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APPENDIX H

Evaluation of Facilities

1.0 INTRODUCTION

The evaluations and recommendations in this report were performed for producing an appraisal-level cost estimate for the rehabilitation, repair, and needed improvement of the irrigation facilities. The rehabilitation and improvement recommendations are not the only feasible options and should not eliminate other viable options from consideration.

The purpose of this study is to investigate and identify the deficiencies, to recommend repair, rehabilitation, preventive measures, any needed improvement, and estimated costs. The evaluation process was done by trained civil engineers to quickly identify those components in an irrigation system that should be rehabilitated to assure the system's functional reliability. The facilities include diversion structures, canals, ditches, water storage ponds, laterals, drains, and pipelines.

The irrigation and drainage facilities investigated are located in eighteen pueblos in the Rio Grande basin in New Mexico. The Bureau of Indian Affairs (BIA) is responsible for the operation, maintenance and management of the facilities, and to adequately provide irrigation to the Pueblos' cultivated land. BIA Northern Pueblo Agency is responsible for the eight northern pueblos: Taos, Picuris, San Juan, Santa Clara, San Ildefonso, Nambe, Pojoaque, and Tesuque. There are ten southern pueblos: Cochiti, Santo Domingo, San Felipe, Santa Ana, Sandia, Isleta, Acoma, Laguna, Jemez, and Zia. Laguna Pueblo is managed by BIA Laguna Pueblo Agency. The other nine pueblos are managed by BIA Southern Pueblo agency. Zuni Pueblo is not included at this time because it is not in the Rio Grande basin.

Six of the pueblos are part of the Middle Rio Grande Conservancy District (MRGCD). These six pueblos had their irrigation infrastructure rehabilitated as part of Reclamation's Middle Rio Grande Project in the 1950's and 1960's. MRGCD is responsible for the operation, maintenance and management of both the reservation and non-reservation facilities within the MRGCD. They include diversion structures, canals, laterals, drains, and flood control levees. MRGCD has contractual obligation to adequately provide irrigation and drainage to lands on the following six southern pueblos: Cochiti, Santo Domingo, San Felipe, Santa Ana, Sandia, and Isleta.

Pueblo Governors' representatives assisted during site visits by accompanying the inspection team to remote sites and pointing out operational and maintenance problems in the field. Site visits and field inspection of the facilities was conducted on September 23-25, 1998, and on January 13-15, 1999.

The Bureau of Indian Affairs (BIA) provided information and relevant input on the irrigation needs for all Pueblos. BIA's assessment includes evaluation of each Pueblo irrigation system on several components: diversion structure and headworks, water storage, and water delivery infrastructure.

Various reports were used in researching the existing infrastructure and developing the cost estimate. The titles and the reports themselves are available by contacting the authors. The titles and reports are being left out of this report for the present time because of confidentiality and sensitivity issues regarding potential and ongoing water rights litigation.

2.0 PROBLEMS

The problems experienced by the Pueblos can be grouped into the following: (1) water storage and diversion; (2) water conveyance; (3) excessive water; and (4) seepage losses. A more complete discussion follows.

2.1 Water Storage and Diversion. The irrigation water supply for these Pueblos is from flows in the Rio Grande and its tributaries. These flows come primarily from spring snow melt runoff, and secondarily from summer thunderstorm runoff. Water is diverted from the river at a diversion structure headworks, and is conveyed by concrete lined ditches, earthen ditches, or pipelines to the irrigable land.

A significant overall problem is deficient water diversion systems. Many diversion structures are damaged, difficult to operate, or maintenance intensive, due to long term deterioration and lack of maintenance or inadequately designed or constructed structures. Taos Pueblo provides typical examples, where rock-and-brush diversions are easily washed out with spring and thunderstorm runoffs.

Sediment and debris accumulation can seriously reduce intake capacity at diversion structures. Diversion structures with sediment and debris accumulation are extremely maintenance intensive. In some cases, the sediment and debris accumulation is due to a structure's lack of adequate sluicing capability, poor location, or some other design deficiency. Sediment and debris accumulation can lead to a change in the river's thalweg. In these cases, the active river channel can move to the opposite side of a diversion structure and away from the irrigation intake structure. There may be sufficient water for diversion, but it becomes impossible to divert the river flows into the irrigation system.

Water collection and storage facilities are inadequate for the most part. Tesuque Pueblo provides an example, as there is inadequate capture of both surface and subsurface flows in the Rio Tesuque during the summer and fall low flow seasons. The irrigation storage ponds which store these flows are silted in. Presently, most of the abundant water from spring and thunderstorm runoffs is lost, as it passes downstream and is not available for irrigation during later dry spells.

These storage and diversion problems have hindered and discouraged farming activities in the pueblos. Many tribal farmers have become reluctant to farm because the delivery of water in the most critical time periods has been unreliable, and they have previously encountered numerous crop failures. This has contributed to numerous farms laying fallow in some pueblos.

2.2 Water Conveyance. Many of the Pueblos have unreliable water delivery due to the inadequate and poor condition of the irrigation system's water conveyance infrastructure. In several pueblos, sizable lengths of ditches have severely deteriorated, considerably reducing or eliminating their conveyance capacity. An example is Sandoval Ditch in Acoma Pueblo. Its flow efficiency has been considerably reduced, and seepage losses have increased.

Other ditches along hillsides are often plugged by surface runoff deposits. Sediment and debris from hillsides often deposits in open ditches, plugging the ditch or reducing its flow

capacity. Where frequent debris problems and severely dilapidated conditions exist, open ditches should be replaced with PVC pipelines.

Laterals and ditches are maintenance intensive and many are in deteriorated conditions. In the more northern or higher elevation pueblos (Taos in particular) the ditches are susceptible to frost heave action which causes sections of the concrete lined ditch panels to heave or buckle. These problems have resulted in flow restriction and water leakage.

Pipelines built in 1930's, such as Santa Clara Canyon pipe lateral, have deteriorated from settlement and tree roots growing inside the pipe. The problem has caused frequent pipe breaks and maintenance is intensive.

