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Ecological Impacts to the Little Colorado River Humpback Chub Habitat

Disclaimer: The Navajo Nation does not take responsibility for any data, information, or interpretation of source material in the following report. ESTIMATIONS OF ACRE-FEET OF WATER VARY DEPENDING UPON THE SOURCE OF INFORMATION. AS OF THIS DATE THE MOST RECENT INFORMATION IS IN "REPORT OF AMENDED WATER CLAIMS BY THE U.S.A FOR THE INDIAN LANDS IN THE LITTLE COLORADO RIVER BASIN". (Natural Resource Consulting, Inc. November 22, 1994).

INTRODUCTION

The Little Colorado River gorge on the Navajo Nation is critical habitat for the largest population of Humpback chub (*Gila cypha*) in the lower Colorado River basin. Existing and possible future ecological impacts to this habitat will be discussed with reference to proposed development projects, water quality, water quantity, and biotic invasions.

PROPOSED DEVELOPMENT PROJECTS

It has been proposed that Blue Springs water be used for the production of hydroelectric power by a pumped storage development (Bureau of Reclamation, 1972). This plan outlined an inner gorge dam and reservoir on the Little Colorado River at River Mile 9.8, an underground powerhouse, and an upper storage reservoir located at the foot of Gold Hill. Requisite to this proposed project was another plan for the Coconino Dam at River Mile 48.5 on the Little Colorado River. The Coconino Dam was planned to provide sediment and debris control (Bureau of Reclamation, 1972). The inner gorge dam would have made use of 145,000 acre-feet per year of the Blue Springs area inflow; this is approximately 90% of the total inflow. The proposed Coconino Dam would maintain sediment in a 40,000 to 80,000 acre-foot detention pool.

Another major alternative for use of Blue Springs area water would be as cooling water for fossil fuel thermal powerplants. It has been estimated that Blue Springs water could support a cooling pond for a 8,000 megawatt installation (Bureau of Reclamation, 1972). A thermal powerplant in vicinity of Cameron, Arizona has been proposed. This powerplant would be fired by coal from the Navajo and Hopi lands (Bureau of Reclamation, 1966).

Plans to develop the surface waters of the Little Colorado River in the southwestern corner of the Navajo Nation near Leupp were proposed as early as 1917 (Gregory, 1917). One irrigation project includes plans for a reservoir and canals in a project description as well as construction costs, annual costs of operation and annual farm benefits to the Navajo Nation economy (Morrison-Maierle, Inc., 1981). The irrigation project would encompass 20,000 acres, primarily for livestock feeds. An earthen diversion dam on the Little Colorado River would be built. A canal would divert 36,000 acre-feet per month to an off-stream storage site. This reservoir

would store 77,000 acre-feet of water. This evaluation, "The Little Colorado River Basin Resources and Development Plan", also states that smaller projects could be implemented along headwater tributaries of the Little Colorado River on the eastern side of the Navajo Nation.

Presently, there is still interest in this type of project for irrigation. The Navajo Nation has claimed 330,552 acre-feet of the Little Colorado River system for additional use for future irrigation (Statement of Claimant, The Navajo Nation; General Adjudication of all Rights to Use Water in the Little Colorado River System and Source; Civ. No. 6417, 1985). The location and volume of the planned irrigation impoundments are listed in the following table (Statement of Claimant, The Navajo Nation; General Adjudication of all Rights to Use Water in the Little Colorado River System and Source; Civ. No. 6417, 1985). Table #?

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In the upper Little Colorado River system, there are 17 proposed projects in the Chevelon Creek, Clear Creek and Jacks Canyon watersheds (Little Colorado River System Inventory of Water Uses; In Re the General Adjudication of The Little Colorado River System and Source. Arizona Department of Water Resources (AZDWR), 1994). AZDWR states in this report that " Of the 17 projects, only Wilkins Reservoir and Tucker Flat Reservoir sites appear to be feasible.

The proposed Tucker Flat Reservoir site is on the Navajo Nation near Birdsprings, AZ in section 23, T 20N, R 15E. This project was designed as an off channel reservoir supplied via pipeline from Clear Creek and Chevelon Creeks; however this project was abandoned by the USBR in favor of the Wilkins Reservoir site (AZWDR, 1994). Recently interest in the Tucker Flat Reservoir site has been renewed, and preliminary estimates show a reservoir with a capacity of 400,000 acre-feet (AZDWR, 1994).

