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FENNEMORE CRAIG, P.C.
Jay L. Shapiro (No. 014650)
Patrick Black (No. 017141)
3003 N. Central Ave.
Suite 2600
Phoenix, Arizona 85012

Attorneys for Pine Water Company, Inc.

BEFORE THE ARIZONA CORPORATION COMMISSION

IN THE MATTER OF THE APPLICATION OF PINE WATER COMPANY FOR A DETERMINATION OF THE CURRENT FAIR VALUE OF ITS UTILITY PLANT AND PROPERTY AND FOR INCREASES IN ITS RATES AND CHARGES BASED THEREON FOR UTILITY SERVICE AND FOR APPROVAL TO INCUR LONG-TERM DEBT	DOCKET NO: W-03512A-03-0279 **NOTICE OF FILING**

In accordance with Decision No. 67823 (May 5, 2005), Pine Water Company hereby files its Report on Water Supply Alternatives.

DATED this 10th day of November, 2005.

FENNEMORE CRAIG, P.C.

By _____
Jay L. Shapiro
Patrick Black
3003 North Central Avenue
Suite 2600
Phoenix, Arizona 85012
Attorneys for Pine Water Company

Original and 13 copies were filed this 10th day of November, 2005, to:

Docket Control
Arizona Corporation Commission
1200 West Washington
Phoenix, Arizona 85007

COPY of the foregoing via hand-delivery this 10th day of November, 2005, to:

Dwight D. Nodes, Assistant Chief ALJ
Hearing Division
Arizona Corporation Commission
1200 W. Washington St.
Phoenix, AZ 85007

David Ronald
Legal Division
Arizona Corporation Commission
1200 W. Washington St.
Phoenix, AZ 85007

COPY of the foregoing via priority mail this 9th day of November, 2005, to:

John O. Breninger
P.O. Box 2096
3475 Whispering Pines Road
Pine, AZ 85544-2096

Robert M. Cassaro
P.O. Box 1522
Pine, Arizona 85544

By: Whitney Buik
PHX/JSHAPIRO/1730697.1/75206.006

2005 Report by Pine Water Co., Inc. on Water Supply Alternatives

November 10, 2005

In the Matter of the Application of Pine Water Co. for a Determination of the Current Fair Value of Its Utility Plant and Property, A Rate Increase and for Approval to Incur Long-Term Debt

Pursuant to Decision No. 67823 (May 5, 2005) Supplemental Opinion and Order on New Service Connection Moratorium

ACC Docket No. W-03512A-03-0279

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Conventions

The following list of abbreviations is used throughout this report.

Abbreviation	Description
A.A.C.	Arizona Administrative Code
ACC	Arizona Corporation Commission
ADEQ	Arizona Department of Environmental Quality
ADOT	Arizona Department of Transportation
ADWR	Arizona Department of Water Resources
ALJ	Administrative Law Judge
BOR	U.S. Department of the Interior, Bureau of Reclamation
BUI	Brooke Utilities, Inc.
CAP	Central Arizona Project
CC&N	Certificate of Convenience and Necessity
Gila Co.	Gila County
GPM	Gallons per minute
MB	Myndi Brogdon, Customer Relations Representative, Brooke Utilities
MRWRMS	Mogollon Rim Water Resources Management Study
PSWID	Pine-Strawberry Water Improvement District
PWCo.	Pine Water Co., Inc.
RMU	Remote Monitoring Device
RTH	Robert T. Hardcastle, President, Brooke Utilities, Inc.
SHDWID	Strawberry Hollow Domestic Water Improvement District
SRP	Salt River Project
Survey	"*Survey: Customers of Pine Water Co. and Strawberry Water Co.*"
SWCo.	Strawberry Water Co., Inc.
TOP	Town of Payson, Arizona
USFS	U.S. Forest Service
USGS	U.S. Geological Survey

EXECUTIVE SUMMARY

In it's Decision No. 67823 dated May 5, 2005 the Arizona Corporation Commission revised the number of installed residential water meters for Pine Water Co. to two and prohibited main extension agreements altogether subject to review and reconsideration in April 2006. Further, the Commission ordered Pine Water Co. to undertake an extensive research project with other stakeholders to determine what alternative water supplies, if any, were available for Pine.

Pine Water Co. reports that Stage 1 conditions were in effect throughout the peak demand summer period of 2005 and have been in effect since September 2004. Pine Water Co. further reports that Stage 5 water conservation has not been necessary in Pine since July 8, 2003.

Because of Stage 1 water conditions throughout 2005 Pine Water Co. has a unique opportunity to measure customer demand during peak demand summer periods while supplies were sufficient. This condition has not existed before. Pine Water Co. reports that for the period May through September 2005 customers required an average of 79.9 gallons per day per customer. In Table 2.0 Pine Water Co. extrapolates this water demand and compares lifestyles to nearby Payson, AZ and determines that 266 gallons per day per customers is the projected demand. At this level Pine Water Co. would currently require approximately 200 gallons per minute of additional production to meet this equivalent lifestyle demand. Pine Water Co. cautions that this projected demand represents the demand for current customers compared to Payson's lifestyle based on approximately 50% of the real estate parcels developed. Pine Water Co. projects that more than twice this level of additional production would be necessary if all of Pine's residential parcels were developed.

Pine Water Co. reports 2004 water loss at 10.79% while sister-Strawberry Water Co.'s 2004 water loss was 4.79%. Pine Water Co.'s water loss through September 2005 was calculated at approximately 8% and is expected to be lower by year end.

In June 2005 Pine Water Co. conducted a Customer Survey of approximately 3,012 Pine and Strawberry customers. Pine Water Co. concludes that (a) customers believe a water supply deficiency exists, (b) more part time residents responded to the survey than full time residents, (c) a majority of people in Pine and Strawberry indicate that previous water service interruptions have been a "minor and occasionally inconvenient" event, (d) customers in Pine and Strawberry expect that future water costs will be higher than current levels, (e) more than 80% of all Customer Survey respondents said they could not afford a water cost increase in excess of $20 per month, and (f) approximately half of all Pine and Strawberry residents said water hauling paid for on a "pay as you go" basis was a viable water supply alternative.

Pine Water Co. provides substantial information concerning its participation on the Mogollon Rim Water Resources Management Study group. This group includes all of the stakeholders required by Decision No. 67823.

Pine Water Co. provides discussion and analysis of no less than twenty four different water supply alternatives and components that include a financial analysis indicating annual ratepayer impact, monthly ratepayer impact, annual operating costs, and Pine Water Co.'s feasibility ranking of each alternative.

Pine Water Co. concludes that few water supply alternatives exist that are not expensive, very risky, and have substantial uncertainty related to sustained yield production.

I. WATER SUPPLY DISCUSSION

A. Background

On May 5, 2005 the ACC issued Decision No. 67823 (the "Decision") (see EXHIBIT 1) modifying the number of residential water meters permitted to be installed within the CC&N of PWCo. located in Pine, Gila Co., Arizona. The Decision allows the installation of residential water meters as follows:

- *"IT IS FURTHER ORDERED that Pine Water Co. shall be limited to two new residential service connections per month, implemented on a first-come, first-serve basis, with no carryover from month-to-month, and such limitation shall remain in effect until further Order of the Commission or until April 30, 2006 whichever comes first."*[1]

The Decision also required, among other things, that PWCo. submit, jointly with Staff or separately[2], a report with recommendations regarding specific long-term solutions to the water supply shortage issues of PWCo. For the purposes of addressing the requirements of this portion of the Decision, PWCo. submits this *2005 Report by Pine Water Co., Inc. on Water Supply Alternatives* (the "Report"). The Decision required the Report to provide the following:

- *IT IS FURTHER ORDERED that representatives of Pine Water Co. shall commence an analysis and discussion with all affected entities and stakeholders, including Staff, ADEQ, ADWR, SRP, Payson, PSWID and Gila County, in order to develop long-term permanent solution to the chronic water shortage issues in the Pine, Arizona areas."*[3]

- *IT IS FURTHER ORDERED that, in the analysis and discussion undertaken by the participating entities, consideration should be given to, at a minimum, to the following: growth limits on Gila County development outside of the Pine Water service area; additional well sources; additional storage capacity; Blue Ridge Reservoir pipeline; CAP water trade with SRP for Fossil Creek water; deep drilling in the Coconino sandstone; and any other permanent solutions that may be suggested or developed by the stakeholders and government entities."*[4]

The Report constitutes PWCo.'s compliance with this section of the Decision, as amended by Procedural Order dated October 31, 2005 (see Exhibit 2).

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1 ACC Decision No. 67823, page 13, lines 3 through 6.

2 The requirements for filing by Staff and the other parties to the instant docket were modified by the presiding ALJ in the Procedural Order dated October 31, 2005.

3 *Ibid.* page 13, lines 17 through 20.

4 *Ibid.* page 13, lines 21-26.

B. Stakeholders

The individuals or entities identified as having a vested interest in a permanent long-term water supply solution for PWCO and its customers in Pine, Arizona are identified as follows:

- Customers of PWCo.
- Customers of SWCo.
- ACC Utilities Division Staff
- ADEQ
- ADWR
- BOR
- SRP
- TOP
- PSWID
- Gila Co.
- PWCo.
- USFS

C. The "100 Day War" of 2005

PWCo. refers to the annual period between Memorial Day and Labor Day as the "100 Day War". During this period, PWCo.'s management and operational assets are focused primarily on managing fragile water systems in the Pine and Strawberry areas. During the 100 Day War, BUI works diligently to balance the day-to-day needs of each of its water systems with the demands of managing the fragile water supply serving Pine, Arizona, without ever sacrificing the quality of service to any of its more than 8000 customers in the State.

Some years the 100 Day War is more demanding than others. In years when ground water supplies are more than satisfactory to meet customer demand, the task of water system management by PWCo. is not necessarily lessened as compared to years when ground water supplies are deficient. Excessive customer demand, water system interruptions due to main line breaks, power failures, and natural phenomena like forest fires, can influence the degree of management attention required during the 100 Day War. Generally, the success of BUI's management of the PWCo. water systems during the 100 Day War can be gauged by two factors:

(a) number of days off Stage 1 water conservation levels, and
(b) number of days on Stage 5 water conservation levels. (see Exhibit 1)

Any number other than zero indicates that water conservation measures were required and in effect at sometime during the period between Memorial Day in late May and Labor Day in early September. If the answer to (a) is anything other than zero, it is equally important that the answer to (b) be as close to zero as possible.

Under this analysis, the 100 Day War of 2005 was PWCo.'s most successful year since BUI ownership began in August 1996. At no time during the 100 Day War in 2005 was water conservation measures imposed under PWCo.'s curtailment tariff (see EXHIBIT 3). In fact, PWCo. has not changed water conservation staging signs since the following dates:

(i) Current Stage 1 water conservation level since September 22, 2004.
(ii) Last Stage 2 water conservation level was September 21, 2004.
(iii) Last Stage 3 water conservation level was September 19, 2004.
(iv) Last Stage 4 water conservation level was September 9, 2004.
(v) Last Stage 5 water conservation level was July 8, 2003.

None of BUI's Arizona water systems were required to implement water conservation measures during any period of 2005.

D. Unique Opportunity to Measure Peak Demand

Throughout the decades of deficient water supplies to the Pine, and sometimes Strawberry, communities, there has been a great deal of speculation over how to quantify and plan for projected customer demand during peak periods. These efforts were hampered by the absence of sufficient water supplies, the lack of opportunity to measure peak period demand and the uncertain and ever-changing impact of water conservation measures. Thus, the maximum customer demand during peak periods of demand has never been able to be accurately determined.

The 100 Day War of 2005 provided a unique opportunity[5] to accurately measure peak customer demand because water conservation stages were not in effect. As a result, accurate measurement of production facilities and customer demand has never been more precise and PWCo. now has a baseline against which to measure future customer demand and production and distribution facilities that are required to meet this demand.

For the period August 1996 through September 2005 peak monthly demand occurred in July in seven of the nine years. In 1999 and 2001, the peak customer demand month was August. For the months May through September 2005, the aggregate monthly water consumption for PWCo. is shown in Table 1.0 below:

TABLE 1.0

Month 2005	Customers	Gallons of Consumption	Gallons of Consumption per Day	Gallons of Consumption GPM	Gallons per Customer per Month	Gallons per Customer per Day
May-05	1,996	3,684,000	118,839	83	1,846	59.5
Jun-05	1,996	4,968,000	165,600	115	2,489	83.0
Jul-05	1,996	5,889,000	189,968	132	2,950	95.2
Aug-05	1,992	5,428,000	175,097	122	2,725	87.9
Sep-05	1,997	4,434,088	147,802	103	2,226	74.1
Average	1,995	4,880,618	159,461	111	2,446	79.9

From this data, it certainly appears that a water conservative mentality is pervasive in Pine. Despite the fact that sufficient water supplies existed throughout the 100 Day War of 2005, customers continued to conserve water in a manner similar to that of previous years. It follows that it would likely take several consecutive years without the imposition of conservation measures before the water conservation mentality of PWCo. And its ratepayers would materially change.

[5] Maybe the first opportunity ever.

This data also indicates that peak demand of 5,889,000 gallons was required to meet the needs of PWCo. customers in July 2005. Depending on the effect of water conservation and the correlation of full-time and part-time customers, the demand shown below in Table 2.0 can be extrapolated from this data:

TABLE 2.0

- 100 gallons/day/customer requires 5,988,000 gallons of monthly production
- 120 gallons/day/customer requires 7,185,600 gallons of monthly production
- 150 gallons/day/customer requires 8,982,000 gallons of monthly production
- 175 gallons/day/customer requires 10,479,000 gallons of monthly production
- 200 gallons/day/customer requires 11,976,000 gallons of monthly production
- 243 gallons/day/customer requires 14,551,000 gallons of monthly production[6]

By way of comparison, the MRWRMS study group community population and water demand forecast of actual consumption of residential and commercial customers in TOP in 2002 was 266 gallons per day (see EXHIBIT 4). Furthermore, TOP recently reported that residential customer demand for the month of July 2005 resulted in 243 gallons per day per customer. Extrapolating the TOP data to Pine, where lifestyles can reasonably be correlated to those of residents in Payson, projected peak demand of PWCo. could require as much as 14,551,000 gallons of water production (see TABLE 2.0). This projected demand measured against the actual peak consumption of Pine customers shown in Table 1.0 above leaves a supply deficiency of approximately 8,600,000 gallons or 26.6 acre feet. This production deficiency equates to approximately 200 GPM. [

It is critically important to consider, however, that 200 GPM probably does not represent a long-term water supply solution for Pine because existing parcels in Pine are only approximately 50% developed. This means that *the projected long term water supply solution in Pine could easily be twice the amount projected by Table 2.0.*

E. Water Loss

For calendar year 2004, PWCo. timely reported water loss to the ACC at 10.57% or approximately 5,586,000 gallons of water. This water loss includes all sources of water such as infrastructure damages, water theft, leaks, fire department emergency use, flushing, and unauthorized diversions. It should be noted that PWCo.'s nearby sister company, SWCo., reported 2004 annual water loss at 4.79%. PWCo.'s 2005 water loss through September has been approximately 8% and is expected to be less by year end.

F. Customer Survey

As early as the initial meeting with newly elected Gila Co. Supervisor Martin in April 2005, PWCo. stressed that a community referendum of water supply alternatives and related costs would be appropriate. PWCo. concluded that the governmental agencies regularly engaged in water issues of the area were well informed as to the challenges, opportunities, and costs related to any partial or permanent water supply alternative. PWCo. believed that direct input from water customers was

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[6] MRWRMS, Table 6, Population and Water Demand, 2002 and 2040; teleconference with Buzz Walker of TOP on October 6, 2005.

lacking and necessary to any analysis and decision making regarding future courses of action. Supervisor Martin agreed that input form the constituents of Pine and Strawberry should be obtained.

Accordingly, PWCo. developed the "Survey: Customers of Pine Water Co. and Strawberry Water Co." (the "Survey") (see EXHIBIT 5) and mailed it to all 3,012 customers of PWCo. and SWCo. on June 28, 2005. Each customer mailing included a self-addressed stamped return envelope for all customer's use. PWCo. defined the objectives of the Survey as the following:

(a) Determine customers belief as to the existence of a water supply deficiency
(b) Determine the extent to which previous water supply shortages in Pine have effected customer lifestyles
(c) Determine the degree of customer price elasticity related to the cost of water supply alternatives
(d) Determine if "water hauling" remains a viable water supply alternative among customers.

A total of 1,338 responses were received from all Pine and Strawberry customers as late as September 26, 2005. This response level of almost 45% is reflective of a "statistically relevant" event to the Survey.

The results of the Survey (see EXHIBIT 6) provide important insight into the perspective of customers of PWCo. and SWCo. This perspective should be closely considered in determining the proper course of action related to developing water supply alternatives in the area.

The first Survey question asked respondents personal belief as to whether an "actual" water supply shortage existed in Pine. Almost 87% of all PWCo. respondents indicated that an "actual" water supply shortage existed. In addition, more than 75% of all SWCo. customers likewise replied that an "actual" water shortage existed. In the aggregate, 81.3% of all respondents replied that an "actual" water supply shortage existed in the Pine area.

The second portion of the first question asked on the Survey dealt with respondent personal belief as to whether an "actual" water supply shortage existed in Strawberry. Surprisingly, almost 38% of all respondents indicated that a water supply shortage did not exist in Strawberry. Further, 29.2% of all PWCo. respondents indicated a water shortage did not exist in Strawberry while 27.3% indicated that a water supply shortage existed in Strawberry. At the same time, almost 47% of all Strawberry respondents indicated that a water supply shortage did not exist in Strawberry while 31.5% of all Strawberry respondents indicated that a water supply shortage existed in Strawberry.

The results of the second question are more interesting. The question asked respondents to indicate whether they were "full time" or "part time" residents of the area. More than 60.5% of Pine respondents indicated they were "part time" residents while 39.3% of Pine respondents indicated they were "full time" residents. In Strawberry, slightly more than 64% of all respondents indicated they were "part time" residents while 35.1% of all Strawberry respondents indicated they were "full time" residents. In the aggregate, almost 62% of all Pine and Strawberry respondents to the Survey indicated they were "part time" residents of the area.

The data collected from the second question suggests that more interest in responding to the Survey was indicated by "part time" residents than "full time" residents. If this response represents a conclusion it is unclear why "full time" residents of Pine and Strawberry would have less interest in Survey responses and results than "part time" residents. The data is clear, however, that these two

groups of local residents have differing perspectives of the seriousness of the water supply situation in Pine and Strawberry, Arizona.

The third Survey question asked respondents to indicate "to what extent" has water supply shortages in Pine and Strawberry affected the lifestyles of themselves and their families. In Pine, more than 58% of Survey respondents indicated that the lifestyles effect, due to water shortages, has not existed or otherwise was considered a "minor and occasional inconvenience". Only 7.8% of Pine Survey respondents indicated that their lifestyle had been "severely" affected due to water supply shortages. In Strawberry, the Survey results to the same question are even more dramatic. More than 74% of all Strawberry respondents indicated that their lifestyles had been unaffected or only to a "minor and occasional inconvenience" degree. Only 5.5% of all Strawberry residents indicated that their lifestyles, and that of their family, had been "severely" affected because of water supply shortages to the area. In the aggregate, more than 65.6% of all Survey respondents indicated that their lifestyles had been unaffected or only to a "minor and occasional inconvenience" degree. Further, only 6.8% of aggregate Pine and Strawberry residents indicated that their lifestyles had been "severely" affected by water supply shortages.

The fourth Survey question is reflective of Pine and Strawberry respondent's expectations regarding the future cost of water. The individual results of Pine and Strawberry respondents are not materially different (see EXHIBIT 6). Aggregate respondents to the Survey overwhelmingly indicated, by a showing of almost 81%, that they expect to pay more for water in the future if any long term water supply solution is employed.

The fifth question of the Survey dealt with Pine and Strawberry water customers' expectation of the cost of water in the future. This question asked respondents to indicate how much *additional* cost they were willing to incur over the next ten or twenty years if a long term water supply solution was developed. Survey responses were not materially different between Pine and Strawberry. In Pine, more than 66% of the respondents indicated that they would be wiling to an additional $10 or less per month for a long term solution to the water supply situation. Further, 21.8% of Pine respondents indicated they would not be willing to pay any additional cost for a long term local water supply solution. At the same time, 4.6% of Pine respondents indicated they would be willing to pay an additional "$50 per month or as much as is required" for a long term solution to the water supply problem. In Strawberry, more than 68% of the respondents indicated they would be willing to pay an additional $10 or less per month for a long term solution to the water supply situation. Further, 26.3% of Strawberry respondents indicated they would not be willing to pay *any* additional cost for a long term local water supply solution. At the same time, only 3.8% of Strawberry respondents indicated they would be willing to pay an additional "$50 per month or as much as is required" for a long term solution to the water supply problem. In the aggregate, Pine and Strawberry residents indicated that more than 67% of the respondents indicated they would be willing to additionally pay $10 or less per month for a long term solution to the water supply situation and 23.9% of Pine and Strawberry respondents indicated they would not be willing to pay any additional cost for a long term local water supply solution. At the same time, 4.3% of Pine and Strawberry respondents indicated they would be willing to pay an additional "$50 per month or as much as is required" for a long term solution to the water supply problem.

The last Survey question asked whether or not water hauling should be considered a viable water supply alternative. The results between Pine and Strawberry respondents are not materially different. In the aggregate, more than 48.5% of all respondents indicated that water hauling, paid for by customers on a "pay as you go" basis, should be considered a viable water supply alternative. On the

other hand, 44.3% of all Survey respondents indicated the contrary that water hauling should not be considered a viable water supply alternative to the local water supply shortage.

The general conclusions of the Survey can be summarized as follows:

(A) Most people in Pine and Strawberry believe a water supply deficiency exists.
(B) A disproportionate number of "part time" residents responded to the Survey as compared to "full time" residents.
(C) A majority of people in Pine, and more in Strawberry, believe that historical water service interruptions have had a "minor and occasionally inconvenient" affect on their family lifestyle.
(D) A majority of people in Pine and Strawberry expect future water costs to be higher.
(E) While some people in Pine and Strawberry are willing to pay nothing additional for a long term water solution to the area, and fewer people are willing to pay any cost necessary for such a solution, a long term solution to the water supply shortage that *additionally* costs more than $20 per month will not be affordable by more than 80% of the Survey respondents.
(F) Nearly half of the people in Pine and Strawberry believe that water hauling, paid for on a "pay as you go" basis, is a viable alternative long term water supply solution.

PWCo. believes that any consideration of alternative solutions to the long term water supply deficiency in the area must carefully consider the perspective of Pine and Strawberry residents as expressed in the Survey.

G. USGS Scientific Investigations Report - 2004

The USGS of the U.S. Department of the Interior authored a report published in 2004 titled "Hydrology of theMogollon Highlands, Central Arizona (see EXHIBIT 7). It provides invaluable information necessary to understand the hydrogeology of the area and the opportunities that exist to discover additional water supplies in the Pine and Strawberry areas.

H. MRWRMS Meeting and Discussion Accomplishments

In accordance with the Decision, PWCo. has met frequently with various local and regional groups to discuss water supply alternatives, including most importantly, the regional discussions of the MRWRMS study group (see EXHIBIT 8).. The MRWRMS Study Group meets monthly and consists of the broadest cross section of participants and representatives from the stakeholders referenced herein (see EXHIBIT 9).

MRWRMS has defined its area of study to include the Pine, Arizona area as indicated in EXHIBIT 10. The MRWRMS study area is bordered to the west by the Gila County boundary and the north again by the county boundary and the Mogollon Rim. The eastern boundary is Christopher Creek and the southern boundary is the Gila County boundary at or near latitude N 34_ 09'. The study area encompasses 632 square miles.

MRWRMS Study Partners include the Bureau of Reclamation, Town of Payson and Gila County. Other parties represented in the study group include the Tonto Apache Tribe, Gila County participants (i.e. County Authorized Water Improvement Districts), and private water utilities including BUI. All of these parties are experiencing the same essential problem with respect to having

a sustainable water supply. Each party is learning that insufficient winter precipitation results in insufficient recharge of local aquifers and shortages of required water supplies. This limitation on existing water supplies is hindering future community growth and economic development. To satisfy these needs, each study partner is seeking new sources of water to provide for their respective communities' current and future water demands. It is common knowledge among these participants that PWCo. is frequently short of water in Pine during the summer months, providing the most dramatic example of the water deficiency in the area.

In the past, each party sought to develop their own water supply without the participation of the other study partners. Now the study partners have found it both impossible and impractical to develop water supply projects independent of each other. As a consequence, the MRWRMS study partners are seeking to share vision and resources in an effort to develop suitable regional alternatives to fulfill their water resource needs. A key example is the Blue Ridge Pipeline study being sponsored by TOP. TOP has contracted an engineering firm, Black and Veatch, to provide a cost estimate for the pipeline and facilities needed to bring water from Blue Ridge to Payson. As a component of that study Change Order #1, approved by the TOP Council, will specifically estimate the cost of an additional pipeline and plant to bring water to Pine via USFS Control Rd. 32 and north on Highway 87. After PSWID declined to fund the cost of the Change Order #1 proposal, BUI agreed to reimburse TOP for the cost of this work because of the clear benefit to PWCo. And SWCo. Customers. The scope of work is outlined in EXHIBIT 11.

By the end of 2005, MRWRMS expects to have a completed document including a needs assessment, a demand analysis and a set of draft alternatives ranked by their feasibility. This document will review a compiled history of the region, identify the problem, discuss the hydrogeology of the area, review surface water rights, review ground water rights, usage and quality, identify the ability of the current resources to meet the current and future demands, identify legal and institutional concerns regarding water, discuss management techniques, includes the master plans of the study partners, identify the most feasible alternatives and support them with hydrological and geological data. This completed document will be pressed to congressional representatives along with requests for federal funding

In 2006, MRWRMS expects to drill exploratory holes in the Pine area to verify the hydrogeologic work that has been accomplished. This information will be primarily used to substantiate the feasibility of specific alternatives in the request for federal funds. This information will also be shared with all of the partners with the intent to benefit any and all who can use this information in their own master plans.

In sum, through the MRWRMS study, hydrogeological information that was uneconomic for one entity to procure has become available to all of the study partners. This information remains to be tested both by individual members, including BUI, and study partners and the group as a whole. Under any circumstances, members have benefited from the shared statistical information. Moreover, this study group has provided a forum in which to launch discussions about alternatives.

I. Previous Request for "Guidance"

On July 24, 2002, PWCo. met with Staff to discuss various water supply alternatives that might be available to PWCO. to augment existing water supplies. On August 7, 2002, counsel for PWCo. wrote to Mr. Olea of the Utilities Division advising him of the short-, mid-, and long-term alternatives to be considered by PWCo. Subsequently, as ordered by the ACC, PWCo. submitted a "Water Augmentation Plan" (see EXHIBIT 17) as part of a rate filing. This plan described reasonable and prudent water supply alternatives then known to PWCo. and which PWCo. believed should be considered. In that same ratemaking process, PWCo. sought the ACC's guidance as to how to proceed with the various water supply alternatives. In short, the difficulty of making plant investment decisions for PWCo. cannot be understated. Water exploration is very costly and there is no assurance that any particular effort will result in additional supplies that can be delivered to customers at just and reasonable rates. In other words, while supplies can almost certainly be augmented—at what price? Also unanswered are questions of how much risk is prudent and who should bear those risks. PWCo. Submits it is unreasonable to expect the company's shareholder to invest large amounts of capital searching for supplies that might not be found, or if found, might not be economically delivered, if a return on such investment is conditioned on the discovery of viable water supplies. Unfortunately, the ACC provided PWCO. with no such guidance. PWCo. Respectfully submits, however, that the ACC can no longer avoid providing such guidance. The comprehensive nature of the Report and the decisions that must be made in the future require the ACC to provide guidance regarding the proper way for PWCo., as a regulated entity, to proceed in the face of overwhelming hydrologic and investment uncertainty.

J. CONCLUSION

This Report contains the comprehensive analysis of known alternatives for augmenting the water supplies available to PWCo. sought by the ACC in the Decision. The Report provides all interested stakeholders important information concerning the possible solutions to the chronic water shortages in Pine, Arizona. The Report also confirms the position PWCo. has advanced before the ACC for several years--supplies in Pine, Arizona are insufficient to meet demand, additional water supplies are uncertain and costly, and PWCo. has made prudent decisions to manage and augment existing supplies resulting in an increasingly stable supply and the highest service quality ever seen in Pine, Arizona.

In PWCo.'s view, the Customer Survey is perhaps the most important aspect of the Report. Customers agree that supplies are deficient, and clearly, from the water use data presented, customers are doing their part to conserve. However, few customers view themselves as having been severely impacted and most customers view the water supply problems as a "minor or occasional inconvenience", further illustrating the success of BUI's stewardship of the region's fragile and limited water supplies. The vast majority of customers also expect to pay more for water in the future, but clearly do not want to shoulder substantial rate increases to augment existing supplies. In fact, roughly one of every four customers surveyed does not want to pay any more for water and only one out of every 20 customers is willing to pay an additional $50 a month for a more larger and/or more stable supply. Instead, nearly half of the customers surveyed appear to prefer the "pay as you go" approach, i.e., water hauling, PWCo. has relied upon the past several years.

Thus, the Report also confirms that there are no easy answers.

Under the best case scenarios, the hydrology is uncertain and the costs substantial. Clearly, the implementation of solutions cannot take place in the traditional regulatory environment. Future decision making requires the balancing of the tremendous risks with the speculative and potentially limited benefits of any of the analyzed alternatives. In the end, no stakeholder can be expected to shoulder a disproportionate share of the burden of augmenting PWCo.'s water supplies. Rather, all interested parties must now assess the information contained in this comprehensive report and work together, creatively, to determine the most prudent courses of action. BUI and PWCo. look forward to those discussions.

II. ANALYSIS OF ALTERNATIVE WATER SUPPLIES IN PINE AND STRAWBERRY, ARIZONA

The Decision frequently and specifically refers to water supply solutions in Pine and for PWCo. At the same time the Decision specifies numerous stakeholders with vested interests in a solution. It must be understood that water supply alternatives in Pine are frequently considered as "regional" solution involving other communities in the area such as Strawberry. Where appropriate the discussion below will specify the applicability of water supply solutions.

The discussion of water supply alternatives below is a comprehensive list but my not be all inclusive of every possible approach to resolving the issue. The subject matter of hydrology in the area is a very dynamic topic and water supply alternatives usually require extensive exploration, research, and consideration before it can be feasible for any specific approach to be ascertained. The discussion list below is not written is any order of priority or expectation of success. For the sake of PWCo. ranking some water supply solutions higher, or lower, than others this Report includes a ranking system of 1 to 5 where 5 is believed to be far less feasible than an alternative ranked number 1.

For the purposes of the Report, PWCo. includes a brief discussion of each alternative as described by the proponent, the water source of the alternative, an economic analysis translated to monthly and annual effect on PWCo. rate payers, and a brief PWCo. discussion of the water supply alternative. Attached to the Report as EXHIBIT 12 is a more complete financial analysis of the impact on ratepayers of each water supply alternative.

Alternative #1: Horizontal Well, North Pine:

This alternative was developed by PSWID and identified as "Alternative JB1" in their Alternatives Summary Report dated April 14, 2005 and adopted by the Board of Directors. Although no formal arrangements have been negotiated between PSWID and PWCo., presumably economically justified water discovered under this Alternative would be offered to PWCo. on a wholesale basis. PSWID reports required property access or easement have not been obtained for this water supply alternative. Numerous disadvantages to this water supply alternative were identified by PSWID including production reliability, recharge capability, impact on other wells in the area, uncertainty of drilling regulations with ADWR and ADEQ, and some drilling and operational conditions.

Estimated Cost:	$3,280,000
Annual Operating Costs:	$33,000 (estimated)
Annual Ratepayer Impact:	$411
Monthly Ratepayer Impact:	$34.18
Scope of Benefit:	Pine
PWCo. Ranking:	5
PWCo. Discussion:	This water alternative is heavily discounted by PWCo. because of the high development cost and low, or unknown, probability of success. Horizontal water well drilling, although prominent in other industries in other areas, in Northern Gila Co. has not previously been attempted. PWCo. believes this alternative would literally be a "stab in the dark" at a potential solution to the local water supply problem and likely represents a low probability of success. PSWID does not provide any additional information about movement of discovered water to storage or treatment facilities. PSWID ranks this water supply alternative's

reliability as a water source as "moderate to marginal" but does not provide additional supporting documentation for this classification. PSWID admits that uncertainty exists with regard to regulations of ADWR and ADEQ for horizontal water wells. PSWID does not provide any projections of sustainable yield to be discovered from this water supply alternative. PWCo. is also concerned that more precise estimates of actual development cost have not been fully developed and could be dramatically more expensive than the cost projections provided. PSWID has not provided a wholesale cost associated with water supply from this alternative.

Alternative #2: Single Deep Well, Strawberry, AZ; Existing BUI Site

This alternative was developed by PSWID and identified as "Alternative JB3" in their Alternatives Summary Report dated April 14, 2005 and adopted by the Board of Directors. Although no formal arrangements have been negotiated between PSWID and PWCo. presumably economically justified water discovered under this Alternative would be offered to PWCo. on a wholesale basis. PSWID proposes to use an existing unproductive PWCo. well site in Strawberry for this alternative which provides for further exploration of a 700 foot well to a depth of at least 2,000 feet. PSWID believes this alternative would require a 12 inch well bore casing, a 75 horsepower pump set at approximately 1,800 feet, and delivery high quality water at the rate of 150 GPM. PSWID admits that the "risk is costly if the well proves to not be a viable producer". PSWID provides no expectation of success. PSWID has proposed to fund the full cost of the well and that BUI be obligated to purchase the well after agreeing to a sustained yield water supply criteria. PSWID has also not considered the risk of on-site water treatment facilities located near the well site.

Estimated Cost:	$3,750,000 (includes water system costs)
Annual Operating Costs:	$33,000 (estimated)
Annual Ratepayer Impact:	$465
Monthly Ratepayer Impact:	$38.74
Scope of Benefit:	Pine and Strawberry
PWCo. Ranking:	5
PWCo. Discussion:	PSWID considered this alternative prior to understanding that PWCo. has completed development of this well site and is producing approximately 25 GPM. PWCo. advised PSWID several months before their formal consideration of this water supply alternative that this site would likely not be available because of its current production and importance to PWCo. in meeting peak customer demand. This water alternative is unavailable to PSWID as PWCo. has completed development of the subject well site and has placed the well into production. PSWID has not sufficiently demonstrated to PWCo. that the probability of success of this water supply alternative is probable enough to justify termination of known water supply sources. Further, PSWID failed to consider distribution of water supplies discovered under this alternative. At present, the water system infrastructure of SWCo. is insufficiently sized and incapable of storing water production from an alternative projecting production at stated levels. Therefore, in addition to the direct cost of development of this water supply alternative additional costs of water line infrastructure, storage and pumping capabilities would be required to be added to the projected development

cost above. PWCo. is also concerned that more precise estimates of the actual development cost estimated by PSWID are necessary. PSWID ranks this water supply alternative's reliability as a water source as "good" but does not provide additional supporting documentation for this classification. PSWID has not provided a wholesale cost associated with water supply from this alternative.

Alternative #3: Single Deep Well, the "SB5950A" site, Strawberry, AZ

This alternative was developed by PSWID and identified as "Alternative JB4" in their Alternatives Summary Report dated April 14, 2005 and adopted by the Board of Directors. Although no formal arrangements have been negotiated between PSWID and PWCo., presumably economically justified water discovered under this Alternative would be offered to PWCo. on a wholesale basis. PSWID proposes drill a well bore approximately 2,190 deep in northwest Strawberry at a location described in a 2003 study, the "Kaczmarek Study", contracted by PSWID[1]. According to PSWID, this 12 inch well bore would be equipped with a sizeable pump set at approximately 1,750 feet capable of delivering 300-500 GPM. This well has been sited, pursuant to pages 116-117 of the Kaczmarek Study, on privately owned property near the location of other water supply alternatives under consideration.. PSWID reports required property access or easement have not been obtained for this water supply alternative. PSWID indicates that "tentative wholesale cost of water" has been prepared but has not been disclosed to PWCo. PSWID acknowledges that complex property negotiations are required to acquire ownership or access to this well site. PSWID indicates the proposed site of this water supply alternative is located near an existing power substation. PSWID also references a sizeable water storage tank could be located so as to gravity flow water to Project Magnolia for delivery in Pine. It is not clear from the PSWID discussion of this alternative whether or not the unspecified size and cost of the water storage tank has been included in the projected costs. PSWID also acknowledges that water rights and environmental concerns with local interests and SRP have not been resolved. PSWID believes this alternative ranks "good" water supply reliability. PSWID provides no expectation of success but describes the minimum water supply available from this site as 300 GPM.

Estimated Cost:	$4,722,000 (includes water system and storage tank costs)
Annual Operating Costs:	$55,000 (estimated)
Annual Ratepayer Impact:	$596
Monthly Ratepayer Impact:	$49.74
Scope of Benefit:	Pine and Strawberry
PWCo. Ranking:	5
PWCo. Discussion:	This water supply alternative analysis is, in PWCo.'s opinion, seriously flawed due to economic factors that have not been fully considered. For example, no economic consideration of an environmental assessment report, if applicable, has been included in the cost projections. Additionally, no contingent legal costs have been provided in the cost estimate to address environmental and SRP challenges to use of the groundwater supply. Further, PSWID has not considered the additional cost of water system infrastructure and storage necessary to supply water to Pine from Strawberry. As a part of the above referenced Estimated Cost PWCO. has included $550,000 of water system improvements and $500,000 for additional water storage. PSWID's proposal of this water supply alternatives provides for no less than 300 GPM of additional supply. PWCo. believes this volume of water supply, which is sufficient to resolve the entire water supply problem in Pine as stated above in

Table 2.0, is unknown, unproven, embellished, and unrealistic. PSWID has not sufficiently demonstrated to PWCo. that the probability of discovering water as described by PSWID's summary (i.e. 300-500 GPM) justifies the high cost of this project. Further, PSWID indicates that water production of 300 GPM is an assured threshold level of production that is unsupported by PSWID's documentation as well as uncollaborated by hydrology professionals. As referenced in Table 2.0 above the approximate water supply deficiency in Pine, if measured using approximately the same lifestyle as Payson, is 200 GPM. To the best of PWCo.'s belief a similar demand analysis has not been completed by PSWID and any surplus production, as contemplated by this water supply Alternative, has not been thoroughly considered. PWCo. is also concerned that more precise cost estimates of the actual development by PSWID is necessary. PSWID ranks this water supply alternative's reliability as a water source as "good" but does not provide additional supporting documentation for this classification. PSWID has not provided a projected wholesale cost associated with water supply from this alternative. In the view of PWCo. the justification of this water supply alternative fails on the basis of the very high economic cost of the project (likely higher than that considered by PSWID) and the associated risk of same.

Alternative #4: Single Deep Well, the "SB5950B" site, Strawberry, AZ

This alternative was developed by PSWID and identified as "Alternative JB5" in their Alternatives Summary Report dated April 14, 2005 and adopted by the Board of Directors. This water supply alternative proposal by PSWID involves a site in close proximity to the "SB5950A" site but is owned by a different private party where less complex property negotiations are expected. Although no formal arrangements have been negotiated between PSWID and PWCo., presumably economically justified water discovered under this Alternative would be offered to PWCo. on a wholesale basis. PSWID proposes drill a well bore approximately 2,190 deep in northwest Strawberry at a location described in a 2003 study, the "Kaczmarek Study", contracted by PSWID[2]. According to PSWID, this 12 inch well bore would be equipped with a sizeable pump set at approximately 1,750 feet capable of delivering 300-500 GPM. This well has been sited, pursuant to pages 116-117 of the Kaczmarek Study, on privately owned property near the location of other water supply alternatives under consideration.. PSWID reports required property access or easement have not been obtained for this water supply alternative. PSWID indicates that "tentative wholesale cost of water" has been prepared but has not been disclosed to PWCo. PSWID acknowledges that complex property negotiations are required to acquire ownership or access to this well site. PSWID indicates the proposed site of this water supply alternative is located near an existing power substation. PSWID also references a sizeable water storage tank could be located so as to gravity flow water to Project Magnolia for delivery in Pine. It is not clear from the PSWID discussion of this alternative whether or not the unspecified size and cost of the water storage tank has been included in the projected costs. PSWID also acknowledges that water rights and environmental concerns with local interests and SRP have not been resolved. PSWID believes this alternative ranks "good" water supply reliability. PSWID provides no expectation of success but describes the minimum water supply available from this site as 300 GPM.

Estimated Cost:	$4,722,000 (includes water system and storage tank costs)
Annual Operating Costs:	$55,000 (estimated)
Annual Ratepayer Impact:	$596

Monthly Ratepayer Impact: $49.74
Scope of Benefit: Pine and Strawberry
PWCo. Ranking: 5
PWCo. Discussion: This water supply alternative analysis is, in PWCo.'s opinion, also seriously flawed due to economic factors that have not been fully considered. For example, no economic consideration of an environmental assessment report, if applicable, has been included in the cost projections. Additionally, no contingent legal costs have been provided in the cost estimate to address environmental and SRP challenges to use of the groundwater supply. Further, PSWID has not considered the additional cost of water system infrastructure and storage necessary to supply water to Pine from Strawberry. As a part of the above referenced Estimated Cost PWCO. has included $550,000 of water system improvements and $500,000 for additional water storage. PSWID's proposal of this water supply alternatives provides for no less than 300 GPM of additional supply. PWCo. believes this volume of water supply, which is sufficient to resolve the entire water supply problem in Pine as stated above in Table 2.0, is unknown, unproven, embellished, and unrealistic. PSWID has not sufficiently demonstrated to PWCo. that the probability of discovering water as described by PSWID's summary (i.e. 300-500 GPM) justifies the high cost of this project. Further, PSWID indicates that water production of 300 GPM is an assured threshold level of production that is unsupported by PSWID's documentation as well as uncollaborated by hydrology professionals. As referenced in Table 2.0 above the approximate water supply deficiency in Pine, if measured using approximately the same lifestyle as Payson, is 200 GPM. To the best of PWCo.'s belief a similar demand analysis has not been completed by PSWID and any surplus production, as contemplated by this water supply Alternative, has not been thoroughly considered. PWCo. is also concerned that more precise cost estimates of the actual development by PSWID is necessary. PSWID ranks this water supply alternative's reliability as a water source as "good" but does not provide additional supporting documentation for this classification. PSWID has not provided a projected wholesale cost associated with water supply from this alternative. In the view of PWCo. the justification of this water supply alternative fails on the basis of the very high economic cost of the project (likely higher than that considered by PSWID) and the associated risk of same.

Alternative #5: Pine Creek Storm Water Runoff and Storage; CAP Exchange Agreement

This alternative was originally developed by private Pine citizen James Richey in May 2005. This water supply alternative was also adopted by PSWID as "Water Supply Alternative JB6" at about the same time. After review of Mr. Richey's water supply alternative PWCo. replied by letter to Mr. Richey on June 1, 2005 (see EXHIBIT 18) citing four primary reasons why this water supply alternative was operationally infeasible and economically impractical. This water supply alternative proposes to retrofit and/or reconstruct existing abandoned water storage facilities in Pine, extract water from Pine Creek using a CAP exchange arrangement with SRP, and re-fill newly retrofitted water storage tanks with the water. These four reasons cited in PWCo.'s reply letter are as follows: (a) a water source for re-filling the storage tanks does not exist, (b) project capital costs are dramatically

understated, (c) the positive effect of "resting" wells is speculative, and (d) business model facts are incorrect. After receipt of PWCo.'s comments Mr. Richey revised his water supply alternative and re-submitted same to PWCo. on July 5, 2005 inclusive of the computational errors included in the initial draft of the proposed water supply alternative (see EXHIBIT 19). PWCo. subsequently reviewed Mr. Richey's revised proposal and concluded that, while several initial computational errors had been revised, the proposal remained economically impractical for an unknown water supply benefit that was not likely available on a year-round basis.

Estimated Cost:	$3,074,500 (includes costs of water treatment plant)
Annual Operating Costs:	$150,000 estimated
Annual Ratepayer Impact:	$485
Monthly Ratepayer Impact:	$40.47
Scope of Benefit:	Pine
PWCo. Ranking:	5
PWCo. Discussion:	This water supply alternative is practical and possible from an operational perspective. The fundamental basis of Alternative #5 is founded on utilizing PWCo.'s CAP allocation through an exchange with SRP for water deliveries through the CAP. While such an exchange with SRP may be feasible, irregular and inconsistent water stream flows from Pine Creek during peak demand periods that would allow the delivery of water through existing and retrofitted water storage tanks falls far short of the volume requirement of the area (see Table 2.0 above). It is likely that a CAP exchange agreement with SRP could be achieved. This water supply alternative appears to be impractical because of two critically important problems. First, stream flows of water in Pine Creek are heaviest during winter periods when precipitation is the highest. Conversely, Pine Creek stream flows are the lowest during peak demand periods of the "100 Day War". Thus, when the water is most needed to meet increasing customer is when stream flow from Pine Creek is not available. Second, this project begs for a mass storage component that may largely alleviate the first problem. If mass storage could be constructed at a reasonable cost higher winter time stream flows from Pine Creek could be collected and stored for later water treatment and distribution when needed to meet the highest customer demand. Water supply Alternative #5, as proposed, did not contemplate these problems. In addition, the cost of Alternative #5 far exceed the financial capability of Pine and Strawberry ratepayers as expressed by the Customer Survey (see EXHIBIT 5).

Alternative #6: Pine Surface Water Storage Reservoir; Pine Reservoir Project

This water supply alternative is not a supply alternative at all. Rather, it is a component of a solution related to other water supply alternatives. As such, this alternative must be considered in addition to other alternatives discussed herein. This alternative can also be referred to as PSWID Alternative "JB7". This water supply component was originally developed by BUI in late 2000. Conceptually, this component of a water supply solution proposes to develop a 70 acre feet (i.e. approximately 22 million gallon) above ground water storage reservoir on an 8.4 acre site in south Pine. The reservoir would be supported by a local water treatment plant capable of processing approximately 300,000 gallons daily that would continually replace above ground fixed water storage of the same size. The above ground fixed storage would be directly connected to PWCo.'s distribution system. Using the Project Magnolia

pipeline water stored in this facility could supplement water supplies in Strawberry as well. In its current proposed form the reservoir would be constructed below ground with an eight foot berm perimeter surrounding the facility. The reservoir would be lined with an industry specific NSF 60 mil liner that would support and protect potable and non-potable water supplies. The reservoir site has been secured through 2005 pursuant to an Option Agreement entered into with the property owner several years ago. In its current form the reservoir would be designed to store and process non-potable water supplies as the source of water, either potable or non-potable, cannot be specifically identified. Water storage could result from both ground water and surface water sources in accordance with this Report. The treatment plant processing capacity would be sufficient to support the 200 GPM supply deficiency provided in Table 2.0 above. Final engineering design, property costs, and construction development will dictate final costs. It should be noted that this proposed water supply alternative component does not actual produce addition water supplies and should be considered into conjunction with many or most of the other water supply alternatives. Further, PSWID estimated the cost of their "JB7" water supply alternative in excess of $20,000,000.

Estimated Cost:	$3,830,000 (reservoir construction)
Estimated Cost:	$1,180,000 (treatment plant development)
Estimated Cost:	$470,000 (fixed water storage and water system infrastructure improvement)
Estimated Cost:	$5,480,000 (total)
Annual Operating Costs:	$100,000 estimated
Annual Ratepayer Impact:	$723
Monthly Ratepayer Impact:	$60.28
Scope of Benefit:	Pine and Strawberry
PWCo. Ranking:	3
PWCo. Discussion:	It is highly likely that any single or multiple component solution to developing an additional 200 GPM, in conjunction with Table 2.0 above, will require substantially more storage. This water supply alternative component provides a single source solution to this requirement. When Pine eventually fully develops and all existing parcels are developed more water treatment capacity may need to be added but additional mass water storage could be less likely.

Alternative #7: Blue Ridge Reservoir Pipeline Options for Payson, Pine, and Strawberry

This alternative was originally developed by BOR and a second revised analysis draft report was published in February 1999 (see EXHIBIT 15). The report explains that Blue Ridge Reservoir is located approximately 23 miles north of Payson on the Mogollon Plateau. Since the 1960's Phelps Dodge pumped up to 11,000 acre feet of water through a 30 inch pipeline into the East Verde River under a water exchange arrangement with SRP. The report make reference to a 3,000 acre feet allocation available to the Northern Gila County communities of Payson, Pine and Strawberry. The report describes cost estimates for four water delivery options as follows: (1) Option #1: Control Road Option generally forms the basis of Alternative #8 hereunder, (2) Option #2: In stream Diversion Option provides for water from Blue Ridge Reservoir to be delivered to the East Verde River and extracted north of Payson at Houston Mesa Road, (3) Option #3: Rim Road Option diverts water to Payson and Strawberry into two pipelines, and (4) Option #4: Highway 87 Option provides for water from Blue Ridge Reservoir to be moved across a forest road directly to Highway 87 north of Strawberry. It appears that Option #2 may have formed in whole, or part, the basis for PSWID's "JB7" and "JB8" water alternatives (see Alternative #6 above). Further, it appears that this report could have been partially responsible for TOP's development of a pipeline concept from Blue Ridge

Reservoir to a receiving location north of Payson. From this water supply alternative the basis of Black & Veatch's Change Order #1 was likely conceived (see EXHIBIT 16). The report emphasizes that one of the most expensive unscheduled costs of any of the Options under this alternative could be the environmental mitigation required and possible litigation associated with them. The report explains that Option #4 is particularly problematic in this regard because the proposed pipeline location would transverse two National Forest and invite close examination of endangered species issues. Option #3 is only slightly less problematic in the same regard. Option #2 has the potential of also inviting arguments relating to water rights in the East Verde River and environmental concerns relating the diversion structure required to be built. Although far from simple, Option #1 avoids many of these concerns. It should be noted that the PSWID concludes that "Alternative JB8 not to be a viable option for Pine and Strawberry" but should "held open for future consideration as a long-term secondary source" of water supply. The report concludes that cost estimates for the four Options are as follows:

Option #1:	
Estimated Cost:	$73,100,000
Annual Operating Costs:	$50,000
Annual Ratepayer Impact:	$8,559
Monthly Ratepayer Impact:	$713
Scope of Benefit:	Pine
PWCo. Ranking:	5

Option #2:	
Estimated Cost:	$53,500,000
Annual Operating Costs:	$50,000
Annual Ratepayer Impact:	$6,275
Monthly Ratepayer Impact:	$523
Scope of Benefit:	Pine
PWCo. Ranking:	5

Option #3:	
Estimated Cost:	$72,000,000
Annual Operating Costs:	$50,000
Annual Ratepayer Impact:	$8,430
Monthly Ratepayer Impact:	$702.53
Scope of Benefit:	Pine
PWCo. Ranking:	5

Option #4:	
Estimated Cost:	$91,100,000
Annual Operating Costs:	$50,000
Annual Ratepayer Impact:	$10,655
Monthly Ratepayer Impact:	$887.96
Scope of Benefit:	Pine
PWCo. Ranking:	5

PWCo. Discussion: All of the various Options under this Alternative suffer from two significant problems: (1) they are excessive expensive and unaffordable for the ratepayers of Pine, and (2) there is no assurance that annual water yields from Blue Ridge Reservoir will always be available. PWCo. is unaware of subject revised drafts of the report.

Alternative #8: Blue Ridge Reservoir Control Road #32 Pipeline and Water Treatment Plant; Also Known as Black & Veatch Engineering Study Change Order #1

This water supply alternative is an adjunct to Alternative #7 above (see EXHIBIT 15, Option #1) proposed by the TOP. This alternative proposes to provide 500 acre feet delivered over the nine month period annually that SRP operates the turbine pumps. This proposed alternative intersects the proposed 20 inch pipeline connecting Blue Ridge Reservoir and TOP at a location near Washington Park (see EXHIBIT 13). A sufficiently sized pipeline (i.e. likely 8 inch diameter) would be developed in a south-southwesterly direction to intersect with USFS Control Road #32. The pipeline would transverse Control Road #32 to the west approximately 17.4 miles intersecting with Highway 87. The pipeline would proceed north in an ADOT Highway 87 right-of-way to Pine approximately another four miles to a water treatment plant for which a site has not been designated. As indicated by the map in EXHIBIT 13 the proposed pipeline would require no less than three pump lifting stations in order to move the water to higher locations as it proceeds along Control Road #32 and Highway 87. The Black & Veatch Change Order #1 cost estimate associated with this proposed water supply alternative was originally considered and subsequently declined by PSWID. BUI agreed to reimburse TOP $10,022 for the Change Order #1 work completed by Back & Veatch. The Black & Veatch cost estimate[3] (see EXHIBIT 14) does not include estimated annual operating costs, environmental report costs related to USFS requirements for use of Control Road #32, SRP costs of Blue Ridge Reservoir water, and distribution system costs incurred by PWCo. The cost of wholesale water from SRP and delivered to TOP's pipeline has not been finalized. This water supply alternative is generally similar to Option #1 of Alternative #7 (see EXHIBIT 15) discussed above except that Black & Veatch's Change Order #1 has more precisely considered the cost impact of this alternative. It should be noted that the PSWID concludes that "Alternative JB8 not to be a viable option for Pine and Strawberry" but should "held open for future consideration as a long-term secondary source" of water supply.

Estimated Cost:	$17,344,080 (Black & Veatch Change Order #1 only)
Estimated Cost:	$600,000 (environmental report costs, SRP water costs, and PWCo. water system distribution costs)
Estimated Cost:	$17,944,080 (total)
Annual Operating Costs:	$100,000 estimated
Annual Ratepayer Impact:	$2,175
Monthly Ratepayer Impact:	$181.28
Scope of Benefit:	Pine
PWCo. Ranking:	5
PWCo. Discussion:	This water supply alternative is conceptually practical and possible from an engineering and operational perspective. The proposed pipeline would deliver up to 500 acre feet (approximately 162 million gallons) over the nine month period that SRP plans to operate the facility. This northern Gila County allocation is part of a 3,500 acre feet annual capability of Blue Ridge Reservoir. It is PWCo.'s understanding that the 500 acre feet allocated to northern Gila County would be made available on a "as available" basis provided that TOP received all of the remaining 3,000 acre feet allocation from SRP. There is no guarantee that annual precipitation would yield water stores of this level on an annual basis. Obviously, the most serious problem associated with this alternative is the prohibitive cost and impact to ratepayers. This level of economic burden far exceeds the capability and expectations of ratepayers as expressed in the June 2005 Customer Survey. For this reason PWCo.

believes this water supply alternative fails to provide a reasonable hydrological and economic solution to the water supply deficiencies of Pine.

Alternative #9: Camp Geronimo Water Diversion, Control Road #32 Pipeline, Water Treatment Plant; Internally Also Known as "Project Maverick"

This alternative was originally brought to the attention of BUI on August 24, 2005 by water representatives of Gila Co. It seems that approximately a year previously representatives of the Camp Geronimo Boy Scout Camp had been contacted by Gila Co. concerning excess water supplies from Poison Springs just south of the Mogollon Rim located on USFS property. The actual water source is located approximately two miles from the Boy Scout camp. Camp representatives estimated that approximately 80 GPM flowed from Poison Springs into an above- and below ground pipeline that connected to the Camp. The Camp representatives indicated that an additional approximate 50 GPM was captured from Herron Springs located in the nearby vicinity. The water source is aggregated into four 15,000 gallon water storage tanks where it is treated with excess water returning downstream to Weber Creek. Camp Geronimo estimated annual use of only 2,100,000 gallons during a nine week summer period. Gila Co. represented that 20-50 GPM of excess water may be available for purchase and distributed to either (a) Payson Water Co.'s Geronimo Estates and Elusive Acres water systems, and/or (b) Pine. The Camp Board of Directors is managed by an environmental water attorney located in Phoenix. The Camp expressed interest in commercial sale of the water to the Geronimo Estates or Pine customers of BUI. A representative of USFS Tonto National Forest was contacted and indicated that confusion existed regarding Camp Geronimo's water rights claims for the water from Poison Springs and Herron Springs. The USFS explained that it might be "possible but not likely" that a commercial pipeline could be developed across USFS lands for the Geronimo Estates customers or along Control Road #32 for supplemental supplies to Pine similar to that provision under Alternative #8 herein.

Estimated Cost:	$17,400,000 (estimated but minimum)
Estimated Cost:	$1,000,000 (estimated environmental report requirements, commercial water costs, and water system infrastructure costs)
Estimated Cost:	$18,400,000 (total)
Annual Operating Costs:	$150,000 estimated
Annual Ratepayer Impact:	$2,271
Monthly Ratepayer Impact:	$189.25
Scope of Benefit:	Pine
PWCo. Ranking:	5
PWCo. Discussion:	Beginning in early September 2005 BUI's representatives began researching the possibilities of this water source for (a) customers of Payson Water Co.'s Geronimo Estates and Elusive Acres, and (b) as a supplemental water source for Pine using USFS Control Road #32 is a manner similar to that proposed in Alternative #8 herein. An internal report (i.e. deemed "Project Maverick") was developed concerning the possible water source (see EXHIBIT 22). Currently, Payson Water Co. serves 70 customers in Geronimo Estates and 13 customers in Elusive Acres. According to representatives of Camp Geronimo the water rights connected with this supply pre-dates the area water rights of SRP. This water rights standing has not been confirmed with SRP. An extensive environmental report may be necessary to satisfy downstream water rights holders from Weber Creek including USFS. Payson Water Co.

and/or PWCo. would pay Camp Geronimo a commercial wholesale water fee for access to this water. According to SRP Camp Geronimo could only provide excess wholesale water to Payson Water Co. and/or PWCo. to the extent they could demonstrate a reduction in beneficial and historical use. Thus, it appears that not more than 5 to 10 acre feet per year would be available from the Camp Geronimo water source. PWCo. estimates the cost of this project would be at least equal to those indicated in Alternative #8 exclusive of environmental assessment reports, commercial wholesale water costs, and additional delivery infrastructure necessary to connect Camp Geronimo to an appropriate location on Control Road #32. PWCo. estimated these additional costs could easily exceed $1,000,000. It seems extraordinarily unlikely that a project of this financial magnitude would be affordable by customers of Geronimo Estates and Elusive Acres or PWCo.

Alternative #10: Bray Creek Ranch Water Diversion, Control Road #32 Pipeline, Water Treatment Plant; Internally Also Known as "Project Maverick"

This alternative was originally brought to the attention of BUI at the same time Alternative #9 was considered. It seems that at the same time the Camp Geronimo water supply alternative was learned by Gila Co. that this additional water source was further considered as well. The Bray Creek Ranch property is located at approximately the same elevation as Camp Geronimo but approximately 1-1/2 miles east and north of Control Road #32. The property is owned by a limited liability company comprised of doctor and lawyer members. Two old houses are located on the property in additional to a meadow and pond. BUI contacted managing member representatives of Bray Creek Ranch to investigate this potential water source. Bray Creek Ranch estimated the water flow from natural springs at 40 to 50 GPM. Bray Creek Ranch currently has a commercial wholesale water contract with a bottled water distributor in Phoenix. The distributor uses water tenders to truck water from the source to its Phoenix facilities for filtration and processing. Bray Creek Ranch expressed concern about the viability of the commercial water sales contract as the distributor has recently experienced operational and financial difficulties. USFS is aware of the "bottled water contract" and, likewise, expressed concern that it is "possible but not likely probable" that a commercial pipeline could be developed across lands for use by Geronimo Estates, Elusive Acres, or PWCo. customers. Bray Creek Ranch indicates that a prior application to the USFS was denied for development and construction of a pipeline from their property to intersect with Control Road #32 for commercial use by the bottled water contractor.

Estimated Cost:	$17,400,000 (estimated but minimum)
Estimated Cost:	$1,200,000 (estimated environmental report requirements, commercial water costs, and water system infrastructure costs)
Estimated Cost:	$18,600,000 (total)
Annual Operating Costs:	$150,000 estimated
Annual Ratepayer Impact:	$2,294
Monthly Ratepayer Impact:	$191.19
Scope of Benefit:	Pine
PWCo. Ranking:	5
PWCo. Discussion:	Beginning in early September 2005 BUI's representatives also began researching the possibilities of this water source for (a) customers of Payson Water Co.'s Geronimo Estates and Elusive Acres, and (b) as a supplemental water source for Pine using USFS Control Road #32 in a

manner similar to that proposed in Alternative #8 and #9 herein. An internal report (i.e. deemed "Project Maverick") was developed concerning the possible water source (see EXHIBIT 22). Currently, Payson Water Co. serves 70 customers in Geronimo Estates and 13 customers in Elusive Acres. According to representatives of Bray Creek Ranch the water rights connected with this supply pre-dates the area water rights of SRP. This water rights standing has not been confirmed with SRP. An extensive environmental report may be necessary to satisfy downstream water rights holders including USFS. Payson Water Co. and/or PWCo. would pay Bray Creek Ranch a commercial wholesale water fee for access to this water. According to SRP Bray Creek Ranch could only provide excess wholesale water to Payson Water Co. and/or PWCo. to the extent they could demonstrate a reduction in beneficial and historical use. Bray Creek Ranch disputes SRP's calculus of the amount of beneficial and historical water use. PWCo. estimates the cost of this project would be at least equal to those indicated in Alternative #8 and #9 exclusive of environmental assessment reports, commercial wholesale water costs, and additional delivery infrastructure necessary to connect Bray Creek Ranch to an appropriate location on Control Road #32. PWCo. estimated these additional costs could easily exceed $1,200,000. It seems extraordinarily unlikely that a project of this financial magnitude would be affordable by customers of Geronimo Estates and Elusive Acres or PWCo.

Alternative #11: Develop Above Ground Water Storage Facilities

This water supply alternative component has been suggested by numerous public comments in the past despite the fact that PWCo. already has developed water storage facilities that exceeds the requirements of ADEQ and other regulatory agencies. In conjunction with other water supply alternatives additional water storage may be a necessary component for storing water for future use. Generally, the unit cost of larger water storage facilities is less than that of smaller facilities. PWCo. estimates the cost of large water storage facilities at approximately $1 per gallon plus land acquisition costs, permits, fees, and annual operating costs.

Estimated Cost:	$2,000,000 (approximately 2,000,000 gallon facility)
Annual Operating Costs:	$20,000
Annual Ratepayer Impact:	$250
Monthly Ratepayer Impact:	$20.83
Scope of Benefit:	Pine and Strawberry
PWCo. Ranking:	5
PWCo. Discussion:	For many years PWCo. has commented that additional water storage facilities are not realistic because water supplies that enabling filling the facilities are not available. Winter well production of existing and future wells for storage in such facilities would likely require water treatment facilities if planned for long term periods. The effect on winter well recharge from annual precipitation is also unknown if yields are use for water storage.

Alternative #12: Expansion of Water Sharing Agreements with Existing Water Well Owners

In 1998 BUI developed the idea of contracting with private property well owners (i.e. "Partners") to either (a) buy excess water from existing well production, or (b) drill new wells on private property. To date, SWCo. and PWCo. have entered into approximately twelve Water Sharing Agreements with Partners and the total water production from these sources has provided a critically important source of water to the communities of Strawberry and Pine for many years. These agreements have a twenty year term with automatic renewal provisions in five or ten year increments. Partners are paid a monthly fee for the actual water metered from the water source pursuant to a rate schedule that is the same for each water sharing agreement Partner. Newly developed wells on private property are developed and constructed at water company expense with operating agreements over many future years. Obviously, newly developed water wells must be sufficiently productive to repay the cost of the well development as well as provide water sales revenues pursuant to the applicable water company tariffs. SWCo. and PWCo. has made it widely and publicly known that they are interested in numerous additional Partner wells for the same purpose.

Estimated Cost:	$35,000 (per newly developed well site)
Annual Operating Costs:	$1,800
Annual Ratepayer Impact:	$5.60
Monthly Ratepayer Impact:	$00.47
Scope of Benefit:	Pine and Strawberry
PWCo. Ranking:	1
PWCo. Discussion:	This water supply alternative is highly attractive because of its low development and operational cost. PWCo. has been very successful in utilizing this water supply option during the past ten years. However, the substantial disadvantage of this option is that few private property owners are interested in becoming Water Sharing Agreement Partners with SWCo. and PWCo. because they fear de-watering a private, presently exclusive water source. A further disadvantage of this water supply alternative is that the number of Partners would need to more than double in order to overcome the volume of deficient water production according to Table 2.0 above. The permit process, ADEQ approval process, and development process of these water sources has nearly tripled in the last two years because of additional requirements constantly being placed on these sources of supplemental water supplies from regulatory agencies. Currently, BUI has secured approval from a private property owner in Strawberry to develop a six-acre parcel in a good prospective well drilling location from which PWCo. expects to use an existing well currently located on the property and develop at least three more wells each producing 10-15 GPM and able to supply water to customers of SWCo. and PWCo. PWCo. hopes to have a portion of this project in service by May of 2006.

Alternative #13: Well Exploration of Public Lands

This water supply alternative has been obviously to most people familiar with the water supply challenges of Pine for many years. No Gila County has a small percentage (i.e. less than 5%) of all its land available as private land. Thus, USFS owns and maintains the vast amount of other property in the area. Obtaining special use permits for well drilling sites is an expensive and time consuming process. Some of the most attractive USFS prospective well drilling sites are at the most remote locations. If

vast quantities of water was discovered at these locations an additional special use permit would be required to move the discovered water across USFS lands – possibly for many miles over greatly varying terrain elevations. This water supply alternative would likely also require additional mass water storage facilities as described under Alternative #11 or utilize the proposed Pine reservoir facilities as described under Alternative #6. USFS would likely require environmental reports for all special use permits issued including public comment periods at which environmental claims would likely be raised. This process could easily require 1 to 2 years for each special use permit processes. existing and retrofitted water storage tanks falls far short of the volume requirement of the area.

Estimated Cost:	Unknown
Annual Operating Costs:	Unknown
Annual Ratepayer Impact:	Unknown
Monthly Ratepayer Impact:	Unknown
Scope of Benefit:	Pine and Strawberry
PWCo. Ranking:	5
PWCo. Discussion:	This water supply alternative has practical applications is sufficient water supplies are discovered. The cost of water exploration and movement of water to storage and/or treatment facilities is an unknown expense depending on well location. The costs of water storage, Pine reservoir development, and water treatment plant development can be found elsewhere in this Report.

Alternative #14: Pine Creek CAP Water Exchange Agreement with SRP

During a meeting with representatives from Gila Co., TOP, SRP, BUI, and PSWID earlier this year the idea of a water exchange utilizing USFS TNF's water allocation at various marinas and facilities statewide was considered. SRP proposed that, possibly, TNF has difficulty collecting water fees from permitees and desire permanent water rights for their facilities. TNF was thought to want to severe water rights from various stock tanks and other facilities and transfer permanent rights to permitees. This action would likely cause cancellation of TNF's water exchange agreement with SRP and prohibit reassignment of the water rights to Pine Creek where PWCo. could extract the water from Pine Creek during sufficient run off periods. According to SRP this total volume of exchanged water with TNF was about 150 acre feet throughout the State. Subsequent to this unlikely scenario SRP has expressed their interest in entering into a water exchange agreement for the 161 acre feet CAP contract possessed by PWCo. Previously, it was believed that down stream rights holders and claimants could cause this transaction to be very expensive, time consuming, and ultimate successful accomplishment uncertain. After further research by BUI and SRP it has been determined that the downstream rights holders and claimants likely represent a less complex obstacle than first believed. PWCo. would be responsible for all permits, fees, and costs associated with the exchange agreement as well as all capital, operating, and maintenance costs. PWCo. would likely enter into a 50 year contract with SRP for this water. Water diversion measurement equipment with an accuracy of 5% must be developed and constructed by PWCo. PWCo. will also be responsible for all CAP water costs, deliver CAP to SRP at its interconnection facility, pay SRP for use of the interconnection facility, and pay SRP certain administrative fees for agreement administration. SRP does not guarantee that sufficient stream flows will be available from Pine Creek nor that water quality will not require treatment plant processing. The requirements of entering into a water exchange agreement with SRP is well known and requires six primary steps as follows: (1) PWCo. must determine the economic viability of the exchange project; (2) PWCo. and SRP would negotiate a water exchange agreement; (3) because the water exchange agreement exceeds 50 acre feet, SRP would be required to submit a water exchange application with ADWR as required by ARS 45-1041 through 1046; (4) ADWR would review and

likely approve the water exchange agreement application; (5) PWCo. would construct necessary facilities on Pine Creek; and, (6) water exchange is implemented by PWCo. at Pine Creek and SRP at the interconnection facility. SRP projects that as much as 18 months would be required to complete this transaction. SRP emphatically reminds PWCo. that it has no reliable information on the amount of stream flow available from Pine Creek under this water alternative.

Estimated Cost:	$1,000,000 (estimated all costs including diversion constriction)
Annual Operating Costs:	$50,000
Annual Ratepayer Impact:	$158
Monthly Ratepayer Impact:	$13.25
Scope of Benefit:	Pine only
PWCo. Ranking:	3
PWCo. Discussion:	PWCo. highly desires implementing this water supply alternative. SRP estimates that approximately 60 acre feet of Pine Creek water is used for irrigation and minor domestic use. SRP estimates total Pine Creek water use of about 183 acre feet per year. *Although this water supply alternative, in conjunction with Alternative #6, is practical, useful, and realistic there is a high likelihood that sufficient stream flow from Pine Creek would be insufficient to meet PWCo. demand of an additional 100 acre feet annually, and most particularly, at highest demand times during the year when the water supply is most needed.*

Alternative #15: Water Hauling on an "As Needed" Basis

Since 1998 BUI has arranged with transportation companies and wholesale water providers to transport truck loads of potable water from other BUI water companies as well as commercial sources in Coconino County. Approximately 6,500 gallons of water can be transported at one time and pumped into strategic water system locations. Not more than 150,000 gallons of water can be supplied from the Coconino County site per day. On several occasions, when available, BUI has arranged to have multiple pieces of equipment operating on an "around the clock" basis to supply water to customers of PWCo. This supplemental water facility continues to remain available. Discussions with ACC Utilities Division Staff on previous occasions has indicated that the commercial source of water in Coconino County is the only statewide known source of water of its type. Staff has expressed concern that, if the Coconino County source of commercial wholesale water became unavailable, no other known alternative site is available in Arizona.

Estimated Cost:	$35.75 per truck load water cost
Estimated Cost:	$39.25 per 1,000 gallons transportation and delivery cost
Annual Operating Costs:	Internal management and operational costs
Annual Ratepayer Impact:	Unknown – depends on volume supplied
Monthly Ratepayer Impact:	Customers charged for proportional use of volume supplied
Scope of Benefit:	Pine
PWCo. Ranking:	2
PWCo. Discussion:	This water supply alternative has long been considered unpopular by customers of PWCo. because it is seen as an interim solution to a problem needing a long-term approach. However, the communities of Pine and Strawberry were nearly equally divided in the interest in water hauling as a "viable" water supply alternative in the Customer Survey discussed herein. In the past, this water supply alternative has required substantial management resources of BUI to schedule, supervise, and

coordinate deliveries to needed facilities. There is no assurance that the Coconino County water source will be available in the long term.

Alternative #16: Blue Ridge Reservoir Water Diversion to Pine Creek

This water supply alternative has been informally discussed by several members of the MRWRMS study group. This alternative has not been fully explored and little information is available at this time. This water supply alternative provides for water from Blue Ridge Reservoir, as discussed under Alternative #7 herein, to be delivered to the upper end of Pine Creek by means of a pipeline across USFS property. The water would be allowed to flow through Pine Creek and would collected downstream in south Pine and distributed to a mass storage facility like that discussed in Alternative #6 above. The water flowing through Pine Creek would be exchanged by PWCo. under an agreement with SRP through a CAP water exchange arrangement. PWCo. currently has a 161 acre feet CAP water allocation that would be utilized to capture this stream flow. The captured non-potable water would be stored and treated before being distributed to the water systems of PWCo. and SWCo. It should be noted that the PSWID concludes that "Alternative JB8 not to be a viable option for Pine and Strawberry" but should "held open for future consideration as a long-term secondary source" of water supply.

Estimated Cost:	Unknown
Annual Operating Costs:	Unknown
Annual Ratepayer Impact:	Unknown
Monthly Ratepayer Impact:	Unknown
Scope of Benefit:	Pine and Strawberry
PWCo. Ranking:	Unknown
PWCo. Discussion:	Insufficient information has been developed concerning this water supply alternative to allow PWCo. to comment. If water can be economically moved from the Blue Ridge Reservoir to Pine Creek the feasibility of in stream water collection under a CAP water exchange arrangement with SRP; storage in a mass water storage facility; development of a sufficiently sized water treatment plant; and, distribution to the water systems of PWCo. and SWCo. are operational feasible.

Alternative #17: Deep Well Exploration in Fault Areas in Pine (Ploughe Recommendation)

This water supply alternative was developed after extensive discussion and investigation with Mike Ploughe of Highland Water Resources, Inc. of Payson, AZ. Ploughe also operates as an employee of the TOP's Water Department as a geological engineer and has developed extensive experience in the development of water sources for TOP. Ploughe also operated as the private consulting engineer for SHDWID (see Alternative #20 below). Using his extensive geology and hydrology references, Ploughe believes that sufficient water supplies are located under the town of Pine. Ploughe believes that 4,600 feet ASL elevation likely represents the depth at which such water supplies can be found. Thus, if the elevation of a Pine deep well drilling site is 6,000 feet ASL a vertical bore depth of approximately 1,400 would be necessary to enter the water bearing geology. Ploughe recommends that deep well bore depths extend approximately 200 feet below the depth when the water bearing zone is first encountered.[4] Accordingly, Ploughe believes it is extremely important to precisely known the ASL elevation of the prospective well drilling site prior to exploration. To support this belief Ploughe, in conjunction with other hydrology professionals, has developed extensive geological maps of the Pine, Strawberry, and surrounding areas (see EXHIBIT 20). Further, Ploughe has used these mapping

techniques to locate cross sections of the geology under Pine on, and across, fault areas of the area. Ploughe reasons that the likelihood of locating alternative water supplies under Pine is best explored on, or at the intersection, fault lines. To further support this contention Ploughe has provided cross sections (see EXHIBIT 21) of the area geology to specifically locate the most prospective drilling areas. Why Ploughe remains confident of his research and the likelihood of alternative water supplies under Pine, he admits that projecting sustained yield water production volumes is highly uncertain. As such, Ploughe admits that numerous deep wells may be required to locate the volume of water demanded by Pine as indicated in Table 2.0 above. To compute the costs shown below the costs associated with Alternative #3 have been extrapolated for a deep well bore of 1,800 feet using a unit cost of $2,156 per foot.

Estimated Cost:	$3,880,800 (includes water system and storage improvements)
Annual Operating Costs:	$55,000 estimated
Annual Ratepayer Impact:	$498
Monthly Ratepayer Impact:	$41.57
Scope of Benefit:	Pine
PWCo. Ranking:	4
PWCo. Discussion:	This hydrogeological information developed by Ploughe and his associates was utilized during the exploration of the SH3 well described under Alternative #20. According to the SHDWID *Application for Assured Water Supply* submitted to ADWR we can project that at least 39 GPM was discovered using this methodology. This approach to water exploration in Pine is, however, highly risky because of the following issues: (1) it should not be expected that the ratio of successful productive well locations will approach 100%. Therefore, it might be necessary to drill three or more wells to provide economically justified water supplies from two wells. While the actual ratio is, of course, unknown the *total* cost of deep well drilling would have to be considered when computing the impact on PWCo. ratepayers; (2) the water production deficiency of Pine is approximately 200 GPM (see Table 2.0 above). In other words, at a production rate of 40 GPM at least five deep wells would be required to be drilled in Pine to secure the necessary water supplies. The incremental cost of these additional wells could dramatically inflate the projected ratepayer impact shown above. Ploughe has no deep Pine well discoveries to his credit other than the SH3 well of SHDWID. The projected costs and ratepayer impact of this alternative are far in excess of the expectations and capabilities of the respondents in the Customer Survey.

Alternative #18: Cessation of Further Development in Pine and Strawberry

Likely considered a drastic reaction to deficient water supplies in Pine, restricted or terminated property development in the area should be anticipated to be a very unpopular alternative for many residents. Approximately 50% of the existing Pine parcels are undeveloped. Obviously, these property owners want to develop their properties or market them for future buyers. Without the provision of water these properties will likely be worth much less.

Estimated Cost:	Unknown
Annual Operating Costs:	Unknown
Annual Ratepayer Impact:	Unknown

Monthly Ratepayer Impact:	Unknown
Scope of Benefit:	Pine and Strawberry
PWCo. Ranking:	5
PWCo. Discussion:	Although this water supply alternative may be palatable and attractive to some people it seems that such an alternative exceeds the scope of PWCo.'s regulatory responsibilities and likely would have to be a decision that local citizens would make.

Alternative #19: Legislative Alternatives

The scope of the water supply problems as evidenced by the individual alternative costs associated with the discussion of this Report and the related risk of capital provides for unique problems. These problems do not easily lend themselves to solutions in the regulatory environment where "used and useful" statutory requirements exist. At the same time goals and objectives of Pine and Strawberry citizens don't change as it relates to the full enjoyment of their property. It is possible that legislative consideration needs to be contemplated that might provide assistance with managing serious water supply deficiencies. In this regard questions should be asked like the following:

- Should No. Gila Co. be included as an AMA of ADWR?
- Can private property development be deferred until adequate water supplies are available?
- Should property development outside of CC&N's be regulated?
- When are water improvement districts detrimental to local water supplies?
- Should communities with adequate water supplies be required to conserve water?
- What penalties should be attributed to individuals and business that fail to use water wisely?
- What should be the societal penalties for failure to recognize the importance of limited water supplies?
- What role should regulators play in the legislative effort?
- What incentives can be developed for public service corporations to provide services to communities at risk for deficient natural resources?

Estimated Cost:	Not applicable
Annual Operating Costs:	Not applicable
Annual Ratepayer Impact:	Not applicable
Monthly Ratepayer Impact:	No applicable
Scope of Benefit:	Pine and Strawberry
PWCo. Ranking:	5
PWCo. Discussion:	No further comment.

Alternative #20: Strawberry Hollow Domestic Water Improvement District Water Adequacy Application

This alternative was developed by SHDWID in the form of a *Water Adequacy Application* received by ADWR (File #22- 401908.0000) on October 11, 2005. A copy of the Application and the accompanying report requested and received from ADWR by PWCo. on or about October 20, 2005 (see EXHIBIT 20). In it's Application SHDWID asserts that it has intercepted a deep aquifer under Pine that provides enough sustained water yield to adequately supply its customers and, in addition, make available up to 25 GPM (i.e. 36,000 gallons per day) to "other providers" in the Pine area. On October 19, 2005 ADWR corresponded with SHDWID's submitting engineering representative indicating the application was incomplete and listed six additional issues requiring resolution before

the application could be considered complete and subject to further review. The report does not disclose the total sustained yield in excess of the demand of SHDWID. Therefore, the extent of the available excess water supply has not been disclosed. In 2000 and 2003 SHDWID drilled two wells, SH2 and SH3, to depths of 240 feet and 1,300 feet respectively. The deeper SH3 well includes a six inch bore with steel casing slotted from 900 feet to the bottom of the bore. The reported water yield is based on extensive hydrological and geological supporting documentation some of which is also included as other exhibits, including the MRWRMS regional study group, in PWCo.'s Report. Though yet unproven as an actual excess water source SHDWID's report combines currently available data with historical research documents to reach its conclusions. SHDWID expects a maximum build-out by 2030 of 72 residential lots located in Pine. SHDWID expects most of these lots to be part-time residents but used a daily maximum demand of 288 gallons per day per lot (i.e. 15.1 GPM or 24.35 acre feet per year) as the basis for its application calculations. In light of the absence of approval of other water adequacy applications submitted for this area the eventual approval of SHDWID's application cannot be ascertained.

Estimated Cost:	Unknown
Annual Operating Costs:	Unknown
Annual Ratepayer Impact:	Unknown
Monthly Ratepayer Impact:	Unknown
Scope of Benefit:	Pine
PWCo. Ranking:	Unknown

Alternative #21: Condemnation of Existing Local Water Supplies

As an Arizona public service corporation PWCo. has the legal ability to condemn the private property of individuals, water improvement districts, and others. The process can be expected to be confrontational and develop ill will with community members. The process can also be time consuming and expensive if litigation ensues. The process of valuing condemned property can also be easily disputed and contentious. According to PWCo.'s counsel immediate possession of property condemned is afforded only to governments and municipalities and excludes public service corporations.

Estimated Cost:	Unknown
Annual Operating Costs:	Unknown
Annual Ratepayer Impact:	Unknown
Monthly Ratepayer Impact:	Unknown
Scope of Benefit:	Pine and Strawberry
PWCo. Ranking:	5
PWCo. Discussion:	PWCo. would consider condemnation of individual private property only under extreme conditions where (a) water supply opportunities were to important to ignore, (b) where the greater public interest was clearly served, and/or (c) where regulatory orders were to be served.

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BEFORE THE ARIZONA CORPORATION COMMISSION

Arizona Corporation Commission
DOCKETED
MAY 0 5 2005
DOCKETED BY

COMMISSIONERS

JEFF HATCH-MILLER Chairman
WILLIAM A. MUNDELL
MARC SPITZER
MIKE GLEASON
KRISTIN K. MAYES

JAY SHAPIRO

MAY 1 2 2005

ACTION

IN THE MATTER OF THE APPLICATION OF PINE WATER COMPANY FOR A DETERMINATION OF THE CURRENT FAIR VALUE OF ITS UTILITY PLANT AND PROPERTY, A RATE INCREASE AND FOR APPROVAL TO INCUR LONG-TERM DEBT.

DOCKET NO. W-03512A-03-0279

DECISION NO. 67823

SUPPLEMENTAL OPINION AND ORDER ON NEW SERVICE CONNECTION MORATORIUM

DATES OF HEARING:	January 31, 2005 (Public Comment, Pine, Arizona); February 14 and 25, 2005
PLACE OF HEARING:	Phoenix, Arizona
ADMINISTRATIVE LAW JUDGE:	Dwight D. Nodes
IN ATTENDANCE:	William A. Mundell, Commissioner Mike Gleason, Commissioner Kristin K. Mayes, Commissioner
APPEARANCES:	Mr. Jay Shapiro, FENNEMORE CRAIG, P.C., on behalf of Pine Water Company; Mr. Robert M. Cassaro, in propria persona; Mr. John O. Breninger, in propria persona; and Mr. Jason Gellman, Staff Attorney, Legal Division, on behalf of the Utilities Division of the Arizona Corporation Commission.

BY THE COMMISSION:

By Decision No. 67166, (August 10, 2004) the Arizona Corporation Commission ("Commission") granted Pine Water Company ("Pine Water" or "Company") a permanent revenue increase of approximately 11.8 percent pursuant to a settlement agreement entered into by Pine Water, the Commission's Utilities Division Staff ("Staff"), and other intervenors[1]. Decision No.

[1] The other signatory intervenors were the Strawberry Hollow Domestic Water Improvement District ("District") and Mr. John Breninger. The only other intervenor, Mr. Robert Cassaro, did not sign the settlement agreement. The District withdrew its intervention in this subsequent phase of the proceeding.

67166 also directed Staff to prepare a Staff Report within three months addressing the issue of whether a moratorium on new water hook-ups should be reinstituted for Pine Water. Pine Water is currently subject to a limited moratorium pursuant to Decision No. 65435 (December 9, 2002), whereby the Company is limited to a maximum of 25 new service connections per month[2].

On November 19, 2004, Staff issued its Staff Report in accordance with Decision No. 67166. Staff recommended that Pine Water be prohibited from connecting any new customers due to Staff's determination that inadequate sources of water are available to serve additional customers. Staff also raised issues with respect to Pine Water's compliance with Arizona Department of Environmental Quality ("ADEQ") regulations.

A Procedural Order was issued on November 23, 2004 scheduling a procedural conference for December 1, 2004. The procedural conference was held as scheduled.

On December 2, 2004, a Procedural Order was issued scheduling a hearing for February 14, 2005, directing the Company to publish notice of the hearing, and establishing other filing dates.

Pine Water's president, Robert Hardcastle filed Direct testimony on January 18, 2005.

On January 21, 2005, a Procedural Order was issued scheduling a public comment hearing for January 31, 2005 in Pine, Arizona. Pine Water was also directed to notify customers of the public comment hearing by newspaper publication and other means. The public comment hearing was conducted in Pine, as scheduled, on January 31, 2005.

On February 1, 2005, Staff engineer Marlin Scott filed Rebuttal testimony in support of Staff's recommendations.

On February 8, 2005, Mr. Hardcastle filed Surrebuttal testimony.

The evidentiary hearing commenced on February 14, 2005 and continued on February 25, 2005.

* * * * * * * * * *

Having considered the entire record herein and being fully advised in the premises, the Commission finds, concludes, and orders that:

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[2] The 25 service connection per month limit was originally established in Decision No. 64400 (January 31, 2002). Decision No. 65435 clarified that the 25 connection per month limit applies to the entirety of Pine Water's certificated service area.

FINDINGS OF FACT

1. Pine Water provides domestic water utility service to approximately 2,000 customers in the Pine, Arizona area. Pine Water is owned by Brooke Utilities, Inc. ("Brooke Utilities") which, along with its sister company, Brooke Water, LLC, own and operate 26 water systems serving a total of approximately 8,000 customers in Arizona.

2. The territory served by Pine Water is subject to water shortages, where ground water is the primary source of water. Groundwater in the Pine area typically flows through scattered rock fractures and is heavily dependent on replenishment from rain and snow melt. As a result, Pine Water's service area is susceptible to shortages in dry years, especially during summer months when demand is highest.

3. The Pine Water system and its predecessors have been subject to new service connection limits for a number of years. In 1989, due to historical water shortages in and around the Pine area, the Commission ordered various moratoria on new service connections and main extensions in the area previously served by E&R Water Company, Inc. ("E&R") and Williamson Waterworks, Inc. ("Williamson").

4. In Decision No. 56539 (July 12, 1989), the Commission determined that new service connections should be curtailed in E&R's service area due, in part, to a drought in the region and lowering of the water table. In Decision No. 56654 (October 6, 1989), the Commission reaffirmed the moratorium and also prohibited additional main extensions. The Commission directed that the moratorium should remain in place until such time as E&R could demonstrate an ability to increase water supplies by implementing conservation measures and by obtaining additional water resources.

5. In Decision No. 57047 (August 22, 1990), the Commission approved a modification to the new service connection limit, allowing ten new connections per month under certain conditions. However, in Decision No. 59753 (July 18, 1996), the Commission revised the moratorium, limiting E&R to one single family residential connection per month on a first come first served basis. The complete moratorium on new main extensions was reaffirmed in that Decision (Decision No. 59753, at 12).

6. In August 1996, Brooke Utilities acquired E&R and Williamson and subsequently

reorganized seven separate water companies and systems into five subsidiaries, including Pine Water and Strawberry Water Company ("Strawberry"). The reorganization was approved by the Commission in Decision No. 60972 (June 19, 1998). The Pine Water system remained subject to the one connection per month limit and by 2001 the waiting list for new connections had grown to 243 customers.

7. In September 2001, Pine Water filed an application seeking to increase the new service connection limit to 25 per month. The Commission granted the Company's modification request in Decision No. 64400 (January 31, 2002)[3] based on Brooke Utilities' representations that it had made significant improvements to the Pine Water system that would enable the Company to provide adequate water service to new customers. Foremost on the list of improvements was Project Magnolia, a pipeline interconnecting the Pine Water and Strawberry systems that is capable of moving up to 700,000 gallons of water per day. The Company also claimed that water resources had been enhanced as a result of repairs to system infrastructure, drilling of new wells in both Pine and Strawberry, and construction of new storage capacity for both systems. *See*, Decision No. 64400, at 3-4.

8. As indicated above, in Decision No. 67166 (August 10, 2004) the Commission kept the above-captioned docket open for the purpose of investigating whether a complete moratorium on new service connections should be implemented for the Pine Water system. Staff filed its Staff Report on November 19, 2004 recommending that "no new service connections be added to the Pine Water system at this time" based on Staff's conclusion that insufficient quantities of water are available for Pine Water to adequately serve its customers.

9. According to the Staff Report and Mr. Scott's testimony, Staff determined that Pine Water's 19 well production sources are capable of serving a maximum of 555 average water customers, based on Staff's analysis of customer usage from August 2002 to July 2004 (Ex. S-2, at 2)[4]. Mr. Scott testified that Staff considered the availability of water from the Strawberry system

[3] As amended by Decision No. 65435 (December 9, 2002) for purposes of clarification.

[4] To reach its conclusion, Staff evaluated the Company's Water Use Data Sheets for the peak month of June 2003 (6,400,669 gallons) and divided the usage by 30 days and the actual water users during the month (1,752) to obtain a result of 121.78 gallons per day ("GPD") per user. This result was multiplied by a factor of 2.0 (due to the lack of peak day water use data) to determine a value of 243.56 GPD per user, which equated to a value of 0.17 gallons per minute

through Project Magnolia, but concluded that Strawberry's 8 wells can produce less than 110 GPM which, at continuous use at half capacity, would quickly be detrimental to water service in Strawberry. Staff considers the Company's only other source of water, hauling water by truck, to be an emergency measure that should not be considered for purposes of determining resource availability (*Id.* at 3).

10. Through his testimony, Mr. Hardcastle agrees that Pine Water faces ongoing water supply issues. However, he contends that adoption of Staff's recommendation will exacerbate the situation if a similar limit on new connections is not also imposed on Gila County (Ex. P-1, at 2; Ex. P-2, at 3). Mr. Hardcastle testified that a total moratorium for Pine Water will lead to other customers outside the Commission's jurisdiction using the same water supplies currently used by Pine Water. Mr. Hardcastle cites to the existence of a number of water districts that are not subject to limits on connecting new customers and ongoing efforts by Gila County to develop the Pine/Strawberry area despite the lack of adequate sources of water (Ex. P-1, at 3-5). He claims that the Staff Report fails to recognize that a moratorium on Pine Water will not improve the water supply situation because the County and developers will continue to circumvent the Commission's jurisdiction by forming districts (*Id.* at 6).

11. The Company also contends that Staff's analysis does not take into account the limited short-term nature of Pine Water's peak demand. As described above, Staff determined that Pine Water's current water resources were capable of serving a maximum of 555 customers based on usage data averaged over the June 2003 peak month. Despite Staff's calculation, Mr. Hardcastle stated that Pine Water has been able to serve its entire base of nearly 2,000 active customer accounts for several years by pumping water through the Project Magnolia pipeline and, when necessary, by hauling water into the system. The Company claims that these measures are generally necessary only to meet demand during summer weekends, especially holiday weekends.

12. At the January 31, 2005 public comment hearing in Pine, and at the beginning of the evidentiary hearing, a number of Pine Water customers offered comments regarding the proposed

("GPM") per user. Staff then divided the Company's available well production sources of 93.88 by 0.17 GPM per user to reach its conclusion that Pine Water is capable of serving only 555 service connections during peak months (*Id.* at 2-3).

moratorium on new connections. Among the public comment witnesses was Harry Jones, who read into the record a letter written by District 1 Supervisor for Gila County, Ms. Tommie Cline Martin (Tr. 32-37). Supervisor Martin's letter raised a number of issues related to the proposed moratorium and advocated using a cooperative approach between various stakeholders[5] to attempt to develop a long-term regional solution to the long-standing water shortage issues in northern Gila County. In her letter, Supervisor Martin requested that the Commission limit Pine Water's new service connection limit to two per month, for the next six months, in order to allow time for her to get up to speed and assist in developing a solution for the water issues facing Gila County.

13. Although Pine Water opposes reducing the current 25 new meters per month limit, Mr. Hardcastle testified that the Company was not opposed to Supervisor Martin's proposed two meter per month limit as an interim measure (Tr. 193-194; 361). As a practical matter, the two connections per month limitation would not cause an adverse effect on Pine Water's operations because the Company added a total of only 22 new customers in 2004 (Tr. 194).

14. Staff continues to recommend that a total moratorium on new connections should be imposed due to the lack of available water resources to Pine Water. However, at the hearing, Staff witness Steve Olea testified that it may be appropriate to phase-in the moratorium along the lines suggested in Supervisor Martin's letter (Tr. 316).

Blue Ridge Reservoir

15. During public comments and the evidentiary hearing, the possibility that Pine Water could obtain water from the Blue Ridge Reservoir was a frequent topic for discussion. The Blue Ridge Reservoir is a water reservoir located approximately 25 miles north of Pine in Coconino County, near an area called Clint's Well. Mr. Hardcastle stated that the water rights to the reservoir were formerly owned by Phelps Dodge but, through a recent transaction, the Phelps Dodge water rights will be transferred ultimately to the Bureau of Reclamation. According to Mr. Hardcastle, the agreement provides that up to 3,500 acre feet per year of water from the Blue Ridge Reservoir would be available for Gila County, of which the first 3,000 acre feet would be allocated to the City of

[5] Supervisor Martin stated that she intends to bring together representatives of Pine Water, various area water districts, Gila County staff members, real estate developers, landowners, and other interested citizens.

Payson, and the other 500 acre feet, subject to availability, would be allocated to northern Gila County, including the Pine-Strawberry area (Tr. 108). Mr. Hardcastle testified that preliminary estimates of the cost of constructing pipelines to access the Blue Ridge water are $30 million to $40 million for Payson and $10 million to $15 million for the Pine area. Due to the projected cost of building such a pipeline, with no assurance that water would be available within any given year, Mr. Hardcastle stated that a Blue Ridge Reservoir project as a source of water for Pine Water "just doesn't seem to make a lot of sense" (Tr. 111).

Additional Storage

16. Another potential solution raised at the hearing was the issue of whether it would be feasible for Pine Water to build additional storage facilities. The possibilities of mining water during winter months for use in the summer, as well as the use of additional storage to mitigate summer weekend peaks, were discussed by various customers. Pine Water currently has approximately 900,000 gallons of storage capacity. Mr. Hardcastle testified that adding an additional 1 million gallons of storage would cost approximately $1 million. In response to questions regarding the storage issue, Mr. Hardcastle testified that there is likely not a sufficient incremental amount of production capacity available during off-peak periods that would enable the Company to build up sufficient storage capacity to avert weekend peak shortages. With respect to winter storage, Mr. Hardcastle claims that it is unclear whether "over-mining" in winter months would have a detrimental effect on the fragile sources available during summer months (Tr. 129-130). He stated that three or four years ago the Company explored building a large above-ground storage reservoir but determined that such a facility was not economically feasible. According to Mr. Hardcastle, the cost of a 25 million gallon winter storage reservoir would range from $750,000 up to $7 million depending on a number of factors, including the size and location of the property used; water treatment costs; cost of a delivery system to the reservoir; and whether the facility was lined and what type of lining is used (*e.g.*, unlined, concrete lined, balloon storage vessel) (Tr. 130-133).

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Additional Wells

17. During public comments, Mr. Thomas Filesi claimed that various residents of the Portals III community, where he is a part-time resident, have successfully drilled wells with production of approximately 30 to 35 GPM (Tr. 21). Mr. Filesi contends that the success in finding water in Portals III undermines the Company's claim that additional sources of water are not available in the Pine area. At the hearing, Commissioner Mundell requested that Mr. Filesi provide evidence substantiating his claims. No additional documentation was received in the record on this issue and Pine Water maintains that it has repeatedly been unsuccessful in drilling wells in both the Pine and Strawberry areas (Tr. 143-144).

New Improvement Districts

18. At the hearing, Staff introduced a letter dated April 22, 2003 from ADEQ to Loren Peterson of an improvement district called Strawberry Hollow informing Mr. Peterson that although Strawberry Hollow had previously been issued an Approval to Construct ("ATC") and an Approval of Construction ("AOC"), Strawberry Hollow "does not meet the requirements to begin operating pursuant to R18-4-602.B of the Arizona Administrative Code ("A.A.C.")." The letter advised Strawberry Hollow that it does not have a 100-year drinking water certification from the Arizona Department of Water Resources ("ADWR"), and therefore could not operate as a regulated public water system. The letter also indicated that Strawberry Hollow does not meet the requirements of a "community water system" which limits service to a "public water system that serves 15 or more service connections used by year-round residents or that serves 25 or more year-round residents" (Ex. S-3; Tr. 316, 322-323). Staff raised this point to suggest that it is not likely that a significant number of new districts will be formed in the near future. According to Staff, Pine Water's concerns about the formation of new improvement districts are mitigated by the difficulty improvement districts would have in meeting the 100-year supply criteria needed to qualify as a public water system (Tr. 262-264).

Other requested data

19. Commissioner Mundell requested Pine Water to provide the name of the land owner and parcel number of property for which Pine Water previously had entered into an agreement to drill

a well. According to Mr. Hardcastle, the property was subsequently sold and the new owner is not interested in permitting access to the Company. Mr. Hardcastle did not believe there was an assignment to the new owner of the Company's right to drill a well on the property (Tr. 215). In response to Commissioner Mundell's request, Pine Water submitted a late-filed exhibit on March 15, 2005 and attached the previous owners' recorded deed as well as a map of the subject property (Late-Filed Exhibit A). However, the exhibit did not include documentation showing whether there was an assignment of Pine Water's right to access the property for purposes of drilling a well.

20. During the hearing, Mr. Hardcastle conceded that there is an emergency situation generally with respect to the water supply in the Pine-Strawberry area. However, he disagreed that Staff's proposed moratorium on Pine Water was an appropriate remedy and indicated that the Company would not face a real crisis in its ability to serve customers for another six to eight years (Tr. 218-220). Commissioner Mayes requested that the Company provide internal projections that support its claim that no crisis would exist for a 6-8 year period at current growth levels and Mr. Hardcastle agreed to provide that information (Tr. 220-221). In its March 15, 2005 late-filed exhibit, the Company submitted an analysis performed in 2001 that appears to be a projection of customer growth and capacity requirements over a number of years (Late-Filed Exhibit B).

21. Commissioner Mayes also requested that the Company provide actual water loss data for 2004 to support its claim that the annualized water loss rate is 10 percent (Tr. 223). In its March 15, 2005 late-filed exhibit, the Company attached its water use data for 2004 and calculated a water loss rate of 10.54 percent (Late-Filed Exhibit C).

ADEQ Compliance Issues

22. In the Staff Report, Staff cited several deficiencies it had discovered with respect to the interconnected Pine Water-Strawberry Water system's compliance with ADEQ requirements. Staff indicated that Pine Water was deficient in the following respects: failure to submit an accurate drawing of the system pursuant to a Consent Order between ADEQ and E&R Water; existence of a Notice of Violation ("NOV") for operating two wells (the Blooms and Weeks wells) without an ATC or AOC and failure to properly maintain certain specified facilities; NOV for the interconnected

Strawberry system for failure to provide a consumer confidence report[6]; and an ADEQ report of approximately 20 plant facility deficiencies that need to be corrected (Ex. S-1, at 2). In its March 17, 2005 late-filed exhibit, Staff attached an ADEQ Drinking Water Compliance Status Report for the Pine system which indicates that the system "is currently delivering water that meets water quality standards...."

23. In his Direct testimony, Mr. Hardcastle testified that Pine Water was not aware of the 1994 Consent Order between ADEQ and E&R Water when Brooke Utilities acquired E&R. He stated that preparation of an as-built set of engineering drawings, that was agreed to be produced by E&R as part of the Consent Order, would likely cost the Company in excess of $100,000. Mr. Hardcastle stated that such an expenditure of funds would not be a prudent investment given the ongoing water supply issues facing Pine Water. He said the Company would attempt to resolve the issue with ADEQ (Ex. A-1, at 9).

24. With respect to the Blooms and Weeks wells, Mr. Hardcastle indicated that Brooke Utilities owns and operates the wells pursuant to water sharing agreements with the owners of the land where the wells are located. He stated that when the wells were drilled in 1998, Brooke Utilities did not believe that an ATC or AOC were required because the cost of each well was under $50,000. Mr. Hardcastle testified that the other deficiencies associated with those wells are being promptly addressed by the Company (*Id.* at 10-11).

25. Regarding the other plant facility deficiencies identified by ADEQ, Mr. Hardcastle testified that Pine Water has not been found in violation with respect to those items and ADEQ has not set forth any obligations or timelines for repair of the deficiencies. He stated the Company is in the process of replacing three concrete well slabs and fences around the well sites, and he expects that all of the deficiencies "will be corrected promptly and certainly by the next regularly scheduled field inspection" (*Id.* at 11).

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...

[6] The Company attached to Mr. Hardcastle's testimony a letter from ADEQ, dated January 12, 2005, stating that ADEQ had closed the NOV because the Company had previously sent the required documentation (Ex. P-1, at 8-9; Ex. A).

Conclusion

26. We believe it is appropriate to place a two new residential meters per month limit on Pine Water on an interim basis as a means of enabling all affected stakeholders to discuss possible long-term solutions to the chronic water shortage issues that have plagued the Pine area for a number of years. However, a total moratorium on main extension agreements and commercial connections shall continue to be in effect in order to mitigate the potential detrimental effects associated with adding a significant number of customers and/or high volume users.

27. We expect representatives of Pine Water and the Commission's Staff to be actively involved in analyzing and discussing all feasible long-term permanent[7] solutions to the water shortage issues in Pine. Consideration should be given to, at a minimum, the following: growth limits on Gila County development outside the Pine Water service area; additional well sources; additional storage capacity; Blue Ridge Reservoir pipeline; CAP water trade with Salt River Project ("SRP") for Fossil Creek water; deep drilling in the Coconino sandstone; and any other permanent solutions that may be suggested or developed by the stakeholders and government entities. Such discussions should attempt to include representatives of all affected entities and stakeholders, including ADEQ, ADWR, SRP, Payson, Pine-Strawberry Water Improvement District ("PSWID") and Gila County. The participation of Gila County in this effort is especially critical because restrictions placed exclusively on Pine Water will not resolve the long-standing chronic water shortage issues faced in northern Gila County.

28. Staff and the Company should submit jointly or separately, by no later than October 31, 2005, a report with recommendations regarding specific long-term solutions to the Pine Water shortage issues. We also direct the parties to work with Gila County Supervisor Martin, and other county officials, to ensure that Gila County's input is received and considered in any recommendations that are proposed in the forthcoming analysis and report.

29. The two new residential connections per month limit for Pine Water shall be

[7] Staff witness Steve Olea defined a "permanent" solution as a "permanent, continuous source of water that can adequately supply not only the existing customers, but growth" (Tr. 309).

implemented on a first-come, first-served basis, with no carryover from month-to-month[8], and shall remain in effect until further Order of the Commission.

30. Regarding the compliance issues raised by Staff, it appears from Staff's latest filing that Pine Water is currently in compliance with ADEQ drinking water requirements and, as such, there do not appear to be any immediate health and safety issues raised by Pine Water's ongoing operations. However, there are several matters identified by Staff that require Pine Water's attention and we will therefore direct the Company to immediately contact ADEQ in order to resolve the issues discussed above. Specifically, Pine Water shall seek to resolve the need for as-built engineering drawings; the existing NOV for the Blooms and Weeks wells; and repair of any outstanding plant facilities deficiencies. Pine Water shall file within 90 days of the effective date of this Decision a report discussing how these matters have been resolved and what efforts the Company has taken to ensure that similar deficiencies are not likely to reoccur.

CONCLUSIONS OF LAW

1. Pine Water is a public service corporation within the meaning of Article XV of the Arizona Constitution and A.R.S. §§40-201, 40-203, and 40-252.

2. The Commission has jurisdiction over the Company and of the subject matter of the application.

3. Modification of the 25 new service connections per month previously imposed on Pine Water pursuant to Decision No. 64400, as modified by Decision No. 65435, is reasonable and in the public interest.

4. Staff's recommendation for a complete moratorium on new connections should be modified to allow up to two new residential service connections per month, on a first-come, first-served basis, with no carryover from month-to-month.

ORDER

IT IS THEREFORE ORDERED that the modification proposed in this Decision of the 25

[8] The prohibition against a month-to-month carryover will limit Pine Water to connecting no more than two new customers in any given month, and may require the Company to develop a waiting list to ensure that new connections are established on a first-come, first-served basis. The "no carryover" policy is currently in effect for the 25 connections per month limit pursuant to Decision No. 64400 (January 31, 2002).

new service connections per month previously imposed on Pine Water Company pursuant to Decision No. 64400, as modified by Decision No. 65435, is reasonable and in the public interest.

IT IS FURTHER ORDERED that Pine Water Company shall be limited to two new residential service connections per month, implemented on a first-come, first-served basis, with no carryover from month-to-month, and such limitation shall remain in effect until further Order of the Commission or until April 30, 2006, whichever comes first.

IT IS FURTHER ORDERED that if by April 30, 2006, a permanent solution to Pine Water Company's water shortage issues is not established or if the Commission has not issued a further Order to the contrary, a total moratorium on any new connections to Pine Water Company shall become effective on May 1, 2006.

IT IS FURTHER ORDERED that all conditions placed on the installation of meters that have been contained in previous Commission Decisions for Pine Water Company shall remain in effect during this modified moratorium.

IT IS FURTHER ORDERED that a total moratorium on main extension agreements and commercial connections shall continue to be in effect in order to mitigate the potential detrimental effects associated with adding a significant number of customers and/or high volume users.

IT IS FURTHER ORDERED that representatives of Pine Water Company shall commence an analysis and discussions with all affected entities and stakeholders, including Staff, ADEQ, ADWR, SRP, Payson, PSWID and Gila County, in order to develop a long-term permanent solution to the chronic water shortage issues in the Pine, Arizona area.

IT IS FURTHER ORDERED that, in the analysis and discussions undertaken by the participating entities, consideration should be given to, at a minimum, the following: growth limits on Gila County development outside the Pine Water service area; additional well sources; additional storage capacity; Blue Ridge Reservoir pipeline; CAP water trade with SRP for Fossil Creek water; deep drilling in the Coconino sandstone; and any other permanent solutions that may be suggested or developed by the stakeholders and government entities.

IT IS FURTHER ORDERED that Pine Water Company and Staff shall submit jointly or separately, by no later than October 31, 2005, a report with recommendations regarding specific long-

term solutions to the Pine Water shortage issues.

IT IS FURTHER ORDERED that Pine Water Company shall immediately contact ADEQ in order to resolve issues related to: the need for as-built engineering drawings; the existing NOV for the Blooms and Weeks wells; and repair of any outstanding plant facility deficiencies.

IT IS FURTHER ORDERED that Pine Water Company shall file within 90 days of the effective date of this Decision a report discussing how these ADEQ matters have been resolved and what efforts the Company has taken to ensure that similar deficiencies are not likely to reoccur.

IT IS FURTHER ORDERED that this Decision shall become effective immediately.

BY ORDER OF THE ARIZONA CORPORATION COMMISSION.

CHAIRMAN COMMISSIONER COMMISSIONER

COMMISSIONER COMMISSIONER

IN WITNESS WHEREOF, I, BRIAN C. McNEIL, Executive Secretary of the Arizona Corporation Commission, have hereunto set my hand and caused the official seal of the Commission to be affixed at the Capitol, in the City of Phoenix, this 5th day of May, 2005.

BRIAN C. McNEIL
EXECUTIVE SECRETARY

DISSENT _____

DISSENT _____

DDN:mj

2

BEFORE THE ARIZONA CORPORATION COMMISSION

COMMISSIONERS

JEFF HATCH-MILLER, Chairman
WILLIAM A. MUNDELL
MARC SPITZER
MIKE GLEASON
KRISTIN K. MAYES

JAY SHAPIRO

NOV 0 1 2005

ACTION_____

IN THE MATTER OF THE APPLICATION OF PINE WATER COMPANY FOR A DETERMINATION OF THE CURRENT FAIR VALUE OF ITS UTILITY PLANT AND PROPERTY AND FOR INCREASES IN ITS RATES AND CHARGES BASED THEREON FOR UTILITY SERVICE AND FOR APPROVAL TO INCUR LONG-TERM DEBT.

DOCKET NO. W-03512A-03-0279

PROCEDURAL ORDER

BY THE COMMISSION:

In Decision No. 67823 (May 5, 2005), the Arizona Corporation Commission ("Commission") modified the limit on new service connections for Pine Water Company ("Pine Water" or "Company") to allow two new residential connections per month until further Order of the Commission or April 30, 2006, whichever occurs first. Decision No. 67823 also directed Pine Water and the Commission's Utilities Division Staff ("Staff") to, among other things, "submit jointly or separately, by no later than October 31, 2005, a report with recommendations regarding specific long-term solutions to the Pine Water shortage issues."

On October 27, 2005, Pine Water filed a Request for Extension of Deadline to File Water Supply Alternatives Report. The Company requested an extension until November 7, 2005 to analyze information recently provided to the Arizona Department of Water Resources regarding the Strawberry Hollow development, which is located within Pine Water's CC&N area.

On October 31, 2005, counsel for Pine Water and Staff contacted the Administrative Law Judge regarding the pending extension request. During the teleconference, it was agreed that Pine Water would be granted an extension until November 10, 2005 for file its report; that Staff and intervenors would be given until December 12, 2005 to file a response; and that the Company would have until December 23, 2005 to file a reply to any such responses. Counsel for Pine Water was directed to contact intervenors John Breninger and Robert Cassaro regarding these filing dates.

IT IS THEREFORE ORDERED that Pine Water Company's request for an extension of time to file its long-term solutions report in compliance with Decision 67823 is granted, and accordingly the Company shall file such report by no later than November 10, 2005; Staff and intervenors shall file responses by December 12, 2005; and the Company shall file a reply by December 23, 2005.

IT IS FURTHER ORDERED that in all other respects Decision No. 67823 shall remain in full forces and effect.

Dated this 31st day of October, 2005

DWIGHT D. NODES
ASSISTANT CHIEF ADMINISTRATIVE LAW JUDGE

Copies of the foregoing mailed/delivered
this 31 day of October, 2005 to:

Jay Shapiro
Patrick Black
FENNEMORE CRAIG
3003 N. Central Avenue, Suite 2600
Phoenix, Arizona 85012
Attorneys for Pine Water Company

Robert M. Cassaro
P.O. Box 1522
Pine, AZ 85544

John O. Breninger
P.O. Box 2096
Pine, AZ 85544

Christopher Kempley, Chief Counsel
LEGAL DIVISION
Arizona Corporation Commission
1200 W. Washington Street
Phoenix, Arizona 85007

Ernest G. Johnson, Director
UTILITIES DIVISION
Arizona Corporation Commission
1200 W. Washington Street
Phoenix, Arizona 85007

By: Molly Johnson
Secretary to Dwight D. Nodes

3

Water Conservation Guidelines

The following five (5) stages of water conservation have been adopted by Brooke Utilities, Inc. for all of its water systems located in Gila, Navajo, and Pinal Counties, Arizona. ACC Decision No.'s 61076 and 61072 officially regulated these water staging levels for Pine in 1998 and remain applicable. During periods of low water supply periods Brooke Utilities, Inc. encourages all its customers to strictly abide by the water conservation measures in effect at all times. Violations of effective water conservation stages should be reported to the Brooke Utilities, Inc. Call Center at (800) 270-6084.

Stage 1	No water conservation measures are in effect.
Stage 2	**Voluntary** customer water conservation measures should be employed to reduce daily consumption by approximately ten percent (10%). Outside watering on weekends and holidays should be curtailed. Outside vegetation watering may occur during weekday periods on even days of the month for even numbered lots and odd numbered days of the month for odd numbered lots.
Stage 3	**Voluntary** water conservation measures should be employed to reduce daily consumption by approximately twenty-five percent (25%). Outside watering should be completely curtailed except for permitted livestock. Indoor water conservation techniques should be employed wherever possible. Restaurant patrons should be served water only upon request.
Stage 4	**Voluntary** water conservation measures should be employed to reduce daily consumption by approximately forty percent (40%). Outside watering should be completely curtailed and livestock should be watered only when necessary. Mandatory indoor water conservation techniques should be employed throughout customer residences. Restaurant patrons should be served water only upon request.
Stage 5	**Mandatory** water conservation restrictions are currently in effect pursuant to regulatory enforcement proceedings. Such regulatory restrictions may be in the form of moratoriums, curtailment orders, meter disconnection without notice or the like. Customers should confine themselves to not more than one-half of their usual indoor daily water consumption except for permitted livestock. No outside watering should be conducted. Restaurant patrons should be served water only upon request.

Water Conservation is Everybody's Business! Please do your part!

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Table 6. Mogollon Rim Water Resources Management – Population and Water Demands – 2002 & 2040									
	2002						20		
Location	Population	Developed Parcels	Total Parcels	Gallons per Capita Per Day	Million Gallons per Year	Acre-Feet per Year	Population	Total Parcels (Developed)	Gallon Capita Day
Public - Municipal									
Payson	14,500	7,254	9,747	111.0	588.1	1,804.9	44,637	19,594	
Public – Domestic Water Improvement District									
Pine: Solitude Trails DWID	22	34	78	149.0	1.2	3.7	187	78	
Pine: Strawberry Hollow DWID	0	12	41	0.0	0.2	0.6	173	72	
Pine: Pine Water Association DWID[1]	50	47	55	192.0	3.5	10.7	132	55	
Pine: Pine Creek Canyon/Portals IV DWID	20	70	170	342.0	2.5	7.7	432	180	
RimTrail/Washington Park/Shadow Rim [1]	45	122	163	233.0	3.8	11.7	391	163	
Private Unregulated Cooperatives/Homeowners Associations, etc.									
Bear Flat	12	61	144	250.0	1.1	3.4	346	144	
Bonita Creek [1]	30	30	84	110.0	1.2	3.7	202	84	
Camp Geronimo Boy Scout Camp [3]	60	1	1	96.0	2.1	6.4	68	1	
Christopher Creek/Zane Grey/Brooks	150	342	528	73.0	4.0	12.3	1,363	568	
Collins Ranch	15	20	20	146.0	0.8	2.5	48	20	
Diamond Point Recreation	4	45	45	137.0	0.2	0.6	108	45	
Diamond Point Shadows	140	181	197	250.0	12.8	39.3	473	197	
Ellison Creek Estates	30	50	80	130.0	1.4	4.3	192	80	
Ellison Creek Recreation	10	60	60	137.0	0.5	1.5	144	60	

Table 6. Mogollon Rim Water Resources Management – Population and Water Demands – 2002 & 2040

	2002						2040				
	Population	Developed Parcels	Total Parcels	Gallons per Capita Per Day	Million Gallons per Year	Acre-Feet per Year	Population	Total Parcels (Developed)	Gallons per Capita Per Day	Million Gallons per Year	Acre-Feet per Year
	35	75	166	571.0	7.3	22.4	398	166	300.0	43.6	133.9
	270	134	192	70.0	6.9	21.2	461	192	120.0	20.2	61.9
	240	70	75	120.0	10.5	32.2	250	75	150.0	13.7	42.0
	0	0	260	0.0	0.0	0.0	624	260	150.0	34.2	104.9
	20	1	1	96.0	0.7	2.1	23	1	101.0	0.8	2.6
	300	178	202	230.0	25.2	77.3	581	242	230.0	48.8	149.6
:out	12	1	1	96.0	0.4	1.2	14	1	101.0	0.5	1.6
	0	0	27	0.0	0.0	0.0	65	27	150.0	3.5	10.9
	5	85	85	657.0	1.2	3.7	204	85	200.0	14.9	45.7
	21	85	129	144.0	1.1	3.4	324	135	175.0	20.7	63.5
cres	59	46	50	204.0	4.4	13.5	132	55	225.0	10.8	33.3
	16,050				**681.1**	**2,090.4**	**51,971**			**2,441.8**	**7,494.0**
lity											
s)	180	164	246	79.0	5.2	16.0	590	246	130.0	28.0	86.0
es)	40	42	73	137.0	2.0	6.1	192	80	150.0	10.5	32.3
ties)	35	109	252	141.0	1.8	5.5	624	260	150.0	34.2	104.9
	25	85	126	99.0	0.9	2.8	302	126	130.0	14.3	44.0
ities)	640	409	455	92.0	21.5	66.0	1,092	455	130.0	51.8	159.0
	1,889	2,111	2,798	75.0	51.7	158.7	8,393	3,497	120.0	367.6	1,128.2
	700	461	708	84.0	21.5	66.0	2,378	991	120.0	104.2	319.7
	1,002	1,199	1,667	90.0	32.9	101.0	5,002	2,084	150.0	273.8	840.4
ties)	80	171	228	195.0	5.7	17.5	547	228	200.0	39.9	122.6
	240	231	351	82.0	7.2	22.1	842	351	150.0	46.1	141.6
Vater	60	49	60	200.0	4.4	13.5	168	70	200.0	12.3	37.6
	30	65	65	137.0	1.5	4.6	156	65	150.0	8.5	26.2

180 GPDPC

Table 6. Mogollon Rim Water Resources Management – Population and Water Demands – 2002 & 2040									
	2002						204		
Location	Population	Developed Parcels	Total Parcels	Gallons per Capita Per Day	Million Gallons per Year	Acre-Feet per Year	Population	Total Parcels (Developed)	Gallons Capita I Day
Tonto Village	350	303	353	68.0	8.8	27.0	847	353	1
Sub-total	**5,271**				**165.1**	**506.7**	**21,133**		
Total	**21,321**				**846.2**	**2,597.1**	**73,105**		

[1] Uses a combination of surface and ground water.
[2] Oxbow Estates present population density exceeds the assumed future density of 2.4; therefore, the future population is based on an assumed density
[3] Population for seasonal camps represents a full time equivalent.

5

Brooke Utilities, Inc.

P. O. Box 82218 • Bakersfield, California 93380-2218
Customer Call Center • P.O. Box 9005 • San Dimas, California 91773-9016 • (800) 270-6084

June 28, 2005

Re: **Pine-Strawberry Water Supply Alternatives**

Dear Customer,

The chronic water supply problem in the Pine-Strawberry area has existed for decades. There are numerous opinions as to the reasons for these problems. There are even more opinions, some supported by contracted water studies conducted since the 1960's, as to possible solutions to the problem. Unfortunately, after all this debate and discussion no new long-term source of water has been identified for the area.

The seriousness of this problem continues to receive a lot of attention and analysis from local officials, State water authorities, scientists, hydrologists, and politicians. Generally, Pine is regarded by the Arizona Corporation Commission as the most serious water supply deficiency problem in the State of Arizona. It is easy to understand why people become frustrated, suspicious, and impatient for a solution. The problem may appear easy to solve. However, it should be evident that, since the numerous agencies and parties studying this problem for a long time have not been successful in finding a new long-term source of water, the problem is more difficult to solve than it appears. Part of the reason for this difficulty is the cost of a solution. We at Brooke continue to maintain that a water supply solution for Pine-Strawberry that is unaffordable by its customers is no solution at all!

New approaches to this problem are being discussed and considered. New sources of water may be available. Prior proposals are getting re-consideration and review. Technology is advancing and playing a role as well. Maybe a solution is possible. But how much will it cost? We believe it is time for customers to respond. We want your opinions regarding these issues.

On the reverse side of this letter you will find a Customer Survey for all customers of Pine Water Co. and Strawberry Water Co. This is a **VERY** important issue and we ask just a few minutes of your time to respond. Please take this opportunity and provide your responses to the questions in the self addressed envelope and return to our offices not later than July 18, 2005. The results of the Customer Survey will be published soon thereafter.

Thank you for your help!

Sincerely,

Robert T. Hardcastle
President

Survey: Customers of Pine Water Co. and Strawberry Water Co.

July 2005

(1) There has been a lengthy community debate as to the existence and severity of the water supply deficiency in the Pine-Strawberry area. In your opinion, does a water supply shortage in Pine or Strawberry actually exist?

In Pine:	☐	Yes	In Strawberry:	☐	Yes
	☐	No		☐	No

(2) Are you a full-time or part-time resident of the Pine-Strawberry area?

- ☐ Full-time resident
- ☐ Part-time resident

(3) If you believe a water supply deficiency exists in the Pine-Strawberry area, to what extent has the problem affected the lifestyle of you and your family?

- ☐ Not at all
- ☐ Minor and occasional inconvenience
- ☐ Modestly
- ☐ Severely

(4) If you believe a water supply deficiency exists in the Pine-Strawberry area, do you expect that any long-term solution to the problem will increase the cost of water in the future?

- ☐ Yes
- ☐ No

(5) There has long been discussion of the water problems in the Pine-Strawberry area as well as water studies, community debate, and proposals for solving any water supply deficiency that may exist. Currently, some new ideas are being considered by different groups studying this problem that might have future application. All of the currently considered alternatives suggest that water will be more costly in the future. In that regard, how much *additional* monthly cost are you willing to pay over the next ten or twenty years for a long-term water supply solution?

- ☐ Nothing
- ☐ approximately $10 per month
- ☐ approximately $20 per month
- ☐ approximately $30 per month
- ☐ more than $30 per month
- ☐ more than $50 per month or as much as required to solve the problem

(6) The water supply problem in the Pine-Strawberry area primarily occurs between Memorial Day and Labor Day each year. In light of the capital expense and higher monthly customer cost required for a long-term water supply solution, should water hauling be considered a viable alternative water supply solution paid for by customers on a "pay as you use" basis?

- ☐ Yes
- ☐ No

6

Pine-Strawberry Customer Aggregate Survey Results

Jul-05

Population: 3012

Question		Pine Water		Strawberry Water		Aggregate	
	Number of Respondents	687		631		1338	44.42%
1A	**Water Supply Shortage in Pine?**						
	Yes	597	86.90%	476	75.44%	1,088	81.32%
	No	50	7.28%	51	8.08%	106	7.92%
	Left Blank	33	4.80%	75	11.89%	108	8.07%
	Other Answer provided	7	1.17%	29	6.09%	36	2.69%
	Total	687		631		1,338	100.00%
1B	**Water Supply Shortage in Strawberry?**						
	Yes	188	27.37%	199	31.54%	396	29.60%
	No	201	29.26%	296	46.91%	504	37.67%
	Left Blank	293	42.65%	124	19.65%	421	31.46%
	Other Answer provided	5	0.73%	12	1.90%	17	1.27%
	Total	687		631		1338	100.00%
2	**Full or Part Time Resident?**						
	Full	270	39.30%	222	35.18%	503	37.59%
	Part	416	60.55%	404	64.03%	829	61.96%
	Blank	1		5		6	0.45%
	Total	687		631		1338	100.00%
3	**To What Extent Are You Affected?**						
	Not at all	76	11.06%	186	29.48%	267	19.96%
	Minor & occasional inconv.	324	47.16%	282	44.69%	611	45.67%
	Modestly	219	31.88%	97	15.37%	322	24.07%
	Severely	54	7.86%	35	5.55%	91	6.80%
	Blank	14	2.04%	31	4.91%	47	3.51%
	Total	687		631		1338	100.00%
4	**Do You Expect Long-Term Solution Will Increase Cost?**						
	Yes	568	82.68%	500	79.24%	1,083	80.94%
	No	82	11.94%	64	10.14%	149	11.14%
	Blank	30	4.37%	50	7.92%	82	6.13%
	Other Answer provided	7	1.02%	17	2.69%	24	1.79%
	Total	687		631		1338	100.00%
5	**How Much Are You Willing To Pay For A Solution?**						
	Nothing	150	21.83%	166	26.31%	321	23.99%
	$10	307	44.69%	264	41.84%	579	43.27%
	$20	97	14.12%	92	14.58%	192	14.35%
	$30	37	5.39%	22	3.49%	59	4.41%
	More then $30	15	2.18%	10	1.58%	25	1.87%
	More then 50 or as much	32	4.66%	24	3.80%	58	4.33%
	Blank	32	4.66%	40	6.34%	74	5.53%
	Filled in Amount	15		6	0.95%	21	3.06%
	$5.00	1	0.15%	2	0.32%	3	0.44%
	2%-4% of bill	1	0.15%	1	0.16%	2	0.15%
	5% of bill			3		3	0.22%
	10% of bill			1		1	0.07%
	Total	687		631		1338	101.70%
6	**Should Water Hauling Be Considered A Viable Alternative?**						
	Yes	335	48.76%	310	49.13%	650	48.58%
	No	308	44.83%	272	43.11%	594	44.39%
	Blank	29	4.22%	31	4.91%	61	4.56%
	Other Answer provided	15	2.18%	18	2.85%	33	2.47%
	Total	687		631		1338	100.00%

7

Hydrogeology of the Mogollon Highlands, Central Arizona

Scientific Investigations Report 2004–5294

U.S. Department of the Interior
U.S. Geological Survey

USGS

Hydrogeology of the Mogollon Highlands, Central Arizona

By John T.C. Parker, William C. Steinkampf, *and* Marilyn E. Flynn

Prepared in cooperation with the
ARIZONA DEPARTMENT OF WATER RESOURCES

Scientific Investigations Report 2004–5294

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U.S. Geological Survey

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Gale A. Norton, Secretary

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Conversion Factors and Datum

Multiply	By	To obtain
	Length	
inch (in.)	2.54	centimeter (cm)
inch (in.)	25.4	millimeter (mm)
foot (ft)	0.3048	meter (m)
mile (mi)	1.609	kilometer (km)
	Area	
acre	4,047	square meter (m^2)
acre	0.004047	square kilometer (km^2)
square foot (ft^2)	0.09290	square meter (m^2)
square mile (mi^2)	2.590	square kilometer (km^2)
	Volume	
gallon (gal)	3.785	liter (L)
gallon (gal)	0.003785	cubic meter (m^3)
cubic foot (ft^3)	0.02832	cubic meter (m^3)
acre-foot (acre-ft)	1,233	cubic meter (m^3)
	Flow rate	
acre-foot per year (acre-ft/yr)	1,233	cubic meter per year (m^3/yr)
cubic foot per second (ft^3/s)	0.02832	cubic meter per second (m^3/s)
gallon per minute (gal/min)	0.06309	liter per second (L/s)
	Specific capacity	
gallon per minute per foot [(gal/min)/ft)]	0.2070	liter per second per meter [(L/s/m]
	Transmissivity*	
foot squared per day (ft^2/d)	0.09290	meter squared per day (m^2/d)

Temperature in degrees Fahrenheit (°F) may be converted to degrees Celsius (°C) as follows:

$$°C = (°F - 32) / 1.8$$

Vertical coordinate information is referenced to the National Geodetic Vertical Datum of 1929 (NGVD 29).

Horizontal coordinate information is referenced to the North American Datum of 1927 (NAD 27).

Altitude, as used in this report, refers to distance above the vertical datum.

*Transmissivity: The standard unit for transmissivity is cubic foot per day per square foot times foot of aquifer thickness [(ft^3/d)/ft^2]ft. In this report, the mathematically reduced form, foot squared per day (ft^2/d), is used for convenience.

Specific conductance is given in microsiemens per centimeter at 25 degrees Celsius (µS/cm at 25°C).

Concentrations of chemical constituents in water are given either in milligrams per liter (mg/L) or micrograms per liter (µg/L).

Hydrogeology of the Mogollon Highlands, Central Arizona

By John T.C. Parker, William C. Steinkampf, *and* Marilyn E. Flynn

Abstract

The Mogollon Highlands, 4,855 square miles of rugged, mountainous terrain at the southern edge of the Colorado Plateau in central Arizona, is characterized by a bedrock-dominated hydrologic system that results in an incompletely integrated regional ground-water system, flashy streamflow, and various local water-bearing zones that are sensitive to drought. Increased demand on the water resources of the area as a result of recreational activities and population growth have made necessary an increased understanding of the hydrogeology of the region. The U.S. Geological Survey conducted a study of the geology and hydrology of the region in cooperation with the Arizona Department of Water Resources under the auspices of the Arizona Rural Watershed Initiative, a program launched in 1998 to assist rural areas in dealing with water-resources issues. The study involved the analysis of geologic maps, surface-water and ground-water flow, and water and rock chemical data and spatial relationships to characterize the hydrogeologic framework.

The study area includes the southwestern corner of the Colorado Plateau and the Mogollon Rim, which is the eroded edge of the plateau. A 3,000- to 4,000-foot sequence of early to late Paleozoic sedimentary rocks forms the generally south-facing scarp of the Mogollon Rim. The area adjacent to the edge of the Mogollon Rim is an erosional landscape of rolling, step-like terrain exposing Proterozoic metamorphic and granitic rocks. Farther south, the Sierra Ancha and Mazatzal Mountain ranges, which are composed of various Proterozoic rocks, flank an alluvial basin filled with late Cenozoic sediments and volcanic flows. Eight streams with perennial to intermittent to ephemeral flow drain upland regions of the Mogollon Rim and flow into the Salt River on the southern boundary or the Verde River on the western boundary. Ground-water flow paths generally are controlled by large-scale fracture systems or by karst features in carbonate rocks. Stream channels are also largely controlled by structural features, such as regional joint or fault systems. Precipitation, which shows considerable variability in amount and intensity, recharges the ground-water system along the crest of the Mogollon Rim and to a lesser extent along the crests and flanks of the rim and the Mazatzal Mountains and Sierra Ancha. Flashy runoff in the mainly bedrock stream channels is typical. Springs are distributed throughout the region, typically discharging at or above the contact of variably permeable formations along the face of the Mogollon Rim with a scattering of low-discharge springs in the Proterozoic rocks below the rim.

The surface of the Colorado Plateau is the primary recharge area for the C aquifer in which ground-water flows north toward the Little Colorado River and south toward the Mogollon Highlands. Within the study area, flow from the C aquifer primarily discharges from large, stable springs in the upper East Verde River, Tonto Creek, and Canyon Creek Basins along the top of the Mogollon Rim and to the west as base flow in West Clear Creek. On the basis of chemical evidence and the distribution and flow characteristics of springs and perennial streams, the C aquifer is also the source of water for the limestone aquifer that discharges from carbonate rocks near the base of the Mogollon Rim. Vertical flow from the C aquifer, the base of which is in the Schnebly Hill Formation, recharges the limestone aquifer that discharges mainly at Fossil Springs in the western part of the study area and as base flow in Cibecue Creek on the eastern edge of the study area.

Local, generally shallow aquifers of variable productivity occur in plateau and mesa-capping basalts in the sedimentary rocks of the Schnebly Hill and Supai Formations, in fractured zones of the Proterozoic Payson granite, and in the alluvium of the lower Tonto Creek Basin. Where time series data exist, such water-bearing zones are shown to be sensitive to short-term climatic fluctuations, in particular, the drought which began in the mid-1990s and continued during the course of this study.

A regional water budget for the C and limestone aquifers was developed from precipitation, spring, and streamflow data. Of an estimated 1,730,000 acre-feet of precipitation that falls on the Mogollon Rim annually, about 8 percent is estimated to recharge the regional aquifers. About 40 percent of recharge to the limestone aquifer is estimated to be leakage from the overlying C aquifer.

Introduction

The Mogollon Highlands of east central Arizona is a region of forested plateau and mountains, deep, sheer-walled canyons, and desert valleys. Known for its scenic beauty and characterized by a generally mild climate, the area, though still sparsely populated, attracts an increasing number of tourists and summer residents. Furthermore, the permanent population is expected to nearly double during the next 50 years. Consequently, there is increased pressure on the water resources of this area for a number of sometimes conflicting uses. Rational management of water resources is necessary to meet increased domestic requirements while ensuring an adequate supply of water for commercial and agricultural use, for Indian lands, and for preservation of valued environmental elements, including surface waters, riparian woodlands, forest and grassland areas, and wildlife and aquatic habitat. Such management requires an understanding of the relations between different components of the hydrologic system—recharge areas, surface flows, shallow aquifers, deep aquifers, discharge areas, and the regional ground-water flow system—and how each is affected by geology, climate, topography, and human use.

Purpose and Scope

This report presents the findings of an investigation into the hydrogeology of the Mogollon Highlands (fig. 1) conducted by the U.S. Geological Survey (USGS) in cooperation with the Arizona Department of Water Resources (ADWR) under the auspices of the State of Arizona Rural Watershed Initiative (RWI). The study is one of three conducted by the USGS in a contiguous area covering about 17,000 mi^2 in central and northern Arizona (fig. 2). The purpose of the RWI is to provide assistance to rural Arizona communities in defining and solving local water resources issues. The purpose of the USGS studies is to increase understanding of the ground-water flow systems in the Mogollon Highlands, the middle and upper Verde River watersheds, and the Coconino Plateau and in particular to assess the extent and availability of water resources, define ground-water flow paths and the relations among different sources of ground water, define the relations between surface-water flow and ground water, and assess the effects of continued development on the water resources of the areas.

The basic objectives of this study are to:

1. Develop an understanding of the hydrogeologic framework, which is the relation between geologic units and hydrologic properties.
2. Define the relations among the different components of the hydrologic system, namely the interactions among climate, water use, and surface-water and ground-water systems.
3. Synthesize the findings into a conceptual model that can be used for water-resources management purposes and will support the development of an interpretive numerical model to examine the effects of climate and water use on the sustainability of regional water resources.

The scope of work included collection, compilation, and analyses of existing hydrologic, chemical, and geologic data to describe the spatial and temporal behavior of the hydrologic system. For the most part, the study considers the hydrological system beginning in the mid-20th century during a period of considerable water-resources development and through two periods of extreme drought. Additional data collected during the course of the study included spring-discharge measurements and water-chemistry analyses for purposes of delineating the ground-water flow paths in both regional and local aquifers. The report presents these findings and uses them to present a conceptual model of the hydrologic system and a water budget for the regional aquifers of the study area.

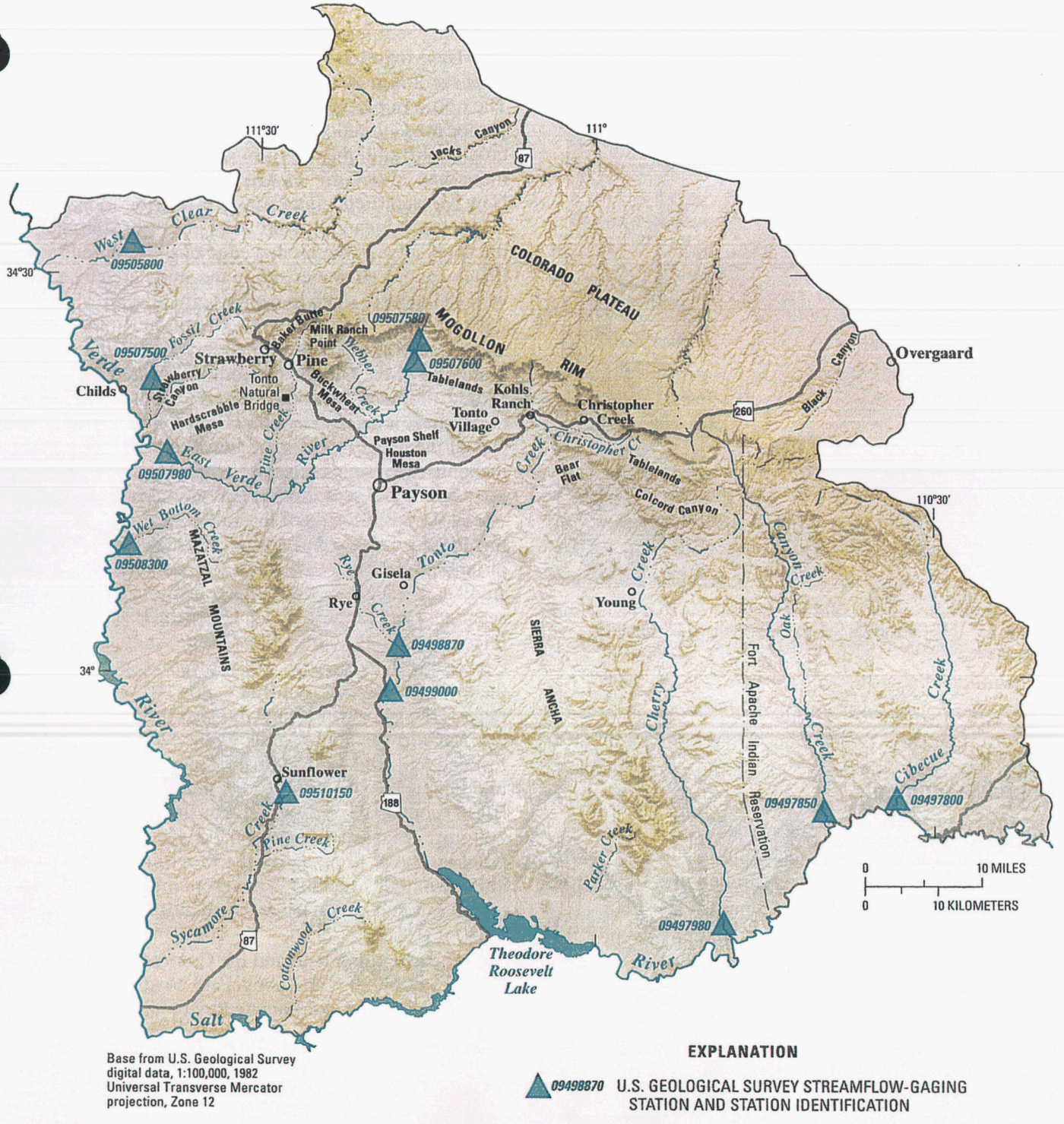


Figure 1. Study area and U.S. Geological Survey streamflow-gaging stations in the Mogollon Highlands, central Arizona.

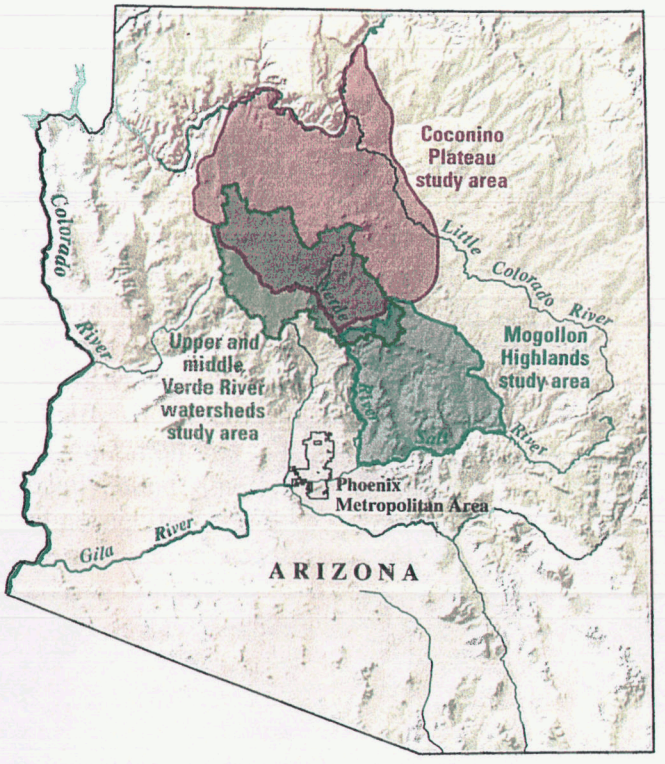


Figure 2. U.S. Geological Survey Rural Watershed Initiative study areas.

Acknowledgments

The Pine-Strawberry Water Improvement District provided supplemental funding through the ADWR for this project; the Northern Gila County Water Plan Alliance provided technical and community support for the project; Robert Sejkora, Arizona State Parks, provided data on spring flow at Tonto Natural Bridge State Park; Kevin Bright, Arizona Game and Fish Department provided data on spring flow at the Tonto Creek and Canyon Creek fish hatcheries; Grant Loomis, U.S. Department of Agriculture (USDA) Forest Service, Tonto National Forest, provided data on discharge measurements at Fossil Creek and Tonto Creek; Michael Ploughe, town of Payson and Arizona Hydrologic Sources, provided data on wells in the Payson area and for a well in the community of Pine; Dr. Donald Burt, Arizona State University, provided an overview of the geology of the study area; several property owners granted access to springs for water sampling and discharge measurements.

Description of the Study Area

The Mogollon Highlands, as defined in this study, consists of four distinct physiographic regions (fig. 1). The northern part of the study area is the southernmost part of the Colorado Plateau, a region formed by the broad uplift of lightly deformed rocks that covers more than 75,000 mi^2 of Arizona, Utah, Colorado, and New Mexico (Fenneman, 1931). The Mogollon Rim, which trends generally northwest-southeast through the study area, is the eroded edge of the Colorado Plateau and is characterized in the study area by a well-delineated, steep to nearly vertical scarp about 2,000 ft high. The crest of the Mogollon Rim is the narrow strip of land above the scarp separating the drainages of the Gila River from the drainage of the Little Colorado River that are well to the south and north of the study area, respectively (fig. 2). Below the steepest part of the Mogollon Rim, referred to here as the face, the landscape is characterized by tablelands generally bounded by the scarps of large regional faults (fig. 1). Along the eastern side of the study area, the tablelands form a broad, rugged plateau that flanks the eastern side of the Sierra Ancha to the Salt River. To the south, the study area mainly is within the transitional zone that separates the Colorado Plateau from the Basin and Range Physiographic Province. Most of the study area is characterized by rugged, rocky terrain, especially on the face of the Mogollon Rim and in the two mountain ranges, the Mazatzal Mountains and the Sierra Ancha that flank lower Tonto Creek on the west and east, respectively (fig. 1). The lower Tonto Basin and the middle reaches of Cherry Creek near the town of Young (fig. 1) contain the only significant area of alluvial valley bottoms. Total relief is about 6,700 feet with the highest point on Baker Butte above the Mogollon Rim at an altitude of 8,077 ft, and the lowest point at the confluence of the Salt and Verde Rivers at an altitude of about 1,330 ft (fig. 1).

The Mogollon Rim and the Colorado Plateau, at altitudes of 6,000 ft and above, are covered mainly with a conifer forest dominated by ponderosa pine. Smaller stands of ponderosa pine forest occupy the higher ridges and peaks south of the Mogollon Rim. Piñon pine and juniper woodlands dominate the tablelands and the northern slopes of the Mazatzal Mountains and much of the northern part of the Sierra Ancha. The ponderosa and piñon-juniper forests cover almost 60 percent of the study area. A severe infestation of pine-bark beetle beginning in 2002 has resulted in high mortality of ponderosa and piñon pine throughout much of north-central Arizona. Some stands of ponderosa pine have suffered as much as 80 to 90 percent mortality during the outbreak that has been blamed on severe drought and overcrowding of trees. In April 2002, nearly 50 percent of the ponderosa pine forest in Tonto National

Forest was affected by the infestation, and the winter of 2003 was considered favorable for continued spread of the infestation (DeGomez, 2002, 2003). Most other hillslopes are covered with interior chaparral vegetation consisting of woody shrubs and oak species. Desert grasslands occupy the valley floors above about 3,000 ft, and upland Sonoran desert vegetation dominates below that altitude. From June 18 to July 7, 2002, the largest fire to date in Arizona history burned 467,066 acres of forest and brushland in the east-central part of the State, including much of the Cibecue Creek watershed along the eastern edge of the study area (U.S. Department of Agriculture, Forest Service, 2003).

Population of the study area is approximately 24,400, of which almost 60 percent is in the town of Payson (fig. 1; U.S. Census Bureau, 2000). According to the Arizona State Land Department, about 80 percent of the land is owned by the Federal Government, primarily within the Tonto National Forest, and about 15 percent of the land is included within five Indian reservations. Only 2.4 percent of the land within the study area is privately owned. Water use is almost entirely municipal and domestic, and virtually all water comes from ground-water sources. Annual ground-water withdrawals by the town of Payson, which is the largest consumer of water in the area, increased at an average rate of about 8 percent a year from 268 acre-ft in 1975 to about 1,706 acre-ft in 2000 (fig. 3; Ploughe, 2001). Water-use figures for the rest of the study area have not been as diligently reported, but in 1997, the most recent year for which generally complete data are available, 17 water companies reported a combined annual water use of 670 acre-ft (Arizona Corporation Commission, written commun., 2000).

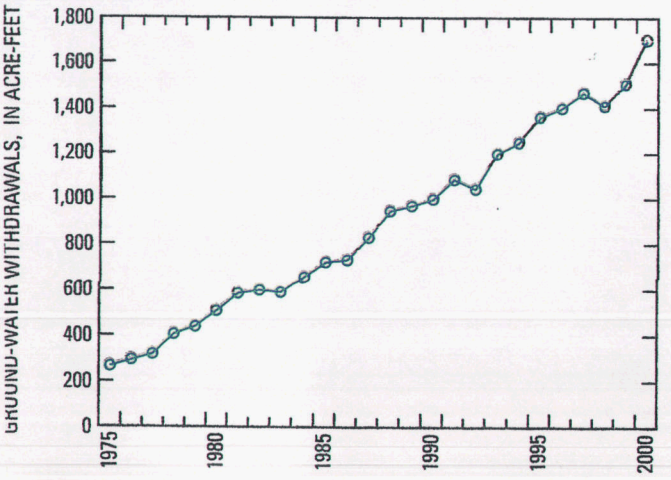


Figure 3. Annual ground-water withdrawals by the town of Payson, Arizona (Ploughe, 2001).

Previous Investigations

Feth and Hem (1963) conducted the first detailed hydrogeologic investigation with an inventory of springs and a general description of the geology of upland areas of north-central Arizona that included the Mogollon Highlands. In many cases, spring-discharge data reported in that study are the only such data available for the study area. The report also described likely recharge paths from the crest of the Mogollon Rim to the underlying water-bearing rocks. Ross (1977) published the first description of ground-water conditions in the Mogollon Highlands area based on well data, primarily in the Payson and Pine-Strawberry areas. Denis (1981) conducted a more comprehensive survey of ground-water conditions throughout the Tonto Basin using well data. Hart and others (2002) conducted a regional study of the C aquifer that overlapped somewhat with the study area of this investigation. They produced a potentiometric map of the C aquifer along the crest of the Mogollon Rim that indicates possible flow paths into the ground-water system of the Mogollon Highlands study area.

Water-resources issues have provided the impetus for several recent studies for the town of Payson, including Southwest Ground-water Consultants, Inc. (1998), Ploughe (2000, 2001), and Gæorama, Inc. (2001, 2003). Southwest Ground-water Consultants, Inc. (1998) projected future water needs for the town of Payson and estimated the extent of water resources developed at the time of the study. Southwest Ground-water Consultants, Inc. also described the relation of structural features within the Payson granite (fig. 4) to the ground-water system and presented detailed mapping of faults and lineaments. Ploughe (2000, 2001) described results of exploratory well-drilling and monitoring of wells in granitic rocks north of Payson. Gæorama, Inc. (2001, 2003) presented the results of detailed mapping of the Diamond Rim Fault system (fig. 4) east of Payson and reported on hydrogeologic characteristics of the Payson granite and related rocks from which Payson draws its water. Similar studies were conducted east of Payson by AGRA Earth and Environmental, Inc. (1999) for the Arizona Department of Transportation, which was seeking to secure a water supply for the major upgrading of State Route 260 east of Payson (fig. 1).

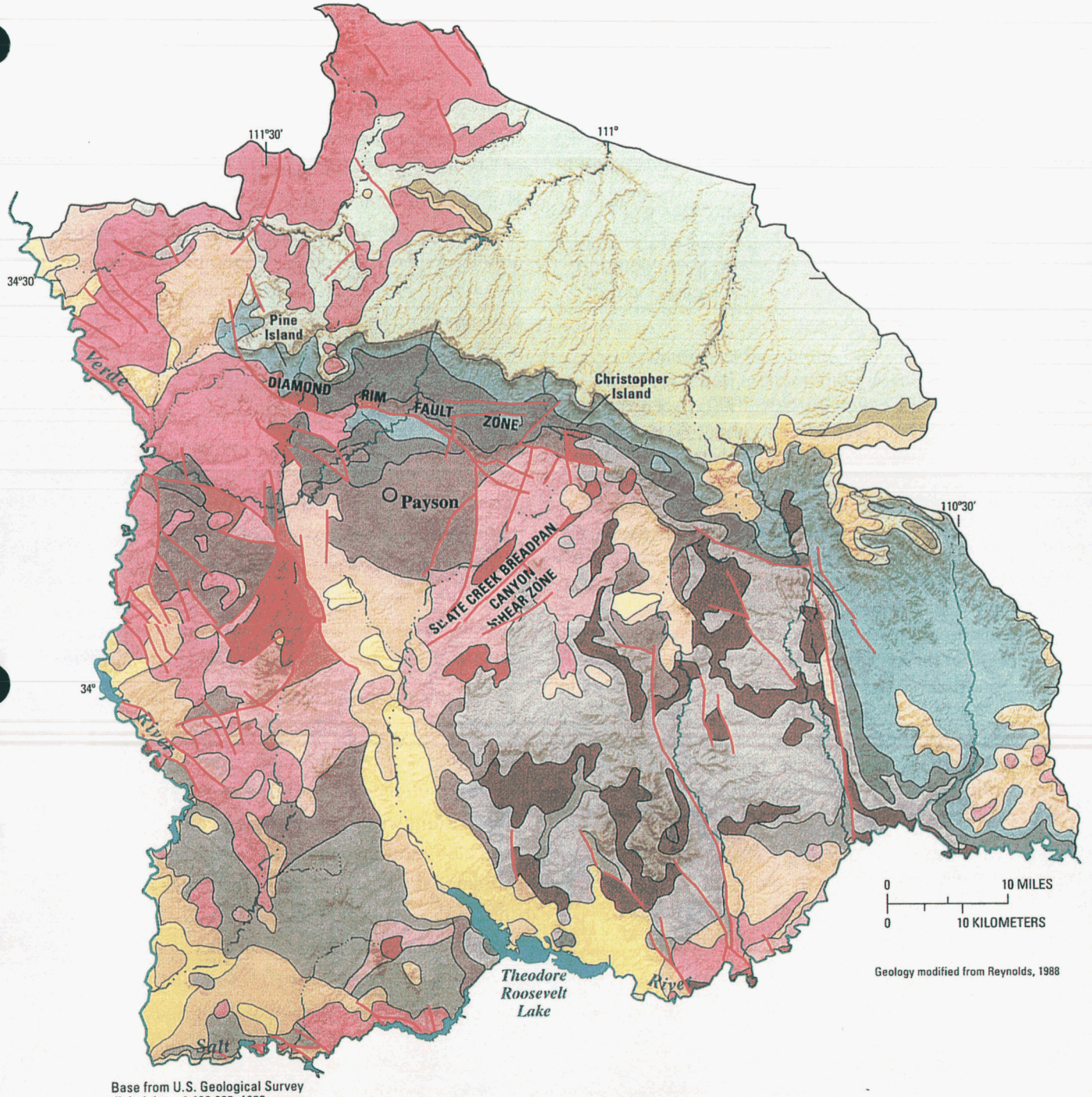


Figure 4. Geology and geologic structure of the Mogollon Highlands, central Arizona.

