ponds are potential sources for contaminants in the groundwater. There is a potential for contaminants in groundwater to reach vegetation around seeps and impact the biota.

The chance of sediments in the study area being subject to disturbance by aquatic biota is considered very remote since aquatic ecosystems are lacking at OU4. Therefore, sediments are not considered to be a viable exposure pathway for aquatic biota, and the aquatic biota component will be excluded from the conceptual exposure model. Consequently, the aquatic uptake portions of the conceptual exposure model shown in Figure 5-1 will not apply at OU4.

5.1.2 Conceptual Biota Transport Model

A Biota Transport Model (BTM) predicts the probability of contaminant loads dispersing outward in biotic vectors from the study area. The model provides data on the biotic dispersal of contaminants to complement data on contaminant transport in abiotic media. BTM development must rely on a combination of information sources to establish values for the parameters involved. Such sources include published life history data on target taxa and associated predators, empirical data from traplines and sweeps deployed on the study area boundaries, immigration trapline data from adjacent OUs, and professional judgement.

A BTM, or some more sophisticated variation of the concept it embodies, could be used to estimate biotic transport of contaminants from an OU, as an adjunct to abiotic transport data. Development and validation of any BTM will be necessary if two specific conditions can be met within the study area: (1) bioaccumulating target analytes are found in target taxa at above background levels, and (2) life history and ecological data demonstrate that these taxa have significant movement beyond the study area boundaries.

5.1.3 Selection of Contaminants of Concern

A preliminary list of COCs as chemical stressors has been selected based on criteria in three general categories:

Occurrence: The known or suspected occurrence of a bioavailable chemical in environmental media will be ascertained from: (1) existing data regarding abiotic media such as soil, water, and air, (2) biota, (3) waste stream identification and disposal practices, (4) process analyses to identify potentially hazardous substances used in large quantities, or (5) historical accounts of use or accidental release.

Ecotoxicity: A chemical will be considered for inclusion on the list of target analytes if, at levels detected within the study area, it is known to exhibit bioaccumulation, significant bioconcentration factors (BCFs of >0.03 for terrestrial species), adherence to skin or fur, or accumulation in lung tissue.

Extent of Contamination: A chemical will be considered for inclusion on the list of target analytes if it is widely distributed, occurs in ecologically sensitive areas leading to contact with wildlife, or occurs in localized areas of high concentration.

The following list of COC's was prepared based on contaminant information presented in Section 2.0 of the RFI/RI Work Plan and on the above three criteria:

<u>ANALYTE</u>	<u>REQUIRED DETECTION LIMIT</u> <u>TISSUE ANALYSIS (ppm)</u>
Metals:	
arsenic	< 0.05
cadmium	< 0.05
chromium (IV)	< 0.05
copper	< 0.05
lead	< 0.10
mercury	< 0.10
selenium	< 0.10
silver	< 0.10
zinc	< 0.10
PCBs (per EG&G, 1991a)	To be determined
Radionuclides	(pCi/g)
plutonium-238	0.021
plutonium-239/240	0.021
uranium-238	0.10
uranium-235	0.10

A complete list of COCs will be prepared following Phase I RFI/RJ quantitative data evaluation.

5.1.4 Target Taxa

Given the poorly developed communities present in the study area, the disparate distribution of the taxa present, and the limited character of the food webs present, target taxa selection criteria have been limited to those which:

- Have a reasonable home range within or near the study area;
- Are present in sufficient numbers or sizes to allow collection of sufficient biomass for tissue analysis;
- Are not a threatened, endangered, or special concern species;
- Potential to display morphological anomalies;
- Have a reasonable probability (based on published information, results from Stage 1 studies, or results from EE work at other OUs) of having a target analyte or analytes present in its tissues; or
- Have a reasonable probability of displaying an aberrant histopathology due to contaminant exposure.

All habitats present in the OU4 study area are disturbed, small, and limited in the number of taxa and trophic levels present. The most likely terrestrial food chains are:

- (A) weedy vegetation -> small to medium mammals or small birds,
- (B) weedy vegetation -> insects -> small mammals or small birds,
- (C) weedy vegetation -> small to medium mammals or small birds -> predator,
- (D) weedy vegetation -> insects -> small mammal or small bird -> predator.

Aquatic habitats are also extremely limited or non-existent, and are not likely to contribute insect taxa with aquatic life stages to a food web. Winged adult forms of these insects will enter terrestrial food chains as indicated in (B) and (D) above.

Taking into consideration the above selection criteria and food web structure within the study area, target taxa for use in ecotoxicological investigations will be limited to vegetation, small mammals (deermice), medium-sized large mammals (desert cottontails) and possibly small birds (eggs or unfledged nestlings) of ground nesting species. During a recent site visit, feral domestic cat sign (tracks and scat) was noted, however these animals will not be sampled since they are a predator and highly mobile.

For Stage 2 ecotoxicological activities, vegetation will be sampled by destructive techniques in order to supply tissue samples for contaminant concentration measurements.

Deermice are a logical choice as a target taxon since it is the most abundant mammal (74%) trapped in disturbed areas (DOE, 1992C), and has been studied as a target taxon at OU1 and OU3. Medium-sized mammals, as described in the baseline characterization report (DOE, 1992c), include prairie dogs, hares, rabbits, and muskrats. The taxon of interest here is a lagomorph (rabbits and hares), particularly the desert cottontail rabbit which has been observed in the study area, and is the possible second choice in addition to the deermouse. Herbivorous mammals such as the deermouse and desert cottontail are an important component of ecological investigations and contaminant pathways analyses because they (1) are generally abundant and easily captured, (2) occupy small home ranges and thus reflect habitat quality or contamination of a specific area, (3) live in intimate contact with the soil and thus are maximally exposed to surficial contaminants, (4) include species with a wide range of diets, including leafy tissue, seeds and insects, and (5) are a primary prey component for a variety of predators including weasels, foxes, coyotes, owls, hawks, kestrels, and snakes.

