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VIA EMAIL to nm.awsa@state.nm.us

July 25, 2014

New Mexico Interstate Stream Commission
Santa Fe, NM
Attn: Craig Roepke, Project Manager

Bureau of Reclamation
Phoenix Area Office
Attn: Vivian Gonzales, Project Manager

Subject: Bureau of Reclamation Appraisal Level Report on the Arizona Water Settlements Act Tier-2 Proposals and other Diversion and Storage Configurations

Dear ISC and Reclamation:

The flawed and deceptive planning process for the New Mexico Unit of the Central Arizona Project authorized and limited by the Arizona Water Settlements Act has expended millions of dollars of public funds on a multitude of studies to define the New Mexico Unit of the Central Arizona Project. None of these studies, nor any other work made public, have set forth the amount of water expected to be legally available for diversion pursuant to the AWSA, much less the reliable yield of usable water that the New Mexico Unit would provide. Neither the ISC nor Reclamation have publicly addressed the certainty of pervasive shortfalls in the usable water that would result from any conceptual configuration of the New Mexico Unit of the Central Arizona Project as constrained by the AWSA. Instead, the ISC's public statements deceptively describe the project as if it would yield the authorized 14,000 acre-feet per year on average of consumptive use.

It won't. Professional consideration of the net yield of New Mexico's AWSA diversion and storage alternatives will show that a New Mexico Unit of the Central Arizona Project cannot be developed in an economically sound manner, that is, consistent with Reclamation's mission statement. It is not financially feasible.

CONTEXT FOR THESE COMMENTS

The subject report was prepared by the Bureau of Reclamation (Reclamation) with its own funds to inform New Mexico decision-makers. The scope of this report is

set forth in a Memorandum of Understanding (MOU) between Reclamation and the New Mexico Interstate Stream Commission (ISC) executed in May 2013. Reclamation's responsibilities include preparation of a preliminary report by February 1, 2014, and a final report by July 31, 2014. ISC's responsibilities include "[w]ork[ing] with Reclamation, in instances where specific information is not available, to develop and support appropriate assumptions to allow Reclamation to complete its appraisal level analysis", including sharing information from other ongoing ISC studies. These comments show that appropriate assumptions were not developed and that the flawed planning process continues.

These comments are addressed to Reclamation and to the ISC. The evidence available today indicates the ISC's forthcoming decision may disregard evidence of no firm yield of usable water and low average net yield. Additionally, there may not be a subsequent formal opportunity to provide additional substantive comments to Reclamation before the public scoping phase of the Environmental Impact Statement that must follow New Mexico's presumed affirmative decision. Therefore, I have decided to comment to both agencies regarding the inadequacies of the flawed planning process as well as the specific content and omissions of Reclamation's report.

As shown below, Reclamation's appraisal report has fundamental errors of omission related to the net yield of usable water, which is the basis of any water development project. Reclamation admits (page 11) that some historic years would produce no diversion yield, yet Reclamation's economic analysis inappropriately assumes full reservoirs and continuous full supplies of usable water.

Despite assuming full supplies, which results in overstatement of the project benefits, Reclamation's economic analysis shows that project costs vastly exceed project benefits for all alternatives except water conservation.

Reclamation's report is late. Reclamation has not provided the 30-day public review period it promised earlier. The three business days available between the due date for public comments and the due date for the final version of this report indicate Reclamation does not intend to substantively respond to public comments.

Although the second to last recital of the MOU indicates the central importance to the ISC of Reclamation's economic analysis, and even though presentation of Reclamation's 350 page report was a principal purpose of the ISC's July 21 input group and stakeholder group public involvement meetings, the ISC's agenda for those meetings did not include Reclamation's economist's presentation of his economic analysis, even though he travelled from Denver to Cliff, NM, to attend these meetings. This is consistent with the flawed process approach to suppress information it considers negative and to limit and control public information and discussion.

Cramming essentially all substantive work into the last months of the 10-year planning process prior to ISC decision-making, failing to consider the amount and reliability of usable water, inappropriately assuming full project supplies in the economic analysis, not allowing time for Reclamation to respond to public review comments, and failing to present the negative results of the economic analysis to the input and stakeholder groups on July 21 are additional indications of the flawed planning process.

My remaining review comments pertaining to the subject report are organized into three main sections: overarching comments, errors of omission, and errors of fact.

