

*United States of America and Zuni Indian Tribe v. State of New Mexico, ex. rel State Engineer, et al.*  
*No. 07cv00681 BB*

**ANALYSIS OF WATER RIGHT SURVEYS OF THE ZUNI INDIAN TRIBE AND THE  
UNITED STATES ON BEHALF OF THE ZUNI INDIAN TRIBE BY THE STATE OF NEW  
MEXICO,  
OFFICE OF THE STATE ENGINEER**

Prepared for:

State of New Mexico  
Office of the State Engineer  
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Litigation and Adjudication Program  
Office of the State Engineer



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February 26, 2010

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**INTRODUCTION AND BACKGROUND**

The purpose of this report is to review and analyze the United States' water use survey conducted on behalf of the Zuni Indian Tribe, as well as supplemental or additional surveys conducted by the Zuni Indian Tribe. This review pertains only to irrigated lands served by permanent works. These claims together are referred to as "Tribal irrigation claims" and are distinguished from claims as yet not filed.

The United States' claims were submitted 05/11/2007 in a document titled, "UNITED STATES' SUBPROCEEDING COMPLAINT AND STATEMENT OF CLAIMS FOR WATER RIGHTS ON BEHALF OF, AND FOR THE BENEFIT OF, THE ZUNI INDIAN TRIBE AND ZUNI ALLOTTEES".

A supplemental claim was submitted by the Zuni Indian Tribe titled, "ZUNI INDIAN TRIBE'S SUPPLEMENTAL SUBPROCEEDING COMPLAINT", DATED 07/27/2007.

The Tribal claims survey was conducted by Natural Resource Consulting Engineers (NRCE), and the results were presented in the report titled, "ZUNI INDIAN RESERVATION IDENTIFICATION OF LANDS AND ESTIMATION OF WATER REQUIREMENTS FOR PAST AND PRESENT IRRIGATED LANDS SERVED BY PERMANENT IRRIGATION WORKS", by L. Niel Allen, dated November 3, 2008 ("Allen Report").

The reports and supplemental surveys of the United States set forth above were also reported as a geographic information system ("GIS") project by the United States dated February 26, 2009. This delivery, plus the paper copies of all surveys and supplemental reports mentioned above, comprised all GIS and documentation provided by the US and Zuni to review the Tribal irrigation claims.

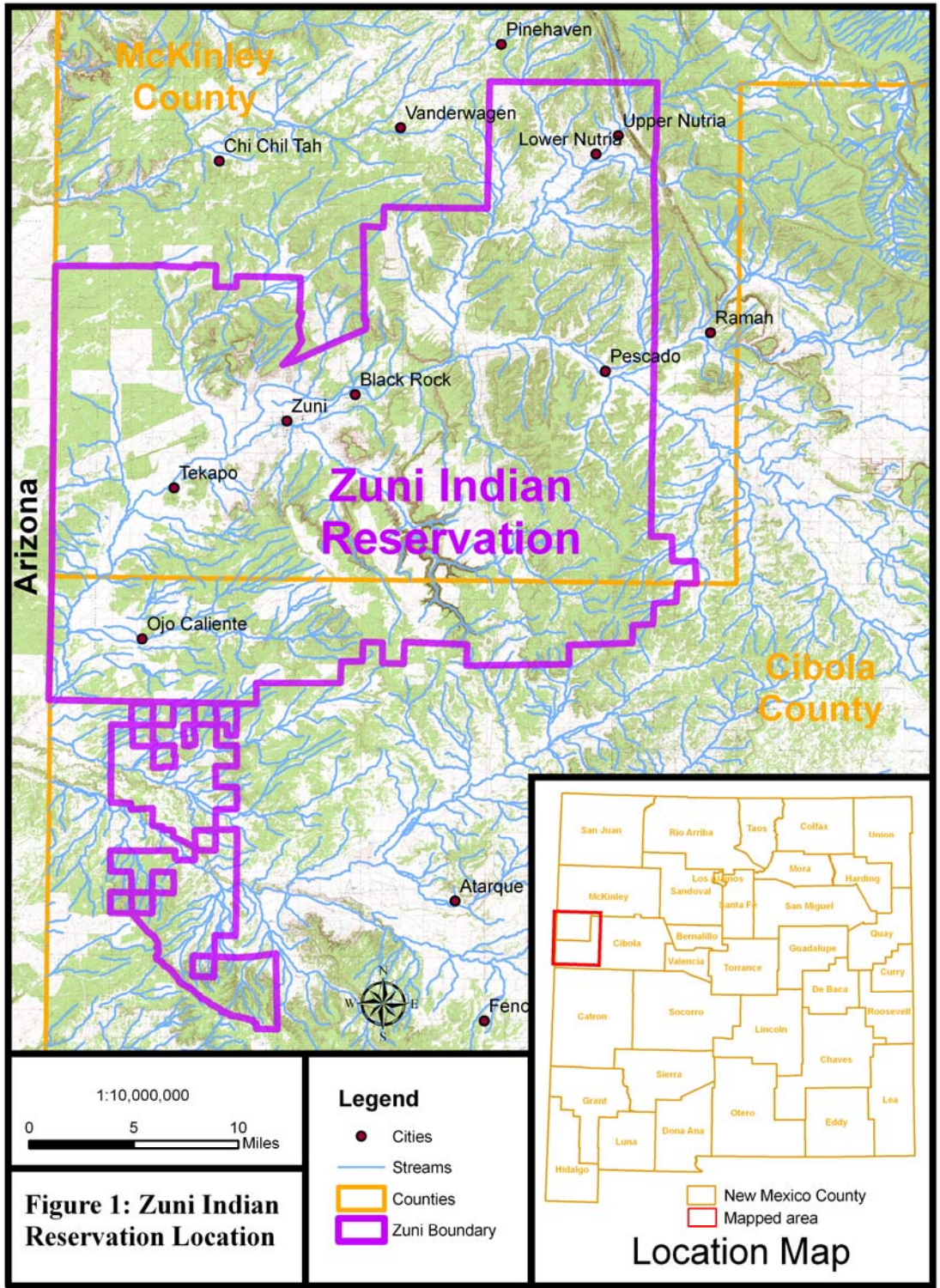
In order to analyze these surveys, the Office of the State Engineer's Hydrographic Survey and Mapping Bureau (HSMB) staff collected data and information dealing with past and present water uses within the Zuni River Basin and, specifically, the Zuni Indian Reservation. These data and documentation consist of: a historical aerial photography ("HAP"), a compilation of aerial photography from 1935, 1954, 1971, 1978, 1996-98, 2005 and 2009; two sets of historical maps from 1956 and 1966; the digital versions of

all 1:24,000 scale topographic maps of the area; and a New Mexico data set containing roads, railways, rivers, streams, water bodies and county boundaries.

