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ENVIRONMENTAL RESTORATION PROJECT

Memorandum

Risk Reduction & Environmental Stewardship (RRES)
Environmental Restoration (ER) Project, MS M992

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SUBJECT: LOS ALAMOS/PUEBLO SURFACE AGGREGATE REPORT – RECORD OF COMMUNICATION #1

The attached Record of Communication (ROC) provides the results of technical discussions held during meetings between the Los Alamos National Laboratory (LANL) project team and New Mexico Environment Department Hazardous Waste Bureau and Department of Energy-Oversight Bureau personnel between January and July 2002. The objective of the meetings was to reach agreement on technical aspects of a biota sampling program designed to meet the data requirements for an assessment of potential adverse ecological effects due to contamination in the Los Alamos/Pueblo Canyon watershed. Details of these meetings and the resulting technical strategy for biota data collection are presented in the ROC.

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This record of communication presents the proposed biological sampling for the Los Alamos and Pueblo Canyons Surface Aggregate Report (LAPSAR). The purpose for this communication is to document the acceptability of this proposed biological data collection for assessing potentially unacceptable adverse ecological effects when making decisions regarding risk management in Los Alamos and Pueblo Canyons. Additional data needs will be evaluated throughout the assessment process to ensure that a thorough and valid assessment of potential adverse ecological effects is achieved. It is understood that additional data may be necessary to meet the objectives of the ecological assessment.

The proposed biological sampling resulted from technical discussions held in ten meetings between the Los Alamos National Laboratory (LANL) LAPSAR project team and New Mexico Environment Department (NMED) Hazardous Waste Bureau (HWB) and Department of Energy Oversight Bureau (DOE-OB) personnel between January and July 2002. The dates and agenda for these meetings are summarized below.

- ✓ January 29, 2002 – kickoff meeting for discussions on the nature of the LAPSAR and the reasons to reach up-front agreements on the assessment approach for the ecological risk, human-health risk, and other applicable assessments
- ✓ February 19, 2002 – discussion of watershed attributes (location of water, general contaminant trends, land use, and location of threatened and endangered species habitat); review of reach (or interim) report scope/contents; use of the Superfund ecological risk assessment guidance (ERAGS); review list of programmatic issues
- ✓ March 4, 2002 – overview of geomorphic approach to sediment characterization
- ✓ March 18, 2002 – overview of ERAGS process; review of eco-risk findings from reach reports; updated screening assessment with additional sediment data to refine contaminants of potential ecological concern (COPECs)
- ✓ March 28, 2002 – continued to review findings of the hazard quotient (HQ) analysis to refine COPECs and identify assessment endpoints and associated measures
- ✓ April 11, 2002 – discussion of using anthropogenic concentrations as basis to eliminate COPECs and finding ways to account for naturally elevated concentrations of many constituents in Cerro Grande fire ash when screening for COPECs; review existing dioxin data and determine if dioxins are COPECs[1]; revisit hazard quotient analysis and develop assessment endpoints for terrestrial; format for biological sampling plan
- ✓ April 25, 2002 – presentation on draft assessment endpoints and associated measures for the terrestrial ecosystem
- ✓ May 7, 2002 – review of the endpoints, measures, and proposed study design for the terrestrial ecological assessment
- ✓ June 18, 2002 – tour of mammal sampling sites in Pueblo, Los Alamos, and Guaje Canyons
- ✓ July 18, 2002 – discussion of the results of the aquatic receptor and pathway screening and the proposed aquatic sampling methods and locations

Salient information distributed at these meetings has been added to the NMED Administrative Record for LANL. These documents are listed in Table 1.

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[1] Dioxins were not measured in pre-Cerro Grande fire deposits in Los Alamos/Pueblo Canyon sediments. One dioxin source was identified in Pueblo Canyon (PRS 73-002); however, data were presented to show decreasing trends from the source area into Pueblo Canyon. Thus, dioxins were not considered COPECs for LAPSAR biological sampling addendum.

Table 1: List of Materials from LAPSAR Meetings Placed in NMED Administrative Record

Meeting Date	Materials Provided
1/29/02	LA/PC Surface Aggregate Report slides from 1/16/02
2/19/02	Water and sediment sampling summary
3/6/02	Geomorphic approach summary
3/18/02	Problem Formulation slides Draft Revised Sediment Eco-screen Meeting notes
3/28/02	Soil_COPECs_box_plots_TA-2_fixed.doc Sediment data pivot tables (3) COPEC notes
4/11/02	Canyons_TRVs.xls (spreadsheet of sources/values for benchmarks) Map of dioxin data from PRS 73-002 Dioxins TEQs Data Request Dioxin plots HI plots Terrestrial receptor HQ Table notes Podolsky thesis on metal contaminants
4/18/02*	HQ for max values for shrew, robin, plant, invert LAPSAR meeting notes sent 4/19/02 Metals Pre-and post-fire (summary sheet only) WRS results for selected metals
4/25/02	Graphs of revised HQ values for canyon contaminants Tables of HQs for robin, invert, plant, and shrew Table of LAPSAR contaminants
4/30/02*	LAPSAR Assessment Endpoints and Associated Measures-Terrestrial
5/02/02*	Graphs of revised HQs Stats by subreach_rev3
5/7/02	5/8/02 draft record of communication
7/18/02	Meeting agenda Email from Ryti to Olson on aquatic screening notes Water screening table for aquatic receptors and wildlife Water COPEC plots Sediment screening table for aquatic receptors and aerial insectivores Sediment COPEC plots Sediment screening table for terrestrial receptors Proposed locations for aquatic toxicity testing using *Chironomus tentans*
8/12/02*	Weight of evidence forms

* No meeting; follow-up document sent by email

Terrestrial Study Design

To evaluate the terrestrial ecological effects of COPECs in Los Alamos and Pueblo Canyons, the Environmental Restoration (ER) Project LAPSAR Team and representatives of HWB identified the valued biological entities, characterized the attributes of these entities potentially at risk, and discussed how the attributes might be measured. Sampling designs to provide additional information on these measurements were then developed and are summarized in Attachment 1.