OVERARCHING COMMENTS

All Major Elements of my Critique are Affirmed. Reclamation's report and the highly critical May 30, 2014, report prepared by RJH Consultants, Inc. for the ISC together affirm all of the important elements of my April 30, 2014, critique:

RJH Consultants identified off channel dams and storage reservoirs, project water availability, and Gila Water sediment as potentially representing "significant technical challenges or potential fatal flaws" not addressed to date.

RJH Consultants directly and Reclamation by inference from Reclamation's data show that seepage losses from off-channel storage reservoirs constructed in tributary arroyos located in areas of Gila Conglomerate bedrock are likely to lose most or all of the water stored in them through seepage. Only in the absolute best case will seepage not consume all or most of the diverted water.

Sediment will be a major challenge provided that the project is configured so that sediment will not be a fatal flaw. Bohannon-Huston, Inc.'s preferred alternative as described in their final report remains fatally flawed due to certain plugging of pressure pipe conveyances by sedimentation, in my professional opinion. Reclamation says sediment can be managed through design and operations and maintenance. The reduction in usable water to deal with sediment through forgone diversions due to excessive sediment in the river and sluicing, draining, and flushing conveyance canals and pipes will be significant but is not estimated.

RJH Consultants and Reclamation show the off-channel dams and reservoirs will cost 200% or more of the BHI cost estimate. Reclamation shows that costs of a project to export 10,000 acre-feet of water per year across the Continental Divide will cost more than $750,000,000, in contrast to the first BHI estimate of $350,000,000.

Reclamation shows that diversion dams must span the entire flood plain and must be designed to prevent them from being undermined or bypassed by floods.

RJH Consultants emphasized the importance of understanding net project yield, which they described as "the foundation for justifying the project." However, Reclamation's analysis on pages 10-12 glosses over the fundamental problem of not understanding net yield. Reclamation defines safe yield not in terms of usable water but in terms of water legally available for diversion, presents long-term averages rather than historical extended low flows, ignores reduced river flows expected due to climate change, and fails to estimate the range of seepage losses that can be expected from reservoirs constructed in sediment overlying Gila Conglomerate bedrock.

Appraisal and Feasibility. Project proponents have maintained recently that determination of feasibility is not appropriate until an appraisal is completed. Common sense dictates that if fatal flaws or significant constraints are suspected, they should be ruled out before expending large amounts of money and effort. Reclamation's project manager wrote in 2008:

> We would expect that by 2014, New Mexico would identify a plan that is sufficiently detailed that we could move forward with the EIS process without delay. One way to do that is through a thorough planning process that identifies a range of reasonable alternatives and their anticipated impacts. Further, we would expect that New Mexico would have considered the cost and environmental impacts of the plan in sufficient detail to conclude that the plan was viable, such that no fatal flaws would be discovered during the detailed environmental compliance process.

The situation today is that the process has expended millions but it has not defined or confronted shortfalls in the yield of usable water due to both the low amounts of water expected to be legally and practically available for diversion and the high expected conveyance, evaporation and seepage losses. The process has made progress in the last few months in preparing defensible cost estimates but has failed to address financial feasibility, that is, to identify parties willing and able to pay the extremely high costs. The process has ignored environmental impacts that will be caused by construction of a diversion and conveyance channels in the Upper Gila Box. The process has shown that concepts to limit impacts to listed species, such as diversion without a diversion dam, are infeasible. The process has failed to show that flow augmentation from project water for the benefit of riparian and riverine species is possible or to quantify the associated reduction in the yield of usable water. The process has developed facts and approaches that show water development will cause destruction and fragmentation of listed species habitat but the process has not addressed these impacts. These omissions are likely to be fatal. ISC's decision is still in the future, but if its decision is to proceed, Reclamation will have to decide how to deal with all of these likely fatal flaws. This will cause yet additional wasteful expenditures.

Purpose and Need. One of the flaws of the planning process to date is that the purpose and need is ambiguous. The purpose appears to be to develop the New Mexico Unit of the Central Arizona Project, not to improve the water supplies for the people of Southwest New Mexico. For example, water supply problems in the Silver City region would be relatively inexpensively solved on a long-term basis at much lower environmental impact by the regionalization alternative or by an alternative, not evaluated by the flawed planning process, that would utilize some of the senior but unused water rights of Freeport-McMoRan's Bill Evans lake at significantly less cost. Is it true that this alternative was identified earlier but banned from consideration?