Some conveyance facilities are simply undersized, and do not carry sufficient flow to meet demand. An example is the Santa Clara Main Canal, which was concrete lined in the early 1970's. The ditch cross section was also reduced. The flow capacity is inadequate for supplying the required amount of water downstream to San Ildefonso Pueblo.

Some of the O&M roads along the ditches are also in need of maintenance upkeep. Without adequate O&M roads to access the ditches, insufficient O&M takes place on the ditches, leading to further deterioration.

Irrigation conveyance facilities vary greatly in the replacement, repair, or maintenance needed. Many of the laterals and ditches are in adequate condition for the system's present use and operation. Several facilities are in need of routine maintenance. However, many deficiencies exist that require extensive maintenance effort, or even replacement. In all cases, these structures are important for effective delivery of irrigation water to the users.

2.3 Excessive Water. In some Pueblos, other problems exist that results from periodic excesses of water, usually during spring runoff in years of abundant snow pack. These problems include flooding, high sedimentation rates, meandering of the river, and water logging of lands.

Flooding can occur with rock-and-brush diversion structures, or diversion structures that do not have adequate sluicing capabilities. The amount of water diverted can be difficult or impossible to control with these structures. Sometimes an excess of water is diverted during high river flows, resulting in ditch breaks and flooding of farmlands.

High sedimentation rates in a river can result in aggradation, raising the water table in an entire valley. The raised water table can result in waterlogged lands, decreasing agricultural productivity or rendering lands useless for farming. Sometimes a raised water table results from using drainage ditches to convey water. In either case, installation of subsurface drains in farm fields, construction of drainage ditches, and modifications to an existing drainage system can alleviate the problem. Roughly 4,000 acres of waterlogged lands were identified in the six southern pueblos along the Rio Grande in 1984.

River meandering can occur with both aggrading and degrading rivers, but is more serious in degrading rivers. River meandering can threaten riverside irrigation facilities and farmlands.

2.4 Seepage Losses. Many earthen ditches are located in areas with highly permeable soils, which leads to severe seepage losses. The seepage losses can result in waterlogged lands. It often results in a shortage of water for downstream irrigators. Reducing seepage water loss can be accomplished by concrete lining or installing pipe.

3.0 EVALUATIONS, DEFICIENCIES, AND RECOMMENDATIONS

This section describes major facilities which were visited and evaluated at different Pueblos. A possible solution or recommendation to each of the problems encountered is offered. The cost estimate was based on these solutions. Photos of many of the structures are shown in Appendix A.

3.1 Taos Pueblo. Diversion structures on the following ditches were evaluated: Mirabal Acequia, Mexican Ditch, Phia-No Ditch, South Trash Pile Ditch, North Trash Pile Ditch, Pull Leaf Ditch, Pottery Ditch, Buried Roots Ditch, Cicada Nose Acequia and Elk Horn Ditch, Tenorio Ditch, and Taos Rio Lucero Indian Ditch.

The Mirabal Acequia on the Rio Pueblo de Taos is a wide-open channel and its shallow banks are vegetated. Flow in this river directly feeds the ditch. There is no control at the ditch inlet and the amount of ditch flow depends on the river flow depth. A low head diversion berm placed across the river bed is made of rocks, logs and wood boards. Sediment deposit upstream of the berm has also silted and plugged the ditch inlet. There is no means to allow sediments to pass downstream. High flow in the river, during spring runoff, is about 3- to 5-ft deep and spreads beyond the banks of the main river channel and into the farmlands. Summer and fall flows are about 1-ft deep, and no flow can be diverted into the ditch.

One solution is to construct a 50-ft wide concrete diversion structure with sluicing capability and headworks. An inlet structure with a slide gate should be installed. Flow can be conveyed to the ditch using a 300-ft length of 18-inch diameter PVC pipe. The pipe should be extended 200 ft beyond the existing ditch inlet. Dredging should take place upstream 200-300 ft above the structure, and riprap installed on both river banks to minimize bank erosion and confine flow within the main channel. On the downstream side, a stilling basin should be constructed to dissipate energy and minimize downstream scouring.

The Mexican Ditch diversion structure is constructed of gabion wire baskets. The baskets are in disarray and the structure needs a major overhaul. The stream bank is stable. The ditch headworks are in very poor condition and need to be replaced. Flow from this diversion serves land both on and off the reservation.

The rock gabions have shifted around and some have broken. The structure is capable of diverting adequate flows when the stream depth is higher than 1-ft. The concrete head wall is cracked and there is major spalling.

The suggested solution is to replace the entire structure with a 50-ft wide concrete diversion with ditch headworks that have sluicing capability to remove sediment. A downstream stilling basin would be added to minimize downstream erosion. The river channel would be

dredged for 200 ft, both upstream and downstream. Both channel banks should be lined with riprap to prevent bank erosion and to confine the river channel.

At the Phia-No Ditch diversion on the Rio Pueblo de Taos is at the southwest edge of the Pueblo near the bridge. From this diversion, Rio Pueblos flows are diverted to three ditches: Phia-No, Phia-No B (B-Ditch), and Phia-No C (C-ditch). The river banks are well defined and fully vegetated. River flow is to the southwest. All three ditches serve tribal land, and the B-Ditch also serves non tribal land. All three ditches are in good condition and functioning. Phia-No supplies water to an area east of the river and southeast of the Pueblo. The headworks for this ditch is a small concrete box located on the river's east bank, about 200-ft south of the bridge. Inflow is controlled with stoplogs. River flows are diverted by means of a low head berm, constructed of loose rocks about 2-ft high, beginning at the box inlet and extend diagonally upstream about 50-ft.

The inlet to the B-Ditch is approximately 200-ft upstream from the Phia-No Ditch and directly below the bridge crossing that accesses the Day School and east area of the Pueblo. The diversion berm is constructed of loose rocks. The ditch inlet pipe runs diagonally across the river from the ditch inlet. There is no control at the ditch inlet and the amount of ditch flow depends on the river flow and condition of the loose rock berm. The river bed appears stable with a minimal aggradation-degradation problem.

