40-3453

United States Department of the Interior
FISH AND WILDLIFE SERVICE
UTAH FIELD OFFICE
LINCOLN PLAZA
145 EAST 1300 SOUTH SUITE 404
SALT LAKE CITY, UTAH 84115

In Reply Refer To
(CO/KS/NE/UT)

June 22, 1998

Mr. Richard Blubaugh
Vice President Environmental and Governmental Affairs
Atlas Corporation
Republic Plaza, 370 Seventeenth Street, Ste. 3050
Denver, CO 80202

RE: Proposal to Conduct Bioassay Studies to Determine a Safe Level of Ammonia That is Protective of Endangered Fish in the Upper Colorado River

Dear Mr. Blubaugh:

Pursuant to discussions at the meeting held at the Fish and Wildlife Service's (Service) office's in Denver on May 22, 1998 concerning the Section 7 consultation for the proposed reclamation of the Atlas mill tailings site in Moab, Utah, the Service is hereby providing Atlas Corporation with a courtesy copy of the bioassay study proposal for work to be completed in 1998. As we discussed at the meeting and in a subsequent conference call, the Service requested that Atlas Corporation contribute $50,000 to cost share in this study as part of the Reasonable and Prudent Alternative to avoid jeopardy to the endangered Colorado River fishes. At the time, you identified that Atlas Corporation would like to see a copy of the study proposal prior to committing to any funding.

Please contact Reed Harris or Janet Mizzi regarding your commitment following review of the proposal.

Sincerely,

Reed E. Harris

Reed E. Harris
Utah Field Supervisor

Enclosure

cc: Grant Ohland, Harding-Lawson Associates, 707 17th Street, Ste. 2400, Denver, Colorado 80202
Joseph J. Holonich, Chief, High-Level Waste and Uranium Recovery Project Branch, Division of Waste Management, U.S. Nuclear Regulatory Commission, 11555 Rockville Pike, Rockville, Maryland 20850
Larry Shanks, FWS, Denver, CO

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NLOS

Quick Response Proposal: Determination of a Safe Level of Ammonia that is Protective of Juvenile Colorado River Endangered Fish in the Upper Colorado River

Submitted to

Reed Harris, Bruce Waddell, and Ronette Reisenburg

U.S. Fish and Wildlife Service
Ecological Services
Utah Field Office
145 East 1300 South, Suite 404
Salt Lake City, UT 84115
(801) 524-5001

by

James Fairchild
Environmental and Contaminants Research Center
Biological Resources Division, USGS
4200 New Haven Rd
Columbia, MO 65201

June 15, 1998

I. INTRODUCTION

This Quick Response Project will determine the level of ammonia that is protective of juvenile Colorado squawfish (*Ptychocheilus lucius*) and razorback sucker (*Xyrauchen texanus*) in the Upper Colorado River. This research is needed to develop discharge criteria for contaminated groundwater leaching from beneath the Atlas Uranium Mill Tailings (Atlas) site located near Moab, Utah. The research is being requested by the Utah Field Office, U.S. Fish and Wildlife Service, Salt Lake City, Utah. This agency, in addition to the National Park Service (NPS) and the Environmental Protection Agency (EPA), has the statutory interest to develop biological information for this site for the development and evaluation of management and regulatory actions. This research is being conducted by the U.S. Geological Survey, Biological Resource Division, Environmental and Contaminants Research Center (ECRC), Columbia, Missouri.

II. BACKGROUND

History of the Atlas Mill Facility:

The Atlas site is located 750 feet from the west bank of the Colorado River and is partially located within the 100-year flood plain. The property and facilities were originally owned by the Uranium Reduction Company and regulated by the Atomic Energy Commission, precursor to the Nuclear Regulatory Commission (NRC). The mill and site were acquired by the Atlas Corporation in 1962. Atlas Corporation ceased operation of the mill and ore milling in 1984.

Milling of ore at the Atlas site has resulted in a large tailings pile located 230 m from the west bank of the Colorado River and 3.7 km northwest of Moab, Utah. The pile occupies about 53 ha of land and is about 0.8 km in diameter and 28.65 m high. The pile rises to an elevation of 1237m above mean sea level with a height of about 27 m above the surface of the Colorado River terrace, which is approximately 1210 m above mean sea level at the south side of the pile nearest the river.