The proposed Wilkins Reservoir site is located on Clear Creek in sections 31 and 32, T 15N and R13E. The USBR proposed dam would create a reservoir with a capacity of 45,000 acre-feet (AZDWR, 1994). The project has been modified to support irrigation on the Navajo Nation; it would divert water from the reservoir via pipeline to a Leupp storage reservoir (AZDWR, 1994). It could supply an estimated 35,000 acre-feet per year of water to the Leupp project (AZDWR, 1994).

The following table is directly reproduced from the AZDWR report; comments in the table are also those of AZDWR. Table #

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The Hopi Tribe has identified a summary of quantification of future additional water demands (Statement of Claims of The Hopi Tribe; In Re the General Adjudication of all Rights to Use Water in the Little Colorado River System and Source; Civ No. 6417). The following irrigation storage facilities are identified in this quantification of water demands:

FACILITY	WATER SUPPLY	LEGAL DESCRIP. (Sec. T. R.)	GROSS STORAGE (AF)	SURFACE AREA (A)	EVAP (AF)
Moenkopi	Moenkopi Wash	Unsurveyed	24,900	380	2019
Dinnebito	Dinnebito Wash	4 30N 16E	1,200	120	500
Oraibi	Oraibi Wash	2 30N 16E	1,300	130	540
Wepo	Wepo Wash	Unsurveyed	800	80	330
Polacca	Polacca Wash	7 26N 17E	1,500	150	620
Jeddito	Jeddito Wash	27 26N 18E	1,300	130	540
Leupp Unit	L. Colorado R.		280,000	5,650	22,600

In addition the Hopi Tribe has outlined a summary of future quantification of water demand (acre-feet per year) (Statement of Claims of the Hopi Tribe; In Re the General Adjudication of all Rights to Use Water in the Little Colorado River System and Source; Civ. No. 6417, 1985):

WATER USE	FUTURE ADDITIONAL (Acre-feet per year)
Irrigation from surface water	60,915
Evaporation from Irrig. Storage	9,359
Irrigation from groundwater	15,780
Municipal and domestic	6,165
Recreation	151
Stock ponds and stockwater	295
Commercial and industrial	1,102
Mining and related industry	29,120

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The Navajo Nation has identified future annual water needs for industrial and commercial development (Statement of Claimant the Navajo Nation; In Re the General Adjudication of all Rights to Use Water in the Little Colorado River System and Source; Civ. No. 6417).

INDUSTRY	LOCATION	WATER SOURCE	USE (Acre-feet)
Coal fired power plant	T21N, R12E	C-aquifer	16,000
Coal fired power plant	T24N, R21E	N-aquifer	16,000
Feed lot and beef packing plant	T24N, R12E	C-aquifer	120
Potato operations and vegetable processing plant	T22N, R12E	C-aquifer	460
Miscellaneous industrial & commercial development	all	all	1,000
Mining use			11,887.6

The Little Colorado River basin produces large floods; in 1923, a flood of record is estimated at 120,000 cfs at Grand Falls and 60,000 cfs at Holbrook. Consequently, flood control projects have been proposed. The Corps of Engineers have developed designs for levees at Holbrook (Army Corps of Engineers, 1991). Channel excavation and vegetation clearance were not recommended in these plans. In a recent study, channel excavation was recommended as an additional design consideration for the proposed levees (Navajo County Department of Public Works, 1993). In the same study, channel alignment clearing of vegetation were recommended in the Holbrook and Winslow areas. A series of dams on the Rio Puerco was outlined; the purpose of these dams would be to reduce the sediment inflow into the Little Colorado River. (Navajo County Department of Public Works, 1993). Another alternative outlined in the 1993 study proposes to lower bedrock elevation in the riverbed at selected reaches, particularly between Winslow and Leupp and between Winslow and Penzance Dam (Navajo County Department of Public Works, 1993).

CURRENT WATER USES

The current water uses in the Arizona non-Indian portion of the Little Colorado River system have been inventoried by the Arizona Department of Water Resources (Little Colorado River System Inventory of Water Uses; In Re The General Adjudication of The Little Colorado River System and Source, 1994). The information in the following paragraph is all derived from the AZDWR report.