Figure 4. Continued.

In the Pine-Strawberry area (fig. 1), Weitzman (2002) surveyed the geology and hydrology south of the Mogollon Rim between Strawberry and the headwaters of the East Verde River north of Payson. His work included the detailed geologic mapping of the Buckhead Mesa and upper East Verde River area, and he plotted ground-water flow paths along Pine Creek and the East Verde River (fig. 1). Kaczmarek (2003) investigated the hydrogeology of the Pine-Strawberry area and concluded that prolonged pumping of wells that tap the Schnebly Hill Formation and the Supai Formation (fig. 4) results in decreased yields over time. Wells in the Strawberry area that draw water from the Schnebly Hill Formation were found to be somewhat more reliable than those in the Pine area that draw water from the Supai Formation because the porosity of the Schnebly Hill Formation allows for some storage of water within those rocks. In the Supai Formation, Kaczmarek (2003) found, water is produced entirely from fractures, and there is no significant storage in the essentially impermeable rocks. He concluded that neither formation is an adequate resource to meet current and future water demands in the area. Using the few available borehole data and the analysis of discharge from Fossil Springs, Kaczmarek concluded that the limestone aquifer, consisting of the Martin Formation, Redwall Limestone, and possibly the Naco Formation (fig. 4), may provide a dependable source of water at a depth of more than 1,500 ft below the land surface in Strawberry.

Geology

The significant geologic components of the Mogollon Highlands (fig. 4) are (1) the Paleozoic sedimentary rocks of the Colorado Plateau that are exposed like the edge of a card deck on the face of the Mogollon Rim; (2) Proterozoic metamorphic and granitic rocks that underlie the Paleozoic sedimentary rocks and form the rolling, step-like terrain south of the Mogollon Rim; (3) Proterozoic metamorphic, sedimentary, and volcanic rocks that form the Sierra Ancha and Mazatzal Mountain ranges; (4) a system of generally northwest-southeast trending faults associated with Basin and Range extensional deformation; and (5) late Cenozoic volcanic rocks that overlie the Paleozoic section in the north-eastern part of the study area, and late Cenozoic volcanic and basin-fill sediments primarily in the lower Tonto Creek Basin.

Geologic History

Proterozoic rocks record a period of volcanism, sedimentation, and deformation that concluded about 1.7 billion years ago (Karlstrom and others, 1987; Conway and Silver, 1989). Subsequently, the Proterozoic rocks constituted the surface of several positive areas in what is now eastern Arizona that affected deposition patterns throughout the Paleozoic Era. The main area of positive relief was in the region of the Defiance Uplift, a structural feature formed during the Laramide deformational episode in the Cretaceous Period about 150 mi northeast of the study area. Pine Ridge is a buried extension of that uplift that extends beneath the Mogollon Rim with an arm extending south toward Pine and another arm extending south toward Christopher Creek (fig. 1; Teichert, 1965). Although relief generally was low on this positive area, it at times formed a barrier to transgressing seas during the time that the lower Paleozoic sedimentary rocks of the study area were being deposited. Consequently, such units in the Mogollon Highlands are often thinner and less continuous than their equivalents in Grand Canyon and elsewhere on the Colorado Plateau and southeastern Arizona. Two islands delineated by outcrops of Mazatzal Group quartzite near Pine and Christopher Creek (fig. 4) stood above base level throughout the early Paleozoic Era, truncating deposition until they were buried by sediments in the Mississippian Period or Early Pennsylvanian Epoch (Teichert, 1965; McKee and Gutschick, 1969).

The first Paleozoic deposition was a layer of sandstone that was deposited in a braided stream environment at the edge of the North American craton. Teichert (1965) called this unit the "basal sandstone" and considered it Devonian in age, but Hereford (1977) found the unit to be lithologically similar to the Tapeats Sandstone of Cambrian age. which immediately overlies Proterozoic rocks in the upper Verde River Basin and Grand Canyon. Assuming the Cambrian designation is correct, the Mogollon Highlands then underwent a long period of erosion, nondeposition, or both, producing a stratigraphic unconformity representing at least 80 million years.

Shallow marine conditions prevailed during the Devonian and Mississippian Periods when the carbonate rocks of the Martin Formation and Redwall Limestone were deposited. Deposition of both units was truncated against the quartzite cliffs of the Pine and Christopher Creek islands. A long period of surface exposure in the Late Mississippian Epoch led to the development of a karst topography that includes extensive caves and sinkholes throughout central Arizona; karst features are particularly extensive and well developed in the study area, presumably reflecting the greater duration of exposure in the Mogollon Highlands than occurred over more negative areas of the State. The period of surface exposure was followed by renewed shallow marine conditions in the Early Pennsylvanian Epoch with deposition of the mainly carbonate rocks of the Naco Formation (Brew, 1965). The gradual transition from Naco Formation carbonate rocks to overlying siltstones and sandstones records the fluctuating position of the coastline in Late Pennsylvanian time. Increasingly terrestrial conditions prevailed during the deposition of the Supai Formation in the Late Pennsylvanian and Early Permian Epochs. Fluvial sediments were laid down in coastal marshes and flood plains to produce the red siltstones and sandstones that characterize most of the formation. In the middle Permian Period, mudstones, evaporites, and carbonates were deposited in the Holbrook Basin to form the Schnebly Hill Formation, which includes the carbonate Fort Apache Member in the middle of the depositional sequence (Blakey, 1990).

The record of Paleozoic deposition within the study area concluded with another period of shallow marine conditions and deposition of the Kaibab Formation (Hopkins, 1990); the subsequent Mesozoic history is missing because of erosion. According to Bilodeau (1986), the Mogollon Rim area was the site of a surface of gentle relief he termed the Mogollon Slope, across which volcanic ash and fluvial sediments were transported to the northeast from a volcanic arc terrane in southern Arizona and Mexico.

The next episode in the formation of the present-day geologic setting of the Mogollon Highlands was the uplift of the Colorado Plateau, possibly in late Cretaceous time during the period of Laramide deformation (Bilodeau, 1986). Formation of the Mogollon Rim was a result of Basin and Range extensional tectonics along the southern margins of the plateau and the subsequent cliff erosion parallel to major faults (Mayer, 1979). The last major geologic event in the region was a period of volcanism in middle Miocene times that saw mainly basaltic lava flows over the crest of the Mogollon Rim at the western edge of the study area and into Fossil Creek canyon. Lava deposition also occurred in the Mazatzal Mountains along the edges of the Tonto Creek valley in the lower basin.

Description of Geologic Units

Geologic mapping of the study area has not been as detailed relative to other parts of Arizona until recently, in part because of the absence of significant mineral resources. Most of the study area falls within Gila County for which geologic mapping was done by Wilson and others (1959) and State-level mapping was done by Reynolds (1988). Geologic mapping was done for the Strawberry and Pine 7.5-minute quadrangles northwest of Payson by Weir and Beard (1997) and Weisman and Weir (1990), respectively. Detailed stratigraphic studies of rocks that occur in the study area, particularly the Paleozoic sedimentary rocks, have been conducted by Brew (1965), Teichert (1965), McKee and Gutschick (1969), Hereford (1977), and Blakey (1990). Proterozoic rocks and associated structure have been extensively mapped by Conway (1976), Karlstrom and others (1987), Conway and Silver (1989), Cox and others (2002), and Gæorama, Inc. (2003). The geologic units described here have been generalized from those mapped by Reynolds (1988).

Cenozoic Rocks

Tertiary volcanic rocks cover much of the western Mogollon Rim as far east as Milk Ranch Point where Baker Butte (fig. 1), the highest point in the study area, stands above basalt flows (fig. 4). Lava flows fill the canyon west of Fossil Creek to a thickness of more than 3,000 ft (Twentner, 1962) and spill onto Hardscrabble Mesa to the south where flows are nearly 2,000 ft thick. In addition to basalt flows, volcanics in the region include tuff, agglomerates, cinders and interspersed fluvial deposits (Weisman, 1984). Potassium-argon dating of the basalt from the top of Baker Butte yielded an age of 11.4 ± 0.27 million years and from the base of the top flow layer on the southern end of Milk Ranch Point yielded an age of 14.23 ± 0.74 million years (Peirce and others, 1979). Stratigraphic relations show that the Mogollon Rim pre-dates all the basalt flows in the area although abundant basalt float on slopes beneath Milk Ranch Point is testament to some degree of cliff retreat since emplacement of the basalt flows.

The Tonto Creek Basin below Payson is the site of the most significant basin-fill deposits in the study area (figs. 1 and 4). Tertiary and Quaternary colluvial, alluvial-fan, stream-terrace, pediment-terrace, and fluvial deposits interlayered with basalt flows fill the basin to depths of 1,000 to 3,500 ft (Richards, 1987; Mayes, 1990). Mesa-capping gravels and sedimentary rocks of Oligocene to Miocene age that are both preceded and followed by Basin and Range faulting are exposed mainly along the western and southern boundaries of the study area (Reynolds, 1988) and are not differentiated here from other late Cenozoic sedimentary units.

Upper Paleozoic Rocks

Middle to Late Permian age rocks form the cap of the Mogollon Rim except where buried by younger volcanic rocks (fig. 4). The Permian Coconino Sandstone is a clean, aeolian sandstone that forms a nearly vertical escarpment at the top of the Mogollon Rim (Blakey, 1990). The unit varies greatly in thickness; it is an erosional veneer on top of Milk Ranch Point but attains a maximum thickness of nearly 1,200 ft above the headwaters of the East Verde River (Reynolds, 1988). The fine- to medium-grained sandstone is extensively crossbedded, is heavily fractured, and is in gradational contact with the underlying Schnebly Hill formation (Blakey, 1990).

The Permian Kaibab Formation is a fossiliferous limestone containing chert nodules and interbeds of layered chert, shale, and poorly cemented sandstone reflecting the near-shore depositional environment of the unit in the study area (Weisman, 1984; Hopkins, 1990). A measured section of the Kaibab Formation on the Mogollon Rim above Strawberry Canyon (fig. 4) showed a thickness of about 300 ft lying unconformably over the Coconino Sandstone (Weisman, 1984).

Middle Paleozoic Rocks

Rocks of Pennsylvanian to Early Permian age form the middle slopes of the Mogollon Rim from Fossil Creek, where they are buried beneath younger volcanic flows, southeast to the Salt River (fig. 4). The Pennsylvanian age Naco Formation unconformably overlies the Redwall Limestone with a basal red shale composed of reworked residuum that fills the underlying, uneven karst surface (Brew, 1965). The contact generally is hidden beneath slopes of colluvium. All stratigraphic and lithologic descriptions of the Naco Formation that follow are from Brew (1965) and from observations made during this study. Above the shale, the Naco Formation consists mainly of discontinuous, ledge-forming, light gray nodular limestones in tabular beds from less than 1 ft thick to 10 ft thick and more, alternating with layers of purple to red siltstone and shale. Orange chert is locally

present in the limestone, and some units are highly fossiliferous. Measured sections show thicknesses of more than 400 ft at Fossil Creek and north of the East Verde River; measured sections along Tonto Creek show a thickness of about 114 ft north of Highway 260, and a thickness of nearly 240 ft near Kohls Ranch (figs. 1 and 4). The Naco Formation thickens to more than 1,000 ft east of the study area on the Fort Apache Indian Reservation.

According to Blakey (1990), the suite of reddish to yellow sandstones, siltstones, and shales that constitute the lower half of the Mogollon Rim escarpment are here separated into the lower and upper parts of the Supai Formation and the overlying Schnebly Hill Formation. The Supai Formation's contact with the underlying Naco Formation is transitional, and placement of that contact is within a complex 100- to 200-ft interval of limestone, mudstone, and sandstone, which Blakey (1990) notes is poorly exposed and difficult to map. All descriptions of the Supai and Schnebly Hill Formations that follow are from Blakey (1990). The lower part of the Supai Formation of Pennsylvanian age is about 300 ft thick and consists primarily of very fine-grained massive sandstone, cross-stratified sandstone, and conglomerate that range in color from reddish gray to reddish brown to pale grayish orange. The unit forms ledges, steep slopes, and local cliffs. The upper part of the Supai Formation, which averages about 300 ft in thickness, contains a variable assemblage of sandstone and conglomerate red beds, which generally are of local extent with abrupt lateral changes. At Fossil Creek, the middle of the upper part of the formation contains a complex suite of fluvial features and deposits with several fining-upward sequences, cross-stratified sandstones, conglomerate beds, and accumulations of organic material including plant debris. On the basis of regional correlations, Blakey (1990) places the Pennsylvanian-Permian boundary at the top of the channeled complex.

The Permian Schnebly Hill Formation is in sharp contact with the underlying Supai Formation and is the product of deposition in a rapidly subsiding closed basin. The unit is exposed along the full length of the Mogollon Rim within the study area, forming steep slopes at Fossil Creek where it is about 835 ft high and thickens slightly to the east. The bottom 425 ft of the Schnebly Hill Formation is poorly exposed, very fine-grained sandstone and reddish-brown siltstones. A little more than half way up the sequence, the Fort Apache Member is a 50- to 60-ft-thick carbonate unit that consists mainly of limestone in the study area and becomes more dolomitic to the north; the upper parts of the formation consist of siltstone, mudstone, and some carbonates capped by a 130-ft sequence of extensively cross-stratified sandstone that thins to the east from Fossil Creek.

Lower Paleozoic Rocks

Rocks of Cambrian to Mississippian age are exposed continuously along the base of the Mogollon Rim from Pine Creek southeast to the Salt River (fig. 4), as well as in several fault blocks north and east of Payson and as outliers scattered throughout the southern part of the study area. The Cambrian Tapeats Sandstone lies unconformably upon the Payson granite and is exposed north of Payson on Houston Mesa (figs. 1 and 4), along the East Verde River and along the base of the Diamond Rim Fault north of Webber Creek and as far east as Kohls Ranch (figs. 1 and 4). Within the study area, the Tapeats Sandstone is a very coarse-grained sandstone to small pebble conglomerate with thin, lenticular beds of shale and siltstone. In vertical sections, it shows distinct crossbedded sandstone and conglomerate that fill channels cut into underlying beds (Hereford, 1977).

The Devonian age Martin Formation lies unconformably over the Tapeats Sandstone in the East Verde River area and directly overlies Proterozoic rocks farther to the east. Exposures of the unit, which forms vertical, blocky cliffs of well-bedded dolomite, limestone, and clastic sedimentary rocks, are visible along State Highway 87 between Payson and Pine north of the East Verde River crossing (figs. 1 and 4); on the eastern side of the canyon above Tonto Natural Bridge; along most canyon walls that are cut into the Paleozoic section of the Mogollon Rim, including Webber Creek, the East Verde River, Tonto Creek, Christopher Creek, and Canyon Creek; along the Diamond Rim escarpment; and along the north bank of the Salt River east of Cibecue Creek. The Martin Formation consists of two members (Teichert, 1965). The lower Becker Butte Member reportedly is as thick as 160 ft, but it is not exposed or is missing in most measured sections. Teichert (1965) describes it as having a basal crossbedded sandstone and conglomerate below a dolomitic sandstone and shale, but Hereford (1977) believes that only the dolomitic sandstone is part of the Martin Formation, and that the basal sandstone is the Tapeats Sandstone. The Jerome Member can include any of the following units: (1) a finely laminated lower unit at the base called the fetid dolomite that is up to 55-ft thick; (2) an aphanitic dolomite up to 159-ft thick that may be sandy and in some places contains chert; and (3) an upper sequence as much as 385-ft thick that contains beds of fine to coarse-grained mottled dolomite, which east of the East Verde River contains varying amounts of sandstone, siltstone, and shale (Teichert, 1965). Isopach

maps of the Jerome Member show the unit as thickening from less than 100 ft northeast of the Mogollon Rim above Christopher Creek to more than 300 ft parallel to the rim and to nearly 400 ft at Tonto Natural Bridge Spring (Teichert, 1965). The Martin Formation is also shown as pinching out around the margins of Pine and Christopher Islands (fig. 4).

Throughout much of the study area, the Redwall Limestone of Mississippian age is little more than a layer of rubble, the residuum of extended weathering of the Redwall surface during a period of surface exposure that lasted tens of millions of years before deposition of the overlying Naco Formation (Brew, 1965). Of the four members of the formation that are present in the Grand Canyon, where the unit is nearly 800 ft thick, only the Mooney Falls Member, the second youngest member, is present east of Fossil Creek (McKee and Gutschick, 1969). East of Pine, McKee and Gutschick's isopach maps show the Redwall Limestone generally to be less than 50 ft thick, not counting residuum, and to pinch out to the northeast of the Mogollon Rim in approximately the same area as the Martin Formation does. West of Pine, isopach maps show the Redwall abruptly thickening to more than 100 ft at Fossil Creek. Well cuttings and geophysical evidence at a recently developed well northwest of Pine, however, were interpreted as showing a thickness of 495 ft of Redwall Limestone, a much greater thickness for the unit than previously reported in that area (Michael Ploughe, hydrologist, Arizona Hydrologic Sources, oral commun., 2003). The residuum typically consists of a conglomerate containing pebble- to boulder-sized limestone gravel and white pebble- to cobble-sized chert in a red clay matrix (McKee and Gutschick, 1969). Fossils are abundant in some exposures. In exposures along State Highway 87 north of the East Verde River (figs. 1 and 4), the residuum comprises nearly 50 percent of the total thickness of the Redwall, and at exposures along Tonto Creek, it comprises nearly 40 percent of the formation's total thickness. The intact part of the Redwall Limestone consists of various textures of light-gray limestone that form knobby outcrops. Bedding, where present, ranges from 2 to 12 ft thick, but massive, unbedded outcrops are common. The limestone may contain a variety of fossils, including brachiopods, corals, horn corals, and foraminifers. The upper part of the Mooney Falls Member is a clean limestone that is permeable and susceptible to solution, so that it is often honeycombed with solution openings along bedding and joint surfaces. Measured sections within the study area are 38 ft (16 ft of residuum) at Colcord Canyon near the base of the Mogollon Rim at the eastern end of the study area (figs. 1 and 4), 80 ft (30 ft of residuum) at Tonto Creek north of Kohls Ranch, and 31 ft at Tonto Natural Bridge (no residuum; figs. 1 and 4). Southeast from Colcord Canyon the Redwall thickens to 316 ft (95 ft of residuum) in the Salt River canyon (McKee and Gutschick, 1969).

Proterozoic Rocks

Proterozoic sedimentary, volcanic, and metamorphic rocks are exposed mainly south of the Mogollon Rim within the Mazatzal Mountains and Sierra Ancha (figs. 1 and 4). The Tonto Super Group includes within its nearly 30,000 ft-thick sequence from top to bottom, the 1.70 billion year old Mazatzal Group consisting mainly of quartzite, shale, and a basal conglomerate; the 1.70 billion year old Red Rock group consisting of rhyolitic ash, tuff, and flows; the 1.71 billion year old Alder Group consisting of alternating sequences of volcanic rocks, sand and siltstone, ash flows and basalt, and shale, sandstone, and carbonate rocks; and the 1.72 billion year old East Verde River Formation consisting of graywacke sandstones and ash flow tuff (Cox and others, 2002). Only the Mazatzal Group is exposed within the Mogollon Rim itself where it appears within fault blocks at the base of Paleozoic sedimentary rocks in Pine Creek at Tonto Natural Bridge and just south of the community of Pine (figs. 1 and 4). The Mazatzal Group rocks are also exposed in the lower reach of Christopher Creek near its confluence with Tonto Creek (figs. 1 and 4). Quartzites in the Mazatzal Group, which include the Mazatzal Peak Quartzite and the lower-lying Deadman Quartzite generally are coarse to fine grained with good preservation of primary depositional features such as ripples and crossbedding (Cox and others, 2002). Proterozoic sedimentary rocks of the Apache Group and diabase are exposed over much of the eastern Sierra Ancha (fig. 4).

Proterozoic plutonic rocks include the Payson granite and associated granophyres and rhyolite intrusions, which are about 1.69 to 1.70 billion years old (Karlstrom and others, 1987) and are exposed over a 128 mi^2 area informally known as the Payson Shelf (figs. 1 and 4). The Payson granite intrudes the mafic rocks of the Gibson Creek batholith south of Payson (Conway, 1976) and a complex of gneissic granitoids north of the town (AGRA Earth and Environmental, 1999). Both of the mafic complexes are included with the Payson granite map designation (fig. 4). The Payson granite is also exposed on the northwestern and southeastern edges of the Mazatzal Mountains and in scattered exposures along upper Cherry Creek. The Payson granite is a tan to reddish potassium feldspar and quartz-rich granite with numerous intrusions of

silica-rich, finer-grained, alkali-rich granite that form ridges and hills because they are more resistant to weathering and erosion than the host rock. Weathering of the Payson granite is most developed where the unit is close to the overlying Tapeats Sandstone; outcrops of the rock are sparse in the town of Payson because of deep weathering and the accumulation of grus, the residual particles of resistant quartz and feldspars that are the remains of the original rock.

Structure

The region's geologic history has left a substantial structural imprint on rocks in the study area. Tectonic stresses have raised land surface and deformed rock formations and have enabled erosional forces to dramatically sculpt the landscape. The overlying sedimentary beds are relatively flat-lying and generally dip gently to the northeast. Within fault blocks, the lowermost formations in this assemblage dip 10 degrees or more (Gæorama, Inc., 2003).

Faulting has been sporadic. Major Proterozoic faults and lineaments trend northeast-southwest across the structural trend of more recent faulting and generally are highly silicified (Gæorama, Inc., 2003). The Slate Creek-Breadpan Canyon Shear Zone defines the middle reaches of the Tonto Creek canyon through the Sierra Ancha (fig. 4; Karlstrom and others, 1987).

The most abundant faults, however, and those most significant in controlling the modern landscape are the product of a Miocene episode of crustal extension that has left a generally north-south to northwest-southeast trending structural fabric (fig. 4; Reynolds, 1988). This activity yielded high-angle normal and reverse faults throughout the Basin and Range Physiographic Province. In the Mogollon Highlands, major extensional faults show displacements of as little as 50 to 100 ft locally and as much as 600 to 1,500 ft on the Diamond Rim Fault north of Payson and where it crosses the East Verde River (fig 4; Gæorama, Inc., 2003). The Diamond Rim Fault, which dips 75 to 80 degrees to the south and is upthrown on the northern side, is the major regional fault in the study area and extends 30 mi, generally east-west from east of Tonto Creek to Pine Creek (Conway 1976, Wrucke and Conway, 1987), and likely continues for some distance west of Pine Creek (Gæorama, Inc., 2003). The juxtaposition of crystalline and sedimentary formations caused by such displacements plays a significant role in the development of surface drainage, determination of ground-water flow directions, and the occurrence and distribution of springs below the Mogollon Rim as faults variably enable or preclude drainage of water-bearing formations.

Fracturing of rocks by jointing is apparent in several geologic units, particularly the Payson granite, the rocks of the Coconino Sandstone and Schnebly Hill Formation near the top of the Mogollon Rim, and the Tertiary volcanic rocks in the northwestern part of the study area. Fractures affect recharge, ground-water flow paths, and the location of springs. An unpublished synthesis of geophysical data shows evidence of large-scale fracture systems within Paleozoic sedimentary rocks that extend from the face of the Mogollon Rim northward beneath the Colorado Plateau (Mark Gettings and Mark Bultman, geologists, U.S. Geological Survey, written commun., 2003). Within carbonate rocks, fracture systems may be enlarged by dissolution of rocks to create opportunities for karstic ground-water flow.

Climate

Precipitation and temperature generally vary with altitude throughout the study area; some variation is attributable to local rain-shadow effects. Precipitation contours closely parallel the topographic features of the study area; the highest annual amounts occur in a narrow band along the crest of the Mogollon Rim (fig. 5). Mean precipitation over the entire study area is about 21.3 in/yr. Mean monthly maximum temperatures, occurring in June and July range from more than 100°F in the Sonoran Desert near Roosevelt Lake to the mid-80s°F in the ponderosa forests of the Mogollon Rim and Colorado Plateau. Mean minimum temperatures range from the upper-30s°F in the lowest parts of the region to between 10 and 20°F in the upland areas (Sellers and others, 1985).

Precipitation results primarily from two types of storms: intense, convective thunderstorms in the summer and less intense but more regional, frontal storms in the winter. Tropical storms, which tend to be more regional than convective thunderstorms but produce locally intense precipitation, occasionally deliver large amounts of precipitation, usually in late September and October (Sellers and others. 1985). At higher altitudes, much of the winter precipitation falls as snow; annual mean snowfall ranges from about 48 in. at Blue Ridge Ranger Station at an altitude of 6,880 ft to 24 in. at Payson at an altitude of about 4,900 ft (fig. 5). Precipitation is spread somewhat equably throughout the year; it is only slightly less in spring than in the other three seasons (National Climatic Data Center, 2003a; fig. 6).

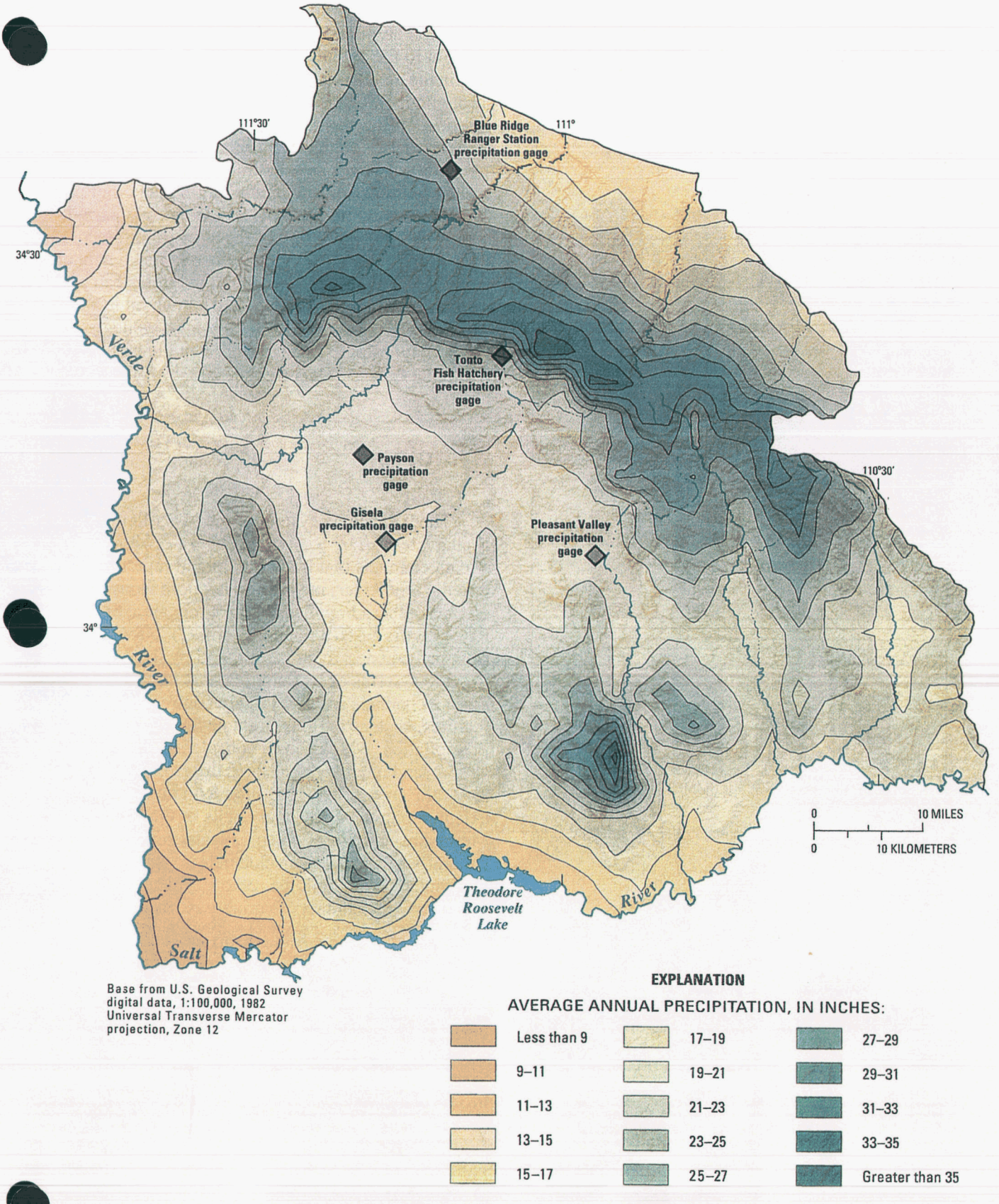


Figure 5. Average annual precipitation and locations of active weather stations in the Mogollon Highlands, central Arizona.

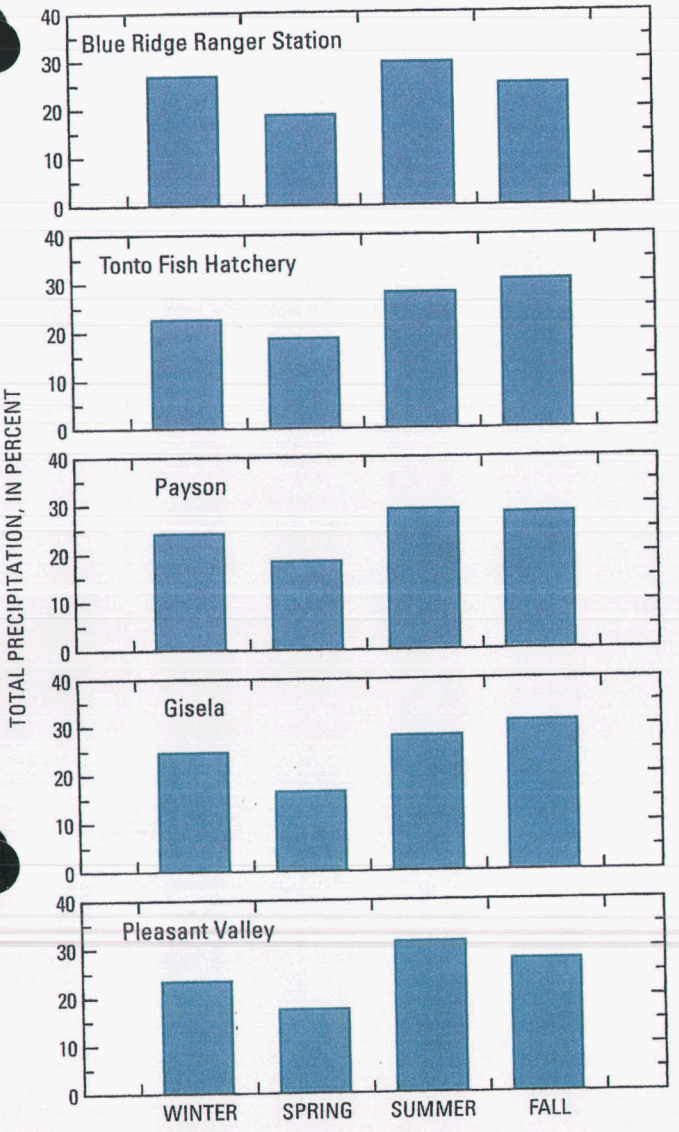


Figure 6. Seasonal distribution of precipitation for selected sites in the Mogollon Highlands, central Arizona.

For the active weather stations within the Mogollon Highlands that have a period of record extending to the 1950s or earlier, certain precipitation trends are apparent. Examination of the precipitation record for selected stations shows a cluster of lower annual precipitation during the 1950s with a less pronounced cluster of low precipitation beginning in the 1990s (fig. 7*A*). The pattern is clearer at the Tonto Fish Hatchery and the Payson and Gisela stations and less so at Pleasant Valley. Average decadal precipitation and variability show limited change from one decade to another. The 1980s is the wettest decade at all four stations; however, the driest decade on record is different at all four stations (table 1).

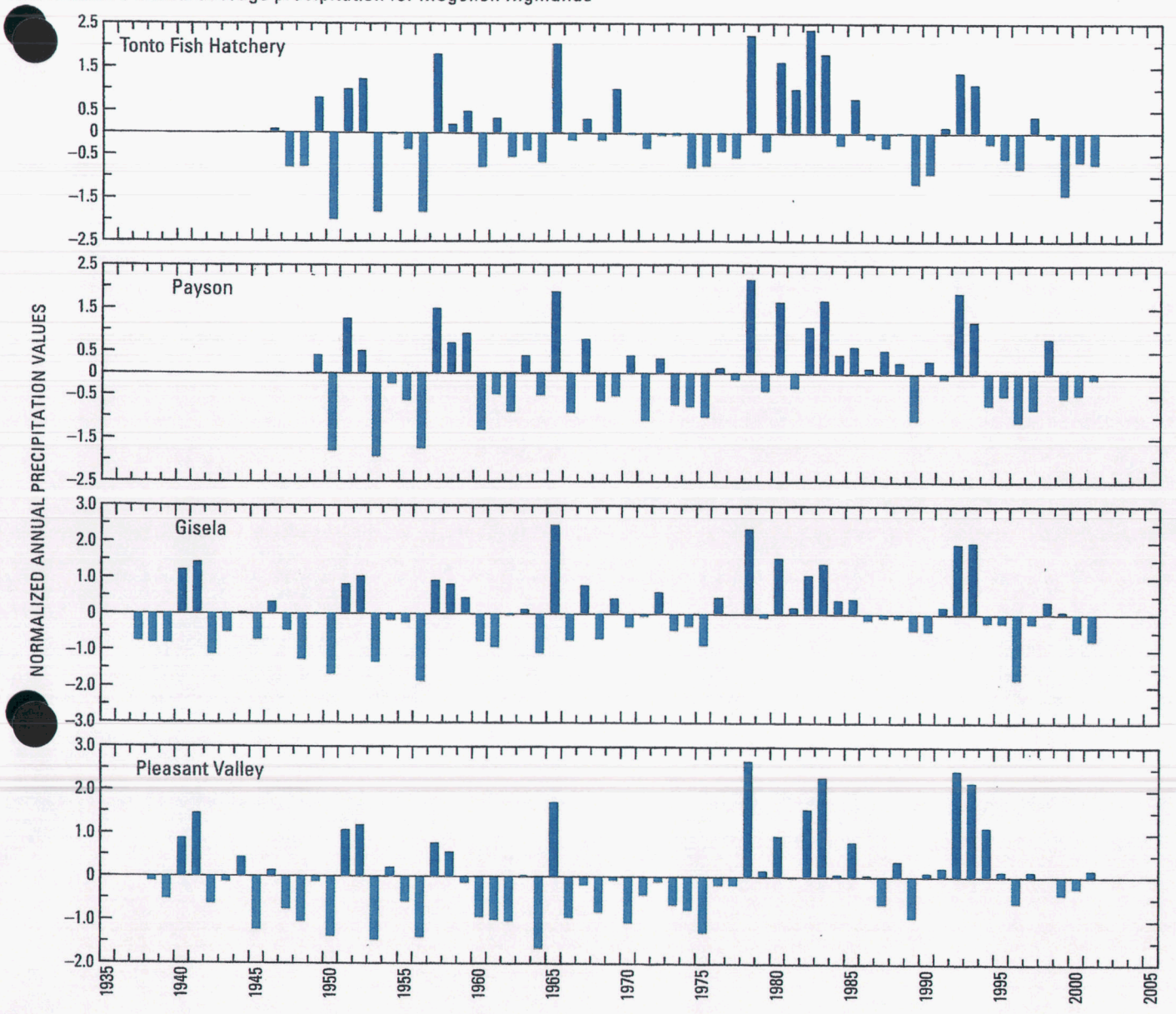
During the course of this investigation, the Mogollon Highlands was undergoing a period of severe drought to the extent that most of the study area was within the most severely drought-stricken part of Arizona throughout 2002 and much of 2003. The drought, which extended throughout the Southwest, was the most severe since the 1950s (National Climate Data Center, 2003b). The 1950s drought appears to be characterized by greater extremes of low precipitation than other periods (fig. 7*A*), including the most recent drought period; however, an examination of the temperature record at Payson (fig. 7*B*) shows a major rise in mean annual temperature since 1989. Such temperatures can affect evapotranspiration, snowfall, and snowmelt in ways that would account for the historically high values of the Palmer Hydrologic Drought Index in the early 2000s. (National Climate Data Center, 2003b, 2003c).

Hydrology

The hydrologic system of the Mogollon Highlands is characterized by a surface network of short, steep stream channels that drain the upland regions and flow into the Salt River, including Theodore Roosevelt Lake, on the southern boundary of the study area, or the Verde River on the eastern boundary (fig. 1). Ground-water flow paths generally are controlled by large-scale fracture systems or by karst features in carbonate rocks. Stream channels are also largely controlled by structural features, such as regional joint or fault systems. Precipitation, which shows considerable variability in amount and intensity, recharges the ground-water system along the crest of the Mogollon Rim and, to a lesser extent, along the crests and flanks of the Mazatzal Mountains and Sierra Ancha. Flashy runoff in the generally bedrock stream channels is typical. Springs are distributed throughout the region, typically discharging at or above the contact of variably permeable formations.

Drought and the limited surface- and near-surface water resources have resulted in not-infrequent water shortages for more than a century. Anecdotal reports describe declining ground-water levels and the drying up of previously productive springs and creeks between 1882 and 1922 that were attributed to an increase in well production; an 18-month drought in 1904–1905 reportedly devastated the cattle ranching industry (Northern Gila Historical Society, 1984). Water shortages continue to plague the region, particularly in the Pine-Strawberry area (Arizona Department of Water Resources, written comm. 1984, 1996), one of many such areas that has organized to address rural water-supply issues under the auspices of the state of Arizona Rural Watershed Initiative.

A. Normalized annual average precipitation for Mogollon Highlands



B. Normalized annual average temperature for Payson

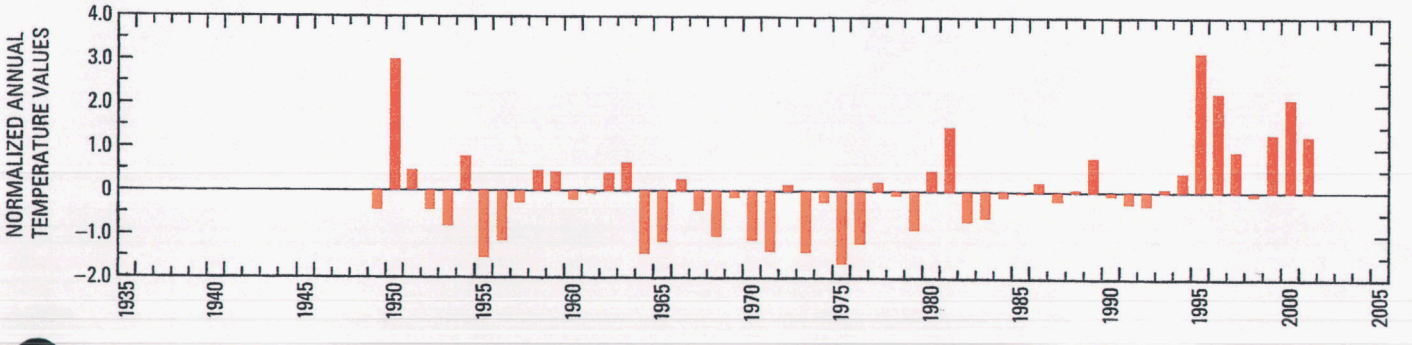


Figure 7. *A,* Normalized annual average precipitation for the Mogollon Highlands, central Arizona; *B,* Normalized annual average temperature for Payson, Arizona. Blue Ridge Ranger Station record begins in 1967 and is not shown here.

Table 1. Summary precipitation statistics for Mogollon Highlands, Arizona, weather stations by decade

[Precipitation values are in inches. Data from National Climate Data Center, 2003a; ***, no record; ---, only three years of record for the period]

Station		1940–49	1950–59	1960–69	1970–79	1980–89	1990–2001	Period of record
Blue Ridge Ranger Station	Mean	***	***	---	18.79	22.20	20.09	20.43
	Standard deviation	***	10.01	6.42	3.94	3.83	4.81	4.36
	Coefficient of variation	***	.31	.19	.21	.17	.24	.21
Tonto Fish Hatchery	Mean	***	31.99	33.26	32.03	37.47	31.36	33.04
	Standard deviation	***	10.01	6.42	7.30	8.93	6.74	7.89
	Coefficient of variation	***	.31	.19	.23	.24	.21	.24
Pleasant Valley	Mean	20.38	20.33	18.40	19.94	23.20	23.14	20.92
	Standard deviation	4.40	5.35	4.74	5.64	5.02	4.97	5.07
	Coefficient of variation	.22	.26	.26	.28	.22	.22	.24
Payson	Mean	***	21.73	20.99	20.60	23.40	21.20	21.53
	Standard deviation	***	6.44	5.13	5.22	4.08	5.12	5.13
	Coefficient of variation	***	.30	.24	.25	.17	.24	.24
Gisela	Mean	17.07	16.99	17.41	18.31	19.90	17.81	17.70
	Standard deviation	4.82	5.98	5.70	4.74	3.69	5.57	5.01
	Coefficient of variation	.28	.35	.33	.26	.19	.31	.28

Surface Water

All of the major streams within the study area originate on the Colorado Plateau or the face of the Mogollon Rim and then flow eastward into the Verde River or southward into Theodore Roosevelt Lake or the Salt River (fig. 1). The largest streams generally are intermittent on the face of the Mogollon Rim and become perennial below the Mogollon Rim, and in some cases become ephemeral near the channel mouth. For the most part, the streams have cut bedrock channels that are covered with a thin layer of generally coarse-grained or sandy alluvium. Except in the lower Tonto Creek Basin and along middle reaches of Cherry Creek, flood plains generally are narrow or non-existent, and some reaches are confined within deep canyons.

The USGS has operated continuous-recording streamflow-gaging stations on all of the major streams in the study area (fig. 1 and table 2); however, the period of record is brief on Canyon Creek, and the gage at Fossil Creek measures only flow diverted for power plant use at the Arizona Power Service hydroelectric plant near Childs (fig. 1). Monroe (2002) modeled annual flows for Fossil Creek. He estimated that in years having a flood with a 2-year recurrence interval, annual flow would be about 35,230 acre-ft. Years in which a 5-year flood occurred would result in annual flow of about 68,510 acre-ft. Flow records on tributaries of the East Verde River and Tonto Creek are available, but the period of record is short.

During most flow conditions, the major streams are gaining in their downstream reaches. In the uppermost reaches, above major springs, flow typically occurs only during periods of runoff, but below such springs, baseflow is maintained year round. In some tributary streams, flow from source springs percolates through deep alluvium within a few thousand feet to several miles below the spring outlet, leaving some reaches dry much of the year (Feth and Hem, 1963; Brown and others, 1981; Kaczmarek, 2003). Perennial flow generally is reestablished on the major streams, however, well before the stream comes off the lower slopes of the Mogollon Rim.

Peak discharges of the largest perennial streams occur most often in winter or spring as a result of regional, frontal storms. Runoff during such storms is sometimes augmented by snowmelt. Winter storms account for most of the annual floods above the median peak discharge on all the gaged perennial streams draining the Mogollon Rim, although the flood of record on the East Verde River was caused by a monsoonal storm on September 5, 1970 (fig. 8). Summer storms account for the highest number of peak discharges on Rye Creek, which is a lowland, ephemeral stream. The 1970 flood was by far the largest recorded flood on Rye Creek (fig. 8).

Table 2. Streamflow-gaging stations in the Mogollon Highlands, central Arizona, referred to in this report

[Data from Pope and others, 1998, and the U.S. Geological Survey National Water Information System database. Stations showing period of record to "present" were in service as of October 1, 2004]

Station name	Station number	Period of record	Latitude	Longitude
Cibecue Creek near Chrysotile	09497800	1959–present	335035	1103325
Canyon Creek near Globe	09497850	1975–81	334947	1103950
Cherry Creek near Globe	09497980	1965–present	334940	1105120
Rye Creek near Gisela	09498870	1965–85	340157	1111726
Tonto Creek above Gun Creek	09499000	1940–present	335848	1111810
West Clear Creek near Camp Verde	09505800	1964–present	343219	1114136
Fossil Creek Diversions near Camp Verde	09507500	1952–present	342206	1113956
East Verde River Diversions from East Clear Creek	09507580	1965–present	342504	1111547
East Verde River near Pine	09507600	1961–71	342330	1111605
East Verde River near Childs	09507980	1961–65, 1967–present	341635	1113817
Wet Bottom Creek near Childs	09508300	1967–present	340939	1114132
Sycamore Creek near Sunflower	09510150	1961–76	335105	1112709

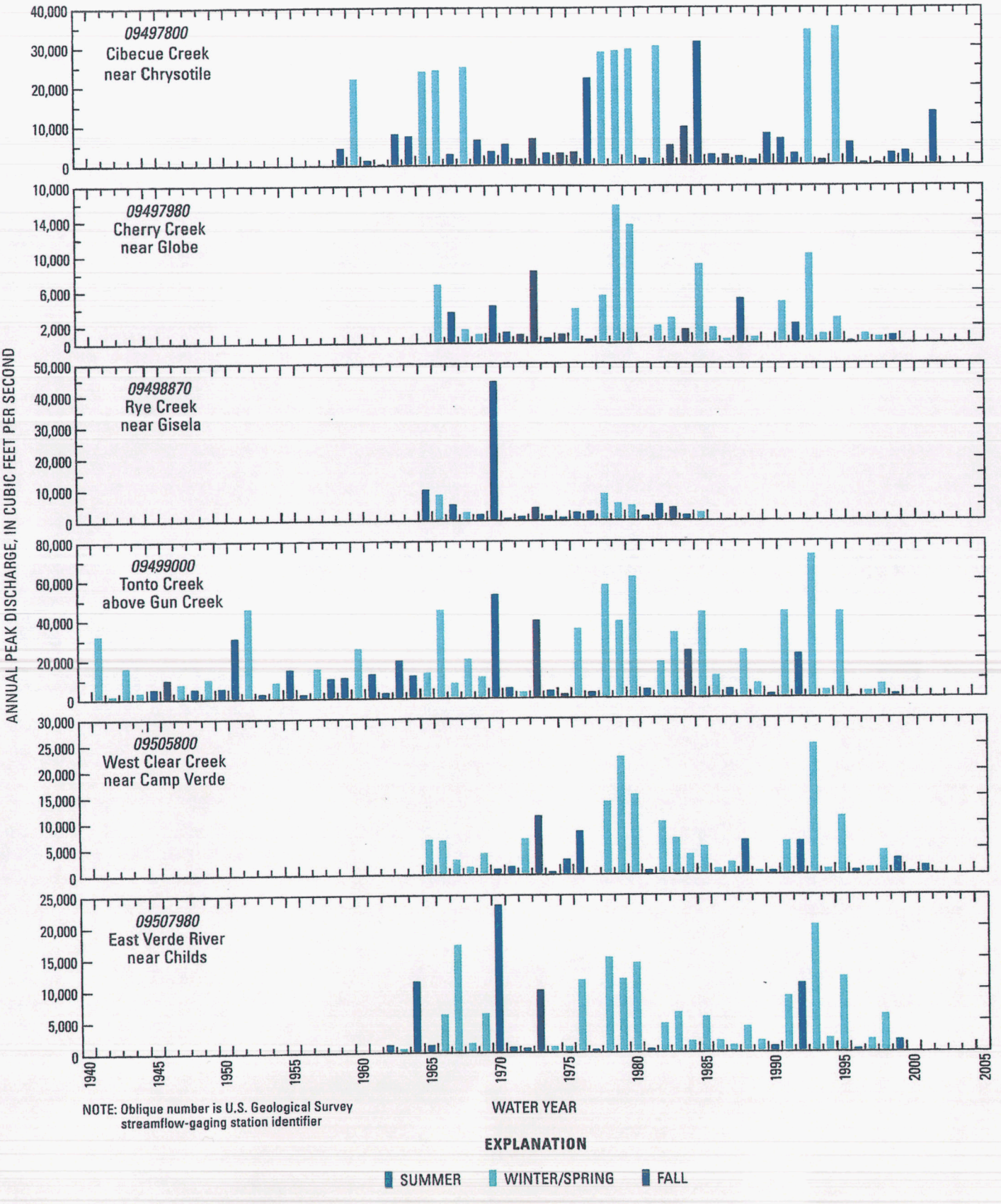


Figure 8. Seasonal distribution of annual peak discharges of selected streams in the Mogollon Highlands, central Arizona.

Although the distribution of precipitation does not vary greatly throughout the year, all the streams for which continuous-flow records are available show that more than 70 percent of streamflow volume occurs during the winter and spring (fig. 9). The disproportionately high flow volumes from December through March reflect the difference in the nature of the runoff sources. Summer storms deliver short, intense bursts of precipitation over limited areas, and even exceptionally large storms of this nature may generate runoff over only a part of the watershed. Widespread frontal storms, especially when coupled with snowmelt, typically involve the entire watershed and are more likely to involve all the watersheds in the study area.

Daily mean discharges for the largest streams commonly fluctuate over three to four orders of magnitude in a single year and four to seven orders of magnitude over the period of record (fig. 10 and table 3). Among the five perennial streams that have active continuous-record gaging stations, the level of variability is about the same; Tonto Creek and Cherry Creek are somewhat more variable than West Clear Creek and the East Verde River, and Cibecue Creek shows the least variability. The two gaged streams that drain the western side of the Mazatzal Mountains, Wet Bottom Creek, which is ephemeral, and Sycamore Creek, which is intermittent (fig. 1), show the highest levels of variability (table 3). Rye Creek, an intermittent stream that drains the northeastern side of the Mazatzal Mountains (fig. 1), shows about the same degree of variability as the perennial streams; however, the period of record ended in 1985.

The most apparent trend in daily flows is a large increase in the frequency of the lowest flows in the early 21st century with the exception of Cibecue Creek, which is striking in the degree to which it varies from the other streams in the study area (fig. 11). From 2000 through 2003, the frequency of flows in the 2.5 percentile ranges from 2 to 30 times greater than in any previous decade or partial decade of record. Even if no further flows were to occur within the 2.5 percentile by the end of the decade, the period 2000–2009 would easily record the highest frequency of low flows at four of the five gages. Not only does Cibecue Creek record only one extreme low flow after 1999, the station shows a much greater frequency of low flows in the 1960s and 1970s than other stations, a trend that appears to have started at least as early as 1959 when 30 such flows occurred during only 7 months of record.

The singularity of Cibecue Creek's record perhaps indicates a greater lag between climatic conditions and flow conditions than at other stations. Another distinction among the various streams is the amount of discharge at the 2.5 percentile level. Tonto Creek and the East Verde River are at nearly zero flow at that level; Cherry Creek has a flow of 3.2 ft^3/s; Cibecue Creek has a flow of 6.2 ft^3/s; and West Clear Creek has a flow of 14 ft^3/s at that level and never records daily flows below 11 ft^3/s (table 3).

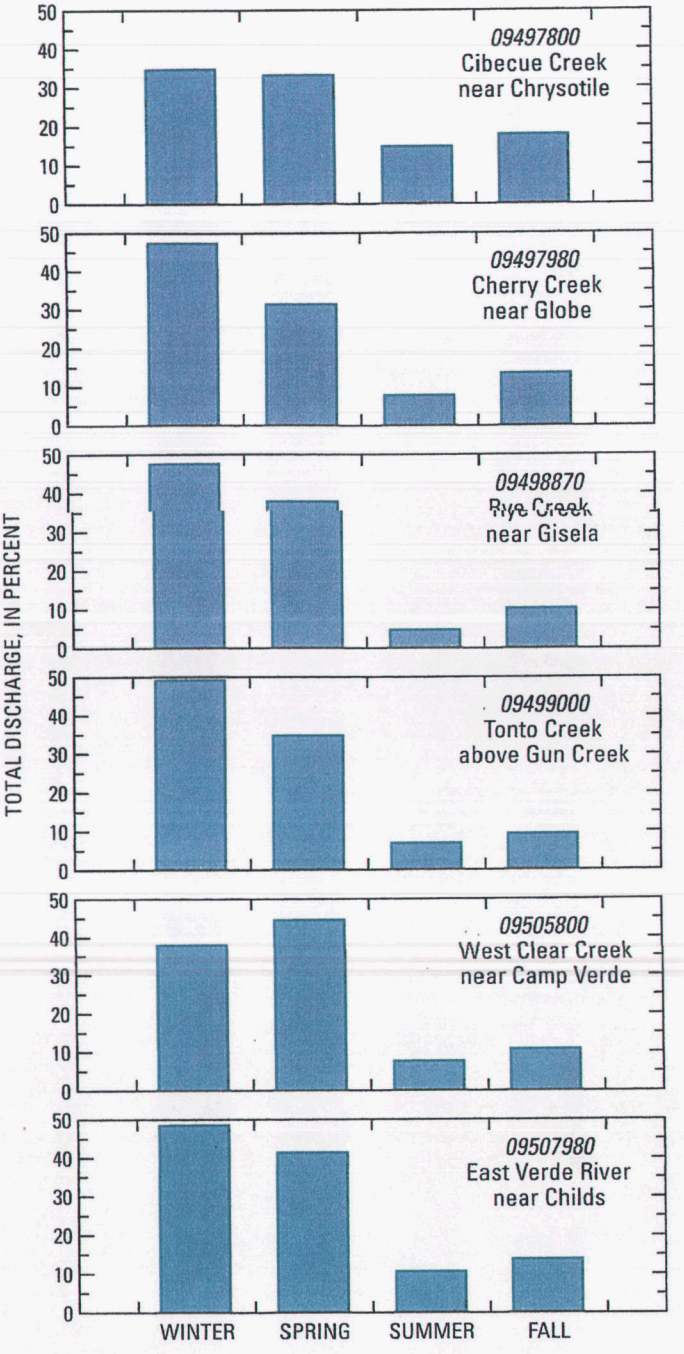


Figure 9. Seasonal distribution of discharge of selected streams in the Mogollon Highlands, central Arizona.

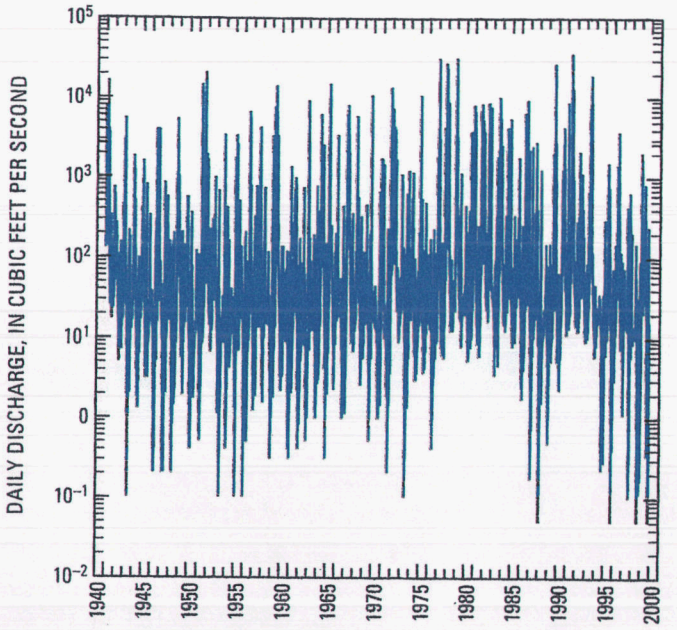


Figure 10. Daily discharge of Tonto Creek above Gun Creek showing typical range of daily discharge for Mogollon Highlands streams, central Arizona.

Table 3. Summary statistics of average daily streamflow values for active streamflow-gaging stations in the Mogollon Highlands, central Arizona

[Streamflow values are in cubic feet per second. Sycamore and Wet Bottom Creeks drain the Mazatzal Mountains, all others drain the Mogollon Rim]

Station name	Station number	Mean	Standard deviation	Coefficient of variation	Maximum	Minimum
Sycamore Creek near Sunflower	09510150	27.1	184	6.79	8,300	0
Wet Bottom Creek near Childs	09508300	14.3	93	6.51	3,410	0
East Verde River near Childs	09507980	62.2	276	4.44	11,000	0
West Clear Creek near Campe Verde	09505800	63.6	276	4.35	13,100	11
Tonto Creek above Gun Creek	09499000	157.9	864	5.47	36,700	0
Cherry Creek near Globe	09497980	35.5	199	5.60	13,000	2
Cibecue Creek near Chrysotile	09497800	45.5	139	3.07	4,930	4.1

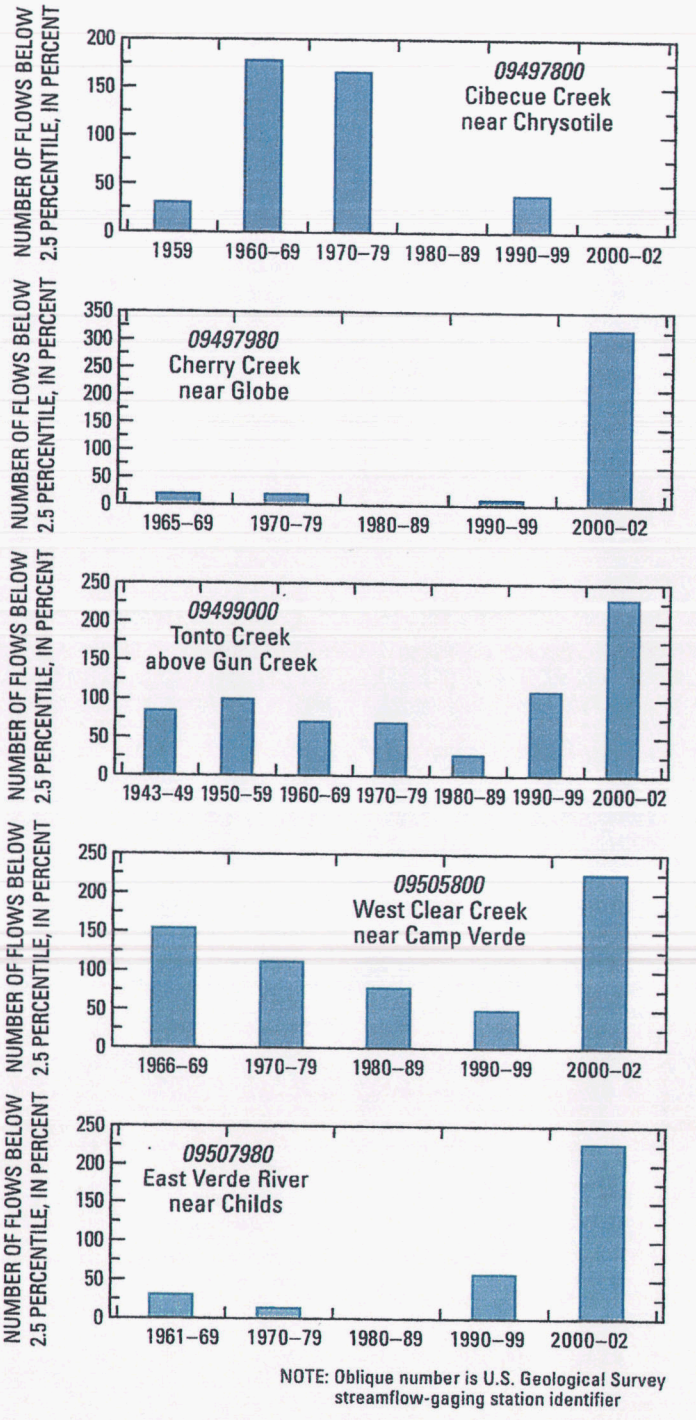


Figure 11. Lowest flows on selected perennial streams in the Mogollon Highlands, central Arizona.

Runoff was separated from base flow by constructing flow-duration curves (fig. 12) and choosing the value at the break in the upper slope of the curve as the boundary between base flow and runoff. That point is close to the 80th percentile of flows for all streams in the study area. The total stream volume was then calculated for base flow by truncating the daily values at the 80th percentile. For most major streams, base flow is about 30 percent of the total flow volume (fig. 13). Only Canyon Creek, for which records were extended by regression, and Cibecue Creek show significant deviation from that relation. Indeed, Cibecue Creek shows more than half of its total stream volume resulting from base flow. The degree to which Cibecue Creek is distinguished from other streams in its low-flow history (fig. 11), the relative high discharge at the 2.5 percentile (table 3), and the large contribution of base flow to total flow (fig. 13) indicate that its hydrologic regimen is affected by unique watershed characteristics, most likely geologic structure.

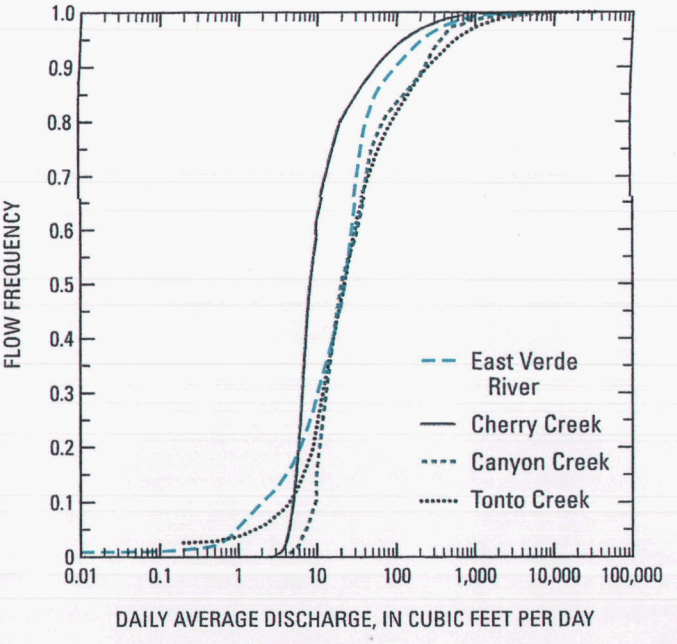


Figure 12. Flow duration curve for selected streams in the Mogollon Highlands, central Arizona.

Ground Water

The Mogollon Highlands has a complex and incompletely integrated ground-water flow system, which is the product of its diverse topography and geologic history and heterogeneity. It is characterized by multiple and divergent ground-water flow paths, disconnected recharge areas, and multiple water-bearing zones beneath sedimentary and igneous rocks. Analysis of spring and well data and their relation to geology and climate are the primary methods used here to better understand the ground-water system of the area.

Springs

Springs are intersections of the ground-water flow system with the land surface and thus provide a glimpse of that system. USGS databases contain information for about 73 springs within the study area; there are many other springs shown on USGS topographic maps and USDA Forest Service maps for which no information is available in USGS databases (fig. 14). Most springs in the study area issue from sedimentary rocks along the face of the Mogollon Rim, but because of pervasive fracture-induced secondary permeability, springs occur in almost all rock types within the study area. In this report, springs are referred to either by their spring name as it appears in the USGS database or on topographic maps; or, when a spring is unnamed, by its station name, which uses the same coding as the well-station code system.

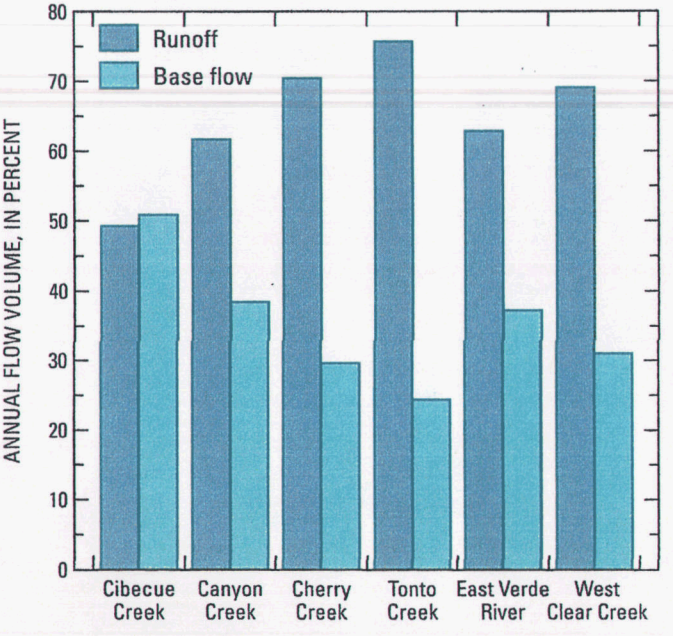


Figure 13. Runoff and base-flow components of selected streams in the Mogollon Highlands, central Arizona.

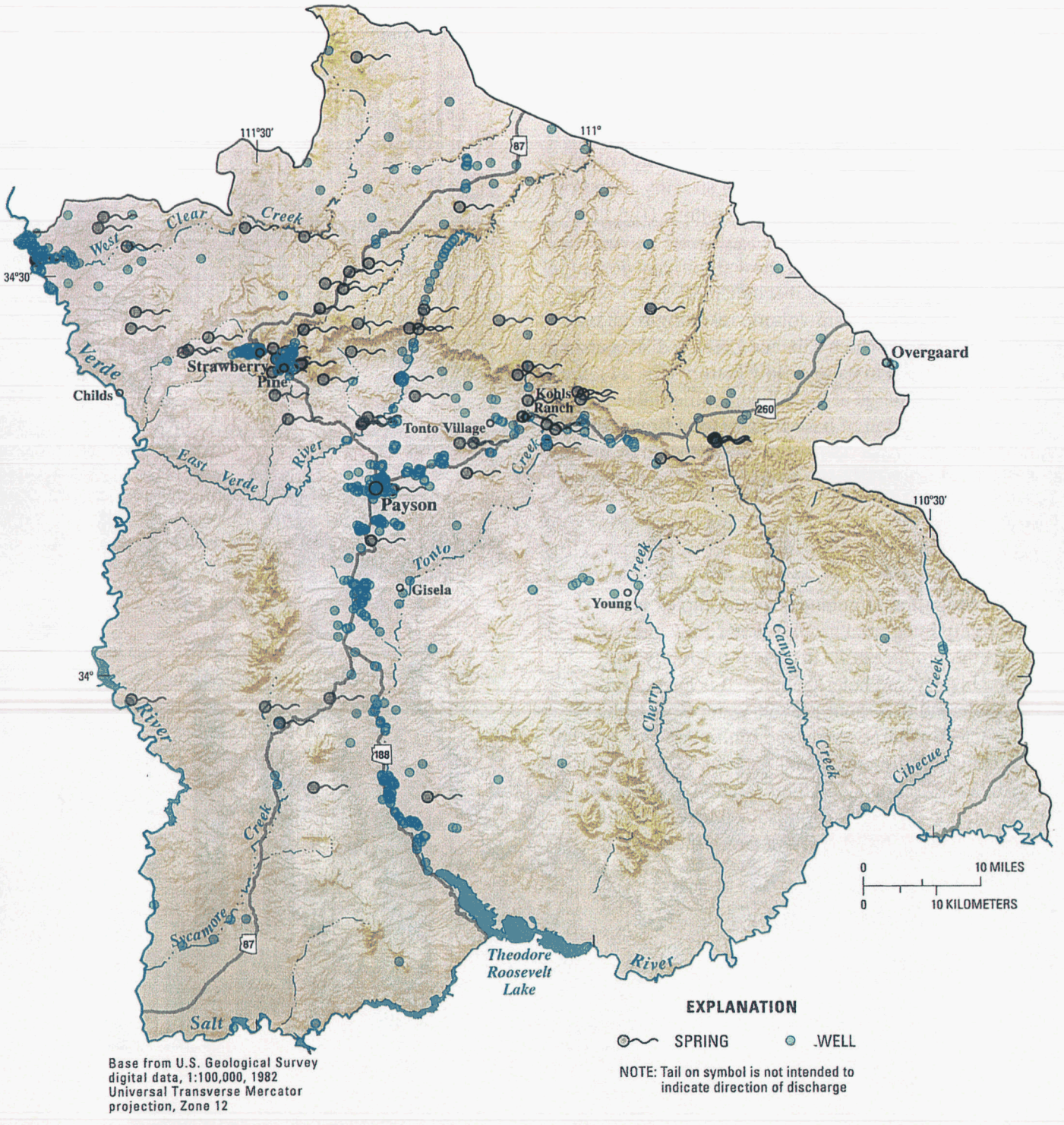


Figure 14. Distribution of springs and wells in the Mogollon Highlands, central Arizona.

Springs of the Mogollon Highlands have been little studied since Feth and Hem (1963). Of the 46 discharge values recorded in the USGS databases, more than half are estimates or anecdotal reports. Most of the values were recorded before 1960, and until this study no values had been added to the database since 1981. Furthermore, at only a few springs has flow been measured, estimated, or reported more than once in the nearly 60 years of record. Consequently, there exists almost no record of flow variability.

That spring flow can be highly variable is illustrated by the differences between discharges measured in this study and the historic values (table 4). There are several causes for such variability. Measurement of spring flow is subject to large error if it cannot be measured directly at the spring outlet or if all the flow cannot be forced through a flume or into containers for volumetric measurements. During attempts in this study at measuring flow volumetrically from See Spring (table 4 and fig. 15, no. 61) that discharged from numerous points in a bouldery stream terrace, as much as 25 percent of the flow could not be channeled into the containers being used. If terrain difficulties prevent measurement directly from the spring's discharge point, the discharge is typically measured by using a current meter in the stream at some point downstream from the spring, the distance of which depends on the location of a satisfactory control reach for making the measurement. The farther down-stream the measurement is made, the greater the opportunity for the measurement to be affected by losses or gains in the channel reach. Such measurements may also include a significant runoff component in the measured flow. Flow from many springs is also affected by recent precipitation or snowmelt, so single measurements are not likely to provide an accurate characterization of long-term spring conditions.

Table 4. Discharge values for springs in the Mogollon Highlands, central Arizona

[gal/min, gallons per minute; ac-ft/yr, acre-feet per year. Method codes: V, volumetric; O, observation; E, estimated; F, flume; R, reported; C, current meter; G, gaged. Other data available codes: I, isotope; C, chemical. ***, unknown]

Map code[1] (see fig. 15)	Spring or station name	Discharge (gal/min)	Discharge year	Method	Annual discharge (ac-ft/yr)	Other data available[8,9]
36	Lee Johnson	0.21	2001	V[2]	0.34	I
36	Lee Johnson	.00	2002	O	.00	
17	Cottonwood	.25	1946	E	.40	
23	A-12-09 30DDC1	.25	1946	E	.40	
24	A-12-09 30DDC2	.25	1946	E	.40	
16	A-07-08 12CDA	.50	1976	V	.81	
21	A-07-09 19AAB	.93	1976	V	1.50	
49	Winters NO 1	1.00	1952	E	1.61	
20	A-12-08 26DAB	1.00	1946	E	1.61	
18	Fuller	1.00	1946	E	1.61	
33	Fortyfour	1.00	1953	E	1.61	
7	A-14-06 29DAD	1.00	1981	E	1.61	
9	Hackberry	2.00	1977	V	3.23	
19	A-11H09 30DCB	3.00	1946	E	4.84	
28	Red Rock	3.00	1946	E	4.84	
28	Red Rock	.50	2001	V[2]	.81	I
28	Red Rock	.32	2002	V[2]	.51	

See footnotes at end of table.

Table 4. Discharge values for springs in Mogollon Highlands, central Arizona—Continued

Map code[1] (see fig. 15)	Spring or station name	Discharge (gal/min)	Discharge year	Method	Annual discharge (ac-ft/yr)	Other data available[8,9]
40	Blue Spring south	4.00	1952	E	6.46	
54	Bear Flat	4.00	1975	V	6.46	C
41	Turkey (south)	5.00	1952	E	8.07	
12	A-12-07 22C UNSURV	5.00	1978	E	8.07	C
8	Bull Pen	7.00	1959	E	11.3	
63	Allenbaugh	8.00	2001	V[2]	12.9	I
63	Allenbaugh	.00	2002	O	.00	
53	Bootleg	8.00	2001	V[2]	12.9	I
53	Bootleg	5.00	2002	V[2]	8.07	
26	A-12-09 08CCD	10.0	1946	E	16.1	
3	A-13-05 16BBD2	13.0	1980	E	21.0	
35	Geronimo	14.0	2001	F[2]	22.6	C,I
60	A-11-13 18AA	15.0	1966	E	24.2	
34	Clover	20.0	1952	E	32.3	
2	Catfish	22.0	1981	V	35.5	
47	Wildcat	58.5	1952	R[3]	94	
51	Henturkey	60.0	1952	C	97	
59	Nappa	70.0	1966	C	113	I
42	A-11H10 24BCA	75.0	1952	E	121	C
4	A-13-05 16BBD1	90.0	1980	E	145	
50	Indian Gardens	100	1952	R[3]	102	
50	Indian Gardens	57.5	2001	V/F[2,4]	93	C,I
50	Indian Gardens	26.5	2002	F[2]	43	
27	Bear	100	1959	E	161	C
45	Pieper Hatchery	125	1952	E	202	
37	Big	175	1952	C	282	C
37	Big	100	1952	R[3]	161	
65	A-11-14 35DBA1	310	***	C	500	
38	The Grotto	340	1952	C	549	
38	The Grotto	10	1952	R[3]	16	
66	A-11-14 35DBA2	410	***	C	662	
64	A-11-14 35DBB	480	***	C	775	
58	R-C	800	1952	E	1,291	C
22	Tonto Natural Bridge	841	2002	G[5]	1,357	C,I
61	See	900	1966	E	1,453	
61	See	104	2001	V[2]	168	
61	See	84	2002	V[2]	136	C,I

See footnotes at end of table.

Table 4. Discharge values for springs in Mogollon Highlands, central Arizona—Continued

Map code[1] (see fig. 15)	Spring or station name	Discharge (gal/min)	Discharge year	Method	Annual discharge (ac-ft/yr)	Other data available[8,9]
15	Buckhorn	1,000	1959	E	1,614	C
56	Horton	1,100	2002	C[2]	1,776	C,I
52	Tonto	1,291	2001	F[6]	2,084	C,I
39	Webber	1,300	1952	F	2,082	
39	Webber	1,570	2001	C[2]	2,534	C,I
39	Webber	996	2002	F[2]	1,608	
67	Canyon	2,224	2001	F[6]	3,590	
44	Cold	4,200	1952	C	6,779	
44	Cold	1,060	1952	R[3]	1,711	
44	Cold	830	1952	R[3]	1,340	
14	Fossil	21,647	2001	C[7]	34,941	C,I

[1]Map code "1" not used.
[2]Measured during this study.
[3]Published in Feth and Hem (1963). Method not known.
[4]At higher flows, discharge emanates from two outlets that require different measurement methods.
[5]Mean of once-daily stage measurements from May 2001 through September 2002, Arizona State Parks.
[6]Mean of once-monthly flume measurements in fish hatcheries from January 1980 through May 2001, Arizona Game and Fish Department.
[7]Mean of various measurements made from 1946 through 2001. Sources include Feth and Hem (1963); U.S. Department of Agriculture, Forest Service (Tonto National Forest); U.S. Geological Survey.
[8]See table 7 for chemical data.
[9]See tables 10 and 11 for isotope data.

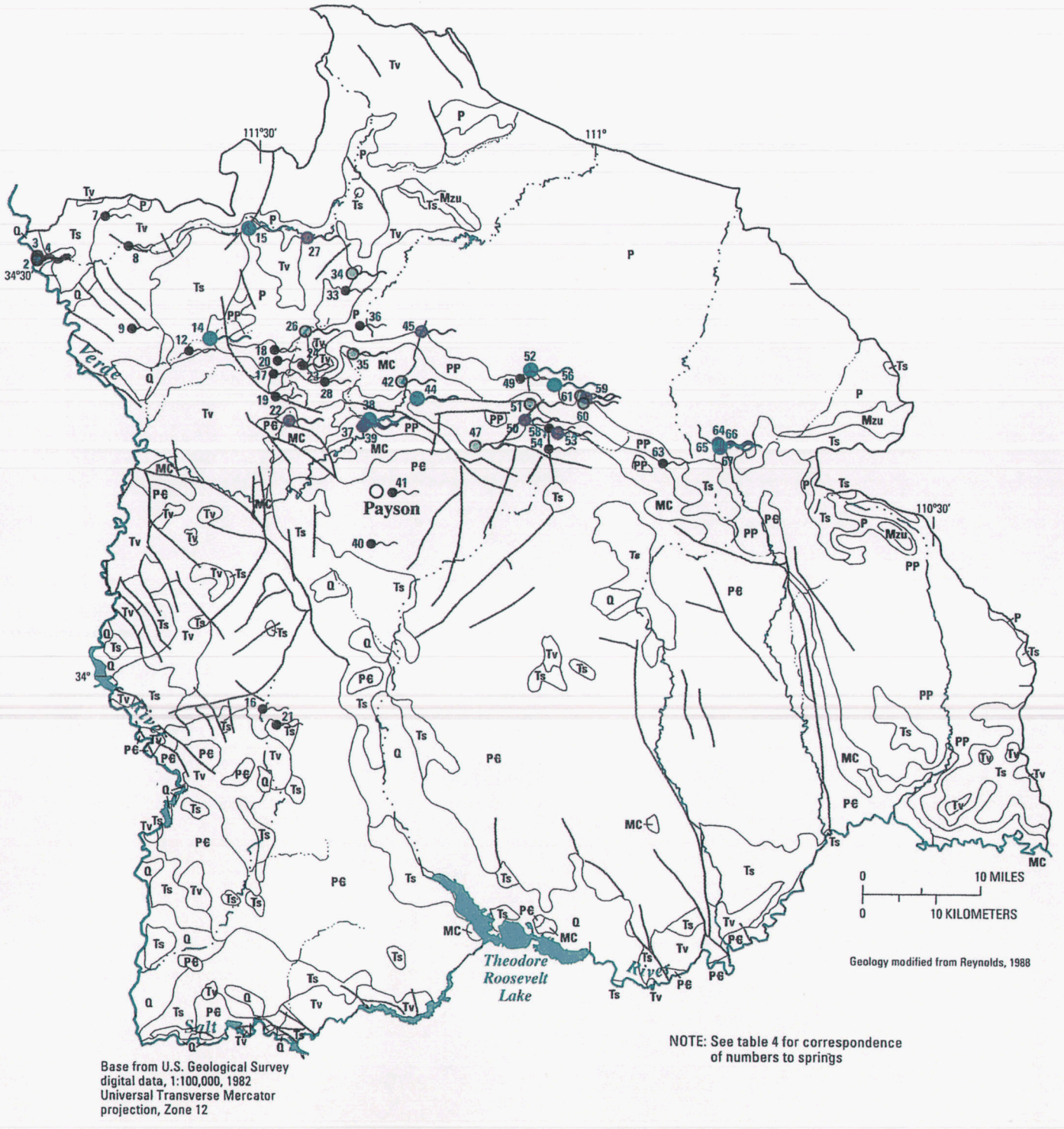


Figure 15. Geology, geologic structure, and locations of springs for which discharge records are available, Mogollon Highlands, central Arizona.

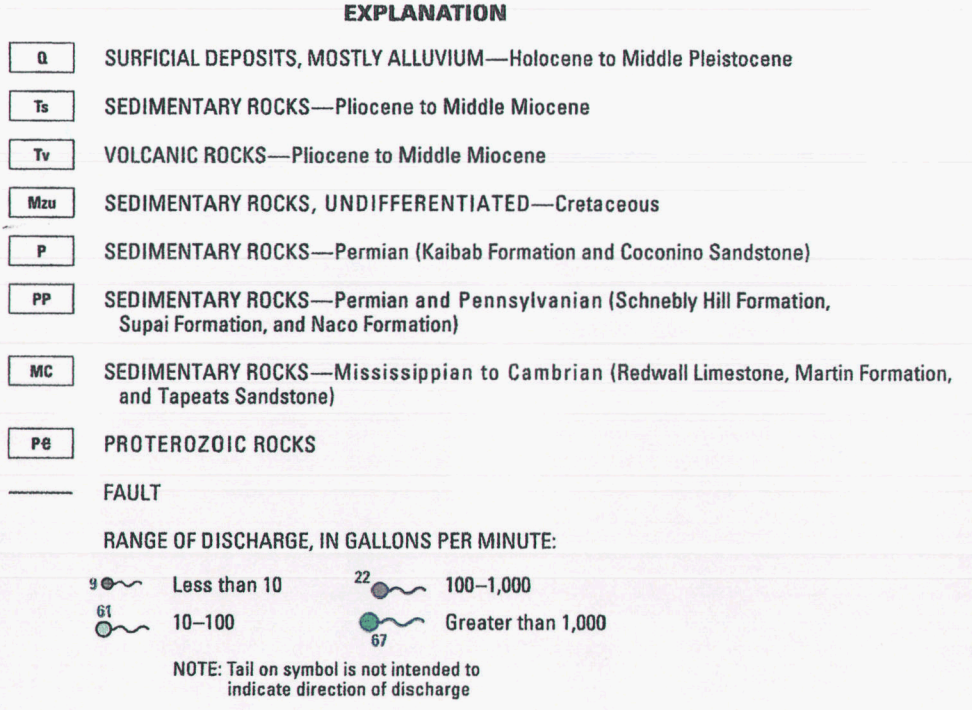


Figure 15. Continued.

For the most part, spring discharge measurements have been too few to allow meaningful statistical comparisons. Multiple discharge measurements are available, however, for four major springs. The Arizona Game and Fish Department operates hatcheries in the headwaters of Tonto and Canyon Creeks and has measured spring discharges monthly since 1980 (fig. 16*A*). Arizona State Parks has monitored flow in Pine Creek in Tonto Natural Bridge State Park once a day since May 2001. During base-flow conditions, most flow comes from Tonto Natural Bridge Spring (fig. 16*B*; Robert Sejkora, water program manager, Arizona State Parks, oral commun., 2003). Tonto National Forest collected 16 discharge measurements of flow in Fossil Creek below the springs between November 1999 and April 2001; measurements made above the springs showed that almost all flow was accounted for by discharge from the springs (fig. 16*C*). All these springs show fairly consistent minimum flows during the period of record and some spikes during periods of runoff. [illegible]on Spring is the only monitored spring to show a significant change in base flow over time—a decline of about 1,000 gal/min in average flow between 1992 and 1994 that has continued to the end of the period of record. Statistical summaries of discharge from the four springs shows them to be characterized by low variability and a generally narrow range of values (table 5).

Nearly half of all spring discharges recorded are below 10 gal/min (figs. 15 and 17). On the basis of inspection of several springs in the area, most that have never been measured probably do not exceed 10 gal/min, and during drought conditions, many are dry. A few springs account for almost all of the spring discharge in the Mogollon Highlands; indeed, the average discharge of 20,345 gal/min at Fossil Springs is greater than the total average discharge of all other springs in the study area (figs. 16 and 17). Despite their relative insignificance in the total water budget of the Mogollon Highlands, low-discharge springs do provide evidence of the hydrologic characteristics of the various water-bearing zones from which they discharge, and they also are of local environmental significance, providing moisture for meadowlands, riparian vegetation, and aquatic and wildlife habitat.

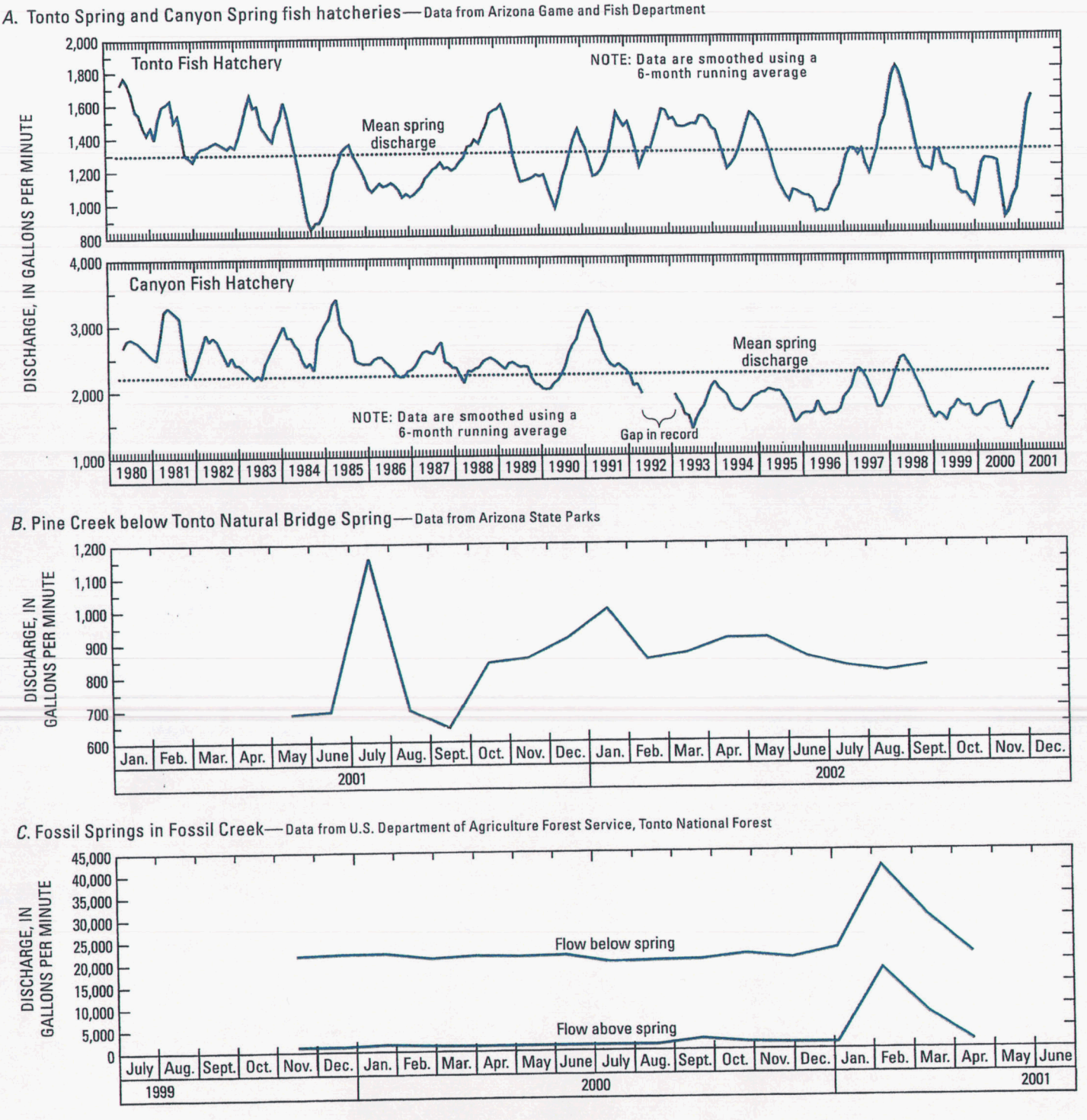


Figure 16. Discharge of springs for which repeated measurements are available, Mogollon Highlands, central Arizona: *A*, Spring discharge measured at fish hatcheries once a month; *B*, Discharge measured once daily in Pine Creek below Tonto Natural Bridge Spring; *C*, Discharge from intermittent current-meter measurements in Fossil Creek above and below springs.

Table 5. Statistical summary of discharge values for monitored springs, Mogollon Highlands, central Arizona

[harge values are in gallons per minute. Coefficient of variation is the standard deviation divided by the mean]

Spring name	Mean	Standard deviation	Coefficient of variation	Maximum	Minimum
Tonto	1,296	287	0.221	2,042	696
Canyon	2,224	597	.269	5,009	902
Tonto Natural Bridge	841	124	.148	1,157	641
Fossil	20,345	1,448	.071	23,743	18,407

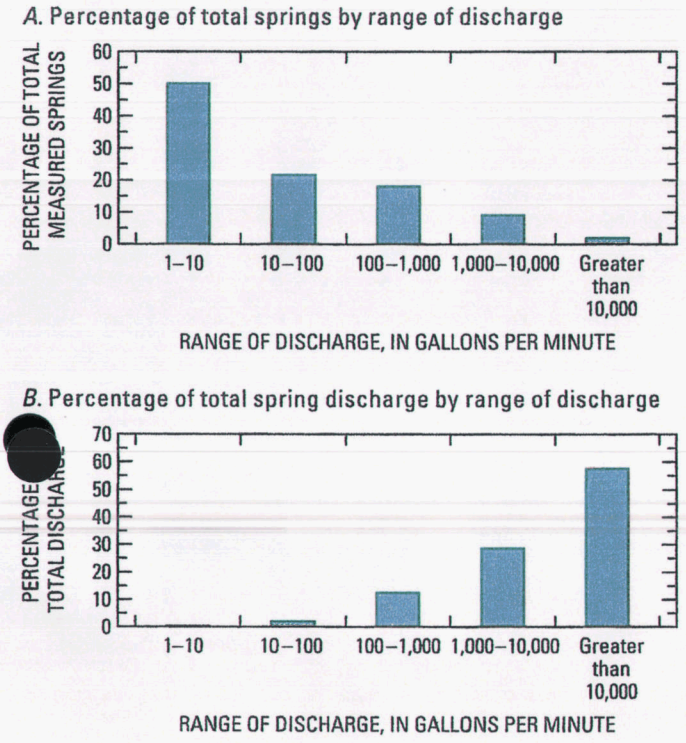


Figure 17. *A*, Percentage of total springs by range of discharge; *B*, Percentage of total spring discharge by range of discharge, Mogollon Highlands, central Arizona.

With the exception of Buckhorn Spring (table 4 and fig. 15, no. 15), springs having a discharge greater than 100 gal/min issue from carbonate rocks or just below carbonate rocks. Buckhorn Spring, which has a recorded discharge of 1,000 gal/min, issues from Coconino Sandstone beneath a layer of volcanic rocks in West Clear Creek on the Colorado Plateau. A cluster of springs, from Pieper Hatchery Spring (table 4 and fig. 15, no. 45) on the west in the East Verde River drainage to Canyon Spring (table 4 and fig. 15, no. 67) above Canyon Creek on the east, discharge from the Fort Apache Member of the Schnebly Hill Formation. These are the stratigraphically and topographically highest springs on the face of the Mogollon Rim. Most other large carbonate springs are in the East Verde River drainage where they discharge from the lower Paleozoic rocks of the Redwall Limestone or the Martin Formation, or at Tonto Natural Bridge Spring, from the base of the Paleozoic rocks where the Tapeats Sandstone overlies Proterozoic rocks. Fossil Springs discharges from near the contact between the Naco Formation and the Redwall Limestone. High-discharge carbonate springs tend to be where linear features mapped by Gettings and Bultman (geologists, U.S. Geological Survey, written commun., 2003) converge, suggesting that such springs occur at the intersection of large scale structural features indicated by geophysical properties, maps, and remotely sensed data.

Wells

About 750 wells within the study area are registered with the State of Arizona (fig. 14). Many of these wells are clustered around the communities of Payson and Pine-Strawberry, as well as in the northwestern corner of the study area on the outskirts of Camp Verde. There is also a high density of wells along the valley of lower Tonto Creek, and another string of wells parallels an aqueduct above the Mogollon Rim. The remainder of the 750 wells are sparsely scattered throughout the study area (fig. 14).

Although well data are important for analysis of a ground-water system, there is no information in USGS databases for most wells in the study area. Furthermore, the usefulness of the well data are limited by their patchy geographic distribution, few repeated water-level measurements, and the small percentage of wells for which discharge, aquifer characteristics, and hydrogeologic information were recorded. In 1979, the ADWR assumed the ground-water monitoring program from the USGS in Arizona; and in 1982, it merged its database

with the USGS database (W.H. Remick, hydrologist, Arizona Department of Water Resources, written commun., 2003).

From the 1950s to 2003, nearly 2,600 water-level altitudes were recorded for 522 wells; however, several anecdotal reports, especially before 1975, are problematic (table 6). Water-level reporting has been sporadic with most measurements recorded during the 1970s and 1980s, and a decline in the number of measurements after 1990. The ADWR measures water levels quarterly in 16 index wells in the Payson and Pine-Strawberry areas (table 6 and fig. 18, insets B and C). The town of Payson has conducted extensive monitoring of water levels in its production wells since at least the mid-1990s (fig. 18, inset C).

Most water levels reflect depths to water of less than 100 ft and all but about 40 values are less than 300 ft. All but six wells in the USGS database having water-level depths of more than 300 ft are on the Colorado Plateau. Although water levels typically are given for production levels, well logs, especially for deeper wells, frequently describe multiple water-bearing zones, and dry wells are not uncommon (Southwest Ground-water Consultants, Inc., 1998; AGRA Earth and Environmental, Inc., 1999; Weitzman, 2002).

Table 6. Selected wells for which water-level data are available, Mogollon Highlands, central Arizona

[In "Notes" column, 1 indicates water-chemistry data are available in table 8, and 2 indicates an Arizona Department of Water Resources index well]

Map code (see fig. 18)	Station name	Date of most recent water-level measurement	Land surface altitude (feet)	Water depth below land surface (feet)	Water-table altitude (feet)	Notes
1	A-01-08 19DAA3	12–17–1984	1,678	612	1,066	
2	A-03-08 33DBC UNSURV	12–03–1991	1,419	27.9	1,391	
3	A-04-01 31DAD	12–18–1984	1,214	383.8	830	
4	A-04-07 26CBA	03–24–1981	1,560	45.1	1,515	
5	A-04-08 19DD UNSURV	03–31–1981	1,660	62	1,598	
6	A-05-11 05DCC2	03–25–1981	2,190	37.8	2,152	
7	A-05-11 08BBC1	03–01–1969	2,161	5	2,156	1
8	A-05-11 08BBC2	03–01–1969	2,161	5	2,156	1
9	A-05-11 18AAA	10–13–1997	2,145	11.04	2,134	
10	A-06-03 03CCB2	08–18–1982	2,240	171.8	2,068	
11	A-06-10 10DAD1	08–01–1970	2,335	40	2,295	1
14	A-06-10 14ABA1	03–25–1981	2,321	29.5	2,292	
15	A-06-10 14ABA2	10–18–1978	2,320	32.7	2,287	1
16	A-06-10 14ABD1	08–01–1970	2,335	32	2,303	1
17	A-06-10 14ACA1	08–01–1970	2,315	11	2,304	1
18	A-06-10 14BBC	10–11–1978	2,380	14.4	2,366	
19	A-06-10 14BBD	04–01–1969	2,320	11	2,309	1
20	A-06-10 23ACC2	04–01–1976	2,290	20	2,270	
21	A-06-10 23DAC	06–27–1976	2,290	26	2,264	
22	A-06-10 26ABA2	08–01–1970	2,315	25	2,290	1
24	A-06-10 36DDA	11–03–1978	2,210	20	2,190	
25	A-06-11 05CAD	10–13–1997	2,720	43.7	2,676	
26	A-06-11 07BDC	11–02–1978	2,570	81.5	2,489	
28	A-06-11 31DDA	12–15–1976	2,200	18	2,182	

le 6. Selected wells for which water level data are available, Mogollon Highlands, central Arizona—Continued

Map code (see fig. 19)	Station name	Date of most recent water-level measurement	Land surface altitude (feet)	Water depth below land surface (feet)	Water-table altitude (feet)	Notes
29	A-07-09 19ABD2	04–23–1976	3,920	19	3,901	
30	A-07-10 10BAA	11–09–1979	2,590	66	2,524	1
33	A-07-10 22AAC	03–08–1977	2,450	9	2,441	
34	A-07-10 23CAB	09–02–1978	2,440	18.1	2,422	
37	A-08-10 13CBD	09–17–1977	2,720	12	2,708	
38	A-08-10 20ABA	03–17–1982	3,040	72.82	2,967	
39	A-08-10 27ACB2	02–02–1978	2,820	18	2,802	
41	A-09-10 05AAA	10–17–1997	4,200	97	4,103	
42	A-09-10 20BAA	10–13–1997	3,155	66.45	3,089	
44	A-09-10 24AAC1	02–21–1976	2,990	110	2,880	
46	A-09-10 25BDA3	11–10–1977	2,880	19	2,861	
48	A-09-10 29BAA	11–05–1976	3,080	20	3,060	
49	A-09-10 32ABB	09–03–1978	3,048	33.5	3,015	
50	A-09-10 32BDB	10–24–2002	3,030	40.3	2,990	2
51	A-09-12 23DBB	10–03–1979	5,120	23.61	5,096	
55	A-09-13 21BAB	10–04–1979	5,000	10.58	4,989	1
56	A-09-13 21BCB	10–03–1979	4,960	26.85	4,933	1
58	A-09-14 20ACA	10–21–2002	5,165	21.7	5,143	2
59	A-10-10 02DDB1	05–11–1993	4,960	43	4,917	
60	A-10-10 03ABA	03–27–1980	5,040	33.3	5,007	
61	A-10-10 03BAD	02–13–2003	4,985	213.2	4,772	2
62	A-10-10 03CBC	07–02–1975	4,950	49.3	4,901	
63	A-10-10 03CCD	02–14–2003	4,920	122.4	4,798	2
64	A-10-10 03DAC1	04–14–1981	4,980	87.57	4,892	
65	A-10-10 04ABD	02–17–1994	4,940	122	4,818	
66	A-10-10 04DBA	02–13–2003	4,960	210.7	4,749	2
67	A-10-10 05CCA	02–13–2003	4,820	45	4,775	1,2
68	A-10-10 05CCB	10–16–1975	4,800	20	4,780	1
71	A-10-10 08ABD	08–24–1987	4,820	27.3	4,793	
72	A-10-10 09ADB	02–13–2003	4,970	87.8	4,882	2
73	A-10-10 11ACB	02–13–2003	4,828	11.27	4,817	2
74	A-10-10 11BBA	06–11–1981	4,960	33.83	4,926	
75	A-10-10 22CAB	10–30–1992	4,860	57.2	4,803	
76	A-10-10 22CBB	05–16–1978	4,870	57	4,813	
77	A-10-10 22DBD1	11–03–1975	4,800	19.1	4,781	1

Table 6. Selected wells for which water level data are available, Mogollon Highlands, central Arizona—Continued

Map code (see fig. 19)	Station name	Date of most recent water-level measurement	Land surface altitude (feet)	Water depth below land surface (feet)	Water-table altitude (feet)	Notes
78	A-10-10 22DCA2	10–30–1984	4,840	44.01	4,796	
79	A-10-10 23DDB	08–19–1992	4,700	26.4	4,674	
80	A-10-10 25BBA	10–30–1992	4,650	20.7	4,629	
81	A-10-10 27CAA	11–19–1993	4,760	19.2	4,741	
82	A-10-10 28BCA1	10–25–1979	4,630	18	4,612	1
83	A-10-10 28BCA2	10–25–1979	4,650	25	4,625	1
84	A-10-10 28BCC2	06–02–1988	4,690	112.5	4,578	
85	A-10-10 28BCD1	10–25–1979	4,640	28.9	4,611	1
87	A-10-10 29ADD	03–01–1976	4,700	22	4,678	
88	A-10-11 05BAD	07–17–1975	4,600	7.8	4,592	1
90	A-10H12 19DAD	07–17–1975	5,270	10	5,260	1
92	A-10H14 20BAC	09–24–1979	6,180	14.44	6,166	1
93	A-10H14 27CBD	09–25–1979	6,200	45	6,155	1
94	A-10H14 27CCB	09–25–1979	6,550	41.45	6,509	
95	A-11-10 11AAA1	08–05–1975	4,920	212.6	4,707	
97	A-11-10 23AAD1	07–01–1975	5,180	236	4,944	
99	A-11-10 23ACA	07–01–1975	5,150	134	5,016	1
101	A-11-10 27CCB	02–13–2003	5,000	159.2	4,841	1,2
102	A-11-10 27DDB	02–17–1994	5,052	84.7	4,967	
103	A-11-10 28DBD	07–02–1975	5,040	190	4,850	
104	A-11-10 31DAC	11–05–2002	5,060	176.3	4,884	2
105	A-11-10 32ACD	02–13–2003	5,140	342	4,798	1, 2
106	A-11-10 34ABA	11–20–1998	5,070	91	4,979	2
107	A-11-10 35CCC	02–13–2003	5,060	129.3	4,931	2
108	A-11-10 36AAA	07–14–1975	4,750	20.3	4,730	
109	A-11-10 36ADD4	08–25–1975	4,725	15	4,710	
110	A-11-11 27BBB	08–21–1975	5,050	162	4,888	
111	A-11-11 27BBD	08–22–1975	5,080	130.7	4,949	
112	A-11-11 27BCB1	07–16–1975	5,040	140	4,900	1
113	A-11-11 27CBC	07–16–1975	4,920	81	4,839	
115	A-11-11 31ADC1	07–15–1975	4,650	94.5	4,556	1
116	A-11-11 31CAA	07–14–1975	4,680	25.3	4,655	
117	A-11-11 31DBC	07–14–1975	4,680	20	4,660	
118	A-11-11 32BBC1	07–16–1975	4,670	42.2	4,628	
119	A-11-11 32CBB	07–15–1975	4,670	35	4,635	1

Table 6. Selected wells for which water level data are available, Mogollon Highlands, central Arizona—Continued

Map code (see fig. 19)	Station name	Date of most recent water-level measurement	Land surface altitude (feet)	Water depth below land surface (feet)	Water-table altitude (feet)	Notes
120	A-11-11H05DBC	12–23–1973	5,800	194	5,606	
121	A-11-11H05DCD	08–21–1975	5,770	181.5	5,589	1
122	A-11-11H08AAA	08–21–1975	5,750	162	5,588	1
124	A-11-12 04CDC	07–17–1975	5,800	151	5,649	
125	A-11-12 32BBA	08–21–1975	5,720	91.5	5,629	1
126	A-11-12 34ADD2	10–14–1979	5,000	8.2	4,992	
127	A-11-13 20CCB1	10–11–1979	5,860	18.7	5,841	
128	A-11-13 29CCD	05–14–1952	5,800	14.96	5,785	1
129	A-11-13 30AAB	05–18–1974	5,820	58	5,762	1
130	A-11-13 34CBA	08–23–1975	6,165	18.6	6,146	1
131	A-11-13 34CBA2	10–21–2002	6,145	148.8	5,996	2
132	A-11-13 35DAD1	09–24–1979	6,240	60.63	6,179	1
133	A-11-13 36CAC	09–24–1979	6,300	50	6,250	1
135	A-11-14 13ACA	06–14–1966	7,555	403	7,152	
136	A-11-14 14BAB	08–01–1959	7,500	435	7,065	1
137	A-11-14 22CBD	08–09–1966	7,575	680	6,895	1
139	A-11-15 20BDC	06–14–1966	7,550	696.6	6,853	
140	A-11-16 20ADB2	06–01–1973	6,865	410	6,455	
143	A-11H11 35BBB	07–17–1975	5,510	123.4	5,387	1
144	A-11H11H32ABC	01–01–1958	5,980	700	5,280	
145	A-12-07 32B UNSURV	07–01–1975	3,585	92	3,493	
146	A-12-08 20DAD	05–05–1987	5,880	168.8	5,711	
147	A-12-08 21CCA2	05–04–1987	5,839	98	5,741	
148	A-12-08 21CCC1	11–07–1974	5,770	69	5,701	1
149	A-12-08 21CDC2	11–19–1993	5,790	68.8	5,721	
151	A-12-08 22CAC	11–08–1974	5,920	258	5,662	
152	A-12-08 22CCC1	02–13–1998	5,840	126.1	5,714	
153	A-12-08 22CDA	11–08–1974	5,900	79	5,821	
154	A-12-08 22DCB	05–06–1987	5,880	89.2	5,791	
155	A-12-08 24DAD	05–05–1987	5,760	218.9	5,541	
156	A-12-08 25AAC	11–19–1993	5,562	164.8	5,397	
157	A-12-08 25ABB	05–05–1987	5,820	274.1	5,546	
158	A-12-08 25ACC	05–05–1987	5,590	151.27	5,439	
159	A-12-08 25ADC	10–17–1974	5,523	72.5	5,451	1
160	A-12-08 25CCA	10–17–1974	5,517	87	5,430	

Table 6. Selected wells for which water level data are available, Mogollon Highlands, central Arizona—Continued

Map code (see fig. 19)	Station name	Date of most recent water-level measurement	Land surface altitude (feet)	Water depth below land surface (feet)	Water-table altitude (feet)	Notes
161	A-12-08 25CDC	05–06–1987	5,460	81.8	5,378	
162	A-12-08 25DCB	05–05–1987	5,470	188.1	5,282	
163	A-12-08 26DAB	02–13–1998	5,645	100.1	5,545	
165	A-12-08 28BAA1	05–06–1987	5,790	110.4	5,680	
166	A-12-08 29AAA2	09–09–2001	5,755	1,377.5	4,378	2
167	A-12-08 29AAB	11–07–1974	5,740	100.5	5,640	
168	A-12-08 29BAB	05–04–1987	5,705	88.9	5,616	
169	A-12-08 30AAD	05–04–1987	5,675	137	5,538	
170	A-12-08 30ABA	11–15–2002	5,820	709.9	5,110	2
171	A-12-08 36ADD	05–06–1987	5,420	530.9	4,889	1
172	A-12-08 36CBB	11–07–1974	5,435	336	5,099	
173	A-12-09 19BAC	05–05–1987	5,715	114.1	5,601	
174	A-12-09 19CCC1	10–17–1974	5,620	79	5,541	1
175	A-12-09 30BBA1	11–28–1968	5,545	28.5	5,517	1
176	A-12-09 30BBA5	05–05–1987	5,556	23.76	5,532	
178	A-12-09 31BAC2	05–06–1987	5,580	229.8	5,350	
179	A-12-09 36CBB	01–01–1971	5,450	680	4,770	
181	A-12-12 16BDC	10–30–1997	7,503	498.99	7,004	
182	A-12-13H01BBD	07–22–1964	7,160	750	6,410	
183	A-12-15 36DDC	06–13–1972	6,960	535	6,425	1
184	A-12-16 24BBA	05–15–1968	6,450	287.3	6,163	
185	A-12-16 25CAD	11–21–1972	6,520	426.9	6,093	
186	A-12-17 32CAD	10–02–1969	6,637	543.5	6,094	
188	A-13-05 05BDC	10–14–1997	3,110	57.1	3,053	
189	A-13-05 05DAB2	12–01–1976	3,095	45.6	3,049	
190	A-13-05 06DCB3	03–23–1982	3,062	18.27	3,044	
191	A-13-05 08AAB2	03–26–1981	3,074	25.71	3,048	
192	A-13-05 09DBA1	04–09–1981	3,190	137.48	3,053	
193	A-13-05 09DCC	03–23–1982	3,078	47.54	3,030	
194	A-13-05 11DAB	01–25–1982	3,210	94.07	3,116	
195	A-13-05 13BAC1	12–08–1976	3,195	93.3	3,102	
196	A-13-05 13BDA	03–31–1977	3,190	12.5	3,178	
197	A-13-05 15AAA	03–28–1983	3,129	40.99	3,088	
198	A-13-05 15BAC	12–02–1976	3,105	35	3,070	
199	A-13-05 16ACB2	08–26–1981	3,048	15.98	3,032	

Table 6. Selected wells for which water level data are available, Mogollon Highlands, central Arizona—Continued

Map code (see fig. 19)	Station name	Date of most recent water-level measurement	Land surface altitude (feet)	Water depth below land surface (feet)	Water-table altitude (feet)	Notes
200	A-13-05 21ABD2	01–28–1982	3,015	11.54	3,003	
201	A-13-05 21BAB	08–26–1981	3,021	12.85	3,008	
202	A-13-05 26ADA	02–02–1977	3,390	389.72	3,000	
203	A-13-05 27CAD	01–28–1982	3,010	72.45	2,938	
204	A-13-05 27DCB2	11–09–1981	2,995	28.3	2,967	
205	A-13-06 11BAB	03–10–1978	3,670	35.1	3,635	
206	A-13-06 13BCD	02–15–1978	4,500	233	4,267	
207	A-13-06 23BBC	09–22–1966	4,420	347	4,073	
208	A-13-07 14BAB	10–13–1997	5,955	729.9	5,225	
209	A-13-10 06ADA	02–10–1972	6,865	472	6,393	
210	A-13-10 24DCC	10–08–1963	7,276	447	6,829	
211	A-13-10 25CAA	06–10–1964	7,334	427	6,907	
212	A-13-15 14DCA	10–01–1971	6,830	910	5,920	
213	A-14-04 13BDA	10–31–1979	3,120	30	3,090	
214	A-14-05 26DAB	05–27–1981	3,665	550.8	3,114	
215	A-14-06 26BDC	05–26–1981	4,400	240	4,160	
216	A-14-10 02ACB	07–11–1978	6,697	295	6,402	1
217	A-14-10 07CDB	04–16–1985	6,850	517.5	6,333	
218	A-14-10 30ACA	07–13–1966	6,900	867	6,033	
219	A-14-10 32DBD	10–13–1997	6,855	332.1	6,523	
220	A-14-11 09ADC	10–17–1997	6,905	507.5	6,398	
221	A-14-11 09DCA	07–20–1966	6,885	471.5	6,414	
222	A-14-11 12BCD	07–21–1966	6,730	358.4	6,372	
224	A-14-22 13CBC	09–06–1972	5,697	394.3	5,303	
225	A-15-11 05BDC	06–22–1966	6,710	640.3	6,070	
226	A-15-11 33DCD	09–18–1972	6,760	385	6,375	
227	A-15-11 34DCD	09–20–1966	6,810	461.32	6,349	
228	A-15-12 15DDC	10–17–1997	6,503	669.3	5,834	
230	A-15-13 30A	06–30–1967	5,993	99.6	5,893	
231	A-16-09 10CCC1	12–10–1976	7,845	30	7,815	

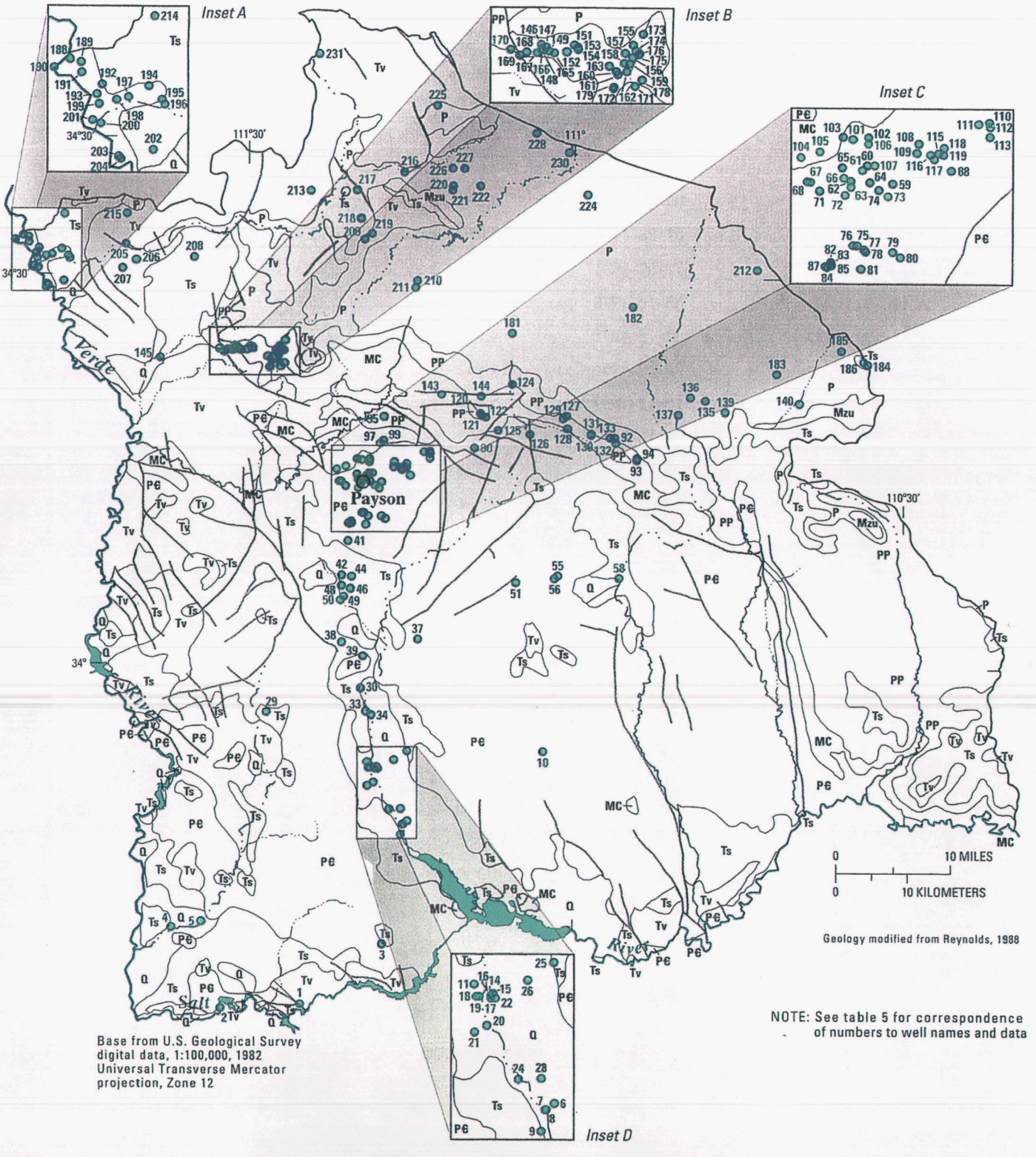


Figure 18. Selected wells for which water-level data are available, Mogollon Highlands, central Arizona.

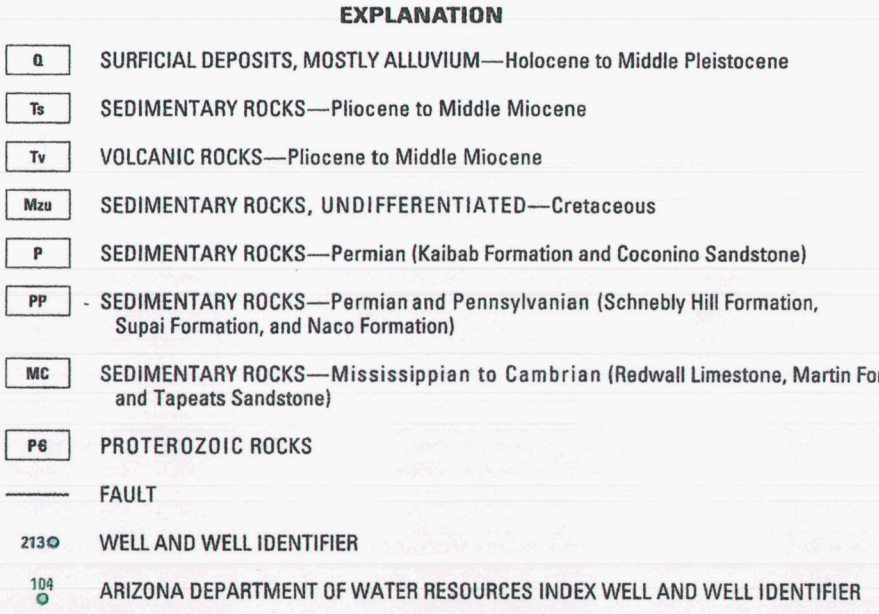


Figure 18. Continued.

The shallowest water levels tend to be in the wells of lower Tonto Creek Basin where median depth to water in 209 wells is 20 ft, and the maximum recorded depth to water is 123 ft. In the Payson area, 125 wells have a median depth to water of 55 ft and a maximum depth to water of 342 ft; 82 wells in the Pine-Strawberry area have a median depth to water of 100 ft and a maximum depth to water of 1,379 ft; and on the Colorado Plateau, 49 wells show a median depth to water of 438 ft and a maximum depth to water of 910 ft. Finally, wells in the tablelands from the East Verde River eastward have a median depth to water of 47.5 ft and a maximum depth to water of 700 ft (table 6 and fig. 18).

Although water levels have been repeatedly measured in some wells, gaps of 5 to 10 years are common for wells in and around Payson and in the Pine-Strawberry area (fig. 19 and table 6). On the basis of data from the few wells which have been measured repeatedly since the 1970s or 1980s, water levels at depths below 300 ft generally were stable into the late 1980s, fluctuated after the 1980s, and showed a general but not universal declining trend since the mid-1990s (fig. 19). Wells deeper than 300 ft for which repeat measurements are available show little water-level fluctuation (fig. 19).

Pumping discharge values are recorded for 131 wells in the USGS database, and there are no repeated measurements available. About 70 percent of wells for which there is a record show discharges of less than 50 gal/min. The highest density of recorded well-discharge values is near Payson, Pine-Strawberry, and near the mouth of West Clear Creek. The mean discharge of 19 wells in the Payson area is 35 gal/min, but only 4 wells have discharges above the mean. Pine-Strawberry wells also yield about 35 gal/min. Almost all wells having discharges of 50 gal/min or more are on the Colorado Plateau where they are drilled mainly into the Coconino Sandstone. The few discharge values that are available for wells on the tablelands east of the East Verde River ranged from 13 to 50 gal/min.

Hydrogeology

Almost all the rock units within the study area contain some water-bearing zones, although the hydrogeology of some units have been studied little or not at all. Working in the Flagstaff area, Bills and others (2000) characterize the hydrologic properties of the Paleozoic sedimentary rocks and regard all of the units from the Kaibab Formation to the Middle Supai Formation as part of the regional C aquifer; they describe the Lower Supai Formation as a confining unit and regard the Redwall Limestone and Martin Formation as a limestone aquifer. The characterization appears appropriate for the Mogollon Highlands as well. In addition, the Naco Formation, which does not occur in the Flagstaff area, has many of the properties of underlying carbonate units, including dissolution features that are conducive to flow, and it is considered here to be a component of the limestone aquifer. In some parts of the study area, rocks that are water bearing elsewhere in Arizona have been uplifted along high-angle faults and drained.

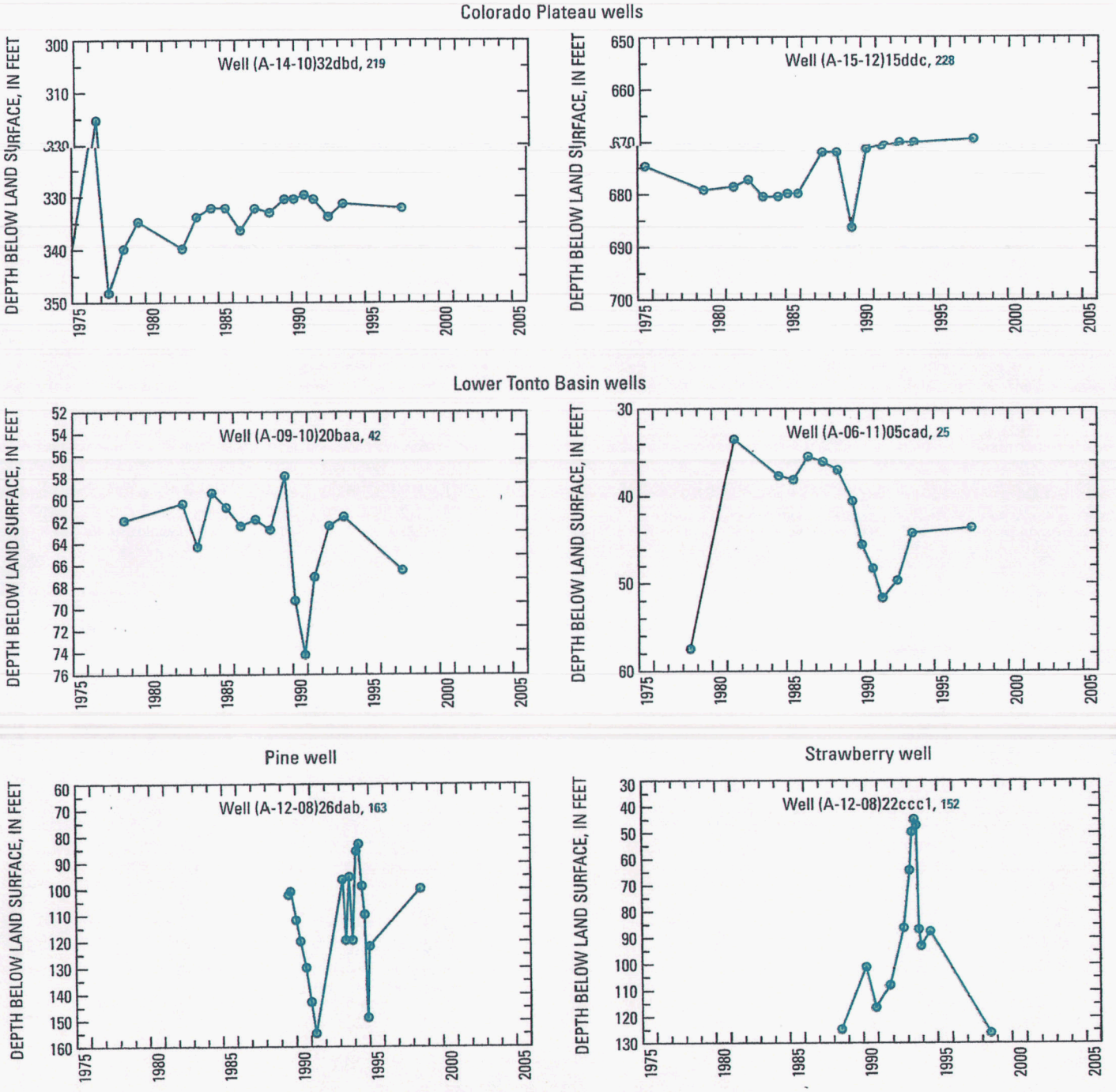
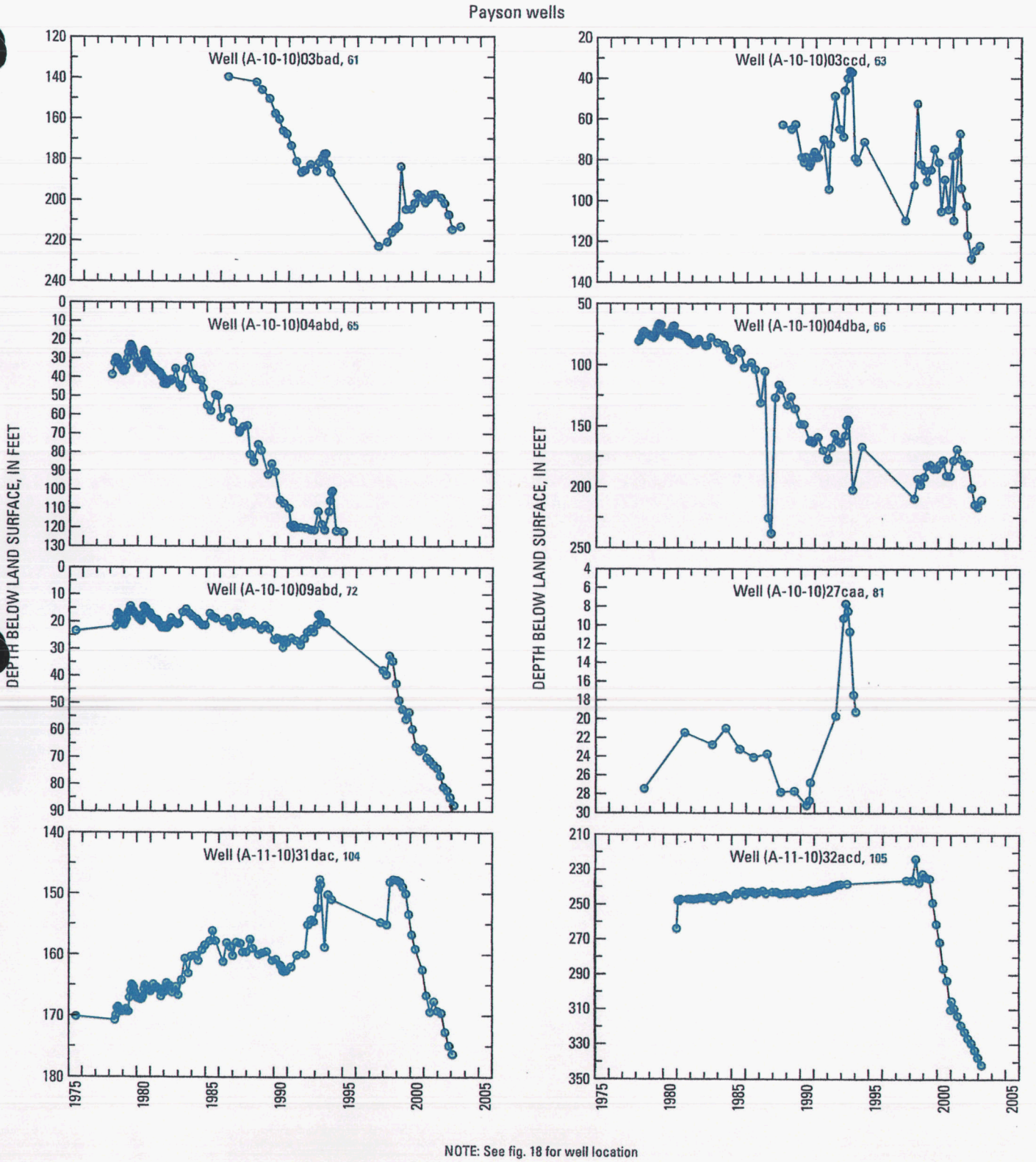


Figure 19. Time series of water depths in selected wells, Mogollon Highlands, Arizona.



NOTE: See fig. 18 for well location

Figure 19. Continued.

Hydrogeologic Units

Tertiary-Quaternary Alluvium and Basin Fill

The basin fill of the Tonto Creek Basin generally is of low permeability, and well productivity is low (Denis, 1981). Water resources in the basin are lightly developed and the alluvial aquifer has not been well studied. Wells in the alluvium of the lower Tonto Creek Basin typically are shallow and of low productivity.

Tertiary Volcanic Rocks

The mainly basaltic Tertiary volcanic rocks in the northwestern part of the study area are the only such rocks in the study area known to be of any hydrogeologic significance. Two low-discharge springs in Fossil Creek Canyon, (A-12-07)22C (table 4 and fig. 15, no. 12) and (A-12-07)21D (not shown), most likely flow from a locally recharged aquifer. Few wells are completed in volcanic rocks, and those for which production information is available show discharges generally below 20 gal/min.

Upper Paleozoic Rocks

The Coconino Sandstone is the primary water-bearing unit of the C aquifer elsewhere in Arizona, particularly in the Little Colorado River Basin to the north of the study area (Hart and others, 2002). Within the study area, the Coconino Sandstone is the most important aquifer for well production on the Colorado Plateau. The Coconino Sandstone and the Kaibab Formation, where it exists, are also the transport zones for recharge of underlying aquifers. Although a mound of ground water, centered north of the Tonto Creek drainage basin, is believed to exist along the edge of the Mogollon Rim (Hart and others, 2002), no significant springs issue from cliffs formed by the Coconino Sandstone within the study area except for Buckhorn Spring, which discharges from the unit into West Clear Creek. Both the Kaibab Formation and the Coconino Sandstone show extensive secondary permeability in the form of solution features in limestone and pervasive fracturing that contribute to rapid vertical flow.

Middle Paleozoic Rocks

The base of the C aquifer is in the middle Paleozoic rocks of either the Schnebly Hill Formation or the Supai Formation in the eastern part of the study area (Hart and others, 2002). The C aquifer does not seem to discharge from the face of the Mogollon Rim in the western part of the study area. The stratigraphically highest discharge of any significance comes from the perennial springs of the upper East Verde River, Tonto Creek, Christopher Creek, and Canyon Creek that issue from the Fort Apache Member of the Schnebly Hill Formation (fig. 15). These springs are found within prominent recesses in the wall of the Mogollon Rim that are probably formed from sapping erosion related to the spring position (Higgins, 1990). The consistent north to northeast trend of the recesses suggests that spring location is related to large-scale structural features. The existence of such features seems to be consistent with the occurrence of springs at the convergence of lineations deduced by Gettings and Bultman (geologists, U.S. Geological Survey, written commun., 2003). East of Pieper Hatchery Spring, springs along the upper face of the Mogollon Rim have low discharges and issue mainly from the clastic sedimentary rocks of the Schnebly Hill Formation or from the underlying Supai Formation (fig. 15).

The only wells below the crest of the Mogollon Rim that produce water from the Schnebly Hill Formation are in the Strawberry area. In neighboring Pine, most wells are completed in the Supai Formation, and the few well-discharge data available show yields of about 10–30 gal/min in the Pine area and 20–80 gal/min in Strawberry. Kaczmarek (2003) suggests that this is because well production in both areas is dependent on the proximity of fractures within the host rocks, but the somewhat greater primary porosity of the Schnebly Hill Formation allows for some ground-water storage that permits more rapid and dependable flow into fractured areas as water is pumped from them. The importance of fractures and other secondary permeability features in conductance of ground-water flow is illustrated by the ranges of transmissivity and hydraulic conductivity values, more than three to four orders of magnitude, that have been published for wells completed in the C aquifer (Mann and Nemecek, 1983; Bills and others, 2000; Hart and others, 2002). The absence of spring discharge from the Fort Apache Member of the Schnebly Hill Formation above Pine and Strawberry, the low discharge from springs in the clastic rocks, and the generally poor production of wells in the Pine-Strawberry area suggest that the regional C aquifer does not intersect the face of the Mogollon Rim in this area; rather, the ground-water system within the upper Paleozoic rocks of this area appears to be a local aquifer.

The Naco Formation has several characteristics, including fractures, open bedding planes, and solution features that would favor rapid transmission of a large volume of ground water, but the unit generally stands above the saturated zone in the study area. Wells penetrating the Naco Formation in the Pine area commonly intersect voids, and there is little production from the unit (Kaczmarek, 2003). During drilling of the Strawberry exploratory well, (A-12-08)29AAA2 (table 6 and fig. 18, insert B; no. 166), no cuttings were obtained below a depth of 970 ft because of loss of fluid circulation associated with large voids or fractures at that level. Voids were repeatedly encountered and drilling was finally suspended at a depth of 1,460 ft because of unacceptable fluid losses. On the basis of well logs, geophysical data, and regional stratigraphy, Corkhill (2000) placed the Naco Formation between 1,040 and 1,295 feet deep in this area, about 85 ft above the saturated zone. At Fossil Creek, springs discharge from rocks at the base of the Naco Formation or the top of the Redwall Limestone—the only location where saturation of the Naco is evident. Because of its physical characteristics, however, the Naco Formation may be considered to be part of the limestone aquifer that generally is associated with the lower Paleozoic rocks of the Redwall Limestone and Martin Formation. The limestone aquifer must be supplied at least in part from the leakage through the overlying Permian-Pennsylvanian rocks from the C aquifer and thus ground water must travel through the Naco Formation at some locations beneath the Plateau.

Lower Paleozoic Rocks

The limestone aquifer is composed mainly of rocks of the Redwall Limestone and Martin Formation. Within the study area, the main discharge points from the limestone aquifer are the large-volume springs in the middle reaches of the East Verde River and its tributaries and in Fossil Creek. Discharge from the limestone aquifer also is likely into all the major streams draining the study area, except perhaps West Clear Creek. Wells drilled into the limestone aquifer are few, are mainly concentrated in the Tonto Village-Kohls Ranch area (fig. 1), and are not highly productive. The limestone aquifer has not been extensively studied. Farrar (1980) investigated the hydrological properties of the Redwall Limestone and the Jerome Member of the Martin Formation and found that primary porosity was of little importance in both formations. In the Mooney Falls Member of the Redwall Limestone, the only member of the formation that is present in the study area, Farrar found that virtually all secondary porosity was the result of karst formation that resulted in a highly variable distribution of solution conduits. Fractures and solute-widened bedding planes in the upper Jerome Member of the Martin Formation provide the secondary porosity of that unit. Caverns in the Martin Formation were most likely to occur at the intersection of large joints or faults. From eight wells in the Flagstaff area, Farrar (1980) reported specific capacity values ranging from 0.9 gal/min/ft at the Supai-Redwall contact to 100 gal/min/ft at the Redwall-Martin contact.

Two high-discharge springs flow from below the Paleozoic section in the study area. Tonto Natural Bridge Spring discharges from the Tapeats Sandstone (Feth and Hem, 1963), and R-C Spring east of Tonto Creek discharges from the Mazatzal Group quartzite (fig. 15 and table 3); however, both the volume of spring discharge and the nature of the rocks from which the springs discharge suggest that the main flow paths are through the limestone aquifer.

Proterozoic Igneous and Metamorphic Rocks

The hydrogeological characteristics of the Payson granite and related intrusive rocks have been studied more extensively than any other units in the Mogollon Highlands because of Payson's reliance on the fractured-rock aquifer for its water supply (Southwest Ground-water Consultants, Inc., 1998; AGRA Earth and Environmental, Inc., 1999; Ploughe, 2000, 2001; Gæorama, Inc., 2001, 2003). The Payson granite is extensively fractured and faulted. Proterozoic faults typically are mineralized and of little hydrologic importance, but Tertiary faulting has created significant secondary permeability. Although most wells are shallow, the town of Payson began an exploratory well-drilling program north of the town in 1999 in which water-bearing zones as deep as 750 ft were located (Ploughe, 2000). On the basis of numerous aquifer tests throughout the area, transmissivity ranges from 40 to 2,270 ft^2/d and is greatest where wells are associated with major fracture systems (Southwest Ground-water Consultants, Inc., 1998). In general, shallow water-bearing zones are dependent on winter recharge and thus are highly susceptible to drought (Ploughe, 2001); however, water in deeper fracture systems might be fed by sources flowing into the system from the Mogollon Rim (Gæorama, Inc., 2003). The lowest productive level of the Payson granite might be as deep as 1,000 ft (Gæorama, Inc., 2003). The Payson granite aquifer is characterized by numerous local ground-water divides so that the effects of drawdown in one well or well field may be restricted to a localized area (AGRA Earth and Environmental, Inc., 1999). The few springs that discharge from Proterozoic igneous rocks show low discharges (table 4 and fig. 15, nos. 40 and 41).

Other Proterozoic rocks in the area are little studied. A handful of wells are completed in the Proterozoic rocks of the Mazatzal Mountains and the Sierra Ancha; a few springs emit discharges of less than 10 gal/min (table 4 and fig. 15, nos. 16 and 21). In general, such rocks probably are barriers to ground-water flow where they are in contact with water-bearing rocks.

Water Chemistry

Chemical data are available for 23 springs (table 7 and figs. 20–23), 81 wells (table 8 and figs. 24 and 25), and 4 streams (table 9). Surface and ground waters in the study area are largely dilute waters that have specific conductance values below 1,000 µS/cm. A specific conductance value typically reflects the amount of material dissolved in water and enables an estimate of the total solute concentration. The total solute concentration, in mg/L, typically is on the order of two-thirds of the specific conductance value. Stream and spring temperatures can vary greatly as a function of season, time of collection, discharge rate, and physical setting. Stream chemistry reflects that of the ground water that supports the base flow of the stream and the volume and composition of varying seasonal runoff. During the lowest flows in smaller streams, the total solute concentration can be significantly increased by evaporation.

Concentrations of sodium, chloride, and sulfate tend to be higher in ground waters that have longer residence times in their respective aquifers. Both major and minor dissolved constituents reflect the rocks through which the waters have flowed.

Chemistry of Spring Waters

Thirty-two analyses of varying completeness are available for the 23 springs for which data were identified or developed (table 7 and figs. 20–22). In addition to the these chemical analyses, 22 samples were collected from 19 springs for stable hydrogen- and oxygen-isotope data (δ^2H and $\delta^{18}O$) in this study, and 10 samples of water and rock were taken for strontium isotope ($^{87}Sr/^{86}Sr$) analyses (tables 10 and 11 and figs. 20 and 23). Three of the hydrogen- and oxygen-isotope samples were collected from separate outlets in Fossil Springs. The δ^2H and $\delta^{18}O$ data plot in a tight group slightly above and left of the meteoric water line (fig. 23), indicating that the recharge is dominated by precipitation that falls during the coldest part of the year (Craig, 1961). When compared to stable-isotope values for precipitation collected at Flagstaff from 1961 through 1971, values for the spring samples from this study fall within the range of values for cold-season precipitation samples, those having $\delta^{18}O$ values smaller than -9 per mil (fig. 23). Data from one spring sample, Pig Spring in mafic granitic rocks south of Payson, were discarded because the $\delta^{18}O$ value of about -2 per mil reflects a sample that underwent substantial evaporation prior to collection and is not representative of spring discharge at that site. The range of the spring isotopic data, although narrow relative to recent precipitation data, indicates that most of the springs discharging at or near the Mogollon Rim, particularly those having the highest discharge, isotopically resemble the discharge of Fossil Springs (table 10, no. 14 and fig. 23). In general, those springs having lower discharge and those farther from the Mogollon Rim reflect either a warm-season component or evaporative enrichment. Strontium-isotope data generally show a close relation between isotope composition of water and that of the host rocks from which the springs discharge (table 11).

The specific-conductance values for the 23 springs range from 25 to 753 µS/cm. These are dilute, fresh waters. Three of the springs—(A-12-07)21D UNSURV (table 7, no. 11), (A-12-10)01BDA (table 7, no. 46 and figs. 20 and 21), and (A-12-13H)01BBD (table 7, no. 62 and figs. 20 and 21)— are calcium sodium bicarbonate types; the remainder are calcium magnesium bicarbonate types (fig. 21), following the hydrochemical facies scheme described by Back (1961). The springs discharging the most dilute waters (specific conductance ≤ 250 µS/cm) are four of the seven on the Colorado Plateau—Pivot Rock, (A-12-10)01BDA, (A-12-12)11BAB, and (A-12-13H)01BBD (table 7, nos. 30, 46, 57, and 62 and figs. 20 and 22*A*)—three near the Mogollon Rim in the headwaters area of Tonto Creek—Horton, Tonto, and See Springs (table 7, nos. 56, 52, and 61 and figs. 20 and 22*A*)—and Bear Flat Spring, 5 to 6 mi downstream from the near-rim group (table 7, no. 54 and figs. 20 and 22*A*). The reported value for Dripping Springs of 74 µS/cm probably is in error as it does not agree with the analytical data (table 7, no. 25 and figs. 20 and 22*A*). Spring (A-12-10)01BDA (table 7, no. 46, figs 20 and 22*A*) is the most dilute and owes its composition to recharge into and flow through the Coconino Sandstone. The Coconino is a clean, indurated quartz (98 percent) sandstone, containing about 2 percent feldspar and chert, that is cemented by silica, calcite, and iron oxides. Feldspar grains in the Coconino are the primary source of solutes in waters derived from that formation. The reported calcium, magnesium, and sodium concentrations and low bicarbonate concentration rule out a limestone or calcite contribution, as does the low pH, which also indicates relatively brief interaction with the feldspars. This spring is indicative of the starting chemistry of water discharged by most of the springs in the study area. Departures from this model are the result of water-rock interactions along respective flow paths.

Table 7. Physical and chemical properties and chemical composition of spring waters in the Mogollon Highlands, central Arizona

[µS/cm, microsiemens per centimeter; mg/L; milligrams per liter; µg/L, micrograms per liter; FET, fixed end point titration; IT, incremental titration; ANC, acid neutralizing capacity; <, less than. Dashes indicate no data]

Map code (see fig. 20)	Station name	Spring name	Date	Time	Specific conductance (µS/cm)	pH, field	Water temperature (degrees Celsius)	Oxygen, dissolved (mg/L)
54	A-10H12 24AAB	Bear Flat	07–16–1975	1100	250	7.5	---	---
54	A-10H12 24AAB	Bear Flat	10–20–1952	---	348	---	16.5	---
58	A-11-12 26BDB	R-C	07–31–1997	1130	330	7.44	15.5	6.0
58	A-11-12 26BDB	R-C	05–14–1952	---	275	---	9	---
37	A-11-10 08AAD	Big	08–21–1997	900	480	7.3	16	47.8
22	A-11-09 05DCA	Tonto Natural Bridge	08–19–1997	830	620	7.4	20	5.6
50	A-11-12 20DAB	Indian Gardens	07–15–1975	1300	700	7.1	---	---
50	A-11-12 20DAB	Indian Gardens	07–30–1997	1430	645	7.13	14.5	6.2
50	A-11-12 20DAB	Indian Gardens	05–17–1952	---	497	---	14.5	---
42	A-11H10 24BCA1		08–04–1998	1400	290	7.3	11	5.5
52	A-12-12 33BAC	Tonto	07–31–1997	900	145	7.09	9	11.5
52	A-12-12 33BAC	Tonto	10–17–1952	---	174	---	9	---
10	A-12-07 21DCD1		05–24–1978	945	560	7.3	16	---
11	A-12-07 21DCD2		08–18–1997	1100	470	7.6	25	5.7
35	A-12-09 24CCC	Geronimo	08–20–1997	900	530	7.4	14.5	43.6
12	A-12-07 22C UNSURV		05–24–1978	1530	510	8.2	19	---
14	A-12-07 14D UNSURV	Fossil	05–24–1978	1100	700	6.7	22	---
14	A-12-07 14D UNSURV	Fossil	08–07–1998	1030	720	7	21	5.1
14	A-12-07 14D UNSURV	Fossil	07–15–1959	---	745	7.3	21	---
14	A-12-07 14D UNSURV	Fossil	02–16–1952	---	753	---	21.5	---
48	A-12-11 12AAC		08–22–1995	1430	305	7.38	13	7.0
57	A-12-12 11BAB		08–23–1995	1130	110	7.36	22	5.0
46	A-12-10 01BDA		08–22–1995	1200	25	6.34	16	3.5
62	A-12-13H01BBD		08–21–1995	1500	75	6.77	14	5.9
30	A-13-09 28ABB	Pivot Rock	08–01–1994	1200	210	7.26	10	8.3
27	A-14-09 31DDC	Bear	05–27–1959	---	418	7.8	11	---
15	A-14-08 32A UNSURV	Buckhorn	05–28–1959	---	401	8	---	---
39	A-11-10 04CAD	Webber	10–22–2002	830	459	7.3	14.4	3.3
61	A-11-13 08CBB	See	10–22–2002	1500	250	7.7	9.5	8.2
25	A-12-09 30DDD2	Dripping	10–24–2002	1015	74	6.9	13.3	6.6
56	A-11-12 02BDB	Horton	10–23–2002	1042	186	7.3	10.2	8.3
43	A-12-10 11CCD	Washington	10–22–2002	1205	301	7.50	10.1	7.3

Table 7. Physical and chemical properties and chemical composition of spring waters in the Mogollon Highlands, central Arizona—Continued

Map code (see fig. 20)	Carbon dioxide, dissolved (mg/L)	Hardness, total (mg/L as $CaCO_3$)	Alkalinity, dissolved, FET, field (mg/L as HCO_3)	Alkalinity, dissolved, IT, field (mg/L as $CaCO_3$)	Alkalinity, total, FET, field (mg/L as $CaCO_3$)	ANC, total, FET, lab (mg/L as $CaCO_3$)	Dissolved solids, sum of constituents (mg/L)	Calcium, dissolved (mg/L)	Magnesium, dissolved (mg/L)	Ca/Mg (molar)
54	10	170	207	---	170	---	185	48	12	2.43
54	---	190	227	---	186	---	202	54	13	2.52
58	9.8	160	170	---	139	142	180	49	9.6	3.09
58	---	140	163	---	134	---	158	43	9.0	2.90
37	25	260	314	---	257	260	269	73	18	2.44
22	26	330	409	---	336	337	350	79	32	1.50
50	33	370	260	---	213	---	275	95	32	1.80
50	52	360	442	---	362	332	362	92	30	1.83
50	---	280	333	---	273	---	278	68	27	1.53
42	15	150	188	---	154	156	158	41	12	1.98
52	10	66	80	---	66	66	75	19	4.5	2.53
52	---	96	111	---	91	---	104	26	7.6	2.07
10	30	310	370	---	300	---	402	64	37	1.05
11	11	220	285	---	233	229	309	40	30	.81
35	21	270	332	---	272	268	307	69	24	1.76
12	3.3	270	330	---	270	---	326	54	33	.99
14	153	410	480	---	390	---	437	98	39	1.52
14	75	390	470	---	385	390	418	96	35	1.67
14	38	410	480	---	394	---	437	110	35	1.84
14	---	420	485	---	398	---	440	100	40	1.58
48	13	170	196	---	161	162	161	35	19	1.12
57	4.6	44	66	---	54	39	59	11	4.0	1.67
46	7.8	7	11	---	9	9	14	1.8	.54	2.02
62	11	33	42	---	34	35	48	9.2	2.4	2.32
30	9.6	90	110	---	90	96	119	20	9.7	1.25
27	7.1	230	284	---	233	---	248	55	22	1.52
15	4.3	220	268	---	220	---	239	51	22	1.41
39	26	250	301	247	---	260	256	62	22	1.71
61	3.7	130	118	96	---	103	143	37	8.2	2.74
25	58	230	285	234	---	243	266	56	21	1.62
56	9.0	98	111	91	---	102	105	29	6.1	2.88
43	9.4	170	195	160	---	169	167	43	14	1.86

Table 7. Physical and chemical properties and chemical composition of spring waters in the Mogollon Highlands, central Arizona—Continued

Map code (see fig. 20)	Sodium, dissolved (mg/L)	Ca/Na (molar)	Potassium, dissolved (mg/L)	HCO_3 (molar)	Sulfate, dissolved (mg/L)	Chloride, dissolved (mg/L)	Fluoride, dissolved (mg/L)	Silica, dissolved (mg/L)	Arsenic, dissolved (µg/L)	Boron, dissolved (µg/L)
54	3.4	8.1	0.70	3.39	1.7	4.2	0.1	13	---	<20
54	---	---	---	3.72	2.3	3.0	.2	15	---	---
58	3.1	9.07	.71	2.79	23	2.0	<.1	7.7	---	12
58	---	---	---	2.67	13	1.0	.1	8.9	---	---
37	3.3	12.63	.54	5.14	4.6	2.2	<.1	13	<1	19
22	6.4	7.09	.94	6.71	3.2	6.1	.16	19	---	20
50	3.8	14.34	.80	4.26	1.1	3.4	.1	10	---	<20
50	3.2	16.4	.72	7.24	2.7	3.5	.11	10	---	15
50	---	---	---	5.46	4.1	2.0	.2	8.9	---	---
42	1.4	16.93	.63	3.08	3.0	1.1	<.1	5.8	<1	<16
52	1.3	8.17	.83	1.31	1.7	1.0	<.1	7.1	---	6.8
52	---	---	---	1.82	3.1	2.0	.2	8.7	---	---
10	18	2.04	1.8	6.06	8.5	13	.2	75	---	<20
11	11	2.10	2.1	4.67	5.1	8.4	.15	68	---	31
35	9.2	4.26	.63	5.45	20	2.8	.12	18	---	17
12	11	2.82	3.2	5.41	4.8	7.1	.1	50	---	<20
14	12	4.68	1.8	7.87	27	8.3	.1	13	---	60
14	11	5.20	1.8	7.7	23	7.1	.19	12	<1	69
14	---	---	---	7.87	23	9.0	.3	17	---	---
14	---	---	---	7.95	27	9.0	.1	14	---	
48	1	20.08	.50	3.22	2.4	1.1	<.1	4.7	---	<10
57	1.3	4.85	.50	1.08	1	3.5	<.1	5	---	10
46	.70	1.47	.80	.18	1.2	1.6	<.1	1.9	---	<10
62	1.9	2.78	.60	.69	1.4	.90	.2	9.4	---	<10
30	3.1	3.70	.50	1.81	2.1	2.0	<.1	27	<1	10
27	---	---	---	4.65	.60	4.0	.1	21	---	---
15	---	---	---	4.39	1.6	6	<.1	20	---	---
39	4.2	8.47	.70	4.93	5.2	3.6	.2	10	---	---
61	2.2	9.65	.60	1.93	27	1.4	.1	8.3	---	---
25	8.2	3.92	.70	4.67	2.2	6.3	.1	31	---	---
56	1.4	11.88	.90	1.82	2.8	1.7	<.1	8.2	---	---
43	1.9	12.98	.50	3.20	1.3	2.3	<.1	7.7	---	---

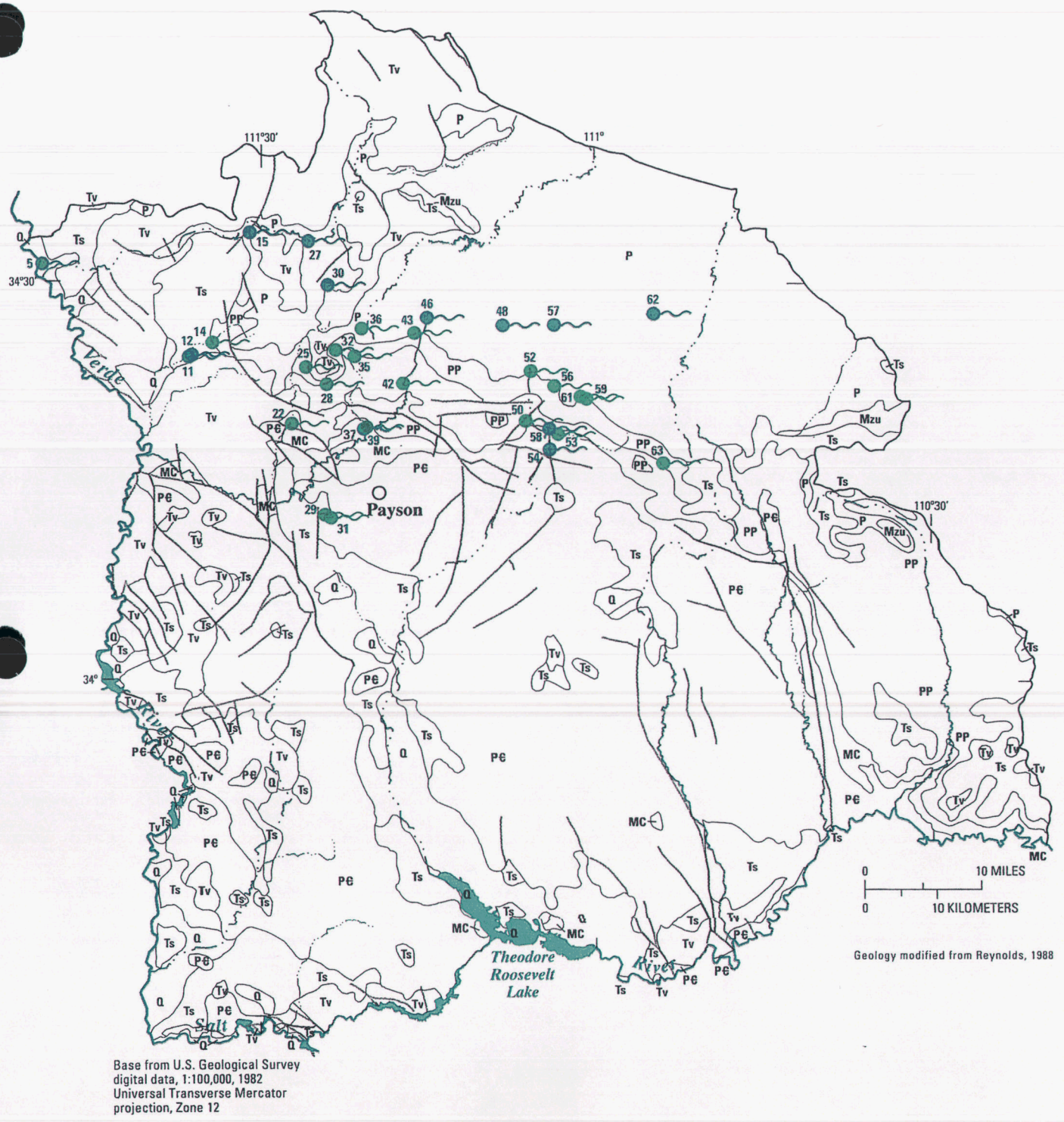


Figure 20. Springs for which chemical data are available and sampling sites for isotope analysis of spring water, Mogollon Highlands, central Arizona.