Perching birds (Passeriformes) are the major taxonomic group of birds occurring within the study area at OU4. Small populations and lack of nesting habitat will preclude the use of birds for toxicological investigations.

Deer, coyotes, fox (other large mammals or carnivores possibly present in the study area), raptors, and migratory birds will have only occasional contact with the study area due to lack of access (fencing and security) and their high mobility; therefore, sampling of these taxa is

unlikely. Amphibians are also unlikely to be sampled largely due to a lack of habitat suitable for these taxa. Habitat exists for certain reptiles, but these taxa may not be present in sufficient numbers to allow or justify destructive sampling.

Using the above considerations and criteria, the most likely animal target taxa were considered the deermice (*Peromyscus maniculatus*) and desert cottontail (*Sylvilagus audubonii*) with some consideration given to the house mouse (*Mus musculus*), and meadow vole (*Microtus pennsylvanicus*). Birds will not be collected unless the habitat surveys show nesting population that can withstand destructive sampling.

5.2 FIELD SAMPLING PLAN

Objectives of the Stage 2 field sampling program are to collect site specific data on biota and important abiotic parameters, collect tissue samples for measurement of target analyte concentrations in terrestrial organisms, collect tissue samples to support histopathological investigations, and to provide data for verification and validation of the conceptual models. As indicated in Section 5.1.4, terrestrial sampling will be limited to vegetation, small mammals (deermice), a medium-sized large mammal (cottontail rabbits). No reference area is planned for OU4 because the criteria needed to correlate and match the uniquely disturbed site cannot be met.

All of the field sampling activities will be accomplished in compliance with the Ecology Standard Operating Procedures (EG&G, 1992) developed for sampling biota as part of the EE process at RFP. These SOPs include discussion of purpose and scope, responsibilities and qualifications, references, equipment, and execution of protocols. Sampling procedures for the large mammals are given in SOP EE.8, and in SOP EE.10 for vegetation. Procedural SOPs (EE.11 through EE.15, respectively), have been prepared for identifying habitat types, sampling soil for soil description, developing ecology field sampling plans, assigning species codes, and assigning wildlife habitat codes. Additional procedural SOPs are still being developed and Volume V is being revised. Specific sampling is discussed in the following sections.

5.2.1 Site Description

OU4 encompasses the Solar Ponds and their area of influence, the study area as indicated in Section 3.0 and on Figure 3-1. The Solar Ponds have historically been the recipients of industrial and hazardous waste stream products produced at the Rocky Flats Plant. Five ponds are presently in existence and Pond 207-A is the largest pond. Ponds 207-B North, Center, and South are smaller, ponds to the east of Pond 207-A. Pond 207-C is approximately equal in size to the B series ponds and lies to the west of Pond 207-A.

5.2.1.1 Study Site Detail

Although the ponds were lined, it is known that some leakage into the ground around and underneath the ponds has occurred. The water collected in the ITS is pumped back into the ponds. As noted previously, overlap with other operable units is expected and coordination with them for the exact extent of the OU4 study area boundaries has been necessary. Tentative study area boundaries for OU4 are the perimeter access road around the security fenced area to the north of the ponds, the area around and east of the ponds to an access road, west to the dirt road just west of Pond 207-C, and south to the paved road to the south of the ponds. The entire OU4 and study area has been disturbed by grading and facilities construction and drainage control. Plants have subsequently revegetated some areas by planned seeding or natural invasion, and some animals have become reestablished. Ponds are dormant at the present time, and implementation of interim closure activities postponed.

5.2.1.2 Reference Site Detail

No reference site for OU4 will be used since the criteria needed for using a reference area as a control situation cannot be met. These criteria include: a habitat type within a restricted access area and vegetation disturbed; industrial usage; habitat size equivalent to OU4; a north aspect at a degree of slope within about 25° of the slope below the ponds; and a similar soil type to OU4 which would take into account disturbance, fill materials, and loss of topsoil.

5.2.2 Objectives

Objectives for the field sampling plan are:

Collect site specific data on biota, habitats and species of concern;

- Measure concentrations of contaminants in selected tissue of terrestrial organisms; and
- Measure indicators of impacts or stresses (ecological endpoints).

COCs and Ecological Target Taxa

The Solar Ponds received nitrates, radionuclides, metals, and other process wastes produced at the Rocky Flats Plant and are expected to have high contamination of these analytes. A preliminary list of COCs has been compiled, and is presented in Section 5.1.3.

Target taxa (receptors of concern) will be limited to plant species, herbivorous small mammals, and a medium sized large animal (desert cottontail). They are limited to producers and primary consumers. Secondary consumers (predatory birds, mammals) are not of concern because of mobility and too little of their diet is composed of material from the OU4 study area.

Habitat and Taxa Specific Sampling

The major community habitat type found in the study area is the disturbance/barren land. A minor community within this is the cheat grass/weedy forbs community type. A second major type is the mixed grassland complex. A minor community within the grassland is comprised of two short marsh/wet meadow type areas. None of these communities have natural, undisturbed soils or vegetation.