Current drainage from the pile has been estimated by Oak Ridge National Laboratory (ORNL) in Grand Junction, Colorado to be between 6.7 and 20 gallons per minute (gpm) and could take up to 270 years to drain the pile and up to 238 years for the ground water to reach a steady state (ORNL, 1998 a). The ground water contamination plume extends beyond the Atlas property to the south and is over 5,000 feet wide and 40 feet deep and discharges directly into the Colorado River (ORNL, 1998 b). The plume for some contaminants (ammonia, uranium, molybdenum and nitrates) is mature and these constituents have been discharging to the river since the early 70's (ORNL, 1998 c). The U.S. Fish and Wildlife Service (Service) believes that for other contaminants like selenium, the plume has not fully reached the bank of the Colorado River (USFWS, 1998).

Atlas Corporation activities at the Atlas site are currently covered by NRC Source Material License SUA-917 and regulated under the Title II Uranium Mill Tailings Radiation Control Act of 1978. Atlas Corporation is currently in the process of closing and reclaiming the Atlas site. The Atlas Corporation is currently implementing a Corrective Action Plan (CAP)

that was approved by NRC and has begun to collect additional data to update and revise the CAP for NRC review.

Status of Current Water Quality Information Related to the Site:

The direct impacts to Service trust resources from ground water contamination associated with the tailings pile leaching into the Colorado River have not been fully assessed. Limited water quality measurements by the Utah Department of Environmental Quality (UDEQ) have identified a site-specific source of contaminated ground water entering the Colorado River from beneath the tailings pile. This source exceeds Water Quality Standards for at least five parameters, including total ammonia, dissolved manganese, dissolved molybdenum, and dissolved vanadium (Table 1) (UDEQ, 1996a). In addition, levels of gross alpha and total uranium levels in groundwater below the Atlas site exceed those measured upstream (Table 1).

Table 1. Metals and radiation measurements taken in the vicinity of the Moab Tailings Pile by the Utah Department of Environmental Quality on April 11, 1996[1] (UDEQ 1996a).

Site	Total Ammonia (mg/L)	Unionized Ammonia (ug/L)	Molybdenum (ug/L)	Manganese (ug/L)	Vanadium (ug/L)	Gross Alpha (pCi/L)	Total Uranium (pCi/L)
CR[2] Hwy 191	0.132	0.01	8	8	<40	12	3
Atlas Seep	219.00	5.85	1550	3470	96	720	825
CR 0.0 mi BS[3]	3.57	0.09	10	14	<40	50	5
CR 0.25 mi BS	0.00	0.00	7	<5	<40	20	5
CR 0.5 mi BS	0.14	0.01	7	9	<40	19	3
CR 1.0 mi. BS	0.13	0.01	3	50	<40	19	5
Criteria value[4]	**1.29**	**0.02**	**40**	**40**	**60**	**15**	**20**

[1]Data from Nov. 8, 1996 letter from Utah Department of Environmental Quality to Mr. Myron Fliegel, Uranium Recovery Branch, NRC, Washington, D.C. Ammonia criteria based on pH of 8.0 and temperature of 15 degrees C for Class 3B river.
[2]CR refers to within Colorado River.
[3]BS refers to distance below entry of seep into river.
[4]Criteria from various sources obtained from Utah Department of Environmental Quality (1996) and HLA (1998). Criteria do not exist for fish and wildlife for all constituents; thus, sources and resource categories may vary. Data are for comparison purposes only.

Preliminary Desktop Toxicological Assessment:

Ammonia appears to be the major contaminant of concern in the vicinity of the Atlas site. Ammonia primarily exists in two forms: unionized (NH_3) and the ionized ammonium ion (NH_4). The relative distribution of the two forms is controlled by pH and temperature. It is the unionized form of ammonia which is most toxic; therefore, total ammonia data must be interpreted as unionized ammonia (typically calculated from a pH/temperature nomograph; e.g. Thurston et al., 1977) prior to toxicological interpretations.