The data also include a variety of documents and maps collected by the State's expert historian, Stan Hordes. These documents include many reports created by the Bureau of Indian Affairs ("BIA"), including annual crop reports, annual reports to the Department of the Interior and Congress, work progress reports and other various reports related to agriculture on the Zuni Indian Reservation.

There may be other documents that have not been made available to the HSMB staff which could change the results of this report. The State's expert historian currently has a Freedom of Information Act request for documentation pending, so the HSMB staff reserves the right to amend their conclusions should other information arise.<sup>1</sup>

The review presented is primarily an "office-based" review, without the benefit of extensive fieldwork. HSMB staff visited the area at the invitation of the Zuni Indian Tribe on one occasion, July 22-24, 2009 and was able to view most of the irrigation areas and works. The results of this analysis are below. Figure 1, titled Zuni Indian Reservation Location, illustrates the reservation location.



**Figure 1: Zuni Indian Reservation Location**

## TRIBAL CLAIMS

A survey of the Zuni's past and present irrigated lands by permanent works is set forth in the Allen Report. This survey of Tribal irrigation claims submitted by the United States (and as adopted and supplemented by the Zuni Indian Tribe) is primarily based on aerial imagery interpretation. In Section 1 of the Allen Report, it states: "Irrigated lands were delineated from aerial photography taken between 1934 and 2005. Maps from the BIA showing irrigation works and irrigated lands, field visits, and BIA crop reports also provided supplemental information on the extent of irrigated lands."

The survey of Tribal irrigation claims is dominated by past uses, as there are very few irrigated acres today. The methodology subscribed to by NRCE suggests that all acreage that may appear on aerial imagery to have been cultivated at some time should be included in their survey of irrigated acreage, without any demonstration of actual irrigation or amount of water the Tribe actually historically used in any one year. Based on Appendix A of the Allen Report, the claims accumulate to a diversion of over 32,000-acre-feet per year.

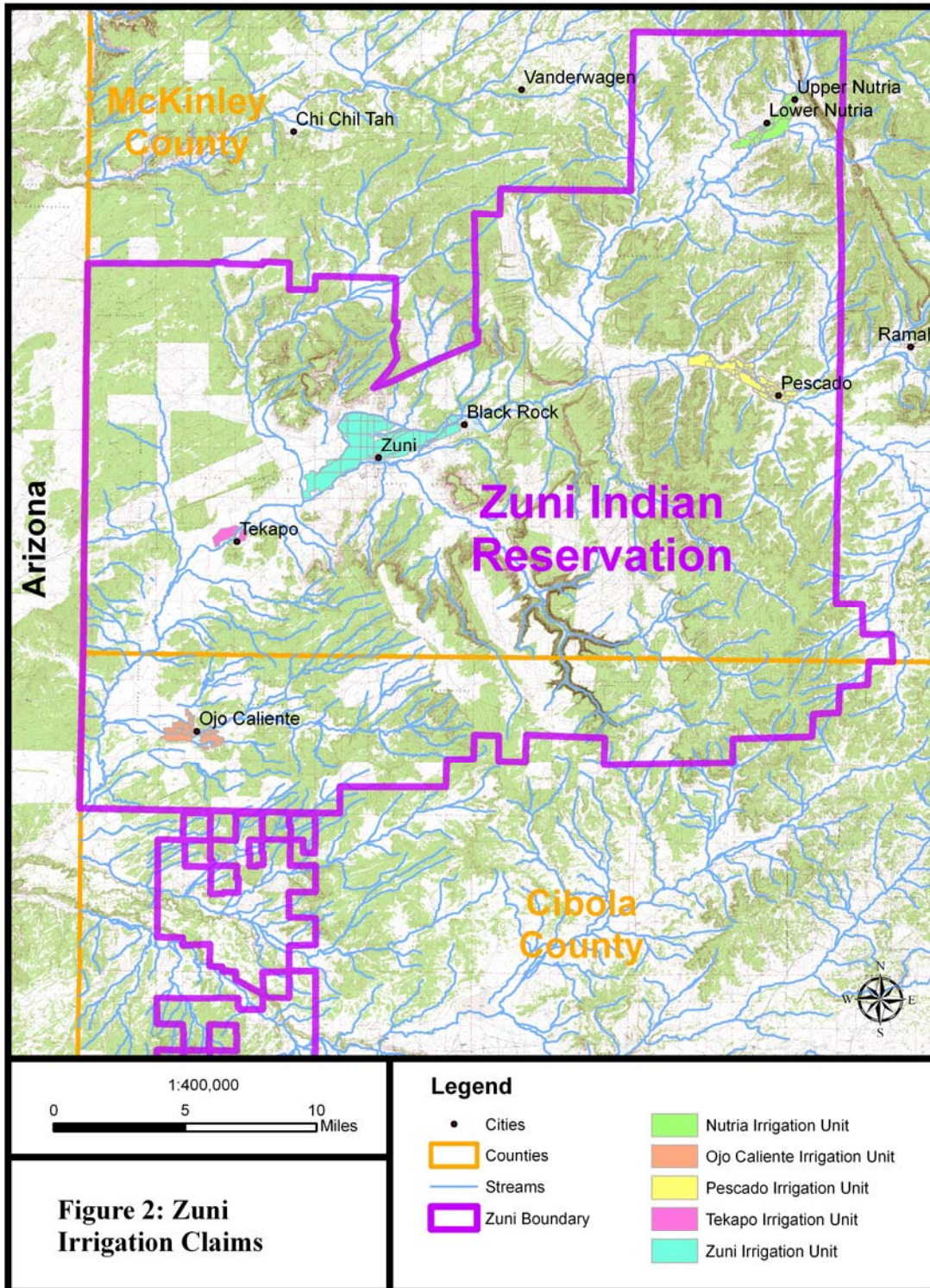
Figure 2, titled Zuni Irrigation Claims, shows the lands which were surveyed as irrigated by surface water diverted by permanent works. There are 7018.55-acres of irrigated land claimed by the United States and Zuni Indian Tribe. The Tribal irrigation claims are divided among five different irrigation units. The table below indicates the acreages surveyed in the Allen report as irrigated in each of these irrigation units.

Table 1: Tribal Irrigation Claims (Irrigation by Permanent Works)

| <b>Irrigation Unit</b> | <b>Acreage</b> |
|------------------------|----------------|
| Nutria                 | 976.61         |
| Ojo Caliente           | 773.73         |
| Pescado                | 1317.86        |
| Tekapo                 | 320.57         |
| Zuni                   | 3629.78        |
| <b>Total</b>           | <b>7018.55</b> |

Aside from aerial imagery interpretation, the only other historical data presented to establish irrigated acreage served by permanent works are the two sets of BIA maps, dated 1956 and 1966. No reports related to these maps have been provided to date. There are also no crop reports that correspond to the dates of the maps.