5.2.3 Habitat and Taxa Specific Sampling

The disturbed habitats at OU4 are small and limited in the number of taxa and trophic levels present. Aquatic habitats are lacking, and the ponds in their present condition support little or no biota other than algae and bacteria. The terrestrial sampling will be limited to vegetation, small mammals, and a medium sized large mammal. Coyotes, fox and feral cats, the large mammals probably present in the study area, and birds, including raptors, would be only occasional users due to their high mobility and the condition of the small and highly disturbed study area. Therefore, they were not included in the sampling program. Sampling of reptiles, amphibians, and arthropods for tissue analysis is not anticipated.

5.2.3.1 Terrestrial Sampling

The objective of data and sample collection in terrestrial habitats is to gather data for construction of exposure pathways models and biotic transport of contaminants. Relative abundance and distribution will be assessed for all relevant major groups of terrestrial organisms. Sampling locations for small mammals and the medium sized large mammal will coincide with vegetation sampling locations. Collection of samples for tissue analysis will include small mammals, lagomorphs, and vegetation. Preliminary sampling locations are shown in Figure 5-2.

5.2.3.2 Vegetation

Objectives

Data and sample collection will follow procedures described in SOP EE.10. Quantitative data and tissue samples will be collected for analysis between mid-June to mid-July 1993. Data collected will be used to assess the following objectives:

- Total plant cover;
- Cover by perennial grasses, annual grasses, perennial forbs, and annual or biennial forbs;
- Cover by individual species;
- Richness (number of species);
- Production (standing biomass in grams per square meter [g/m^2] and pounds per acre [lbs/acre]); and
- Height (in centimeters).

Sample Locations

Study site sample locations were determined on the basis of vegetative community availability and are depicted in Figure 5-2. These locations are preliminary and will have a final determination during the initiation of work. Potential locations in adjacent OUs are identified, but are not included in the present sampling scheme.

Collection Methods

Collection methods for terrestrial plant sampling will follow the procedures outlined in Section 6.0 of SOP EE.10. The limited amount of vegetation and total lack of any naturally occurring vegetation restricts the quantitative surveys to the use of the production plots method only. Sample size adequacy in cover and biomass surveys will be determined using Cochran's formula (Cochran, 1977).

The qualitative sampling methods will involve compiling a comprehensive species list for the entire site by traversing the entire study area during the growing season, and describing abiotic features such as substrate, topography, and soil moisture conditions that could influence composition and structure. The releve-method (also known as the sample-stand or species-list method) will be used since the area is too limited for cover transects (Section 6.3.1 SOP EE.10).

Collection of plant tissue for laboratory analysis will be conducted independent of the community surveys and will follow Section 6.4 of SOP EE.10. Only aboveground biomass will be collected. Collection locations will be in the same location as the releve-method surveys on the study area. Tissue samples will consist of five samples per plot in the weedy area, up to eight plots in the grassland area, and one sample in each of the seep areas. Field equipment will be decontaminated following procedures in SOP FO.02. Samples locations will be co-located with the three surficial soil sampling sites within the survey areas, with up to five additional samples with co-located soil samples as necessary to adequately sample the area. The samples will consist of aboveground biomass from 0.5 m² plots. All plant tissue will be composited.

Sampling Intensity

Sample size will be determined at the time of sampling with sample adequacy calculations. Because sample frequency is dependant on the seasonal weather pattern (temperatures and precipitation) of the year the sampling is done, exact sampling dates will be determined during the sampling season. One sampling period is assumed during the mid-summer at the height of the growing season.

QA/QC Sample Schedule

Quality assurance/quality control will following field procedures defined in SOP F0.02. Any variance from SOP will be described and the reason explained. Quality assurance/quality control for tissue sample collection should be accomplished by collection of co-located duplicates or split samples according to the Quality Assurance Project Plan (QAPP).

Sample Handling and Preservation

Biomass samples will be separated by species into labeled paper bags and oven-dried in the bag (104°C for 24 hours) then weighted. Clipped material will be maintained in the marked paper bags until the conclusion of the study. Samples collected for tissue analysis will follow the sample preparation and packaging specified by the laboratory protocols for the selected analytes and should be generally consistent with SOP 1.13.

5.2.3.3 Small Mammals

Objectives

Small mammal populations will be surveyed to determine habitat use and relative abundance. The results will be used to confirm the species to be collected for tissue analysis. The deermouse has been determined to be the most abundant mammal on disturbed areas and has been the taxon of choice on other OUs. The data will be used in development of pathways models and the exposure assessment. The community evaluation for description and characterization endpoints will include:

- Richness (number of species);
- Abundance (number per trapping period) by species; and
- Mean weight.

Sample Locations

Sampling locations will coincide with vegetation sampling locations in areas of suspected contamination.

Collection Methods

Population of the mammals of concern within OU4 will be surveyed to determine habitat use and relative abundance. Small mammals will be collected using the live-trapping techniques described in SOP EE.6. Trap grids or lines (size and shape to be field determined) will be set for four consecutive nights in the early summer, as described in SOP EE.6.

Tissue samples will be collected, if determined necessary, from grids corresponding to vegetation transects in areas of known contamination. To collect individuals for tissue analysis, each individual of the designated target taxon will be randomly assigned to a particular analytical suite. Collection will continue until all of the required sample quantity is obtained, and field procedures will follow SOP FO.14. If composite samples are required, each individual will be randomly assigned to a sample, and collection will continue until six samples of the appropriate quantity are obtained. If multiple trap-nights are required to obtain adequate sample quantity, individuals will be frozen as soon as possible, but within four hours of collection. Tissue sampling will occur in mid-summer after the conclusion of the live-trapping program.

