Review of Bean 1988 (or 1989?) Carl Austin

In accordance with various requests from both individuals and governmental entities and agencies, I have prepared a written review of the report entitled "Hydrogeologic Conditions in the Indian Wells Valley and Vicinity". The format of this review is as follows: (1) general comments and impressions plus the basis of my review; (2) specific line by line discussions of omissions, errors of fact, and the use of unwarranted assumptions; and (3) some general observations and suggestions.

GENERAL COMMENTS AND IMPRESSIONS

My review of the report by Mr. Bean is not based upon whether or not I agree with his notions of hydrology and geology for this area. What I base my review on is his pervasive lack of objectivity -- instead of discussion of opposing views, he simply selects assumptions and proceeds. By his own statements, he makes no effort to evaluate published assumptions -- he simply uses them where convenient. I prefer to begin every review of the hydrology of this basin with a set of quotations from the text "Hydrology" edited by Meinzer, one of the truly great names in the science of hydrology in this country. The following quotations set the scene for us, including Mr. Bean.

> "....basins are of two general types -- (1) the "closed basin" in which the alluvial fill is for practical purposes completely enclosed by impermeable bedrock bottom and sides continuous with the surrounding hills or mountains; (2) the "open basin" in which the bedrock is leaky or the alluvial fill has one or more areas of direct contact with similar formations outside of the valley that are sufficiently permeable to transmit ground water. The open basin type presents difficulties of measurement that are in some valleys insurmountable."
>
> "Gross error in the final results can easily arise by the omission of hidden elements whose importance is not fully realized, or by the omission of measurements for which funds are not available."

What then was Mr. Bean to do? He had no funds to obtain any new data. Thus it was my understanding from the statements of work and public presentations made, that Mr. Bean was to critically evaluate the various concepts being proposed for the basin and evaluate the various hypotheses and make some suggestions on how to proceed with studies to enable more definitive choices between the various conflicting ideas extant regarding the valley. He did not do this. What he did was prepare a remarkably incomplete review of the data and the various published assumptions and from this mixture of materials he has prepared another water balance based on the closed basin assumptions of the late 60's and 70's as enunciated by the U.S.G.S. southern California ground water offices. This was a total waste of money and time, as it contributed nothing to our data base and nothing to our understanding of how to use any of the newer data on the valley. Bean simply ignored the new data and its implications to both recharge and discharge. What Mr. Bean has done is combine selected bits and pieces of the publications of the U.S.G.S. ground water group with his own notions, with no attempt on his part to evaluate whether or not these past assumptions are even of any use any longer. Thus our problem remains -- what is our hydrology? We all know what past authors have assumed. There is surely no scientific validity in continuing to simply average divergent views, or in creating another hydrologic balance based on the very

assumptions that are being challenged by the new data, which rather unsurprisingly leads Mr. Bean to the same grandiose overdraft conclusions the makers of the original assumptions arrived at.

An unfortunate fundamental problem I raised both in public meetings and face to face with Mr. Bean was the question of whether or not an elderly traditionalist such as Mr. Bean, whose consulting livelihood is definitely impacted by the attitude of the U.S.G.S. ground water group in southern California, could approach a problem such as the local hydrology in this valley with an open mind. Would he be willing to take the time to carefully review the new data on the structure of this valley and its surroundings, or would he rely on what he read about this area in the literature of the past? I find it deeply disappointing that Mr. Bean clearly showed his traditionalism, his bias, and his need to appease the U.S.G.S.; in a number of places in his text rather sarcastically so.

I find the use by Mr. Bean of the editorial "we" to be an intolerable arrogance which will give an unwarranted aura of credibility to his writings. This report does not reflect a collective "we". It is merely one man's opinions and guesses and unfortunately they are the opinions and guesses of someone clearly unfamiliar with the geology of the valley and its surroundings. Indeed, Mr. Bean declined to tour the area with me despite my repeated offers to take him out into the field to look at areas of geologic interest and areas of specific controversy.

A major problem with reports of the type written by Mr. Bean is that by virtue of their being both voluminous and vague, it is very time consuming and tedious to critique them, indeed taking in many respects as much or more time and money to evaluate than did the writing of the original report. In the preparation of such reports it is not uncommon for an author to make pontifical statements in the hopes that the opposition will spend the time and money to provide the facts enabling a later revision.

In a nutshell, in my opinion, the report of Mr. Bean is poorly founded, poorly researched, makes little or no attempt to evaluate the various assumptions that have led to the present controversies, and the report is badly biased in what was chosen for assumptions and what was and was not criticized. Let us see why I believe this is to be the case.

SPECIFIC LINE BY LINE COMMENTS

Pg 1 lines 6-7: "The valley floor is underlain by permeable materials containing <u>ample</u> ground water reservoir"

This is an obvious contradiction to the conclusion expressed on lines 20-21 of page 43 where the author states: "continuing falling ground water levels indicate that significant overdraft is occurring." If the reservoir is ample, there is no problem. If overdraft is significant then the reservoir can not be ample for our needs. Which is it?

Pg 1 lines 18-20: "Extraction by pumping is considered by all concerned to be the principal discharge of ground water at the present time."

If, as I believe, the recharge to the basin is at least 30,000 acre feet per year, and the original discharge was the playa evaporation plus the subsurface

leakage to the east (principal) and the subsurface leakage to the south (at least major), then at present the discharge subsurface should still be about equal to the present pumping and may still exceed it as there are no pumping depressions that have spread to the valley edge, hence the subsurface discharge heads are still unchanged. Therefore this statement is a misrepresentation and is in direct conflict with what I presented to Mr. Bean. There are over 25 geologists and hydrologists active in this basin. Most of them tell me they have never talked to Mr. Bean about this.

Pg 2 lines 22ff. The objectives that are presented are not answered by the report. Instead the author wandered off into a water balance, not what he was tasked to do according to the public presentations and not what I read the objectives to show.

Pg 3 lines 19-21. The author appears to acknowledge the need to reject data from wells recently pumped yet he glibly cites U.S.G.S. well level measurements taken during the pumping season, some measurements taken while the pump was actually running, according to reliable witnesses, and taken with unweighted tapes, by my own personal observations. It is my belief that most of the water level data taken in this valley is useless as far as any comparative detail is concerned, whether taken by the U.S.G.S. or by private parties. Mr. Bean makes no effort in his text to acknowledge these problems regarding any of the records he uses. A lack of good data is not an excuse to use bad data.

Pg 4 lines 15-17: "There was no attempt to critically analyze the various reports and publications, including U.S. Geological Survey models, in detail."

This statement alone shows beyond a shadow of a doubt that this study, which uses the various U.S.G.S. reports at face value to prove the present authors points, is a waste of time and money. Let us briefly consider such key U.S.G.S. assumptions in the reports used by Mr. Bean as those quoted here:

> "None of the rocks of the basement complex can be considered as bearing significant quantities of ground water, although minor quantities may percolate through cracks and fractures." (Kunkle and Chase, 1969)
>
> "The basement complex includes undifferentiated plutonic hyabyssal and metamorphic rocks of pre-Tertiary age. For the most part, the basement complex rocks are impervious and, except for minor amounts of water in fractures or weathered zones, yield little or no water to wells." (Bull. 91-9)
>
> "The valley is a closed container with limited space beneath the valley floor to hold water, and not all of this water is good." (St. Amand, 1986)

I would remind everyone that the prolific granitic bedrock wells of the Cosos are still encountering water bearing fractures at 10,500 feet and that the water is almost exclusively derived from the Sierra with the Sierran component increasing with depth and to the south. It is remarkable to me that Mr. Bean states that he accepts such U.S.G.S. assumptions and in his words does not "critically analyze" these reports, especially as he then goes on to use these assumptions to reach his own conclusions regarding recharge. This is truly circular reasoning -- i.e. he uses the U.S.G.S. assumptions to reach a

conclusion and then since his conclusion is about the same as that of the U.S.G.S., he considers the U.S.G.S. assumptions correct. This is not science, it is sophistry.