EXPLANATION

Q	SURFICIAL DEPOSITS, MOSTLY ALLUVIUM—Holocene to Middle Pleistocene
Ts	SEDIMENTARY ROCKS—Pliocene to Middle Miocene
Tv	VOLCANIC ROCKS—Pliocene to Middle Miocene
Mzu	SEDIMENTARY ROCKS, UNDIFFERENTIATED—Cretaceous
P	SEDIMENTARY ROCKS—Permian (Kaibab Formation and Coconino Sandstone)
PP	SEDIMENTARY ROCKS—Permian and Pennsylvanian (Schnebly Hill Formation, Supai Formation, and Naco Formation)
MC	SEDIMENTARY ROCKS—Mississippian to Cambrian (Redwall Limestone, Martin Formation, and Tapeats Sandstone)
PC	PROTEROZOIC ROCKS
	FAULT
62	SPRING FOR WHICH CHEMICAL DATA ARE AVAILABLE
42	SPRING SAMPLED FOR ISOTOPE ANALYSIS

NOTE: See table 7 for chemical-data correspondence of numbers to springs and table 10 for isotope-analysis correspondence of numbers to springs. Tail on symbol is not intended to indicate direction of discharge

Figure 20. Continued.

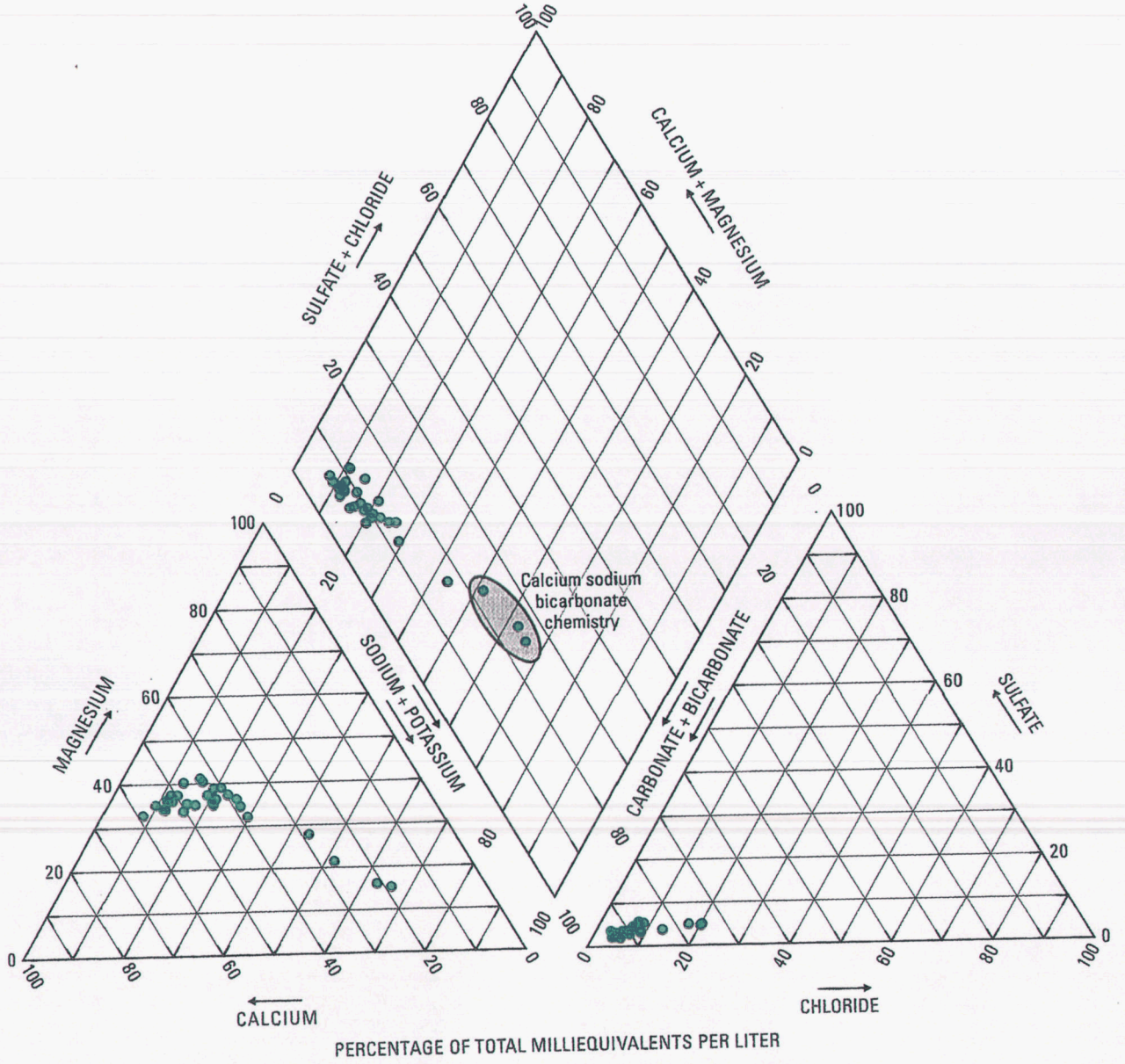


Figure 21. Relative compositions of water from springs in the Mogollon Highlands, central Arizona.

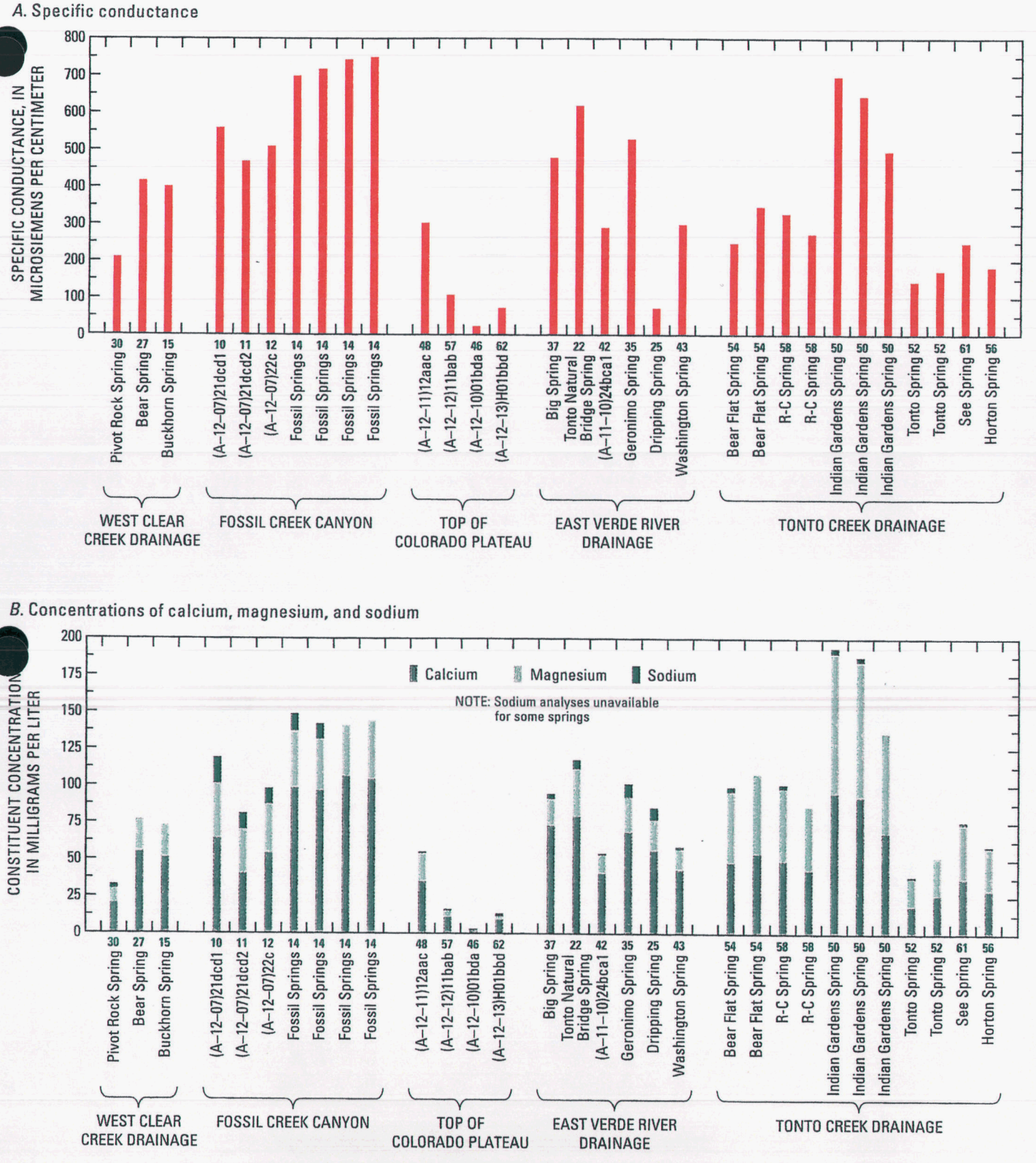
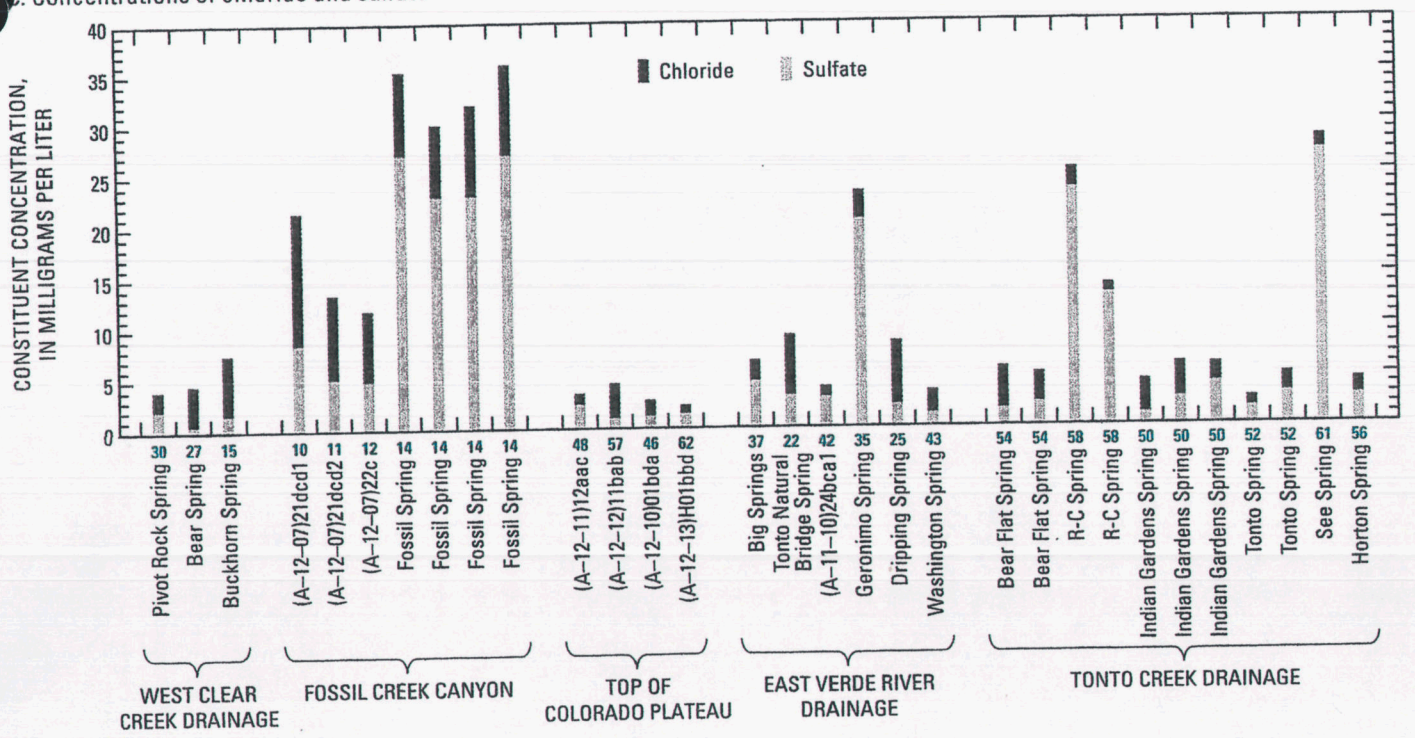
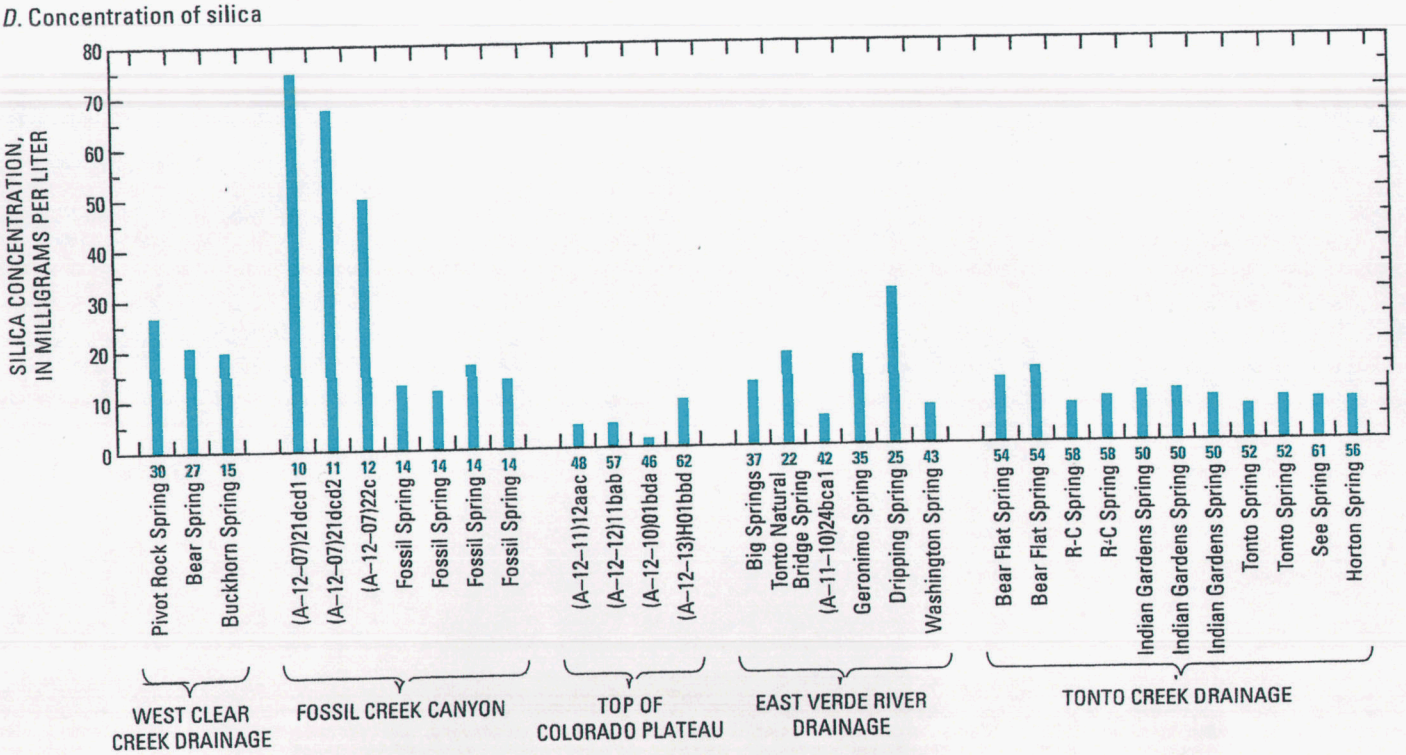


Figure 22. Chemical composition of spring waters within different drainages, Mogollon Highlands, central Arizona. *A*, Specific conductance; *B*, Calcium, magnesium, and sodium; *C*, Chloride and sulfate; *D*, Silica.

C. Concentrations of chloride and sulfate



D. Concentration of silica



NOTE: See table 7 for chemical composition values. Repeated locations represent multiple sampling and analyses. See fig. 20 for correspondence of numbers and well names to location

Figure 22. Continued.

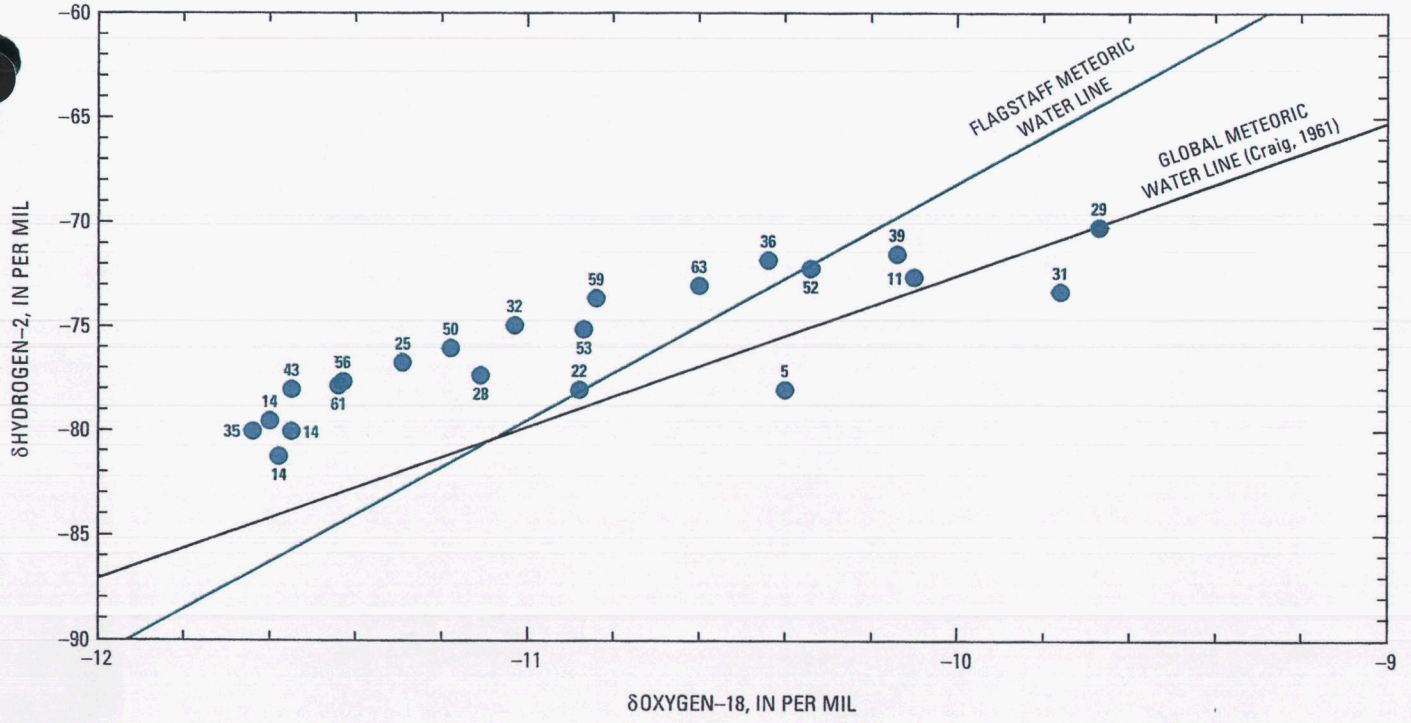


Figure 23. Isotope values for water from springs in the Mogollon Highlands, central Arizona.

Table 8. Physical and chemical properties and chemical composition of ground water at wells in the Mogollon Highlands, central Arizona

[µS/cm, microsiemens per centimeter; mg/L, milligrams per liter; ANC, acid neutralizing capacity; FET, fixed endpoint titration; <, less than. Bold face numbers indicate water-depth data are available in table 6. Dashes indicate no data]

Map code (see fig. 24)	Station name	Date	Time	Specific conductance (µS/cm)	pH, field	Water temperature (degrees Celsius)	Oxygen, dissolved (mg/L)
7	**A-05-11 08BBC1**	**05–25–1970**	**---**	**530**	**---**	**22**	**---**
8	**A-05-11 08BBC2**	**05–25–1970**	**---**	**560**	**---**	**21**	**---**
11	**A-06-10 10DAD1**	**08–27–1970**	**---**	**550**	**7.90**	**19.5**	**---**
12	A-06-10 10DAD2	08–27–1970	---	---	---	---	---
13	A-06-10 11CCD	07–29–1998	1455	---	7.50	19	3.6
15	**A-06-10 14ABA2**	**08–27–1970**	**---**	**459**	**7.40**	**---**	**---**
16	**A-06-10 14ABD1**	**08–27–1970**	**---**	**525**	**7.80**	**18.5**	**---**
17	**A-06-10 14ACA1**	**08–27–1970**	**---**	**459**	**7.40**	**---**	**---**
19	**A-06-10 14BBD**	**08–27–1970**	**---**	**698**	**---**	**---**	**---**
22	**A-06-10 26ABA2**	**05–25–1970**	**---**	**510**	**---**	**---**	**---**
22	**A-06-10 26ABA2**	**08–11–1997**	**1000**	**690**	**7.10**	**21**	**3.3**
23	A-06-10 36DBA	07–30–1998	1500	---	6.90	19	1.6
27	A-06-11 31DCB4	07–28–1998	1230	541	7.70	18	2.8
30	**A-07-10 10BAA**	**09–05–1979**	**---**	**460**	**---**	**---**	**---**
31	A-07-10 11BCD	05–25–1970	---	605	7.70	---	---
32	A-07-10 13BBA	05–25–1970	---	680	---	---	---
35	A-07-10 23CDC	07–28–1998	1600	411	7.40	20.5	3.1
36	A-08-10 05CDC	08–11–1997	1400	430	6.84	20	1.9
40	A-08-10 27ACB3	07–30–1998	1200	---	7.90	21	4.2
43	A-09-10 20CDC	07–23–1998	1115	653	7.60	19	6.5
45	A-09-10 24DCC	07–23–1998	1345	805	7.10	19	3.9
47	A-09-10 25CCD	07–23–1998	1645	695	7.30	20	3.4
52	A-09-12 23DBC	08–13–1997	1030	790	7.39	19	5.0
53	A-09-13 15CDD	10–04–1979	---	375	---	---	---
55	**A-09-13 21BAB**	**10–04–1979**	**---**	**459**	**---**	**17**	**---**
56	**A-09-13 21BCB**	**10–03–1979**	**---**	**395**	**---**	**22**	**---**
57	A-09-13 25ABB	05–23–1994	1330	300	7.90	17	6.6
57	A-09-13 25ABB	05–02–1995	1230	305	7.90	17	6.9
57	A-09-13 25ABB	04–06–1998	1200	275	8.10	16.5	3.8
57	A-09-13 25ABB	04–14–1997	1000	290	7.95	17	2.4
57	A-09-13 25ABB	05–06–1996	1540	297	8.42	17	7.0
67	**A-10-10 05CCA**	**07–08–1975**	**1200**	**310**	**7.50**	**---**	**---**
68	**A-10-10 05CCB**	**07–30–1986**	**1100**	**358**	**6.80**	**---**	**2.6**
69	A-10-10 05DBC1	09-09-1959	---	263	6.80	15.5	---
70	A-10-10 08ABA	07–14–1975	1100	590	7.90	---	---
77	**A-10-10 22DBD1**	**07–28–1997**	**1300**	**970**	**7.28**	**17.5**	**4.6**
77	**A-10-10 22DBD1**	**07–03–1975**	**1015**	**660**	**7.70**	**---**	**---**

Table 8. Physical and chemical properties and chemical composition of ground water at wells in the Mogollon Highlands, central Arizona—Continued

Map code (see fig. 24)	Station name	Date	Time	Specific conductance (µS/cm)	pH, field	Water temperature (degrees Celsius)	Oxygen, dissolved (mg/L)
82	A-10-10 28BCA1	10–25–1979	---	1050	---	22	---
83	A-10-10 28BCA2	10–25–1979	---	1240	---	22	---
83	A-10-10 28BCA2	08–14–1997	900	1420	7.30	18	2.9
85	A-10-10 28BCD1	10–25–1979	---	859	---	18	---
86	A-10-10 29ACA2	07–27–1998	1420	1510	7.50	17	4.0
88	A-10-11 05BAD	07-17-1975	1200	275	7.10	---	---
89	A-10-13 13CAC UNSURV	07–22–1998	1410	490	7.40	14	3.2
90	A-10H12 19DAD	10–04–1979	---	175	---	22	---
90	A-10H12 19DAD	08–12–1997	930	305	7.10	21	5.6
91	A-10H12 24AAB	07–16–1975	---	250	7.50	---	---
92	A-10H14 20BAC	09–24–1979	---	890	---	16	---
93	A-10H14 27CBD	09–25–1979	---	668	---	22	---
96	A-11-10 23AAB	08–06–1998	1330	690	7.40	18	1.5
98	A-11-10 23AAD3	08–11–1998	1000	600	7.40	18	1.3
99	A-11-10 23ACA	07–01–1975	1030	700	7.60	---	---
100	A-11-10 23ADC	08–25–1997	1400	535	7.40	21.5	12.6
101	A-11-10 27CCB	07–07–1975	1100	290	7.90	---	---
101	A-11-10 27CCB	07–30–1986	1415	350	6.85	18.5	5.6
105	A-11-10 32ACD	08–07–1986	1045	635	7.40	17	.7
112	A-11-11 27BCB1	07-16-1975	1000	450	7.90	---	---
112	A-11-11 27BCB1	07-29-1997	1400	455	7.29	17.5	8.2
114	A-11-11 29DAD	08–14–1997	1500	550	7.08	16.5	5.4
115	A-11-11 31ADC1	07–15–1975	1130	330	7.70	---	---
115	A-11-11 31ADC1	07–29–1997	1000	330	7.30	17.5	9.3
119	A-11-11 32CBB	07–15–1975	1100	540	7.70	---	---
121	A-11-11H05DCD	08–27–1975	1300	735	---	---	---
121	A-11-11H05DCD	07–30–1997	900	760	7.14	14	7.4
122	A-11-11H08AAA	08–28–1975	900	655	---	---	---
122	A-11-11H08AAA	07–30–1997	1100	775	7.21	15.5	5.1
123	A-11-11H20CBC	09–24–1979	---	145	---	13	---
123	A-11-11H20CBC	08–12–1997	1100	285	6.87	17	1.0
125	A-11-12 32BBA	08–27–1975	1200	605	---	---	---
125	A-11-12 32BBA	08–01–1997	930	515	7.67	15.5	4.5
128	A-11-13 29CCD	08–27–1975	1200	680	---	---	---
129	A-11-13 30AAB	10–11–1979	---	485	---	---	---
130	A-11-13 34CBA	08–28–1975	1200	950	---	---	---
130	A-11-13 34CBA	07–31–1997	1400	920	7.11	13.5	1.0
132	A-11-13 35DAD1	09–24–1979	---	649	---	15	---
133	A-11-13 36CAC	09–24–1979	---	1080	---	26	---

Table 8. Physical and chemical properties and chemical composition of ground water at wells in the Mogollon Highlands, central Arizona—Continued

Map code (see fig. 24)	Station name	Date	Time	Specific conductance (µS/cm)	pH, field	Water temperature (degrees Celsius)	Oxygen, dissolved (mg/L)
133	A-11-13 36CAC	08–12–1997	1400	1220	7.17	12.5	2.4
134	A-11-13 36CCD	07–22–1998	1020	741	7.10	13	2.3
136	A-11-14 14BAB	00–00–1959	---	---	---	---	---
137	A-11-14 22CBD	08–09–1966	---	107	7.30	21.8	---
138	A-11-15 07CBB	08–21–1995	1100	460	7.54	11.5	7.2
141	A-11H10 24BDC2	08–11–1998	1330	590	7.20	16	1.3
142	A-11H11 24CCC	08–13–1998	1030	570	7.30	12	0.66
143	A-11H11 35BBB	07–17–1975	1200	550	7.40	---	---
148	A-12-08 21CCC1	11–07–1974	1200	515	8.10	10	---
150	A-12-08 21CDD	08–19–1997	1430	520	7.50	15	---
159	A-12-08 25ADC	10–17–1974	1000	555	8.10	24	---
164	A-12-08 27BBC	08–25–1997	1200	570	7.50	14.5	---
171	A-12-08 36ADD	11–07–1974	1400	335	8.10	8	---
174	A-12-09 19CCC1	10–17–1974	900	540	7.60	19	---
175	A-12-09 30BBA1	10–13–1974	---	470	7.80	16	---
177	A-12-09 30BBC1	08–12–1998	1430	290	7.50	18	3.3
180	A-12-10 26CBB	08–13–1998	1400	440	7.6	15	4.46
183	A-12-15 36DDC	06–22–1972	---	471	7.40	12	---
187	A-12-17 32DDC	06–22–1972	---	417	7.9	---	---
187	A-12-17 32DDC	10–02–1967	---	333	---	---	---
216	A-14-10 02ACB	07–13–1978	---	640	7.40	---	---
223	A-14-11 30DDD	10–26–1965	---	532	7.70	13	---
229	A-15-12 31DDC	08–25–1995	1100	620	7.37	13	7.2

Map code (see fig. 24)	Hardness, total (mg/L as $CaCO_3$)	ANC, FET, field (mg/L as $CaCO_3$)	ANC, FET, field (mg/L as HCO_3)	Dissolved solids, sum of constituents (mg/L)	Calcium, dissolved (as mg/L)	Magnesium, dissolved (mg/L)	Ca/Mg (molar)	Sodium, dissolved (mg/L)
7	230	187	228	137	36	33	.66	---
8	230	212	258	143	71	14	3.08	---
11	220	208	254	511	71	11	3.91	24
12	600	---	---	485	160	50	1.89	---
13	200	177	216	400	55	14	2.38	36
15	170	151	184	309	47	13	2.19	---
16	210	189	230	296	57	17	2.03	24
17	170	185	226	244	47	13	2.19	22
19	240	207	252	248	61	21	1.76	50
22	250	185	226	206	68	19	2.20	42
22	210	188	229	239	60	15	2.43	---

Table 8. Physical and chemical properties and chemical composition of ground water at wells in the Mogollon Highlands, central Arizona—Continued

Map code (see fig. 24)	Hardness, total (mg/L as $CaCO_3$)	ANC, FET, field (mg/L as $CaCO_3$)	ANC, FET, field (mg/L as HCO_3)	Dissolved solids, sum of constituents (mg/L)	Calcium, dissolved (as mg/L)	Magnesium, dissolved (mg/L)	Ca/Mg (molar)	Sodium, dissolved (mg/L)
23	460	---	---	185	120	37	2.02	91
27	260	200	244	178	76	18	2.56	35
30	**---**	**---**	**---**	**517**	**---**	**---**	**---**	**---**
31	860	226	276	515	65	170	.23	---
32	280	41	50	514	64	28	1.39	---
35	170	163	198	513	51	11	2.84	23
36	200	217	265	565	55	15	2.29	13
40	100	227	277	562	26	7.9	2.03	110
43	280	278	339	576	91	13	4.17	28
45	270	270	---	442	79	17	2.79	59
47	230	245	298	568	69	14	2.92	64
52	300	281	343	593	67	31	1.30	38
53	---	---	---	719	---	---	---	---
55	**---**	**---**	**---**	**---**	**---**	**---**	**---**	**---**
56	**---**	**---**	**---**	**603**	**---**	**---**	**---**	**---**
57	140	123	150	573	48	4.4	6.62	6.4
57	130	121	148	575	45	4.6	5.81	6.5
57	140	106	129	571	48	4.6	6.33	6.9
57	130	118	144	572	44	4.1	6.51	7.0
57	130	135	150	573	45	4.5	5.99	6.2
67	**120**	**121**	**148**	**---**	**31**	**10**	**1.88**	**16**
68	**150**	**127**	**155**	**---**	**38**	**13**	**1.77**	**13**
69	110	---	---	168	26	10	1.58	---
70	250	161	196	---	57	25	1.38	20
77	**440**	**327**	**399**	**---**	**110**	**39**	**1.73**	**43**
77	**280**	**286**	**349**	**---**	**71**	**26**	**1.66**	**34**
82	**---**	**---**	**---**	**---**	**---**	**---**	**---**	**---**
83	**---**	**---**	**---**	**---**	**---**	**---**	**---**	**---**
83	**520**	**562**	**685**	**---**	**120**	**50**	**1.51**	**120**
85	**---**	**---**	**---**	**730**	**---**	**---**	**---**	**---**
86	640	441	538	---	160	61	1.56	85
88	**110**	**128**	**156**	**171**	**30**	**9.4**	**1.94**	**13**
89	240	253	309	---	61	22	1.68	5.9
90	**---**	**---**	**---**	**---**	**---**	**---**	**---**	**---**
90	**120**	**127**	**154**	**---**	**27**	**13**	**1.31**	**20**
91	170	170	207	---	48	12	2.43	3.4
92	**---**	**---**	**---**	**---**	**---**	**---**	**---**	**---**
93	**---**	**---**	**---**	**---**	**---**	**---**	**---**	**---**
96	320	288	351	---	92	22	2.52	18

Table 8. Physical and chemical properties and chemical composition of ground water at wells in the Mogollon Highlands, central Arizona—Continued

Map code (see fig. 24)	Hardness, total (mg/L as $CaCO_3$)	ANC, FET, field (mg/L as $CaCO_3$)	ANC, FET, field (mg/L as HCO_3)	Dissolved solids, sum of constituents (mg/L)	Calcium, dissolved (as mg/L)	Magnesium, dissolved (mg/L)	Ca/Mg (molar)	Sodium, dissolved (mg/L)
98	290	285	347	---	80	21	2.33	17
99	180	154	188	---	40	19	1.28	20
100	240	263	320	---	71	14	3.02	17
101	130	115	140	---	29	15	1.17	20
101	110	112	136	---	24	12	1.21	18
105	280	293	357	---	69	27	1.55	16
112	220	224	273	253	52	21	1.50	6.4
112	230	228	---	268	63	18	2.13	5.5
114	250	277	337	---	78	14	3.48	14
115	140	159	194	---	34	13	1.59	14
115	140	161	196	---	36	13	1.72	14
119	230	261	318	---	65	17	2.32	16
121	410	189	230	---	---	29	2.41	2.6
121	400	422	515	---	120	24	3.03	3.4
122	370	147	179	---	120	16	4.55	3.0
122	390	373	455	---	130	16	4.77	5.4
123	---	---	---	---	---	---	---	---
123	62	44	54	---	19	3.8	2.98	12
125	290	215	262	---	67	29	1.41	16
125	290	316	385	---	69	29	1.44	16
128	360	212	258	---	110	20	3.34	8.0
129	---	---	---	---	---	---	---	---
130	470	157	192	---	130	35	2.25	22
130	460	380	463	---	130	31	2.62	19
132	---	---	---	---	---	---	---	---
133	---	---	---	---	---	---	---	---
133	570	254	309	---	190	23	5.06	48
134	400	370	451	---	100	33	1.91	17
136	35	28	34	---	9.0	3.0	1.82	1.0
137	52	54	66	---	14	4.1	2.07	---
138	250	260	316	---	54	28	1.17	1.6
141	330	334	---	408	78	33	1.44	2.6
142	310	307	---	329	100	15	3.99	4.8
143	290	270	329	286	83	20	2.52	2.2
148	---	---	---	---	---	---	---	---
150	260	253	309	---	66	23	1.76	8.4
159	---	---	---	---	---	---	---	---
164	290	312	380	---	67	29	1.42	11
171	---	---	---	---	---	---	---	---

Table 8. Physical and chemical properties and chemical composition of ground water at wells in the Mogollon Highlands, ...tral Arizona—Continued

Map code (see fig. 24)	Hardness, total (mg/L as $CaCO_3$)	ANC, FET, field (mg/L as $CaCO_3$)	ANC, FET, field (mg/L as HCO_3)	Dissolved solids, sum of constituents (mg/L)	Calcium, dissolved (as mg/L)	Magnesium, dissolved (mg/L)	Ca/Mg (molar)	Sodium, dissolved (mg/L)
174	---	---	---	---	---	---	---	---
175	---	---	---	---	---	---	---	---
177	150	148	181	---	36	13	1.66	2.8
180	240	235	---	242	63	19	2.03	2.0
183	250	256	312	---	52	29	1.09	2.3
187	240	176	214	---	60	22	1.65	---
187	170	141	172	---	32	23	.84	3.0
216	330	290	350	---	85	29	1.78	4.1
223	290	294	358	---	74	26	1.73	---
229	340	314	383	---	80	33	1.47	5.0

Map code (see fig. 24)	Ca/Na (molar)	Potassium, dissolved (mg/L)	Sulfate, dissolved (mg/L)	Chloride, dissolved (mg/L)	Fluoride, dissolved (mg/L)	Silica, dissolved (mg/L)
7	---	---	40	34	.50	18
8	---	---	30	22	.40	18
11	1.70	1.2	24	32	.40	18
12	---	---	2,700	24	3.0	---
13	.87	1.4	33	31	.51	21
15	---	---	11	40	.30	9.1
16	1.36	1.8	11	41	.30	11
17	1.23	1.6	11	40	.30	9.1
19	.70	1.2	79	36	.30	30
22	.93	1.6	87	57	.48	20
22	---	---	34	32	.40	17
23	.77	1.5	240	94	.66	26
27	1.25	1.5	59	39	.37	19
30	---	---	---	---	.50	---
31	---	---	15	48	.30	16
32	---	---	16	72	.20	29
35	1.27	1.5	9.6	24	.38	16
36	2.41	1.9	11	10	.13	21
40	.13	3.0	14	59	.56	26
43	1.86	.36	16	33	.21	22
45	.77	2.0	15	81	.60	21
47	.62	2.5	14	83	.71	20
52	1.02	2.3	19	43	.75	20
53	---	---	---	---	.40	---
55	---	---	---	---	.40	---
56	---	---	---	---	.40	---

Table 8. Physical and chemical properties and chemical composition of ground water at wells in the Mogollon Highlands, central Arizona—Continued

Map code (see fig. 24)	Ca/Na (molar)	Potassium, dissolved (mg/L)	Sulfate, dissolved (mg/L)	Chloride, dissolved (mg/L)	Fluoride, dissolved (mg/L)	Silica, dissolved (mg/L)
57	4.30	.70	2.6	7.3	.20	25
57	3.95	.76	2.1	9.3	.19	24
57	3.99	.80	1.9	9.4	.20	23
57	3.61	.90	1.9	9.2	.20	24
57	4.13	.90	1.9	9.4	.27	24
67	1.11	.40	10	8.5	1.0	36
68	1.68	.7	21	9.4	.80	30
69	---	---	1.9	8	1.4	34
70	1.63	.70	7.7	17	.20	28
77	1.47	1.3	81	64	.24	28
77	1.20	1	32	17	.30	26
82	---	---	---	---	.50	---
83	---	---	---	---	1.0	---
83	.61	.26	70	90	.74	34
85	---	---	---	---	.30	---
86	1.05	0.3	61	180	.37	30
88	.36	.30	3.1	5.2	1.3	31
89	5.92	1.2	11	3.4	.16	13
90	---	---	---	---	.50	---
90	.77	.35	8.2	10	2.2	35
91	8.10	.7	1.7	4.2	.10	13
92	---	---	---	---	.30	---
93	---	---	---	---	.30	---
96	2.86	2.0	7.8	41	.19	28
98	2.63	1.9	4.9	15	.33	30
99	1.15	1.5	5.5	35	.20	27
100	2.38	1.4	.71	14	.32	28
101	.83	.6	25	12	.60	32
101	.76	.4	12	6.8	.60	29
105	2.47	1	6.0	15	.40	29
112	4.66	.9	2.2	7.6	.2	24
112	1.37	.94	.89	9.1	.19	29
114	3.23	.65	2.6	9.4	.44	26
115	1.39	.5	5.4	5.0	.70	23
115	1.46	.39	6.5	5.4	.63	24
119	2.33	.7	11	8.2	.30	23
121	25.21	.9	4.1	3.3	.10	8.6
121	20.24	.7	3.8	2.9	.10	9.5
122	22.94	.9	3.7	4.4	.10	8.1
122	13.90	.68	7.7	14	<.10	8.9

Table 8. Physical and chemical properties and chemical composition of ground water at wells in the Mogollon Highlands, central Arizona—Continued

ρ code (see fig. 24)	Ca/Na (molar)	Potassium, dissolved (mg/L)	Sulfate, dissolved (mg/L)	Chloride, dissolved (mg/L)	Fluoride, dissolved (mg/L)	Silica, dissolved (mg/L)
123	---	---	---	---	.40	---
123	.91	28	13	25	.14	29
125	2.44	.93	.95	8.8	.58	31
125	2.47	1.2	1.3	5.0	.40	29
128	7.89	1	15	6.5	.20	7.9
129	---	---	---	---	.20	---
130	3.39	2	160	16	.10	9.3
130	3.97	1.5	56	45	.16	11
132	---	---	---	---	.40	---
133	---	---	---	---	.70	---
133	2.26	4.0	380	14	.19	15
134	3.44	1.4	44	13	.14	9.6
136	5.16	---	10	10	.50	---
137	---	---	1.0	2.0	---	10
138	19.36	.4	.40	1.7	.10	7.3
141	17.2	1.1	4.9	2.4	.12	7.8
142	11.92	.65	7.0	3.9	<.1	13
143	21.64	.9	5.5	3.9	.1	8.6
148	---	---	---	---	---	---
150	4.54	.64	6.6	8.1	.12	22
159	---	---	---	---	.40	---
164	3.39	.97	5.2	.81	.28	23
171	---	---	---	---	---	---
174	---	---	---	---	.24	---
175	---	---	---	---	.23	---
177	7.51	.59	1.2	1.9	.16	13
180	17.76	.88	4.6	1.9	<.1	8.74
183	12.97	.7	3.7	3.1	.10	8.3
187	---	---	9	4	---	---
187	6.12	---	8.0	4.0	.10	---
216	11.89	.8	7.2	12	.10	9.4
223	---	---	1.0	6.5	.10	---
229	9.18	.8	11	6.9	.10	8.9

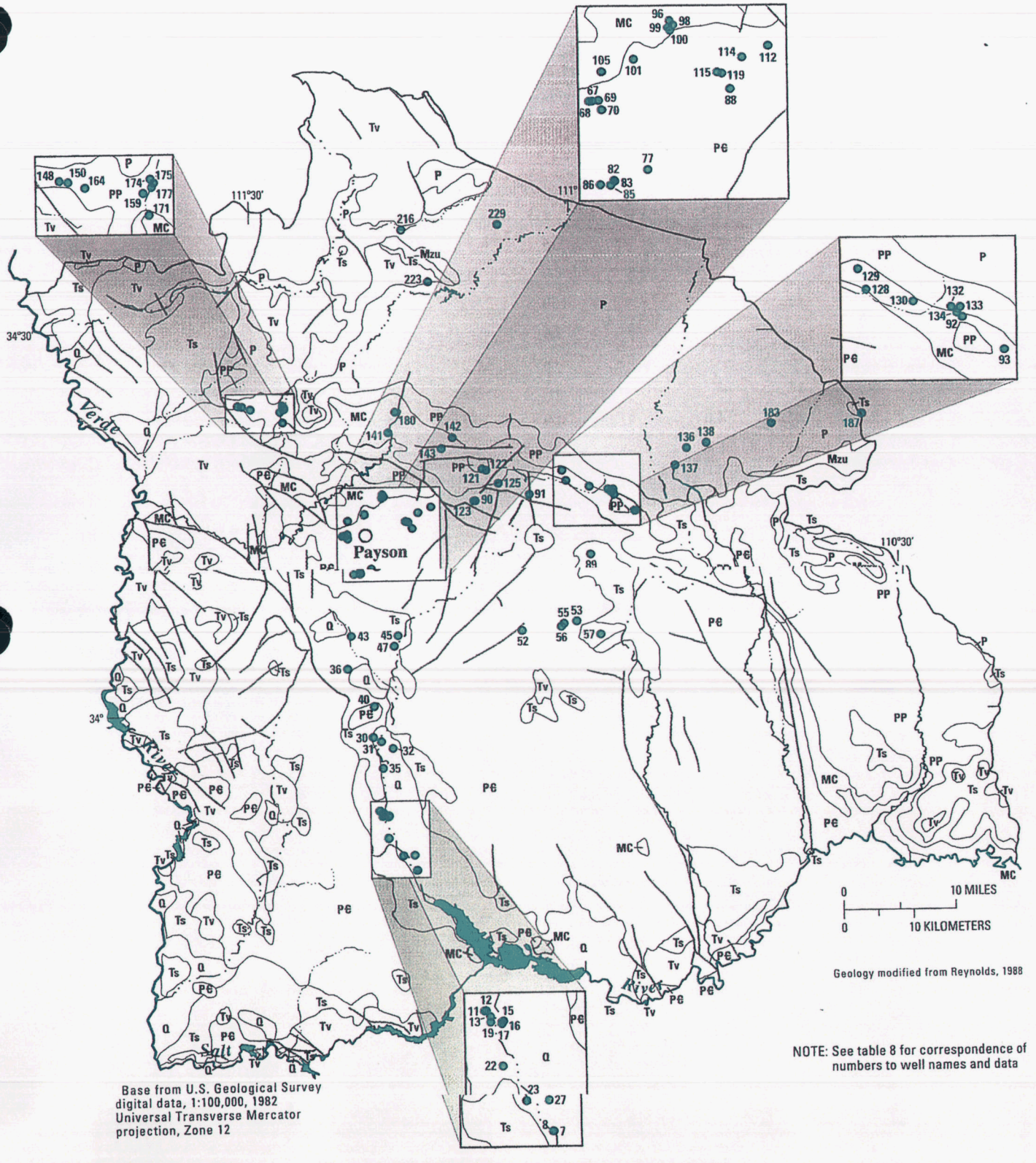


Figure 24. Wells for which chemical data are available, Mogollon Highlands, central Arizona.

EXPLANATION

Q	SURFICIAL DEPOSITS, MOSTLY ALLUVIUM—Holocene to Middle Pleistocene
Ts	SEDIMENTARY ROCKS—Pliocene to Middle Miocene
Tv	VOLCANIC ROCKS—Pliocene to Middle Miocene
Mzu	SEDIMENTARY ROCKS, UNDIFFERENTIATED—Cretaceous
P	SEDIMENTARY ROCKS—Permian (Kaibab Formation and Coconino Sandstone)
PP	SEDIMENTARY ROCKS—Permian and Pennsylvanian (Schnebly Hill Formation, Supai Formation, and Naco Formation)
MC	SEDIMENTARY ROCKS—Mississippian to Cambrian (Redwall Limestone, Martin Formation, and Tapeats Sandstone)
PG	PROTEROZOIC ROCKS
———	FAULT
229	WELL AND WELL IDENTIFIER

Figure 24. Continued.

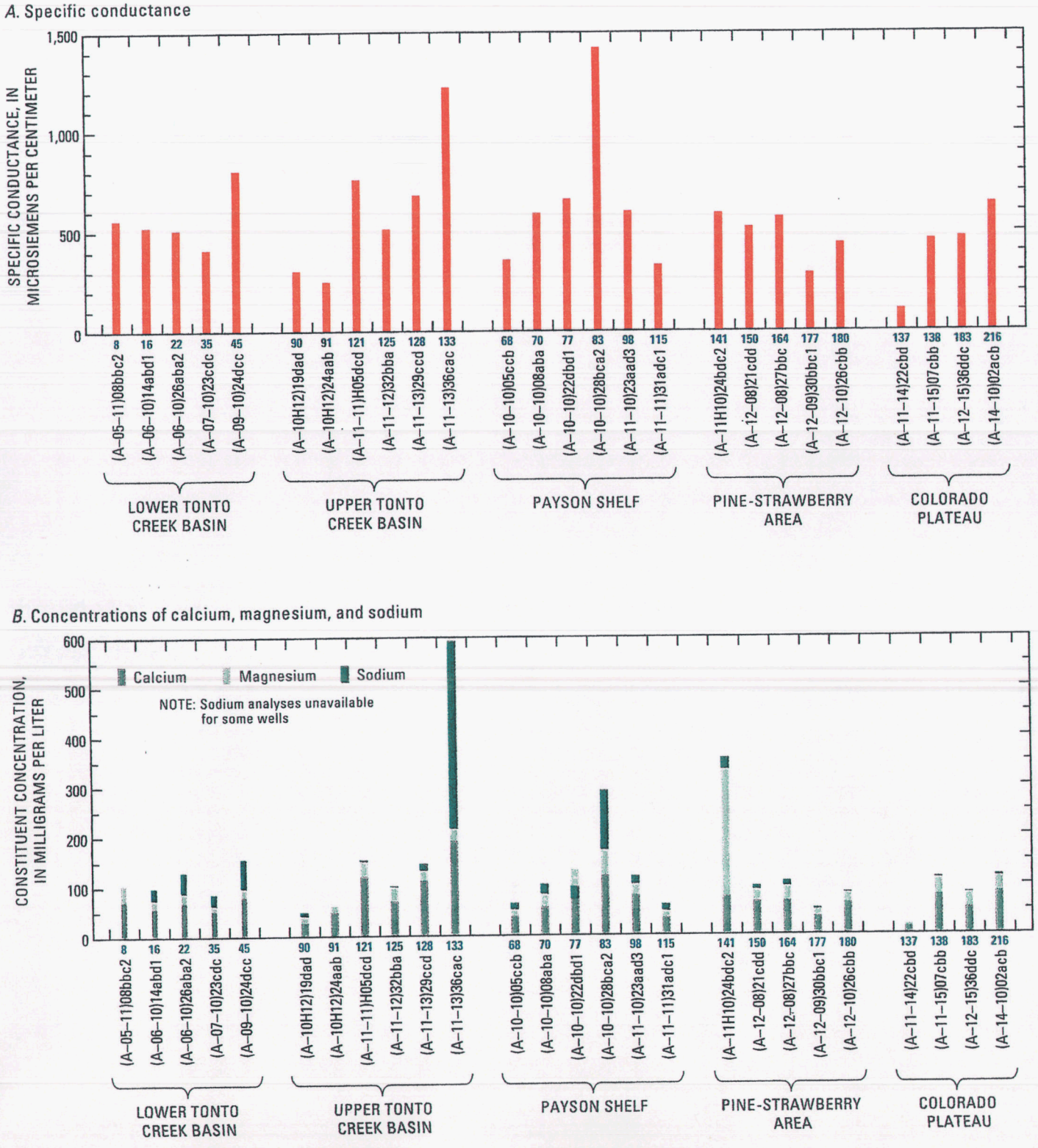
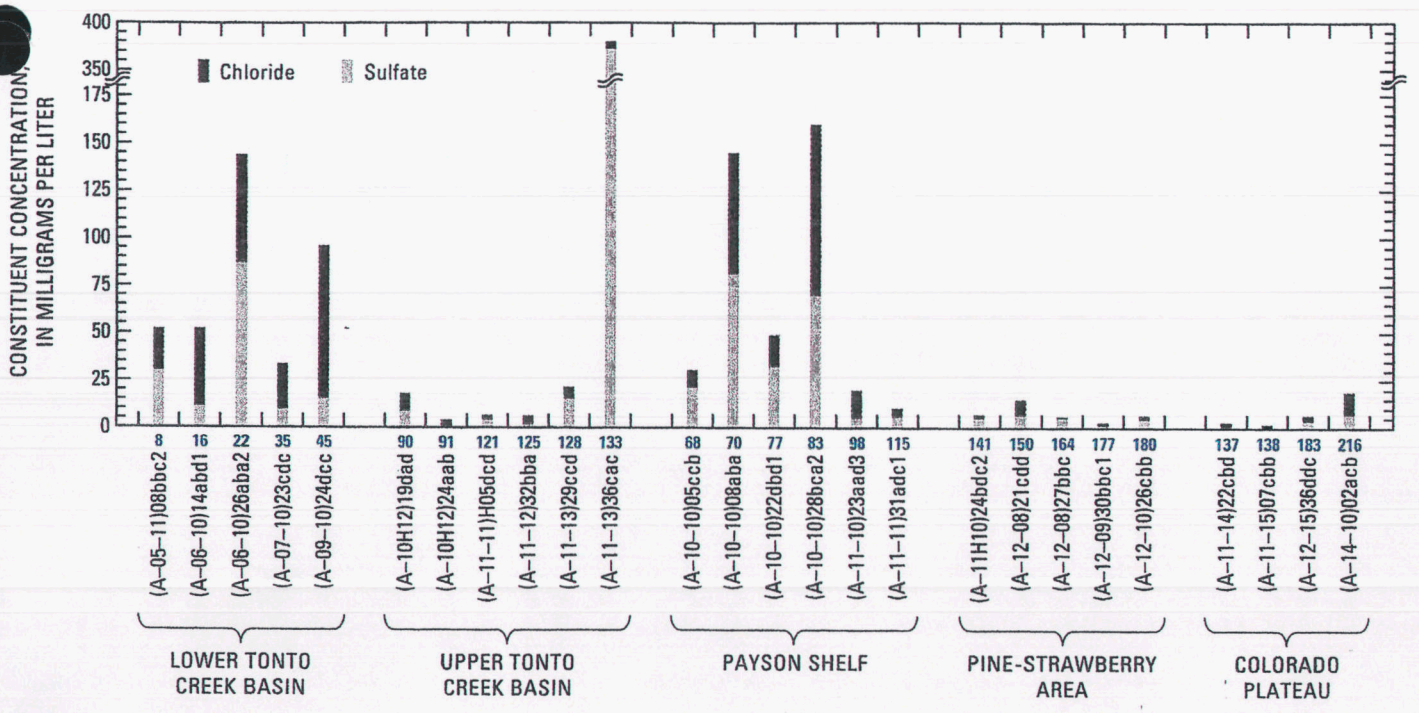
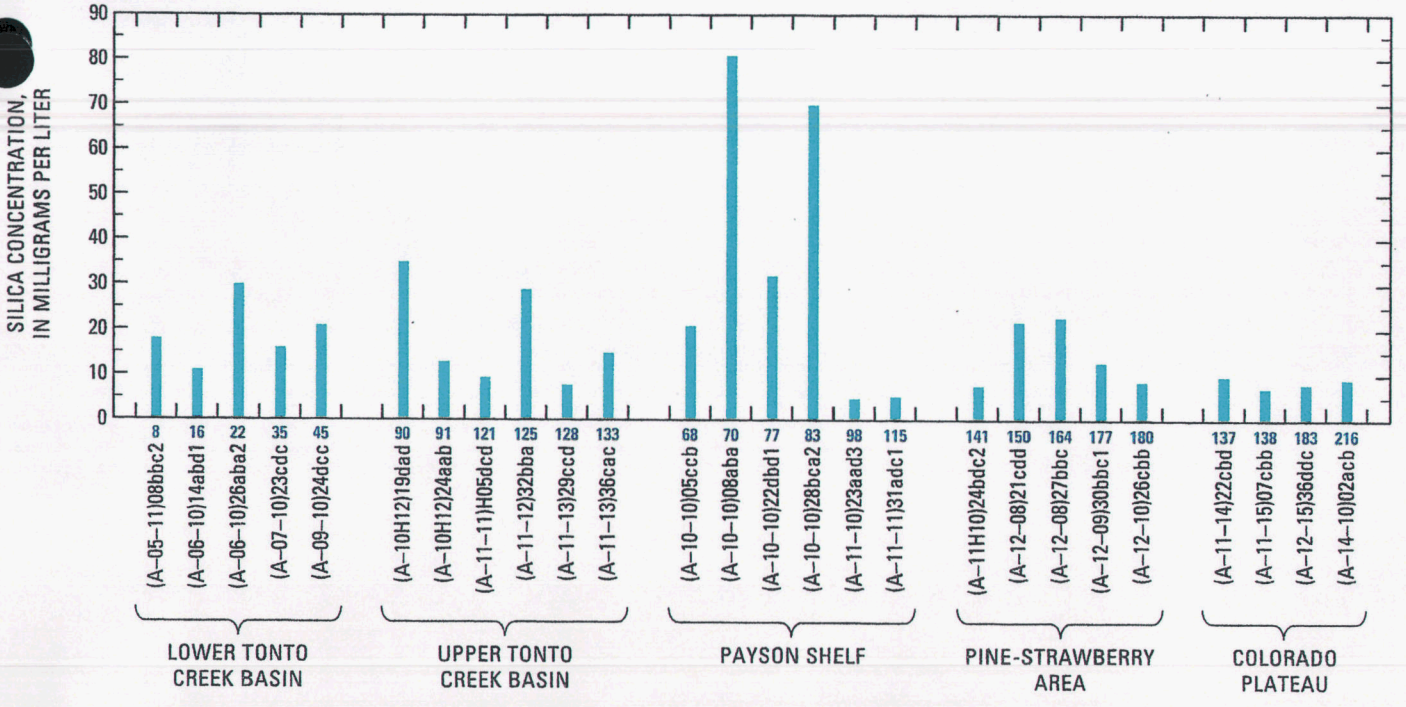


Figure 25. Chemical composition of waters from wells in various locations, Mogollon Highlands, central Arizona. *A*, Specific conductance; *B*, Calcium, magnesium, and sodium; *C*, Chloride and sulfate; *D*, Silica.

C. Concentrations of chloride and sulfate



D. Concentration of silica



NOTE: See fig. 24 for correspondence of numbers and well names to location and table 8 for chemical composition values. Repeated locations represent multiple sampling and analyses

Figure 25. Continued.

Table 9. Summary statistics of water-chemistry data for Mogollon Highlands streams

[µS/cm, microsiemens per centimeter; mg/L, milligrams per liter]

Statistic	Specific conductance (µS/cm)	pH, field	Water temperature (degrees Celsius)	Oxygen, dissolved (mg/L)	Hardness (mg/L as $CaCO_3$)	Dissolved solids (tons per day)	Calcium, dissolved (mg/L)	Magnesium, dissolved (mg/L)	Sodium, dissolved (mg/L)	Potassium, dissolved (mg/L)
Tonto Creek above Gun Creek (09499000). Samples collected 01–28–1976 to 05–28–1992										
Maximum	660	8.90	31.0	17.2	220	620	59	17	52	2.6
Minimum	142	7.20	2.0	5.8	64	.23	18	4.7	4.5	.80
Mean	419	8.17	18.6	9.5	150	58	42	11	29	1.8
Median	424	8.20	19.5	9.2	150	19	42	12	31	1.8
Standard deviation	127	.35	8.0	2.2	29	110	7.6	2.7	14	.51
Coefficient of variation	.30	.04	.4	.2	.19	1.8	.18	.23	.49	.28
Number of samples	60	59	59	44	58	56	58	58	58	57
West Clear Creek near Camp Verde (09505800). Samples collected 09–15–1967 to 03–24–2000										
Maximum	380	8.75	27.1	11.3	200	490	42	24	7.5	1.9
Minimum	65	5.58	5.5	7.3	35	6.5	8.6	3.3	1.1	.68
Mean	320	8.38	15.5	9.2	150	41	31	18	4.9	1.2
Median	353	8.55	15.1	9.3	170	9.6	34	21	5.6	1.2
Standard deviation	88	.46	5.8	1.0	53	88	10	6.7	1.6	.24
Coefficient of variation	.28	.05	.4	.1	.35	2.2	.33	.37	.33	.19
Number of samples	99	99	98	90	65	62	65	65	63	63
East Verde River near Childs (09507980). Samples collected 12–04–1990 to 05–30–2000										
Maximum	800	8.59	30.6	11.6	250	250	61	24	94	4.9
Minimum	195	7.76	6.0	5.6	87	.05	23	7.1	4.0	.74
Mean	413	8.35	17.8	8.9	180	23	41	18	20	1.9
Median	402	8.40	17.0	8.8	180	11	40	18	14	1.6
Standard deviation	104	.19	7.6	1.5	28	44	7.3	3.2	19	.93
Coefficient of variation	.25	.02	.4	.2	.16	2.0	.18	.17	.94	.49
Number of samples	56	55	56	55	56	56	56	56	56	56
Wet Bottom Creek near Childs (09508300). Samples collected 01–29–1968 to 01–29–1996										
Maximum	580	12.00	32.0	12.2	240	35	62	20	40	3.4
Minimum	17	6.00	.2	5.4	18	.02	4.8	1.1	2.5	.50
Mean	258	7.81	16.0	8.8	94	2.5	25	7.4	19	1.2
Median	282	7.90	15.0	8.4	100	.45	27	7.8	20	1.2
Standard deviation	129	.70	7.1	1.5	47	5.6	13	3.8	10	.44
Coefficient of variation	.50	.09	.4	.2	.50	2.3	.50	.51	.54	.36
Number of samples	190	183	223	119	176	171	176	176	176	176

le 9. Summary statistics for water chemistry in Mogollon Highland streams—Continued

Statistic	Sulfate, dissolved (mg/L)	Chloride, dissolved (mg/L)	Fluoride, dissolved (mg/L)	Silica, dissolved (mg/L)	Suspended sediment (mg/L)
Tonto Creek above Gun Creek (09499000). Samples collected 01–28–1976 to 05–28–1992					
Maximum	21	92	0.70	18	2,200
Minimum	5.9	3.2	.20	9.0	.00
Mean	14	44.6	.38	13	99
Median	15	46.5	.40	12	8.5
Standard deviation	2.8	25	.12	2.4	430
Coefficient of variation	.19	.57	.32	.19	4.3
Number of samples	56	58	57	58	26
West Clear Creek near Camp Verde (09505800). Samples collected 09–15–1967 to 03–24–2000					
Maximum	9.7	6.2	0.20	19	2,700
Minimum	1.0	.69	.00	9.1	1.0
Mean	2.4	3.1	.11	15	66
Median	2.1	3.4	.10	15	4.0
Standard deviation	1.5	1.1	.03	2.0	370
Coefficient of variation	.62	.35	.29	.13	5.6
Number of samples	65	63	34	65	54
East Verde River near Childs (09507980). Samples collected 12–04–1990 to 05–30–2000					
Maximum	20	54	1.3	16	180
Minimum	3.6	2.8	.10	8.6	.10
Mean	8.2	11	.34	12	13
Median	7.2	7.9	.30	11	4.0
Standard deviation	3.9	9.5	.26	2.8	29
Coefficient of variation	.47	.84	.74	.23	2.2
Number of samples	56	56	55	11	50
Wet Bottom Creek near Childs (09508300). Samples collected 01–29–1968 to 01–29–1996					
Maximum	28	30	3.3	52	110
Minimum	.00	1.5	.00	7.9	.00
Mean	8.0	8.5	1.4	29	4.8
Median	7.6	8.2	1.5	30	2.0
Standard deviation	3.8	4.9	.74	9.2	13
Coefficient of variation	.47	.58	.52	.32	2.7
Number of samples	172	176	176	176	167

Table 10. Oxygen and hydrogen isotope values for Mogollon Highlands springs

Map code (see figs. 20 and 23)	Spring or station name	Date	$\delta^{18}O$ (per mil)	$\delta^{2}H$ (per mil)
5	Blue north[1]	04–09–1981	-10.40	-78.00
11	A-12-07 21DCD	08–22–2000	-10.10	-72.60
14	Fossil[2]	08–22–2000	-11.60	-79.50
14	Fossil[2]	08–22–2000	-11.58	-81.20
14	Fossil[2]	08–22–2000	-11.55	-80.00
22	Tonto Natural Bridge	08–24–2000	-10.88	-78.00
25	Dripping	08–24–2000	-11.29	-76.70
28	Red Rock	08–25–2000	-11.11	-77.30
29	Grapevine	04–20–2001	-9.67	-70.20
31	Grimes	09–10–2000	-9.76	-73.30
32	Turkey north	08–25–2000	-11.03	-74.90
35	Geronimo	09–09–2000	-11.64	-80.00
36	Lee Johnson	08–23–2000	-10.44	-71.80
39	Webber	09–09–2000	-10.14	-71.50
43	Washington	09–06–2002	-11.55	-78.00
50	Indian Gardens	09–11–2000	-11.18	-76.00
52	Tonto	09–11–2000	-10.34	-72.20
53	Bootleg	06–15–2001	-10.87	-75.10
56	Horton	09–11–2000	-11.43	-77.60
59	Nappa	09–11–2000	-10.84	-73.60
61	See	09–11–2000	-11.44	-77.80
63	Allenbaugh	04–19–2001	-10.60	-73.00

[1]Obtained from U.S. Geological Survey water-quality database. All other samples collected in this study.
[2]Samples collected from three different outlets.

Table 11. Strontium isotope values for spring waters and host rocks

[µg/L, micrograms per liter; N, normal; NA, not applicable]

Map code (see fig. 20)	Spring or station name	Strontium (µg/L)	$^{87}Sr/^{86}Sr$ for spring water	$^{87}Sr/^{86}Sr$ for source rocks (0.1N HCl leach)	Source rocks
NA	NA	NA	NA	0.71225	Coconino Sandstone[1]
25	Dripping	160	0.70719	.70894	Schnebly Hill Formation (siltstone)
31	Grimes	1,140	.70577	.70539	Payson granite
61	See	115	.70900	.70928	Schnebly Hill Formation (sandstone)
28	Red Rock	125	.70782	.70894	Supai Formation (siltstone)
52	Tonto	40	.71076	.71036	Schnebly Hill Formation (limestone)
39	Webber	100	.71132	.71018	Martin Formation (limestone)
32	Turkey (north)	102	.70724	.70894	Supai Formation (siltstone)
22	Tonto Natural Bridge	165	.70912	.71233	Tapeats Sandstone
14	Fossil	275	.70899	.70905	Naco Formation (limestone)
				.70865	Redwall Limestone
11	A-12-07 21DCD	445	.70594	.70617	Tertiary volcanics

[1]None of springs sampled for strontium analysis discharge from Coconino Sandstone, but recharge occurs through these rocks for most springs.

Of the Colorado Plateau springs with the most lute waters, (A-12-13H)01BBD has a significantly higher silica concentration than (A-12-12)11BAB and (A-12-10)01BDA (fig. 22*D*), suggesting a longer ground-water residence time. This is consistent with the northerly ground-water flow in the vicinity of this spring based on the potentiometric-surface map by Hart and others (2002) and the flow gradient in this area being lower than in the vicinity of the Mogollon Rim. Colorado Plateau springs in the West Clear Creek drainage—Pivot Rock, Bear, and Buckhorn Springs—have higher solute and silica concentrations than those mentioned above (fig. 22*A, D*). These springs discharge in an area of basaltic rocks, the glassy matrix of which is much more soluble than sandstone components. Spring (A-12-11)12AAC (table 7, no. 48 and fig. 20), though discharging on the Colorado Plateau above the Mogollon Rim, generally has higher solute concentrations than the most dilute springs (fig. 22*A*). Its lower calcium-magnesium ratio (fig. 22*B*) and much higher bicarbonate concentration (table 7) and calcium-sodium ratio suggest contact with the Kaibab Formation during recharge, and its low sodium and silica concentrations suggest a residence time on the order of that of spring (A-12-12)11BAB (fig. 22*B, D*).

As noted earlier, the chemistries of all springs below the Mogollon Rim derive from the rock and water chemistries of those geologic units on the Colorado Plateau. Their calcium-sodium ratios are compatible with the expected reaction of waters with arenaceous rocks, such as the Coconino Sandstone and the upper sandstone unit of the Schnebly Hill Formation. Variations from this initial signature result from flow through other rock types. Large calcium-sodium ratios and high silica concentrations of springs (A-12-07)21DCD and (A-12-07)22C UNSURV (table 7, nos. 11 and 12 and figs. 20 and 22*B, D*) in Fossil Creek Canyon reflect flow through and discharge from the basaltic rocks that cap Hardscrabble Mesa. In addition, the aqueous strontium-isotope ratio ($^{87}Sr/^{86}Sr$) of spring (A-12-07)21DCD is in close agreement with that of a basalt sample from this locale collected during this study (table 11), confirming the basaltic signature. The principal direction of regional ground-water flow in the vicinity of these two springs is to the southwest; however, springs (A-12-07)21D UNSURV and (A-12-07)22C UNSURV are on north-facing slopes below Hardscrabble Mesa (fig. 1) and are supplied by ground-water flow to the northwest. These springs, herefore, almost certainly are not connected to the regional flow system and only drain the Hardscrabble Mesa basalts. The δ^2H and $\delta^{18}O$ data for spring (A-12-07)21DCD indicate that the water has a significant component of precipitation that reflect conditions warmer than those which controlled the isotopic signature of paleorecharge in Fossil Springs (fig. 23).

The δ^2H and $\delta^{18}O$ data for Fossil Springs, from samples collected at three different spring outlets, are at the light end of the data range, indicating colder recharge conditions than present-day conditions (table 10, no. 14 and fig. 23). The spring chemistry is indicative of recharge through the Coconino Sandstone and flow through limestone because it is a calcium magnesium bicarbonate water that has, except for silica and some minor solutes, the highest solute concentrations of all the springs (fig. 22*A–D*). The spring discharges essentially at the contact of the Redwall Limestone and the overlying Naco Formation, which have strontium isotope ratios of 0.70865 and 0.70905, respectively (table 11). The corresponding value for Fossil Springs water is 0.70899. This close correspondence suggests the strontium-isotope imprint of the Redwall and Naco rocks has been superimposed on Fossil Springs water over the initial strontium-isotope signatures the water would have obtained from reaction with feldspar grains and secondary calcite cement in the Coconino Sandstone that has a $^{87}Sr/^{86}Sr$ value of 0.71225.

Tonto Natural Bridge Spring, southeast of Fossil Creek, has similar chemical characteristics as Fossil Springs, but is slightly more dilute (table 7, no. 22 and figs. 20 and 22*A*). A relatively high silica concentration, however, reflects the influence of basaltic rocks that cap the Paleozoic rocks that flank the spring (fig. 22*D*). The δ^2H and $\delta^{18}O$ values indicate a small degree of enrichment over the waters of Fossil Springs (table 10, no. 14 and fig. 23). Big Spring and Webber Spring are both in the East Verde River drainage basin and they have similar concentrations of dissolved solids (table 7, nos. 37 and 39 and figs. 20 and 22*A*) and are more dilute than Tonto Natural Bridge Spring. Isotope values for Webber Spring are at the heavier end of the data range, suggesting warmer recharge conditions than for Tonto Natural Bridge or Fossil Springs (fig. 23). On the other hand, both Geronimo and Washington Springs, which are in the headwaters of the East Verde River drainage, have δ^2H and $\delta^{18}O$ values near the light end of the data range (table 10, nos. 35 and 43 and figs. 20 and 23), and Turkey Spring in the headwaters of Webber Creek, a tributary of the East Verde River, has δ^2H and $\delta^{18}O$ values in the middle of the range (table 10, no. 32 and figs. 20 and 23).

Dripping Springs discharges on the western side of Milk Ranch Point, a south-jutting promontory of the Mogollon Rim (figs. 1 and 20). This spring differs from

others at or adjacent to the Mogollon Rim in that its silica concentration is higher (table 7, no. 25 and fig. 22*D*), suggesting that it is influenced by the volcanic rocks that cap the promontory. Its δ^2H and $\delta^{18}O$ values are similar to those of other springs discharging from the face of the Mogollon Rim and suggest a slightly larger component of warmer recharge, which could be expected with recharge of local, recent cold-season precipitation through the capping volcanic rocks (fig. 23). This seems more likely than enrichment of a Colorado Plateau source, as the spring discharges at a low rate from within the Schnebly Hill Formation. Its stratigraphic position and relatively high bicarbonate and calcium concentrations, together with its $^{87}Sr/^{86}Sr$ value, suggest that most of the dissolved strontium contribution is due to basalt-water interaction, and that the spring discharge does not include a significant component of water recharged through the Colorado Plateau (table 11).

Springs near or below the base of the Mogollon Rim for which chemical analyses are available—Tonto Natural Bridge, Webber, (A-11H10)24BCA1, Indian Gardens, Bear Flat, and R-C Springs—tend to have higher calcium, magnesium, and sodium concentrations than springs discharging from the rim face because of longer travel and water-rock interaction times (table 7, nos. 22, 39, 42, 50, 54, and 58 and fig. 22*B*). The ranges in concentrations of individual solutes also are a function of the rock types traversed by the individual flow paths.

Indian Gardens and R-C Springs and Spring (A-11H10)24BCA1 are nearest the face of the Mogollon Rim within this group and about equidistant from it (table 7, nos. 50, 58, 42). On the basis of the most recent analytical data, the chemistry of Indian Gardens resembles that of Spring (A-11H10)24BCA1 in relative solute concentrations (table 7 and fig. 22*B*), but Indian Gardens has the highest specific conductance value in the group of seven, and individual concentrations are about double those of Spring (A-11H10)24BCA1 (table 7, no. 42 and fig. 22*A*). Both issue from lower Paleozoic rocks, and their chemistries are dominated by interaction with limestone (calcium magnesium bicarbonate) waters. The Indian Gardens water, however, is chemically more evolved, suggesting a longer flow path and residence time (table 7, no. 50 and fig. 22*B*). Bear Flat Spring chemically resembles R-C Spring in its relative chemical abundance (table 7, nos. 54 and 58; fig. 22*B*).

The isotopic signature of Grimes and Grapevine Springs, discharging from mafic granitic rocks east of Payson (table 10, nos. 29 and 31 and figs. 20 and 23), show enrichment indicative of warm-water recharge or evaporation. The springs are in fractured rocks in an area of rugged topography but low relief and are likely recharged by recent warm-water precipitation falling on relatively low altitudes. They are isotopically closest to Lee Johnson Spring on the southern edge of the Colorado Plateau (table 10, no. 36 and figs. 20 and 23), another spring that appears to discharge from a shallow ground-water system and is probably recharged locally as well as spring (A-12-07)21DCD that is discussed above (table 10, no. 11). Grimes and Grapevine are also similar isotopically to Webber Spring and Tonto Spring, both of which appear to indicate mixing of more recent warmer recharge waters with the older waters of the C aquifer, perhaps as a result of rapid infiltration through a fractured rock system.

Chemistry of Well Waters

The chemical composition of Mogollon Highlands well waters show little spatial correlation, and generalizations of constituent concentrations and geographic location are difficult to make. For the most part, well waters are dilute and have the most consistently low values of specific conductance in the Pine-Strawberry area and the lower Tonto Creek Basin (table 8 and figs. 24 and 25*A*); however, in the case of Pine-Strawberry, well chemistry data are few. Specific conductance values generally are less than 600 µs/cm in well waters throughout the study area, but values of more than 1,000 µs/cm are found in water in wells scattered mainly across the Payson shelf and in the carbonate rocks of the upper Tonto Creek Basin. The highest silica concentrations tend to be in the waters of wells along the Payson shelf, reflecting the influence of igneous and metamorphic rocks in which the wells are drilled. The high variability in ionic constituents (figs. 25*B, C*) reflect the complexity of flow paths throughout the study area.

Chemistry of Surface Waters

Water-chemistry samples have been collected from four streams in the Mogollon Highlands during varying time periods (table 9). Because samples usually are collected during base-flow conditions, the chemical make up of the waters may reflect ground-water chemistry to some extent. The samples found to be the most dilute were collected in the waters of West Clear Creek, which primarily drains the Coconino Sandstone of the C aquifer, and Wet Bottom Creek, which drains the metamorphic and igneous rocks of the Mazatzal Mountains. Maximum and average values of specific

onductance are lowest for the samples from these two streams: however, the relative constituent concentrations do not vary significantly from those of the samples from the waters of East Verde River and Tonto Creek, which drain the carbonate rocks of the limestone aquifer before flowing into the igneous and metamorphic terranes of their lower reaches. Surface-water chemistry seems to reflect the generally low degree of chemical evolution in Mogollon Highlands waters.

Hydrogeologic Framework and Conceptual Model

Data on water levels, spring discharge, and spring altitudes are primarily for the upper part of the stream basins that drain the study area; long-term streamflow records are all for locations near the southern and eastern boundaries of the study area. A reasonable approximation of the ground-water system and its geologic controls can, therefore, be constructed for the upper basins. Between the base of the Mogollon Rim and the drainage outlets, however, few data are available, except in the Payson granitic aquifer and in the shallow alluvial aquifer of lower Tonto Creek. Delineation of ground-water flow paths in much of the study area is problematic because of the presence of multiple water-bearing zones and because many published water levels in wells are based upon anecdotal reports as much as 50 years old. Consequently, attempts to define such flow paths, especially in deeper water-bearing zones, must be considered tentative. Some characteristics of the ground-water system can be derived from analysis of surface-water records, particularly the relative contribution of base flow and runoff to the total water budget and the relative unit-values of water yield. Nonetheless, chemical characteristics, distribution and flow characteristics of springs and wells, and their relation to geologic and topographic features suggests that the C aquifer is the origin of virtually all the regional ground-water flow within the study area, including that which discharges from the underlying limestone aquifer (figs. 26 and 27).

Recharge Zone

Feth and Hem (1963) provided a descriptive view of recharge processes along the Mogollon Rim. Water from precipitation and snowmelt percolates through the permeable volcanic, limestone, or sandstone units to the rocks below. The Mogollon Rim within the study area is capped primarily by volcanic rocks in the west and by as much as 1,200 ft of Coconino Sandstone in the east. The Coconino Sandstone generally underlies the volcanic rocks as well. The ground-water system of the study area originates primarily from a narrow recharge zone of about 225 mi^2 along the crest of the Mogollon Rim. On the basis of PRISM (Parameter-elevation Regressions on Independent Slopes Model) data, an average of 31.2 in/yr of precipitation, about 375,000 acre-ft, falls on the this area between the top edge of the Mogollon Rim and the C aquifer ground-water divide, from Cibecue Creek on the east and West Clear Creek on the west (figs. 5 and 26). Beneath that recharge zone, Hart and others (2002) describe a mound of ground water, the top of which is within the Coconino Sandstone at an altitude of 6,800 ft, about 700 ft below the land surface (fig. 26). The spatial distribution of high-discharge springs in regional carbonate aquifers and chemical characteristics of waters from those springs point to a source in the Coconino Sandstone. Little evidence exists of significant discharge from the Coconino Sandstone, except for that issuing from Buckhorn Spring and in base flow of West Clear Creek in the northwestern part of the study area (fig. 15, no. 15). Wells on the Colorado Plateau north of the Mogollon Rim, however, generally are producing from the Coconino Sandstone, indicating that the highest potentiometric surface is within the formation. The Coconino Sandstone forms a sheer cliff face along the top of the Mogollon Rim, but seeps and springs are not abundant. The highest altitude springs that produce significant discharge are those flowing from the Fort Apache Member of the Schnebly Hill Formation in the headwaters of Tonto and Canyon Creeks.

Other major springs in the study area discharge from the limestone aquifer that includes all the Paleozoic sedimentary units from the Naco Formation to the basement rocks, which can be either Tapeats Sandstone or Proterozoic crystalline rocks (fig. 15). Chemical evidence, distribution of springs, and known flow paths suggest that the limestone aquifer is recharged primarily from vertical flow originating in the overlying C aquifer. The maximum possible extent of the limestone aquifer is controlled by the boundaries of the carbonate rocks as suggested in isopach maps that show the Redwall Limestone pinching out in the northeastern corner of the study area (McKee and Gutschick,1969) and the Martin Formation pinching out to the northeast beneath the Little Colorado River (Teichert, 1965).

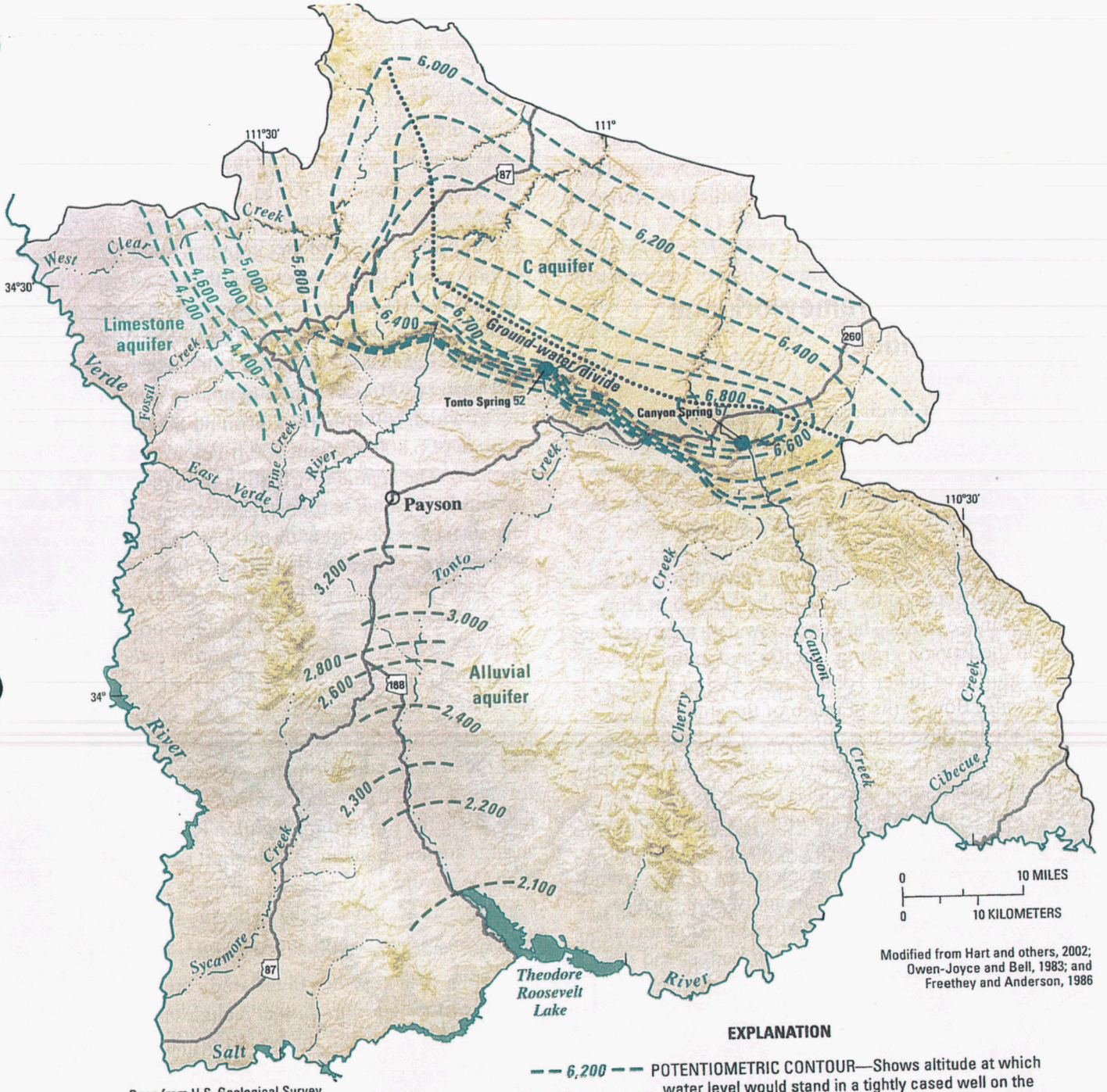


Figure 26. Potentiometric surfaces of the C aquifer, limestone aquifer, and alluvial aquifer in the lower Tonto Creek Basin, Mogollon Highlands, Arizona.

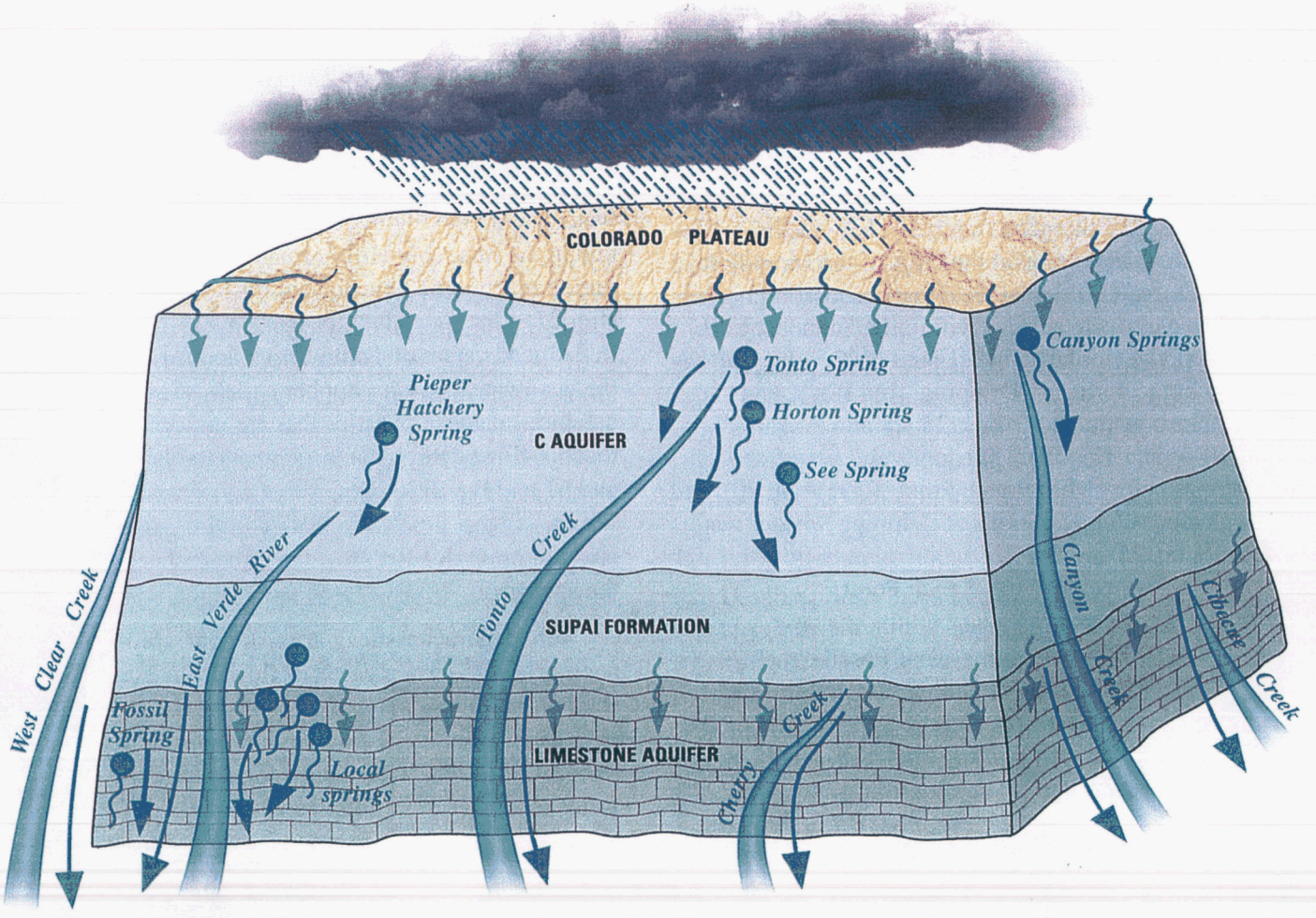


Figure 27. Schematic diagram of the ground-water system in the Mogollon Highlands, central Arizona.

No attempt has been made to delineate a ground-water divide for the limestone aquifer, although it presumably trends roughly parallel to the ground-water divide of the C aquifer on the Colorado Plateau (fig. 26). Additional recharge of the limestone aquifer can occur by infiltration of streamflow originating on the upper slopes of the Mogollon Rim as a result of runoff or discharge from the C aquifer springs, or from precipitation on the face of the Mogollon Rim and the tablelands near the base of the rim where limestone rocks are exposed. For most of the study area, recharge from precipitation or runoff is not likely to be a major component of the total water budget for the limestone aquifer because the Mogollon Rim face is quite steep with slopes of 10 to nearly 100 percent, and the tablelands are primarily a discharge area where much of the limestone aquifer is drained. For recharge to take place below the top of the Mogollon Rim, rapid vertical flow through large, open-joint or cavern systems would have to occur if the water were to reach the aquifer upstream from the principal discharge points. Some mixing of recent recharge with spring flow is suggested by the hydrogen and oxygen isotopic signature of Tonto Natural Bridge and Webber Springs (table 10, nos. 22 and 39 and fig. 23).

One area where local recharge of the limestone aquifer might be significant is along the eastern edge of the study area near Cibecue Creek where a southeast-trending plateau is capped by middle Paleozoic rocks. The more subdued slopes of this area and the presence of major structures along the western boundary of the plateau could facilitate local recharge (figs. 1 and 4). Numerous springs appear along the canyon walls flanking Cibecue Creek; however, they have not been inventoried by any State or Federal agency, and there are no data available on their flow characteristics that would help evaluate the likelihood of local recharge in this area.

The study area includes several local aquifers that have little or no hydraulic connection to the regional aquifers and, therefore, must be recharged locally. These aquifers include the water-bearing zones of the Schnebly Hill Formation in the Strawberry area and the Supai Formation in the Pine area and in the western headwaters of the East Verde River. Several lines of evidence suggest that these aquifers share a common, restricted recharge zone on the crest of the Mogollon Rim. Such evidence includes, the absence of high-discharge carbonate springs within the Schnebly Hill Formation, the similarity in δ^2H and $\delta^{18}O$ values among low-discharge springs—Dripping, Red Rock, and Turkey Springs (table 10, nos. 25, 28 and 32 and fig. 23)—emanating from siltstones and very fine sandstones below Milk Ranch Point (figs. 1 and 20), and the high silica concentrations of Dripping Springs waters (table 10, no. 25 and fig. 22*D*) indicative of flow through basaltic rocks that cap Milk Ranch Point.

Other local recharge zones within the study area include the basalt-covered mesas of Fossil Creek Canyon, the Payson granite and related granitic rocks that form the Payson Shelf, and the upper slopes of the Mazatzal Mountains and Sierra Ancha. Virtually all the water-bearing zones in the Payson granite are locally recharged by percolation of meteoric waters through fractures and weathered rock. Ploughe (2001) suggests, however, that deeper water-bearing zones may occur in fractures that capture ground-water flow from the Mogollon Rim.

Within the Proterozoic rocks of the Mazatzal Mountains and Sierra Ancha, the occurrence of some low-discharge springs and base flow in the streams draining those mountains, especially Cherry Creek, suggest that these areas are at least minor recharge zones.

Upper Discharge Zone

The sedimentary rocks that compose the C aquifer are drained by at least 36 springs along the face of the Mogollon Rim. The most important discharge points are West Clear Creek, including Buckhorn Spring, on the western edge of the study area, and the high-volume springs in upper Tonto and Canyon Creeks to the east (figs. 15 and 27). Except for Buckhorn Spring, which is on the Colorado Plateau, all the springs having reported discharges of more than 100 gal/min discharge from carbonate rocks (fig. 15 and table 4). From Pieper Hatchery Spring in the uppermost headwaters of East Verde River east to Tonto and Canyon Creeks, high-discharge springs flow from the Schnebly Hill Formation, mainly from the Fort Apache Member. Spring altitudes in this area range from about 6,200 to 6,800 ft, which is about 800 to 1,300 ft below the crest of the Mogollon Rim.

The absence of significant spring discharge above the Fort Apache Member indicates that the movement of water within the highly fractured Coconino Sandstone and in the Schnebly Hill Formation is primarily vertical until it reaches the limestone of the Fort Apache Member (fig. 27). Chemical data for Horton and Tonto Springs in the headwaters of Tonto Creek and for See Spring in the headwaters of Christopher Creek, show similar calcium-magnesium ratios that are indicative of water that has flowed through clastic rocks (table 7, nos. 56, 52, and 61 and fig. 22*B*). Low silica concentrations in these waters suggest little chemical evolution, an indication of rapid ground-water flow from the recharge site to the springs.

Flow characteristics vary from one spring to another. Long-term records of flow from Tonto Spring show little fluctuation in base flow over a 20-year period (fig. 16*A*). Stability of flow in Tonto Spring results from its location about 300 ft below the crest of the ground-water mound (fig. 26). In the headwaters of Christopher Creek, See and Nappa Springs appear to be considerably less stable, but few discharge measurements have been published (table 4, nos. 61 and 59). Both springs discharge from bouldery alluvium, so it is not clear whether they issue originally from the Fort Apache Member or from other rocks in the Schnebly Hill or Supai Formations. Fluctuation of discharge most likely reflects their location near the top of the ground-water mound (fig. 26) where they are affected by changes in its altitude.

Discharge at Canyon Springs was stable until the mid 1990s when its average discharge declined from about 2,500 to 1,500 gal/min (fig. 16*A*). Canyon Springs are situated at an altitude of 6,800 ft, which is also near the top of the ground-water mound (fig. 15, no. 67). Consequently, the springs are susceptible to the effects of short-term climatic fluctuations that result in changes to the water table at the top of the C aquifer. The reduction in discharge from Canyon Springs might reflect drought conditions of recent years. Although there are a few wells on the Colorado Plateau above the spring outlets, there has been no recent large increase in well development that would be likely to produce such an abrupt change in spring discharge by a lowering of the regional ground-water table.

In the East Verde River drainage, Pieper Hatchery Spring discharges from the Fort Apache Member of the Schnebly Hill Formation (table 4, no. 45 and fig. 15). The only published discharge is an estimated value of 125 gal/min. Discharges from other springs in the headwaters of the East Verde River typically are less than 10 gal/min. The paucity of flow from springs discharging from the sand and siltstones of the Supai Formation parallels the generally poor productivity of wells in that unit in the Pine area (Kaczmarek, 2003). West of Pieper Hatchery Spring there is little or no discharge directly from the C aquifer along the face of the Mogollon Rim. Indeed, the only major discharge point from the C aquifer in the western part of the study area appears to be within the persistent base flow of West Clear Creek (table 3), part of which is supplied by discharge from Buckhorn Spring. The absence of significant discharge from the Mogollon Rim face west of the East Verde River implies some structural control that blocks lateral ground-water flow. Such structural control could be a feature that diverts flow vertically into the limestone aquifer.

Except for West Clear Creek, base flow in excess of spring flow in the upper reaches of streams draining the face of the Mogollon Rim does not seem to be a significant source of discharge from the C aquifer. Most flow in the upper channel reaches in excess of spring flow is almost certainly runoff rather than ground-water discharge.

Lower Discharge Zone

The lower discharge zone is that area on the lower slopes of the Mogollon Rim face and the tablelands formed by the Naco Formation at the base of the Supai Formation, and the Redwall Limestone, Martin Formation, and Tapeats Sandstone, where present. The underlying Proterozoic rocks are the base of the ground-water flow system, but deep fractures may permit flow into those rocks. With a few exceptions, spring discharge is highly variable from the limestone aquifer of this zone. Heterogeneities in geologic structure, lithology, or both result in variable travel lengths, residence times, flow stability, flow volume, and chemical composition of spring waters. The dilute nature of spring waters draining the limestone aquifer indicates such waters are little evolved and probably share a common source.

The main discharge areas are Fossil Springs, which account for about 60 percent of recorded spring flow in the study area, and Cibecue Creek, where base flow accounts for about 50 percent of total annual streamflow, suggesting a strong ground-water component of streamflow (figs. 13 and 27). Cibecue Creek also flows for most of its length through a canyon, cut into Paleozoic rocks, where numerous springs discharge from the cliffs above the stream. Between Fossil and Cibecue Creeks, most discharge from the limestone aquifer is at springs in the East Verde River and Tonto Creek Basins. All springs with discharges greater than 100 gal/min flow from carbonate rocks except Tonto Natural Bridge and R-C Springs, which discharge just below the base of carbonate lower Paleozoic rocks.

Fossil Springs discharges from the base of the Naco Formation or the top of the Redwall Limestone (table 4, no. 14). Various measurements during the past 50 years indicate that these springs maintain a flow of about 20,000 gal/min that has varied little (table 4 and fig. 16*C*). The volume and stability of spring flow, as well as the depleted δ^2H and $\delta^{18}O$ values, indicate that Fossil Springs has a large contributing area and is connected with the limestone aquifer by large, open structures. The precise location of this connection can only be surmised. It is bound by ground-water divides to the northwest where flow is toward West Clear Creek and to the southeast where flow is toward Pine Creek. Gila County drilled exploratory well (A-12-08)29AAA2 (table 6, no. 166) in the Strawberry area in 2000. The water level in the well, 1,380 ft below land surface, may indicate the potentiometric surface of the limestone aquifer (Corkhill, 2000). Water in the well stands at an altitude of 4,376 ft. The well is about 4 mi east of Fossil Springs, which has an altitude of about 4,290 ft. If those two points are on a flow path at the potentiometric surface of the limestone aquifer, the gradient of the water table is less than 0.5 percent.

No long-term records are available for spring discharge in the East Verde River drainage, but scattered measurements made during the past 50 years indicate that discharge is highly variable in some of the springs. A 2-year record of flow in Pine Creek below Tonto Natural Bridge Spring, however, shows little change in base flow, most of which is supplied by the spring (fig.16*B*; Robert Sejkora, water program manager, Arizona State Parks, oral commun., 2003). Feth and Hem (1963) suggest that the variability of flow in springs of the East Verde River and its tributaries indicates that the springs are draining an area of low storage. High variability would also indicate the possibility of local recharge resulting in a rapid response of springs to climatic fluctuations. All the springs cited by Feth and Hem (1963), The Grotto, Big Spring, and Cold Spring, were measured in May and July 1952, and Cold Spring

was measured again in November 1952 (table 4 and figure 15, nos. 38, 37, and 44). The wide range of discharges recorded in that brief period strongly suggests that the spring discharge is affected by variations in local recharge. With the exception of Pieper Hatchery Spring, all high-discharge carbonate springs in the East Verde River drainage flow from lower Paleozoic rocks, and of those, only Cold Spring discharges on the upthrown side of the Diamond Rim Fault (fig. 15, nos. 45 and 44). The presence of relatively high-discharge springs in Webber Creek and along the East Verde River below the Diamond Rim Fault suggests that faulting is influencing ground-water discharge in this area. Uplift of the lower Paleozoic rocks north of the fault increased the subaerial exposure of lower Paleozoic carbonate rocks, enabling drainage of a thicker section of the Colorado Plateau sediments into the graben below the fault (fig. 15). Another fault to the south, running subparallel to the Diamond Rim Fault, apparently impedes ground-water flow, producing a local bulge in the potentiometric surface between the two faults and causing spring discharge in Webber Creek and along the East Verde River. Tonto Natural Bridge Spring on Pine Creek is situated within the same graben to the northwest, however, it appears to have more stable discharges than the nearby springs. Also, its isotopic signature is more similar to that of Fossil Springs, showing relatively cold recharge conditions, than that of Webber Springs that showed warmer recharge conditions.

Within the Tonto Creek Basin, springs issuing from the limestone aquifer have relatively lower discharge and greater variability in flow than Tonto and Horton Springs in the upper reaches, which account for more flow than all other springs in the basin combined (table 4, nos. 52 and 56). Nonetheless, chemical characteristics of all springs in the Tonto Creek Basin for which data are available show that spring waters are more similar than different, indicating their common origin (table 7 and fig. 22*A–D*). Indian Gardens Spring has higher specific-conductance values and higher concentrations of chemical constituents than neighboring springs, which reflects the local variation in hydrogeologic properties that affects ground-water flow in the limestone aquifer.

Tonto Natural Bridge Spring on Pine Creek has isotopic and specific-conductance values similar to those of Fossil Springs (figs. 22 and 23). Furthermore, flow from both springs is apparently stable, although the period of time during which flow in Tonto Natural Bridge Spring has been measured is considerably less than that for Fossil Springs (fig. 16*B,C*). This suggests that the contributing area for Tonto Natural Bridge Spring is large enough to assure a constant supply of water, presumably from the same aquifer as that which supplies Fossil Springs. The slightly greater enrichment of δ^2H and $\delta^{18}O$ values, the chemical evidence of flow through basaltic rocks, and the much lower discharge indicate that the Tonto Natural Bridge Spring is not as well connected to the limestone aquifer and that some local recharge is contributing to the flow. In Pine, a well that was completed in November 2002 hit water at a depth of 894 ft below land surface (altitude of 4,608 ft) in the Redwall Limestone (Michael Ploughe, hydrologist, Arizona Hydrologic Source, oral commun., 2003). The well is within the Pine Creek watershed, but whether it is on the Pine Creek or Fossil Creek side of the ground-water divide for the limestone aquifer is uncertain.

Although the springs in the Diamond Rim Fault area are no doubt connected to the limestone aquifer and their waters share a common origin with those in Tonto Natural Bridge and Fossil Springs, they apparently are not as tightly connected to the limestone aquifer. A greater amount of mixing of younger meteoric waters falling on local recharge zones seems to take place along the flow paths leading to the Diamond Rim Fault springs as evidenced by the oxygen isotope signature of Webber Spring waters (fig. 23, no. 39).

Local Water-Bearing Zones on the Mogollon Rim

On the upper slopes of the Mogollon Rim area, the highest well density is in the Pine and Strawberry areas where ground-water flow in the shallow, local aquifers follows topography, flowing west toward the Verde River in the Strawberry area and south along Pine Creek in the Pine area (table 6 and figs.14 and 18). In Strawberry, the water-level altitude as reported in wells declines from about 5,820 to 5,600 ft over a distance of about 2.3 mi. Depth to water generally is less than 100 ft. In Pine, the water-level altitude in wells declines from about 5,640 to 5,440 ft over a distance of about 1.8 mi (table 6 and fig. 18). According to Kaczmarek (2003), wells in Strawberry generally are more productive and less prone to effects of drought than wells in Pine. He suggests this is because of the different hydrologic properties of the Schnebly Hill Formation, in which most of the wells in Strawberry are drilled, and the Supai Formation, in which the wells of Pine are drilled, the former having greater primary permeability and storage than do the tight siltstones and very fine sandstones of the latter. In both places, well productivity is dependent on the proximity, density, and

transmissivity of fractures, but in Pine, the absence of significant storage retards the recovery of wells after drawdown. The shallow aquifers are poorly connected to the regional aquifer system and likely dependent on local recharge over a contributing area of limited extent.

Wells are scattered throughout the tablelands from the East Verde River east to Colcord Canyon (figs. 1, 14, and 18). Most wells are completed in the Redwall Limestone or in the Martin Formation. Those clustered along the East Verde River are little more than 10 ft deep and probably are in alluvium (figs. 1 and 18). To the east near Tonto Village and Kohls Ranch, wells likely are completed in the limestone aquifer and water levels typically are 100 to 200 ft below land surface. Water-level altitudes in wells cluster around 5,600 ft, which is similar to the range of altitudes for springs in the area that discharge at surface altitudes from 5,640 to 5,350 ft, suggesting that springs are issuing from the same aquifer as the wells. The only well discharge record for the area shows a discharge of 50 gal/min. The wide range of spring discharge in the area, from 4 to 800 gal/min, illustrates the variability of ground-water flow in the tablelands that is a function of geologic structure and climatic fluctuations that affect local recharge.

Local Water-Bearing Zones Below the Mogollon Rim

Records for major streams that flow out of the Mogollon Rim indicate that base-flow discharge increases downstream under most conditions although that flow may not continue without loss all the way to the mouth of the stream. Except for the Payson Shelf (fig. 1), hydrogeologic characteristics of the predominantly Proterozoic rocks across which the East Verde River, Tonto Creek, Cherry Creek, and Canyon Creek flow are essentially unstudied. The presence of some low-discharge springs in the Sierra Ancha and Mazatzal Mountains and base flow in several streams that drain those strata, including Rye Creek, Sycamore Creek, and Cherry Creek, suggest the existence of some mountain recharge sites. What is not known at present is the extent to which ground-water flow makes its way into the lower basin by way of faults and fractures within the Proterozoic rocks. In the Payson granite, most known water-bearing zones are shallow and are dependent on winter precipitation to sustain ground-water levels. The shallow granite aquifer has little or no connection with regional flow systems. Deeper water-bearing zones within the Payson granite, however, may be storing or transporting flow from the Mogollon Rim (Gæorama, Inc., 2003).

Other Proterozoic rocks in the study area probably have similar hydrologic characteristics in that they have extremely limited primary permeability but do have fracture-controlled secondary permeability. As indicated by the few low-flow springs and by the handful of shallow wells in Proterozoic rocks along the southeastern edge of Tonto Creek below the Mogollon Rim, the water-bearing zones are mainly shallow systems that are probably dependent on local winter precipitation to sustain water levels. These rocks may also include deep-seated fractures through which ground water is transmitted from the regional ground-water systems. Although many of the Proterozoic faults and fracture systems may be too mineralized to allow significant fluid movement, some of those systems were reactivated during Basin and Range faulting and perhaps serve as conduits for ground-water flow. Within the study area, the upper reaches of all the major streams trend northeast along the same trend as the apparently fracture-controlled tributaries of the Little Colorado River on the Colorado Plateau or, in the case of Canyon and Cibecue Creeks, northwest-trending upper reaches nearly join the headwaters of the north-flowing plateau streams. Because the fractures on the plateau are through Paleozoic rocks, they are presumably either Basin and Range extensional structures or reactivated Proterozoic structures, and their continuation on the southern side of the Mogollon Rim is not improbable.

Within the basin fill and Quaternary alluvium of the lower Tonto Creek Basin, the shallow aquifer that is exploited by wells in the area is likely recharged from streamflow and precipitation. Generally higher dissolved solids concentrations in the wells of the lower Tonto Creek Basin, however, might be evidence of more evolved waters that have been transported from the regional ground-water system.

Water Budget

The water budget is a summation of all the inflows to and outflows from the ground-water system. In the Mogollon Highlands, the control volume represented by the C aquifer south of the ground-water divide is fairly well established (Hart and others, 2002) and inflow, almost entirely in the form of precipitation, can be constrained within tolerable limits. Although a 30-percent decrease in the flow of Canyon Spring after

1992 (fig. 16*A*) offers some evidence of water-table decline in the C aquifer near the crest of the Mogollon Rim, the total volume of water in the aquifer has probably not fluctuated significantly in historic times and can be considered to be in steady-state condition. The limestone aquifer is not as well understood, however. The extent of the aquifer below the C aquifer is not known, nor is its recharge area well constrained. Although it is almost certainly recharged by vertical flow through large regional structures from the overlying C aquifer, the ground-water divide of the limestone aquifer, separating that part of the aquifer that flows toward the Mogollon Rim from that which flows toward the Little Colorado River, has not been delineated, and the degree of local recharge occurring on the lower slopes of the rim has not been established. Nonetheless, the persistence and consistency of flow from Fossil Springs and the rather steady base flow of Cibecue Creek, which drains the aquifer along the eastern edge of the study area, suggest that the volume of water in the aquifer does not fluctuate significantly over time, and it is probably reasonable to consider the volume as steady in the long term. For the purposes of this study, it is assumed that the C aquifer and limestone aquifer are hydraulically connected, that they share a common recharge area above the Mogollon Rim, and that only the limestone aquifer receives secondary recharge from precipitation falling below the Mogollon Rim crest and possibly from spring flow at higher altitudes that percolates back into channel bottoms above the limestone aquifer. Local water-bearing zones are not considered separately in this analysis.

Ground-Water Budget Data and Approach

The inflow data used in this study include recharge values estimated from areal precipitation totals using the PRISM geographic coverages (fig. 5) and published recharge rates for the Flagstaff area (Errol L. Montgomery and Associates, 1993). Outflow data include spring-discharge and stream-discharge records.

The PRISM coverages consist of a map of contoured annual precipitation values that have been generated using point precipitation data and digital elevation models to model the spatial distribution of precipitation (Johnson and Taylor, 2003). The data are organized into polygons, which enables calculation of surface area over which a given value of average annual precipitation falls and which permits calculation of area-weighted annual precipitation.

Almost all the significant spring discharge is from the Paleozoic rocks of the Mogollon Rim, and these discharges were used to estimate the outflow from the C aquifer and limestone aquifer within those rocks (table 12). Values of average annual spring discharge were estimated from single point discharges where those were the only data available, or from averages of multiple measurements. Where there were great discrepancies between reported values for the same spring, estimated or anecdotal values were eliminated in favor of measured values when such were available. When using such scanty data, considerable error can be introduced into the estimates of annual spring discharge; however, the four springs or spring systems for which good, multiple measurements exist—Fossil Springs, Tonto Natural Bridge Spring, Tonto Spring, and Canyon Spring—account for about 75 percent of the total recorded spring discharge for the study area (table 4, nos. 14, 22, 52, and 67). Discharge from non-carbonate springs generally is below 10 gal/min, and such springs discharge an inconsequential portion of the total water budget for the aquifers within the Paleozoic sedimentary rocks. The precision and completeness of discharge data, or lack thereof, for low-discharge springs is, therefore, not of major concern. The most problematic records are for those springs that have demonstrated high but variable discharge during the few times they have been measured. These include Cold Spring, Big Spring, See Spring, and The Grotto (table 4, nos. 44, 37, 61, and 38). The difference between the extremes of range produce changes in the total outflow from the regional aquifers of 2 percent greater or 4 percent lower than the value obtained by using average or best values, as was done here.

For purposes of calculating the budget, averages of multiple measurements were used, except in the case of See Spring for which the highest value was discarded because technical notes on file in the USGS Tucson office indicate that runoff could be included in that estimate. Springs having discharges below 10 gal/min were not used in calculations of the water budget. Most of the smaller springs do not appear to issue from the regional aquifer but from local water-bearing rock zones.

Streamflow records for the six largest streams draining the study area were also used to calculate outflows from the C and limestone aquifers. On Cherry Creek and the East Verde River, records were used from two discontinued streamflow-gaging stations (fig. 1 and tables 2 and 12) that were near the base of the Mogollon Rim, near Young and Payson, respectively, and the short records there were extended by regression (table 13).

Table 12. Stream-discharge, spring-discharge, and precipitation values used to compute water budget for regional aquifer

[ft^3/s, cubic feet per second; ac-ft/yr, acre-feet per year; gal/min, gallons per minute; E, estimated; C, current meter; V, volumetric; F, flume; R, reported; in., inches. All stream data from U.S. Geological Survey except where noted. Precipitation values are calculated from Parameter-elevation Regressions on Independent Slopes Model coverage (see fig. 5). Dashes indicate no data]

Stream name	Average daily discharge (ft^3/s)	Average annual discharge (ac-ft/yr)	Average annual runoff (ac-ft/yr)	Average annual base-flow discharge (ac-ft/yr)	Average annual spring flow into drainage (ac-ft/yr)	Net base flow (ac-ft/yr)
C aquifer drainage						
West Clear Creek near Camp Verde	63.55	46,041	31,794	14,247	1,614	12,633
Limestone aquifer drainage						
East Verde River near Payson[1]	49.30	35,716	22,896	12,820	7,544	5,276
Tonto Creek at Bear Flat[2]	5.50	3,961	674	3,287	5,733	[5]0
Cherry Creek near Young[1]	6.92	5,012	1,651	2,312	([4])	2,312
Canyon Creek near Globe[1]	69.56	50,390	31,052	19,339	5,527	13,812
Cibecue Creek near Chrysotile	45.45	32,929	16,198	16,731	([4])	16,731
Total[3]		**154,800**	**94,200**	**60,600**	**13,300**	**38,100**

Spring or station name	Altitude (ft above NGVD 29)	Drainage	Discharge (gal/min)	Year of latest record	Method	Annual discharge (ac-ft/yr)
C aquifer springs						
Buckhorn	5,060	West Clear Creek	1,000	1959	E	1,614
Nappa	6,620	Tonto Creek	70	1966	C	113
A-11-14 35DBA2	6,800	Canyon Creek	410	--	C	662
A-11-14 35DBA1	6,800	Canyon Creek	310	--	C	500
A-11-14 35DBA2	6,780	Canyon Creek	480	--	C	775
Pieper Hatchery	6,210	East Verde River	125	1952	E	202
See	6,660	Tonto Creek	94	2001	Average V	152
Horton	6,700	Tonto Creek	1,100	2002	C	1,776
Tonto	6,480	Tonto Creek	1,291	2001	Average F	2,084
Canyon		Canyon Creek	2,224	2001	Average F	3,590
Total[3]						**11,500**

See footnotes at end of table.

Table 12. Stream-discharge, spring-discharge, and precipitation values used to compute water budget for regional aquifer—Continued

Spring or station name	Altitude (ft above NGVD 29)	Drainage	Discharge (gal/min)	Year of latest record	Method	Annual discharge (ac-ft/yr)
Limestone aquifer springs						
The Grotto	4,640	East Verde River	175	1952	Average C	282
Big	4,640	East Verde River	138	1952	Average C	223
R-C	5,550	Tonto Creek	800	1952	E	1,291
Tonto Natural Bridge	4,600	East Verde River	841	2002	Average G	1,357
Cold	5,190	East Verde River	2,030	1952	Average C	3,277
Webber	4,640	East Verde River	1,290	2001	Average F/C	2,082
Fossil	4,290	Fossil Creek	20,345	2001	Average C	32,839
Indian Gardens	5,420	Tonto Creek	63	2002	Average F/C	102
Wildcat	5,640	Tonto Creek	59	1952	R	94.4
A-11-13 18AA	6,320	Tonto Creek	15	1966	E	24.2
Henturkey	5,560	Tonto Creek	60	1952	C	96.8
A-11H10 24BCA1	5,215	East Verde River	75	1952	E	121
Total[3]						**41,800**

Recharge zone	Area-averaged annual precipitation	Size of recharge zone (acres)	Total precipitation (ac-ft)
C aquifer precipitation			
Colorado Plateau south of ground-water divide for C aquifer (see fig. 27)	31.2 in. (2.6 ft)	144,000	374,400
Limestone aquifer precipitation			
Upper slopes of Mogollon Rim (limestone aquifer)	25.7 in. (2.15 ft)	344,000	739,600
Lower slopes (tablelands) of Mogollon Rim	22.0 in. (1.83 ft)	160,200	293,200
Cibecue Creek drainage basin	20.7 in. (1.73 ft)	188,800	326,600
Total[3]			**1,359,000**

[1]Record extended by regression (table 13).
[2]Data from U.S. Department of Agriculture Forest Service, Tonto National Forest.
[3]Rounded value.
[4]Spring flow unknown.
[5]Calculated value is less than zero.

Table 13. Results of regression to extend stream records

Independent stream record (x)	Dependent stream record (y)	Dates used	Equation	r^2
Cherry Creek near Globe	Canyon Creek near Globe	10–1–1975 to 9–30–1981	y=2.34x.956	0.785
Cherry Creek near Globe	Cherry Creek near Young	5–4–1965 to 9–30–1977	y=0.344x-0.298	.905
East Verde River near Childs	East Verde River near Payson	9–19–1961 to 9–30–1965	y=0.737x+0.614	.972

These stations were used instead of the active stations because of their proximity to the Paleozoic rocks from which the ground-water discharges from the regional aquifers. At Tonto Creek, monthly low-flow measurements conducted by the USDA Forest Service at Bear Flat (fig. 1) were used to estimate base flow. West Clear Creek, Canyon Creek, and Cibecue Creek have no records other than from the stations close to the mouth of the streams. West Clear Creek flows most of its length through rocks that constitute the C aquifer, and it is reasonable to suppose that the ground-water component of base flow in these streams is derived from that aquifer. Cibecue Creek flows most of its length through the limestone aquifer and most of its base flow probably comes from those rocks.

Daily average streamflows were used to calculate a daily value of stream volume, and the average daily stream volume was used to calculate an average annual volume for the period of record (table 12). As described in the hydrology section, base flow was estimated to be the sum of all flows below the discharge level that occurred at the 80th percentile of total streamflow. For calculation of total outflow from each stream, estimated total annual discharge from springs upstream from the measurement site was subtracted from the total annual base flow to avoid double accounting of discharges (table 12).

Inflows

Total precipitation over the approximately 3,950 mi^2 of the study area south of the C aquifer ground-water divide parallel to the Mogollon Rim is more than 4.4 million acre-ft/yr. Most of that precipitation, however, does not occur over probable recharge zones. The main recharge area for the C aquifer and the minor water-bearing zones in the Schnebly Hill and Supai Formations occurs along the crest of the Mogollon Rim over an area of about 225 mi^2 that receives about 9 percent of the total precipitation for the Mogollon Highlands. The subdued topography, geologic structures, high winter precipitation, and a winter snowpack all promote high rates of infiltration and recharge relative to much of the rest of the study area. Errol L. Montgomery and Associates (1993) estimated that 4 to 17 percent of precipitation was recharged into the regional aquifer near Flagstaff in an area of geology similar to that in the study area. A 17-percent recharge rate was initially used to calculate the total recharge on the crest of the Mogollon Rim (table 14*A*).

The limestone aquifer is recharged by leakage from the overlying C aquifer and by local recharge—precipitation falling on areas below the recharge area for the C aquifer but above the limestone aquifer. Although more precipitation—18 percent of the total for the study area—falls on the face of the Mogollon Rim than on the crest, steeper slopes; thinner soils; lower, less dependable, less persistent snow accumulation; and less permeable geologic units result in a higher percentage of the total being lost to runoff. A recharge rate of 4 percent to the regional aquifer was initially assumed for the steepest slopes of the Mogollon Rim (table 14*A*).

In the tablelands forming the base of the Mogollon Rim, slopes are more subdued. Soils are typically thin, and geologic units generally are of low permeability, except where fractured or weathered. The tablelands are near the bottom of the winter snowline and snow accumulations are so light and of such brief duration that they are probably not a significant factor in recharge. Nonetheless, evidence cited above, including isotopic values and spring-flow instability, suggest some local recharge occurs. A recharge rate of 4 percent of total precipitation was assumed for the tablelands although the local variation over the entire area certainly is quite high. Because of the characteristics of the Cibecue Creek watershed, namely generally subdued topography and permeable geologic units, a recharge rate of 10 percent was initially used for precipitation in that basin (table 14*A*). The Mazatzal Mountains and the Sierra Ancha and highlands to the east receive, respectively, about 4.5 and 10 percent of the total precipitation in the study area (figs. 1 and 5). These mountainous areas have more subdued slopes than the face of the Mogollon Rim, which might promote greater recharge relative to runoff although the Proterozoic rocks have little permeability except where fractured. Mountain-front recharge along the eastern edge of the Mazatzal Mountains and the western edge of the Sierra Ancha likely occurs to the alluvial aquifer of the lower Tonto Creek Basin. Recharge probably also occurs to the alluvial aquifer from precipitation on the valley floor because of the subdued topography and permeability of sediments at the land surface. No attempt is made here to quantify a regional water budget for that part of the study area in the generally Proterozoic rocks below the base of the Mogollon Rim. Except for the Payson granite, there are too few data to incorporate that terrane into a regional budget, and for the most part, those rocks are not hydraulically connected to the regional aquifers beneath the Mogollon Rim.

Table 14. Summation of water inflows and outflows for C aquifer and limestone aquifer

[Values are in acre-feet per year]

A. Initial water-budget calculations.

Inflows to C aquifer		Outflows from C aquifer		Inflow + outflow
Precipitation	374,400	Stream base flow	-12,600	
Percent infiltration	17	Spring discharge	-11,500	
Total inflow	63,600	Total surface discharge	-24,100	[1]39,500
		Vertical flow to limestone aquifer	-39,500	0
Inflows to limestone aquifer		**Outflows from limestone aquifer**		**Inflow + outflow**
Precipitation upper slopes Mogollon Rim and tablelands	1,032,800	Stream base flow	-38,100	
Percent infiltration	4	Spring discharge	-41,800	
Total recharge upper slopes and tablelands	41,300			
Precipitation Cibecue Creek watershed	326,600			
Percent infiltration	10			
Total recharge Cibecue Creek watershed	32,700			
Total recharge from precipitation	74,000			
Interaquifer flow from C aquifer	39,500			
Total inflow	113,500	Total surface discharge	-79,900	33,600

B. Iteration of water-budget calculations using lower estimates of infiltration of precipitation.

Inflows to C aquifer		Outflows from C aquifer		Inflow + outflow
Precipitation	374,400			
Percent infiltration	15			
Total inflow	56,200	Total surface discharge	-24,100	32,100
Inflow to limestone aquifer		**Outflows from limestone aquifer**		**Inflow + outflow**
Precipitation upper slopes Mogollon Rim and tablelands	1,032,800			
Percent infiltration	2			
Total recharge upper slopes and tablelands	20,700			
Precipitation Cibecue Creek watershed	326,600			
Percent infiltration	8			
Total recharge Cibecue Creek watershed	26,100			
Total recharge from precipitation	46,800			
Interaquifer flow from C aquifer	32,100			
Total inflow	78,900	Total surface discharge	-79,900	-1,000

[1]Vertical ground-water flow to limestone aquifer.

Outflows

Spring discharge and stream base flow account for the greatest component of outflow, except for evapotranspiration and runoff, which account for the 83 to 98 percent of precipitation that does not recharge the ground-water system (fig. 27 and table 14). Almost all the spring discharge results from a handful of high-volume springs in carbonate rocks on the face of the Mogollon Rim or in the tablelands below the face (fig. 15 and table 12). Water use is not considered because almost all ground-water for domestic use is taken from shallow, local water-bearing zones rather than from the regional aquifers, and the total reported water use from the entire study area, not just the Mogollon Rim, is less than 2,400 acre-ft/yr, which is inconsequential in a regional context.

The C aquifer discharges mainly from nine springs that emit from the Schnebly Hill Formation, probably from the Fort Apache Member, and from Buckhorn Spring, which discharges from the Coconino Sandstone in the West Clear Creek drainage (table 12). The stability of spring flow is known only for Tonto Spring and Canyon Spring; however, Christopher Creek and upper Tonto Creek are both perennial streams suggesting that additional springs in those headwaters probably are perennial. West Clear Creek, which is the other most significant source of discharge from the C aquifer in the study area, maintains a minimum base flow of 11 ft^3/s that indicates it derives from a ground-water source with a large contributing area that has not been affected by climatic fluctuations or well pumpage during the period of record. Most other streams originate well up on the Mogollon Rim, but are ephemeral upstream from springs and do not appear to have any significant ground-water discharge to their channels except from springs. Stream base flow, therefore, is not considered a significant source of C aquifer discharge for any channel except West Clear Creek.

Discharge from the C aquifer in the study area calculated here is 62 percent of the estimated recharge (fig. 14*A*). Possible reasons for excess of recharge over discharge include an overly high estimate of the percentage of precipitation recharged, unmeasured spring discharge, drainage through base flow in streams other than West Clear Creek, and vertical flow from the C aquifer into local water-bearing zones or into the limestone aquifer or both. Because of the generally high permeability of fractured rocks on the Colorado Plateau and the subdued topography, a substantially lower estimate of recharge does not seem warranted. Also unlikely is the chance that sizeable springs with no record of discharge exist within the study area. Some ground-water discharge into stream channels in addition to spring discharge that has been accounted for is not unlikely, especially in Cibecue Creek and Canyon Creek. Because there are no data available that would enable partitioning of ground-water flow in those streams between the C and limestone aquifers, all flow here is assumed to come from the limestone aquifer except for that discharging from the springs at the head of Canyon Creek. The entire reach of Cherry Creek on the face of the Mogollon Rim is ephemeral, indicating that flow is almost entirely runoff with no significant ground-water contribution. The Forest Service has measured the flow of Tonto Creek below the Mogollon Rim, and the amount of base flow was nearly equivalent to the combined discharge of springs in upper Tonto Creek and its tributaries, indicating that there is not a significant ground-water contribution to the channel from either the C or limestone aquifer other than spring flow (table 12). There are no data to determine the extent to which flow of the East Verde River is maintained by the C aquifer beyond spring discharge, and all base flow in excess of spring discharge is assumed to come from the limestone aquifer. Because of the chemical and discharge data referred to above, the C aquifer is considered to be the source of most flow that discharges from the underlying limestone aquifer. The excess outflow over inflow of 39,500 acre-ft/yr for the C aquifer is, therefore, believed to be accounted for by vertical flow from that aquifer into the limestone aquifer (table 14*A* and fig. 27).

High-discharge springs below the Supai Formation drain the limestone aquifer. Almost 80 percent of spring discharge from the limestone aquifer is from Fossil Springs. The other significant drain is Cibecue Creek (table 12 and fig. 27). The high percentage of Cibecue Creek streamflow that is attributable to base flow indicates a ground-water component. As mentioned above, some of the Cibecue Creek flow may be directly from the C aquifer; however, data are not available to determine the percentage of total Cibecue Creek flow, if any, that comes from the C aquifer. That a sizeable component does come from the limestone aquifer is indicated by the incision of Cibecue Creek into the rocks of the middle and lower Paleozoic sedimentary rocks and the presence of numerous springs in those rocks along the length of the channel.

The regional water budget constructed from these data show a surplus of recharge in the C aquifer, which is presumed to be recharged into the limestone aquifer, and a surplus of discharge from the limestone aquifer, and

therefore from the entire regional ground-water system, of 33,600 acre-ft/yr, about 24 percent of the combined recharge from precipitation that is estimated for the two aquifers (table 14*A*). If all the estimates of inflows and outflows used in calculation of the budget are reasonably accurate, the results would indicate that storage within the regional aquifers is increasing. There is no evidence, however, to suggest that this is the case. As noted above, a recent decrease in discharge from Canyon Spring could indicate that the water table at the top of the C aquifer has been lowered, but that would argue for a negative change in storage within the C aquifer rather than an increase. The surplus of inflow over outflow must, therefore, be the result of overestimates of inflow or underestimates of outflow.

Several errors can account for the discrepancy, however, most of the likely errors would produce an even greater excess of inflow over outflow. The most question-able estimates include the amount of base flow and spring flow that drain the two aquifers. As noted above, spring-flow values are probably reasonably accurate for four spring systems that account for 75 percent of the spring discharge from the Mogollon Rim. In the unlikely event that all other discharges are closer to the maximum value recorded rather than the mean or best values used in this report, the total increase in estimated spring discharge would be about 5,600 acre-ft/yr. No net gain in outflows would be realized, however, because spring discharges have been subtracted from base flows in the streams into which the springs discharge. The only exception is Fossil Springs. No base-flow estimate is available for Fossil Creek and an increase in the estimated annual discharge from those springs would increase the net outflow. Records on Fossil Creek are reasonably good and consistent over time, and low variability of discharge from those springs (table 5) indicates that the estimate of annual spring discharge cannot be significantly increased.

An increase in base flow in the streams draining the Mogollon Rim would produce an increase in net outflow. For the East Verde River and Cherry Creek, a conservative value of base flow was estimated by using the brief discharge records at discontinued stations that were near the base of the Mogollon Rim (table 12). Tonto Creek base flow was calculated from a series of monthly low-flow measurements and the value achieved might be lower than the long-term average. Nonetheless, even a 75-percent increase in the value of base flow on Tonto Creek at the base of the Mogollon Rim would result in a net zero discharge once the values of annual spring discharge are subtracted from the base flow (table 12). The rationale for using those records, rather than the long-term records at stations near the mouth of the streams, is the assumption that there is little significant ground-water flow from the regional aquifers entering stream channels from the Proterozoic rocks below the Mogollon Rim. As noted above, there is some evidence of major regional joints or faults that are continuous from beneath the Mogollon Rim into the Proterozoic terranes to the south that could serve as conduits for ground-water flow into the lower reaches of stream channels. Also, base flow calculated at Tonto Creek at Bear Flat is nearly 2,400 acre-ft/yr lower than the total estimated spring discharge entering the channel upstream. The loss of flow could be the result of leakage into deep fractures within the Proterozoic rocks that emerges in the channel farther downstream as well as some combination of evapotranspiration losses from the channel and over-estimates of total annual spring discharge. Considering the dearth of evidence, the existence of ground-water flow into the lower reaches of stream channels within the study area is still speculative, and its inclusion in a regional water budget is not justified. Indeed, given the flashy nature of streamflow in the Mogollon Highland streams, the component of ground-water flow in those streams occurring as base flow is more likely to be overestimated here than underestimated.

More likely sources of error are those that would produce an overestimate of inflows into the hydrologic system. These would include an overestimate in the contributing area to the regional aquifers, an overestimate in the total precipitation, and overestimates of the percentage of total recharge. Any changes in these estimates are somewhat arbitrary, but reasonable as long as such changes allow for an excess of inflow into the C aquifer because, on the basis of the evidence noted above, that aquifer is the source for much of the ground water that discharges from the limestone aquifer. Consequently, a minimal reduction in estimates of inflow to the C aquifer is warranted. Reducing the estimate of the recharge rate from 17 to 15 percent would produce a total recharge to the C aquifer of 53,300 acre-ft/yr and total excess of inflow over outflow of 29,200 acre-ft/yr, which would enter the limestone aquifer by vertical flow (table 14*B*). This would reduce the total excess of inflow over outflow for the limestone aquifer to 23,100 acre-ft/yr. The most likely source of error accounting for the remaining excess is probably in the estimated rate of local recharge from precipitation to the limestone aquifer. Reducing the estimated rate of local recharge by 2 percent for precipitation falling on the

face of the Mogollon Rim, the tablelands, and the Cibecue Creek watershed, results in a reduction in total discharge that produces a water budget with a deficit of 1,000 acre-ft/yr, which is less than 1 percent of the combined recharge from precipitation for the C and limestone aquifers (table 14*B*). Further adjustments could be made to achieve a perfectly balanced budget, but considering the potential errors in hydrologic measurements, there seems to be little reason to do so. The adjustments that were made are not necessarily the correct adjustments, but they are reasonable and demonstrate how small changes in estimates of the various components of the water budget can produce substantial changes in the total regional budget.

Additional Data Needs

Among the topics that cannot be adequately answered with current data are (1) the short- and long-term water-level fluctuations in shallow wells, low-discharge springs, and tributary streams that discharge from local aquifers; (2) the short- and long-term water-level fluctuations in deeper wells that tap the regional aquifers; (3) the characteristics of the limestone aquifer along Canyon and Cibecue Creeks where the creeks flow through the Fort Apache Indian Reservation; (4) the short- and long-term behavior of high-discharge springs discharging from regional aquifers; (5) delineations of ground-water flow paths and the potentiometric surface of the limestone aquifer; (6) the degree to which ground water recharged on the Mogollon Rim crest and slopes intrudes into the Proterozoic rocks and alluvium of the lower parts of the study area; and (7) the relative length of ground-water flow paths and residence time within the C and limestone aquifers along the face of the Mogollon Rim.

An extensive well-monitoring program is being conducted by the town of Payson in water-bearing zones of the Payson granite and related Proterozoic rocks. Expansion of well monitoring in the Pine-Strawberry area and in other communities with relatively high well density would begin to provide data necessary for evaluating the effects of water-resources development and climatic variability in other local aquifers. Monitoring low-discharge springs and tributary streams is necessary if any quantitative relation among climatic fluctuations, water-resources development, and ground-water surface-water interactions is to be developed. Such springs and streams primarily drain local aquifers, which are also the most heavily utilized aquifers for water use in the Mogollon Highlands.

Although there is a paucity of wells below the crest of the Mogollon Rim deeper than 300 ft, more may become available as water providers, especially in the Pine-Strawberry area, seek more dependable sources of ground water. If this resource, which to date has been little exploited and is not well described, is to be more fully developed, monitoring of water levels would be desirable to identify how the ground-water system responds to development and climate change. Above the Mogollon Rim, additional monitoring of wells that draw from the C aquifer could provide early warning of watertable declines as a result of drought or increased development. Because several high-discharge springs in the study area flow from near the top of the ground-water mound, short- or long-term declines in the water table in this area could have detrimental effects on streamflow below those springs.

Monitoring of high-discharge spring flow could range from continuous monitoring to semiannual or quarterly measurement of high-discharge springs mainly on the East Verde River and its tributaries and on Tonto and Christopher Creeks. The more infrequent the measurements, the longer the record needed to assess the variability of such flows.

Mapping the potentiometric surface of the limestone aquifer to subsequently develop an understanding of ground-water flow paths would require considerable new well development and confirmation that those wells are in fact within the limestone aquifer. Because most of the study area is within public lands, and because the most critical water needs are primarily in the Pine-Strawberry area where the limestone aquifer is at considerable depths, such information can be acquired as economic realities allow. An inventory of existing wells in the East Verde River and Tonto Creek watersheds to confirm water levels and to ascertain whether or not they are in the limestone aquifer might improve understanding of flow paths and extend mapping of the potentiometric surface in that area. The degree to which regional ground-water flows through fractures in Proterozoic rocks below the Mogollon Rim would also require additional well development. The town of Payson has conducted some investigations, but there is little impetus for significant deep-well development in the Proterozoic rocks in the southern part of the study area. Additional analysis of geophysical data might also improve understanding of the regional fracture and fault system at depth, which would help in the interpretation of probable ground-water

flow paths. Finally, seepage runs along Cherry and Tonto Creeks, and the East Verde River below the Mogollon Rim would identify losing and gaining reaches in those streams as they flow through Proterozoic terrane and further clarify the extent to which they are recharged, either locally or from the regional system in their lower reaches. Characterization of the limestone aquifer on lower Canyon and Cibecue creeks would require a cooperative effort with the Fort Apache tribal government.

Dating of spring waters could provide some indication of the relative lengths of ground-water flow paths, residence time of water, and the degree of mixing with younger waters as a result of local recharge.

Summary and Conclusions

The Mogollon Highlands receive an average annual precipitation of 21.3 in., and nearly twice that amount at the highest altitudes where most recharge takes place. Nonetheless, the geologic characteristics of the region serve to limit the availability of water resources. The only area of significant ground-water storage is above the Mogollon Rim where the C aquifer comprises the Coconino Sandstone and Schnebly Hill Formation. The subdued topography and the highly fractured rocks of the Coconino Sandstone (and, where present, the Kaibab Formation, or Tertiary volcanic rocks, or both that overlie the Coconino) facilitate recharge on the Colorado Plateau along the crest of the Mogollon Rim. Most of the water that reaches the Mogollon Highlands ground-water system flows through the C aquifer, either vertically or horizontally. The C aquifer is drained by high-discharge springs that flow into the East Verde River, and Tonto, Christopher, Canyon, and West Clear Creeks. Flow to these springs occurs along fracture systems, possibly enlarged by dissolution, in the Schnebly Hill Formation and mainly in the Fort Apache Member of that formation. Springs near the base of the Mogollon Rim discharge from the limestone aquifer. Although the limestone and C aquifers are separated by the Supai Formation, a confining unit, the persistent high volume of flow discharging from Fossil Springs, and the chemical signatures of those springs and others that discharge from the limestone aquifer indicate a relation to waters of the C aquifer. The low specific conductances and isotopic signatures of spring waters suggests that flow paths are short and travel times rapid.

Precipitation falling outside the main recharge area of the study area mainly is lost to runoff and evapotranspiration because of the general impermeability of the rocks that form the Mogollon Rim and because of the steep slopes of the rim face. Streamflow within the study area tends to be flashy because of bedrock channels, narrow or nonexistent flood plains, and steep slopes. Base flow in most streams is less than 30 percent of total flow. In the Proterozoic terrane below the Mogollon Rim, ground-water contributions to flow are probably minimal. Cibecue Creek on the eastern edge of the study area has a base-flow component of greater than 50 percent, which suggests a more significant ground-water contribution, probably from the limestone aquifer that discharges into the channel or underlies it through most of its length. Some precipitation recharges local, shallow aquifers in the Paleozoic sedimentary rocks and in the Proterozoic rocks below the Mogollon Rim. These aquifers tend to be the most heavily developed within the study area and are also most susceptible to fluctuations in water level as a result of climatic variability and ground-water withdrawals. Several wells in the Payson area, where the most data on water levels over time are available, show sharp declines in water-level altitudes beginning in the mid-1990s with the onset of the drought that was occurring coincident with the study period for this project.

The regional aquifers are more resistant to short-term climatic fluctuations as indicated by the stability of flow in the high-discharge springs draining those aquifers. A decline in average discharge of Canyon Spring above Canyon Creek in the mid-1990s, however, could indicate a lowering of the water-table altitude of the C aquifer as a result of the drought. The spring discharges from near the top of the C aquifer and can be expected to be sensitive to changes in water-table altitude. The stability of Fossil Springs and other high-discharge springs that drain the limestone aquifer also points to resistance to short-term climatic fluctuations; however, the discharges of springs along the East Verde River and its tributaries have demonstrated significant variability. Such variability may be the result of differences in flow paths or the spatial relations between spring mouths and the water table in the limestone aquifer.

Inflows to regional aquifers are approximately balanced by outflows. Leakage from the C aquifer is estimated to account for about 37 percent of the inflows into the limestone aquifer. Although initial calculations showed a surplus of inflow over outflow from the regional aquifers, reasonable modification of estimates of contributing area and recharge rates produced a balanced water budget for the study area.

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8

STAKEHOLDER MEETING MINUTES

Meeting Date	Location, Parties, Purpose
January 25, 2005	Pine, AZ. MB attended this meeting on behalf of BUI. This was the first meeting of the newly elected Board of Directors of the PSWID. The purpose of the meeting was to organize the PSWID and establish a direction for the group. MB introduced herself as the local community representative of BUI and expressed the desire of BUI to develop a cooperative relationship with PSWID.
January 26, 2005	Payson, AZ; Gila Co. Supervisor Martin, Gila Co. Water Consultant Harry Jones, MB, and RTH. Meeting purpose was to meet newly elected Supervisor Martin and generally discuss some of the background and history of water supply challenges in the Pine and Strawberry communities as well as listen to any comments, ideas, or solutions that Supervisor Martin would like to introduce.
February 17, 2005	Pine, AZ; MB attended PSWID's regularly scheduled monthly meeting. MB expressed interest in assisting the Board of Directors with establishing water supply alternatives.
April 19, 2005	Payson, AZ; MB attended the regular monthly meeting of the MRWRMS regional study group. The study group reviewed the progress to date and established action items to continue the progress.
April 25, 2005	Pine, AZ. PSWID Board of Director Brenniger, MB, and RTH. Meeting purpose was to better understand water supply alternatives contemplated by PSWID including the economic considerations of each alternative.
April 27, 2005	Payson, AZ. Gila Co. Water Consultant Harry Jones, TOP Water Department Manager Buzz Walker, TOP Water Department Engineer Mike Ploughe, SRP Contracts Manager Greg Kornrup, PSWID Chairman Barbara Hall, MB, and RTH. The purpose of this meeting was various including (a) determine the status of Gila Co.'s formation of a regional water authority that can transaction business with SRP in delivering Blue Ridge Reservoir water to rural Gila Co. communities; (b) determine status of TOP's engineering and cost study by Black & Veatch as it pertains to a water delivery and treatment system of Blue Ridge Reservoir water; (c) discuss PSWID's consideration of various prioritized water supply alternatives for Pine; (d) further learn of SRP's process of potential water exchange arrangements using PWCo.'s CAP or existing USFS water supply contracts from Pine Creek; and, (e) agree that the MRWRMS group is the logical and proper water study group through which all discussion, analysis, and planning should occur for regional water related consideration should take place.
May 17, 2005	Pine, AZ; MB met with Jim Richey to discuss his water supply alternatives proposal utilizing water storage vessels. This discussion topic eventually became PSWID's water alternatives "JB6".

May 19, 2005 — Bakersfield, CA; MB attended a two-day meeting with MJ and RTH in the corporate offices to discuss the status of water supply alternatives in the regional area and further discussion community relations and operational issues of PWCo.

June 14, 2005 — Payson, AZ; MB met with RTH to provide an update on local discussions of regional water supply alternatives. RTH provided direction to MB as to the importance of participation in these groups as long as there was materially or prospective progress being made.

July 6, 2005 — Teleconference with PSWID Board of Director members Brenniger and Brown, MB, and RTH. The purpose of this meeting was to discuss the economic considerations of PSWID's various water supply alternatives in light of the actual water requirements of PWCo. PSWID desires a commitment from PWCo. to irrevocably commit to a minimum quantity of water from a PSWID water source that would allow PSWID's further development of financial analysis of the various alternatives. PWCo. asked PSWID to determine the price of the water related to the minimum quantity commitment sought by PSWID. The meeting concluded with agreement that quantification of PWCo.'s actual water demand requirement for the "100 Day War" of 2005 would be completed in October and would better form the basis of projecting actual water volumes required by PWCo. rather than speculating on water demand based on previous years consumption.

August 18, 2005 — Pine, AZ; MB attended the regular monthly meeting of the Board of Directors of PSWID. Harry Jones of Gila Co. presented an "opportunity" to PSWID to participate in funding of TOP's Black and Veatch Change Order #1 water supply study and cost estimate.

August 29, 2005 — Pine, AZ; MB met with PSWID Chairperson Hall to discuss PSWID's direction and better understand how BUI can meaningfully participate in the solutions direction of PSWID. MB expressed on BUI's behalf concern about the direction of the PSWID's water committees as it relates to the work being done by MRWRMS. MB reiterated to Chairperson Hall that it was extremely important that PSWID develop into a meaningful participant at the MRWRMS discussions so as to share any information developed about water supply alternatives in the area.

September 20, 2005 — Payson, AZ; MB attended the regular monthly meeting of the MRWRMS regional study group. The study group reviewed the progress to date and established action items to continue the progress.

September 28, 2005 — Payson, AZ. TOP Water Department Engineer Mike Ploughe, MB, and RTH. The purpose of this meeting was to review and discuss TOP's water research technology applied to the Pine and Strawberry areas. This review included discussion of hydrogeological maps and cross-sections of geological fractures and fault lines.

October 21, 2005 — Payson, AZ; MB met with Gila Co. water representative Harry Jones to review Gila Co.'s recent meeting with ACC staff and discuss alternatives to existing water supply issues.

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September 20, 2005

Mogollon Rim Water Resources Management Study – Technical Committee				
Name	**Organization**	**Address**	**Phone/Fax**	**E-mail**
Leslie Meyers	U.S. Bureau of Reclamation	P.O. Box 81169 Phoenix, AZ 85069-1169	602-216-3835 / 602-216-4007	lmeyers@lc.usbr.gov
Marvin Murray	U.S. Bureau of Reclamation	P.O. Box 81169 Phoenix, AZ 85069-1169	602-216-3839 / 602-216-4007	mmurray@lc.usbr.gov
Buzz Walker	Town of Payson	303 N. Beeline Hwy Payson, AZ 85541	928-474-5242x289 / 928-474-7052	bwalker@ci.payson.az.us
Mike Ploughe	Town of Payson	303 N. Beeline Hwy Payson, AZ 85541	928-474-5242x284 / 928-474-7052	mploughe@ci.payson.az.us
Fred Carpenter	Town of Payson	303 N. Beeline Hwy Payson, AZ 85541	928-474-5242x262 / 928-474-4610	fcarpenter@ci.payson.az.us
Robert Henley Council Member	Town of Payson	303 N. Beeline Hwy Payson, AZ 85541	928-474-5242x203 / 928-474-4610	rhenley@ci.payson.az.us
George Barriger Council Member	Town of Payson	303 N. Beeline Hwy Payson, AZ 85541	928-474-5242 x202	
La Ron Garrett	Town of Payson	303 N. Beeline Hwy Payson, AZ 85541	928-474-5242x283 / 928-472-7490	lgarrett@ci.payson.az.us
Sam Streichman	Town of Payson	303 N. Beeline Hwy Payson, AZ 85541	928-474-5242x287	toplegal@cybertails.com
Tom Wright	Town of Payson	303 N. Beeline Hwy Payson, AZ 85541	928-474-5242x286	twright@ci.payson.az.us
Robert Gardner	Gila County – Rep.	HC 3, Box 510-G Payson, AZ 85541	928-474-3883 / 928-474-4754	bbbgard@mindspring.com
Harry Jones	Gila County – Rep.	HC8 Box 363, Payson, AZ 85541	928-474-2876 / 928-474-2876	harryjoneshdj@earthlink.net
Tommie Martin	Gila County Sup.		928-474-7100	trmartin@cybertrails.com
John Nelson	Gila County		928-474-7100	jnelson@co.gila.az.us
Lionel Martinez	Gila County		928-474-7100	
Walt Nader	Tonto Apache Tribe		928-474-5000	wnader@tonto.apache.com
Wally Davis	Tonto Apache Tribe		928-474-5000	wdavis@tonto.apache.com
Richard Caron	Tonto Apache Tribe	Tonto Apache Reservation #30, Payson AZ 85541	928-474-5000/928-474-9125	rcaron@tontoapache.com
Greg Kornrumph	SRP	P.O.. Box 52025 Phoenix, AZ 85072-2025	602-236-3264 / 602-236-2159	gskornru@srpnet.com
John Fortune	ADWR	500 N. 3rd St. Phoenix, AZ 85004-3903	602-417-2400x7166/ 602-417-2423	jlfortune@adwr.state.az.us
Bill Remick	ADWR	500 N. 3rd St. Phoenix, AZ 85004-3903	602-417-2400x7325	whremick@adwr.state.az.us
Tom Whitmer	ADWR	500 N. 3rd St. Phoenix, AZ 85004-3903	602-417-2400x7243	tgwhitmer@adwr.state.az.us
Rod Byers	U.S. Forest Service	1009 E. Hwy 260 Payson, AZ 85541	928-474-7900 / 928-474-7966	rbyers@fs.fed.us
Grant Loomis	U.S. Forest Service	2324 E. McDowell Rd. Phoenix, AZ 85006	602-225-5253 / 602-225-5302	gjloomis@fs.fed.us
John Parker	U.S. Geological Survey			jtparker@usgs.gov
Myndi Brogdon	Brooke Utilities	HRC 01, P.O. Box 1544 Strawberry, AZ 85544	928-476-2500/928-476-2870	mbrogdon@theriver.com
Bruce Whiting	PREDC	106 E. Bonita Payson, AZ 85541	928-970-7777 / 928-472-8128	bruce@brucewhiting.com
Loren Peterson	Strawberry HollowWID		928-472-4477	lorenpeterson@cybertrails.com
Joe Abraham	University of Arizona			jabraham@email.arizona.edu
John Breninger	PSWID	P.O. Box 2096, Pine AZ 85544	928-476-3707/928-476-3701	ihunt4u@cybertrails.com
Glenn Brown		HCI Box 1254, Strawberry AZ 85544	928-476-4590	glbrown@cybertrails.com

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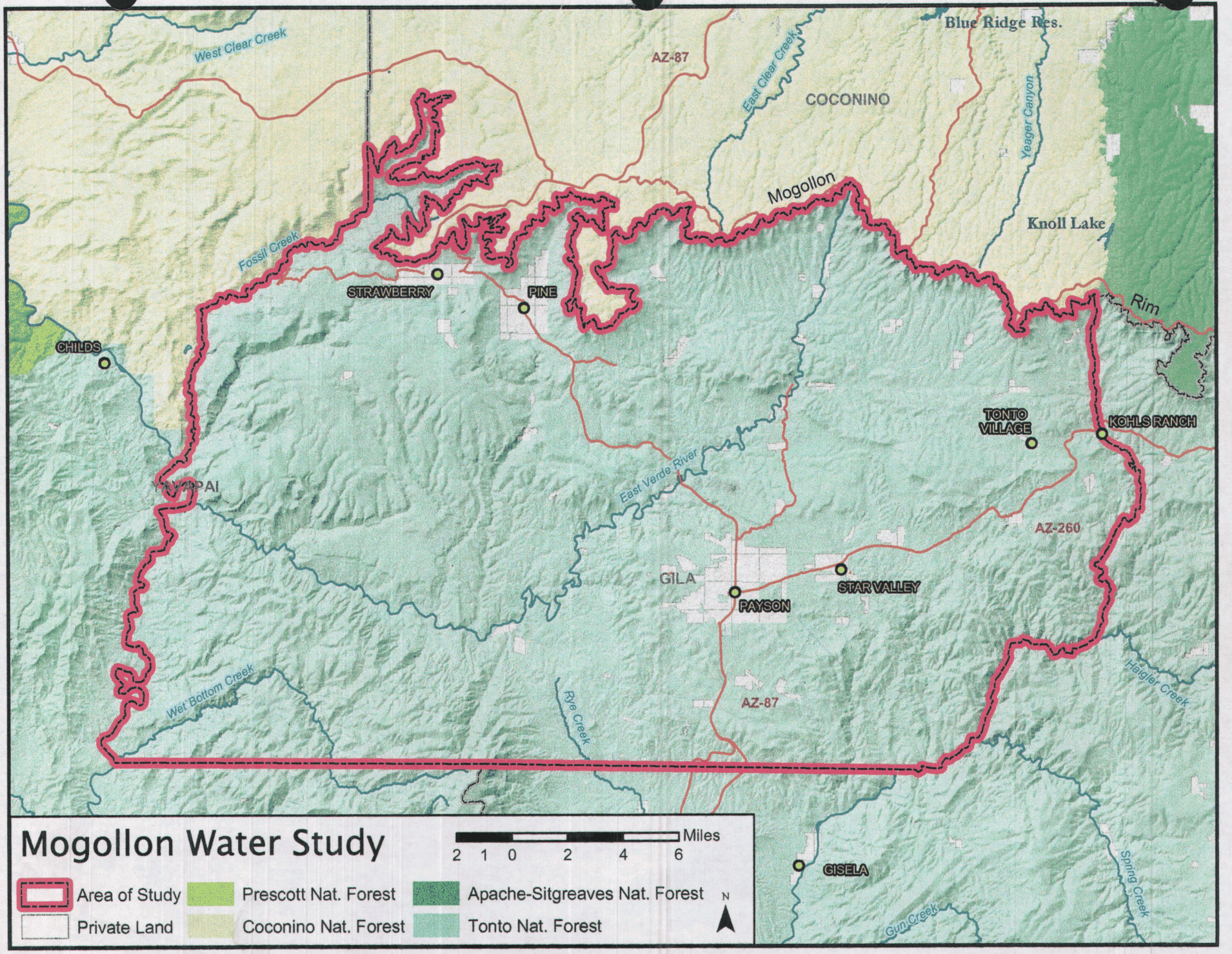
Blue Ridge Res.
West Clear Creek
AZ-87
East Clear Creek
COCONINO
Yeager Canyon
Mogollon
Knoll Lake
Fossil Creek
STRAWBERRY
PINE
Rim
CHILDS
TONTO VILLAGE
KOHLS RANCH
YAVAPAI
East Verde River
AZ-260
GILA
STAR VALLEY
PAYSON
Wet Bottom Creek
Rye Creek
AZ-87
Haigler Creek
GISELA
Spring Creek
Gun Creek
Mogollon Water Study
Miles
2 1 0 2 4 6
Area of Study
Private Land
Prescott Nat. Forest
Coconino Nat. Forest
Apache-Sitgreaves Nat. Forest
Tonto Nat. Forest
N

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BLACK & VEATCH

2850 E. Camelback Road
Suite 240
Phoenix, AZ 85016 USA

Tel: (602) 381-4400

Black & Veatch Corporation

Blue Ridge Reservoir Water Supply
Pipeline and Treatment Plant

B&V Project 141789
B&V File N
July 25, 2005

Mr. Buzz Walker
Town of Payson
303 N. Beeline Highway
Payson, AZ 85541-4306

Subject: Change Order No. 1

Dear Mr. Walker:

This Change Order No. 1 covers additional work associated with the Pine Extension, including pipeline, lift station and water treatment plant to our Agreement dated May 6, 2005 for the above reference project. The total amount of this work shall be increased by $10,022. Therefore the total compensation shall be increased from $12,673 to $22,695 and this total amount shall not be exceeded without prior written authorization from the Engineer.