Sampling Intensity

Each sampling suite will be run for a least four consecutive nights. Live trapping will be conducted in the mid-summer from June 15 to July 15, 1993.

QA/QC Sample Schedule

Quality assurance/quality control will following procedures defined in SOP FO.02. Any variance from SOP will be described and the reason explained. Special attention will be given to minimizing chance of harm to the animals not intended for tissue analysis and to avoid injury to the workers from animal bites or scratches.

Sample Handling and Preservation

Animals collected for tissue analysis will be sacrificed by placing into a sealed container with cotton saturated in Metafane, inducing hypothermia, or cervical separation. The dead animal will be placed in a plastic sample containers in a cooler with Blue or dry ice for up to four hours. After four hours, the samples must be shipped to the analytical laboratory or place in a freezer

overnight or until shipped. Labeling, handling, and shipping of small mammals for laboratory analysis should be generally consistent with SOP 1.13. Samples collected for tissue analysis must follow the sample preparation and packaging specified by the laboratory protocols for the selected analytes.

5.2.3.4 Large Mammals

Objectives

The data will be used in development of exposure assessment and impact analysis. For community evaluation; endpoints will include:

- Richness (number of species);
- Relative abundance (number per survey period) by species; and
- Habitat utilization.

The most obvious mammal observed by inspection during site visits was the cottontail rabbit which occurred around the buildings, ponds, and on the sloping hillside. The other evidence of animals present was canine scat, either of a fox or coyote which were able to penetrate the security fences and prey on the cottontails. The field investigations will focus on these biotic components. Fecal pellets of cottontail rabbits were noted to be abundant where animals congregate. The scat of the predatory fox or coyote were noted in low amounts. Scat of the cottontail and the canine predators (if available) may also be collected and analyzed for target analytes to determine what portion of the contaminants ingested are not absorbed in the gut. This sampling of scat may not be appropriate unless the contaminant concentration can be related to the animals ingesting the vegetation can correlated to concentrations in the vegetation and soil uptake. This may be difficult in a field sampling situation.

Sample Locations

Sampling locations will coincide with vegetation sampling locations in OU4, or in other areas of known contamination.

Collection Methods

Habitat utilization and relative abundance of the large mammal populations will be determined by visual surveys for animal sightings and scat occurrence. The relative abundance of the rabbit population will be determined by visual surveys for animals present.

A trapping strategy and technique will be developed for the collection of cottontail rabbits using larger live traps such as a culvert type. Whole animals will be trapped as live specimens, marked for identification, sampled for sequential blood and hair samples and then released. The rationale for sampling blood is that there are standardized tests and procedures that have been developed for analyzing blood including metal concentrations. Rabbits are a common laboratory animal that previous studies can be used for comparisons. The field procedures for non-destructive sequential sampling of cottontails that must be developed include; determining population parameters for the animals prior to capture, marking and recapture of individual animals, volumes of blood that can be collected from an individual. The habitat utilization must be determined, especially for feeding habit, in order to develop causal relations with food ingestion and other abiotic factors. This portion of the sampling program will not be conducted without proper procedures developed and in place, and identification of good field conditions, including a large enough breeding population of cottontails. A portion of the cottontail rabbit population will be collected for destructive tissue analysis at the end of the sampling period. Animals collected will be sectioned into skin, gut, lungs, and the remainder of the animal for analysis. These parts of the animal correspond to dermal contact (skin), ingestion (gut), inhalation (lungs) and deposition in other body parts (remainder). In addition, the heart, lungs and liver will be examined for obvious lesions or other abnormalities.

Sampling Intensity

The trapping intensity for large mammals is dependent on the findings during the qualitative sampling. A preliminary goal for blood and hair analysis on rabbits would be 10 samples. If possible, 5 cottontail rabbits would be collected for destructive tissue analysis.

QA/QC Sample Schedule

Quality assurance/quality control will following procedures defined in SOP FO.02. Any variance from SOP will be described and the reason explained.

Sample Handling and Preservation

The details of the sampling procedures for the non-destructive histological sampling will be developed preceding the start of the field season. Animals collected for tissue analysis will be sacrificed by cervical separation or other appropriate technique for the larger mammals. The dead animal will be placed in a suitable container in a cooler with Blue or dry ice for no more than 4 hours. After 4 hours, samples must be immediately shipped to the analytical laboratory or placed in a freezer overnight or until shipped. Labeling, handling, and shipping of large mammals for laboratory analysis will be generally consistent with SOP EE.13. Samples collected for tissue analysis must follow the sample preparation and packaging specified by the laboratory protocols for the target analytes.

3.2.3.5 Soil Sampling

Objectives

Soils will be sampled for ecological meaningful parameters in the same locations as the vegetation and small mammals sample locations (see Figure 5-2). The soil parameters of importance are the concentrations of contaminants in the upper layer (0 to 36 centimeters), and the physical and chemical characteristics of the disturbed soil substrate supporting the vegetation.

Sample locations

The soil samples will be co-located with the vegetation and small mammals sample sites. These locations will be field determined at the time of the qualitative early surveys.

Collection methods

Soil will be collected and substrate profiles described from hand-dug pits at the sample locations after the vegetation and small mammal sampling has been completed. Soils will be collected at incremental depths down to 36 centimeters, and the profiles described for texture, consistency,

and root depths. Samples will be analyzed at a minimum for pH, exchangeable cations, bulk density, and concentrations of contaminants.

Terrestrial Sampling Matrix

A matrix of field sampling activities is presented in Table 5-1. This activity matrix will be revised as necessary according to the initial qualitative surveys for sample locations and numbers.