Pg 5 line 24: "....the editorial "we" is used instead of the more formal "the writer"."

This is a standard bureaucratic ploy to lend an aura of authenticity to a report. To the casual reader, especially the lay reader, it will appear as an indication of a consensus. Saying we think Mr. Bean wrote a very poor report is rather different than saying I think Mr. Bean wrote a very poor report, as an example. The disclaimer on page 5 is totally inadequate as quotations from other parts of the text will not use or acknowledge this disclaimer.

Pg 6 lines 7ff: "Alluvial fans....constitute the principal recharge areas for the ground water reservoir."

If Mr. Bean truly believes this, then the whole study was a pointless misrepresentation, i.e. he has already made his conclusion that the basin is closed before he even gets his study started. This is a constant thread throughout the entire report where he repeatedly states or shows that he accepts the closed basin hypothesis as a fact, as he does in this quotation. Carrying this problem a little farther, let us for the moment assume the so-called alluvial fans, and these are not all simple alluvial fans either, do in fact receive the runoff that Bloyd and Robson hypothesized for the valley. Then by definition, something must be coming in subsurface in order to come even close to the mid-valley underflow calculated for the valley by Kunkel and Chase, and the basin has to be significantly open. We know for a fact that the wells at Coso produce Sierran water that has gone down deep, passed beneath Rose Valley, and risen convectively in the geothermal field. We know the Coso rest stop produces Sierran water, not Rose Valley water, that flows east in a thin gravel horizon. Why does Mr. Bean conclude these processes do not happen only a few miles south in this valley? As a matter of fact, my own ranch wells produce typical Sierran water that leaks east out of the Five Finger Ridge area, as shown explicitly by the chemistry of my well water when compared with the chemistry of the water in the Tungsten Peak Mine. Does Mr. Bean propose that my wells are a restricted special case?

Pg 6 lines 17-20: "....deposits which range in geologic age from Recent to Pleistocene. Partly consolidated continental sediments of Tertiary age underlie the alluvium at depths ranging up to nearly 2000 feet, according to Dutcher and Moyle (1973)."

Although it would be interesting to know how Dutcher and Moyle determined this since some of the underlying beds seem to be marine, it would be even more interesting to know why Mr. Bean chose to use this old assumption. I do not know of any dating of the valley fill and I know of no data for the thickness of the Pleistocene or younger material in the areas we are most interested in. Even if Bean does not believe the work of Prairie Eagle for AMOCO or the work published some years ago which shows Indian Wells Valley to appear subsurface as two separate deep basins, he should at least acknowledge that much more definitive work has been done than that which he cites and uses. The best current data shows 14,000 to 15,000 feet of Tertiary at the west edge of the valley, with very thick Paleozoics below that. The work of Dutcher and Moyle

with respect to the subsurface geology of the valley is totally obsolete and I am unable to understand why he used it. In any event, I showed him a number of studies, both published and unpublished that gave modern subsurface data on the valley fill. He has ignored this material.

Pg 6 lines 22-24: "Permeability of the underlying Tertiary deposits is generally much less than that of the alluvium."

It is this type of grandiose academic generalization based on no local data at all that leads one inexorably to a grand falacy. We know for a fact that some of the shallow sediments are virtually impermeable. We also know from actual drilling through some of the impermeable shallow zones that the material below is very permeable. At the very least, a fair minded investigator would discuss in some detail just how permeable is permeable -- i.e. what do we need in the form of a bed or a few beds of modest permeability in the Tertiary to provide us major recharge zones. In this same vein, later in his text Mr. Bean clearly shows he does not understand that the curvilinear microfractures indicate folding at modest depths, showing the valley fill to be folds, not flat sheets. This folding, confirmed by seismic work, gives the opportunity for permeable Tertiary bedding to be folded up to drillable depths, and an opportunity to leak vertically as such folds give tensile cracks on their crests. Is this why we get an upwelling of water near Vitro as an example, or upwellings of heated water in the Athel road area. Modern seismic work also shows what appear to be relaxation fractures cutting the Tertiary section on the west side of the valley. Are these not potential groundwater conduits? Where is his discussion of these?

Pg 7 lines 1-2 and 4-6: "The alluvium in general becomes progressively more fine grained and clayey toward the eastern part of the valley....Deposits underlying the playas are high in clay, have low permeability, and generally contain water of poor quality."

It would be interesting to know why Mr. Bean has made these assumptions. In a general way they are true for the surface, but why do we have to assume the geology is two dimensional. We do not know what is down a few hundred or a thousand feet or two below the playa, ignoring Mr. Bean's later contention (pg 38 line 17) that water coming up through the playa is what keeps it fluffy. We certainly do not know what the water quality might be. In the early 1960's a test pit was dug in Area R to provide a saltwater pond for a weapons test. The water encountered was drinkable fresh water. In similar manner St. Amand in his text "Water Supply of the Indian Wells Valley, California" (1986) shows on page 43 a cross section indicating marginal to unusable water in old lake beds at the location of a recent Navy well near Inyokern. This well encountered no such materials and instead produces some of the best ground water in the valley. It is high time that authors stop blindly perpetuating past notions. Mr. Bean was supposedly doing a critical evaluation of the various ideas propounded by various investigators. His report is rather like an incomplete book report than a critical review of opposing ideas.

Pg 8 lines 4-6: "Carl Austin (June 10, 1988) believes that the faulting in the Sierra Nevada brings ground water to Indian Wells Valley at depth from west of the crest of the range."

This statement is true but is presented as though this were some personal notion of some sort instead of a hypothesis believed in and published on by others. Mr. Bean totally fails to note the consistent geology and range geometry along the Sierra from roughly Chimney Peak north to Olancha Peak, and he ignores the fact that the U.S.G.S. (Fournier et al) published some time ago that Sierran Waters from as far west as the South Fork of the Kern River are re-emerging in the Coso geothermal field on the east side of Rose Valley, a fact also supported by work by the Navy's geothermal contractor and by the work done by the consultants to Credit Suisse who is funding the geothermal project to a large extent. Why does he think the Indian Wells Valley is unique and receives no such recharge?

Pg 8 lines 20-23: "However, his cross sections show the dip of almost all rocks to be toward Indian Wells Valley, not a favorable attitude for groundwater movement away from the valley. Furthermore, the occurrence of limestone appears to be rather patchy."