The 1956 maps delineate "Irrigated Lands", "Irrigable Lands" and "Irrigable Lands under Constructed Works". The note on these maps states that the maps were "Traced from Land Classification Survey Plane Table Sheet, Bureau of Reclamation...June 1939". The 1966 maps delineated only "Irrigated Lands". There is no note indicating the source of the mapping.



## **ANALYSIS**

### **Irrigation Diversion Points**

The data analyzed were the *PODs\_HIA* GIS layer found in the data delivered on February 26, 2009. A total of 11 Points of Diversion (“POD”s) were reported. The HSMB staff visited seven of the 11 PODs on its site visit in July 2009. Since the HSMB staff did not field-verify all of these PODs, the approach to the analysis was to overlay the POD layer on the historical aerial photography, on the digital version of the 1:24,000 topographic maps, and on the 1956 and 1966 historical maps.

A table showing the PODs can be found in Appendix I. The aerial photography indicates the strong possibility that all the PODs not visited in the field fall on places likely to be diversion points. Thus, the HSMB agrees that all surveyed PODs reported are actual diversion points.

### **Irrigation Conveyance**

The data analyzed were presented on the *CanalsPipes* GIS layer in the February 26, 2009 data delivery. A total of 293 ditch segments were included in that layer. HSMB staff verified many of these ditches and pipes in the field. Since the HSMB staff did not field-verify all of these ditches, the approach to the analysis was to overlay the ditch layer on the historical aerial imagery.

Each ditch segment was analyzed to determine if it was either visible or not visible on the historic aerial imagery. Eighty-nine ditch segments were located during the HSMB staff field visit to Zuni, and all of the remaining were found visible on the historical aerial imagery. The evidence indicates that the ditches exist or existed in the past. A table of the ditches analyzed by HSMB can be found in Appendix II.

Two connected ditch segments in the Pescado unit appear to be an intermittent stream channel upstream of the nearest POD. Another ditch segment in the Ojo Caliente unit exists, but it is utilized to supply a stock pond only. The HSMB staff does not agree with these three ditch segments, as noted in Appendix II. Thus, the HSMB staff agrees with 290 of the 293 ditch segments presented by the United States.

### **Irrigated Acreage**

The data analyzed were presented on the *Nutria\_HIA*, *OjoCaliente\_HIA*, *Pescado\_HIA*, *Tekapo\_HIA* and *Zuni\_HIA* GIS layers in the February 26, 2009 GIS. A total of 139 irrigated tracts were included in these layers. The HSMB staff visited all five of the irrigation units in Zuni Pueblo in July 2009. There was very little agricultural activity throughout the reservation.

Since the HSMB staff did not verify every surveyed tract during the visit mentioned above, as well as the fact that most of the fields have been fallow for many years, the approach to the analysis was to overlay the NRCE surveyed irrigated tracts on top of the historical aerial photography to determine if the tracts appeared clear and irrigable in the imagery available. The tracts were also compared with the 1956 and 1966 historical maps from the BIA.

### *Historical Aerial Photography*

The methodology utilized by NRCE bases the survey of the Zuni irrigation claims on the sum total of all acreage appearing on aerial imagery as having possibly been irrigated at some time. As discussed earlier in this report, the Allen report states that the BIA crop reports were utilized as supplementary data for mapping. In section 2.5 of the Allen report, it states, “The acreages in the BIA crop reports are less in any given year than the total acreages developed from aerial photography...because the aerial

photography acreage data represents a composite total of all acreages determined to have been irrigated, as opposed to the total acreage in any one year.”

Based on the historical aerial imagery review and the location of irrigation conveyance works, the HSMB concludes that, while the reasoning behind some delineation in the mapping is not quite clear, the areas delineated by NRCE appear to be irrigable lands under constructed works that may have been irrigated in the past. However, there is no evidence to suggest that the total acreage surveyed was ever irrigated in any one year.

### *Historical Maps*

The two sets of historical maps utilized by NRCE in its mapping of irrigated lands covered all five units of the Zuni Pueblo under irrigation. These maps were provided in Appendix B of the Allen report. The maps were digitized and georeferenced and GIS layers were created by drawing polygons tracing the areas depicted on the maps. The acreages associated with these polygons were tabulated.

The first set of maps is dated 1956 and delineates irrigated lands, irrigable lands under constructed works, and irrigable lands. The HSMB staff evaluated these maps by overlaying them on the HAP that was collected for analysis. The HSMB staff found that the areas depicted as irrigated appear to be relatively clear and irrigable based on aerial imagery from 1935 and 1954. Table 2 shows the acreages delineated on the 1956 maps.

Table 2: 1956 BIA Irrigated Lands

| Area             | Irrigated Acreage | Irrigable Acreage under Permanent Works | Irrigable Acreage |
|------------------|-------------------|---|-------------------|
| Nutria HIA       | 553               | 135                                     | 0                 |
| Ojo Caliente HIA | 948               | 644                                     | 0                 |
| Pescado HIA      | 812               | 260                                     | 0                 |
| Tekapo HIA       | 309               | 0                                       | 0                 |
| Zuni HIA         | 3187              | 852                                     | 851               |
| <b>Total</b>     | <b>5809</b>       | <b>1890</b>                             | <b>851</b>        |

The second set of historical maps is dated 1966 and delineated irrigated acreages only. Table 3 below shows the amount of acreage depicted as irrigated on the 1966 maps.

Table 3: 1966 BIA Irrigated Lands

| Area         | Acreage     |
|--------------|-------------|
| Nutria       | 595         |
| Ojo Caliente | 1512        |
| Pescado      | 986         |
| Tekapo       | 197         |
| Zuni         | 3538        |
| <b>Total</b> | <b>6827</b> |

In all areas but Tekapo, the irrigated acreage shown on the 1966 maps was increased by encompassing the majority of the lands that were previously delineated as “Irrigable Lands under Constructed Works”. Comparative analysis with the aerial imagery from 1954 and 1971 showed that there were undeveloped tracts of land included in the “irrigated acreage” delineation on the 1966 maps. The total increase in



irrigated acreage over the 10 years between map sets was over 1000-acres. Questions remain as to whether these maps were planning documents for a project or actual surveyed irrigated lands. These facts further illustrate that without an actual report explaining the purpose and/or usefulness of these maps, the maps should not be interpreted as making any specific statement.