The AZDWR identified 26 industrial/commercial and power uses within the Little Colorado River System that total 63,600 acre-feet per year of which 16,500 acre-feet is surface water use and 47,100 acre-feet is groundwater use. Three power generations uses withdraw 28,250 acre-feet of groundwater per year. There are 23 other industrial/commercial uses that withdraw 35,400 acre-feet from the system; 16,500 acre-feet are withdrawn from the surface water system and 18,900 acre-feet are withdrawn from the groundwater system. Of the 26 water uses, 5 totaling 15,000 acre-feet are found within the Upper Little Colorado River watershed; 7 totaling 25,200 acre-feet are found in the Lower Little Colorado River watershed; and 14 totaling 23,400 are found in the Silver Creek watershed. For industrial/commercial purposes, the largest use is for 2 water exports from Show Low Lake and Blue Ridge Reservoir. Including evaporation and seepage, these exports deplete 15,800 acre-feet per year. The largest groundwater diversion is 17,000 acre-feet per year for the Snowflake Paper Mill from the Silver Creek watershed. An additional 31 industrial/commercial claims or uses were identified; for these no information was obtained by AZDWR.

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In the Arizona non-Indian Little Colorado River System, 78,000 acre-feet per year are diverted to irrigate 31,140 acres (Little Colorado River System Inventory of Water Uses; In Re The General Adjudication of The Little Colorado River System and Source. AZDWR, 1994). In this study, 4,841 reservoirs and ponds were identified; these have an estimated annual use of 101,590 acre-feet per year. In addition, there are large reservoirs over 1,000 acre-feet in capacity that form an integrated system with a combined capacity of 245,915 acre-feet. (Little Colorado River System Inventory of Water Uses; In Re The General Adjudication of The Little Colorado River System and Source. AZDWR, 1994).

The Navajo Nation identified current annual water uses in the Little Colorado River System as of 1985 (Statement of Claimant; The Navajo Nation. In Re the General Adjudication of all Rights to Use Water in the Little Colorado River System and Source. Civ. No. 6417). The following information is derived from that document.

WATER USE	TOTAL
Domestic Water Use	300.81 acre-feet
Irrigation Water Use	36,147.00 acre-feet
Stockpond Water Use (including New Lands)	3,027.70 acre-feet
Mining Water Use (Groundwater)	4,132.80 acre-feet
Mining Water Use (Impoundments)	1,689.80 acre-feet
Recreation, Fish, Wildlife and Conservation Water Use	3,000.90 acre-feet

The Hopi Tribe has identified a summary of quantification of current annual water uses as of 1985 (Statement of Claims of The Hopi Tribe In Re the General Adjudication of all Rights to Use Water in the Little Colorado River System and Source; Civ. No. 6417. 1985).

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WATER USE	TOTAL
Irrigation from surface water	10,114 acre-feet
Evaporation from irrigation storage	186 acre-feet
Irrigation from groundwater	1,250 acre-feet
Municipal and domestic	2,060 acre-feet
Recreation	80 acre-feet
Stock ponds and stockwater	1,504 acre-feet
Mining and related industry	2,325 acre-feet

Withdrawals of groundwater from the Coconino aquifer by irrigation and industry are approximately 85,000 acre-feet per year (AZDWR, 1989). Artesian wells and other depletions from the Coconino aquifer may have decreased spring discharges and streamflows in recent years (Mann, 1976). Declines in water levels have been identified near Joseph City, Snowflake, Springerville, and St. Johns (AZDWR, 1989).

WATER QUALITY

Ground and surface water in the Little Colorado River basin have occurrences of contamination by radionuclides and other chemical constituents due to discharge of mine-dewatering effluents released by mining operations (USGS, 1994). Also in 1979, the largest known release of water contaminated by uranium tailings in the U.S. occurred due to the failure of a tailings-pond dike on the Rio Puerco River in this basin (USGS, 1994). The USGS began a four year study of the occurrence and movement of these chemical constituents, as well as hydrologic and geologic data in the basin in 1988 (USGS, 1994). The data has yet to be analyzed. The USGS has concluded that effects of mining can no longer be identified in water and sediment samples from the Little Colorado River and the Puerco River (USGS, 1994). Filtered water meets the drinking water standards set by the U.S. Environmental Protection Agency's Safe Water Drinking Act for the dissolved elements measured in the USGS study. However, high sediment concentrations cause unfiltered streamflow to exceed Federal standards for uranium, radium, beryllium, copper, lead, and manganese (Wirt, 1993).