Acute exposure of fish to unionized ammonia can cause loss of equilibrium, hyperexcitability, and increased respiration in fishes (WHO, 1986). Dwyer (1998) determined that unionized ammonia was toxic to juvenile razorback suckers, Colorado squawfish, and the

standard surrogate test species the fathead minnow *(Pimephale promelas)* at concentrations as low as 1.040, 0.229, and 0.227 mg/L, respectively (7-d LC50, unionized ammonia) (Table 2).

Table 2. Sensitivity of razorback sucker, Colorado squawfish, and fathead minnows to total and unionized ammonia determined by Dwyer (1998).

Species	7-d LC50 Total Ammonia (mg/L)[1]	7-d LC50 Unionized Ammonia (mg/L)[2]
Razorback sucker	12.3 - >17	1.04
Colorado squawfish	4.44 - 22.6	0.229
Fathead minnow	7.34 - >17	0.277

[1] Range of 2 or more tests.

[2] Calculated from lowest total ammonia value measured.

These data are greatly exceeded by concentrations measured in the Atlas seep by the UDEQ (value of 5.90 mg/L unionized ammonia; April 11, 1996) (UDEQ,1996a), and are approached or exceeded by peak levels found in the Colorado River in the immediate vicinity of the tailings pile by both the UDEQ (peak 0.29 ug/L unionized ammonia; September 5, 1996) (UDEQ, 1996b) and the Atlas Corporation (peak of 0.13 mg/L unionized ammonia; Dec. 4-5, 1997) (HLA, 1998). HLA (1998) indicated that this ammonia plume extended for nearly a mile distance along the Atlas side of the river in areas suspected of being of major ecological importance to larval and juvenile fishes (USFWS 1998).

Chronic exposure of fish to unionized ammonia has been shown to reduce egg hatching, growth, and development, and can cause pathological changes in gills, liver, and kidney (WHO, 1986). Chronic data for the effects of unionized ammonia on razorback suckers and Colorado squawfish are not available. However, Mayes et al. (1986) determined that unionized ammonia decreased hatching and survival of larval fathead minnows at 0.26 mg/L. Thurston et al. (1986) determined that chronic exposure to 0.91 mg/L unionized ammonia resulted in decreased survival, growth, and reproduction of fathead minnows, and that at 0.21 mg/L exposures, adult fatheads commonly exhibited brain lesions. Further, Le-Ruyet Person et al. (1997) determined that 28-d exposure of juvenile turbot resulted in significantly decreased growth at unionized ammonia exposures as low as 0.1 mg/L due to decreased food intake. Pathological changes (e.g. gill hyperplasia; necrosis; and tissue disintegration) have been observed at unionized ammonia concentrations $\leq$ 0.1 mg/L (Flis, 1963; Smith and Piper, 1974). Thus, a comparison of published effects levels to measured exposure data in the immediate vicinity of the Atlas Mill Tailings Pile indicates that endangered fish populations are at risk.

Several dissolved inorganic constituents, including molybdenum and vanadium, also exceed published State or National Water Quality Standards. However, concentrations of these constituents do not approach levels that have been demonstrated in the laboratory as acutely toxic to razorback suckers or Colorado squawfish. For example, Hamilton and Buhl (1997)

studied the effects of vanadium on Colorado squawfish and razorback sucker and determined 96-h LC50s of 7.8 and 8.8 mg/L, respectively, indicating a margin of safety of well over 100. Molybdenum is toxic to fathead minnows at 360 mg/L (Eisler, 1989) and acute toxicities of other dissolved inorganics including uranium, boron, arsenate, and zinc generally exceed 10 mg/L (Hamilton, 1997; Hamilton and Buhl, 1997). However, data on chronic toxicity of these elements to Colorado squawfish and razorback suckers are not available. In addition, the effects of chronic exposure to mixtures of these constituents have not been adequately addressed even though there is evidence that synergistic effects may be possible (Hamilton and Buhl 1997; Irwin et al. 1997).