Freeport-McMoRan, Inc. It appears that Freeport-McMoRan, Inc. (FMI) owns almost all of the irrigated land along the Gila River upstream from the Virden Valley that might benefit from stored irrigation water, although the process has revealed nothing to date about that. Why should or would the public in the four counties, the state, or the country pay--in dollars and through destruction of the wild Gila River in the Upper Gila Box--to increase the water supply to these lands? It is unclear how the New Mexicans who are currently leasing and irrigating that land would benefit. It is unknown if those uncertain benefits would continue into the future.

Is FMI the previously unknown but intended beneficiary of the secretive, flawed and irrational planning process?

Benefits and Beneficiaries vs. Costs and Who Pays. Development of the New Mexico Unit of the Central Arizona Project will provide speculative and uncertain benefits to a limited number of people at significant financial costs that greatly exceed the federal appropriations made in the AWSA. Taxpayers throughout the state and the nation will pay. Those who value and enjoy the impacted areas will pay. High quality, treasured, and rare environmental values will be destroyed—an important part of the costs that the flawed process has ignored.

The flawed planning process has not addressed any concepts for beneficial use of any Gila River that the process proposes for export over the Continental Divide. Silver City is advocating for their water system regionalization alternative, a non-diversion Tier 2 alternative. Would Silver City use or be willing to pay for the much more expensive water diverted from the Gila River? Local and regional water plans indicate they don't want it or need it. Grant County officials have not identified any direct beneficial uses but have clearly stated they don't want Gila River water to leave Grant County. Luna County and Deming officials are seeking water from the Gila River, but the amount they seek is insignificant when compared to agricultural groundwater withdrawals that are the cause of Deming's declining aquifer.

It is not clear what parties, including the State of New Mexico, might be willing and able to pay the costs of construction. I think it is very clear that the beneficiaries

who are not FMI will not be both willing and able to pay the very high continuing costs of operations and maintenance.

ERRORS OF FACT

Reclamation makes a few errors based on the facts. I describe below the factual errors that I have identified.

Deming Pipeline Pumping Costs are Underestimated. Reclamation's report on page 53 erroneously says the high point of the conveyance pipeline to Deming at the Continental Divide is at elevation 5851. The USGS topographic quadrangle Silver City, NM, shows the elevation at US180 at the Continental Divide benchmark is elevation 6128.

The actual static pumping lift is 28% higher that Reclamation reports. With 25% friction head losses, the total lift will be 2080 feet. Reclamation says on page 54 that the maximum lift per pump station is 400 feet. Thus, additional pump stations and a 28% higher electricity budget will be required. Both the capital and the annual operations and maintenance costs are underestimated.

Length of Conveyance for Diversion 4. Diversion 3 and Diversion 4 are both described on page 73 as having the same 7.28 mile conveyance length from Mogollon Creek. Diversion 4 appears to be about ½ mile upstream.

Similarly, Storage Reservoirs tables in Appendix A show a smaller conveyance length for some reservoirs for Diversion 4 than for Diversion 3. This is physically impossible. Other comparative distances are inconsistent and some must be erroneous. Are the corresponding cost estimates erroneous, also?

Costs of Conveyance Canals within the Upper Gila Box. Reclamation indicates on page 68, that "a more standard canal could be built for about 55% of the length [of the Upper Box river left canal] for $400 per foot," while excavation of rock and attaching a concrete walled canal to steep hillside would be required for the other 45% at $3000 per foot. Examination of the topography that the canal route must traverse indicates the percentage of low cost canal construction is much too low.

For some distance downstream of the diversion, the canal requires separation from the river to an elevation that will protect it from floods. This will be expensive, requiring engineered structures to achieve horizontal and vertical separation in the confined canyon floodplain. Once the canal route has gained adequate vertical separation from the Gila River flood plain a mile or so downstream, its route is almost entirely through the rock slopes with many steep rock faces that border both sides of the flood plain. The elevation of the canal is less than the elevation of the top of many steep rock faces and slopes that border the floodplain throughout the

Upper Gila Box. These facts indicate construction much more expensive than "a more standard canal" would be required for most of the length. Many culverts would be required. Note that siphons cannot be used due to excessive head loss and the associated dramatic reduction of the maximum water storage in the off-channel reservoirs downstream. Appendix A provides the details of my examination.