The irrigated lands delineated by the Allen report generally concur with the irrigated areas shown in the two sets of historic maps, although they are expanded in some areas. While these maps may have indicated areas that had been irrigated in the past, there is no data to suggest that the sum total of the acreage mapped was ever irrigated in any one year. Comparison of the crop reports from 1955 and the mapped acreages from 1956 shows a more than double increase in “irrigated” acreage on the maps. While the 1955 BIA crop report states that 2475-acres were irrigated, the 1956 map delineates 5809-acres as irrigated. This fact also suggests that the areas mapped as “irrigated” indicate acres that appeared to have been irrigated in the past, not areas that were in fact irrigated during the growing season of 1956. Again, without a report detailing the purpose of these maps, the maps should not be interpreted as making any specific statement.

### *BIA Crop Reports*

The crop reports utilized by the HSMB to evaluate annual irrigation practices at Zuni were provided by a consulting historian, and were found at various BIA and Zuni agencies. There are many gaps in the data, as well as different reporting methods utilized through different time periods. A table compiling all available crop report data is provided in Appendix III. The variation in the crop report data is discussed below.

Crop reports in the 1920s state that the reports provide “an estimate of the crops planted during this year.” These estimates do not distinguish between crops produced on irrigated land and crops produced through dryland farming practices, and therefore, are not accepted as evidence of irrigated acreage. There is also little information provided to distinguish data for the Zuni Irrigation Unit from data for the entire Zuni Reservation.

The 1924 crop reports were presented on two pages, one titled “Zuni” and one titled “Zuni Reservation”. The “Zuni” report shows that 3885-acres were planted in 1924. The “Zuni Reservation” report shows that 7481-acres were planted in 1924. The latter report also contains the statement, “3885-acres under the Zuni Project. 3596-acres cultivated outside the project. About one third under irrigation, and the balance dry farming.”

The 1926 crop reports were divided into “Zuni” with a note stating “Irrigated from Zuni Reservoir” and “Nutria, Pescado, Tekapo, Ojo Caliente Tracts” with a note stating “These are both irrigated and dry farming.”

In 1930s, the crop reports began to state that the acreage counts referred to irrigated lands. The 1931 report was a single page for “Zuni”. The 1932 report contained pages for “Zuni”, “Pescado”, “Nutria” and “Summary”, but no data for Tekapo or Ojo Caliente units. The 1933 and 1934 crop reports contained data for all units except Tekapo.

The 1947–1950 crop reports are very complete, containing data for all five irrigation units, as well as a summary data page. This is also the timeframe that we find the most acreage irrigated in any one year.

Based on these seemingly credible reports, the most acreage ever irrigated in any one year was 2904-acres in 1949.

The crop reports for 1952, 1953 and 1955 contain only one page with the Unit of Project space filled with “Zuni Pueblo” for the former and “Zuni” for the latter two. There is confusion as to whether these reports refer to the Zuni irrigation unit only or to the entire Zuni reservation.

There then exists a 25-year gap in the crop report data from 1956 through 1980. This gap corresponds to the time period that the BIA historic maps were created. At some time during this period, agricultural production on the Zuni reservation declined.

There is data to suggest that there were approximately 1800-acres irrigated in 1981, but this was reported in a non-standard crop report (the data was presented on a form not seen prior to or after 1981). The data does not fit the pattern that follows from 1982 on, which starts around 500 irrigated acres, fluctuates a bit, and then declines over the next 20 years to approximately 200 irrigated acres.

#### *Other Data*

There are other reports and information that indicate higher amounts of irrigated acreages at various time periods. Specifically, there exists a compilation of data from 1911 to 1919 in a table included in a report submitted for a court case that indicates “total irrigated acres cultivated”.<sup>2</sup> There is a variety of conflicting information from this time period that indicates a general unreliability of the data. For instance, the compiled table originally listed 5120 total irrigated acres cultivated. The original number is scratched out and a handwritten number replaces it with 5060 total irrigated acres cultivated. But, the 1916 Summary Irrigation Data report submitted to the Department of the Interior United States Indian Irrigation Service states that there were 3150 irrigated acres.

The data from the compiled table also indicates 3000, 4000 and 5000 total irrigated acres for the years 1913, 1914 and 1915, respectively. The Summary Irrigation Data reports for those same years indicate 2500, 3000 and 3000 irrigated acres. The round numbers provided in both of these sets of data indicate that the numbers were estimated, whereas actual crop reports provide detailed data. No crop reports were available for that timeframe. These facts suggest that this data is not fully understood and, without the actual crop reports that correspond, the HSMB staff to qualify this data as valid.

## **CONCLUSION**

The HSMB staff agrees that all Zuni PODs surveyed in the Allen report are actual diversion points. In addition, the HSMB staff agrees with 290 of the 293 ditch segments presented in the Allen report. But, the HSMB disagrees with the approach used by Zuni, the United States and NRCE to survey the historically irrigated lands.

The mapping from NRCE was based primarily on aerial photography, and although the delineated areas appear to indicate lands that are irrigable and may have been irrigated in the past, there is no data to suggest that all of the acreage mapped was ever irrigated in any one year. Based on a thorough review of all available data, the HSMB finds the crop reports from the BIA to be the most reliable information on actual irrigation. The crop report data from BIA suggests that the maximum acreage under irrigation in any one year was 2904-acres in 1949. Therefore, the HSMB staff does not agree with the survey of irrigated lands conducted by NRCE.

## Notes

<sup>1</sup>Hordes, Stan. CRITIQUE OF “A HISTORY OF ZUNI WATER USE: EXECUTIVE SUMMARY,” BY E. RICHARD HART, FEBRUARY 27, 2006 (SUBMITTED NOVEMBER 26, 2007), AND SUPPLEMENTAL ANALYSIS OF IRRIGATION AND WATER USE AT ZUNI PUEBLO, 1902-2004, February 26, 2010, p.2.

<sup>2</sup>BIA, SWRO, SPA, Water Rights Files, Texas vs. New Mexico, S. Lyman Tyler Report, II., D. American Period Part I, Annual Reports, Office of Indian Affairs, New Mexico Pueblos, Irrigation and Crop Statistics, p. 292.