The area bordering and including the Little Colorado River between Cameron and Black Falls Crossing has many open-pit surface mines and adjacent tailings piles from mining operations in the 1950s and 1960s. Surface water, ground water, soil/sediment, and

air samples were taken in the area to determine whether a radioactive release to the surface water of the Little Colorado River could occur (Ecology and Environment, 1989). The study indicated that this was unlikely because of the small amount of precipitation in the area (Ecology and Environment, Inc., 1989).

The USFWS has completed an assessment of the radionuclides and trace element contaminant concentrations in biotic samples in the Puerco River and Little Colorado River. Radium-226 at 0.0004 picocuries per gram wet weight were detected in the humpback chub. (USFWS, 1993). Also, trace element and radionuclide levels were tested in tissues of longfin dace, carp, horned lark, killdeer, crayfish and freshwater clams (USFWS, 1993). The data has yet to be interpreted by the USFWS (Curt King, personal communication). A forthcoming report will identify potential problems as well as provide suggestions for the management of habitat and the humpback chub (USFWS, 1993). Eisler of the USFWS Pautuxent facility in Maryland has developed a report on the impact of radionuclide contamination in fish and wildlife. However, this report is in press and has not yet been released (Eisler, personal communication). A Colorado River Area Contingency Plan has been developed to promote a fast, efficient, effective and coordinated response to a release of hazardous materials into the Colorado River; however, the Little Colorado River is not explicitly addressed (U.S.E.P.A., 1993)

WATER QUANTITY

I. Groundwater

Most of the groundwater in the Little Colorado River Basin is in sandstone rock formations. The major water yielding units are the Navajo and Coconino sandstones; these form multiple-aquifer systems (ADEQ, 1991). The Dakota/Cow Springs aquifer, or D system, includes the Dakota, Morrison, and Cow Springs sandstones. The Navajo/Lukachukai aquifer, or N system, includes the Navajo sandstone, the sandy facies of the Kayenta Formation, and the Lukachukai Member of the Wingate Sandstone. The Coconino-DeChelly aquifer, or C system, includes the Coconino and Dechelly sandstones (ADEQ, 1991). The D and N aquifers, located entirely on the Navajo and Hopi lands, contain 181 million acre-feet of water (ADEQ, 1991). These two aquifers contribute only a little to the surface water (ADEQ, 1991). Separated by 1,000 feet of the shaley Chinle formation from the D and N aquifers, is the C aquifer. The Coconino aquifer contains 413 million acre-feet of water. Extensive use of the Nand D aquifers would not have a significant effect on the C aquifer (ADEQ, 1991). The C aquifer can be tapped throughout the basin. The C aquifer contribution to surface water on the Navajo Nation is very small (ADEQ, 1991). The N-aquifer contribution to the LCR system is insignificant given the long stretch of the Moencopi Wash before it reaches the Little Colorado River; most N-aquifer discharges occurs in the Laguna Creek which is a tributary of Chinle Creek which is not part of the Little Colorado River System (Stanley Pollack, personal communication).

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Blue Springs in the Little Colorado River gorge discharges nearly all the ground water from the Paleozoic rocis in the 28,000 square mile Black Mesa hydrologic basin (Laughlin, 1983). This ground water is moving from the area of the highest hydraulic head, the San Francisco volcanic field, to the area's lowest hydraulic head, Blue Springs (Laughlin, 1983). Ninety-five per cent of the water discharged from the Esplanade and Redwall aquifers at Blue Springs is derived from the Coconino aquifer (Cooley, 1969).