The effective date of this Change Order is August 5, 2005.

Please review and acknowledge your acceptance by executing and returning a signed copy of this letter. We appreciate the opportunity to work for the Town on this important project.

Very truly yours,

BLACK & VEATCH

Brad E. Hemken
Project Manager

Black & Veatch Corporation	Town of Payson
Brad Hemken	
(Signature)	(Signature)
Brad Hemken Vice President	
(Printed name & title)	(Printed name & title)

cc: Brad Hemken
Kathy Tambascio

ATTACHMENT A

Town of Payson

Blue Ridge Reservoir Water Supply Pipeline - Pine Extension and Treatment Plant

Preliminary Sizing and Cost Estimate

Scope of Work

GENERAL

The Community of Pine may have access to a 500 ac. ft annual allocation of water from the Blue Ridge Reservoir. The Community of Pine plans to divert its allocation from the raw water main that would convey the Town of Payson's Blue Ridge Reservoir allocation from the Blue Ridge Power Plant. The Community of Pine will take its Blue Ridge Reservoir allocation continuously over the nine month SRP operates the turbine, which corresponds to the nine month period the Town of Payson will take its Blue Ridge Reservoir allocation. For the purpose of this analysis the Town of Payson will set the pipeline alignment and a membrane filtration plant will be assumed.

The purpose of this scope of work is to develop sizing and preliminary cost estimate for the pipeline, lift station and treatment facilities.

WORK TASKS

201 – Facilities Sizing. Sizing will be developed to take Pine's 500 ac. ft/yr allocation continuously over a nine month period at a base rate of 0.6 mgd. Pipeline, lift station and treatment plant capacity will be at the base rate. The previous sizing of the raw water main for the Town of Payson, prior to the Pine Extension, will be reevaluated to include the additional capacity of 0.6 mgd.

202 – Alignment. Review the proposed preliminary alignment and adjust as appropriate.

203 – Pipe Materials and Unit Cost. Potential pipe suppliers will be contacted to obtain appropriate pressure rated materials and obtain associated unit costs. A list of suggested alternative pipeline materials will be provided.

204 – Preliminary Pipeline Cost. A preliminary estimated pipeline cost will be developed to include pipe, installation, wash/stream crossings, pavement replacement and appurtenances.

205 – Preliminary Lift Station Cost. A preliminary lift station cost estimate will be developed for a nominal 0.6 mgd capacity facility, including capital and operational costs.

206 – Preliminary Water Treatment Cost. A preliminary water treatment plant cost estimate will be developed for a nominal 0.6 mgd capacity facility, including capital cost, operational cost and cost per thousand gallons treated ($/1,000 gal).

Town of Payson
Pine Extension, Lift Station & WTP

Engineering Design Services Fee

TASK	DESCRIPTION	Proj Mngr	Civil Engr	Technician	TOTAL HOURS
201	Facilities Sizing	2	8		10
202	Alignment		8	16	
203	Pipe Materials and Unit Cost	1	8		9
204	Preliminary Pipeline Cost	2	16		18
205	Preliminary Lift Station Cost	2	16		18
206	Preliminary WTP Cost	1	16		17
Total Hours		8	72	16	72
Cost Per Hour		210	92	68	
TOTAL LABOR		**1,680**	**6,624**	**1,088**	**9,392**
Expenses @ $8.75/hr					630
TOTAL PROPOSAL					**$10,022**

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Pine Water Company
Computation of Incremental Impact on Project

Schedule
Page 1

Reference: Alternative #1: Horizontal Well

Line No.			
1	[redacted]		
2	Project Capital Costs	$	3,280,000
3	Average Annual # of Customers		1,990
4	Operating & Maintenance Expenses	$	33,000
5	Depreciation @ 2.5%	$	82,000
6	Required Rate of Return		11.41%
7			
8			
9	[redacted]		
10	Annual Impact on Customer bill	$	410.15
11	Monthly Impact on Customer Bill	$	34.18
12	Average 5/8 Inch (14A) Monthly Bill Prior Rate Case	$	34.09
13	% Increase in 5/8 Inch (14A) Average Monthly Bill		100.26%
14			
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21			

Pine Water Company
Computation of Incremental Impact Increase in Gross Revenue
Modified A-1 Schedule

Schedule
Page 2

Line No.				From Inputs 11.41%
1	Fair Value Rate Base			$ 3,284,125
2				
3	Adjusted Operating Income			(115,000)
4				
5	Current Rate of Return			-3.50%
6				
7	Required Operating Income			$ 374,719
8				
9	Required Rate of Return on Fair Value Rate Base			11.41%
10				
11	Operating Income Deficiency			$ 489,719
12				
13	Gross Revenue Conversion Factor			1.6667
14				
15	Increase in Gross Revenue			
16	Requirement			$ 816,198
17				
18	Annual Impact on Customer bill			$ 410.15
19	Monthly Impact on Customer Bill			$ 34.18
20	Average 5/8 Inch (14A) Monthly Bill Prior Rate Case			$ 34.09
21	% Increase in 5/8 Inch (14A) Average Monthly Bill			100.26%
22				
22	**Fair Value Rate Base Calculation**			
23	Original Cost	$ 3,280,000		
24				
25	Net Plant In Service	$ 3,280,000		
26	Working Capital	4,125		
27	Rate Base Total	$ 3,284,125		
28				
29	**Adjusted Operating Income Calculation**			
30	Revenues (amount collected in current rates)	$ -		
31				
32	Depreciation	82,000		
33	Operating Expenses (Excl inc. taxes)	33,000		
34	Operating Income Deficiency	$ (115,000)		
35				
36	**Revenue Conversion Factor**			
37				
38	Income Tax Percentage		40%	
39				
40	Operating Income % = 100% - Tax Percentage		60%	
41				
42				
43	1 = Gross Revenue Conversion Factor		1.6667	
44	Operating Income %			
45				

Pine Water Company
Computation of Incremental Impact on Project

Schedule
Page 1

Reference: Alternative #2: Single Deep Well, Strawberry; existing BUI site

Line No.			
1	Inputs		
2	Project Capital Costs	$	3,750,000
3	Average Annual # of Customers		1,990
4	Operating & Maintenance Expenses	$	33,000
5	Depreciation @ 2.5%	$	93,750
6	Required Rate of Return		11.41%
7			
8			
9	Outputs		
10	Annual Impact on Customer bill	$	464.90
11	Monthly Impact on Customer Bill	$	38.74
12	Average 5/8 Inch (14A) Monthly Bill Prior Rate Case	$	34.09
13	% Increase in 5/8 Inch (14A) Average Monthly Bill		113.65%
14			
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19			
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21			

Pine Water Company
Computation of Incremental Impact Increase in Gross Revenue
Modified A-1 Schedule

Schedule
Page 2

Line No.				From Inputs 11.41%
1	Fair Value Rate Base			$ 3,754,125
2				
3	Adjusted Operating Income			(126,750)
4				
5	Current Rate of Return			-3.38%
6				
7	Required Operating Income			$ 428,346
8				
9	Required Rate of Return on Fair Value Rate Base			11.41%
10				
11	Operating Income Deficiency			$ 555,096
12				
13	Gross Revenue Conversion Factor			1.6667
14				
15	Increase in Gross Revenue			
16	Requirement			$ 925,159
17				
18	Annual Impact on Customer bill			$ 464.90
19	Monthly Impact on Customer Bill			$ 38.74
20	Average 5/8 Inch (14A) Monthly Bill Prior Rate Case			$ 34.09
21	% Increase in 5/8 Inch (14A) Average Monthly Bill			113.65%
22				
22	**Fair Value Rate Base Calculation**			
23	Original Cost	$ 3,750,000		
24				
25	Net Plant In Service	$ 3,750,000		
26	Working Capital	4,125		
27	Rate Base Total	$ 3,754,125		
28				
29	**Adjusted Operating Income Calculation**			
30	Revenues (amount collected in current rates)	$ -		
31				
32	Depreciation	93,750		
33	Operating Expenses (Excl inc. taxes)	33,000		
34	Operating Income Deficiency	$ (126,750)		
35				
36	**Revenue Conversion Factor**			
37				
38	Income Tax Percentage		40%	
39				
40	Operating Income % = 100% - Tax Percentage		60%	
41				
42				
43	1 = Gross Revenue Conversion Factor		1.6667	
44	Operating Income %			
45				

Pine Water Company
Computation of Incremental Impact on Project

Schedule
Page 1

Reference: Alternative #3: Single Deep Well, the "SB5950A" site, Strawberry, AZ

Line No.	Inputs		
1			
2	Project Capital Costs	$	4,722,000
3	Average Annual # of Customers		1,990
4	Operating & Maintenance Expenses	$	55,000
5	Depreciation @ 2.5%	$	118,050
6	Required Rate of Return		11.41%
7			
8			
9	**Outputs**		
10	Annual Impact on Customer bill	$	596.83
11	Monthly Impact on Customer Bill	$	49.74
12	Average 5/8 Inch (14A) Monthly Bill Prior Rate Case	$	34.09
13	% Increase in 5/8 Inch (14A) Average Monthly Bill		145.90%
14			
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19			
20			
21			

Pine Water Company
Computation of Incremental Impact Increase in Gross Revenue
Modified A-1 Schedule

Schedule
Page 2

Line No.				From Inputs 11.41%
1	Fair Value Rate Base			$ 4,728,875
2				
3	Adjusted Operating Income			(173,050)
4				
5	Current Rate of Return			-3.66%
6				
7	Required Operating Income			$ 539,565
8				
9	Required Rate of Return on Fair Value Rate Base			11.41%
10				
11	Operating Income Deficiency			$ 712,615
12				
13	Gross Revenue Conversion Factor			1.6667
14				
15	Increase in Gross Revenue			
16	Requirement			$ 1,187,691
17				
18	Annual Impact on Customer bill			$ 596.83
19	Monthly Impact on Customer Bill			$ 49.74
20	Average 5/8 Inch (14A) Monthly Bill Prior Rate Case			$ 34.09
21	% Increase in 5/8 Inch (14A) Average Monthly Bill			145.90%
22				
22	**Fair Value Rate Base Calculation**			
23	Original Cost	$ 4,722,000		
24				
25	Net Plant In Service	$ 4,722,000		
26	Working Capital	6,875		
27	Rate Base Total	$ 4,728,875		
28				
29	**Adjusted Operating Income Calculation**			
30	Revenues (amount collected in current rates)	$ -		
31				
32	Depreciation	118,050		
33	Operating Expenses (Excl inc. taxes)	55,000		
34	Operating Income Deficiency	$ (173,050)		
35				
36	**Revenue Conversion Factor**			
37				
38	Income Tax Percentage		40%	
39				
40	Operating Income % = 100% - Tax Percentage		60%	
41				
42				
43	1 = Gross Revenue Conversion Factor		1.6667	
44	Operating Income %			
45				

Pine Water Company
Computation of Incremental Impact on Project

Schedule
Page 1

Reference: Alternative #4: Single Deep Well, the "SB5950B" site, Strawberry, AZ

Line No.			
1			
2	Project Capital Costs	$	4,722,000
3	Average Annual # of Customers		1,990
4	Operating & Maintenance Expenses	$	55,000
5	Depreciation @ 2.5%	$	118,050
6	Required Rate of Return		11.41%
7			
8			
9			
10	Annual Impact on Customer bill	$	596.83
11	Monthly Impact on Customer Bill	$	49.74
12	Average 5/8 Inch (14A) Monthly Bill Prior Rate Case	$	34.09
13	% Increase in 5/8 Inch (14A) Average Monthly Bill		145.90%
14			
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16			
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18			
19			
20			
21			

Pine Water Company
Computation of Incremental Impact Increase in Gross Revenue
Modified A-1 Schedule

Schedule
Page 2

Line No.				From Inputs 11.41%
1	Fair Value Rate Base			$ 4,728,875
2				
3	Adjusted Operating Income			(173,050)
4				
5	Current Rate of Return			-3.66%
6				
7	Required Operating Income			$ 539,565
8				
9	Required Rate of Return on Fair Value Rate Base			11.41%
10				
11	Operating Income Deficiency			$ 712,615
12				
13	Gross Revenue Conversion Factor			1.6667
14				
15	Increase in Gross Revenue			
16	Requirement			$ 1,187,691
17				
18	Annual Impact on Customer bill			$ 596.83
19	Monthly Impact on Customer Bill			$ 49.74
20	Average 5/8 Inch (14A) Monthly Bill Prior Rate Case			$ 34.09
21	% Increase in 5/8 Inch (14A) Average Monthly Bill			145.90%
22				
22	**Fair Value Rate Base Calculation**			
23	Original Cost	$ 4,722,000		
24				
25	Net Plant In Service	$ 4,722,000		
26	Working Capital	6,875		
27	Rate Base Total	$ 4,728,875		
28				
29	**Adjusted Operating Income Calculation**			
30	Revenues (amount collected in current rates)	$ -		
31				
32	Depreciation	118,050		
33	Operating Expenses (Excl inc. taxes)	55,000		
34	Operating Income Deficiency	$ (173,050)		
35				
36	**Revenue Conversion Factor**			
37				
38	Income Tax Percentage		40%	
39				
40	Operating Income % = 100% - Tax Percentage		60%	
41				
42				
43	1 = Gross Revenue Conversion Factor		1.6667	
44	Operating Income %			
45				

Pine Water Company
Computation of Incremental Impact on Project

Schedule
Page 1

Reference: Alternative #5: Pine Creek Storm Water Runoff and Storage; CAP Exchange Agreement

Line No.			
1			
2	Project Capital Costs	$	3,074,500
3	Average Annual # of Customers		1,990
4	Operating & Maintenance Expenses	$	150,000
5	Depreciation @ 2.5%	$	76,863
6	Required Rate of Return		11.41%
7			
8			
9			
10	Annual Impact on Customer bill	$	485.60
11	Monthly Impact on Customer Bill	$	40.47
12	Average 5/8 Inch (14A) Monthly Bill Prior Rate Case	$	34.09
13	% Increase in 5/8 Inch (14A) Average Monthly Bill		118.70%
14			
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19			
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21			

Pine Water Company
Computation of Incremental Impact Increase in Gross Revenue
Modified A-1 Schedule

Schedule
Page 2

Line No.				From Inputs 11.41%
1	Fair Value Rate Base			$ 3,093,250
2				
3	Adjusted Operating Income			(226,863)
4				
5	Current Rate of Return			-7.33%
6				
7	Required Operating Income			$ 352,940
8				
9	Required Rate of Return on Fair Value Rate Base			11.41%
10				
11	Operating Income Deficiency			$ 579,802
12				
13	Gross Revenue Conversion Factor			1.6667
14				
15	Increase in Gross Revenue			
16	Requirement			$ 966,337
17				
18	Annual Impact on Customer bill			$ 485.60
19	Monthly Impact on Customer Bill			$ 40.47
20	Average 5/8 Inch (14A) Monthly Bill Prior Rate Case			$ 34.09
21	% Increase in 5/8 Inch (14A) Average Monthly Bill			118.70%
22				
22	**Fair Value Rate Base Calculation**			
23	Original Cost	$ 3,074,500		
24				
25	Net Plant In Service	$ 3,074,500		
26	Working Capital	18,750		
27	Rate Base Total	$ 3,093,250		
28				
29	**Adjusted Operating Income Calculation**			
30	Revenues (amount collected in current rates)	$ -		
31				
32	Depreciation	76,863		
33	Operating Expenses (Excl inc. taxes)	150,000		
34	Operating Income Deficiency	$ (226,863)		
35				
36	**Revenue Conversion Factor**			
37				
38	Income Tax Percentage		40%	
39				
40	Operating Income % = 100% - Tax Percentage		60%	
41				
42				
43	1 = Gross Revenue Conversion Factor		1.6667	
44	Operating Income %			
45				

Pine Water Company
Computation of Incremental Impact on Project

Schedule
Page 1

Reference: Alternative #6: Pine Surface Water Storage Reservoir; Pine Reservoir Project

Line No.			
1			
2	Project Capital Costs	$	5,480,000
3	Average Annual # of Customers		1,990
4	Operating & Maintenance Expenses	$	100,000
5	Depreciation @ 2.5%	$	137,000
6	Required Rate of Return		11.41%
7			
8			
9			
10	Annual Impact on Customer bill	$	723.36
11	Monthly Impact on Customer Bill	$	60.28
12	Average 5/8 Inch (14A) Monthly Bill Prior Rate Case	$	34.09
13	% Increase in 5/8 Inch (14A) Average Monthly Bill		176.83%
14			
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19			
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Pine Water Company
Computation of Incremental Impact Increase in Gross Revenue
Modified A-1 Schedule

Schedule
Page 2

Line No.					From Inputs 11.41%
1	Fair Value Rate Base				$ 5,492,500
2					
3	Adjusted Operating Income				(237,000)
4					
5	Current Rate of Return				-4.31%
6					
7	Required Operating Income				$ 626,694
8					
9	Required Rate of Return on Fair Value Rate Base				11.41%
10					
11	Operating Income Deficiency				$ 863,694
12					
13	Gross Revenue Conversion Factor				1.6667
14					
15	Increase in Gross Revenue				
16	Requirement				$ 1,439,490
17					
18	Annual Impact on Customer bill				$ 723.36
19	Monthly Impact on Customer Bill				$ 60.28
20	Average 5/8 Inch (14A) Monthly Bill Prior Rate Case				$ 34.09
21	% Increase in 5/8 Inch (14A) Average Monthly Bill				176.83%
22					
22	**Fair Value Rate Base Calculation**				
23	Original Cost	$	5,480,000		
24					
25	Net Plant In Service	$	5,480,000		
26	Working Capital		12,500		
27	Rate Base Total	$	5,492,500		
28					
29	**Adjusted Operating Income Calculation**				
30	Revenues (amount collected in current rates)	$	-		
31					
32	Depreciation		137,000		
33	Operating Expenses (Excl inc. taxes)		100,000		
34	Operating Income Deficiency	$	(237,000)		
35					
36	**Revenue Conversion Factor**				
37					
38	Income Tax Percentage			40%	
39					
40	Operating Income % = 100% - Tax Percentage			60%	
41					
42					
43	1 = Gross Revenue Conversion Factor			1.6667	
44	Operating Income %				
45					

Pine Water Company
Computation of Incremental Impact on Project

Schedule
Page 1

Reference: Alternative #7: Option #1 Control Road

Line No.			
1			
2	Project Capital Costs	$	73,100,000
3	Average Annual # of Customers		1,990
4	Operating & Maintenance Expenses	$	50,000
5	Depreciation @ 2.5%	$	1,827,500
6	Required Rate of Return		11.41%
7			
8			
9			
10	Annual Impact on Customer bill	$	8,558.56
11	Monthly Impact on Customer Bill	$	713.21
12	Average 5/8 Inch (14A) Monthly Bill Prior Rate Case	$	34.09
13	% Increase in 5/8 Inch (14A) Average Monthly Bill		2092.15%
14			
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21			

Pine Water Company
Computation of Incremental Impact Increase in Gross Revenue
Modified A-1 Schedule

Schedule
Page 2

Line No.				From Inputs 11.41%
1	Fair Value Rate Base			$ 73,106,250
2				
3	Adjusted Operating Income			(1,877,500)
4				
5	Current Rate of Return			-2.57%
6				
7	Required Operating Income			$ 8,341,423
8				
9	Required Rate of Return on Fair Value Rate Base			11.41%
10				
11	Operating Income Deficiency			$ 10,218,923
12				
13	Gross Revenue Conversion Factor			1.6667
14				
15	Increase in Gross Revenue			
16	Requirement			$ 17,031,539
17				
18	Annual Impact on Customer bill			$ 8,558.56
19	Monthly Impact on Customer Bill			$ 713.21
20	Average 5/8 Inch (14A) Monthly Bill Prior Rate Case			$ 34.09
21	% Increase in 5/8 Inch (14A) Average Monthly Bill			2092.15%
22				
22	**Fair Value Rate Base Calculation**			
23	Original Cost	$ 73,100,000		
24				
25	Net Plant In Service	$ 73,100,000		
26	Working Capital	6,250		
27	Rate Base Total	$ 73,106,250		
28				
29	**Adjusted Operating Income Calculation**			
30	Revenues (amount collected in current rates)	$ -		
31				
32	Depreciation	1,827,500		
33	Operating Expenses (Excl inc. taxes)	50,000		
34	Operating Income Deficiency	$ (1,877,500)		
35				
36	**Revenue Conversion Factor**			
37				
38	Income Tax Percentage		40%	
39				
40	Operating Income % = 100% - Tax Percentage		60%	
41				
42				
43	1 = Gross Revenue Conversion Factor		1.6667	
44	Operating Income %			
45				

Pine Water Company
Computation of Incremental Impact on Project

Schedule
Page 1

Reference: Alternative #7: Option #2 Instream Diversion

Line No.			
1	[redacted]		
2	Project Capital Costs	$	53,500,000
3	Average Annual # of Customers		1,990
4	Operating & Maintenance Expenses	$	50,000
5	Depreciation @ 2.5%	$	1,337,500
6	Required Rate of Return		11.41%
7			
8			
9	[redacted]		
10	Annual Impact on Customer bill	$	6,275.18
11	Monthly Impact on Customer Bill	$	522.93
12	Average 5/8 Inch (14A) Monthly Bill Prior Rate Case	$	34.09
13	% Increase in 5/8 Inch (14A) Average Monthly Bill		1533.97%
14			
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16			
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19			
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21			

Pine Water Company
Computation of Incremental Impact Increase in Gross Revenue
Modified A-1 Schedule

Schedule
Page 2

Line No.				From Inputs 11.41%
1	Fair Value Rate Base			$ 53,506,250
2				
3	Adjusted Operating Income			(1,387,500)
4				
5	Current Rate of Return			-2.59%
6				
7	Required Operating Income			$ 6,105,063
8				
9	Required Rate of Return on Fair Value Rate Base			11.41%
10				
11	Operating Income Deficiency			$ 7,492,563
12				
13	Gross Revenue Conversion Factor			1.6667
14				
15	Increase in Gross Revenue			
16	Requirement			$ 12,487,605
17				
18	Annual Impact on Customer bill			$ 6,275.18
19	Monthly Impact on Customer Bill			$ 522.93
20	Average 5/8 Inch (14A) Monthly Bill Prior Rate Case			$ 34.09
21	% Increase in 5/8 Inch (14A) Average Monthly Bill			1533.97%
22				
22	**Fair Value Rate Base Calculation**			
23	Original Cost	$ 53,500,000		
24				
25	Net Plant In Service	$ 53,500,000		
26	Working Capital	6,250		
27	Rate Base Total	$ 53,506,250		
28				
29	**Adjusted Operating Income Calculation**			
30	Revenues (amount collected in current rates)	$ -		
31				
32	Depreciation	1,337,500		
33	Operating Expenses (Excl inc. taxes)	50,000		
34	Operating Income Deficiency	$ (1,387,500)		
35				
36	**Revenue Conversion Factor**			
37				
38	Income Tax Percentage		40%	
39				
40	Operating Income % = 100% - Tax Percentage		60%	
41				
42				
43	1 = Gross Revenue Conversion Factor		1.6667	
44	Operating Income %			
45				

Pine Water Company
Computation of Incremental Impact on Project

Schedule
Page 1

Reference: Alternative #7: Option #3 Rim Road

Line No.			
1	**Inputs**		
2	Project Capital Costs	$	72,000,000
3	Average Annual # of Customers		1,990
4	Operating & Maintenance Expenses	$	50,000
5	Depreciation @ 2.5%	$	1,800,000
6	Required Rate of Return		11.41%
7			
8			
9	**Outputs**		
10	Annual Impact on Customer bill	$	8,430.41
11	Monthly Impact on Customer Bill	$	702.53
12	Average 5/8 Inch (14A) Monthly Bill Prior Rate Case	$	34.09
13	% Increase in 5/8 Inch (14A) Average Monthly Bill		2060.82%
14			
15			
16			
17			
18			
19			
20			
21			

Pine Water Company
Computation of Incremental Impact Increase in Gross Revenue
Modified A-1 Schedule

Schedule
Page 2

Line No.				From Inputs 11.41%
1	Fair Value Rate Base			$ 72,006,250
2				
3	Adjusted Operating Income			(1,850,000)
4				
5	Current Rate of Return			-2.57%
6				
7	Required Operating Income			$ 8,215,913
8				
9	Required Rate of Return on Fair Value Rate Base			11.41%
10				
11	Operating Income Deficiency			$ 10,065,913
12				
13	Gross Revenue Conversion Factor			1.6667
14				
15	Increase in Gross Revenue			
16	Requirement			$ 16,776,522
17				
18	Annual Impact on Customer bill			$ 8,430.41
19	Monthly Impact on Customer Bill			$ 702.53
20	Average 5/8 Inch (14A) Monthly Bill Prior Rate Case			$ 34.09
21	% Increase in 5/8 Inch (14A) Average Monthly Bill			2060.82%
22				
22	**Fair Value Rate Base Calculation**			
23	Original Cost	$ 72,000,000		
24				
25	Net Plant In Service	$ 72,000,000		
26	Working Capital	6,250		
27	Rate Base Total	$ 72,006,250		
28				
29	**Adjusted Operating Income Calculation**			
30	Revenues (amount collected in current rates)	$ -		
31				
32	Depreciation	1,800,000		
33	Operating Expenses (Excl inc. taxes)	50,000		
34	Operating Income Deficiency	$ (1,850,000)		
35				
36	**Revenue Conversion Factor**			
37				
38	Income Tax Percentage		40%	
39				
40	Operating Income % = 100% - Tax Percentage		60%	
41				
42				
43	1 = Gross Revenue Conversion Factor		1.6667	
44	Operating Income %			
45				

Pine Water Company
Computation of Incremental Impact on Project

Schedule
Page 1

Reference: Alternative #7: Option #4 Highway 87

Line No.			
1			
2	Project Capital Costs	$	91,100,000
3	Average Annual # of Customers		1,990
4	Operating & Maintenance Expenses	$	50,000
5	Depreciation @ 2.5%	$	2,277,500
6	Required Rate of Return		11.41%
7			
8			
9			
10	Annual Impact on Customer bill	$	10,655.55
11	Monthly Impact on Customer Bill	$	887.96
12	Average 5/8 Inch (14A) Monthly Bill Prior Rate Case	$	34.09
13	% Increase in 5/8 Inch (14A) Average Monthly Bill		2604.76%
14			
15			
16			
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19			
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21			

Pine Water Company
Computation of Incremental Impact Increase in Gross Revenue
Modified A-1 Schedule

Schedule
Page 2

Line No.				From Inputs 11.41%
1	Fair Value Rate Base			$ 91,106,250
2				
3	Adjusted Operating Income			(2,327,500)
4				
5	Current Rate of Return			-2.55%
6				
7	Required Operating Income			$ 10,395,223
8				
9	Required Rate of Return on Fair Value Rate Base			11.41%
10				
11	Operating Income Deficiency			$ 12,722,723
12				
13	Gross Revenue Conversion Factor			1.6667
14				
15	Increase in Gross Revenue			
16	Requirement			$ 21,204,539
17				
18	Annual Impact on Customer bill			$ 10,655.55
19	Monthly Impact on Customer Bill			$ 887.96
20	Average 5/8 Inch (14A) Monthly Bill Prior Rate Case			$ 34.09
21	% Increase in 5/8 Inch (14A) Average Monthly Bill			2604.76%
22				
22	**Fair Value Rate Base Calculation**			
23	Original Cost	$ 91,100,000		
24				
25	Net Plant In Service	$ 91,100,000		
26	Working Capital	6,250		
27	Rate Base Total	$ 91,106,250		
28				
29	**Adjusted Operating Income Calculation**			
30	Revenues (amount collected in current rates)	$ -		
31				
32	Depreciation	2,277,500		
33	Operating Expenses (Excl inc. taxes)	50,000		
34	Operating Income Deficiency	$ (2,327,500)		
35				
36	**Revenue Conversion Factor**			
37				
38	Income Tax Percentage		40%	
39				
40	Operating Income % = 100% - Tax Percentage		60%	
41				
42				
43	1 = Gross Revenue Conversion Factor		1.6667	
44	Operating Income %			
45				

Pine Water Company
Computation of Incremental Impact on Project

Schedule
Page 1

Reference: Alternative #8: Black & Veatch Change Order #1 Control Rd. 32 Pipeline

Line No.			
1			
2	Project Capital Costs	$	17,944,080
3	Average Annual # of Customers		1,990
4	Operating & Maintenance Expenses	$	100,000
5	Depreciation @ 2.5%	$	448,602
6	Required Rate of Return		11.41%
7			
8			
9			
10	Annual Impact on Customer bill	$	2,175.42
11	Monthly Impact on Customer Bill	$	181.28
12	Average 5/8 Inch (14A) Monthly Bill Prior Rate Case	$	34.09
13	% Increase in 5/8 Inch (14A) Average Monthly Bill		531.78%
14			
15			
16			
17			
18			
19			
20			
21			

Pine Water Company
Computation of Incremental Impact Increase in Gross Revenue
Modified A-1 Schedule

Schedule
Page 2

Line No.				From Inputs 11.41%
1	Fair Value Rate Base			$ 17,956,580
2				
3	Adjusted Operating Income			(548,602)
4				
5	Current Rate of Return			-3.06%
6				
7	Required Operating Income			$ 2,048,846
8				
9	Required Rate of Return on Fair Value Rate Base			11.41%
10				
11	Operating Income Deficiency			$ 2,597,448
12				
13	Gross Revenue Conversion Factor			1.6667
14				
15	Increase in Gross Revenue			
16	Requirement			$ 4,329,080
17				
18	Annual Impact on Customer bill			$ 2,175.42
19	Monthly Impact on Customer Bill			$ 181.28
20	Average 5/8 Inch (14A) Monthly Bill Prior Rate Case			$ 34.09
21	% Increase in 5/8 Inch (14A) Average Monthly Bill			531.78%
22				
22	**Fair Value Rate Base Calculation**			
23	Original Cost	$ 17,944,080		
24				
25	Net Plant In Service	$ 17,944,080		
26	Working Capital	12,500		
27	Rate Base Total	$ 17,956,580		
28				
29	**Adjusted Operating Income Calculation**			
30	Revenues (amount collected in current rates)	$ -		
31				
32	Depreciation	448,602		
33	Operating Expenses (Excl inc. taxes)	100,000		
34	Operating Income Deficiency	$ (548,602)		
35				
36	**Revenue Conversion Factor**			
37				
38	Income Tax Percentage		40%	
39				
40	Operating Income % = 100% - Tax Percentage		60%	
41				
42				
43	1 = Gross Revenue Conversion Factor		1.6667	
44	Operating Income %			
45				

Pine Water Company
Computation of Incremental Impact on Project

Schedule
Page 1

Reference: Alternative #9: Camp Geronimo Water Diversion; Control Rd. #32

Line No.			
1			
2	Project Capital Costs	$	18,400,000
3	Average Annual # of Customers		1,990
4	Operating & Maintenance Expenses	$	150,000
5	Depreciation @ 2.5%	$	460,000
6	Required Rate of Return		11.41%
7			
8			
9			
10	Annual Impact on Customer bill	$	2,271.00
11	Monthly Impact on Customer Bill	$	189.25
12	Average 5/8 Inch (14A) Monthly Bill Prior Rate Case	$	34.09
13	% Increase in 5/8 Inch (14A) Average Monthly Bill		555.15%
14			
15			
16			
17			
18			
19			
20			
21			

Pine Water Company
Computation of Incremental Impact Increase in Gross Revenue
Modified A-1 Schedule

Schedule
Page 2

Line No.			From Inputs 11.41%
1	Fair Value Rate Base		$ 18,418,750
2			
3	Adjusted Operating Income		(610,000)
4			
5	Current Rate of Return		-3.31%
6			
7	Required Operating Income		$ 2,101,579
8			
9	Required Rate of Return on Fair Value Rate Base		11.41%
10			
11	Operating Income Deficiency		$ 2,711,579
12			
13	Gross Revenue Conversion Factor		1.6667
14			
15	Increase in Gross Revenue		
16	Requirement		$ 4,519,299
17			
18	Annual Impact on Customer bill		$ 2,271.00
19	Monthly Impact on Customer Bill		$ 189.25
20	Average 5/8 Inch (14A) Monthly Bill Prior Rate Case		$ 34.09
21	% Increase in 5/8 Inch (14A) Average Monthly Bill		555.15%
22			
22	**Fair Value Rate Base Calculation**		
23	Original Cost	$ 18,400,000	
24			
25	Net Plant In Service	$ 18,400,000	
26	Working Capital	18,750	
27	Rate Base Total	$ 18,418,750	
28			
29	**Adjusted Operating Income Calculation**		
30	Revenues (amount collected in current rates)	$ -	
31			
32	Depreciation	460,000	
33	Operating Expenses (Excl inc. taxes)	150,000	
34	Operating Income Deficiency	$ (610,000)	
35			
36	**Revenue Conversion Factor**		
37			
38	Income Tax Percentage		40%
39			
40	Operating Income % = 100% - Tax Percentage		60%
41			
42			
43	1 = Gross Revenue Conversion Factor		1.6667
44	Operating Income %		
45			

Pine Water Company
Computation of Incremental Impact on Project

Schedule
Page 1

Reference: Alternative #10: Bray Creek Ranch Water Diversion; Control Rd. #32

Line No.	Item		Amount
1			
2	Project Capital Costs	$	18,600,000
3	Average Annual # of Customers		1,990
4	Operating & Maintenance Expenses	$	150,000
5	Depreciation @ 2.5%	$	465,000
6	Required Rate of Return		11.41%
7			
8			
9			
10	Annual Impact on Customer bill	$	2,294.30
11	Monthly Impact on Customer Bill	$	191.19
12	Average 5/8 Inch (14A) Monthly Bill Prior Rate Case	$	34.09
13	% Increase in 5/8 Inch (14A) Average Monthly Bill		560.84%
14			
15			
16			
17			
18			
19			
20			
21			

Pine Water Company
Computation of Incremental Impact Increase in Gross Revenue
Modified A-1 Schedule

Schedule
Page 2

Line No.				From Inputs 11.41%
1	Fair Value Rate Base			$ 18,618,750
2				
3	Adjusted Operating Income			(615,000)
4				
5	Current Rate of Return			-3.30%
6				
7	Required Operating Income			$ 2,124,399
8				
9	Required Rate of Return on Fair Value Rate Base			11.41%
10				
11	Operating Income Deficiency			$ 2,739,399
12				
13	Gross Revenue Conversion Factor			1.6667
14				
15	Increase in Gross Revenue			
16	Requirement			$ 4,565,666
17				
18	Annual Impact on Customer bill			$ 2,294.30
19	Monthly Impact on Customer Bill			$ 191.19
20	Average 5/8 Inch (14A) Monthly Bill Prior Rate Case			$ 34.09
21	% Increase in 5/8 Inch (14A) Average Monthly Bill			560.84%
22				
22	**Fair Value Rate Base Calculation**			
23	Original Cost	$ 18,600,000		
24				
25	Net Plant In Service	$ 18,600,000		
26	Working Capital	18,750		
27	Rate Base Total	$ 18,618,750		
28				
29	**Adjusted Operating Income Calculation**			
30	Revenues (amount collected in current rates)	$ -		
31				
32	Depreciation	465,000		
33	Operating Expenses (Excl inc. taxes)	150,000		
34	Operating Income Deficiency	$ (615,000)		
35				
36	**Revenue Conversion Factor**			
37				
38	Income Tax Percentage		40%	
39				
40	Operating Income % = 100% - Tax Percentage		60%	
41				
42				
43	1 = Gross Revenue Conversion Factor		1.6667	
44	Operating Income %			
45				

Pine Water Company
Computation of Incremental Impact on Project

Schedule
Page 1

Reference: Alternative #11: Above Ground Water Storage Facilities

Line No.			
1			
2	Project Capital Costs	$	2,000,000
3	Average Annual # of Customers		1,990
4	Operating & Maintenance Expenses	$	20,000
5	Depreciation @ 2.5%	$	50,000
6	Required Rate of Return		11.41%
7			
8			
9	**Outputs**		
10	Annual Impact on Customer bill	$	249.99
11	Monthly Impact on Customer Bill	$	20.83
12	Average 5/8 Inch (14A) Monthly Bill Prior Rate Case	$	34.09
13	% Increase in 5/8 Inch (14A) Average Monthly Bill		61.11%
14			
15			
16			
17			
18			
19			
20			
21			

Pine Water Company
Computation of Incremental Impact Increase in Gross Revenue
Modified A-1 Schedule

Schedule
Page 2

Line No.					From Inputs 11.41%
1	Fair Value Rate Base				$ 2,002,500
2					
3	Adjusted Operating Income				(70,000)
4					
5	Current Rate of Return				-3.50%
6					
7	Required Operating Income				$ 228,485
8					
9	Required Rate of Return on Fair Value Rate Base				11.41%
10					
11	Operating Income Deficiency				$ 298,485
12					
13	Gross Revenue Conversion Factor				1.6667
14					
15	Increase in Gross Revenue				
16	Requirement				$ 497,475
17					
18	Annual Impact on Customer bill				$ 249.99
19	Monthly Impact on Customer Bill				$ 20.83
20	Average 5/8 Inch (14A) Monthly Bill Prior Rate Case				$ 34.09
21	% Increase in 5/8 Inch (14A) Average Monthly Bill				61.11%
22					
22	**Fair Value Rate Base Calculation**				
23	Original Cost	$	2,000,000		
24					
25	Net Plant In Service	$	2,000,000		
26	Working Capital		2,500		
27	Rate Base Total	$	2,002,500		
28					
29	**Adjusted Operating Income Calculation**				
30	Revenues (amount collected in current rates)	$	-		
31					
32	Depreciation		50,000		
33	Operating Expenses (Excl inc. taxes)		20,000		
34	Operating Income Deficiency	$	(70,000)		
35					
36	**Revenue Conversion Factor**				
37					
38	Income Tax Percentage			40%	
39					
40	Operating Income % = 100% - Tax Percentage			60%	
41					
42					
43	1 = Gross Revenue Conversion Factor			1.6667	
44	Operating Income %				
45					

Pine Water Company
Computation of Incremental Impact on Project

Schedule
Page 1

Reference: Alternative #12: Water Sharing Agreement Partner Wells

Line No.			
1			
2	Project Capital Costs	$	85,000
3	Average Annual # of Customers		1,990
4	Operating & Maintenance Expenses	$	1,800
5	Depreciation @ 2.5%	$	875
6	Required Rate of Return		11.41%
7			
8			
9			
10	Annual Impact on Customer bill	$	5.61
11	Monthly Impact on Customer Bill	$	0.47
12	Average 5/8 Inch (14A) Monthly Bill Prior Rate Case	$	34.09
13	% Increase in 5/8 Inch (14A) Average Monthly Bill		1.37%
14			
15			
16			
17			
18			
19			
20			
21			

Pine Water Company
Computation of Incremental Impact Increase in Gross Revenue
Modified A-1 Schedule

Schedule
Page 2

Line No.					From Inputs 11.41%
1	Fair Value Rate Base				$ 35,225
2					
3	Adjusted Operating Income				(2,675)
4					
5	Current Rate of Return				-7.59%
6					
7	Required Operating Income				$ 4,019
8					
9	Required Rate of Return on Fair Value Rate Base				11.41%
10					
11	Operating Income Deficiency				$ 6,694
12					
13	Gross Revenue Conversion Factor				1.6667
14					
15	Increase in Gross Revenue				
16	Requirement				$ 11,157
17					
18	Annual Impact on Customer bill				$ 5.61
19	Monthly Impact on Customer Bill				$ 0.47
20	Average 5/8 Inch (14A) Monthly Bill Prior Rate Case				$ 34.09
21	% Increase in 5/8 Inch (14A) Average Monthly Bill				1.37%
22					
22	**Fair Value Rate Base Calculation**				
23	Original Cost	$	35,000		
24					
25	Net Plant In Service	$	35,000		
26	Working Capital		225		
27	Rate Base Total	$	35,225		
28					
29	**Adjusted Operating Income Calculation**				
30	Revenues (amount collected in current rates)	$	-		
31					
32	Depreciation		875		
33	Operating Expenses (Excl inc. taxes)		1,800		
34	Operating Income Deficiency	$	(2,675)		
35					
36	**Revenue Conversion Factor**				
37					
38	Income Tax Percentage			40%	
39					
40	Operating Income % = 100% - Tax Percentage			60%	
41					
42					
43	1 = Gross Revenue Conversion Factor			1.6667	
44	Operating Income %				
45					

Pine Water Company
Computation of Incremental Impact on Project

Schedule
Page 1

Reference: Alternative #14: Pine Creek CAP Water Exchange Agreement with SRP

Line No.			
1			
2	Project Capital Costs	$	1,000,000
3	Average Annual # of Customers		1,990
4	Operating & Maintenance Expenses	$	50,000
5	Depreciation @ 2.5%	$	25,000
6	Required Rate of Return		11.41%
7			
8			
9	**Outputs**		
10	Annual Impact on Customer bill	$	158.97
11	Monthly Impact on Customer Bill	$	13.25
12	Average 5/8 Inch (14A) Monthly Bill Prior Rate Case	$	34.09
13	% Increase in 5/8 Inch (14A) Average Monthly Bill		38.86%
14			
15			
16			
17			
18			
19			
20			
21			

Pine Water Company
Computation of Incremental Impact Increase in Gross Revenue
Modified A-1 Schedule

Schedule
Page 2

Line No.				From Inputs 11.41%
1	Fair Value Rate Base			$ 1,006,250
2				
3	Adjusted Operating Income			(75,000)
4				
5	Current Rate of Return			-7.45%
6				
7	Required Operating Income			$ 114,813
8				
9	Required Rate of Return on Fair Value Rate Base			11.41%
10				
11	Operating Income Deficiency			$ 189,813
12				
13	Gross Revenue Conversion Factor			1.6667
14				
15	Increase in Gross Revenue			
16	Requirement			$ 316,355
17				
18	Annual Impact on Customer bill			$ 158.97
19	Monthly Impact on Customer Bill			$ 13.25
20	Average 5/8 Inch (14A) Monthly Bill Prior Rate Case			$ 34.09
21	% Increase in 5/8 Inch (14A) Average Monthly Bill			38.86%
22				
22	**Fair Value Rate Base Calculation**			
23	Original Cost	$ 1,000,000		
24				
25	Net Plant In Service	$ 1,000,000		
26	Working Capital	6,250		
27	Rate Base Total	$ 1,006,250		
28				
29	**Adjusted Operating Income Calculation**			
30	Revenues (amount collected in current rates)	$ -		
31				
32	Depreciation	25,000		
33	Operating Expenses (Excl inc. taxes)	50,000		
34	Operating Income Deficiency	$ (75,000)		
35				
36	**Revenue Conversion Factor**			
37				
38	Income Tax Percentage		40%	
39				
40	Operating Income % = 100% - Tax Percentage		60%	
41				
42				
43	1 = Gross Revenue Conversion Factor		1.6667	
44	Operating Income %			
45				

Pine Water Company
Computation of Incremental Impact on Project

Schedule
Page 1

Reference: Alternative #15: Water Hauling on an "As Needed" Basis

Line No.		
1	**Inputs**	
2	Project Capital Costs	Unknown
3	Average Annual # of Customers	1,990
4	Operating & Maintenance Expenses	$ 50,000
5	Depreciation @ 2.5%	#VALUE!
6	Required Rate of Return	11.41%
7		
8		
9		
10	Annual Impact on Customer bill	#VALUE!
11	Monthly Impact on Customer Bill	#VALUE!
12	Average 5/8 Inch (14A) Monthly Bill Prior Rate Case	$ 34.09
13	% Increase in 5/8 Inch (14A) Average Monthly Bill	#VALUE!
14		
15		
16		
17		
18		
19		
20		
21		

Pine Water Company
Computation of Incremental Impact Increase in Gross Revenue
Modified A-1 Schedule

Schedule
Page 2

Line No.				From Inputs 11.41%
1	Fair Value Rate Base			#VALUE!
2				
3	Adjusted Operating Income			#VALUE!
4				
5	Current Rate of Return			#VALUE!
6				
7	Required Operating Income			#VALUE!
8				
9	Required Rate of Return on Fair Value Rate Base			11.41%
10				
11	Operating Income Deficiency			#VALUE!
12				
13	Gross Revenue Conversion Factor			1.6667
14				
15	Increase in Gross Revenue			
16	Requirement			#VALUE!
17				
18	Annual Impact on Customer bill			#VALUE!
19	Monthly Impact on Customer Bill			#VALUE!
20	Average 5/8 Inch (14A) Monthly Bill Prior Rate Case			$ 34.09
21	% Increase in 5/8 Inch (14A) Average Monthly Bill			#VALUE!
22				
22	**Fair Value Rate Base Calculation**			
23	Original Cost	Unknown		
24				
25	Net Plant In Service	#VALUE!		
26	Working Capital	6,250		
27	Rate Base Total	#VALUE!		
28				
29	**Adjusted Operating Income Calculation**			
30	Revenues (amount collected in current rates)	$ -		
31				
32	Depreciation	#VALUE!		
33	Operating Expenses (Excl inc. taxes)	50,000		
34	Operating Income Deficiency	#VALUE!		
35				
36	**Revenue Conversion Factor**			
37				
38	Income Tax Percentage		40%	
39				
40	Operating Income % = 100% - Tax Percentage		60%	
41				
42				
43	1 = Gross Revenue Conversion Factor		1.6667	
44	Operating Income %			
45				

Pine Water Company
Computation of Incremental Impact on Project

Schedule
Page 1

Reference: Alternative #16: Blue Ridge Reservoir Water Diversion to Pine Creek

Line No.		
1	**Input**	
2	Project Capital Costs	Unknown
3	Average Annual # of Customers	1,990
4	Operating & Maintenance Expenses	$ 50,000
5	Depreciation @ 2.5%	#VALUE!
6	Required Rate of Return	11.41%
7		
8		
9	**Output**	
10	Annual Impact on Customer bill	#VALUE!
11	Monthly Impact on Customer Bill	#VALUE!
12	Average 5/8 Inch (14A) Monthly Bill Prior Rate Case	$ 34.09
13	% Increase in 5/8 Inch (14A) Average Monthly Bill	#VALUE!
14		
15		
16		
17		
18		
19		
20		
21		

Pine Water Company
Computation of Incremental Impact Increase in Gross Revenue
Modified A-1 Schedule

Schedule
Page 2

Line No.				From Inputs 11.41%
1	Fair Value Rate Base			#VALUE!
2				
3	Adjusted Operating Income			#VALUE!
4				
5	Current Rate of Return			#VALUE!
6				
7	Required Operating Income			#VALUE!
8				
9	Required Rate of Return on Fair Value Rate Base			11.41%
10				
11	Operating Income Deficiency			#VALUE!
12				
13	Gross Revenue Conversion Factor			1.6667
14				
15	Increase in Gross Revenue			
16	Requirement			#VALUE!
17				
18	Annual Impact on Customer bill			#VALUE!
19	Monthly Impact on Customer Bill			#VALUE!
20	Average 5/8 Inch (14A) Monthly Bill Prior Rate Case			$ 34.09
21	% Increase in 5/8 Inch (14A) Average Monthly Bill			#VALUE!
22				
22	**Fair Value Rate Base Calculation**			
23	Original Cost	Unknown		
24				
25	Net Plant In Service	#VALUE!		
26	Working Capital	6,250		
27	Rate Base Total	#VALUE!		
28				
29	**Adjusted Operating Income Calculation**			
30	Revenues (amount collected in current rates)	$ -		
31				
32	Depreciation	#VALUE!		
33	Operating Expenses (Excl inc. taxes)	50,000		
34	Operating Income Deficiency	#VALUE!		
35				
36	**Revenue Conversion Factor**			
37				
38	Income Tax Percentage		40%	
39				
40	Operating Income % = 100% - Tax Percentage		60%	
41				
42				
43	1 = Gross Revenue Conversion Factor		1.6667	
44	Operating Income %			
45				

Pine Water Company
Computation of Incremental Impact on Project

Schedule
Page 1

Reference: Alternative #17: Deep Well Exploration, Pine: Ploughe Recommendation

Line No.			
1			
2	Project Capital Costs	$	3,880,800
3	Average Annual # of Customers		1,990
4	Operating & Maintenance Expenses	$	55,000
5	Depreciation @ 2.5%	$	97,020
6	Required Rate of Return		11.41%
7			
8			
9			
10	Annual Impact on Customer bill	$	498.83
11	Monthly Impact on Customer Bill	$	41.57
12	Average 5/8 Inch (14A) Monthly Bill Prior Rate Case	$	34.09
13	% Increase in 5/8 Inch (14A) Average Monthly Bill		121.94%
14			
15			
16			
17			
18			
19			
20			
21			

Pine Water Company
Computation of Incremental Impact Increase in Gross Revenue
Modified A-1 Schedule

Schedule
Page 2

Line No.					From Inputs 11.41%
1	Fair Value Rate Base				$ 3,887,675
2					
3	Adjusted Operating Income				(152,020)
4					
5	Current Rate of Return				-3.91%
6					
7	Required Operating Income				$ 443,584
8					
9	Required Rate of Return on Fair Value Rate Base				11.41%
10					
11	Operating Income Deficiency				$ 595,604
12					
13	Gross Revenue Conversion Factor				1.6667
14					
15	Increase in Gross Revenue				
16	Requirement				$ 992,673
17					
18	Annual Impact on Customer bill				$ 498.83
19	Monthly Impact on Customer Bill				$ 41.57
20	Average 5/8 Inch (14A) Monthly Bill Prior Rate Case				$ 34.09
21	% Increase in 5/8 Inch (14A) Average Monthly Bill				121.94%
22					
22	**Fair Value Rate Base Calculation**				
23	Original Cost	$	3,880,800		
24					
25	Net Plant In Service	$	3,880,800		
26	Working Capital		6,875		
27	Rate Base Total	$	3,887,675		
28					
29	**Adjusted Operating Income Calculation**				
30	Revenues (amount collected in current rates)	$	-		
31					
32	Depreciation		97,020		
33	Operating Expenses (Excl inc. taxes)		55,000		
34	Operating Income Deficiency	$	(152,020)		
35					
36	**Revenue Conversion Factor**				
37					
38	Income Tax Percentage			40%	
39					
40	Operating Income % = 100% - Tax Percentage			60%	
41					
42					
43	1 = Gross Revenue Conversion Factor			1.6667	
44	Operating Income %				
45					

Pine Water Company
Computation of Incremental Impact on Project

Schedule
Page 1

Reference: Alternative #18: Cessation of Further Development in Pine and Strawberry

Line No.		
1		
2	Project Capital Costs	Unknown
3	Average Annual # of Customers	1,990
4	Operating & Maintenance Expenses	$ 50,000
5	Depreciation @ 2.5%	#VALUE!
6	Required Rate of Return	11.41%
7		
8		
9		
10	Annual Impact on Customer bill	#VALUE!
11	Monthly Impact on Customer Bill	#VALUE!
12	Average 5/8 Inch (14A) Monthly Bill Prior Rate Case	$ 34.09
13	% Increase in 5/8 Inch (14A) Average Monthly Bill	#VALUE!
14		
15		
16		
17		
18		
19		
20		
21		

Pine Water Company
Computation of Incremental Impact on Project

Schedule
Page 1

Reference: Alternative #19: Legislative Alternatives

Line No.		
1	Inputs:	
2	Project Capital Costs	Unknown
3	Average Annual # of Customers	1,990
4	Operating & Maintenance Expenses	$ 50,000
5	Depreciation @ 2.5%	#VALUE!
6	Required Rate of Return	11.41%
7		
8		
9	Outputs:	
10	Annual Impact on Customer bill	#VALUE!
11	Monthly Impact on Customer Bill	#VALUE!
12	Average 5/8 Inch (14A) Monthly Bill Prior Rate Case	$ 34.09
13	% Increase in 5/8 Inch (14A) Average Monthly Bill	#VALUE!
14		
15		
16		
17		
18		
19		
20		
21		

Pine Water Company
Computation of Incremental Impact Increase in Gross Revenue
Modified A-1 Schedule

Schedule
Page 2

Line No.				From Inputs 11.41%
1	Fair Value Rate Base			#VALUE!
2				
3	Adjusted Operating Income			#VALUE!
4				
5	Current Rate of Return			#VALUE!
6				
7	Required Operating Income			#VALUE!
8				
9	Required Rate of Return on Fair Value Rate Base			11.41%
10				
11	Operating Income Deficiency			#VALUE!
12				
13	Gross Revenue Conversion Factor			1.6667
14				
15	Increase in Gross Revenue			
16	Requirement			#VALUE!
17				
18	Annual Impact on Customer bill			#VALUE!
19	Monthly Impact on Customer Bill			#VALUE!
20	Average 5/8 Inch (14A) Monthly Bill Prior Rate Case			$ 34.09
21	% Increase in 5/8 Inch (14A) Average Monthly Bill			#VALUE!
22				
22	**Fair Value Rate Base Calculation**			
23	Original Cost	Unknown		
24				
25	Net Plant In Service	#VALUE!		
26	Working Capital	6,250		
27	Rate Base Total	#VALUE!		
28				
29	**Adjusted Operating Income Calculation**			
30	Revenues (amount collected in current rates)	$ -		
31				
32	Depreciation	#VALUE!		
33	Operating Expenses (Excl inc. taxes)	50,000		
34	Operating Income Deficiency	#VALUE!		
35				
36	**Revenue Conversion Factor**			
37				
38	Income Tax Percentage		40%	
39				
40	Operating Income % = 100% - Tax Percentage		60%	
41				
42				
43	1 = Gross Revenue Conversion Factor		1.6667	
44	Operating Income %			
45				

Pine Water Company
Computation of Incremental Impact on Project

Schedule
Page 1

Reference: Alternative #20: SHDWID Water Adequacy Application

Line No.		
1	**Inputs**	
2	Project Capital Costs	Unknown
3	Average Annual # of Customers	1,990
4	Operating & Maintenance Expenses	$ 50,000
5	Depreciation @ 2.5%	#VALUE!
6	Required Rate of Return	11.41%
7		
8		
9	**Outputs**	
10	Annual Impact on Customer bill	#VALUE!
11	Monthly Impact on Customer Bill	#VALUE!
12	Average 5/8 Inch (14A) Monthly Bill Prior Rate Case	$ 34.09
13	% Increase in 5/8 Inch (14A) Average Monthly Bill	#VALUE!
14		
15		
16		
17		
18		
19		
20		
21		

Pine Water Company
Computation of Incremental Impact Increase in Gross Revenue
Modified A-1 Schedule

Schedule
Page 2

Line No.				From Inputs 11.41%
1	Fair Value Rate Base			#VALUE!
2				
3	Adjusted Operating Income			#VALUE!
4				
5	Current Rate of Return			#VALUE!
6				
7	Required Operating Income			#VALUE!
8				
9	Required Rate of Return on Fair Value Rate Base			11.41%
10				
11	Operating Income Deficiency			#VALUE!
12				
13	Gross Revenue Conversion Factor			1.6667
14				
15	Increase in Gross Revenue			
16	Requirement			#VALUE!
17				
18	Annual Impact on Customer bill			#VALUE!
19	Monthly Impact on Customer Bill			#VALUE!
20	Average 5/8 Inch (14A) Monthly Bill Prior Rate Case			$ 34.09
21	% Increase in 5/8 Inch (14A) Average Monthly Bill			#VALUE!
22				
22	**Fair Value Rate Base Calculation**			
23	Original Cost	Unknown		
24				
25	Net Plant In Service	#VALUE!		
26	Working Capital	6,250		
27	Rate Base Total	#VALUE!		
28				
29	**Adjusted Operating Income Calculation**			
30	Revenues (amount collected in current rates)	$ -		
31				
32	Depreciation	#VALUE!		
33	Operating Expenses (Excl inc. taxes)	50,000		
34	Operating Income Deficiency	#VALUE!		
35				
36	**Revenue Conversion Factor**			
37				
38	Income Tax Percentage		40%	
39				
40	Operating Income % = 100% - Tax Percentage		60%	
41				
42				
43	1 / Operating Income % = Gross Revenue Conversion Factor		1.6667	
44				
45				

Pine Water Company
Computation of Incremental Impact on Project

Schedule
Page 1

Reference: Alternative #21: Condemnation of Existing Local Water Supplies

Line No.		
1	[redacted]	
2	Project Capital Costs	Unknown
3	Average Annual # of Customers	1,990
4	Operating & Maintenance Expenses	$ 50,000
5	Depreciation @ 2.5%	#VALUE!
6	Required Rate of Return	11.41%
7		
8		
9	[redacted]	
10	Annual Impact on Customer bill	#VALUE!
11	Monthly Impact on Customer Bill	#VALUE!
12	Average 5/8 Inch (14A) Monthly Bill Prior Rate Case	$ 34.09
13	% Increase in 5/8 Inch (14A) Average Monthly Bill	#VALUE!
14		
15		
16		
17		
18		
19		
20		
21		

Pine Water Company
Computation of Incremental Impact Increase in Gross Revenue
Modified A-1 Schedule

Schedule
Page 2

Line No.				From Inputs 11.41%
1	Fair Value Rate Base			#VALUE!
2				
3	Adjusted Operating Income			#VALUE!
4				
5	Current Rate of Return			#VALUE!
6				
7	Required Operating Income			#VALUE!
8				
9	Required Rate of Return on Fair Value Rate Base			11.41%
10				
11	Operating Income Deficiency			#VALUE!
12				
13	Gross Revenue Conversion Factor			1.6667
14				
15	Increase in Gross Revenue			
16	Requirement			#VALUE!
17				
18	Annual Impact on Customer bill			#VALUE!
19	Monthly Impact on Customer Bill			#VALUE!
20	Average 5/8 Inch (14A) Monthly Bill Prior Rate Case			$ 34.09
21	% Increase in 5/8 Inch (14A) Average Monthly Bill			#VALUE!
22				
22	**Fair Value Rate Base Calculation**			
23	Original Cost	Unknown		
24				
25	Net Plant In Service	#VALUE!		
26	Working Capital	6,250		
27	Rate Base Total	#VALUE!		
28				
29	**Adjusted Operating Income Calculation**			
30	Revenues (amount collected in current rates)	$ -		
31				
32	Depreciation	#VALUE!		
33	Operating Expenses (Excl inc. taxes)	50,000		
34	Operating Income Deficiency	#VALUE!		
35				
36	**Revenue Conversion Factor**			
37				
38	Income Tax Percentage		40%	
39				
40	Operating Income % = 100% - Tax Percentage		60%	
41				
42				
43	1 = Gross Revenue Conversion Factor		1.6667	
44	Operating Income %			
45				

13

OVERSIZED MAP

SEE SUPERVISOR (EXHIBIT CABINET)

BOX 17

14

BLACK & VEATCH
Corporation

2850 E. Camelback Road, Suite 240, Phoenix, AZ 85016, (602) 381-4400

B&V Project 141789.0100

PRELIMINARY

Town of Payson, Arizona

Blue Ridge Reservoir Water Supply Pipeline and Treatment Plant
Pine Extension

OPINION OF
PROBABLE CONSTRUCTION COST
26-Oct-05

SUMMARY

General Requirements		$1,145,664
Pipeline		$8,852,100
Pump Station No. 1		$822,250
Pump Station No. 2		$822,250
Pump Station No. 3		$822,250
Water Treatment Plant		$1,410,750
Subtotal - Pine Extension		$13,875,264
Contingencies	25%	$3,468,816
TOTAL PROBABLE CONSTRUCTION COST		**$17,344,080**

RECEIVED
OCT 28 2005
BY:

15

Second Draft - Subject to Revision

BLUE RIDGE DAM and RESERVOIR WATER SUPPLY ALTERNATIVE

PIPELINE OPTIONS for PAYSON, STRAWBERRY & PINE

PRELIMINARY COST ESTIMATES

THE UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

PHOENIX AREA OFFICE
PROGRAM DEVELOPMENT DIVISION

FEBRUARY 1999

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Introduction..... 1

Scope..... 1

Design Summary..... 1

Assumptions and Details..... 3

Cost Summary..... 4

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Introduction:

This paper is a preliminary look at several options to move water from the Blue Ridge Reservoir to the communities of Payson, Pine and Strawberry. These communities currently meet all their water needs by pumping groundwater. Studies projecting population growth and water consumption into the year 2050 have made it apparent that a supplemental source of water is needed.

Presently, the Phelps Dodge Corporation has a water rights certificate to 11,000 acre-feet per annum captured by the dam at Blue Ridge Reservoir located approximately 23 miles northeast of Payson on the Mogollon Plateau. Phelps Dodge pumps water out of the reservoir, through a 30 inch pipeline, over the Mogollon Rim and into the East Verde River as part of a water exchange agreement with the Salt River Project. For purposes of this analysis, it is assumed that the communities of Payson, Pine and Strawberry will obtain 3000 acre-feet per annum from Blue Ridge Reservoir in normal or wet years. This amount was selected for use in this analysis although it should be noted that the final quantity is subject to negotiations.

Scope:

This paper gives the probable opinion of construction costs for several options to transport 3000 acre-feet of water to the communities of Payson, Pine and Strawberry. Land purchase, rights of way, safety, reliability, geology, utility relocations, pump selection and configuration, social problems, economic analysis are beyond this paper and will have to be addressed in future studies. Initial costs to write the initial Environmental Impact Statement are included unforseen costs of environmental problems, mitigation or litigation can not be calculated at this point. The complete project costs were not computed and could possibly double the construction costs.

What this paper provides is a level or magnitude of the construction costs for the various piping options under the Blue Ridge Dam and Reservoir Water Supply Alternative.

Design Considerations:

No attempt was made to produce a final design of a water supply system. Only the major components of a water supply system and the estimated costs for those key components were examined.

Environmental considerations were the governing factor in pipeline alignment since they will cross lands of the Tonto National Forest and the Sitgreaves National Forest. The pipelines were aligned along existing roads to minimize impact to the national forests. It was assumed the pipeline would be laid directly along the centerline of the existing gravel roads and minor asphalt roads located in the forests. Pipelines would not be placed under Highway 87 but within the

right of way of the highway as replacement costs for the highway would be prohibitive. The pipe would be buried with a minimum four foot cover for protection from the freezing winters. Rock and earth excavation costs were split 40% to 60 % respectively due to the rocky geology of the Rim country.

The pipe sizes are based on pumping eleven out of twelve months, keeping the friction losses to a minimum and for some expansion capability if more water becomes available from the Blue Ridge Reservoir.

Operation of the system was not analyzed in detail.

Initial examination of the various options indicates that much of the water could be transported in the required quantity by gravity. Where pumping is necessary, pump size was noted but no selection of pumps was made at this level of investigation.

Three reservoir sites were located by the Gila County Engineering staff where there would be minimal environmental impact to the national forests. These sites are tentative at the best.

The water treatment plants are sized to meet the quantity of water available not to meet future demand or future summer peak demand.

Each community would still be required to install piping systems to distribute the water from the final storage tanks to final user. These distribution systems were not addressed in this paper.

Option 1 or the **Control Road Option** takes water directly from Phelps Dodge's power plant pipeline and follows Control Road west along the base of the Mogollon Rim. A 3000 acre-foot reservoir would be located near Buckhead Mesa, along with a 2.5 million gallons a day (mg/d) water treatment facility and a 10 million gallon (mg) clearwell. Water would then be pumped north to Pine and Strawberry to 0.5 mg storage tanks and use gravity flow south to Payson to storage.

Option 2 or the **Instream Diversion Option** puts the water into the East Verde River at Phelps Dodge's power plant. The water is then taken out of the river near the Houston Mesa Road crossing. A small ogee dam would be built to get the depth required for the infiltration diversion system. Water would be pumped up a pipeline aligned along Houston Mesa Road into a 3000 acre-foot reservoir located at Sunflower Mesa. The water would then pumped through a 18 inch pipeline aligned along Houston Mesa Road to near Highway 87 where a 2.5 mg/d water treatment facility and a 10 mg clearwell would be located for Payson's needs. The water would then pumped up a 8 inch pvc line aligned along Highway 87 to holding tanks for Strawberry and Pine.

Option 3 or the **Rim Road Option** splits the supply of water to Payson and to Strawberry and Pine in two separate pipelines. The water to Payson is taken directly from the Phelps Dodge

power plant and follows Houston Mesa Road via a 18 inch steel pipeline to a reservoir located at Sunflower Mesa. A pump station would then pump the water to a 2.5 mg/d water treatment plant and 10 mg clearwell located near Payson. The water for Strawberry and Pine would be diverted from the Phelps Dodge pipeline on top of the Mogollon Rim. It would be pumped through a 8 inch pvc pipeline along the Rim Road to Highway 87. The pipeline would then follow Highway 87 down to a small water treatment plant located near Pine and then by gravity feed to final storage near Strawberry.

Option 4 or the **Highway 87 Option** pumps water out of Blue Ridge Reservoir along a forest road directly to Highway 87 via a 18 inch steel pipeline. The pipeline then follows Highway 87 south, down the Mogollon, past Strawberry, through Pine to a 3000 acre-foot reservoir located northwest of the Highway 87 and Control Road intersection. The water would then be treated at a 2.5 mg water treatment plant and stored in a 10 mg clearwell before being pumped south to Payson and back north to Strawberry and Pine.

Assumptions and Details:

One of the greatest costs for this project may be the mitigation and possible litigation over environmental issues. Several of the options may have difficult environmental concerns associated with them.

Moving water from the Mogollon Plateau to below the rim is an inter-basin transfer of water. Since Phelps Dodge has been pumping water from Blue Ridge Reservoir every year since the 1960's to the bottom of the rim this system should be used. If this existing system was to be ignored and water was pumped out of the reservoir, as in the **Highway 87 Option**, around the north route and then into the lower watershed is inviting heavy opposition from environmental organizations. This option also lays pipeline through two separate national forests, the Tonto National Forest and the Sitgreaves National Forest. Traversing through two national forests would cause additional environmental assessments and a greater chance that an endangered species could be encountered.

The **Rim Road Option** also has the same environmental concerns as **Highway 87 Option**. While not pumping out of the reservoir the water is intercepted before it is in the lower watershed and then re-routed along the Rim Road and then down Highway 87 into the lower watershed. This may or may not attract environmental concern about inter-basin transfers. But the **Rim Road Option** does transverse through both national forests.

The **Instream Diversion Option** only traverses one national forest problem and avoids the inter-basin transfer problem. The greatest concern with this option is water rights issues once the water is introduced into the East Verde River. An environmental issue would be the construction of the diversion structure. The diversion structure would require a ogee dam to pond water to create the head for the diversion. The dam, although, very small may lead to environmental

problems. Doubts have been expressed from several sources with this option while researching data for this paper. While the **Instream Diversion Option** looks like the least expensive for construction purposes if it is environmentally unsound or water rights issues are difficult to solve then the water should be taken directly from the Phelps Dodge power plant and not put into the river.

The **Control Road Option** avoids some of the thorny issues that the other options have.

The location of the 3000 acre-foot reservoir may be the most exacting task of the project. The reservoir would require approximately 150-200 acres of land. Three tentative locations have been suggested for the reservoir, but do those locations meet the engineering requirements, geological requirements and the environmental concerns? The selection of which pipeline option is implemented may depend on where the reservoir can be located.

Cost Summary:

Costs were gathered from several different sources, including Means Heavy Construction Cost Data, previous contracts with Bureau of Reclamation and personal contacts. All costs were brought forward to 1999 dollars using a 6.4% inflation rate.

Some of the costs not considered are: environmental mitigation and/or litigation, purchase of land, cost to operate, profit and overhead for the contractor, or inflation during life time of the project.

Many of the same features will be required for each option such as an operating reservoir, water treatment facilities, pumps and pump houses and clear wells. Many of the costs for these features are the same for each option since no attempt was made to establish a final location in this preliminary examination.

Costs of operation and maintenance are not included.

The probable opinion of construction costs for each option is as follows. A breakdown of costs is on the subsequent pages. Please note the further discussions because the least expensive construction option may not be the least expensive when other factors are considered.

Control Road Option 1 .....$73,100,000.00

Instream Diversion Option 2 .....$53,500,000.00

Rim Road Option 3 .....$72,000,000.00

Highway 87 Option 4 .....$91,100,000.00

Alternative: Blue Ridge Dam and Reservoir
Annual Water Supply: 3000 acre-feet
Probable Opinion of Construction Cost December 1998

Control Road Option 1

Item	Description	Quantity	Unit	Price	Amount
one	18" steel pipe, excav, placed & back. Earth	82680	ft	85	7027800
two	18" steel pipe, excav, placed & back. Rock	55120	ft	212	11685440
three	8 " pvc pipe, excav, placed & back. Earth	14520	ft	60	871200
four	8 " pvc pipe, excav, placed & back. Rock	9680	ft	150	1452000
five	6" pvc pipe, excav, placed & back. Earth	25320	ft	50	1266000
six	6 " pvc pipe, excav, placed & back. Rock	16880	ft	125	2110000
seven	Valve & modifications at Power Plant	1	each	125000	125000
eight	0.67 cfs Pump Station	1	each	115000	115000
nine	0.33 cfs Pump Station	1	each	75000	75000
ten	3000 ac-ft Reservoir	1	each	9700000	9700000
eleven	2.5 mgd Water Treat. Facility	1	each	2430000	2430000
twelve	10 mg Clearwell	1	each	3285000	3285000
thirteen	1 mg Storage Tank	1	each	300000	300000
fourteen	0.5 mg Storage Tank	2	each	240000	480000
fifteen	Repair Gravel Road	15.2	mile	25000	380000
sixteen	mobilization @ 5%				2065122
seventeen	Contract Costs				43367562
eighteen	Contigency @ 25%				10841891
nineteen	Total Field Costs				54209453
twenty	Non-conctract Costs @ 33%				17889119
twenty one	EIS				1000000
Total Construction Costs					**73098572**

Alternative. Blue Ridge Dam and Reservoir
Annual Water Supply: 3000 acre-feet
Probable Opinion of Construction Cost December 1998

Instream Diversion Option 2

Item	Description	Quantity	Unit	Price	Amount
one	18" steel pipe, excav, placed & back. Earth	21225	ft	85	1804125
two	18" steel pipe, excav, placed & back. Rock	14150	ft	212	2999800
three	8 " pvc pipe, excav, placed & back. Earth	43084	ft	60	2585040
four	8 " pvc pipe, excav, placed & back. Rock	28723	ft	150	4308450
five	6" pvc pipe, excav, placed & back. Earth	7920	ft	50	396000
six	6 " pvc pipe, excav, placed & back. Rock	5280	ft	125	660000
seven	4.5 cfs Pump Station & Diversion Structure	1	each	345000	345000
eight	4.5 cfs Pump Station	1	each	245000	245000
nine	0.67 cfs Pump Station	1	each	115000	115000
ten	0.33 cfs Pump Station	1	each	75000	75000
eleven	3000 ac-ft Reservoir	1	each	9700000	9700000
twelve	2.5 mgd Water Treat. Facility	1	each	2430000	2430000
thirteen	10 mg Clearwell	1	each	3285000	3285000
fourteen	0.5 mg Storage Tank	2	each	240000	480000
fifteen	Repair Gravel Road	4.2	mile	25000	105000
sixteen	Repair Minor Asphalt Road	2.5	mile	91000	227500
seventeen	mobilization @ 5%				1488046
eighteen	Contract Costs				31248961
nineteen	Contigency @ 25%				7812240
twenty	Total Field Costs				39061201
twenty one	Non-conctract Costs @ 33%				12890196
tewnty two	EIS				1500000
Total Construction Costs					**53451397**

Alternative: Blue Ridge Dam and Reservoir
Annual Water Supply: 3000 acre-feet
Probable Opinion of Construction Cost December 1998

Rim Road Option 3

Item	Description	Quantity	Unit	Price	Amount
one	18" steel pipe, excav, placed & back. Earth	44640	ft	85	3794400
two	18" steel pipe, excav, placed & back. Rock	29760	ft	212	6309120
three	8 " pvc pipe, excav, placed & back. Earth	74760	ft	60	4485600
four	8 " pvc pipe, excav, placed & back. Rock	49840	ft	150	7476000
five	Valve and Work at pipeline on Rim	1	each	50000	50000
six	Valve and Work at power plant	1	each	125000	125000
seven	3.8 cfs Pump Station	1	each	200,000	245000
eight	0.67 cfs Pump Station	1	each	115000	115000
nine	3000 ac-ft Reservoir	1	each	9700000	9700000
ten	2.5 mgd Water Treat. Facility	1	each	2430000	2430000
eleven	0.5 mgd Water Treat. Facility	1	each	1000000	1000000
twelve	10 mg Clearwell	1	each	3285000	3285000
thirteen	0.5 mg Storage Tank	2	each	240000	480000
fourteen	Repair Gravel Road	25.8	mile	25000	645000
fifteen	Repair Minor Asphalt Road	2.5	mile	91000	227500
sixteen	mobilization @ 5%				2018381
seventeen	Contract Costs				42386001
eighteen	Contigency @ 25%				10596500
nineteen	Total Field Costs				52982501
twenty	Non-conctract Costs @ 33%				17484225
tewnty one	EIS				1500000
Total Construction Costs					**71966727**

Alternative: Blue Ridge Dam and Reservoir
Annual Water Supply: 3000 acre-feet
Probable Opinion of Construction Cost December 1998

Highway 87 Option 4

Item	Description	Quantity	Unit	Price	Amount
one	18" steel pipe, excav, placed & back. Earth	138283	ft	85	11754055
two	18" steel pipe, excav, placed & back. Rock	92188	ft	212	19543856
three	6 " pvc pipe, excav, placed & back. Earth	24000	ft	50	1200000
four	6" pvc pipe, excav, placed & back. Rock	16000	ft	125	2000000
five	4.5 cfs Pump Plant at Blue Ridge Reservoir	1	each	345000	345000
six	4.5 cfs Booster Station	1	each	200000	125000
seven	3.8 cfs Pump Station	1	each	200,000	245000
eight	0.33 cfs Pump Station	1	each	75000	115000
nine	3000 ac-ft Reservoir	1	each	9700000	9700000
ten	2.5 mgd Water Treat. Facility	1	each	2430000	2430000
eleven	10 mg Clearwell	1	each	3285000	3285000
twelve	0.5 mg Storage Tank	2	each	240000	480000
thirteen	Repair Gravel Road	5	mile	25000	125000
fourteen	mobilization @ 5%				2567396
fifteen	Contract Costs				53915307
sixteen	Contigency @ 25%				13478827
seventeen	Total Field Costs				67394133
eighteen	Non-conctract Costs @ 33%				22240064
nineteen	EIS				1500000
Total Construction Costs					**91134197**

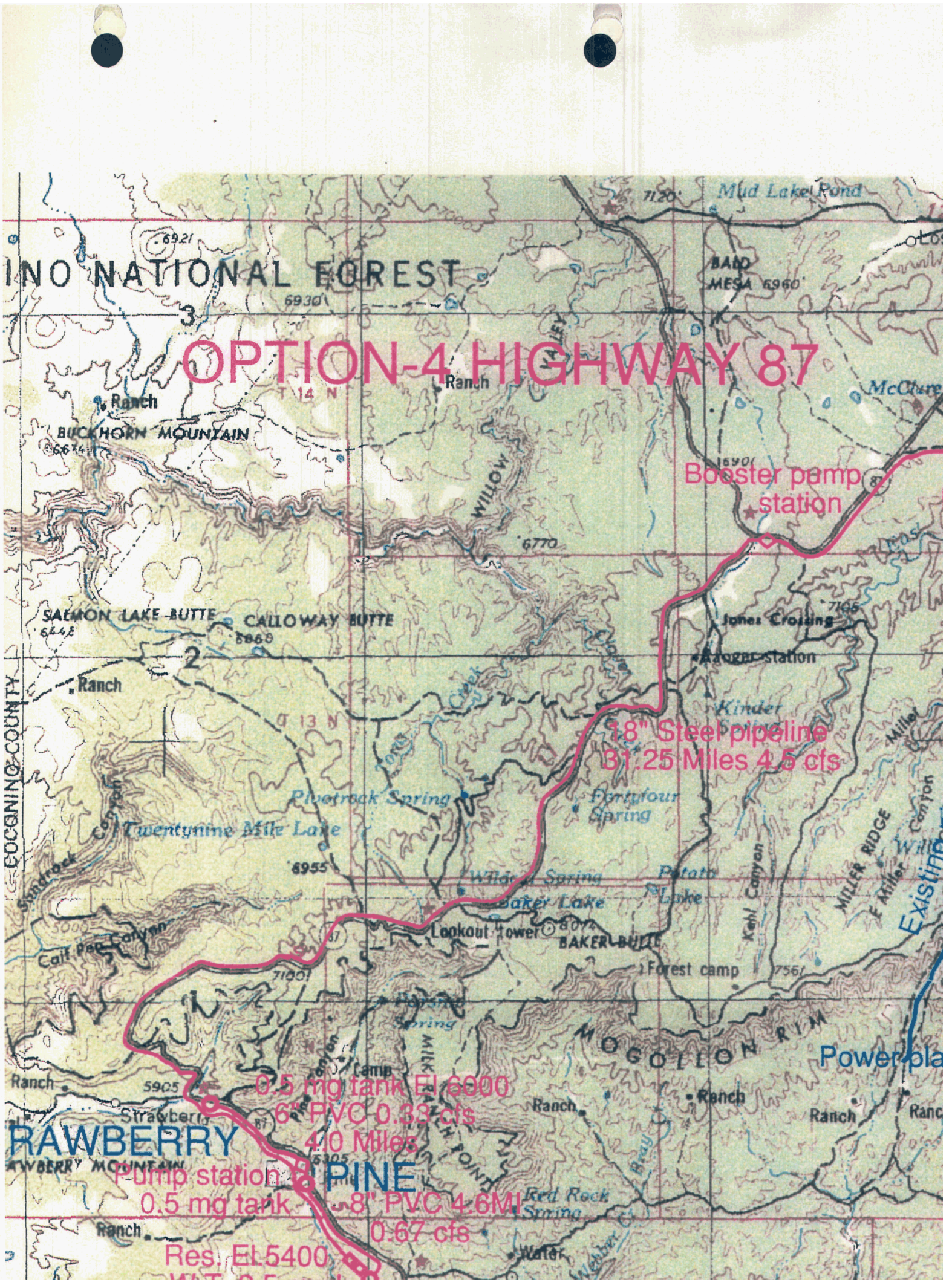
Maps of Proposed Options:

The following maps show the proposed routes. Only tentative locations were selected for water treatment facilities, storage tanks, pumping stations, etc.

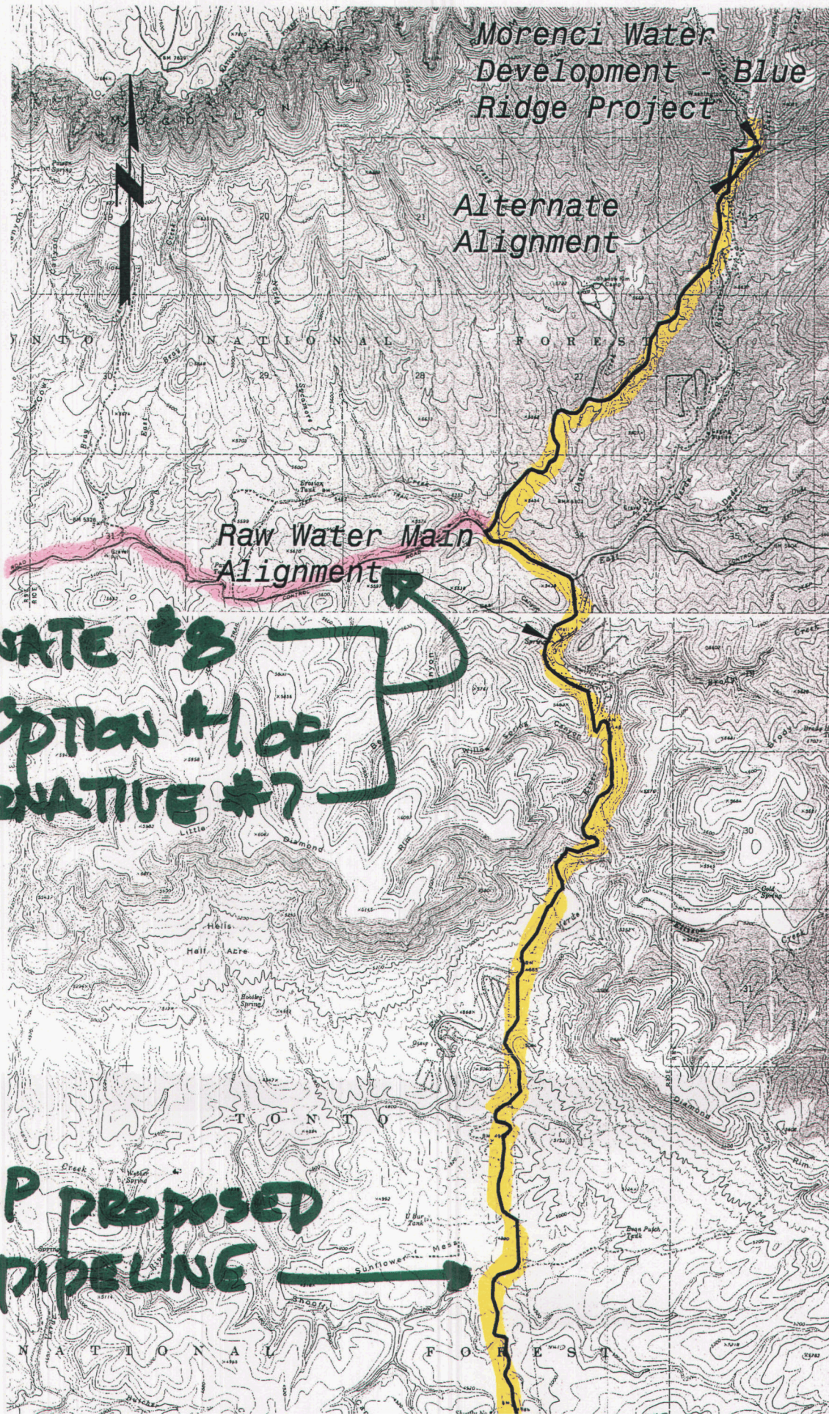
OPTION-1 CONTROL ROAD
ONINO NATIONAL FOREST
Mud Lake Pond
BALD MESA 6960
Ranch
BUCKHORN MOUNTAIN
6674
T 14 N
T 13 N
SALMON LAKE BUTTE
CALLOWAY BUTTE
6442
6860
Jones Crossing
Ranger Station
Kinder Spring
Phantom Spring
Twentynine Mile Lake
6955
Wildcat Spring
Baker Lake
Lookout Tower
BAKER BUTTE
Forest camp
7561
7100
Pigeon Spring
MOGOLLON RIM
Ranch
5905
Corral
Strawberry
STRAWBERRY
STRAWBERRY MOUNTAIN
5305
Pine
Red Rock Spring
Camp
0.5 mg tank El 6000
6" PVC 0.33 cfs
4.0 Miles
8" PVC 4.6MI
17.4 Miles
4.5 cfs
Powerplan
Existing
YAVAPAI COUNTY
COCONINO COUNTY
WILLOW
6770
6901
7105
MILLER RIDGE
Kehl Canyon
Miller Canyon
Fortyfour Spring
Potato Lake
Calf Pen Canyon
Sycamore Creek
Oak Creek
Willow Creek
Gray Mt.

ONINO NATIONAL FOREST
OPTION-2 INSTREAM DIVER
Mud Lake Pond
BALD MESA 6960
Ranch
BUCKHORN MOUNTAIN
6674
T 14 N
WILLOW VALLEY
6770
6901
87
SALIDA LAKE BUTTE
6442
CALLOWAY BUTTE
8860
Jones Crossing
7105
Ranger Station
YAVAPAI COUNTY
COCONINO COUNTY
T 13 N
Kinder Spring
Pivotrack Spring
Fortyfour Spring
Twentynine Mile Lake
8955
Miller Canyon
MILLER RIDGE
Existing
Baker Lake
Potato Lake
Lookout Tower
8074
BAKER BUTTE
Forest camp
7561
7100
Spring
MOGOLLON RIM
Powerplan
0.5 mg tank El 6900
6" PVC 0.33 cfs
2.5 Miles
Camp
5905
Strawberry
STRAWBERRY
STRAWBERRY MOUNTAIN
PINE
Red Rock

OPTION-3 RIM ROAD
COCONINO NATIONAL FOREST
Mud Lake Rona
BALD MESA 6960
Ranch
BUCKHORN MOUNTAIN
6674
WILLOW VALLEY
6770
6901
McClure
SALMON LAKE BUTTE
6446
CALLOWAY BUTTE
6860
Jones Crossing
7105
Ranch
Ranch
Kinder Spring
Pivetrock Spring
Twentynine Mile Lake
6955
Fortyfour Spring
MILLER RIDGE
Existing
22.2 Miles 8" PVC 0.67 cfs
Lookout Tower
BAKER BUTTE
Forest camp
7561
7100
Spring
W.T. 0.5 mg/d +
.5 mg Clearwell
1.4 Miles
8" PVC 0.67 cfs
MOGOLLON RIM
Power plan
RAWBERRY
Corral
Strawberry
0.5 mg tank
5710
STRAWBERRY MOUNTAIN
El.6000
PINE
MILK RANCH POINT
Ranch
Ranch
Ranch
Red Rock
Bray
YAVAPAI COUNTY
COCONINO COUNTY
Sandstock Canyon
Calf Pen Canyon
Tonto Creek
Kehl Canyon
Miller Canyon
Wildcat Spring
Baker Butte
6930
6921
7120
T 14 N
T 13 N
1
2
3


OPTION-4 HIGHWAY 87
Booster pump station
18" Steel pipeline
31.25 Miles 4.5 cfs
0.5 mg tank El 6000
6" PVC 0.33 cfs
4.0 Miles
Pump station
0.5 mg tank
8" PVC 4.6MI
0.67 cfs
Res. El 5400
PINE
RAWBERRY
Mud Lake Pond
BAND MESA 6960'
Ranch
BUCKHORN MOUNTAIN
6674
WILLOW VALLEY
6770
McClure
6901
SALMON LAKE BUTTE
6448
CALLOWAY BUTTE
6868
Jones Crossing
7105
Ranger station
Kinder
Pivotrock Spring
Twentynine Mile Lake
6955
Fortyfour Spring
Potato Lake
Baker Lake
Lookout Tower
8074
BAKER BUTTE
Forest camp
7561
MOGOLLON RIM
Strawberry
5905
Red Rock Spring
Water
COCONINO COUNTY
MILLER RIDGE
Existing
Power pla

16


Morenci Water Development - Blue Ridge Project
Alternate Alignment
Raw Water Main Alignment
ALTERNATE #8 AND OPTION #1 OF ALTERNATIVE #7
TOP PROPOSED PIPELINE
TONTO NATIONAL FOREST
Mogollon Rim
Little Diamond Rim
Diamond Rim
Sunflower Mesa
Hells Half Acre
Boulder Spring
Verde
Cold Spring
Dean Peak Tank
U Bar Tank
Erosion Test Pit
Willow Spring
Cabin
Trail
Road

COUNCIL DECISION REQUEST

SUBJECT: Blue Ridge Reservoir Water Supply

MEETING DATE: September 15, 2005

CSP ITEM: Yes X☐ No ☐ KRA#2

ITEM NO.:

TENTATIVE SCHEDULE: 60 Day Completion

SUBMITTED BY: Buzz Walker (CAO)

AMOUNT BUDGETED: $10,022.00

SUBMITTAL TO AGENDA
APPROVED BY TOWN MANAGER

EXPENDITURE REQUIRED: $10,022.00

CONT. FUNDING REQUIRED: $-0-

EXHIBITS (If Applicable, To Be Attached):

RECOMMENDED MOTION: I MOVE TO AUTHORIZE CHANGE ORDER No.1 TO THE BLUE RIDGE RESERVOIR WATER SUPPLY, PIPELINE AND TREATMENT PLANT COST ESTIMATE CONTRACT WITH BLACK & VEATCH CORPORATION IN THE AMOUNT OF $10,022.00 AND TO ALLOCATE ALL COSTS TO THE WATER ENTERPRISE FUND

SUMMARY OF THE BASIS FOR RECOMMENDED MOTION: **It is necessary to determine the costs of utilizing surface water from Blue Ridge Reservoir in various northern Gila County communities. Black & Veatch engineering firm is currently preparing a cost estimate for infrastructure costs pertaining to the Town of Payson. There is a need to determine the cost of utilizing water from the same source for the Pine and Strawberry area. This knowledge will help us and other communities to determine if they have the capabilities to use the water and to retire the infrastructure debt and operations and maintenance costs associated with that source. Mr. Bob Hardcastle of Brooke Utilities has agreed to reimburse the Town for the cost of the study.**

PROS: **Complete and accurate information is vital for the implementation of a program to develop and utilize Blue Ridge Reservoir water in northern Gila County.**

CONS: **N/A**

PUBLIC INPUT (if any): **CSP Process**

BOARD/COMMITTEE/COMMISSION ACTIONS/RECOMMENDATIONS (if any) (give dates and attach minutes): **N/A**

SEP 15 2005 H.1

BLACK & VEATCH

2850 E. Camelback Road
Suite 240
Phoenix, AZ 85016 USA

Tel: (602) 381-4400

Black & Veatch Corporation

Blue Ridge Reservoir Water Supply
Pipeline and Treatment Plant

B&V Project 141789
B&V File N
July 25, 2005

Mr. Buzz Walker
Town of Payson
303 N. Beeline Highway
Payson, AZ 85541-4306

Subject: Change Order No. 1

Dear Mr. Walker:

This Change Order No. 1 covers additional work associated with the Pine Extension, including pipeline, lift station and water treatment plant to our Agreement dated May 6, 2005 for the above reference project. The total amount of this work shall be increased by $10,022. Therefore the total compensation shall be increased from $12,673 to $22,695 and this total amount shall not be exceeded without prior written authorization from the Engineer.

The effective date of this Change Order is August 5, 2005.

Please review and acknowledge your acceptance by executing and returning a signed copy of this letter. We appreciate the opportunity to work for the Town on this important project.

Very truly yours,

BLACK & VEATCH

Brad Hemken

Brad E. Hemken
Project Manager

P:\141789 - Payson Blue Ridge Pipeline\Payson CO1.doc

Black & Veatch Corporation	Town of Payson
Brad Hemken	
(Signature)	(Signature)
Brad Hemken Vice President	
(Printed name & title)	(Printed name & title)

cc: Brad Hemken
Kathy Tambascio

ATTACHMENT A

Town of Payson

Blue Ridge Reservoir Water Supply Pipeline - Pine Extension and Treatment Plant

Preliminary Sizing and Cost Estimate

Scope of Work

GENERAL

The Community of Pine may have access to a 500 ac. ft annual allocation of water from the Blue Ridge Reservoir. The Community of Pine plans to divert its allocation from the raw water main that would convey the Town of Payson's Blue Ridge Reservoir allocation from the Blue Ridge Power Plant. The Community of Pine will take its Blue Ridge Reservoir allocation continuously over the nine month SRP operates the turbine, which corresponds to the nine month period the Town of Payson will take its Blue Ridge Reservoir allocation. For the purpose of this analysis the Town of Payson will set the pipeline alignment and a membrane filtration plant will be assumed.

The purpose of this scope of work is to develop sizing and preliminary cost estimate for the pipeline, lift station and treatment facilities.

WORK TASKS

201 – Facilities Sizing. Sizing will be developed to take Pine's 500 ac. ft/yr allocation continuously over a nine month period at a base rate of 0.6 mgd. Pipeline, lift station and treatment plant capacity will be at the base rate. The previous sizing of the raw water main for the Town of Payson, prior to the Pine Extension, will be reevaluated to include the additional capacity of 0.6 mgd.

202 – Alignment. Review the proposed preliminary alignment and adjust as appropriate.

203 – Pipe Materials and Unit Cost. Potential pipe suppliers will be contacted to obtain appropriate pressure rated materials and obtain associated unit costs. A list of suggested alternative pipeline materials will be provided.

204 – Preliminary Pipeline Cost. A preliminary estimated pipeline cost will be developed to include pipe, installation, wash/stream crossings, pavement replacement and appurtenances.

205 – Preliminary Lift Station Cost. A preliminary lift station cost estimate will be developed for a nominal 0.6 mgd capacity facility, including capital and operational costs.

206 – Preliminary Water Treatment Cost. A preliminary water treatment plant cost estimate will be developed for a nominal 0.6 mgd capacity facility, including capital cost, operational cost and cost per thousand gallons treated ($/1,000 gal).

Town of Payson
Pine Extension, Lift Station & WTP

Engineering Design Services Fee

TASK	DESCRIPTION	Proj Mngr	Civil Engr	Technician	TOTAL HOURS
201	Facilities Sizing	2	8		10
202	Alignment		8	16	
203	Pipe Materials and Unit Cost	1	8		9
204	Preliminary Pipeline Cost	2	16		18
205	Preliminary Lift Station Cost	2	16		18
206	Preliminary WTP Cost	1	16		17
Total Hours		8	72	16	72
Cost Per Hour		210	92	68	
TOTAL LABOR		**1,680**	**6,624**	**1,088**	**9,392**
Expenses @ $8.75/hr					630
TOTAL PROPOSAL					**$10,022**

A	Mayor Brewer opened the public hearing. There being no comments, Mayor Brewer closed the public hearing.	Public Hearing Opened/Closed
B	**Resolution No. 2105.** A RESOLUTION OF THE MAYOR AND COMMON COUNCIL OF THE TOWN OF PAYSON, ARIZONA, ADDING SECTION 5 TO RULE 12 OF THE TOWN OF PAYSON PERSONNEL RULES AND PROCEDURES MANUAL TO CREATE A RECRUITMENT INCENTIVE POLICY.	Res 2105 – Recruitment Incentive Policy
C	The resolution, if passed, would give permission to offer incentives while recruiting employees.	Reason
D	Clmn. Fruth **moved**, **seconded** by Clmns. Wilson and Henley, to approve Resolution No. 2105. **Motion carried, 7-0.**	Res 2105 APPROVED, 7-0

UNFINISHED BUSINESS

E	Council Decision Request filed by Buzz Walker, Public Works Director, regarding a change order to the Blue Ridge Reservoir Water Supply, Pipeline and Treatment Plant cost.	CDR: Blue Ridge Change Order
F	LaRon Garrett, Public Works Engineer, said this would take the water line up to Pine, paid by Brookes Utilities.	To Pine
G	Clmn. Fruth **moved**, **seconded** by Clmns. Henley and Wilson, to authorize Change Order No. 1 to the Blue Ridge Reservoir Water Supply, Pipeline and Treatment Plant cost estimate contract with Black & Veatch Corporation in the amount of $10,022.00, and to allocate all costs to the Water Enterprise Fund. **Motion carried, 7-0.**	Change Order APPROVED, 7-0

NEW BUSINESS

H	Council Decision Request filed by LaRon G. Garrett, Public Works Engineer, to request that the Arizona Department of Transportation ADOT proceed with a revised scoping study to construct a roundabout at the intersection of Highway 87 and Airport Road/Airline Lane with the Town of Payson paying $25,000 for the study; OR	CDR: Roundabout or Traffic Signal

RTH committed to spend 8/23

HDJ Management

HC8 Box 363
Payson, AZ 85541
(928) 474-2876
Cell (928) 595-1111
FAX (928) 474-2876

** MEMO **

TO: **Barbara Hall, Chairman**
Pine/Strawberry Water Improvement District
Cc: Buzz Walker, Town of Payson
Tommie Martin, Gila County Supervisor

FROM: **Harry Jones, Gila County**

DATE: **8-4-05**

SUBJECT: **Cost Proposal for Pipeline Extension to Pine**

As the County's representative to the Mogollon Rim Water Resource Management Study, I need to bring to your Board's attention the opportunity for PSWID to obtain valued preliminary engineering information and cost estimates related to potentially bringing a portion of the County's share of Blue Ridge water to Pine, and potentially on to Strawberry by use of the Magnolia pipeline.

It appears to me that this effort would be a direct benefit to the Pine/Strawberry Water Improvement District that is searching for answers to its water supply problems. It seems your search for estimated costs of any alternative solutions needs to be supported by projections produced by credible professional engineering firms with knowledge of the local area.

The attached change order addressed to the Town of Payson is a proposal from Black and Veach (Payson's engineering firm for the Blue Ridge pipeline) to generate a cost estimate for extending the proposed pipeline to Pine. This study would be an extension of the current contract Black and Veach is completing for the Town related to the cost of the pipeline going directly from the Washington Park area down the Houston Mesa Road to the proposed Town of Payson treatment plant immediately north of the new Home Depot store.

The change order is designed to answer the question that many have asked: What is the cost of bringing Blue Ridge water to Pine so that the Pine and Strawberry communities could directly share in part of Gila County's 500 annual acre foot allocation of Blue Ridge water? The estimate would

cover the costs of the additional pipeline leg, the lift station(s), and the water treatment plant, and would be based on the attached Scope of Work. The cost of the change order would be $10,022. The Town of Payson would be assisting with this project by supplying Black and Veach with elevations and other preliminary data to minimize the costs of the efforts required to prepare the estimate for a route going from the corner of Forest Rd. 32 and the Control Road, west across the Control Road to Highway 87, and north on Highway 87 to Pine.

As you are aware from attending several meetings with our group, the MRWRMS partners and Technical Committee have spent considerable time and effort evaluating the situation in Pine and Strawberry in an effort to generate a mix of alternatives that will allow a true "regional" solution to be put in place to solve the area's water challenges. Please be aware that the Bureau of Reclamation has budgeted $350,000 to our MRWRMS efforts, the Town of Payson $150,000, Gila County $150,000, the Arizona Department of Water Resources $20,000, and a major contribution toward water chemistry by Salt River Project. Most funds have already been spent since the study is within a few months of completion.

Therefore, I respectively request that the PSWID Board approve payment for this effort that would likely cost significantly more if completed by an engineering firm that did not have the advantage of being nearly finished with the estimate for the pipeline (16"-20") going to Payson. The Pine extension would be much smaller in size, but would have added complexities of lift stations and going over/under many old rock road culverts, etc. as it extends across the Control Road.

If you agree to fund this portion of the cost estimate studies that need to be done for many additional alternatives, I would suggest PSWID promptly execute an Intergovernmental Agreement whereby the District agrees to advance the Town of Payson for this fixed cost proposal. The proposed change order would take Black and Veach a few weeks to complete, hopefully while they are finishing the work on the main pipeline to Payson.

I expect to attend your meeting of August 18 when approval of this request can hopefully appear on your agenda. Please call me with any questions or if you need any more information prior to your meeting.

BLACK & VEATCH

2850 E. Camelback Road
Suite 240
Phoenix, AZ 85016 USA

Tel: (602) 381-4400

Black & Veatch Corporation

Blue Ridge Reservoir Water Supply
Pipeline and Treatment Plant

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Please review and acknowledge your acceptance by executing and returning a signed copy of this letter. We appreciate the opportunity to work for the Town on this important project.

Very truly yours,

BLACK & VEATCH

Brad E. Hemken
Project Manager

Black & Veatch Corporation	Town of Payson
Brad Hemken	
(Signature)	(Signature)
Brad Hemken Vice President	
(Printed name & title)	(Printed name & title)

cc: Brad Hemken
Kathy Tambascio

ATTACHMENT A

Town of Payson

Blue Ridge Reservoir Water Supply Pipeline - Pine Extension and Treatment Plant

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Town of Payson
Pine Extension, Lift Station & WTP

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Expenses @ $8.75/hr					630
TOTAL PROPOSAL					**$10,022**

August 18, 2005

Motion to hire Black & Veatch for engineering information and cost estimates for bringing the proposed Blue Ridge pipeline from the corner of Forest Rd. 32 and Control Rd. to Pine/strawberry. The estimate would cover the cost of the pipeline, the lift station, and the water treatment plant. The cost is to be $10,022.

Barbara Hall

17

Water Supply Augmentation Plan

for

Pine Water Co., Inc.

Pine, Arizona

May 1, 2003

Water Supply Augmentation Plan for Pine Water Co., Inc.

Statement of Purpose

Pine Water Co., Inc. (hereinafter "Pine Water") serves domestic potable water to nearly 2000 customers in the community of Pine, Arizona. Pine is located north of Payson in Northern Gila Co. Pine, like much of Northern Gila County, is heavily populated in the "summer" months by part-time residents. Pine Water, a wholly owned subsidiary of Brooke Utilities, Inc. ("Brooke"), has owned and operated the water systems in Pine since August 1996.

For *decades* the community of Pine has suffered from chronic ground water supply deficiencies caused by consumption in excess of the available water supply. Excessive development of the area, lack of mandated water conservation measures, poor water system management prior to Pine Water's ownership, and insufficient development of alternative sources have contributed to the history of deficient water supplies relative to demand.

During the last several years the entire State of Arizona, and particularly Northern Gila County, has been severely affected by the worst drought conditions in over 100 years. The confluence of these conditions has intensified Pine's already serious water supply conditions. For several days during the summer of 2002 customers of Pine Water were without any water supplies.

The Arizona Corporation Commission (the "Commission") has recognized Pine Water's success to date in enhancing water availability and improving service. Still, the Commission desires that Pine Water continue in its efforts to address water supply problems, and in Decision No. 65435 (the "Decision") directed Pine Water to "develop a detailed plan showing how it will address the water shortage problem". As a result, Pine Water has developed this *Water Supply Augmentation Plan for Pine Water Co., Inc.* (the "Plan") in an effort to (a) comply with the directives of the Commission, and (b) discuss effective alternatives to Pine's chronic water shortage problems.

It cannot be overstated, however, that Pine Water alone cannot address the water supply problems that prevail in Pine, Arizona. It will take the collective effort of Pine Water, its shareholder Brooke Utilities, Inc., its ratepayers, the Commission and its Staff and various other local, state and federal governmental agencies to develop strategies to explore and utilize additional water resources. Then, it will take a great deal of capital investment and allocation of risk to pursue implementation of such strategies. And, despite all that effort, very little additional water may be available to Pine Water's ratepayers. At its core, the water supply dilemma plaguing Pine, Arizona is an act of nature and no amount of planning, study and capital investment can change hydrological reality.

Short Range Water Supply Augmentation

Increased Water Storage: Pine Water currently has 950,000 gallons of available water storage. This storage is currently supplied and re-supplied exclusively from ground water sources in Pine and nearby Strawberry.[8] Pine Water is currently in compliance with required storage requirements under Arizona law, including A.A.C. R-18-4-503.

This Plan alternative contemplates building additional storage at the rate of 160,000 gallons for every 100th customer connection added to the water system. Pine Water estimates that 9 acre feet, or approximately 2.9 million gallons, of water supply would be required to meet peak customer demand for ten days. Under this alternative, new storage would be filled with off-season excess water supplies and stored for peak demand

[8] Water is transferred to Pine from Strawberry through Project Magnolia at a rate of up to 700,000 gallons per day.

consumption. It is likely that water treatment facilities would be required to store potable water for long periods of time.[9]

There are several disadvantages to this alternative. For one thing, it is not likely that this water augmentation alternative could be utilized during peak demand months once water is initially distributed from the storage because peak demands prevents regular re-supply of water storage reservoirs. Therefore, water stored in this manner only provides a brief respite (about 10 days) to periods of water shortages. Additionally, water storage, water treatment, and property acquisition are costly. For this reason, this Plan alternative may not be as attractive, or could be rendered unnecessary, if Pine Water were able to successfully develop larger, more permanent water storage in the area as discussed below.

Projected Cost:	
160,000 gallons water storage (each)	$100,000
Water treatment facilities[10]	$125,000
Property acquisition	$ 25,000[11]
Total Projected Cost	$250,000[12]
Development Period (per)	120 to 150 days
Funding Source:	Equity/Debt

Condemnation of Local Water Supplies: Pine Water believes it has the legal authority to exercise the power of eminent domain and that such power could theoretically be used to condemn privately owned water wells throughout its Certificate of Convenience and Necessity ("CC&N"). The condemnation process would be time consuming and expensive, however, and it is virtually impossible to estimate the economic impact on Pine Water and its ratepayers. Condemnation of water sources also represents significant risk as sustained flow characteristics for high demand public water systems are generally unknown with respect to wells previously used for private purposes. As a consequence, any such effort must be preceded by significant operational, hydrological and legal study of possible condemnation targets, increasing the necessary investment of time and capital.

Projected Cost: (estimated per private well)	
Hydrological study	$ 10,000
Operational costs	$ 10,000
Condemnation award	Unknown
Legal costs	$ 50,000
Total Projected Cost	$ 70,000 (plus award)
Acquisition Period:	Up to one year
Funding Source:	Equity/Debt

Revised Curtailment Tariff/Water Hauling Surcharge: Pine Water has implemented voluntary and mandatory water conservation measures since acquiring the water system serving Pine, Arizona. Unfortunately, such measures have been inadequate, in large part because mandatory conservation restrictions are not implemented

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[9] It is likely that long-term water storage would be required for at least six months during the period of January through mid-July of each year.

[10] Water treatment facilities could be constructed to support more than one 160,000 gallon increment of additional above ground water storage.

[11] Assumes a negotiated purchase, as opposed, for instance, to a condemnation.

[12] Excludes additional operating expenses associated with additional storage capacity.

until the situation becomes critical and Stage 5 of the current Curtailment Tariff is reached. Moreover, in the past, there has been no penalty for violation of these mandatory conservation restrictions.

Pursuant to Commission order, Pine Water filed a revised Curtailment Tariff on February 18, 2003. The revised Curtailment Tariff, expected to be approved in May 2003, is the product of the cooperative effort of Pine Water and the Commission's Utilities Division Staff to revise the curtailment plan to incorporate stricter conservation requirements and penalties for violations. Specifically, under the revised Curtailment Tariff, mandatory conservation measures begin in Stage 3. In addition, under the revised Curtailment Tariff, Pine Water is required to augment water supplies by hauling or other similar means during Stages 4 and 5.

In order that Pine Water meets the obligation to augment supplies during Stages 4 and 5, Pine Water and Staff have recommended Commission approval of an interim rate surcharge. Historically, water hauling costs have run ten times normal operating expenses and Pine Water does not currently recover any portion of such increased costs through rates. The surcharge is designed to allow Pine Water to timely recover the cost of water supply augmentation along with the costs of implementing the revised Curtailment Tariff.[13] As a result, if approved, the revised Curtailment Tariff and rate surcharge will constitute components of Pine Water's plan to address water supply problems.

Well Exploration/Water Sharing Program: Since acquiring the water systems in Pine and Strawberry, Arizona in 1996, Brooke has undertaken an aggressive water well exploration program. To date, Pine Water has drilled 5 new wells and Strawberry Water Co., Inc., another Brooke Utilities subsidiary ("Strawberry Water") has drilled 6 new wells. Pine Water has also drilled three wells that were not economically productive. Generally, these wells have been drilled on utility-owned property or private property under water sharing agreements with private property owners. These agreements provide for well development and long-term water production from those wells. Water produced from wells under water sharing agreements is then distributed to Pine Water customers and the private property owners are paid a monthly royalty.

Pine Water expects to continue this well exploration program over the foreseeable future. In 2003, Pine Water began drilling three new wells for this purpose. These wells are permitted through the Arizona Department of Water Resources ("ADWR") and water quality monitoring is conducted pursuant to the regulations of the Arizona Department of Environmental Quality ("ADEQ"). Newly drilled water wells that do not prove to be economically justifiable will not be fully developed but may be retained for the private property owner's personal use if desired.

Projected Cost:	
Well drilling and development	$ 75,000
Annual operating expenses	$ 6,000
Total Projected Cost	$ 81,000
Development Period	90 days
Funding Source	Equity/debt/current cash flow

Mid-Range Water Supply Augmentation

Cooperative Water Exchange: Pine Water possesses a Municipal and Industrial water exchange contract with the Central Arizona Water Conservation District ("CAWCD") for 160 acre feet of Central Arizona project ("CAP") water (about 52 million gallons). Despite having this valuable right, Pine Water cannot use CAP water given its location far from the CAP canal and the rights under the CAP subcontract cannot be sold. However,

[13] The costs of the revised Curtailment Tariff and surcharge are discussed in detail in Commission Docket Nos. W-03512A-03-104 and -106.

Pine Water has previously explored the possibility of an "exchange" with Salt River Project ("SRP") whereby SRP would take receipt of Pine Water's allocation from the CAP canal near Phoenix, where SRP already takes delivery of significant amounts of water. In "exchange" Pine Water would be given access to SRP's surface water rights in Pine Creek and the East Verde River or other area tributaries.[14]

Although such an "exchange" may appear simple, it is not. There are numerous operational, legal, regulatory and practical impediments to an "exchange" of Pine Waters CAP allocation. For example, when Pine Water most requires supplemental water sources, the peak demand summer months, there is typically little or no flow in Pine Creek. The CAP exchange concept requires a surface water source for storage, treatment, and distribution to be operationally viable, except during limited periods of above normal flow.

In addition to the supply problems, the requirements of dealing with down stream water rights holders who may be impacted by Pine Water's upstream access to SRP's surface water are substantial, as are the compliance obligations under federal law. Approval of the use of SRP's surface water sources in Pine Creek and of the "exchange" of the CAP subcontract would require NEPA compliance, i.e., an environmental assessment or even an environmental impact study, and it is possible there will be Endangered Species Act and Clean Water Act compliance issues as well. Overcoming such regulatory and legal hurdles could result in hundreds of thousands of dollars of costs, with no guarantee of a successful outcome.

Projected Costs:	
Legal costs	$ 50,000
Environmental study costs	$ 100,000
Water reservoir costs (minimum)	$ 650,000[15]
Water treatment costs	$ 100,000
Property acquisition	$ 165,000[16]
Annual operating costs	$ 50,000
Total Projected Costs	$1,115,000
Development Period:	3 years
Funding Sources:	Equity/Debt/surcharge[17]

Progressive Rate Design: In Pine Water's application for permanent adjustment of its rates, the Company has proposed a new seasonal, tiered rate design. An overarching goal of this rate design is to place a "premium" on water consumption during peak demand periods, the same time that water conservation is most required, and that Pine Water is likely to be required to augment supplies under the revised Curtailment Tariff.

Development of a rate design that equitably allocates costs, promotes conservation and protects Pine Water's financial viability is an ongoing process. The rate design proposed in this rate proceeding is a significant step, however, more remains to be done. For example, the ideal rate design for Pine Water will not only recognize seasonal fluctuations in supply and demand, but also increased demand during weekend and holiday periods when the part-time population in the Pine area dramatically increases. This would, in turn, require implementation of advanced technology water meter systems that permit the collection of "time of use" consumption data in addition to other operational changes. In addition, implementation of the rate design proposed herein will lead to more information and the likelihood of refinement and modification, a sort of trial and error process Pine Water and its customers will need to pass through before achieving maximum benefit

[14] It might also be possible to "exchange" the CAP allocation for finds to be used to develop new water resources.
[15] In conjunction with other discussion provided herein it is possible that the flow of water from Pine Creek could be captured during winter months and stored in a mass water storage facility for future use in peak demand summer months.
[16] Assumes a negotiated purchase, as opposed, for instance, to a condemnation.
[17] In its request for permanent rate relief, Pine Water seeks approval of a Water Exploration Surcharge. This surcharge is explained in detail in the Direct Testimony of Thomas J. Bourassa.

from a progressive rate design. For now, it is imperative that the Commission approve a seasonal, tiered rate design like the one proposed by Pine Water in its application for rate relief so that the economic value of scarce water supplies in Pine, Arizona become a reality.

Engineering and Hydrological Studies: Pine Water recognizes that any consideration of alternative water sources must have a sound hydrologic and engineering foundation. It would not be prudent, Pine Water believes, to search for water in areas that do not support such exploration. Pine Water recently commissioned a regional geohydrological study of ground water sources in the Pine, Arizona area. *See* Direct Testimony of Robert T. Hardcastle, Exhibit A. Generally, this report indicates that sub-surface water flows in to Strawberry from the north and continues southerly into Pine while, at the same time, flows westerly through Strawberry valley. The report concludes that Pine has a very limited sub-surface water structure and that Strawberry is a far better water production candidate than Pine. The report further concludes that it is likely a minimum of 300-500 acre feet of subsurface water flows through these areas at various depths during the course of a year.

Geohydrological Report Cost: $13,000[18]

Water Well Exploration of Public Lands: More than 90% of all land in Gila Co. is publicly owner by the U.S. Forest Service ("USFS") or other governmental landowners. There are areas surrounding Pine and Strawberry that could be attractive sub-surface water sources. Pine Water has thoroughly discussed the potential of such projects with representatives from USFS on previous occasions. Brooke Utilities also has significant experience in dealing with USFS through its development of Project Magnolia in 2000.[19] The permitting process of exploring for water on USFS land is time consuming and expensive. An additional and separate permitting process may be required to move produced water supplies off USFS or other public land and into Pine Water or Strawberry Water's existing water system infrastructure. All of these processes require NEPA compliance, including the possibility of environmental studies of unknown duration and cost to determine whether or not other water rights holders are impacted by water well development, as well as the potential need for compliance with other federal laws.

Project Cost (per well):	
Water well exploration	$ 40,000
Well development	$ 35,000
USFS permitting process	$ 10,000
Environmental study[20]	$ 100,000
Legal Costs	$ 50,000
Water distribution costs[21]	$ 100,000
Total Projected Costs	$ 335,000
Development period	2-3 years
Funding Sources	Equity/Debt/Surcharge

Legislative Relief: This Plan alternative bears discussion, but is largely outside of Pine Water's ability to implement due to the potential for substantial cost and the fact that Pine Water lacks any sort of political clout. The Commission, for instance, or perhaps DWR, could pursue changes in legislation that would enhance long-term water management in the Pine, Arizona area. Pine Water believes at least three forms of legislative reform are needed. First, legislation to limit County authority to form water improvement districts without a showing

[18] This amount has already been paid by Pine Water

[19] As explained in detail by Mr. Hardcastle in his direct testimony, Project Magnolia is a 10,800 foot eight inch water line that connects the water systems of Pine and Strawberry.

[20] Cost estimate is based on the known cost of such a study for Project Magnolia.

[21] The process of obtaining a USFS permit to move water off public lands, if discovered, and connect to water system infrastructure may be able to be conducted at the same time as the well exploration process.

that adequate water resources exist and that utilization of such resources will not be at the expense of existing water service customers. Otherwise, these districts exacerbate current water supply deficiencies and interfere with effective management of existing water systems, as Pine Water has learned from its ongoing battle with Gila County over the proliferation of water improvement districts to facilitate development. Second, legislation should be proposed that limits growth in water plagued areas. Growth without proper water resources is problematic for any water purveyor and, ultimately, its customers and the community in general. Third, Pine Water's ability to withdraw and transport groundwater from other groundwater basins is currently restricted under Arizona's Groundwater Code. See, e.g., A.R.S. § 45-544(A)(2). These restrictions were temporarily relaxed by the Legislature in 2000 to address severe drought conditions. 2000 Ariz. Laws, 2d Reg. Sess., Ch. 205 (repealed on April 30, 2001). Given the severity of the water supply situation in Pine, Arizona, similar longer-term relief appears warranted.

Long Range Water Supply Augmentation (5 to 10 years)

Pine Reservoir Project: Pine Water has been diligently working on the design of a surface water storage facility in South Pine. This facility would be able to store approximately 75 acre feet of water (approximately 24.4 million gallons) collected from off peak demand season water supplies in Pine and Strawberry and stored for distribution and consumption during peak demand periods. Pine Water has entered into an option agreement with a large property owner in South Pine that provides for a 7.63 acre site on which the facility would be constructed. The site is well situated for distribution of stored water to both Pine and Strawberry.[22] The option agreement expires at the end of 200____. The Lease Agreement associated with this facility provides for a 15-year term and three consecutive 5-year renewable option periods for a total operating period of 30 years.
This Plan alternative would be extremely expensive and even an estimate of the total costs would be overly speculative. Development costs for such a project could vary substantially depending on design, reservoir materials, coverage, and operational design. Given the significance of the capital investment that would have to be made, and the substantial uncertainty from factors outside Brooke's ability to control, this is an example of the type of project that would require collective planning by multiple interested parties and Commission approval of funding sources and cost recovery before the conceptual alternative can become a reality.

Projected Cost:	
Reservoir development (minimum)	$ 650,000
Water treatment facility	$ 100,000
Distribution and connection infrastructure	$ 90,000
Annual operational costs	$ 85,000
Total Projected Cost	$ 925,000[23]
Development Period:	Up to 5 years
Funding Sources:	Equity//debt/surcharge

Deep Well Exploration: There has long been a "layman's" belief that a large amount of water lies underneath Pine at depths up to and exceeding 2000 feet. However, Pine Water is not aware of any data, study, or expert hydrological or hydrogeological information that supports such a belief. Moreover, Pine Water has always maintained that it is most reasonable and prudent to first exhaust all less expensive, realistic alternatives for increasing available water supplies and improving water service.

Nevertheless, Pine Water understands that representatives of the Pine-Strawberry Water Improvement District ("PSWID") are conducting a study to discover the prudency of drilling so-called deep wells. While Pine Water remains skeptical that such sources actually exist, even if they are discovered, there are certain economic

[22] Project Magnolia is designed to also flow water in a northerly direction from Pine if necessary.
[23] Again, it cannot be overstated that these are very speculative estimates. The actual costs could be substantially higher.

realities that undermine the viability of this fabled resource. For instance, Pine Water estimates that a deep exploration endeavor such as PSWID envisions would cost between $5 and $10 million with no greater certainty of outcome of hydrological result than any other shallow well exploration project.[24]

Project Cost:	
Well exploration cost	$5,000,000
Well development cost	Unknown
Annual operating expenses	Unknown
Development Period	3 years
Funding Sources	Unknown[25]

[24] A representative of PSWID, speaking as a private citizen, testified in Docket No. W-03512A-03-0104 and –106, not only as to his firm believe in the availability of such resources but also that he believed that the exploration costs could easily exceed $4,000,000, exclusive of well development costs and annual operating expenses. Pine Water believes the costs would be substantially higher and likelihood of success far less than projected by this witness.

As seen in Mr. Hardcastle's direct testimony, the impact on rates of even a $4,000,000 capital investment in deep well exploration by Pine Water is tremendous. Direct Testimony of Robert T. Hardcastle at 5.

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Brooke Utilities, Inc.

P. O. Box 82218 • Bakersfield, California 93380-2218
Customer Call Center • P.O. Box 9016 • San Dimas, California 91773-9016 • (800) 270-6084

ROBERT T. HARDCASTLE
(661) 633-7526
Fax (781) 823-3070
RTH@brookeutilities.com

June 1, 2005

James Richey
P.O. Box 2379
Pine, AZ 85544

FILE COPY

Re: ***Alternative JB6 Study, Pine Water Co., Inc., Pine, AZ***

Dear Mr. Richey,

Thank you for your effort on the above referenced study dated April 14, 2005. It is clear that your analysis and interest in this topic substantiates the importance of future additional water supplies for the communities of Pine and Strawberry. As you are aware this has been a long standing problem that is related to numerous exhaustive water studies of the area that date as early as the 1960's. Virtually every water study conducted since that time has concluded the same result: that Pine does not have a sufficient source of groundwater to meet its current or future year-round needs.

At your request I have reviewed the above referenced document (hereafter the "JB6 Proposal") in some detail. For many years Brooke Utilities ("Brooke") has argued that a hydrological solution to the area's water problems which is supplanted by an equivalent or more serious, economic problem is no solution at all. Thus, in our view any solution to the local water problem ***must*** be inextricably linked to a reasonable economic approach that provides for affordably delivered water supplies. If cost was unimportant the water supply problem in the local area probably could have been resolved some time ago using various different means. However, a failed water solution that includes high risk and high cost has the potential for deterring other solutions for many years or decades. It is very important to make our best collective effort the first time. The JB6 Proposal identifies one of many possible future solutions. I commend you for your effort.

For many years Brooke has explained the complexity of the problem to the community with many disbelievers. For this reason we have advocated, since 1998, a detailed examination of every possible alternative solution to the problem. We believe every conventional, unconventional, reasonable, and unreasonable alternative should be considered and prioritized in descending order of risk (defined as likelihood of success) and cost. After many years of advocating this position to everyone from community members to regulatory officials to Gila County representatives, Brooke is pleased to finally see an organized and professional approach to the problem largely void of bickering, suspicion, personal agendas, and accusations of conspiracy.

James Richey
Alternative JB6 Study
June 1, 2005

During a recent hearing at the Arizona Corporation Commission (the "Commission") I recall evidentiary statements made by a member of the local community. His interest was to expose Brooke as a "conspirator" only interested in knowingly withholding huge volumes of water supply from the community for the purpose of driving the cost per customer to the highest possible level. Of course, these unsupported and preposterous statements are false and universally recognized as such by the growing body of people interested in this issue. In fact, the regulatory officials genuinely interested in the solution of Pine's water supply problems recognize that such people and statements retard the opportunity for a solution. Worst of all these people, and their statements, have nearly destroyed the creditability of the concerned people of Pine and Strawberry at the regulatory functions that control this process. I think most people in attendance at the hearing were embarrassed for the person making the statements.

Long ago Brooke has considered every reasonable and unreasonable resolution to the Pine water supply problem we could think of. That doesn't mean that we have considered every *possible* alternative. We have traveled far down the road of numerous proposals. We have less explored others. We have prioritized the alternatives in terms of risk and cost. We have discussed these alternatives and reported same to the Commission on numerous occasions. As it relates to the current discussion there is very little new information that hasn't been previously considered. That, also, doesn't mean that further discussion isn't warranted or necessary. But, the more people that consider the complexities of this situation ultimately come to three facts that will be related to any future solution:

- First, any solution to the water source and supply problem will mean a higher cost of water in the future.
- Second, any solution to the water source and supply problem will probably come from outside of the area.
- Third, any solution to the water source and supply problem will probably have a legislative component steering the outcome.

Some people see these facts are discouraging. Others see these facts as encouraging. Brooke views these facts as the reality. Brooke has asked the Commission for "guidance" on the proper course of the numerous alternatives for our future consideration. The regulatory scheme requires our "reasonable and prudent" consideration of any proposal to expend investment capital toward such a solution. Unfortunately, the Commission has declined to provide the "guidance" we seek. The Commission's declination to become involved has, in our opinion, further deterred a solution as well. Thus, we don't have the luxury of capital intensive experimentation through incremental progress. Brooke is no different than any business charged with the responsibility to expend capital to improve business operations in the most efficient manner possible. In the case of solving Pine's water supply problems the most preferred capital expenditure is, unfortunately, much more difficult to identify and the consequences of erroneous solution identification can be far more expensive than members of the local community realize.

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It is important to for you to realize that there is an important regulatory component to *everything* Pine Water Co. does. Regulatory financial analysis, accounting, capital expenditures, return on investment, rates of return, and almost every other water business consideration is much different than the standard business environment. *Every* business decision made by Pine Water Co. and Brooke must carefully consider the effect of the regulatory environment and, in some cases, project regulatory treatment of future issues. It provides an additional element of concern, frequently referred to as "regulatory risk" that most businesses do not have to consider. The regulatory environment can be very challenging and disappointing. In the case of the most recent Pine Water Co. rate application approximately $500,000 was spent by the Company and the opposing interveners in the regulatory application process. Most disappointing is that these funds were necessarily spent *reaching a settlement conclusion that was largely proposed by the Commission's Staff in the first few weeks of the case.* Unfortunately, the attorneys enjoyed the process immensely. But the community lost the exploratory ability of this largely wasted capital expenditure. Unfortunately, Pine Water Co. will only be allowed to capitalize $200,000 of this expense over a period of four years. All of this capital, which is ultimately repaid by community rate payers inclusive of an approved rate of return, could have been much better spent exploring for water sources. Thus, the regulatory process is a *very* important component of anything done by Pine Water Co. and one that cannot be considered lightly.

The JB6 Proposal

The concept of the JB6 Proposal has been previously considered by Brooke. In our view the JB6 Proposal is flawed in at least the following areas:

(a) a constant, reliable source of re-filling the storage tanks does not exist
(b) the capital cost is dramatically understated and comparatively very high
(c) the positive effect of "resting" Pine wells is speculative at best
(d) business model foundational facts are seriously inaccurate

Accordingly, I have provided some brief argument in support our conclusions in the form of the statements below.

Source of Supply

The JB6 Proposal correctly identifies the period between Memorial Day and Labor Day annually as the most challenging. For clarification purposes, Brooke refers to this period as the "100 Day War".

Unfortunately, the JB6 Proposal relies on water from Pine Creek as the source of supply for the retrofitted storage tanks (the "Pine Creek Tanks"). Traditionally, and with rare exceptions, the period during the "100 Day War" provides for little or no surface flow available for re-supply of the storage tanks. Thus, at best, a single cycle of 800,000 gallons would be available for introduction into Pine Water Co.'s water system during periods of

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deficient supply most likely during the long 4th of July holiday weekends. Once used this additional water supply would be unavailable until the next available surface flow through Pine Creek. That may, or may not, be during the immediately subsequent winter months. For the period 1996-2004 the *average* peak customer month of July demanded 5,855,000 gallons of water. This monthly demand translates to approximately 195,000 gallons per day for the entire month. Most troubling issue is the fact that customer *daily* demand during a long 4th of July weekend can approach 900,000 gallons. As can easily be seen from this data the additional supply represented by one cycle of the Pine Creek Tanks does little to resolve the water supply shortage in the area. Further, once expended this additional source of water cannot be retrieved until the next available water flow through Pine Creek. The surface flow of Pine Creek only marginally supported the needs of a 140 person population in 1967 with very little potential for development of a higher utilization.[1] That much additional water might avert a one-time disastrous situation but will not eliminate a water source deficiency problem.

There are additional problems related to the use of Pine Creek water flow as well. These issues include entering into an exchange arrangement with Salt River Project ("SRP") to exchange surface water supplies from Pine Creek with SRP access to water from the Central Arizona Project ("CAP"). The likelihood of entering into such an arrangement is currently better than has existed for some time. However, before such an arrangement could be completed with SRP a settlement agreement with all downstream claimants and bona fide rights holders would be necessary before water could be extracted from Pine Creek. It should be anticipated that non-bona fide water rights holders would strenuously argue as to their prioritized position for rights to the water flow as well. This settlement process will also include an environmental review in the form of a Categorical Exclusion or Environmental Assessment. It was Brooke's experience during the development and construction of the Project Magnolia pipeline project that an Environmental Assessment can cost more than $125,000 and require almost two years before being completed. The business and regulatory risk associated with these advance expenditures, in light of unknown future water flows through Pine Creek, can be very high if not regulatorily deemed "reasonable and prudent". Of course any negative Commission ruling would come after the expenditure of the capital. This regulatory risk of this result was the primary reason for Pine Water Co. previously seeking regulatory "guidance" in this matter. As stated above, unfortunately, this "guidance" was not proffered by the Commission.

The JB6 Proposal accurately concludes that the project can be completed inclusive of all of the additional components discussed above. However, the additional costs of this process must be included as part of the development cost and risk of recovering these costs is unknown.

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[1] *Investigation of Groundwater Availability for the Pine/Strawberry Water Improvement District*, August 2003, Preface, item 1, Comment 1A, page vii.

Cost of Capital

The JB6 Proposal dramatically understates the financial issues related to the project. The financial analysis of the JB6 Proposal is seriously flawed, not because of inaccurate financial analysis, but because the requirements of the regulatory process have not been accurately considered.

For Commission rate making purposes the allowable returns are applied on a "net" basis. In other words, only "net profits" are computed when considering the return on investment period or the rate of return. "Net profits" are those applied *after* all expenses related to a project. Likewise, a net present value ("NPV") analysis is frequently utilized by regulatory authorities as a normalizing mechanism to assure regulators that sufficient future water company cash flow exists to meet the requirements of the project. Thus, recurring operational costs must be included as part of the project. In the section above I have explained the effect of additional costs related to an exchange agreement with SRP. In additional to the additional infrastructure costs not considered by the JB6 Proposal we estimate the revised capital costs of the project to be approximately $1,511,700. The "net" regulatory effect of these costs must also include "grossed up" income taxes, depreciation, amortization, regulatory costs, and the approved Pine Water Co. rate of return of approximately 11.41%[2]. Therefore, the adjusted approximate cost of the JB6 Proposal is $2,524,500 and must be recovered through additional customer rate adjustments.

Brooke's perspective is that such a small incremental solution to a problem that has dubious applicability, because of the seasonal unpredictable availability of Pine Creek water flow, demands strong consideration of other more productive and less economically burdensome alternatives.

"Resting" Water Wells

The JB6 Proposal concludes that the "supplemental storage system would reduce the strain on the Pine and Strawberry wells during the winter months" by utilizing surface water flowing through Pine Creek. This water flow is proposed to be collected through constructed intake infrastructure and stored in the "Pine Creek Tanks". The JB6 Proposal concludes that higher utilization of the surface water sources decreases the utilization of water wells in Pine and Strawberry and, as a result, allows increased availability of groundwater supplies for future use during the "100 Day War". The JB6 Proposal provides no supporting documentation of this conclusion whatsoever.

Brooke believes the "resting" conclusion reached by the JB6 Proposal is speculative, at best, and does not provide a sufficient basis to meet the "reasonable and prudent" regulatory standard, discussed herein, to justify substantial capital investment of the type

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[2] Arizona Corporation Commission, Decision No. 67166, page 8, at line 7.

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and nature of the JB6 Proposal. Further, there are several previously developed water supply studies conducted since the 1960's concluding that sub-surface water flow, if not used, is lost to a downstream water source user. Therefore, the increased peak-period performance of water wells in the Pine and Strawberry areas is unproven because customer demand conditions throughout off-peak periods have never been afforded the luxury of providing a data basis to determine the speculative nature of this argument.

Foundation Facts

The economic premise of JB6 Proposal is entirely based on the converted use of capital used to pay for transported water from outside the Pine area. Instead, this capital would be used to fund the investment capital necessary to construct the supplemental water storage facility.[3] The JB6 proposal calculates that 2003 water hauling transportation costs totaling $344,540 as defined by Pine Water Co.'s income statement. This amount is represented to be the sum of "Purchased Water" and "Transportation Expense".

The JB6 Proposal is in error in this conclusion. Pine Water Co., as well as all of Brooke's water companies, utilizes the uniform system of accounts as adopted by the National Association of Regulatory Commissioners ("NARUC")[4] and as required by the Commission.[5] As defined therein the expenses related to "Purchased Water" and "Transportation Expense" is not only inclusive of water transportation expenses. In fact, these account descriptions include various different expenses unrelated to water transportation expenses. Therefore, a computation made from the aggregated account summaries of Pine Water Co.'s income statement would by hugely inaccurate.

Since 1998 Brooke's various water companies have contracted with a single source vendor to provide water transportation services. These services include the transportation of wholesale purchased water for Pine Water Co. For the periods described below the aggregate annual water transportation costs paid for the services are as follows:

- Year 2003 $62,505
- Year 2004 $38,611

Either of these years' costs is substantially less than the $344,540 premised by the JB6 Proposal. The same water transportation services contractor has quoted Brooke a cost of $250 per truck load of water hauled from the Starlight Pines water source in Coconino

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[3] *Alternative JB6 Study*, page 10: "The proposed supplemental system would be paid for by utilizing the dollars that are currently spent for water that is being purchased outside the Strawberry system through the trucking effort. Operating costs for the buying and trucking additional water could be converted to capital costs, which would pay for the supplemental storage (i.e. Pine Creek Tanks) system within five years."

[4] Accounting for Public Utilities, 1999 updated 2004, Chapter 11, sections 11.01 through 11.03.

[5] Arizona Corporation Commission, Decision No. 67166, page 6, lines 16-17

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County to Pine Water Co.'s storage tanks in 2005[6]. This unit price compares favorably to the same $243 unit price of 2003 and 2004. Indisputably, the 2003 unit cost divided into amount described by the JB6 Proposal[7] would have computed a total of 1,417 loads of water or approximately 9,216,000 gallons of transported water. That is far more water than was actually transported.

The business model premise of the JB6 Proposal must, therefore, be more closely scrutinized. At the same rate of water transportation expense occurrence in future years as that actually incurred in 2004 it would require Pine Water Co. more than 65 years to break even on the same value investment while not considering the time value of money for the same period. Clearly, such a business investment alternative is preposterous and inconceivable.

The JB6 Proposal error related to not fully understanding the nature of regulatory accounting is understandable. It is an error frequently made. The regulatory business is unique from any other type of business transaction and, therefore, requires any exterior analysis to be firmly rooted in the regulatory nature of the business before embarking on a detailed analysis of the type represented by the JB6 proposal.

It is Brooke's perspective that the business model premise of the JB6 Proposal, based entirely on paying for the Pine Creek Tanks with converted operating capital, easily fails to justify itself on the erroneous foundation facts alone without considering any of the other equally persuasive flaws discussed above. In the opinion of Brooke the errors cited by this section should have been readily detectable to the individual attributions referenced on page 10 of the JB6 Proposal.

Conclusion

Brooke sincerely believes that you should be commended for the serious effort put forth in the JB6 Proposal. The concept of the JB6 Proposal is logical and valid. The analysis is consistent with that performed by business leaders throughout industry. The nature of the utility regulatory environment is, however, much different than any other business form known by myself. Brooke has insisted that all of its managers, operational superintendents, and others attend a special utility school to better understand these conceptual differences. This is another reason why it is so hazardous for untrained community members to suggest logical options that, upon closer examination, do not survive the regulatory analysis scheme.

Thank you, ***again***, for your interest and effort.

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[6] Water transportation costs will be adjusted by as much as $.18 per mile as a fuel surcharge cost.
[7] *Alternative JB6 Study*, page 8.

James Richey
Alternative JB6 Study
June 1, 2005

Sincerely,

FILE COPY

Robert T. Hardcastle
President

ec: RTH correspondence file
,MJ, MB, DS, JS

19

Stream/Storm Water Runoff & Storage/CAP Allocation Study
Report Number V5.0

TO:

--Robert Hardcastle, President Pine Water Co. and Brooke Utilities, Inc. (See letter June 1, 2005)
--Greg Komrumph, Water Rights Division, Salt River Project
--Tommie Martin, Gila County Supervisor, District 1
--Harry Jones, Gila County Representative Mogollon Rim Water Resource Management Study.
--Mike Ploughe, Hydrogeologist and Buzz Walker, Public Works Director, Town of Payson
--Leslie Meyers, Program Manager for MRWRMS Bureau of Reclamation
--Barbara Hall, Chairman Pine/Strawberry Water Improvement District (See memo from Alternative Study Committee)
--Steve Olea and Kristin Mayes, Arizona Corporation Commission
--Robert Cassaro, Citizen of Pine

From:

James Richey, Citizen of Pine, President Pine Verde Foods
P.O. Box 2379
Pine, Arizona 85544
602-920-7826
5/27/2005

Water Model and supporting documents available on request.

RECEIVED
JUL 5 2005
BY:

5/27/2005

Stream/Storm Water Runoff & Storage/CAP Allocation

This report attempts to address the problem that is associated with the "100 day" summer water shortage in Pine, Arizona. It is has been observed that Pine has gone into various conservation stages during May through September in the past decade. During this period of time each year, well production is reduced to levels between 7-10 gallons per minute in Pine (testimony from Bob Hardcastle at ACC). Over the last few years, many of the wells have went dry (John Breninger). Also it has been observed, Pine Creek has substantial running surface water during the months of November through February. It is believed, peak demand events occur only during this "100 day" period in the summer in Pine. This study includes a series of models which attempts to understand what happens in the "100 day" period and its effect on the water storage system that exists and value of a proposed supplemental storage system.

During the fall, winter, and spring, 265 days of the year (non-summer), the average household usage is 58 gallons, based upon allocated meters and water usage. During the "100 days" period (Peak demand), the household usage is between 76 and 124 gallons per day. There are two types of events that occur within that hundred day period. Type 1 event is equivalent to 124 gallons per day for 3 days and 4 days at 76 gallons per household. Type II event is equivalent to 124 gallons for a 4 day event. Type 2 events are holiday weekends, like Memorial Day, Fourth of July, and Labor Day. So the purpose of this proposal is to find an most economical way to resolve the known problem with the use of existing supplemental storage during the peak summer demand period ("100 days").

This proposal involves refurbishing three tanks located just south of the Highway 87 bridge that crosses Pine Creek in Pine, Arizona. These tanks and property are owned by Brooke Utilities, Inc. (parent company of Pine Water Company) per letter in the appendix from Brooke Utilities. A new lining system and filtration system would allow these tanks to act as a supplemental potable storage system for Pine. Each tank was measure via laser scope and calculated to be approximately 274,000 gallons, which will yield overall supplemental storage of 822,000 gallons to the Pine Water Company System. These tanks were taken out of service more than a decade ago. Today's, new lining and cover systems technology will allow these tanks to be reused at a reasonably low cost compared to rebuilding them. In the past, these tanks were used for irrigation and supplemental potable water.

Their are many systems available for lining of old tanks. This liners are double walled NSF 61 potable water approved containment systems. For example , Fab-Seal's internal liners (shown below) are mechanically held and become the primary containment with the tank becoming the secondary containment, with leak detection monitors for insured protection.

See pricing below which has been included in overall pricing.

One (1) drop in liner fabricated of NSF 60 mil Aqua Pure (1/16" thick) to fit a tank 54' diameter x 16' high.

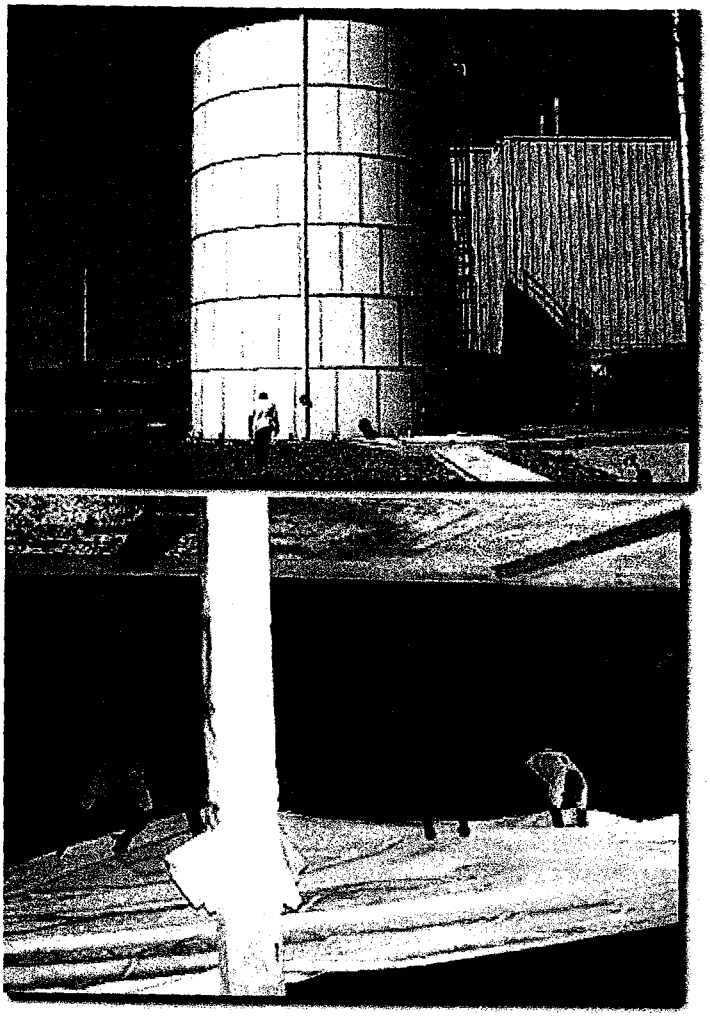
$31,415.00 prefabricated liner
$6,283.00 (20%) discount
$25,132.00 net liner
$2,312.00 geotextile abrasion barrier blanket
$2,088.00 hardware for attachment
$700.00 pipe boots
$30,232.00 total materials
$2,888.00 freight & transportation
$10,000.00 labor/tools/equipment (4 men/5 days)
$3,600.00 subsistence for crew
$46,720.00 grand total (each tank)

Note* the above pricing is for each tank.

Paul W. Palmer

PWP:aw

Fab-Seal Industrial Liners, Inc
42404 Moccasin Trail
Shawnee, OK. 74804
Phone: 800-874-0166
Fax: 888-323-1223

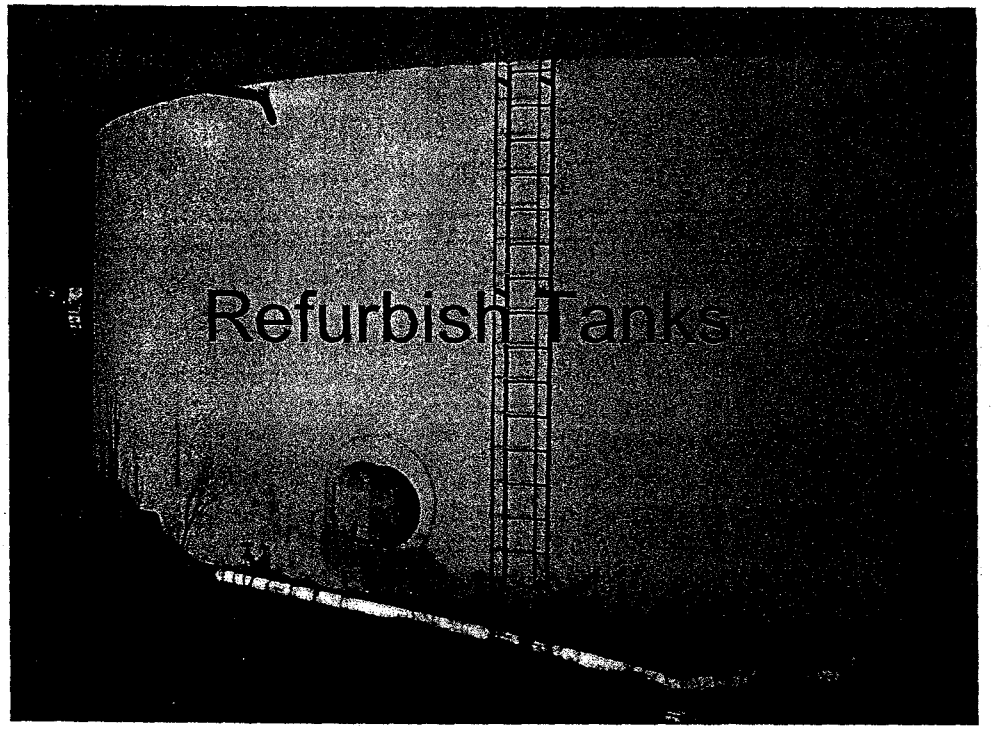


NSF/ANSI Standard "61" Approved

Specifications

Durometer(A-scale)	*ASTM D 676*	*76*
Elongation, %	*ASTM D 683*	*400 (minimum)*
Elongation (PSI)	*ASTM D 683*	*930 (minimum)*
Volatility (%)	*Activated Carbon 24 Hrs 87 degrees C*	*1.7*

The new potable tanks once lined will require a cover system. Again, many types exist. When covering treatment plant equipment for weather protection, odor control, appearance or protection against contaminants, there are several advantages to choosing an aluminum geodesic dome. The all-aluminum construction provides a structure that is light-weight, strong and durable. The geodesic design combines the advantages of a clear-span covering with the architectural attractiveness of modern geodesics. The cost of this cover is approximately $50,000 per tank and has included in the overall cost. See picture below.



The basic idea is to scoop water from Pine Creek during four winter months (November through February). An elongated concrete intake scoop would be placed in the center of Pine Creek just south of the Highway 87 bridge. Sensing devices would be placed in the scoop to activate pumps that would fill the three tanks. The tanks could also be recharged during other possible periods of the year in which water flowed south of the bridge. The water would be filtered and chlorinated before entering the tanks.

Besides the lining system, the tanks would be covered and the water would be continuously circulated through the filtration and chlorination system. The water in the tanks would meet all necessary potable drinking water guidelines using a low cost membrane filtration system. This has been included in the cost proposal from Christ Water shown below.

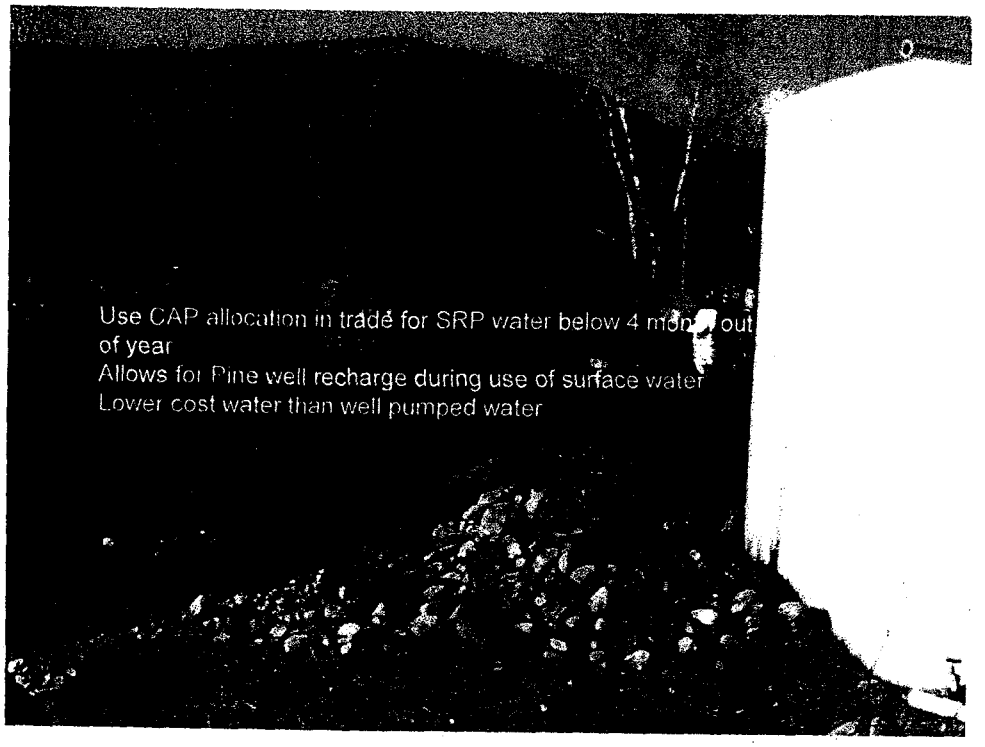
Recent tests of water from the Pine Creek showed a TDS reading of 60 ppm.

> "The total dissolved solids (TDS) of the Pine Creek stream water is 60 mg/l. It will increase in salinity as the year progresses and evaporation in the hotter months increases. We'll take a reading in the summer to see if (1) there is still water in the stream and (2) if it reaches the 600 to 1,000 mg/l range.
>
> This is the same quality as San Francisco water and twice as saline as Vancouver, WA water. Rain Water or snow is usually between 15 and 30 mg/l. It is, however, 14 times less saline than Phoenix water at 840 mg/l TDS. In fact, my home RO unit in Chandler produces 70 mg/l TDS water. Finally, the last comparison, supermarket RO water vending machines usually produce less than 2 mg/l of TDS.
>
> FYI: The World Health Org recommends < 500 mg/l TDS for potable water. 1,000 mg/l TDS is their maximum." (From the Christ Water representative email and measurement)

This proposal for supplemental storage involves three major effects: 1. supplemental storage for the so-called "100 days" during the summer months (May 15 through September 15) (at least 820,000 gallons backup) (to remove Pine outages and water hauling) and 2. capture of water during the winter months (November through February) (20 acre-ft) (use of surface water instead of underground sources), and 3. the slowing of the pumping Pine and Strawberry wells during the winter months with the possibly of long term well recharge.

Currently, 161 acre-feet of CAP water has been allocated for the Pine/Strawberry area. The certificates for this water is currently being held by the Pine Water Company/Brooke Utilities. SRP currently owns the surface water in Pine Creek, South of the Highway 87 bridge. Recent discussions, with SRP showed extreme high interest in supporting a project that would trade CAP allocation for water from Pine Creek. The tanks would take only 3 acre-feet to fill as supplemental storage. But if used in a continuous bases during the winter to slow the pumping of Pine wells, it would take approximately 20 acre-feet of CAP allocation.

Also, Harry Jones from Gila County received information during a recent local meeting with Bob Hardcastle that the US Forest Service has been allocated 1000 acre-feet from Pine Creek of which approximately 400 acre-feet are not being used. Given Brooke Utilities current special use permit it might be possible for Brooke to expand the permit and workout an arrangement with US Forest Service and SRP. It's believed that US Forest Service might be interested in offering such opportunity because the reduce effect of taking well water during the winter months. It might be possible to store water by back flowing water into the current Pine Water System to induce recharge. A recharge study would need to be conducted to determine the feasibility of such effort. This recharge model is currently be considered in the Payson area.