Selenium concentrations in water adjacent to the Atlas Mill Tailings Pile range from 1-4 ug/L as total selenium, which approaches the Water Quality Criterion of 5 ug/L. Selenium is of particular concern in the western United States due to its propensity to undergo organic transformations which lead to biomagnification in aquatic food webs (Hamilton, 1998). Concentrations of selenium above 5 ug/L have been shown to result in reproductive failure and developmental abnormalities in fish and birds (Hermanutz et al., 1992; Lemly et al., 1993). However, selenium has never been measured in biological matrices in the Colorado River near the Atlas Mill Tailings Pile, resulting in a major data gap for the site risk assessment.

Ecological Significance of Contaminant Data to Rare and Endangered Fishes of the Upper Colorado River:

These data indicate that ground water discharge from the Moab Tailings Pile to the Upper Colorado River may pose a threat to federally endangered fishes including the Colorado squawfish and razorback sucker. Designated critical habitat for the Colorado squawfish and the razorback sucker occurs within the entire proposed project area. Critical habitats include the Colorado River and the 100-year floodplain of the river adjacent to and downstream of the Atlas Mill Tailings Site.

Colorado squawfish populations now only occupy historical habitats in the Upper Colorado River Basin in Colorado, New Mexico, Utah and Wyoming (USFWS, 1996a). The most important rearing area in the Colorado River for young-of-the-year Colorado squawfish is between Moab, Utah and the confluence with the Green River (USFWS, 1990). In a mark-recapture study of Colorado squawfish, 21 of 51 (41%) fish in this sampling reach were caught in the Moab Valley area between river miles 57.3 and 64.9 (Osmundson, 1997).

The Atlas tailings pile site is perched at the top of the Moab Valley at River Mile 64.3. The Colorado River Fisheries Project implemented an Interagency Standardized Monitoring Program in 1986 to monitor population trends of the Colorado squawfish and humpback chub *(Gila cypha)* in the Colorado River Basin. The program targeted young-of-year Colorado squawfish in the Green and Colorado Rivers; subadult and adult Colorado squawfish in the Green, Colorado, White, and Yampa Rivers; and adult humpback chub in Black Rocks and Westwater Canyon on the Colorado River. However, information on other rare or introduced species was also collected in the process.

Low numbers of Colorado squawfish (between 1 and 28 fish) were consistently collected between 1986 and 1996 near the Atlas mill tailings site between river miles 68-49. Both adults and subadults were collected in Moab Wash and directly below the tailings pile. The

Atlas mill tailings site is located at river mile 64.3. Young-of-year Colorado squawfish sampling between river miles 48-84 collected anywhere from 0 to 53 squawfish at any one site (Osmondson et al., 1997).

A potential spawning site for Colorado squawfish exists upstream of the Atlas site above Westwater Canyon. Larval Colorado squawfish are consistently found from above Moab to the confluence of the Colorado River with the Green River. This includes the Colorado River section in the vicinity of the Atlas mill tailings pile. Larval Colorado squawfish congregate in the backwater areas of this reach of the river. The geomorphological and hydrological characteristics of the Colorado River significantly change in the Moab Valley providing suitable nursery habitat for larval and young-of-year Colorado squawfish (UDWR, 1998). Therefore, high numbers of Colorado squawfish have been observed in this section of the Colorado River. The standardized monitoring data has shown that the average size of larval and young-of-year Colorado squawfish collected below the Atlas site is smaller than larval and young-of-year fish collected in the Green River system. No attempt has been made to explain this difference (USFWS, 1998).

During the standardized monitoring of the Colorado River near Moab, no Colorado River razorback suckers have been collected recently; however, historically, they were present in the area and limited numbers may still occupy this reach of the river (USFWS, 1998).

Bonytail chubs *(Gila elegans)* are considered extirpated from the upper Colorado River Basin. However, recovery efforts to restore the species to its former habitat have resulted in the stocking of 2,000 bonytail in the Colorado River above the Atlas mill tailings site at River Mile 86. Therefore, it is possible that bonytail chub have drifted downstream and are present in the vicinity of the Atlas mill tailings pile at River Mile 64.3 (USFWS, 1998).