Whereas Blue Springs, 13.1 miles upstream from the confluence of the Little Colorado and Colorado rivers, is the largest springs in the Little Colorado River Gorge, a total of 56 springs and seeps have been identified (Laughlin, 1983). The springs discharge 160,000 acre feet of water (Laughlin, 1983). Springs occur in the Esplanade Sandstone, the Redwall Sandstone, the Muave Limestone, and undifferentiated Cambrian Units (Laughlin, 1983). It has been estimated that 4/5 ths of the total discharge is from the Redwall Limestone (Laughlin, 1983); this discharge has been measured at 173/cubic feet/second (Laughlin, 1983).

Temperature of the springs increase from 68 degrees F to 77 degrees F down canyon toward the confluence of the two rivers (Laughlin, 1983). Total dissolved solids in the springs discharge ranges from 2,270 mg/l to 4,177 mg/l (Laughlin, 1983). Studies of the water chemistry of the spring discharge demonstrate that there are two distinct types of water (Laughlin, 1983). All the water is of the Na Cl type; however there is a large range in the concentrations of Ca, NA, HCO , and CL (Laughlin, 1983). The regional distribution of the major chemical constituents is as follows. Mg , Na , Cl , and SO concentrations increase from west to east; Ca , HCO , and SiO concentrations increase from east to west; and SiO concentrations decrease from south to north (Laughlin, 1983). The water chemistry data demonstrates that the Little Colorado River springs discharge is a mixture of seventy-five percent Ca , Mg, and HCO water from the San Francisco field and twenty-five percent Na , Mg, Cl, SO water from the eastern part of the Black Mesa hydrologic basin (Laughlin, 1983). The large contribution from the San Francisco volcanic field is due to the higher recharge rates there relative to elsewhere in the Black Mesa hydrologic basin (Laughlin, 1983).

II. Surface Water

The Little Colorado River system can be subdivided into five major watersheds: Woodruff, Silver Creek, Chevelon Creek, Clear Creek and the Puerco River (AZDWR, 1989). Accurate gage measurements of streamflow in this river system is particularly poor due to discontinued gages, changes in the riverbed, and changes due to cultural uses (AZDWR, 1989).

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Figure 4.2 displays data from the gage at Grand Falls near Cameron, AZ. It demonstrates the large year to year variability in flows. At his particular gage, 39 % of the total annual runoff

occurs during the spring peak of March to April. Low flows occur during June and November. Summer storms can produce large flows. The majority of summer runoff that reaches the Navajo Nation is derived from the Puerco River (AZDWR, 1989). This runoff has a high sediment load (AZDWR, 1989). Most of the spring runoff is derived from snowmelt; it originates principally from the Clear Creek and Chevelon Creek watersheds (AZDWR, 1989). If the depletions from town and crop irrigation, industrial diversions, stockponds and reservoirs were delivered instead to the Navajo Nation boundary, then the estimated undepleted flow to the Navajo Nation boundary would be an estimated 222,000 acre-feet per year (AZDWR, 1989).

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LANDSCAPE ECOLOGY

The landscape ecology of the Little Colorado River (LCR) has changed over this century; this is due in large part to changes in climate. In the early 20th century the LCR experience high annual discharge regimes; this resulted in a wide, aggrading, braided, and low sinuosity system. (Kolbe, 1991). Consequently the flood-plain area diminished. In the latter part of the century, the LCR experienced low annual discharge regimes; this resulted in a narrow river, high sinuosity, vertical erosion and an increased flood-plain area. Studies of cottonwood cores, indicate that the river regime changed in 1988 and 1930 respectively.

Tamarisk began growing on the flood-plain in 1935 (Kolbe, 1991). One study found a significant relationship between vegetation and alluvial bar characteristics, but could not demonstrate that the vegetation was influencing bar morphology (Hinchman, 1993).

THE HUMPBACK CHUB

The Humpback chub, Gila cypha, was described as a species until 1946 (Miller, 1946). The historical abundance and distribution is not well known (USFWS, 1994). In the lower basin, the humpback chub occurs in the Little Colorado and the Colorado Rivers; in the upper basin, it is found in the Black Rocks/Westwater Canyon and Cataract Canyon in the Colorado River, Desolation and Gray Canyons in the Green River, and Yampa and Whirpool Canyons in Dinosaur National Monument, Green and Yampa Rivers (USFWS, 1994).