APPENDIX I: POD Data

| <b>ID</b>    | <b>SOURCE</b>              | <b>UNIT</b>  | <b>HSMB VISIT</b> |
|--------------|----------------------------|--------------|-------------------|
| 2C-3D-DIV001 | Nutria Diversion Reservoir | Nutria       | Yes               |
| 5B-3F-DIV002 | Rainbow Spring             | Ojo Caliente | Yes               |
| 5B-3F-DIV001 | Springs                    | Ojo Caliente | No                |
| 5A-3J-DIV002 | Ojo Caliente Reservoir     | Ojo Caliente | No                |
| 5A-3J-DIV001 | Sacred Spring              | Ojo Caliente | Yes               |
| 2C-6D-DIV001 | Springs                    | Pescado      | No                |
| 2C-5S-DIV001 | Pescado Reservoir          | Pescado      | Yes               |
| 2C-5R-DIV002 | Pescado Spring             | Pescado      | Yes               |
| 2C-5R-DIV001 | Spring                     | Pescado      | No                |
| 5B-1G-DIV001 | Tekapo Reservoir           | Tekapo       | Yes               |
| 1C-3T-DIV001 | Black Rock Reservoir       | Zuni         | Yes               |

APPENDIX II: Conveyance Data

| NAME                                  | UNIT         | HSMB VISIT | NOTES |
|---------------------------------------|--------------|------------|-------|
| Nutria South Canal                    | Nutria       | Yes        |       |
| Nutria South Canal                    | Nutria       | No         |       |
| Nutria South Canal                    | Nutria       | Yes        |       |
| Nutria South Canal                    | Nutria       | Yes        |       |
| Nutria South Canal                    | Nutria       | Yes        |       |
| Nutria North Canal                    | Nutria       | Yes        |       |
| Rio Nutria Canal                      | Nutria       | Yes        |       |
| Nutria North Canal                    | Nutria       | No         |       |
| Nutria North Canal                    | Nutria       | Yes        |       |
| Rio Nutria Canal                      | Nutria       | Yes        |       |
| Nutria North Canal                    | Nutria       | No         |       |
| Nutria North Canal                    | Nutria       | Yes        |       |
| Nutria South Canal                    | Nutria       | No         |       |
| Nutria North Canal                    | Nutria       | No         |       |
| Nutria Pipeline                       | Nutria       | Yes        |       |
| Nutria North Canal                    | Nutria       | No         |       |
| Nutria South Canal                    | Nutria       | No         |       |
| Nutria South Canal                    | Nutria       | No         |       |
| Nutria South Canal                    | Nutria       | Yes        |       |
| Nutria North Canal                    | Nutria       | Yes        |       |
| Nutria South Canal                    | Nutria       | Yes        |       |
| Nutria South Canal                    | Nutria       | Yes        |       |
| Nutria South Canal                    | Nutria       | Yes        |       |
| Rainbow Spring Pipeline               | Ojo Caliente | Yes        |       |
| Ojo Caliente Reservoir South Pipeline | Ojo Caliente | No         |       |
| Ojo Caliente Reservoir South Pipeline | Ojo Caliente | No         |       |
| Ojo Caliente Reservoir South Pipeline | Ojo Caliente | No         |       |
| Ojo Caliente Reservoir South Pipeline | Ojo Caliente | No         |       |
| Ojo Caliente Reservoir South Pipeline | Ojo Caliente | No         |       |
| Ojo Caliente Reservoir South Pipeline | Ojo Caliente | No         |       |
| Ojo Caliente Reservoir South Pipeline | Ojo Caliente | No         |       |
| Ojo Caliente Reservoir South Pipeline | Ojo Caliente | Yes        |       |
| Rainbow Spring Pipeline               | Ojo Caliente | Yes        |       |
| Ojo Caliente Reservoir North Pipeline | Ojo Caliente | No         |       |
| Rainbow Spring Pipeline               | Ojo Caliente | Yes        |       |
| Rainbow Spring Canal                  | Ojo Caliente | No         |       |
| Rainbow Spring Pipeline               | Ojo Caliente | Yes        |       |
| Ojo Caliente South Canal 'B'          | Ojo Caliente | No         |       |
| Ojo Caliente South Canal              | Ojo Caliente | No         |       |
| Ojo Caliente North Canal              | Ojo Caliente | No         |       |
| Ojo Caliente Reservoir North Canal    | Ojo Caliente | No         |       |
| Ojo Caliente Reservoir South Canal    | Ojo Caliente | No         |       |

| NAME                                  | UNIT         | HSMB VISIT | NOTES  |
|---------------------------------------|--------------|------------|--|
| Ojo Caliente South Canal              | Ojo Caliente | No         |  |
| Rainbow Spring Pipeline               | Ojo Caliente | Yes        |  |
| Rainbow Spring Pipeline               | Ojo Caliente | No         |  |
| Rainbow Spring Pipeline               | Ojo Caliente | No         |  |
| Rainbow Spring Pipeline               | Ojo Caliente | Yes        |  |
| -unnamed-                             | Ojo Caliente | No         | Ditch exists, feeds stock pond only, not for irrigation. |
| Rainbow Spring Pipeline               | Ojo Caliente | No         |  |
| Ojo Caliente Reservoir South Canal    | Ojo Caliente | No         |  |
| Ojo Caliente Reservoir North Pipeline | Ojo Caliente | Yes        |  |
| Rainbow Spring Pipeline               | Ojo Caliente | Yes        |  |
| Rainbow Spring Pipeline               | Ojo Caliente | No         |  |
| Ojo Caliente North Pipeline           | Ojo Caliente | Yes        |  |
| Sacred Spring Pipeline                | Ojo Caliente | Yes        |  |
| Sacred Spring Pipeline                | Ojo Caliente | Yes        |  |
| Ojo Caliente Reservoir North Pipeline | Ojo Caliente | Yes        |  |
| Ojo Caliente Reservoir North Pipeline | Ojo Caliente | Yes        |  |
| Ojo Caliente Reservoir North Pipeline | Ojo Caliente | Yes        |  |
| Ojo Caliente North Pipeline Canal     | Ojo Caliente | No         |  |
| Rainbow Spring Pipeline               | Ojo Caliente | Yes        |  |
| Rainbow Spring Pipeline               | Ojo Caliente | Yes        |  |
| Rainbow Spring Pipeline               | Ojo Caliente | Yes        |  |
| Rainbow Spring Pipeline               | Ojo Caliente | Yes        |  |
| Rainbow Spring Pipeline               | Ojo Caliente | Yes        |  |
| Rainbow Spring Pipeline               | Ojo Caliente | No         |  |
| Rainbow Spring Pipeline               | Ojo Caliente | No         |  |
| Rainbow Spring Pipeline               | Ojo Caliente | Yes        |  |
| Rainbow Spring Pipeline               | Ojo Caliente | Yes        |  |
| Rainbow Spring Pipeline               | Ojo Caliente | Yes        |  |
| Rainbow Spring Pipeline               | Ojo Caliente | Yes        |  |
| Rainbow Spring Pipeline               | Ojo Caliente | Yes        |  |
| Rainbow Spring Pipeline               | Ojo Caliente | Yes        |  |
| Rainbow Spring Pipeline               | Ojo Caliente | Yes        |  |
| Rainbow Spring Pipeline               | Ojo Caliente | Yes        |  |
| Pescado South Canal                   | Pescado      | No         |  |
| Upper Rio Pescado Canal               | Pescado      | No         |  |
| Pescado South Canal                   | Pescado      | Yes        |  |
| Upper Rio Pescado Canal               | Pescado      | No         |  |
| Pescado North Canal                   | Pescado      | No         |  |
| Upper Rio Pescado Canal               | Pescado      | No         |  |
| Upper Rio Pescado Canal               | Pescado      | No         |  |
| Pescado North Canal                   | Pescado      | Yes        |  |
| Pescado South Canal                   | Pescado      | Yes        |  |
| Pescado North Canal                   | Pescado      | No         |  |
| Pescado North Canal                   | Pescado      | No         |  |
| Pescado North Canal                   | Pescado      | No         |  |