Offers to take Mr. Bean out to look at the limestones that occur to the south of the valley were met with no interest. If Mr. Bean had bothered to look at them, he would have found them not to be of uniform dips but to be folded and badly broken, with some of the limestone sections forming what appear to be great intruded drag folds. In any event, even a casual perusal of the geology south and west of Ridgecrest will show it to consist of Quaternary alluvium (Qal) with a string of bedrock outcrops of limestone sticking out of the Qal. These limestones are mapped by the state as "Paleozoic Marine". What has been mapped as Pleistocene non-marine by the state covers a portion of this limestone zone, but as limestone outcrops protrude through this Pleistocene veneer, it does not seem unreasonable to conclude the limestone is continuous from well into the Indian Wells Valley to the Cantil Valley. As I explained to Mr. Bean, I have operated a mining property in that limestone block for about 20 years and have mapped parts of it (and had others map it) in great detail, and I showed Mr. Bean why it should be carefully considered as representing a zone at least 5 miles wide that could provide significant leakage to the south. Mr. Bean can choose to ignore this, but he should support his decision to ignore it with reasonable data, including if necessary geologic data from more than one source and data based on actual detailed field investigations.

Pg 9 line 12: "Indian Wells Valley itself is a great block bordered by faults on all sides."

The best data in hand at the moment is that the Indian Wells Valley is a complex of faulted marine and estuarine sediments, overthrust from the west by the Sierra with complex lystral faulting and thrusting giving the Argus on the east, with thrusting and folding giving the Cosos on the north, and lystral and tectonic denudation processes accompanied by sliding and shallow spreading to the south giving the El Paso--Black Range complex. To characterize this complex mess as a great block is misleading geological nonsense. If nothing else, Mr. Bean would do well to read the recent COCORP conclusion in GSA in which they concluded the least likely model for the basin and range is the graben and horst model, such as was described for this valley by Roquemore in writing and then most recently by St. Amand during a public review of the work by O'Brian. I cannot resist pointing out that I showed Mr. Bean a number of texts and reports on the compressional and overthrusting models for this

region, including those published in 1871 (King), 1913 (Baker), Willis (1934), Lawson (1936), Mayo (1941), Eardley (1951), Hewett (1954) and Silver (1986) to name a few. Mr. Bean should at least review the published literature fairly broadly and not just choose some textbook model he may have learned 40 years ago and that he personally prefers as the basis of his study. His job was to critically review differing ideas and interpretations, not to pontificate.

Pg 9 line 15ff: "Dutcher and Moyle (1973) state that northwest-trending faults are most common in the central and western part of the valley".

Dutcher and Moyle did a very cursory study of the area, and the only detailed fracture study available is that done recently for the EKCRCD by W.H. Austin. It seems odd to single out an old report rather than do an analysis of the modern day work based on satellite imagery and orthoquad annotation. That a particular fault may or may not be a barrier to water at some given location is not surprising. But it is wrong to hypothesize that generically faults are all conduits or all barriers. Neither is true, even along the same fault, assuming water levels were accurately measured. Having seen such things as years of data from a well not in hydrologic continuity with the water table (the U.S.G.S. and the Inyo Well) and depth to water measurements reported that were over 100 feet deeper than the TD of the well being measured, this 50 foot offset should be approached with some degree of caution and not just blindly repeated endlessly, especially as the valley has in the past yielded numerous localized perched water tables above the main aquifer to give vary disparit local water levels.

Pg 14 lines 3-5: "The largest amount of recharge takes place by percolation of the intermittent streams from the sierra Nevada after they reach the Valley floor."

This is an unverifiable assumption and once again shows the utterly unacceptable bias of the author. Because of this obvious bias, the report as presently constituted should be rejected out of hand.

Pg 14 line 6: "...this ground water from the west moved eastward."

Certainly much of it starts out moving eastward but if Berman is right, a rather significant amount may well be moving south and since there are apparently continuous limestones from the Indian Wells Valley to Cantil Valley, that potential egress may also be capturing a fair amount of water to also allow a flow to the south.

Pg 14 lines 10-11: "...and returned to the atmosphere by evapotranspiration."

This bias will be commented on further, but once again Mr. Bean has clearly accepted the mid 60's-70's U.S.G.S./St. Amand version of the geology and hydrology of the valley with the result he downplays and at times even satirizes any opposing views, such as the flow eastward subsurface into Searles Valley the open basin concept entails.

Pg 14 line 15: "However, the presence, quality and availability of such deep ground water is yet to be demonstrated, and until this is done, we can only describe the occurrence and movement of the known water body."

By this statement Mr. Bean demonstrates exactly the same kind of thinking a U.S.G.S. researcher demonstrated when he measured the heat output of Coso Hot Springs and concluded there was no commercial potential for the development of what is now the second largest geothermal project in the U.S. and the 5th largest producing area in the world. He is saying in effect that you measure oil field potential by measuring oil seeps. On that basis the Elk Hills does not exist. What we have here is the question of what Mr. Bean is to do. Is he to measure recharge? He can not. He assumes, I repeat, he assumes various closed basin advocate estimates of water recharge into the edges of the valley are correct. He assumes that despite highly favorable geologic conditions no water flows in subsurface. Why is one assumption any better than the other or is our problem the lack of experience of Mr. Bean with fractured bedrock systems? I personally tried to show Mr. Bean the tremendous production of Sierran derived water in the Coso system. His disinterest and lack of comprehension were notable. He has clearly been unable to extrapolate the few miles (less than three miles in consistent geologic structures and exposures) from Southern Rose Valley to northern Indian Wells Valley. If Mr. Bean wishes to deal only with demonstrable recharge, he is out of luck except for the surface leakage out of Rose Valley. Despite his statement that this surface recharge is "very rare" (pg 31) and "negligible" (also pg 31) he could at any time have taken a bucket and stopwatch up there and measured a steady surface runoff of about 1000 acre feet per year. This does not speak well for his accuracy, or his intentions. He can not document much of anything. This does not mean he should selectively use the undocumented assumptions of others as a substitute for facts.

Pg 14 line 21: "...a regional cone of depression"

Assuming that Mr. Bean is reasonably consistent in his use of the word "regional", I have a problem. The "regional cone of depression" he refers to appears, based on all available data, to represent a minor portion of the total basin of the Indian Wells Valley. There is nothing regional about it at all. Localized perhaps, surely not characterizable as regional. Especially not in relation to "regional" flow or hydrology patterns. This terminology is highly misleading.

Pg 15 lines 1-2: "In the eastern part of the valley, beds of clay and silt confine the principle ground water body."

It would indeed be interesting to know how he determines this, since he presents it as a fact. How does he know that several hundred, say a thousand, feet of alluvial fan debris is not in contact with sandy and conglomeritic zones from a foot or two to hundreds of feet thick below the present playa at some modest depth as a result of past major pluvial activity. We know at least 14 pluvials affected this valley. We know sands and gravels extend well out below localized playas in other valleys in this region. Why does he assume the Indian Wells Valley is any different? This is simply another of his montage of unsupportable assumptions, consistent with his pervasive bias in favor of a few selected U.S.G.S. reports and assumptions.

Pg 16 lines 23-24: "The western limit of the total area evaluated runs roughly along Highway 14 and the eastern limit is the western edge of confining clays."

Mr. Bean here accepts without comment the study of Kunkel and Chase, yet even a cursory review will show some of the most prolific storage areas should be west of Highway 14 as the alluvial fan and morrainal debris mixes with the coarser valley fill, ignoring that a few thousand feet of shattered granite should make a superb reservoir in its own right. As an example, the Coso geothermal area appears to contain several cubic miles of water in the fractured granitics of the initial area that is under development. This is not a guess, it is based on over 80 miles of production drill holes now completed and tested.

Pg 17 lines 13-14: "...and recent water level data from the U.S.G.S."