Storage Volume of Mogollon Creek Reservoir. Reclamation bases the amount of water that could be stored in Mogollon Creek Reservoir associated with Diversion 4 on a maximum reservoir water surface elevation of 4766 feet MSL. Reclamation says Diversion 4 will be located at elevation 4777 and that the conveyance canal will have 13 feet of head loss. The difference indicates the Mogollon Creek maximum water surface elevation could not exceed 4764 feet MSL. This two feet of difference represents a significant fraction of the volume of the reservoir.

ERRORS OR PROBLEMS OF OMISSION

Omission of Relevant History. Reclamation's report in the section entitled "Background" omits any mention of the three previous failed attempts to develop the New Mexico Unit of the Central Arizona Project: Hooker Dam, Conner Dam, and off-stream storage behind Mangas Creek Dam. This history is important. The reasons these three prior attempts failed are still relevant: environmental impact, high costs, lack of need for the developed water, and impacts on listed species. The flawed planning process, in essence, is seeking the fourth best way to develop the New Mexico Unit of the Central Arizona Project. The alternatives for the fourth best way are much more complex and expensive. The continuing lack of need for the water is illustrated by the fact that the flawed planning process identifies no beneficial uses for water exported from the Gila River over the Continental Divide. Additional species have been listed.

It's also relevant that the federal authorization of the New Mexico Unit of the Central Arizona Project resulted from political horse-trading at the highest levels of the US Senate and not from any engineering or feasibility investigations. It was the price that legendary New Mexico Senator Clinton P. Anderson exacted from Arizona for approval by Senator Anderson's committee of the Central Arizona Project. The fact that there is a congressional allocation of Central Arizona Project water by exchange to New Mexico has never meant that development of this water is feasible.

Seepage. Reclamation provides only one value for expected reservoir seepage losses. This sole estimate is for the Mangas Creek Reservoir. The following are quotations from page 52 of Reclamation's report regarding seepage from Mangas Creek Reservoir.

- …based on the surface geology and historic seepage from similar reservoirs, seepage losses were estimated at 800 acre-feet.

- The foundation probably consists of rhyolite having hydraulic conductivity K values that range from 10-5 to 10-6 ft/day.

Reclamation doesn't otherwise discuss likely seepage loss values or projected ranges for reservoir sites where the underlying rock is Gila Conglomerate. Reclamation does quantify hydraulic conductivity values for Gila Conglomerate per the following quotations:

- Mogollon Creek abutments consists (sic) of Gila Conglomerate…the channel is filled with sand, gravel, cobbles and boulders with minor fines up to 50 to 120 feet thick….Hydraulic conductivity (K) values in the alluvium likely range from 100 to 1,000 ft/day. K values in the underlying conglomerate range from 0.01 to 1 feet per day. Page 48
- The Gila Conglomerate in Tyrone and Hurley…was aquifer tested by consultant DBSA (2007, unpublished). For Hurley in 46 tests, the hydraulic conductivity ranged from 0.03 to 800 ft/day (geometric mean = 13.9 ft/day…Their Tyrone tests (13 tests) showed hydraulic conductivity of 1.0 to 339.1 ft/day (geometric mean 9.44 ft/day). Page Appendix D, page 9.

Darcy's Law says that flow through porous media, such as the bedrock underneath the off-channel reservoirs, is proportional to the product of the hydraulic conductivity, the hydraulic gradient, and the cross sectional area through which flow takes place. If the cross sectional area and hydraulic gradient are the same, seepage flow is directly proportional to hydraulic conductivity. The hydraulic conductivity of the Gila Conglomerate, using Reclamation's values, is 1,000 to 1,000,000 times higher than that of rhyolite. Does this mean that seepage losses would be 1,000 to 1,000,000 times higher, also? If Gila Conglomerate seepage losses were only 10 times greater than Reclamation's estimate of 800 acre-feet of seepage losses per year at Mangas Creek Reservoir, seepage losses would render off-channel reservoirs constructed in Gila Conglomerate so leaky they would not be functional. This appears to be a conceptual fatal flaw for almost all of the reservoirs examined by Reclamation (all but those downstream reservoirs Reclamation identifies as being constructed above rhyolite bedrock).

It appears that Reclamation chose to quantify seepage only where the result was favorable. Reclamation did not present seepage ranges that are likely to render most of the evaluated reservoirs infeasible. Reclamation could have but did not present the facts that:

- only in the best case implied by actual measurement of bedrock hydraulic conductivity would a reservoir constructed in areas underlain by Gila Conglomerate be functional, and
- even favorable hydraulic conductivity measurements from drilling and testing at selected locations might not be representative of conditions throughout the area of the reservoir.