The C-ditch is within the Pueblo historic area. This berm is constructed of loose rocks and runs from the ditch inlet diagonally upstream across the river. There is no control at the ditch inlet and the amount of ditch flow depends on the depth of flow in the river and the condition of the loose rock berm. The river bed appears stable with a minimal aggradation-degradation problem. The east side ditch served by this structure is no longer used.

Approximately 300-ft downstream of the bridge, there is another low head berm, constructed of rocks, cobbles, and timber logs. It is a 3-ft high drop structure.

There are no sound diversion structures for these ditches. Water is diverted by a berm consisting of placed rocks, brush and logs that frequently wash out. After each washout, the berm has to be reconstructed in order to continue diverting. Washouts occur every spring or after any high runoff event.

Construction of a permanent structure is needed, but may cause flooding of the upstream historic pueblo. The recommendation is to leave things as they are, to place large boulders to assist in diverting water, and to build a concrete inlet structure at the C-ditch location for diverting flow into the three ditches. These three ditches could be served with a 12-inch pipeline and risers with in-line valves. Additional hydrologic study is needed to assess the impact of a permanent diversion structure at the existing or alternate location.

The South Trash Pile Ditch diversion is a low head diversion berm constructed of timber logs, about 1-ft to 2- ft high that spans the 30-ft wide channel. The river banks are well defined and fully vegetated. The ditch inlet is a gated inlet structure. The river bed appears stable with minimal aggradation-degradation problems. The open channel earth ditch and the diversion are in good condition and functioning.

Although the timber log berm appears intact, it is a nonpermanent structure that can easily get washed out.

The diversion section area requires cleaning and the ditch inlet needs reshaping. Constructing a permanent and reliable concrete weir with sluicing capability will provide stability on the south side. At the other end, constructing a concrete wall will provide an anchor for the timber logs, support, and stability.

The North Trash Pile Ditch diversion is a berm constructed of rocks and cobbles across the full width of the river bed, or more than 50-ft long. Elevation drop is about 1-ft. The river banks are well defined and fully vegetated. Flow in this river directly feeds the North Trash Pile ditch. The ditch inlet is about 150-ft upstream of the diversion berm. The river bed appears stable with minimal aggradation or degradation. Vegetative debris accumulation is evident in the wide rock berm area. Both the open channel earthen ditch and the diversion are functional. About 50 feet of riprap skirts the north bank of the stream and protects the dirt road that serves the Canyon area.

The rock berm is moderately washed out and is not well defined. Vegetative debris accumulation in the berm area obstructs flow. There is no control at the ditch inlets and amount of ditch flow depends on the river flow depth.

The recommendation is to construct a permanent, 80-feet long concrete structure, with sluicing capability.

The Pull Leaf Ditch diversion structure was built in 1985 and consists of a three-stepped, concrete capped rock gabion on the downstream end and sheet pile at the upstream end. Total drop is approximately 5 ft. It extends across the river width, with a concrete wing wall at one end and a gated concrete inlet structure at the other end. Both banks are protected with riprap gabions.

Sediment accumulation upstream of the diversion structure tends to plug the bay to the ditch inlet. The inlet requires frequent clean-out and is maintenance intensive.

The recommendation is to install a concrete cap on the structure that would be 3-ft wide by 35-ft long, 4- to 6-in thick, with rebar and fiber cement.

The Pottery Ditch does not have headworks. The diversion berm is constructed of loose rocks and small logs or sticks. The ditch inlet is at the same elevation as that of the stream. The loose rocks stockpiled and spread in the stream creates just enough backwater for water to flow into the ditch. The beginning of a well-defined ditch is about 30- to 40-ft downstream of the ditch inlet. There is no control at the ditch inlet and the amount of ditch flow depends on the river flow depth and rock berm. The open channel earthen ditch and the diversion are functional.

The berm is moderately washed out and is in poor condition. The loose rock berm is subject to washouts during high flows, and requires reconstruction to allow flow to be diverted into the ditch. Storm runoffs often cause the upper portion of the ditch to wash out.

A new and more permanent diversion concrete structure is needed at this site to provide a reliable source of water for the ditch. An alternative way of delivering water to the ditch may be more economical, although it might conflict with historical and cultural values. For now, the recommendation is to construct a pipeline from Cicada Nose Ditch that will feed this ditch.

The Buried Roots Ditch Diversion is a sound concrete diversion structure with riprap both upstream and downstream. The drop in elevation is about 6- to 8-ft. The river banks are well defined and fully vegetated. Flow in this river directly feeds the ditch. The river bed appears stable with minimal scouring or erosion problems. Vegetative debris accumulation is evident in the wide rock berm area. Water is piped from this diversion to the Buried Roots Ditch.

The structural concrete shows spalling and there is minor loss of the riprap sections. The recommendation is to perform needed concrete repairs on the structure and add riprap for erosion protection.

Cicada Nose Acequia and Elk Horn Ditch - The diversion structure consists of a 3-stepped, concrete capped rock gabion drop structure, with a total drop of about 6 ft. It extends across the river width, with concrete wing walls and concrete inlet structures with slide gates at each end. Both banks are protected with riprap gabions. At one bank, Cicada Nose Acequia begins with 150 ft of 18-inch diameter corrugated metal pipe (CMP) that goes to an open earth ditch. At the other abutment, Elk Horn Acequia begins with 2,560 ft of 18-inch CMP and continues with 2,880 feet of open earth ditch.

Concrete walls are showing deterioration and minor spalling. Concrete caps of the drop floors have minor spalling. The recommendation is to repair the diversion by sandblasting spalled concrete and placing new concrete.