Capital Cost

The capital costs are shown below. This does not include the capital cost associated with the pipeline connection to the SH tank and North- South Inter-Tie point

1. Reline, refurb and repaint tanks:	$ 300,000.00
2. New Automatic Sand Filter System	$ 80,000.00
3. In line Filter Aid Chem Feed System	$ 20,000.00
4. Auto Chlorination System with Meters and Controls	$ 60,000.00
5. New Dual Pump Station with VFD, Pressure Controls and Backwash Pump	$ 100,000.00
6. Installation of Piping Distribution System to Network	$ 100,000.00
7. Design and Coordination Engineering	$ 90,000.00
Budget Total	**$750,000.00**

CHRIST Water USA, Inc

Christ Water Technology Group

Michael I. Stefanic
Sales Manager
4018 NE 112th Ave.
Vancouver, WA 98682
USA

The Magnolia pipeline coming from Strawberry is connected to the SH Tank (300K gallons). This proposed supplemental storage system would be connected to the SH Tank and the North South Inter-tie point. This will allow this for new proposed supplemental storage to be recharged through the Magnolia pipeline (bi-direction line). The capital cost for these two additional pipelines are approximately $264,000. Additional cost information is shown below from the supplemental storage model.

Capital Cost	
Capital Cost of Supplement Storage System (includes, filters, scupe, pumps, chlorination)	$ 750,000
Capital Cost for Pipeline to SH Storage Tank	$ 211,200
Capital Cost for Pipeline to North/South Inter-Tie	$ 264,000
Total Material Capital Cost	$1,225,200
Cost of Money at 10% 3 year Lease to Purchase	$ 306,300
Total Capital Cost	$1,531,500

Operation Cost	
Water Capture Cost (4 months out of Pine Creek)	$ 1,296
Annual Maintenance	$ 61,260
Circulation Cost	$ 3,888
CAP allocation Water Costs	$ 5,077
Operation Mgt	$ 40,000
Total Annual Operation Cost	$ 111,521
Monthly Operation Cost	$ 9,293

Payment Method	
Cost per month to each meter for five years (includes Capital and Operation)	$17
Cost per month after five years (includes Operation)	$5

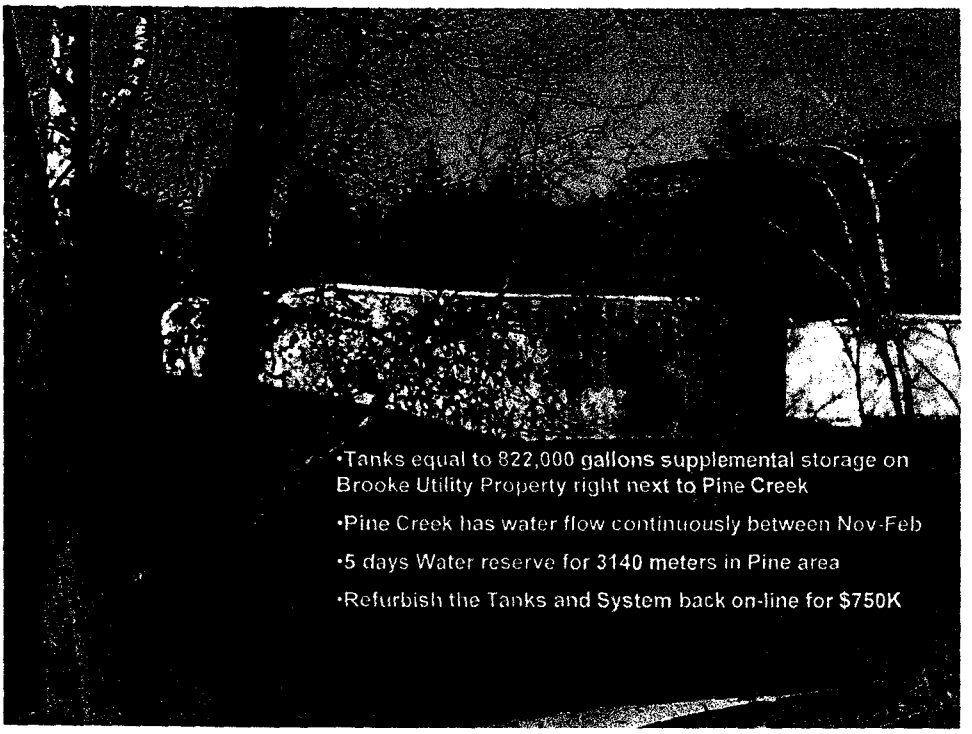
Model

The enclosed model demonstrates that the Strawberry Wells/Magnolia pipeline is not sufficient to support the "100 day" summer events. The trucking of water is required to maintain a 50% reserve in the current storage system of 850,000 gallons in Pine. Currently, approximately 1,000,000 gallons of water is placed in the Magnolia pipeline and directly in the SH tanks to supplement the Pine water system during the months of July through September (3 months) by the trucking effort caused by the reduced well production in both Strawberry and Pine.

The cost of the SRP water is ~$5K total (for 20 acre-ft) in the proposed supplemental storage case (scooped from Pine Creek) and does not requiring trucking. Pine Water Company already holds CAP allocation certificates that can be traded for SRP surface water south of the Highway 87 bridge. The cost of the proposed supplemental storage system over a five-year period is approximately $417,821/year for total of $1,531,500 capital and $111,521/year operation cost. This does NOT include regulatory costs.

This system would allow hauling charges per year to be removed in lieu of storage capital/operational charges. The proposed payment of this supplemental storage system could be made in two ways by Brooke Utilities: 1. A proportion of CAP allocation could be sold (~100 acre-ft) to Phoenix Valley cities to pay for the capital cost but keeping 20+ acre-ft to support the current (winter months) and 41+ acre-ft for future demand. Future demand is limited by the maximum number property parcels and controlled by Gila county. Storage of the future demand could be new tanks, a small reservoir along Pine Creek, or underground through well recharge, all of which will need to be studied and could be an additional cost of capital. The supplemental storage operation cost would be $5/month per meter. It should be made clear, Brooke Utilities might profit from the sale of the allocation and INVEST capital back into the community in which the allocation was originally designated. This is the same model that was used in Payson to pay for capital for the development of the Payson water system. The decision required to utilize this payment approach is completely under the control of Brooke Utilities and ACC. Or alternatively, 2. a fixed $17/month per meter for five years would pay the capital and then be reduced to $5/month per meter to continue paying the operation cost after 5 years.

In both cases, regulatory costs would need to be included as additional factors. The method of payment of the proposed system would need to be agreed to by appropriate government agencies (ACC and Pine Water Company). The agreement would replace the hauling/trucking (July- Sept) pricing structure.



Conclusion

Based on the study model, it should be understood that at the present time the Pine water storage (850K gallons) is sufficient (with spike holiday outage and current conservation measures) and assuming that the Magnolia pipeline continues to operate and supplemental trucking of water occurs to the pipeline terminal during the summer "100 days" events.

The major advantage of this proposed supplemental storage system is to create additional backup storage to avoid system spikes and temporary outages during the "100 day" period. Growth in the community is currently limited by meter allocation and a commercial meter moratorium. Expansion and growth causes larger spikes and outages during the "100 day" because of limited storage available in the system. Also, the proposed supplemental storage system would eliminate the need for trucking to the Magnolia terminal or SH tanks in Pine. More importantly, the supplemental storage system would reduce the water take on the Pine and Strawberry well systems during the winter months by taking water from the surface storm and snow melt runoff. Minimum levels of water would be needed from Strawberry during those winter months.

NO spike summer holiday outages would be experienced (the real problem). The current system and utility operator (Pine Water) is supplying sufficient water throughout the system but the storage system is insufficient to handle the PEAK DEMAND during the "100 days" Event Type 2.

Also, a limiting factor in the current system is moving water from Strawberry through the Magnolia pipeline to the existing SH 300K gallon storage tank. The pipeline is capable of

delivering 5,004,000 gallons per week. But due to the limiting storage capacity the pipeline on the receiving end, it cannot deliver more than 451,103 gallons per week even if water was available in Strawberry. It should be noted that more water is available from Strawberry wells during the summer months that Pine wells by 2 times. Once the proposed supplemental storage system is online and interconnected with SH 300K gallon storage tank the pipeline could deliver 1,600,000 gallons per week (greater than the total demand). Based on the model, this would allow the number of meters to grow to approximately 5500 before the proposed supplemental storage reserve would deplete (assuming the same usage profile and Strawberry well system could support the demand).

The model shows that if no hauling was done today Pine would experience many water outages from July 4 thru the end of Sept, water reserve would go as low as (negative) -186,000 gallons per week. The hauling if done on time by the operations people still create high number opportunities for outages and the reserve will dip to an average of 221,000 from 850,000 gallons in late August and September. The proposed supplemental system will allow more water to flow down from Strawberry in summer months (assuming water is available) and less to none in the winter months. The will cause the overall take from Strawberry well system to be substantially less (approximately ~10 acre-ft.) The bottleneck that reduces the capacity of the Magnolia Pipeline will be removed by the supplemental storage and tie-lines to the existing Pine system.

The proposed supplemental storage system would also reduce water taken from the Strawberry well system that is piped through the Magnolia pipeline during the winter months due to scooping water from Pine Creek. It is clear that a well recharge study should be completed to determine whether "well resting" during the winter months would create any effect on underground storage. Previous, geology reports did not address the underground storage capacity or recharge rate. It is common practice to "rest wells" but the effect on long term resting is not known (it is known in Payson).

This proposed supplemental system would be paid for by utilizing existing Brooke Utilities capital (exiting property, tanks, and CAP allocation) or by a rate increase for limited period of time. To remove the summer outages and stigma of Pine water shortages, the community must pay for the capital development (just like Fire and Police) or sacrifice community service development. Alternatively, finding a large source of water underground for summer supplementation is a very high risk option and have a high operation cost to deliver to Pine. Defining and understanding the real problem is first step in the solution. The real problem is summer community outages and reduced required water usage stages. The community, year around families, retired members, businesses, and valley commuters must resolve the common problem of outages and community growth.

The moratorium on community development (zero commercial meters) will not allow services in the area for support of the Pine community. Many people in the community can't afford the cost of frequent driving to Payson for community services. The community desire to AVOID creating more government (creating a town government that would tax for growth and water development projects) should be respected, and WATER must NOT be a limiting factor in the community growth given the problem only exists during the summer months. Water is a limited resource and lots water is going down Pine Creek to valley communities during the winter

months and being stored for the summer months for their use. This same water needs to be stored for Pine/Strawberry community usage.

Special thanks to John Breninger, Harry Jones, and Bob Cassaro for his data input, support, teaching, and understanding of the problem.

Jim Richey
P.O. Box 2379
Pine, Arizona 85544
602-920-7826

APPENDIX

APPENDIX

Response to the Bob Hardcastle letter of June 1, 2005

It should be noted Mr. Hardcastle reviewed the Final V4.0 report. The new Final V5.0 report that is enclosed correcting some of the misunderstand that I had of certain data. I agree with Mr. Hardcastle (include my lack of regulatory cost understanding) on almost every point EXCEPT the conclusion that this logical option (supplemental storage) may not survive the regulatory analysis.

I would suggest that the ACC and Pine Water Co. focus on the real problem; outages in the summer and community service growth and expansion issues. It seems the ACC has responded to the growth and expansion issues with the use of a meter moratorium. The hauling charges is directly connected to the outages and supplemental storage requirements. We need a solution to these problems.

The supplemental storage purpose is to remove the summer spikes and reduce the volume of water coming from Strawberry during the winter months by using available surface water from Pine Creek. No hauling will be needed. Summer months will not see outages due to additional supplemental storage.

After a study is completed on long term recharge (winter months), then an answer to the meter moratorium can be addressed. Based on the study, only 1M additional gallons are currently needed during the "100 days" which can come from the winter runoff. With the usage and increased demand that will likely increase over the next decade Pine will require other sources of water such as Blue Ridge and other well alternatives like horizontal wells systems. All alternatives must examine the cost/risk ratio before spending resources (not just cost per 1000 gallons).

Brooke Utilities, Inc.

P. O. Box 82218 • Bakersfield, California 93380-2218
Customer Call Center • P.O. Box 9016 • San Dimas, California 91773-9016 • (800) 270-6084

ROBERT T. HARDCASTLE
(661) 633-7526
Fax (781) 823-3070
RTH@brookeutilities.com

June 1, 2005

James Richey
P.O. Box 2379
Pine, AZ 85544

Re: ***Alternative JB6 Study, Pine Water Co., Inc., Pine, AZ***

Dear Mr. Richey,

Thank you for your effort on the above referenced study dated April 14, 2005. It is clear that your analysis and interest in this topic substantiates the importance of future additional water supplies for the communities of Pine and Strawberry. As you are aware this has been a long standing problem that is related to numerous exhaustive water studies of the area that date as early as the 1960's. Virtually every water study conducted since that time has concluded the same result: that Pine does not have a sufficient source of groundwater to meet its current or future year-round needs.

At your request I have reviewed the above referenced document (hereafter the "JB6 Proposal") in some detail. For many years Brooke Utilities ("Brooke") has argued that a hydrological solution to the area's water problems which is supplanted by an equivalent or more serious, economic problem is no solution at all. Thus, in our view any solution to the local water problem ***must*** be inextricably linked to a reasonable economic approach that provides for affordably delivered water supplies. If cost was unimportant the water supply problem in the local area probably could have been resolved some time ago using various different means. However, a failed water solution that includes high risk and high cost has the potential for deterring other solutions for many years or decades. It is very important to make our best collective effort the first time. The JB6 Proposal identifies one of many possible future solutions. I commend you for your effort.

For many years Brooke has explained the complexity of the problem to the community with many disbelievers. For this reason we have advocated, since 1998, a detailed examination of every possible alternative solution to the problem. We believe every conventional, unconventional, reasonable, and unreasonable alternative should be considered and prioritized in descending order of risk (defined as likelihood of success) and cost. After many years of advocating this position to everyone from community members to regulatory officials to Gila County representatives, Brooke is pleased to finally see an organized and professional approach to the problem largely void of bickering, suspicion, personal agendas, and accusations of conspiracy.

James Richey
Alternative JB6 Study
June 1, 2005

During a recent hearing at the Arizona Corporation Commission (the "Commission") I recall evidentiary statements made by a member of the local community. His interest was to expose Brooke as a "conspirator" only interested in knowingly withholding huge volumes of water supply from the community for the purpose of driving the cost per customer to the highest possible level. Of course, these unsupported and preposterous statements are false and universally recognized as such by the growing body of people interested in this issue. In fact, the regulatory officials genuinely interested in the solution of Pine's water supply problems recognize that such people and statements retard the opportunity for a solution. Worst of all these people, and their statements, have nearly destroyed the creditability of the concerned people of Pine and Strawberry at the regulatory functions that control this process. I think most people in attendance at the hearing were embarrassed for the person making the statements.

Long ago Brooke has considered every reasonable and unreasonable resolution to the Pine water supply problem we could think of. That doesn't mean that we have considered every *possible* alternative. We have traveled far down the road of numerous proposals. We have less explored others. We have prioritized the alternatives in terms of risk and cost. We have discussed these alternatives and reported same to the Commission on numerous occasions. As it relates to the current discussion there is very little new information that hasn't been previously considered. That, also, doesn't mean that further discussion isn't warranted or necessary. But, the more people that consider the complexities of this situation ultimately come to three facts that will be related to any future solution:

- First, any solution to the water source and supply problem will mean a higher cost of water in the future.
- Second, any solution to the water source and supply problem will probably come from outside of the area.
- Third, any solution to the water source and supply problem will probably have a legislative component steering the outcome.

Some people see these facts are discouraging. Others see these facts as encouraging. Brooke views these facts as the reality. Brooke has asked the Commission for "guidance" on the proper course of the numerous alternatives for our future consideration. The regulatory scheme requires our "reasonable and prudent" consideration of any proposal to expend investment capital toward such a solution. Unfortunately, the Commission has declined to provide the "guidance" we seek. The Commission's declination to become involved has, in our opinion, further deterred a solution as well. Thus, we don't have the luxury of capital intensive experimentation through incremental progress. Brooke is no different than any business charged with the responsibility to expend capital to improve business operations in the most efficient manner possible. In the case of solving Pine's water supply problems the most preferred capital expenditure is, unfortunately, much more difficult to identify and the consequences of erroneous solution identification can be far more expensive than members of the local community realize.

It is important to for you to realize that there is an important regulatory component to *everything* Pine Water Co. does. Regulatory financial analysis, accounting, capital expenditures, return on investment, rates of return, and almost every other water business consideration is much different than the standard business environment. *Every* business decision made by Pine Water Co. and Brooke must carefully consider the effect of the regulatory environment and, in some cases, project regulatory treatment of future issues. It provides an additional element of concern, frequently referred to as "regulatory risk" that most businesses do not have to consider. The regulatory environment can be very challenging and disappointing. In the case of the most recent Pine Water Co. rate application approximately $500,000 was spent by the Company and the opposing interveners in the regulatory application process. Most disappointing is that these funds were necessarily spent *reaching a settlement conclusion that was largely proposed by the Commission's Staff in the first few weeks of the case.* Unfortunately, the attorneys enjoyed the process immensely. But the community lost the exploratory ability of this largely wasted capital expenditure. Unfortunately, Pine Water Co. will only be allowed to capitalize $200,000 of this expense over a period of four years. All of this capital, which is ultimately repaid by community rate payers inclusive of an approved rate of return, could have been much better spent exploring for water sources. Thus, the regulatory process is a *very* important component of anything done by Pine Water Co. and one that cannot be considered lightly.

The JB6 Proposal

The concept of the JB6 Proposal has been previously considered by Brooke. In our view the JB6 Proposal is flawed in at least the following areas:

(a) a constant, reliable source of re-filling the storage tanks does not exist
(b) the capital cost is dramatically understated and comparatively very high
(c) the positive effect of "resting" Pine wells is speculative at best
(d) business model foundational facts are seriously inaccurate

Accordingly, I have provided some brief argument in support our conclusions in the form of the statements below.

Source of Supply

The JB6 Proposal correctly identifies the period between Memorial Day and Labor Day annually as the most challenging. For clarification purposes, Brooke refers to this period as the "100 Day War".

Unfortunately, the JB6 Proposal relies on water from Pine Creek as the source of supply for the retrofitted storage tanks (the "Pine Creek Tanks"). Traditionally, and with rare exceptions, the period during the "100 Day War" provides for little or no surface flow available for re-supply of the storage tanks. Thus, at best, a single cycle of 800,000 gallons would be available for introduction into Pine Water Co.'s water system during periods of

deficient supply most likely during the long 4th of July holiday weekends. Once used this additional water supply would be unavailable until the next available surface flow through Pine Creek. That may, or may not, be during the immediately subsequent winter months. For the period 1996-2004 the *average* peak customer month of July demanded 5,855,000 gallons of water. This monthly demand translates to approximately 195,000 gallons per day for the entire month. Most troubling issue is the fact that customer *daily* demand during a long 4th of July weekend can approach 900,000 gallons. As can easily be seen from this data the additional supply represented by one cycle of the Pine Creek Tanks does little to resolve the water supply shortage in the area. Further, once expended this additional source of water cannot be retrieved until the next available water flow through Pine Creek. The surface flow of Pine Creek only marginally supported the needs of a 140 person population in 1967 with very little potential for development of a higher utilization.[1] That much additional water might avert a one-time disastrous situation but will not eliminate a water source deficiency problem.

There are additional problems related to the use of Pine Creek water flow as well. These issues include entering into an exchange arrangement with Salt River Project ("SRP") to exchange surface water supplies from Pine Creek with SRP access to water from the Central Arizona Project ("CAP"). The likelihood of entering into such an arrangement is currently better than has existed for some time. However, before such an arrangement could be completed with SRP a settlement agreement with all downstream claimants and bona fide rights holders would be necessary before water could be extracted from Pine Creek. It should be anticipated that non-bona fide water rights holders would strenuously argue as to their prioritized position for rights to the water flow as well. This settlement process will also include an environmental review in the form of a Categorical Exclusion or Environmental Assessment. It was Brooke's experience during the development and construction of the Project Magnolia pipeline project that an Environmental Assessment can cost more than $125,000 and require almost two years before being completed. The business and regulatory risk associated with these advance expenditures, in light of unknown future water flows through Pine Creek, can be very high if not regulatorily deemed "reasonable and prudent". Of course any negative Commission ruling would come after the expenditure of the capital. This regulatory risk of this result was the primary reason for Pine Water Co. previously seeking regulatory "guidance" in this matter. As stated above, unfortunately, this "guidance" was not proffered by the Commission.

The JB6 Proposal accurately concludes that the project can be completed inclusive of all of the additional components discussed above. However, the additional costs of this process must be included as part of the development cost and risk of recovering these costs is unknown.

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1 *Investigation of Groundwater Availability for the Pine/Strawberry Water Improvement District*, August 2003, Preface, item 1, Comment 1A, page vii.

Cost of Capital

The JB6 Proposal dramatically understates the financial issues related to the project. The financial analysis of the JB6 Proposal is seriously flawed, not because of inaccurate financial analysis, but because the requirements of the regulatory process have not been accurately considered.

For Commission rate making purposes the allowable returns are applied on a "net" basis. In other words, only "net profits" are computed when considering the return on investment period or the rate of return. "Net profits" are those applied *after* all expenses related to a project. Likewise, a net present value ("NPV") analysis is frequently utilized by regulatory authorities as a normalizing mechanism to assure regulators that sufficient future water company cash flow exists to meet the requirements of the project. Thus, recurring operational costs must be included as part of the project. In the section above I have explained the effect of additional costs related to an exchange agreement with SRP. In additional to the additional infrastructure costs not considered by the JB6 Proposal we estimate the revised capital costs of the project to be approximately $1,511,700. The "net" regulatory effect of these costs must also include "grossed up" income taxes, depreciation, amortization, regulatory costs, and the approved Pine Water Co. rate of return of approximately 11.41%[2]. Therefore, the adjusted approximate cost of the JB6 Proposal is $2,524,500 and must be recovered through additional customer rate adjustments.

Brooke's perspective is that such a small incremental solution to a problem that has dubious applicability, because of the seasonal unpredictable availability of Pine Creek water flow, demands strong consideration of other more productive and less economically burdensome alternatives.

"Resting" Water Wells

The JB6 Proposal concludes that the "supplemental storage system would reduce the strain on the Pine and Strawberry wells during the winter months" by utilizing surface water flowing through Pine Creek. This water flow is proposed to be collected through constructed intake infrastructure and stored in the "Pine Creek Tanks". The JB6 Proposal concludes that higher utilization of the surface water sources decreases the utilization of water wells in Pine and Strawberry and, as a result, allows increased availability of groundwater supplies for future use during the "100 Day War". The JB6 Proposal provides no supporting documentation of this conclusion whatsoever.

Brooke believes the "resting" conclusion reached by the JB6 Proposal is speculative, at best, and does not provide a sufficient basis to meet the "reasonable and prudent" regulatory standard, discussed herein, to justify substantial capital investment of the type

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2 Arizona Corporation Commission, Decision No. 67166, page 8, at line 7.

and nature of the JB6 Proposal. Further, there are several previously developed water supply studies conducted since the 1960's concluding that sub-surface water flow, if not used, is lost to a downstream water source user. Therefore, the increased peak-period performance of water wells in the Pine and Strawberry areas is unproven because customer demand conditions throughout off-peak periods have never been afforded the luxury of providing a data basis to determine the speculative nature of this argument.

Foundation Facts

The economic premise of JB6 Proposal is entirely based on the converted use of capital used to pay for transported water from outside the Pine area. Instead, this capital would be used to fund the investment capital necessary to construct the supplemental water storage facility.[3] The JB6 proposal calculates that 2003 water hauling transportation costs totaling $344,540 as defined by Pine Water Co.'s income statement. This amount is represented to be the sum of "Purchased Water" and "Transportation Expense".

The JB6 Proposal is in error in this conclusion. Pine Water Co., as well as all of Brooke's water companies, utilizes the uniform system of accounts as adopted by the National Association of Regulatory Commissioners ("NARUC")[4] and as required by the Commission.[5] As defined therein the expenses related to "Purchased Water" and "Transportation Expense" is not only inclusive of water transportation expenses. In fact, these account descriptions include various different expenses unrelated to water transportation expenses. Therefore, a computation made from the aggregated account summaries of Pine Water Co.'s income statement would by hugely inaccurate.

Since 1998 Brooke's various water companies have contracted with a single source vendor to provide water transportation services. These services include the transportation of wholesale purchased water for Pine Water Co. For the periods described below the aggregate annual water transportation costs paid for the services are as follows:

- Year 2003 $62,505
- Year 2004 $38,611

Either of these years' costs is substantially less than the $344,540 premised by the JB6 Proposal. The same water transportation services contractor has quoted Brooke a cost of $250 per truck load of water hauled from the Starlight Pines water source in Coconino

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[3] *Alternative JB6 Study*, page 10: "The proposed supplemental system would be paid for by utilizing the dollars that are currently spent for water that is being purchased outside the Strawberry system through the trucking effort. Operating costs for the buying and trucking additional water could be converted to capital costs, which would pay for the supplemental storage (i.e. Pine Creek Tanks) system within five years."

[4] Accounting for Public Utilities, 1999 updated 2004, Chapter 11, sections 11.01 through 11.03.

[5] Arizona Corporation Commission, Decision No. 67166, page 6, lines 16-17

James Richey
Alternative JB6 Study
June 1, 2005

Sincerely,

Robert T. Hardcastle
President

cc: RTH correspondence file
MJ, MB, DS, JS

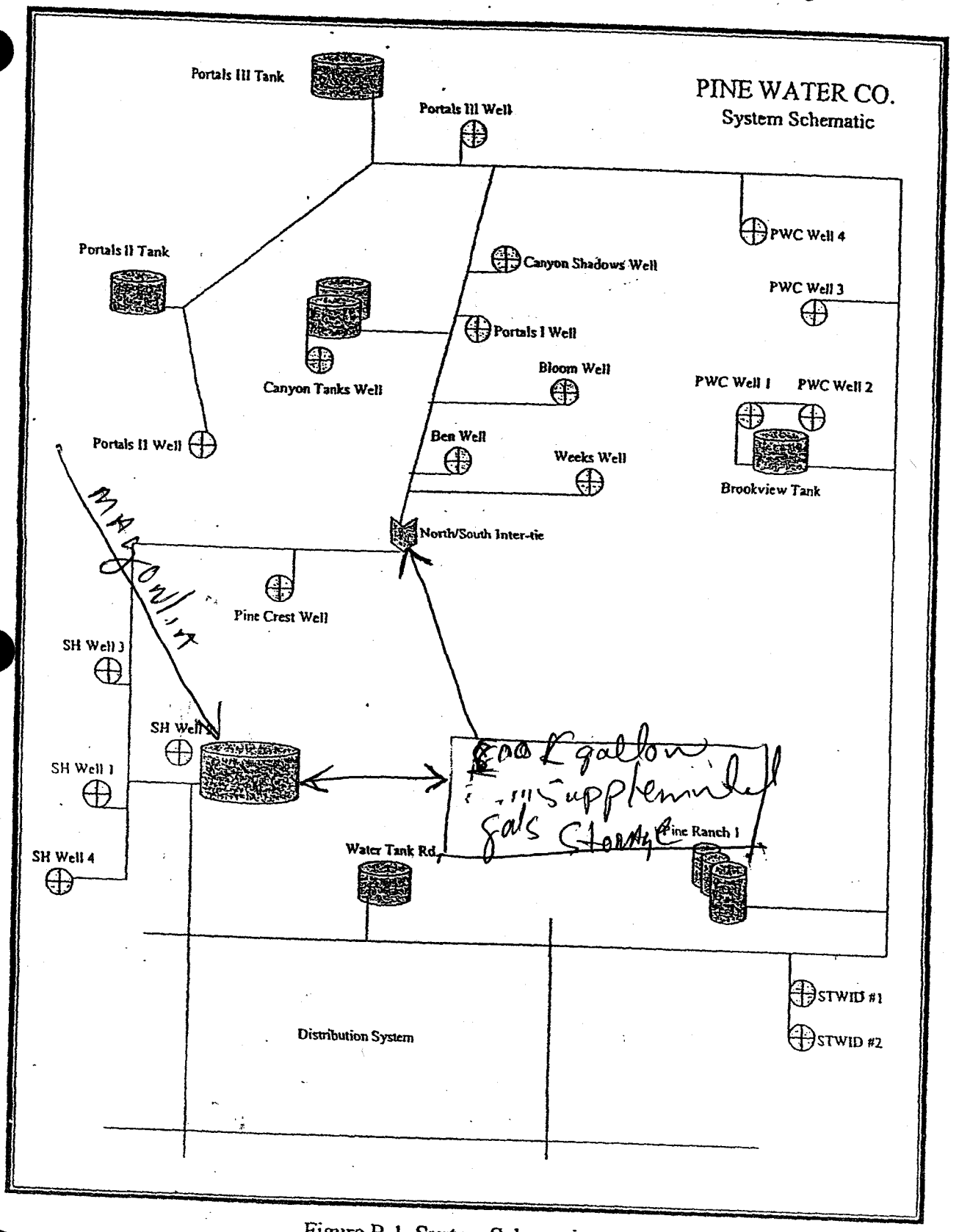


Figure B-1. System Schematic

Assumptions

Pine Peak Demand Model (100 days)

Assumptions	2005	
Non Peak- Household usage per day (Gallons)	76	
Peak (100 days) Household usage per day	124	
Number of Allocated Meters	2,000	
Water Production Model (PSWID) Annual	55,964,000	Well+ Pipeline+ Trucked + Adjustment for 2002 data
Max Current Storage	850,000	
Size- Diameter of Tanks (ft)	54	Measured with Range finder
Size- Height of Tanks (ft)	16	Measure at 16 feet- 1 foot
Volume per Tank	36,644	
Gallons per Tank	274,094	
Number of Tanks	3	
Proposed Supplemental Storage	822,281	

current state

Weekly Usage Rates		
Community Avg usage per day (Gallons)	151,103	
Supplemental Avg Hold days	5.4	
Community Avg peak Usage per day	248,107	During 100 days
Supplemental Peak Hold Days	3	
Magnolia Pipe Line Max Delivery	720,000	Max pumping in Gallon/day 5040000
Strawberry Production Capability	8,375,113	Three times Pine (Well output double)
Pineline Max per week	451,103	
Storage Limits + Daily comsumption	451,103	This number matches actual data below on pileline flow

Capital Cost			
Capital Cost of Supplement Storage System (includes, filters, scupe, pumps, chlorination)	$750,000	Using Exisiting tanks with Lining system	
Capital Cost for Pipeline to SH Storage Tank	$ 211,200		1mile = 5280ft @$40/ft
Capital Cost for Pipeline to North/South Inter-Tie	$ 264,000		1.25 miles
Total Material Capital Cost	$ 1,225,200		
Cost of Money at 5% 5 year Lease to Purchase	$ 306,300		
Total Capital Cost	$ 1,531,500		
Monthly Capital Payment	$ 25,525		
Capital Cost per meter per month 60 months	$ 13		

Operation Cost			
Water Capture Cost (4 months out of Pine Creek)	$ 1,296	Assume 60 Gallons/minute pumps; Winter months	1 horsepower=1000watts, 60 gallon/minute pump needs 3 horsepower pump
Annual Maintence	$ 61,260	5% of Capital Cost	
Circulation Cost	$ 3,888	Assume 60 Gallons/minute pumps	
CAP allocation Water Costs	$ 5,077	16.9235136 acre ft (4 months)	
Cost of Power kwh		$ 0.15	
Operation Mgt	$ 40,000		
Total Annual Operation Cost	$ 111,521		
Monthly Operation Cost			
Cost per meter per month	$ 9,293		
	$ 5		

Total Cost per meter per month	
Capital	$ 13
Operation Cost	$ 5
Total cost for five years	$ 17
Total Cost after Five Years	$ 5

Calendar of 100 days	WEEKLY Model	No Hauling														
	2005	2 day	4 day						Pine	Water	Pipeline	Trucking	Estimated			
	Assume Fridays	Type 1 Event	Type 2 Event	Event Description	Capture	Peak Demandw	Normal Demand	Supplement	Cebebilty (Wells)	Need	Supplement		Current Storage	Backup Storage		
					Pine Creek Fill (Winter Snow/Rain)			Requirement			Capacity Via Pipe			Well Recharge	Combine Storage	
	13-May	1			Magnolia	1,348,732	1,057,720	291,013	1,125,038	223,695	426,818	0	850,000	822,281	1,672,281	
	20-May	1		1	Magnolia	1,348,732	1,057,720	291,013	1,125,038	223,695	426,818	0	850,000	822,281	1,672,281	
	27-May			Memorial Day	Magnolia	1,445,737	1,057,720	388,017	1,125,038	320,699	426,818	0	850,000	822,281	1,672,281	
	3-Jun	1			Magnolia	1,348,732	1,057,720	291,013	851,438	497,295	426,818	0	779,523	822,281	1,601,804	
	10-Jun	1		1	Magnolia	1,251,726	1,057,720	194,009	851,438	400,291	426,818	0	779,523	822,281	1,601,804	
	17-Jun			Strawberry Fest	Magnolia	1,348,732	1,057,720	291,013	851,438	497,295	426,818	0	709,046	822,281	1,531,327	
	24-Jun	1		1	Magnolia	1,348,732	1,057,720	291,013	851,438	497,295	426,818	0	638,570	822,281	1,460,851	
	1-Jul			4th of July	Magnolia	1,445,737	1,057,720	388,017	851,438	594,299	426,818		471,089	822,281	1,293,370	
	8-Jul	1			Magnolia	1,348,732	1,057,720	291,013	851,438	497,295	426,818		400,612	822,281	1,222,893	
	15-Jul	1			Pine Creek (Monsoon)	1,348,732	1,057,720	291,013	851,438	497,295	426,818		330,135	822,281	1,152,416	
	22-Jul	1			Pine Creek (Monsoon)	1,348,732	1,057,720	291,013	851,438	497,295	426,818		259,658	822,281	1,081,939	
	29-Jul	1			Magnolia	1,348,732	1,057,720	291,013	851,438	497,295	426,818		189,182	822,281	1,011,463	
	5-Aug	1			Magnolia	1,348,732	1,057,720	291,013	1,105,563	243,170	426,818		189,182	822,281	1,011,463	
	12-Aug	1		1	Magnolia	1,348,732	1,057,720	291,013	1,105,563	243,170	426,818		189,182	822,281	1,011,463	
	19-Aug			Rodeo	Magnolia	1,348,732	1,057,720	291,013	1,105,563	243,170	426,818		189,182	822,281	1,011,463	
	26-Aug	1		1	Magnolia	1,348,732	1,057,720	291,013	1,105,563	243,170	426,818		189,182	822,281	1,011,463	
	2-Sep			Labor Day	Magnolia	1,445,737	1,057,720	388,017	1,105,563	340,174	426,818		189,182	822,281	1,011,463	
	9-Sep	1			Magnolia	1,348,732	1,057,720	291,013	733,400	615,332	426,818		667	822,281	822,948	
	16-Sep	1			Magnolia	1,348,732	1,057,720	291,013	733,400	615,332	426,818		-187,847	634,434	634,434	
			Peak Usage		Total	25,819,924					8,109,544	0				

- No hauling Scenario
- Lots of outages

Calendar of 100 days	WEEKLY Model	Current State														
										Pine	Water	Pipeline	Trucking	Estimated	Backup Storage	
	2005	2 day	4 day													
	Assume Fridays	Type 1 Event	Type 2 Event	Event Description	Capture	Peak Demand/w	Normal Demand	Supplement		Cabability (Wells)	Need	Supplement		Current Storage	Well Recharge	Combine Storage
					Pine Creek Fill (Winter Snow/Rain)			Requirement				Capacity Via Pipe		850,000	822,281	1,672,281
	13-May	1			Magnolia	1,348,732	1,057,720	291,013		1,125,038	223,695	426,818	0	850,000	822,281	1,672,281
	20-May	1	1		Magnolia	1,348,732	1,057,720	291,013		1,125,038	223,695	426,818	0	850,000	822,281	1,672,281
	27-May			Memorial Day	Magnolia	1,445,737	1,057,720	388,017		1,125,038	320,699	426,818	0	850,000	822,281	1,672,281
	3-Jun	1			Magnolia	1,348,732	1,057,720	291,013		851,438	497,295	426,818	0	779,523	822,281	1,601,804
	10-Jun	1	1		Magnolia	1,251,728	1,057,720	194,009		851,438	400,291	426,818	0	779,523	822,281	1,601,804
	17-Jun			Strawberry Fest	Magnolia	1,348,732	1,057,720	291,013		851,438	497,295	426,818	0	709,046	822,281	1,531,327
	24-Jun	1	1		Magnolia	1,348,732	1,057,720	291,013		851,438	497,295	426,818	0	638,570	822,281	1,460,851
	1-Jul			4th of July	Magnolia	1,445,737	1,057,720	388,017		851,438	594,299	426,818	24,375	495,464	822,281	1,317,745
	8-Jul	1			Magnolia	1,348,732	1,057,720	291,013		851,438	497,295	426,818	24,375	449,362	822,281	1,271,643
	15-Jul	1			Pine Creek (Monsoon)	1,348,732	1,057,720	291,013		851,438	497,295	426,818	24,375	403,260	822,281	1,225,541
	22-Jul	1			Pine Creek (Monsoon)	1,348,732	1,057,720	291,013		851,438	497,295	426,818	24,375	357,158	822,281	1,179,439
	29-Jul	1			Magnolia	1,348,732	1,057,720	291,013		851,438	497,295	426,818	133,250	419,932	822,281	1,242,213
	5-Aug	1			Magnolia	1,348,732	1,057,720	291,013		1,105,563	243,170	426,818	133,250	419,932	822,281	1,242,213
	12-Aug	1	1		Magnolia	1,348,732	1,057,720	291,013		1,105,563	243,170	426,818	133,250	419,932	822,281	1,242,213
	19-Aug			Rodeo	Magnolia	1,348,732	1,057,720	291,013		1,105,563	243,170	426,818	133,250	419,932	822,281	1,242,213
	26-Aug	1	1		Magnolia	1,348,732	1,057,720	291,013		1,105,563	243,170	426,818	89,250	419,932	822,281	1,242,213
	2-Sep			Labor Day	Magnolia	1,445,737	1,057,720	388,017		1,105,563	340,174	426,818	89,250	419,932	822,281	1,242,213
	9-Sep	1			Magnolia	1,348,732	1,057,720	291,013		733,400	615,332	426,818	89,250	320,667	822,281	1,142,948
	16-Sep	1			Magnolia	1,348,732	1,057,720	291,013		733,400	615,332	426,818	89,250	221,403	822,281	1,043,684
			Peak Usage		Total	25,819,924						8,109,344	987,500			

- Current State
- Hauling 1 million gallons
- Reserve as low as 221K gallons
- [redacted]
- Outages in Aug & Sept.

Assumptions

Pine Peak Demand Model (100 days)

Assumptions	2005	
Non Peak- Household usage per day (Gallons)	76	
Peak (100 days) Household usage per day	124	
Number of Allocated Meters	2,000	
Water Production Model (PSWID) Annual	55,964,000	Well+ Pipeline+ Trucked + Adjustment for 2002 data
Max Current Storage	850,000	
Size- Diameter of Tanks (ft)	54	Measured with Range finder
Size- Height of Tanks (ft)	16	Measure at 16 feet- 1 foot
Volume per Tank	36,644	
Gallons per Tank	274,094	
Number of Tanks	3	
Proposed Supplemental Storage	822,281	

Supplemental Storage

Weekly Usage Rates		
Community Avg usage per day (Gallons)	151,103	
Supplemental Avg Hold days	5.4	
Community Avg peak Usage per day	248,107	During 100 days
Supplemental Peak Hold Days	3	
Magnolia Pipe Line Max Delivery	720,900	Max pumping in Gallon/day 5040000
Strawberry Production Capablity	3,375,113	Three times Pine (Well output double)
Pineline Max per week	1,273,103	
Storage Limits + Daily comsumption	1,273,103	This number matches actual data below on pileline flow

Capital Cost			
Capital Cost of Supplement Storage System (includes, filters, scupe, pumps, chlorination)	$750,000	Using Exisiting tanks with Lining system	
Capital Cost for Pipeline to SH Storage Tank	$ 211,200		1mile = 5280ft @$40/ft
Capital Cost for Pipeline to North/South Inter-Tie	$ 264,000		1.25 miles
Total Material Capital Cost	$ 1,225,200		
Cost of Money at 5% 5 year Lease to Purchase	$ 306,300		
Total Capital Cost	$ 1,531,500		
Monthly Capital Payment	$ 25,525		
Capital Cost per meter per month 60 months	$ 13		

Operation Cost			
Water Capture Cost (4 months out of Pine Creek)	$ 1,296	Assume 60 Gallons/minute pumps; Winter months	1 horsepower=1000watts, 60 gallon/minute pump needs 3 horsepower pump
Annual Maintence	$ 61,260	5% of Capital Cost	
Circulation Cost	$ 3,888	Assume 60 Gallons/minute pumps	
CAP allocation Water Costs	$ 5,077	16.9235136 acre ft (4 months)	
Cost of Power kwh		$ 0.15	
Operation Mgt	$ 40,000		
Total Annual Operation Cost	$ 111,521		
Monthly Operation Cost			
Cost per meter per month	$ 9,293		
	$ 5		

Total Cost per meter per month	
Capital	$ 13
Operation Cost	$ 5
Total cost for five years	$ 17
Total Cost after Five Years	$ 5

Calendar of 100 days	WEEKLY Model	No Hauling/Supplemental Storage Connected to SH 300K and Tie Point												Estimated			
	2005	2 day	4 day						Pine	Water	Pipeline	Trucking		Current Storage	Backup Storage		
	Assume Fridays	Type 1 Event	Type 2 Event	Event Description	Capture	Peak Demand/w	Normal Demand	Supplement	Cabablity (Wells)	Need	Supplement			Well Recharge	Combine Storage		
					Pine Creek Fil (Winter Snow/Rain)			Requirement			Capacity Via Pipe			850,000	822,281	1,672,281	
	13-May	1			Magnolia	1,348,732	1,057,720	291,013	1,125,038	223,695	1,204,567	0		850,000	822,281	1,672,281	
	20-May	1	1		Magnolia	1,348,732	1,057,720	291,013	1,125,038	223,695	1,204,567	0		850,000	822,281	1,672,281	
	27-May			Memorial Day	Magnolia	1,445,737	1,057,720	388,017	1,125,038	320,699	1,204,567	0		850,000	822,281	1,672,281	
	3-Jun	1			Magnolia	1,348,732	1,057,720	291,013	851,438	497,295	1,204,567	0		850,000	822,281	1,672,281	
	10-Jun	1	1		Magnolia	1,251,728	1,057,720	194,009	851,438	400,291	1,204,567	0		850,000	822,281	1,672,281	
	17-Jun			Strawberry Fest	Magnolia	1,348,732	1,057,720	291,013	851,438	497,295	1,204,567	0		850,000	822,281	1,672,281	
	24-Jun	1	1		Magnolia	1,348,732	1,057,720	291,013	851,438	497,295	1,204,567	0		850,000	822,281	1,672,281	
	1-Jul			4th of July	Magnolia	1,445,737	1,057,720	388,017	851,438	594,299	1,204,567			850,000	822,281	1,672,281	
	8-Jul	1			Magnolia	1,348,732	1,057,720	291,013	851,438	497,295	1,204,567			850,000	822,281	1,672,281	
	15-Jul	1			Pine Creek (Monsoon)	1,348,732	1,057,720	291,013	851,438	497,295	1,204,567			850,000	822,281	1,672,281	
	22-Jul	1			Pine Creek (Monsoon)	1,348,732	1,057,720	291,013	851,438	497,295	1,204,567			850,000	822,281	1,672,281	
	29-Jul	1			Magnolia	1,348,732	1,057,720	291,013	851,438	497,295	1,204,567			850,000	822,281	1,672,281	
	5-Aug	1			Magnolia	1,348,732	1,057,720	291,013	1,105,583	243,170	1,204,567			850,000	822,281	1,672,281	
	12-Aug	1	1		Magnolia	1,348,732	1,057,720	291,013	1,105,583	243,170	1,204,567			850,000	822,281	1,672,281	
	19-Aug			Rodeo	Magnolia	1,348,732	1,057,720	291,013	1,105,583	243,170	1,204,567			850,000	822,281	1,672,281	
	26-Aug	1	1		Magnolia	1,348,732	1,057,720	291,013	1,105,583	243,170	1,204,567			850,000	822,281	1,672,281	
	2-Sep			Labor Day	Magnolia	1,445,737	1,057,720	388,017	1,105,583	340,174	1,204,567			850,000	822,281	1,672,281	
	9-Sep	1			Magnolia	1,348,732	1,057,720	291,013	733,400	615,332	1,204,567			850,000	822,281	1,672,281	
	16-Sep	1			Magnolia	1,348,732	1,057,720	291,013	733,400	615,332	1,204,567			850,000	822,281	1,672,281	
			Peak Usage		Total	25,619,924					22,886,785	0					

- Add supplental Storage
- NO outage
- Reserve above 850K due to Pipeline flow.

		Peak Usage		Total
Total usage	55,964,000		Peak Avg/meter/day	
May @ 8.1%	0.081	4,533,084	75.5514	
Jun @ 12.9%	0.129	7,219,356	120.3226	
Jul @ 13.3%	0.133	7,443,212	124.0535333	Using 125gallons/meter
Aug @ 10.1%	0.101	5,652,364	94.20606667	
Sep @ 7.4%	0.074	4,141,336	69.02226667	
Total		28,989,352		

Magonila On-line

Data from email; Storage Levels	2000	2001	2002	2003	2004	Avg		Month Avg
28-May	242	672	355	403	825	499	May	499
1-Jun	281	288	525	732	428	451	June	530
3-Jun	316	680	540	758	605	580		
13-Jun	218	722	520	740	621	564		
26-Jun	247	835	162	722	652	524		
16-Jul	220	702	490	636	738	557	July	588
23-Jul	402	770	500	635	789	619		
10-Aug	576	822	745	496	809	656	August	627
19-Aug	512	850	0	670	809	568		
31-Aug	638	850	340	730	721	656		
6-Sep	378	830	550	802	535	619	Sept	636
17-Sep	217	850	750	815	634	653		

Magnolia Pipeline Data		From John
2002	Gallons (K)	
	Monthly	Weekly
Jan	770,000	192,500
Feb	166,000	41,500
March	465,000	116,250
April	0	0
May	1,345,000	336,250
June	1,400,000	350,000
July	1,000,000	250,000
Aug	939,000	234,750
Sept	675,000	168,750
Oct	1,300,000	325,000
Nov	1,700,000	425,000
Dec	1,700,000	425,000
Total	11,460,000	

	2002	
Hauling	Gallons	Gallons/week
July	97,500	24375
August	533000	133250
Sept	357000	89250
Total	987,500	

Water Usage		From Harry Jones	
2002	Gallons (K)		
	Sold Meter	Pumped	Weekly Pumped
Jan	3,315,376	3,841,000	960250
Feb	3,294,104	2,913,000	728250
March	2,965,012	2,913,000	728250
April	3,651,369	4,208,000	1052000
May	5,002,895	4,737,000	1184250
June	6,605,607	3,585,000	896250
July	5,156,652	3,478,000	869500
Aug	4,576,358	4,655,000	1163750
Sept	5,076,021	3,088,000	772000
Oct	4,602,227	4,102,000	1025500
Nov	4,046,117	2,880,000	720000
Dec	3,714,276	3,105,000	776250
			10876250
Total	52,006,014	43,505,000	906354.1667

Water Loss	2,958,986
Percentage Loss	5%

Peak Demand Model (100 days)

Assumptions

Non Peak- Household usage per day (Gallons)	58	
Peak (100 days) Household usage per day	125	
Number of Allocated Meters	3,140	
Water Production Model (PSWID) Annual	66,000,000	
Proposed Supplemental Storage	1,068,000	

Weekly Usage Rates

Community Avg usage per day (Gallons)	180,822	
Supplemental Avg Hold days	5.9	
Community Avg peak Usage per day	392,500	During 100 days
Supplemental Peak Hold Days	3	
Magnolia Pipe Line Max Delivery	275,000	Max pumping in Gallon/day
Strawberry Production Capablity	3,619,728	Three times Pine (Well output double)
Pineline Max per week	1,925,000	Assume no limitions due to tank storage

Capital Cost

Capital Cost of Supplement Storage System (includes, filters, scupe, pumps, chlorination)		$750,000	Using Exisiting tanks with Lining system	
Capital Cost for Pipeline to SH Storage Tank	$	211,200	Alternative #1	1mile = 5280ft @$40/ft
Capital Cost for Pipeline to North/South Inter-Tie	$	264,000	Alternative #2	1.25 miles
Total Material Capital Cost	$	1,014,000	Using alternative #2 worst case cost	
Cost of Money at 10% 3 year Lease to Purchase	$	304,200		
Total Capital Cost	$	1,318,200		
Monthly Capital Payment	$	109,850	Structure Lease payment for 4 month during the summer	
4 Month summer Payment	$	439,400		

Operation Cost

Water Capture Cost (4 months out of Pine Creek)	$	1,296	Assume 60 Gallons/minute pumps; Winter months	1 horsepower=1000watts, 60 gallon/minute pump needs 3 horsepower pump
Annual Maintence		$50,700	5% of Capital Cost	
Circulation Cost	$	3,888	Assume 60 Gallons/minute pumps	
CAP allocation Water Costs	$	1,013	20.25205479 acre ft (4 months)	
Cost of Power kwh			$ 0.15	
Operation Mgt	$	40,000		
Total Annual Operation Cost	$	96,897		
Monthly Operation Cost	$	8,075		

Payment Method

4 Month summer Payment	$	439,400	
Annual Operation Cost	$	96,897	
Total Supplmental System Annual Cost	$	536,297	
Cost of Trucking in 3 months	$	523,537	2002 Data
Cost of Electric for Well Water for 4 months	$	172,244	

Calendar of 100 days																
	2005	2 day	4 day						Pine	Water	Pipeline	Trucking	Estimated	Backup Storage		
	Assume Fridays	Type 1 Event	Type 2 Event	Event Description	Capture	Peek Demand/w	Normal Demand	Supplement	Cabablity (Wells)	Need	Supplement		Current Storage	Well Recharge	Combine Storage	
					Pine Creek Fill (Winter Snow/Rain)			Requirement			Capacity		850,000	1,068,000	1,918,000	
	13-May	1			Magnolia	1,689,110	1,265,753	423,356	1,206,576	482,534	679,412	0	850,000	1,068,000	1,918,000	
	20-May	1		1	Magnolia	1,689,110	1,265,753	423,356	1,206,576	482,534	679,412	0	850,000	1,068,000	1,918,000	
	27-May			Memorial Day	Magnolia	2,112,466	1,265,753	846,712	1,206,576	905,890	679,412	0	623,522	1,068,000	1,691,522	
	3-Jun	1			Magnolia	1,689,110	1,265,753	423,356	1,206,576	482,534	679,412	0	623,522	1,068,000	1,691,522	
	10-Jun	1		1	Magnolia	1,689,110	1,265,753	423,356	1,206,576	482,534	679,412	0	623,522	1,068,000	1,691,522	
	17-Jun			Strawberry Fest	Magnolia	1,900,788	1,265,753	635,034	1,206,576	694,212	679,412	0	608,722	1,068,000	1,676,722	
	24-Jun	1		1	Magnolia	1,689,110	1,265,753	423,356	1,206,576	482,534	679,412	0	608,722	1,068,000	1,676,722	
	1-Jul			4th of July	Magnolia	2,112,466	1,265,753	846,712	1,206,576	905,890	679,412	24,375	406,619	1,068,000	1,474,619	
	8-Jul	1			Magnolia	1,689,110	1,265,753	423,356	1,206,576	482,534	679,412	24,375	406,619	1,068,000	1,474,619	
	15-Jul	1			Pine Creek (Monsoon)	1,689,110	1,265,753	423,356	1,206,576	482,534	679,412	24,375	406,619	1,068,000	1,474,619	
	22-Jul	1			Pine Creek (Monsoon)	1,689,110	1,265,753	423,356	1,206,576	482,534	679,412	24,375	406,619	1,068,000	1,474,619	
	29-Jul	1			Magnolia	1,689,110	1,265,753	423,356	1,206,576	482,534	679,412	133,250	406,619	1,068,000	1,474,619	
	5-Aug	1			Magnolia	1,689,110	1,265,753	423,356	1,378,944	310,166	679,412	133,250	406,619	1,068,000	1,474,619	
	12-Aug	1		1	Magnolia	1,689,110	1,265,753	423,356	1,378,944	310,166	679,412	133,250	406,619	1,068,000	1,474,619	
	19-Aug			Rodeo	Magnolia	1,900,788	1,265,753	635,034	1,378,944	521,844	679,412	133,250	406,619	1,068,000	1,474,619	
	26-Aug	1		1	Magnolia	1,689,110	1,265,753	423,356	1,378,944	310,166	679,412	89,250	406,619	1,068,000	1,474,619	
	2-Sep			Labor Day	Magnolia	2,112,466	1,265,753	846,712	1,378,944	733,522	679,412	89,250	441,759	1,068,000	1,509,759	
	9-Sep	1			Magnolia	1,689,110	1,265,753	423,356	1,378,944	310,166	679,412	89,250	441,759	1,068,000	1,509,759	
	16-Sep	1			Magnolia	1,689,110	1,265,753	423,356	1,378,944	310,166	679,412	89,250	441,759	1,068,000	1,509,759	
			Peak Usage		Total	33,788,507					12,908,824	987,500				

Current STATE

COMPANY NAME: Pine Water Co., Inc.

WATER USE DATA SHEET BY MONTH FOR CALENDAR YEAR 2002

metered

MONTH	NUMBER OF CUSTOMERS	GALLONS SOLD	GALLON PUMPED (Thousands)
JANUARY n	1,846	3,315,376	3,841
FEBRUARY	1,846	3,294,104	3,047
MARCH	1,853	2,965,012	2,913
APRIL	1,865	3,651,369	4,280
MAY	1,872	5,002,895	4,737
JUNE	1,885	6,605,607	3,585
JULY	1,885	5,156,652	3,478
AUGUST	1,885	4,576,358	4,655
SEPTEMBER	1,885	5,076,021	3,088
OCTOBER	1,885	4,602,227	4,102
NOVEMBER	1,885	4,046,117	2,880
DECEMBER	1,887	3,714,276	3,105
	TOTAL	N/A	43,711

52006014 CAP
56m

Is the Water Utility located in an ADWR Active Management Area (AMA)?

( ) Yes (x) No

Does the Company have An ADWR Gallons Per Capita Per Day (GPCPD) requirement?

( ) Yes (x) No

If yes, provide the GPCPD amount:_____

What is the level of arsenic for each well on your system. 0.005 mg/l
(If more than one well, please list each separately)

Note: If you are filing for more than one system, please provide separate data sheets for each system.

1100 meter did convert 1991

94 km.. Roth

COMPANY NAME: PINE WATER COMPANY, INC

COMPARATIVE STATEMENT OF INCOME AND EXPENSE

Acct. No.	OPERATING REVENUES	2002 PRIOR YEAR	2003 CURRENT YEAR
461	Metered Water Revenue	$ 662,011	$ 705,714
460	Unmetered Water Revenue		
474	Other Water Revenues	8,436	98,795
	TOTAL REVENUES	**$ 670,447**	**$ 804,509**
	OPERATING EXPENSES		
601	Salaries and Wages	$ 131,402	$ 114,698
610	Purchased Water	125,033	174,500
615	Purchased Power	36,942	31,686
618	Chemicals	604	2,512
620	Repairs & Maintenance	59,423	38,600
621	Office Supplies and Expense		
630	Outside Services	161,856	133,286
635	Water Testing	7,758	8,116
641	Rents		
650	Transportation Expenses	176,144	170,040
657	Insurance - General Liability		
659	Insurance - Health and Life	12,663	13,787
666	Regulatory Commission Expense - Rate Case		42,650
675	Miscellaneous Expense	55,761	55,210
403	Depreciation Expense	47,457	49,155
408	Taxes Other Than Income	41,363	44,186
408.11	Property Taxes	51,177	32,849
409	Income Tax		
	TOTAL OPERATING EXPENSES	**$ 907,583**	**$ 911,276**
	OPERATING INCOME/(LOSS)	**$ (237,136)**	**$ (106,767)**
	OTHER INCOME/EXPENSE		
419	Interest and Dividend Income	$ -	$ -
421	Non-Utility Income	408	
426	Miscellaneous Non-Utility Expenses		
427	Interest Expense	(7,694)	(5,625)
	TOTAL OTHER INCOME/EXPENSE	**$ (7,287)**	**$ (5,625)**
	NET INCOME/(LOSS)	**$ (244,423)**	**$ (112,392)**

Brooke Utilities, Inc.
P. O. Box 82218 • Bakersfield, California 93380-2218
Customer Call Center • P.O. Box 9005 • San Dimas, California 91773-9016 • (800) 270-6084

March 16, 2005

Jim Richey
PO Box 2379
Pine, AZ 85544

RE: Abandoned Tanks: Hwy 87 and Pine Creek

Dear Mr. Richey,

You inquiry regarding the abandoned tanks at Highway 87 and Pine Creek has been forwarded to me for response.

We appreciate your interest in the topic of future water supply for Pine Water Co., Inc. ("Pine Water") customers; unfortunately, your approach appears to demonstrate a misunderstanding of the tanks and the designed use.

The tanks located at Highway 87 and Pine Creek, known as the "filter plant tanks" are **not** potable water tanks. The filter plant tanks were owned and operated approximately twenty (20) years ago by the founder of E&R Water Co. (Pine Water's predecessor) for ditch water rights he personally owned. As you are aware, ditch water can not be used as a drinking water source, nor may the tanks which housed non-potable water supply be used for potable water supply. Upon sale of the water company, the tanks remained with the company but the ditch water rights remained with the individual.

As you know, drinking water quality is governed by federal, state and county standards. To refurbish such tanks to meet all the minimum requirements of the Environmental Protection Agency's Safe Drinking Water Act would be an extremely high and unjustifiable cost for the company and its ratepayers.

Pine Water has held discussions with SRP in the past regarding exchange of water rights as you recommended. SPR denied the proposal and citied specific reasons for such denial. We would be very interested in discussing this matter further with your SRP contact person who indicated SRP is now willing to negotiate such a trade. At your convenience,

please provide contact information to me or our public relations consultant, Myndi Brogdon, or he/she may contact us directly.

Thank you for your inquiry,

Sincerely,

Mistie S. Jared
Operations Manager

Cc: RTH, MB, DS, file

Ultraflote CORPORATION
AN ISO-9001:2000 COMPANY

Municipal Solutions

Municipal Solutions

HOME
COMPANY PROFILE
SERVICES
PETROLEUM COVERS
PETROLEUM DOMES
MUNICIPAL
ULTRAFLOTE VIDEO
CONTACT US

Ultradome

The Ultradome is a fully triangulated spherical, spaceframe structure. Its inherent design benefits such as its clear-span and self-supporting features make it ideal for Water and Wastewater applications such as the following:

- Wastewater tanks such as clarifiers to contain odors.
- Potable water tanks to prevent the contamination of the water from rust as is common with steel roofs.
- Trickling Filters to improve efficiency during severe weather.
- Sludge tanks to capture gases.

When covering treatment plant equipment for weather protection, odor control, appearance or protection against contaminants, there are several advantages to choosing an aluminum geodesic dome. The all-aluminum construction provides a structure that is light-weight, strong and durable. The geodesic design combines the advantages of a clear-span covering with the architectural attractiveness of modern geodesics.

Benefits

- Aluminum construction makes the Ultradome compatible with all the typical by-products of wastewater treatment processes.
- Low profile design minimizes space under dome to lower cost of handling air volume.
- Clear-span feature is ideal to avoid interference with tank mechanical equipment.
- Protects microbiology from freezing in cold climates.
- Will not rust, corrode, or suffer from solar degradation as other roofing materials can.
- Integral tension ring avoids adding radial thrust into the tank walls which may not have been designed to handle such loads.
- Can be built in place on such units as trickling filter media or built along side the tank and crane lifted into place.
- Low profile design can be constructed to fit under bridges or walkways.
- Aluminum construction will not drop rust into potable water tanks.

The ULTRADOME combines the self-supporting space truss geodesic design with high strength aluminum alloys to produce a strong, yet light-weight structure that is entirely supported at a peripheral tension ring. No center supports or massive foundations are required. This clear-span design accommodates a variety of equipment that would otherwise be restricted by columns.

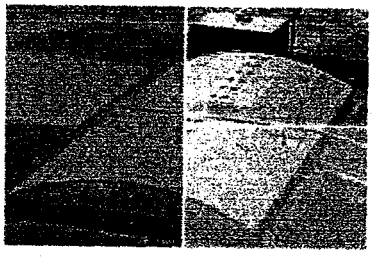
The ULTRADOME is a maintenance-free structure. Aluminum's built-in resistance to weathering and corrosion eliminates the periodic maintenance expenses of

recoating and replacement experienced with alternate roof designs.

Several options are available with the ULTRADOME, including skylights, dormers, access doors and hatches, hinged periphery access panels, ducting, venting systems, lightning protection, handrails, guardrails, platforms, stairs, and other custom designed features fabricated to customer requirements.

Geotruss

The company has developed an all aluminum rectangular basin cover, the Ultraflote Geotruss, that utilizes much of the same proven technology of the aluminum geodesic dome, the Ultradome. The all aluminum construction is virtually maintenance-free, weather-resistant and compatible with the typical by-products of water and wastewater tanks. The Ultraflote Geotruss is a clear span, self-supporting structure that applies only vertical loads into the tank sidewalls. Its lightweight construction also minimizes tank wall loadings.



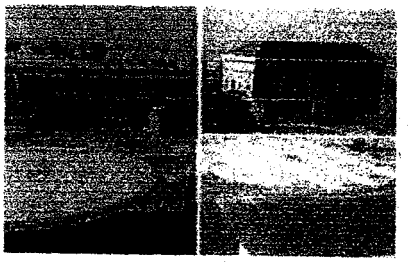
The Geotruss protects the microbes and the tank interior equipment from the harsh weather and also contains odors which would otherwise escape to the atmosphere.

The Geotruss can be custom designed with many of the company's special accessories such as dormers, skylights, walkways, vents, ductwork, walls, etc.

Quad Seal™ Flat Cover

The Ultraflote Quad Seal Flat Cover is ideal for your odor control applications. Constructed of custom extrusions welded around the perimeter of heavyweight flat aluminum plates (either diamond tread plate or mill finish) forming a strong yet lightweight, corrosion resistant structure. The extrusions are designed to form a unique interlocking seam between the panels and between the panels and their supports. Panels can be designed to cover large spans of up to 38 ft and may be truss supported for even larger applications.

Our novel "A" frame aluminum support trusses are intrinsically stable and can be designed for virtually any span/loading combination without subjecting the existing equipment to unplanned loadings.



The Quad-Seal Batten seam design provides a completely air tight seal for odor control. This design allows for addition of optional hidden latches that lock the panels tightly together yet are quickly and easily released for access under the panels. Lifting handles are also built in along the ends of every panel.

▲

Ultraflote Technology = Ultimate Quality

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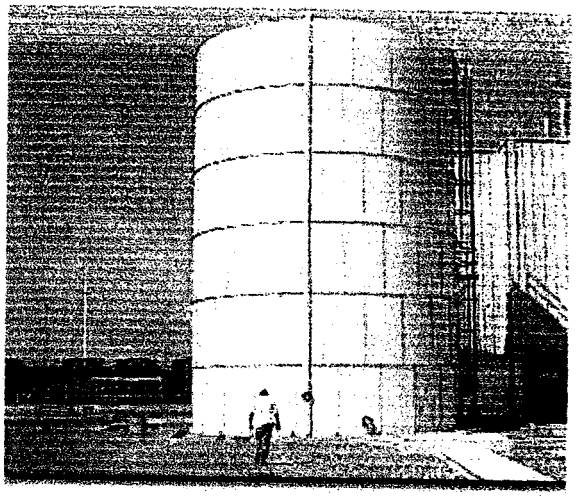
Fab-Seal Industrial Liners, Inc. 1-800-874-

Custom Fabricated Liners for Lining of Vessels, Tanks, Pits
Ponds, Lagoons, Reservoirs, Berms, Sumps, Landfills, etc.

Water Tank Liners

Fab-Seal offers N.S.F./Ansi Standard 60 or 61 approved flexible membrane liner systems for tanks, clear wells, water vaults, chlorine, aluminum sulfate, and waste water tanks.



Potable Water Tank

Fab-Seal Industrial Liners, Inc is N.S.F./Ansi Standard 60 or 61 approved! See our Certificate.

Fab-Seal's liner systems are fabricated in our factory using dielectric sealing of the same material. Thi lets all seams have the same flexibility and strength as the sheet of mate

Fab-Seal Specializes in:

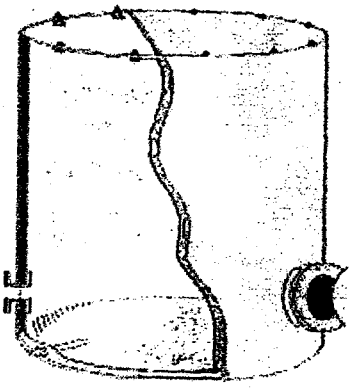
- **Potable Water Tank Liners**
- **Steel and Fiberglass**
- **Concrete Cisterns**
- **Clear Wells**
- **Underground Water Storage Vaults**

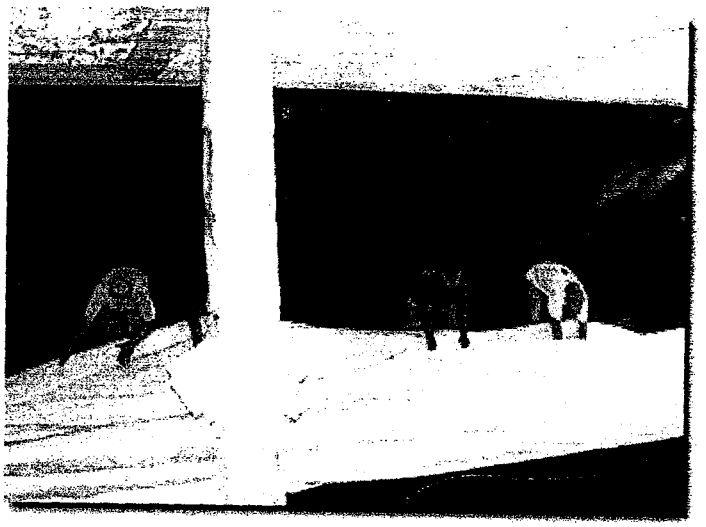
Typical Water Storage Ti

Fab-Seal's internal liners are mechanically held and become the primary containment with the tank becoming the secondary containment, with leak detection monitors for insured protection.

What Are Leak Detection Monitors?
Leak detection monitors are valves installed into the tank wall just above the floor that can be opened on a scheduled

basis to monitor the liner integrity.

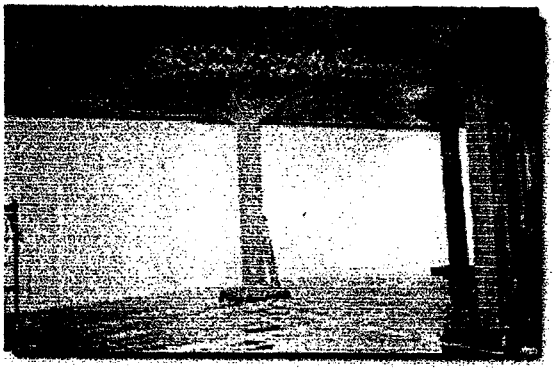




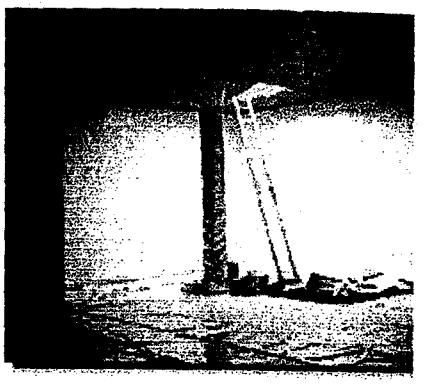
NSF/ANSI Standard "61" Approved

Specifications

Specific Gravity	*ASTM D 1505*	*1.27*
Durometer(A-scale)	*ASTM D 676*	*76*
Tensile Strength (PSI)	*ASTM D 683*	*2200 (minimum)*
Elongation, %	*ASTM D 683*	*400 (minimum)*
100% Modulus, PSI		
Elongation (PSI)	*ASTM D 683*	*930 (minimum)*
Low Temprature Impact, C	*ASTM D1043*	*-26*
Volatility (%)	*Activated Carbon 24 Hrs 87 degrees C*	*1.7*
Water Absorption (%)	*ASTM D*	*0.25*



Picture shows clear well liner
before the columb cover was installed



Picture shows suppor
columns with water tight c
(100% Potable Water Contai

ALTERNATIVES STUDY COMMITTEE
PINE / STRAWBERRY WATER IMPROVEMENT DISTRICT
P.O. Box 134
Pine, Arizona 85544-0134

April 16, 2005

REPORT JB2 – Review of Water Supply-Demand Parameters

REFERENCE: "WATER SUPPLY AND DEMAND FOR THE PINE/STRAWBERRY WATER IMPROVEMENT DISTRICT, GILA COUNTY, ARIZONA " Adopted by the District Board of Directors, February 8, 2003

The referenced PSWID parameters document, adopted in 2003, was based upon long-range planning statistics and projections for Gila County that do not reflect the land availability and zoning constraints found in the Pine/Strawberry communities. The total build out quantity of homes, listed as 7949, exceeds the current number of approximately 4900 property parcels, and seems to exceed the reasonable consideration of subdividing and splitting of the remaining parcels in the future. The culture of the community supports limiting the development to a percentage of the current parcels at full build-out, as evidenced by property owners holding multiple parcels, vacant and adjacent to their residences. Larger parcels of undeveloped land may be adequate for a few hundred additional residential units in the area. Land swaps with the NFS and high density zoning do not seem to be realistic considerations. Therefore, the projected number of homes should be set at 5500 homes, for planning and funding of the water supply. In addition, planning should consider using a further reduction of the number at a full build out of 80%, = 4400 homes.

The "Water Demand Factor" of 375 gpd adopted by the PSWID should be retained as a target capacity factor of the community full time demand of the residential occupancy and normal commercial support services,.

Resort and summertime peak consumption are heavy demand factors on the water supply. Therefore, the evaluation and the projection of "equivalent residential units" (ERU) should be retained. The planning number of 4400 homes for the capacity factor should be increased by an initial quantity of 424 ERU and doubling to 848 ERU over a period of twenty-five years, when the full commercial resort and cultural development of the community is expected to mature. This capacity factor is allocated in addition to the 375 gpd gross consumption factor but is applied only during the "100 days of summer" season, May 15 – Sep. 15, to serve the demand from the additional level of resort/commercial activities.

The community has exhibited a strong conservation ethic, and even when the supply of water is not constrained, the actual consumption per household is low when compared to other Arizona communities. The two parts of the community have both exhibited this conservation ethic. While Pine has been under restricted summertime usage, Strawberry usage has only been a consistent 4% higher level per household over the full year, both summer and winter. Therefore, two water demand parameters should be utilized when planning the capacity and revenues of water delivery. Instead of rating the capacity requirement initially at 375 gpd per residential unit, the capacity factor should be set to an initial 150 gpd and increasing to the full 375 gpd over a period of fifty years. For funding and revenue planning, the revenue factor should be set to an initial 58 gpd increasing only to 220 gpd over a period of fifty years (year 2055). The additional ERU adjustment may be used with the revenue factor.

The total unrestricted water production estimated for year 2005 for the various water companies and domestic water improvement districts in Pine and Strawberry is 66 million gallons. The daily water production rates, reported in the PSWID parameters document of 2003, appear to have been calculated from reported pump output values, in gallons per minute, which may not have been sustained under prolonged duration of pumping. The document should be revised accordingly.

For the revised version (proposed), see File:
"PSWID Water Supply-Demand Revised 04-21-05.doc"

Respectfully submitted,

Glenn L. Brown, Chairman
Alternatives Study Committee

John O. Breninger, Member
Alternatives Study Committee

PINE / STRAWBERRY WATER IMPROVEMENT DISTRICT
P.O. Box 134
Pine, Arizona 85544-0134

April 21, 2005

Revised Water Supply and Demand for the Pine and Strawberry Area of Gila County Arizona 2005 - 2055

REFERENCE: "WATER SUPPLY AND DEMAND FOR THE PINE / STRAWBERRY WATER IMPROVEMENT DISTRICT, GILA COUNTY, ARIZONA", Adopted by the District Board of Directors, February 8, 2003

SUMMARY: Arizona is a desert state where water is continually becoming more scarce as we place more demand on current sources of supply. The Pine/Strawberry Community, with emphasis in Pine, has experienced the limitations of its groundwater that supports the current well field system. It should be expected that water conservation measures would always be necessary but not the severe limitation they have been up to the present. An adequate water supply can and should be developed to meet the expected growth in population through the year 2055. A study for the PSWID entitled, "Investigation of Groundwater Availability for the Pine / Strawberry Water Improvement District" was completed in August 2003. This study has given insight about the performance of the current well field and has identified a potential new source of adequate water supply to meet the demands of this Community. The supply and demand parameters of the referenced prior document have been revised to better reflect the current and future needs, in agreement with a reasonable water conservation ethic. These revised parameters describe the requirements for the Supplemental Water Supply to augment the production from the present groundwater well field.

DISCUSSION: The referenced document was reviewed as the PSWID's expression of water supply and demand assessment for this community. This review indicated a number of positions that seem to be inappropriate to and inconsistent with the current conditions in the community. An evaluation of alternative sources of supply revealed that the parameters of the prior document gave results that were not reasonable nor realistic in describing the present and future supply requirements and potential demand of the Community

The revised parameters are:

1) Water Demand Factor - **PSWID defines as 375 gpd per residence, with additional allowances for commercial and peak usages on holidays and weekends.**

2) Demographics of Home/Population – PSWID defines water demand based upon two parameters: A) number of service connections, and B) daily demand value per connection.

The 2005 current number of parcels ~4900, and is projected to grow to a maximum of 5500, and an assumed build out of 80% by 2055.

A) Number of Service Connections:

	Year 2005		Year 2055
Within PSWID Area, Residential	3000	2000 Pine	4000 @ 80%
Beyond PSWID Area, Residential	140	1000 Strawberry	400 @ 80%
Totals	**3140**	140 3140	**4400**

(This assumes no significant changes in zoning practices, no increase in land area due to land swaps with the National Forest Service, and maintaining the current rural mountain resort community culture with many part-time residents and a consistent conservation ethic.)

B) Daily Residential Demand per Connection:

	Year 2005	Year 2055
Per Constrained Usage @ 2.3 persons	116 gpd	220 gpd
Per Normal Usage @ 2.3 persons	**150 gpd**	**375 gpd**

(The "Constrained Usage" represents the projected demand pattern, under a strong conservation ethic. "Normal Usage" provides for transition into the more typical demand pattern exhibited in rural Arizona.)

3) Resort/Commercial Demographics in Equivalent Residential Units - PSWID allots an additional quantity of "Equivalent Residential Units" (ERU) to the quantities of connections, increasing to a maximum over the next 25 years, based on the 2003 document analysis

	Year 2005	Year 2030
ERU Additions	424 Units	828 Units

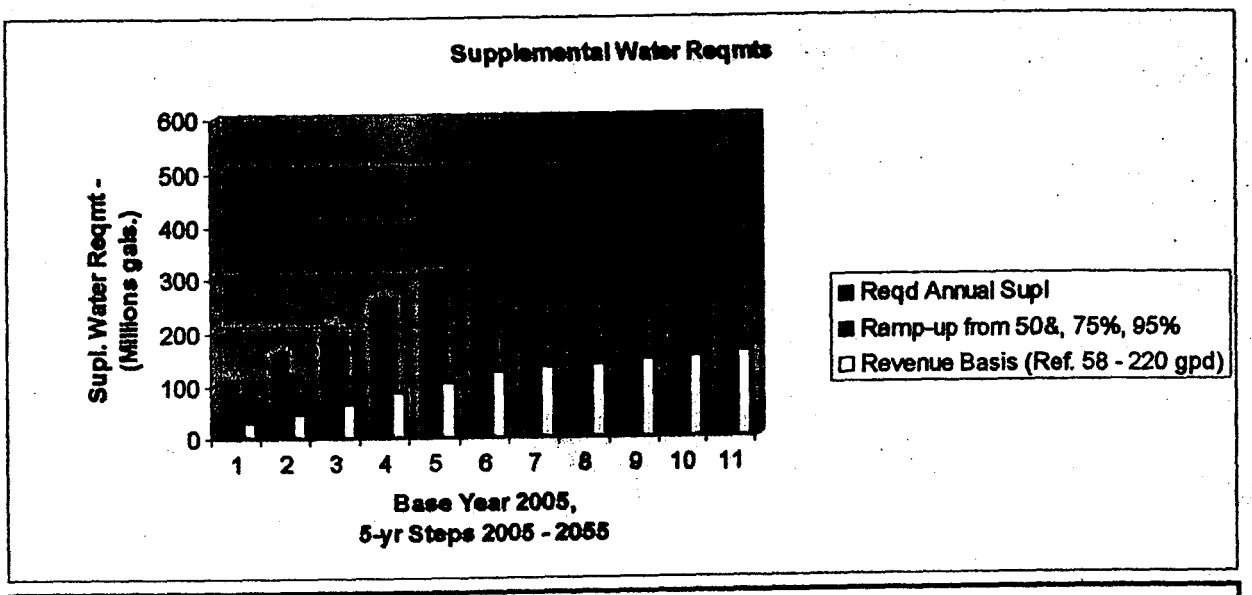
This factor may be used when projecting water supply capability and consumption under summertime demand, but may be omitted when evaluating the potential revenue for financial analysis. (This provides a surer mechanism for allocating demand for holiday and summertime impact than attempting to estimate full vs. part-time residency and the influx of residential guests. Recent data suggests that the part time consumption per connection, the part time frequency and duration of demand, and the percentage of part time occupancy are all on the increase relative to full time usage.)

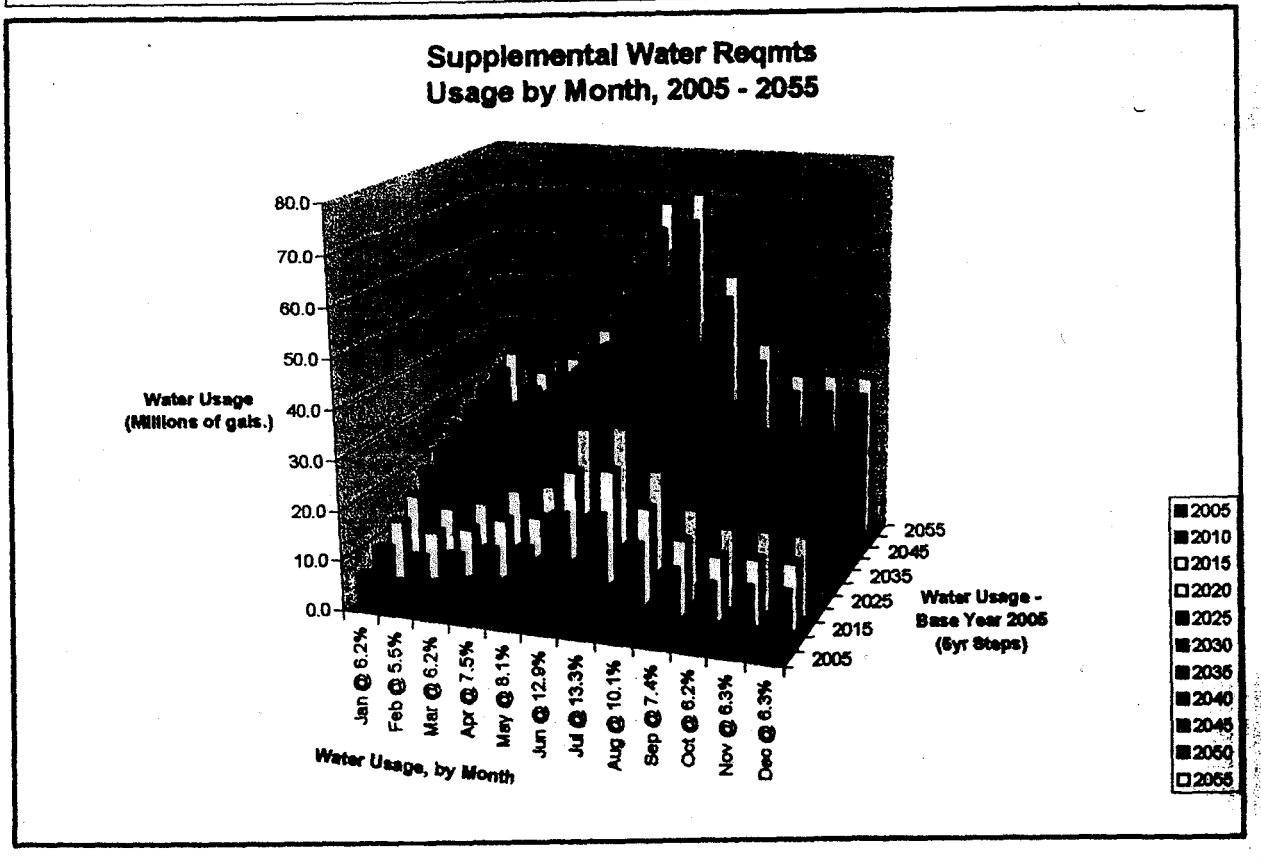
4) Assumptions of Water Supply Capability – The previous PSWID position stated "Average daily water production as reported by Pine and Strawberry Water Companies over the past four years equals 680,000 gallons per day, or 472 gallons per minute. Estimated water production of the one additional private water company, and the four domestic water improvement districts is 149,625 gallons per day, or 104 gallons per minute. Total annual water production was then estimated as 302,959,000 gallons." The assumptions for this calculation from gallon per minute (gpm) to gallons per year were not consistent with recent actual consumption figures, reported over the past ten years. These reports have indicated that total production/consumption was less than 60 million gallons per year for both Pine and Strawberry, and declining. This occurred while the wells in Pine were pumping at a declining capacity while the number of meters was steadily increasing in both areas.

A) Avoid the interpreting of instantaneous pump output ratings in gallons per minute (gpm) on an annual basis, except as supported and modified by long-term and continuous pumping operations.

B) Total current annual water production by all the local purveyors is estimated for 2005 as 66,000,000 gallons. [Estimated value is based on various substantiated reports of recent past water deliveries and production and is projected forward into 2005.] **"Supplemental Water Requirements"** is the difference between the annual water production and the projected water demand.

C) Current values are available to define the monthly consumption values and the ratios against the annual water demand projections. **See Charts below for the projected demand values:**





5) Correlation of Water Demand/Consumption – The prior PSWID position did not clearly describe any difference between "demand" and "consumption".
Utilize two separate parameters, as follows:

Demand: water production capability that is adequate to serve the distribution of water volume to meet the rated 375 gpd per residential unit and reasonable peak demands typical

of the residential /resort culture of the community, as well as replacing reasonable and/or emergency water losses.

Consumption: water consumption that produces revenue used to fund the operations and maintenance of the system, recovery of investment costs, allowances for reserves and depletion, The resulting revenue stream may be used as a basis for financial analysis of the implementation and operation of the supplemental water system, as well as the rate structure for sale of water.

[Adopted by the PSWID Board of Directors, April 21, 2005.]

Replaces: "WATER SUPPLY AND DEMAND FOR THE PINE / STRAWBERRY WATER IMPROVEMENT DISTRICT, GILA COUNTY, ARIZONA", Adopted by the District Board of Directors, February 8, 2003

Response to Breninger and Brown memo of May 19, 2005

It should be noted that PSWID purpose it to examine alternative to improve the water situation in Pine/Strawberry Area. For comparison purpose, they have decided to use the wholesale operating cost of water/1000 gals for this evaluation. The real problem is Pine outages and service growth and expansion issues as the ACC and Brooke Utilities has addresses in various forms. To solve this issue requires capital, the sub committee has asserted that $1,560,000 needs an additional $1M for cost of money to bring it to $2,560,000. If the capital is paid by a bond this might be the case. But in this case all the capital burden is by a CAP allocation that is sold for $3-4$Million dollars or a five year lease paid by the water consumer. Also, they have decide that 4 months of the winter should not be included in the cost of water which would reduce the wholesale cost to less than $10/1000 gallons. It turns out the Pine Water Co. buys sufficient water to support Pine now during the summer. Hauling can not prevent outages because of Peak Demand. The current storage system is insufficient to support the PEAK DEMAND. Event if you had wells that could produce all the water Pine needs your could not deliver it due to storage limitations. Supplement storage is required to avoid summer outages. A study must be conducted to determine the effects of winter resting. The comments about "if you don't use it, you will lose it" is a non-qualified statement. Only biased opinion might state this as fact. Only a study can confirm whether underground storage is an additional storage method or not.

How do we know this?

Summertime re-fill could possibly be made from Strawberry wells. This seems to be a political charged discussion by some members of the sub-committee. It should be understood that "water take" from Strawberry would be REDUCED by 10+ acre-ft during the winter months and only 1+ acre-ft INCREASE is needed in the summer over current levels. Strawberry would yield a net 9+ acre-ft per year.

RECEIVED
JUL 5 2005
BY:

ALTERNATIVES STUDY COMMITTEE
PINE / STRAWBERRY WATER IMPROVEMENT DISTRICT
P.O. Box 134
Pine, Arizona 85544-0134

March 30, 2005

Report on Water Supply and Demand (PSWID Model Document))

REFERENCE: "WATER SUPPLY AND DEMAND FOR THE PINE/STRAWBERRY WATER IMPROVEMENT DISTRICT, GILA COUNTY, ARIZONA", Adopted by the District Board of Directors, February 8, 2003

SUMMARY: The evaluation of the various alternative sources of water supply for the Pine / Strawberry community has been assigned to the PSWID Alternatives Study Committee by the PSWID Board of Directors. The Committee, in applying the PSWID positions on water supply and demand per the model document, identified five main parameters contained therein, retaining one, the Water Consumption Factor of 375 gpd, and modifying the remaining four. The Committee will propose a revision of the referenced document accordingly, and recommend adoption of the model document that will establish the evaluation parameters as described below.

DISCUSSION: The referenced document was reviewed as the PSWID's expression of water supply and demand assessment for this community. This review indicated a number of model positions that seem to be inappropriate to and inconsistent with the current circumstances of the community. The evaluations of Alternatives by this Committee may include the conceptual project descriptions, technical parameters and financial feasibilities that should be based upon, and be consistent with, the positions of this report. Applying these positions to the evaluations gave results that did not appear as reasonable or realistic in describing the present and future measures of water consumption. For further discussion, see. [1]

The critical model positions that were reviewed were:
1) Water Consumption Factor - **PSWID defines as 375 gpd per residence, with additional allowances for commercial and peak usages on holidays and weekends.**
Review recommends: **SAME.**

2) Demographics of Home/Population – **PSWID total build out quantities under current zoning:**

Strawberry	**2559**	**Homes**
	2431	**People**
Pine	**5390**	**Homes**
	5121	**People**
Total	**7949**	**Homes**
	7552	**People**

(There seems to be no adequate justification for an increase in quantity of property parcels to provide for 7949 homes from the current quantity of ~4900. Large parcels of land for subdivision

5) Correlation of Water Demand/Consumption – **PSWID position does not clearly describe any difference between "demand" and "consumption".**
Review recommends: **Utilize two separate parameters, as follows:**

Demand: water production capability that is adequate to serve the distribution of water volume in excess of the rated 375 gpd per residential unit and reasonable peak demands typical of the residential /resort culture of the community, as well as replacing reasonable and/or emergency water losses.

Consumption: water consumption that produces revenue used to fund the operations and maintenance of the system. The resulting revenue stream may be used to evaluate the financial viability of the implementation and operation of the water supply system, as well as the rate structure for sale of water.

End of Review/Recommendations.

REF: 1) FILE: Review PSWID Supply-Demand Parameters.doc

Respectfully submitted,

Glenn Brown,
Ch. Alternatives Study Committee

John Breninger,
Committee Member

Response to Breninger and Brown memo of May 19, 2005

It should be noted that PSWID purpose it to examine alternative to improve the water situation in Pine/Strawberry Area. For comparison purpose, they have decided to use the wholesale operating cost of water/1000 gals for this evaluation. The real problem is Pine outages and service growth and expansion issues as the ACC and Brooke Utilities has addresses in various forms. To solve this issue requires capital, the sub committee has asserted that $1,560,000 needs an additional $1M for cost of money to bring it to $2,560,000. If the capital is paid by a bond this might be the case. But in this case all the capital burden is by a CAP allocation that is sold for $3-4$Million dollars or a five year lease paid by the water consumer. Also, they have decide that 4 months of the winter should not be included in the cost of water which would reduce the wholesale cost to less than $10/1000 gallons. It turns out the Pine Water Co. buys sufficient water to support Pine now during the summer. Hauling can not prevent outages because of Peak Demand. The current storage system is insufficient to support the PEAK DEMAND. Event if you had wells that could produce all the water Pine needs your could not deliver it due to storage limitations. Supplement storage is required to avoid summer outages. A study must be conducted to determine the effects of winter resting. The comments about "if you don't use it, you will lose it" is a non-qualified statement. Only biased opinion might state this as fact. Only a study can confirm whether underground storage is an additional storage method or not.

How do we know this?

Summertime re-fill could possibly be made from Strawberry wells. This seems to be a political charged discussion by some members of the sub-committee. It should be understood that "water take" from Strawberry would be REDUCED by 10+ acre-ft during the winter months and only 1+ acre-ft INCREASE is needed in the summer over current levels. Strawberry would yield a net 9+ acre-ft per year.

RECEIVED
JUL 5 2005
BY:

ALTERNATIVES STUDY COMMITTEE
PINE / STRAWBERRY WATER IMPROVEMENT DISTRICT
P.O. Box 134
Pine, Arizona 85544-0134

May 19, 2005

REPORT JB6 – Refurbish Pine BUI Storage Tanks – CAP Water Exchange

REFERENCE: Alternative JB6, Stream/Storm Water Runoff & Storage/CAP Allocation Study, James Richey (Pine resident and PSWID Volunteer), V4.0, 4/14/05

SUMMARY: – The PSWID Alternatives Study Committee has reviewed the referenced proposal to provide increased storage of water in the Pine area by means of re-furbishing three existing storage tanks previously used to accumulate irrigation water, pump water out of the Pine Creek bed, and deliver it via a pipeline into the infrastructure of Pine Water Co. The principal purpose was to provide added storage in a system that could provide water insertions during the short term peak shortages of water in Pine while the existing system continued to operate at capacity. A preliminary conceptual cost/revenue structure has been prepared by Mr. Richey to evaluate the potential feasibility for such a project. Other than acting as a facilitator/investor, it is not apparent that PSWID has a part to play in implementing this proposal – the operative principals are BUI/Pine Water Co., ACC, CAWCD (CAP water), and SRP. However, the PSWID Committee defined a project implementation, for comparison purposes, to amortize the project capital and operational costs, including the tentative wholesale cost of water (dollars per thousand gallons) for this evaluation.

DISCUSSION:

The PSWID Committee is currently evaluating all available options on an equal basis, in order to give a firm recommendation on the best and first priority option to pursue. We feel strongly that what is best for Pine and Strawberry within the means available to us must predominate, and in the end, PSWID must act on the one option that will serve us best. Time is critical and money will be a stumbling block to address the option yet to be selected

This proposal is highly desirable for providing additional water from a new second source and providing a system to further bridge summertime peak demands. If means could be found to refill the tanks for several additional cycles in the summertime, it could then better keep up with the projected growth of the community. Under the present proposal with a single storage cycle available, it falls short by 20% of the amount of water trucked for Pine in 2003.

PRELIMINARY PROJECT SCENARIO (See referenced report for details)

The referenced report, in addition to helping bridge the summertime peaks, proposes the capability to take Pine Creek water during the remaining eight months on an "as available" basis and allow the reduction in demand on the Pine wells and water transfers from Strawberry via the Magnolia pipeline. The effect to improve the performance of the Pine wells by "resting" their pumping in the off season is unknown. Past experience has not indicated positive results from the "resting", but only from discontinuing the extended periods of continuous summertime pumping. Hydrologists have repeatedly stated that after the recharge of the limited storage in fractures in the rock, "...if you don't use it, you will lose it," as it continues to percolate down to lower

levels, possibly the R-Aquifer, where it then flows back under the Rim because of the slant of the strata.

The Committee did not consider the six months actions to feed the surface water into the Pine Water Co. system because there was no verifiable tangible benefit and it only added to the costs.

Evaluation Summary:

The cost analysis was performed, assuming a BUI buyout in the second year, with PSWID providing the up front investment and fulfillment of the contractual agreements among the principal parties. The Cost Parameters, shown below, do not indicate a continuing PSWID operation of the system after the second year. The Richey JB6 proposal has a lower Total Capital Cost of $1,531,500, with a lease arrangement at 10%, and spreads the cost as an even charge assessed against each Pine Water metered household at $17/mo. for five years, then reducing to $5/mo. For comparison with the other Alternatives under evaluation, it was necessary to reduce the costs to an equivalent $$/1000 gals. The PSWID project costs include funds for legal fees, other lesser project costs, and cost of bonds at 8% for the two-year assumed life of the PSWID operation.

There may be other developments, now under discussion in the MRWRMS Group, that may provide additional Blue Ridge Reservoir water into Pine Creek, which has the potential to increase the number of storage cycles for this system. The Committee viewed that as a long-term (5-10 years) consideration. Also, this proposal could be considered in conjunction with the Alternative JB7 (Surface Reservoir in Pine), but that does not improve the economic viability.

STRONG POINTS:

1. Addresses the current summertime peak demand shortages
2. Brings new surface water into the Pine system through the CAP allocation of Pine Creek waters.

RISKS & NEGATIVE POINTS:

1. Reliability is rated "B-Moderate" to "C-Marginal", (based on un-availability of water to refill tanks in Pine Creek in summertime).
2. After all investment costs are recovered, cost of delivered water is still higher than trucked water ($67 vs $38-45 / 1000 gals.)
3. Currently no known source of water to re-fill storage tanks in summertime after first cycle of storage is exhausted.

ALTERNATIVE JB6

COST PARAMETERS: (PSWID Project & Investment)

Project Implement (incl. cost of money @ 8%)		$2,560,000
After Pay-off of Investment, Annual Operating Costs (6-mos. period)	@	$55,758/yr
Storage Capability	(1 storage cycle per season)	822,000 gal/yr
Cost per 1000 gal:		$67 / 1000 gal.

Notes:

1. 6-months Project Lead + 4 months Construction Lead = 10 months total lead time

Respectfully submitted,

/s/

Glenn L Brown, Chairman
PSWID Alternatives Study Committee

/s/

John O. Breninger
Member, Alternatives Study Committee

ACRONYMS & TERMINOLOGY:

1. ACC – Arizona Corporation Commission (Regulation of Water Utilities)
2. BUI – Brooke Utilities, Inc. (Current holder of Pine CAP Water Allocation)
3. CAP – Central Arizona Project (Colorado River water to Arizona)
4. CAWCD – (Administrator of CAP water allocations)
5. MRWRMS – Mogollon Rim Water Resources Management Study Group
6. PSWID – Pine/Strawberry Water Improvement District.
7. SRP – Salt River Project (Senior water rights holder to water in Pine Creek downstream from the Hwy 87 bridge – party to a potential CAP water Exchange)

END

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OVERSIZED MAP

SEE SUPERVISOR (EXHIBIT CABINET)

BOX 17

21

OVERSIZED MAP

SEE SUPERVISOR (EXHIBIT CABINET)

Box 17

22

Project Maverick

Preliminary Evaluation for: Brooke Utilities, Inc

October 5, 2005

Lake at Camp Geronimo Boy Scout Camp, used for camp activities such as canoeing.

Information brought to Brooke Utilities, Inc (BUI's) by Harry Jones, water information specialist for Gila County brought about this preliminary study of the possibility of gaining water from Camp Geronimo, operated by the Boy Scouts of America and Bray Creek Ranch, a private residence owned by a partnership for use in the Geronimo Estates and Elusive Acres areas.

Geronimo Estates currently has 70 meter connections and Elusive Acres has 13 for a total of 83. Both are under a complete meter moratorium. According to Gila County the potential build out will not exceed 260 home sites, 30 in Elusive Acres and 230 in Geronimo Estates.

This report is strictly a preliminary look at evaluating the water source, and cost of its availability. Further evaluation is necessary to determine sustainability and quality.

AVAILABILITY

Both Camp Geronimo (CG) and Bray Creek Ranch (BCR) have a surface water right that predates Salt River Project's water right.

Each entity has voiced an interest in selling 'excess water' to BUI. What they define as excess water is water they are allowing to run into surface creeks after they take what they need for the property. This water is not available to these entities to sell. It would require further research into downstream rights holders, primarily United States Forest Service (USFS) and Salt River Project (SRP). Both of these agencies have indicated that is 'possible but not probable' and would likely involve a Central Arizona Project (CAP) trade and an extensive Environmental Assessment of the creeks affected.

BUI would then be paying CG and/or BCR for the use of their facilities to capture this 'excess water' – in effect paying twice for a water source.

To make water available for sale to BUI, CG and/or BRC would have to prove a historical and beneficial use on the property. Then they would have to prove a reduction in that use. That reduction would be the only right they would be able to sell to BUI. To effect that sale SRP would have to oversee and approve a 'sever and transfer' of the water right from them to us. This requires going before the Board of Directors with the information and request.

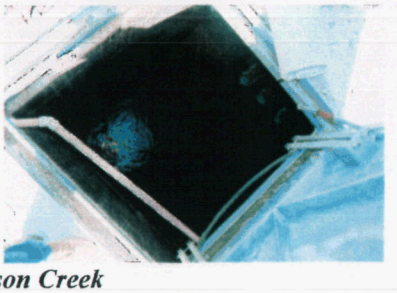
In an estimate of water available to these two alternatives, CG estimates a possible 5-10 acre feet per year available to BUI, of again what they call 'excess water'. BCR estimates 30-40 gpm coming from Bray Creek without much in the way of monitoring or metering what has been in use on the property. Both of these figures are rough estimates that would require closer scrutiny as to how much is truly available based on the criteria set forth above.

CG has plant in place that captures most of the water from Horton Creek and Poison Creek* sending the water via a two and a half mile, 4" pipeline to storage tanks at the Camp. This pipeline is above and below ground, making it very susceptible to breaks, freezing and other hazards. Each spring feeds a different set of storage tanks.

Horton Creek feeds the camp hosts personal home and small pond and has no existing treatment facilities.

Spring Box at Horton Creek

Storage tanks for Horton Springs



Spring Box at Poison Creek

Poison Creek (also known as Geronimo Creek) feeds into another system that feeds the main camp. Before being distributed to the users at the camp the water travels through a filtering plant and chorine is added. Camp officials state this exceeds current ADEQ standards. This system exists because the majority of their users are children. The unused water fills a lake on the property being used for camp activities.

Storage tanks and treatment facility for Poison Springs

The plan as they see it is for us to utilize their plant connecting the two storage systems into one, in effect treating all the water and connecting a pipeline for BUI at the Poison Springs storage tanks.

The pipeline would conceptually follow the camp road for two miles, cross the Control Road (a forest service road deemed an archeological/historical site per USFS this adds a lot of cost to the project) and continue for another 1 to 1½ miles to a connection site into the BUI systems. This requires an Environmental Assessment (EA) of the area with one of the biggest obstacles being identified as the crossing of the Control Road.

BCR has less plant available and has been attempting to create pipelines to sell bottle water off of this site with little to no luck. Creating a pipeline here for BUI purposes would be a greater hurdle to cross at a much greater cost for less available water.

COST –

Based on the amount of legal, operations, engineering and administrative work necessary, rough estimates run $10,000 to $50,000 just to determine the legal availability, sustainability, water quality and the ability to transport water from these sources.

An EA for the CG pipeline would take two to three years at best and cost in the "tens of thousands of dollars" according to USFS with the outcome unpredictable. The assessment for a pipeline from BCR was deemed even less likely to be approved and more costly based on distance and the amount of interference with the Control Road.

Cost for plant materials have been estimated at $30 per foot for an 8" pipeline running approximately 3 miles or 15,840 feet equaling $475,000.

- SUMMARY

Costs for this project would very likely exceed $500,000. This does not include the charges from either CG or BCR for the use of their plants and/or cost of water or ongoing costs of maintaining the system.

While attractive in its ability to solve a long-term water shortage in the Geronimo Estates and Elusive Acres developments this project lacks economic feasibility. At best this development will have 260 meter connections, less than half of which will be full-time residents.

Respectfully Submitted,
Myndi J. Brogdon
Community Relations Consultant
Brooke Utilities, Inc.

RESOURCES

Harry Jones, Water Information Specialist Gila County
Rod Byers, Lands/Minerals Staff Officer United States Forest Service
Greg Cornrupp, Senior Analyst Water Rights & Contracts,
Salt River Project
Mogollon Rim Water Resources Management Study
Eric Heiser, , Environmental Water Quality Attorney and Board Member in charge of facilities for the Grand Canyon Council of Boy Scouts of America, the camp owners.
Ted Juilius, Camp Geronimo Site Manager
Mike Johns, Bray Creek Ranch owner, partner.

**** Did you know that there are over 100 springs in Arizona named 'Poison Springs'? Early ranchers did this in hopes that other settlers would think the springs dangerous and not use them.***

Bob Hardcastle

From: Bob Hardcastle
Sent: Thursday, August 25, 2005 10:35 AM
To: 'harryjoneshdj@earthlink.net'
Cc: 'Myndi Brogdon'
Subject: RE: Excess Spring Water Near Geronimo Estates; Star Valley Issues.

Harry-

As always thanks for the information. No, we have not been further contacted by any of the Coalition parties in Star Valley. That's fine with me.

Your other comments regarding alternative water supplies for GE/EA are also interesting. Some of the information we are previously aware of as part of our previous investigations. Because ownership of water rights is always a problem I always considered SRP's surface water position to be as rigid as others that we are both aware of. I am hopeful that your optimism regarding SRP's position with these areas is more malleable. As measured year-over-year I am *very* surprised there is that much stream flow despite last winter's unusually high precipitation levels.

I have appointed Myndi Brogdon to be our point person on this matter. I think this makes sense because of her existing involvement with the MRWRMS parties, her local familiarity, and her availability. We are concluding a long summer of constant management, adjustment, and monitoring of fragile water systems. A project of this nature is difficult to staff with internal resources under such circumstances. MB will make local contact with the areas, the USFS, and other parties. She'll extensively record these activities on digital pictures. I'm going to give her a fair amount of latitude on this project. MB will not be able to commit BUI to a course of action but will have significant involvement in any conclusion we make. In advance of her contacts I will make contact with both Messrs. Hiser and Johns indicating our interest and advising them of MB's involvement. We make no assumptions that the hydrology or economics of this potential water supply alternative will, in the end, justify themselves. It is, however, worth a close look to see what may be available.

I have asked MB to provide me a thorough report not later than October 5 regarding this matter. I would appreciate your cooperation with her as required.

Thanks, again, for the information.

RTH
Robert T. Hardcastle
Brooke Utilities, Inc.
P.O. Box 82218
Bakersfield, CA 93380-2218
(661) 633-7526 phone
(661) 823-3070 fax
RTH@brookeutilities.com

8/25/2005

Bob Hardcastle

From: Bob Hardcastle
Sent: Thursday, August 25, 2005 10:10 AM
To: 'Myndi Brogdon'
Subject: Project Maverick

MB-

Ok, here's how I want to proceed. We'll consider you project manager of this project. I want you to become the expert on these areas by the time we're done. However, this work cannot be accomplished at the expense of the other things you're working on. As always I want to keep time, costs, and expenses as low as possible. I'd prefer to see lots of applicable digital pictures. I also want separate monthly billings for your time involvement on this project. I can be as involved as you require.

I don't want to assume a solution is present until we thoroughly examine the available hydrology and economics of any solution. I will follow up this message with a reply message to HJ indicating your involvement. You are not in a position to make Company commitments but, rather, are collecting all the information possible for us to make a later judgment as to how to proceed and include a thorough discussion in our ACC report. I'd like to see a written report on this matter no later than October 5, 2005.

As indicated in HJ's message I will, later today, attempt to make contact with Hiser and Johns indicating our interest in looking at the water supply prospects of these areas. I will introduce you as our local contact and ask them to expect your later contact regarding this matter. I am not sure how much background, knowledge, and experience Dean has with any of these areas. He always surprises me as to his familiarity/knowledge of some of these remote ideas.

This is like investigative reporting. We know there is a story - we just don't know where (or if) it will lead us anywhere. We must be prepared to conclude these prospective ideas will not make sense.

Initially, this project prompts many questions from me as follows:

(1) On an annual basis over many years how much water is available from any of these sources?
(2) Who owns the water rights to the creek flow?
(3) Is there recorded proof of their water rights?
(4) Where does the current excess water go?
(5) Will our taking of excess water flow effect downstream users?
(6) If so, to what extent? Does an EA have to be prepared to use any of this water for our water customers?
(7) How much will the water cost from the current rights holders?

(8) **How was the price of the water determined?**
(9) **What do recent water quality lab report results indicate?**
(10) **What will it take to move water from the creek to where we need it south of the Control Rd.?**
(11) **What involvement does UFSF have?**
(12) **What requirements will the USFS have for us using, and moving, this water to GE/EA?**
(13) **What is the future growth potential in GE/EA is the current meter moratorium was lifted?**
(14) **Does moving this water to GE/EA make economic sense?**
(15) **What involvement does SRP have with excess surface water?**
(16) **Is SRP just going to let us take and move excess water to areas where we need it?**
(17) **How long will it take to accomplish an infra-structure project to deliver this water to GE/EA if proved feasible?**
(18) **What are the alternatives of this project compared to the proposed BRR pipeline in the future?**
(19) **Is there any opportunity to use excess water in other locations?**
(20) **What is the source of the water?**

I can probably easily think of another 20 questions over lunch. These issues, however, will probably get you started. Remember, on October 5 I'll need your report.

Have you started yet? Go get 'em.

RTH
Robert T. Hardcastle
Brooke Utilities, Inc.
P.O. Box 82218
Bakersfield, CA 93380-2218
(661) 633-7526 phone
(781) 823-3070 fax
RTH@brookeutilities.com

From: Myndi Brogdon [mailto:mbrogdon@theriver.com]
Sent: Thursday, August 25, 2005 9:16 AM
To: Bob Hardcastle
Subject: RE: Excess Spring Water Near Geronimo Estates; Star Valley Issues.

I have more familiarity than you but less than HJ –
My suggestion at this point is to allow me to make initial contacts – visit the areas and provide you a report – then work on a game plan. Given the need in the Geronimo estates area and the desire of the ACC staff for us to address this issue, this would be a small fairly inexpensive step forward and would likely give you more info as to how to proceed.
My guess is that if we can come up with some cost estimates including the EA needed for pipeline installation (and Forest Service i.e. Rod Byers may just have to allow this sort of thing given the existence of PM and the upcoming BRR pipeline) we can approach the GE community and via a similar survey as we sent out in P-S find out if they are willing to support that.
Can we ask in the ACC rate making process for what are commonly called 'impact fees' to recover some of this cost.

From: Bob Hardcastle [mailto:rth@brookeutilities.com]
Sent: Thursday, August 25, 2005 9:04 AM
To: Myndi Brogdon

Subject: RE: Excess Spring Water Near Geronimo Estates; Star Valley Issues.

I think it's interesting. I also think HJ has obligated me to a lot more work with modest (at best) prospects for more water sales without substantial capital investment.

I confess I am not as familiar with these areas as I could be or HJ seems to be. I am not familiar with Herron springs at all. I know he has a lot of involvement with RTWID and, as a result, probably has a great deal of familiarity with some of these issues. I think USFS's position is interesting as well. USFS usually does not like to be supportive of commercial businesses solely for the sake of profit. It's also interesting as to the involvement of bottled water companies in the process.

It further strikes me that such a solution, as opposed to an outlet from the future BRR pipeline, may be far more expensive than customers would be willing to pay. Sure, future connections of 150 or more is attractive is you can wait 30 years.

I need to develop a game plan approach to this matter as part of my ACC compliance report. Any suggestions? How much specific familiarity do you have with the area, people, facilities, referenced in HJ's message?

RTH
Robert T. Hardcastle
Brooke Utilities, Inc.
P.O. Box 82218
Bakersfield, CA 93380-2218
(661) 633-7526 phone
(661) 823-3070 fax
RTH@brookeutilities.com

From: Myndi Brogdon [mailto:mbrogdon@theriver.com]
Sent: Thursday, August 25, 2005 8:52 AM
To: Bob Hardcastle
Subject: FW: Excess Spring Water Near Geronimo Estates; Star Valley Issues.

So what do you think of all this?
Do you want me to do some follow up with any of these folks?

From: harry jones [mailto:harryjoneshdj@earthlink.net]
Sent: Wednesday, August 24, 2005 5:12 PM
To: Bob Hardcastle
Cc: Myndi Brogdon; Steve Besich; John Nelson; Tommie Martin
Subject: Excess Spring Water Near Geronimo Estates; Star Valley Issues.

Thanks for you e-mail related to the Black and Veach Change Order #1. Your participation is appreciated. I talked to Buzz this afternoon about payment, and he said he will just send you an invoice.

The Star Valley/Payson mess is continuing with the Star Valley group continuing to try to draw the County into the middle of the action. After a presentation to the Bd. of Supervisors yesterday by Gary Hatch (Diamond Star Fire Chief), the Board has established an action item to have the County step into the middle to try to bring the parties together. However, tomorrow night the Town is set to accept or not accept the agreement with the developers who would be building the pipeline to move water from a second choice well about 1000-1500 feet further from the old landfill. I'll let you know how it all comes out. Has the Coalition made further inquiry of you related to contamination of wells, import of Blue Ridge water to recharge Star valley well fields, who can be trusted, etc.?

Camp Geronimo Water: About a year ago I contacted Ted Julius, the manager of the camp (928-474-4688). At that time he indicated they capture all the water from Poison Springs (great name for a spring with up to 1000 kids drinking the water) which is on Forest service land about two miles from the camp. He believes the year around flow is about 80 gpm through a pipeline that runs both above and below ground across the Forest. He also said they have about 50 gpm out of Herron Springs, from which about one-half the water is captured. The water from both springs runs into four 15K storage tanks, with no filtration, but with chlorine added (unnecessary per Ted, but for safety). He thought they had excess water all the time, with the excess flowing into Webber Creek, where the water then goes underground most of the year at somewhere near the camp's boundary. Ted thought there is excess water all year, with the camp only using 2.1 million gallons per year, with most of it during about nine weeks in the summer, with usage rates the other 40+ weeks at 10% of the summer rates. I gathered he felt like there may be 20-50 gpm of excess capacity. The camp just installed a new sewage treatment facility to protect this water source as it leaves the camp. Ted estimated the camp may grow only by a total of 10%-15% over the years since it is nearly at its useful capacity at this time, meaning that the excess water may be available for years.

On Monday of this week, I met with the board member in charge of facilities for the Grand Canyon Council of Boy Scouts of America, the camp owners. His name is Eric L. Hiser, an impressive guy who seemed to really know his stuff about the water situation. He is a environmental water quality attorney and partner in the firm of Jordan Bischoff & Hiser of 7272 E. Indian School Rd., Suite 205, Scottsdale, AZ 85251, office phone 480-505-3927 and cell of 602-622-6885. He thought Ted was high on the estimates of flow, but he mentioned a third spring called Bear Spring, and a water right to 24a/f of Webber creek water which they do not use. He indicated a desire to help the Geronimo Estates area if they could utilize excess water without ever jepordizing their own situation. He was aware that the camp is part of the Whispering Pines Fire District along with Rim Trail and Geronimo Estates.

Once I knew there was some interest on the Scouts part to (a) help the area and (b) to probably generate some revenue for sale of water, I gave Eric all of you contact information. I indicated you had expressed an interest in any solution to the tough situation in Geronimo Estates, thus he is expecting your call.

To satisfy the MRWRMS study groups interest in a solution, I also went to see Rod Byers of the Forest Service on 8-10-05 about the possibility of a pipeline along the roadways between the camp and GE. Rod said it was "possible, but not real likely". He was fully aware of the situation at the camp and confirmed the FS has no question about the rights to the water from the springs, and their ability to sell any excess (see Bray Creek Ranch discussion below).

Bray Creek Ranch: This property is about 1.5 miles east of Camp Geronimo. The old ranch is owned by 14 doctors and lawyers as members of an LLC. Only two old houses are on the site along with a meadow and a pond. The managing partner is Mike Johns (602-514-7566) who is a U.S. District attorney that specializes in litigation and happens to handle litigation of water rights issues, special permits, etc. for Tonto National Forest (also son of one of my neighbors). Thus, again we have a party familiar with the important issues and hang ups that can occur. Mike thinks the flow from the springs is 40-50 gpm that runs into and overflows a 1500 gallon tank that stays up with demand of two houses, mainly used in the summertime.

An interesting situation with this location is that the owners have wanted to sell excess water for some time, and they currently have a contract in place with a bottled water company to come in and truck water (no treatment or chlorination) out to be bottled for sale as pure "spring" water. However, Mike said this contract is falling apart because of problems with the bottling company not ever coming to take the water. He thinks the contract will end by default in about October of this year.

When I saw Rod Byers, we talked about the possibility of a pipeline and I got the same "possible, but not probable" answer. He was fully aware of the bottled "spring" water contract and its status. He said Mike had applied for a special use permit to build a pipeline line out to the Control Road where the truck loading could occur, however the F.S. turned Mike down on the basis that the F.S. has no question about their right to sell the excess water or their right to have ingress and egress on the roadways, however they were not obligated to provide a permit to make a commercial venture more profitable.

Bob, I would think the special use permits might be justified for the same reasons as the public service needs of the Magnolia line and the line from Deer Creek to the ADOT rest stop at H87-H188. I presume the F.S. has some obligation to allow reasonable use of roadways for the public good, like moving water from excess water supply areas to areas that are short in supply, such as existed between Strawberry and Pine. These options may not be economically feasible, however it may be a solution, especially if another 150 homes could come on line in GE if there was an adequate water supply. I wonder if the Boy Scouts or a bunch of doctors and lawyers might like to finance a pipeline in order to generate revenue from an excess supply of water that is currently going into the ground in both cases? I know Mike and his group would like to generate money to help improve their road into the property, and maybe they, rather than the bottling company, were the ones who were going to pay for the pipeline.

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Eric is expecting a call from you. I will notify Mike to expect the same. Good luck!

harry jones
harryjoneshdj@earthlink.net
EarthLink Revolves Around You.

8/25/2005

: Water Co.

ater Supply Alternatives

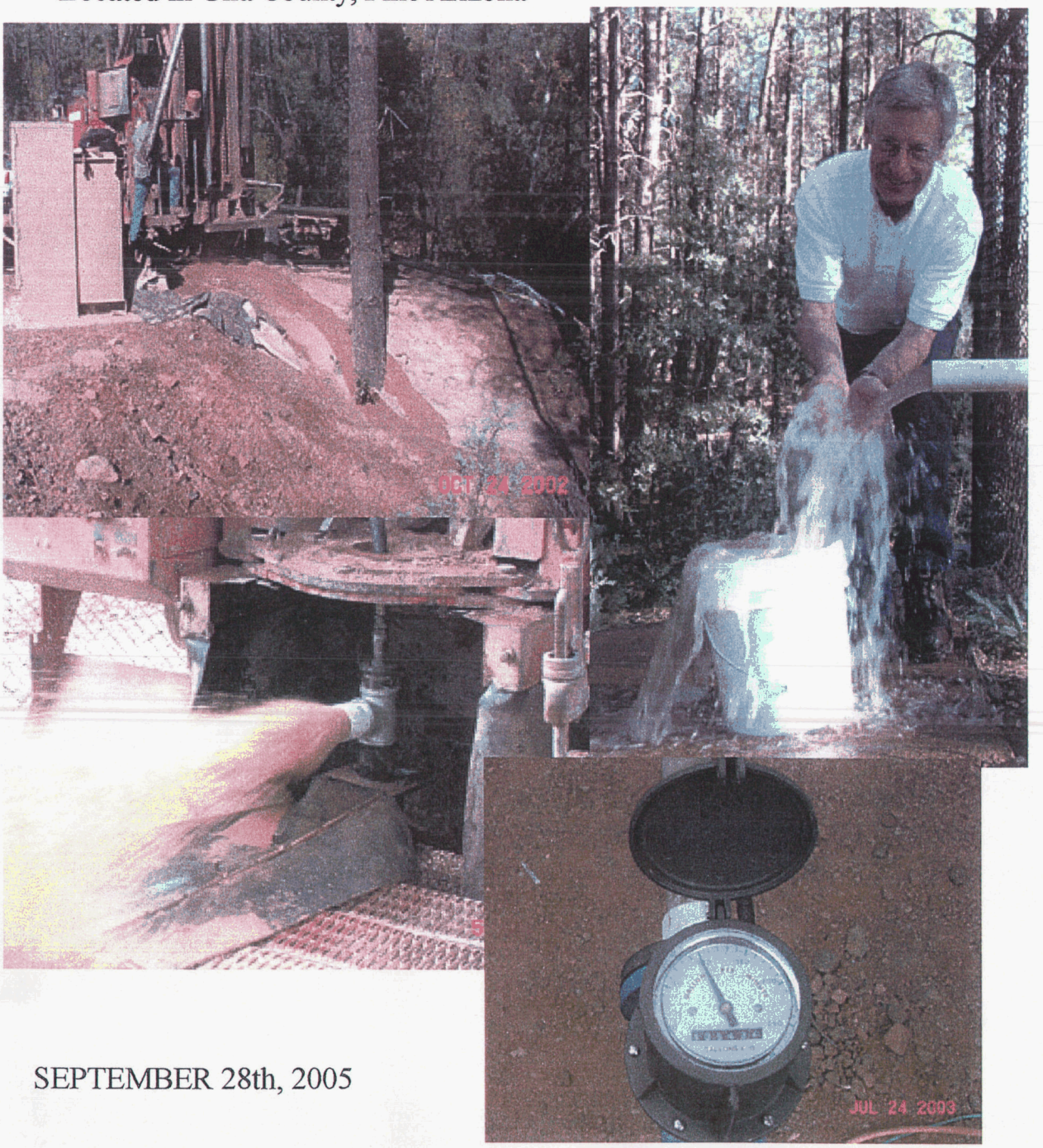
ov-05

rnative Ref.	Option	Description	Estimated Capital Cost	Estimated Operating Cost	Estimated Annual Ratepayer Impact	Estimated Monthly Ratepayer Impact	PWCo. Rank
1		Horizontal Well, North Pine	$ 3,280,000	$ 33,000	$ 411	$ 34.18	5
2		Single Deep Well, Strawberry, BUI Existing Site	$ 3,750,000	$ 33,000	$ 465	$ 38.74	5
3		Single Deep Well, PSWID SB5950A site	$ 4,722,000	$ 55,000	$ 596	$ 49.74	5
4		Single Deep Well, PSWID SB5950B site	$ 4,722,000	$ 55,000	$ 596	$ 49.74	5
5		Pine Creek Storm Runoff and Storage, CAP Exchange Agreem	$ 3,074,500	$ 150,000	$ 485	$ 40.47	5
6		Pine Surface Water Storage Reservoir; Pine Reservoir Project	$ 5,480,000	$ 100,000	$ 723	$ 60.28	3
7	1	Blue Ridge Reservoir Pipeline Options	$ 73,100,000	$ 50,000	$ 8,559	$ 713.00	5
7	2	Blue Ridge Reservoir Pipeline Options	$ 53,500,000	$ 50,000	$ 6,275	$ 523.00	5
7	3	Blue Ridge Reservoir Pipeline Options	$ 72,000,000	$ 50,000	$ 8,430	$ 702.53	5
7	4	Blue Ridge Reservoir Pipeline Options	$ 91,100,000	$ 50,000	$ 10,655	$ 887.96	5
8		Blue Ridge Reservoir Pipeline Project Control Rd. #32	$ 17,944,080	$ 100,000	$ 2,175	$ 181.28	5
9		Camp Geronimo Water Diversion, Control Rd. #32 Pipeline	$ 18,400,000	$ 150,000	$ 2,271	$ 189.25	5
10		Bray Creek Ranch Water Diversion, Control Rd. #32 Pipeline	$ 18,600,000	$ 150,000	$ 2,294	$ 191.19	5
11		Develop Above Ground Water Storage Facilities	$ 2,000,000	$ 20,000	$ 250	$ 20.83	5
12		Expansion Water Sharing Agreement with Property Owners (e	$ 35,000	$ 1,800	$ 6	$ 0.47	1
13		Well Exploration on Public Lands	Unknown	Unknown	Unknown	Unknown	5
14		Pine Creek CAP Water Exchange with SRP	$ 1,000,000	$ 50,000	$ 158	$ 13.25	3
15		Water Hauling on "As Needed" Basis	Minimal	Minimal	Minimal	Minimal	2
16		Blue Ridge Reservoir Water Diversion to Pine Creek	Unknown	Unknown	Unknown	Unknown	5
17		Deep Well Exploration in Pine Fault Areas	$ 3,880,800	$ 55,000	$ 498	$ 41.57	4
18		Cessation of Further Development in Pine and Strawberry	Unknown	Unknown	Unknown	Unknown	5
19		Legislative Alternatives	Unknown	Unknown	Unknown	Unknown	5
20		Strawberry Hollow Application for Water Adequacy Certificate	Unknown	Unknown	Unknown	Unknown	5
21		Condemnation of Existing Local Water Supplies	Unknown	Unknown	Unknown	Unknown	5

24

HYDROGEOLOGICAL STUDY
FOR THE DEMONSTRATION OF AN ADEQUATE WATER SUPPLY

Strawberry Hollow Development
Located in Gila County, Pine Arizona



SEPTEMBER 28th, 2005

Prepared For: Strawberry Hollow Domestic Water Improvement District

Prepared By:
Highland Water Resources Consulting Inc.
P.O. Box 891
Payson, Arizona 85547
(928)-468-0252

RECEIVED
OCT 27 2005
BY:

ARIZONA DEPARTMENT OF WATER RESOURCES
Office of Assured and Adequate Water Supply
500 North Third Street, Phoenix, Arizona 85004
Telephone 602 417-2465
Fax 602 417-2467

Janet Napolitano
Governor

Herbert R. Guenther
Director

October 19, 2005

Mr. Michael Ploughe, P.G.
P.O. Box 891
Payson, Arizona 85547

COPY

Re: Application for Water Adequacy Report
Strawberry Hollow (DWR #22-401908.0000)
Completeness Review

Mr. Ploughe:

We received your application for a Water Adequacy Report for Strawberry Hollow on October 11, 2005. During our review, we have determined your application to be **incomplete**. Please provide the following information, in order for the Department to continue reviewing your application:

1. Proof of ownership of the property. Please provide a recent title report (within the last six months) or a recent deed (dated within 30 days) to establish ownership of the property. In accordance with Arizona Administrative Code R12-15-716.A.1.a, you must provide a statement naming the type of legal entity that owns the property and listing the interest and extent of such interest of each principal in the entity. Under rule, "principal" means any person or entity having a 10% or more financial interest in the development or, if the legal entity is a trust, each beneficiary of the trust holding a 10% or more beneficial interest in the development. Signatory authority should be made explicit.

2. Two copies of the preliminary plat maps as approved by the platting authority, Gila County Planning and Zoning. The plat provided does not indicate the number of acres associated with the development. The plat should specify acreage associated with each land use type.

3. A Notice of Intent to Serve signed by an authorized representative of the water provider that will serve the proposed subdivision. You may download the current form at the Department's Website, www.water.az.gov.

4. Proof of Legal availability. Please provide a copy of the resolution order from the County Board of Supervisors indicating the district has been formed and approved. Please include a boundary map for this provider.

5. Proof of adequate water quality for the proposed new central water provider. Arizona Administrative Code R12-15-718 states that the director shall approve an application for a water adequacy report only if the applicant submits information from which the director determines that the applicant's proposed water sources will satisfy existing state water quality standards. Please provide analytical results from a drinking water testing laboratory licensed by the Arizona Department of Health Services on water samples taken from a well or wells constructed within the subdivision. Analytical results should be reported in a format following Form DWAR-9 for new source approval from the Arizona Department of Environmental Quality (ADEQ), Drinking Water Section. Information on the required analyses may be found at the ADEQ Web site, www.adeq.state.az.us/environ/water/dw/index.html. As an alternative, you may submit the Public Water Supply Identification Number issued by the Arizona Department of Environmental Quality (ADEQ) for the new water provider, and a copy of the new water source approval issued by ADEQ which demonstrates compliance with drinking water quality standards by the new provider.

6. An accurate calculation of all water demands for the proposed subdivision. The Department recommends that you visit the Department's Web site at www.water.az.gov and suggests that you consider the potential of utilizing the demand estimate calculator found on the Office of Assured and Adequate Water Supply page as a planning tool.

Please submit the requested items to the Office of Assured and Adequate Water Supply **within 60 days** of the date of this letter. Review of your application has stopped and will not resume until the needed information is received. If the above information is not submitted **within 60 days** of the date of this letter, the Department may deny your application and close the file.

If you have any questions, please call me at (602) 417-2465.

Sincerely,

Norma J. Coupaud

Norma J. Coupaud
Office of Assured and Adequate Water Supply

ARIZONA DEPARTMENT OF WATER RESOURCES
OFFICE OF ASSURED & ADEQUATE WATER SUPPLY
500 NORTH THIRD STREET
PHOENIX, ARIZONA 85004

PHONE: 602-417-2465 FAX:602-417-2467
www.water.az.gov

DATE RECEIVED:

RECEIVED
OCT 11 2005
OFFICE OF ASSURED WATER SUPPLY

FI 22-401908.0000
Strawberry Hollow

APPLICATION FOR A WATER ADEQUACY REPORT
(Refer to application guidelines for assistance in completing this form)

PART A – GENERAL INFORMATION

1. Name of Subdivision: Strawberry Hollow

2. Location: 12N (Township) 8E (Range) 26 (SE quadrant) (Section(s)) Gila (County)

3. Owner Name: Loren Peterson Phone: 928-472-4477 Fax: 928-472-4868

   Address: P.O. Box 244, Pine, Arizona 85544

4. Water Provider: Strawberry Hollow Domestic Water Improvement District Phone: 928-472-4477 Fax: 928-472-4868

   Address: P.O. Box 244, Pine, Arizona 85544

5. Consultant Name Highland Water Resources Consulting Phone: 928-468-0252 Fax: 928-468-0252

   Address: P.O. Box 891, Payson, Arizona 85547

6. Primary Contact: Michael Ploughe P.G. Phone: 928-468-0252 Fax: 928-468-0252

   Address: P.O. Box 891, Payson, Arizona 85547

PART B – WATER DEMAND INFORMATION

1. Include two copies of the map of the proposed subdivision plat, and reference map as an attachment: Included in Attached Hydrologic Report Will a copy of this version of the map be submitted to the appropriate platting agency? X Yes ___ No
   If no, explain: ___

2. Number of lots: 72 Size of lots: ~1/3ac Total Acreage: 39

3. Projected water demand per residential lot: 288 gallons per day

   Non-Residential demands: Golf course: n/a AF/year Parks: n/a AF/year

   Lakes: n/a AF/year Other (specify): <1acft/yr to be used for re-establishment of native vegetation in common areas up to year 5 only.

   Total projected demand for the proposed subdivision: 23.2 acre-feet (AF) per year
   (24.4 with losses)

4. Expected year of completion (build out): 2030 - assuming 3 homes per year built from 2005 forward (based on average homes per years since 2001)

PART C- WATER SUPPLY INFORMATION

1. Please indicate source(s) of water to be used: X Groundwater ____Surface Water other than Colorado River water _____Colorado River water _____Central Arizona Project water X Effluent (If the source includes non-groundwater supplies, please complete "Table A" below.)

2. Provide two copies of a hydrologic study, and reference the attachment: Sept. 28, 2005 Hydrogeologic Report Attached.

3. a. Method of water distribution: X central distribution system ___dry lot subdivision(individual wells)

   b. If water is to be obtained from a water provider, include a "Notice of Intent to Serve" agreement and reference the attachment: Water to be provided by the Strawberry Hollow Domestic Water Improvement District , forms Attached, See also the Hydrogeologic Report

4. If any wells proposed to serve the development are within one mile of a Water Quality Assurance Revolving Fund or Superfund site, or if the proposed water supply fails to meet safe drinking water quality standards, provide a study identifying and describing this water and reference the attachment: n/a

5. If a "Letter of Water Availability" or "Analysis of Adequate Water supply" has previously been issued for this subdivision, provide a copy of the document and reference the attachment: This application is in revision to ADWR applications #22-400383 and #22-4016170000, copies included in Attachment 1 within the Hydrogeologic Study attached

Table A: Indicate water sources other than groundwater to be used:

Source of Supply	100 Year Volume (acre feet)	Required Supporting Information (reference any attached documents)
Colorado River water directly delivered		Letter from Bureau of Reclamation contract holder specifying allocation amount and commitment to serve.
Central Arizona Project water directly delivered		What is the term of the contract? Please attach a copy and reference as an attachment:
Surface Water (other than Colorado River water) directly delivered		Surface water right number(s) and type(s) or water district name:
Effluent directly delivered (for non-potable uses only)	~1,008acft/100yr.	Name of entity providing effluent: Strawberry Hollow Wastewater System Any related contracts or agreements (attachment): APP #P-501757 -- See attached Hydrologic Report, an additional ~1,000acft/100yr. is expected to recharge the shallow aquifer.
Total 100 Year Volume	~1,008acft/100yr.	

PART D – WATER QUALITY

If the subdivision will be served by a provider regulated by the Arizona Department of Environmental Quality, you must request a report to assess the water quality of the proposed supply. Requests for compliance reports should be directed to Arizona Department of Environmental Quality (ADEQ), Drinking Water Compliance Unit (telephone 602-771-4624), or for areas of Maricopa County that are located outside the boundaries of the Phoenix Active Management Area, contact Maricopa County Environmental Services (telephone 602-506-6666). For new providers, please provide the initial source approval sampling results. For a dry lot subdivision, please provide water quality data from on-site or from nearby sources, usually wells, equivalent to initial source approval data. It may be necessary for the applicant to provide further information in order for ADWR to determine the quality of the proposed supply. If the proposed subdivision is located within one mile of a Water Quality Assurance Revolving Fund or Superfund site, or if the proposed supply fails to meet safe drinking water quality standards, the source of the water which does not meet standards must be identified and a contaminant migration analysis must be submitted.

Reference either the attached study or a copy of a previous determination of water quality: See September 2005 Hydrogeological Study which Includes Water Quality Results per ADEQ New source Approval

PART E-FEES

Please calculate fees by complete the appropriate items below, and include the total fees with your application. Payment may be made by cash, check or by entry in an existing fee credit account. Checks should be made payable to the Department of Water Resources. Failure to enclose the required fees will cause the application to be returned. Fees for water adequacy reports are authorized by A.R.S. § 45-113.

1.	Basic Application fee (includes first 20 lots)		**$200.00**
2.	Per-lot review fee (for lots in excess of the first 20):		
	Total lots in this application	72	
	Less first 20 lots	-20	
	Lots subject to additional review fees	52 x .50 per lot:	$ 26.00
3.	Subtotal (add items #1 and #2 – maximum of $800.00)		$ 226.00
4.	Credit for prior determination of physical availability 0.20 x subtotal (#3)		$ n/a
5.	**TOTAL FEE DUE** (Subtract #4 from #3)		$226.00

OWNER CERTIFICATION

I DO HEREBY certify that the information contained in this application and all information accompanying it is true and correct to the best of my knowledge and belief.

LOREN PETERSON
Owner Name (Please type or print)

Loren Peterson
Signature

10/4/05
Date

ARIZONA DEPARTMENT OF WATER RESOURCES
OFFICE OF ASSURED WATER SUPPLY
500 NORTH THIRD STREET
PHOENIX, ARIZONA 85004
PHONE: (602) 417-2465 FAX: (602) 417-2467

SUPPLEMENT TO APPLICATION FOR A WATER ADEQUACY REPORT

NOTICE OF INTENT TO SERVE

Municipal Water Provider Name (please type or print): Strawberry Hollow Domestic Water Improvement District (SHDWID)

ADEQ Public Water System Number (please indicate the number valid for this subdivision): 04-090

Subdivision/Development Name: Strawberry Hollow

The undersigned municipal water provider agrees to provide to the development indicated above an amount of water sufficient to satisfy the water demands of the development as stated in the application for an assured water supply or water adequacy. This Notice of Intent to Serve is conditioned upon the provider's receipt of necessary approvals from the Arizona Corporation Commission and other regulatory agencies, and the provider's receipt of all necessary payments.

The municipal water provider, if a private water company, further attests that the subject development is either within the boundaries of the company's existing Certificate of Convenience and Necessity or that a formal request has been filed with the Arizona Corporation Commission to extend the boundaries to include the development.

This Notice of Intent to Serve agreement is agreed to under the signature of an agent of the municipal water provider authorized to sign the agreement:

Name of Municipal Water Provider's authorized agent (please type or print)

LOREN PETERSON

Signature of Authorized Agent of Municipal Water Provider

Loren Peterson

Date

10/4/05

HIGHLAND WATER
RESOURCES CONSULTING

Water Resources Solutions for Northern Arizona

RECEIVED
OCT - 7 2005
OFFICE OF ASSURED WATER SUPPLY

October 3rd, 2005

Alan Dulaney
Arizona Department of Water Resources
500 North 3rd Street
Phoenix, AZ 85004

RE: Application for a Water Adequacy Report for: Strawberry Hollow, Located in the Northern Gila County Community of Pine, AZ

Dear Mr. Dulaney,

Highland Water Resources Consulting Inc. has been contracted by the Strawberry Hollow Domestic Water Improvement District (SHDWID) and Strawberry Hollow Development to provide professional hydrogeologic support for its development of an adequate water supply. The Strawberry Hollow development which is served by the SHDWID (PWS #04-090) has been platted and approved for selling lots by the Department of Real Estate with an inadequacy statement since its formation in 2001 and per ADWR inadequacy reports of #22-400383 and #22-4016170000. I am pleased to submit this application and supporting hydrogeological study on behalf of the SHDWID and Strawberry Hollow Development in anticipation of the department's approval and issuance of a Water Adequacy Report in revision to the current inadequacy statements.

Specific care has been taken to ensure the department's satisfaction with data presented in the hydrogeologic report attached. In consequence, this application has taken several years to complete due to a necessity for data collection and the inherent complicated nature of the subject aquifers in the region. The resulting report concludes that with conjunctive utilization of: 1) Previously existing shallow groundwater, 2) Newly developed deep regional groundwater, 3) Reclaimed water, and 4) Conservation; the water supplies available to the District are indeed more than adequate. In fact, it is demonstrated that surplus supplies are available to augment the needs of the community of Pine should the arrangements be made.

Per our discussion on the 28th of September, I will be submitting additional supplemental documents as you requested. These documents are 1) Proof of ownership via title report(s) and 2) A water quality compliance report from ADEQ. I will forward these documents to you and/or the assigned staff at ADWR as soon as I obtain them. In addition, I will be preparing digital files of testing data for further consideration by assigned hydrology staff should such data be requested. If you or any assigned ADWR staff wish to contact me, I can be reached via email at mike@highlandh2o.com or phone at 928-468-0252 office, 928-970-9055 cell, or by mail at HWRC, P.O. Box 891, Payson, AZ 85547. Thank you for your consideration of this most important project concerning the realities of groundwater resources in the community of Pine.

Regards,

Michael Ploughe P.G.
Highland Water Resources Consulting Inc.

cc: Loren Peterson, Strawberry Hollow
Ralph Bossert P.E., Tetra Tech
Harry Jones, Gila County

CHECK DEPOSIT REQUEST
OFFICE OF ASSURED AND ADEQUATE WATER SUPPLY

SUBMITTED BY: Norma Coupaud

DATE: October 11, 2005

APPLICANT: Loren Peterson

CHECK SENT BY: Strawberry Hollow Domestic Water Improvement District

NAME OF COMPANY OTHER THAN APPLICANT)

FILE PREFIX	TYPE OF FILING FEE	PUBLIC NOTICE FEE	APP. FEE	TOTAL AMOUNT OF CHECK
20-	Application for a Physical Availability Demonstration (PAD)			
21-	Application for a Designation of Adequate Water Supply			
22- 401908.0000	Application for a Water Adequacy Report		226.00	226.00
'	Application for an Analysis of Water Adequacy			
26-	Application for a Designation of Assured Water Supply			
27-	Assignment of a Certificate of Assured Water Supply			
28-	Application for an Analysis of Assured Water Supply			
TOTAL				226.00

THE STOCKMEN'S BANK
P.O. BOX 249
PAYSON, AZ 85547

1186

STRAWBERRY HOLLOW DOMESTIC WATER IMPROVEMENT DISTRICT
P O BOX 2141
PINE, AZ 85544

91-504/1221
27

10/5/2005

PAY TO THE ORDER OF ADWR $ **226.00

Two Hundred Twenty-Six and 00/100********** DOLLARS

ADWR

Water Adequacy Fees

MEMO

[redacted]

MP

[redacted]

HIGHLAND WATER
RESOURCES CONSULTING

Water Resources Solutions for Northern Arizona

22-401908.0000

October 3rd, 2005

Alan Dulaney
Arizona Department of Water Resources
500 North 3rd Street
Phoenix, AZ 85004

RE: Application for a Water Adequacy Report for: Strawberry Hollow, Located in the Northern Gila County Community of Pine, AZ

Dear Mr. Dulaney,

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Regards,

Michael Ploughe P.G.
Highland Water Resources Consulting Inc.

cc: Loren Peterson, Strawberry Hollow
Ralph Bossert P.E., Tetra Tech
Harry Jones, Gila County

ARIZONA DEPARTMENT OF WATER RESOURCES
OFFICE OF ASSURED & ADEQUATE WATER SUPPLY
500 NORTH THIRD STREET
PHOENIX, ARIZONA 85004

PHONE: 602-417-2465 FAX:602-417-2467
www.water.az.gov

DATE RECEIVED:

RECEIVED
OCT 11 2005
OFFICE OF ASSURED WATER SUPPLY

FILE NUMBER:

APPLICATION FOR A WATER ADEQUACY REPORT
(Refer to application guidelines for assistance in completing this form)

PART A – GENERAL INFORMATION

1. Name of Subdivision: Strawberry Hollow

2. Location: 12N (Township) 8E (Range) 26 (SE quadrant) (Section(s)) Gila (County)

3. Owner Name: Loren Peterson Phone: 928-472-4477 Fax: 928-472-4868

   Address: P.O. Box 244, Pine, Arizona 85544

4. Water Provider: Strawberry Hollow Domestic Water Improvement District Phone: 928-472-4477 Fax: 928-472-4868

   Address: P.O. Box 244, Pine, Arizona 85544

5. Consultant Name Highland Water Resources Consulting Phone: 928-468-0252 Fax: 928-468-0252

   Address: P.O. Box 891, Payson, Arizona 85547

6. Primary Contact: Michael Ploughe P.G. Phone: 928-468-0252 Fax: 928-468-0252

   Address: P.O. Box 891, Payson, Arizona 85547

PART B – WATER DEMAND INFORMATION

1. Include two copies of the map of the proposed subdivision plat, and reference map as an attachment: Included in Attached Hydrologic Report Will a copy of this version of the map be submitted to the appropriate platting agency? X Yes ___ No
   If no, explain: ___

2. Number of lots: 72 Size of lots: ~1/3ac Total Acreage: 39

3. Projected water demand per residential lot: 288 gallons per day

   Non-Residential demands: Golf course: n/a AF/year Parks: n/a AF/year

   Lakes: n/a AF/year Other (specify): <1acft/yr to be used for re-establishment of native vegetation in common areas up to year 5 only.

   Total projected demand for the proposed subdivision: 23.2 (24.4 with losses) acre-feet (AF) per year

4. Expected year of completion (build out): 2030 - assuming 3 homes per year built from 2005 forward (based on average homes per years since 2001)

PART C- WATER SUPPLY INFORMATION

1. Please indicate source(s) of water to be used: X Groundwater ____Surface Water other than Colorado River water _____Colorado River water _____Central Arizona Project water X Effluent
(If the source includes non-groundwater supplies, please complete "Table A" below.)

2. Provide two copies of a hydrologic study, and reference the attachment: Sept. 28, 2005 Hydrogeologic Report Attached.

3. a. Method of water distribution: X central distribution system ___dry lot subdivision(individual wells)

   b. If water is to be obtained from a water provider, include a "Notice of Intent to Serve" agreement and reference the attachment: Water to be provided by the Strawberry Hollow Domestic Water Improvement District , forms Attached, See also the Hydrogeologic Report

4. If any wells proposed to serve the development are within one mile of a Water Quality Assurance Revolving Fund or Superfund site, or if the proposed water supply fails to meet safe drinking water quality standards, provide a study identifying and describing this water and reference the attachment: n/a

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Table A: Indicate water sources other than groundwater to be used:

Source of Supply	100 Year Volume (acre feet)	Required Supporting Information (reference any attached documents)
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Central Arizona Project water directly delivered		What is the term of the contract? Please attach a copy and reference as an attachment:
Surface Water (other than Colorado River water) directly delivered		Surface water right number(s) and type(s) or water district name:
Effluent directly delivered (for non-potable uses only)	~1,008acft/100yr.	Name of entity providing effluent: Strawberry Hollow Wastewater System Any related contracts or agreements (attachment): APP #P-501757 -- See attached Hydrologic Report, an additional ~1,000acft/100yr. is expected to recharge the shallow aquifer.
Total 100 Year Volume	~1,008acft/100yr.	

PART D – WATER QUALITY

If the subdivision will be served by a provider regulated by the Arizona Department of Environmental Quality, you must request a report to assess the water quality of the proposed supply. Requests for compliance reports should be directed to Arizona Department of Environmental Quality (ADEQ), Drinking Water Compliance Unit (telephone 602-771-4624), or for areas of Maricopa County that are located outside the boundaries of the Phoenix Active Management Area, contact Maricopa County Environmental Services (telephone 602-506-6666). For new providers, please provide the initial source approval sampling results. For a dry lot subdivision, please provide water quality data from on-site or from nearby sources, usually wells, equivalent to initial source approval data. It may be necessary for the applicant to provide further information in order for ADWR to determine the quality of the proposed supply. If the proposed subdivision is located within one mile of a Water Quality Assurance Revolving Fund or Superfund site, or if the proposed supply fails to meet safe drinking water quality standards, the source of the water which does not meet standards must be identified and a contaminant migration analysis must be submitted.

Reference either the attached study or a copy of a previous determination of water quality: See September 2005 Hydrogeological Study which Includes Water Quality Results per ADEQ New source Approval

PART E-FEES

Please calculate fees by complete the appropriate items below, and include the total fees with your application. Payment may be made by cash, check or by entry in an existing fee credit account. Checks should be made payable to the Department of Water Resources. Failure to enclose the required fees will cause the application to be returned. Fees for water adequacy reports are authorized by A.R.S. § 45-113.

1.	Basic Application fee (includes first 20 lots)	**$200.00**
2.	Per-lot review fee (for lots in excess of the first 20): Total lots in this application 72 Less first 20 lots -20 Lots subject to additional review fees 52 x .50 per lot:	$ 26.00
3.	Subtotal (add items #1 and #2 – maximum of $800.00)	$ 226.00
4.	Credit for prior determination of physical availability 0.20 x subtotal (#3)	$ n/a
5.	**TOTAL FEE DUE** (Subtract #4 from #3)	$ 226.00

OWNER CERTIFICATION

I DO HEREBY certify that the information contained in this application and all information accompanying it is true and correct to the best of my knowledge and belief.

LOREN PETERSON
Owner Name (Please type or print)

Loren Peterson
Signature

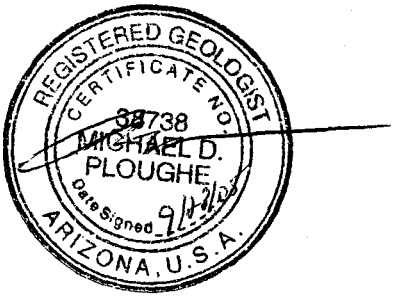
10/4/05
Date

Hydrogeological Study
For The Demonstration of an Adequate Water Supply

For

Strawberry Hollow

Located in
Pine -- Gila County, Arizona



September 28, 2005

Prepared for
Strawberry Hollow Domestic Water Improvement District

Prepared by:
Highland Water Resources Consulting Inc.
P.O. Box 891
Payson, Arizona 85547
(928)-468-0252

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Appendices

Appendix I -- Geological Maps of the Pine Area

Appendix II –Borehole Geophysical Logs

Appendix III -- Groundwater Quality and Chemistry Results

Appendix IV -- Well Testing Data and Graphs

Attachments

Attachment 1 --- Strawberry Hollow Development – Final Plats, Original ADWR Water Adequacy Report Determinations, and SHDWID Descriptions.

Attachment 2 --- Town of Payson 2005 Water Resources Status Report – *MRWRMS Hydrogeologic Study Preliminary Results Presented*

1.0 Introduction and Background

The Strawberry Hollow Domestic Water Improvement District (SHDWID), located in the community of Pine within Gila County, AZ is applying to the Arizona Department of Water Resources (ADWR) for the designation of an adequate water supply (100-year water adequacy statement) for its service area. The attached application is in revision to all previous submittals for water adequacy involving prior phases of the Strawberry Hollow Development. Specifically, this application is intended to revise and update applications #22-400383 and #22-401670000 of Strawberry Hollow Phases I and II respectively. Water service to the Strawberry Hollow subdivision is provided by the SHDWID (ADEQ PWS #04-090) which is an approved water provider. See Attachment 1 for details.

The SHDWID service area is located within the northwest portion of the community of Pine (see Figure I) and includes the two phases of the Strawberry Hollow Development. The SHDWID would like to provide additional service with surplus water in a not to exceed quantity of 25 gallons per minute or 40.3 acre feet per year to aid the community of Pine in the near future. The demand for the SHDWID within its existing service area alone has been calculated to be 15.1 gallons per minute (gpm) or 24.35acre feet per year (acft/yr). The additional 25gpm being provided to Pine results in an additional 40.3 acre feet per year and a total demand of 64.65 acre feet per year.

The hydrologic study presented herein, is intended to meet or exceed all requirements of ADWR intended to ensure that subject water supplies are both physically and continuous available for up to 100 years. The report presents data demonstrating the physical availability of groundwater resources and concludes that available water supplies will be sufficient to meet all present and future or build-out needs (current, future, and committed demands) of water for the Strawberry Hollow Domestic Water Improvement District for 100 years.

In it's request for a designation of assured and adequate water supply the SHDWID recognizes that for developments outside of AMA's and in particular northern Arizona, ADWR has yet to develop specific criteria for its review and consideration of such projects relying on groundwater. It is clear that such projects must be reviewed on a case by case basis due to the highly variable geology and related types of aquifers being considered for development. With this in mind, the district has been working closely with ADWR Hydrology staff in an effort to address potential concerns up front and to facilitate good communication and ensure that sufficient data is obtained to address staff concerns. The major concern has been the consideration of groundwater resources developed from hard-rock or fracture dominant aquifers of relatively low storage by nature. As such, rather than conducting "typical" well tests in a boiler plate fashion, as is done for the consideration of groundwater supplies within the typical sand and gravel aquifers of AMAs, the subject groundwater supplies of SHDWID have been monitored closely for several years and subjected to far more rigorous testing and conservative analyses than is typically required by ADWR rule.

Nearly five years of comprehensive study on both the existing shallow aquifer and deeper previously untapped regional aquifer are presented within this report. Presented also is a comprehensive water resources management concept intended to ensure sustainability beyond simply demonstrating an ability to "mine" groundwater for 100 years. Conjunctive use utilizing two independent sources of groundwater in concert with reclaimed water reuse and recharge along side a conservation program is presented as an additional method to ensure water resources remain continually available beyond 100 years. Moreover, this report considers such aspects as recharge, groundwater quality, and groundwater isotopes in comparison to precipitation and appropriable waters of regionally significant springs. In this way, the SHDWID has worked diligently to address ADWR staff concerns expressed over the physical and legal availability of the subject groundwater supplies it intends to serve its customers. Additionally, groundwater sources capable of four times the actual projected demand are proposed for utilization.

2.0 Demand

Current water demand for the Strawberry Hollow service area is minimal as less than three homes have been occupied since the water system was placed into service in 2001 thru the May 31st, 2005. As such, historical water demand for the subdivision is of little value other than for curiosity. Regular well meter reading began on June 21st of 2003 and thru May 31st, 2005 and results in the accounted use of 972,251 gallons of water supplied thru the well meter to the storage tank. Uses over this time frame have been for construction, initial irrigation for the establishment of landscape plants in common areas, the intended purging of water through the system to avoid stagnation, to provide water to the 10 homes now occupying the subdivision, and includes at least one continuous 3-day pumping test. Nonetheless, averaged over the time period above (~709 days), the above stated usage can be rationalized to a value of approximately 1,371 gallons per day or not quite 1gpm.

Committed daily annualized average water demand anticipated for the Strawberry Hollow development, at a build out of 72 lots, is expected to be below 120gpcd (gallons per capita day). This gpcd value is conservative, as typical annualized water demand in the Pine, Strawberry, and Payson areas fall between 90 and 100gpcd, including industrial and commercial uses, peak days, and peak month usage. [1&2] Assuming a conservative usage value of 120gpcd and applying an average population per lot or household of approximately 2.4, the anticipated annualized water usage demand can be conservatively estimated at 20,736 gallons per day. This value is equivalent to 14.4 gallons per minute. Usage criteria recommended by the Arizona Department of Environmental Quality yields a value of 18,000 gallons per day or 12.5gpm at 250 gallons per day per lot. This number however does not include seasonal peak demand as is typically observed in the Pine, Strawberry, and Payson areas. Therefore, it may not be as accurate as the previous usage estimates.