| NAME                               | UNIT    | HSMB VISIT | NOTES  |
|------------------------------------|---------|------------|--|
| Pescado North Canal                | Pescado | No         |  |
| Pescado North Canal                | Pescado | No         |  |
| Pescado Spring Main Pipeline Canal | Pescado | Yes        |  |
| Pescado Draw                       | Pescado | Yes        |  |
| Pescado North Canal                | Pescado | No         |  |
| Ruins Spring Canal                 | Pescado | No         |  |
| Pescado North Canal                | Pescado | Yes        |  |
| Pescado North Canal                | Pescado | No         |  |
| Pescado North Canal                | Pescado | No         |  |
| Pescado North Canal                | Pescado | No         |  |
| Pescado Draw                       | Pescado | No         |  |
| North Pescado Draw                 | Pescado | No         |  |
| South Pescado Draw                 | Pescado | No         |  |
| South Pescado Draw                 | Pescado | No         |  |
| South Pescado Draw                 | Pescado | No         |  |
| Lower Rio Pescado Canal            | Pescado | Yes        |  |
| Pescado South Canal                | Pescado | No         |  |
| Pescado South Canal                | Pescado | Yes        |  |
| South Pescado Draw Supply Canal    | Pescado | No         |  |
| South Pescado Draw                 | Pescado | No         |  |
| Pescado Draw                       | Pescado | No         | Appears to be an intermittent stream course. No POD. |
| Pescado Draw                       | Pescado | No         | Appears to be an intermittent stream course. No POD. |
| South Pescado Draw                 | Pescado | No         |  |
| Pescado Draw                       | Pescado | No         |  |
| Pescado Spring Main Pipeline       | Pescado | Yes        |  |
| Pescado North Canal                | Pescado | No         |  |
| Pescado North Canal                | Pescado | No         |  |
| Pescado North Canal                | Pescado | No         |  |
| Pescado Draw                       | Pescado | No         |  |
| Pescado Spring Main Pipeline       | Pescado | Yes        |  |
| Spring Pipeline                    | Pescado | No         |  |
| North Pescado Draw Canal 'C'       | Pescado | No         |  |
| Pescado Spring Main Pipeline       | Pescado | Yes        |  |
| Lower Rio Pescado Canal            | Pescado | No         |  |
| Pescado Spring Main Pipeline       | Pescado | Yes        |  |
| Pescado Spring Main Pipeline       | Pescado | Yes        |  |
| Pescado Spring South Pipeline      | Pescado | No         |  |
| Pescado Spring South Pipeline      | Pescado | No         |  |
|                                    | Pescado | No         |  |
| North Pescado Draw                 | Pescado | No         |  |
| Lower Rio Pescado Canal            | Pescado | No         |  |
| Pescado Spring South Pipeline      | Pescado | Yes        |  |
| North Pescado Draw                 | Pescado | No         |  |
| Pescado Draw                       | Pescado | No         |  |
| Pescado Draw                       | Pescado | No         |  |
| Pescado Draw                       | Pescado | No         |  |
| Pescado Draw                       | Pescado | No         |  |
| North Pescado Draw Canal 'C'       | Pescado | No         |  |
| North Pescado Draw Canal 'C'       | Pescado | No         |  |

| NAME                         | UNIT    | HSMB VISIT | NOTES |
|------------------------------|---------|------------|-------|
| North Pescado Draw Canal 'C' | Pescado | No         |       |
| Pescado North Canal          | Pescado | Yes        |       |
| North Pescado Draw           | Pescado | No         |       |
| Lower Rio Pescado Canal      | Pescado | No         |       |
| North Pescado Draw           | Pescado | No         |       |
| Lower Rio Pescado Canal      | Pescado | No         |       |
| Lower Rio Pescado Canal      | Pescado | No         |       |
| Lower Rio Pescado Canal      | Pescado | No         |       |
| Lower Rio Pescado Canal      | Pescado | No         |       |
| Lower Rio Pescado Canal      | Pescado | No         |       |
| Pescado Draw                 | Pescado | No         |       |
| North Pescado Draw Canal 'C' | Pescado | No         |       |
| Ruins Canal                  | Pescado | No         |       |
| Pescado Draw                 | Pescado | Yes        |       |
| North Pescado Draw Canal 'A' | Pescado | No         |       |
| North Pescado Draw Canal 'A' | Pescado | No         |       |
| North Pescado Draw Canal 'A' | Pescado | No         |       |
| North Pescado Draw Canal 'A' | Pescado | No         |       |
| North Pescado Draw           | Pescado | No         |       |
| Lower Rio Pescado Canal      | Pescado | No         |       |
| Ruins Canal                  | Pescado | No         |       |
| Lower Rio Pescado Canal      | Pescado | No         |       |
| Ruins Canal                  | Pescado | No         |       |
| Ruins Canal                  | Pescado | No         |       |
| Ruins Canal                  | Pescado | No         |       |
| Ruins Canal                  | Pescado | No         |       |
| Ruins Canal                  | Pescado | No         |       |
| South Pescado Draw           | Pescado | Yes        |       |
| Pescado Spring Canal         | Pescado | Yes        |       |
| North Pescado Draw           | Pescado | No         |       |
| Lower Rio Pescado Canal      | Pescado | No         |       |
| Lower Rio Pescado Canal      | Pescado | No         |       |
| Lower Rio Pescado Canal      | Pescado | No         |       |
| Pescado North Canal          | Pescado | No         |       |
| Pescado North Canal          | Pescado | No         |       |
| Pescado North Canal          | Pescado | No         |       |
| Lower Pescado Pipeline Canal | Pescado | No         |       |
| North Pescado Draw Canal 'C' | Pescado | No         |       |
| Lower Pescado Pipeline Canal | Pescado | No         |       |
| Pescado Spring Canal         | Pescado | Yes        |       |
| Pescado South Canal          | Pescado | Yes        |       |
| Pescado South Canal          | Pescado | Yes        |       |
| North Pescado Draw Canal 'B' | Pescado | No         |       |
| North Pescado Draw           | Pescado | No         |       |
| Lower Rio Pescado Canal      | Pescado | Yes        |       |
| Lower Rio Pescado Canal      | Pescado | No         |       |
| Lower Rio Pescado Canal      | Pescado | Yes        |       |
| Lower Pescado Pipeline Canal | Pescado | No         |       |
| North Pescado Draw Canal 'C' | Pescado | No         |       |