The headworks for the Tenorio Ditch is a concrete diversion structure across the Rio Lucero, which was built in 1975. This structure has a radial gate and two inlets that divert water from the Rio Lucero to Tenorio ditch and the Rio Lucero Indian ditch. Its overall condition is good and it functions well. The Tenorio ditch consists of 2.4 miles of 18-inch and 24-inch PVC pipe at the upstream end, installed in 1975, and continues with 1.5 miles of open earth ditch at the downstream end. Total elevation drop of the pipeline is estimated at 300- to 500-ft.

At the diversion structure, the radial gate leaks and the head gate's slide gate stems have been damaged and are difficult to operate. The pipeline has an inadequate number of turnouts needed to efficiently distribute the water to end users. The earthen ditch is maintenance intensive due to erosion and siltation.

Recommendations for the diversion structure are to replace the radial gate seals, install a pad on the gate sill, and replace the two slide gates. Recommendations for the ditch are to install 10 additional turnout risers along the existing pipeline, and to replace 1 mile of the open earthen ditch with 24-inch PVC pipeline and 10 turnout risers.

Taos Rio Lucero Indian Ditch - The concrete diversion structure has a radial gate and two headworks to divert water from the Rio Lucero to the Tenorio ditch and the Rio Lucero Indian ditch.

This ditch was concrete lined in the 1930's. Since then, the upper one mile of a 2.2 mile total length of this ditch has been replaced with a 24- and 30- inch CMP or concrete pipe. The remaining 7,700 feet of open ditch is in poor condition, subject to freeze thaws, and is susceptible to breaching.

About 1.5 miles of the concrete lined ditch is disintegrating and has lost its conveyance capacity.

The recommendation is to replace 7,700 feet of disintegrating concrete lined ditch with 24-inch PVC-80 psi pipe, and to replace the slide gates at the headworks.

3.2 Picuris Pueblo. The following facilities were evaluated: the Main Diversion Headworks Structure, Highline Ditch, Middle Ditch, Upper Ditch, West Ditch, and Jack Rabbit Ditch.

The Main Diversion Headworks Structure is a concrete, radial gate check structure with headworks that diverts water from the Rio Pueblo to the Highline Ditch. The main diversion structure is in good condition, but the diversion box has been severely undermined. Further erosion and undermining may cause the inlet box to collapse. Repairing and stabilizing the inlet box by placing or pumping concrete is recommended.

The Highline Ditch conveys flow for about half a mile to a concrete desilting box that diverts the flow into three ditches: the Upper Ditch, Middle Ditch, and West Side Ditch. The stilling basin of the concrete desilting box has severe concrete spalls. Most of the ditches are earth lined with some concrete lined sections, and have general deterioration or disrepair. Concrete panels have settled, heaved, or cracked. Deteriorated earth ditches have been partially plugged, eroded, or lost their shape.

From the ditch headworks box, flow from the Highline Ditch to the West Side ditch is conveyed by a 24-inch diameter steel pipe flume crossing the Rio Pueblo. The flume is supported by four concrete piers. The main span is a railroad-type inverted steel truss structure about 80-ft long. It is at a 30-degree skew with a pipe stand at the end.

The steel pipe has lost most of its paint and minor corrosion is evident throughout its length. The flume's timber decking platform has deteriorated and shows several broken planks. The decking is narrow and there is no walkway or handrail for safe O&M work access. There is also no access ladder to the platform.

Recommendations include repairing spalled concrete at the desilting box, installing a new 30-in head gate, and repairing a leak around the head gate to the West Side ditch. The steel pipe should be painted to prevent the corrosion from becoming severe. Deteriorated timber planks on the decking should be replaced. A grated metal catwalk with a handrail and a 5-ft ladder for maintenance access and safety should be installed. Structural inspection on the metal beams supporting the flume crossing should be performed.

Recommendations are to repair 3,000 linear ft of the concrete lined Highline Ditch. Concrete lining 2,400 linear ft of earth ditch (West Ditch) should take place, as well as reshaping

and rehabilitating the remaining 15,500 linear ft. of the earth ditches.

3.3 Santa Clara Pueblo. The following facilities were evaluated: Pajarito Ditch, Gauchupangue Ditch, Middle Pueblo and East Pueblo Ditches, Santa Clara Siphon, Santa Clara Creek Pipeline and Diversion, Santa Clara Middle Ditch, Holcomb Ditch, and Santa Clara Main Canal.

The Pajarito Ditch was abandoned by the tribe when the Rio Grande was dredged in the early 1960's, as the oxbow that fed water to this ditch system was cut off from the river. In 1997, a new 48-inch CMP pipeline with head gates was installed through the berm separating the river from the oxbow. This allows river flows to enter the oxbow and ditch.

Sediment deposition and river bank erosion have altered and moved the river's thalweg away from the irrigation ditch intake, toward the opposite river bank. Water supply to the ditch will be unreliable, particularly during low flows.

The recommendation is to construct three spur dikes, groins, or bendway weirs on the river's east bank, about 300 feet upstream from the ditch headworks. This will train river flow toward the west bank, where the ditch headworks is located.

The Gauchupangue Ditch diversion structure is comprised of a L-shaped rock wall, located in Santa Clara Canyon. It diverts water from the Santa Clara Creek to a 18-inch pipeline. The pipeline feeds Gauchupangue ditch. Behind the rock wall dam is a concrete desilting basin which requires periodic dredging. The structure has two sluice gates which have cracked and settled. The structure's drop is approximately 3 ft.

The structure leaks around the gates and shows long term deterioration, cracking, and settling. Its integrity as a dam is questionable. Debris accumulation requires clean up of the inlet area several times in a season. This site is maintenance intensive.

The recommendation is to construct a new 80-ft wide concrete diversion with sluicing capability and a headworks that directly feeds the pipeline.

The Middle Pueblo, Village, and East Pueblo Ditches run through the heart of Santa Clara Pueblo. The Middle Pueblo and Village ditches serve garden areas within the pueblo. The East Pueblo ditch serves garden areas within the pueblo and the areas above the Santa Clara Main Canal. These earth ditches are small and their flow conveyance is poor. Concrete lining these ditches should greatly alleviate the flow problem.