Assuming continuous average annual committed demand were to be realized for a 100 year period or life of the subdivision, the total future/committed demand for potable water from within the SHDWID service area can be estimated at 2,323 acre-feet. Still, no water system is entirely leak proof, even a new and small system like the SHDWID. In consequence, a 5% loss factor has been applied to the above numbers and results in a SHDWID annualized demand of 15.1gpm or 24.4 acre-feet per year. This yields a 100 year demand of 2,440 acre-feet for the SHDWID service area.

2.1 Demand for Surplus Supplies

The SHDWID is anticipating delivering surplus groundwater supplies to the community of Pine via contract with other water suppliers in the area. The district is confident that an additional 25gpm or 40.3acrft/yr is available for such purposes and will limit demands for surplus water via contract to this amount. Notably, the annual total delivery of this surplus water may in fact be half the above value due to the likely seasonal demand for this water. However, for purposes of this document and for added assurance of availability, it is assumed that this delivery will occur year round. With this in mind, the District would like to add this amount to future committed demand calculations. When added to the above demand numbers, the total future/committed demand for water from the SHDWID is increased to 40.1gpm or 64.68 acre-feet per year or 6,468acrft total 100 year demand. The additional 25gpm water demand is as yet not under contract and may not be realized. However, the District would like to have this demand considered for all total future/committed demand projections and calculations used for purposes of conservatively demonstrating water adequacy and availability for 100 years.

2.2 Peak Demand and Storage

Most homes within the development will be second homes occupied seasonally or on weekends, as are the majority of homes in Rim Country. With this reality, continuous water demand may never be realized for more than a three day period. Peak day demand is expected to be approximately 1.4 times the average peak month daily demand.[1&3 i] Average peak day demand is expected to occur during the month of June or July when each household is using water at a rate of 150gpcd or 360 gallons per unit per day or 18gpm for the Strawberry Hollow Service area. Applying the factor of 1.4, the anticipated peak day demand for Strawberry Hollow is estimated to be approximately 25gpm or 36,000gpd for the subdivision. As stated previously, this situation would typically only occur for three continuous days. If this situation were to be realized, approximately 108,000 gallons of water would be required to meet this worst-case yet short-term demand.

---

[i] Due to a concern over the accuracy of water usage data (particularly historical data) from Pine area water companies, Payson data is used for comparison and is most assuredly a more reliable source of regionally relevant water usage statistics. In fact, if Pine area water provider annualized water usage data were used it would likely result in underestimating the water demand of Strawberry Hollow.

Adequate water storage to meet consecutive peak day demands has historically been a problem for the community of Pine.[4] SHDWID addresses this concern via a 140,000 gallon water storage tank. This volume of potable water storage is more than capable of meeting three day consecutive peak day demands for its 72 lots, even if all capable sources of supply are turned off.

Table 1 below summarizes the water demand statistics for Strawberry Hollow followed by Table 2 which presents the proposed sources relative to their capabilities to meet the presented demands based on testing results to be presented in following sections.

Table 1
Water Demand of the SHDWID

Scenario	gpm	Day (gal)	Month (gal)	Year (acft)
Average Peak Day Demand for Service Area	18	25,920	803,520 *	-
Peak Day Demand for Service Area	25	36,000	-	-
Average Annualized Demand for Service Area [n]	**15.1**	**21,744**	**674,064**	**24.4**
Average Annualized Delivered Surplus Water	**25**	**36,000**	**1,116,000**	**40.3**
Total 100 Year Annualized Demand for Service Area Customers[n]	-	-	-	**2,440**
Total 100 Year Annualized Demand [n] Including Surplus Deliveries	**40.1**	**57,744**	**1,790,064**	**6,468**

n -- Includes total daily annualized average demand, this includes peak months and peak days and is inflated by 5% for losses.
* Constitutes peak month demand which occurs only one month a year, typically June or July.

Table 2
Proposed Groundwater Sources and Capacities vs. Demand

Well Name	ADWR 55#	Current Maximum Yield (gpm)	100 year Pump Testing Rate (gpm)	Total Combined 100 year Capacity (gpm)	Total Combined 100 year Yield Available (acre-feet)
SH-2	579973	20	15.3		
SH-3	587628	100*	46	**61.3**	**9,888**
--	--	--	--	Projected Demand **40.1gpm**	Projected100 year Demand **6,468acrft**[b]
--	--	--	--	**21.2gpm Reserve Capacity**	**3,420acrft Reserve Supply**

* Testing data indicate a max capacity of over 100gpm, yet, current well construction limits production to no more than 100gpm.
b -- Includes delivery of 25gpm (40.3acrft/yr) under contract to users outside of the SHDWID service area which may not occur.

2.3 Conservation or Drought Response Plan

The SHDWID is most interested in managing demands for the water resources available to it with the utmost responsibility. The District recognizes that the shallow aquifers in the region are sensitive to drought and that maintaining storage in its water tank for fire fighting is a priority. As such, a conservation plan has been developed herein to ensure

the continued availability of water for its customers even in times of drought or fire. The SHDWID has adopted voluntary guidelines which will be posted From April thru September of each year to encourage the conservation of its water supplies. Four water conservation levels and associated triggers have been developed to structure the SHDWID water conservation plan. The conservation plan is described in Table 3 below.

Table 3
SHDWID Water Conservation Levels – A Conservation and Drought Response Plan

Conservation Level	Course of Action	Triggers
Level I	Maintain only efficient and wise use of water	Normal – Above Normal Winter Precipitation or Groundwater Levels 90% or better of previous year's March level or Storage Capacity maintainable 90% or Better
Level II **In addition to Level I Actions**	Reduce normal water consumption by 10-20% Odd – Even outdoor watering days No Outdoor Watering on Mondays No hosing down of driveways or decks unless for health reasons, maintenance, or repairs	1-20% Below Normal Winter Precipitation or Groundwater Levels 80% or better of previous year's March Level or Storage Capacity maintainable 80% or Better
Level III **In addition to Level II Actions**	Reduce normal water consumption by 20-30% No car washing w/o pressure washer	Fire Department Issues Extreme Fire Hazard or 21-50% Below Normal Winter Precipitation or Groundwater Levels 70% or better of previous year's March Level or Storage Capacity maintainable 70% or Better
Level IV **In addition to Level III Actions**	Reduce normal water consumption by 40%+ No outdoor water use Limit indoor water usage to minimum required for health and safety	Wildfire within Threatening Distance or 51%+ Below Normal Winter Precipitation or Groundwater Levels 60% or less than previous year's March Level or Storage Capacity maintainable at only 60% or less

It is recognized by the District that certain uses of water in the local environment are not efficient or responsible. As such, the Strawberry Hollow Development has placed restrictions on the following water wasting features.

- ✓ No swimming pools are permitted
- ✓ No water features such as ponds or fountains greater than 100 gallons and, if installed, they must be fitted with recirculation pumps and placed in shaded areas only to minimize evaporation.
- ✓ No lawns.
- ✓ No fugitive water or water waste – water needlessly running into common areas, streets, or lost to untimely repair of leaks.
- ✓ No watering of native vegetation unless necessary and as prescribed by the homeowners association and/or the fire dept.

The Strawberry Hollow Homeowners Association and Association Construction Design Review Board will be assisting the District in the enforcement of the above outlined restrictions.

3.0 Supply

The subject Strawberry Hollow water supplies consists of two separate and independent groundwater sources in addition to a reclaimed water source (up to 18,000gpd) for proposed future utilization as an irrigation supply of medians and common areas in addition to passive recharge via the current percolation basin (APP #P-501757). The location of each of these sources within the Strawberry Hollow Domestic Water Improvement District service area is displayed in Figure I. It is proposed that each of these sources be used conjunctively along side conservation to most efficiently and continuously provide water to the district's customers. In this respect, the deeper groundwater source is planned to be used during the summer months on no more than a 12 hour per day run time while the shallow groundwater source will be used primarily in the winter months as demand occurs. Utilizing the sources in this way allows each source to recover fully and avoids inadvertent over pumping while also minimizing the effects of well interference in the shallow system (See well testing section).

3.1 Proposed Groundwater Sources

Two sources of groundwater are proposed to meet all current, committed, and future demands of the SHDWID. The subject sources of groundwater supply for the Domestic service area are from well #55-587628, typically identified as well SH-3 and well #55-579973, typically identified as well SH-2. SH-3 is a 6-inch well, constructed with slotted steel casing from 900ft. to a depth of 1,300ft. and has an average static water level of approximately 900ft. or approximately 4,600ft elevation. This well is constructed solely within the deep regional aquifer where the Martin-X portions are saturated. Well

SH-2 is a 4-inch well, constructed with perforated pvc casing from 120-160ft. and 200-240ft. and has an average static level of approximately 25ft. or an elevation of 5,569ft. This well is constructed within the edge of the lower portion of the "C-Aquifer" system (within the lower Supai Formation). Again, please see Figure 1 for the locations of these sources within the SHDWID service area. Details concerning each of these sources and their abilities to provide adequate sources of potable water are presented in the following sections.

3.2 Physiographic Setting and Regional Geology

The SHDWID is located within Township 12N and Range 8E within section 26 within the community of Pine, Arizona. Pine is located approximately 16 miles north-northwest of Payson along Hwy. 87. The SHDWID is directly adjacent to the Mogollon Rim or at the edge of the Colorado Plateau or locally the Coconino Plateau. Within the context of the three major geological provinces of the State of Arizona, from south to north: Basin and Range, Transition Zone, and the Colorado Plateau, the district plans to utilize groundwater produced from the extreme northern edge the Transition Zone. This region dominantly consists of thick sequences of Paleozoic rocks[13&14&15] that in places are partially eroded and heavily faulted by young tertiary aged faults relating to the end of extensional faulting. The geologic strata of concern for this study consist of the Permian-Pennsylvanian Schnebly Hill and Supai Formations (limey siltstone, shale, sandstone and conglomerate) Pennsylvanian Naco Formation (interbedded limestone and shale), Mississippian Redwall Formation (karstified limestone), Devonian Martin Formation (limestone-dolomite and sandstone), Cambrian Tapeats Sandstone (cemented course sandstone), and Precambrian Mazatzal Quartzite and Haigler Rhyolite.

The region is of high relief with surface elevations ranging from greater than 7,000ft. to 5,000ft. over small distances. The climate is semi-arid with annual precipitation averaging around 22 inches per year.[5&20] This average precipitation supports large populations of ponderosa pines with mixed juniper varieties in addition to annual forbs and grasses.

Surface water in the vicinity of the district exists in the form of seasonal runoff from snowmelt and summer rains along with limited spring discharges from the edge of the Mogollon Rim. Pine Creek, located approximately 1.5 miles southeast of the district, constitutes the major ephemeral surface water drainage within the area. Pine Creek seasonally flows south ultimately into the East Verde River. All such surface waters are prior appropriated waters. Within the community of Pine, Pine Creek is a "loosing" stream, as surface water is observed to "go underground" when flows in the creek drop below an estimated 3cfs. It is likely that surface water "losses" from Pine Creek recharge indirectly into the Redwall and Martin formations at nearly this rate as a natural fixed recharge rate and, as such, implies a profound renewable affect on any groundwater developed from the deep regional aquifer in the vicinity of Pine.

A comprehensive geological map with cross sections of the Pine area is currently being developed by the regional Mogollon Rim Water Resources Management Study or "MRWRMS" and, in part, is supported by data shared by the SHDWID. This mapping is not complete as yet but is much more accurate than existing maps. However, a geological map of the SHDWID and Pine area is included in Appendix I. This map, developed by the SHDWID in support of this project, displays the generalized geology of Pine and also the structural fabric that is so important to the region's aquifers. In referencing the map it is clear that the lower Supai Formation immediately underlies the entire SHDWID. It is also evident that there are many minor and some major faults dissecting the Pine area. The interaction of these faults is complex and results in variable dip angles and directions for the geological strata. In general, the geology typically dips 9-12 degrees northwesterly as has been previously mapped. However, some strata in Pine dip 9-12 degrees north to northeasterly due to the effects of faulting. Previously unmapped faults with significant effects yet minor offsets are observed to exist in the Pine area. In fact, portions of Naco Fm. strata were found to dip steeply southeasterly near fault intersections in the heart of Pine. The reality of faulting within the area accounts for the unexpected thickness of Paleozoic strata beneath Pine and the SHDWID area. The many faults within the Pine area, though of limited offset, create excellent flow paths for groundwater where the limestone, dolomite, sandstone, and crystalline geology of the Martin-X aquifer is saturated at depths below an elevation of approximately 4,600ft. in Pine.

3.2.1 Deep Well SH3 Borehole Logging and Geophysics
A Cross-Section of the Geology Beneath the SHDWID

Prior to drilling well SH3 #55-587628, the area within the Strawberry Hollow development and relevant area outside were mapped to obtain surface geology data and investigate the presence of faults and lineaments as identified via aerial photo analyses during earlier groundwater investigations (data presented above). The SH3 well site was ultimately selected to intercept sections of the Strawberry Hollow Fault lineament and other un-named lineaments below the regional groundwater elevation. It was recognized by Strawberry Hollow that recording the geology encountered by the drilling of the well would be of great importance. In consequence, drill cuttings were collected and analyzed for consideration as to the formation from which they came (Figure F Below). In addition, the well was inspected by down hole video and later gamma, neutron density, and temperature logs were also conducted (See Appendix III). The application of borehole geophysics was found to be a most valuable tool, as cuttings samples collected below approximately 600ft. were not believed to be as "clean" as desired and the apparent thickness of the Redwall Fm. seemed much too thick. This was caused due to poor sample recovery via repeated lost circulation zones within the Naco and Redwall Formations.

Figure F
Well SH3 Cuttings

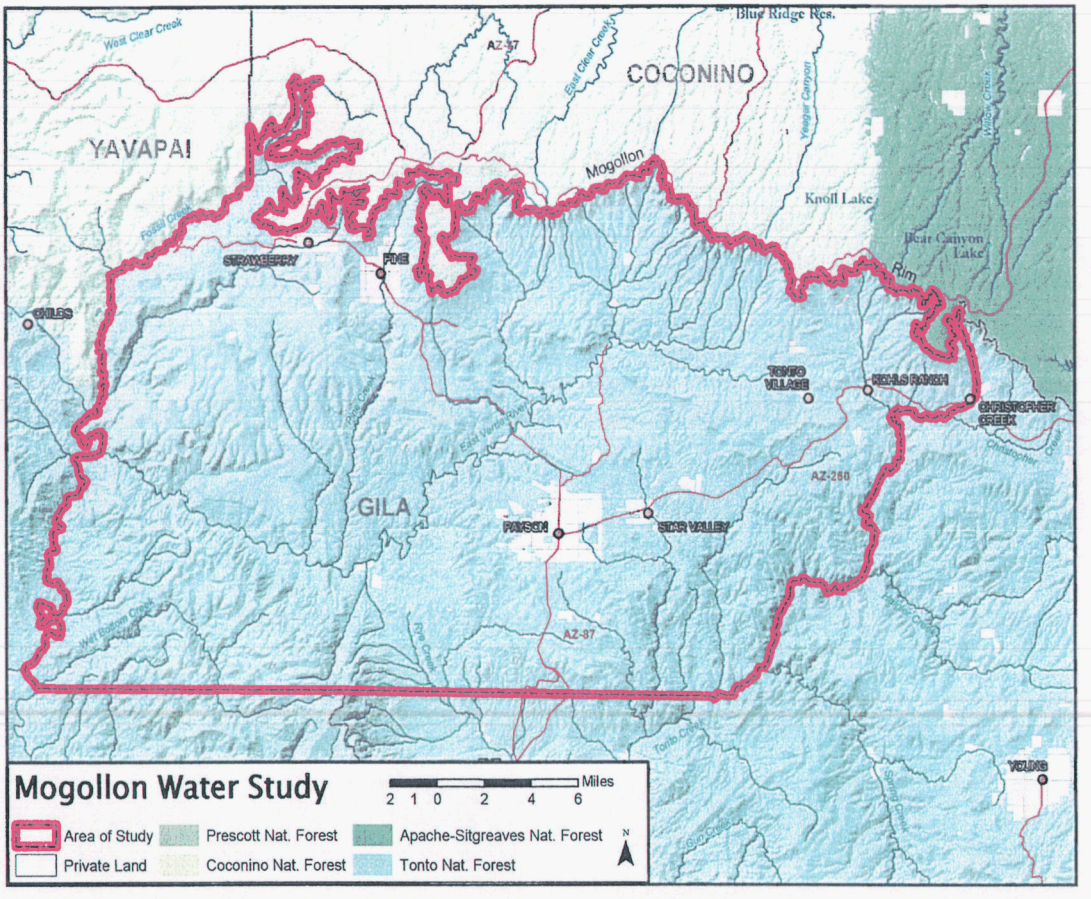
To summarize, the well site is immediately underlain by approximately 20ft. of alluvial fill. Below this recent alluvium rests the Supai Formation. The Supai Formation was present until approximately 258ft. when the alternating shale and limestone layers typical of the Naco Formation were first encountered. The Naco Fm. was found to be present from 258-605ft. when the top of the Redwall Formation was encountered. The Redwall Formation was found to exist from approximately 605-850ft., ending just above the static water level of approximately 900ft.. At approximately 850ft. the Martin Formation was encountered and may have persisted to approximately 1,155ft.. Highly weathered Tapeats sandstone was likely encountered below this point to a depth of 1,272ft.. Below the 1,272ft. level, to final drilled depth of 1,320ft. highly weathered or fractured Mazatzal Quartzite or Rhyolite may have been encountered.

Borehole geophysical data collected from the well indicate that the Martin Formation is mostly saturated and though dominantly consisting of Dolomite, the lower 20ft. of the formation was "dirty" with an increasingly dirty sandstone content. Data also indicate the lower 200ft. of the well has a higher porosity than the upper section in consequence to the increasing sandy nature of the Martin Formation and the weathered nature of the Tapeats and Quartzite or Rhyolite in this location. The "dirty" layers of the Martin may be related to the nearby Mazatzal Quartzite which outcrops in the south of Pine in addition to the potential presence of the Becker Butte Member of the Martin. The Mazatzal Quartzite was in fact a monadnoc in Paleozoic times. As such, the presence of it can alter the typical character of formations in close proximity to it. In the case of the Martin Fm. at this location, it appears to result in sandy layers and overall increasing sand content with depth. This coupled with the action of faults and lineaments in the vicinity of the well site may have resulted in the observed decrease in density and implied increase in permeability in the lower 200ft. of the well. This is of particular interest in regard to the lower 48ft. of the well which appears to be highly weathered and/or fractured Quartzite or Rhyolite. See the Figure IV and Appendix II for the complete set of borehole logs from the SH3 well.

3.3 Regional Hydrogeologic Framework

At present, there is at least one extensive regional groundwater study underway which the SHDWID continues to participate in. The Mogollon Rim Water Resources Management Study or "MRWRMS" has developed extensive geological and hydrological data, which is now being finalized for the purpose of developing a much-needed conceptual hydrogeological framework for the regions groundwater systems. Preliminary results for the hydrogeological studies of the MRWRMS group have been presented in the 2005 Town of Payson Water Resources Status Report and a copy of this document is included as Attachment 2, for review purposes. The study area includes Pine and all of Northern Gila County and is displayed in Figure A on the following page.

Figure A
MRWRMS Area
Base Map Provided by USBR with Permission



Work being conducted by the study group includes the analyses of general chemistry, oxygen and hydrogen stable isotopes, as well as, strontium 87/86 ratios and tritium in addition to carbon 14 dating. Relevant portions of this data provided by or through the cooperation of the district will be presented in following sections. Information obtained through the study is being utilized with permission of the MRWRMS partners. In addition to the hydrochemistry work, the study is wrapping up extensive geological mapping that has proven to be much needed due to the lack of sufficient detail provided on previously available geological works typically referenced in the area such as Weisman, Weir, and Beard's older USGS geological reports and maps[6&7&8] and even more recent work by the Pine Strawberry Water Improvement District[9]. Though these works are sufficient for most purposes, the existence of aquifers in crystalline bedrock dual porosity environments is directly related to the degree of faulting, fracturing, and weathering that the formations have been subjected to.[10&11] This is of paramount importance to the deep regional aquifer system within the region.[11&12] In fact, many

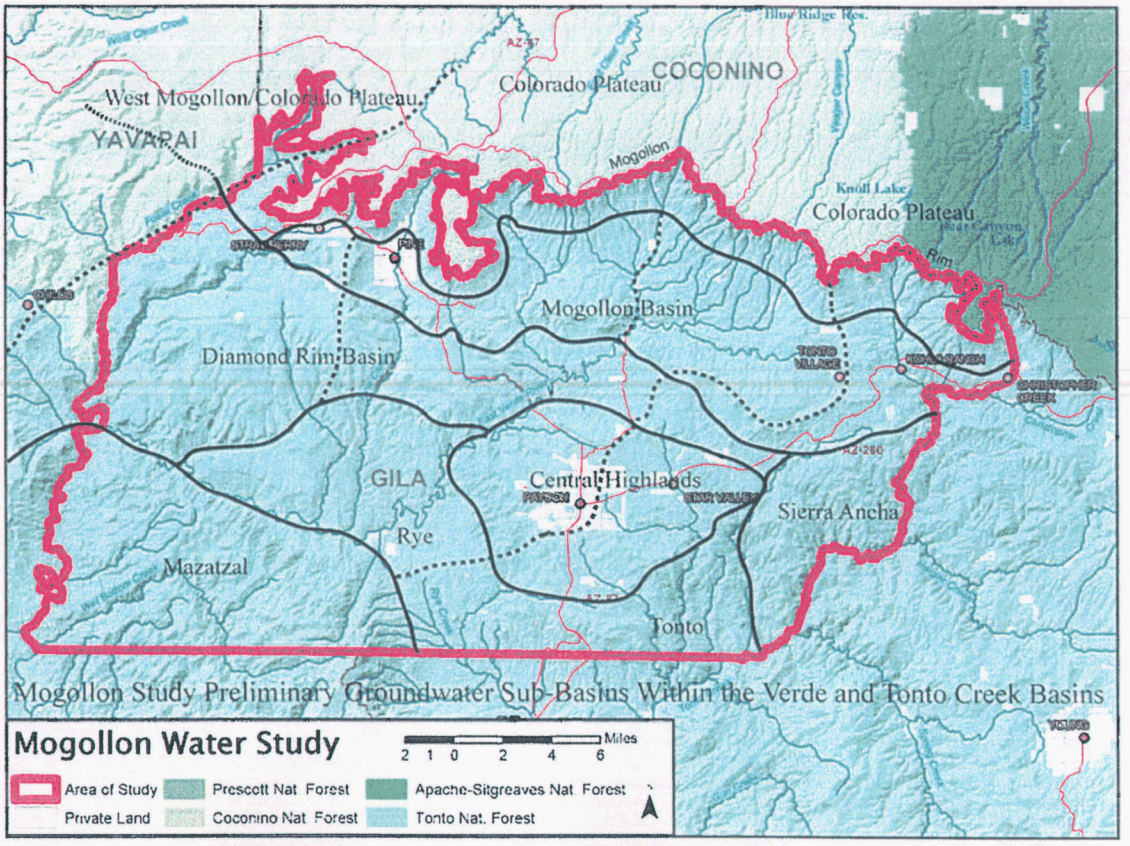
important revisions to previous mapping are taking place as numerous previously unmapped faults and structural features have been identified which will aid in identifying highly permeable areas of the aquifer, recharge area, and potential flow boundaries.[13] Finally, an elevation survey of all critical data collection points for the study, such as springs and wells is also being wrapped up. The SHDWID is participating in the study by providing access to both the deep and shallow wells within its service area and also by sharing the hydrogeological data developed herein.

Regionally, several distinct yet related aquifer systems and associated sub-basins have tentatively been identified by the MRWRMS study.[1(2005)] The edge of the Mogollon Rim constitutes the edge of the C-Aquifer portion of the deep regional aquifer system[14&15&20] and is associated with the edge of the Colorado Plateau, whereby numerous springs are observed to discharge along the southern face of the rim via drainage from C-Aquifer strata. A few examples of some of these C-aquifer springs are Fossil Springs, Washington Springs, Pieper Hatchery Springs, Tonto Fish Hatchery Springs, and Parsnip and Dripping Springs near Pine (See the Pine, Strawberry, Kehl Ridge, and Promontory Butte USGS Quadrangle Maps for Locations of These and Other Springs). However, not all of the regions springs may be discharges from the C-Aquifer portion of the deep regional aquifer system as recent data collected suggests some springs may simply be perched discharges from C-Aquifer strata or deep regional C-Aquifer drainage mixing with locally recharged sources.[20]

The geology exposed below the rim and southerly up to the regionally extensive Diamond Rim Fault constitutes the primary portion of the deep regional aquifer of concern for this document. This portion of the deep regional aquifer essentially extends east of Strawberry toward Kohls Ranch. This region has been identified as the Mogollon Basin, a sub-basin to the larger Verde River and Tonto Creak Basins[16] by the MRWRMS (see Figure B below). Groundwater occurs within this basin system within saturated portions of the fractured Redwall Fm. (limited saturation), Martin Fm., Tapeats Fm. (where present) and Precambrian basement rocks consisting of granitic rocks, quartzite, and ryholite. No horizontal barriers to interconnectivity such as large shale beds or extensive clay layers exist between these formations in the region. Hence the aquifer has been coined the "Redwall-Martin-X" or "RMX" portion of the deep regional aquifer by this author. The aquifer is dominantly unconfined accept directly against the face of the Mogollon Rim where it likely becomes semi-confined. Because of significant weathering, faulting and fracturing, and a high sand content within the lower Martin Fm. and Tapeats (where present) in the region, the M-X portion of the deep regional aquifer is considered to be of the dual porosity type.[3&17] The Paleozoic sections of this aquifer are essentially the southernmost equivalent to the Redwall-Mauve (Redwall and Becker Butte Member of the Martin Formation) aquifer as considered north towards Flagstaff and the Grand Canyon.[14] Base flow recharge to this aquifer is predominantly via leakage from the C-Aquifer portion of the deep regional aquifer system located atop the Colorado Plateau.[14&15] The major discharge locations of the C-Aquifer portion of the deep regional aquifer are various springs which discharge into the Grand Canyon located several hundred miles north of Pine and Fossil Springs located approximately seven miles northwest of the District.[14&15] Atop the Plateau, recharge to the deep regional aquifer's

RMX portions occurs primarily along faults and fracture systems where the typically confining shale beds of the Naco Fm. are breached. Recent studies conducted by the USGS along with the on going MRWRMS are generating data that indicate, within the Mogollon Basin, that this "cross connection" occurs primarily in the form of both discharge from perched and deep regional C-Aquifer springs along the face of the rim in addition to the percolation and mixing of local precipitation.[1(2005)&20] Precipitation washes over C-Aquifer strata picking up its isotopic signature along the exposed face of the rim and drains into the Mogollon Basin's network of loosing streams which percolate at some fixed loss rate into the associated strata of the RMX portion of the deep regional aquifer (See Groundwater Chemistry Section).[21&1(2005)&20]

Figure B
Mogollon Rim Study Area Groundwater Sub-Basins
Base Map Provided By USBR and Modified with Permission



Note: Dark lines define sub-basin boundaries, dashed lines define potential groundwater divides, note as well, that nearly all of the blue lines in the upper portions of the Mogollon Basin represent loosing streams.

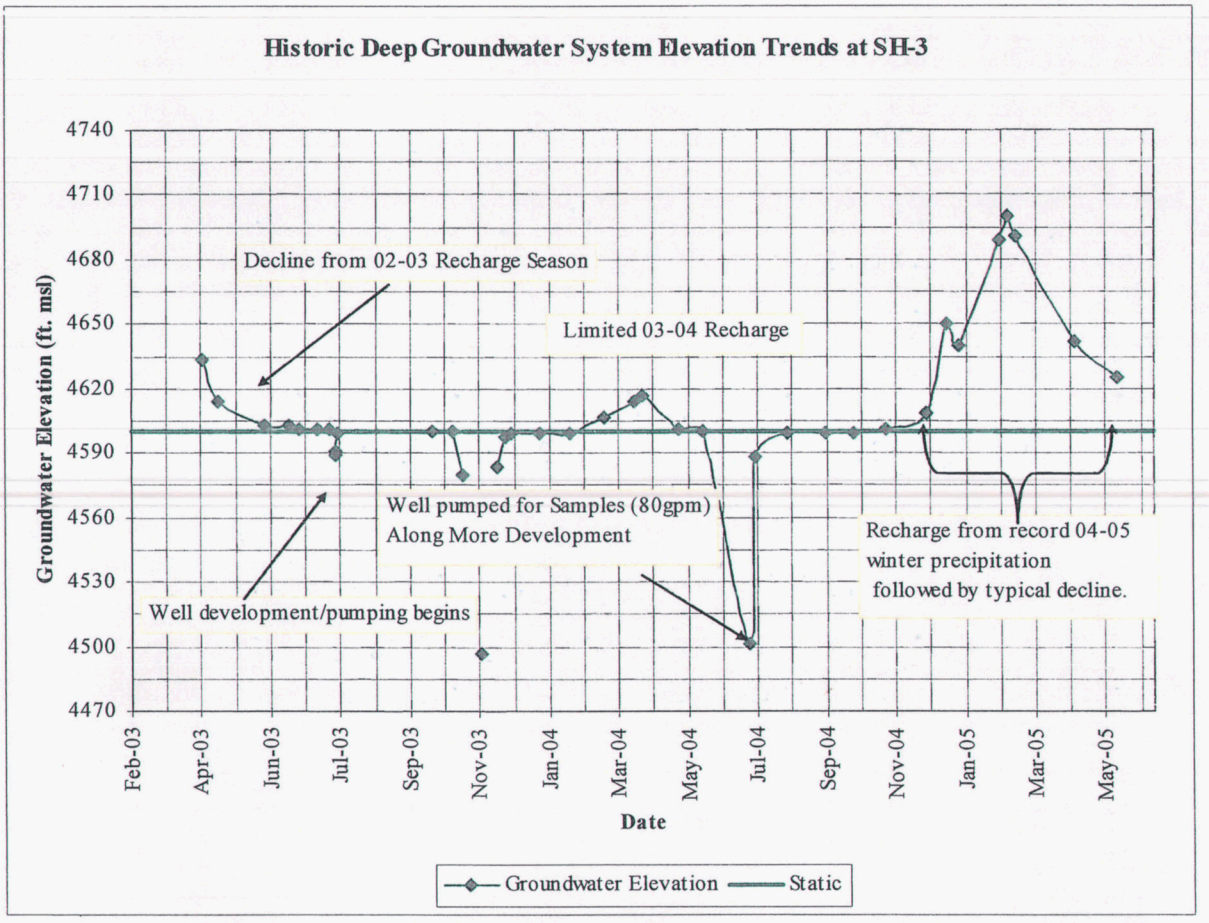
3.3.1 Groundwater Elevations and Flow

Groundwater elevation data for the deep regional aquifer in the vicinity of Pine remains nearly as sparse as it is atop the southern Colorado Plateau.[14&20] Only two wells have been installed into the RMX portion of the deep regional aquifer in the vicinity of the SHDWID and only one of them, well SH3, is accessible for testing. The other is a deep borehole 55-581081 installed as part of the now defunct Northern Gila County Water Alliance.[18] The well is now collapsed (plugged) below a depth of 1,420ft., however, the depth to water has been consistently within a few feet of 1,382ft. or an approximate elevation of 4,365ft. since its installation. At this location the Redwall is partially saturated.[18&9] Attempts by the Pine Strawberry Water Improvement District to confirm validity of the groundwater elevation data[19] were made and results indicated that the water level should be representative of the deep regional groundwater elevation at the site. However, leakage from the lower portions of the C-Aquifer into the well may yet be occurring. The groundwater elevation observed at the well when considered with the groundwater elevation at SH3 does point to the likelihood of a groundwater divide between the communities of Pine and Strawberry and this would agree with topography.[20&21] However, flow in the C-Aquifer portion of the deep regional system atop the rim is in a southwesterly direction with a steep gradient off the rim.[20&21] In general, deep regional groundwater flow should continue in this direction into the RMX portions of the deep system adjacent to the rim via faulting that has breached the base of the C-Aquifer (considered as the Naco Fm. here) all along the edge of the Plateau and near Pine (See Geology Section).[20]

With so few useful groundwater elevation data points from wells, generating accurate groundwater elevation and gradient maps is problematic without an understanding of the regional hydrogeological framework. However, it is not unreasonable to consider that groundwater flow in the MX portion of the deep regional aquifer in the vicinity of Pine is west-southwesterly. Relating the groundwater elevations of Cold Springs, Whispering Pines Spring, Webber Springs, the SH3 well, the Deep Borehole in Strawberry, the Tonto Natural Bridge springs and others located within the Mogollon and adjacent Diamond Rim basins imply this likelihood. When considering recharge mounding related to drainage into the RMX portion of the deep regional aquifer system within Pine and the Mogollon Basin (See Figure C Below for Groundwater Elevation History at Well SH3) and considering how discharges from RMX springs south and east of Pine have been known to fluctuate with precipitation[20] as well, the above assumption is again quite reasonable. If groundwater were to be flowing northwesterly towards Fossil Creek Canyon from the RMX portion of the deep regional aquifer in Pine, as speculated by previous studies,[9&18] large springs would certainly exist below Fossil Springs emitting from the exposed Redwall and, so too, flow would vary similarly to the springs of the Redwall and Martin Fms.. However, this is not the case, as no major springs issue from the Redwall or Martin below Fossil Springs and discharges from Fossil are essentially constant and of high elevation deep regional C-Aquifer source.[20&1(2005)] In addition, isotope sampling (presented in following sections) appears to confirm the C-Aquifer portion of the deep regional aquifer is the source to Fossil Springs from a northwest-

northeast direction.[1(2005)&20&21] Each of the above observations support deep regional groundwater flow, within the Martin and X formations particularly, as being towards the southwest within the Mogollon Basin. Groundwater flow through the MX portion of the deep regional aquifer beneath Pine is both below the Redwall and Naco formations and is structurally isolated from Fossil Springs. The resultant groundwater flow scenario yields an average southwesterly gradient of .03 for the MX portion of the deep regional aquifer system in Pine. See Figure II Deep Regional Aquifer Groundwater Elevation Map.

Figure C
Groundwater Elevation History at Deep Well SH3 – MX Aquifer

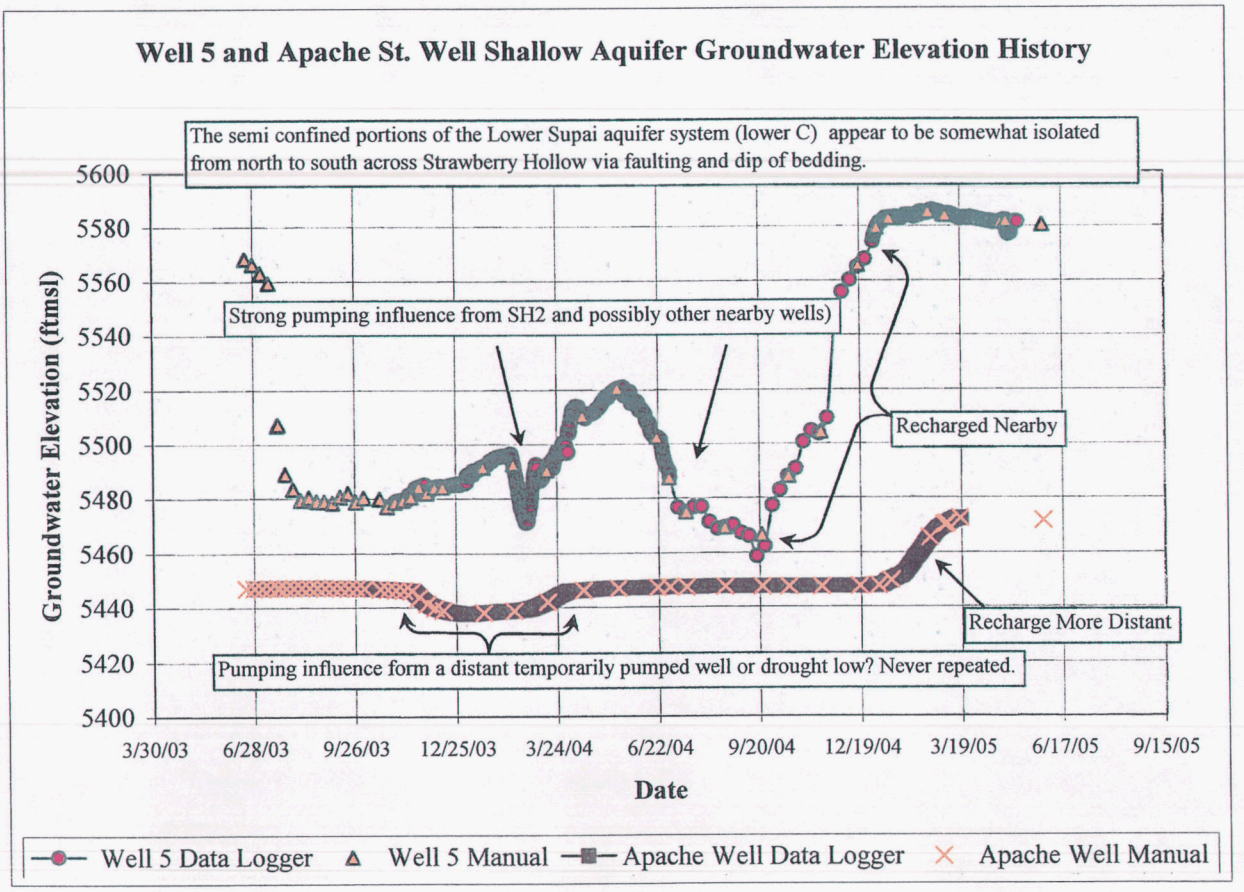


Still, another element of groundwater flow must be considered. Sub-vertical percolation of mixed C-Aquifer drainage/leakage along with deep percolation of precipitation within the Mogollon Basin may be occurring in a northerly direction through the cavernous Redwall Fm.. This could occur directly adjacent to the rim but above the deep regional groundwater elevation via a complex network of fractures and caverns. While this flow is possible, the saturated Martin Formation and "tighter" Cambrian and Precambrian portions of the MX system would still preferentially flow downward and southwesterly as presented prior, along smaller joints, faults, and fractures influenced by the deep regional aquifer's flow towards adjacent basins. With this in mind, the likelihood of sub-vertical

gradients within the R-M-X should be acknowledged. This flow component may account for theorized backward mixing of the Redwall groundwaters within the C-Aquifer.[20] However, defining this potential element of flow from the Redwall back into the lower Naco or Supai (presumably via faulting) will require extensive study beyond the scope of this document.

Groundwater elevations and flow in the shallow aquifer of Pine is much less complicated. The primary source of water for the shallow aquifers in Pine is flow from beneath the rim as drainage of the lower C-Aquifer (perched and/or fringe regional) through the Supai Fm. This however is complicated by the seasonal influx of precipitation recharged into this system and is also underlain by well recovery trends induced by the termination of heavy pumping following the summer months (See Figure D Below – Groundwater Elevation History at Shallow Well 5 #55-578551, 300ft. and Apache Ln. #55-646314, 260ft.). Nonetheless, the confined to semi-confined productive (gray sandy-lime) layers within the lower Supai in northwest Pine result in a southerly groundwater flow direction across the district from an elevation of approximately 5,600ft. to 5,440ft at gradient of approximately .07.[21] See Figure III.

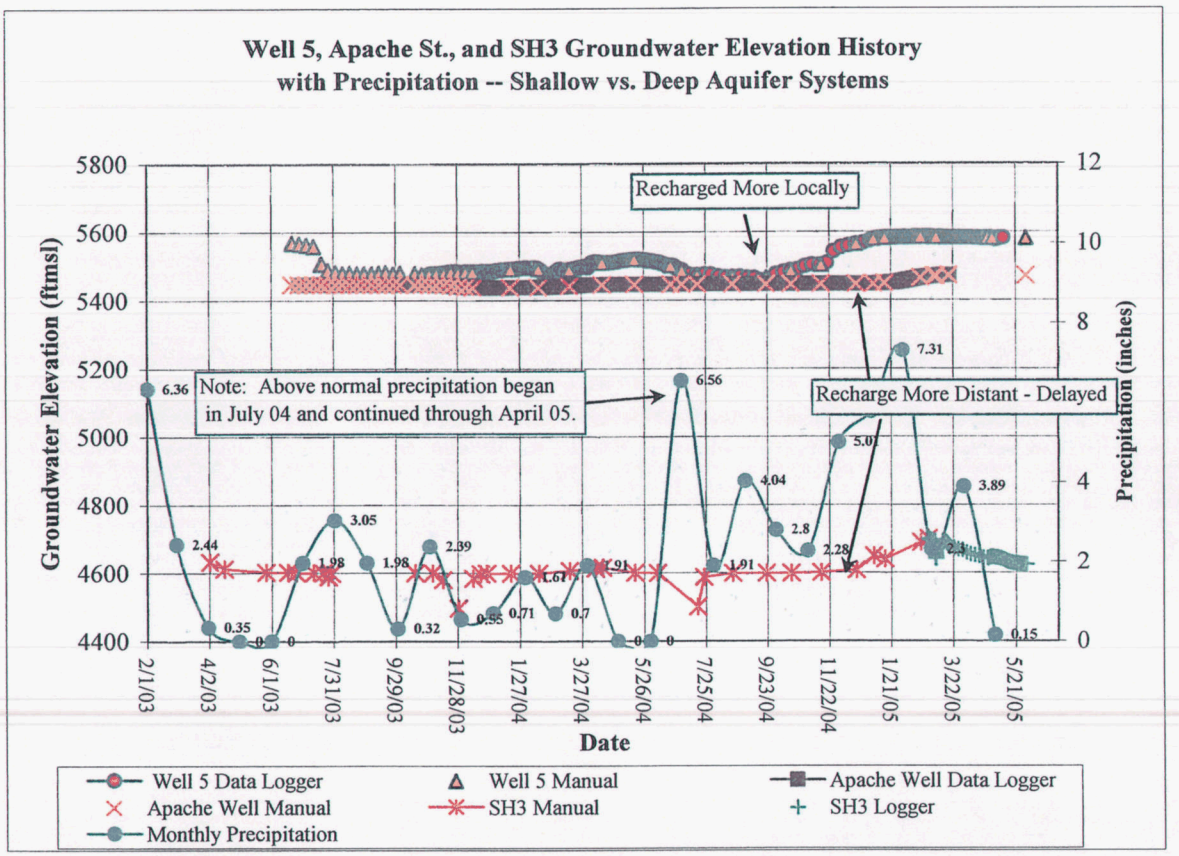
Figure D
Groundwater Elevation History at Shallow Wells 5 and Apache Ln.



3.3.2 Precipitation as an Important Component of Renewability

Precipitation within the Mogollon Basin results in significant recharge to the RMX portion of the deep regional aquifer and (to a lesser extent) the lower Supai or Lower C-Aquifer. This average annual recharge is in addition to the more consistent drainage from the C-Aquifer strata and flow from the deep regional aquifer system into the Mogollon Basin. Discharges from RMX springs are observed to peak in the months following winter precipitation in particular.[22&20] Also, historic water level data collected by SHDWID on the deep well (SH3) indicate response to recharge via fluctuations in groundwater elevation associated with seasonal recharge and particularly following times of heavy precipitation. The observed recharge of precipitation comes as no surprise due to the highly weather, fractured, and cavernous nature of the Redwall and Martin Formations which are exposed all along the southern edge of Pine and along the southern boundary of the Mogollon and Diamond Rim Basins. Indeed the entire Mogollon Basin is a prime area for recharge to the RMX portion of the deep regional aquifer system. For perspective, northerly and beneath the rim, the Redwall and Martin portions of the deep regional aquifer should be quite similar in most respects as to other nationally significant limestone aquifers such as the Edwards Aquifer of Texas.[23] The Precambrian rocks (where exposed further south) also recharge quickly due to deep weathering and fracturing as well.[1&11] As such, a mixing of sources to the groundwater is evident in the groundwater chemistry of the MX portion of the deep regional aquifer within the Mogollon Basin, See Hydrochemistry Section. Similarly, the lower C Aquifer (lower Supai and Schnebly Hill) also receives recharge from precipitation along the exposed edge of the Mogollon Rim, though this is limited due to slope and silt and clay contend of these formations where weathered. Still, this situation partially accounts for the documented "rapid recovery" of existing water supply wells in Pine and Strawberry area over the typical winter recharge months.[9] This occurrence was in fact documented during the testing and observation of SHDWID wells as part of this study. Clearly, the observed discharges from C-Aquifer springs (perched or otherwise) along the edge of the Mogollon Rim provide a continuous source of recharge to the RMX portion of the deep regional aquifer within the Mogollon Basin. Also, both the shallow (lower Supai) and deeper (RMX) aquifers recharged locally via precipitation. See Figure E on the following page.

Figure E
Precipitation and Groundwater Elevation – Deep vs. Shallow Groundwater Systems



In summary, relating to the newly developed deep regional aquifer source for the SHDWID, the M-X portion of the deep regional aquifer system yields water from interconnected fractured and porous mediums, and therefore has dual porosity. The deep regional aquifer is quite extensive as it extends for hundreds of miles beneath the Mogollon Rim to the north, east, and west of Pine, while the Devonian - Precambrian portions of the aquifer extend further south to the edge of the Diamond Rim basin and beyond. As such, the aquifer has both tremendous high elevation recharge and storage over its aerial extent. Yet, the RMX portion of the deep regional aquifer is essentially untapped north of Payson due to its elevation below the rim, existence below dominantly public lands, and fact that it is below the C-Aquifer portion of the system which yields plenty of water to those in need atop the Plateau. However, along the edge of the Colorado Plateau, or the Mogollon Rim itself, the upper portions of the RMX aquifer's geology is exposed and accepts significant recharge via discharges from the C-Aquifer system and local precipitation. The RMX portion of deep regional aquifer has only a few discharges along its southern boundaries (edge of the Mogollon Basin) accept where local recharge exceeds deep percolation rates as is in evidence thru the variability in discharge relative to precipitation.[20&21]

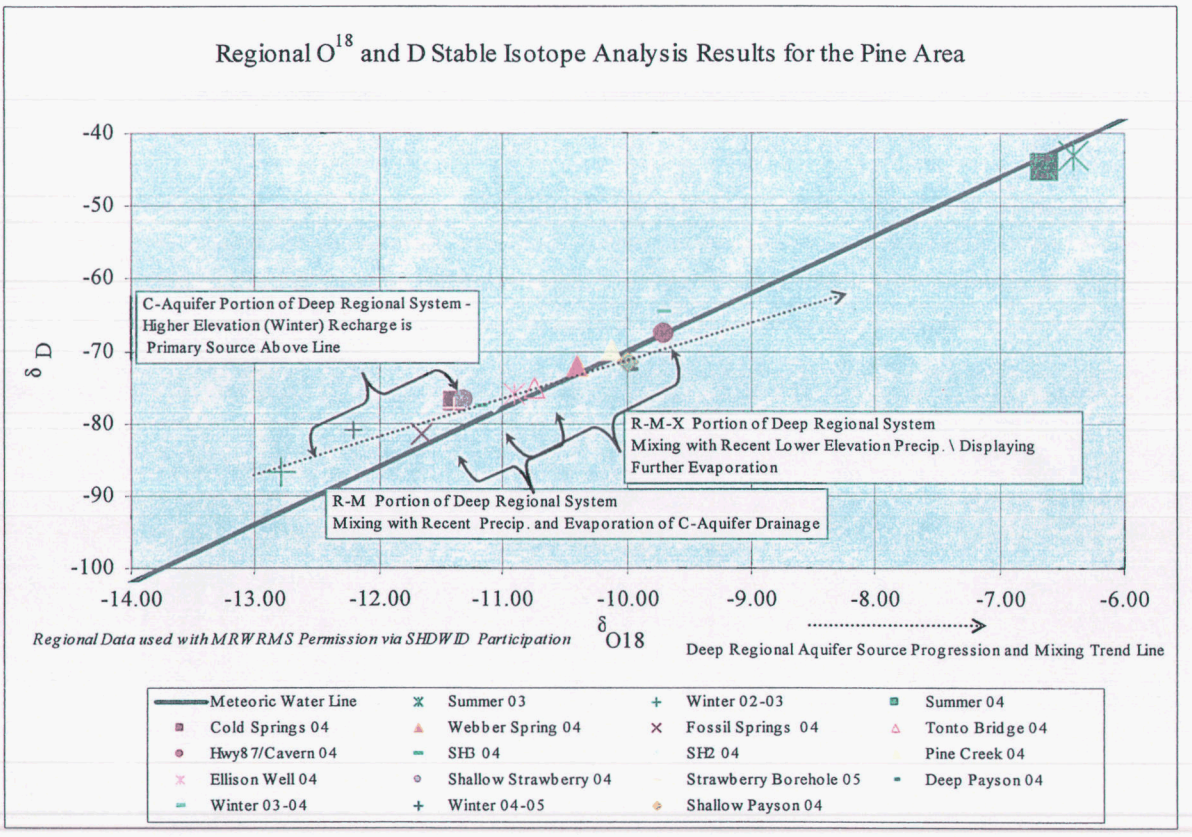
3.4 Groundwater Quality and Hydrochemistry

Numerous groundwater samples have been collected from the SH3 and SH2 wells. As with other wells in the region, both of these sources are of the Ca-Mg-HCo_3 type.[20] Arizona Department of Environmental Quality (ADEQ) new source approval samples have been collected from both the deep and shallow sources of groundwater and are included in Appendix IV. The shallow well, SH2 #55-579973, has already been approved by ADEQ and currently is in use. New source approval process is currently underway for the deep well. The results of sampling indicate that, SH3 #55-587628, will meet all ADEQ standards. Still, variable turbidity resulting from very fine sediment which becomes suspended in the groundwater issuing from caverns and fissures in the Martin, is anticipated. (See Well Development in Section 4 Below). The observed groundwater elevation history indicates the aquifer recharges readily during precipitation events. Enhanced recharge of groundwater systems in fractured and/or cavernous limestone or crystalline aquifer formations is typical. The RMX aquifer portion of the deep regional aquifer is no different, as open voids and cracks or fractures in the limestone, dolomite, and crystalline formations channel groundwater rapidly down into the this regional groundwater system. This situation may result in an occasional natural increase in turbidity of groundwater due to the disturbance of fine sediment within the solution cavities or fractures of the formations. This occurrence can be expected of the limestone and dolomite formations and has been observed in some of the regions other limestone and granite wells.[22] This reality may require (at least seasonally) a "polishing" of the groundwater for turbidity and removal of sediment produced by the well. See Appendix III – Groundwater Quality and Chemistry Results.

3.4.1 Isotope and Tritium Sampling Results

In addition to general water quality, samples have also been collected from both the deep and shallow wells for consideration of Isotopes. Some of this sampling has been done in collaboration with the MRWRMS. Stable isotopes samples of Hydrogen (Deuterium, "D") and Oxygen (^{18}O) have been collected from SHDWID wells. The values of these isotopes in groundwater point to its origins relative to snowmelt and rainfall as well as to elevation and evaporation. The "meteoric water line" represents the typical region on which all the earth's waters would plot relative to the D and ^{18}O isotopes. The farther to the left on the meteoric water line that the data plots, the higher the elevation the groundwater likely originated from as snowmelt. Also, whether the data plots above or below the meteoric water line indicates how much the groundwater is recharged from winter or summer season precipitation.[24] Mixing of local recent precipitation within the shallow and deep regional aquifers is apparent in the ^{18}O and H isotopes. On Figure G below, results of isotope sampling from the District's wells are plotted with results from other springs and sources in the region.[1(2005)]

Figure G



Regional Well and Spring Data Utilized with Permission of the MRWRMS Partners

Data presented above confirms the important roles that both the C-Aquifer portion of the deep regional aquifer and precipitation play as a source to the groundwater within the M-X portion of the deep regional aquifer system that the SH3 well produces from. This data is also in agreement with the recent USGS Mogollon Highlands Study data.[20]

Tritium is currently contained in rainfall at levels ranging from 5.3 – 7.3 tritium units (tu) regionally.[1 (2005)] In general, the lower the tritium number in the sample the older the water likely is.[24] This fact can be related to the groundwater sources being utilized by Strawberry Hollow. In consideration of the precipitation recharge source to the deep regional aquifer in the Pine area one would expect relatively higher tritium in the deep regional aquifer of Pine vs. any shallower lower Supai and Schnebly Hill portions of the C-Aquifer as well as to any upgradient discharges of the deep regional aquifer system. This is precisely what was found with the deep well SH3 containing nearly 4tu and the shallow well SH2 containing 2.3tu and a shallow Strawberry well containing 1.6tu. To put this into perspective, Pine Creek was found to contain 4.3tu with Webber and Cold Springs containing 4tu. Fossil Springs, being sourced from the C-Aquifer portion of the deep regional aquifer, contains 1.5tu.[1(2005)] This data is consistent with the overall hydrogeologic framework presented prior. Also, this Tritium data suggests that any cross

flow from the Redwall or Martin into the C-Aquifer portion of the deep regional aquifer that discharges at Fossil Springs[20] is negligible relative to the C-Aquifer contribution. See Table 4 below and Appendix III for groundwater sampling results.

Table 4

Regional Tritium Sampling Results and Implicit Groundwater Systems			
Source	**Date**	**Result**	**GW System**
Webber	8/11/2004	4.1	MX Portion of Deep Regional Aquifer, C-Aquifer Sourced with Local Recharge Blend
Pine Creek	4/12/2004	5.4	Surface Water, Flows Over C-Aquifer Geology and Mixes with Perched C-Aquifer Drainage
SH2	4/21/2004	2.3	Perched Lower C-Aquifer with Local Precip Recharge Blend
SH3	4/21/2004	4	MX Portion of Deep Regional Aquifer, C-Aquifer Sourced with Local Recharge Blend
Deep Payson	4/21/2004	2.2	Deep X Portion of Deep Regional Aquifer with Local Recharge Blend
Summer 2003	na	7.3	Local Recharge Source for Mixing with Deep Regional System
Fossil Spring	4/27/2004	1.7	C-Aquifer Discharge from Deep Regional Aquifer
Winter 03-04	na	6.1	Local Recharge Source for Mixing with Deep Regional System
Tonto Bridge 04	10/20/2004	2	Discharge from MX Portion of Deep Regional Aquifer - Local Mix Seasonal
Ellison Well 04	10/21/2004	5.9	MX Portion of Deep Regional Aquifer with Local Recharge Blend
Winter 04-05	na	3.6	Local Recharge Source for Mixing with Deep Regional System
Summer 2004	na	5.8	Local Recharge Source for Mixing with Deep Regional System
Hwy87/Cavern	4/12/2004	6	Local Recharge Source for Mixing with Deep Regional System
Shallow Strawberry	10/25/2004	1.6	Perched Lower C-Aquifer or Fringe Deep Regional C
Cold Springs	8/11/2004	4	MX Portion of Deep Regional Aquifer, C-Aquifer Sourced with Local Recharge Blend
Shallow Payson	4/22/2004	3.7	Upper X Aquifer - Slight Blend with X Portion of Deep Regional Aquifer

Source: [1(2005)] and with Permission of the MRWRMS Partners

4.0 Well Drilling, Construction, and Development

The Shallow well, SH2 #55-579973 was drilled in 2000 and was completed prior to this investigation. However, it is known that the well was drilled via conventional air rotary and as such required very little effort to develop. The well was constructed to a depth of 240ft. with 4" PVC casing perforated between 120-160 and 200-240. See Figure V for a schematic of the wells construction.

In the fall of 2000, investigations began in consideration of the opportunities to drill a deep well within the SHDWID service area. Following a well site location assessment, the current location of well SH3 #55-587628 was selected. Drilling commenced in July, 2001 and continued, intermittently, until the well was completed to a depth of 1,320ft. in November of 2002. Significant circulation losses occurred frequently during drilling and required the upper 720ft. to be grouted. In addition, this grouting was done such that the upper shallow aquifer system could be sealed off. Blank 8" well casing was installed to a depth of approximately 608ft.. A video inspection of the bottom of the casing was conducted in November 2002 and confirmed a good seal had been made as no water was observed to be cascading around the bottom of the 8" casing. Below 840 feet, cavernous zones in the vicinity of the Redwall/Martin contact were encountered that extended to a

depth of approximately 900ft.. During video inspection many voids and cavernous areas were observed to have dripping water and were lined with drilled cuttings, particularly between 870-900ft., just above the water table. Additional voids and possible cavernous zones were encountered below 900ft. during drilling but could not be inspected due to an obstruction at 903ft.. As would be expected, circulation during drilling below the water table (~900ft.) was less than efficient, with only about 20% of circulation fluids and drilled cuttings being recovered to total depth. Airlift gpm estimated during drilling on the final day was between 5 and 25gpm but with huge losses to formation. It was expected that the well would be capable of 80-100gpm. See Figure VI for a schematic of the wells construction.

The aforementioned losses of circulation resulted in a significant well development concern. The well was constructed as a 6" diameter dual purpose exploratory-production well with .125in slots from 985-1,300ft.. Airlift attempts upon completion of the well were not successful as, even with casing installed, losses were not overcome. In addition, upon pumping the well, large volumes of sediment consisting of drill cuttings and fine red silt were removed but this quickly damaged the pumping equipment. In consequence, an eductor pipe method was utilized to airlift the well in an attempt to clear sediment and develop the well. The eductor system had only limited success due to very inefficient operation caused by the small well size and limited submergence.[10] In addition, borehole geophysics conducted after the installation of the 6" well casing indicated that potential water production zones in the upper 80ft, of the aquifer had been cased off. This could have been causing the observed intermittent pulses of sediment coming into the well via variable intermitting bridging of sediment within the wells annulus but above the perforations. As such, the well was mechanically perforated from approximately 910ft. to the top of the existing perforations. This was done to permit the upper producing zones to yield water into the well and also to readily pass sediment (larger fraction being cuttings) from the formation surrounding the well until stable. Beginning in July, 03 the well was subjected to both continuous and intermittent pumping until it was last bailed of sediment in November, 2004. From July 2003 to November 2004 more than one half a million gallons of groundwater was pumped from the well for development purposes. Most drilled cuttings have now been removed. However, during initial run times and/or during recharge season, fine sediment still persists along with a fine clean sand that is now thought to be issuing from the lower sandy ~200ft. of the well. In time, a natural gravel pack will likely develop with the wells continued use. However, until such time, particle filtration is recommended as turbidity upon startup is likely.

5.0 Well Testing

As in integral part of demonstrating the physical availability of the subject groundwater supplies the District subjected both of its groundwater supply sources to rigorous pump testing. The testing was conducted longer than the minimum time required by ADWR in order to address potential concerns of boundary conditions. Still, testing durations much longer than 7 days are not practical as the analytical methods utilized to assess well and aquifer characteristics are based on logarithmic formula and graphs. In consequence, data collected beyond 7 days "piles up" at the end of the graphs. In reality, pumping of the wells continuously will not be practiced and therefore any boundary condition effects brought about by an intended over-pumping of a source is not indicative of actual operating conditions. However, in order to yield the most conservative projections, the wells were not only pumped longer than typical run times but SH3 was pumped at three times the anticipated demand of the subdivision. In consideration of these realities constant rate well tests were conducted at the deep regional source for 7 days and for 4 consecutive days at the shallow supply well. Nevertheless, long-term projections utilizing "no recharge" scenarios were utilized to project impacts out to 100 years even with the realities of long- term average recharge. As such, the results presented below should be considered conservative.

5.1 Deep Well SH3 Testing and Impact Analyses

The deep well SH3 was tested on March 4th thru March 11th 2005. The well was equipped with submersible Berkeley model 6TS40-95 pump set on 2.5 inch column pipe to a depth of approximately 1,040ft.. Also, a Troll data logger was installed and calibrated on February 26th 2005 to record water levels and temperature data prior to and throughout the testing period. Utilizing a variable frequency drive, the well was pumped continuously at a rate of 46gpm for seven days three hours and one minute. Upon the completion of testing the final specific capacity was calculated at 3.2gpm/ft with drawdown stabilized in the vicinity of 15 ft.. Ph, Temperature, and conductivity were measured repeatedly and stabilized at approximately 7.2, 52°F, and 270µS respectively. Please see Appendix V for all testing data and graphs.

Early in the test, steeper drawdown was observed briefly and again at about 1,050min when drawdown was observed to approach 50ft.. During these times, flow into the well was temporarily obstructed due to sediment. Temperature data collected by the transducer indicate this obstruction occurred in shallower producing zones above the pump as the water temperature increased when the blockage occurred. Upon the clearing of this obstructing sediment, drawdown quickly lessened and approached the final stabilized drawdown of nearly 15ft. while the temperature recorded at the transducer declined. After seven days of pumping, the well was turned off and rapid recovery was observed to occur. The well recovered to pre-pumping levels in only 9 minutes.

Clearly the deep well SH3 is pumping from a large unconfined (possibly semi-confined) groundwater system. No negative boundary conditions were observed during testing other than when the well's perforations were temporarily plugged with sediment. This problem has been observed repeatedly at the well but also has been observed to improve the more the well is used. The data collected during and following the test indicate the aquifer may not have been stressed at 46gpm.. This is apparent in Table 5 below, displaying the calculated Transmissivity, Conductivity, and Storage values per various methods.[17&25&26&28] The T values seem very low in comparison to the wells actual performance, yet they are reasonable for limestone-sandstone strata of the region.[14&15&20] In addition, recharge conditions were being observed during and prior to the test. As such, the aquifer characteristics presented below are considered approximate. A storage value of .07 or 7% may yet be assumed as this value falls within typical storage coefficient values for unconfined aquifers and that documented for other Paleozoic strata in the region.[27&28&2914&10] Due to the small well size and volume of sediment apparent in the aquifer's cavernous areas, it is not recommended that this well be pumped at a much higher rate due to the likelihood for developing sediment in unprecedented quantities. Well reconstruction would likely be required in order to produce what the well may indeed be capable of when considering the documented specific capacity of over 3gpm/ft of drawdown.

Table 5
Estimated Deep Aquifer Characteristics per Method via SH3 Well Testing

Method	**T** gpd/ft *	**K** gpd/ft² *
Theis (Jacob Approx.) Pumping Early Time	880	2.2
Theis (Jacob Approx.) Pumping Late Time	1,227	3.1
Theis (Cooper Jacob) Recovery	1,202	3.0
Papadopulos (Forward) – Pumping Early Time	1,676	4.2
Papadopulos (Forward) – Pumping Late Time	5,909	14.8
Theis (Forward) – Pumping Early Time	1,406	3.5
Theis (Forward) – Pumping Late Time	6,650	16.6
Theis Early Time	1,025	2.6
Theis Late Time	3,478	8.7
Total Average Values	**2606**	**6.52**

** Storage values are not provided due to method limitations. Assumes effective saturated thickness of ~400ft.. Late time data is considered more accurate due to unconfined to semi-confined condition of aquifer. Due to limited drawdown unconfined corrections for s were not necessary for most methods. To obtain values in ft/day or ft2/day, divide by 7.48.*

Long-term 100 year impact projections, (See 100 year projection plots in Appendix IV) indicate the well and aquifer is readily capable of yielding groundwater in the amount tested (46gpm) for 100 years (See Also Tables 1 and 2 in Demand Section for Quantity Information). Three drawdown projections are displayed taking into consideration drought, recharge, and long-term average. Drought conditions can be modeled by the time in which flow into the well was restricted when shallower groundwater producing zones were obstructed due to sediment bridging. A characteristic curve can be observed in these less efficient pumping times that display a steeper drawdown projection than

when the well was pumping from all producing zones during the latter part of the test. By considering the projected drawdown in this fashion one can expect 100 year drawdown to range between 47 and 112 feet or a pumping level (taken from the long-term average static of 900ft.) range of 947 to 1,012 feet. The resulting average of these two extreme scenarios, indicate the well should be a more than adequate 100 year supply for the District. In addition, the observed influence of recharge to the aquifer clearly points to the long-term renewable nature of the deep groundwater supply.

Well distance drawdown impact analyses are problematic due to this being a single well test. Firm storage values cannot be calculated. Given the wells observed rapid recovery, it is quite apparent that drawdown in the well itself is more than likely much more than would be observed at even a close distance from the well. All data indicate the aquifer is essentially unconfined but may become semi-confined at some distance to the northeast of the well. The aquifer has a dual porosity due to the presence of both open fractures and caverns in addition to sandy layers at depth. Yet, the aquifer test did not appear to stress the well enough to observe the dual porosity nature. The secondary porosity is believed to be oriented primarily in a northwest – southeast trend along the Strawberry Hollow fault with additional secondary porosity oriented northeast - southwest. This situation would point to the development of a slightly elongated cone of depression in the southeast – northwest direction. For purposes of managing this newly developed resource at only 46gpm, it is requested that ADWR staff consider a one-half mile radius (1,320ft. NW and 1,320ft. SE) around the well as an assumed capture width from the MX portion of the deep regional aquifer until additional data from other potential future deep wells proves that closer spacing is acceptable. This would in effect result in impact considerations similar to that within AMA's should additional demands within close proximity to this region of the deep aquifer arise and therefore serve to protect the interests of the public and the SHDWID customers.

5.2 Shallow Well SH2 Testing and Impact Analyses

The shallow well SH2 was pump tested on April 29th thru May 3rd 2005. The well was equipped with submersible pump set on 1.5 inch column pipe to a depth of approximately 200ft.. Also, a Troll data logger was installed and calibrated on April 24th to record water levels and temperature data prior to and throughout the testing period. In addition to the pumping well, Well 5 (#55- 578551, 350ft south) was used as an observation well during testing. A previously installed and calibrated Troll data logger was utilized to collect data at this well. Due to the confined to semi-confined nature of the subject aquifer and nearby pumping, daily water level fluctuations were notable. In the few days prior to testing the water level was observed to be rising. As such, "static" levels were approximated at 16.61ft. at SH2 and 19.5 at Well 5 (See Appendix V – SH2 and Well 5 dtw trends). The well was pumped continuously at a rate of 15.3gpm into the distribution system for four days and thirty three minutes. Upon the completion of testing the final specific capacity was calculated at .89gpm/ft with drawdown stabilized in the vicinity of 17 ft.. Ph, Temperature, and conductivity were measured on day four and had stabilized at approximately 7.3, 52°F, and 685µS respectively. Drawdown at

Well 5 was observed to stabilize at approximately 4 feet. Please see Appendix IV for all testing data and graphs.

During pumping, the rate of drawdown was observed to increase following initial stabilization at approximately 2,000 minutes at both wells. However, this condition reversed by 3,000 minutes and drawdown recovered during pumping towards the final trend. This situation appears to be caused by well interference from a nearby intermittently used well. Imbedded in the trends displayed are what appear to be dual porosity effects as well. After four days of pumping, the SH2 well was turned off and complete recovery was observed to occur by the afternoon of May 5th. The well was placed back into service on May 6th. Again, see Appendix V for all depth to water and drawdown plots.

The shallow well SH2 appears to be producing groundwater from a confined to semi-confined groundwater system. The data collected during and following the test indicate the aquifer is also of the dual porosity type. The confined nature of the aquifer is confirmed by the calculated storage coefficient being only $1.2*10^{-4}$. This value is typical for confined systems and is also indicative of the limited storage.[27&10]

Table 6 below displays Transmissivity, Conductivity, and Storage values per various methods.[10&25&26&29]

Table 6
Estimated Shallow Aquifer Characteristics per Method via SH2 Well Testing

Method	**T** gpd/ft	**S**	**K** gpd/ft^2
Theis (Jacob Approx.) Pumping Late Time, SH2	1,154		5.8
Theis (Jacob Approx.) Pumping Late Time, Well 5	2,525	$1.2*10^{-4}$	12.6
Theis (Cooper Jacob) Recovery, Late Time, SH2	4,039		20.2
Theis (Cooper Jacob) Recovery, Late Time, Well 5	1,355		6.8
Theis Late Time Pumping, Well 5	2,154	$1.2*10^{-4}$	10.8
Theis Late Time Pumping, SH2	1,189		6
Total Average Values	**2,069**	**$1.2*10^{-4}$**	**10.4**

Note: Effective saturated thickness assumed to be ~200ft.

Long-term 100 year impact projections, (See 100 year projection plots for SH2 in Appendix V) indicate the well and aquifer is capable of yielding groundwater in the amount tested (15.3gpm) for 100 years (see also Tables 1 and 2 in Demand Section) assuming well interference is only intermittent. Three drawdown projections are displayed taking into consideration drought, recharge, and long-term average. Drought conditions can be modeled by adding 100 feet to the initial static depth to water. This extreme drought static level has been observed historically in Well 5 and SH2. It is assumed that the observed drawdown trends would be similar. It is also assumed that the observed drawdown during testing is indicative of a fully recovered and recharged aquifer. Most realistically, the average of these two extreme scenarios is the expected

long-term impact from pumping well SH2. With this in mind, the 100 year pumping level is expected to be approximately 98 feet. The "drought" scenario is projected at 158 feet of drawdown and the "recharged" scenario at 38 feet.

A distance drawdown impact analyses was conducted to assess the long-term impacts of pumping well SH2 on the shallow system. Utilizing observation Well 5, a distance drawdown projection was constructed[10] (See Appendix V – Well 5 Distance Impact Plot). Due to the confined nature of the aquifer and typical low storage value, long-term drawdown impacts can be expected to be relatively far reaching compared to the deep unconfined aquifer. Drawdown at a distance of one mile from the SH2 well at 100 years is projected to be 7 feet. When considering drought, the entire system is expected to have declined and therefore the impact is essentially the same but is relative to the drought controlled "static" level. It should be noted that distance impacts can only occur out to the boundaries of the subject aquifer and are also subject to well interference. In a southerly direction the subject aquifer is bounded within one mile. Also, there are other wells within the influence of SH2 such that interference cannot be controlled. Therefore, though not indicated in the pumping test, a boundary condition does exist within one mile south of the SH2 well and other wells are located north and south of the SH2 well which may interfere with SH2 drawdown.

Similarly to the deep aquifer system, secondary porosity is believed to be oriented primarily in a northwest – southeast trend along the Strawberry Hollow fault with additional secondary porosity oriented northeast - southwest. However, the aquifer is bounded on the south. This situation would point to the development of a slightly elongated cone of depression in the southeast – northwest direction with increased drawdown towards the south. See SH2 anticipated 100 year cone of influence map in Appendix IV and Figure VII for Registered Wells Near SHDWID

In the end, the projections indicate the well should be an adequate 100 year supply for the District, assuming limited well interference. Similarly to the deep aquifer, the observed influence of recharge to the aquifer clearly points to the long-term renewable nature of even the shallow groundwater supply. This reality also helps to minimize well interference and the long-term drawdown impacts projections which assume no recharge occurs for 100years.

6.0 Conclusion

Intermittent well interference at well SH2 cannot be ruled out and as such the primary supply for the SHDWID is expected to be the deep SH3 well. Still, by operating the two independent groundwater sources conjunctively, winter runtimes for SH2 and summer runtimes for SH3, long-term yields from the shallow source are expected to be maintained. The SHDWID has clearly demonstrated via long duration testing, beyond the requirements of typical AWS filings, and also by the hydrogeoligcal investigations presented herein that an adequate 100 year supply of groundwater is available for its service area customers. A more than adequate groundwater supply, from a previously untapped deep aquifer source, is capable of meeting project demands by exceeding 100 year water supply requirements. In conclusion, the development of two independent groundwater sources along with a governing demand side management plan constitutes unprecedented voluntary water resource planning by a water provider in rural Arizona.

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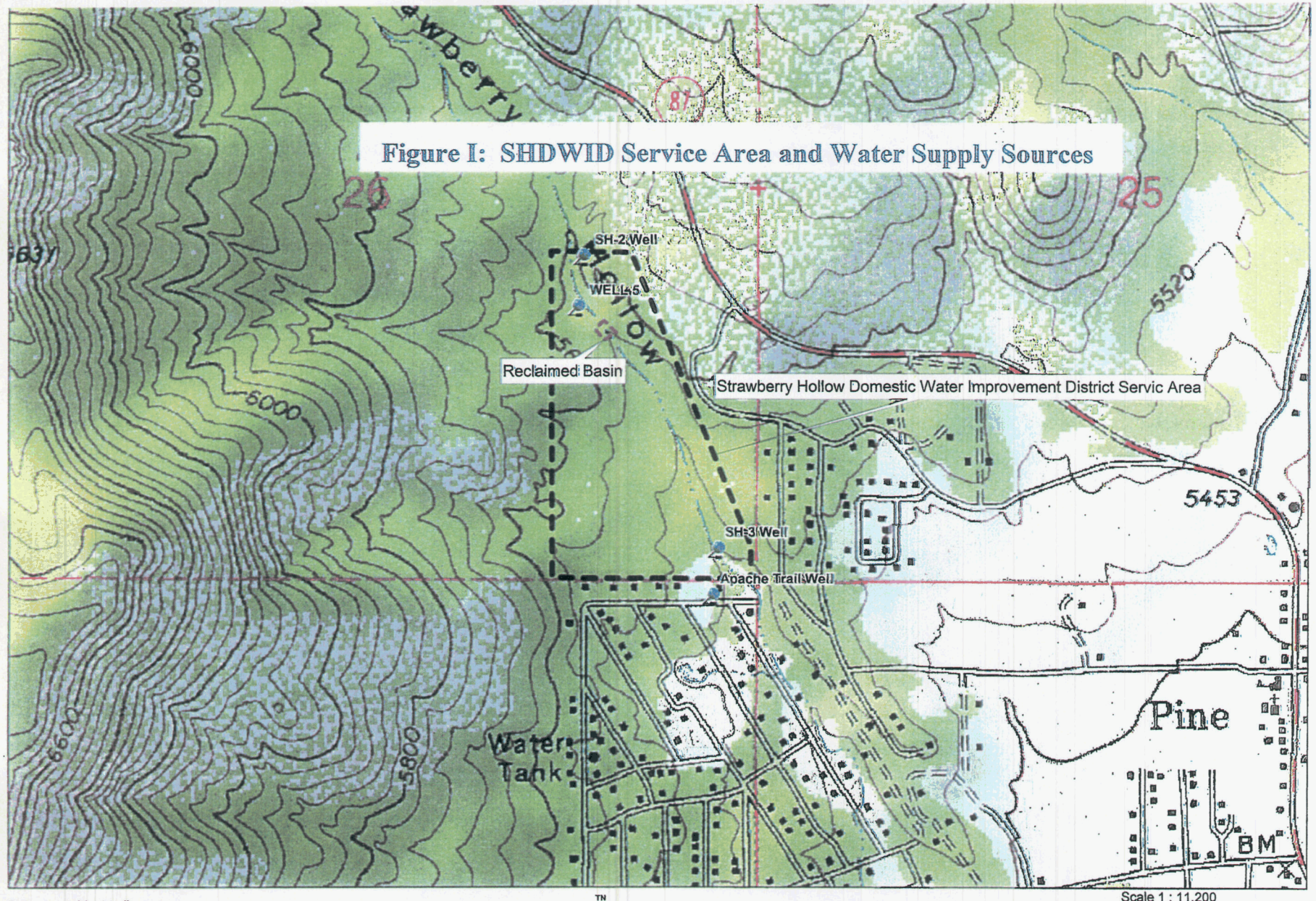
FIGURES

Figure I: SHDWID Service Area and Water Supply Sources



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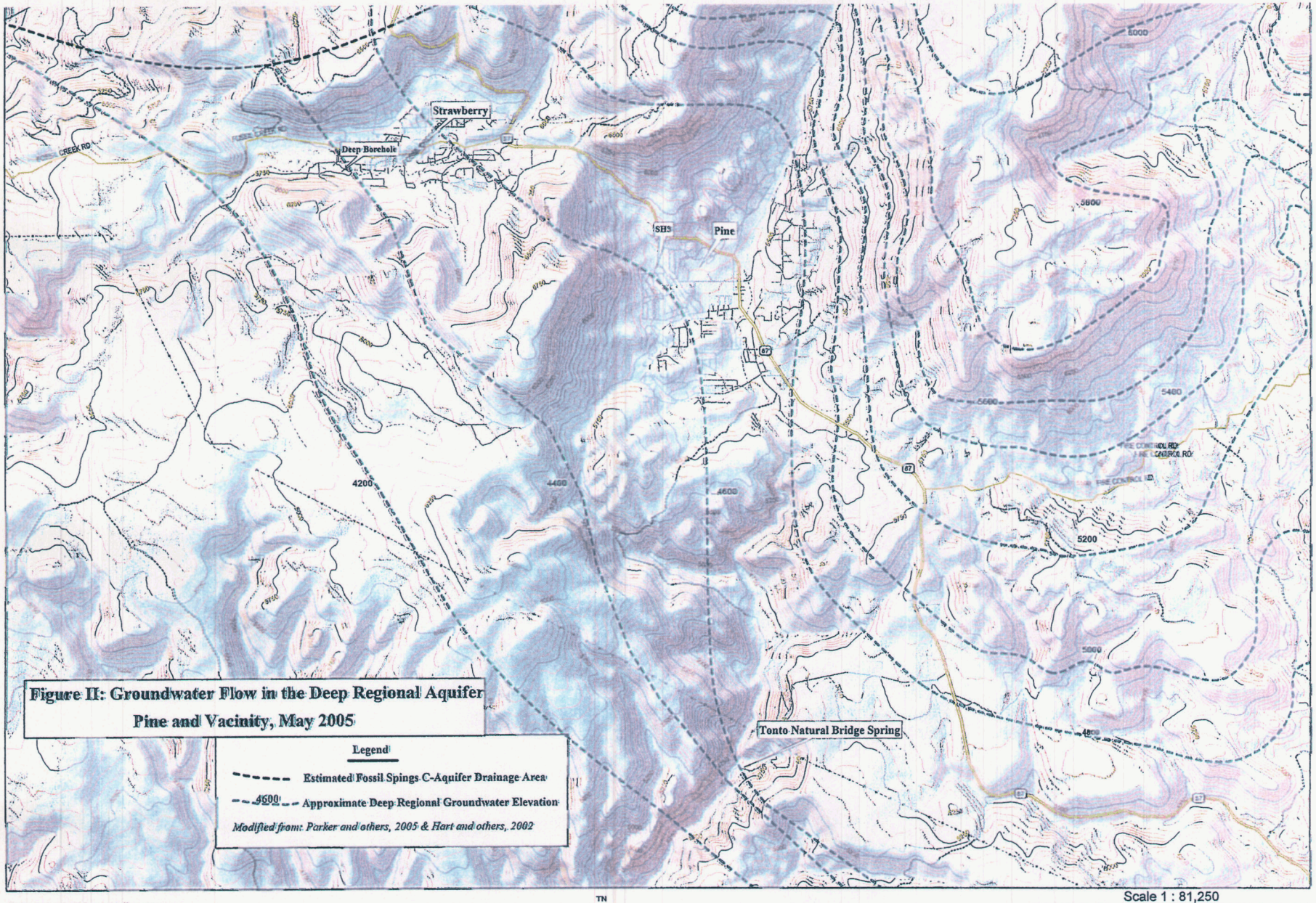
TN
MN (11.6°E)

Scale 1 : 11,200

1" = 933.3 ft Data Zoom 14-0



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TN
MN (11.5°E)

Scale 1 : 81,250

1" = 1.28 mi

Data Zoom 12-0

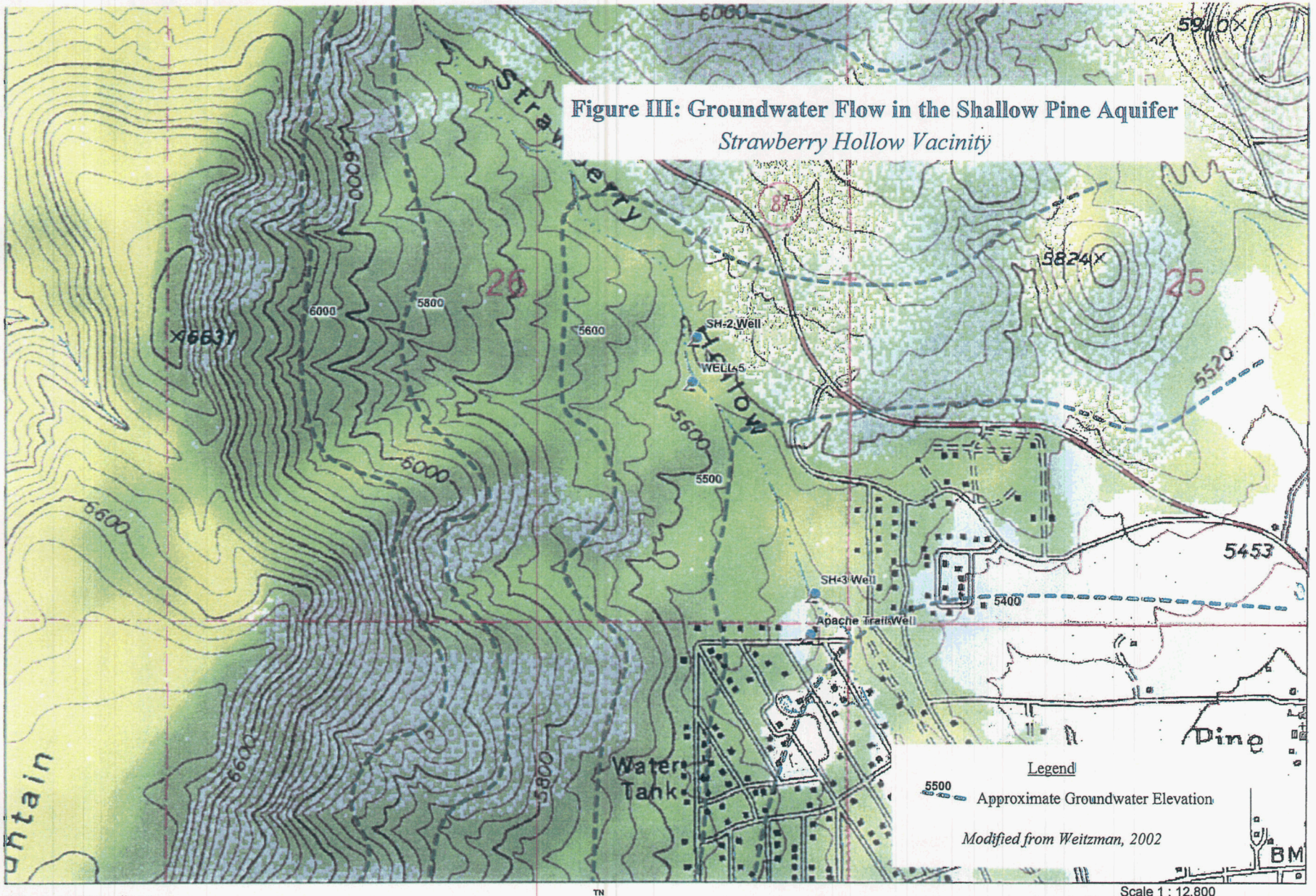


Figure III: Groundwater Flow in the Shallow Pine Aquifer
Strawberry Hollow Vacinity
6060
5910
Straw
berry
6000
6000
5800
26
6000
5800
5600
SH-2 Well
WELL 5
Hollow
5824
25
5520
6631
5600
6000
5500
5600
5453
SH-3 Well
5400
Apache Trails Well
Pine
5600
5800
Water
Tank
Legend
5500
Approximate Groundwater Elevation
Modified from Weitzman, 2002
BM
Data use subject to license.
© 2004 DeLorme. XMap® 4.5.
www.delorme.com
TN
MN (11.6°E)
Scale 1 : 12,800
0 200 400 600 800 1000
0 100 200 300 400 500
1" = 1,066.7 ft
Data Zoom 14-0

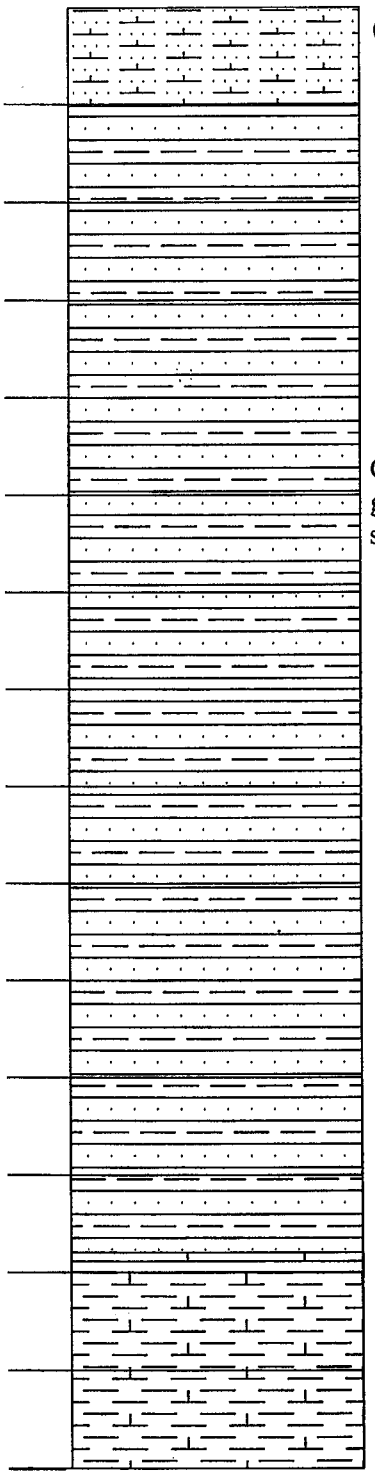
FIGURE IV

SH3 Borehole Logs

Log of Borehole — Well Name: Strawberry Hollow: SH-3

th Highland Water Resources Description and Notes

rface Drilling begins July 3rd 2001, Aero Drilling, Air Rotary, Hammer, 6.25" bit.



0-15ft. sandy silt and gravel (dry)
Red silt and sand 15-20ft. (dry)

Weathered Supai Fm.
20-30ft. 10gpm.

Strong reaction to acid

50-60ft. Silty sandstone, gray, lime, lifting 35gpm.

Hole is reamed for 60ft., 10" blank surface casing installed and grouted to 60ft. Further drilling is conducted with the 6" hammer and bit.

CS - up to 3/8", red and gray limestone and siltstone

CS - up to 3/8", DR - 1.2ft/min

moist

No sig. changes
Cuttings continue to average 1/8-3/8" with fines.

Note: A detailed lithological description of each of the Formations is not within the scope of this investigation. However, the entire section of Supai Fm. can be described as follows: Dominantly red limy silt/mudstone interbedded with gray limestone and gray limy sandstone layers. Occasional limestone conglomerate is present. Clay is typical in weathered and fractured intervals within the siltstone. Small confined aquifers occur in relatively thin isolated limy sandstone layers. These small shallow aquifers are those utilized for water supplies in the Pine and Strawberry area. These aquifers were isolated via casing and cement grout in order to prevent under draining and cross connection with the deeper regional groundwater system.

240-260ft. water encountered, lost circulation shortly after however.

Transition to Naco Fm.

258-260ft. clay rich layer, lost circulation below. Likely top of confining Naco Shale -Cemented hole to 280ft. to continue.
(Note: Due to the repeated cementing of the upper 700ft. of the borehole, gamma logs do not show the typical spikes of shale layers within the Naco)

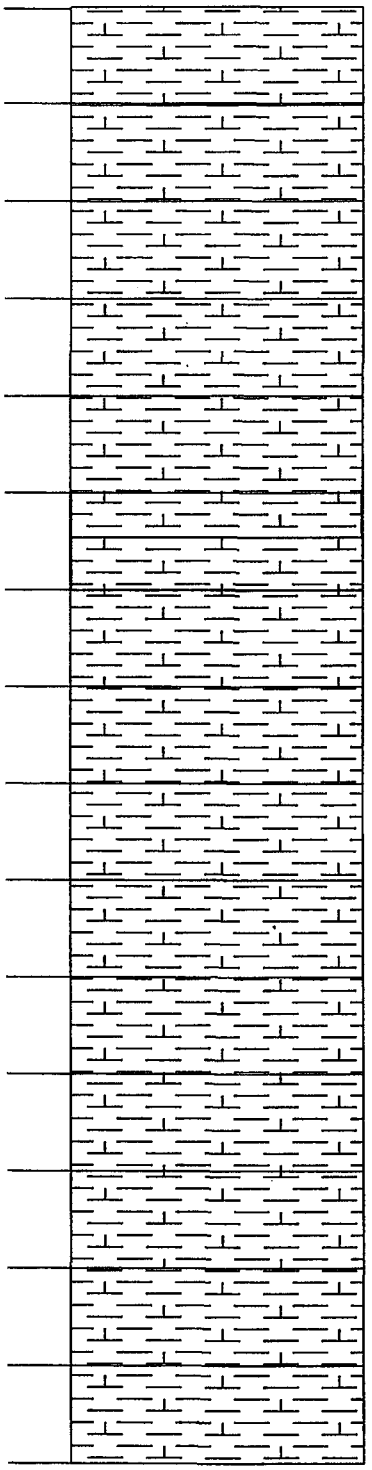
280-305ft. Limestone layer.
CS - up to 1 inch.

Recent Alluvium
Tertiary Gravels
Tertiary Basalts
Permian–Pennsylvanian Supai Fm. (Siltstone–Limestone)
Pennsylvanian Naco Fm. (Limestone–Shale)
Mississipian Redwall Fm. (Limestone and Terra Rosa)
nian n nite/Limestone
Cambrian Tapeats ss.
Precambrian Rhyolite (possibly quartzite)
Precambrian Payson Granite
PreCambrian Gniessic Granite – Granodiorite
PreCambrian Diorite

ne: -3	Project: **Strawberry Hollow**	Page 1 of 5
ell No. 587628	ADWR Cadastral A(12-8)26DDD	Surface Elevation **5502ft.**

; of Borehole Well Name: Strawberry Hollow: SH-3

th Highland Water Resources Description and Notes



305-320ft. silt and clay in shale layers and limestone fractures.

Drill binding loosing circ again. Grout hole to 320ft. to continue.

Red/Gray Limestone CS - up to 3/8" , strong reaction to acid.

DR - 1.2ft/min

Less silt and clay now, less weathered and more massive red/gray limestone.

Orange Chert and vug fragments, 400-420ft.

Note: Bottom of Supai - Top of Naco Transition

The Shale layer encountered at 258ft. signaled an increase in the frequency of alternating shale and limestone beds with orange chert. This is to distinguish it from the Supai Fm. Also, the Supai Fm. contains very little chert as compared to the lower limestone units. Also, In some literature the lower Supai Fm. includes the Naco Fm.

Moist Red Shale-Clay 470-473ft.
-- Circulation Lost --

Lost circulation 473-600ft. Not cuttings returned.

From 480-680ft. the borehole was grouted repeatedly in order to facilitate drilling through the Naco Fm.

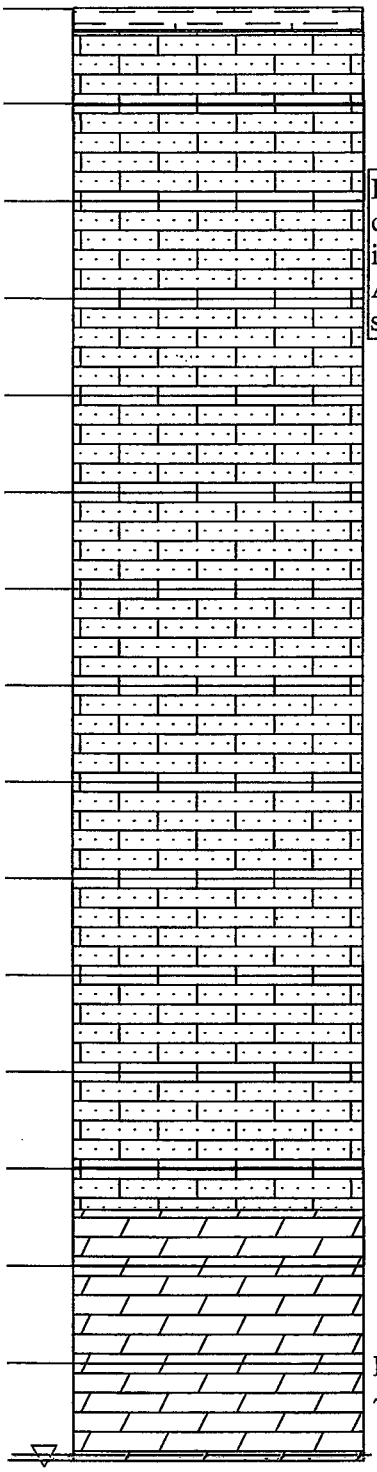
Alternating hard and soft zones to ~610ft. Likely limestone beds alternating with shale -- typical of Naco Fm.

Borehole reamed to 612ft. for 8" blank casing, installed to facilitate continued drilling and seal off upper units.

Redwall thought to begin around 600-610ft.

Recent Alluvium
Tertiary Gravels
Tertiary Basalts
Permian–Pennsylvanian Supai Fm. (Siltstone–Limestone)
Pennsylvanian Naco Fm. (Limestone–Shale)
Mississipian Redwall Fm. (Limestone and Terra Rosa)
nian in mite/Limestone
Cambrian Tapeats ss.
Precambrian Rhyolite (possibly quartzite)
PreCambrian Payson Granite
PreCambrian Gniessic Granite – Granodiorite
PreCambrian Diorite

ne: -3	Project: **Strawberry Hollow**	Page 2 of 5
ell No. 87628	ADWR Cadastral A(12-8)26DDD	Surface Elevation **5502ft.**



Redwall Fm. contact is at approximately 605ft. Though samples are limited, they no longer exhibit orange chert, there is an obvious presence of Terra Rosa below 620ft. (video), and a lack of a distinct layered nature to drilling beyond this depth. Also, borehole video clearly indicates Redwall Fm. is present by 650ft.. (Upper portions obscured by grouting.) Gamma and Neutron logs confirm.

Drilling with air only and 7.8" tricone bit upon reaming and setting 8 inch casing to 612ft. (6/02-9/02) Cuttings are dry (except where noted), indicating a good seal was made and that deeper zones are isolated. Also, the original 6inch borehole was cemented to ~680ft. to stabilize and seal the borehole before reaming for casing and continuing on.

No Orange Chert
Fine grained Limestone,with Terra Rosa, Strong Reaction to Acid

Redwall Limestone: Moderately hard fine grained limestone with weathered zones containing Terra Rosa

Cuttings are mostly fines due to use of tricone bit, good circulation, cuttings are dry, dusty.

DR - .3ft/min

Moist 750-760ft.

More terra rosa in cuttings

slt. less brown/red color - less terra rosa

More gray by 810ft.

Fracture/void 815-818ft.

Circulation dropping off below 840ft. due to voids, fractures, and caverns in Redwall -- sample recovery decreases.

DR - .4ft/min

Increasing voids and cavernous areas in Redwall beginning about 840ft. Likely transition to **Martin Fm. 840-860ft..**

Very soft 843-850ft.

Fracture/void/cavern 849-856ft.

Moist zones 860-900ft.

Clean clear calcite fragments 870-900ft. -- Typical of cavernous Martin Fm.

874ft. fracture/loose

DR - 1ft/min -- faster since ~850ft. - Martin Fm.

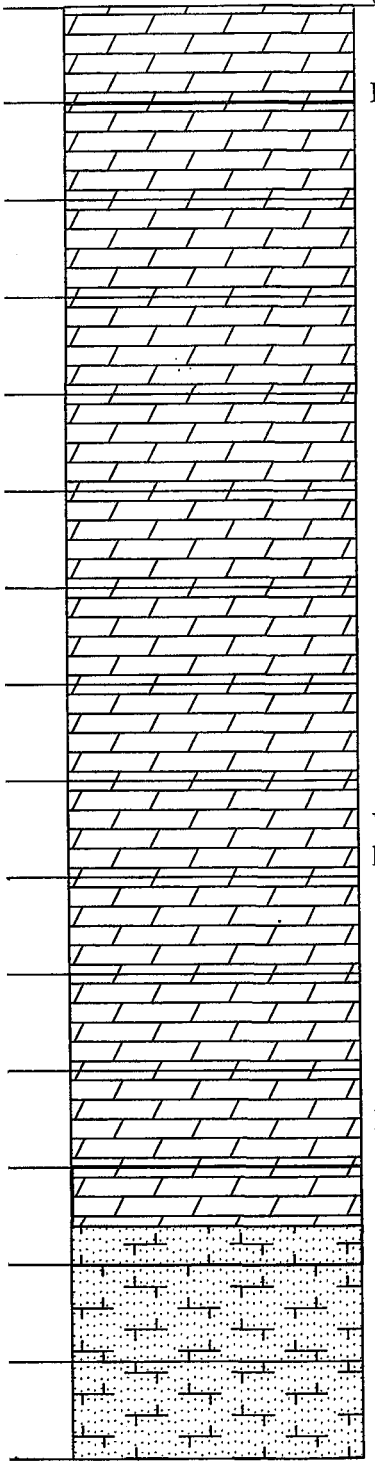
onion
tin
omite/Limestone
Cambrian Tapeats ss.
Recent Alluvium
Tertiary Gravels
Tertiary Basalts
Permian–Pennsylvanian Supai Fm. (Siltstone–Limestone)
Pennsylvanian Naco Fm. (Limestone–Shale)
Mississipian Redwall Fm. (Limestone and Terra Rosa)
PreCambrian Rhyolite (possibly quartzite)
PreCambrian Payson Granite
PreCambrian Gniessic Granite - Granodiorite
PreCambrian Diorite

ne: 3	Project: **Strawberry Hollow**	Page 3 of 5
ell No. 587628	ADWR Cadastral A(12-8)26DDD	Surface Elevation **5502ft.**

h Highland Water Resources Description and Notes

Well video upon completion of drilling indicates static water level of approximately 900ft.

Regional Water Table ~4,600ft.



Lost circulation -- no sample recovery

Harder with thin softer zones.

Formations are saturated below ~900ft. or an elevation of 4,600ft..

Large caverns in Lower Redwall and Upper Martin from approximately 840ft.-904ft. are observed in video. These voids in, addition to now being below the regional water table, is the primary reason for limited and lost circulation below. Large quantities of cuttings are observed in these spaces and other smaller voids above it. Significant water airlift losses can be expected into these areas.

Void 1010-1014ft. Muddy sample then Lost circulation -- limited sample recovery

Flow zone observed in Temp. log. 1020-1025ft.

Moist 1030-1040ft., low sample recovery

Flow zone observed in Temp. log. 1042-1048ft.

Fractures in Martin 1050-1055ft. First water airlifted now, ~15gpm., subject to losses

Very hard limestone 1060-1100ft. -- DR - .15ft/min low sample recovery, mostly red/brown fines.

slt. increase in DR beyond 1080ft.

DR increase, very low sample recovery, organic odor.

Note: Rig startup pressures to break water head suggests depth to water is ~900ft.

More brown color, cuttings mostly fine, with sandy zones, moderate reaction to acid, DR up to .5ft/min - Martin Fm.

Increase in red/brown color, increasing sand and hard and soft zones, likely **transition to Tapeats 1,150-1,160**, Neutron and Gamma log confirm.

Airlift circulated from 1200ft. was continued for 30 minutes in an attempt to clean borehole. 15gpm of groundwater was airlifted from 1200ft. and carried fine red silt (terra rosa) washed out of the Redwall Fm. and residual cuttings still in the borehole. Note: circulation and cuttings removal has been less than 20 % since 840ft. suggesting that airlifted water production may also be 20 % of actual.

Recent Alluvium | Tertiary Gravels | Tertiary Basalts

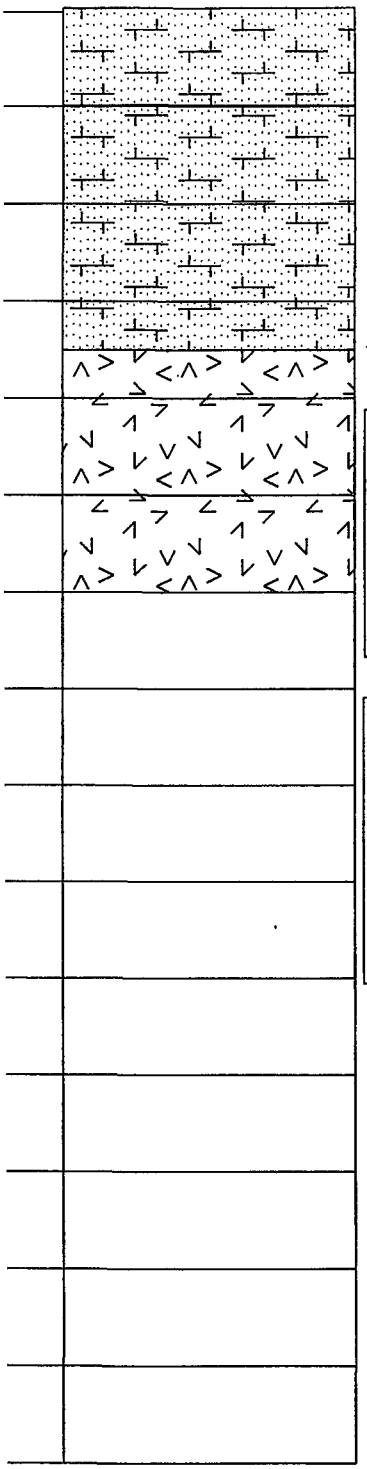
Permian–Pennsylvanian Supai Fm. (Siltstone–Limestone) | Pennsylvanian Naco Fm. (Limestone–Shale) | Mississipian Redwall Fm. (Limestone and Terra Rosa)

onian lin ɔmite/Limestone | Cambrian Tapeats ss. | PreCambrian Rhyolite (possibly quartzite) | PreCambrian Payson Granite | PreCambrian Gniessic Granite – Granodiorite | PreCambrian Diorite

ne: -3	Project: **Strawberry Hollow**	Page 4 of 5
ell No. 87628	ADWR Cadastral A(12-8)26DDD	Surface Elevation **5502ft.**

h Highland Water Resources Description and Notes

ne observed in temp. log 1,210-1,214ft.



Fine grained dolomite with pink ground mass, fine sand from sandy layers in Martin notable in cuttings. Quarts grains from Tapeats notable. CS - mostly fines with some chips up to 1/4". 1200-1230ft. Flow zone observed in video log. 1,220-1,225ft. Increase in rounded to sub rounded qtz. med-fine sand grains. Ground mass color is more purple and overall reaction to acid is much less vigorous than samples from intervals above. Rig action smoother, Tapeats appears to be weathered/fractured.

Drilling from 1,272-1,320 is smooth. Cuttings contain a few small fragments of a reddish Rhyolite or possible quartzite. Gamma and Neutron log indicate formation change. Contact with weathered/fractured Precambrian likely.

Water airlift increasing with depth. Airlift observed from 20-30gpm from 1260-1280ft. Tapeats Fm. appears to be conductive near contact with Precambrian. Additional depth will likely increase well yield, as the X portion of the deep regional aquifer system is only slightly penetrated by 1320ft., in this location.

T.D. 11/12/02

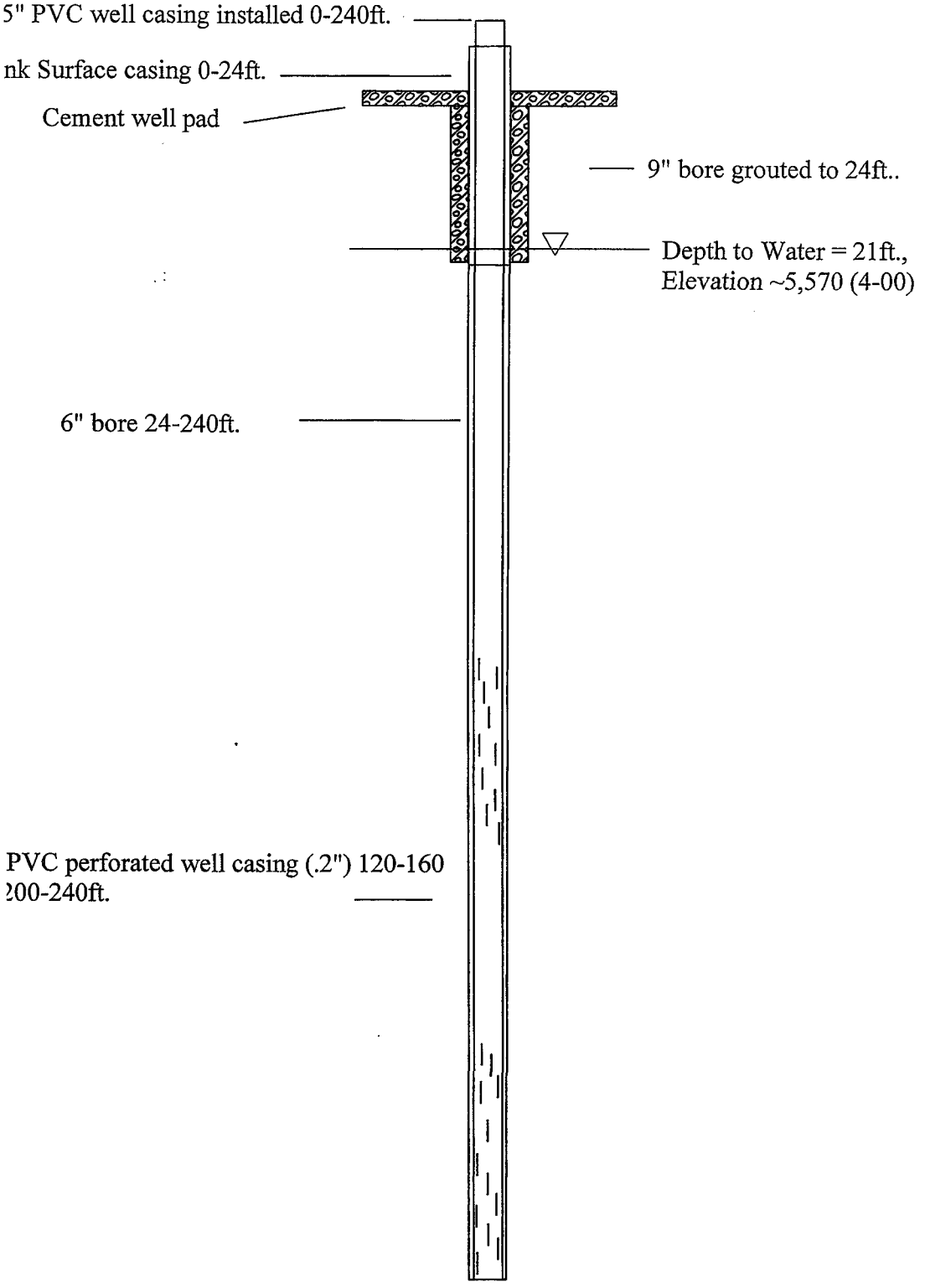
Special Notes: Circulation was dominantly low below 840ft. with less than 20% of cuttings exiting the borehole at the surface for the remainder of drilling. In consequence, samples are not discretely representative. However gradual changes in sample composition can be observed and are therefore utilized. Borehole geophysical runs conducted on June 17, 2003 and again on November 19, 2004 were utilized to update orignal well log and provided an excellent means for clarifying formation contacts and flow zones.

Recent Alluvium
Tertiary Gravels
Tertiary Basalts
Permian–Pennsylvanian Supai Fm. (Siltstone–Limestone)
Pennsylvanian Naco Fm. (Limestone–Shale)
Mississipian Redwall Fm. (Limestone and Terra Rosa)
nian in nite/Limestone
Cambrian Tapeats ss.
PreCambrian Rhyolite (possibly quartzite)
PreCambrian Payson Granite
PreCambrian Gniessic Granite – Granodiorite
PreCambrian Diorite

ne: 3	Project: **Strawberry Hollow**	Page 5 of 5
ell No. 87628	ADWR Cadastral A(12-8)26DDD	Surface Elevation **5502ft.**

FIGURE V
SH2 WELL CONSTRUCTION

SH-2 Shallow Well #579973 Construction Details



Not to Scale - All Sizes Nominal

ARIZONA DEPARTMENT OF WATER RESOURCES
500 North 3rd Street
Phoenix, Arizona 85004

WELL DRILLER REPORT

ort should be prepared by the driller in all detail and filed with the Department within 30 days g completion of the well.

AERO DRILLING AND PUMPS, INC.
P.O. BOX 499
PAYSON, AZ 85547-0499

RECEIVED
APR 27 2000
RECORDS MGT

ner Name: Strawberry Hollow, LLC
ress: P.O. Box 2141, Pine, AZ 85544
City State Zip

ation: 12N N/S 8E E/W 26 ¼ SW ¼ NE ¼ SE
Township Range Section 10-acre 40-acre 160-acre

ll Registration No. 55-579973 (Required)

mit No. N/A (If Issued)

DESCRIPTION OF WELL

al depth of hole 240 ft.
e of casing Steel & PVC
meter and length of casing 6"stl in from 0 to 24, 4.5PVC in from 0 to 240
nod of sealing at reduction points Adapter
forated from 120 to 160, from 200 to 240 from ____ to ____
e of cuts 20 Number of cuts per foot ____
reen was installed: Length N/A ft. Diam ____ in. Type ____
thod of construction Drilled
(drilled, dug, driven, bored, jetted, etc)
e started 4/14/00
Month Day Year
e completed 4/14/00
Month Day Year
pth to water 21 ft. (If flowing well, so state)
scribe point from which depth measurements were made, and give sea level elevation if availabl
p of steel casing
owing well, state method of flow regulation: N/A
marks: ____

DO NOT WRITE IN THIS SPACE
OFFICE RECORD
Registration No. 55- 579973
File No. A(12-8) 26 DAC
Received ____ By ____
Entered ____ By ____

-7/95 (Rev)

LOG OF WELL

epth at which water was first encountered, and the depth and thickness of water bearing beds If water is ndicate depth at which encountered, and depth to which it rose in well.

n t)	To (feet)	Description of formation material
0	22	Alluvial boulders in silt & clay
22	150	Redwall limestone Supai
150	170	Gray shale with carbon and clay
170	240	Redwall limestone
		Encountered water at 21, 55, 155, 175ft.

ertify that this well was drilled by me (or under by supervision), and that each and all statements tained are true to the best of my knowledge and belief.

Driller Name· AERO DRILLING AND PUMPS, INC

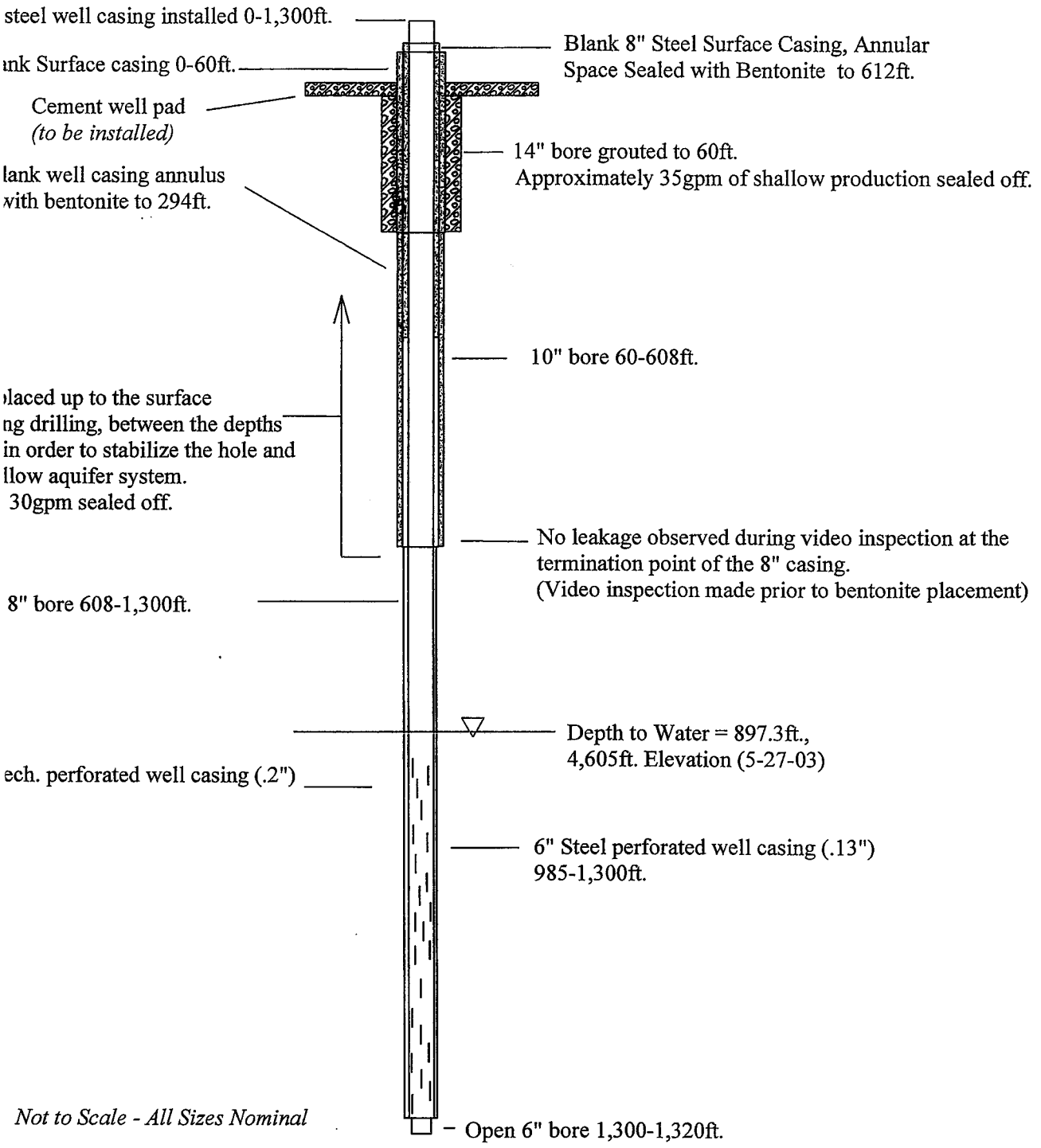
P.O. BOX 499
Street

PAYSON, AZ 85547-0499
City State Zip Phone No

Signature of Driller 4/14/00
Date

FIGURE VI
SH3 WELL CONSTRUCTION

SH-3 Deep Well #587628 Construction Details



ARIZONA DEPARTMENT OF WATER RESOURCES
Records Management Section
500 N. 3rd Street * Phoenix, Arizona 85004
(602) 417-2405 * (800) 352-8488
www.water.az.gov

RECEIVED
JUL 22 2003
Water Management

Well Driller Report and Well Log

FILE NUMBER: A(12-8) 26 DDD
WELL REGISTRATION NUMBER: 55- 587628
PERMIT NUMBER (IF ISSUED):

/ instructions prior to completing form
port should be prepared by the driller in detail and filed with the Department within
s following completion of the well.
\SE PRINT CLEARLY **

. REGISTRY INFORMATION

er
COMPANY, ORGANIZATION OR INDIVIDUAL: RRY HOLLOW LLC
SS: 41
IP: 544
ON NAME AND TITLE:
MBER: 7 FAX:

Location of Well

WELL LOCATION ADDRESS (IF KNOWN):

TOWNSHIP (N/S)	RANGE (E/W)	SECTION	160 ACRE	40 ACRE	10 ACRE
12N	8E	26	SE 1/4	SE 1/4	SE 1/4

LATITUDE			LONGITUDE		
34 °	23 '	23.0 "N	111 °	28 '	01.7 "W

LAND SURFACE ELEVATION AT WELL: 5510 Feet Above Sea Level
METHOD OF LATITUDE / LONGITUDE (CHECK ONE): [X] Hand-Held
[ ] USGS Quad Map [ ] Conventional Survey [X] GPS : [ ] Survey-Grade
COUNTY ASSESSOR'S PARCEL ID NUMBER: BOOK 301 MAP 2 PARCEL 011A
COUNTY WHERE WELL IS LOCATED: Gila

. DRILLING AUTHORIZATION

rm
LING AND PUMPS, INC.
UMBER
MBER: 6 FAX:

. WELL CONSTRUCTION DETAILS

STRUCTION STARTED:
DATE WELL CONSTRUCTION COMPLETED: 6/24/03
IF FLOWING WELL, METHOD OF FLOW REGULATION: [ ] Valve [ ] Other N/A

d

ary
r Augered
ool
tary
tary
e Circulation

cussion / Odex Tubing
please specify)

Method of Well Development

CHECK ONE
- [x] Airlift
- [ ] Bail
- [ ] Surge Back
- [ ] Surge Pump
- [ ] Other (please specify)

Method of Sealing at Reduction Points

CHECK ONE
- [ ] None
- [ ] Packed
- [ ] Swedged
- [x] Welded
- [ ] Other (please specify)

Water Level Information

STATIC WATER LEVEL: 887 Feet Below Land Surface
DATE MEASURED: 6/24/03

ANSWERED JUL 2 2 2003

01 (Rev.)

Report and Well Log

WELL REGISTRATION NUMBER
55- 587628

WELL CONSTRUCTION DESIGN (AS BUILT) (attach additional page if needed)

rehole		Installed Casing													
OM E		DEPTH FROM SURFACE			MATERIAL TYPE (X)				PERFORATION TYPE (X)						
TO (feet)	BOREHOLE DIAMETER (inches)	FROM (feet)	TO (feet)	OUTER DIAMETER (inches)	STEEL	PVC	ABS	IF OTHER TYPE, DESCRIBE	BLANK OR NONE	WIRE WRAP	SHUTTER SCREEN	MILLS KNIFE	SLOTTED	IF OTHER TYPE, DESCRIBE	SLOT SIZE IF ANY (inches)
60	14	0	63	10	X				X						
608	10	0	608	8	X				X						
1300	8	0	985	6	X				X						
		985	1300	6	X								X		1/8 X 3"
1320	6														

Installed Annular Material											
OM E	ANNULAR MATERIAL TYPE (X)								FILTER PACK		
TO (feet)	NONE	CONCRETE	NEAT CEMENT OR CEMENT GROUT	CEMENT-BENTONITE GROUT	BENTONITE GROUT	BENTONITE CHIPS	BENTONITE PELLETS	IF OTHER TYPE OF ANNULAR MATERIAL, DESCRIBE	SAND	GRAVEL	SIZE
60			X								
300					X		X				

RING
Feet Below Land Surface

DEPTH OF COMPLETED WELL
6/24/03
Feet Below Land Surface

W01 (Rev.)

ir Report and Well Log

WELL REGISTRATION NUMBER
55- 587628

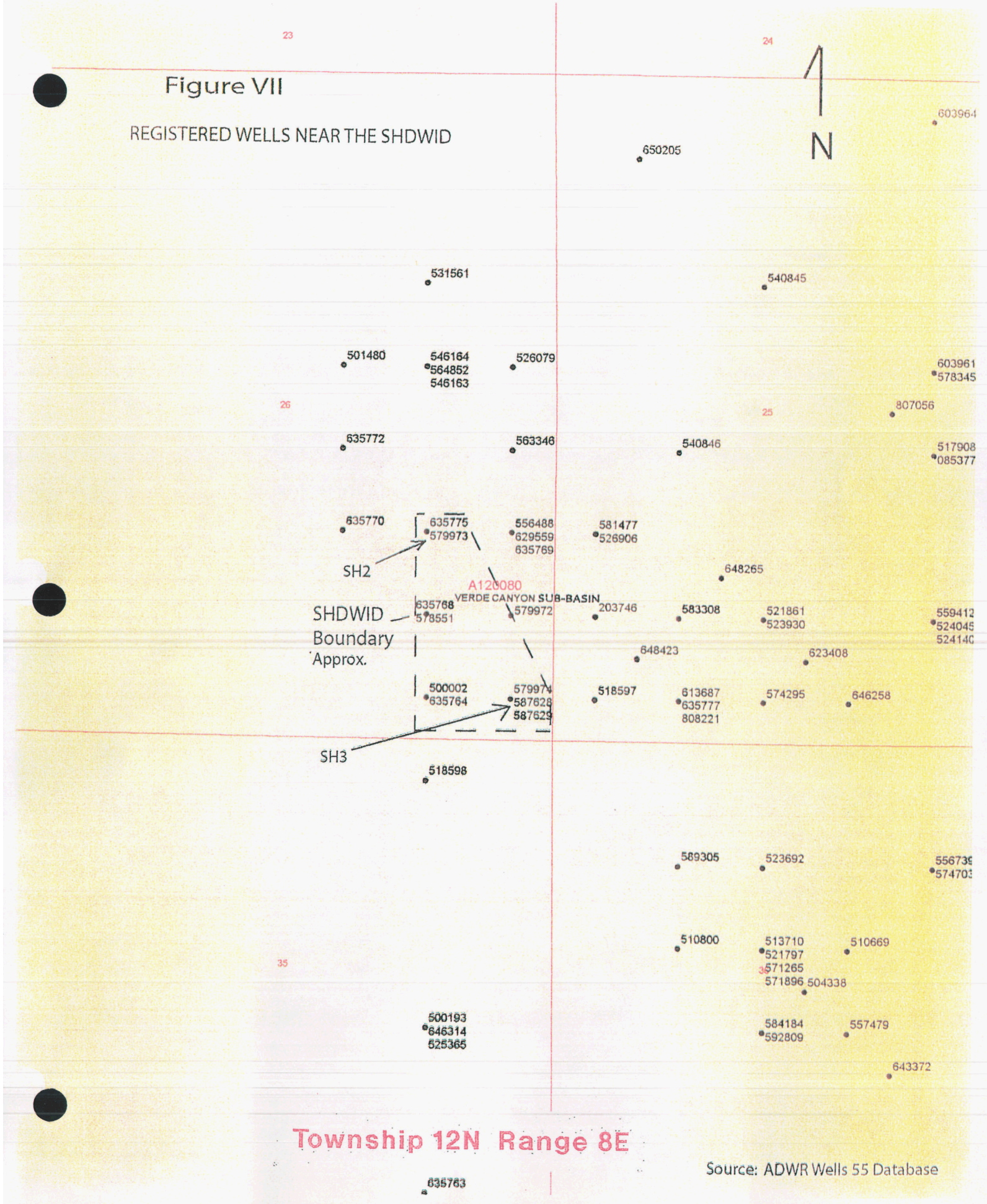
GEOLOGIC LOG OF WELL

I SURFACE TO (feet)	DESCRIPTION Describe material, grain size, color, etc.	Check (X) every interval where water was encountered
720	Existing	
1255	Limestone	X
1300	Tapeat sandstone	
1320	Granodiorite ?	

FIGURE VII
REGISTERED WELLS NEAR SHDWID

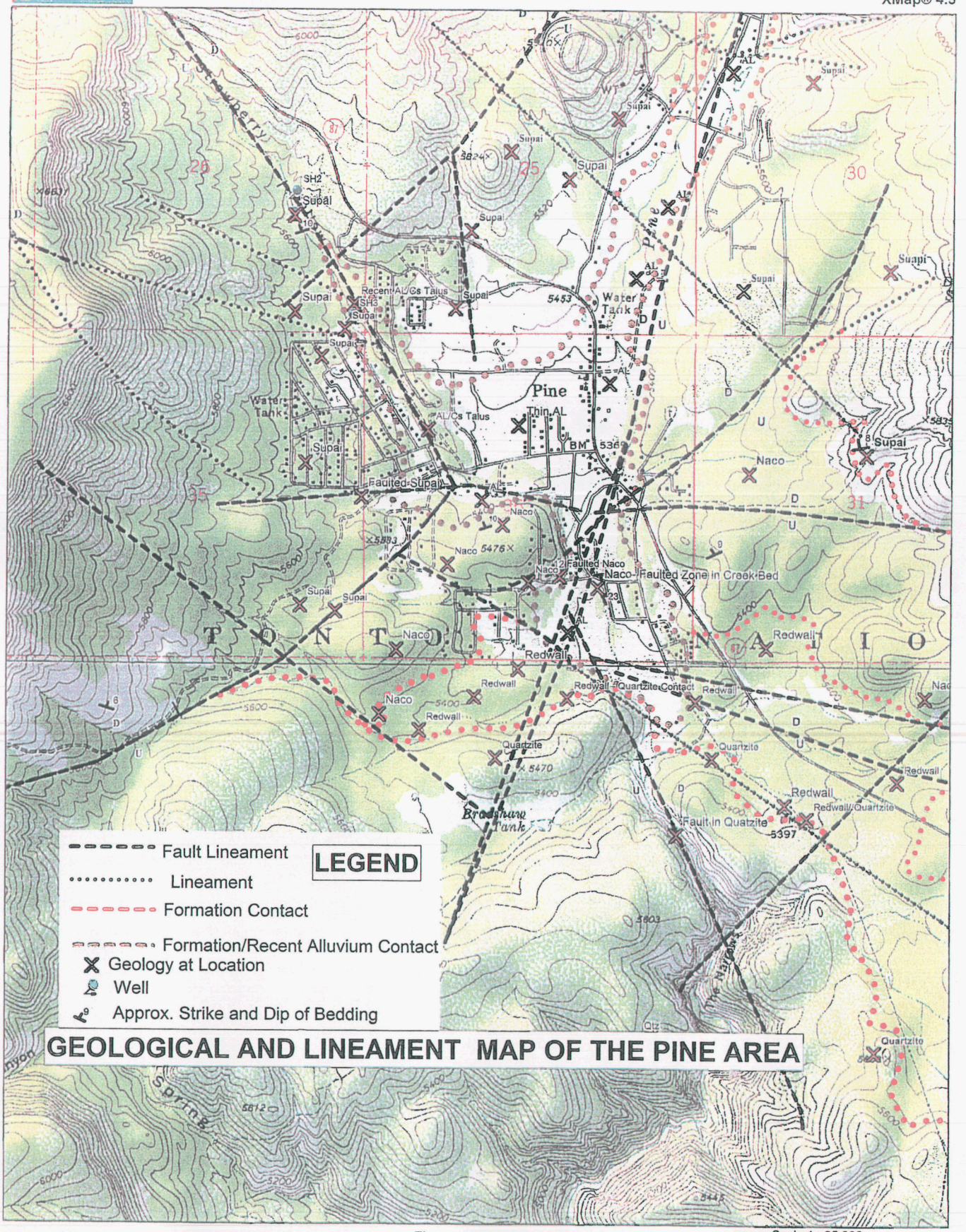
Figure VII

REGISTERED WELLS NEAR THE SHDWID



APPENDIX I

GEOLOGICAL MAPS OF THE PINE AREA

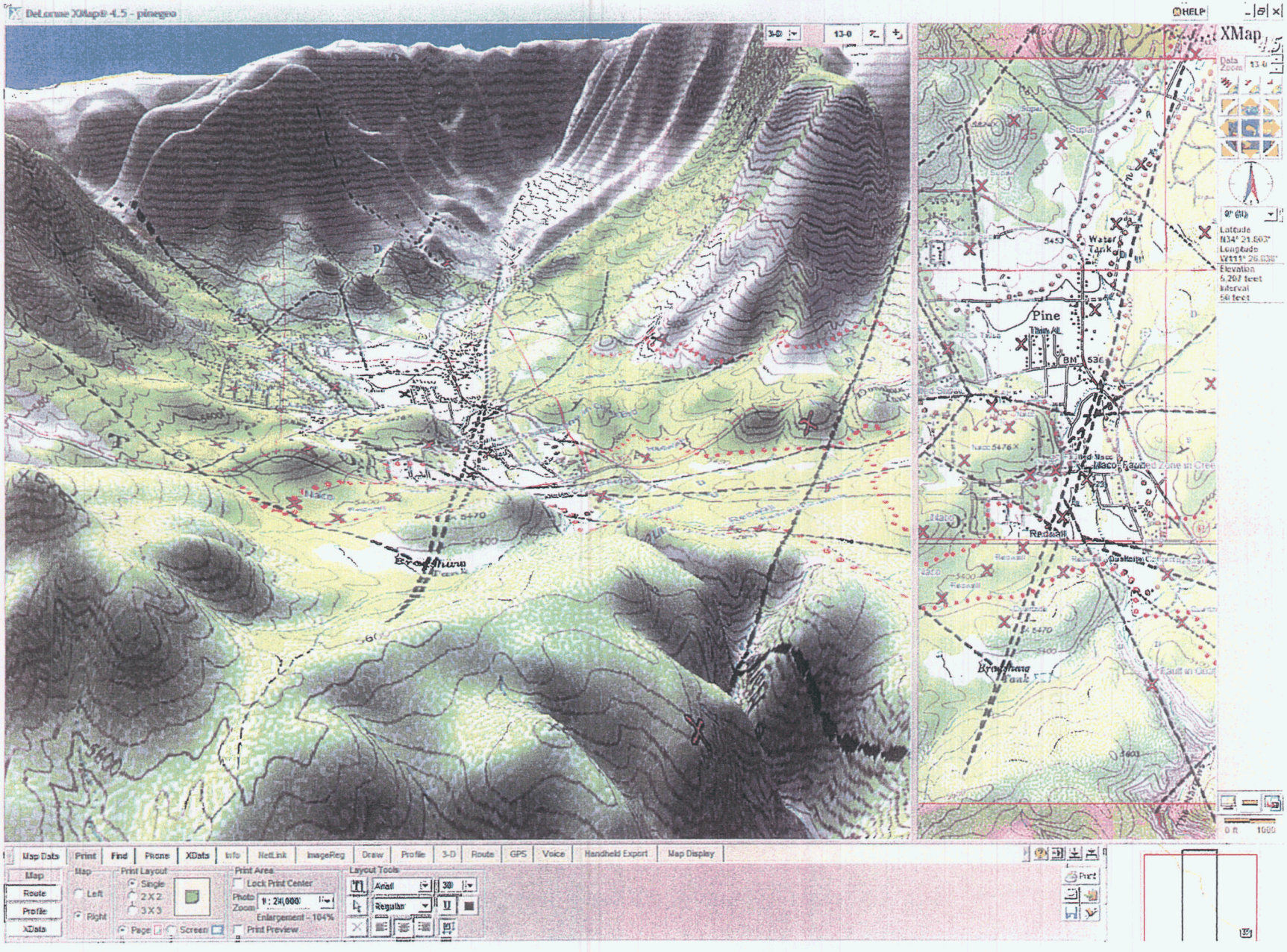


GEOLOGICAL AND LINEAMENT MAP OF THE PINE AREA

Data use subject to license.
© 2004 DeLorme. XMap® 4.5.
www.delorme.com

TN
MN (11.5°E)

Scale 1 : 25,000
1" = 2,083.3 ft
Data Zoom 13-0


DeLorme XMap® 4.5 - pinegeo
HELP
XMap
Pine
Water Tank
Broadhurst Peak
Redcastle
Map Data
Print
Find
Phone
XData
Info
NetLink
ImageReg
Draw
Profile
3-D
Route
GPS
Voice
Handheld Export
Map Display
Map
Route
Profile
XData
Print Layout
Single
2 X 2
3 X 3
Print Area
Lock Print Center
Print Preview
Layout Tools
Arial
Regular
Print

APPENDIX II

BOREHOLE GEOPHYSICS

OVERSIZED MAP

SEE SUPERVISOR (EXHIBIT CABINET)

BOX 17

APPENDIX III

GROUNDWATER QUALITY AND CHEMISTRY RESULTS

Aerotech Environmental — Analytical Report — Date: *17-Jun-04*

CLIENT:	Town of Payson MRWRMS	**Client Sample ID:**	NW Pine Deep
Lab Order:	04041192	**Tag Number:**	
Project:	Wells + Springs 2004	**Collection Date:**	4/21/2004 3:20:00 PM
Lab ID:	04041192-08A	**Matrix:**	GROUNDWATER

Analyses	Result	Limit	Qual	Units	DF	Date Analyzed
ICP METALS, DISSOLVED		**E200.7**				Analyst: **TD**
Aluminum, Dissolved	< 0.10	0.10		mg/L	1	4/26/2004
Calcium, Dissolved	60	2.0		mg/L	1	4/26/2004
Iron, Dissolved	< 0.050	0.050		mg/L	1	4/26/2004
Magnesium, Dissolved	19	2.0		mg/L	1	4/26/2004
Potassium, Dissolved	< 2.0	2.0		mg/L	1	4/26/2004
Silica (Silicon dioxide-SiO2)	13	0.21		mg/L	1	4/26/2004
Sodium, Dissolved	5.3	2.0		mg/L	1	4/26/2004
ICP/MS METALS, DISSOLVED		**E200.8**				Analyst: **HK**
Copper, Dissolved	0.0012	0.0010		mg/L	1	4/25/2004 11:32:26 AM
Manganese, Dissolved	0.025	0.0050		mg/L	1	4/25/2004 11:32:26 AM
ANIONS BY ION CHROMATOGRAPHY		**E300**				Analyst: **LB**
Chloride	4.4	2.0		mg/L	1	4/22/2004 3:31:00 PM
Fluoride	< 0.40	0.40		mg/L	1	4/22/2004 3:31:00 PM
Nitrogen, Nitrate (As N)	0.89	0.20		mg/L	1	4/22/2004 3:31:00 PM
Nitrogen, Nitrite (As N)	< 0.20	0.20		mg/L	1	4/22/2004 3:31:00 PM
Sulfate	6.2	2.0		mg/L	1	4/22/2004 3:31:00 PM
ALKALINITY		**M2320 B**				Analyst: **T A**
Alkalinity, Bicarbonate (As CaCO3)	230	2.0		mg/L CaCO3	1	4/26/2004
Alkalinity, Carbonate (As CaCO3)	< 2.0	2.0		mg/L CaCO3	1	4/26/2004
Alkalinity, Hydroxide (As CaCO3)	< 2.0	2.0		mg/L CaCO3	1	4/26/2004
Alkalinity, Total (As CaCO3)	230	6.0		mg/L CaCO3	1	4/26/2004
CONDUCTANCE		**M2510 B**				Analyst: **D N**
Specific Conductivity	420	1.0		µmhos/cm	1	4/22/2004 1:55:00 PM
NITROGEN, TOTAL		**CALC**				Analyst: **AC**
Nitrogen, Total	<1.7	0		mg/L	1	5/6/2004
PH (3)		**E150.1**				Analyst: **T S**
pH	7.63	2.00		pH units	1	4/22/2004 1:55:00 PM
RESIDUE, FILTERABLE		**M2540 C**				Analyst: **AC**
Total Dissolved Solids	320	10		mg/L	1	4/26/2004

Footnotes: All analysis performed at AEL Phoenix laboratory unless indicated by footnotes.
(1) AEL - Tucson Laboratory
(2) AEL - Knudsen Laboratory
(3) The holding time for pH analysis is immediate. For the most accurate result, the pH should be taken in the field within 15 minutes of sampling.

Main Laboratory: 4645 E. Cotton Center Boulevard, Building 3, Suite 189 Phoenix, AZ 85040 Phone: 602.437.3340 Toll Free: 866.772.5227 Fax. 623.445.6192 www.aeroenvirolabs.com
Tucson Facility: 4455 S. Park Ave. Ste. 110 Tucson, AZ 85714 Phone: 520.807.3801 Fax: 520.807.3803
Corporate Address: 1501 W. Knudsen Drive, Phoenix, Arizona 85027 Phone: 623.780.4800 Toll Free: 800.651.4802 Fax: 623.780.7695 www.aerotechlabs.com

Aerotech Environmental Laboratories
a division of Aerotech Laboratories, Inc.

Aerotech Environmental — Analytical Report — Date: *17-Jun-04*

CLIENT:	Town of Payson MRURMS	**Client Sample ID:**	NW Pine Deep
Lab Order:	04041192	**Tag Number:**	
Project:	Wells + Springs 2004	**Collection Date:**	4/21/2004 3:20:00 PM
Lab ID:	04041192-08C	**Matrix:**	GROUNDWATER

Analyses	Result	Limit	Qual	Units	DF	Date Analyzed
NITROGEN, TOTAL KJELDAHL AS N		**E351.4**				Analyst: **HS**
Nitrogen, Total Kjeldahl	< 1.3	1.3		mg/L	1	5/3/2004 11:00:00 AM

Footnotes: All analysis performed at AEL Phoenix laboratory unless indicated by footnotes.
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(3) The holding time for pH analysis is immediate. For the most accurate result, the pH should be taken in the field within 15 minutes of sampling.

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Aerotech Environmental — Analytical Report — Date: *17-Jun-04*

CLIENT:	Town of Payson mRuRmS	**Client Sample ID:**	NW Pine Shallow
Lab Order:	04041192	**Tag Number:**	
Project:	Wells + Springs 2004	**Collection Date:**	4/21/2004 3:00:00 PM
Lab ID:	04041192-09A	**Matrix:**	GROUNDWATER

Analyses	Result	Limit	Qual	Units	DF	Date Analyzed
ANIONS BY ION CHROMATOGRAPHY		**E300**				Analyst: **LB**
Chloride	10	2.0		mg/L	1	4/22/2004 3:15:00 PM
Fluoride	< 0.40	0.40		mg/L	1	4/22/2004 3:15:00 PM
Nitrogen, Nitrate (As N)	0.54	0.20		mg/L	1	4/22/2004 3:15:00 PM
Nitrogen, Nitrite (As N)	< 0.20	0.20		mg/L	1	4/22/2004 3:15:00 PM
Sulfate	26	2.0		mg/L	1	4/22/2004 3:15:00 PM
ALKALINITY		**M2320 B**				Analyst: **T A**
Alkalinity, Bicarbonate (As CaCO3)	370	2.0		mg/L CaCO3	1	4/26/2004
Alkalinity, Carbonate (As CaCO3)	< 2.0	2.0		mg/L CaCO3	1	4/26/2004
Alkalinity, Hydroxide (As CaCO3)	< 2.0	2.0		mg/L CaCO3	1	4/26/2004
Alkalinity, Total (As CaCO3)	370	6.0		mg/L CaCO3	1	4/26/2004
CONDUCTANCE		**M2510 B**				Analyst: **D N**
Specific Conductivity	710	1.0		µmhos/cm	1	4/22/2004 1:55:00 PM
NITROGEN, TOTAL		**CALC**				Analyst: **AC**
Nitrogen, Total	<1.7	0		mg/L	1	5/6/2004
H (3)		**E150.1**				Analyst: **T S**
pH	7.31	2.00		pH units	1	4/22/2004 1:55:00 PM
RESIDUE, FILTERABLE		**M2540 C**				Analyst: **AC**
Total Dissolved Solids	460	10		mg/L	1	4/26/2004

Footnotes: All analysis performed at AEL Phoenix laboratory unless indicated by footnotes.
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(2) AEL - Knudsen Laboratory
(3) The holding time for pH analysis is immediate. For the most accurate result, the pH should be taken in the field within 15 minutes of sampling.

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Corporate Address: 1501 W. Knudsen Drive, Phoenix, Arizona 85027 Phone: 623.780.4800 Toll Free: 800.651.4802 Fax: 623.780.7695 www.aerotechlabs.com

Aerotech Environmental — Analytical Report — Date: *17-Jun-04*

CLIENT:	Town of Payson MRWMS	**Client Sample ID:**	NW Pine Shallow
Lab Order:	04041192	**Tag Number:**	
Project:	Wells + Springs 2004	**Collection Date:**	4/21/2004 3:00:00 PM
Lab ID:	04041192-09B	**Matrix:**	GROUNDWATER

Analyses	Result	Limit	Qual	Units	DF	Date Analyzed
ICP METALS, TOTAL RECOVERABLE		**E200.7**				Analyst: **TD**
Aluminum	< 0.10	0.10		mg/L	1	4/27/2004
Calcium	84	2.0		mg/L	1	4/27/2004
Iron	0.064	0.050		mg/L	1	4/27/2004
Magnesium	42	2.0		mg/L	1	4/27/2004
Potassium	2.6	2.0		mg/L	1	4/27/2004
Silica (Silicon dioxide-SiO2)	17	0.21		mg/L	1	4/27/2004
Sodium	16	2.0		mg/L	1	4/27/2004
ICP/MS METALS, TOTAL RECOVERABLE		**E200.8**				Analyst: **HK**
Copper	0.0018	0.0010		mg/L	1	4/25/2004 1:01:52 PM
Manganese	< 0.0050	0.0050		mg/L	1	4/25/2004 1:01:52 PM

Footnotes: All analysis performed at AEL Phoenix laboratory unless indicated by footnotes.
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(2) AEL - Knudsen Laboratory
(3) The holding time for pH analysis is immediate. For the most accurate result, the pH should be taken in the field within 15 minutes of sampling.

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Aerotech Environmental — Analytical Report — Date: *17-Jun-04*

CLIENT:	Town of Payson	**Client Sample ID:**	NW Pine Shallow
Lab Order:	04041192	**Tag Number:**	
Project:	Wells + Springs 2004	**Collection Date:**	4/21/2004 3:00:00 PM
Lab ID:	04041192-09C	**Matrix:**	GROUNDWATER

Analyses	Result	Limit	Qual	Units	DF	Date Analyzed
NITROGEN, TOTAL KJELDAHL AS N		**E351.4**				Analyst: **HS**
Nitrogen, Total Kjeldahl	< 1.3	1.3		mg/L	1	5/3/2004 11:00:00 AM

Footnotes: All analysis performed at AEL Phoenix laboratory unless indicated by footnotes.
(1) AEL - Tucson Laboratory
(2) AEL - Knudsen Laboratory
(3) The holding time for pH analysis is immediate. For the most accurate result, the pH should be taken in the field within 15 minutes of sampling.

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Tucson Facility: 4455 S. Park Ave. Ste. 110 Tucson, AZ 85714 Phone: 520.807.3801 Fax: 520.807.3803
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WELL SH3

ARIZONA DEPARTMENT OF ENVIRONMENTAL QUALITY

DRINKING WATER SOURCE APPROVAL FORM

SAMPLES TO BE TAKEN AT SOURCE ONLY

>>>> PUBLIC WATER SYSTEM INFORMATION <<<<

>>>> **TO BE FILLED OUT BY SYSTEM PERSONNEL** <<<<

[___-____] System ID#

Strawberry Hollow Development Inc. System Name

[03/10/05] Sample date [09:10] (24 hr clock) Sample time

_____ ADEQ Project Number

55-587628 Well ID Number

NEW SYSTEM YES ____ NO____

_____ Surface Water Intake ID Number

NEW P.O.E. YES XX NO ____

~~Jay Fumusa~~ Loren Peterson Owner/Contact Person Name

(928) 472-4477 Owner/Contact Person Phone Number

(928) 472-7768 Owner/Contact Fax Number

POE #2 SAMPLING SITE ID

MPLE TYPE
Compliance Monitoring

SAMPLE COLLECTION POINT/ID
☐ Point of Entry# [_____]

This form is intended to be completely filled out and ALL pages submitted together for all microbiological and chemical tests detailed on this form. If more than one laboratory participated in the analyses, please attach a copy of the original laboratory report, signed by the performing laboratory, to the back of this form. ALL RESULTS SHALL BE REPORTED IN MILLIGRAMS PER LITER (mg/L) UNLESS OTHERWISE SPECIFIED.

PLEASE MAIL THIS COMPLETED FORM TO:

ARIZONA DEPARTMENT OF ENVIRONMENTAL QUALITY
TECHNICAL REVIEW UNIT
DRINKING WATER SECTION (5415B-2)
1110 W. Washington Street
Phoenix, AZ 85007

INORGANIC CHEMICAL ANALYSIS

Analysis Method	MCL	Reporting Limit	Contaminant Name	Cont. Code	Analysis Run Date	Result	Exceeds MCL	Exceeds Trigger
200.9	0.05	0.05	Arsenic	1005	03-18-05	<0.002	☐	☐
200.7	2.0	2.0	Barium	1010	03-18-05	0.03	☐	☐
200.7	0.005	0.005	Cadmium	1015	03-18-05	<0.002	☐	☐
200.7	0.1	0.1	Chromium	1020	03-18-05	<0.01	☐	☐
200.7	1.3*	0.050	Cooper	1022	03-18-05	<0.01	☐	☐
4500F C	4.0	2.0	Fluoride	1025	03-28-05	0.2	☐	☐
200.9	0.015*	0.0025	Lead	1030	03-15-05	0.002	☐	☐
245.1	0.002	0.002	Mercury	1035	03-17-05	<0.0005	☐	☐
4500 NO3 B	10	5	Nitrate (as N)	1040	03-11-05	0.63	☐	☐
4500 NO2 B	1	0.5	Nitrite (as N)	1041	03-10-05	0.01	☐	☐
200.9	0.05	0.05	Selenium	1045	03-31-05	<0.002	☐	☐
200.9	0.006	0.006	Antimony	1074	04-04-05	<0.002	☐	☐
200.7	0.004	0.004	Beryllium	1075	03-18-05	<0.002	☐	☐
4500CN E	0.2	0.2	Cyanide (as free)	1024	03-16-05	<0.01	☐	☐
200.7	0.1	0.1	Nickel	1036	03-18-05	<0.01	☐	☐
200.9	0.002	0.002	Thallium	1085	03-22-05	<0.001	☐	☐

PHYSICAL ANALYSIS

Analysis Method	Contaminant Name	Cont. Code	Analysis Run Date	Result
4500 SO4	Sulfate	1055	03-16-05	<2.
200.7	Sodium	1052	03-22-05	3.2
150.1	pH	1925	03-10-05	7.1
310.1	Alkalinity	1927	03-11-05	123.
Calc	Hardness/Calcium	1918	03-18-05	95.1
Calc	Langelier Index	1997	03-18-05	-0.78
170.1	Temperature (°C)	1996	03-10-05	20 **
160.1	Total Dissolved Solids-TDS	1930	03-11-05	130.