Mr. Bean accepts this data with no reservations despite intense local dispute over measuring wells with pumps running, measuring wells with unweighted tapes, and measuring at least one well that was not connected to any subsurface water. The resulting water level calculations are just as useless as much of the so-called data utilized. As a personal observation, I watched a U.S.G.S. employee measure my east well with an unweighted tape. When I told him to weight the tape, which he claimed was unnecessary but then finally did, the remeasurement showed my well had "magically" come up 2 1/2 feet between measurements. This suggests some U.S.G.S. personnel need a lesson in how to measure water depths. These and other deficiencies in the data were pointed out to Mr. Bean. He has ignored them.

Pg 19 lines 10-11: "We do not find in any of the reports at hand a description of the criteria used to locate the possible thermal plume centers."

When Mr. Bean and I discussed this, there was no "we" present, I showed him pages 462 through 466 of NWC TP 6498 which told him exactly how some of these plumes were identified, gives a suggested list of how the others have been identified, and I also showed him snow-melt pattern photos in this valley that are definitions of the presence of hot ground. Mr. Bean had this NWC reference offered to him, indeed as I recall, I gave him xerox copies of these pages. That he chose to not consider this data "at hand" is consistent with his bias and his lack of experience with geothermal systems.

Pg 21 lines 5-8: "...poorer quality water underlying China Lake playa and vicinity in the principal aquifer is now moving down the hydraulic gradient towards Ridgecrest and the well fields to the northwest."

There is certainly patchy poor water in the immediate shallow sediments beneath some of the playa, possibly even most of it, but I would point out fresh water ponds and springs occur along the margins of part of the playa as well. Of more import, what is the actual gradient? Has Mr. Bean any evidence that the edge of any of the pumping depressions have spread to the playa yet? If not, how can the depressions capture the playa? Also, why does he not discuss the gradient eastward from the playa, which on at least a regional basis is 45 feet per mile? How does this impact his proposed flow to the southwest? Again, let us practice geology in three dimensions.

Pg 22 lines 10-11: "...the validity of each quantitative item will be evaluated,....the degree of uncertainty in that figure will be indicated."

These are brave statements of intent, but Mr. Bean does none of this. Instead he gives unsupported opinions at best. Let us examine this in some detail. He states (pg 23 lines 12-13) that Austin with one exception give <u>no</u> (his

underline) quantitative data. This is not true. I provided Mr. Bean with 31 in house papers I had written for the NAVWPNCEN command. These papers included detailed analyses of the geology, hydrology, geochemistry, possible flow rates, flow patterns, local and regional drilling data and the like. Where there was in my opinion enough data to calculate a volume or challenge an assumption, I said so. I did not simply make up numbers for Mr. Bean for the sake of having numbers. I must point out that if you blindly accept the unsupportable assumptions of the U.S.G.S., their assumptions will pretty much lead you to their conclusions which are also unsupportable. Our problem all along is we have very few numbers to work with and making them up does not help. I provided Mr. Bean with a specific measured number for the present surface runoff from Rose Valley. He did not use it. I provided him an estimate and explained why I made it, for Coso Basin which he did use. I provided him great detail on thermal upwellings and showed him how to calculate a probable flow by using a mixing nodel, he did not do this. I explained in great detail how using various estimations and assumptions of the U.S.G.S., I could arrive at various conflicting numbers for both recharge and discharge. He did not use these numbers or refer to my analyses and calculations. I explained in detail why I chose the rough estimate of 30,000 acre feet per year as the probable recharge for this valley. He has chosen to ignore all of this and makes instead what I consider as a sarcastic, erroneous and insulting reference to me.

Pg 23 line 23: "We therefore must use information and data from other sources modified by our evaluation of that information from our experience and observations in the Indian Wells Valley, in obtaining quantitative figures for each item."

Mr. Bean first challenges my number for leakage from Los Angeles Department of Water and Power's (LADWP) aqueduct. My number was provided by LADWP in a briefing they gave at the NAVWPNCEN and was verified by discussions with a senior LADWP official at the time. The numbers provided by LADWP if Bean is right, seem to be rather flexible. In any event, if Mr. Bean were to walk or drive the aqueduct he would find it leaks especially badly in what LADWP calls Soda Hill, where the leakage for a number of years has been both serious and obvious and has consistently defied repairs although they made another repair attempt this year. Mr. Bean's hydrologic balance, a morass of unsupportable assumptions and judgements with no reliability or uncertainty data given is especially intriguing when he uses as a model, the San Gabriel Mountains as a challenge to the open basin concepts. This will be addressed in more detail separately as the geology and hydrology of the San Gabriel Mountains is patently unlike our area.

Pg 24 lines 21ff: "The first direct estimates of runoff from the Sierra Nevada alone were made by Bloyd and Robson (1971) -- Bloyd and Robson estimated the total recharge from Sierran streams at 6235 acre feet annually."

It is interesting to note that this stream runoff value was chosen by its originators solely to account for water levels in the valley in 1920-21, on the assumption that there was no inflow or outflow in the bedrock, that is, all Bloyd and Robson were trying to account for was the U.S.G.S. recalculation of Lee's playa evaporation estimate. Bean is right when he says I am critical of these numbers -- but he sidesteps why I am critical and how if you accept the

original unmodified numbers the U.S.G.S. model will not work and the fact that one of the key numbers is only about 5% of what you can actually measure on the surface today. There is of course no way you can reconcile these stream runoff estimates with the midvalley underflow model. Citing generic studies without relating them in any way to local conditions does not help either. Indeed what are our rainfall and runoff conditions. When I moved on base in 1961, the cited 10 year annual rainfall average was 2.7" as I recall, and now our average is over twice that and we are now a steppe and not a desert according to recent articles. Does this not mean our runoffs should have doubled to 12,000 or more acre feet per year by the same assumptions? Just what rainfall numbers did Bloyd and Robson use -- today's, last year's, those of one of the recent pluvials, are we just in a temporary dry spell? When one considers transit time across the valley, it becomes obvious that for the recharge values to mean anything one does not just use this year's rainfall. Instead we should be modeling events of years and even centuries ago. Bean does not address this.

Pg 26 lines 1-4: "In our opinion, this figure of 6,235 acre-feet of recharge to the Indian Wells Valley from the Sierra Nevadan streams is in all probability much more nearly correct than the earlier estimates of Lee and Thompson, which did not separate out the Sierran streams as such."

Mr. Bean wants us to conclude that of the 27,000 acre feet per year Thompson cites, only 6,300 is Sierran and the rest is the Argus and El Pasos, but not the Cosos where Thompson concluded another 12,000 acre feet was the runoff, and Mr. Bean grandly ignores Thompson's companion statement that Rose Valley contributed 10,000 acre feet per year alone to the Indian Wells Valley. He suggests instead that Rose Valley recharges the Coso geothermal system. This would require flow through fractured granite (which Mr. Bean denies in the Indian Wells Valley) that is equal to at least 10,000 acre feet per year. Besides this, the water isotope signatures and water chemistry signatures are incompatible. Rose Valley water flows to the Indian Wells Valley. Thus we have Mr. Bean deciding that the Sierra gives 6,300 acre feet per year of Thompson's 27,000 acre feet per year recharge which would mean he thinks the Argus and El Pasos must be giving 20,700 acre feet per year. This does not seam reasonable but Mr. Bean does not address this little problem. Indeed Mr. Bean is simply ignoring what Lee and Thompson said regarding the Sierra. Mr. Bean talks about the need for stream gauging stations. I can not help but wonder how he plans to stream gauge in deep alluvial filled canyons, many following very permeable fault zones. If he really thinks that long term surface stream gauging will answer our recharge questions he has little understanding of our hydrology at all and his input in this regard seems especially useless as he is disregarding the issue of transit tines across the valley.