My conclusion is supported by the RJH Consultants, Inc. report to the ISC dated May 30, 2014. The excerpt below is copied from pages 2 and 3 of that report. The last sentence should be of great concern to project proponents and is another indication of the lack of objectivity of the flawed planning process.

- The highly permeable soils in the reservoir basins could result in significant seepage losses that could exceed evaporation losses. The PER tabulated a total of 6,140 ac-ft of evaporation per year at full reservoir storage for the four recommended Alternative 2B Reservoir sites. Based on information on Page 10 of a report dated August 2013 for the New Mexico Interstate Stream Commission titled *Review of Aquifer Characteristics in Gila Group Aquifer & Preliminary Design of Wells and Evaluation of Well Performance in Grant County, New Mexico* the hydraulic conductivity of the upper Gila Conglomerate ranges from about 1 to 10 feet per day. The Upper Gila Conglomerate appears to be the predominate material at the selected reservoir sites according to the Geo-Test Geology and Geotechnical Services Report dated December 17, 2013. Based on this conductivity data and an assumption that the entire reservoir basin consists of this Upper Gila Conglomerate, seepage losses for the four reservoirs could be tens of thousands to hundreds of thousands of ac-ft per year. If the Gila Conglomerate at the selected reservoir sites is the well cemented unit, the hydraulic conductivity is anticipated to be between 0.0013 and 0.7 feet/day, and the corresponding combined seepage losses for the four reservoirs could be in the range of 600 to tens of thousands of ac-ft per year. The broad range of potential seepage losses highlights the importance of evaluating the hydraulic conductivity of the reservoir basin soils. The expected seepage losses, when combined with the evaporation losses, could easily equal or exceed the

planned minimum annual diversion yield of 10,000 ac-ft, which would result in no available usable water from the project.

Why does Reclamation's appraisal level report fail to address this obvious potential fatal flaw by applying scientific concepts to interpret existing information for decision-makers, as did RJH Consultants? Does Reclamation agree or not. Decision-makers need to know the potential for seepage to be a fatal flaw before committing yet additional funds to the flawed planning process.

Does Reclamation estimate, per the discussion on page 69, that the storage reservoirs can be lined to control seepage in a manner that will work for the lifetime of the reservoir for $1.74 per square foot, the same unit price Reclamation developed for lining small, shallow, and erosion-protected farm ponds?

Yield. Reclamation's appraisal report has several important omissions or errors related to yield.

Reclamation did not evaluate the amount of water legally available for diversion based on application of the New Mexico Consumptive Use and Forbearance Agreement (CUFA) constraints on diversion to the U. S. Geological Survey's historical record of the measured flow of the Gila River as set forth in the CUFA. Reclamation instead includes several illustrations of annual volumes of water legally available for diversion as calculated by the ISC using its secret spreadsheet. I have obtained a copy of the version of this spreadsheet that the ISC provided to Bohannon-Huston, Inc. in 2013. This version of the spreadsheet contains data and calculations that end in 2001. I have reviewed several aspects of this spreadsheet and have determined that it contains errors in the application of CUFA constraints to the USGS historical gage record. I have worked with others to extend the data and calculations in the spreadsheet through the end of 2012. The results of this extended but erroneous spreadsheet are identical to Reclamation's depiction of the ISC's model results in Figure II-1, page 10. (These results are markedly different from the model calculation results the ISC provided to me in February 2014 in response to my public records request for a copy of the spreadsheet, as described in my April 30, 2014 letter report to the ISC. Why did the ISC provide different model results to Reclamation and to me?)

Reclamation presents a definition of "safe yield" that is very different from my understanding of the term. Reclamation says "[s]afe yield is considered the quantity of water that can be diverted without impacting water rights holders and river functionality." Safe yield is a term that appears in the AWSA. I believe it is synonymous with firm yield, alternately called minimum annual yield, which Reclamation defines correctly as "as the maximum amount of water that can be consistently withdrawn from a reservoir on an annual basis without completely depleting the reservoir during a drought period equivalent to the historical drought of record." Reclamation correctly notes the firm yield of the New Mexico Unit of the Central Arizona Project would be zero.