The Santa Clara Siphon carries the Santa Clara Main Canal over the Santa Clara stream. It is CMP pipe embedded in concrete. The length is about 130 feet. The underside of this structure is exposed. This siphon needs replacing. The new siphon should include an apron or desilting basin to protect the siphon and to control erosion. The length of this structure is approximately 130 feet.

The Santa Clara Creek Pipeline (Canyon Ditch) is approximately 3.5 miles long. Water is diverted from Santa Clara Creek, a tributary of Rio Grande. The Santa Clara Creek

Diversion slide gates are damaged and difficult to operate, and the desilting box frequently fills with silt. The diversion structure and 18-inch diameter concrete pipeline were installed in the 1930's. In the past 10 years there have been major problems with tree roots getting into the line and clogging it, as well as pipe breaks and leakage. Numerous repairs have been made and the annual maintenance cost has been very high. This deteriorated pipeline should be replaced with 18-inch PVC pipe.

NRCS is currently working with the Tribe through the USDA-EQUIP Program to fund a new pipeline project that would be laid alongside the existing line. An application has been submitted by NRCS on behalf of the Tribe for approximately $286,000. This amount will cover some of the materials, but will not cover construction.

The Santa Clara Middle Ditch is an earth ditch lateral off the Santa Clara Main Canal which ties into the Pajarito ditch at its lower end. Because the terrain is very flat, seepage loss is significant and the Tribe proposes lining it with concrete.

The Holcomb Ditch runs parallel to the Los Alamos Highway through Santa Clara and borders the highway right-of-way fence. Several years ago the Tribe eliminated the lower end of the Canyon ditch. This section of ditch was earthen and traversed around a mountain side. It had uncontrollable pocket gopher problems. Last fall, BIA installed a flume crossing in order to activate this ditch so it would serve the area irrigated previously by the Canyon ditch. Maintenance of the Holcomb ditch in the past has been minimal in terms of time and the cost involved, compared to the Canyon ditch. Seepage losses in this ditch are high and the amount of available water is limited–flow releases have to be scheduled. This ditch should be concrete lined or replaced with pipeline.

The Santa Clara Main Canal Diversion was constructed in 1992. It is an a L-shaped metal sheet wall embankment with a gated headworks for the canal and a flow bypass gate. A 48-inch pipe diverts water from the Rio Grande to the Santa Clara Main Canal. The dike is approximately 7-ft high.

A considerable amount of floating debris in the Rio Grande flows directly into the diversion channel and collects immediately at the headworks. Debris accumulation reduces the headworks' flow capacity. The bypass culvert was not designed to flush out floating debris. Clean up at the inlet area has to be done several times a season and is maintenance intensive.

The diversion structure should be modified by installing a sluiceway capable of removing floating debris from the diversion channel. A 20-ft wide radial gate, placed across the embankment dike, would vastly improve sluicing capabilities. A trash rack should be installed across the diversion channel at a 45-degree skew, and located 30 feet upstream of the radial gate sluiceway. The trash rack will further help keep debris out of the sluiceway. Another type of sluiceway that can be considered is a bypass channel with stop logs.

3.4 San Ildefonso Pueblo. The only existing facility evaluated was the Main Diversion Structure.

The existing 500-ft long diversion structure spans the width of the Rio Pojoaque. It

consists of a 200-ft concrete drop and a 300-ft of steel sheet pile drop structure. Heavy sediment deposits on both the upstream and downstream sides have covered the top of the structure. The sediment is fine sand with silt. The entire sheet pile drop structure has collapsed, from scouring on the downstream side.

There is a subsurface infiltration gallery system across the river bed upstream of the drop structure. This system delivers water to the ditch when river bed is dry. The diversion structure protects the subsurface infiltration gallery by providing a grade control point in the river. The diversion structure is critical for proper functioning of the subsurface infiltration gallery.

There is no provision for passing the sediment load, which has resulted in heavy siltation upstream of structure. River low flows should be directed toward the south bank, where the ditch headworks is located.

The north side of the structure that has collapsed should be replaced with a concrete drop and stilling basin. The new concrete structure should be set at a slightly higher elevation than the original to direct stream flow to the south side. Sluice gates should be installed to minimize upstream sedimentation.

3.5 Nambe Pueblo. The existing facilities evaluated are the Highline Ditch and Laterals, Highline Ditch Extension, Chili Line, Alabama Ditch, Acequia de Llano, and Acequia Nueva.

The Highline Ditch concrete diversion is one of two that serves Pueblo farm lands. This diversion is the uppermost one. The diversion has sluicing capabilities and serves a concrete lined canal. Two large drainages are present just upstream of the diversion.

Spalling on the diversion structure's cap should be repaired. The angle iron bolted to the cap has loosened in some places, and needs to be anchored.

Repairs are needed for 2,500 linear ft of concrete lined ditch. Concrete lining is needed for 10,000 linear ft of earth ditch. The entire cap of the diversion structure, which is about 2-ft wide by 75-ft long, needs rehabilitation.

About 14 Highline Ditch Laterals traverse through porous and permeable soils and seepage losses are very high. Water from these laterals is limited, and flows have to be scheduled. These laterals should be concrete lined or placed in pipeline.

The Highline Ditch Extension, Chile Line, Alabama Ditch, Acequia del Llano, and Acequia Nueva are mostly earthen ditches that will require cleaning and shaping, as well as rehabilitation of some concrete lined sections.

3.6 Tesuque Pueblo. The facilities evaluated are the Main Headworks, Tesuque Creek Infiltration Gallery, Navajo Ditch Headworks, Storage Ponds, Mitchell Ditch, Post Ditch and Laterals, Wild Plum Ditch, Quiyo Ditch, Corral Ditch, Pueblo Ditch, Pine Ditch and Pond, and Suazo Ditch.