Pg 29 lines 1-2: "C. Austin was asked directly for a quantitative estimate, but declined to give one."

What I did do, as noted earlier in part, was provide him with the detailed methodology one would have to employ in order to obtain numerical data and I explained to him what data was missing at present that one would need to give anything other than the crudest of estimates. Mr. Bean has chosen to ignore this lengthy discussion to deliver instead what I consider a gratuitous insult. I did provide him data that shows beyond a shadow of a doubt his 100 acre feet per year number is a ridiculous understatement.

To illustrate this, let us begin with the thermally driven upwelling in the Vitro area. This area clearly is involved with the midvalley underflow of 18,000 acre feet per year proposed by Kunkel and Chase. One must then ask -- how many acre feet per year must be entering this underflow to drive the shallow "midvalley" temperatures to the mid to high 90°F value? To propose to do this with some portion of only 100 acre feet per year is non-sensical. A value of 1,000 to 10,000 acre feet per year might be supportable, but to guess closer than an order of magnitude is unreasonable. As there are three other demonstrable (not hypothesized) centers of thermal upwelling in the valley, the 100 acre foot value proposed by Mr. Bean is even less reasonable. Consider the Athel road zone. Here you have Tertiary sediments in excess of 10,000 feet apparent thickness (extrapolating from the 15,000 feet shown at the foot of Walker Pass) yet you have 81 degree shallow water despite the proximity to major Sierran recharge from the Indian Wells and Short Canyons as well as bedrock recharge from the faulted embayment of lower Short Canyon (described by Argonaut Resources in a proprietary study that I described and offered to show to Mr. Bean). The point is that it is unreasonable to expect only 100 acre feet per year to heat the zones of warm to hot water seen in shallow wells in this valley.

Pg 29 lines 19-21: "To date, however, no significant supply to ground water in the Indian Wells Valley from a source or sources west of the Sierran Crest has been demonstrated."

Ignoring the fact that this is the basis of much of the debate that Mr. Bean was supposed to evaluate, let us once again examine the situation. We know that in other valleys, flow of recharge travels through and under granitic ranges in large volumes. The U.S.G.S. has done some very fine studies showing this in other valleys and we know it for a gold plated fact for Rose Valley and Coso. The only real question seems to be, are we willing to extrapolate from Rose Valley to this valley, prior to doing drilling and isotope measurements. Just what kind of water does upwell in the Vitro area? Is it Sierran in origin? We do not know at this time but it is clearly partly geothermal in origin and is good to drink. Likewise there is strong evidence the Little Dixie area is fed by leakage from a geothermal system located under the granitics south of Walker's Pass, and the Navy well at the Inyokern Switch looks surprisingly geothermal too. These areas were all explained in detail to Mr. Bean, as was the potential that these areas were the result of the upwellings of deep Sierran waters, driven upwards by combinations of folding in both the Tertiary and the alluvial outwash debris and by deep heat sources. If Mr. Bean wants to deny the existence of these hydrologic features in the face of specific geophysical, temperature and geochemical data and deny that excellent analogies exist with respect to studies in other very similar areas, that is his privilege but he should at least offer some rationale why he makes such decisions selectively -- i.e. he accepts some assumptions and extrapolations regarding surface runoff and recharge but then denies them for all aspects of subsurface recharge and discharge. Why the selectivity?

Pg 30 lines 1-ff: "We suggest a modification of a calculation based on a subsurface in flow to San Gabriel Valley...."

The geology and rainfall patterns of the San Gabriel mountains and San Gabriel Valley seem a strange choice to offer as a model for the recharge of the Indian Wells Valley and the fact that Mr. Bean may have worked there and be familiar

with them is immaterial. During his visit with me I explained in detail to him the search I went through to find a geographic location that could be used as an analogy for the Indian Wells Valley, not to provide a definitive set of answers for us but to clearly give us semiquantitative guidelines. The valley I chose has been studied and published on by respected hydrologists of the U.S.G.S. The basin I chose to be our analogy is at a little higher elevation and gets a little more snow than we do but is still very much a desert. The following tabulation shows good similarities between the two sites:

Indian Wells Valley	Selected Analogue
a. Dry desert valley	a. Dry desert valley
b. No perennial streams flowing in	b. No perennial streams flowing in
c. Adjacent tributary valleys	c. Adjacent tributary valleys
d. Traversed by a major canal	d. Traversed by major canals
e. Scattered alfalfa farms	e. Scattered alfalfa farms
f. 1 large and 1 small town	f. 1 large and 1 small town
g. Adjacent granitic mountains border valley	g. Adjacent granitic mountains border valley
h. Bordered by known geothermal system	h. Bordered by known geothermal system
i. Area of 1152 square miles	i. Area of 1160 square miles

These two valleys/basins are clearly very, very similar. The U.S.G.S. published the following recharge for the Milford Valley, the analogue for our valley:

a. subsurface inflow from tributary valleys . .	1,700 acre ft/yr
b. subsurface inflow in a particular large wash	2,200 acre ft/yr
c. losses from stream channels	5,000 acre ft/yr
d. losses from major canals	8,500 acre ft/yr
e. infiltration from farms	22,700 acre ft/yr
f. infiltration from lawns & gardens in town . . .	100 acre ft/yr
g. infiltration from precipitation on the valley floor	2,000 acre ft/yr
h. subsurface inflow from bedrock in the mountains	16,000 acre ft/yr
Total Recharge Rounded	58,000 acre ft/yr

This comparison shows several things. It shows a hydrologic balance made by respected hydrologists on unseen recharge, such as item h. It shows that competent and respected hydrologists are quite willing to rely on and expect recharge from fractured granitics, in this case primarily from the Mineral Range.

Instead of considering this possible analogue, Mr. Bean has chosen to use the San Gabriel mountains. He justifies this by saying:

(a) "The geologic conditions are similar -- in fact, the San Gabriel Mountains are a thrust block, similar to the Sierra Nevada as modeled by the Austin's and their co-workers."

(b) "Rocks of the San Gabriel's are mostly granitic and metamorphic, but the fracturing of the San Gabriel's is generally considered to be greater than that of the Sierra Nevada."

(c) "However, precipitation in the Sierra Nevada above the Indian Wells Valley is less than one-third that of the frontal portion of the San Gabriels."

(d) "Furthermore, we have done hydrogeologic work in both the San Gabriel Mountains and the Sierra Nevada, and the former are definitely more highly fractured than the latter."

Let us consider these statements in turn.

(a) Geologic similarity (quoting from a currently in print textbook): "The San Gabriel Mountains are a high rugged block located between the Los Angeles Basin and the Mojave Desert. They form a continuous feature some 60 miles (96 km) long and up to 24 miles (39 km) wide, roughly along a north-south line that passes through Mts Wilson and Pacifico. The Sierra Madre fault zone forms the ranges southern boundary. The eastern boundary is the San Andreas fault zone, which crosses through Cajon Pass and separates the San Gabriel Mountains from the similar but higher San Bernardino Mountains. The San Gabriel Mountains face the Soledad Basin on the northwest and the San Fernando Valley on the west." (from Geology of California by Norris and Webb)

Norris and Webb go on to state:

"Because the San Gabriel Mountains have experienced considerable uplift in recent geologic time, the range has become a deeply dissected, rugged horst."