What are the potentially affected biota for Los Alamos and Pueblo Canyons?

Threatened and endangered (T&E) raptor species (primarily Mexican spotted owl) and species that are representative of the terrestrial food web in Los Alamos and Pueblo Canyons include

1. Avian ground invertevores (e.g., robins and blue birds)
2. Mammalian invertevores (e.g., shrews and deer mice)
3. Detritivores (earthworms and other soil organisms)
4. Primary producers (plants)

These four feeding guilds represented the receptors with the largest HQ for COPECs. T&E species were included because of their special status and because of the sensitivity of avian receptors to some COPECs.

What are the attributes of these entities at risk?

Information on the COPECs is derived from the ECORISK Database (March 2002 version). Screening levels are based on existing toxicity information for terrestrial plants and animals and are equivalent to "no adverse effect" concentrations. Toxicity information as documented in the ECORISK database is primarily based on adverse effects on reproduction or survival for individual organisms measured in laboratory toxicity studies. Some toxicity values are also based on other ecologically relevant effects (e.g., reduced body weight). Screening of maximum concentrations against ecological screening levels (ESLs) for terrestrial receptors yielded a list of 29 COPECs. For nine COPECs the HQ for the maximum concentration in the watershed was less than five, and these COPECs were not considered further for the purposes of developing the terrestrial study design.

COPECs with HQ between 1 and 5 based on the maximum watershed concentration would not warrant special biological studies because maxima are overly protective compared to central tendency values that are considered more representative of exposure levels. These COPECs were categorized into groups that included analytes with ubiquitous HQ (or ratio of sediment concentration to ESL) values >> 1, analytes within localized areas that have HQ values >> 1, and analytes with most HQ values < 1 (Table 2). Analytes in the first group primarily include metals that are elevated in concentration in post-Cerro Grande fire deposits. Analytes in the second group include DDT (plus metabolites) and PCBs (Aroclor-1254). Potential adverse effects of these COPECs on plants and animals include decreased reproduction or increased mortality. Analytes in the third group also have elevated HQ values across the canyons but at lower levels than the first group. Analytes in the fourth group have HQ values close to or less than one for the subreach average data, suggesting that they are unlikely to be risk drivers.

For T&E species, adverse impacts on individual Mexican spotted owls are a key concern. Because the owl does not currently nest in Los Alamos and Pueblo Canyons, the potential for adverse effects will be investigated through empirical studies of body burdens in prey species and

modeling of the dose to owl resulting from the levels seen in soil and prey items. Foraging patterns and nest locations of owls will be based on information available from the literature and from spotted owl field studies on other parts of LANL.

For species more broadly representative of the food web in Los Alamos and Pueblo Canyon, potential for adverse effects on animal populations also are a concern. For detritivores potential decreases in nutrient cycling rates is an issue, while for plants maintaining the diversity of native plant species is the primary issue.

How will the attributes be measured and what are the potential uncertainties associated with these measures?

For each assessment endpoint, measures of exposure (e.g., sediment concentrations, concentrations in food), measures of effects (e.g., results of toxicity bioassays, literature toxicity information), and measures of ecosystem/receptor characteristics (e.g., nesting habitat, foraging habitat) were developed. Potential confounding factors affecting the assessment include changes in population structure and dynamics as a result of wildfire impacts to areas upstream of the study areas; residence time of species in the canyons; elevation, slope and aspect; and drought conditions in 2001–2002. The sewer line upgrade in Pueblo Canyon and the planned decontamination and decommissioning (D & D) activities at TA-2 in Los Alamos Canyon are other potentially confounding factors.

Table 2. Synopsis of Terrestrial HQ Analysis of LAPSAR Potential Contaminants

COPEC	Los Alamos & DP	Acid & Pueblo	Receptor with Largest HQ for COPEC
Acenaphthene	0	0	N/A
Americium-241	0	0	N/A
Antimony	1	3	Plant
Antimony detects only	2	2	Plant
Aroclor-1254	2	2	Shrew, robin
Aroclor-1260	0	0	N/A
Arsenic	3	2	Shrew
Barium	1	1	Shrew
Bis-2-ethylhexyl phthalate	0	0	N/A
Cadmium	4	4	N/A
Chromium VI/III=1/6	1	2	Plant, invertebrate
Chrysene	0	0	N/A
Cobalt	1	1	Robin, shrew
Copper	0	0	N/A
Cyanide	*	*	N/A
DDE	2	2	Robin
DDT	2	2	Robin
Endrin aldehyde	2	2	Plant, robin
Lead	0	0	N/A
Manganese	3	3	Plant
Methyl mercury	0	0	N/A
Mercury	2	2	Invertebrate
Naphthalene	3	3	Robin
Naphthalene detects only	3	3	Robin
Plutonium-239, -240	4	2	Invertebrate
Selenium	3	3	Plant
Silver	2	2	Shrew, plant
Thallium	4	3	Plant, shrew
Titanium	4	2	Shrew
Uranium	0	0	N/A
Zinc	3	2	Plant

N/A = not applicable
* = Too few samples
0 = HQ for maximum concentration less than 5, dropped as COPEC for biological sampling
1 = high HQs occur over most of the canyon
2 = high HQs occur at particular spots within canyon
3 = lower but still elevated HQs occur over most of the canyon
4 = HQs are close to target hazard goal or background HQ throughout canyon; therefore this constituent is unlikely to be a risk driver

Aquatic Study Design

The results of the numerical water/sediment screening were used to inform an approach to evaluate the potential for adverse effects from COPECs in water and sediment for aquatic pathways and receptors. The process used to develop the aquatic study design differs in approach and complexity from the terrestrial design because of the limited nature of aquatic environments in Los Alamos and Pueblo Canyons.