The Main Headworks is a new gabion drop structure with no provision to capture surface

flows in the Rio Tesuque. This gabion structure acts as a river grade control structure to protect a subsurface collection system installed in the 1970's, the Tesuque Creek Infiltration Gallery. It is the subsurface collection system which delivers subsurface water to the irrigation storage ponds. The river bed is highly permeable sand and gravel. The subsurface pipe system was poorly constructed and many pipe joints have separated, allowing sand and gravel to plug the pipes. This subsurface collection system delivers minimal flow to the irrigation ditch. There is no provision to divert surface flow to the main irrigation ditch. Diversion of water for the main irrigation ditch is unreliable and inadequate.

A new concrete diversion with sluicing capability should be constructed about one-half mile upstream from the new gabion drop structure. One-half mile of 24-inch pipeline should be installed to convey diverted surface waters to the irrigation ponds. An in-line valve at the midway point will be needed to divert water from the pipeline to the Mitchell ditch. A 12-inch spur about 200 feet long would be necessary.

The Tesuque Creek Infiltration Gallery should be repaired or replaced. This system is required for reliable water delivery. Most of the asbestos pipes comprising the gallery have broken joints and are plugged. Replacement will require installation of 3,300 linear ft of 24-inch slotted or perforated pipeline.

The Navajo Ditch Headworks is a gabion structure that diverts water to an irrigation pond. At times, flows in Rio Tesuque can be 2,000 to 4,000 cfs.

Several rock baskets in the middle of the structure have collapsed due to high flow scouring below the gabions. Most of the gabion structure is settling, and losing foundation support due to scour. The gabion basket wire is rotting, evidenced by the whitish and brownish colors. Due to the high flows in this river and the structure's deteriorated condition, the gabion structure is structurally deficient and there is good potential for complete washout with the next large flow.

The structure should be replaced with a concrete diversion with sluicing capabilities and a stilling basin.

The irrigation Storage Ponds need to be dredged to restore storage capacity. Seepage losses of ponds 1 and 2 can be reduced by placing PVC liner.

The Mitchell Ditch, Post Ditch and Laterals, Wild Plum Ditch, Quiyo Ditch, Corral Ditch, Pueblo Ditch, Pine Ditch and Pond, and Suazo Ditch are mainly earthen ditches that will require cleaning and reshaping as well as rehabilitation of some concrete lined sections.

3.7 Pojoaque Pueblo. The only facility evaluated is the Main Ditch.

The Main Ditch is the primary conveyance facility for this Pueblo. It is a one-mile long earth ditch with one flume structure and road crossing culverts.

Overall condition is poor to fair, due to lack of regular maintenance. Several road culverts are damaged or have long term deterioration.

The earth ditch should be clean and reshaped. The 24-inch diameter flume and 15 of the road crossing culverts should be replaced.

3.8 San Juan Pueblo. The facilities evaluated are the El Guique (San Rafael) Ditch, Reyes Montoya Ditch, Chamita Ditch, Aquino Ditch, Middle/Bosque/Consolidated Ditch, Acequia Madre, Acequia Madre Highline, Alcalde Ditch, El Llano Ditch, and the San Juan Pueblo Ditch.

These ten irrigation ditches deliver water to various sections of the Pueblo. They are mainly earth ditches with a few concrete-lined sections. There are siphons that cross creeks and washes and road crossing culverts along the ditch alignments. The ditches vary in length from 1,500 ft to 19,200 ft. Utilization of water in these ditches varies. The El Guique (San Rafael) ditch traverses through grazing areas and supplies cattle with drinking water.

Most of the earth lined ditches are in poor condition due to lack of maintenance.

Earth ditches and sections of the concrete lined ditches should be repaired. Thirty-one road crossing culverts and two siphons need replacement. Eight new turnouts are needed for delivering water to the fields.

3.9 Jemez Pueblo. The existing facilities evaluated are the Main Headworks and Pecos Diversion. Various earth and concrete-lined irrigation ditches were noted by quick visual inspection.

The Main Headworks concrete diversion structure was built in the late 1930's to early 1940's. It is about 200-ft long, spanning the Rio Jemez. A drop inlet at each abutment supplies the West Side Ditch and East Side Ditch. Safety features are lacking. Additional safety features, such as handrails, should be installed.

The Pecos Diversion was built in 1995-1996, and is concrete-capped, stepped gabion structure with a concrete stilling basin. A drop inlet at one abutment supplies an irrigation ditch. Gabions at the lower steps are settling, due to downstream bed erosion and scouring or foundation material loss due to piping behind the gabion wall. The cause of the gabion settlement needs to be determined and corrected. The lower gabions should be repaired and additional erosion protection added.

Irrigation ditches are mostly in fair condition. The earth ditches need cleaning and reshaping. Many sections of the concrete lined ditches have cracks and other minor deteriorations and repair is recommended.

3.10 Zia Pueblo. The facilities evaluated are the New Zia Diversion Dam, Old Zia Diversion Dam, and Zia Irrigation Flume. Irrigation facilities consist of a diversion dam, 12 miles of main canal and 12 miles of farm laterals. The Rio Jemez supplies water for irrigation. The availability of water is inadequate for full utilization of all irrigable lands.

The New Zia Diversion Dam is discussed in detail in Appendix B. Recommendations for repair include:

1. Stability of the dam should be reviewed, due to the severity of erosion around the structure and the embankment material. Sliding and piping potential should be checked.

2. A concrete stilling basin with a cutoff wall should be constructed to stabilize the dam against sliding and piping problems.

3. The dam crest should be lowered by several feet to reduce the upstream sedimentation. A sluiceway should be installed near the headworks to flush out sediment deposits upstream of the diversion dam.

4. The upstream berm should be raised and riprap erosion protection should be added. The downstream banks should be reshaped riprap erosion protection should be placed.

Old Zia Diversion Dam - This structure is discussed in detail in Appendix B. Some sort of river bed grade control needs to be installed, probably in the river channel downstream of the new diversion structure to prevent failure of the new Zia Diversion Dam.

The Zia Irrigation Flume is discussed in detail in Appendix B. Some river bed grade control structure is necessary, along with river bank riprap protection, to prevent failure of the flume foundation.