III. SIGNIFICANCE OF RESEARCH TO THE USFWS AND OTHER MANAGEMENT AGENCIES

The Service's Utah Field Office has been involved with, and concerned about, the proposed reclamation of the Atlas mill tailings since 1983. At that time the Utah Field Office expressed it's concern in a letter to the Assistant Regional Director concerning a review of the Emergency and Remedial Response Information System Inventory and identified concerns about possible affects to Colorado squawfish and razorback sucker. On June 26, 1997, the Service issued a draft jeopardy biological opinion (DBO) to the Nuclear Regulatory Commission. Since issuance of the DBO, the Service, Council of Environmental Quality (CEQ), Department of Interior (DOI), and Service solicitors have all been working with NRC and the Atlas Corporation to resolve the issues and determine the best means of reclamation of the Atlas site. The Service subsequently issued a revised draft biological opinion (RDBO) on April 14, 1998 and intends to issue a final biological opinion by June 30, 1998. The RDBO concluded jeopardy to the Colorado squawfish and razorback sucker from the contaminated leachate leaking into the Colorado River from the tailings pile.

Data collected by ORNL supports the Service's RDBO in concluding that the Atlas site is a site specific point source and that the proposed capping of the pile in place jeopardizes the continued existence of razorback sucker and Colorado squawfish due to the continued

leaching contaminated groundwater into the Colorado River (ORNL, 1998 b). Additionally, the proposed action will result in the destruction or adverse modification of designated critical habitat for the Colorado squawfish and razorback sucker (USFWS, 1998).

The ORNL studies further identified a second source of uranium contamination on the Atlas site as a former catch pit which received effluent from early mill operations (ORNL, 1998 b). ORNL has substantiated that this site is leaching high concentrations of uranium into the Colorado River (ORNL, 1998 a,b,c) . The Service is concerned that the combined effects of the uranium and/or the gross alpha levels and the trace elements in the river may be jeopardizing listed fishes (USFWS, 1998).

The current RDBO jeopardy opinion is based on the best available data and opinion of Service resource professionals. Based on the precarious existence of the Colorado River fishes and the fact that the Atlas site is perched at the top of a nursery area, the Service has determined that the level of take anticipated under the proposed action is impacting population numbers and recruitment and is sufficient to jeopardize the continued existence of the species (USFWS, 1998). All three constituent elements of designated critical habitat for razorback sucker and Colorado squawfish will be adversely modified (USFWS, 1998). These three constituent elements include 1) water that is of good quality; 2) physical habitat potentially habitable by fish during all life stages; and 3) a biological environment capable of providing a food supply for the endangered fishes. The Service feels that the reclamation project activities as currently proposed will result in continued input of contaminated water into the Colorado River mixing zone until an acceptable groundwater corrective action plan is approved and implemented. The development of this plan is dependent on the availability of a criteria or safe level of ammonia that is protective of Colorado squawfish and other endangered fishes in the river. This requires additional research to determine levels of ammonia that are protective at the level of the individual (e.g. EC1) and whether or not that level is affected by other factors such as variations in pH or metals.

IV. SCIENTIFIC OBJECTIVES

This study has two objectives:

1) Conduct spatial mapping to determine the distribution of ammonia exposures in the Upper Colorado River adjacent to and below the Moab Tailings Pile, and

2) Conduct toxicity testing of early life stages of fathead minnows and Colorado squawfish to determine the concentration of ammonia that is protective of Colorado squawfish in the Upper Colorado River. This objective will be conducted in two separate studies that will determine the following: 2a) the concentration of ammonia that is protective of Colorado squawfish (e.g. EC1); 2b) the effect of source water on the sensitivity of Colorado squawfish to ammonia; 2c) the relative sensitivity of Colorado squawfish compared to fathead minnows, 2d) the effect of life-stage on sensitivity of fish to ammonia; and 2e) the interactive effects of ammonia, pH, and copper in exposures with Colorado squawfish.