The receptors potentially at risk from aquatic pathways for COPECs in water/sediment include

1. Wildlife receptors (mouse, shrew, cottontail, fox, bat, robin, kestrel, swallow) through the drinking water pathway
2. Aerial insectivores (bat, swallow) through food chain exposure to COPECs in sediment
3. Aquatic community (e.g., benthic macroinvertebrates, algae)

Based on the numerical screening of the water data, the drinking water pathway to terrestrial receptors is not an important means for potential adverse effects of COPECs[2]. It was also decided that the aerial insectivores did have the potential for adverse effects from COPECs in sediments but that special investigations of this feeding guild are not warranted. The first and most important reason is that water resources in Los Alamos and Pueblo Canyons are limited in spatial extent and are of a more ephemeral than perennial nature. This limited extent directly reduces the potential for maintaining either individuals or populations of aerial insectivores on emergent insects from these resources. Second, the invertebrate feeding guild is being thoroughly assessed for the terrestrial receptors, and this information from the terrestrial studies may provide some information on the importance of the insect-eating pathways from aquatic environments.

Based on this reasoning, a single assessment endpoint for the aquatic study design was selected. This endpoint is the protection of the aquatic community in the more persistently wet segments of Los Alamos and Pueblo Canyons. The selected measure, *Chironomus tentans* growth and mortality (EPA method 100.2), was also used in the Cañon de Valle aquatic study design. The advantage of using the Cañon de Valle measure of effect is that the results from the additional 12 locations in the Los Alamos and Pueblo watershed can be evaluated in combination with the Cañon de Valle locations. This analysis could result in developing LANL-specific screening levels for water and sediment. The aquatic study design is presented in Attachment 2.

Deviations

Deviations to the proposed terrestrial and aquatic study designs are documented in Attachment 3. At each location there will be a toxicity test using *Chironomus tentans* to evaluate effects on growth and mortality. The results of the tests will be compared to the reference location for either persistent water or dry using Dunnett's T-Test. The water/sediment or sediment will also be collected for chemical analysis for the following analytical suites: metals, cyanide, PAHs, PCBs, pesticides, Am-241, Sr-90, isotopic plutonium, gamma spectroscopy radionuclides. Information from the toxicity tests will be evaluated versus COPEC concentrations in the water and sediment. Depending on the nature of the toxicity test results, it may be possible to evaluate a response in growth or mortality versus concentration.

In addition to these tests, notes on the physical condition of the location sampled for toxicity tests will be maintained. Field parameters (i.e., total dissolved solids [TDS], pH, conductance) will be collected. A rapid bioassessment characterization (Barbour et al. 1999) will also be conducted for each location with sufficient water near the end of the rainy season (late August or September). In

[2] The contribution of the drinking water pathway was documented in materials presented at the 7/18/02 meeting. It was also decided at the 7/18/02 meeting that isotopic uranium did not need to be included in the aquatic analyte suite. The suite for chemical analysis of water/sediment is to be metals (aluminum, antimony, arsenic, barium, beryllium, cadmium, calcium, total chromium, cobalt, copper, iron, lead, magnesium, manganese, mercury, nickel, potassium, selenium, silver, sodium, thallium, titanium, vanadium, zinc), total cyanide, PAHs, pesticides, PCBs, Am-241, Sr-90, gamma spectroscopy radionuclides, and isotopic plutonium.

addition to the physicochemical parameters listed above, the rapid bioassessment will include habitat ratings for a 50-m reach based on watershed features, riparian vegetation, in-stream features, aquatic vegetation, and benthic substrate. Aquatic invertebrate samples will be collected under standardized effort (*e.g.*, time, spatial coverage) using an aquatic dipnet in order to sample the major habitat types present in the reach. Samples will be picked and preserved in the field. The invertebrate specimens will be identified in the lab and analyzed using a set of 10–12 metrics that have been shown to be robust across wide geographic areas, including measures of diversity, community composition, feeding groups, and tolerance to perturbation (DeShon 1995; Barbour et al. 1996; Fore et al. 1996). These metrics will be used in a semi-quantitative manner to support characterization of the test sites. Results from test sites will be compared to the reference location to evaluate the level of impairment. Up to four additional reference locations will be sampled if necessary to establish an expected condition. The results of the rapid bioassessment will be used to evaluate site quality independently of contaminants and provide information about the ecological characteristics of the aquatic community.

References

Barbour, M.T., J Gerritsen, G.E. Griffith, R. Frydenborg, E. McCarron, J.S. White, and M.L. Bastian, 1996. "A Framework for Biological Criteria for Florida Streams Using Benthic Macroinvertebrates," *Journal of the North American Benthological Society* 15(2):185-211.

Barbour, M.T., J Gerritsen, B.D. Snyder, and J.B. Stribling, 1999. "Rapid Bioassessment Protocols for Use in Streams and Wadable Rivers: Periphyton, Benthic Macroinvertebrates, and Fish," Second Edition. EPA 841-B-99-002. US Environmental Protection Agency; Office of Water; Washington DC.