5.2.4 Schedule

An approximate schedule for conducting and completion of the work outlined in this TM is presented in Table 5-2. Decision points in this schedule for the timing of, and necessity for, a task are determined by seasonal and time constraints of the EE process. However, the process for these decisions is included in the EEWP.

Seasonal changes and weather patterns profoundly affect the required timing and results of ecological field sampling. The general timing of field activities will be subject to change in relationship to the seasons. The exact timing of the field sampling activities are dependent on rainfall and temperature during the growing season and the preceding winter's precipitation. To the extent possible, this timing will be adjusted to take into account these weather related factors.

5.3 LABORATORY ANALYSIS

Tissue samples collected will be analyzed for target analytes according to the contaminants of concern. The preliminary COCs have been determined as radionuclides (plutonium-239, plutonium-239/240, americium-240, total uranium); metals (arsenic, cadmium, total chromium, copper, lead, mercury, selenium, and zinc); and PCBs.

Tissues samples collected for target analyte analysis will be processed in accordance with SOPs and/or recognized laboratory practices appropriate to the type of tissue and target analyte involved. Analysis of tissue contaminant concentrations will provide direct proof that target taxa carry a body burden of target analytes, as well as a measure of the relationship between environmental concentrations and target taxa contaminant loads.

Histopathological tissue and blood samples will be processed for analysis or light microscopic examination in accordance with SOPs and/or recognized laboratory practices appropriate to the type of tissue or organ involved. Consideration should be given to measurement or staining techniques that are differentially sensitive to various target analytes or that discriminate against a particular suspected pathologic feature.

5.4 ECOLOGICAL RISK ASSESSMENT

Because the study area is known to have few ecological attributes at risk within its own boundaries, ecological risk in this context is defined as the probability for biological impacts and biotic vector transport of potentially toxic quantities of bioaccumulating or bioconcentrating contaminants outward from the study area at OU4, either to another OU or elsewhere. Therefore, unlike more typical ecological risk assessments, the study area risk assessment will address the following chain of logic:

- A. Are target analytes excluded, or accumulating and/or concentrating in target taxa at levels that may pose a threat either to that target taxa or their prey species?

IF NO, THEN NO ACTION

IF YES, THEN

- B. Are the contaminated target taxa capable of migration beyond the study area boundaries?

OR

- C. Are contaminated target taxa (if any) prey for highly mobile species that move beyond the study or study area boundaries?

ELSE

- D. There is presumed to be no risk of contamination of off-site biota by target taxa inhabiting the study area.

If conditions (A) and [(B) or (C)] are fulfilled, the conceptual biota transport model will be populated with measured target analyte concentration values. Quantitative estimates of off-site transport masses may be calculated by converting the conceptual model into a logic diagram and assigning probabilities to the steps in the model. These quantitative estimates will be made available to EEs being conducted at adjacent OUs to serve as input source terms for contaminants reaching these other OUs via the biota.

5.4.1 Remediation Criteria

Remediation criteria will be developed for contaminants for which a significant probability of impacts or transport is detected. Criteria will address remediation of the contaminant source so that remaining environmental concentrations and forms are not available for uptake and transport by target taxa or other ecological receptors. Contaminant concentrations in the environmental will be estimated using exposure assessments to calculate contaminant concentrations in abiotic media below which ecotoxicological effects are not expected to occur. The acceptable (no effects) criteria levels will be used in conjunction with ARARs to evaluate potential adverse effects from biotic transport of COCs. This approach will be integrated with the human health risk assessment process and will assist in development of potential remediation criteria.

5.4.2 Operable Unit Coordination

Work within the study area will be coordinated with the human health risk assessment, adjacent or off-site OU EE activities, and the site characterization studies for contaminants in abiotic environmental media. Potential sample sites for biota and contaminants will be coordinated with a modified FSP for soil and other source materials within the study area. To avoid duplication, the FSP will be tied into the one for OU6. COCs selected for study area EEs will suggest similar surveys, measurements, and sample collections on adjacent OUs, particularly OU6. Information developed for other OUs will be compared with information developed for the study area.

Currently, the potential for transport from surficial soils from the study area to the OU6 drainage is poorly understood. This potential will be better defined following the Phase I RFI/RI work. The EE will also define potential impacts to biota outside of the study area. The potential for transport by groundwater, surface water, and sediments will be fully evaluated during the Phase II RFI/RI process.

6.0 REFERENCES

- DOE, 1992a. Memorandum on Environmental Evaluations within the Production Areas of the Rocky Flats Plant. From United States Department of Energy, Rocky Flats Office to EG&G Rocky Flats, Inc. March 2, 1992.
- DOE, 1992b. Environmental Evaluation Technical Memorandum, Addendum to Final Phase I RFI/RI Work Plan, OU9. Golden, Colorado. June 1992.
- DOE, 1992c. Baseline Biological Characterization of the Terrestrial and Aquatic Habitats at the Rocky Flats Plant. Final Report. Golden, Colorado. September 1992.
- EPA, 1992. Framework for Ecological Risk Assessment. EPA/630/R-92/001. February 1992.
- EG&G, 1992a. Standard Operating Procedures Manual, Volume V, Ecology, Manual No. 5-21200-OPS-EE. Golden, Colorado. EG&G Rocky Flats, Inc. (Currently undergoing review)
- EG&G, 1992b. Standard Operating Procedures Manual, Volume I, Field Operations, Manual No. 5-21000-OPS-FO. Golden, Colorado. EG&G Rocky Flats, Inc. (revision 5/12/92).
- EG&G, 1991a. Assessment of Known, Suspect, or Potential Environmental Releases of Polychlorinated Biphenyls (PCBs), Preliminary Assessment/Site Description. Golden, Colorado. EG&G Rocky Flats, Inc.
- EG&G, 1991b. Threatened and Endangered Species Evaluation at the Rocky Flats Plant Site. Golden, Colorado. EG&G Rocky Flats, Inc., Environmental Management, NEPA Division. April 4, 1991.