| <b>NAME</b>                  | <b>UNIT</b> | <b>HSMB VISIT</b> | <b>NOTES</b> |
|------------------------------|-------------|-------------------|--------------|
| Pescado North Canal          | Pescado     | No                |              |
| Pescado Spring Canal         | Pescado     | Yes               |              |
| Pescado North Canal          | Pescado     | No                |              |
| Pescado North Canal          | Pescado     | No                |              |
| Pescado Draw                 | Pescado     | No                |              |
| Pescado Draw                 | Pescado     | No                |              |
| Pescado Draw                 | Pescado     | No                |              |
| Upper Rio Pescado Canal      | Pescado     | No                |              |
| Pescado Draw                 | Pescado     | No                |              |
| Pescado North Canal          | Pescado     | No                |              |
| North Pescado Draw Canal 'C' | Pescado     | No                |              |
| North Pescado Draw Canal 'C' | Pescado     | No                |              |
| North Pescado Draw Canal 'C' | Pescado     | No                |              |
| North Pescado Draw           | Pescado     | No                |              |
| North Pescado Draw           | Pescado     | Yes               |              |
| Lower Rio Pescado Canal      | Pescado     | No                |              |
| Lower Rio Pescado Canal      | Pescado     | No                |              |
| Pescado Draw                 | Pescado     | No                |              |
| Lower Rio Pescado Canal      | Pescado     | Yes               |              |
| Lower Rio Pescado Canal      | Pescado     | Yes               |              |
| Lower Rio Pescado Canal      | Pescado     | No                |              |
| Lower Rio Pescado Canal      | Pescado     | No                |              |
| Stockpond Canal              | Pescado     | No                |              |
| Pescado North Canal          | Pescado     | No                |              |
| South Pescado Draw           | Pescado     | No                |              |
| Pescado North Canal          | Pescado     | No                |              |
| Upper Rio Pescado Canal      | Pescado     | No                |              |
| Upper Rio Pescado Canal      | Pescado     | No                |              |
| Upper Rio Pescado Canal      | Pescado     | No                |              |
| Upper Rio Pescado Canal      | Pescado     | No                |              |
| Pescado South Canal          | Pescado     | No                |              |
| Pescado North Canal          | Pescado     | Yes               |              |
| Pescado South Canal          | Pescado     | Yes               |              |
| Pescado North Canal          | Pescado     | No                |              |
| South Pescado Draw           | Pescado     | No                |              |
| Tekapo Main Canal            | Tekapo      | No                |              |
| Tekapo South Canal           | Tekapo      | Yes               |              |
| Tekapo Reservoir Pipeline    | Tekapo      | Yes               |              |
| Tekapo South Canal           | Tekapo      | Yes               |              |
| Zuni River                   | Tekapo      | Yes               |              |
| Tekapo Reservoir Pipeline    | Tekapo      | No                |              |
| Tekapo Main Canal            | Tekapo      | No                |              |
| Tekapo Main Canal            | Tekapo      | No                |              |
| Zuni South Pipeline          | Zuni        | No                |              |
| Zuni Main Pipeline Canal     | Zuni        | No                |              |
| Zuni Main Pipeline Canal     | Zuni        | No                |              |
| Zuni Main Pipeline Canal     | Zuni        | No                |              |
| Zuni Main Pipeline Canal     | Zuni        | No                |              |
| Zuni Main Pipeline Canal     | Zuni        | No                |              |

| <b>NAME</b>              | <b>UNIT</b> | <b>HSMB VISIT</b> | <b>NOTES</b> |
|--------------------------|-------------|-------------------|--------------|
| Zuni Main Pipeline Canal | Zuni        | No                |              |
| Zuni Main Pipeline Canal | Zuni        | No                |              |
| Zuni Main Pipeline       | Zuni        | Yes               |              |
| Zuni Main Pipeline Canal | Zuni        | No                |              |
| Zuni Canal               | Zuni        | No                |              |
| Zuni Canal               | Zuni        | No                |              |
| Zuni Canal               | Zuni        | No                |              |
| Zuni Canal               | Zuni        | No                |              |
| Zuni Main Pipeline Canal | Zuni        | No                |              |
| Zuni South Pipeline      | Zuni        | No                |              |
| Zuni Pipeline 'A'        | Zuni        | Yes               |              |
| Zuni Pipeline 'B'        | Zuni        | Yes               |              |
| Zuni Pipeline 'B'        | Zuni        | Yes               |              |
| Zuni Pipeline 'C'        | Zuni        | Yes               |              |
| Zuni Canal               | Zuni        | No                |              |
| Zuni Canal               | Zuni        | Yes               |              |
| Zuni Main Pipeline Canal | Zuni        | No                |              |
| Zuni Canal               | Zuni        | Yes               |              |
| Zuni Main Pipeline Canal | Zuni        | No                |              |
| Zuni South Pipeline      | Zuni        | No                |              |
| Zuni South Pipeline      | Zuni        | No                |              |
| Zuni South Pipeline      | Zuni        | No                |              |
| Zuni South Pipeline      | Zuni        | No                |              |
| Zuni Main Pipeline Canal | Zuni        | No                |              |
| Zuni Main Pipeline       | Zuni        | No                |              |
| Zuni Canal               | Zuni        | Yes               |              |
| Zuni Main Pipeline Canal | Zuni        | No                |              |
| Zuni Main Pipeline Canal | Zuni        | Yes               |              |
| Zuni Main Pipeline Canal | Zuni        | No                |              |
| Zuni Main Pipeline Canal | Zuni        | No                |              |
| Zuni Main Pipeline Canal | Zuni        | No                |              |
| Zuni Main Pipeline Canal | Zuni        | No                |              |
| Zuni Canal               | Zuni        | Yes               |              |
| Zuni Main Pipeline Canal | Zuni        | No                |              |
| Zuni Main Pipeline Canal | Zuni        | No                |              |
| Zuni Main Pipeline Canal | Zuni        | No                |              |
| Zuni Main Pipeline Canal | Zuni        | No                |              |
| Zuni Main Pipeline Canal | Zuni        | No                |              |
| Zuni Main Pipeline Canal | Zuni        | Yes               |              |
| Zuni Main Pipeline Canal | Zuni        | No                |              |
| Zuni Main Pipeline Canal | Zuni        | No                |              |
| Zuni Main Pipeline Canal | Zuni        | No                |              |
| Zuni Canal               | Zuni        | Yes               |              |
| Zuni Canal               | Zuni        | No                |              |
| Zuni South Pipeline      | Zuni        | No                |              |
| Zuni South Pipeline      | Zuni        | No                |              |
| Zuni South Pipeline      | Zuni        | No                |              |
| Zuni Main Pipeline Canal | Zuni        | No                |              |