DeShon, J.E., 1995, "Development and Application of the Invertebrate Community Index (ICI)" in W.S. Davis and T.P. Simon (eds.) *Biological Assessment and Criteria: Tools for Water Resource Planning and Decision Making.* Lewis Publishers, Boca Raton, Florida.

Fore, L.S., J.R. Karr, and R.W. Wisseman, 1996. "Assessing Invertebrate Responses to Human Activities: Evaluating Alternative Approaches," *Journal of the North American Benthological Society* 15(5): 212-231.

Attachment 1: Proposed Terrestrial Study Design for Los Alamos/Pueblo Surface Aggregate Report

Seven measures (or lines of evidence) are proposed for the terrestrial ecological effects evaluation. The relationship between these measures and the assessment endpoints is depicted in Table 1.1.

(1) Small mammal study

Objectives: measure of exposure (body burden) for spotted owl, measure of effect (food abundance) for spotted owl, measure of effect (abundance, diversity) for mammalian invertevore feeding guild.

Spatial coverage: four areas were selected as representative of potential spotted owl nesting, specifically, sediment deposits with key COPECs for owl and mammal invertevore. The areas represent post-Cerro Grande fire deposits. (Note: these areas are not expected to be habitats of the shrew, which is the most sensitive small mammal in the ecological screening evaluation.) The rationale for selecting these reaches is provided in Table 1.2.

- ✓ Reaches LA-1C, AC-3, P-3W near Hamilton Bend upstream of Bayo Wastewater Treatment Plant (WWTP); the outfall is not impacted by the 2002 sewer line upgrade in Pueblo Canyon
- ✓ Guaje Canyon: dry area site will be selected to match vegetation in reaches LA-1C and P-3W

Temporal coverage: summer (post-snow melt, but no appreciable snow melt in 2002 because of drought conditions); fall (post-monsoon).

Trapping design: use same trapping grid as used in the Cañon de Valle investigation.[3] One hundred traps per array (5-by-20 pattern, two arrays per location). Coordinates of locations will be estimated by GPS, and there will also be reconnaissance pitfall trap sampling for shrews at each location.

Sampling and analysis—body burden: Collect six animals per location per species since six animals are required to meet the minimum power for detecting median shifts (see Cañon de Valle design), and this number also corresponds to the minimum needed for basic statistical data plots (e.g., box plots) for PCBs, pesticides, and metals (aluminum, antimony, arsenic, barium, beryllium, cadmium, calcium, total chromium, cobalt, copper, total cyanide, iron, lead, magnesium, manganese, mercury, nickel, potassium, selenium, silver, sodium, thallium, titanium, vanadium, zinc) analysis. Detection limits in fresh weight for PCBs = 0.27 mg/kg; DDE/DDT = 0.019 mg/kg; total cyanide = 0.1 mg/kg; cobalt = 3.6 mg/kg. These levels are based on the avian toxicity reference values (TRVs) and food intake of the spotted owl (see Table 1.3). The sample mass needed to attain these detection limits will be determined by contacting the analytical laboratory. Currently we assume that only one animal will be needed for all analyses. Additional animals will be collected (if possible) for possible analysis by NMED or because of other contingencies (e.g., data quality problems).

Risk Characterization—abundance/diversity: elevation, presence of flowing water, presence/absence of ash deposits, and plant abundance/species composition are expected to be

[3] "Baseline Ecological Effects Characterization for Terrestrial Receptors in a Semi-Arid Canyon with Perennial Flow." Los Alamos National Laboratory Report, LA-UR-01-6515, December 2001.

confounding factors. We propose an exploratory data analysis (EDA) to evaluate the importance of these factors before evaluating trends in small mammal abundance/diversity over these locations. The EDA will include scatter plots to evaluate trends in abundance or body burden along gradients in elevation or COPEC concentrations; the EDA will also include correlation analysis using parametric and nonparametric statistical methods. To evaluate potential adverse or beneficial effects of fire abundance/diversity, information from burned (or ash-impacted areas) will be compared to unburned areas using box plots and statistical analyses. Information from the scientific literature and other studies at LANL will be used as secondary information to support the interpretation of adverse effects. The primary tool for risk characterization of abundance/diversity is trend analysis versus predicted HQ for key COPECs (PCBs, barium, cobalt).

Risk Characterization—bioaccumulation: estimate the central tendency and upper bound (95% upper confidence limit) of body burdens for PCBs, pesticides, and metals as well as estimate a model relating body burdens to sediment concentrations by location (see item (1a) below). Confounding factors include the drought, the reactor D&D in Los Alamos Canyon, the presence or absence of ash, elevation, and slope/aspect.

(1a) Sediment characterization

Objectives: supporting as a measure of exposure (body burden) for wildlife receptors in the four areas being trapped for small mammals. This information is needed because sediment sample results are not available for all COPECs in Guaje Canyon. This information will help supplement characterization of reaches in Los Alamos and Pueblo Canyons and permit comparisons with calculated COPEC concentrations based on area-weighted concentration calculations (see the reach reports for more information).