TABLES

TABLE 4-1

GENERAL LIST OF SPECIES OF CONCERN FOR THE RFP

FEDERAL ENDANGERED SPECIES:

Birds

- American Peregrine Falcon (*Falco peregrinus anatum*)¹
- Peregrine Falcon (*Falco peregrinus*)^{1,4}
- Bald Eagle (*Haliaeetus leucocephalus*)⁴
- Whooping Crane (*Grus americana*)²
- Least Tern (*Sterna antillarum*)²
- Piping Plover (*Charadrius melodus*)²

Mammals

- Black-footed Ferret (*Mustela nigripes*)³

FEDERAL THREATENED SPECIES:

Plants

- Ute Ladies'-tresses (*Spiranthes diluvialis*)

Insects

- Pawnee Montane Skipper (*Hesperia leonard montana*)²

Birds

- Arctic Peregrine Falcon (*Falco peregrinus tundrius*)¹

FEDERAL CANDIDATE SPECIES:

Plants

- Colorado Butterfly Plant (*Gaura neomexicana* var. *coloradensis*) (C-1)
- Bell's Twinpod (*Physaria bellii*) (C-2)
- Alcove Bog Orchid (*Habenaria zothecina*) (C-2). This orchid is often identified as Northern Bog Orchid (*Habenaria hyperborea*). It would be advisable to key out the orchids in Woman Creek that Ebasco previously identified as *H. hyperborea* to be certain which species is present. This population was originally discovered after the flowering season was completed. Identification of a species can depend on the taxonomic authority used during keying.

Front Range Cinquefoil (*Potentilla effusa* var. *rupicola*) (C-2). This plant is variously identified as several synonyms in the plant keys. One synonym is *Potentilla hippiana*, which is present at RFP. It would be advisable to key specimens out to be sure which subspecies or variety is present. EG&G will have to consult with the listing recommendations to determine which taxonomic authority must be used to classify the RFP population.

Fish

Plains Topminnow (*Fundulus sciadicus*) (C-2)

Reptiles

Texas Horned Lizard (*Phrynosoma cornutum*) (C-2)

Birds

Southwestern Willow Flycatcher (*Empidonax traillii extimus*) (C-1)

Loggerhead Shrike (*Lanius ludovicianus*)⁴ (C-2)

Ferruginous Hawk (*Buteo regalis*)⁴ (C-2)

Western Snowy Plover (*Charadrius alexandrinus nivosus*) (C-2)

Mountain Plover (*Charadrius montanus*) (C-2)

Black Tern (*Chlidonias niger*) (C-2)

White-faced Ibis (*Plegadis chihi*) (C-2)

Mammals

Spotted Bat (*Euderma maculatum*) (C-2)

Fringed-tailed Bat (*Myotis thysanodes pahasapensis*) (C-2)

Kit (Swift) Fox (*Vulpes velox*) (C-2)

Preble's Meadow Jumping Mouse (*Zapus hudsonius preblei*)⁴ (C-2)

COLORADO SPECIES OF SPECIAL CONCERN:⁵

Plants

Forktip Threeawn (*Aristida basiramea*)⁴

Gay-feather (*Liatris ligulistylus*)

Toothcup (*Rotala ramosior*)

Black Spleenwort (*Asplenium adiantum-nigrum* = *A. andrewsii*) (C-3B)

Tulip Gentian (*Eustoma grandiflora*) This species has not been observed at RFP, but suitable habitat exists, and as recovery and succession continue, it may become established.

Yellow Stargrass (*Hypoxis hirsuta*)

Adder's Mouth Orchid (*Malaxis brachypoda*) This species could occur with *Spiranthes diluvialis*.

Fish

Common Shiner (*Notropis cornutus*)
Stonecat (*Noturus flavus*)

Birds

Barrow's Goldeneye (*Bucephala islandica*)
Long-billed Curlew (*Numenius americanus*) (C-3C)
Plains Sharp-tailed Grouse (*Tympanuchus phasianellus jamesi*)
Greater Sandhill Crane (*Grus canadensis tibida*)
American White Pelican (*Pelecanus erythrorhynchos*)

FOOTNOTES:

- 1) The species *Falco peregrinus* is listed as endangered wherever found in the coterminous 48 states. Some subspecies are listed separately.
 - 2) These species have historically used areas in the vicinity, and suitable feeding or residential habitat exists at RFP.
 - 3) This species was previously collected near RFP.
 - 4) This species is resident or regularly visits RFP.
 - 5) Colorado Species of Special Concern List includes species of concern to Colorado that are not included in federal lists.
- C-1 USFWS has enough data on file to indicate potential need for listing as threatened or endangered.
- C-2 USFWS has enough data on file to indicate the potential need for listing as threatened or endangered.
- C-3B These taxa are not recognized as distinct species by USFWS, but may be reevaluated in the future.
- C-3C These taxa have been proven more abundant than previously believed. USFWS may reevaluate them in the future.

SOURCES USED TO DEVELOP SENSITIVE SPECIES LIST

Endangered and Threatened Wildlife and Plants. 50 CFR 17.11 & 17.12. August 29, 1992. US Fish and Wildlife Service.