V. PROPOSED METHODS

Site mapping for contaminant exposure: Water will be collected in a regular grid framework extending from ½ mile above to 2 miles below the Atlas site. Because ammonia is a major contaminant known to be directly associated with the tailings pile and is easily analyzed in the field, it will be used as a primary variable for mapping. A differentially-corrected global positioning system will be used to establish a sampling grid arranged in a regularly-distributed pattern. Depth-integrated samples will be collected at each grid intersection and analyzed for temperature, pH, dissolved oxygen and conductivity using a Hydrolab Water Quality Monitor. Ammonia will be analyzed in a stream-side laboratory to give rapid on-site results. These results will be graphed to identify the exposure plume and mixing zone and will be used to select sampling sites for toxicity testing. Water will be stored in clean polyethylene car-buoys and transported to the mobile testing trailer. Sub-samples will be taken, stored on ice, and shipped via overnight mail to the partner EPA facility for water quality analyses conducted under EPA Quality Assurance Procedures. Additional splits will be stored on ice and shipped to the ECRC for toxicity testing.

Toxicity Testing: Toxicity testing will be conducted using larval fathead minnows and juvenile Colorado squawfish. Toxicity testing will be conducted according to standard procedures as described by the U.S. EPA Effluent Toxicity Procedures (EPA, 1996) and American Society for Testing of Materials (ASTM; 1997).

The level of ammonia that is protective of Colorado squawfish will be determined using ammonium phosphate. Seven-d static renewal studies will be conducted. Ten juvenile Colorado squawfish (approximately 60 days old) will be exposed in 1000-ml beakers containing one of two water sources: 1) Colorado River Water, or 2) ECRC well water. This comparison will be conducted in order to determine if the source of water (i.e. site-specific conditions) has an effect on the toxicity of ammonia. Approximately 200 L of Colorado River Water will be collected from above the Moab Tailings Pile (i.e. low in ammonia) and will be shipped on ice in polyethylene carboys to the ECRC. Water will be stored at $\leq 4^{\circ}$ C until use. Four days prior to the study a total of 200 Colorado squawfish will be acclimated to the Colorado River Water. Then, the toxicity tests will be initiated. Ammonia will be delivered in an 80% dilution series ranging from 0 - 15 mg/L, for a total of fifteen concentrations (e.g. 15.00, 12.00, 8.60, 7.68, 6.14, 4.91, 3.93, 3.14, 2.51, 2.01, 1.61, 1.28, 1.03, 0.82, and 0 mg/L); each concentration will be tested in duplicate. Larval fathead minnows (<48 h old) and juvenile fathead minnows (approximately 60 d old) will also be tested at the same time in well water only using the same experimental design in order to test the effects of ammonia across fish species and life-stage. Thus, a total of 120 beakers will be held in a completely randomized design in a water bath at 25° C under a 16:8 h light:dark schedule. This will allow testing of the following factors: 1) the relative sensitivity of Colorado squawfish to ammonia in two separate water types; 2) the relative sensitivity of Colorado squawfish and fathead minnows to ammonia; 3) the effect fish life-stage on sensitivity to ammonia; and 4) the effects of time on sensitivity to ammonia. Mortality will be measured daily in each beaker. Total ammonia, pH, dissolved oxygen, and temperature will be measured daily in the high, medium, low, and control treatments prior to

renewal (e.g. 4 concentrations in duplicate in 4 treatment types or 32 total measures). In addition, total ammonia, pH, temperature, and dissolved oxygen will be measured daily in the high, medium, low, and control treatments from each source water (e.g. 4 concentrations in duplicate from 2 source waters or 16 total measures) in renewal water. Alkalinity, hardness, and conductivity will be measured in the high, medium, low, and controls of both source waters (e.g. 4 concentrations in duplicate from 2 source waters or 16 total measures) in water prior to renewal at the beginning and end of the test. All water quality measures will be conducted using ECRC Standard Operating Procedures, which are developed in accordance with methods recommended by the APHA (1995) and manufacturers recommendations . Fish will be fed brine shrimp *ad libitum* two times per day at least 6 h apart. At the end of the study fish will be immediately frozen (-10° C) for final weights. At a later date, the fish will be thawed, dried at 60° C, and weighed to the nearest 0.1 mg to determine final biomass.