Even with that understanding, Reclamation's economic analysis assumes full supply every year for all of the alternatives. Benefits are based on this full supply example. One example of this error is Reclamation's assumption that the storage reservoirs would always be full, providing maximum recreational benefits. Reclamation's conclusions regarding of benefits of additional water supply are overstated as the result of Reclamation's own admission of zero firm yield.

Reclamation's analysis of the Mogollon Creek Reservoir as proposed to supply the pipeline to Deming from water originating in Mogollon Creek could have but did not determine, at the appraisal level, the amount of water that could be stored in Mogollon Creek based on historical gage records of Mogollon Creek flows on those

days when the New Mexico Unit of the Central Arizona Project would have been in priority. My cursory examination of the Mogollon Creek gage record on those days indicates volumes of water are usually much less lower than would be allowed for a New Mexico AWSA diversion from the main stem of the Gila River.

Sediment. Reclamation's report also omits any discussion of the extensive historical sediment data collected by the USGS for Reclamation and the ISC and the extreme sediment concentrations that occur during floods or after forest fires in the Gila River watershed. Reclamation concludes, "[d]ealing with sediment will be a constant maintenance concern and will increase O&M costs, but Reclamation believes this is a manageable issue." Reclamation does not identify the yield that will be lost due to diversions that must be foregone because of extreme sediment concentrations during floods or due to the sluicing, flushing, and draining operations that management of sediment in the conveyance system will require. Project viability cannot depend on diverting more water to offset the diversions lost due to these operations because often there is no more water legally available for diversion. If the concept is to rely on extra diversions to offset these losses to either the diversion rate (design the diversion for more than 350 cfs to offset sluicing rates) or the diversion volume (divert more days), these extra diversions should be addressed in the analysis.

Sediment will impair and complicate the operation and maintenance of siphons, which Reclamation says on page 75 are 90 inches in diameter to cause "a flow velocity of 8 ft/s when carrying 350 cfs, which is considered sufficient to limit sediment deposition." Diversions are frequently much less than 350 cfs. Diversion rates of less than about 100 cfs will cause the flow velocity to drop below 2 ft/sec, and that will allow sedimentation in the siphons.

OTHER QUESTIONS AND COMMENTS

The diversion dam drawing on page 72 indicates a water surface elevation at 20,000 cfs five feet above the dam crest and illustrates little freeboard. Given that the diversion must be designed to withstand floods that are significantly greater than 20,000 cfs, is the illustrated design adequate or must it be larger and more costly?

The Gila River moves large cobbles and boulders downstream during floods. These will pile up against the dam to the elevation of the dam crest and won't be removed by operation of the sluice gates illustrated on page 82. Will water at lower flows after such deposition reliably flow to the canal gates when the New Mexico Unit comes into priority or will it flow over the dam crest. Does Reclamation anticipate the routine requirement for heavy equipment to remove the trapped cobbles and boulders after every flood large enough to mobilize cobbles?

Flows in Mogollon Creek and all the other off-channel reservoirs would require bypass through the dams almost all of the time, while retaining the legally stored water. This would be a complex operation requiring accurate inflow gaging, which

would be problematic, and outlet works that would accurately bypass both high and low flows. Reclamation should address this complex inherent requirement in its appraisal.

Reclamation devotes much effort and many pages of the report to the show the infeasibility of storage and recovery of diverted water using the unconfined shallow aquifer adjacent to the Gila River. Conversely, Reclamation provides no or only cursory treatment in the report to important matters such as the yield of usable water or the environmental impact and cost of constructing open canals along the rock faces and cliffs of the Upper Gila Box.

The report needs editorial attention. For example, it contains duplicate paragraphs with identical wording in close proximity. Tables in Appendix A are duplicated. Wolves that were extirpated are described as extricated.

These comments also would have benefited from my additional attention. I regret that the short review period as precluded that.

Please do not hesitate to contact me if you have any questions regarding these comments.