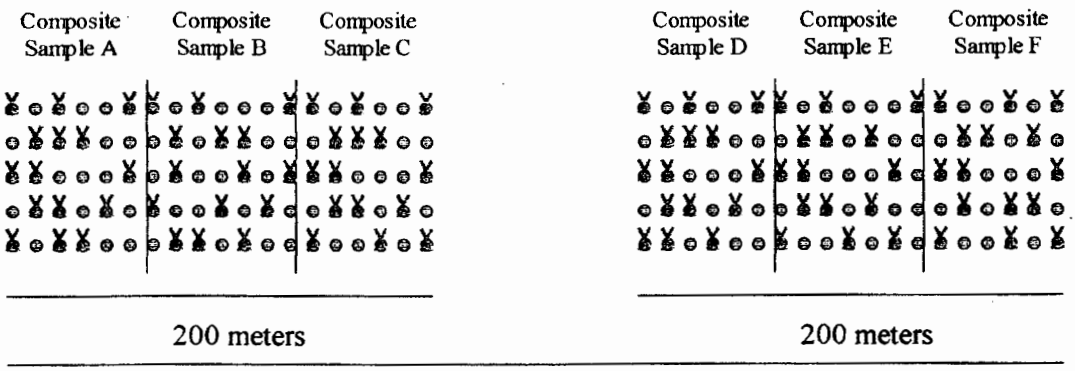
Spatial coverage: the four areas selected for small mammal trapping

- ✓ Reaches LA-1C, AC-3, P-3W near Hamilton Bend, upstream of Bayo WWTP outfall. This area is not impacted by the 2002 sewer line upgrade in Pueblo Canyon.
- ✓ Guaje Canyon: 500 m length of dry area (the site will be selected to match vegetation in reaches LA-1C and P-3W)

Temporal coverage: collected in summer 2002 to represent current exposure concentrations.

Sampling design—sediment: collect representative samples for PCBs, pesticides, and metals in small mammal trapping array locations. Each sediment sample will be collected from 0 to 6 in. (0–15 cm) depths at each of the small mammal trapping arrays. The 0–6 in. interval was selected because it represents the surface exposure concentrations for these animals under the assumption that most exposure occurs during foraging and not in building or maintaining underground burrows. A trapping array is roughly 200-m by 50-m. Five trapping lines are placed parallel to the axis of the canyon with 10 m trap spacing. Samples for compositing will be collected within one-third of the array length (roughly 65-m by 50-m or about equal to a deer mouse's home range). Within each trap line of each array three locations, picked at random out of the 6–7 trap locations within the 65-m by 50-m plot, will be selected for compositing. The composite for each location will therefore be based on 15 subsamples: three samples per trap line times five trap lines (see figure below). A total of 24 sediment samples will be collected for the small mammal arrays (three composite samples from four locations, two arrays per location). Samples will be collected to a depth of six in., with equal aliquots from each individual sample in a composite. Samples will be field composited for metals, cyanide, PCBs, and pesticides so each trapping array will have three composite samples for analysis. The sediment will be described at each sampling location to

help interpret the chemical results from the interval submitted for analysis (e.g., ash-laden sediment would be expected to contain elevated concentrations of metals).



X Composite sample aliquot collected at random within trap line

Risk Characterization: use sediment concentrations as exposure concentrations for wildlife in ECORSK.6 modeling. We will generate an estimate of central tendency and upper bound (95% upper confidence limit) of sediment concentrations for PCBs, pesticides, and metals and use this information to develop a model relating body burdens (see (1) above) to sediment concentrations. Confounding factors include the drought, the reactor D&D in Los Alamos Canyon, the presence or absence of ash, elevation, and slope/aspect.

(2) Nest box study

Objectives: measure of effect (occupancy, nest success, eggshell thickness, sex ratio [see note on eggs]) for avian ground invertevore, measure of exposure. Note: regarding egg concentrations, females dump contaminants into eggs, and thus eggs provide measure of exposure for avian ground invertevore.

Spatial coverage: sediment deposits with a gradient in COPEC concentrations, areas representing post-Cerro Grande fire ash deposits; the rationale for selecting these reaches is provided in Table 1.2.

- ✓ Use existing nest box network
- ✓ Add nest boxes in reaches LA-0, LA-1FW, LA-1W, LA-1C, LA-1E, LA-2W, AC-1, AC-2, AC-3, ACS, P-1FW, P-1W, P-1E (roughly 75 more nest boxes). Reaches P-1W through P-2W are disturbed because of the post-fire flooding and the 2002 sewer line upgrade; other reaches in Pueblo Canyon are also disturbed from post-fire flooding.
- ✓ Add nest boxes in Guaje Canyon in the 500 m long reach where the small mammal study is being conducted.

Temporal coverage: breeding season.

Network design: use 50–75 m nest box spacing, the same as the rest of network.[4]

Sampling design—sediment: use sediment information from (1a) for the small mammal investigation reaches; sediment samples for other reaches will use existing data representative of surface exposure concentrations (sample depths that include 0–6 in. depth).

Sampling design—eggs: use results from analysis of PCBs, pesticides, and metals for eggs collected in Los Alamos and Pueblo Canyons for the ongoing nest box study. (Note that blue birds sometimes double clutch, and the second clutch would reflect on-site exposure as opposed to a combination of winter and summer intake.)

Risk Characterization—nest occupancy/success/eggshell thickness: elevation, openness of canyon, and plant abundance/species composition are expected to be confounding factors. We propose an EDA to evaluate the importance of these factors before evaluating trends in nest occupancy/success/eggshell thickness over these locations. The EDA will include scatter plots to evaluate trends in nest occupancy/success/eggshell thickness along gradients in elevation or COPEC concentrations. The EDA will also include correlation analysis using parametric and nonparametric statistical methods. To evaluate potential adverse or beneficial effects of fire abundance/diversity, information from burned (or ash-impacted areas) will be compared to unburned areas using box plots and statistical analyses. Information from the scientific literature and other studies at LANL will be used as secondary information to support the interpretation of adverse effects. The primary tool for risk characterization of abundance or diversity is trend analysis versus predicted HQ for key COPECs (DDT, PCBs, cobalt).