Endangered and Threatened Wildlife and Plants: Animal Candidate Review for Listing as Endangered or Threatened Species. 50 CFR Part 17. November 21, 1991. US Fish and Wildlife Service.

Endangered and Threatened Wildlife and Plants: Review of Plant Taxa for Listing as Endangered or Threatened Species. February 21, 1990. US Fish and Wildlife Service.

Colorado Statutes, Article 2, Title 33, Nongame, Endangered or Threatened Species Conservation Act. February 18, 1988. Colorado Division of Wildlife.

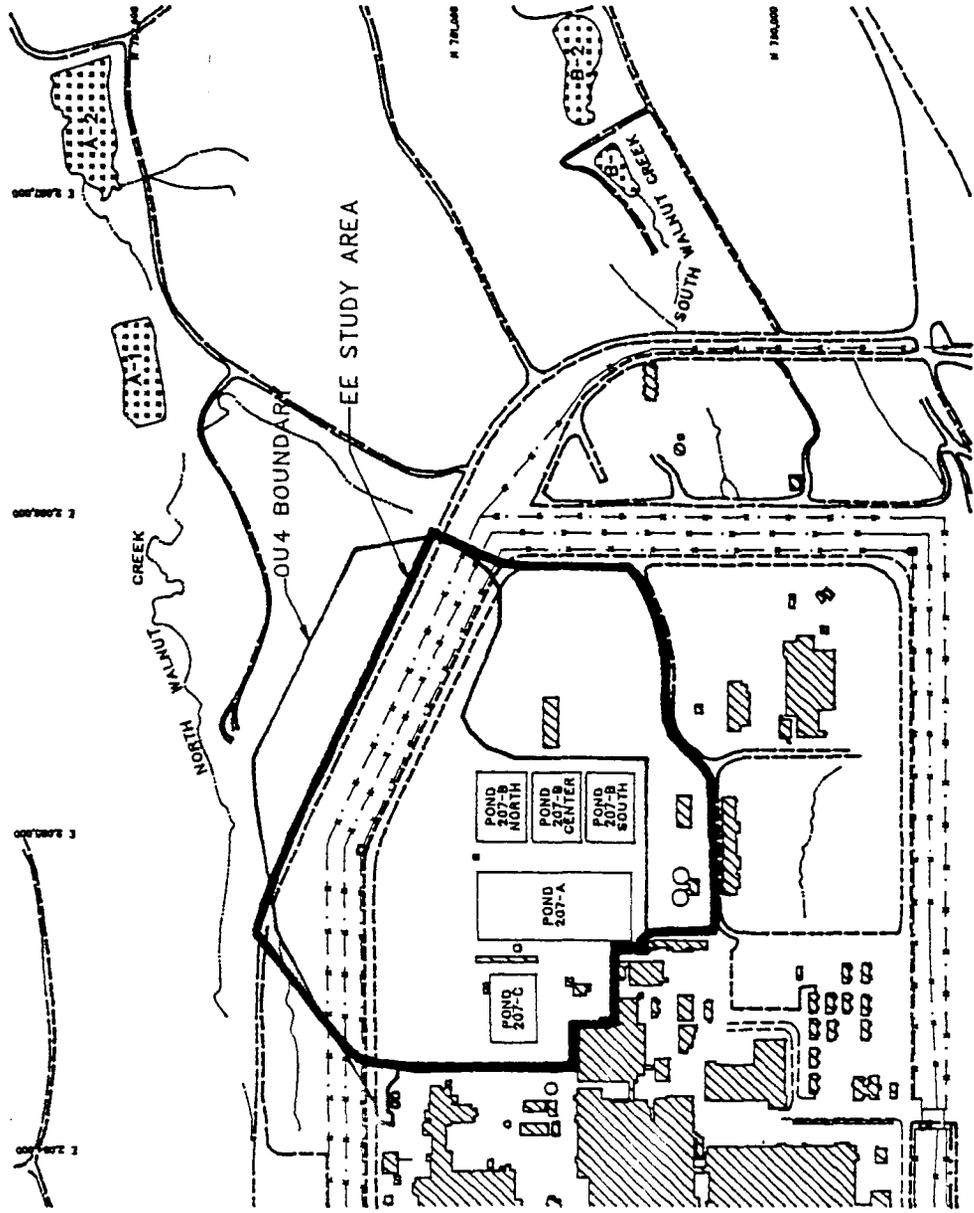
Draft amended list of Colorado Species of Special Concern/Species of Undetermined Status. May 1990. Colorado Division of Wildlife.

Colorado Plant Species of Special Concern. April 1991. Colorado Natural Areas Program.

TABLE 5-1
SUMMARY OF FIELD SAMPLING ACTIVITIES FOR TERRESTRIAL BIOTA FOR OU 4

ACTIVITY	PURPOSE	ANALYSES	LOCATIONS	NUMBER OF LOCATIONS	RATIONALE
Stage 1. Qualitative Field Surveys					
Habitat	Characterize site	Field reconnaissance	Entire site	--	Information needed for site characterization
Animal	Characterize species present	Species, relative abundance, habitat utilization	Entire site	--	Record species numbers, abundance, use of site
Vegetation	Characterize vegetation types	Field reconnaissance	Entire site	As needed	Record species composition, cover, and present conditions
Soil/substrate	Characterize substrates	Field observations	Selected locations	As needed	Surveys sufficient to determine substrate characteristics
Stage 2. Ecotoxicological Quantitative Field Sampling					
Vegetation	Characterize vegetation parameters, sample plant tissue	Species cover, density, biomass, COC's	Locations as shown on Figure 5-2	8	Vegetation analyses will determine biomass and uptake of contaminants
Small Mammals (deer/mice)	Measure contaminants in tissues	Contaminants	Co-located with vegetation and soils	5	Small mammals have the potential for contaminant uptake analysis
Large Mammals (cottontail)	Measure contaminants in herbivore	Contaminants	At areas of animal concentrations	Estimated at 4 locations	Animals have the potential for contaminant uptake
Soil Parameters	Measure contaminant concentrations	Contaminants and soil parameters	Co-located with vegetation sites	8	Soil contaminant levels will determine biotic uptake