3.11 Cochiti Pueblo. Cochiti Pueblo is served by MRGCD. The HKM report was used to evaluate MRGCD facilities.

(1) MRGCD Facilities. The following MRGCD irrigation facilities were evaluated in the HKM report: Arguero Lateral, Baca Lateral Nos. 1 and 2, Cochiti Eastside Main Canal and Wasteway, Island Lateral, Peña Blanca Lateral Nos. 1 and 2, Sile Main Canal, Trujillo Feeder Canal, and Village Feeder Canal.

The following MRGCD drainage facility was evaluated in the HKM report: Peña Blanca Riverside Drain.

(2) Indian Facilities. The HKM Report describes waterlogged areas at Cochiti Pueblo. These were caused by Cochiti Reservoir, which elevated water tables downstream of Cochiti Dam. However, subsurface drains have been installed by the Corp of Engineers to rectify the waterlogging problem in the early 1990's, after the HKM Report was written. No further subsurface drainage is required by Cochiti Pueblo.

3.12 Santo Domingo Pueblo. Santo Domingo Pueblo is served by MRGCD. The HKM report was used to evaluate MRGCD facilities.

(1) MRGCD Facilities. The following MRGCD irrigation facilities were evaluated in the HKM report: Cochiti East Side Main Canal and Wasteways, Majada Lateral, Pueblo Lateral, Railroad Lateral, Rivera Lateral, Santiago Lateral, and Sile Main Canal and Wasteways.

The following MRGCD drainage facilities were evaluated in the HKM report: Majada Drain, Peña Blanca Riverside Drain, Eastside Riverside Drain, Interior Drain, and Westside

Riverside Drain.

(2) Indian Facilities. The HKM Report describes two waterlogged areas. These areas will require subsurface drains.

3.13 San Felipe Pueblo. San Felipe Pueblo is served by MRGCD. The HKM report was used to evaluate MRGCD facilities.

(1) MRGCD Facilities. The following MRGCD irrigation facilities were evaluated in the HKM report: Algodones Lateral, Angostura Lateral, Cociti Eastside Main Canal and Wasteways, Cubero Lateral, Elota Lateral, Monica Lateral, Parallel Lateral, Tongue Lateral, Yeso Lateral, San Felipe Siphon, Santa Ana Feeder, Sile Main Canal and Wasteways, and Valencia Feeder.

The following MRGCD drainage facilities were evaluated in the HKM report: Algodones Riverside Drain, Bernalillo Riverside Drain (Atrisco Feeder), San Felipe Lower Riverside Drain, San Felipe Riverside Drain, Santo Domingo Eastside Riverside Drain, and Yeso Drain Nos. 1 and 2.

(2) Indian Facilities. The HKM Report describes two waterlogged areas. The waterlogging in this area can be alleviated in two ways: (1) install subsurface drains or (2) deepen and extend the existing Santo Domingo Eastside drain, an MRGCD facility.

3.14 Santa Ana Pueblo. Santa Ana Pueblo is served by MRGCD. The HKM report was used to evaluate MRGCD facilities.

(1) MRGCD Facilities. The following MRGCD irrigation facilities were evaluated in the HKM report: Albuquerque Main Canal, Bosque Lateral No. 1, Feeder Canal (Albuquerque Main STA. 69+50), Parallel Laterals (Along Albuquerque Main), and Santa Ana Acequia (Siphon Under Hwy. 85).

The following MRGCD drainage facilities were evaluated in the HKM report: Bernalillo Riverside Drain (Atrisco Feeder), and Ranchitos Drain.

(2) Indian Facilities. The HKM Report did not find any waterlogged areas on Santa Ana Pueblo.

3.15 Sandia Pueblo. Sandia Pueblo is served by MRGCD, which is responsible for delivering water to the Pueblo. MRGCD facilities tend to be the larger canals, laterals, and drains. Smaller facilities are Indian ditches, which convey water from the MRGCD delivery facility to the farm fields.

Information on improvements to MRGCD facilities is taken from a report entitled Comprehensive Analysis of Irrigation and Drainage Facilities, Six Southern Pueblos, with Recommended Rehabilitation and Betterment Plan, Volume 1 (HKM report). This report was prepared by HKM Associates of Billings, Montana in November, 1984. This report also discusses new open and subsurface drains which are needed to properly drain waterlogged farm lands. These new drainage facilities would be Indian facilities.

(1) MRGCD Facilities. The following MRGCD irrigation facilities were evaluated in the HKM report: Alameda Lateral, Albuquerque Main Canal, Bosque Lateral No.2, Corrales Main Canal, Sandia Acequia, Sandia Lateral, Sandia Lateral No. 2, East-West Diversion, and the Hwy85/Railroad diversion culvert crossings.

The following drainage facilities were evaluated in the HKM report: Albuquerque Riverside Drain, Bernalillo Interior Drain, and Bernalillo Riverside Drain (Atrisco Feeder).

Operation of the Bernalillo Riverside Drain and the Albuquerque Main Canal has significantly changed from their original designs. The Bernalillo Riverside Drain now serves as a water supply canal.

(2) Indian Facilities. The HKM Report describes one large waterlogged area. This area will require subsurface drains.

3.16 Isleta Pueblo. Isleta Pueblo is served by MRGCD. The HKM report was used to evaluate MRGCD facilities.

(1) MRGCD Facilities. The following MRGCD irrigation facilities were evaluated in the HKM report: Arenal Canal and Wasteway, Barr Canal and Wateway, Belen Highline Canal and Wateway, Butte Lateral, Cacique (Sand Hill) Lateral, Chical Lateral and Wasteways, Hell's Canyon Wasteway, Indian Lateral No. 1 and Wasteway, Los Lunas Lateral, New Belen Ditch, Otero Lateral, Peralta Main Canal and Wasteway, Cacique Acequia, Chical Acequia, and Lower Chical Acequia.

The following MRGCD drainage facilities were evaluated in the HKM report: Albuquerque Riverside Drain, Atrisco Riverside Drain, Belen Interior Drain, Belen Riverside Drain, Indian Interior Drain, Isleta Interior Drain, Isleta Riverside Drain, Peralta Riverside Drain, and Tome Interior Drain.