"The southern and western flanks are steep and bold where they face the lowlands of the Los Angeles Basin and the San Fernando Valley. The north face is less dramatic, although equally steep."

"The Vincent thrust is well exposed north of Mr. San Antonio, but dips south under the highest part of the range. The Vincent is much older than the faults already mentioned because it is cut by late Mesozoic granitic rocks."

"A feature of the San Gabriel Mountains...is the presence of ancient crystalline rocks, particularly in the northwest of the range."

"Large exposures of older metamorphic rocks also exist in the northeast San Gabriel Mountains. These are generally assigned to the Pelona Schist formation."

"Mesozoic granitic rocks...constitute perhaps 70 percent of the exposed rocks."

Thus we have Mr. Bean proposing that an isolated block of schists, anorthosites, and granites, with all sides steep and fairly symmetrical, intimately involved with the San Andreas and other large bounding faults is geologically and hydrologically the same as a nearly flat mega sill system with a tremendous nearly flat upland water collecting area (2^{o} average west dip). Furthermore, there is no evidence presented whatsoever that the San Gabriel Mountains are thrust over young valley fill, as opposed to increasingly definitive evidence for such geometry in the Sierra Nevada adjacent to the Indian Wells and Rose Valley basins. There is simply no logical comparison between the two ranges.

(B) The anorthosites and schists of the San Gabriels are not duplicated in the Sierra Nevada adjacent to the area we are concerned with. As to fracturing frequency, I offered to drive Mr. Bean up into the Sierra, to show him the canyons which give us a good idea as to the extent of fracturing, and he declined. It needs to be pointed out to Mr. Bean that his unsupported statements on fracturing, in the light of his limited field experience here, are of no value at all. Has he performed a fracture analysis? Or is he attempting to compare the San Gabriels (certainly well fractured) with the wide joint spacing easily seen in the Sierra as you drive up the highway north of Lone Pine. Our concern is the Sierra west of the crest from opposite Dove Spring roughly to about opposite Cottonwood. That is the area within which our Sierran recharge seems to occur. In my detailed examination of the Sierra and casual examination of the San Gabriels, and I went down and looked at the San Gabriels again before writing this, I have seen no indication the fracturing of the San Gabriels is comparable to the extreme shattering observed in the Sierra in our local area. Furthermore, I can not resist a sarcastic "so what" because it only takes a few widely scattered fracture zones as macro-fractures to give us the amount of recharge I propose, and only a few broad zones of micro-fractures can do the same. I respectfully suggested to Mr. Bean during one of his visits that he study a text such as "Naturally Fractured Reservoirs" before he presented himself as an expert in fluid flow in fractured rock but I do not see it in his list of references employed.

(C) Mr. Bean proposes that precipitation in the Sierra above the Indian Wells Valley is less than 1/3 that of the front of the San Gabriel Mountains. Our tree line marks about 11 inches of precipitation, so he is apparently proposing the front of the San Gabriels averages over 33 inches. This assumes he is referring only to the rain shadow portion of the Sierra above this valley. If this is what he meant, then he totally missed the point, i.e. flow subsurface from west of the crest. The recharge through the bedrock portion of the Sierra that is of major interest to us is derived from the flat part on top of the Sierra -- the part with square mile after square mile of Jeffery Pine and White Fir on intensely fractured granitics. This area receives over 24 inches of precipitation. Is Mr. Bean really proposing the San Gabriels receive over 70 inches of moisture, ignoring that the San Gabriels have no major fractured plateau as a recharge area, only deeply incised steep sides. What makes the Sierra so valuable to us is not just their high precipitation but that the

collecting area is very widespread, very fractured and very asymmetric with the Indian Wells and Rose Valleys on the only steep downhill side. Mr. Bean does not appear to recognize the fundamental geometry of our local situation.

(D) If Mr. Bean can show some study that the fracturing in the San Gabriels exceeds that of the Sierra along the side of this valley, then he should do so. He does not accept the unprinted word of local researchers (except as convenient) but grandly gives his own unsupported notions as being definitive. This is certainly inconsistent if nothing else.

Pg 31 lines 10-14: "On the other hand, as indicated by Spane (1978), perhaps a very large amount of water moves from Rose Valley into the Coso geothermal field instead."

In this statement Mr. Bean shows a strange contradiction. He clearly does not believe water flows through the fractured Sierran granitics into the Indian Wells and Rose Valley, yet to avoid having Rose Valley provide a significant recharge to the Indian Wells Valley he is willing to consider flow with virtually no head difference from Rose Valley laterally into the Coso geothermal system, and do so through fractured granitics. He can not have it both ways. Either flow in fractured granitics is important to consider with respect to our regional hydrology or it is not. He can not (perhaps should not is a better term) use such flow just where convenient in order to support the recent unsubstantiated U.S.G.S. assumptions regarding recharge from Rose Valley. It also should be noted for the reader that Mr. Bean makes mistatements of Spane's conclusions. Spane showed a regional flow pattern recharging both Coso and the Indian Wells Valley, an interbasin flow south into the Indian Wells Valley from Rose Valley, and a regional bedrock discharge into Searles Valley. These hypothesis have been confirmed by deep drilling and by both water chemistry and stable isotopes in Rose Valley and the Cosos. I note that Mr. Bean chose not to use the U.S.G.S. publications that showed a deep Sierran underflow into and under Rose Valley or the intricately detailed geologic sections including recharge patterns prepared for this area by geologists actually studying the area full time, which were made available to him.

Pg 31 lines 15-16: "Surface flow from Rose Valley into the Indian Wells Valley below Little Lake is apparently very rare."

The best suggestion I can make is that since Mr. Bean did not believe the numbers I gave him he should have taken a stopwatch and bucket up to lower Little Lake Ranch (getting permission from the owner) and measure the surface flow himself. It is about 1,000 acre feet per year at present.

Pg 32 lines 1-3, 6-7, and 10-12: "...inflow through Little Lake Gap...43 acre feet per year"; "...a constraining width of about 1,500 feet"; "flow through the gap of about 400 acre feet per year."

It would be fascinating to have Mr. Bean present a series of diagrams showing his notion of the geology of the so-called gap. I showed him all of the geologic variables known to date, how they could be interpreted and which were geologically reasonable in the light of what we know today. He has ignored all of this. He has ignored the numerical data provided and the geologic data provided. He has ignored what has been published. He is clearly assuming the

margins of the "gap" and the landslides on the west to be impermeable at depth. He clearly does not believe water can flow south under the clay lens on the north side of the landslide area (defined by drilling) or around the clay lens, or through fractured granitics. (If water really can't flow through fractured granites in the Indian Wells Valley, then I wish Mr. Bean would explain to me why I have to pump so much water out of a mine I own along side the Indian Wells Valley, a mine that is in limestones and fractured granitics.) In any event, Mr. Bean grandly ignores the simple problem of accounting for the recharge of Rose Valley. Where does it go? Thompson (of the U.S.G.S.) proposed it goes to the Indian Wells Valley to the tune of 10,000 acre feet per year, not counting leakage south from Owens Valley, which number I also provided to him. We are talking shallow Sierran and Coso recharge. Indian Wells Valley has a Sierran crest length of 34 1/2 miles with about 20 1/2 being a good recharge area (Bird Spring and vicinity is too low and is also too much in the rain shadow pattern). Rose Valley has 16 miles of superb Sierran crest, better than that of the Indian Wells Valley in terms of precipitation. This means that the Rose Valley recharge must be at least 78% of the Indian Wells Valley recharge considering only recharge from the Sierra's east front. Where does it go? Especially where does it go as hydrologically the downhill direction for shallow waters (i.e. the top few thousand feet) appears to be to the south, not to the east into the geothermal system.