Risk Characterization—bioaccumulation: generate estimate of central tendency and upper bound (95% upper confidence limit) of egg concentrations for PCBs, pesticides, and metals; estimate model relating egg concentrations to sediment concentrations by location. Confounding factors include the drought, the reactor D&D in Los Alamos Canyon, and the sewer line upgrade in Pueblo Canyon.

Note that a Population Viability Assessment (PVA) is underway for long-term nest box studies on bluebirds in the west. Information from this PVA will help determine the population impact of changes in reproduction/mortality.

(3) Plant survey

Objectives: measure of effect (abundance/diversity) for primary producer, measure of receptor characteristics of key species, e.g., vegetation is an indicator for the presence/absence of bird species, including the Mexican spotted owl) for other endpoints.

Spatial coverage: sediment deposits with a gradient in COPEC concentrations, areas representing post-Cerro Grande fire ash deposits; the rationale for selecting these reaches is provided in Table 1.2.

- ✓ Reaches LA-0, LA-1W, LA-1C, LA-2W, LA-3, DP-2, AC-3, P-3W, P-3E
- ✓ Guaje Canyon: located in the 500 m long reach where the small mammal study is being conducted

[4] "Avian Individual and Population Health Status on Los Alamos National Laboratory, 2001 Update," J. Fair. Los Alamos National Laboratory Report LA-UR-02-0779.

Temporal coverage: the summer growing season (the spring growing season is impacted by the drought).

Sampling design—plants: use the design from Los Alamos and Guaje Canyon report[5] and consistently use the protocols outlined in the Quantitative Habitat Analysis quadrats (D. Keller, pers. comm.)

Sampling design--sediment: use sediment information from (1a) for the small mammal investigation reaches. Sediment samples for other reaches will use existing data representative for rooting depth exposure concentrations (sample depths that include 0–6 in. depth)

Risk Characterization—abundance/diversity: elevation, openness of canyon, and presence of flowing water are expected to be confounding factors. We propose an EDA to evaluate the importance of these factors before evaluating trends in plant abundance/diversity over these locations. The primary tool for risk characterization of abundance/diversity is trend analysis versus predicted HQ for key COPECs (metals). The EDA will include scatter plots to evaluate trends in plant abundance/diversity along gradients in elevation or COPEC concentrations; the EDA will also include correlation analysis using parametric and nonparametric statistical methods. To evaluate potential adverse or beneficial effects of fire abundance/diversity, information from burned (or ash-impacted areas) will be compared to unburned areas using box plots and statistical analyses. Information from the scientific literature and other studies at LANL will be used as secondary information to support the interpretation of adverse effects.

(4) Breeding bird survey

Objectives: measure of effect (abundance/diversity) for avian ground invertevore.

Spatial coverage: sediment deposits with a gradient in COPEC and areas representing post-Cerro Grande fire ash deposits. The rationale for selecting these reaches is provided in Table 1.2.

- ✓ Reaches LA-0, LA-1W, LA-1C, LA-2W, LA-3, DP-2, AC-3, P-3W, P-3E
- ✓ Guaje Canyon: 500 m long reach where the small mammal study is being conducted

Temporal coverage: the breeding season.

Sampling design--point counts: every 1000 m [2–3 per subreach] three times during breeding season.

Sampling design--sediment: use sediment information from (1a) above for the small mammal investigation reaches; sediment samples for other reaches will use existing data representative for surface exposure concentrations (sample depths that include 0–6 in. depth).

Risk Characterization—abundance/diversity: elevation, openness of canyon, and presence of flowing water are expected to be confounding factors, We propose an EDA to evaluate the importance of these factors before evaluating trends in abundance/diversity over these locations. The EDA will include scatter plots to evaluate trends in abundance/diversity along gradients in elevation or COPEC concentrations; EDA will also include correlation analysis using parametric and nonparametric statistical methods. To evaluate potential adverse or beneficial effects of fire abundance/diversity, information from burned (or ash impacted areas) will be compared to

[5] "Ecological Baseline Studies in Los Alamos and Guaje Canyons, County of Los Alamos, New Mexico," compiled by T.S. Foxx. Los Alamos National Laboratory Report LA-13065-MS, November 1995.

unburned areas using box plots and statistical analyses. Information from the scientific literature and other studies at LANL will be used as secondary information to support the interpretation of adverse effects. The primary tool for risk characterization of abundance/diversity is trend analysis versus predicted HQ for key COPECs (metals).

(5) Earthworm bioassay
Objectives: measure of effect (mortality) for detritivores.

Spatial coverage: sediment deposits with a gradient in COPEC and areas representing post-Cerro Grande fire ash deposits. The rationale for selecting these reaches is provided in Table 1.2.

- ✓ Reaches LA-0, LA-1W, LA-1C, LA-2W, LA-3, DP-2, AC-3, P-3W, P-3E
- ✓ Guaje Canyon: 500 m long reach where the small mammal study is being conducted

Temporal coverage: not applicable for single-event laboratory tests.

Sampling design: use American Society for Testing and Materials (ASTM) design for each location (ASTM E1676-97).

Sampling design--sediment: submit sediment sample for PCBs, pesticides, metals analysis for each location tested. The locations will be selected based on the existing geomorphic characterization and sediment characterization results in these reaches.

Risk Characterization: look for statistical significant changes in survival for sediments tested.

(6) Seedling germination
Objectives: measure of effect (germination) for primary producers.

Spatial coverage: sediment deposits with a gradient in COPEC concentrations, areas representing pre- and post-Cerro Grande fire ash deposits, the rationale for selecting these reaches is provided in Table 1.2.

- ✓ Reaches LA-0, LA-1W, LA-1C, LA-2W, LA-3, DP-2, AC-3, P-3W, P-3E
- ✓ Guaje Canyon: 500 m long reach where the small mammal study is being conducted

Temporal coverage: not applicable for single-event laboratory tests.