(2) Indian Facilities. The HKM Report listed seven areas which were waterlogged. Since the HKM Report was written, subsurface drains have been installed on five of these areas, which are on the east side of the Rio Grande. The remaining areas on the west side of the Rio Grande are included in the cost estimate.

3.17 Laguna Pueblo. The following irrigation facilities were evaluated: North Acomita Ditch, Seama Diversion, Casa Blanca Ditch at the Philadelphia Diversion, Encinal Canyon Ditch, Mesita Diversion, Mesita Pipeline, New Laguna Ditch and Paguate Ditch.

The North Acomita Ditch delivers irrigation water from Acomita Lake (located in Acoma Pueblo) to Seama Reservoir (in Laguna Pueblo). The existing North Acomita earthen ditch is four miles long, traversing along a hillside at a fairly flat grade, starting at Acomita Lake turnout and ending at the concrete lined portion starting at the west boundary of Laguna Pueblo. The earthen ditch has deteriorated and filled with sediment and wind deposits. Several sections have reverse grade. It has low conveyance efficiency and seepage losses are high. It also lacks adequate ditch check gates and turnouts for delivering waster to the end users.

The recommendation is to construct a reliable 3-mile long water conveyance structure, either concrete lined ditch or PVC pipeline, from Acomita Lake to the west boundary of Laguna Pueblo.

The Seama Diversion outlet structure gate is deteriorated and damaged, causing the slide gate not to seat well when closed. The upstream side of the diversion dam is nearly filled with sediment. The downstream side of the sluiceway is eroding and needs to be stabilized.

The damaged head gate and sill should be replaced. The sluiceway should be stabilized.

The gate for the Casa Blanca Ditch at the Philadelphia Diversion is poorly seated due to long term deterioration and cannot be closed properly. It cannot adequately back up water for diversion to Casa Blanca ditch. The damaged head gate and sill should be replaced.

The Mesita Diversion head gate is damaged from long term deterioration and is poorly seated when closed. The damaged head gate and sill should be replaced. Damaged concrete on the structure should be repaired.

A new pipeline, the Mesita Pipeline, is needed to improve water delivery from Mesita Dam to the Mesita ditch. Currently, released water flows into the Rio San Jose before it is delivered to the ditch at the Mesita diversion, five miles away. A new head gate control box and 3.5 miles of 18-in PVC pipeline is recommended.

The Encinal Canyon Ditch, a 5-mile earth ditch from Encinal Diversion to Beecher Dam is not functional and has not been in operation for the several years. The gate at Beecher Dam is damaged and does not function. The estimated acreage irrigated by this ditch is about 120 acres.

This ditch has not been used for several years. Irrigation from this ditch has been very limited due to its poor condition. To provide efficient irrigation to the fields the ditch should be concrete lined. The gate at Beecher Dam needs to be replaced.

The New Laguna Ditch is an existing 2.5 miles of earth ditch, between Encinal flume to Old Lady Lake in New Laguna. This ditch has badly deteriorated due to lack of maintenance. Its flow efficiency is reduced. It also lacks turnouts for delivering water to the end users. Concrete lining is recommended for 2.5 miles of the New Laguna Ditch. Fourteen new check gates and 200 turnouts would be needed.

The lower portion of the Paguate Ditch is about 0.8 miles of earthen ditch which flows through the village of Paguate. It receives water from the upper diversion on the Rio Paguate and irrigates about 100 acres. This ditch is badly deteriorated due to age and lack of maintenance. It also lacks turnouts for delivering water to the end users. The NRCS has surveyed and developed an engineering design for replacing the ditch with a 10-in low-head PVC pipe.

The recommendation is to replace this 0.8 mile length of existing ditch with 10 inch low-head PVC pipe as designed by the NRCD, and to install 15 alfalfa valves, 4 air relief valves, one open air vent, and 15 rubble masonry turnout structures.

3.18 Acoma Pueblo. The following irrigation facilities were evaluated: Sandoval Ditch, Anzac Ditch, and the South McCarty Ditch.

The Sandoval Ditch begins at Estevan Diversion in Rio San Jose. It was built in 1950's and is 7.2 miles long. It runs easterly near the Pueblo's northern boundary, supplying irrigation water to land it traverses, and discharging into Acomita Lake. The Sandoval Ditch is concrete lined with extensive deterioration over half of its length, particularly where it traverses hillside terrain in the North McCarty Augustine Seymore and in the Domingo Concho residential areas. Deterioration includes settlement and collapsing concrete panels. Damaged panels cause severe seepage losses and reduce conveyance efficiency. Stretches of ditch along hillsides are also susceptible to plugging by material that slides or erodes from the hillside. Approximately 85 of the existing turnouts are malfunctioning due to long term deterioration.

In order to restore the ditch capacity, damaged ditch sections should be repaired or replaced with a 36-inch diameter PVC or HDPE pipeline. Replacing 4.5 miles of the concrete ditch with PVC pipeline will also reduce future O&M or replacement cost, as it will be less susceptible to buckling or plugging by hillside erosion. Approximately 100 pipe turnouts will be needed to deliver water to the water users. Another 85 concrete ditch turnouts should be replaced.

The Anzac Ditch begins at Gottlieb Diversion in Rio San Jose and runs easterly, south of Interstate 40 (I-40), and ends at Silver Bridge, near the intersection of Anzac Road and I-40. At the end of the Anzac Ditch is a weir to divert excess water from the Anzac Ditch into the South McCarty Ditch. The weir has been eroded and breached. The weir should be repaired.

The South McCarty Ditch carries water from the Rio San Jose at Silver Bridge to the McCarty Church. The ditch is plugged by debris and sediment from surrounding hillside runoff. The site should be evaluated and a new structure installed that will reduce hillside sediment deposition. This ditch may require extension of concrete lining for about 2 miles, and 20 turn out gates.