Sincerely,

/s/

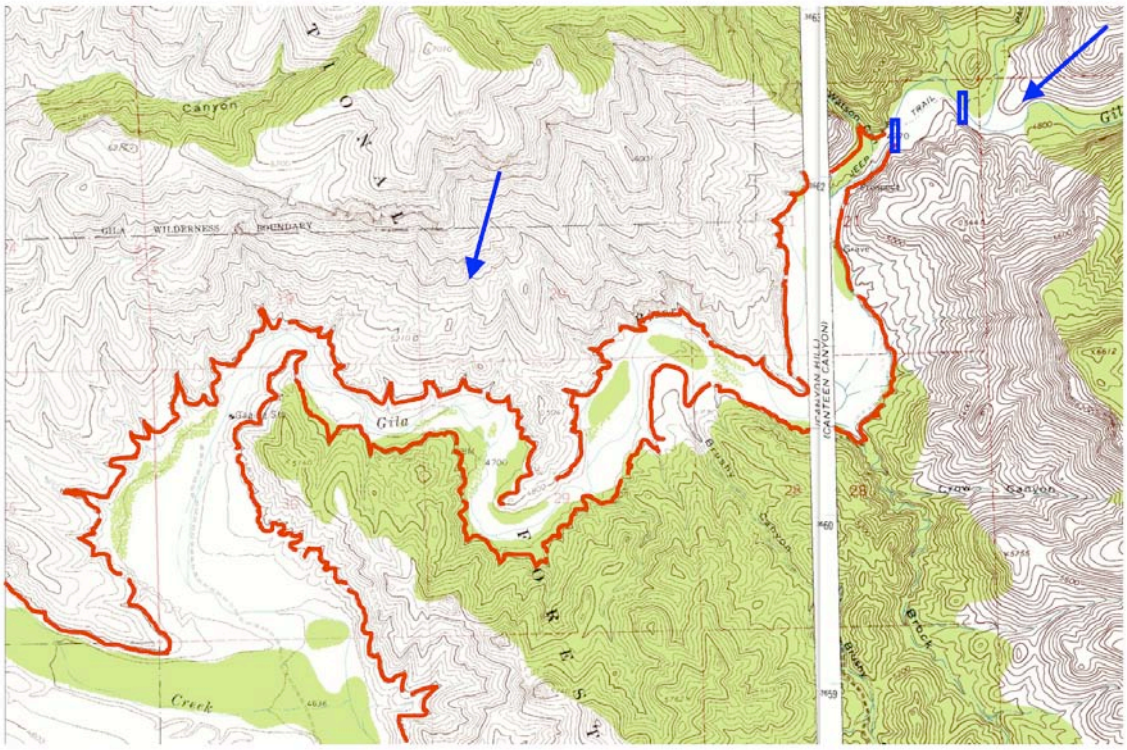
Norman Gaume, P.E. (ret.)

Attachment

ATTACHMENT--COST/PRACTICALITY/IMPACT OF OPEN CHANNEL CONVEYANCE THROUGH UPPER GILA BOX

Reclamation's diversion locations 2, 3, and 4 entail construction of a 350 cfs conveyance canal within the Upper Gila Box from their respective locations 5.7, 7.3, and approximately 7.8 miles upstream of Mogollon Creek. Reclamation says the canal will have a slope of 0.0003, and a head loss of only 13 feet from the farthest upstream diversion 4 to Mogollon Creek. The river has a slope of 19.5 feet per mile between diversion 4 and diversion 1, so the river surface elevation change from diversion 4 to diversion 1 would be 117 feet, based on the elevations Reclamation provides on pages 72-73. The canal in the vicinity of diversion 1 would be about 100 feet above the river.

The elevation of a canal from diversion 4 would begin at about 4777 feet and end 13 feet lower at about 4764 feet. To examine the location of the canal with respect to the river and the sides of the Upper Gila Box, I plotted the canal location on USGS 7.5 minute USGS topographic maps. The contour interval on these maps is 40 feet, so the canal path would be between the 4760 foot and 4800 foot contours. Figure A, below, shows the route of the canals through the Upper Gila Box. The area covered by this map includes the confluences of the Gila River with Turkey Creek in the upper right and with Mogollon Creek in the lower left. The terrain is so steep that the width of my digital pen is often wider than the width of the 40 foot contour interval.



The two arrows represent the approximate direction of view in two aerial oblique views from Google Earth, shown as Figures B and C below. Figure B shows the entire Upper Gila Box, with Turkey Creek in the lower left and Mogollon Creek in the upper center right. Steep rock slopes line both sides of the floodplain, with the rivers path controlled by rock peninsulas on both sides of its sinuous path.

Figure C shows a steep rock slope the proposed river left canal would have to traverse. The rock peninsula pointing toward the lower right corner of Figure C that the river loops around is the prominent peninsula outlined by the canal route projecting upward in the left center of the topographic map Figure A. The canal route illustrated in Figure C, which is based on Figure A, shows the river left canal must traverse all of the steep and cliff faces on river left. The canal must be routed along the faces of the rock peninsula forming the Gila River loop, not over the top.