Sampling design: use ASTM design for each location (use wheat seeds or native seeds—discuss options with bioassay vendor [ASTM E1963-98]).

Sampling design—sediment: submit sediment sample for PCBs, pesticides, and metals for each location tested.

Risk Characterization: look for statistical significant changes in germination for sediments tested.

(7) ECORSK.6
Objectives: measure of effect (Hazard Quotient) for wildlife receptors.

Spatial coverage: modeled parts of Los Alamos/Pueblo watershed.

- ✓ Reaches LA-0, LA-1W, LA-1C, LA-2W, LA-3, DP-2, AC-3, P-3W, P-3E
- ✓ Guaje Canyon: 500 m long reach where the small mammal study is being conducted

Temporal coverage: not applicable.

Sampling design: none, but will use empirical bioaccumulation data and improved TRV information.

Risk Characterization: look for individual effects on spotted owl via Hazard Index (HI) >1, and measure of population effects on invertevore species by proportion of population with HI>1. See Gonzales et al.[6] for more information on the ECORSK.6 model and its application.

[6] "Tier 2 Ecological Risk Assessment of the Los Alamos National Laboratory Institutional Issues on the Pajarito Plateau Using ECORSK.6," G.J. Gonzales et al. Draft Los Alamos National Laboratory Report, November 2000.

Table 1.1. Crosswalk Between Terrestrial Endpoints and Proposed Measures

Measure	Endpoints (species)				
	T & E species (Mexican Spotted Owl)	**Avian Ground Invert. Feeding Guild (bluebird)**	**Mammalian Invert. Feeding Guild (shrew, deer mouse)**	**Detritivores (earthworm)**	**Primary Producers (plants)**
Small mammal field survey	Effect–body burdens Effect–food availability	N/A	Effect–abundance/ diversity	N/A	N/A
Nest box field survey	N/A	Effect–occupancy, nest success, eggshell thickness Exposure–egg concentrations	N/A	N/A	N/A
Plant field survey	Receptor characteristics–nesting/foraging ranges	Receptor characteristics–nesting/foraging ranges, species	Receptor characteristics–species	Receptor characteristics–species	Effect–abundance/ diversity
Breeding bird survey	N/A	Effect–abundance/ diversity	N/A	N/A	N/A
Earthworm bioassay	N/A	N/A	N/A	Effect–mortality	N/A
Seedling germination	N/A	N/A	N/A	N/A	Effect–regeneration
ECORSK.6	Effect–comparison to TRVs	Effect–comparison to TRVs	Effect–comparison to TRVs	N/A	N/A

N/A = Not applicable

Effects Questions for Assessment Endpoints:

Mexican Spotted Owl: Do elevated concentrations of COPECs in sediments in Los Alamos and Pueblo Canyons lead to decreased survival and/or reproduction of Mexican Spotted Owls?

Avian Ground Invertevore Feeding Guild: Do elevated concentrations of COPECs in sediments in Los Alamos and Pueblo Canyons lead to decreased species diversity, population abundance and/or persistence of avian ground invertevore feeding guild species (e.g., robin, blue bird, ash throated flycatcher, etc.)?

Mammalian Invertevore Feeding Guild: Do elevated concentrations of COPECs in sediments in Los Alamos and Pueblo Canyons lead to decreased species diversity, population abundance and/or persistence of mammalian invertevore feeding guild species (e.g., shrew, deer mouse, harvest mouse, brush mouse, etc.)?

Detritivores: Do elevated concentrations of COPECs in sediments in Los Alamos and Pueblo Canyons lead to decreased rates of nutrient cycling?

Primary Producers: Do elevated concentrations of COPECs in sediments in Los Alamos and Pueblo Canyons lead to decreased native plant species diversity and the absence of certain native plant species?

Table 1.2. Rationale for Selection of Terrestrial Biota Investigation Reaches

Reach	Field Survey Measures			Physical	COPECs
	Mammal	Bird	Plant		
LA-0		√	√	Possible baseline, persistent water	DDE/DDT
LA-1FW		√	√	persistent water	DDE/DDT
LA-1W		√	√	Dry	DDE/DDT
LA-1C	√	√	√	Dry	DDE/DDT, PCBs, metals
LA-1E		√	√	Dry	DDE/DDT, PCBs
LA-2W		√	√	Dry	DDE/DDT, metals
LA-3		√	√	Downstream, dry	N/A
DP-2		√	√	Meadow, ephemeral	DDE/DDT, cobalt
AC-1		√		Possible baseline, dry	DDE/DDT, metals
AC-2		√		Dry	DDE/DDT, metals
AC-3	√	√	√	pools	DDE/DDT, PCBs
ACS		√		Bedrock pool	Metals
P-1FW		√		Possible baseline, ephemeral, fire effects	DDE/DDT, metals
P-1W		√		ephemeral, fire effects	DDE/DDT, metals
P-1E		√		Dry, fire effects	Metals
P-3W	√	√	√	Dry, fire effects	Metals
P-3E		√	√	Persistent water, fire effects	Metals
Guaje	√	√	√	Dry, fire effects	to be determined

N/A = Not applicable

Table 1.3. Calculation of detection limits for small mammal body burden analysis

Spotted owl prey detection limits
or concentrations in a small mammal that equal the avian TRV