Worth special note is that Mr. Bean totally ignores the U.S.G.S. studies on the gravel filled river channel beneath the basalts east of Little Lake. I described this to him, I gave him a copy of the paper, I told him of the drilling done in the channel a few years ago, and I read to him the U.S.G.S.'s conclusion:

> "Moreover, the older buried channel east of Little Lake may now provide a major conduit for groundwater to help recharge the heavily pumped subsurface waters of China Lake Basin."

Mr. Bean ignored all of this.

Pg 33 lines 4-7: "...the total recharge to ground water from human activity about 1,500 acre feet in 1985."

I pointed out to Mr. Bean that although some controversy existed over recharge from hay fields (no rancher wants to publicly admit to washing salts, pesticides and fertilizers into the underlying water table) there is good reason to suspect as much as 1/3 the hay pumpage may be returning to the water table. In the case of Milford Valley, the U.S.G.S. found farms there were returning an estimated 22,700 acre feet per year to the water table. Mr. Bean apparently chose to ignore this aspect.

Pg 33 lines 8 and ff: "Total Recharge"

Mr. Bean presents meaningless numbers. They are not qualified as to range, high, low, probable, possible or the like despite his proposal to do so. He ignores what other investigators in other basins very similar to ours consider highly significant. His Rose Valley recharge number is silly and his geothermal leakage number is simply an uneducated guess plucked out of thin air.

Pg 33 lines 22 and ff: "...there is no assignment of values..."

Mr. Bean presents this as a criticism of my personal estimate of 30,000 acre feet per year of recharge, and says I gave him no data. As noted earlier I spent (apparently wasted is a better word) several hours with him starting with the Thompson estimate of about 49,000 acre feet per year recharge, showed him how the Kunkle and Chase midvalley underflow estimate could be usefully used in the context of the actual geology and geometry of the basin, showed him how by analogy with wells, mines, and other studies in similar basins we could arrive at reasonable estimates for various recharge and discharge components and then spent considerable time reviewing with him the uncertainties, probabilities and what I felt we knew, what we suspected and ways we could convert suspicions and suspects to facts. Somehow Mr. Bean has translated his task to examine the various hydrologic theories and concepts into a task to defend the U.S.G.S.'s latest ground water notions, not to mention some of their past ones. It is these past ones that are now largely outdated interpretations and assumptions and he seems to feel his job is to challenge me personally. He has done this by ignoring most of what I told him, showed him and have written and by stating things both in error and out of context. This may please his friends and supporters in the U.S.G.S. but it certainly does not make for good hydrology.

Pg 36 lines 12-15: "All authorities agree that the principal discharge of ground water from the Indian Wells Valley was originally by evaporation and transpiration at and in the vicinity of the playas, principally the China Lake Playa."

This statement is in error unless it is his contention none of the geologists working the open basin concept are to be considered authorities. Ignoring this apparent insult, Mr. Bean has once again failed to consider what Thompson said in his U.S.G.S. water supply paper on the area (W.S.P. 578, 1929). Thompson shows:

> "Run-off from the mountains in Indian Wells Valley alone is about 27,000 acre feet per year."
>
> "The total run-off into Rose Valley is therefore estimated to be about 10,000 acre feet."
>
> "The mountains bordering the Coso Basin...the total run-off of this area is estimated at about 12,000 acre feet."
>
> "Lee estimated the total discharge...by evaporation and transpiration is about 32,000 acre feet annually."

Now it does not take any towering intellect to realize that 27,000 + 10,000 + 12,000 - 32,000 equals 17,000 acre feet per year that still has to go someplace. Since Lee only estimated the playa discharge I have always assumed Thompson was telling us the bedrock underflow to the east was about 17,000 acre feet per year. In fact, this is not an unreasonable number.

In any event, after I showed this to Mr. Bean I showed him the technical paper published in Economic Geology showing the proposed discharge of water from Searles Lake that takes place at a gradient of only 28 feet per mile to the east through the fractured granitics and metamorphics of the Slate Range

(although recent work clearly suggests some flows take place to the south under the Garlock fault which in that area dips south at 12°). Since the gradient from the Indian Wells Valley to Searles Valley is 45 feet per mile, one might suspect there is a major subsurface loss to the east that should be tested for. The only tests of this to date are with chemistry of the Leslie Salt Well in Searles Valley. This well pumps over a thousand gallons per minute with the water being pumped chemically identifiable as about 90% Indian Wells Valley leakage into Searles Valley.

Pg 37 line 7: "...an intermediate figure..."

I have never believed that averaging different scientific estimates would give one a better estimate. In any event, until such time as the water level (gradients) around the playa change, the evaporation rate should stay fairly constant. Is it Mr. Bean's contention that water table under the playa has dropped? If so, by how much? As a matter of reality, our optimal use of the basin would be to position sufficient pumping to stop the evaporation loss. The water loss from the playa is a total waste.

Pg 37 line 14: "Overflow to Salt Wells"

The U.S.G.S. states how much this is. The number is small but it is also important because if we have maintained a continued overflow it would indicate that other than for localized pumping depressions, the valley is still as full as it can get. Despite Mr. Bean stating, "None of the previous workers have considered this to be an item of discharge..." Kunkle and Chase stated in 1969:

> "...indicates that ground water outflow from Indian Wells Valley occurs through the well defined channel to Salt Wells Valley in sec 7, T26S, R41E."

Mr. Bean's statements are in error on this matter.

Pg 38 line 10: "Most ranges in California do not contain known thick limestone sections."

As a matter of fact the U.S.G.S. in Water Supply Paper 2181 (1981) notes that the Sierra is underlain by Triassic to Devonian marine sediments including limestones from roughly Lake Isabella to Lake Tahoe, and if Mr. Bean kept up on modern geologic thinking he would note the belief and the impressive data as well, that many if not most of the desert ranges including the Argus range are detachments over sedimentary sections including limestones. We are dealing with three dimensional geology as it actually exists right here, not outdated two dimensional models of the past half century.

Pg 38 lines 17-19: "An irregular, fluffy bed showing evidence of much evaporation occurs in basins where little or no ground water leaks out of the basin."

What this fluffy surface shows is that the basin is full or at least that there is a perched water table under the playa. Has Mr. Bean considered that all the playa surface may represent is simply the shallow recharge from the Cosos and Argus and that given simple underlying clay beds alternating with alluvial fan

debris, the evaporation on the playa may have surprisingly little to do with the hydrology of the valley as a whole? A fluffy surface means water near the surface -- it has absolutely nothing to do with whether the basin is open or closed or whether or not the basin as a whole is full.

Pg 39 lines 6-7: "...Dutcher and Moyle do not consider ground water movement through the Argus Range..."

That is not surprising as they stated in their text that (and I am assuming Bean is referring to Bulletin 91-9 of 1963):

"For the most part, the basement complex rocks are impervious..."

This highly simplifying assumption may have been convenient but there is no evidence to support it and considerable to refute it (such as the chemistry and pumpage rate of the Leslie Salt Well).

Pg 39 lines 22-23: "We doubt if there is any significant leakage through El Paso Mountains from Indian Wells Valley."