>>>>>LABORATORY INFORMATION<<<<<

SPECIMEN NUMBER: [_BM02790-I_____]

[03/10/05] Sample date

[09:10] (24 hr clock) Sample time

ID Number [AZ 0/0/0/3] Name: [Aquatic Consulting & Testing, Inc_____]

Comments: [_** Laboratory Temp._____]

Authorized Signature: [Chris J Chat]

SYNTHETIC ORGANIC CHEMICAL ANALYSIS

Analysis [redacted]	MCL	Reporting Limit	Contaminant Name	Cont. Code	Analysis Run Date	Result	Exceeds MCL	Exceeds Trigger
515.1	0.07	0.0001	2,4-D	2105	03-21-05	<0.00010	☐	☐
515.1	0.05	0.0002	2,4,5-TP (Silvex)	2110	03-21-05	<0.00020	☐	☐
525.2	0.002	0.0002	Alachlor	2051	03-16-05	<0.00020	☐	☐
505	0.003	0.001	Toxaphene	2020	03-21-05	<0.00004	☐	☐
525.2	0.003	0.0001	Atrazine	2050	03-16-05	<0.00010	☐	☐
531.1	0.04	0.0009	Carbofuran	2046	03-12-05	<0.00090	☐	☐
515.1	0.001	0.00004	Pentachlorophenol	2326	03-21-05	<0.00004	☐	☐
505	0.002	0.0002	Chlordane	2959	03-17-05	<0.0002	☐	☐
504.1	0.0002	0.00002	Dibromochloropropane(DBCP)	2931	03-19-05	<0.000020	☐	☐
504.1	0.00005	0.00001	Ethylene Dibromide(EDB)	2946	03-19-05	<0.000010	☐	☐
525.2	0.0004	0.00004	Heptachlor	2065	03-24-05	<0.00004	☐	☐
525.2	0.0002	0.00002	Heptachlor Epoxide	2067	03-24-05	<0.00002	☐	☐
525.2	0.0002	0.00002	Lindane	2010	03-24-05	<0.00002	☐	☐
525.2	0.04	0.0001	Methoxychlor	2015	03-24-05	<0.0001	☐	☐
_____	0.0005	0.0001	PCB:Polychlorinated Biphenyls*	2383	_____	_____	☐	☐
525.2	0.0002	0.00002	Benzo (a) Pyrene	2306	03-16-05	<0.00020	☐	☐
515.1	0.2	0.001	Dalapon	2031	03-21-05	<0.001	☐	☐
525.2	0.006	0.0006	Di(2-ethylhexyl)phthalate	2039	03-16-05	<0.00060	☐	☐
525.2	0.4	0.0006	Di(2-ethylhexyl)adipate	2035	03-16-05	<0.00060	☐	☐
515.1	0.007	0.0002	Dinoseb	2041	03-21-05	<0.00020	☐	☐
[redacted]	$3x10^{-8}$	$5x10^{-9}$	2,3,7,8-TCDD (Dioxin)	2063	03-22-05	<5.0e-09	☐	☐
[redacted]	0.02	0.0004	Diquat	2032	03-14-05	<0.00040	☐	☐
548.1	0.1	0.009	Endothall	2033	03-15-05	<0.0090	☐	☐
525.2	0.002	0.00001	Endrin	2005	03-24-05	<0.00001	☐	☐
547	0.7	0.006	Glyphosate	2034	03-17-05	<0.0060	☐	☐
525.2	0.001	0.0001	Hexachlorobenzene	2274	03-16-05	<0.00010	☐	☐
525.2	0.05	0.0001	Hexachlorocyclopentadiene	2042	03-16-05	<0.00010	☐	☐
531.1	0.2	0.002	Oxamyl	2036	03-12-05	<0.0020	☐	☐
515.1	0.5	0.0001	Picloram	2040	03-21-05	<0.00010	☐	☐
525.2	0.004	0.00007	Simazine	2037	03-16-05	<0.00007	☐	☐

* Aroclor results may be submitted in lieu of PCB

>>>>>LABORATORY INFORMATION<<<<<

SPECIMEN NUMBER: [_BM02970-S_____]

[03/10/05] Sample date

[09:10] (24 hr clock) Sample time

ID Number [AZ0/0/0/3] Name: [_Aquatic Consulting & Testing, Inc. _____]

Comments: [_____See attached subcontract laboratory reports_____]

Authorized Signature: [_____]

AROCLOR (PCBs SCREENING TEST)

Analysis Method	Reporting Limit	Contaminant Name	Cont. Code	Analysis Run Date	Result	Exceeds Reporting Limit
505	0.00008	Aroclor 1016	2388	03-17-05	<0.00008	☐
505	0.02	Aroclor 1221	2390	03-17-05	<0.02	☐
505	0.0005	Aroclor 1232	2392	03-17-05	<0.0005	☐
505	0.0003	Aroclor 1242	2394	03-17-05	<0.0003	☐
505	0.0001	Aroclor 1248	2396	03-17-05	<0.0001	☐
505	0.0001	Aroclor 1254	2398	03-17-05	<0.0001	☐
505	0.0002	Aroclor 1260	2400	03-17-05	<0.0002	☐

>>>>>LABORATORY INFORMATION<<<<<

SPECIMEN NUMBER: [_BL02970-P_____] [03/10/05] Sample date [09:10] (24 hr clock) Sample time

ID Number [AZ0/0/0/3] Name: [__Aquatic Consulting & Testing, Inc._____]
Comments: [_____See attached subcontract laboratory reports_____]
Authorized Signature: [Chris J Christie]

*** VOLATILE ORGANIC CHEMICALS ANALYSIS ***

Analysis Method	MCL	Reporting Limit	Contaminant Name	Cont. Code	Analysis Run Date	Result	Exceeds MCL	Exceeds Trigger
524.2	0.007	0.0005	1,1-Dichloroethylene	2977	03-15-05	<0.0005	☐	☐
[illegible]	0.2	0.0005	1,1,1-Trichloroethane	2981	03-15-05	<0.0005	☐	☐
[illegible]	0.005	0.0005	1,1,2-Trichloroethane	2985	03-15-05	<0.0005	☐	☐
[illegible]	0.005	0.0005	1,2-Dichloroethane	2980	03-15-05	<0.0005	☐	☐
524.2	0.005	0.0005	1,2-Dichloropropane	2983	03-15-05	<0.0005	☐	☐
524.2	0.005	0.0005	Benzene	2990	03-15-05	<0.0005	☐	☐
524.2	0.005	0.0005	Carbon Tetrachloride	2982	03-15-05	<0.0005	☐	☐
524.2	0.07	0.0005	cis-1,2-Dichloroethylene	2380	03-15-05	<0.0005	☐	☐
524.2	0.7	0.0005	Ethylbenzene	2992	03-15-05	<0.0005	☐	☐
524.2	0.1	0.0005	(mono)chlorobenzene	2989	03-15-05	<0.0005	☐	☐
524.2	0.6	0.0005	o-Dichlorobenzene	2968	03-15-05	<0.0005	☐	☐
524.2	0.075	0.0005	para-Dichlorobenzene	2969	03-15-05	<0.0005	☐	☐
524.2	0.1	0.0005	Styrene	2996	03-15-05	<0.0005	☐	☐
524.2	0.005	0.0005	Tetrachloroethylene	2987	03-15-05	<0.0005	☐	☐
524.2	1	0.0005	Toluene	2991	03-15-05	<0.0005	☐	☐
524.2	0.1	0.0005	Trans-1,2-Dichloroethylene	2979	03-15-05	<0.0005	☐	☐
524.2	0.005	0.0005	Trichloroethylene	2984	03-15-05	<0.0005	☐	☐
524.2	0.002	0.0005	Vinyl Chloride	2976	03-15-05	<0.0005	☐	☐
524.2	10	0.0005	Xylenes, total	2955	03-15-05	<0.0005	☐	☐
524.2	0.07	0.0005	1,2,4-Trichlorobenzene	2378	03-15-05	<0.0005	☐	☐
524.2	0.005	0.0005	Dichloromethane	2964	03-15-05	<0.0005	☐	☐

>>>>> LABORATORY INFORMATION <<<<<

SPECIMEN NUMBER: [_BM02970-V_____] [03/10/05] Sample date [09:10] (24 hr clock) Sample time

[illegible]lumber [AZ0/0/0/3] Name: [_Aquatic Consulting & Testing, Inc_____]
[illegible]ments: [_____See attached subcontract laboratory reports_____]
[illegible]rized Signature: [Chris J Christie]

*** RADIOCHEMICAL ANALYSIS ***

Analysis Method	MCL	Reporting Limit	Contaminant Name	Cont. Code	Analysis Run Date	Result	Exceeds MCL	Exceeds Trigger
_____	15 pCi/L		Adjusted Gross Alpha	4000	_____	_____	☐	
600/00-02		3 Pci/l	Gross Alpha	4002	03-15-05	1.2 ± 0.6		☐
7500-Rn			Radon	4004	_____	_____		
00-07	30 ug/L	(reserved)	Combined Uranium	4006	_____	_____	☐	☐
00-07			Uranium 234	4007	_____	_____		
00-07			Uranium 235	4008	_____	_____		
00-07			Uranium 238	4009	_____	_____		
_____	5 pCi/L	1 pCi/L	Combined Radium	4010	_____	_____	☐	☐
903.1		1 pCi/L	Radium 226	4020	_____	_____		☐
904.0		1 pCi/L	Radium 228	4030	_____	_____		☐
*_____	4 mrem	3 pCi/L	Gross Beta	4100	_____	_____	☐	☐
*_____	20000 pCi/L	1000 pCi/L	Tritium	4102	_____	_____	☐	☐
*_____		10 pCi/L	Strontium-89	4172	_____	_____		☐
*_____	8 pCi/L	2 pCi/L	Strontium-90	4174	_____	_____	☐	☐
*_____		1 pCi/L	Iodine-131	4264	_____	_____		☐
*_____		10 pCi/L	Cesium-134	4270	_____	_____		☐

* Do not analyze for this contaminant unless notified by ADEQ

>>>>> LABORATORY INFORMATION <<<<<

[CIMEN NUMBER: [03/10/05] [09:10] (24 hr clock)
[___BM02790-R_____] Sample date Sample time

ID Number [AZ0/4/6/2] Name: [Radiation Safety Engineering, Inc_____]
Comments: [_____See Attached Reports_____]
Authorized Signature: [_____]

*** ASBESTOS ***

Analysis Method	MCL	Contaminant Name	Cont. Code	Analysis Run Date	Result	Exceeds MCL
TEM	7 MFL	Asbestos	1094	03-16-05	<5.2	☐

>>>>> LABORATORY INFORMATION <<<<<

SPECIMEN NUMBER: [03/10/05] [09:10] (24 hr clock)
[_2005-01868-1_____] Sample date Sample time

ID Number [AZ0/6/3/3] Name: [____Fiberquant Analytical Services_____]
Comments: [_____See attached reports_____]
[ ]horized Signature: [_____]

*** MICROBIOLOGICAL ANALYSIS ***

Analysis Method	MCL Value	Contaminant Name	Cont. Code	Test Start Date/Time	Analysis Run Date/Time	Result
9223B	Present/ 1 or more Coliform	Total Coliform	3000	03/10/05 12:00	03/11/05 12:00	1

ONLY REPORT FECAL RESULT IF TOTAL COLIFORM RESULT IS POSITIVE

Analysis Method	MCL Value	Contaminant Name	Cont. Code	Test Start Date/Time	Analysis Run Date/Time	Result
9223B	Present/ 1 or more Coliform	Fecal Coliform	3013	03/10/05 12:00	03/11/05 12:00	0

>>>>> LABORATORY INFORMATION <<<<<

SPECIMEN NUMBER: [__N0501455_____] [04/25/05] Sample date [12:35] (24 hr clock) Sample time

ID Number [AZ0/0/0/3] Name:[Aquatic Consulting & Testing, Inc]

Comments: [ ]

Authorized Signature: [ ]

AR 9: Revised 2004

INSTRUCTIONS FOR USING THE ARIZONA DRINKING WATER SOURCE APPROVAL REPORTING FORM
DWAR 9: Revised March 11, 2002

SYSTEM ID: This is a unique 5 digit Public Water System Identification (PWSID) number assigned to each public water system by ADEQ.

SYSTEM NAME: This should be the legal name which the water system will be known as when the system is built. Always notify the Department in writing of any name or ownership change.

ADEQ PROJECT NUMBER: This is the number assigned by ADEQ when the project is first submitted for an " Approval to Construct".

NEW SYSTEM: If this is a new system and a system id number has not yet been assigned by ADEQ, then mark "YES", and be sure that the project number is filled in.

NEW POE: If this source represents a new point of entry (POE) for your system, then mark "YES" on the form. This will allow ADEQ to assign a new point of entry number and the appropriate monitoring year for this point of entry.

WELL ID NUMBER: The Department of Water Resources' registration number goes here. This number always begins with a 55-. If the new source does not constitute a new point of entry, fill in the existing point of entry number that this source is joining.

SURFACE WATER INTAKE ID NUMBER: This number must be assigned by ADEQ. If the new source does not constitute a new point of entry, fill in the existing point of entry number that this source is joining.

SAMPLE DATE: The date the specimen was collected in mm/dd/yy format.

SAMPLE TIME: The time the specimen was collected in hh:mm format (24 hr clock time).

OWNER/CONTACT PERSON NAME: The first and last name of the owner or owner's representative, (contact person) who should be contacted with sample results.

NER/CONTACT PHONE #: The daytime phone number of the owner or owner's representative, (contact person) who should be tacted with sample results.

SAMPLE TYPE: The compliance reason for specimen collection. Only the relevant sample types for each contaminant group are provided on the ADEQ forms.

SPECIMEN NUMBER: A unique 15 character (max) alphanumeric code that identifies a particular sample used to test one contaminant or one category of contaminants (i.e., Microbiological, Inorganic, Organic, VOC) for a specific sampling event. If reporting on different reporting forms, a different (unique) number is required for each contaminant group and for each report.

NOTE: These definitions are general in nature. For specific questions regarding your laboratory submittal, please contact the Arizona Department of Environmental Quality (ADEQ) Drinking Water Section at **1-800-234-5677, ext. 4624, or (602) 207-4624.**

www.adeq.state.az.us - water quality - safe drinking water - forms reports and guidelines - lab reporting forms - Drinking Water ***Source Approval***

Langelier Index

Measured Characteristics of the water	
Sample ID	BM02790
Calcium (mg/L)	38.1
pH	7.1
Temperature (C)	20
Alkalinity (mg/L as CaCO3)	123
TDS (mg/L)	130
Calculated Langelier Index	
Langelier Index [If the Index is Negative, the water may be corrosive]	-0.781
Saturation Index	7.881
Ryzner (stability) Index (>6.0 = corossive; <6.0 = Scale forming)	8.661
Calculated Data	
Ionic Strength	0.003
Activity Coeff (m)	0.938
Activity Coeff (d)	0.775
Ca (moles/L)	0.0009525
Alkalinity (moles/L)	0.00123
pK2	10.378
K2	4.19E-11
K2'	5.40E-11
pK2'	10.267
pKs	8.267
Ks	5.41E-09
Ks'	9.02E-09
pKs'	8.045
pCa	3.021
pHs	7.881

AQUATIC CONSULTING & TESTING, INC.
1525 W[illegible]rsity Drive, Suite 106 • Tempe, AZ 85281
Phone: (480)[illegible]-8044 • Fax: (480) 921-0049

CHAIN OF CUSTODY

PWS ID #_____ PAGE 1 OF 1

Client Name: Strawberry Hollow Dev.
Address: PO box 2141 (Street)
Pine AZ 85544 (City, State, Zip)
Phone: 928-472-4477
Fax: 928-472-7768
Contact: Loren Peterson
Sampler Signature: EWB

PO#_____
Project_____
Remarks:

SAMPLE ID	SAMPLE Date	SAMPLE Time		SAMPLE TYPE	Chemistry: Metals (See Below)	☐ TDS ☐ TSS ☐ TS ☐ SETT ☐ TVS ☐ VSS	☐ O-G ☐ TPHC ☐ MBAS ☐ CN ☐ Sulfide	☐ BOD ☐ COD ☐ New Source	☐ Tot.P ☐ O-PO_4	☐ Nitrate + Nitrite ☐ Nitrite	☐ TKN ☐ Ammonia	☐ THM's ☐ HAAS	☐ Phenol ☐ 420.1 ☐ 625 ☐ 8270	☐ 8260 ☐ 624 ☐ BTEX	☐ Perchlorate ☐ Radio ☐ Asbestos	Biology: Total Coliform ☐ P/A ☐ Colilert ☐ MPN	☐ E. Coli ☐ Fecal Strep	Fecal Coliform ☐ MPN ☐ MF	☐ MICRO SCOPE ID	☐ Plate Count ☐ BIOLOG	NH3 Source	Biomon ☐ Acute ☐ Chronic	☐ AWET (SWRO)	No. of Containers: $Na_2S_2O_3$	H_2SO_4	HNO_3	NONE	NaOH	NaOH/ZnAc	Laboratory Number
POE #2	3-10-05	9:10	AM PM	DW												X					X									BH-02710
			AM PM																											
			AM PM																											
			AM PM																											
			AM PM																											
			AM PM																											
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			AM PM																											
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			AM PM																											
			AM PM																											
			AM PM																											

Metals: ☐ Al ☐ Sb ☐ As ☐ Ba ☐ Be ☐ B ☐ Cd ☐ Ca ☐ Cr ☐ Co ☐ Cu ☐ Au ☐ Fe ☐ Pb ☐ Mg ☐ Mn ☐ Hg ☐ Mo ☐ Ni ☐ Se ☐ Ag ☐ Na
☐ Sr ☐ Tl ☐ Sn ☐ Ti ☐ V ☐ Zn [ ] TOTAL [ ] DISSOLVED [ ] SDWA [ ] TCLP [ ] RCRA

Sample Types: DW, GW, SW, WW, AQ, Soil, Sludge or Solid

Sample Receiving: On Ice
Intact: X Yes ____ No
Temp: 7 C Auth Init: ____
Pres: X Yes/N ____ No/Lab
Sterile: ____ Yes ____ No
Total # containers: 29

1. Relinquished By:	2. Relinquished By:	3. Relinquished By:
Loren Peterson		
Date: 3/10/05 Time: 11:29 AM PM	Date: Time: AM PM	Date: Time: AM PM
1. Received By:	2. Received By:	3. Received By:
[illegible] Johnson		
Date: 3-10-05 Time: 11:29 AM PM	Date: Time: AM PM	Date: Time: AM PM

Attn: Your signature on this document authorizes analysis regardless of sample condition at time of submittal

By signing this chain of custody, the designated client and agent agree to pay Aquatic Consulting & Testing, Inc. for all services rendered in conjunction with the submitted samples within 30 days of invoice. It is the client's responsibility to note purchase order numbers or other responsible parties on the form and failure to do so does not constitute justification for non-payment.

White-Laboratory Yellow-Report Pink-Client

Sample delivery group # :_____ -01

MOHAVE ENVIRONMENTAL LABORATORY

AQUATIC SOUNDINGS

1050 HIGHWAY 95
BULLHEAD CITY, AZ 86429
(928) 754-8101
FAX (928) 754-8103

200 N. 2nd St. Ste. B
Holbrook, AZ 86025
(928) 524-4635

CHAIN OF CUSTODY RECORD

2 OF 2

CLIENT: RECLAIM ENVIRONMENTAL	ADDRESS: HC1 BOX 1533
CONTACT PERSON: WAYNE BENCH	STRAWBERRY AZ 85544
TELEPHONE: 928 476 4554	PROJECT: SH 3 WELL
FAX: 928 476 4181	LAB QUOTE / CONTRACT NO:

• SEE FEE SCHEDULE •

SAMPLE TYPE CODES
S - SOIL D - DRINKING WATER
O - OIL W - WASTEWATER F - FIELD BLANK
G - SLUDGE T - TRAVEL BLANK X - OTHER (SPECIFY): _____

SAMPLE IDENTIFICATION	DATE	TIME	SAMPLE LOCATION	NO. CONTAINERS	COMPOSITE	GRAB	SAMPLE TYPE	CONTAINERS (FOR LAB USE ONLY): Unpreserved	HNO_3	NaOH	H_2SO_4	HCl	Ascorbic Acid	HOLD (Do Not Analyze)	REQUESTED ANALYSES: 524.2	504.1	547	531.1	TOC	ICC	CN	NO3/NO2	DWR #	LABORATORY IDENTIFICATION
H109	03/03/05	0904	~~Rec H2 WELL~~ SH3	3		X	D					X	X		X									
H110	"	0906	"	2		X	D									X								
H111	"	0900	"	2		X	D										X							
H112	"	0902	"	2		X	D											X						
H113	"	0831	"	1		X	D	X											X					
H114	"	0830	"	1		X	D		X											X				
H115	"	0850	"	1		X	D														X			
H116	"	0828	"	1		X	D	X														X		

SAMPLER (SIGNATURE): _____ (PRINT NAME): EWB

PWS # / NPDES #:

COMMENTS:

RELINQUISHED BY (SIGNATURE)	PRINT NAME	RECEIVED BY (SIGNATURE)	PRINT NAME	DATE / TIME
_____	EWB	_____	Loren Peterson	3/10/05 0912
Loren Peterson	Loren Peterson	T. Johnsen	T. Johnsen	3-10-05 11:29

REMARKS: _____

☐ Fax Results ☐ Special Detection Limits / Requirements

SAMPLE PROCESS TURNAROUND TIME:
☐ Standard ☐ Other (specify) _____

MOHAVE AQUATIC ENVIRONMENTAL LABORATORY

1050 HIGHWAY 95
BULLHEAD CITY, AZ 86429
(928) 754-8101
FAX (928) 754-8103

119 E. HOPI DR.
HOLBROOK, AZ 86025
(928) 524-4635

CHAIN OF CUSTODY RECORD

PAGE 1 OF 2

CLIENT: PREMCOR Refining Group	ADDRESS: HC1 Box 15-33
CONTACT PERSON: WAYNE BELL	STANFIELD AZ 85544
TELEPHONE: 928 476 4004	PROJECT: SH3 #2 WELL
FAX: 928 476 4181	JOB / P.O. NO.:
	LAB QUOTE / CONTRACT NO:

• SEE FEE SCHEDULE •

SAMPLE TYPE CODES
S - SOIL, O - OIL, G - SLUDGE, D - DRINKING WATER, W - WASTEWATER, T - TRAVEL BLANK, F - FIELD BLANK, X - OTHER (SPECIFY):

SAMPLE IDENTIFICATION	DATE	TIME	SAMPLE LOCATION	NO. CONTAINERS	COMPOSITE	GRAB	SAMPLE TYPE	CONTAINERS (FOR LAB USE ONLY): Unpreserved	HNO_3	NaOH	H_2SO_4	HCl	$NA_2S_2O_3$	(Do Not Analyze) HOLD	REQUESTED ANALYSES: 507, 508, 515.1, 548.1 DIOXIN, 515.1, 525.2, ASBESTOS, 549.1, RADS	DWR #	LABORATORY IDENTIFICATION
#101	3/3/05	0849	~~RO 5 #1 WELL~~	2		X	D						X		X		
#102	"	837	SH3	2		X	D						X		V		
#103	"	0840	"	1		X	D	X							X		
#104	"	0848	"	2		X	D						X		X		
#105	"	0853	"	2		X	D					X	X		X		
#106	"	0842	"	1		X	D	V							X		
#107	"	0837	"	1		X	D						X		X		
#108	"	0855	"	1		X	D		X	X					X		

SAMPLER (SIGNATURE): EWB
(PRINT NAME): EWB
PWS # / NPDES #:
COMMENTS:

RELINQUISHED BY (SIGNATURE)	PRINT NAME	RECEIVED BY (SIGNATURE)	PRINT NAME	DATE / TIME
EWB	EWB	Loren Peterson	Loren Peterson	3/10/05 0912
Loren Peterson	Loren Peterson	T. Johnsen	T. Johnsen	3-10-05 11:29

REMARKS:

☐ Fax Results ☐ Special Detection Limits / Requirements

SAMPLE PROCESS TURNAROUND TIME:
☐ Standard ☐ Other (specify)

Del Mar Analytical

17461Derian Ave., Suite 100, Irvine, CA 92614 (949) 261-1022 FAX (949) 260-3297
1014 E. Cooley Dr., Suite A, Colton, CA 92324 (909) 370-4667 FAX (949) 370-1046
9484 Chesapeake Dr., Suite 805, San Diego, CA 92123 (858) 505-8596 FAX (858) 505-9689
9830 South 51st St., Suite B-120, Phoenix, AZ 85044 (480) 785-0043 FAX (480) 785-0851
2520 E. Sunset Rd. #3, Las Vegas, NV 89120 (702) 798-3620 FAX (702) 798-3621

LABORATORY REPORT

Prepared For: Aquatic Consulting & Testing
1525 W. University, Suite 106
Tempe, AZ 85281
Attention: Chris Christian

Project:Globe / New Source Approval

Sampled:03/10/05
Received:03/10/05
Issued:03/25/05 08:58

NELAP #01109CA Arizona DHS#AZ0426

The results listed within this Laboratory Report pertain only to the samples tested in the laboratory. The analyses contained in this report were performed in accordance with the applicable certifications as noted. All soil samples are reported on a wet weight basis unless otherwise noted in the report. This Laboratory Report is confidential and is intended for the sole use of Del Mar Analytical and its client. This report shall not be reproduced, except in full, without written permission from Del Mar Analytical. The Chain(s) of Custody, 2 pages, are included and are an integral part of this report.
This entire report was reviewed and approved for release.

CASE NARRATIVE

LABORATORY ID	CLIENT ID	MATRIX
POC0297-01	BM-02790	Water
POC0297-02	Trip Blanks	Water

SAMPLE RECEIPT: Samples were received intact, at 4°C, on ice and with chain of custody documentation.

HOLDING TIMES: All samples were analyzed within prescribed holding times and/or in accordance with the Del Mar Analytical Sample Acceptance Policy unless otherwise noted in the report.

PRESERVATION: Samples requiring preservation were verified prior to sample analysis.

QA/QC CRITERIA: All analyses met method criteria, except as noted in the report with data qualifiers.

COMMENTS: No significant observations were made.

SUBCONTRACTED: Refer to the last page for specific subcontract laboratory information included in this report.

Reviewed By:

Del Mar Analytical - Phoenix
Eshelman
Project Manager

Arizona Department Of Environmental Quality

Drinking Water Source Approval Form

Samples To Be Taken At Source Only

[_____] _____

ystem ID System Name

[_____] [_____] (24 Hr clock)

Sample date Sample Time:

_____ _____

ADEQ Project Number Well ID Number

NEW SYSTEM YES ☐ NO ☐ _____

Surface Water Intake ID Number

NEW P.O.E. YES ☐ NO ☐

_____ (_____) _____ -

Owner/Contact Person Name Owner/Contact Phone Number

SAMPLE TYPE

☐ Compliance Monitoring

SAMPLE COLLECTION POINT/ID

[X] Point of Entry# [_____]

This form is intended to be completely filled out and ALL pages submitted together for all micorbiological and chemical tests detailed on this form. If more than one laboratory participated in the analyses, please attach a copy of the original laboratory report, signed by the performing laboratory, to the back of this form. ALL RESULTS SHALL BE REPORTED IN MILLIGRAMS PER LITER (MG/L) UNLESS OTHERWISE SPECIFIED.

Please note:

The Arsenic MCL is currently .05 mg/L. However, on Jan. 23, 2006, the Arsenic MCL will be .01 mg/L.

There currently is no MCL for Uranium. However, on Dec. 8, 2003 the Uranium MCL will be .03 mg/L.

PLEASE MAIL THIS COMPLETED FORM TO:

ARIZONA DEPARTMENT OF ENVIRONMENTAL QUALITY
TECHNICAL REVIEW UNIT
DRINKING WATER SECTION (5415b-2)
1110 W Washington St,
Phoenix, AZ 85007

*** INORGANIC CHEMICAL ANALYSIS ***

>>> To be filled out by laboratory Personnel <<<

Analysis Method	MCL Value	Reporting Limit	Contaminant Name	Cont. Code	Analysis Run Date/Time	Results	Exceeds MCL	Exceeds Reporting Limit
[redacted]	0.05	0.05	Arsenic	1005			☐	☐
	2.0	2	Barium	1010			☐	☐
	0.005	0.005	Cadmium	1015			☐	☐
	0.1	0.1	Chromium	1020			☐	☐
	1.3	0.050	Copper (Action Level)	1022			☐	☐
	4.0	2.0	Fluoride	1025			☐	☐
	0.015	0.0025	Lead (Action Level)	1030			☐	☐
	0.002	0.002	Mercury	1035			☐	☐
	10	5	Nitrate (as N)	1040			☐	☐
	1	0.5	Nitrite (as N)	1041			☐	☐
	0.05	0.05	Selenium	1045			☐	☐
	0.006	0.006	Antimony	1074			☐	☐
	0.004	0.004	Beryllium	1075			☐	☐
	0.2	0.2	Cyanide (as free cyanide)	1024			☐	☐
	0.1	0.1	Nickel	1036			☐	☐
	0.002	0.002	Thallium	1085			☐	☐

*Action Level

>>>> LABORATORY INFORMATION <<<<

SPECIMEN NUMBER
[COC0446-01K]

[03/10/05] Sample Date [08:37] Sample Time (24 hr clock)

ID Number [AZ AZ0062] Name: [Del Mar Analytical, Colton]

Comments: [ ]

Authorized Signature: [ ]

Physical Analysis

	Sulfate	1055		
	Sodium	1052		
	pH	1925		
	Alkalinity	1927		
	Hardness/Calcium	1918		
	Langlier Index	1997		
	Temperature (°C)	1996		
	Total Dissolved Solids-TDS	1930		

>>>> LABORATORY INFORMATION <<<<

To be filled out by Laboratory Personnel

SPECIMEN NUMBER
[COC0446-01K]

[03/10/05] Sample Date [08:37] Sample Time (24 hr clock)

ID Number [AZ AZ0062] Name: [Del Mar Analytical, Colton]

Comments: [ ]

Authorized Signature: [ ]

Synthetic Organic Chemical Analysis

Analysis	MCL	Reporting	Contaminant	Cont.	Analysis	Result	Exceeds	Exceeds
	0.07	0.0001	2,4-D	2105			☐	☐
	0.05	0.0002	2,4,5-TP (Silvex)	2110			☐	☐
	0.002	0.0002	Alachlor	2051			☐	☐
	0.003	0.001	Toxaphene	2020			☐	☐
	0.003	0.0001	Atrazine	2050			☐	☐
	0.04	0.0009	Carbofuran	2046			☐	☐
	0.001	0.00004	Pentachlorophenol	2326			☐	☐
	0.002	0.0002	Chlorodane	2959			☐	☐
	0.0002	0.00002	Dibromochloropropane(DBCP)	2931			☐	☐
	0.00005	0.00001	Ethylene Dibromide (EDB)	2946			☐	☐
	0.0004	0.00004	Heptachlor	2065			☐	☐
	0.0002	0.00002	Heptachlor Epoxide	2067			☐	☐
	0.0002	0.00002	Lindane	2010			☐	☐
	0.04	0.0001	Methoxychlor	2015			☐	☐
	0.0005	0.0001	PCB (Polychlorinated Biohenyls)	2383			☐	☐
	0.0002	0.00002	Benzo(a)Pyrene	2306			☐	☐
	0.2	0.001	Dalapon	2031			☐	☐
	0.006	0.0006	Di(2-ethylhexyl)phthalate	2039			☐	☐
	0.4	0.0006	Di(2-ethylhexyl)adipate	2035			☐	☐
	0.007	0.0002	Dinoseb	2041			☐	☐
1613	$3x10^{-8}$	$5x10^{-9}$	2,3,7,8-TCDD (Dioxin)	2063	1613	<5pg/L	☐	☐
	0.02	0.0004	Diquat	2032			☐	☐
	0.1	0.0009	Endothall	2033			☐	☐
	0.002	0.00001	Endrin	2005			☐	☐
	0.7	0.006	Glyphosate	2034			☐	☐
	0.001	0.0001	Hexachlorobenzene	2274			☐	☐
	0.05	0.0001	Hexachlorocyclopentadiene	2042			☐	☐
	0.2	0.002	Oxamyl	2036			☐	☐
	0.5	0.0001	Picloram	2040			☐	☐
	0.004	0.0007	Simazine	2037			☐	☐

*Aroclor results may be submitted in lieu of PCB

Laboratory Information

Specimen Number: 109470001
Lab ID Number: AZ0014 Name: PACE ANALYTICAL SERVICES, INC.
Comments:
Authorized Signature: [signature]

*** SYNTHETIC ORGANIC CHEMICAL ANALYSIS ***

>>> To be filled out by laboratory Personnel <<<

Analysis Method	MCL Value	Reporting Limit	Contaminant Name	Cont. Code	Analysis Run Date/Time	Results	Exceeds MCL	Exceeds Reporting Limit
[redacted]	0.07	0.0001	2,4-D	2105			☐	☐
[redacted]	0.05	0.0002	2,4,5-TP (Silvex)	2110			☐	☐
525.2	0.002	0.0002	Alachlor	2051	03/16/2005 19:11	<0.00020	☐	☐
	0.003	0.001	Toxaphene	2020			☐	☐
525.2	0.003	0.0001	Atrazine	2050	03/16/2005 19:11	<0.00010	☐	☐
531.1	0.04	0.0009	Carbofuran	2046	03/12/2005 04:35	<0.00090	☐	☐
	0.001	0.00004	Pentachlorophenol	2326			☐	☐
	0.002	0.0002	Chlordane	2959			☐	☐
504.1	0.0002	0.00002	Dibromochloropropane (DBCP)	2931	03/19/2005 02:02	<0.000020	☐	☐
504.1	0.00005	0.00001	Ethylene Dibromide (EDB)	2946	03/19/2005 02:02	<0.000010	☐	☐
	0.0004	0.00004	Heptachlor	2065			☐	☐
	0.0002	0.00002	Heptachlor Epoxide	2067			☐	☐
	0.0002	0.00002	Lindane	2010			☐	☐
	0.04	0.0001	Methoxychlor	2015			☐	☐
	0.0005	0.0001	PCB: Polychlorinated Biphenyls*	2383			☐	☐
525.2	0.0002	0.00002	Benzo (a) Pyrene	2306	03/16/2005 19:11	<0.000020	☐	☐
	0.2	0.001	Dalapon	2031			☐	☐
525.2	0.006	0.0006	Di(2-ethylhexyl)phthalate	2039	03/16/2005 19:11	<0.00060	☐	☐
525.2	0.4	0.0006	Di(2-ethylhexyl)adipate	2035	03/16/2005 19:11	<0.00060	☐	☐
	0.007	0.0002	Dinoseb	2041			☐	☐
	3.E-08	5.E-09	2,3,7,8-TCDD (Dioxin)	2063			☐	☐
549.2	0.02	0.0004	Diquat	2032	03/14/2005 21:29	<0.00040	☐	☐
[redacted]	0.1	0.0009	Endothall	2033	03/15/2005 16:34	<0.0090	☐	☐
	0.002	0.00001	Endrin	2005			☐	☐
547	0.7	0.006	Glyphosate	2034	03/17/2005 05:21	<0.0060	☐	☐
525.2	0.001	0.0001	Hexachlorobenzene	2274	03/16/2005 19:11	<0.00010	☐	☐
525.2	0.05	0.0001	Hexachlorocyclopentadiene	2042	03/16/2005 19:11	<0.00010	☐	☐
531.1	0.2	0.002	Oxamyl	2036	03/12/2005 04:35	<0.0020	☐	☐
	0.5	0.0001	Picloram	2040			☐	☐
525.2	0.004	0.0007	Simazine	2037	03/16/2005 19:11	<0.000070	☐	☐

* Aroclor results may be submitted in lieu of PCB

>>>> LABORATORY INFORMATION <<<<

>>> To be filled out by laboratory Personnel <<<

SPECIMEN NUMBER [COC0446-01K]

[03/10/05] Sample Date [08:37] Sample Time (24 hr clock)

ID Number [AZ AZ0062] Name: [Del Mar Analytical, Colton]

Comments: [ ]

Authorized Signature: [Compliant]

*** AROCLOR (PCBs SCREENING TEST) ***

>>> To be filled out by laboratory Personnel <<<

Analysis Method	Reporting Limit	Contaminant Name	Cont. Code	Results	Exceeds** Reporting Limit
[redacted]	0.00008	Aroclor 1016	2388		☐
[redacted]	0.02	Aroclor 1221	2390		☐
	0.0005	Aroclor 1232	2392		☐
	0.0003	Aroclor 1242	2394		☐
	0.0001	Aroclor 1248	2396		☐
	0.0001	Aroclor 1254	2398		☐
	0.0002	Aroclor 1260	2400		☐

>>>> LABORATORY INFORMATION <<<<

>>> To be filled out by laboratory Personnel <<<

SPECIMEN NUMBER [AZ006] [03/10/05] Sample Date [08:37] Sample Time (24 hr clock)

ID COC0446-0 [AZ / / /] Name: [Del Mar Analytical, Colton]

-- Comments: [ ]

Authorized Signature: [ ]

*** VOLATILE ORGANIC CHEMICALS ANALYSIS ***

>>> To be filled out by laboratory Personnel <<<

Analysis Method	MCL Value	Reporting Limit	Contaminant Name	Cont. Code	Analysis Run Date/Time	Results	Exceeds MCL	Exceeds Reporting Limit
524.2	0.007	0.0005	1,1-Dichloroethylene	2977	03/15/2005 14:26	<0.00050	☐	☐
524.2	0.2	0.0005	1,1,1-Trichloroethane	2981	03/15/2005 14:26	<0.00050	☐	☐
524.2	0.005	0.0005	1,1,2-Trichloroethane	2985	03/15/2005 14:26	<0.00050	☐	☐
524.2	0.005	0.0005	1,2-Dichloroethane	2980	03/15/2005 14:26	<0.00050	☐	☐
524.2	0.005	0.0005	1,2-Dichloropropane	2983	03/15/2005 14:26	<0.00050	☐	☐
524.2	0.005	0.0005	Benzene	2990	03/15/2005 14:26	<0.00050	☐	☐
[redacted]	0.005	0.0005	Carbon Tetrachloride	2982	03/15/2005 14:26	<0.00050	☐	☐
524.2	0.07	0.0005	cis-1,2-Dichloroethylene	2380	03/15/2005 14:26	<0.00050	☐	☐
524.2	0.7	0.0005	Ethylbenzene	2992	03/15/2005 14:26	<0.00050	☐	☐
524.2	0.1	0.0005	(mono)chlorobenzene	2989	03/15/2005 14:26	<0.00050	☐	☐
524.2	0.6	0.0005	o-Dichlorobenzene	2968	03/15/2005 14:26	<0.00050	☐	☐
524.2	0.075	0.0005	para-Dichlorobenzene	2969	03/15/2005 14:26	<0.00050	☐	☐
524.2	0.1	0.0005	Styrene	2996	03/15/2005 14:26	<0.00050	☐	☐
524.2	0.005	0.0005	Tetrachloroethylene	2987	03/15/2005 14:26	<0.00050	☐	☐
524.2	1	0.0005	Toluene	2991	03/15/2005 14:26	<0.00050	☐	☐
524.2	0.1	0.0005	Trans-1,2-Dichloroethylene	2979	03/15/2005 14:26	<0.00050	☐	☐
524.2	0.005	0.0005	Trichloroethylene	2984	03/15/2005 14:26	<0.00050	☐	☐
524.2	0.002	0.0005	Vinyl Chloride	2976	03/15/2005 14:26	<0.00050	☐	☐
524.2	10	0.0015	Xylenes, Total	2955	03/15/2005 14:26	<0.0015	☐	☐
524.2	0.07	0.0005	1,2,4-Trichlorobenzene	2378	03/15/2005 14:26	<0.00050	☐	☐
524.2	0.005	0.0005	Dichloromethane	2964	03/15/2005 14:26	<0.00050	☐	☐

>>>> LABORATORY INFORMATION <<<<

>>> To be filled out by laboratory Personnel <<<

SPECIMEN NUMBER [COC0446-01K] [03/10/05] Sample Date [08:37] Sample Time (24 hr clock)

ID Number [AZ AZ0062] Name: [Del Mar Analytical, Colton]

Comments: [ ]

Authorized Signature: [ ]

Public Water System Notified: [03/24/2005]

*** RADIOCHEMICAL ANALYSIS ***

>>> To be filled out by laboratory Personnel <<<

Analysis Method	MCL Value	Reporting Limit	Contaminant Name	Cont. Code	Analysis Run Date	Results	Exceeds MCL	Exceeds Reporting Limit
	15 pCi/L		Adjusted Gross Alpha	4000			☐	
		3 pCi/L	Gross Alpha	4002				☐
	30ppb	(reserved)	Combined Uranium	4006			☐	☐
			Uranium 234	4007				
			Uranium 235	4008				
			Uranium 238	4009				
	5 Pci/l	1 pCi/L	Combined Radium (226,228)	4010			☐	☐
		1 pCi/L	Radium 226	4020				☐
		1 pCi/L	Radium 228	4030				
	4 mrem	3 pCi/L	Gross Beta	4100			☐	☐
	20,000 pCi/l	1000 pCi/L	Tritium	4102			☐	☐
		10 pCi/L	Strontium-89	4172				☐
	8 pCi/l		Strontium-90	4174			☐	☐
		1 pCi/L	Iodine-131	4264				☐
		10 pCi/L	Cesium-134_	4270				☐

>>>> LABORATORY INFORMATION <<<<

To be filled out by Laboratory Personnel <<<<

SPECIMEN NUMBER
[COC0446-01K]

[03/10/05] Sample Date [08:37] Sample Time (24 hr clock)

ID Number [AZ AZ0062] Name: [Del Mar Analytical, Colton]

Comments: [ ]

Authorized Signature: [ ]

Date Public Water System Notified: [03/24/2005]

[redacted]posite radiochemical sample means four quarterly samples from a single source only.

[redacted]ss alpha is the value of all alpha particle emitters except for uranium and radon 222. Radium is included in the reported gross alpha value. All units are reported in picocuries per liter (pCi/l) EXCEPT for gross beta which is reported in millirem per year.

*** These values are assumed to produce a total body or organ dose of 4 millirem per year.

*** ASBESTOS ***

>>> To be filled out by laboratory Personnel <<<

Analysis Method	MCL Value	Contaminant Name	Cont. Code	Analysis Run Date	Results	Exceeds MCL
	7 MFL	Asbestos	1094			☐

>>>> LABORATORY INFORMATION <<<<

To be filled out by Laboratory Personnel <<<<

SPECIMEN NUMBER
[COC0446-01K]

[03/10/05] Sample Date [08:37] Sample Time (24 hr clock)

ID Number [AZ AZ0062] Name: [Del Mar Analytical, Colton]

Comments: [ ]

Authorized Signature: [ ]

Date Public Water System Notified: [03/24/2005]

*** MICROBIOLOGICAL ANALYSIS ***

>>> To be filled out by laboratory Personnel <<<

	MCL Value	Contaminant Name	Cont. Code	Test Start Date/Time	Analysis Run Date/Time	Result	Exceeds MCL
	Present/1 1 or more Coliform	Total Coliform	3000				☐

ONLY REPORT FECAL RESULT IF TOTAL COLIFORM RESULT IS POSITIVE

Analysis Method	MCL Value	Contaminant Name	Cont. Code	Test Start Date/Time	Analysis Run Date/Time	Result	Exceeds MCL
	Present/1 1 or more Coliform	Fecal Coliform	3013				☐

>>>> LABORATORY INFORMATION <<<<

To be filled out by Laboratory Personnel <<<<

[03/10/05] Sample Date [08:37] Sample Time (24 hr clock)

SPECIMEN NUMBER
[COC0446-01K]

ID Number [AZ AZ0062] Name: [Del Mar Analytical, Colton]

Comments: [ ]

Authorized Signature: [ ]

Public Water System Notified: [03/24/2005]

INSTRUCTIONS FOR USING THE ARIZONA DRINKING WATER SOURCE APPROVAL REPORTING FORM

Revised 2003

SYSTEM ID: This is a unique 5 digit Public Water System Identification (PWSID) number assigned to each public water system by ADEQ.

SYSTEM NAME: Should be in the legal name which the water system will be known as when the system is built. Always notify the Department in writing of any name or ownership change.

ADEQ PROJECT NUMBER: This is the number assigned by ADEQ when the project is first submitted for an "Approval to Construct".

NEW SYSTEM: If this is a new system and a system in number has not yet been assigned by ADEQ, then mark "YES", and be sure that the project number is filled in.

NEW POE: If this source represents a new point of entry (POE) for your system, then mark "YES" on the form. This will allow ADEQ to assign a new point of entry number and the appropriate monitoring year for this point of entry.

WELL ID NUMBER: The Department of Water Resources' registration number goes here. This number always begins with a 55-. If the new source does not constitute a new point of entry, fill in the existing point of entry number that this source is joining.

SURFACE WATER INTAKE ID NUMBER: This number must be assigned by ADEQ. If the new source does not constitute a new point of entry, fill in the existing point of entry number that this source is joining.

SAMPLE DATE: The date the specimen was collected in mm/dd/yy format.

SAMPLE TIME: The time the specimen was collected in hh:mm format (24 hr clock time).

OWNER/CONTACT PERSON NAME: The first and last name of the owner or owner's representative, (contact person) who should be contacted with sample results.

OWNER/CONTACT PHONE#: The daytime phone number of the owner's representative, (contact person) who should be contacted with sample results.

SAMPLE TYPE: The compliance reason for specimen collection. Only the relevant sample types for each contaminant group are provided on the ADEQ forms.

SPECIMEN NUMBER: A unique 15 character (max) alphanumeric code that identifies a particular sample used to test one contaminant or one category of contaminants. If reporting on different reporting forms, a different (unique) number is required for each contaminant group and for each report.

NOTE: These definitions are general in nature. For specific questions regarding your laboratory submittal, please contact the Arizona Department of Environmental Quality (ADEQ) Water Quality Compliance Section at 1-800-234-5677, ext. 4624, or 602-771-4624.

www.adeq.state.az.us

Arizona Department Of Environmental Quality
Drinking Water Source Approval Form
Samples To Be Taken At Source Only

_____ System ID#
__ 03/10/05 ___ Sample Date

_____ System Name
_ 08:37 __ (24 Hr clock) Sample Time

_____ ADEQ Project Number

55-_____ Well ID Number

New System **YES**____ **NO**____
New POE **YES**____ **NO**____

_____ Surface Water Intake ID Number

_____ Owner/Contact Person Name

_(___)_____ Owner/Contact Person Phone Number

Sample Type
Compliance Monitoring

Sample Collection Point/ID
Point of Entry# _____

This form is to be filled out completely, and all pages are to be submitted together. If more than one laboratory participated in the analyses, please attach a copy of the original laboratory report, signed by the performing laboratory, to the back of this form.

Results Shall Be Reported In Milligrams Per Liter (mg/L) Unless Otherwise Specified.

Please note:
The Arsenic MCL is currently .05 mg/L. However, on Jan. 23, 2006, the Arsenic MCL will be .01 mg/L.

There currently is no MCL for Uranium. However, on Dec. 8, 2003 the Uranium MCL will be .03 mg/L.

Please Mail This Completed Form To:

Arizona Department Of Environmental Quality
Technical Review Unit
Drinking Water Section (5415b-2)
1110 W Washington St,
Phoenix, AZ 85007

Inorganic Chemical Analysis

Analysis Method	MCL	Reporting Limit	Contaminant Name	Cont. Code	Analysis Run Date	Result	Exceeds MCL	Exceeds Reporting Limit
_____	0.05	0.05	Arsenic	1005	_____	_____	☐	☐
_____	2	2	Barium	1010	_____	_____	☐	☐
_____	0.005	0.005	Cadmium	1015	_____	_____	☐	☐
_____	0.1	0.1	Chromium	1020	_____	_____	☐	☐
_____	1.3*	0.050	Copper	1022	_____	_____	☐	☐
_____	4.0	2.0	Fluoride	1025	_____	_____	☐	☐
_____	0.015*	0.0025	Lead	1030	_____	_____	☐	☐
_____	0.002	0.002	Mercury	1035	_____	_____	☐	☐
_____	10	5	Nitrate (as N)	1040	_____	_____	☐	☐
_____	1	0.5	Nitrite	1041	_____	_____	☐	☐
_____	0.05	0.05	Selenium	1045	_____	_____	☐	☐
_____	0.006	0.006	Antimony	1074	_____	_____	☐	☐
_____	0.004	0.004	Beryllium	1075	_____	_____	☐	☐
_____	0.2	0.2	Cyanide (as free	1024	_____	_____	☐	☐
_____	0.1	0.1	Nickel	1036	_____	_____	☐	☐
_____	0.002	0.002	Thallium	1085	_____	_____	☐	☐

*Action Level

Laboratory Information

Specimen Number:_____
Lab ID Number:_____Name:_____
Comments:_____
Authorized Signature:_____

Physical Analysis

Analysis Method	Contaminant Name	Cont. Code	Analysis Run Date	Result
_____	Sulfate	1055	_____	_____
_____	Sodium	1052	_____	_____
_____	PH	1925	_____	_____
_____	Alkalinity	1927	_____	_____
_____	Hardness/Calcium	1918	_____	_____
_____	Langelier Index	1997	_____	_____
_____	Temperature (°C)	1996	_____	_____
_____	Total Dissolved Solids-TDS	1930	_____	_____

Laboratory Information

Specimen Number:_____
Lab ID Number:_____Name:_____
Comments:_____
Authorized Signature:_____

Synthetic Organic Chemical Analysis

[redacted]lysis od	MCL	Reporting Limit	Contaminant Name	Cont. Code	Analysis Run Date	Result	Exceeds MCL	Exceeds Reporting Limit
515.1	0.07	0.0001	2,4-D	2105	03/21/05	<0.00010	☐	☐
515.1	0.05	0.0002	2,4,5-TP (Silvex)	2110	03/21/05	<0.00020	☐	☐
525.2	0.002	0.0002	Alachlor	2051			☐	☐
508	0.003	0.001	Toxaphene	2020			☐	☐
525.2	0.003	0.0001	Atrazine	2050			☐	☐
531.1	0.04	0.0009	Carbofuran	2046			☐	☐
515.1	0.001	0.00004	Pentachlorophenol	2326	03/21/05	<0.00004	☐	☐
508	0.002	0.0002	Chlorodane	2959			☐	☐
504.1	0.0002	0.00002	Dibromochloropropane(DBCP)	2931			☐	☐
504.1	0.00005	0.00001	Ethylene Dibromide (EDB)	2946			☐	☐
508	0.0004	0.00004	Heptachlor	2065			☐	☐
508	0.0002	0.00002	Heptachlor Epoxide	2067			☐	☐
508	0.0002	0.00002	Lindane	2010			☐	☐
508	0.04	0.0001	Methoxychlor	2015			☐	☐
508A	0.0005	0.0001	PCB (Polychlorinated Biohenyls)	2383			☐	☐
525.2	0.0002	0.00002	Benzo(a)Pyrene	2306			☐	☐
515.1	0.2	0.001	Dalapon	2031	03/21/05	<0.001	☐	☐
525.2	0.006	0.0006	Di(2-ethylhexyl)phthalate	2039			☐	☐
525.2	0.4	0.0006	Di(2-ethylhexyl)adipate	2035			☐	☐
[redacted]	0.007	0.0002	Dinoseb	2041	03/21/05	<0.00020	☐	☐
[redacted]A	$3x10^{-8}$	$5x10^{-9}$	2,3,7,8-TCDD (Dioxin)	2063			☐	☐
549.1	0.02	0.0004	Diquat	2032			☐	☐
548.1	0.1	0.0009	Endothall	2033			☐	☐
508	0.002	0.00001	Endrin	2005			☐	☐
547	0.7	0.006	Glyphosate	2034			☐	☐
508	0.001	0.0001	Hexachlorobenzene	2274			☐	☐
508	0.05	0.0001	Hexachlorocyclopentadiene	2042			☐	☐
531.1	0.2	0.002	Oxamyl	2036			☐	☐
515.1	0.5	0.0001	Picloram	2040	03/21/05	<0.00010	☐	☐
525.2	0.004	0.0007	Simazine	2037			☐	☐

*Aroclor results may be submitted in lieu of PCB

Laboratory Information

Specimen Number: MEL05-01442
Lab ID Number: AZO 117 Name: Aqua Tech Environmental Lab – Melmore
Comments:
Authorized Signature: Tara M. Brown

Aroclor (PCB Screening Test)

Analysis Method	Reporting Limit	Contaminant Name	Cont. Code	Analysis Run Date	Result	Exceeds Reporting Limit
508	0.00008	Aroclor 1016	2388			☐
508	0.02	Aroclor 1221	2390			☐
508	0.0005	Aroclor 1232	2392			☐
508	0.0003	Aroclor 1242	2394			☐
508	0.0001	Aroclor 1248	2396			☐
508	0.0001	Aroclor 1254	2398			☐
508	0.0002	Aroclor 1260	2400			☐

Laboratory Information

Specimen Number: Lab ID Number: AZO 117 Name: Aqua Tech Environmental Lab - Melmore
Comments:_____
Authorized Signature:_____

Volatile Organic Chemical Analysis

Analysis Method	MCL	Reporting Limit	Contaminant Name	Cont. Code	Analysis Run Date	Result	Exceeds MCL	Exceeds Reporting Limit
	0.007	0.0005	1,1Dichloroethlene	2977			☐	☐
	0.2	0.0005	1,1,1-Trichlorethane	2981			☐	☐
	0.005	0.0005	1,1,2-Trichloroethane	2985			☐	☐
	0.005	0.0005	1,2-Dichloroethane	2980			☐	☐
	0.005	0.0005	1,2-Dichloropropane	2983			☐	☐
	0.005	0.0005	Benzene	2990			☐	☐
	0.005	0.0005	Carbon Tetrachloride	2982			☐	☐
	0.07	0.0005	cis-1,2 Dichloroethylene	2380			☐	☐
	0.7	0.0005	Ethylbenzene	2992			☐	☐
	0.1	0.0005	(mono) Chlorobenzene	2989			☐	☐
	0.6	0.0005	o-Dichlorobenzene	2968			☐	☐
	0.075	0.0005	para-Dichlorobenzene	2969			☐	☐
	0.1	0.0005	Styrene	2996			☐	☐
	0.005	0.0005	Tetrachloroethylene	2987			☐	☐
	1	0.0005	Tolune	2991			☐	☐
	0.1	0.0005	Trans-1,2-Dichloroethylene	2979			☐	☐
	0.005	0.0005	Trichloroethlene	2984			☐	☐
	0.002	0.0005	Vinyl Chloride	2976			☐	☐
	10	0.0015	Xylenes, Total	2955			☐	☐
	0.07	0.0005	1,2,4-Trichlorobenzene	2378			☐	☐
	0.005	0.0005	Dichloromethane	2964			☐	☐

Laboratory Information

Specimen Number:_____
D Number:_____ Name:_____
ments:_____
orized Signature:_____

Radiochemical Analysis

[redacted] Method	MCL	Reporting Limit	Contaminant Name	Cont. Code	Analysis Run Date	Result	Exceeds MCL	Exceeds Reporting Limit
_____	15 pCi.L		Adjusted Gross Alpha	4000	_____	_____	☐	
_____		3 pCi/L	Gross Alpha	4002	_____	_____		☐
_____	30ppb	(reserved)	Combined Uranium	4006	_____	_____	☐	☐
_____			Uranium 234	4007	_____	_____		
_____			Uranium 235	4008	_____	_____		
_____			Uranium 238	4009	_____	_____		
_____	5 pCi/L	1 pCi/L	Combined Radium	4010	_____	_____	☐	☐
_____		1 pCi/L	Radium 226	4020	_____	_____		☐
_____		1 pCi/L	Radium 228	4030	_____	_____		
_____	4 mrem	3 pCi/L	Gross Beta	4100	_____	_____	☐	☐
_____	20,000 pCi/L	1,000 pCi/L	Tritium	4102	_____	_____	☐	☐
_____		10 pCi/L	Strontium-89	4172	_____	_____		☐
_____	8 pCi/L	2 pCi/L	Strontium-90	4174	_____	_____	☐	☐
_____		1 pCi/L	Iodine-131	4264	_____	_____		☐
_____		10 pCi/L	Cesium-134_	4270	_____	_____		☐

Laboratory Information

Specimen Number:_____
Lab ID Number:_____Name:_____
C[redacted]ments:_____
[redacted]ized Signature:_____
Da[redacted]ublic Water System Notified:_____

Asbestos Analysis

Analysis Method	MCL	Contaminant Name	Cont. Code	Analysis Run Date	Result	Exceeds MCL
_____	7 MFL	Asbestos	1094	_____	_____	☐

Laboratory Information

Specimen Number_____
Lab ID Number_____ Name_____
Comments:_____
Authorized Signature:_____
[redacted] Public Water System Notified:_____

MICROBIOLOGICAL ANALYSIS

Analysis Method	MCL	Contaminant Name	Cont. Code	Test Start Date/Time	Analysis Run Date/Time	Result
_____	Present 1 or More Coliform	Total Coliform	3000	_____	_____	_____

ONLY REPORT FECAL RESULT IF TOTAL COLIFORM RESULT IS POSITIVE

Analysis Method	MCL	Contaminant Name	Cont. Code	Test Start Date/Time	Analysis Run Date/Time	Result
_____	Present 1 or More Coliform	Total Coliform	3013	_____	_____	_____

LABORATORY INFORMATION

>>>To be filled out by laboratory personnel<<<

Specimen Number_____
Lab ID Number_____ Name_____
Comments:_____
Authorized Signature:_____
Date Public Water System Notified:_____
Dwar9: Revised 2003

INSTRUCTIONS FOR USING THE ARIZONA DRINKING WATER SOURCE APPROVAL REPORTING FORM

Revised 2003

SYSTEM ID: This is a unique 5 digit Public Water System Identification (PWSID) number assigned to each public water system by ADEQ.

SYSTEM NAME: Should be in the legal name which the water system will be known as when the system is built. Always notify the Department in writing of any name or ownership change.

ADEQ PROJECT NUMBER: This is the number assigned by ADEQ when the project is first submitted for an "Approval to Construct".

NEW SYSTEM: If this is a new system and a system in number has not yet been assigned by ADEQ, then mark "YES", and be sure that the project number is filled in.

NEW POE: If this source represents a new point of entry (POE) for your system, then mark "YES" on the form. This will allow ADEQ to assign a new point of entry number and the appropriate monitoring year for this point of entry.

WELL ID NUMBER: The Department of Water Resources' registration number goes here. This number always begins with a 55-. If the new source does not constitute a new point of entry, fill in the existing point of entry number that this source is joining.

SURFACE WATER INTAKE ID NUMBER: This number must be assigned by ADEQ. If the new source does not constitute a new point of entry, fill in the existing point of entry number that this source is joining.

SAMPLE DATE: The date the specimen was collected in mm/dd/yy format.

SAMPLE TIME: The time the specimen was collected in hh:mm format (24 hr clock time).

OWNER/CONTACT PERSON NAME: The first and last name of the owner or owner's representative, (contact person) who should be contacted with sample results.

OWNER/CONTACT PHONE#: The daytime phone number of the owner's representative, (contact person) who should be contacted with sample results.

SAMPLE TYPE: The compliance reason for specimen collection. Only the relevant sample types for each contaminant group are provided on the ADEQ forms.

SPECIMEN NUMBER: A unique 15 character (max) alphanumeric code that identifies a particular sample used to test one contaminant or one category of contaminants. If reporting on different reporting forms, a different (unique) number is required for each contaminant group and for each report.

NOTE: These definitions are general in nature. For specific questions regarding your laboratory submittal, please contact the Arizona Department of Environmental Quality (ADEQ) **Water Quality Compliance Section at 1-800-234-5677, ext. 4624, or 602-771-4624.** **www.adeq.state.az.us**

ARIZONA DEPARTMENT OF ENVIRONMENTAL QUALITY
DRINKING WATER SOURCE APPROVAL FORM
*** SAMPLES TO BE TAKEN AT SOURCE ONLY ***

[_____] _____
System ID — System Name

[03/10/05] [08:45] (24 hr clock)
Sample date — Sample time

_____
ADEQ Project Number

_____
Well ID Number

NEW SYSTEM YES _____ NO _____

_____
Surface Water Intake ID Number

NEW P.O.E. YES _____ NO _____

_____
Owner/Contact Person Name

_____
Owner/Contact Person Phone Number

IPLE TYPE
☐ Compliance Monitoring

SAMPLE COLLECTION POINT / ID
☐ Point of Entry# [_____]

This form is intended to be filled out completely, and all pages are to be submitted together. If more than one laboratory participated in the analyses, please attach a copy of the original laboratory report, signed by the performing laboratory, to the back of this form.

ALL RESULTS SHALL BE REPORTED IN MILLIGRAMS PER LITER (MG/L) UNLESS OTHERWISE SPECIFIED.

Please note:
The Arsenic MCL is currently 0.05 mg/L. However, on Jan. 23, 2006, the Arsenic MCL will be 0.01 mg/L.

PLEASE MAIL THIS COMPLETED FORM TO:

ARIZONA DEPARTMENT OF ENVIRONMENTAL QUALITY
TECHNICAL REVIEW UNIT
DRINKING WATER SECTION
1110 W. Washington St.
Phoenix, AZ 85007

Report #: 144521a

***INORGANIC CHEMICAL ANALYSIS ***

Analysis Method	MCL Value	Reporting Limit	Contaminant Name	Cont. Code	Analysis Run Date	Results*	Exceeds MCL	Exceeds Reporting
[redacted]	0.05	0.05	Arsenic	1005			☐	☐
	2.0	2.0	Barium	1010			☐	☐
	0.005	0.005	Cadmium	1015			☐	☐
	0.1	0.1	Chromium	1020			☐	☐
	1.3^	0.050	Copper (Action Level)	1022			☐	☐
	4.0	2.0	Fluoride	1025			☐	☐
	0.015^	0.0025	Lead (Action Level)	1030			☐	☐
	0.002	0.002	Mercury	1035			☐	☐
	10	5	Nitrate (as N)	1040			☐	☐
	1	0.5	Nitrite (as N)	1041			☐	☐
	0.05	0.05	Selenium	1045			☐	☐
	0.006	0.006	Antimony	1074			☐	☐
	0.004	0.004	Beryllium	1075			☐	☐
	0.2	0.2	Cyanide (as free cyanide)	1024			☐	☐
	0.1	0.1	Nickel	1036			☐	☐
	0.002	0.002	Thallium	1085			☐	☐

^ tion Limit

>>>>> LABORATORY INFORMATION <<<<<

[redacted] ECIMEN NUMBER _____

Lab ID Number: [AZ 0 / 4 / 3 / 2] Name: [Environmental Health Laboratories]

Comments: [ ]

Reviewed by:[ ] Finalized by: [ ]

PHYSICAL ANALYSIS

	Sulfate	1055		
	Sodium	1052		
	pH	1925		
	Alkalinity	1927		
	Hardness/Calcium	1918		
	Langlier Index	1997		
	Temperature (°C)	1996		
	Total Dissolved Solids-TDS	1930		

>>>>> LABORATORY INFORMATION <<<<<

SPECIMEN NUMBER _____

Lab ID Number: [AZ 0 / 4 / 3 / 2] Name: [Environmental Health Laboratories]

Comments: [ ]

[redacted] viewed by:[ ] Finalized by: [ ]

Report #: 144521a

*** SYNTHETIC ORGANIC CHEMICAL ANALYSIS ***

To be filled out by laboratory personnel

Analysis Method	MCL	Reporting Limit	Contaminant Name	Cont. Code	Analysis Run Date	Results*	Exceeds MCL	Exceeds Reporting Limit	
	0.07	.0001	2,4-D	2105			☐	☐	
	0.05	.0002	2,4,5-TP (Silvex)	2110			☐	☐	
525.2	0.002	.0002	Alachlor	2051	03/24/05	< 0.0002	☐	☐	S11
505	0.003	.001	Toxaphene	2020	03/17/05	< 0.001	☐	☐	
525.2	0.003	.0001	Atrazine	2050	03/24/05	< 0.0001	☐	☐	S11
	0.04	.0009	Carbofuran	2046			☐	☐	
	0.001	.00004	Pentachlorophenol	2326			☐	☐	
505	0.002	.0002	Chlordane	2959	03/17/05	< 0.0002	☐	☐	
	0.0002	.00002	Dibromochloropropane (DBCP)	2931			☐	☐	
	0.00005	.00001	Ethylene Dibromide (EDB)	2946			☐	☐	
525.2	0.0004	.00004	Heptachlor	2065	03/24/05	< 0.00004	☐	☐	S11
525.2	0.0002	.00002	Heptachlor Epoxide	2067	03/24/05	< 0.00002	☐	☐	S11
525.2	0.0002	.00002	Lindane	2010	03/24/05	< 0.00002	☐	☐	S11
525.2	0.04	.0001	Methoxychlor	2015	03/24/05	< 0.0001	☐	☐	S11
	0.0005	.0001	PCB:Polychlorinated Biphenyls*	2383			☐	☐	
525.2	0.0002	.00002	Benzo(a)pyrene	2306	03/24/05	< 0.00002	☐	☐	S11
	0.2	.001	Dalapon	2031			☐	☐	
525.2	0.006	.0006	Di(2-ethylhexyl)phthalate	2039	03/24/05	< 0.0006	☐	☐	S11
525.2	0.4	.0006	Di(2-ethylhexyl)adipate	2035	03/24/05	< 0.0006	☐	☐	S11, L1
	0.007	.0002	Dinoseb	2041			☐	☐	
	3x10-8	5x10-9	2,3,7,8-TCDD (Dioxin)	2063			☐	☐	
	0.02	.0004	Diquat	2032			☐	☐	
	0.1	.009	Endothall	2033			☐	☐	
525.2	0.002	.00001	Endrin	2005	03/24/05	< 0.00001	☐	☐	S11
	0.7	.006	Glyphosate	2034			☐	☐	
525.2	0.001	.0001	Hexachlorobenzene	2274	03/24/05	< 0.0001	☐	☐	S11
525.2	0.05	.0001	Hexachlorocyclopentadiene	2042	03/24/05	< 0.0001	☐	☐	S11
	0.2	.002	Oxamyl	2036			☐	☐	
	0.5	.0001	Picloram	2040			☐	☐	
525.2	0.004	.00007	Simazine	2037	03/24/05	< 0.00007	☐	☐	S11

* Aroclor results may be submitted in lieu of PCB

>>>>> LABORATORY INFORMATION <<<<<

To be filled out by laboratory personnel

SPECIMEN NUMBER 1203106

Lab ID Number: [AZ 0 / 4 / 3 / 2] Name: [Environmental Health Laboratories]

Comments: [Aqua Tech Sample ID #MEL05-01442 See attached page for additional comments.]

Reviewed by: [William Reeves] Finalized by: [ ]

Report #: 144521a

AROCLOR (PCBs SCREENING TEST)

Analysis Method	Reporting Limit	Contaminant Name	Cont. Code	Analysis Run Date	Results*	Exceeds** Reporting Limit
[redacted]	0.00008	Aroclor 1016	2388	03/17/05	< 0.00008	☐
505	0.02	Aroclor 1221	2390	03/17/05	< 0.02	☐
505	0.0005	Aroclor 1232	2392	03/17/05	< 0.0005	☐
505	0.0003	Aroclor 1242	2394	03/17/05	< 0.0003	☐
505	0.0001	Aroclor 1248	2396	03/17/05	< 0.0001	☐
505	0.0001	Aroclor 1254	2398	03/17/05	< 0.0001	☐
505	0.0002	Aroclor 1260	2400	03/17/05	< 0.0002	☐

>>>>> LABORATORY INFORMATION <<<<<
To be filled out by laboratory personnel

SPECIMEN NUMBER 1203107

Lab ID Number: [AZ 0 / 4 / 3 / 2] Name: [Environmental Health Laboratories]

Comments: [Aqua Tech Sample ID #MEL05-01442 See attached page for additional comments.]

Reviewed by: [[signature]] Finalized by: [[signature]]

*** VOLATILE ORGANIC CHEMICAL ANALYSIS ***

Analysis Method	MCL	Reporting Limit	Contaminant Name	Cont. Code	Analysis Run Date	Results*	Exceeds MCL	Exceeds Reporting Limit
[redacted]	0.007	0.0005	1,1-Dichloroethylene	2977			☐	☐
[redacted]	0.2	0.0005	1,1,1-Trichloroethane	2981			☐	☐
	0.005	0.0005	1,1,2-Trichloroethane	2985			☐	☐
	0.005	0.0005	1,2-Dichloroethane	2980			☐	☐
	0.005	0.0005	1,2-Dichloropropane	2983			☐	☐
	0.005	0.0005	Benzene	2990			☐	☐
	0.005	0.0005	Carbon Tetrachloride	2982			☐	☐
	0.07	0.0005	cis-1,2-Dichloroethylene	2380			☐	☐
	0.7	0.0005	Ethylbenzene	2992			☐	☐
	0.1	0.0005	(mono)chlorobenzene	2989			☐	☐
	0.6	0.0005	o-Dichlorobenzene	2968			☐	☐
	0.075	0.0005	para-Dichlorobenzene	2969			☐	☐
	0.1	0.0005	Styrene	2996			☐	☐
	0.005	0.0005	Tetrachloroethylene	2987			☐	☐

[redacted]

*** VOLATILE ORGANIC CHEMICAL ANALYSIS ***

Analysis Method	MCL	Reporting Limit	Contaminant Name	Cont. Code	Analysis Run Date	Results*	Exceeds MCL	Exceeds Reporting Limit
[redacted]	1	0.0005	Toluene	2991			☐	☐
	0.1	0.0005	trans-1,2-Dichloroethylene	2979			☐	☐
	0.005	0.0005	Trichloroethylene	2984			☐	☐
	0.002	0.0005	Vinyl Chloride	2976			☐	☐
	10	0.0015	Xylenes, total	2955			☐	☐
	0.07	0.0005	1,2,4-Trichlorobenzene	2378			☐	☐
	0.005	0.0005	Dichloromethane	2964			☐	☐

>>>>> LABORATORY INFORMATION <<<<<
To be filled out by laboratory personnel

SPECIMEN NUMBER _____
Lab ID Number: [AZ 0 / 4 / 3 / 2] Name: [Environmental Health Laboratories]
Comments: [_____]
Reviewed by: [_____] Finalized by: [_____]
Date Public Water System Notified: [_____]

*** RADIOCHEMICAL ANALYSIS ***

Analysis Method	MCL	Reporting Limit	Contaminant Name	Cont. Code	Analysis Run Date	Results*	Exceeds MCL	Exceeds Reporting Limit
	15 Pci/L		Adjusted Gross Alpya	4000			☐	
		3 Pci/L	Gross Alpha	4002				☐
[redacted]	30 ppb	(reserved)	Combined Uranium	4006			☐	☐
			Uranium 234	4007				
			Uranium 235	4008				
			Uranium 238	4009				
	5 pCi/L	1 pCi/L	Combined Radium	4010			☐	☐
		1 pCi/L	Radium 226	4020				☐
		1 pCi/L	Radium 228	4030				
	4 mrem	3 pCi/L	Gross Beta	4100			☐	☐
	20,000 pCi/L	1000 pCi/L	Tritium	4102			☐	☐
		10 pCi/L	Strontium-89	4172				☐
	8 pCi/L	2 pCi/L	Strontium-90	4174			☐	☐
		1 pCi/L	Iodine-131	4264				☐
		10 pCi/L	Cesium-134	4270				☐

>>>>> LABORATORY INFORMATION <<<<<
To be filled out by laboratory personnel

SPECIMEN NUMBER _____
Lab ID Number: [AZ 0 / 4 / 3 / 2] Name: [Environmental Health Laboratories]
[redacted]mments: [_____]
[redacted]iewed by: [_____] Finalized by: [_____]
[redacted]e Public Water System Notified: [_____]

Report #: 144521a

*** ASBESTOS ANALYSIS ***

Analysis Method	MCL	Contaminant Name	Cont. Code	Analysis Run Date	Results*	Exceeds MCL
_____	7 MFL	Asbestos	1094	_____	_____	☐

>>>>> LABORATORY INFORMATION <<<<<
To be filled out by laboratory personnel

SPECIMEN NUMBER _____
Lab ID Number: [AZ 0 / 4 / 3 / 2] Name: [Environmental Health Laboratories]
Comments: [ ]
Reviewed by: [ ] Finalized by: [ ]
Date Public Water System Notified: [ ]

*** MICROBIOLOGICAL ANALYSIS ***

Analysis Method	MCL Value	Contaminant Name	Cont. Code	Test Start Date / Time	Analysis Run Date / Time	Result
_____	Present/ 1 or more Coliform	Total Coliform	3000	_____	_____	_____

ONLY REPORT FECAL RESULT IF TOTAL COLIFORM RESULT IS POSITIVE

Analysis Method	MCL Value	Contaminant Name	Cont. Code	Test Start Date / Time	Analysis Run Date / Time	Result
_____	Present/ 1 or more Coliform	Total Coliform	3013	_____	_____	_____

>>>>> LABORATORY INFORMATION <<<<<
To be filled out by laboratory personnel

SPECIMEN NUMBER _____
Lab ID Number: [AZ 0 / 4 / 3 / 2] Name: [Environmental Health Laboratories]
Comments: [ ]
Reviewed by: [ ] Finalized by: [ ]
Date Public Water System Notified: [ ]
DWAR9: Revised 2004

INSTRUCTIONS FOR USING THE ARIZONA DRINKING WATER SOURCE APPROVAL REPORTING FORM

DWAR 9: Revised 2003

SYSTEM ID: This is a unique 5 digit Public Water System Identification (PWSID) number assigned to each public water system by ADEQ.

SYSTEM NAME: This should be the legal name which the water system will be known as when the system is built. Always notify the Department in writing of any name or ownership change.

ADEQ PROJECT NUMBER: This is the number assigned by ADEQ when the project is first submitted for an "Approval to Construct".

NEW SYSTEM: If this is a new system and a system id number has not yet been assigned by ADEQ, then mark "YES", and be sure that the project number is filled in.

NEW POE: If this source represents a new point of entry (POE) for your system, then mark "YES" on the form. This will allow ADEQ to assign a new point of entry number and the appropriate monitoring year for this entry point.

WELL ID NUMBER: The Department of Water Resources' registration number goes here. This number always begins with 55-. If the new source does not constitute a new point of entry, fill in the existing point of entry number that this source is joining.

SURFACE WATER INTAKE ID NUMBER: This number must be assigned by ADEQ. If the new source does not constitute a new point of entry, fill in the existing point of entry number that this source is joining.

SAMPLE DATE: The date the speciman was collected in mm/dd/yy format.

SAMPLE TIME: The time the speciman was collected in hh:mm format (24 hr clock time).

OWNER/CONTACT PERSON NAME: The first and last name of the owner or owner's representative, (contact person) who should be contacted with sample results.

OWNER/CONTACT PHONE #: The daytime phone number of the owner or owner's representative, (contact person) who should be contacted with sample results.

SAMPLE TYPE: The compliance reason for speciman collection. Only the relevant sample types for each contaminant group are provided on the ADEQ forms.

SPECIMEN NUMBER: A unique 15 character (max) alphanumeric code that identifies a particular sample used to test one contaminant or one category of contaminants (i.e., Microbiological, Inorganic, Organic, VOC) for specific sampling event. If reporting on different reporting forms, a different (unique) number is required for each contaminant group and for each report.

NOTE: These definitions are general in nature. For specific questions regarding your laboratory submittal, please contact the Arizona Department of Environmental Quality (ADEQ) Drinking Water Section at 1-800-234-5677, ext. 4624, or (602) 771-4624

www.azdeq.state.az.us - water quality - safe drinking water - forms reports and guidelines - lab reporting forms - Drinking Water Source Approval Form 71 KB

Note: This report may not be reproduced, except in full, without written approval from Environmental Health Laboratories (EHL). EHL is a National Environmental Laboratory Accreditation Program (NELAP) accredited laboratory. These results may not meet the NELAP standard but satisfy the requirements for this project.

17461Derian Ave., Suite 100, Irvine, CA 92614 (949) 261-1022 FAX (949) 260-3297
1014 E. Cooley Dr., Suite A, Colton, CA 92324 (909) 370-4667 FAX (949) 370-1046
9484 Chesapeake Dr., Suite 805, San Diego, CA 92123 (858) 505-8596 FAX (858) 505-9689
9830 South 51st St., Suite B-120, Phoenix, AZ 85044 (480) 785-0043 FAX (480) 785-0851
2520 E. Sunset Rd. #3, Las Vegas, NV 89120 (702) 798-3620 FAX (702) 798-3621

Del Mar Analytical

[redacted] Consulting & Testing
525 W. University, Suite 106
Tempe, AZ 85281
Attention: Chris Christian

Project ID: Globe / New Source Approval

Report Number: POC0297

Sampled: 03/10/05
Received: 03/10/05

PURGEABLE ORGANIC COMPOUNDS BY GC/MS (EPA 524.2)

Analyte	Method	Batch	Reporting Limit	Sample Result	Dilution Factor	Date Extracted	Date Analyzed	Data Qualifiers
Sample ID: POC0297-01 (BM-02790 - Water)								
Reporting Units: mg/l								
Benzene	EPA 524.2	C5C1501	0.00050	ND	1	3/15/2005	3/15/2005	
Bromodichloromethane	EPA 524.2	C5C1501	0.00050	ND	1	3/15/2005	3/15/2005	
Bromoform	EPA 524.2	C5C1501	0.00050	ND	1	3/15/2005	3/15/2005	
Carbon tetrachloride	EPA 524.2	C5C1501	0.00050	ND	1	3/15/2005	3/15/2005	
Chlorobenzene	EPA 524.2	C5C1501	0.00050	ND	1	3/15/2005	3/15/2005	
Chloroform	EPA 524.2	C5C1501	0.00050	ND	1	3/15/2005	3/15/2005	
Dibromochloromethane	EPA 524.2	C5C1501	0.00050	ND	1	3/15/2005	3/15/2005	
1,2-Dichlorobenzene	EPA 524.2	C5C1501	0.00050	ND	1	3/15/2005	3/15/2005	
1,4-Dichlorobenzene	EPA 524.2	C5C1501	0.00050	ND	1	3/15/2005	3/15/2005	
1,2-Dichloroethane	EPA 524.2	C5C1501	0.00050	ND	1	3/15/2005	3/15/2005	
1,1-Dichloroethene	EPA 524.2	C5C1501	0.00050	ND	1	3/15/2005	3/15/2005	
cis-1,2-Dichloroethene	EPA 524.2	C5C1501	0.00050	ND	1	3/15/2005	3/15/2005	
trans-1,2-Dichloroethene	EPA 524.2	C5C1501	0.00050	ND	1	3/15/2005	3/15/2005	
1,2-Dichloropropane	EPA 524.2	C5C1501	0.00050	ND	1	3/15/2005	3/15/2005	
Ethylbenzene	EPA 524.2	C5C1501	0.00050	ND	1	3/15/2005	3/15/2005	
Methylene chloride	EPA 524.2	C5C1501	0.00050	ND	1	3/15/2005	3/15/2005	
Styrene	EPA 524.2	C5C1501	0.00050	ND	1	3/15/2005	3/15/2005	
Tetrachloroethene	EPA 524.2	C5C1501	0.00050	ND	1	3/15/2005	3/15/2005	
Toluene	EPA 524.2	C5C1501	0.00050	ND	1	3/15/2005	3/15/2005	
1,2,4-Trichlorobenzene	EPA 524.2	C5C1501	0.00050	ND	1	3/15/2005	3/15/2005	
1,1,1-Trichloroethane	EPA 524.2	C5C1501	0.00050	ND	1	3/15/2005	3/15/2005	
1,1,2-Trichloroethane	EPA 524.2	C5C1501	0.00050	ND	1	3/15/2005	3/15/2005	
Trichloroethene	EPA 524.2	C5C1501	0.00050	ND	1	3/15/2005	3/15/2005	
Vinyl chloride	EPA 524.2	C5C1501	0.00050	ND	1	3/15/2005	3/15/2005	
m,p-Xylenes	EPA 524.2	C5C1501	0.00050	ND	1	3/15/2005	3/15/2005	
o-Xylene	EPA 524.2	C5C1501	0.00050	ND	1	3/15/2005	3/15/2005	
Xylenes, Total	EPA 524.2	C5C1501	0.0015	ND	1	3/15/2005	3/15/2005	
Trihalomethanes, Total	EPA 524.2	C5C1501	0.00050	**<0.002**	1	3/15/2005	3/15/2005	
Surrogate: 4-Bromofluorobenzene (70-130%)				*95 %*				
Surrogate: 1,2-Dichlorobenzene-d4 (70-130%)				*97 %*				

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Project Manager

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9484 Chesapeake Dr., Suite 805, San Diego, CA 92123 (858) 505-8596 FAX (858) 505-9689
9830 South 51st St., Suite B-120, Phoenix, AZ 85044 (480) 785-0043 FAX (480) 785-0851
2520 E. Sunset Rd. #3, Las Vegas, NV 89120 (702) 798-3620 FAX (702) 798-3621

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A[illegible] Consulting & Testing
15[illegible] W. University, Suite 106
Tempe, AZ 85281
Attention: Chris Christian

Project ID: Globe / New Source Approval

Report Number: POC0297

Sampled: 03/10/05
Received: 03/10/05

PURGEABLE ORGANIC COMPOUNDS BY GC/MS (EPA 524.2)

Analyte	Method	Batch	Reporting Limit	Sample Result	Dilution Factor	Date Extracted	Date Analyzed	Data Qualifiers
ample ID: POC0297-02 (Trip Blanks - Water)								
Reporting Units: mg/l								
enzene	EPA 524.2	C5C1501	0.00050	ND	1	3/15/2005	3/15/2005	
romodichloromethane	EPA 524.2	C5C1501	0.00050	ND	1	3/15/2005	3/15/2005	
romoform	EPA 524.2	C5C1501	0.00050	ND	1	3/15/2005	3/15/2005	
arbon tetrachloride	EPA 524.2	C5C1501	0.00050	ND	1	3/15/2005	3/15/2005	
hlorobenzene	EPA 524.2	C5C1501	0.00050	ND	1	3/15/2005	3/15/2005	
hloroform	EPA 524.2	C5C1501	0.00050	ND	1	3/15/2005	3/15/2005	
ibromochloromethane	EPA 524.2	C5C1501	0.00050	ND	1	3/15/2005	3/15/2005	
,2-Dichlorobenzene	EPA 524.2	C5C1501	0.00050	ND	1	3/15/2005	3/15/2005	
,4-Dichlorobenzene	EPA 524.2	C5C1501	0.00050	ND	1	3/15/2005	3/15/2005	
,2-Dichloroethane	EPA 524.2	C5C1501	0.00050	ND	1	3/15/2005	3/15/2005	
,1-Dichloroethene	EPA 524.2	C5C1501	0.00050	ND	1	3/15/2005	3/15/2005	
is-1,2-Dichloroethene	EPA 524.2	C5C1501	0.00050	ND	1	3/15/2005	3/15/2005	
rans-1,2-Dichloroethene	EPA 524.2	C5C1501	0.00050	ND	1	3/15/2005	3/15/2005	
,2-Dichloropropane	EPA 524.2	C5C1501	0.00050	ND	1	3/15/2005	3/15/2005	
thyl[illegible]zene	EPA 524.2	C5C1501	0.00050	ND	1	3/15/2005	3/15/2005	
M[illegible]e chloride	EPA 524.2	C5C1501	0.00050	ND	1	3/15/2005	3/15/2005	
tyrene	EPA 524.2	C5C1501	0.00050	ND	1	3/15/2005	3/15/2005	
etrachloroethene	EPA 524.2	C5C1501	0.00050	ND	1	3/15/2005	3/15/2005	
oluene	EPA 524.2	C5C1501	0.00050	ND	1	3/15/2005	3/15/2005	
,2,4-Trichlorobenzene	EPA 524.2	C5C1501	0.00050	ND	1	3/15/2005	3/15/2005	
,1,1-Trichloroethane	EPA 524.2	C5C1501	0.00050	ND	1	3/15/2005	3/15/2005	
,1,2-Trichloroethane	EPA 524.2	C5C1501	0.00050	ND	1	3/15/2005	3/15/2005	
richloroethene	EPA 524.2	C5C1501	0.00050	ND	1	3/15/2005	3/15/2005	
Vinyl chloride	EPA 524.2	C5C1501	0.00050	ND	1	3/15/2005	3/15/2005	
n,p-Xylenes	EPA 524.2	C5C1501	0.00050	ND	1	3/15/2005	3/15/2005	
o-Xylene	EPA 524.2	C5C1501	0.00050	ND	1	3/15/2005	3/15/2005	
Xylenes, Total	EPA 524.2	C5C1501	0.0015	ND	1	3/15/2005	3/15/2005	
Trihalomethanes, Total	EPA 524.2	C5C1501	0.00050	**<0.002**	1	3/15/2005	3/15/2005	
Surrogate: 4-Bromofluorobenzene (70-130%)				*99 %*				
Surrogate: 1,2-Dichlorobenzene-d4 (70-130%)				*100 %*				

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2520 E. Sunset Rd. #3, Las Vegas, NV 89120 (702) 798-3620 FAX (702) 798-3621

A[redacted] Consulting & Testing
15[redacted] W. University, Suite 106
Tempe, AZ 85281
Attention: Chris Christian

Project ID: Globe / New Source Approval

Report Number: POC0297

Sampled: 03/10/05
Received: 03/10/05

EDB AND DBCP IN WATER BY GC/ECD (EPA 504.1)

Analyte	Method	Batch	Reporting Limit	Sample Result	Dilution Factor	Date Extracted	Date Analyzed	Data Qualifiers
ample ID: POC0297-01 (BM-02790 - Water)								
Reporting Units: mg/l								
,2-Dibromoethane (EDB)	EPA 504.1	C5C1803	0.000010	ND	1	3/18/2005	3/19/2005	
,2-Dibromo-3-chloropropane	EPA 504.1	C5C1803	0.000020	ND	1	3/18/2005	3/19/2005	
urrogate: 4-Bromofluorobenzene (65-170%)				*94 %*				
ample ID: POC0297-02 (Trip Blanks - Water)								
Reporting Units: mg/l								
,2-Dibromoethane (EDB)	EPA 504.1	C5C1803	0.000010	ND	1	3/18/2005	3/19/2005	
,2-Dibromo-3-chloropropane	EPA 504.1	C5C1803	0.000020	ND	1	3/18/2005	3/19/2005	
urrogate: 4-Bromofluorobenzene (65-170%)				*109 %*				

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A[illegible]onsulting & Testing
15[illegible]W. University, Suite 106
Tempe, AZ 85281
Attention: Chris Christian

Project ID: Globe / New Source Approval

Report Number: POC0297

Sampled: 03/10/05
Received: 03/10/05

ORGANIC COMPOUNDS BY GC/MS (EPA 525.2)

Analyte	Method	Batch	Reporting Limit	Sample Result	Dilution Factor	Date Extracted	Date Analyzed	Data Qualifiers
ample ID: POC0297-01 (BM-02790 - Water)								
Reporting Units: mg/l								
Alachlor	EPA 525.2	C5C1405	0.00020	ND	1	3/14/2005	3/16/2005	
Atrazine	EPA 525.2	C5C1405	0.00010	ND	1	3/14/2005	3/16/2005	
Benzo(a)pyrene	EPA 525.2	C5C1405	0.000020	ND	1	3/14/2005	3/16/2005	
Di(2-ethylhexyl)adipate	EPA 525.2	C5C1405	0.00060	ND	1	3/14/2005	3/16/2005	
Di(2-ethylhexyl)phthalate	EPA 525.2	C5C1405	0.00060	ND	1	3/14/2005	3/16/2005	
Hexachlorobenzene	EPA 525.2	C5C1405	0.00010	ND	1	3/14/2005	3/16/2005	
Hexachlorocyclopentadiene	EPA 525.2	C5C1405	0.00010	ND	1	3/14/2005	3/16/2005	
Simazine	EPA 525.2	C5C1405	0.000070	ND	1	3/14/2005	3/16/2005	
Surrogate: 1,3-Dimethyl-2-nitrobenzene (70-130%)				*100 %*				
Surrogate: Triphenylphosphate (70-130%)				*109 %*				
Surrogate: Perylene-d12 (70-130%)				*78 %*				
Sample ID: POC0297-02 (Trip Blanks - Water)								
Reporting Units: mg/l								
Alachlor	EPA 525.2	C5C1405	0.00020	ND	1.03	3/14/2005	3/16/2005	
Atr[illegible]	EPA 525.2	C5C1405	0.00010	ND	1.03	3/14/2005	3/16/2005	
Ben[illegible]pyrene	EPA 525.2	C5C1405	0.000020	ND	1.03	3/14/2005	3/16/2005	
Di(2-ethylhexyl)adipate	EPA 525.2	C5C1405	0.00060	ND	1.03	3/14/2005	3/16/2005	
Di(2-ethylhexyl)phthalate	EPA 525.2	C5C1405	0.00060	ND	1.03	3/14/2005	3/16/2005	
Hexachlorobenzene	EPA 525.2	C5C1405	0.00010	ND	1.03	3/14/2005	3/16/2005	
Hexachlorocyclopentadiene	EPA 525.2	C5C1405	0.00010	ND	1.03	3/14/2005	3/16/2005	
Simazine	EPA 525.2	C5C1405	0.000070	ND	1.03	3/14/2005	3/16/2005	
Surrogate: 1,3-Dimethyl-2-nitrobenzene (70-130%)				*94 %*				
Surrogate: Triphenylphosphate (70-130%)				*114 %*				
Surrogate: Perylene-d12 (70-130%)				*89 %*				

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9830 South 51st St., Suite B-120, Phoenix, AZ 85044 (480) 785-0043 FAX (480) 785-0851
2520 E. Sunset Rd. #3, Las Vegas, NV 89120 (702) 798-3620 FAX (702) 798-3621

A[redacted] Consulting & Testing
1[redacted] W. University, Suite 106
Tempe, AZ 85281
Attention: Chris Christian

Project ID: Globe / New Source Approval

Report Number: POC0297

Sampled: 03/10/05
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CARBAMATES/CARBAMOXYLOXIME PESTICIDES BY HPLC (EPA 531.1)

Analyte	Method	Batch	Reporting Limit	Sample Result	Dilution Factor	Date Extracted	Date Analyzed	Data Qualifiers
Sample ID: POC0297-01 (BM-02790 - Water)								
Reporting Units: mg/l								
Aldicarb Sulfoxide	EPA 531.1	C5C1111	0.00050	ND	1	3/11/2005	3/12/2005	
Aldicarb Sulfone	EPA 531.1	C5C1111	0.00080	ND	1	3/11/2005	3/12/2005	
Oxamyl	EPA 531.1	C5C1111	0.0020	ND	1	3/11/2005	3/12/2005	
Methomyl	EPA 531.1	C5C1111	0.0010	ND	1	3/11/2005	3/12/2005	
3-Hydroxycarbofuran	EPA 531.1	C5C1111	0.0010	ND	1	3/11/2005	3/12/2005	
Aldicarb	EPA 531.1	C5C1111	0.00050	ND	1	3/11/2005	3/12/2005	
Carbofuran	EPA 531.1	C5C1111	0.00090	ND	1	3/11/2005	3/12/2005	
Carbaryl	EPA 531.1	C5C1111	0.0010	ND	1	3/11/2005	3/12/2005	

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2520 E. Sunset Rd. #3, Las Vegas, NV 89120 (702) 798-3620 FAX (702) 798-3621

A[redacted] Consulting & Testing
15[redacted]W. University, Suite 106
Tempe, AZ 85281
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Sampled: 03/10/05
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ENDOTHALL (EPA 548.1)

Analyte	Method	Batch	Reporting Limit	Sample Result	Dilution Factor	Date Extracted	Date Analyzed	Data Qualifiers
Sample ID: POC0297-01 (BM-02790 - Water)								
Reporting Units: mg/l								
Endothall	EPA 548.1	C5C1503	0.0090	ND	1	3/15/2005	3/15/2005	

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2520 E. Sunset Rd. #3, Las Vegas, NV 89120 (702) 798-3620 FAX (702) 798-3621

A[redacted] Consulting & Testing
1[redacted]W. University, Suite 106
Tempe, AZ 85281
Attention: Chris Christian

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Sampled: 03/10/05
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GLYPHOSATE (EPA 547)

Analyte	Method	Batch	Reporting Limit	Sample Result	Dilution Factor	Date Extracted	Date Analyzed	Data Qualifiers
ample ID: POC0297-01 (BM-02790 - Water)								
Reporting Units: mg/l								
ilyphosate	EPA 547	C5C1611	0.0060	ND	1	3/16/2005	3/17/2005	

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2520 E. Sunset Rd. #3, Las Vegas, NV 89120 (702) 798-3620 FAX (702) 798-3621

A[redacted] Consulting & Testing
1[redacted]. University, Suite 106
Tempe, AZ 85281
Attention: Chris Christian

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DIQUAT (EPA 549.2)

Analyte	Method	Batch	Reporting Limit	Sample Result	Dilution Factor	Date Extracted	Date Analyzed	Data Qualifiers
ample ID: POC0297-01 (BM-02790 - Water)								
Reporting Units: mg/l								
)iquat	EPA 549.2	C5C1406	0.00040	ND	1	3/14/2005	3/14/2005	

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A[redacted] Consulting & Testing
1[redacted] W. University, Suite 106
Tempe, AZ 85281
Attention: Chris Christian

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Report Number: POC0297

Sampled: 03/10/05
Received: 03/10/05

METHOD BLANK/QC DATA

PURGEABLE ORGANIC COMPOUNDS BY GC/MS (EPA 524.2)

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Data Qualifiers
Batch: C5C1501 Extracted: 03/15/05										
Blank Analyzed: 03/15/2005 (C5C1501-BLK1)										
Benzene	ND	0.00050	mg/l							
Bromodichloromethane	ND	0.00050	mg/l							
Bromoform	ND	0.00050	mg/l							
Carbon tetrachloride	ND	0.00050	mg/l							
Chlorobenzene	ND	0.00050	mg/l							
Chloroform	ND	0.00050	mg/l							
Dibromochloromethane	ND	0.00050	mg/l							
1,2-Dichlorobenzene	ND	0.00050	mg/l							
1,4-Dichlorobenzene	ND	0.00050	mg/l							
1,2-Di[redacted]loroethane	ND	0.00050	mg/l							
1,[redacted]roethene	ND	0.00050	mg/l							
cis-1,2-Dichloroethene	ND	0.00050	mg/l							
trans-1,2-Dichloroethene	ND	0.00050	mg/l							
1,2-Dichloropropane	ND	0.00050	mg/l							
Ethylbenzene	ND	0.00050	mg/l							
Methylene chloride	ND	0.00050	mg/l							
Styrene	ND	0.00050	mg/l							
Tetrachloroethene	ND	0.00050	mg/l							
Toluene	ND	0.00050	mg/l							
1,2,4-Trichlorobenzene	ND	0.00050	mg/l							
1,1,1-Trichloroethane	ND	0.00050	mg/l							
1,1,2-Trichloroethane	ND	0.00050	mg/l							
Trichloroethene	ND	0.00050	mg/l							
Vinyl chloride	ND	0.00050	mg/l							
m,p-Xylenes	ND	0.00050	mg/l							
o-Xylene	ND	0.00050	mg/l							
Xylenes, Total	ND	0.0015	mg/l							
Trihalomethanes, Total	<0.002	0.00050	mg/l							
Surrogate: 4-Bromofluorobenzene	*0.00479*		*mg/l*	*0.00500*		*96*	*70-130*			
Surrogate: 1,2-Dichlorobenzene-d4	*0.00477*		*mg/l*	*0.00500*		*95*	*70-130*			

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Ac[redacted]onsulting & Testing
52[redacted]. University, Suite 106
Tempe, AZ 85281
Attention: Chris Christian

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Sampled: 03/10/05
Received: 03/10/05

METHOD BLANK/QC DATA

PURGEABLE ORGANIC COMPOUNDS BY GC/MS (EPA 524.2)

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Data Qualifiers
Batch: C5C1501 Extracted: 03/15/05										
LCS Analyzed: 03/15/2005 (C5C1501-BS1)										
Benzene	0.00929	0.00050	mg/l	0.0100		93	70-130			
Bromodichloromethane	0.00948	0.00050	mg/l	0.0100		95	70-130			
Bromoform	0.00810	0.00050	mg/l	0.0100		81	70-130			
Carbon tetrachloride	0.00941	0.00050	mg/l	0.0100		94	70-130			
Chlorobenzene	0.00920	0.00050	mg/l	0.0100		92	70-130			
Chloroform	0.00942	0.00050	mg/l	0.0100		94	70-130			
Dibromochloromethane	0.00949	0.00050	mg/l	0.0100		95	70-130			
1,2-Dichlorobenzene	0.00940	0.00050	mg/l	0.0100		94	70-130			
1,4-Dichlorobenzene	0.00948	0.00050	mg/l	0.0100		95	70-130			
1,2-Di[redacted]ethane	0.00966	0.00050	mg/l	0.0100		97	70-130			
1-[redacted]oethene	0.00975	0.00050	mg/l	0.0100		98	70-130			
cis-1,2-Dichloroethene	0.00930	0.00050	mg/l	0.0100		93	70-130			
trans-1,2-Dichloroethene	0.00963	0.00050	mg/l	0.0100		96	70-130			
1,2-Dichloropropane	0.00932	0.00050	mg/l	0.0100		93	70-130			
Ethylbenzene	0.00936	0.00050	mg/l	0.0100		94	70-130			
Methylene chloride	0.00910	0.00050	mg/l	0.0100		91	70-130			
Styrene	0.00965	0.00050	mg/l	0.0100		97	70-130			
Tetrachloroethene	0.00880	0.00050	mg/l	0.0100		88	70-130			
Toluene	0.00905	0.00050	mg/l	0.0100		91	70-130			
1,2,4-Trichlorobenzene	0.0108	0.00050	mg/l	0.0100		108	70-130			
1,1,1-Trichloroethane	0.00967	0.00050	mg/l	0.0100		97	70-130			
1,1,2-Trichloroethane	0.00951	0.00050	mg/l	0.0100		95	70-130			
Trichloroethene	0.00941	0.00050	mg/l	0.0100		94	70-130			
Vinyl chloride	0.00948	0.00050	mg/l	0.0100		95	70-130			
m,p-Xylenes	0.0188	0.00050	mg/l	0.0200		94	70-130			
o-Xylene	0.00941	0.00050	mg/l	0.0100		94	70-130			
Xylenes, Total	0.0282	0.0015	mg/l	0.0300		94	70-130			
Trihalomethanes, Total	0.0365	0.00050	mg/l	0.0400		91	70-130			
Surrogate: 4-Bromofluorobenzene	*0.00519*		*mg/l*	*0.00500*		*104*	*70-130*			
Surrogate: 1,2-Dichlorobenzene-d4	*0.00525*		*mg/l*	*0.00500*		*105*	*70-130*			

De[redacted]r Analytical - Phoenix
Ji[redacted]eshelman
Project Manager

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9484 Chesapeake Dr., Suite 805, San Diego, CA 92123 (858) 505-8596 FAX (858) 505-9689
9830 South 51st St., Suite B-120, Phoenix, AZ 85044 (480) 785-0043 FAX (480) 785-0851
2520 E. Sunset Rd. #3, Las Vegas, NV 89120 (702) 798-3620 FAX (702) 798-3621

Consulting & Testing
52[illegible]. University, Suite 106
Tempe, AZ 85281
Attention: Chris Christian

Project ID: Globe / New Source Approval

Report Number: POC0297

Sampled: 03/10/05
Received: 03/10/05

METHOD BLANK/QC DATA

PURGEABLE ORGANIC COMPOUNDS BY GC/MS (EPA 524.2)

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Data Qualifiers
Batch: C5C1501 Extracted: 03/15/05										
Matrix Spike Analyzed: 03/15/2005 (C5C1501-MS1)					Source: COC0368-01					
Benzene	0.00435	0.00050	mg/l	0.00500	ND	87	60-125			
Bromodichloromethane	0.00412	0.00050	mg/l	0.00500	ND	82	70-145			
Bromoform	0.00327	0.00050	mg/l	0.00500	ND	65	55-145			
Carbon tetrachloride	0.00380	0.00050	mg/l	0.00500	ND	76	70-150			
Chlorobenzene	0.00419	0.00050	mg/l	0.00500	ND	84	65-130			
Chloroform	0.00445	0.00050	mg/l	0.00500	ND	89	55-140			
Dibromochloromethane	0.00387	0.00050	mg/l	0.00500	ND	77	65-145			
1,2-Dichlorobenzene	0.00426	0.00050	mg/l	0.00500	ND	85	65-135			
1,4-Dichlorobenzene	0.00419	0.00050	mg/l	0.00500	ND	84	65-135			
1,2-Di[illegible]roethane	0.00450	0.00050	mg/l	0.00500	ND	90	65-135			
1-[illegible]roethene	0.00418	0.00050	mg/l	0.00500	ND	84	60-135			
cis-1,2-Dichloroethene	0.00430	0.00050	mg/l	0.00500	ND	86	60-125			
trans-1,2-Dichloroethene	0.00437	0.00050	mg/l	0.00500	ND	87	60-125			
1,2-Dichloropropane	0.00428	0.00050	mg/l	0.00500	ND	86	65-120			
Ethylbenzene	0.00430	0.00050	mg/l	0.00500	ND	86	60-135			
Methylene chloride	0.00415	0.00050	mg/l	0.00500	ND	83	65-135			
Styrene	0.00402	0.00050	mg/l	0.00500	ND	80	10-150			
Tetrachloroethene	0.00434	0.00050	mg/l	0.00500	0.00067	73	65-130			
Toluene	0.00415	0.00050	mg/l	0.00500	ND	83	60-120			
1,2,4-Trichlorobenzene	0.00470	0.00050	mg/l	0.00500	ND	94	65-140			
1,1,1-Trichloroethane	0.00426	0.00050	mg/l	0.00500	ND	85	65-145			
1,1,2-Trichloroethane	0.00433	0.00050	mg/l	0.00500	ND	87	60-125			
Trichloroethene	0.00507	0.00050	mg/l	0.00500	0.00080	85	65-130			
Vinyl chloride	0.00446	0.00050	mg/l	0.00500	ND	89	60-120			
m,p-Xylenes	0.00866	0.00050	mg/l	0.0100	ND	87	60-135			
o-Xylene	0.00428	0.00050	mg/l	0.00500	ND	86	60-135			
Xylenes, Total	0.0129	0.0015	mg/l	0.0150	ND	86	60-135			
Trihalomethanes, Total	0.0157	0.00050	mg/l	0.0200	ND	78	55-150			
Surrogate: 4-Bromofluorobenzene	*0.00508*		*mg/l*	*0.00500*		*102*	*70-130*			
Surrogate: 1,2-Dichlorobenzene-d4	*0.00521*		*mg/l*	*0.00500*		*104*	*70-130*			

Del Mar Analytical - Phoenix
Jim Eshelman
Project Manager

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9830 South 51st St., Suite B-120, Phoenix, AZ 85044 (480) 785-0043 FAX (480) 785-0851
2520 E. Sunset Rd. #3, Las Vegas, NV 89120 (702) 798-3620 FAX (702) 798-3621

[redacted]atic Consulting & Testing
1525 W. University, Suite 106
Tempe, AZ 85281
Attention: Chris Christian

Project ID: Globe / New Source Approval

Report Number: POC0297

Sampled: 03/10/05
Received: 03/10/05

METHOD BLANK/QC DATA

PURGEABLE ORGANIC COMPOUNDS BY GC/MS (EPA 524.2)

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Data Qualifiers
Batch: C5C1501 Extracted: 03/15/05										
Matrix Spike Dup Analyzed: 03/15/2005 (C5C1501-MSD1)					**Source: COC0368-01**					
Benzene	0.00459	0.00050	mg/l	0.00500	ND	92	60-125	5	15	
[redacted]modichloromethane	0.00431	0.00050	mg/l	0.00500	ND	86	70-145	5	15	
Bromoform	0.00357	0.00050	mg/l	0.00500	ND	71	55-145	9	20	
Carbon tetrachloride	0.00422	0.00050	mg/l	0.00500	ND	84	70-150	10	20	
Chlorobenzene	0.00434	0.00050	mg/l	0.00500	ND	87	65-130	4	15	
Chloroform	0.00463	0.00050	mg/l	0.00500	ND	93	55-140	4	15	
Dibromochloromethane	0.00409	0.00050	mg/l	0.00500	ND	82	65-145	6	15	
1,2-Dichlorobenzene	0.00457	0.00050	mg/l	0.00500	ND	91	65-135	7	15	
1,4-[redacted]lorobenzene	0.00455	0.00050	mg/l	0.00500	ND	91	65-135	8	20	
1[redacted]roethane	0.00467	0.00050	mg/l	0.00500	ND	93	65-135	4	15	
1,1-Dichloroethene	0.00445	0.00050	mg/l	0.00500	ND	89	60-135	6	15	
cis-1,2-Dichloroethene	0.00441	0.00050	mg/l	0.00500	ND	88	60-125	3	15	
trans-1,2-Dichloroethene	0.00459	0.00050	mg/l	0.00500	ND	92	60-125	5	15	
1,2-Dichloropropane	0.00441	0.00050	mg/l	0.00500	ND	88	65-120	3	15	
Ethylbenzene	0.00453	0.00050	mg/l	0.00500	ND	91	60-135	5	15	
Methylene chloride	0.00422	0.00050	mg/l	0.00500	ND	84	65-135	2	15	
Styrene	0.00402	0.00050	mg/l	0.00500	ND	80	10-150	0	20	
Tetrachloroethene	0.00461	0.00050	mg/l	0.00500	0.00067	79	65-130	6	15	
Toluene	0.00430	0.00050	mg/l	0.00500	ND	86	60-120	4	15	
1,2,4-Trichlorobenzene	0.00522	0.00050	mg/l	0.00500	ND	104	65-140	10	20	
1,1,1-Trichloroethane	0.00456	0.00050	mg/l	0.00500	ND	91	65-145	7	15	
1,1,2-Trichloroethane	0.00446	0.00050	mg/l	0.00500	ND	89	60-125	3	15	
Trichloroethene	0.00529	0.00050	mg/l	0.00500	0.00080	90	65-130	4	15	
Vinyl chloride	0.00471	0.00050	mg/l	0.00500	ND	94	60-120	5	35	
m,p-Xylenes	0.00903	0.00050	mg/l	0.0100	ND	90	60-135	4	15	
o-Xylene	0.00449	0.00050	mg/l	0.00500	ND	90	60-135	5	15	
Xylenes, Total	0.0135	0.0015	mg/l	0.0150	ND	90	60-135	5	15	
Trihalomethanes, Total	0.0166	0.00050	mg/l	0.0200	ND	83	55-150	6	15	
Surrogate: 4-Bromofluorobenzene	*0.00507*		*mg/l*	*0.00500*		*101*	*70-130*			
Surrogate: 1,2-Dichlorobenzene-d4	*0.00522*		*mg/l*	*0.00500*		*104*	*70-130*			

[redacted]
Del Mar Analytical - Phoenix
Linda Eshelman
Project Manager

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2520 E. Sunset Rd. #3, Las Vegas, NV 89120 (702) 798-3620 FAX (702) 798-3621

A[redacted] Consulting & Testing
15[redacted]. University, Suite 106
Tempe, AZ 85281
Attention: Chris Christian

Project ID: Globe / New Source Approval

Report Number: POC0297

Sampled: 03/10/05
Received: 03/10/05

METHOD BLANK/QC DATA

EDB AND DBCP IN WATER BY GC/ECD (EPA 504.1)

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Data Qualifiers
atch: C5C1803 Extracted: 03/18/05										
lank Analyzed: 03/18/2005 (C5C1803-BLK1)										
,2-Dibromoethane (EDB)	ND	0.000010	mg/l							
,2-Dibromo-3-chloropropane	ND	0.000020	mg/l							
urrogate: 4-Bromofluorobenzene	*0.00556*		*mg/l*	*0.00500*		*111*	*65-170*			
CS Analyzed: 03/18/2005 (C5C1803-BS1)										
,2-Dibromoethane (EDB)	0.000245	0.000010	mg/l	0.000250		98	70-130			
,2-Dibromo-3-chloropropane	0.000272	0.000020	mg/l	0.000250		109	70-130			
urrogate: 4-Bromofluorobenzene	*0.00609*		*mg/l*	*0.00500*		*122*	*65-170*			
CS Dup Analyzed: 03/19/2005 (C5C1803-BSD1)										
,2-Di[redacted]moethane (EDB)	0.0000983	0.000010	mg/l	0.000100		98	70-130	0	30	
,2[redacted]o-3-chloropropane	0.000107	0.000020	mg/l	0.000100		107	70-130	2	30	
ur[redacted]te: 4-Bromofluorobenzene	*0.00577*		*mg/l*	*0.00500*		*115*	*65-170*			
latrix Spike Analyzed: 03/18/2005 (C5C1803-MS1)					**Source: COC0181-01**					
,2-Dibromoethane (EDB)	0.000251	0.000010	mg/l	0.000250	ND	100	60-130			
,2-Dibromo-3-chloropropane	0.000284	0.000020	mg/l	0.000250	ND	114	60-140			
urrogate: 4-Bromofluorobenzene	*0.00594*		*mg/l*	*0.00500*		*119*	*65-170*			

)[redacted]r Analytical - Phoenix
[redacted]Eshelman
'roject Manager

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2520 E. Sunset Rd. #3, Las Vegas, NV 89120 (702) 798-3620 FAX (702) 798-3621

[redacted] Consulting & Testing
[redacted] W. University, Suite 106
Tempe, AZ 85281
Attention: Chris Christian

Project ID: Globe / New Source Approval
Report Number: POC0297

Sampled: 03/10/05
Received: 03/10/05

METHOD BLANK/QC DATA

ORGANIC COMPOUNDS BY GC/MS (EPA 525.2)

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Data Qualifiers
Batch: C5C1405 Extracted: 03/14/05										
Blank Analyzed: 03/16/2005 (C5C1405-BLK1)										
Alachlor	ND	0.00020	mg/l							
Atrazine	ND	0.00010	mg/l							
Benzo(a)pyrene	ND	0.000020	mg/l							
Di(2-ethylhexyl)adipate	ND	0.00060	mg/l							
Di(2-ethylhexyl)phthalate	ND	0.00060	mg/l							
Hexachlorobenzene	ND	0.00010	mg/l							
Hexachlorocyclopentadiene	ND	0.00010	mg/l							
Simazine	ND	0.000070	mg/l							
Surrogate: 1,3-Dimethyl-2-nitrobenzene	*0.00496*		*mg/l*	*0.00500*		*99*	*70-130*			
Surrogate: Triphenylphosphate	*0.00550*		*mg/l*	*0.00500*		*110*	*70-130*			
Surrogate: Perylene-d12	*0.00391*		*mg/l*	*0.00500*		*78*	*70-130*			
LCS Analyzed: 03/16/2005 (C5C1405-BS1)										
Alachlor	0.00566	0.00020	mg/l	0.00500		113	70-130			
Atrazine	0.00576	0.00010	mg/l	0.00500		115	70-130			
Benzo(a)pyrene	0.00512	0.000020	mg/l	0.00500		102	70-130			
Di(2-ethylhexyl)adipate	0.0108	0.00060	mg/l	0.0100		108	70-130			
Di(2-ethylhexyl)phthalate	0.0115	0.00060	mg/l	0.0100		115	70-130			
Hexachlorobenzene	0.00489	0.00010	mg/l	0.00500		98	70-130			
Hexachlorocyclopentadiene	0.00780	0.00010	mg/l	0.0100		78	70-130			
Simazine	0.00546	0.000070	mg/l	0.00500		109	70-130			
Surrogate: 1,3-Dimethyl-2-nitrobenzene	*0.00461*		*mg/l*	*0.00500*		*92*	*70-130*			
Surrogate: Triphenylphosphate	*0.00517*		*mg/l*	*0.00500*		*103*	*70-130*			
Surrogate: Perylene-d12	*0.00480*		*mg/l*	*0.00500*		*96*	*70-130*			
LCS Dup Analyzed: 03/16/2005 (C5C1405-BSD1)										
Alachlor	0.00572	0.00020	mg/l	0.00500		114	70-130	1	30	
Atrazine	0.00578	0.00010	mg/l	0.00500		116	70-130	0	30	
Benzo(a)pyrene	0.00514	0.000020	mg/l	0.00500		103	70-130	0	30	
Di(2-ethylhexyl)adipate	0.0109	0.00060	mg/l	0.0100		109	70-130	1	30	
Di(2-ethylhexyl)phthalate	0.0118	0.00060	mg/l	0.0100		118	70-130	3	30	
Hexachlorobenzene	0.00460	0.00010	mg/l	0.00500		92	70-130	6	30	
Hexachlorocyclopentadiene	0.00786	0.00010	mg/l	0.0100		79	70-130	1	30	
Simazine	0.00542	0.000070	mg/l	0.00500		108	70-130	1	30	
Surrogate: 1,3-Dimethyl-2-nitrobenzene	*0.00480*		*mg/l*	*0.00500*		*96*	*70-130*			
Surrogate: Triphenylphosphate	*0.00563*		*mg/l*	*0.00500*		*113*	*70-130*			

Del Mar Analytical - Phoenix
[redacted] Eshelman
Project Manager

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2520 E. Sunset Rd. #3, Las Vegas, NV 89120 (702) 798-3620 FAX (702) 798-3621

[redacted] Consulting & Testing
[redacted]. University, Suite 106
Tempe, AZ 85281
Attention: Chris Christian

Project ID: Globe / New Source Approval
Report Number: POC0297

Sampled: 03/10/05
Received: 03/10/05

METHOD BLANK/QC DATA

ORGANIC COMPOUNDS BY GC/MS (EPA 525.2)

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Data Qualifiers
Batch: C5C1405 Extracted: 03/14/05										
LCS Dup Analyzed: 03/16/2005 (C5C1405-BSD1)										
Surrogate: Perylene-d12	*0.00480*		*mg/l*	*0.00500*		*96*	*70-130*			
Matrix Spike Analyzed: 03/16/2005 (C5C1405-MS1)					**Source: COC0262-01**					
Alachlor	0.00521	0.00020	mg/l	0.00483	ND	108	70-130			
Atrazine	0.00509	0.00010	mg/l	0.00483	ND	105	70-130			
Benzo(a)pyrene	0.00489	0.000020	mg/l	0.00483	ND	101	70-130			
Di(2-ethylhexyl)adipate	0.0102	0.00060	mg/l	0.00966	ND	106	70-130			
Di(2-ethylhexyl)phthalate	0.0111	0.00060	mg/l	0.00966	ND	115	70-130			
Hexachlorobenzene	0.00449	0.00010	mg/l	0.00483	ND	93	70-130			
Hexachlorocyclopentadiene	0.00808	0.00010	mg/l	0.00966	ND	84	70-130			
Sim[redacted]	0.00463	0.000070	mg/l	0.00483	ND	96	70-130			
[redacted]: 1,3-Dimethyl-2-nitrobenzene	*0.00474*		*mg/l*	*0.00483*		*98*	*70-130*			
[redacted]rogate: Triphenylphosphate	*0.00500*		*mg/l*	*0.00483*		*104*	*70-130*			
Surrogate: Perylene-d12	*0.00478*		*mg/l*	*0.00483*		*99*	*70-130*			

[redacted]ar Analytical - Phoenix
[redacted] Eshelman
Project Manager

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2520 E. Sunset Rd. #3, Las Vegas, NV 89120 (702) 798-3620 FAX (702) 798-3621

Ac[redacted] Consulting & Testing
15[redacted]v. University, Suite 106
Tempe, AZ 85281
Attention: Chris Christian

Project ID: Globe / New Source Approval
Report Number: POC0297

Sampled: 03/10/05
Received: 03/10/05

METHOD BLANK/QC DATA

CARBAMATES/CARBAMOXYLOXIME PESTICIDES BY HPLC (EPA 531.1)

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Data Qualifiers
Batch: C5C1111 Extracted: 03/11/05										
Blank Analyzed: 03/11/2005 (C5C1111-BLK1)										
Aldicarb Sulfoxide	ND	0.00050	mg/l							
Aldicarb Sulfone	ND	0.00080	mg/l							
Oxamyl	ND	0.0020	mg/l							
Methomyl	ND	0.0010	mg/l							
3-Hydroxycarbofuran	ND	0.0010	mg/l							
Aldicarb	ND	0.00050	mg/l							
Carbofuran	ND	0.00090	mg/l							
Carbaryl	ND	0.0010	mg/l							
LCS Analyzed: 03/11/2005 (C5C1111-BS1)										
Al[redacted]ulfoxide	0.0194	0.00050	mg/l	0.0200		97	80-120			
Al[redacted]Sulfone	0.0195	0.00080	mg/l	0.0200		98	80-120			
Oxamyl	0.0200	0.0020	mg/l	0.0200		100	80-120			
Methomyl	0.0197	0.0010	mg/l	0.0200		98	80-120			
3-Hydroxycarbofuran	0.0196	0.0010	mg/l	0.0200		98	80-120			
Aldicarb	0.0191	0.00050	mg/l	0.0200		96	80-120			
Carbofuran	0.0201	0.00090	mg/l	0.0200		100	80-120			
Carbaryl	0.0191	0.0010	mg/l	0.0200		96	80-120			
LCS Dup Analyzed: 03/11/2005 (C5C1111-BSD1)										
Aldicarb Sulfoxide	0.0199	0.00050	mg/l	0.0200		100	80-120	3	20	
Aldicarb Sulfone	0.0197	0.00080	mg/l	0.0200		98	80-120	0	20	
Oxamyl	0.0202	0.0020	mg/l	0.0200		101	80-120	1	20	
Methomyl	0.0198	0.0010	mg/l	0.0200		99	80-120	1	20	
3-Hydroxycarbofuran	0.0196	0.0010	mg/l	0.0200		98	80-120	0	20	
Aldicarb	0.0192	0.00050	mg/l	0.0200		96	80-120	0	20	
Carbofuran	0.0202	0.00090	mg/l	0.0200		101	80-120	1	20	
Carbaryl	0.0192	0.0010	mg/l	0.0200		96	80-120	0	20	

D[redacted]ar Analytical - Phoenix
[redacted] Eshelman
Project Manager

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9484 Chesapeake Dr., Suite 805, San Diego, CA 92123 (858) 505-8596 FAX (858) 505-9689
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A[redacted] Consulting & Testing
1[redacted]. University, Suite 106
Tempe, AZ 85281
Attention: Chris Christian

Project ID: Globe / New Source Approval

Report Number: POC0297

Sampled: 03/10/05
Received: 03/10/05

METHOD BLANK/QC DATA

CARBAMATES/CARBAMOXYLOXIME PESTICIDES BY HPLC (EPA 531.1)

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Data Qualifiers
atch: C5C1111 Extracted: 03/11/05										
latrix Spike Analyzed: 03/11/2005 (C5C1111-MS1)					**Source: COC0257-01**					
ldicarb Sulfoxide	0.0195	0.00050	mg/l	0.0200	ND	98	65-135			
ldicarb Sulfone	0.0194	0.00080	mg/l	0.0200	ND	97	65-135			
xamyl	0.0201	0.0020	mg/l	0.0200	ND	100	65-135			
lethomyl	0.0198	0.0010	mg/l	0.0200	ND	99	65-135			
-Hydroxycarbofuran	0.0193	0.0010	mg/l	0.0200	ND	97	65-135			
ldicarb	0.0196	0.00050	mg/l	0.0200	ND	98	65-135			
arbofuran	0.0202	0.00090	mg/l	0.0200	ND	101	65-135			
arbaryl	0.0191	0.0010	mg/l	0.0200	ND	96	65-135			

[redacted]r Analytical - Phoenix
[redacted] Eshelman
roject Manager

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Ag[redacted] Consulting & Testing
1[redacted]. University, Suite 106
Tempe, AZ 85281
Attention: Chris Christian

Project ID: Globe / New Source Approval
Report Number: POC0297

Sampled: 03/10/05
Received: 03/10/05

METHOD BLANK/QC DATA

ENDOTHALL (EPA 548.1)

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Data Qualifiers
Batch: C5C1503 Extracted: 03/15/05										
Blank Analyzed: 03/15/2005 (C5C1503-BLK1)										
Endothall	ND	0.0090	mg/l							
LCS Analyzed: 03/15/2005 (C5C1503-BS1)										
Endothall	0.0450	0.0090	mg/l	0.0500		90	40-130			
LCS Dup Analyzed: 03/15/2005 (C5C1503-BSD1)										
Endothall	0.0463	0.0090	mg/l	0.0500		93	40-130	3	30	
Matrix Spike Analyzed: 03/15/2005 (C5C1503-MS1)					**Source: COC0459-01**					
Endothall	0.00743	0.0090	mg/l	0.0500	ND	15	40-130			*M2*

[redacted]

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Ji[redacted]Eshelman
Project Manager

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Ag[redacted]Consulting & Testing
1[redacted]v. University, Suite 106
Tempe, AZ 85281
Attention: Chris Christian

Project ID: Globe / New Source Approval

Report Number: POC0297

Sampled: 03/10/05
Received: 03/10/05

METHOD BLANK/QC DATA

GLYPHOSATE (EPA 547)

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Data Qualifiers
Batch: C5C1611 Extracted: 03/16/05										
Blank Analyzed: 03/16/2005 (C5C1611-BLK1)										
Glyphosate	ND	0.0060	mg/l							
LCS Analyzed: 03/16/2005 (C5C1611-BS1)										
Glyphosate	0.0250	0.0060	mg/l	0.0250		100	70-130			
LCS Dup Analyzed: 03/17/2005 (C5C1611-BSD1)										
Glyphosate	0.0257	0.0060	mg/l	0.0250		103	70-130	3	30	
Matrix Spike Analyzed: 03/16/2005 (C5C1611-MS1)					**Source: COC0181-01**					
Glyphosate	0.0287	0.0060	mg/l	0.0250	ND	115	70-130			
Matrix Spike Analyzed: 03/16/2005 (C5C1611-MS2)					**Source: COC0188-01**					
Gly[redacted]e	0.0285	0.0060	mg/l	0.0250	ND	114	70-130			

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Ac[redacted] Consulting & Testing
15[redacted]. University, Suite 106
Tempe, AZ 85281
Attention: Chris Christian

Project ID: Globe / New Source Approval
Report Number: POC0297

Sampled: 03/10/05
Received: 03/10/05

METHOD BLANK/QC DATA

DIQUAT (EPA 549.2)

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Data Qualifiers
Batch: C5C1406 Extracted: 03/14/05										
Blank Analyzed: 03/14/2005 (C5C1406-BLK1)										
Diquat	ND	0.00040	mg/l							
LCS Analyzed: 03/14/2005 (C5C1406-BS1)										
Diquat	0.0377	0.00040	mg/l	0.0400		94	70-120			
LCS Dup Analyzed: 03/14/2005 (C5C1406-BSD1)										
Diquat	0.0388	0.00040	mg/l	0.0400		97	70-120	3	30	
Matrix Spike Analyzed: 03/14/2005 (C5C1406-MS1)					**Source: COC0403-01**					**M2**
Diquat	0.0178	0.00040	mg/l	0.0400	ND	44	70-120			

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[redacted]. University, Suite 106
Tempe, AZ 85281
Attention: Chris Christian

Project ID: Globe / New Source Approval

Report Number: POC0297

Sampled: 03/10/05
Received: 03/10/05

DATA QUALIFIERS AND DEFINITIONS

M2	Matrix spike recovery was low, the method control sample recovery was acceptable.
ND	Analyte NOT DETECTED at or above the reporting limit or MDL, if MDL is specified.
RPD	Relative Percent Difference

[redacted]

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Project Manager

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A[redacted] Consulting & Testing
1[redacted]. University, Suite 106
Tempe, AZ 85281
Attention: Chris Christian

Project ID: Globe / New Source Approval

Report Number: POC0297

Sampled: 03/10/05
Received: 03/10/05

Certification Summary

ubcontracted Laboratories

Aqua Tech *Arizona Cert #AZ0117*
6878 State Route #100 - Melmore, OH 44845
Analysis Performed: 508.1 AZ Extended-C
Samples: POC0297-01
Analysis Performed: 515.1 (Herbicides)
Samples: POC0297-01

Del Mar Analytical *Arizona Cert #AZ0062*
1014 E. Cooley Dr., Ste. A - Colton, CA 92324
Method Performed: EPA 504.1
Samples: POC0297-01, POC0297-02
Method Performed: EPA 524.2
Samples: POC0297-01, POC0297-02
Method Performed: EPA 525.2
Samples: POC0297-01, POC0297-02
[redacted]thod Performed: EPA 531.1
Samples: POC0297-01
Method Performed: EPA 547
Samples: POC0297-01
Method Performed: EPA 548.1
Samples: POC0297-01
Method Performed: EPA 549.2
Samples: POC0297-01

Pace Analytical
1700 Elm Street, Suite 200 - Minneapolis, MN 55414
Analysis Performed: Dioxin only (1613B)O
Samples: POC0297-01

[redacted]**r Analytical - Phoenix**
[redacted]Eshelman
roject Manager

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ATEL

Aqua Tech Environmental Laboratories, Inc.

- CERTIFICATE OF ANALYSIS -

Client #: I1089

Del Mar Analytical Labs

9830 South 51st Street

Suite B-120

Phoenix, AZ 85044-

Attn: Linda Eshelman

Report Date: *19-Apr-05*

Total Number of Pages: 2

Phone: (480) 785-0043 **Ext:**

FAX: (480) 785-0851

Our Lab#: MEL05-01442 **Your Sample ID:** POC0297-01

Date Logged In: 3/15/05 **Sample Source:** SDWA/WTP's

Sample Type: Water **Client Project #:**

Project #: **Date Submitted to Lab:** 3/11/2005 **PO#:** POC0297

- COLLECTION INFORMATION -

Date/Time/By: 3/10/2005 8:37 AM

EPA Method **Analyst** **Prep Date** **Analysis Date**

CAS Number	Parameter	Result	Report Limit
Sample subcontracted - results attached.			
309-00-2	Aldrin	ug/l	
58-89-9	gamma-BHC (Lindane)	ug/l	
57-74-9	Chlordane(Total)	ug/l	
60-57-1	Dieldrin	ug/l	
72-20-8	Endrin	ug/l	
76-44-8	Heptachlor	ug/l	
1024-57-3	Heptachlor epoxide	ug/l	
118-74-1	Hexachlorobenzene	ug/l	
77-47-4	Hexachlorocyclopentadiene	ug/l	
72-43-5	Methoxychlor	ug/l	
1918-16-7	Propachlor	ug/l	
8001-35-2	Toxaphene	ug/l	
12674-11-2	Aroclor 1016	ug/l	
11104-28-2	Aroclor 1221	ug/l	
11141-16-5	Aroclor 1232	ug/l	
53469-21-9	Aroclor 1242	ug/l	
12672-29-6	Aroclor 1248	ug/l	
11097-69-1	Aroclor 1254	ug/l	
11096-82-5	Aroclor 1260	ug/l	

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ATEL

Aqua Tech Environmental Laboratories, Inc.

- CERTIFICATE OF ANALYSIS -

EPA Method	Analyst	Prep Date	Analysis Date
515.1	AFK	3/17/2005	3/21/2005

CAS Number	Parameter	Result	Report Limit
75-99-0	Dalapon	< 1.0 ug/l	1.0
1918-00-9	Dicamba	< 0.50 ug/l	0.50
94-75-7	2,4-Dichlorophenoxyacetic acid (2,4-D)	< 0.10 ug/l	0.10
88-85-7	Dinoseb	< 0.20 ug/l	0.20
87-86-5	Pentachlorophenol	< 0.04 ug/l	0.04
1918-02-1	Picloram	< 0.10 ug/l	0.10
93-72-1	Silvex	< 0.20 ug/l	0.20

--- Surrogate Recoveries ---

QC Lab#	EPA Method	Surrogate Name	Percent Recovery	Lower Limit	Upper Limit
MEL05-01442	515.1	DCAA (Surr)	94 %R	70	130

End of Report

Report Approved By: Todd M. Brown

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ATEL

Aqua Tech Environmental Laboratories, Inc.

Del Mar Analytical Labs

Batch Quality Control Data (page 1 of 1)

EPA Method: 515.1

Analysis Date: 03/21/2005

Sample(s): MEL05-01442

Compounds	LRB µg/L	LFB % Recovery	LFM % Recovery	Acceptance Criteria LFB	Acceptance Criteria LFM
Dalapon-Me	< R.L.	91	82	70-130	65-135
Dicamba-Me	< R.L.	99	87	70-130	65-135
2,4-D-Me	< R.L.	103	89	70-130	65-135
Pentachlorophenol-Me	< R.L.	109	99	70-130	65-135
2,4,5-TP-Me (Silvex)	< R.L.	103	93	70-130	65-135
Dinoseb-Me	< R.L.	91	[M2]58	70-130	65-135
Picloram-Me	< R.L.	90	95	70-130	65-135

Surrogate Data	LRB % Recovery	LFB % Recovery	LFM % Recovery	Acceptance Criteria
DCAA-Me	96	92	91	70-130

LRB = Laboratory Reagent Blank
LFB = Laboratory Fortified Blank
LFM = Laboratory Fortified Matrix
R.L. = Reporting Limit

Note: Matrix spike was performed on sample MEL05-01442

M2 = Matrix spike recovery was low, the method control sample recovery was acceptable

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Del Mar Analytical

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1014 E. Cooley Dr., Suite A, Colton, CA 92324 Ph (909) 370-4667 Fax (909) 370-1046
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SUBCONTRACT ORDER - PROJECT # POC0297

SENDING LABORATORY:

Del Mar Analytical - Phoenix
9830 South 51st Street, Suite B-120
Phoenix, AZ 85044
Phone: (480) 785-0043
Fax: (480) 785-0851
Project Manager: Linda Eshelman

RECEIVING LABORATORY:

Aqua Tech (ATEL)
6878 State Route #100
Melmore, OH 44845
Phone :(800) 858-8869
Fax: (419) 397-2229

Standard TAT is requested unless specific due date is requested => Due Date:_____ Initials:_____

Analysis	Expiration	Comments
Sample ID: POC0297-01 Water	**Sampled: 03/10/05 08:37**	**True Drinkin Water/Need DWAR 9**
508.1 AZ Extended-C	03/17/05 08:37	ATEL AB
515.1 (Herbicides)-O	03/24/05 08:37	ATEL CD

Containers Supplied:

01442

1 L NM Amber w/Na2S2O3 (POC0297-01C)
1 L NM Amber w/Na2S2O3 (POC0297-01D)
1 L NM Amber w/Na2S2O3 (POC0297-01F)
1 L NM Amber w/Na2S2O3 (POC0297-01G)

508 subbed to EHL

SAMPLE INTEGRITY:

All containers intact: ☑ Yes ☐ No Sample labels/COC agree: ☑ Yes ☐ No Samples Received On Ice:: ☑ Yes ☐ No
Custody Seals Present: ☐ Yes ☐ No Samples Preserved Properly: ☐ Yes ☐ No Samples Received at (temp): 2

Released By	Date	Time	Received By	Date	Time
m Kelly	31005	17:00	[illegible]	3.10.05	17:00
			S. Roach	3-11-05	11:00
Released By	Date	Time	Received By	Date	Time

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www.ul.com/water
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fax: 1 574 233 8207
Customer Service: 1 800 332 4345

LABORATORY REPORT

Client: Aqua Tech Environmental Laboratories
Attn: Todd Brown
6878 SR 100
Melmore, OH 44845

Report: 144521

Priority: Standard Written

Status: Final

ID Number: AZ0432

Sampling Point: MEL05-01442

Samples Submitted: Two drinking water samples

Copies to: None

----------Collected----------
Date: 03/10/05 Time: 08:45 By: Client

----------Received----------
Date: 03/15/05 Time: 09:30

REPORT SUMMARY

[redacted]e of the analytes included in the detailed parameter list were detected in the sample submitted for analysis.

Note: The sample submitted for Method 525.2 analysis was received improperly preserved as demonstrated by the pH(7). The sample was preserved by EHL personnel prior to analysis.

Note: Sample containers were provided by the client.

Detailed quantitative results are presented on the following page.

We appreciate the opportunity to provide you with this analysis. If you have any questions concerning this report, please do not hesitate to call us at (574) 233-4777.

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Reviewed By: Steve Dungy Reporter Date: 4/4/05

[redacted]

Finalized By: [signature] Date: 4-12-05

Client: Aqua Tech Environmental Laboratories

Report: 144521

Sampling Point: MEL05-01442

ID Number: AZ0432

[redacted]AMETER	SDWA Method	Trigger / MRL* (mg/L)	Results (mg/L)	MCL (mg/L)	Extraction Date	Analysis Date	Lab Number	Data Qualifiers
Alachlor (Lasso)	525.2	0.0002	< 0.0002	0.002	03/18/05	03/24/05	1203106	
Aldicarb				postponed				
Aldicarb Sulfone				postponed				
Aldicarb Sulfoxide				postponed				
Aldrin	525.2	0.0001	< 0.0001	---	03/18/05	03/24/05	1203106	
Aroclor 1016	505	0.00008	< 0.00008	£	03/16/05	03/17/05	1203107	
Aroclor 1221	505	0.02	< 0.02	£	03/16/05	03/17/05	1203107	
Aroclor 1232	505	0.0005	< 0.0005	£	03/16/05	03/17/05	1203107	
Aroclor 1242	505	0.0003	< 0.0003	£	03/16/05	03/17/05	1203107	
Aroclor 1248	505	0.0001	< 0.0001	£	03/16/05	03/17/05	1203107	
Aroclor 1254	505	0.0001	< 0.0001	£	03/16/05	03/17/05	1203107	
Aroclor 1260	505	0.0002	< 0.0002	£	03/16/05	03/17/05	1203107	
Atrazine	525.2	0.0001	< 0.0001	0.003	03/18/05	03/24/05	1203106	
Benzo(a)pyrene	525.2	0.00002	< 0.00002	0.0002	03/18/05	03/24/05	1203106	
Butachlor	525.2	0.0001	< 0.0001	---	03/18/05	03/24/05	1203106	
Carbaryl				---				
Carbofuran				0.04				
Chlordane	505	0.0002	< 0.0002	0.002	03/16/05	03/17/05	1203107	
2,4-D				0.07				
Dalapon				0.2				
1,2-Dibromo-3-chloropropane				0.0002				
Dicamba				---				
Dieldrin	525.2	0.0001	< 0.0001	---	03/18/05	03/24/05	1203106	
Di(2-ethylhexyl)adipate	525.2	0.0006	< 0.0006	0.4	03/18/05	03/24/05	1203106	
[redacted]2-ethylhexyl)phthalate	525.2	0.0006	< 0.0006	0.006	03/18/05	03/24/05	1203106	
[redacted]inoseb				0.007				
Diquat				0.02				
Endothall				0.1				
Endrin	525.2	0.00001	< 0.00001	0.002	03/18/05	03/24/05	1203106	
Ethylene dibromide (EDB)				0.00005				
Glyphosate (Round-up)				0.7				
Heptachlor	525.2	0.00004	< 0.00004	0.0004	03/18/05	03/24/05	1203106	
Heptachlor epoxide	525.2	0.00002	< 0.00002	0.0002	03/18/05	03/24/05	1203106	
Hexachlorobenzene	525.2	0.0001	< 0.0001	0.001	03/18/05	03/24/05	1203106	
Hexachlorocyclopentadiene	525.2	0.0001	< 0.0001	0.05	03/18/05	03/24/05	1203106	
3-Hydroxycarbofuran				---				
Lindane (gamma-BHC)	525.2	0.00002	< 0.00002	0.0002	03/18/05	03/24/05	1203106	
Methoxychlor	525.2	0.0001	< 0.0001	0.04	03/18/05	03/24/05	1203106	
Methomyl				---				
Metolachlor (Dual)	525.2	0.0001	< 0.0001	---	03/18/05	03/24/05	1203106	
Metribuzin (Sencor)	525.2	0.0001	< 0.0001	---	03/18/05	03/24/05	1203106	
Oxamyl (Vydate)				0.2				
Pentachlorophenol				0.001				
Picloram (Tordon)				0.5				
Propachlor	525.2	0.0001	< 0.0001	---	03/18/05	03/24/05	1203106	
2,4,5-TP (Silvex)				0.05				
Simazine	525.2	0.00007	< 0.00007	0.004	03/18/05	03/24/05	1203106	
2,3,7,8-TCDD (Dioxin)				3e-08				
Toxaphene	505	0.001	< 0.001	0.003	03/16/05	03/17/05	1203107	

[redacted]

* EHL has demonstrated it can achieve these report limits in reagent water, but can not document them in all sample matrices.

£ Any positive Aroclor result would require analysis for total PCB as decachlorobiphenyl by method 508A (MCL = 0.0005 mg/L).

Environmental Health Laboratories
Continuing Calibration Check

[redacted]ple Matrix: OS
[redacted]quisition File: Not Available
Data Directory: 032405a
Today's Date: 04/23/2005
Instrument: GC/MS - BV
Extracted Date: Not Available
Sample Number: 1208906
State of Origin: Not Available
Project QC: Standard

Method: 525.2
Calibration File: 525 2-bv-c1 2-012805.mth
Analysis Date: 03/24/2005
Analysis Time: 18:49
Analyst: clear
Results Submitted By: clear
Run Number: 75079

Sample Quality Control

Internal Standards Parameter	CCC Area	CCC Area	CCC % Resp	CCC Area Limits Lwr	CCC Area Limits Upr	CCC Pass / Fail	IC Avg Area	IC % Resp	IC Area Limits Lwr	IC Area Limits Upr	IC Pass / Fail
IS-Chrysene-d12	322518	322518	100	70	130	PASS	500274	64	50	150	PASS
IS-Phenanthrene-d10	486585	486585	100	70	130	PASS	774622	63	50	150	PASS
IS-Pyrene-d10	422362	422362	100	70	130	PASS	572620	74	50	150	PASS

Surrogate Standards Parameter	Amount	Units	Target	%Rec	Limits Lower	Limits Upper	Pass/Fail
SS-2,4,5,6-Tetrachloro-m-xylene	4.584	ug/L	5.0	92	70	130	PASS
SS-4,4'-Dichlorobiphenyl	5.111	ug/L	5.0	102	70	130	PASS
SS-Triphenylphosphate	5.453	ug/L	5.0	109	70	130	PASS

Ordered Parameter Results

Parameter	Amount	Units	Target	%Rec	Limits Lower	Limits Upper	Pass/Fail
Alachlor	1.866	ug/L	2.0	93	70	130	PASS
Aldrin	2.099	ug/L	2.0	105	70	130	PASS
Atrazine	2.088	ug/L	2.0	104	70	130	PASS
Benzo[a]pyrene	1.94	ug/L	2.0	97	70	130	PASS
Butachlor	2.028	ug/L	2.0	101	70	130	PASS
Di(2-ethylhexyl)adipate	2.238	ug/L	2.0	112	70	130	PASS
Di(2-ethylhexyl)phthalate	2.327	ug/L	2.0	116	70	130	PASS
Dieldrin	1.982	ug/L	2.0	99	70	130	PASS
Endrin	2.054	ug/L	2.0	103	70	130	PASS
gamma-BHC (Lindane)	1.782	ug/L	2.0	89	70	130	PASS
Heptachlor	1.852	ug/L	2.0	93	70	130	PASS
Heptachlor epoxide	1.839	ug/L	2.0	92	70	130	PASS
Hexachlorobenzene	1.77	ug/L	2.0	88	70	130	PASS
Hexachlorocyclopentadiene	1.465	ug/L	2.0	73	70	130	PASS
Methoxychlor	1.879	ug/L	2.0	94	70	130	PASS
Metolachlor	2.011	ug/L	2.0	101	70	130	PASS
Metribuzin	2.056	ug/L	2.0	103	70	130	PASS
Propachlor	2.008	ug/L	2.0	100	70	130	PASS
Simazine	1.998	ug/L	2.0	100	70	130	PASS

Environmental Health Laboratories
Sample Result Record Sheet

[redacted]ple Matrix: DW
[redacted]quisition File: Not Available
Data Directory: 032405a
Instrument: GC/MS - BV
Extracted Date: 03/18/2005 09:00
Sample Number: 1203106
Dilution Factor: 1.0100
Sample Site: MEL05-01442
Sample Location: Not Available

Method: 525.2
Calibration File: 525 2-bv-c1 2-012805.mth
Analysis Date: 03/24/2005
Analysis Time: 21:33
Analyst: clear
Results Submitted By: clear
Run Number: 75079
State of Origin: Arizona
Project QC: State Compliance

Sample Quality Control

Internal Standards Parameter	CCC Area	CCC % Resp	CCC Area Limits Lwr	CCC Area Limits Upr	CCC Pass / Fail	IC Avg Area	IC % Resp	IC Area Limits Lwr	IC Area Limits Upr	IC Pass / Fail
[redacted]-Chrysene-d12	252920	322518	78	70	130	PASS	Not Found	N/A	N/A	N/A	N/A
IS-Phenanthrene-d10	421752	486585	87	70	130	PASS	Not Found	N/A	N/A	N/A	N/A
IS-Pyrene-d10	356646	422362	84	70	130	PASS	Not Found	N/A	N/A	N/A	N/A

Surrogate Standards Parameter	Amount	Units	Target	%Rec	Limits Lower	Limits Upper	Pass/Fail
SS-2,4,5,6-Tetrachloro-m-xylene	4.304	ug/L	5.0	85	70	130	PASS
SS-4,4'-Dichlorobiphenyl	5.216	ug/L	5.0	103	70	130	PASS
SS-Triphenylphosphate	6.72	ug/L	5.0	133	70	130	*FAIL*

Ordered Parameter Results

Parameter	Amount	MRL	Units	MCL	SMCL
Alachlor	< 0.2	0.2	ug/L	2.0	
Aldrin	< 0.1	0.1	ug/L		
Atrazine	< 0.1	0.1	ug/L	3.0	
Benzo[a]pyrene	< 0.02	0.02	ug/L	0.2	
Butachlor	< 0.1	0.1	ug/L		
Di(2-ethylhexyl)adipate	< 0.6	0.6	ug/L	400	
Di(2-ethylhexyl)phthalate	< 0.6	0.6	ug/L	6.0	
Dieldrin	< 0.1	0.1	ug/L		
Endrin	< 0.01	0.01	ug/L	2.0	
gamma-BHC (Lindane)	< 0.02	0.02	ug/L	0.2	
Heptachlor	< 0.04	0.04	ug/L	0.4	
Heptachlor epoxide-	< 0.02	0.02	ug/L	0.2	
Hexachlorobenzene	< 0.1	0.1	ug/L	1.0	
Hexachlorocyclopentadiene	< 0.1	0.1	ug/L	50	
Methoxychlor	< 0.1	0.1	ug/L	40	
Metolachlor	< 0.1	0.1	ug/L		
Metribuzin	< 0.1	0.1	ug/L		
Propachlor	< 0.1	0.1	ug/L		
Simazine	< 0.07	0.07	ug/L	4.0	

Additional Found Parameters

[redacted]arameter	Amount	MRL	Units	MCL	SMCL

'mbol * in the Amount column above indicates that the sample was re-analyzed for that parameter and the results are presented
ther page.

Environmental Health Laboratories
Run Log

Run Id: **74817** Method: **525.2** Analyst: **clear**

Type	Sample Id	File Name	Sample Site	Matrix	Analysis Date	Analysis Time
LMB	1205679	MB-525A	Not Available	RW	03/18/2005	20:39

Environmental Health Laboratories
Laboratory Method Blank

Sa[redacted]Matrix: RW
[redacted]ion File: Not Available
Data Directory: 031805a
Instrument: GC/MS - BV
Extracted Date: 03/18/2005 09:00
Sample Number: 1205679
Dilution Factor: 0.9690
Sample Site: Not Available
Sample Location: Not Available

Method: 525.2
Calibration File: 525 2-bv-c1 2-012805.mth
Analysis Date: 03/18/2005
Analysis Time: 20:39
Analyst: clear
Results Submitted By: clear
Run Number: 74817
State of Origin: Not Available
Project QC: Standard

Sample Quality Control

Internal Standards Parameter	CCC Area	CCC Area	% Resp	Area Limits Lwr	Area Limits Upr	Pass / Fail	IC Avg Area	% Resp	Area Limits Lwr	Area Limits Upr	Pass / Fail
	---------- CCC ----------						---------- IC ----------				
IS-Chrysene-d12	432197	424650	102	70	130	PASS	Not Found	N/A	N/A	N/A	N/A
IS-Phenanthrene-d10	708265	704892	100	70	130	PASS	Not Found	N/A	N/A	N/A	N/A
IS-Pyrene-d10	675887	629999	107	70	130	PASS	Not Found	N/A	N/A	N/A	N/A

Surrogate Standards Parameter	Amount	Units	Target	%Rec	Limits Lower	Limits Upper	Pass/Fail
SS-2,4,5,6-Tetrachloro-m-xylene	4.141	ug/L	5.0	85	70	130	PASS
SS-4,4'-Dichlorobiphenyl	4.935	ug/L	5.0	102	70	130	PASS
SS-Triphenylphosphate	5.828	ug/L	5.0	120	70	130	PASS

Ordered Parameter Results

Parameter	Amount	MRL	Units	MCL	SMCL
Alachlor	< 0.1	0.1	ug/L	2.0	
Aldrin	< 0.1	0.1	ug/L		
Atrazine	< 0.1	0.1	ug/L	3.0	
Benzo[a]pyrene	< 0.02	0.02	ug/L	0.2	
Butachlor	< 0.1	0.1	ug/L		
Di(2-ethylhexyl)adipate	< 0.6	0.6	ug/L	400	
Di(2-ethylhexyl)phthalate	< 0.6	0.6	ug/L	6.0	
Dieldrin	< 0.1	0.1	ug/L		
Endrin	< 0.01	0.01	ug/L	2.0	
gamma-BHC (Lindane)	< 0.02	0.02	ug/L	0.2	
Heptachlor	< 0.04	0.04	ug/L	0.4	
Heptachlor epoxide	< 0.02	0.02	ug/L	0.2	
Hexachlorobenzene	< 0.1	0.1	ug/L	1.0	
Hexachlorocyclopentadiene	< 0.1	0.1	ug/L	50	
Methoxychlor	< 0.1	0.1	ug/L	40	
Metolachlor	< 0.1	0.1	ug/L		
Metribuzin	< 0.1	0.1	ug/L		
Propachlor	< 0.1	0.1	ug/L		
Simazine	< 0.07	0.07	ug/L	4.0	

Additional Found Parameters

Pa[redacted]ter	Amount	MRL	Units	MCL	SMCL

The symbol * in the Amount column above indicates that the sample was re-analyzed for that parameter and the results are presented on another page.

Environmental Health Laboratories
Run Log

Run Id: **74962** Method: **525.2** Analyst: **clear**

Type	Sample Id	File Name	Sample Site	Matrix	Analysis Date	Analysis Time
LFB	1205680	FB-525A	Not Available	RW	03/22/2005	18:04

Environmental Health Laboratories
Laboratory Fortified Blank

Sample Matrix: RW
Acquisition File: Not Available
Data Directory: 032205A
Today's Date: 04/23/2005
Instrument: GC/MS - BV
Extracted Date: 03/18/2005 09:00
Sample Number: 1205680
State of Origin: Not Available
Project QC: Standard

Method: 525.2
Calibration File: 525 2-bv-c1 2-012805.mth
Analysis Date: 03/22/2005
Analysis Time: 18:04
Analyst: clear
Results Submitted By: clear
Run Number: 74962

Sample Quality Control

Internal Standards Parameter	Area	CCC Area	CCC % Resp	CCC Area Limits Lwr	CCC Area Limits Upr	CCC Pass / Fail	IC Avg Area	IC % Resp	IC Area Limits Lwr	IC Area Limits Upr	IC Pass / Fail
IS-Chrysene-d12	455888	511336	89	70	130	PASS	Not Found	N/A	N/A	N/A	N/A
IS-Phenanthrene-d10	651849	754219	86	70	130	PASS	Not Found	N/A	N/A	N/A	N/A
IS-Pyrene-d10	694316	651008	107	70	130	PASS	Not Found	N/A	N/A	N/A	N/A

Surrogate Standards Parameter	Amount	Units	Target	%Rec	Limits Lower	Limits Upper	Pass/Fail
SS-2,4,5,6-Tetrachloro-m-xylene	4.345	ug/L	5.0	87	70	130	PASS
SS-4,4'-Dichlorobiphenyl	5.121	ug/L	5.0	102	70	130	PASS
SS-Triphenylphosphate	5.556	ug/L	5.0	111	70	130	PASS

Ordered Parameter Results

Parameter	Amount	Units	Target	%Rec	Limits Lower	Limits Upper	Pass/Fail
Alachlor	2.113	ug/L	2.0	106	70	130	PASS
Aldrin	2.465	ug/L	2.0	123	70	130	PASS
Atrazine	2.277	ug/L	2.0	114	70	130	PASS
Benzo[a]pyrene	1.87	ug/L	2.0	94	70	130	PASS
Butachlor	2.531	ug/L	2.0	127	70	130	PASS
Di(2-ethylhexyl)adipate	2.229	ug/L	2.0	111	70	130	PASS
Di(2-ethylhexyl)phthalate	2.713	ug/L	2.0	136	70	130	*FAIL*
Dieldrin	2.265	ug/L	2.0	113	70	130	PASS
Endrin	2.475	ug/L	2.0	124	70	130	PASS
gamma-BHC (Lindane)	1.935	ug/L	2.0	97	70	130	PASS
Heptachlor	2.086	ug/L	2.0	104	70	130	PASS
Heptachlor epoxide	1.977	ug/L	2.0	99	70	130	PASS
Hexachlorobenzene	1.859	ug/L	2.0	93	70	130	PASS
Hexachlorocyclopentadiene	1.593	ug/L	2.0	80	70	130	PASS
Methoxychlor	2.155	ug/L	2.0	108	70	130	PASS
Metolachlor	2.125	ug/L	2.0	106	70	130	PASS
Metribuzin	1.981	ug/L	2.0	99	70	130	PASS
Propachlor	2.097	ug/L	2.0	105	70	130	PASS
Simazine	2.136	ug/L	2.0	107	70	130	PASS

CHAIN-OF-CUSTODY

110048

ATEL

Aqua Tech Environmental Laboratories, Inc.

Client Name:	
Project Name:	
Project No:	
Sampler:	

Sample ID	Date	Time					
MEL05-01442	3-10	0845				2 Qt	508 (AZ)
		pubottles SS31505				(1)	525 1203106
						(1)	505 1203107
							SS31505

CLIENT PROVIDED SAMPLE CONTAINER

SEND RESULTS TO:

Person: Todd Brown

Company: Aqua Tech Env. Labs

Street: 6878 S. S.R 100

City: Melmore State: OH Zip: 44845

Phone: 419-397-2659 Fax: 419-397-2229

ATEL Quote #: _____ Company PO #: _____

Relinquished by: S. Roach	**Date/Time** 3-14-05	**Received by:**	**Date/Time**
Relinquished by:	**Date/Time**	**Received by:**	**Date/Time**
Relinquished by:	**Date/Time**	**Received at Laboratory by:** Pmuff	**Date/Time** 3105 930/1110
Comments: sub to EHL		**Method of Shipment**	
		Cooler Temperature 3.6 °C	

Canton: 5300 Fulton Drive NW, Canton, Ohio 44718, 800-635-3222 fax 330-494-2961

Marion: 1776 Marion-Waldo Rd., Marion, Ohio 43302, 800-873-2835 fax 740-389-1481

Sanford: 936 N Horner Boulevard, Sanford, North Carolina 27330, 800-522-2832 fax 919-774-7068

Tucson: 2700 E Bilby Rd. Bldg. A, Tucson, Arizona 85706, 800-879-2835 fax 520-573-6550

Melmore: 6878 S State Rt. 100, Melmore, Ohio 44845, 800-858-8869 fax 419-397-2229

If you fail to fill out this form completely, it may effect the legal defensibility of your data.

Pace Analytical™

www.pacelabs.com

Report Prepared for:

Linda Eshelman
Del Mar Analytical
9830 South 51st Street
Phoenix AZ 85044

Report Information:

Pace Project #: 109001
Sample Receipt Date: Mar 11, 2005
Client Project #:
Client Sub PO #:
State Certification: AZ0014

REPORT OF LABORATORY ANALYSIS FOR 2,3,7,8-TCDD

This report has been reviewed and prepared by:

Holly Peepers

Ms. Holly Peepers, Project Manager
(612) 607-6407
(612) 607-6444 (fax)
holly.peepers@pacelabs.com

Report Summary:

This report contains results of one drinking water sample analyzed to determine 2,3,7,8-TCDD content. This sample was analyzed according to Method 1613 by High Resolution Gas Chromatography/High Resolution Mass Spectrometry.

Invoicing & Reporting Options:

The report provided has been invoiced as a Level 2 Drinking Water Report. If an upgrade of this report package is requested, an additional charge may be applied.

Please review the attached invoice for accuracy and forward any questions to Ms. Holly Peepers, your Pace Project Manager.

Report Prepared Date:

March 25, 2005

ACCREDITED IN ACCORDANCE WITH nelac

Report of Laboratory Analysis

This report should not be reproduced, except in full,
without the written consent of Pace Analytical Services, Inc.