Suite	Analyte	TRV - mg-COPEC/kg-BW/day	Owl body weight kg *	Owl food intake - fresh weight kg/day **	Food moisture content +	Owl food intake - dry weight kg/day	Concentration in mammal - dry weight mg-COPEC/kg-dry mammal	Proposed mammal detection limit mg/kg-dry wt	Proposed mammal detection limit mg/kg-fresh wt
PCB	Aroclor-1254	0.1	0.55	0.059	0.68	0.019	2.9	0.87	0.27
Pest	DDT	7.10E-03	0.55	0.059	0.68	0.019	0.21	0.062	0.019
Pest	DDE	7.10E-03	0.55	0.059	0.68	0.019	0.21	0.062	0.019
CN	Cyanide-total	0.04	0.55	0.059	0.68	0.019	1.17	0.34	0.1
Metal	Cobalt	1.3	0.55	0.059	0.68	0.019	0.58	11	3.6

* from Gallegos et al 1997 report
** 0.059 kg of woodrat per day (Weathers et al. 2001)
+ from Wildlife Exposure Factors Handbook
++ target concentration*0.3 (HQ<0.3 used to screen COPECs) and truncated to 2 decimal places

Attachment 2: Proposed Aquatic Study Design for Los Alamos and Pueblo Canyons Surface Aggregate Report

Proposed locations for aquatic toxicity testing are presented in the following table.

Type*	Hydrologic reach	Location/Description	COPECs	Fire-impacted?	Refer-ence?
Persistent	Upper LAC	Reach LA-0; near Skating Rink; persistent, discontinuous flow,	low detections of organics	Yes	Yes
	Upper LAC	Reach LA-1FW; near cattail wetlands; wetland not representative of reach but potentially ecologically significant	medium detections of organics [PAHs]	Yes	No
	Middle LAC	Upper DP Canyon bedrock pools in reach DP-1C, DP Tank Farm plus townsite effects	detections of organics [PAHs], post-fire [cyanide]	No	No
	Lower PC	Downstream of Bayo WWTP in reach P-3E, near well PAO-4; representative area with incised channel in wetland	medium detections of rads, Bayo WWTP influence	Yes	No
	Lower LAC	Reach LA-4W; channel of Los Alamos Canyon downstream of Basalt Spring in area of perennial flow	low detections of rads, Bayo WWTP influence, post-fire [cyanide]	Yes	No
Ephemeral	Upper LAC	LA-1W sampling reach	low rad detections, PCBs	Yes	No
	Middle LAC	Near DP Spring at head of reach DP-4	medium-high rad detections	No	No
	Middle LAC	Reach LA-3W; downstream of area of common emergence of water from alluvium ("spring")	low rad detections	Yes	No
	Upper PC	Reach P-1FW; above former Pueblo WWTP outfall	N/A	Yes	Yes
	Middle PC	Reach AC-1; common water from townsite runoff	detections of organics [PAHs]	No	No
	Middle PC	Reach AC-3; pools above first boulder step; common point of emergence of alluvial groundwater; isolated pools; multiple observations of horsehair worms	high rad detections [isoPu, Am-241]	No	No
	Lower LAC	Reach LA-5W; Los Alamos Canyon, short distance below Guaje confluence; more common flow in post-fire regime	low rad detections	Yes	No

N/A = Not applicable
* Type: Persistent water–plan to test both water and sediment
Ephemeral–plan to test only sediments [use lab water]

Attachment 3: Deviations from proposed biological sampling

This attachment documents deviations to the proposed biological sampling that occurred during implementation in July 2002.

(1) Small mammal trapping arrays

Reach P-3W: one of the two arrays was located downstream of the Bayo WWTP outfall and entirely on a pre-1942 stream terrace, although the original intent was to locate both arrays upstream of the outfall and partially within the area of post-1942 sediment. The downstream array was not sampled to determine the concentration of COPECs in soil, and mammals from this array will not be submitted for bioassays. Instead, it is intended that a new array will be located upstream, overlapping with the post-1942 sediment deposits as originally planned. This new array will be added in October, concurrent with the second round of small mammal trapping.

Reach AC-3: the canyon bottom was only wide enough for three trapping lines instead of five as in the other canyons. Each line was 190 m long and had 20 traps. Thus, only 60 traps were located in reach AC-3. Because the arrays were smaller, composite samples from AC-3 were composed of nine subsamples instead of 15 as in the other reaches. We will explore the possibility of expanding the trapping array farther up Acid Canyon to include more traps. This would happen in the planned October trapping round.

(2) Chemical analysis of COPECs

The following suite of radionuclides was added to the analytical requests for all sediment samples to provide more thorough characterization of this media: strontium-90, isotopic plutonium, gamma spectroscopy radionuclides.

(3) Earthworm toxicity bioassay

The 28-day mortality and bioaccumulation will be conducted instead of the 14-day mortality test to increase information from the test. Worms will be analyzed for the metals suite listed in Attachment 1. Two locations were added to the earthworm test–AC-1 and DP-1W–to address potential impacts from elevated levels of PAHs in these reaches.

(4) Plant toxicity bioassay

The species selected for the test was yarrow. This species was recommended by the toxicity testing company (environmental planning & toxicology) as representative of native species and previously good germination success in controls. Two locations were added to the plant test–AC-1 and DP-1W–to address potential impacts from elevated levels of PAHs in these reaches.

(5) Aquatic toxicity tests

An additional tank will be run through the experimental protocol to create a population of exposed *C. tentans* organisms. The morphology (mouth parts) of these animals will be compared to determine if there are any malformations that can be associated with contaminant concentrations. This information may provide a measure of exposure assuming that any diagnostic changes in mouth-part morphology can be noted. Changes in mouth-part morphology will not be used as a measure of effects. This mouth-part evaluation is a pilot investigation of bioindicators under controlled conditions for future environmental monitoring.

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