FIGURES



LEGEND

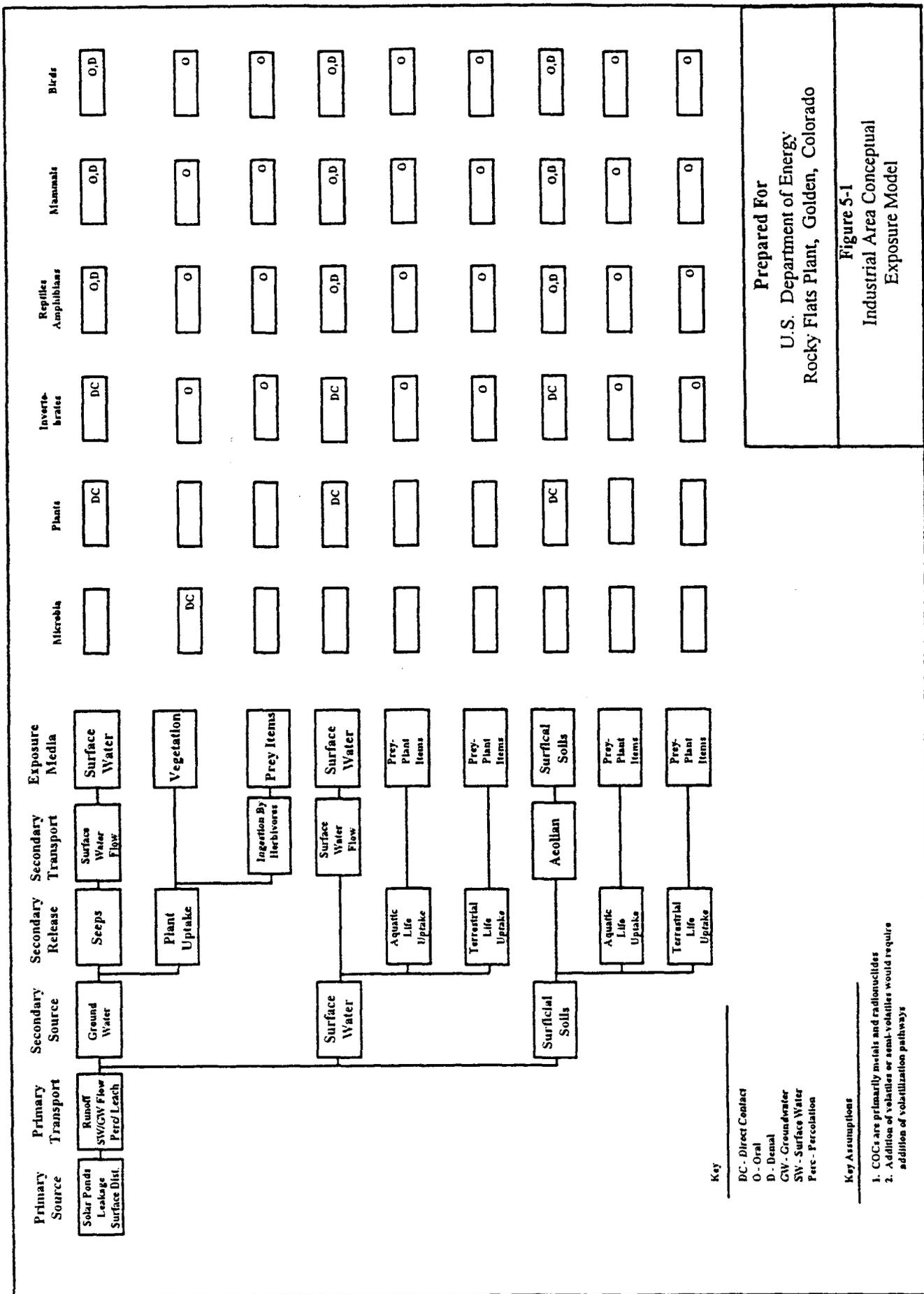
- ==== ROADS
- EE STUDY AREA
- OU4 BOUNDARY

SOURCE: FIGURE 2-1 AND 9-2
OU4 PHASE I RFI/RI WORK PLAN



PREPARED FOR
U.S. DEPARTMENT OF ENERGY
 ROCKY FLATS PLANT
 GOLDEN, COLORADO

FIGURE 3-1
 OU4 AND EE STUDY AREA
 BOUNDARIES
 SOLAR PONDS - OU4



Key

DC - Direct Contact
 O - Oral
 D - Denial
 GW - Groundwater
 SW - Surface Water
 Perc - Percolation

Key Assumptions

1. COCs are primarily metals and radionuclides
 2. Addition of volatiles or semi-volatiles would require addition of volatilization pathways

Prepared For
 U.S. Department of Energy
 Rocky Flats Plant, Golden, Colorado

Figure S-1
 Industrial Area Conceptual
 Exposure Model