On a separate date, studies will also be conducted to determine the additive or synergistic effects of ammonia, pH, and copper to Colorado squawfish. This study will be conducted due to the presence of copper in the groundwater in addition to seasonal fluctuations in pH at the site; results will be used to determine if a safety factor for ammonia must be applied to be protective of site-specific conditions. This study will consist of a 3-way factorial design. Ammonia will be added at 10 concentrations using ammonium phosphate. Copper will be added at 3 levels using copper sulfate. The pH will be studied at three levels: (e.g. pH=7.0, 8.0, and 9.0). The pH will be adjusted using either 0.1 N HCL or 0.1 N NaOH. Each experimental unit will consist of a 1000-ml beaker containing ten fish. Each treatment level will consist of 2 replicates, or a total of 180 beakers containing a total of 1800 fish. Daily monitoring of mortality and water quality will be determined as above.

Analytical Chemistry: All analytical chemistry will be conducted according to standardized procedures described by the EPA (1996), ASTM (1997), or the American Public Health Association (APHA, 1995). Analytical work determined by non-ECRC partners (e.g. EPA or ORNL) will be described according to a separate quality assurance plan.

Data Analysis: All data will be normalized using appropriate data transformation procedures. It is recognized that statistical comparison of field sites will be difficult due to problems with non-independence of sites (Green, 1979; Hurlburt, 1980). Therefore, statistical analyses will vary depending on the type of study and the application of the data. The overall approach to impact assessment will employ a weight-of-evidence approach which will be formed along multiple lines of evidence (e.g. on-site testing; residue analysis; laboratory toxicity testing; and published toxicological data).

Toxicity data will be analyzed by comparison of toxicological responses to measured chemical concentrations. The analysis of the toxicity data will be done using generalized linear models (Agresti 1990; Cox and Snell 1989; Hosmer and Lemeshow 1989; McCullabh and Nelder 1989). These approaches are generalizations of the classic approaches outlined in the book of Finney (1971). Books by Morgan (1992) and Seber and Wild (1989) also provide relevant methodologies to be considered in the analysis of these data. These are modern approaches

based on likelihood theory (see Assalini 1996). Count data from toxicological studies are often over-dispersed and methods outlined in Wedderburn (1974) and Williams (1982) will be employed if over-dispersion is found to be present. Data analysis will be used to explore the relationship between toxicological variables (e.g. survival) and continuous variables such as measured values of ammonia, copper, and pH. The results of these studies will provide two critical pieces of information: 1) what level of ammonia in the Colorado River will be protective of the endangered fish , and 2) do copper and pH alter the availability or effects of ammonia to fish such that additional safety factors must be employed.

Thus, data analysis will be based on combination of robust statistical approaches (see Royal 1997) and viewed in a model selection context (see Akraike 1973, 1974, 1981, and 1983). This general approach allows inference concerning multiple endpoints (e.g. EC1, EC10, EC50, and others) based on more than a single model. This increases the generality of the result and allows estimates of precision that are not dependent on a single model. This approach provides interpretation that can be applied in multiple ecological, toxicological, and legal applications.

Quality assurance: Prior to these studies a Quality Assurance Plan will be developed and approved by the ECRC Quality Assurance Officer; other BRD partners; the Service; EPA; and ORNL. All toxicity and water quality data will be collected and analyzed according to good laboratory practices using Standard Operating Procedures (SOPs) developed within the Quality Assurance Program of the USGS/ECRC, Columbia, Missouri. A separate Quality Assurance Plan will be prepared by the USEPA for analytical chemistry procedures. Full copies of SOP's are available upon request.

VI. MANAGEMENT SIGNIFICANCE OF RESEARCH

These results will be used to determine the acute and chronic concentrations of ammonia that are toxic to Colorado squawfish and other aquatic resources of the Upper Colorado River. Data will be generated to compare environmental concentrations in relation to controlled field and laboratory experiments. Data will be used to establish the concentration of ammonia that can be safely discharged from the Atlas Site into the Colorado River.