Humpback chub populations are found in river canyons where they utilize many habitats including pools, riffles, and eddies (USFWS, 1994). Studies of tagged fish indicate that the fish move between habitats in response to seasonal habitat changes and life history needs (Karp and Tyus, 1990). Potential limiting factors for the humpback chub in the Yampa River were identified as reduced spring flows, availability of shoreline eddy and deep canyon habitats, and competition and predation by nonnative fish (Tyus and Karp, 1989) The chub's food web or trophic attributes of the Upper Colorado River Basin are strongly linked to the geomorphic attributes (Stanford, 1994).

River mile 8 of the Little Colorado River to the confluence with the Colorado River of the Little Colorado River has been declared critical habitat for the endangered fish, the Humpback chub (Gila cypha) (USFWS, 1994). An estimate of the population size has ranged from 18,253 (Minckley, 1989) to 25,000 (Kubly, 1990). Humpback chub spawn in the Little Colorado River. The reproductive

period is probably March through June and perhaps July (Minckley, 1981). LCR fish have spawned naturally in the hatchery on cobble over boulder substrate (Hamman, 1982). The spring runoff and

temperature may be important to successful spawning. Chemical cues also may be important. In the LCR, there are downstream gradients in pH, carbon dioxide, alkalinity, hardness, and turbidity. (Mattes, 1993). These gradients change seasonally; and the most extreme gradients are at base flow. Food resources for the chub may be limited in the LCR by floods, high sediment loads, high salinity, and travertine deposition (Kubly, 1990).

Several species of non-native fish have been captured in the Little Colorado River gorge. These species include channel catfish, rainbow trout, fathead minnow, common carp, black bullhead, brown trout, yellow bullhead, and green sunfish (Douglas, 1992) A parasite, the Asiatic tapeworm has been discovered in humpback chub collected in the Grand Canyon. These species may compete with the chub and also prey upon that native fish species (Kubly, 1990)

SUMMARY

The ecological threats to the critical habitat of the Humpback chub in the Little Colorado River can be addressed from the perspective of the constituent elements or those physical and biological attributes that are essential to species conservation. The primary constituent elements for the recovery and survival of the endangered native fish of the Colorado River basin include but are not limited to the "quantity of water of sufficient quality (i.e. temperature, dissolved oxygen, lack of contaminants, nutrients, turbidity, etc.) that is delivered to a specific location in accordance with a hydrologic regime that is required for the particular life stage of each species" ; physical habitat that provides spawning, nursery, feeding, and rearing habitats; and biological environment includes food supply, predation and competition. The latter are out of balance in many areas due to non- native fish (USFWS, 1994)

Many of the constituent elements have been addressed in the preceding sections of this report. Any possible impact to the critical habitat of the humpback chub in the Little Colorado River will have to be examined on an individual basis in order to identify data gaps or determine the level of precision with which a determination of impact can be made.

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GLEN CANYON ENVIRONMENTAL STUDIES OFFICE

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Mr. Wegner,

Please find enclosed a **draft** copy of the paper entitled "Ecological Impacts to the Little Colorado River Humpback Chub Habitat" pursuant to the Cooperative Agreement No. 1-FC-40-10520 between the Navajo Nation and the Bureau of Reclamation. Under the "DELIVERABLES" section of the Agreement this paper is referred to as a report on the impacts to the ecological integrity of the Little Colorado River basin.

This version of the paper was prepared by Michael Tremble, former Wildlife Manager for the Natural Heritage Program, and was reviewed by the Navajo Justice Department, with certain comments incorporated. It is my opinion that this version, while identifying potential development and other factors which may impact humpback chub habitat, does not fully evaluate or describe those impacts. Given our present limited knowledge of humpback chub habitat requirements it may not be possible to go into much detail about the nature of the impacts. Because the Agreement does not provide specifications about the content of the report we request your review to determine how complete this version is with respect to meeting the intended objectives of the Agreement. In addition, please be forewarned that several tables are missing and will be included when they are developed.

The enclosed paper is a draft submitted for the purpose of your review, and should not be distributed for any other purpose.

If you have any questions I may be contacted at (520)871-7059, or you may contact John Nystedt at 871-7060.

Sincerely,

Jack Meyer

Jack Meyer, Program Manager
Navajo Natural Heritage
Fish & Wildlife Department

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