There is no evidence to support this statement, it is merely closed basin prejudice showing. The limestones are there and the head differentials exist. These are facts. They should be evaluated.

Pg 40 lines 1 and ff: "Total Discharge"

These numbers are highly misleading. The consumptive use does not consider hay field recharge values, the evapo transpiration value ignores how one gets there from Lee's original values, and the leakage number ignores such things as Thompson's paper, the gradients, the published underflow model for Searles Valley, the chemistry of the Leslie Salt Well and the regional underflow model presented by Spane.

Pg 40 lines 17-18: "There is no question that the Indian Wells Valley ground water basin is in serious overdraft..."

I thought this was the whole question that led to Mr. Bean being hired. He has used virtually none of the recent geology learned for this region, he has made no attempt to evaluate any of the uncertainties and he offers nothing to show that we do not get the major proposed underflows and outflows the geology, geophysics and water chemistry show should exist as our regional hydrology. At best, this highly biased and very strangely selective report simply will baffle and confuse the average reader who has neither the time or the knowledge to challenge it line by line as I have done.

Pg 41 line 8: "...regional cone of depression..."

There is no regional cone of depression as the term regional is normally used. This is grossly misleading. We have local pumping depressions.

Pg 42 line 1 and ff: "...water levels have fallen..."

This is a scare tactic, as it makes no effort to show the pumping depressions versus area wide effects, and it makes no attempt to show these levels in relation to when pumps were on or off. My pumping levels are normal. The few

good reports we have show increasing stabilization as one would expect. Where is his data for this? Note in particular that the Cozzens data shows no flat tops on the recharge curves, i.e. water is still coming up the next time the pumps went on for each year.

Pg 43 Conclusion number 2: "There is general agreement..."

This is certainly misleading and is essentially untrue. The closed basin group and the open basin group agree on virtually nothing. That's the problem. There is insufficient data to make valid judgements. I thought Mr. Bean was to evaluate the different positions and suggest ways to gather data to settle these issues -- he has failed to do so.

Conclusion number 4: "...a condition of overdraft."

All Mr. Bean's hydrologic balance (hydrologic selective guesses would be a more accurate description) do is confirm that it is difficult to decide what is here. Most of us figured out a long time ago that if you accept the U.S.G.S.'s assumptions, you will get their conclusions.

Conclusion number 5: "...continually falling ground water levels..."

This is one of the disputes. Are they continually falling? Or are we simply seeing the typical decreasing declines as pumping in this very young area (from a developmental standpoint) is beginning to stabilize, remembering that pumping occurs over only a very small part of the basin, giving very skewed results and a general lack of data. A pumping depression does not prove or even suggest an overdraft. How many times do we have to point this out?

Pg 44 lines 13-15: "It seems quite clear that those who challenge the <u>experienced</u> (my emphasis) evaluations that the Indian Wells Valley is in overdraft should demonstrate additional ground water supply."

This insulting put-down implies that from the pinnacle of his experience someplace else, Mr. Bean can walk in here and tell us all how it really is. I do not believe he is qualified to do this, and I say that from my 39 years of working in wet mines in granitic rocks, studying hydrothermal systems and locating and developing ground water and geothermal resources in the granitic rocks of the adjacent Sierra and desert terrains. Mr. Bean offers no water well data to prove the valley is in overdraft. He makes a series of unsupportable conclusions, unsupportable because they are so clearly based on the unsupportable suppositions and conclusions of others. Is this valley even in overdraft? Obviously, if you run out to measure streams and other surface inflow, we are in terrible overdraft. We all know that. The problem is, what runs in subsurface? What runs down the gravels, a phenomena Mr. Bean seems to accept? What runs down the fault zones, shear zones and breccia zones of the Sierra? Mr. Bean does not accept these yet he fails to show us why they should not be accepted. Others accept them in other areas (such as Milford), why are we different? Why can the recharge geology and hydrology of Rose Valley and Coso not be extrapolated to this valley? Mr. Bean does not address this. Trying to prove an overdraft or no overdraft with the water level data we have in this valley is hopeless. There is simply insufficient usable data. As I showed Mr. Bean, by using one of the few good water level records in the valley, if the well had been measured in July, October, April, April, April and July, this 6 year record would show absolutely no change in water level at

all. If the well (the same well mind you) had been measured in September, April, April, March and March, the readings would have shown a dramatic rise in the water level. If instead the readings had been taken in March, March, March, April, May and September, the well would have proven a dramatic decline. This shows the U.S.G.S. policy of taking data quarterly or yearly, to be valueless in our area and it shows why scattered data from when pumps are pulled in domestic wells is likewise valueless with respect to basin wide predictions or conclusions.

SOME SUGGESTIONS

A newly issued text on hydrology starts out with this statement:

> "In any field of science, soundness of conclusions is dependent upon the validity of basic concepts and principals, accuracy of collected facts, and the level of understanding of processes at work."

In my review of Mr. Bean's hydrologic balance preparation, it is my belief that his basic concepts are in error, his collected facts are both limited as to completeness and as to accuracy and he clearly does not demonstrate an understanding of either regional hydrologic processes or bedrock ground water flow processes.

I am not the least bit upset with having Mr. Bean disagree with me, or with others conducting geologic, geophysical, geochemical and hydrologic studies in the region. What does upset me is that Mr. Bean makes no attempt to evaluate any of the new data on structure and regional hydrology. For the most part he simply ignores it as though it did not exist. His report is not a literature review, as his reference list is very short and very incomplete. His report is not a critical evaluation of ideas held by various researchers as he only selects bits and pieces to comment on. His report draws almost exclusively on a few U.S.G.S. papers without any evaluation of whether or not the assumptions of those authors made sense in the light of knowledge then, or make any sense at all in the light of the data obtained in the last 8 years or so. In short, Mr. Bean's curious selectivity in choosing data and his obvious well documentable bias toward the old U.S.G.S. studies without a critical evaluation of them, has led to a report that contributes nothing to our understanding of the local or regional hydrology or to the resolution of our controversies.

A number of people urged me to "grade" Mr. Bean's report, as I would grade papers in the beginning hydrology class I teach. I have declined to do this, as to do so would make the disagreements I have with Mr. Bean's work too personal for good science.

My suggestion to one and all is that if we wish to continue to bring in outside "experts" we should locate someone who is willing to take each of the recharge and discharge factors and analyze them. They should be clearly defined and for each a tabulation made of what is known, what is suspected, what is geologically possible, and each item evaluated as to the upper and lower limits that are geologically reasonable. Then ways could be suggested for the testing of each component, with the odds for success or failure of each test also presented. From this you could then see what your geologic options are and what it would cost to reduce the uncertainties. I had thought Mr. Bean was employed to do some of this. He obviously did not do so.

I have heard some people state that it was good output by Mr. Bean because he recommends some sort of eventual proof by drilling. I was unaware that anyone had ever questioned this as an ultimate concept, but at this time we are far from knowing what to drill, or where to drill. There is not total agreement within either the open basin or closed basin groups. Ideas must remain flexible as data is obtained and then analyzed and interpreted. Answering the questions extant in the Indian Wells Valley will take a lot of time and a lot of money. Science needs to be given a chance to work which means the public desire for an instant answer must be carefully resisted. It also means political and economic pressures to manipulate the public perception of the hydrology both locally and regionally or to support some institutional policy must also be scrupulously avoided. Let us hope the next report, whoever ends up doing it, is a careful, detailed and complete evaluation of concepts and what needs to be done to verify them and choose between them.