VII. PROPOSED SCHEDULE of MILESTONES

This study will be initiated in June of 1998 using USGS /BRD/ECRC Quick Response Funds. The following timetable is proposed:

- June 1- study area/site selection/researcher site visit
- July/August - laboratory toxicity testing; field water quality assessment
- August/September - data analysis
- October 1 - final report from BRD (final analytical from EPA may be pending).

VIII. ROLES, RESPONSIBILITIES, AND PARTNERSHIPS

The Service, the NPS, and the EPA have an on-going interest in information from this site and a need to substantiate existing information to evaluate management and regulatory actions. The Ecological Services Utah Field Office is responsible for the overall coordination of this investigation among the participating partners conducting this investigation. The Service will also be involved with field studies and data interpretation for report preparations.

The EPA is assuming the major responsibility for providing analytical support (radiochemicals, organics, and inorganics) through in-kind contributions towards this proposed study. The NPS will also provide in-kind support through the availability of its personnel and equipment to assist with on-site investigations and by providing access to facilities as needed while in Moab, Utah. ECRC is providing support to initiate preliminary assessments during FY98 at this site through their Quick Response Program with the Service. The ECRC is also responsible for the field surveys, laboratory bioassays, and toxicity testing and will ensure that the study design and interpretation are based on best science available. ECRC will be responsible for the completion of the final report in a timely manner.

The Service, EPA, and ECRC will be working jointly to ensure analytical, field, and laboratory QA/QC throughout the project.

Additional partners involved with this investigation include: ORNL; Grand Canyon Trust; The Nature Conservancy; UDEQ Division of Radiation Control; and UDEQ Division of Wildlife Resources. These partners will provide in-kind services which include laboratory space, monitoring equipment, river support equipment, field staff, and technical assistance (Table 4).

This investigation is a partnership effort between the Utah Field Office, the USGS/ECRC, the EPA Region 8, the NPS, ORNL in Grand Junction, Colorado, the State of Utah DEQ, Division of Radiation Control and the Division of Wildlife Resources, the Nature Conservancy in Moab, Utah, and the Grand Canyon Trust in Moab, Utah.

Additional funding sources for this investigation include partnership efforts totaling $ for the three year period. Funding from partners will be available through analytical analysis, hard funds, and in-kind services (laboratory space, monitoring equipment, river support equipment, field staff, and technical assistance) in order to support this investigation proposal (Table 4).

Table 4. Partnership contributions for the FY 98 Quick Response Effort.

Partners	Contacts	Contributions	Services Type
FWS-UFO Salt LakeCity, UT	Ronette Reisenburg	18K	in-kind staff
USGS-BRD Columbia, MO	Jim Fairchild /Ann Allert	88K	in-kind staff equipment/laboratory
EPA Region 8 Denver, CO	Richard Graham	35K	analytical analysis
ORNL, Grand Junction, CO	Doug Hadford	0K	funds from EPA
ORNL, Grand Junction, CO	Nic Korte	0K	funds from EPA
ORNL, Grand Junction, CO	Frank Gardner	0K	funds from EPA
DEQ/DWR Salt Lake City, UT	Bill Bradwich	2K	in-kind technical review
DEQ/Rad.Control Salt Lake City, UT	Loren Morton	3K	in-kind technical review
NPS, Moab, UT	Bruce Rodgers	10K	in-kind equipment and office space
NPS, Ft. Collins, CO	Roy Irwin	5K	in-kind technical review and assistance
Totals			

IX. BUDGET

Quick Response Budget Category	FY98 Quick Response Funding
Personnel - Field/Lab	$ 10,000.00
Personnel - Data Analysis	$ 1,000.00
Travel and Per Diem	$ 6,000.00
Supplies	$ 3,000.00
Equipment	$ 0.00
Total Quick Response Budget	**$ 21,000.00**

In-Kind Budget Category	In-Kind Funding
BRD Base Salaries	$ 88,421.00
USFWS Salary/Administration	$ 18,000.00
EPA Analytical	$ 35,000.00
Utah DEQ	$ 5,000.00
NPS Salary/Space	$ 15,000.00
Total In-Kind Contributions	**$ 161,421.00**

[1]Fairchild and Allert at 0.3 FTE.

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