| <b>NAME</b>              | <b>UNIT</b> | <b>HSMB<br/>VISIT</b> | <b>NOTES</b> |
|--------------------------|-------------|-----------------------|--------------|
| Zuni Main Pipeline Canal | Zuni        | No                    |              |
| Zuni Main Pipeline Canal | Zuni        | No                    |              |
| Zuni Main Pipeline Canal | Zuni        | No                    |              |
| Zuni Main Pipeline Canal | Zuni        | No                    |              |
| Zuni Main Pipeline Canal | Zuni        | No                    |              |
| Zuni Main Pipeline Canal | Zuni        | No                    |              |
| Zuni Main Pipeline Canal | Zuni        | No                    |              |
| Zuni Main Pipeline Canal | Zuni        | No                    |              |
| Zuni Canal               | Zuni        | No                    |              |
| Zuni Main Pipeline Canal | Zuni        | No                    |              |

APPENDIX III: Table of compiled BIA crop report data

| Year                         | Irrigation Unit Acreage |        |         |        |              | Total Irrigated Acreage | Note |
|------------------------------|-------------------------|--------|---------|--------|--------------|-------------------------|------|
|                              | Zuni                    | Nutria | Pescado | Tekapo | Ojo Caliente |                         |      |
| 1921                         | 3887                    |        |         |        |              |                         | 1    |
| 1922                         | 2972                    |        |         |        |              |                         | 1    |
| 1923                         | unreadable              |        |         |        |              |                         |      |
| 1924                         | 3885                    |        |         |        |              | 2494                    | 1,2  |
| 1925                         | 1782.5                  |        |         |        |              |                         |      |
| 1926                         | 2523                    | 3676   |         |        |              |                         | 3    |
| 1927                         | 2686                    |        |         |        |              |                         | 4    |
| 1928                         | 2687                    |        |         |        |              |                         | 4    |
| 1929                         | 2701                    |        |         |        |              |                         | 4    |
| 1930                         | 1010                    |        |         |        |              |                         | 4    |
| 1931                         | 1383                    |        |         |        |              |                         | 4    |
| 1932                         | 1482.5                  | 256    | 379     |        |              | 2117.5                  | 5    |
| 1933                         | 1380                    | 261    | 388     |        | 285          | 2314                    | 5    |
| 1934                         | 1018                    | 199    | 228     |        | 163          | 1608                    | 5    |
| 1935-1938 missing (4-years)  |                         |        |         |        |              |                         |      |
| 1939                         |                         |        |         |        |              | 2485                    |      |
| 1940-1946 missing (7-years)  |                         |        |         |        |              |                         |      |
| 1947                         | 1272                    | 196    | 358     | 119    | 427          | 2372                    |      |
| 1948                         | 1523                    | 211    | 386     | 142    | 479          | 2741                    |      |
| 1949                         | 1620                    | 239    | 402     | 153    | 490          | 2904                    |      |
| 1950                         | 1531                    | 223    | 383     | 136    | 462          | 2735                    |      |
| 1951 missing                 |                         |        |         |        |              |                         |      |
| 1952                         | 2297                    |        |         |        |              | 2297                    | 6    |
| 1953                         | 1770                    |        |         |        |              | 1770                    | 6    |
| 1954 missing                 |                         |        |         |        |              |                         |      |
| 1955                         | 2475                    |        |         |        |              | 2475                    | 6    |
| 1956-1980 missing (25-years) |                         |        |         |        |              |                         |      |
| 1981                         | 801.5                   | 488    | 186.5   | 121    | 207          | 1804                    |      |
| 1982                         | 234                     | 24     | 125     | 68     | 73           | 524                     |      |
| 1983                         | 173                     | 53     | 133     | 46     | 99           | 504                     |      |
| 1984                         | 406                     | 147    | 177     | 0      | 70           | 800                     |      |
| 1985                         | 272                     | 42     | 183     | 1.5    | 31           | 529.5                   |      |
| 1986                         | 191                     | 86     | 235     | 27     | 142          | 681                     |      |
| 1987                         | 120                     | 55     | 227     | 19     | 155          | 576                     |      |
| 1988                         | 157                     | 71     | 83      | 28     | 117          | 456                     |      |
| 1989                         | 140                     | 68     | 73      | 20     | 105          | 406                     |      |
| 1990                         | 43                      | 19     | 190     | 0      | 54           | 306                     |      |
| 1991                         | 94.25                   | 44     | 123.5   | 11.5   | 41           | 314.25                  |      |
| 1992                         | 77                      | 26     | 93      | 0      | 67.25        | 263.25                  | 5    |
| 1993                         | 94                      | 7.5    | 209     | 0      | 80           | 390.5                   |      |
| 1994-1996 missing (3-years)  |                         |        |         |        |              |                         |      |
| 1997                         | 0                       | 55.25  | 248.75  | 5.75   | 31.5         | 341.25                  |      |
| 1998                         | 52.25                   | 52     | 190.5   | 0      | 54           | 348.75                  |      |
| 1999                         | 0                       | 0      | 184     | 0      | 22           | 206                     |      |
| 2000                         | 1                       | 23     | 138     | 0      | 32           | 194                     |      |
| 2001                         | 0                       | 41     | 130     | 0      | 27           | 198                     |      |
| 2002 missing                 |                         |        |         |        |              |                         |      |
| 2003                         | 0                       | 33     | 147     | 0      | 15           | 195                     |      |
| 2004                         | -                       | -      | 81      | 0      | 18.5         | -                       | 5    |

<sup>1</sup>estimate of "crops planted", not irrigated

<sup>2</sup>crop report states 7481 under cultivation, 1/3 under irrigation

<sup>3</sup>report states the number is for all other areas outside of zuni unit and that it includes both irrigated and dry farming

<sup>4</sup>reported only for Zuni Irrigation Unit

<sup>5</sup>Missing data for one or more irrigation units

<sup>6</sup>Data is not clear whether referring to the entire reservation or just the Zuni project area