Figure B: Aerial Oblique View of Upper Gila Box looking downstream

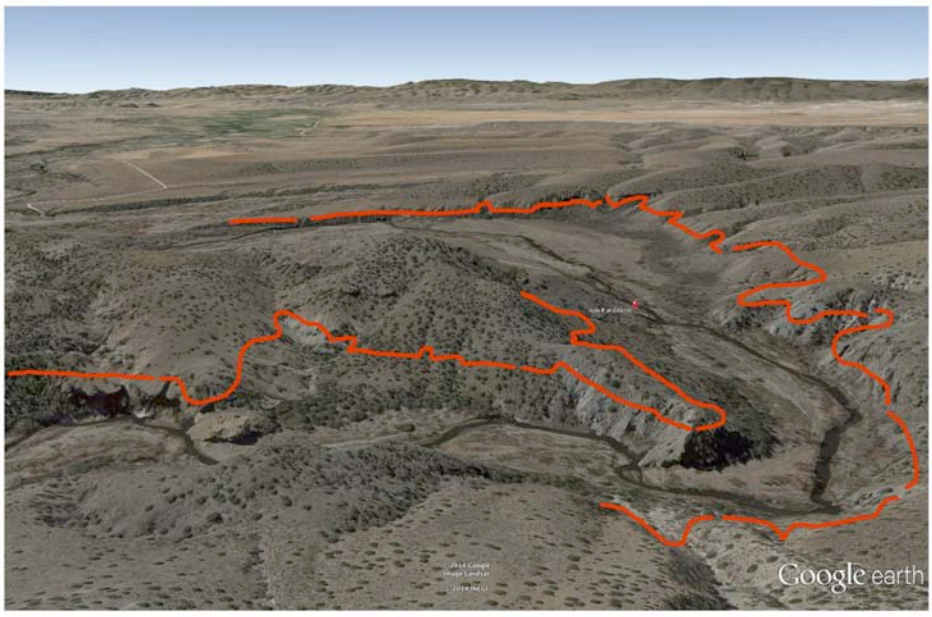


Figure C: Aerial Oblique View of Rock on River Left of Gila River Loop. Lower image shows hand sketched canal routes about 100 vertical feet above the river.

Reclamation's statement on page 68 that "a more standard canal could be built for about 55% of the length [of the Upper Box river left canal] for $400 per foot" seems incredible. For some distance downstream of the diversion, the canal requires separation from the river to an elevation that will protect it from floods. This will be expensive, requiring structures to achieve the horizontal and vertical separation in the confined canyon. Once the canal route has gained adequate vertical separation from the Gila River flood plain a mile or so downstream, its route is almost entirely through the steep rock slopes with many rock faces that border both sides of the flood plain. These facts indicate that a canal that would be much more expensive than "a more standard canal" would be required for essentially all of the length. Many culverts would be required. Reclamation should reexamine its cost-estimate basis that standard canal configuration and costs would be applicable for 55% of the length through the Upper Gila Box.

Reclamation says on page 68 that it can excavate rock and attach a concrete walled canal to the hillside for $3000 per foot. Reclamation provides no basis for this estimate, nor does Reclamation provide any illustration of this concrete walled canal attached to the hillside following rock excavation. What would such an attached canal accessible for maintenance look like?

Can 350 cfs of water be pushed through the circuitous canals over eight miles with only 13 feet of head loss?

Bohannon-Huston's draft Preliminary Engineering Report concluded that open canal conveyance in the Upper Gila Box is not feasible. BHI's final Preliminary Engineering Report drops that conclusion and says canals would cost $2600 per foot. BHI says its estimate is based on preparation of the canal route being 20% rock excavation, 20% rock blasting, and 60% conventional excavation, conditions that my analysis above indicates are not applicable to canal construction within the Upper Gila Box.

What is the potential for 350 cfs maintainable canal construction to be deemed infeasible on the slopes illustrated in Figures B and C or much more costly than Reclamation $1750 blended average per foot of canal price? Decision-makers need to know. Such a determination seems to be well within Reclamation's capability to make at the appraisal level of analysis, that is, based on existing information.

At what stage of Reclamation's appraisal process would Reclamation address the environmental values and its principles and requirements that the construction of canals illustrated in Figure C would confront?