Del Mar Analytical

17461 Derian Ave. Suite 100, Irvine, CA 92614 Ph (949) 261-1022 Fax (949) 261-1228
1014 E. Cooley Dr., Suite A, Colton, CA 92324 Ph (909) 370-4667 Fax (909) 370-1046
9484 Chesapeake Drive, Suite 805, San Diego, CA 92123 Ph (619) 505-9596 Fax (619) 505-9689
9830 South 51st Street, Suite B-120, Phoenix, AZ 85044 Ph (480) 785-0043 Fax (480) 785-0851
2520 E. Sunset Rd., Suite #3, Las Vegas, NV 89120 Ph (702) 798-3620 Fax (702) 798-3621

SUBCONTRACT ORDER - PROJECT # POC0297

SENDING LABORATORY:
Del Mar Analytical - Phoenix
9830 South 51st Street, Suite B-120
Phoenix, AZ 85044
Phone: (480) 785-0043
Fax: (480) 785-0851
Project Manager: Linda Eshelman

RECEIVING LABORATORY:
Pace Analytical
1700 Elm Street, Suite 200
Minneapolis, MN 55414
Phone :612-607-1700
Fax: 612-607-6444

109001

Standard TAT is requested unless specific due date is requested => Due Date:_____ Initials:_____

Analysis	Expiration	Comments
Sample ID: POC0297-01 Water	**Sampled: 03/10/05 08:37**	**True Drinkin Water/Need DWAR 9** 001
Dioxin only (1613B)O	03/10/06 08:37	No Dup

Containers Supplied:
1 L Amber (POC0297-01E)

SAMPLE INTEGRITY:

All containers intact: ☒ Yes ☐ No
Custody Seals Present: ☐ Yes ☒ No
Sample labels/COC agree: ☒ Yes ☐ No
Samples Preserved Properly: ☒ Yes ☐ No
Samples Received On Ice:: ☒ Yes ☐ No
Samples Received at (temp): 2°C

Released By	Date	Time	Received By	Date	Time
[illegible]	3.10.05	17:00	DHL	3/10/05	17:00
DHL			[illegible]	3/11/05	1015

Page 1 of 1

Pace Analytical Services, Inc.
1700 Elm Street - Suite 200
Minneapolis, MN 55414

Tel: 612-607-1700
Fax: 612-607-6444

Drinking Water Analysis Results
2,3,7,8-TCDD -- USEPA Method 1613B

Sample ID.....POC0297-01
Client.....Del Mar Analytical
Lab Sample ID.....109001001

Date Collected.....03/10/2005
Date Received.....03/11/2005
Date Extracted.....03/16/2005

	Sample 109001001	Method Blank	Lab Spike	Lab Spike Dup
[2,3,7,8-TCDD]	**ND**	ND	--	--
PRL	5 pg/L	5 pg/L	--	--
2,3,7,8-TCDD Recovery	--	--	104%	108%
Spike Recovery Limit	--	--	73-146%	73-146%
RPD			3.1%	
[illegible]Recovery	**72%**	77%	74%	71%
IS Recovery Limits	31-137%	31-137%	25-141%	25-141%
CS Recovery	**77%**	79%	71%	73%
CS Recovery Limits	42-164%	42-164%	37-158%	37-158%
Filename	A50322H_2	A50321I_3	A50321I_1	A50321I_2
Analysis Date	03/22/2005	03/21/2005	03/21/2005	03/21/2005
Analysis Time	23:07	22:29	21:24	21:56
Analyst	BAL	BAL	BAL	BAL
Volume	1.024L	1.026L	0.973L	1.015L
Dilution	NA	NA	NA	NA
CCAL Filename	A50322G_2	A50321G_2	A50321G_2	A50321G_2

!	= Outside the Control Limits
ND	= Not Detected
PRL	= Pace Reporting Limit
Limits	= Control Limits from Method 1613 (10/94 Revision), Tables 6A and 7A
RPD	= Relative Percent Difference of Lab Spike Recoveries
	= Internal Standard [2,3,7,8-TCDD-$^{13}C_{12}$]
	= Cleanup Standard [2,3,7,8-TCDD-$^{37}Cl_4$]

Project No.....109001

Del Mar Analytical

17461 Derian Ave. Suite 100, Irvine, CA 92614 Ph (949) 261-1022 Fax (949) 261-1228
1014 E. Cooley Dr., Suite A, Colton, CA 92324 Ph (909) 370-4667 Fax (909) 370-1046
9484 Chesapeake Drive, Suite 805, San Diego, CA 92123 Ph (619) 505-9596 Fax (619) 505-9689
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2520 E. Sunset Rd., Suite #3, Las Vegas, NV 89120 Ph (702) 798-3620 Fax (702) 798-3621

SUBCONTRACT ORDER - PROJECT # POC0297

SENDING LABORATORY:

Del Mar Analytical - Phoenix
9830 South 51st Street, Suite B-120
Phoenix, AZ 85044
Phone: (480) 785-0043
Fax: (480) 785-0851
Project Manager: Linda Eshelman

RECEIVING LABORATORY:

Del Mar Analytical - Colton
1014 E. Cooley Dr., Ste. A
Colton, CA 92324
Phone :(909) 370-4667
Fax: (909) 370-1046

COC0446

Analysis	Expiration	Due	Comments
Sample ID: POC0297-01 Water	**Sampled: 03/10/05 08:37**		**True Drinkin Water/Need DWAR 9**
504.1 AZ EDB, DBCP-C	03/24/05 08:37	03/24/05 15:00	
524.2 (Organics)	03/24/05 08:37	03/24/05 15:00	True Drinking Water!!!
525.2 AZ Extended-C	03/24/05 08:37	03/24/05 15:00	
531.1 AZ Carbamates-C	03/17/05 08:37	03/24/05 15:00	
547 AZ Glyphosate-C	03/24/05 08:37	03/24/05 15:00	
548.1 AZ Endothall-C	03/17/05 08:37	03/24/05 15:00	250 ml Ambers preserved with sodium thiosulfate
549.2 AZ Diquat/Paraquat-C	03/17/05 08:37	03/24/05 15:00	

Containers Supplied:

1 L NM Amber w/Na2SO3+HCL (POC0297-01A)
1 L NM Amber w/Na2SO3+HCL (POC0297-01B)
[illegible]0 ml Amber (POC0297-01H)
[illegible] ml Amber (POC0297-01I)
[illegible]L Brown Poly w/H2SO4+Na2SO3 (POC0297-01J)
40 ml VOA w/C6H8O6+HCL (POC0297-01K)
40 ml VOA w/C6H8O6+HCL (POC0297-01L)
40 ml VOA w/C6H8O6+HCL (POC0297-01M)
60 ml VOA w/Na2S2O3+MCAA (POC0297-01N)
60 ml VOA w/Na2S2O3+MCAA (POC0297-01O)
40 ml VOA w/Na2S2O3 (POC0297-01P)
40 ml VOA w/Na2S2O3 (POC0297-01Q)
40 ml VOA w/Na2S2O3 (POC0297-01R)
40 ml VOA w/Na2S2O3 (POC0297-01S)
40 ml VOA w/Na2S2O3 (POC0297-01T)

Sample ID: POC0297-02 Water	**Sampled: 03/10/05 08:37**		**True Drinkin Water/Need DWAR 9**
504.1 (EDB, DBCP, TCP)-C	03/24/05 08:37	03/24/05 15:00	
524.2 (Organics)	03/24/05 08:37	03/24/05 15:00	True Drinking Water!!!
525.2 AZ Extended-C	03/24/05 08:37	03/24/05 15:00	

Containers Supplied:

1 L NM Amber w/Na2SO3+HCL (POC0297-02A)
40 ml VOA w/C6H8O6+HCL (POC0297-02B)
40 ml VOA w/Na2S2O3 (POC0297-02C)

[illegible]eased By	3/10/05	17:00	DHL Received By	3.10.05	17:00
Released By	Date	Time	Received By	Date	Time
Released By	Date	Time	Received By	3/11/05	10:00
				Date	Time

Aquatic Consulting & Testing
1525 W. University Dr.
Suite 106
Tempe, AZ 85281
ATTN: Chris Christian
Phone (480) 921-8044 Fax (480) 921-0049
E-Mail Address: cchristian@aquaticconsulting.com

LAB I.D. NUMBER: P0C0397

Subcontract Chain of Custody

DATE: 10-Mar-05 PAGE 1 OF 1

Subcontract Laboratory:
Del Mar Analytical Laboratories
9830 South 51st Street Suite 120 B
Phoenix, AZ 85044
Telephone 480-785-0043

AC&T Sample ID	Date	Time	Matrix	Lab ID	524	504	505	515	531.1	525.2	547	548	549	NEW SOURCE APPROVAL	Number of Containers
BM-02790	10-Mar-05	10-Sep	DW	- 01										X	

Project Name	Globe
Project Number	
New Source Approval	
Notes:	

Sample Receipt

No. Containers:		
Custody Seals:	None	
Received Intact:	Yes	No
Received Cold:	Yes	No
Temperature:	3-9-C	
PRIORITY		

RELINQUISHED BY:
Signature: T. Johnsen Time: 1334
Name: T.Johnsen Date: 3/10/2005
Aquatic Consulting & Testing

SAMPLED RECEIVED BY:
Signature: [illegible] Time: 13:34
Name: ERNEST SALGADO Date: 3/10/2005

RELINQUISHED BY:
Signature: [illegible] Time: 13:50
Name: ERNEST SALGADO Date: 3/10/2005

SAMPLED RECEIVED BY:
Signature: [illegible] Time: 13:50
Name: [illegible] Date: 03/10/05
Del Mar Analytical

Radiation Safety Engineering, Inc.

3245 N. WASHINGTON ST. · CHANDLER, ARIZONA 85225-1121 (480) 897-9459
Website: www.radsafe.com FAX (480) 892-5446

Radiochemical Activity in Water (pCi/L)

Aquatic Consulting & Testing
1525 W. University Drive
Suite 106
Tempe, AZ 85281

Sample Received: March 10, 2005
Analysis Completed: March 13, 2005

Sample ID	Gross Alpha Activity Method 600/00-02 (pCi/L)
BM-02790	1.2 ± 0.6

Robert L. Metzger, Ph.D., C.H.P.

Arizona Department of Environmental Quality

Drinking Water Additional Radiochemical Analysis Report

Samples To Be Taken At POE Only

System ID	System Name
03/10/2005	09:10
Sample Date	Sample Time

Owner/Contact Person

POE#

Owner/Contact Fax Number

COMPLIANCE SAMPLE TYPE

- ☐ Reduced Monitoring
- ☐ Quarterly
- ☐ Composite of four quarterly samples

Date Q1 Collected

Date Q2 Collected

Date Q3 Collected

Date Q4 Collected

*****RADIOCHEMICAL ANALYSIS*****

>>>To be filled out by laboratory personnel<<<

Analysis Method	MCL	Reporting Limit	Contaminant Name	Cont. Code	Analyses Run Date	Result	Exceed MCL
	15 pCi/L		Adjusted Gross Alpha	4000			
600/00-02		3 pCi/L	Gross Alpha	4002	03/15/2005	1.2±0.6	
7500 - Rn			Radon	4004			
00-07	30 µg/L	(reserved)	Combined Uranium	4006			
			Uranium 234	4007			
			Uranium 235	4008			
			Uranium 238	4009			
	5 pCi/L	1 pCi/L	Combined Radium(226,228)	4010			
903.1		1 pCi/L	Radium 226	4020			
904.0		1 pCi/L	Radium 228	4030			

*****LABORATORY INFORMATION*****

>>>To be filled out by laboratory personnel<<<

Specimen Number: BM-02790

Lab ID Number: AZ0462 Lab Name: Radiation Safety Engineering, Inc.

Comments: 24497 Authorized Signature: Robert L. Bratton

e Public Water System Notified:

WAR 6: 2003

Aquatic Consulting & Testing
1525 W. University Dr.
Suite 106
Tempe, AZ 85281
ATTN: Chris Christian
Phone (480) 921-8044 Fax (480) 921-0049
E-Mail Address: cchristian@aquaticconsulting.com

LAB JOB NUMBER: 2449

Subcontract Chain of Custody

DATE: 10-Mar-05 PAGE 1 OF 1

Subcontract Laboratory:
Radiation Safety Engineers
3245 N. Washington Street
Chandler, AZ 85225
602-897-9459

AC&T Sample ID	Date	Time	Matrix	Lab ID	Gross Alpha	Gross Beta	Radio Chemistry	Number/Containers
BM-02790	10-Mar-05	9:10 AM	DW				X	1

Project Name	Sample Receipt		
Strawberry	No. Containers:	1	
Project Number	Custody Seals:	None	
	Received Intact:	Yes	No
Notes:	Received Cold:	Yes	No
Please, Continue testing if present	Temperature:		
	PRIORITY		

RELINQUISHED BY:
Signature: T. Johnsen Time: 14:52
Name: T. Johnsen Date: 3/10/2005
Aquatic Consulting & Testing

SAMPLED RECEIVED BY:
Signature: D. Nicklin Time: 14:52
Name: D. Nicklin Date: 3/10/2005
Top Speed

RELINQUISHED BY:
Signature: D. Nicklin Time: 15:47
Name: D. Nicklin Date: 3/10/2005
Top Speed

SAMPLED RECEIVED BY:
Signature: Time: 347p
Name: Mia Pike Date: 3/10/2005
Radiation Safety Engineers

FIBERQUANT ANALYTICAL SERVICES

Determination of Asbestos in Water using TEM

JobNumber: 200501868

Client: AQUATIC CONSULTING & TESTING

PO BOX 1510

TEMPE, AZ 85281-1510

Office Phone: (480) 921-8044

FAX: (480) 921-0049

 # Samples: 1 TEM **Rec:** 3/10/2005 **Method:** EPA 100.1 TEM Water

Client Job: BM-02790/Strawberry **PO Number:** **Routing Number:** -

Report Date: 3/16/2005 **Date Analyzed:** 3/16/2005

Method and Analysis Information: **Fiberquant Internal SOP:** TEMw

Samples are analyzed using the protocols given in EPA method 100.1, as amended by the 1993 EPA guidence. Samples should be un-preserved water in 1 L containers having about 200 ml headspace for shaking. There is a 48 hr deadline between the time the sample is taken and the time it is filtered to minimize loss of asbestos fibers due to biological interference. Each sample is shook for 1 minute, and ultrasonicated for at least 10 minutes, shaking every 5 minutes to disperse any fibers that are present. A measured amount of sample is then filtered through a 0.1 um pore size polycarbonate filter, backed by a 5 um pore size MCE filter and a glass frit. Several volumes of liquid may be filtered for each sample in order to assure that a properly loaded sample is obtained. A portion of each resulting filter (and blanks) is then coated with 100-200 um of carbon in a Denton 502A Carbon Evaporator. The carbon encapsulates all of the larger and most of the smaller particulate on the filter. Three mm square pieces of the coated filter are placed on three or more copper TEM grids, and the original filter material is dissolved away in a Jaffe wick and/or condensation washer. The finished replica in carbon containing the particulate is then examined on a JEOL 1200 or Phillips CM 10 transmission electrom microscope at 10,000 to 20,000x magnification. All asbestos fibers >10um in length are tabulated and characterized as asbestos or non-asbestos using a [redacted]nation of morphology, electron diffraction characteristics, and elemental composition. The result is calculated in millions of fibers per liter [redacted]. The grid is scanned until 20 grid openings have been observed, or until an analytical sensitivity (the hypothetical observation of one fiber) of MFL has been reached. The nominal 20 grid opening cut-off is used for those samples containing so much non-asbestos particulate that the desired analytical sensitivity is impractical to attain.

The method was designed to determine EPA drinking water compliance. The standard for drinking water is <7 MFL as measured by this method. Fiberquant maintains Arizona Environmental Laboratory license #AZ0633 covering EPA Method 100.1.

Overall, the coefficient of variation can be expected to be approximately 0.5 for analyses in which >20 asbestos fibers have been counted, ranging up to 1.00 for analyses in which only a few asbestos fibers are counted.

The analysis was performed under an ongoing quality assurance program which includes: Lab blanks, prepared with each set of samples, and analyzed at the rate of one per 25 samples analyzed. Each analyst has suitable background credentials, such as at least a bachelor's degree in geology or chemistry, and has undergone extensive 2-6 month training in TEM techniques and mineralogy specific to TEM asbestos analysis before being allowed to perform client analyses. Unknown reference samples are routinely identified to ensure that each analyst can collect and correctly interpret TEM information. The TEM is aligned and its performance checked daily. Magnification, electron diffraction pattern size, and analytical performance characteristics are calibrated routinely. Samples are re-analyzed sometimes by the same analyst and sometimes by a different analyst in order to determine accuracy and precision. The total of QC analyses (blanks + recounts) are greater than 10% of analyzed samples. Each analyst participates in interlab round robins and proficiency testing in order to show correlation to other lab's analyses. Because TEM samples are not analyzed in batches, which would be traditional for most water analyses, and not every blank is read, and not every sample has a duplicate or replicate analysis associated with it, it is not possible to include a traditional QC report with the analysis. QC reports are produced monthly, and are available on request. All quality checks performed for these samples were in control except as detailed in the "Analytical Notes" below. Fiberquant is accredited by NVLAP to perform TEM analysis of asbestos in air samples, and has been found to be proficient in the EPA water proficiency program. Accreditation or proficiency does not imply endorsement by the EPA, any other United States governmental agency or any private agency or association. Each lab analysis refers only to the sample tested, and may not, due to the sampling process, be representative of the material sampled. This report may not be reproduced except in full, without the approval of Fiberquant Analytical Services.

Some results may have been calculated using client supplied data, such as volume or area sampled, for which Fiberquant assumes no liability for accuracy.

Job Analysis Notes:

High level of particulate material in the water did not permit analysis to the desired sensitivity of 0.2 million fibers per liter (MFL).

	Date	Time		
Sampled:	3/10/2005	9:10	By:	Aquatic Consulting
Received:	3/10/2005	15:23		
Filtered:	3/10/2005	16:10		
Analyzed:	3/16/2005	14:35		

Analysis Results:

nber	Client Number	Date	Condition	Filtered Vol (ml)	#GOs	GO Area	MFL	AsbestosType	Sensitivity (MFL)
							Job Number:	200501868	
2005-01868- 1	BM-02790	3/10/2005	acceptable	1	20	0.00928	<5.2	-	5.2

Uwe Steimle

Analyst: UWE .. STEIMLE

Printed: 16-Mar-05

Original Print Date: 16-Mar-05

Larry S. Pierce

Larry S. Pierce, Approved Accreditation Signatory

QA Report:	Job Number:	200501868

1. Calibrations	
TEM magnification. date of last.	2/15/2005
TEM camera constant. date of last.	3/11/2005
EDS performance check (k-factors, resolution, low-e perf.). date of last.	2/15/2005
TEM stage drift, minimum beam size. date of last.	2/15/2005
plasma asher. date of last.	3/7/2005

2. Blanks (1/25 samples required)	X not required this job _____ str/mm2

3. Recounts (1/17 samples required)	X not required this job _____ Rel%Diff

4. Analyst Performance	
NVLAP proficiency testing	X current
verified counts. cum. % true positives	93.3
verification of diffraction pattern identifications. cum. % correct	100.0
verification of EDS spectra. cum. % correct	100.0

Aquatic Consulting & Testing
1525 W. University Dr.
Suite 106
Tempe, AZ 85281
ATTN: Chris Christian
Phone (480) 921-8044 Fax (480) 921-0049
E-Mail Address: cchristian@aquaticconsulting.com

LAB I.D. NUMBER

Subcontract Chain of Custody

DATE: 10-Mar-05 PAGE 1 OF 1

Subcontract Laboratory:
Fiberquant, Inc.
5025 S. 33rd Street
Phoenix, AZ 85040
602-276-6139

AC&T Sample ID	Date	Time	Matrix	Lab ID	Asbestos	Number/Containers
BM-02790	10-Mar-05	9:10 AM	DW		X	1

Project Name	Sample Receipt		
Strawberry	No. Containers:	1	
Project Number	Custody Seals:	None	
	Received Intact:	Yes	No
Notes:	Received Cold:	Yes	No
	Temperature:		
	PRIORITY		

RELINQUISHED BY:
Signature: T. Johnsen Time: 14:52
Name: T. Jonsen Date: 3/10/2005
Aquatic Consulting & Testing

SAMPLED RECEIVED BY:
Signature: Time: 14:52
Name: D. NICKLIN Date: 3/10/2005
Top Speed

RELINQUISHED BY:
Signature: Time: 15:05
Name: D NICKLIN Date: 3/10/2005
Top Speed

SAMPLED RECEIVED BY:
Signature: K Townsend Time: 3:05
Name: K TOWNSEND Date: 3/10/2005
Fiberquant

WELL SH2

ARIZONA DEPARTMENT OF ENVIRONMENTAL QUALITY
DRINKING WATER SOURCE APPROVAL FORM
*** SAMPLES TO BE TAKEN AT SOURCE ONLY***
>>>> PUBLIC WATER SYSTEM INFORMATION <<<<
>>>> TO BE FILLED OUT BY SYSTEM PERSONNEL <<<<

	Aero Drilling
System ID	System Name

06/13/2000 13:00 (24 hr clock)
Sample date Sample time

ADEQ Project Number

Well ID Number

NEW SYSTEM YES ___ NO ___

NEW P.O.E. YES ___ NO ___

Surface Water Intake ID Number

Owner / Contact Person Name

Owner / Contact Person Phone Number

BG05276

Owner / Contact Fax Number

SAMPLING SITE ID

SAMPLE TYPE
☐ Compliance Monitoring

SAMPLE COLLECTION POINT/ID
☐ Point of Entry #

This form is intended to be completely filled out and ALL pages submitted together for all microbiological and chemical tests detailed on this form. If more than one laboratory participated in the analysis, please attach a copy of the original laboratory report, signed by the performing laboratory, to the back of this form. ALL RESULTS SHALL BE REPORTED IN MILLIGRAMS PER LITER (MG/L) UNLESS OTHERWISE SPECIFIED.

PLEASE MAIL THIS COMPLETED FORM TO:

ARIZONA DEPARTMENT OF ENVIRONMENTAL QUALITY
TECHNICAL REVIEW UNIT
DRINKING WATER SECTION
3033 NORTH CENTRAL AVE.
PHOENIX, AZ 85012

AQUATIC CONSULTING & TESTING, INC.
1525 W. [redacted]y Drive, Suite 106 • Tempe, AZ 85281
Phone: (480) 921-8044 • Fax: (480) 921-0049

CHAIN OF CUSTODY

AERO/
Client: Strawberry Hollow LLC
Address: PO Box 499
Street
Kyson AZ 85547
City, State, Zip
Phone/Fax: 520 474-2376
Contact: Bobbie
Sampler Signature: B. Miller

				Chemistry											Biology						Biomonitoring					Remarks:			
SAMPLE ID	DATE	TIME	SAMPLE TYPE	Metals* / TCLP	TDS / TSS / TS / SETT	O+G / TPHC / MBAS	BOD / COD	Tot. P / O-PO4	Nitrate + Nitrite / Nitrate / Nitrite	TKN / Ammonia	VOC / THM's	VOC 524.2			Tot. Coliform: P/A	Tot. Coliform: MPN	Fecal Coliform	Colilert (24hr)	Plate Count		Acute	Chronic	AWET (SWRO).	MPA		Resubmit New Source	No. of Containers: ACID	NONE	OTHER	Laboratory Number
Well #2	6/13/00	1300	DW									X																	BG05276

Sample Receiving:
Intact: X Yes ___ No
Temp: 10°C
Preserved: 4 Yes ___ No
Total # containers: 4

1. Relinquished By:	2. Relinquished By:	3. Relinquished By:
B. Miller		
Date/Time: 6/14/00	Date/Time	Date/Time
1. Received By:	2. Received By:	3. Received By:
Date/Time: 6-15-00 11:55	Date/Time	Date/Time

*** Using the "Remarks:" area, please specify which metals are to be analyzed.**

By signing this chain of custody, the designated client and agent agree to pay Aquatic Consulting & Testing, Inc. for all services rendered in conjunction with the submitted samples within 30 days of invoice. It is the client's responsibility to note purchase order numbers or other.

White-Laboratory Yellow-Report Pink-Client

AQUATIC CONSULTING & TESTING, INC.

1525 W. University Drive, Suite 106
P.O. Box 1510
Tempe, Arizona 85281
Phone: (480) 921-8044 • FAX: (480) 921-0049 Lic. No. AZ0003

LABORATORY REPORT

Client: Aero Drilling & Pumps, Inc.
201 West Aero Drive
Payson, AZ 85547

Date Submitted: 6/15/00
Date Reported: 06/30/00

Attn: Bobbie Richey

Sample Type: Drinking Water
Sample Time: 06/13/00 13:00

Client ID: Well #2
ACT Lab No.: BG05276

RESULTS

Parameter	Analysis Date Start	End	Method No.	Result	Unit
Volatile Organics by MS	6/16/00	6/16/00	EPA 524.2	See Attached *	ug/L

* Analysis performed by Bolin Laboratories (AZ0004)

Reviewed by: Frederick A. Amalfi, Ph.D.
Laboratory Director

*** INORGANIC CHEMICAL ANALYSIS ***

>>> To be filled out by Laboratory Personnel <<<

MCL Value	Trigger Value	Contaminant Name	Cont. Code	Test Start Date/Time	Analysis Run Date	Results	Exceeds MCL	Exceeds Trigger
0.05		Arsenic	1005				☐	
2.0		Barium	1010				☐	
0.005		Cadmium	1015				☐	
0.1		Chromium	1020				☐	
1.3		Copper (Action Level)	1022				☐	
4.0		Fluoride	1025				☐	
0.015		Lead (Action Level)	1030				☐	
0.002		Mercury	1035				☐	
10	5	Nitrate (as N)	1040				☐	☐
1	0.2	Nitrite (as N)	1041				☐	☐
0.05		Selenium	1045				☐	
0.006		Antimony	1074				☐	
0.004		Beryllium	1075				☐	
0.2		Cyanide (as free cyanide)	1024				☐	
0.1		Nickel	1036				☐	
0.002		Thallium	1085				☐	

*** CORROSIVITY CHEMICAL ANALYSIS ***

>>> To be filled out by Laboratory Personnel <<<

ysis Method	MCL Value	Trigger Value	Contaminant Name	Cont. Code	Test Start Date/Time	Analysis Run Date	Results	Exceeds MCL	Exceeds Trigger
			Sulfate	1055					
			Sodium	1052					
			pH	1925					
			Alkalinity	1927					
			Hardness/Calcium	1918					
			Langelier Index	1997					
			Temperature (Celsius), Field	1996					
			Total Dissolved Solids-TDS	1930					

>>>>> LABORATORY INFORMATION <<<<<<

To be filled out by laboratory personnel

SPECIMEN NUMBER 0006053260011

06/13/2000 13:00 (24 hr clock)

Sample Date Sample Time

ID Number AZ0004 Name: Bolin Laboratories, Inc.

Comments: _____

Authorized Signature: _____

te Public Water System Notified: _____

*** SYNTHETIC ORGANIC CHEMICAL ANALYSIS ***

>>> To be filled out by Laboratory Personnel <<<

Analysis Method	MCL Value	Trigger Value	Contaminant Name	Cont. Code	Analysis Run Date	Results	Exceeds MCL	Exceeds Trigger
	0.07	0.035	2,4-D	2105			☐	☐
	0.05	0.025	2,4,5-TP (Silvex)	2110			☐	☐
	0.002	0.001	Alachlor	2051			☐	☐
	0.003	0.0015	Toxaphene	2020			☐	☐
	0.003	0.003	Atrazine	2050			☐	☐
	0.04	0.02	Carbofuran	2046			☐	☐
	0.001	0.0005	Pentachlorophenol	2326			☐	☐
	0.002	0.001	Chlordane	2959			☐	☐
	0.0002	0.0002	Dibromochloropropane (DBCP)	2931			☐	☐
	0.00005	0.00005	Ethylene Dibromide (EDB)	2946			☐	☐
	0.0004	0.0002	Heptachlor	2065			☐	☐
	0.0002	0.0001	Heptachlor Epoxide	2067			☐	☐
	0.0002	0.0001	Lindane	2010			☐	☐
	0.04	0.02	Methoxychlor	2015			☐	☐
	0.0005	0.00025	PCB:Polychlorinated Biphenyls	2383			☐	☐
	0.0002	0.0001	Benzo (a) Pyrene	2306			☐	☐
	0.2	0.1	Dalapon	2031			☐	☐
	0.006	0.006	Di(2-ethylhexyl)phthalate	2039			☐	☐
	0.4	0.2	Di(2-ethylhexyl)adipate	2035			☐	☐
	0.007	0.0035	Dinoseb	2041			☐	☐
	3 x 10(-8)	1.5 x 10(-8)	2,3,7,8-TCDD (Dioxin)	2063			☐	☐
	0.02	0.01	Diquat	2032			☐	☐
	0.1	0.05	Endothall	2033			☐	☐
	0.002	0.001	Endrin	2005			☐	☐
	0.7	0.35	Glyphosate	2034			☐	☐
	0.001	0.0005	Hexachlorobenzene	2274			☐	☐
	0.05	0.025	Hexachlorocyclopentadiene	2042			☐	☐
	0.2	0.1	Oxamyl	2036			☐	☐
	0.5	0.25	Picloram	2040			☐	☐
	0.004	0.002	Simazine	2037			☐	☐

>>>>> LABORATORY INFORMATION <<<<<<

To be filled out by laboratory personnel

SPECIMEN NUMBER
0006053260015

06/13/2000 (Sample Date) 13:00 (Sample Time) (24 hr clock)

ID Number AZ0004 Name: Bolin Laboratories, Inc.

Comments:

Authorized Signature:

Date Public Water System Notified:

Aroclor Results may be submitted in lieu of PCB
Methods 504, 508 and 515 performed by ATEL, Melmore OH #AZ0117.
Method 1613 (Dioxin) performed by Pace Analytical Services, Minn. MN #AZ0014

*** AROCLOR (PCBs SCREENING TEST) ***

>>> To be filled out by Laboratory Personnel <<<

Analysis Method	MCL Value	Trigger Value	Contaminant Name	Cont. Code	Analysis Run Date	Results	Exceeds MCL	Exceeds Trigger
		0.00008	Aroclor 1016	2388				☐
		0.02	Aroclor 1221	2390				☐
		0.0005	Aroclor 1232	2392				☐
		0.0003	Aroclor 1242	2394				☐
		0.0001	Aroclor 1248	2396				☐
		0.0001	Aroclor 1254	2398				☐
		0.0002	Aroclor 1260	2400				☐

>>>>> LABORATORY INFORMATION <<<<<<

To be filled out by laboratory personnel

SPECIMEN NUMBER 0006053260015

06/13/2000 13:00 (24 hr clock)

Sample Date Sample Time

ID Number AZ0004 Name: Bolin Laboratories, Inc.

Comments:

Authorized Signature:

Date Public Water System Notified:

*** VOLATILE ORGANIC CHEMICALS ANALYSIS ***

>>> To be filled out by Laboratory Personnel <<<

Analysis Method	MCL Value	Trigger Value	Contaminant Name	Cont. Code	Analysis Run Date	Results	Exceeds MCL	Exceeds Trigger
EPA 524.2	0.007	0.0005	1,1-Dichloroethylene	2977	06/16/2000	<0.0005	☐	☐
EPA 524.2	0.2	0.0005	1,1,1-Trichloroethane	2981	06/16/2000	<0.0005	☐	☐
EPA 524.2	0.005	0.0005	1,1,2-Trichloroethane	2985	06/16/2000	<0.0005	☐	☐
EPA 524.2	0.005	0.0005	1,2-Dichloroethane	2980	06/16/2000	<0.0005	☐	☐
EPA 524.2	0.005	0.0005	1,2-Dichloropropane	2983	06/16/2000	<0.0005	☐	☐
EPA 524.2	0.005	0.0005	Benzene	2990	06/16/2000	<0.0005	☐	☐
EPA 524.2	0.005	0.0005	Carbon Tetrachloride	2982	06/16/2000	<0.0005	☐	☐
EPA 524.2	0.07	0.0005	cis-1,2-Dichloroethylene	2380	06/16/2000	<0.0005	☐	☐
EPA 524.2	0.7	0.0005	Ethylbenzene	2992	06/16/2000	<0.0005	☐	☐
EPA 524.2	0.1	0.0005	(mono)chlorobenzene	2989	06/16/2000	<0.0005	☐	☐
EPA 524.2	0.6	0.0005	o-Dichlorobenzene	2968	06/16/2000	<0.0005	☐	☐
EPA 524.2	0.075	0.0005	para-Dichlorobenzene	2969	06/16/2000	<0.0005	☐	☐
EPA 524.2	0.1	0.0005	Styrene	2996	06/16/2000	<0.0005	☐	☐
EPA 524.2	0.005	0.0005	Tetrachloroethylene	2987	06/16/2000	<0.0005	☐	☐
EPA 524.2	1	0.0005	Toluene	2991	06/16/2000	<0.0005	☐	☐
EPA 524.2	0.1	0.0005	Trans-1,2-Dichloroethylene	2979	06/16/2000	<0.0005	☐	☐
EPA 524.2	0.005	0.0005	Trichloroethylene	2984	06/16/2000	<0.0005	☐	☐
EPA 524.2	0.002	0.0005	Vinyl Chloride	2976	06/16/2000	<0.0005	☐	☐
EPA 524.2	10	0.0005	Xylenes, total	2955	06/16/2000	<0.0005	☐	☐
EPA 524.2	0.07	0.0005	1,2,4-Trichlorobenzene	2378	06/16/2000	<0.0005	☐	☐
EPA 524.2	0.005	0.0005	Dichloromethane	2964	06/16/2000	<0.0005	☐	☐

>>>>> LABORATORY INFORMATION <<<<<<
To be filled out by laboratory personnel

SPECIMEN NUMBER 000605326001V

06/13/2000 13:00 (24 hr clock)
Sample Date Sample Time

ID Number AZ0004 Name: Bolin Laboratories, Inc.

Comments:

Authorized Signature: Susan Mayl

Date Public Water System Notified:

*** RADIOCHEMICAL ANALYSIS ***
>>> To be filled out by Laboratory Personnel <<<

Analysis Method	MCL Value	Trigger Value	Contaminant Name	Cont. Code	Analysis Run Date	Results	Exceeds MCL	Exceeds Trigger
	15 pCi/l	3 pCi/l	Gross Alpha	4000			☐	
	5 pCi/l		Combined Radium (226,228)	4010			☐	
		1 pCi/l	Radium 226	4020				
		1 pCi/l	Radium 228	4030				
	4 mrem	3 pCi/l	Gross Beta	4100			☐	
	20,000 pCi/l ***		Tritium	4102				
	8 pCi/l ***		Strontium-90	4174				

>>>>> LABORATORY INFORMATION <<<<<<
To be filled out by laboratory personnel

SPECIMEN NUMBER 000605326001R

06/13/2000 13:00 (24 hr clock)
Sample Date Sample Time

ID Number AZ0004 Name: Bolin Laboratories, Inc.

Comments:

Authorized Signature:

Date Public Water System Notified:

* A composite radiochemical sample means four quarterly samples from a single source only.
** Gross alpha is the value of all alpha particle emitters except for uranium and radon 222. Radium 226 is included in the reported gross alpha value. All units are reported in picocuries per liter (pCi/l) EXCEPT for gross beta which is reported in millirem per year.
*** These values are assumed to produce a total body or organ dose of 4 millirem per year.

Radiochemistry performed by Lucas Labs, Sedona AZ #AZ0141

***** ABESTOS ANALYSIS *****

>>> To be filled out by Laboratory Personnel <<<

Analysis Method	MCL Value	Trigger Value	Contaminant Name	Cont. Code	Analysis Run Date	Results	Exceeds MCL	Exceeds Trigger
	7 MFL		Asbestos	1094				

>>>>> LABORATORY INFORMATION <<<<<<

To be filled out by laboratory personnel

SPECIMEN NUMBER 000605326001

06/13/2000 (Sample Date) 13:00 (Sample Time) (24 hr clock)

ID Number AZ0004 Name: Bolin Laboratories, Inc.

Comments:

Authorized Signature:

Date Public Water System Notified:

Asbestos performed by Fiberquant, Phoenix AZ #AZ0904

***** MICROBIOLOGICAL ANALYSIS *****

>>> To be filled out by Laboratory Personnel <<<

Analysis Method	MCL Value	Trigger Value	Contaminant Name	Cont. Code	Test Start Date/Time	Analysis Run Date	Results	Exceeds MCL	Exceeds Trigger
	Present / 1 or more Coliform		Total Coliform	3000					

*** ONLY REPORT FECAL RESULT IF TOTAL COLIFORM RESULT IS POSITIVE ***

>>> To be filled out by Laboratory Personnel <<<

Analysis Method	MCL Value	Contaminant Name	Cont. Code	Test Start Date/Time	Analysis Run Date	Results	Exceeds MCL	Exceeds Trigger
	Present / 1 or more Coliform	E. Coli or Fecal Coliform	3013					

>>>>> LABORATORY INFORMATION <<<<<<

To be filled out by laboratory personnel

SPECIMEN NUMBER 000605326001MIC

06/13/2000 (Sample Date) 13:00 (Sample Time) (24 hr clock)

ID Number AZ0004 Name: Bolin Laboratories, Inc.

Comments:

Authorized Signature:

Date Public Water System Notified:

BOLIN LABORATORIES • INC
Legend Technical Services of Arizona

17631 N. 25th Avenue ▪ Phoenix, Arizona ▪ 85023 ▪ (602) 942-8220 ▪ fax (602) 942-1050 ▪ ADHS# AZ0004

Aquatic Consulting
Post Office Box 1510
1525 W. University Dr Ste#106
Tempe, AZ 85281
Attn: Chris Christian

Received: 6/15/00
Reported: 6/28/00
Invoice No: 066152

Project Name: Aero Drilling

Matrix: Drinking Water
Sample No: 0006-05326-001
Sample ID: BG05276

Time Sampled: 13:00
Date Sampled: 6/13/2000

PARAMETER	METHOD	RESULTS	UNITS	PQL	DATE ANALYZED
Chloromethane	EPA 524.2	<0.0005	mg/L	0.0005	6/16/00
Vinyl Chloride	EPA 524.2	<0.0005	mg/L	0.0005	6/16/00
Bromomethane	EPA 524.2	<0.0005	mg/L	0.0005	6/16/00
Chloroethane	EPA 524.2	<0.0005	mg/L	0.0005	6/16/00
1,1-Dichloroethylene	EPA 524.2	<0.0005	mg/L	0.0005	6/16/00
Dichloromethane	EPA 524.2	<0.0005	mg/L	0.0005	6/16/00
MTBE	EPA 524.2	<0.0005	mg/L	0.0005	6/16/00
trans 1,2-Dichloroethylene	EPA 524.2	<0.0005	mg/L	0.0005	6/16/00
1,1-Dichloroethane	EPA 524.2	<0.0005	mg/L	0.0005	6/16/00
cis 1,2-Dichloroethylene	EPA 524.2	<0.0005	mg/L	0.0005	6/16/00
2,2-Dichloropropane	EPA 524.2	<0.0005	mg/L	0.0005	6/16/00
Chloroform	EPA 524.2	<0.0005	mg/L	0.0005	6/16/00
1,1,1-Trichloroethane	EPA 524.2	<0.0005	mg/L	0.0005	6/16/00
1,1-Dichloropropene	EPA 524.2	<0.0005	mg/L	0.0005	6/16/00
Carbontetrachloride	EPA 524.2	<0.0005	mg/L	0.0005	6/16/00
1,2-Dichloroethane	EPA 524.2	<0.0005	mg/L	0.0005	6/16/00
Benzene	EPA 524.2	<0.0005	mg/L	0.0005	6/16/00
Trichloroethylene (TCE)	EPA 524.2	<0.0005	mg/L	0.0005	6/16/00
1,2-Dichloropropane	EPA 524.2	<0.0005	mg/L	0.0005	6/16/00
Dibromomethane	EPA 524.2	<0.0005	mg/L	0.0005	6/16/00
Bromodichloromethane	EPA 524.2	<0.0005	mg/L	0.0005	6/16/00
cis 1,3-Dichloropropene	EPA 524.2	<0.0005	mg/L	0.0005	6/16/00
Toluene	EPA 524.2	<0.0005	mg/L	0.0005	6/16/00
trans-1,3-Dichloropropene	EPA 524.2	<0.0005	mg/L	0.0005	6/16/00
1,1,2-Trichloroethane	EPA 524.2	<0.0005	mg/L	0.0005	6/16/00
1,3-Dichloropropane	EPA 524.2	<0.0005	mg/L	0.0005	6/16/00
Tetrachloroethylene (PCE)	EPA 524.2	<0.0005	mg/L	0.0005	6/16/00
Dibromochloromethane	EPA 524.2	<0.0005	mg/L	0.0005	6/16/00
Chlorobenzene	EPA 524.2	<0.0005	mg/L	0.0005	6/16/00
1,1,1,2-Tetrachloroethane	EPA 524.2	<0.0005	mg/L	0.0005	6/16/00
Ethylbenzene	EPA 524.2	<0.0005	mg/L	0.0005	6/16/00
Styrene	EPA 524.2	<0.0005	mg/L	0.0005	6/16/00

BOLIN LABORATORIES • INC
Legend Technical Services of Arizona

17631 N. 25th Avenue ▪ Phoenix, Arizona ▪ 85023 ▪ (602) 942-8220 ▪ fax (602) 942-1050 ▪ ADHS# AZ0004

Matrix: Drinking Water
Sample No: 0006-05326-001

Time Sampled: 13:00
Date Sampled: 6/13/2000

PARAMETER	METHOD	RESULTS	UNITS	PQL	DATE ANALYZED
Bromoform	EPA 524.2	<0.0005	mg/L	0.0005	6/16/00
1,1,2,2-Tetrachloroethane	EPA 524.2	<0.0005	mg/L	0.0005	6/16/00
1,2,3-Trichloropropane	EPA 524.2	<0.0005	mg/L	0.0005	6/16/00
Bromobenzene	EPA 524.2	<0.0005	mg/L	0.0005	6/16/00
2-Chlorotoluene	EPA 524.2	<0.0005	mg/L	0.0005	6/16/00
4-Chlorotoluene (para)	EPA 524.2	<0.0005	mg/L	0.0005	6/16/00
1,3-Dichlorobenzene (meta)	EPA 524.2	<0.0005	mg/L	0.0005	6/16/00
1,4-Dichlorobenzene (para)	EPA 524.2	<0.0005	mg/L	0.0005	6/16/00
1,2-Dichlorobenzene (ortho)	EPA 524.2	<0.0005	mg/L	0.0005	6/16/00
1,2,4-Trichlorobenzene	EPA 524.2	<0.0005	mg/L	0.0005	6/16/00
Xylenes, Total	EPA 524.2	<0.0005	mg/L	0.0005	6/16/00
Total Trihalomethanes	EPA 524.2	<0.0005	mg/L	0.0005	6/16/00
Surrogate:	EPA 524.2				6/16/00
***Pentafluorobenzene	EPA 524.2	96	% Recovery		6/16/00
**4-Bromofluorobenzene	EPA 524.2	102	% Recovery		6/16/00
***1,2-dichlorobenzene-d4	EPA 524.2	95	% Recovery		6/16/00

Antifoaming agent was added to the sample for 524 drinking water analysis. Data is considered valid.

Authorized Signatory

Aquatic Consulting & Testing
1525 W. University Dr.
Suite 106
Tempe, AZ 85281
ATTN: Chris Christian
Phone (480) 921-8044 Fax (480) 921-0049
E-Mail Address: actlab@sprintmail.com

LAB I.D. NUMBER 00064-053

Subcontract Chain of Custody

DATE: 15-Jun-00 PAGE 1 OF 1

Subcontract Laboratory:
Bolin Labs
17631 N. 25th Avenue
Phoenix, AZ 85023
602-942-8220

AC&T Sample ID	Date	Time	Matrix	Lab ID	524.2	Number/Containers	
BG05276	13-Jun-00	1:00 PM	DW		X	3	-01
BG05276-TB	--	--	AQ		X	1	-02
BG05277	14-Jun-00	7:30 AM	DW		X	3	-03
BG05277-TB	--	--	AQ		X	1	-04

Project Name: Aero Drilling

Project Number:

Notes:
- For new source
- Must reach 0.5 ppb
PQL

Sample Receipt

No. Containers: 8

Custody Seals:

Received Intact: Yes / No

Received Cold: Yes / No

Temperature: 6°C

PRIORITY

RELINQUISHED BY:
Signature: Time: 15:40
Name: Erica Sharp Date: 6/15/00
Aquatic Consulting & Testing

SAMPLED RECEIVED BY:
Signature: Time: 3:40
Name: M. Cruz Date: 6/15/00
Company Top Speed

RELINQUISHED BY:
Signature: Time: 4:30
Name: M. Cruz Date: 6-15-00
Company Top Speed

SAMPLED RECEIVED BY:
Signature: Time: 16:55
Name: Christopherson Date: 6-15-00
Company Bolin

ARIZONA DEPARTMENT OF ENVIRONMENTAL QUALITY
DRINKING WATER INORGANIC CHEMICAL ANALYSIS REPORT
*** Collect samples at P. O. E. only ***

COPY TO ADEQ: YES___ NO_XX_

>>>> SYSTEM INFORMATION <<<<

System ID #

System Name: Strawberry Hollow #2

Sample Date: 4/25/00 Time (24hr): 13:30

Collected By: Bobbie Miller

Sample Type

[ ] Compliance Monitoring

Name: Bobbie Miller
Phone: 520-474-2376
Fax:

Sample Collection Point/ID

[ ] Point of Entry # ___

Sample Site ID

Well 55-579973 (Well #2)

System Mailing Name & Address

Aero Drilling
P. O. Box 499
Payson, Arizona 85547

Use only if initial sample was positive.

Original Violation Specimen Number

Sample Type
[ ] Confirmation
[ ] Confirmation for Composite Trigger

>>>> INORGANIC CHEMICAL ANALYSIS <<<<

Analysis Method	MCL Value	Trigger Value	Contaminant Name	Cont. Code	Test Start Date	Test End Date	Result mg/L	Exceeds MCL	Exceeds Trigger
200.9	0.05		Arsenic	1005	5/1/00	5/1/00	<0.005		
200.7	2		Barium	1010	4/28/00	4/28/00	0.21		
200.7	0.005		Cadmium	1015	4/28/00	4/28/00	<0.002		
200.7	0.1		Chromium	1020	4/28/00	4/28/00	<0.01		
4500F C	4.0		Fluoride	1025	4/28/00	4/28/00	0.2		
245.1	0.002		Mercury	1035	5/16/00	5/16/00	<0.0002		
4500NO3 I	10	5	Nitrate (as N)	1040	5/2/00	5/2/00	0.15		
4500NO2 I	1	0.5	Nitrite (as N)	1041	4/26/00	4/26/00	<0.01		
200.9	0.05		Selenium	1045	4/28/00	4/28/00	<0.005		
200.9	0.006		Antimony	1074	5/5/00	5/5/00	<0.002		
200.7	0.004		Beryllium	1075	4/28/00	4/28/00	<0.002		
4500CN E	0.2		Cyanide	1024	5/4/00	5/4/00	<0.01		
200.7	0.1		Nickel	1036	4/28/00	4/28/00	0.01		
200.9	0.002		Thallium	1085	5/4/00	5/4/00	<0.001		
4500SO4 I	No MCL		Sulfate	1055	4/27/00	4/27/00	8		
200.7	No MCL		Sodium	1052	5/2/00	5/2/00	13		

>>>>> LABORATORY INFORMATION <<<<<

Specimen Number: BG03713-I Date/Time Received: 4/26/00 10:05

ID Number: AZ0003 Name: Aquatic Consulting & Testing, Inc. (602) 921-8044

Comments: Temp:

Authorized Signature: Chris J Austin

Date Public Water System Notified:

DWAR2: Rev. 8-1-96

ARIZONA DEPARTMENT OF ENVIRONMENTAL QUALITY
DRINKING WATER CORROSIVITY CHEMICAL ANALYSIS REPORT
***** Collect samples at P. O. E. only *****

COPY TO ADEQ: YES____ NO_XX_

>>>> SYSTEM INFORMATION <<<<
(To be filled out by system personnel)

System ID # | **System Name** Strawberry Hollow #2

Sample Date 4/25/00 **Time (24hr)** 13:30 **Collected By** Bobbie Miller

Sample Type

[ ] Compliance Monitoring

Name: Bobbie Miller
Phone: 520-474-2376
Fax:

Sample Collection Point/ID

[ ] Point of Entry # _____

Sample Site ID

Well 55-579973 (Well #2)

System Mailing Name & Address

Aero Drilling
P. O. Box 499
Payson, Arizona 85547

>>>> INORGANIC CHEMICAL ANALYSIS <<<<
(To be filled out by laboratory personnel)

Analysis Method	Contaminant Name	Cont. Code	Test End Date	Result mg/L
150.1	pH**	1925	4/26/00	7.0
310.1	Alkalinity *	1927	4/27/00	393
Calc	Hardness (Ca) *	1918	5/1/00	272
Calc	Langelier Index	1997	5/1/00	0.11
170.1	Temperature**	1996	4/26/00	25 ***
160.1	TDS	1930	4/27/00	371

>>>>> LABORATORY INFORMATION <<<<<
(To be filled out by laboratory personnel)

Specimen Number BG03713-C **Date/Time Received** 4/26/00 10:05

ID Number AZ0003 Name: **Aquatic Consulting & Testing, Inc. (602) 921-8044**

Comments: Temp: *** Laboratory Temperature

Authorized Signature: Chris J. Christian

Date Public Water System Notified: _____

* All units to be reported in milligrams per liter as $CaCO_3$

** Field Measurements

DWAR2: Rev. 8-1-96

Sample Calculation

Langelier Index

Measured Characteristics of the water	
Sample ID	BG03713
Calcium (mg/L)	109
pH	7
Temperature (C)	25
Alkalinity (mg/L as CaCO3)	393
TDS (mg/L)	371
Calculated Langelier Index	
Langelier Index [If the Index is Negative, the water may be corrosive]	0.108
Saturation Index	6.892
Calculated Data	
Ionic Strength	0.009
Activity Coeff (m)	0.905
Activity Coeff (d)	0.670
Ca (moles/L)	0.002725
Alkalinity (moles/L)	0.00393
pK2	10.331
K2	4.67E-11
K2'	6.96E-11
pK2'	10.157
pKs	8.326
Ks	4.72E-09
Ks'	1.05E-08
pKs'	7.978
pCa	2.565
pHs	6.892

ARIZONA DEPARTMENT OF ENVIRONMENTAL QUALITY
DRINKING WATER PRIMARY MICROBIOLOGICAL ANALYSIS REPORT
***** Collect samples in distribution system only *****

COPY TO ADEQ: YES____ NO____

>>>> SYSTEM INFORMATION <<<<
(To be filled out by system personnel)

System ID # | **System Name** Strawberry Hollow #2

Sample Date 4/25/00 **Time (24hr)** 13:30 **Collected By** Bobbie Miller

Sample Type
☐ Compliance Monitoring

Owner/Contact Person
Name: Bobbie Miller
Phone: 520-474-2376
Fax:

Sample Collection Point/ID
☐ Zone _____

Sample Site ID
Well 55-579973 (Well #2)

System Mailing Name & Address
Aero Drilling
P. O. Box 499
Payson, Arizona 85547

Use only if initial sample was positive.
_____
Original Violation Specimen Number

☐ Repeat, Original Location
☐ Repeat, Other Location
☐ Repeat, Downstream Location
☐ Repeat, Upstream Location
☐ 400 mL Repeat (Single tap only)
☐ 300 mL Repeat (Single tap only)

>>>> MICROBIOLOGICAL ANALYSIS <<<<
(To be filled out by laboratory personnel)

Analysis Method	MCL Value	Contaminant Name	Contaminant Code	Test Start Date/Time	Test Stop Date/Time	Result
9221D	Present/ 1 or more coliform	Total Coliform	3000	4/26/00 11:00	4/28/00 11:00	0

Only report fecal result if the total coliform result is positive

Analysis Method	MCL Value	Contaminant Name	Contaminant Code	Test Start Date/Time	Test Stop Date/Time	Result
9221E	Present/ 1 or more coliform	Fecal Coliform	3013			

>>>>> LABORATORY INFORMATION <<<<<
(To be filled out by laboratory personnel)

Specimen Number BG03713-M **Date/Time Received** 4/26/00 10:05

ID Number AZ0003 Name: **Aquatic Consulting & Testing, Inc. (602) 921-8044**

Comments: Temp:

Authorized Signature: Chris J Austin

Date Public Water System Notified: _____

DWAR1: Rev. 5-1-98

AQUATIC CONSULTING & TESTING, INC.
1525 [illegible] Drive, Suite 106 • Tempe, AZ 85281
Phone: (480) 921-8044 • Fax: (480) 921-0049

CHAIN OF CUSTODY

PAGE 1 OF 1

Client: Navajo / Tohtsoh Sinilnaa Holdings LLC
Address: P.O. Box 490
Street
Tuba City, AZ 86045
City, State, Zip
Phone/Fax: (928) 474-2376
Contact: Delbert Miller
Sampler Signature: D. Miller

SAMPLE ID	DATE	TIME	SAMPLE TYPE	Chemistry: Metals* / TCLP	TDS / TSS / TS / SETT	O+G / TPHC / MBAS	BOD / COD	Tot. P / O-PO_4	Nitrate + Nitrite / Nitrate / Nitrite	TKN / Ammonia	VOC / THM's	2 New Source	Biology: Tot. Coliform: P/A	Tot. Coliform: MPN	Fecal Coliform	Colilert (24hr)	Plate Count	Biomonitoring: Acute	Chronic	AWET (SWRO)	MPA	No. of Containers: ACID	NONE	OTHER	Laboratory Number
Subtribe Hollow #2	4/25/00	13:30	DW									X													BG03713
55-579973																									
Well #2																									

Remarks: New Source

Sample Receiving:
Intact: X Yes ____ No
Temp: 5C
Preserved: ____ Yes ____ No
Total # containers: ____

1. Relinquished By:	2. Relinquished By:	3. Relinquished By:
D. Miller		
Date/Time: 4/26/00 7AM	Date/Time:	Date/Time:
1. Received By: Transport	2. Received By: Chuck Stelp	3. Received By:
Date/Time:	Date/Time: 4-26-00 10:05	Date/Time:

*** Using the "Remarks:" area, please specify which metals are to be analyzed.***

By signing this chain of custody, the designated client and agent agree to pay Aquatic Consulting & Testing, Inc. for all services rendered in conjunction with the submitted samples within 30 days of invoice. It is the client's responsibility to note purchase order numbers or other responsible parties on the form and failure to do so does not constitute justification for non-payment.

White-Laboratory Yellow-Report Pink-Client

ARIZONA DEPARTMENT OF ENVIRONMENTAL QUALITY
DRINKING WATER INORGANIC CHEMICAL ANALYSIS REPORT
***** Samples may be collected in distribution system or P. O. E. *****

COPY TO ADEQ: YES____ NO_XX_

>>>> SYSTEM INFORMATION <<<<

System ID #

System Name: Strawberry Hollow #2

Sample Date: 4/25/00 Time (24hr): 13:30

Collected By: Bobbie Miller

Sample Type

[ ] Compliance Monitoring

Name: Bobbie Miller
Phone: 520-474-2376
Fax:

Sample Collection Point/ID

[ ] Zone_____

Sample Site ID

Well 55-579973 (Well #2)

System Mailing Name & Address

Aero Drilling
P. O. Box 499
Payson, Arizona 85547

Use only if initial sample was positive.

Original Violation Specimen Number

Sample Type
[ ] Confirmation
[ ] Confirmation for Composite Trigger

>>>> INORGANIC CHEMICAL ANALYSIS <<<<

Analysis Method	MCL Value	Contaminant Name	Cont. Code	Analysis Run Date	Result mg/L	Exceeds MCL
TEM	7 MFL	Asbestos	1094	5/8/00	<0.2	[ ]

>>>>> LABORATORY INFORMATION <<<<<

Specimen Number: BG03713-A Date/Time Received: 4/26/00 10:05

ID Number: AZ0003 Name: Aquatic Consulting & Testing, Inc. (602) 921-8044

Comments: Temp: Analysis performed by Fiberquant (AZ0904)

Authorized Signature: Chris J. Christensen

Date Public Water System Notified:

FIBERQUANT ANALYTICAL SERVICES

Determination of Asbestos in Water using TEM

JobNumber: 2000-2097

Client: AQUATIC CONSULTING & TESTING

PO BOX 1510

TEMPE, AZ 85281-1510

Office Phone: (480) 921-8044

FAX: (480) 921-0049

 # Samples: 1 TEM **Rec:** 4/26/00 **Method:** EPA 100.1 TEM Water

Client Job: BG03713 **PO Number:** **Routing Number:** -

Date Analyzed: 5/8/00

Method and Analysis Information:

Samples are analyzed using the protocols given in EPA method 100.1, as amended by the 1993 EPA guidence. Samples should be un-preserved water in 1 L containers having about 200 ml headspace for shaking. There is a 48 hr deadline between the time the sample is taken and the time it is filtered to minimize loss of asbestos fibers due to biological interference. Each sample is shook for 1 minute, and ultrasonicated for at least 10 minutes, shaking every 5 minutes to disperse any fibers that are present. A measured amount of sample is then filtered through a 0.1 um pore size polycarbonate filter, backed by a 5 um pore size MCE filter and a glass frit. Several volumes of liquid may be filtered for each sample in order to assure that a properly loaded sample is obtained. A portion of each resulting filter (and blanks) is then coated with 100-200 um of carbon in a Denton 502A Carbon Evaporator. The carbon encapsulates all of the larger and most of the smaller particulate on the filter. Three mm square pieces of the coated filter are placed on three or more copper TEM grids, and the original filter material is dissolved away in a Jaffe wick and/or condensation washer. The finished replica in carbon containing the particulate is then examined on a Phillips 300 transmission electrom microscope at 10,000 to 20,000x magnification. All asbestos fibers >10um in length are tabulated and characterized as asbestos or non-asbestos using a combination of morphology, electron diffraction characteristics, and elemental composition. The result is calculated in millions of fibers per liter (MFL). The grid is scanned until 20 grid openings have been observed, or until an analytical sensitivity (the hypothetical observation of one fiber) of 0.2 MFL has been reached. The nominal 20 grid opening cut-off is used for those samples containing so much non-asbestos particulate that the desired analytical sensitivity is impractical to attain.

The method was designed to determine EPA drinking water compliance. The standard for drinking water is <7 MFL as measured by this method.

Overall, the coefficient of variation can be expected to be approximately 0.5 for analyses in which >20 asbestos fibers have been counted, ranging up to 1.00 for analyses in which only a few asbestos fibers are counted.

The analysis was performed under an ongoing quality assurance program which includes: Lab blanks, prepared with each set of samples, and analyzed at the rate of one per 25 samples analyzed. Each analyst has suitable background credentials, such as at least a bachelor's degree in geology or chemistry, and has undergone extensive 2-6 month training in TEM techniques and mineralogy specific to TEM asbestos analysis before being allowed to perform client analyses. Unknown reference samples are routinely identified to ensure that each analyst can collect and correctly interpret TEM information. The TEM is aligned and its performance checked daily. Magnification, electron diffraction pattern size, and analytical performance characteristics are calibrated routinely. Samples are re-analyzed sometimes by the same analyst and sometimes by a different analyst in order to determine accuracy and precision. The total of QC analyses (blanks + recounts) are greater than 10% of analyzed samples. Each analyst participates in interlab round robins and proficiency testing in order to show correlation to other lab's analyses. Because TEM samples are not analyzed in batches, which would be traditional for most water analyses, and not every blank is read, and not every sample has a duplicate or replicate analysis associated with it, it is not possible to include a traditional QC report with the analysis. QC reports are produced monthly, and are available on request. Fiberquant is accredited by NVLAP to perform TEM analysis of asbestos in air samples, and has been found to be proficient in the EPA water proficiency program. Accreditation or proficiency does not imply endorsement by the EPA, any other United States governmental agency or any private agency or association. Each lab analysis refers only to the sample tested, and may not, due to the sampling process, be representative of the material sampled. This report may not be reproduced except in full and with the approval of Fiberquant Analytical Services.

Job Analysis Notes:

BG03713: High levels of particulate material did not permit analysis to the desired sensitivity of 0.2 million fibers per liter (MFL).

	Date	Time
Received:	4/26/00	16:27
Filtered:	4/27/00	9:25
Analyzed:	5/8/00	9:30

Analysis Results:

Lab Number	Client Number	Date	Filtered Vol (ml)	#GOs	G O Area	MFL	AsbestosType	Sensitivity (MFL)
							Job Number:	2000-2097
2000-2097- 1	BG03713	4/25/00	1	20	0.00892	<5.4	-	5.4

Uwe Steimle 08-May-00

Analyst: UWE . STEIMLE

Larry S. Pierce

Larry S. Pierce, Approved Accreditation Signatory

5025 S. 33rd Street Phoenix, Arizona 85040-2816 Phone: 602-276-6139 1-800-743-2687 FAX: 602-276-4558

Job Number:	2000-2097

QA Report:	Job Number:	2000-2097

1. Calibrations	
TEM magnification. date of last.	5/4/00
TEM camera constant. date of last.	5/4/00
EDS performance check (k-factors, resolution, low-e perf.). date of last.	1/20/00
TEM stage drift, minimum beam size. date of last.	1/20/00
plasma asher. date of last.	4/4/00
2. Blanks (1/25 samples required)	___ not required this job _____ str/mm2
3. Recounts (1/17 samples required)	___ not required this job _____ Rel%Diff
4. Analyst Performance	
NVLAP proficiency testing	___ current
verified counts. cum. % true positives	89.7
verification of diffraction pattern identifications. cum. % correct	#Num!
verification of EDS spectra. cum. % correct	#Num!

Phoenix, Arizona 85040-2816 Phone: 602-276-6139 1-800-743-2687 FAX: 602-276-4558

uatic Consulting & Testing
5 W. University Dr.
te 106
ıpe, AZ 85281
TN: David Benjes
ɔne (480) 921-8044 Fax (480) 921-0049
lail Address: actlab@sprintmail.com

LAB I.D. NUMBER

Subcontract Chain of Custody

DATE: 26-Apr-00 PAGE 1 OF 1

bcontract Laboratory:
ɔerquant, Inc.
25 S. 33rd Street
oenix, AZ 85040
2-276-6139

&T Sample ID	Date	Time	Matrix	Lab ID	Asbestos	SEM/EDS	Plate Count	Number/Containers
03713	25-Apr-00	1:30 PM	DW		X			1

Project Name
Aero Drilling
Project Number

tes:

Sample Receipt

No. Containers:	1	
Custody Seals:	None	
Received Intact:	Yes	No
Received Cold:	Yes	No
Temperature:		
PRIORITY		

RELINQUISHED BY:
Signature: [signature] Time: 1445
Name: Erica Sharp Date: 4/26/00
Aquatic Consulting & Testing

SAMPLED RECEIVED BY:
Signature: [signature] Time: 1445
Name: HAZZARD Date: 4/26/00
Company Top Speed

RELINQUISHED BY:
Signature: [signature] Time: 1612
Name: HAZZARD Date: 4/26/00
Company

SAMPLED RECEIVED BY:
Signature: [signature] Time: 16:12
Name: Jo Ann Lutz Date: 4-26-00
Company Fiberquant

ARIZONA DEPARTMENT OF ENVIRONMENTAL QUALITY

DRINKING WATER RADIOCHEMICAL ANALYSIS REPORT

>>>> PUBLIC WATER SYSTEM INFORMATION <<<<

>>>> TO BE FILLED OUT BY SYSTEM PERSONNEL <<<<

[/ /-/ / /] _____

System ID System Name

[04 / 25 / 00] [13 : 30] (24 hr clock)

Sample date Sample time

_____

Owner/Contact Person Name

( ) ext.

Owner/Contact Fax Number

Owner/Contact Person Phone Number

SAMPLE COLLECTION POINT ID

Point of entry # [_____]

SAMPLE COLLECTION POINT/ID

☐ Surface-DWR#[_____]

☐ Well - DWR#[_____]

COMPLIANCE SAMPLE TYPE

☐ Composite* of four quarterly samples

☐ Quarterly

☐ Reduced Monitoring/Grab Sample

Date Q1 collected [_____]

Date Q2 collected [_____]

Date Q3 collected [_____]

Date Q4 collected [_____]

*** RADIOCHEMICAL ANALYSIS ***

To be filled out by laboratory personnel

Analysis Method	MCL Value	MDL Value	Contaminant Name	Cont. Code	Analysis Run Date	Results	Exceeds MCL
900.0	15 pCi/l	3 pCi/l	Gross Alpha**	4000	04/30/00	6.1±0.6	☐
	5 pCi/l		Combined Radium (226,228)	4010			☐
903.1		1 pCi/l	Radium 226	4020	05/09/00	0.9±0.3	
904.0		1 pCi/l	Radium 228	4030			
900.0	4 mrem	3pCi/l	Gross Beta	4100			☐
906.0	20,000 pCi/l***		Tritium	4102			
905.0	8 pCi/l***		Strontium-90	4174			

>>> LABORATORY INFORMATION <<<

To be filled out by laboratory personnel

SPECIMEN NUMBER

[0004273713]

ID Number [AZ 0 / 4 /6 / 2] Name: [Radiation Safety Engineering, Inc.]

Comments:[_____]

Authorized Signature: [_____]

Date Public Water System Notified: [_____]

* A composite radiochemical sample means four quarterly samples from a single sample point only.

** Gross alpha is the value of all alpha particle emitters except for uranium and radon 222. Radium 226 is included in the reported gross alpha value. All units are reported in picocuries per liter (pCi/l) EXCEPT for gross beta which is reported in millirem per year.

*** These values are assumed to produce a total body or organ dose of 4 millirem per year.

Radiation Safety Engineering, Inc.

3245 N. WASHINGTON ST. · CHANDLER, ARIZONA 85225-1121
Website: www.radsafe.com

(480) 897-9459
FAX (480) 892-5446

May 9, 2000

Mr. David Benjes
Aquatic Consulting & Testing, Inc.
1525 W. University Drive, Suite 106
Tempe, Arizona 85281

Dear Mr. Benjes:

The results of the radiochemical analyses performed on the water sample numbered BG03713 are presented in the enclosed table.

As requested, the sample was analyzed for ADEQ compliance.

The Arizona Department of Environmental Quality has established a Maximum Contaminant limit (MCL) for gross alpha in drinking water of 15 pCi/L for all alpha emitting nuclides except uranium and radon. The ADEQ has also established a screening level of 5 pCi/L gross alpha. Samples above this screening level must be analyzed for Radium-226. If the Radium-226 level exceeds 3 pCi/L, the sample must also be analyzed for Radium-228. The MCL for total Radium (sum of Ra-226 and Ra-228) is 5 pCi/L.

The sample submitted to us tested above the screening limit for gross alpha, therefore, it was tested for Radium 226. No further analysis is required.

If you have any questions, please contact me at (480) 897-9459.

Sincerely,

Robert L. Metzger, Ph.D, C.H.P.
President

encl

Gross α and ^{226}Ra Activity in Water (pCi/L)

Aquatic Consulting & Testing, Inc.
1525 W. University Drive, Suite 106
Tempe, Arizona 85281

Sample ID	Date Received	Date Completed	Gross α Activity method 600/00-02 (pCi/L)	^{226}Ra Activity method 903.1 (pCi/L)
BG03713	4/27/00	5/9/00	6.1 ± 0.6	0.9 ± 0.3

Robert L. Metzger, Ph.D., C.H.P.

uatic Consulting & Testing
; W. University Dr.
e 106
pe, AZ 85281
N: David Benjes
ne (480) 921-8044 Fax (480) 921-0049
ail Address: actlab@sprintmail.com

LAB I.D. NUMBER

Subcontract Chain of Custody

DATE: 27-Apr-00 PAGE 1 OF 1

ocontract Laboratory:
diation Safety Engineers
45 N. Washington Street
andler, AZ 85225
2-897-9459

T Sample ID	Date	Time	Matrix	Lab ID	Gross Alpha	Gross Beta	Radio Chemistry	Number/Containers
03713	25-Apr-00	1:30 PM	DW		X			1

Project Name
Aero Drilling
Project Number
tes:

Sample Receipt
No. Containers: 1
Custody Seals: None
Received Intact: Yes No
Received Cold: Yes No
Temperature:
PRIORITY

RELINQUISHED BY:
Signature [signature] Time: 9:15
Name: Erica Sharp Date: 4/27/00
Aquatic Consulting & Testing

SAMPLED RECEIVED BY:
Signature [signature] Time: 9:15
Name: Kelly Webb Date: 4/27/00
Company TOP SPEED

RELINQUISHED BY:
Signature [signature] Time: 9:50
Name: KELLY WEBB Date: 4/27/00
Company TOP SPEED

SAMPLED RECEIVED BY:
Signature [signature] Time: 9:50
Name: PIERRE POUQUETTE Date: 4-27-00
Company RSE

ARIZONA DEPARTMENT OF ENVIRONMENTAL QUALITY

DRINKING WATER SYNTHETIC ORGANIC CHEMICAL ANALYSIS REPORT

*** SAMPLES TO BE TAKEN AT P. O. E. ONLY ***

>>>> PUBLIC WATER SYSTEM INFORMATION <<<<

>>>> TO BE FILLED OUT BY SYSTEM PERSONNEL <<<<

[_____] _____

System ID — System Name

[04/25/00] [13:30] (24 hr clock)

Sample date — Sample time

_____

Owner/Contact Person Name

( ) _____

Owner/Contact Fax Number

( ) _____

Owner/Contact Person Phone Number

SAMPLE TYPE

[X] Compliance Monitoring

SAMPLE COLLECTION POINT / ID

[X] Point of Entry# [_____]

_____

SAMPLING SITE ID

FOR MCL EXCEEDANCE OR COMPOSITE TRIGGER

[_____]

Original Violating Specimen Number

SAMPLE TYPE

[ ] CONFIRMATION

[ ] CONFIRMATION FOR COMPOSITE TRIGGER

***** SYNTHETIC ORGANIC CHEMICAL ANALYSIS *****

To be filled out by laboratory personnel

Analysis Method	MCL Value	Trigger Value	Contaminant Name	Cont. Code	Analysis Run Date	Results*	Exceeds MCL	Exceeds Trigger
515.1	0.07	0.035	2,4-D	2105	05/05/00	< 0.035	[ ]	[ ]
515.1	0.05	0.025	2,4,5-TP (Silvex)	2110	05/05/00	< 0.025	[ ]	[ ]
505	0.003	0.0015	Toxaphene	2020	05/02/00	< 0.0015	[ ]	[ ]
525.2	0.002	0.001	Alachlor	2051	05/01/00	< 0.001	[ ]	[ ]
525.2	0.003	0.003	Atrazine	2050	05/01/00	< 0.0015	[ ]	[ ]
531.1	0.04	0.02	Carbofuran	2046	05/10/00	< 0.02	[ ]	[ ]
515.1	0.001	0.0005	Pentachlorophenol	2326	05/05/00	< 0.0005	[ ]	[ ]
505	0.002	0.001	Chlordane	2959	05/02/00	< 0.001	[ ]	[ ]
504.1	0.0002	0.0002	Dibromochloropropane (DBCP)	2931	05/02/00	< 0.0001	[ ]	[ ]
504.1	0.00005	0.00005	Ethylene Dibromide (EDB)	2946	05/02/00	< 0.000025	[ ]	[ ]
525.2	0.0004	0.0002	Heptachlor	2065	05/01/00	< 0.0002	[ ]	[ ]

>>>>> LABORATORY INFORMATION <<<<<

To be filled out by laboratory personnel

SPECIMEN NUMBER

[489382-90]

ID Number [AZ 0 / 4 / 3 / 2] Name: [Environmental Health Laboratories]

Comments: [_____]

Reviewed by: [_____] Finalized by: [_____]

Date Public Water System Notified: [_____]

* All units must be reported in milligrams per liter

Report #: 489382-92r

DWAR 3: Revised 08/16/99

ARIZONA DEPARTMENT OF ENVIRONMENTAL QUALITY

DRINKING WATER SYNTHETIC ORGANIC CHEMICAL ANALYSIS REPORT

*** SAMPLES TO BE TAKEN AT P. O. E. ONLY ***

>>>> PUBLIC WATER SYSTEM INFORMATION <<<<

>>>> TO BE FILLED OUT BY SYSTEM PERSONNEL <<<<

[_____] _____

System ID — System Name

[04/25/00] [13:30] (24 hr clock)

Sample date — Sample time

***** SYNTHETIC ORGANIC CHEMICAL ANALYSIS *****

To be filled out by laboratory personnel

Analysis Method	MCL Value	Trigger Value	Contaminant Name	Cont. Code	Analysis Run Date	Results*	Exceeds MCL	Exceeds Trigger
525.2	0.0002	0.0001	Heptachlor Epoxide	2067	05/01/00	< 0.0001	☐	☐
525.2	0.0002	0.0001	Lindane	2010	05/01/00	< 0.0001	☐	☐
525.2	0.0002	0.0001	Benzo(a)pyrene	2306	05/01/00	< 0.0001	☐	☐
515.1	0.2	0.1	Dalapon	2031	05/05/00	< 0.1	☐	☐
525.2	0.006	0.006	Di(2-ethylhexyl)phthalate	2039	05/01/00	< 0.003	☐	☐
525.2	0.4	0.2	Di(2-ethylhexyl)adipate	2035	05/01/00	< 0.2	☐	☐
515.1	0.007	0.0035	Dinoseb	2041	05/05/00	< 0.0035	☐	☐
1613	3e-08	1.5e-08	2,3,7,8-TCDD (Dioxin)	2063	05/09/00	< 5e-06	☐	☐
549.1	0.02	0.01	Diquat	2032	05/01/00	< 0.01	☐	☐
548.1	0.1	0.05	Endothall	2033	04/29/00	< 0.05	☐	☐
525.2	0.002	0.001	Endrin	2005	05/01/00	< 0.001	☐	☐
[redacted]	0.7	0.35	Glyphosate	2034	04/29/00	< 0.35	☐	☐
525.2	0.001	0.0005	Hexachlorobenzene	2274	05/01/00	< 0.0005	☐	☐
525.2	0.05	0.025	Hexachlorocyclopentadiene	2042	05/01/00	< 0.025	☐	☐
531.1	0.2	0.1	Oxamyl	2036	05/10/00	< 0.1	☐	☐
515.1	0.5	0.25	Picloram	2040	05/05/00	< 0.25	☐	☐
525.2	0.004	0.002	Simazine	2037	05/01/00	< 0.002	☐	☐
525.2	0.04	0.02	Methoxychlor	2015	05/01/00	< 0.02	☐	☐
_____	0.0005	0.00025	PCB:Polychlorinated Biphenyls	2383	_____	_____	☐	☐

Report Summary: None of the analytes included in the detailed parameter list were detected in the sample submitted for analysis.

Note: The sample submitted for Method 531.1 analysis was received improperly preserved. The sample was preserved by EHL personnel prior to analysis.

Note: Method 549.1 results are suspect due to matrix interference as demonstrated by the low biased recovery of the MS (18%) outside the acceptance limits of 70-130%. Note: Dioxin analysis was performed by Pace Analytical of Minneapolis, MN.

Note: Sample containers were provided by the client. AC & T Sample ID BG03713 and BG03713-TB

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SPECIMEN NUMBER

[489382-90]

Report #: 489382-92r

DWAR 3: Revised 08/16/99

ARIZONA DEPARTMENT OF ENVIRONMENTAL QUALITY
DRINKING WATER AROCLOR ANALYSIS REPORT
*** SAMPLES TO BE TAKEN AT P. O. E. ONLY ***
>>>> PUBLIC WATER SYSTEM INFORMATION <<<<
>>>> TO BE FILLED OUT BY SYSTEM PERSONNEL <<<<

[ ] System ID — System Name

[04/25/00] Sample date [13:30] Sample time (24 hr clock)

Owner/Contact Person Name

( ) Owner/Contact Fax Number

( ) Owner/Contact Person Phone Number

SAMPLE TYPE
[X] Compliance Monitoring

SAMPLE SITE ID

SAMPLE COLLECTION POINT / ID
[X] Point of Entry# [ ]

*****AROCLOR (PCBs SCREENING TEST)*****
To be filled out by laboratory personnel

Analysis Method	Trigger Value	Contaminant Name	Cont. Code	Analysis Run Date	Results*	Exceeds** Trigger
505	0.00008	Aroclor 1016	2388	05/02/00	< 0.00008	☐
505	0.02	Aroclor 1221	2390	05/02/00	< 0.02	☐
505	0.0005	Aroclor 1232	2392	05/02/00	< 0.0005	☐
505	0.0003	Aroclor 1242	2394	05/02/00	< 0.0003	☐
505	0.0001	Aroclor 1248	2396	05/02/00	< 0.0001	☐
505	0.0001	Aroclor 1254	2398	05/02/00	< 0.0001	☐
505	0.0002	Aroclor 1260	2400	05/02/00	< 0.0002	☐

Report Summary: None of the analytes included in the detailed parameter list were detected in the sample submitted for analysis.

Note: Sample containers were provided by the client. AC & T Sample ID BG03713

Note: This report may not be reproduced, except in full, without written approval from Environmental Health Laboratories (div. of MAS Technology Corporation).

>>>>> LABORATORY INFORMATION <<<<<
To be filled out by laboratory personnel

SPECIMEN NUMBER
[489383]
ID Number [AZ 0 / 4 / 3 / 2] Name: [Environmental Health Laboratories]
Comments: [ ]
Reviewed by: [ ] Finalized by: [Paul Ba]
Date Public Water System Notified: [ ]

* All units must be reported in milligrams per liter
** If any trigger value is exceeded, then further testing for Decachlorobiphenyl must be performed.

ARIZONA DEPARTMENT OF ENVIRONMENTAL QUALITY

DRINKING WATER UNREGULATED SYNTHETIC ORGANIC CHEMICAL ANALYSIS REPORT

*** SAMPLES TO BE TAKEN AT P. O. E. ONLY ***

>>>> PUBLIC WATER SYSTEM INFORMATION <<<<

>>>> TO BE FILLED OUT BY SYSTEM PERSONNEL <<<<

[ ] System ID

System Name

[04/25/00] Sample date [13:30] Sample time (24 hr clock)

Owner/Contact Person Name

( ) Owner/Contact Fax Number

( ) Owner/Contact Person Phone Number

SAMPLE TYPE

[X] Compliance Monitoring

SAMPLE SITE ID

SAMPLE COLLECTION POINT / ID

[X] Point of Entry# [ ]

***** UNREGULATED SYNTHETIC ORGANIC CHEMICALS *****

To be filled out by laboratory personnel

Analysis Method	MDL Value	Contaminant Name	Cont. Code	Analysis Run Date	Results*
531.1	.0005**	Aldicarb	2047	05/10/00	< 0.0005
531.1	.0005**	Aldicarb Sulfoxide	2043	05/10/00	< 0.0005
531.1	.0008**	Aldicarb Sulfone	2044	05/10/00	< 0.0008
531.1	No MDL	3-Hydroxycarbofuran	2066	05/10/00	< 0.001
525.2	No MDL	Aldrin	2356	05/01/00	< 0.0001
525.2	No MDL	Propachlor	2077	05/01/00	< 0.0001
525.2	No MDL	Butachlor	2076	05/01/00	< 0.0001
531.1	No MDL	Carbaryl	2021	05/10/00	< 0.001
515.1	No MDL	Dicamba	2440	05/05/00	< 0.0001
525.2	No MDL	Dieldrin	2070	05/01/00	< 0.0001
531.1	No MDL	Methomyl	2022	05/10/00	< 0.0005
525.2	No MDL	Metolachlor	2045	05/01/00	< 0.0001
525.2	No MDL	Metribuzin	2595	05/01/00	< 0.0001

Report Summary: None of the analytes included in the detailed parameter list were detected in the sample submitted for analysis.

Note: The sample submitted for Method 531.1 analysis was received improperly preserved. The sample was preserved by EHL personnel prior to analysis.

Note: Sample containers were provided by the client. AC & T Sample ID BG03713 and BG03713-TB

Note: This report may not be reproduced, except in full, without written approval from Environmental Health Laboratories (div. of MAS Technology Corporation).

>>>>> LABORATORY INFORMATION <<<<<

To be filled out by laboratory personnel

SPECIMEN NUMBER

[489384-85+87]

ID Number [AZ0/4/3/2] Name: [Environmental Health Laboratories]

Comments: [ ]

Reviewed by: [ ] Finalized by: [Paul Ba]

Date Public Water System Notified: [ ]

* All units must be reported in milligrams per liter (mg/l)

** MDL recommended but not required.

Report #: 489382-87(84,85+87)u

DWAR 3B: Revised 08/16/99

Environmental Health Laboratories
The Nation's Drinking Water Laboratory
110 S. Hill Street • South Bend, IN 46617 • Phone (219) 233-4777 • (800) 332-4345
ORDER # 47971

www.ehl.cc
SHADED AREA FOR LAB USE ONLY

CHAIN OF CUSTODY RECORD

PAGE _____ OF _____

CLIENT/COMPANY ORDERING TEST	STATE OF SAMPLE ORIGIN	SAMPLER (Signature)	PWS ID#	PO#
Aquatic Consulting & Testing				

EHL LAB#	COLLECTION DATE	COLLECTION TIME	SAMPLING SITE	TEST NAME	SAMPLE REMARKS	# OF CONTAINERS	MATRIX CODE	TURNAROUND TIME
489382	4/25	1330 AM PM	BG 03713	504		2		
489383	↓	↓ AM PM	↓	505		2		
489384		AM PM		525		2		
489385		AM PM		531		1		
489386		AM PM		547		1		
489387		AM PM		515		2		
489388		AM PM		548		2		
489389		AM PM		549		1		
489390	↓	↓ AM PM	↓	Dioxin		2		
489391	2/23/00	NG AM PM	BG03713-TB	504		1		
489392	↓	↓ AM PM	↓	525		1		
		AM PM						
		AM PM						

FIELD COMMENTS: CARRIER _____ AIRBILL NO. _____ COOLER NO. _____ DATE SHIPPED _____

In House COC

LAB RESERVES THE RIGHT TO RETURN UNUSED PORTIONS OF NON-AQUEOUS SAMPLES TO CLIENT.

RELINQUISHED BY: (Signature)	DATE	TIME AM PM	RECEIVED BY: (Signature)	DATE	TIME AM PM
RELINQUISHED BY: (Signature)	DATE	TIME AM PM	RECEIVED FOR LABORATORY BY: SRyan	DATE 4-27-00	TIME 0915 AM PM

LAB COMMENTS
wet
CLIENT PROVIDED SAMPLE CONTAINER

CONDITIONS UPON RECEIPT: (Check One)
☒ Iced ☐ Ambient or _____ °C Upon Receipt

MATRIX CODES:
DW = DRINKING WATER
GW = GROUNDWATER
SW = SURFACE WATER
PW = POOL
RW = REAGE ER
WW = WASTEWATER

TURN-AROUND TIME (TAT) - SURCHARGES*

SW = STANDARD WRITTEN	0%	IV = IMMEDIATE (3 WORKING DAYS) VERBAL	100%	STAT = LESS THAN 48 HOURS	Call
RV = RUSH (5 WORKING DAYS) VERBAL	50%	IW = IMMEDIATE (3 WORKING DAYS) WRITTEN	125%	Samples received unannounced with less than 48 hours holding time remaining may be subject to addit surcharges.	
RW = RUSH (5 WORKING DAYS) WRITTEN	75%	SP = WEEK OLIDAY	Call		

* Expedited services not available for all tests - call for details.

1 1 1 1

LAB I.D. NUMBER

Aquatic Consulting & Testing
1525 W. University Dr.
Suite 106
Tempe, AZ 85281
ATTN: Chris Christian
Phone (480) 921-8044 Fax (480) 921-0049
E-Mail Address: actlab@sprintmail.com

Subcontract Chain of Custody

DATE: 26-Apr-00 PAGE 1 OF 1

Subcontract Laboratory:
EHL
1[illegible] South Hill Street
South Bend, IN 46617
(219) 233-4777

AG&T Sample ID	Date	Time	Matrix	Lab ID	504	508 505 ss	525.2	5311	547	Dioxin	515	Number/Containers
BG03713	25-Apr-00	1:30 PM	DW		X	X	X	X	X	X	X	15
BG03713-TB	--	--	AQ		X		X					2

Also received 548 and 549 Sample bottles ss 4-27-00
Run 548 & 549 ES
per David Berger
4/27/00 NT 1300

Project Name: Aero Drilling
Project Number:
Notes:

CLIENT PROVIDED SAMPLE CONTAINER

Sample Receipt
No. Containers: 17
Custody Seals: None
Received Intact: Yes No
Received Cold: Yes No
Temperature: Wet ice
PRIORITY

RELINQUISHED BY:
Signature: [signature] Time: 15:00
Name: Erica Sharp Date: 4/26/00
Aquatic Consulting & Testing

SAMPLED RECEIVED BY:
Signature: SSpurgeon Time: 0915
Name: SSpurgeon Date: 4-27-00

RELINQUISHED BY:
Signature: Time:
Name: Date:

SAMPLED RECEIVED BY:
Signature: Time:
Name: Date:
EHL

Table-2 *From Payson 2005 Report*

Selected Hydrogen Oxygen and Tritium Results -- MRWRMS -- Town of Payson				
Well / Site	Year	δ18O ‰	δD ‰	Tritium, TU
CPN-13	2004	-9.9	-71	3.6
NW Pine Deep	2004	-11.2	-78	4.0
NW Pine Shallow	2004	-11.1	-78	2.3
Fossil Springs Upper	2004	-11.6	-81	1.7
Pine Creek	2004	-10.1	-70	5.4
87 and Cavern	2004	-9.7	-68	6.0
Round Valley	2004	-10.5	-75	3.5
CC #3	2004	-10.0	-71	3.7
Woodland #1	2004	-10.0	-73	2.2
Payson Pines 4	2004	-10.9	-77	1.4
Winter 03-04	2004	-9.7	-65	6.1
Fossil Springs Lower	2004	-11.6	-79	1.5
Cold Springs	2004	-11.4	-77	4.0
Webber Springs	2004	-10.4	-72	4.1
Hunter Creek	2004	-8.9	-60	5.1
Fish Hatchery	2004	-10.0	-69	2.6
Ellison	2004	-10.9	-76	5.9
Tonto Bridge Spring	2004	-10.7	-75	2.0
Deep Strawberry (700ft)	2004	-11.1	-77	4.0
Shallow Strawberry	2004	-11.3	-77	1.6
Blue Ridge	2004	-9.3	-67	10.2
Summer Precip. 2004	2004	-6.6	-45	5.8
DB-2	2003	-11.9	-87	0.5
DB-Shallow	2003	-10.2	-73	2.7
Summer Precip. 2003	2003	-6.4	-43	7.3
Cold Springs	2003	-11.2	-77	4
Winter precip 02-03	2003	-12.8	-86.7	4.7
Rye 03 HI-4	2003	-12	-87	0.6
McKamey	2003	-10.4	-72	3
Turtle Rock	2003	-10.9	-75	0.5
CPN-13	2003	-9.7	-70	3.4
GC-1	2003	-10.8	-76	1.3
Luke	2003	-11	-76	2.9
TOP-19	2003	-10.2	-70	4.3
Payson Pines 4	2003	-10.9	-76	0.7
Skypark	2003	-10.2	-74	1.6
Woodland #1	2003	-10.4	-73	2
Beeline	2003	-10.8	-75	1.9
CC-3	2003	-10.2	-71	3.5
Lake Drive	2003	-9	-66	3.6
Mt. View	2003	-9	-71	4.2
Reclaimed	2003	-10.3	-72	3.1
Summit	2001	-11.7	-81	n/s
McKamey	2001	-10.6	-72	n/s
Turtle Rock	2001	-11.2	-78	n/s
CPN-13	2001	-10.1	-73	n/s
GC-1	2001	-11.2	-77	n/s
Luke	2001	-11.2	-77	n/s
TOP-19	2001	-10.5	-72	n/s
Payson Pines 4	2001	-11.3	-78	n/s
NP-2	2001	-11.2	-77	n/s
Skypark	2001	-10.6	-75	n/s
Woodland #1	2001	-10.6	-75	n/s
Beeline	2001	-11.1	-78	n/s
CC-3	2001	-10.5	-73	n/s
Lake Drive	2001	-9.4	-69	n/s

n/s = no sample

APPENDIX IV

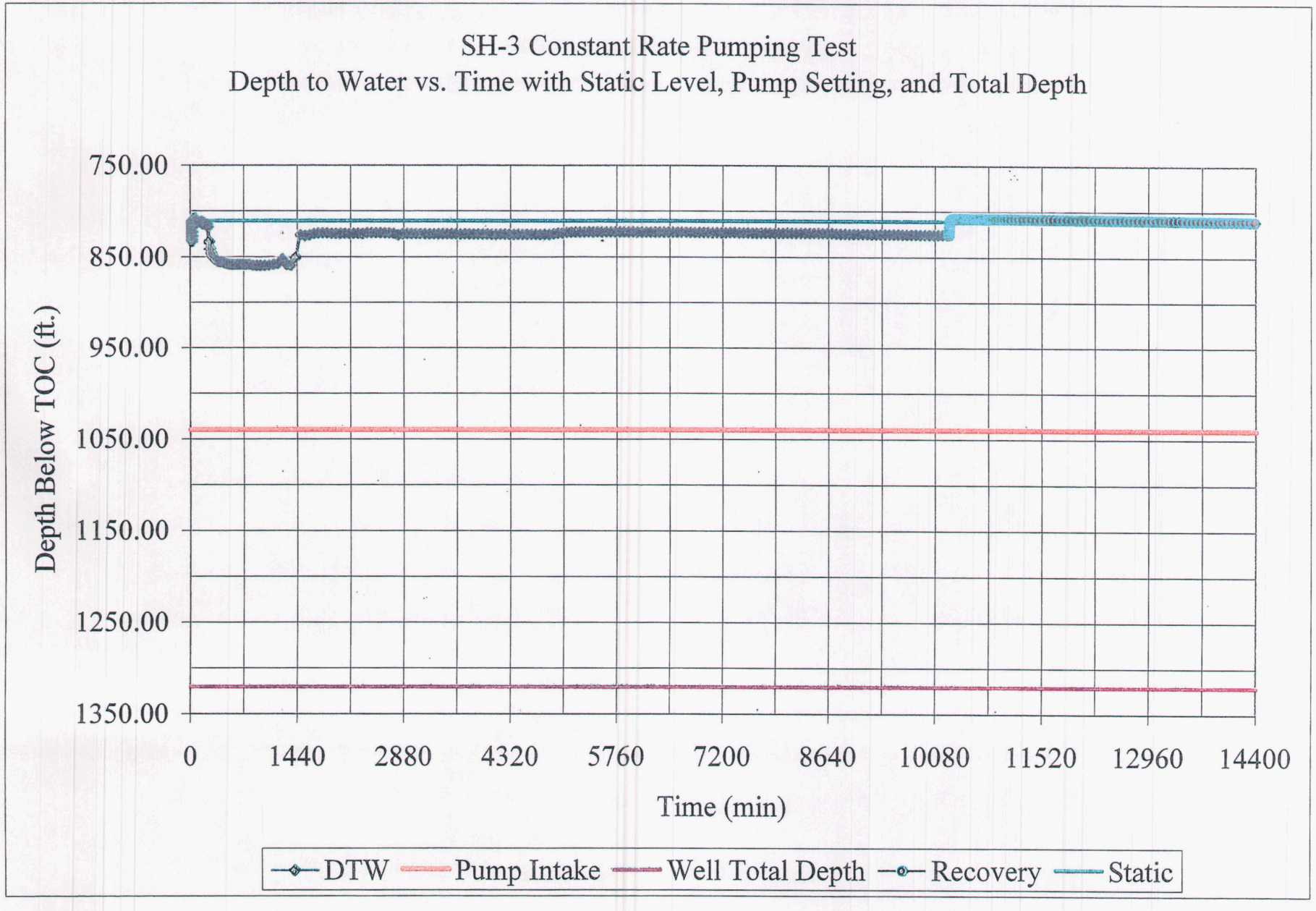
WELL TESTING DATA AND GRAPHS

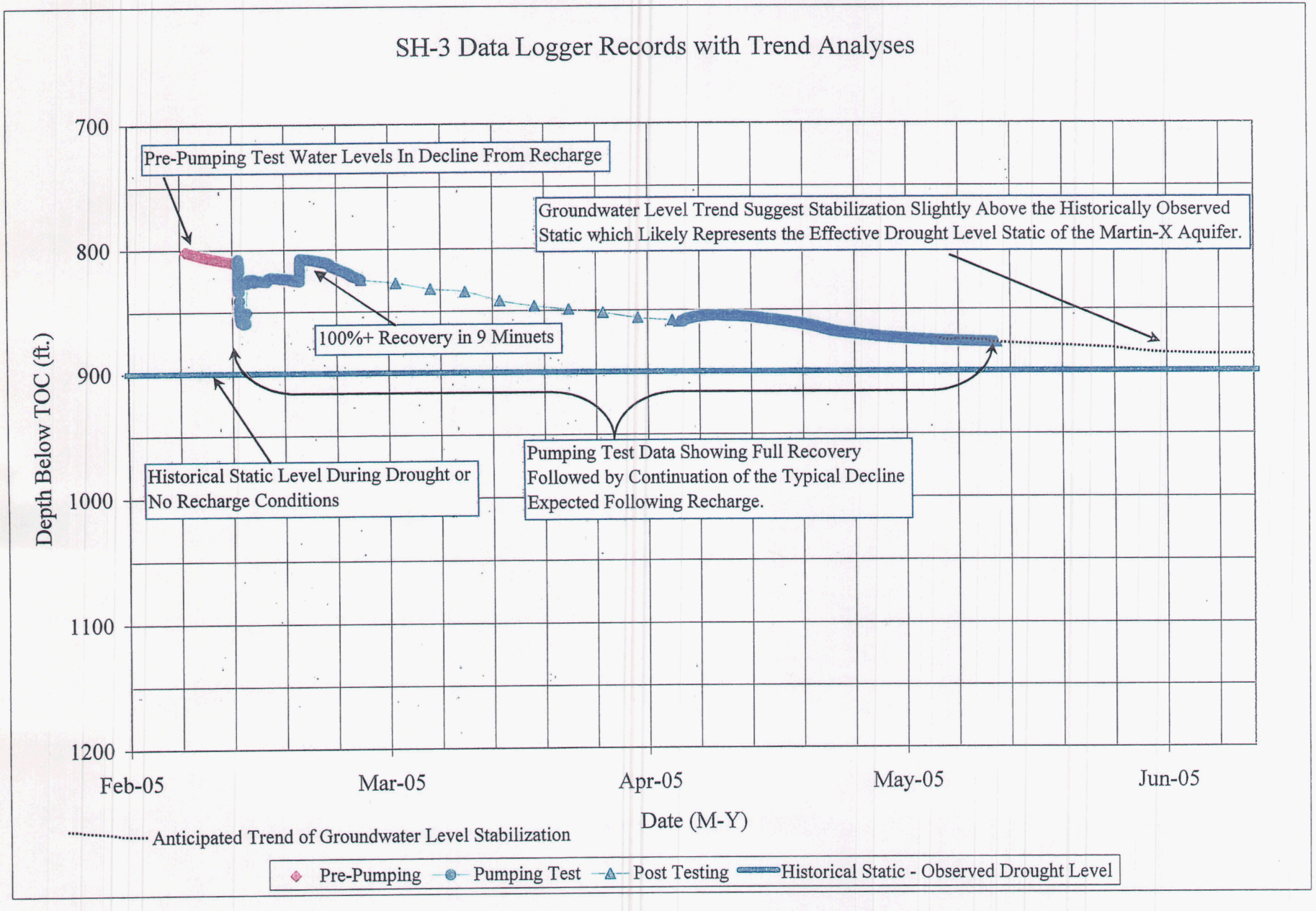
SH3

- SH3 Depth to Water vs. Time with Static Level, Pump Setting, and Total Depth
- SH3 Data Logger Records with Trend Analyses
- SH3 Constant Rate 46gpm Pumping Rate Test Drawdown vs. Log Time
- SH3 Recovery Residual drawdown vs. Log t/t'
- SH3 Constant Rate 46gpm Pumping Rate Test Drawdown vs. Log Time 100 year Impact Projection
- SH3 Constant Rate Test – Theis Earlier Time
- SH3 Constant Rate Test – Theis Late Time
- SH3 Constant Rate Test – Papadopulos Forward – Earlier Time
- SH3 Constant Rate Test – Papadopulos Forward – Late Time
- SH3 Constant Rate Test – Theis Forward – Earlier Time
- SH3 Constant Rate Test – Theis Forward – Late Time
- SH3 Aquifer Testing Data Table
- SH3 Groundwater Elevation History Deep M-X Aquifer

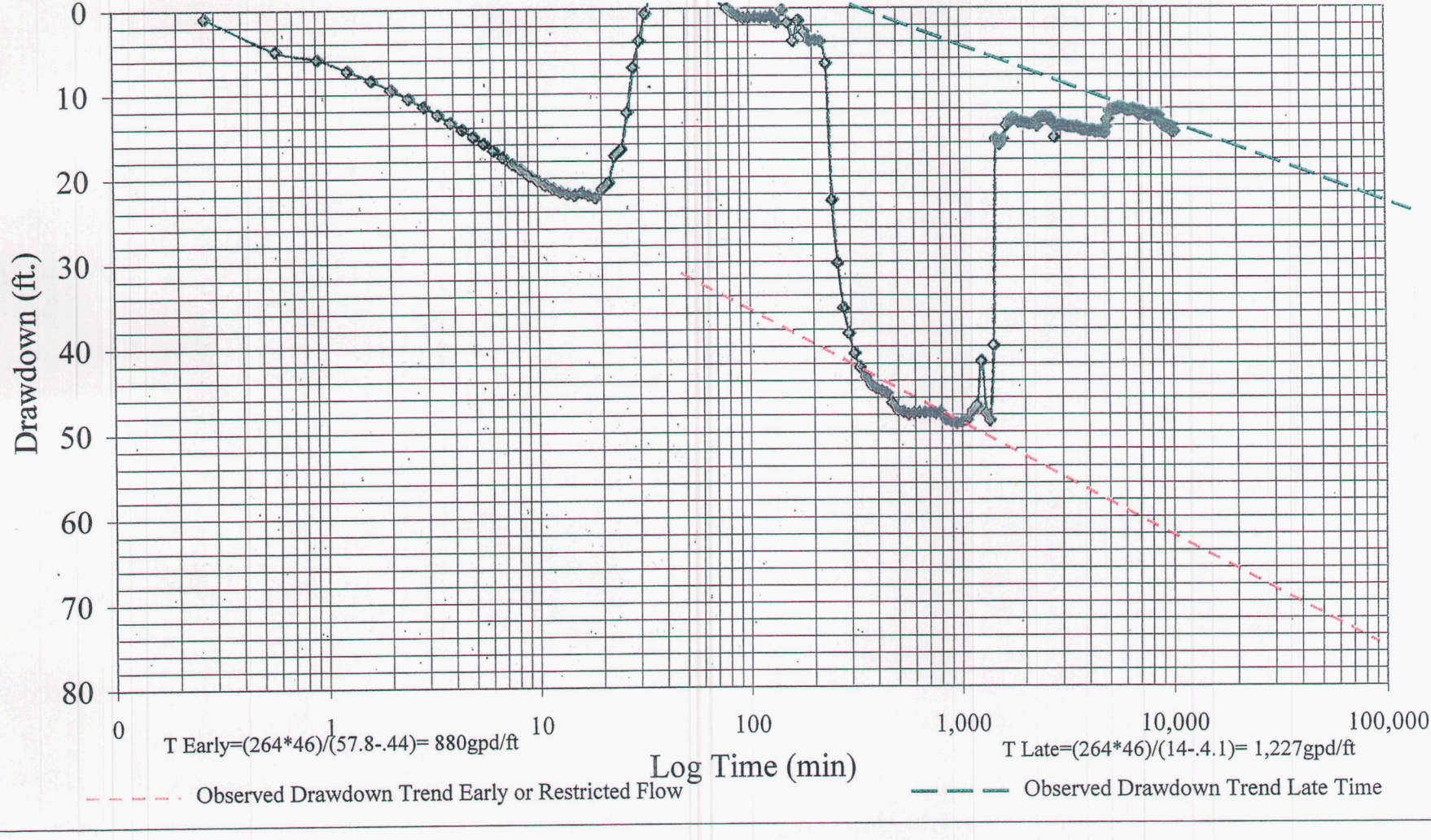
SH2

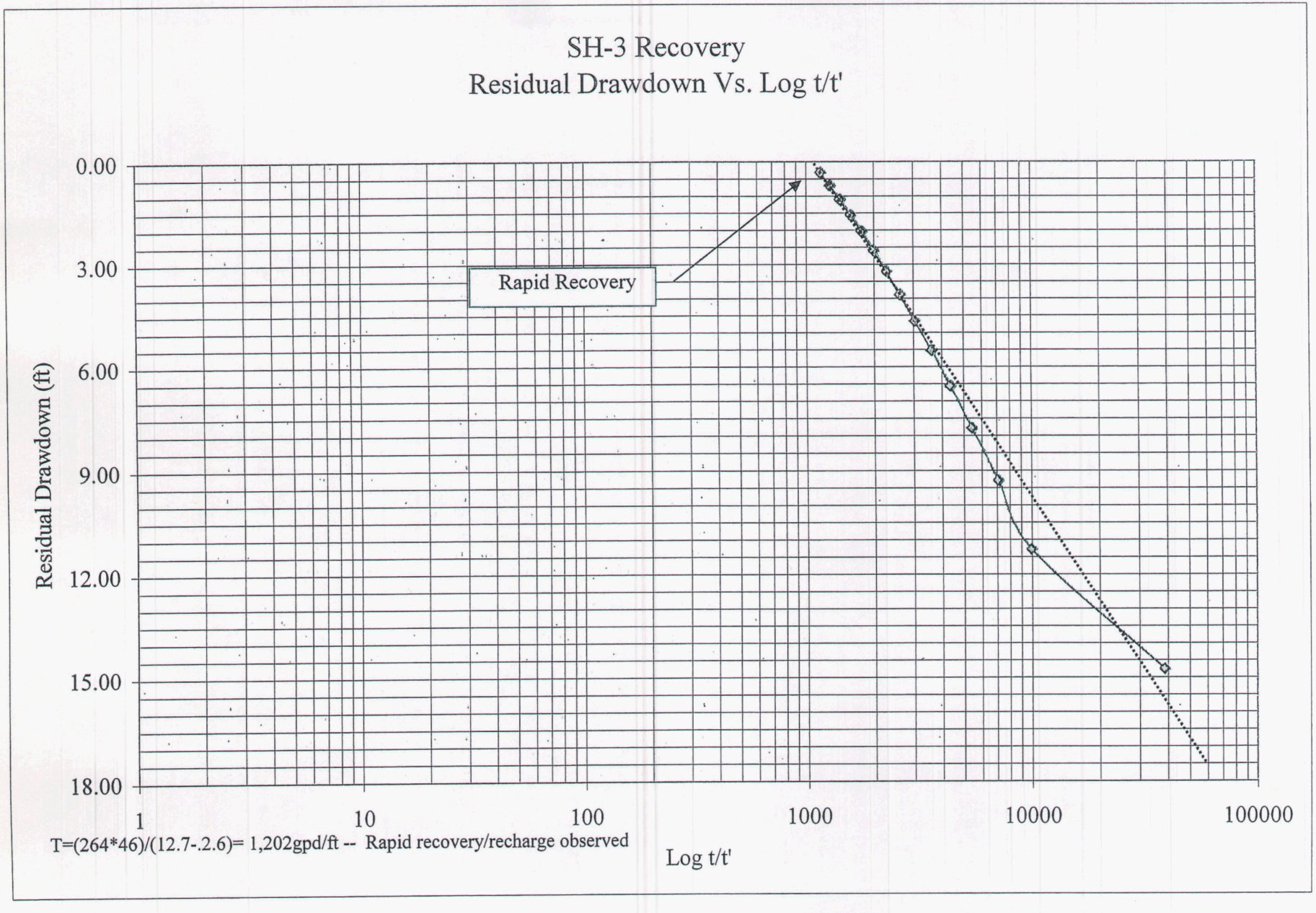
- SH2 Constant Rate Pumping Test Depth to Water vs. Time with Static Level, Pump Setting, and Total Depth
- SH2 Static DTW Trends Pre 2005 Pumping Test
- Well 5 DTW Trends Previous to Pumping at SH2
- SH2 Constant Rate Testing Drawdown vs. Log Time at SH2
- SH2 Testing Residual Drawdown vs. Log t/t' at SH2
- SH2 Testing Well 5 Observed Drawdown vs. Log Time Since Pumping Start
- SH2 Testing Well 5 Residual Drawdown vs. Log t/t'
- SH2 Constant Rate Testing Drawdown vs. Log Time to 100 Years with Projected Drought Scenario
- SH2 Testing Well 5 Observed Drawdown vs. Log Time Since Pumping Start Projected to 10, 40, and 100 Years
- SH2 Testing – Distance Impact Plot
- SH2 Projected Cone of Influence / Drawdown Impact Map
- SH2 Testing – Well 5 Theis – Late Time
- SH2 Testing – Theis Late Time at SH2 – Pumping Well
- SH2 Testing Data Table
- Well 5 Data Table – SH2 Pumping
- Well 5 (55-578551) Shallow Aquifer Groundwater Elevation History complete Data Logger and Manual Record
- Apache Street Well (#55-646314) Shallow Aquifer Groundwater Elevation History complete Data Logger and Manual Record

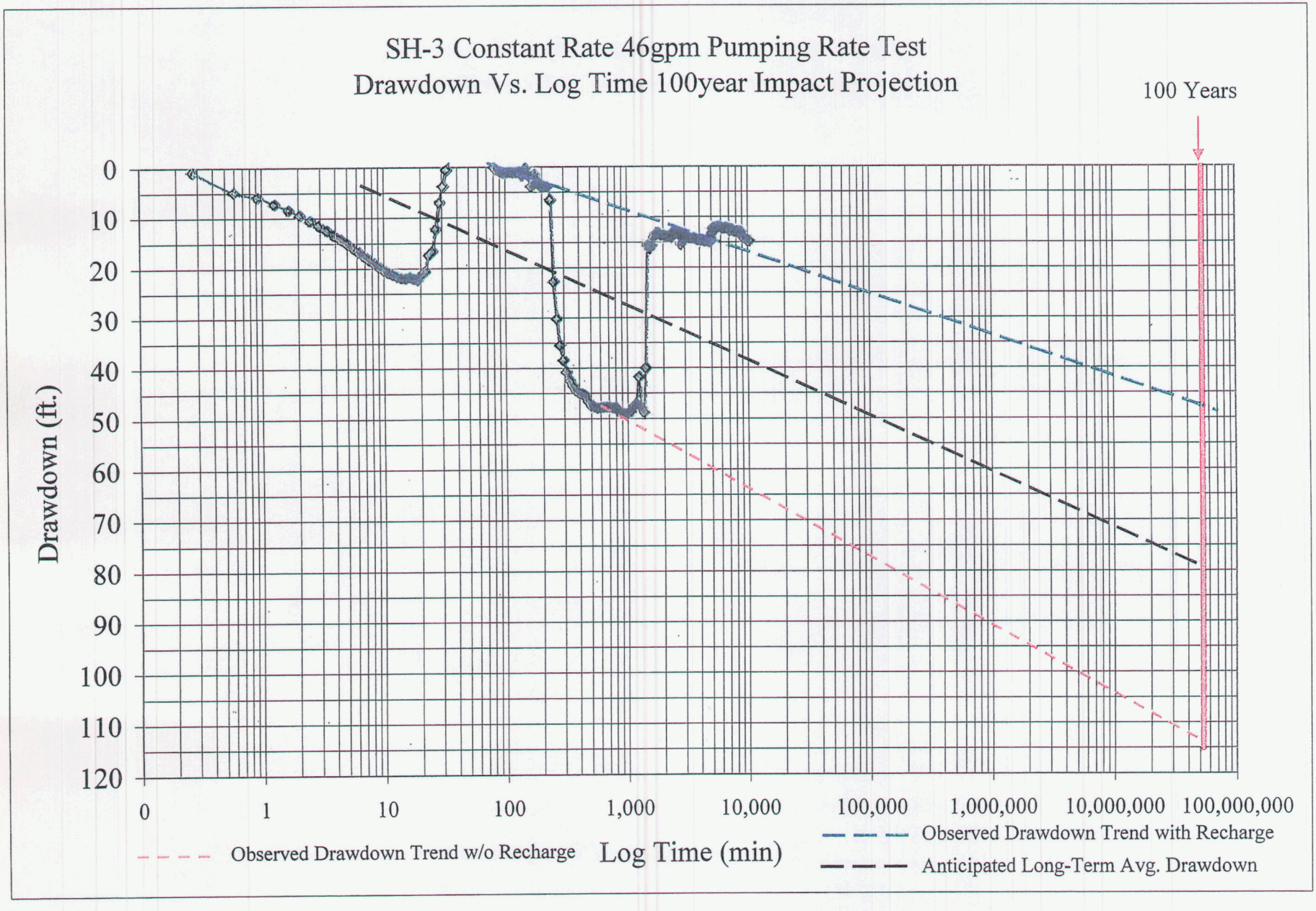

SH-3 Constant Rate Pumping Test
Depth to Water vs. Time with Static Level, Pump Setting, and Total Depth
Depth Below TOC (ft.)
750.00
850.00
950.00
1050.00
1150.00
1250.00
1350.00
0
1440
2880
4320
5760
7200
8640
10080
11520
12960
14400
Time (min)
DTW
Pump Intake
Well Total Depth
Recovery
Static


SH-3 Data Logger Records with Trend Analyses
Pre-Pumping Test Water Levels In Decline From Recharge
Groundwater Level Trend Suggest Stabilization Slightly Above the Historically Observed Static which Likely Represents the Effective Drought Level Static of the Martin-X Aquifer.
100%+ Recovery in 9 Minuets
Historical Static Level During Drought or No Recharge Conditions
Pumping Test Data Showing Full Recovery Followed by Continuation of the Typical Decline Expected Following Recharge.
Depth Below TOC (ft.)
700
800
900
1000
1100
1200
Feb-05
Mar-05
Apr-05
May-05
Jun-05
Date (M-Y)
Anticipated Trend of Groundwater Level Stabilization
Pre-Pumping
Pumping Test
Post Testing
Historical Static - Observed Drought Level

SH-3 Constant Rate 46gpm Pumping Rate Test
Drawdown Vs. Log Time

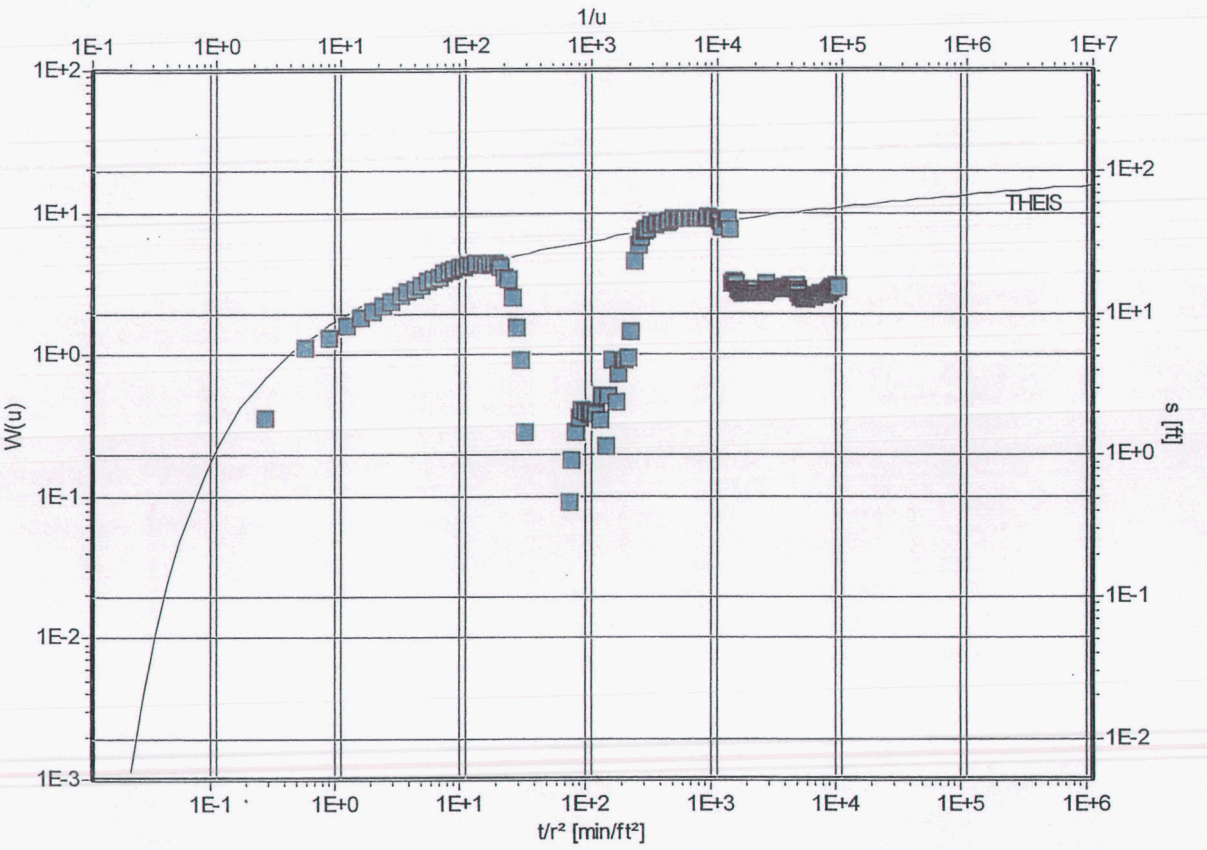



SH-3 Recovery
Residual Drawdown Vs. Log t/t'
Rapid Recovery
Residual Drawdown (ft)
0.00
3.00
6.00
9.00
12.00
15.00
18.00
1
10
100
1000
10000
100000
Log t/t'
T=(264*46)/(12.7-.2.6)= 1,202gpd/ft -- Rapid recovery/recharge observed


SH-3 Constant Rate 46gpm Pumping Rate Test
Drawdown Vs. Log Time 100year Impact Projection
100 Years
Drawdown (ft.)
0
10
20
30
40
50
60
70
80
90
100
110
120
0
1
10
100
1,000
10,000
100,000
1,000,000
10,000,000
100,000,000
Log Time (min)
Observed Drawdown Trend w/o Recharge
Observed Drawdown Trend with Recharge
Anticipated Long-Term Avg. Drawdown

HWRC	Pumping Test Analysis Report
P.O. Box 891	Project: SH testing
Payson, AZ 85547	Number:
Phone: (928)-468-0252	Client:

SH3 Constant Rate Test [Theis]



Pumping Test: **SH3 Constant Rate Test**

Analysis Method: **Theis**

Analysis Results:	Transmissivity:	1.37E+2 [ft²/d]	Conductivity:	3.43E-1 [ft/d]

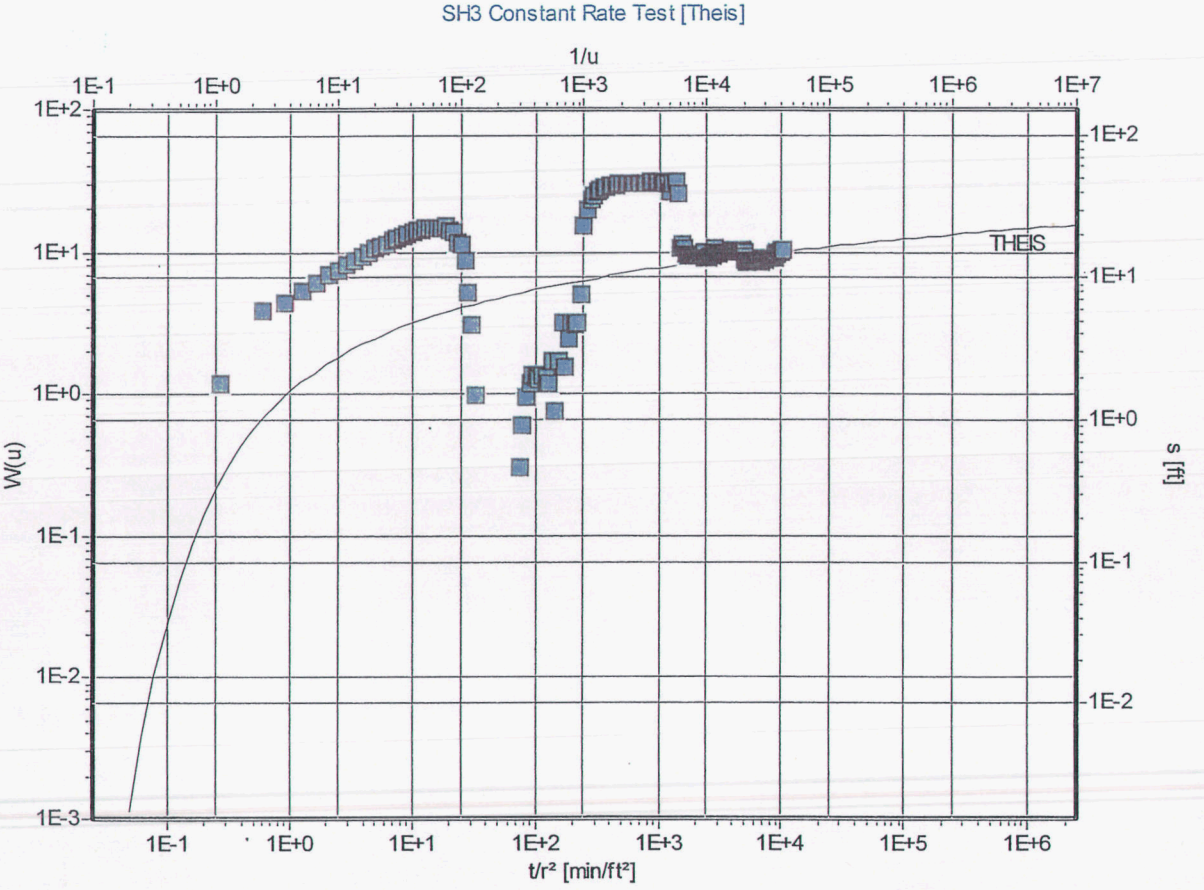
Test parameters:	Pumping Well:	SH3	Aquifer Thickness:	400 [ft]
	Casing radius:	0.25 [ft]	Unconfined Aquifer	
	Screen length:	400 [ft]		
	Boring radius:	0.167 [ft]		
	Discharge Rate:	46 [U.S. gal/min]		

Comments: Thies - Custom Fit to Earlier Time Data

Evaluated by:

Evaluation Date: 7/10/2005

HWRC	Pumping Test Analysis Report
P.O. Box 891	Project: SH testing
Payson, AZ 85547	Number:
Phone: (928)-468-0252	Client:



Pumping Test: **SH3 Constant Rate Test**

Analysis Method: **Theis**

Analysis Results:				
	Transmissivity:	4.65E+2 [ft²/d]	Conductivity:	1.16E+0 [ft/d]

Test parameters:				
	Pumping Well:	SH3	Aquifer Thickness:	400 [ft]
	Casing radius:	0.25 [ft]	Unconfined Aquifer	
	Screen length:	400 [ft]		
	Boring radius:	0.167 [ft]		
	Discharge Rate:	46 [U.S. gal/min]		

Comments: Theis - Fit to Late Time Drawdown

Evaluated by: MP

Evaluation Date: 7/10/2005

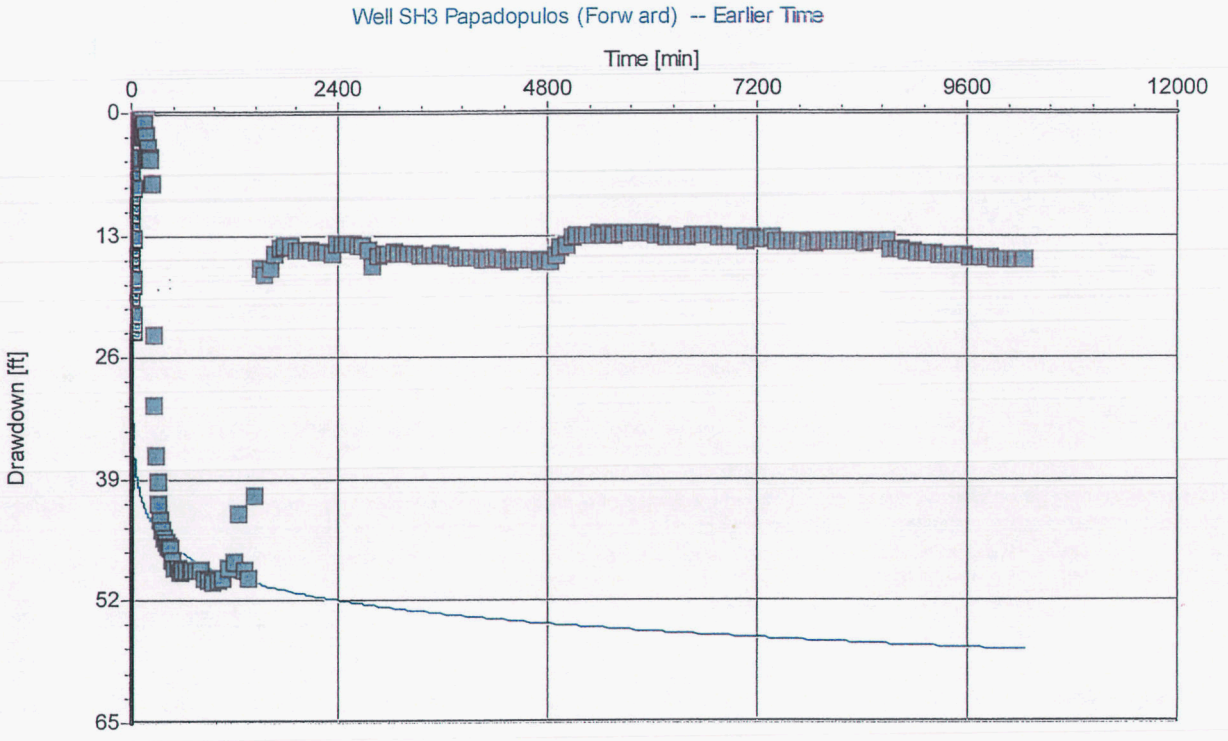
HWRC
P.O. Box 891
Payson, AZ 85547
Phone: (928)-468-0252

Pumping Test Analysis Report

Project: SH testing

Number:

Client:



Pumping Test: SH3 Constant Rate Test

Analysis Method: Papadopulos (1967) Large Diameter Well - Forward Solution

Analysis Results: Transmissivity: 2.24E+2 [ft²/d]

Conductivity: 5.60E-1 [ft/d]

Test Details: Saturated Aquifer Thickness: 400 ft

Pumping Well:	X ft	Y ft	TOC Elev. ft	L ft	R ft	r ft	Q U.S. gal/min	Well Screen
SH3	300	300	5502		0.17	0.25	46	Fully Penetrating

Comments: Effective well radius is large due to cavernous nature of formation

Evaluated by:

Evaluation Date: 7/10/2005

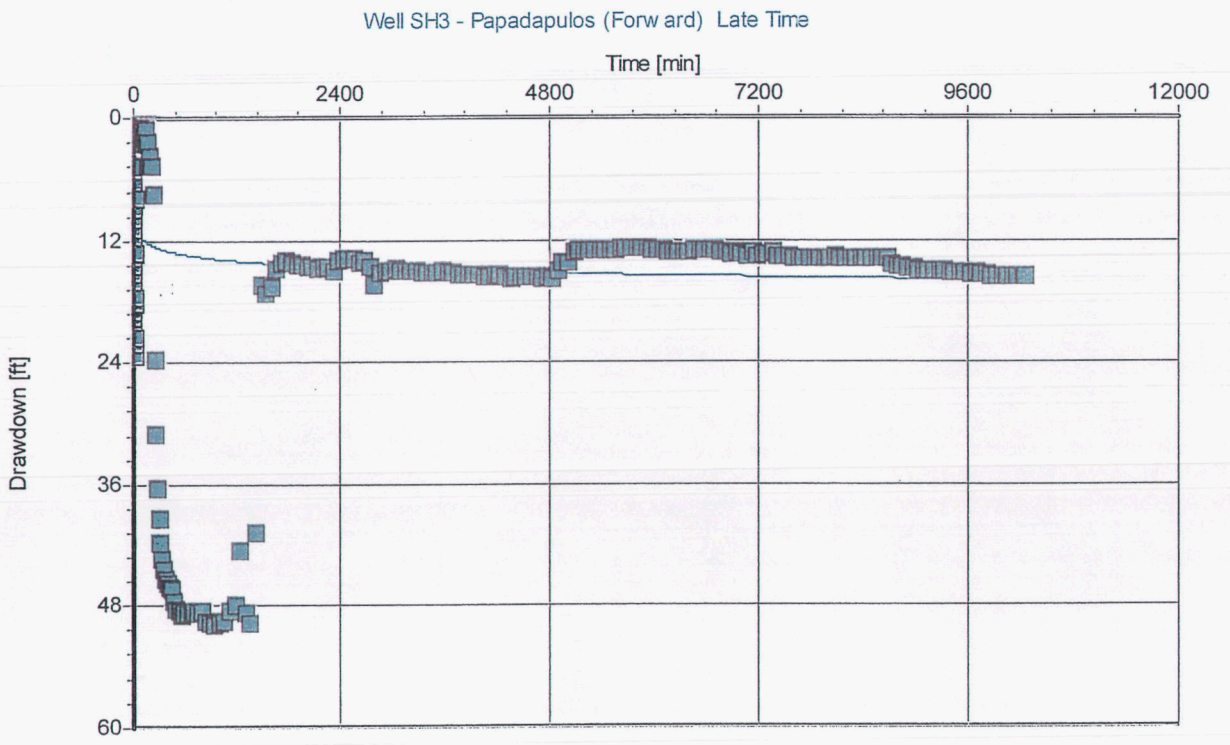
HWRC
P.O. Box 891
Payson, AZ 85547
Phone: (928)-468-0252

Pumping Test Analysis Report

Project: SH testing

Number:

Client:



Pumping Test: SH3 Constant Rate Test

Analysis Method: Papadopulos (1967) Large Diameter Well - Forward Solution

Analysis Results: Transmissivity: 7.90E+2 [ft²/d]

Conductivity: 1.98E+0 [ft/d]

Test Details: Saturated Aquifer Thickness: 400 ft

Pumping Well:	X ft	Y ft	TOC Elev. ft	L ft	R ft	r ft	Q U.S. gal/min	Well Screen
SH3	300	300	5502		0.17	0.25	46	Fully Penetrating

Comments: Effective Radius of Well is Large Due to Cavernous Nature of Formation

Evaluated by: MP

Evaluation Date: 7/10/2005

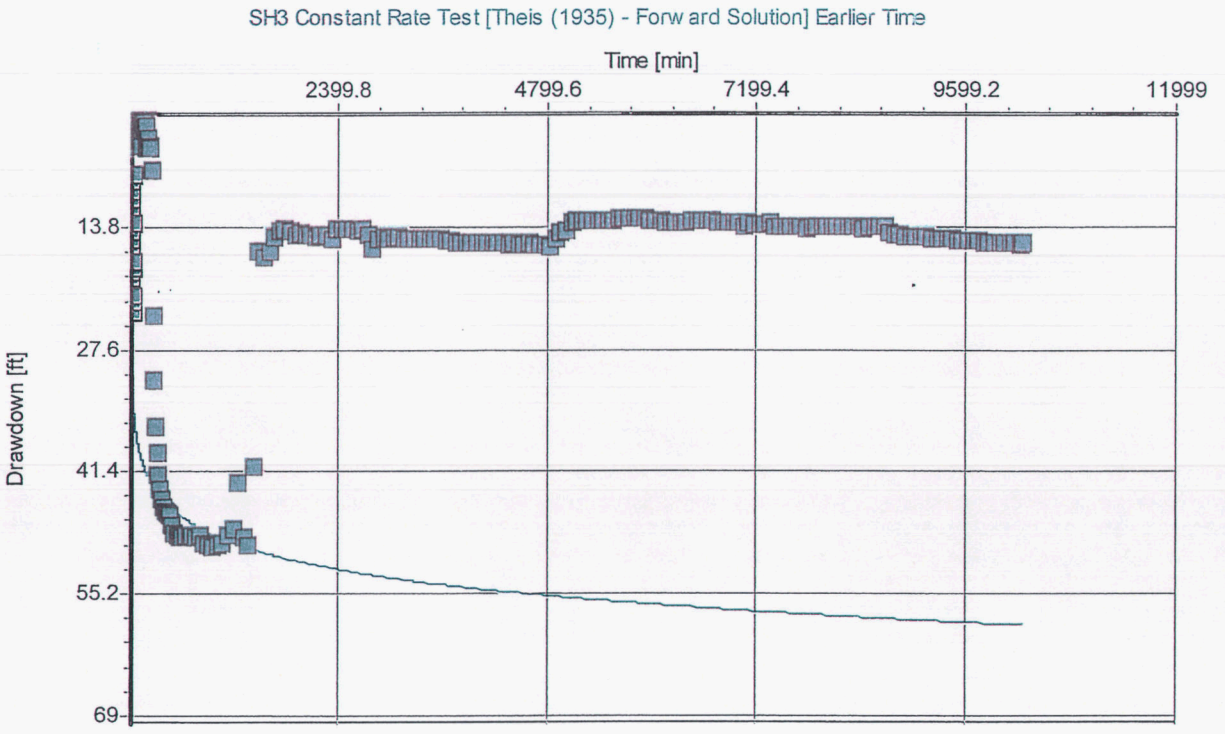
HWRC
P.O. Box 891
Payson, AZ 85547
Phone: (928)-468-0252

Pumping Test Analysis Report

Project: SH testing

Number:

Client:



Pumping Test: SH3 Constant Rate Test ***Analysis Method:*** Theis (1935) - Forward Solution

Analysis Results: Transmissivity: 1.88E+2 [ft²/d]

Conductivity: 4.70E-1 [ft/d]

Test Details: Saturated Aquifer Thickness: 400 ft

Pumping Well:	X ft	Y ft	TOC Elev. ft	L ft	R ft	r ft	Q U.S. gal/min	Well Screen
SH3	300	300	5502		0.17	0.25	46	Fully Penetrating

Comments: Theis forward solution at SH3 , Earlier time

Evaluated by: Evaluation Date: 7/10/2005

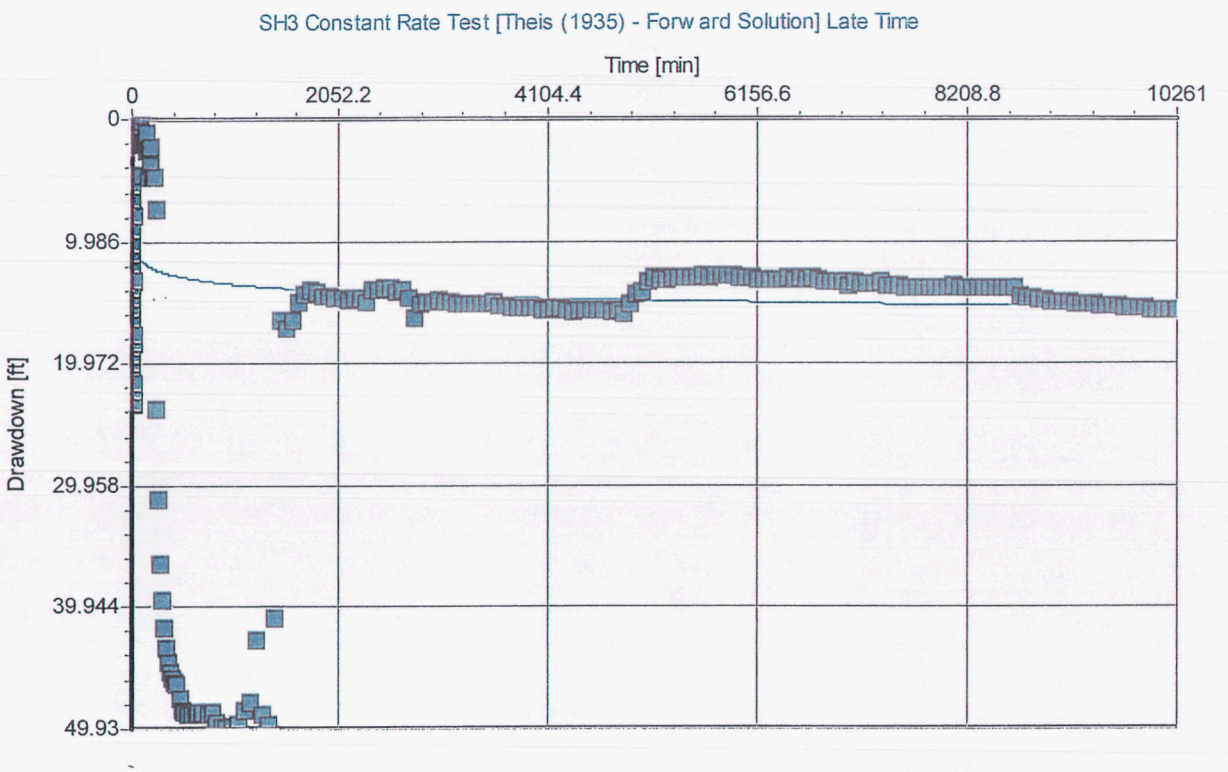
HWRC
P.O. Box 891
Payson, AZ 85547
Phone: (928)-468-0252

Pumping Test Analysis Report

Project: SH testing

Number:

Client:



Pumping Test: SH3 Constant Rate Test ***Analysis Method:*** Theis (1935) - Forward Solution

Analysis Results: Transmissivity: 8.89E+2 [ft²/d]

Conductivity: 2.22E+0 [ft/d]

Test Details: Saturated Aquifer Thickness: 400 ft

Pumping Well:	X ft	Y ft	TOC Elev. ft	L ft	R ft	r ft	Q U.S. gal/min	Well Screen
SH3	300	300	5502		0.17	0.25	46	Fully Penetrating

Comments: Theis Forward - Late Time Trend

Evaluated by:

Evaluation Date: 7/10/2005

Highland Water Resource Consulting -- Pump Testing Data Record Sheet

Well Name: Strawberry Hollow Well SH-3 #55-587628

Test Name/Type: SH-3 Seven Day Constant Rate Test

A(12-8)26DDD

Location: Pine, AZ

Test Type: 7 day test 45gpm, stabilized at 47gpm, total test average of 46gpm

Primary Water Zone(s):1010-1055, 1070-1090, 1240-1260+

ADWR#: 55-587628

Start of Pumping: 3/4/2005 at 1305

End of Pumping: 3/11/05 at 1606

Duration of Pumping: 10,261 min or 7 days 3 hours and 1 minute.

Pumping Rate(s): 45-47gpm

Pump Setting: 1,040

Static Level: 810.93

Available Drawdown: 229.07

Max. Observed Drawdown: 49ft. (occurred during temporary clogging of perforations)

Drawdown at End of Test: 14.75

Specific Capacity at End of Test: 3.2

Total Volume Pumped: ~472,006 gallons

Time to 100% Recovery: 9 minutes

Meter Read Start: 200270

Meter Read at Finish: 3797680

Digital paddle meter totalizer was found to be inaccurate due to calibration problems and variable sediment load.

However, discharge rate measurements obtained from the meter were found to be accurate when water was clean.

Flow rates confirmed with 5 gallon bucket measurements

* Data Logger purposefully collected data for approximately 5 minutes prior to test start and recovery to confirm operation. Thus, a correction was applied to logger time to facilitate proper analysis. Also, at 1300 the dtw was 810.928. This number was used for static.

Date	Time	Data Logger ET (min) (pumping than recove	Corrected Data Logger ET (mir t then t'	Chan[1] Fahrenheit	Chan[2] Feet H2O	Drawdown	Sc	Total ET t	t/t'	Meter gpm**	Meter 20026	Bucket gpm	Field Notes (gpm,meter,bucket, ph, t, cond.) -- Conducted on the rounded up whole number of the ET minute or at time noted
													Static of 810.93 read at 1300.
	3/4/2005 13:05	5.27	0.27	55.18	811.81	0.88	113.51	0.27		100			Adjust Q down to 45
	3/4/2005 13:05	5.58	0.58	55.18	815.79	4.86	16.45	0.58		80			
	3/4/2005 13:05	5.91	0.91	55.15	816.76	5.83	12.86	0.91		75			Adjusting Q down to 45
	3/4/2005 13:06	6.27	1.27	55.15	818.13	7.21	8.33	1.27		60			
	3/4/2005 13:06	6.64	1.64	55.15	819.30	8.37	5.38	1.64		45			Adjusted to 45gpm
	3/4/2005 13:07	7.03	2.03	55.15	820.42	9.50	4.74	2.03		45			Water getting dirty -- silty red with sand
	3/4/2005 13:07	7.45	2.45	55.13	821.48	10.55		2.45					NOTE: **Some flow measurements from meter were 2-4gpm off when sediment load
	3/4/2005 13:07	7.90	2.90	55.15	822.43	11.51	3.91	2.90		45			was heavy during the first 2 hours.
	3/4/2005 13:08	8.37	3.37	55.15	823.40	12.48		3.37					
	3/4/2005 13:08	8.86	3.86	55.15	824.34	13.41	3.37	3.86		45.2			
	3/4/2005 13:09	9.39	4.39	55.15	825.18	14.26		4.39					
	3/4/2005 13:09	9.95	4.95	55.18	826.05	15.12	3.00	4.95		45.3			
	3/4/2005 13:10	10.54	5.54	55.18	826.86	15.93	2.85	5.54		45.3		45.4	
	3/4/2005 13:11	11.17	6.17	55.2	827.69	16.76		6.17					
	3/4/2005 13:11	11.83	6.83	55.22	828.47	17.54		6.83					
	3/4/2005 13:12	12.53	7.53	55.24	829.28	18.35		7.53					
	3/4/2005 13:13	13.28	8.28	55.27	829.94	19.01		8.28					
	3/4/2005 13:14	14.07	9.07	55.29	830.68	19.75		9.07					
	3/4/2005 13:14	14.91	9.91	55.34	831.25	20.32	2.19	9.91		43.5		45.4	Water dirty -- silty red with sand, meter rate fluctuating +/- 2gpm
	3/4/2005 13:15	15.79	10.79	55.36	831.80	20.87	2.15	10.79		44.3		45.4	Bucket rate more accurate when sediment load is up
	3/4/2005 13:16	16.73	11.73	55.38	832.17	21.24		11.73					
	3/4/2005 13:17	17.72	12.72	55.43	832.60	21.67		12.72					
	3/4/2005 13:18	18.78	13.78	55.45	832.85	21.92		13.78					
	3/4/2005 13:19	19.89	14.89	55.5	832.98	22.05		14.89					
	3/4/2005 13:21	21.07	16.07	55.52	832.68	21.75		16.07					
	3/4/2005 13:22	22.32	17.32	55.54	833.00	22.07		17.32					
	3/4/2005 13:23	23.65	18.65	55.59	833.27	22.34		18.65					Sediment load decreasing
	3/4/2005 13:25	25.05	20.05	55.59	832.21	21.28	1.95	20.05		41.5		41.4	Increase Q back to 45
	3/4/2005 13:26	26.54	21.54	55.61	831.53	20.60		21.54					
	3/4/2005 13:28	28.12	23.12	55.7	828.30	17.37		23.12					
	3/4/2005 13:29	29.79	24.79	55.82	827.55	16.62	2.74	24.79		45.1		46.1	Sediment color darker - increasing - pumping water level rising rapidly
	3/4/2005 13:31	31.55	26.55	55.95	823.21	12.29		26.55					
	3/4/2005 13:33	33.43	28.43	56.13	817.88	6.95		28.43					
	3/4/2005 13:35	35.41	30.41	56.11	814.67	3.74	12.86	30.41		50	21142	46.2	Meter check shows totalizer is off significantly -- totalizer suggests 37.2gpm
	3/4/2005 13:37	37.51	32.51	56.04	811.47	0.54		32.51					Meter totalizer not reliable due to sediment affecting the magnetic lead.
	3/4/2005 13:39	39.74	34.74	55.93	809.15	-1.78		34.74					
	3/4/2005 13:42	42.10	37.10	55.7	808.66	-2.26		37.10					
	3/4/2005 13:44	44.60	39.60	55.43	808.33	-2.60		39.60		48.7	21547	46.2	Large increase in sediment load - red silty sand in water
	3/4/2005 13:47	47.24	42.24	55.11	808.40	-2.53		42.24					Well appears to be developing again.
	3/4/2005 13:50	50.05	45.05	54.79	808.87	-2.05		45.05					
	3/4/2005 13:53	53.01	48.01	54.47	808.84	-2.09		48.01					Water level comes up above original static -- well is clearly developing as sediment is passed
	3/4/2005 13:56	56.16	51.16	54.19	808.94	-1.98		51.16					
	3/4/2005 13:59	59.49	54.49	54.06	808.45	-2.48		54.49					
	3/4/2005 14:03	63.02	58.02	53.92	808.12	-2.81		58.02					
	3/4/2005 14:06	66.76	61.76	53.65	809.23	-1.70		61.76		49	22349	48.4	One Hour -- water level up to pre-static! - flow paths developing
	3/4/2005 14:10	70.72	65.72	53.4	809.48	-1.44		65.72					
	3/4/2005 14:14	74.91	69.91	53.14	809.93	-1.00		69.91		46.8	22735	44.7	Sediment load continues to decreasing since 35-40 min mark
	3/4/2005 14:19	79.35	74.35	52.87	810.46	-0.47		74.35					
	3/4/2005 14:24	84.06	79.06	52.57	810.92	-0.01		79.06					
	3/4/2005 14:29	89.05	84.05	52.3	811.44	0.51		84.05					
	3/4/2005 14:34	94.33	89.33	52.07	811.80	0.87	53.11	89.33		47.8	23542	44.4	Sediment load slightly lower
	3/4/2005 14:39	99.92	94.92	51.91	812.06	1.13		94.92					
	3/4/2005 14:45	105.84	100.84	51.82	812.01	1.09		100.84					
	3/4/2005 14:52	112.12	107.12	51.71	811.93	1.00		107.12					
	3/4/2005 14:58	118.77	113.77	51.59	812.02	1.09		113.77					
	3/4/2005 15:05	125.81	120.81	51.52	811.96	1.03	44.24	120.81		46.7	24714	44.7	Sediment load continues to decrease
	3/4/2005 15:13	133.27	128.27	51.52	811.78	0.86		128.27					
	3/4/2005 15:21	141.17	136.17	51.45	812.61	1.68	26.89	136.17		45.5		44.7	Time of measurement 1535
	3/4/2005 15:29	149.54	144.54	51.57	811.14	0.21		144.54					
	3/4/2005 15:38	158.40	153.40	51.61	812.62	1.70		153.40					
	3/4/2005 15:47	167.79	162.79	51.61	814.79	3.86		162.79					
	3/4/2005 15:57	177.74	172.74	51.87	812.37	1.44		172.74					
	3/4/2005 16:08	188.27	183.27	51.84	813.74	2.82	16.25	183.27		46.8	27118	44.7	Meter stuck/cleared
	3/4/2005 16:19	199.43	194.43	51.77	814.78	3.85		194.43					
	3/4/2005 16:31	211.26	206.26	51.68	814.70	3.77	12.07	206.26		46.8		44.1	Time of measurement 1635, sediment increasing, adjust Q up
	3/4/2005 16:43	223.78	218.78	51.71	814.84	3.91		218.78					
	3/4/2005 16:57	237.04	232.04	51.64	817.49	6.56	6.68	232.04		44.9	29072	42.8	Time of measurement 1705, calculated gpm from totalizer = 39gpm, totalizer continues to read low
	3/4/2005 17:11	251.09	246.09	52.23	833.68	22.75		246.09					adjust Q up, pumping level declining rapidly - well is plugging up again?
	3/4/2005 17:25	265.98	260.98	53.44	841.09	30.17	1.44	260.98		44.2		42.6	Time of measurement 1730, adjust Q up
	3/4/2005 17:41	281.74	276.74	54.47	846.38	35.45	1.24	276.74		44.8		42.8	Time of measurement 1735, adjust Q up, wl dropping
	3/4/2005 17:58	298.44	293.44	55.15	849.36	38.43	1.16	293.44		45.2	31299	44	Time of measurement 1805, Adjust Q up, ph=7.46, t=13C, Cond=364
	3/4/2005 18:16	316.13	311.13	55.52	851.71	40.78		311.13					
	3/4/2005 18:34	334.86	329.86	55.79	853.36	42.44		329.86					
	3/4/2005 18:54	354.71	349.71	55.91	854.45	43.52		349.71					
	3/4/2005 19:15	375.73	370.73	55.95	855.37	44.45		370.73					
	3/4/2005 19:38	398.00	393.00	55.97	855.78	44.85		393.00					
	3/4/2005 20:01	421.59	416.59	56	856.07	45.14		416.59					
	3/4/2005 20:26	446.58	441.58	56.07	856.34	45.41	0.99	441.58		45.2	32029	45	Time of meas. 2035
	3/4/2005 20:53	473.04	468.04	56.09	857.54	46.61		468.04					

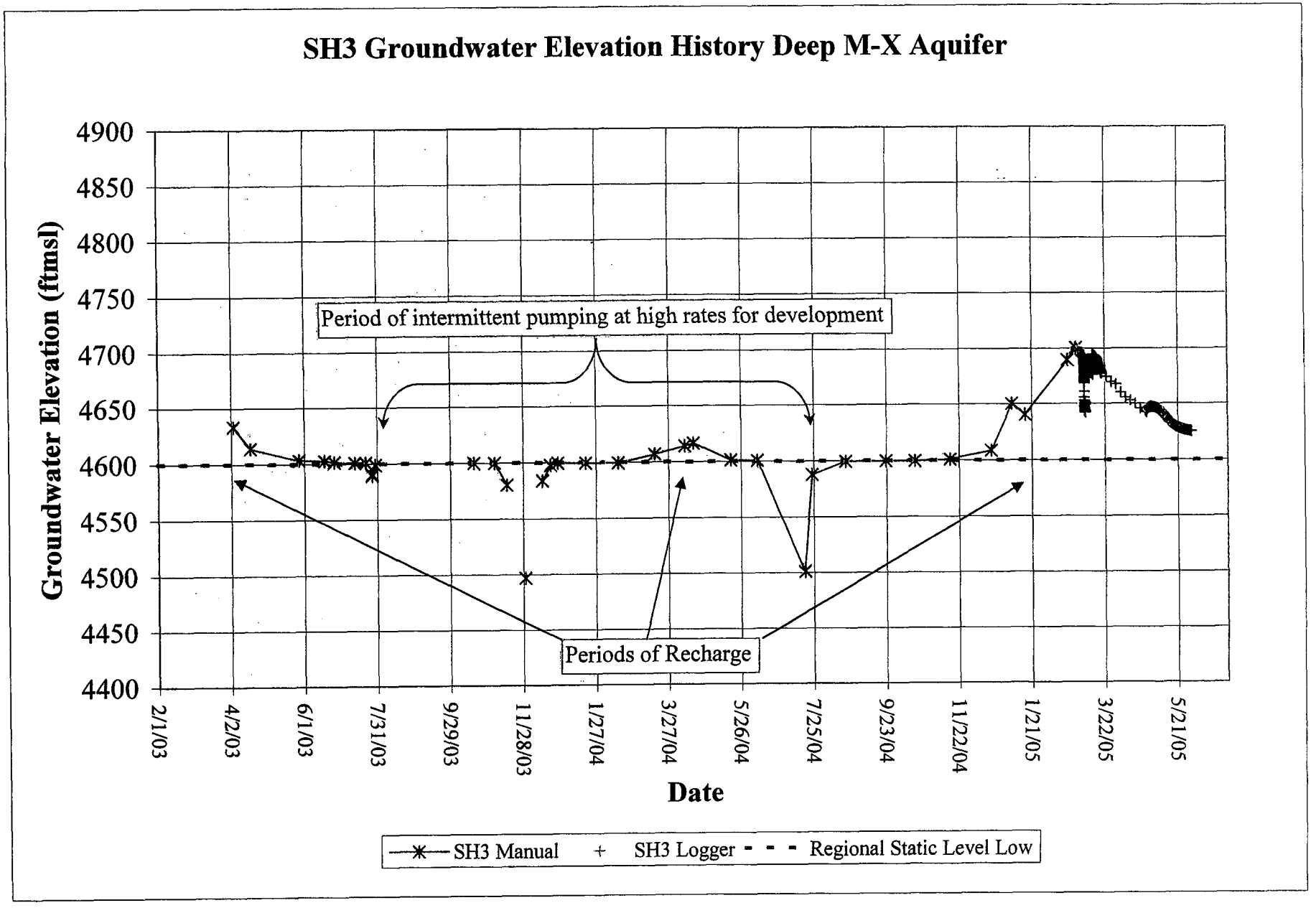
Date	Time	Data Logger ET (min) (pumping than recove	Corrected Data Logger ET (min t then t'	Fahrenheit	Feet H2O		Drawdown	Sc	Total ET t	t/t'	gpm**	Meter 20026	gpm	Field Notes (gpm,meter,bucket, ph, t, cond.) -- Conducted on the rounded up whole number of the ET minute or at time noted Static of 810.93 read at 1300.
3/4/2005	21:21	501.08	496.08	56.09	858.40	47.47			496.08					
3/4/2005	21:50	530.78	525.78	56.13	858.57	47.64			525.78					
3/4/2005	22:22	562.23	557.23	56.13	858.85	47.92			557.23					
3/4/2005	22:55	595.55	590.55	56.18	858.73	47.80			590.55					
3/4/2005	23:30	630.85	625.85	56.23	858.65	47.72			625.85					
3/5/2005	0:08	668.23	663.23	56.25	858.61	47.69			663.23					
3/5/2005	0:47	707.83	702.83	56.25	858.60	47.67			702.83					
3/5/2005	1:29	749.78	744.78	56.25	858.74	47.81			744.78					
3/5/2005	2:14	794.22	789.22	56.29	858.60	47.67	0.89		789.22		42.4	36562	42.2	Time of measurement 0225, adjust Q up, Water is clean/clear, meter and bucket almost same
3/5/2005	3:01	841.28	836.28	56.29	859.48	48.55			836.28					
3/5/2005	3:51	891.14	886.14	56.32	859.71	48.79			886.14					
3/5/2005	4:43	943.95	938.95	56.32	859.93	49.00			938.95					
3/5/2005	5:39	999.88	994.88	56.34	859.79	48.86			994.88					
3/5/2005	6:39	1059.14	1054.14	56.36	859.54	48.61	0.92		1054.14		44.3	44478	45	Time of meas. 0605
3/5/2005	7:39	1119.14	1114.14	56.39	858.51	47.58			1114.14					
3/5/2005	8:39	1179.14	1174.14	56.5	857.87	46.94			1174.14					
3/5/2005	9:39	1239.14	1234.14	57.09	852.65	41.72	0.83		1234.14		35	51055	34	Time of measurement 0915, adjust Q up but intake may be clogged with sed., alt sed in water. ph=7.46, t=14.6, Cond=383
3/5/2005	10:39	1299.14	1294.14	56.13	858.76	47.83	0.94		1294.14		45.1		45.2	Time of measurement 0946, readjust to 45gpm by 0951.
3/5/2005	11:39	1359.14	1354.14	56.09	859.62	48.69			1354.14					
3/5/2005	12:39	1419.14	1414.14	56.43	850.85	39.92	1.11		1414.14		43.5	54864	45	Time of meas. 1235, meter stuck - cleaned out - working again
3/5/2005	13:39	1479.14	1474.14	53.17	826.50	15.58			1474.14					
3/5/2005	14:39	1539.14	1534.14	52.46	827.21	16.29	2.98		1534.14		48.8	59384	48.2	Time of measurement 1416, Heavy sediment load again, well is developing again, pumping water level rising rapidly again, gpm increase
3/5/2005	15:39	1599.14	1594.14	52.25	826.54	15.61	3.00		1594.14		46.8	61220	47	Time of meas. 1505, -- ph=7.36, t=11.6, Cond.=286, lowered Q back to 45
3/5/2005	16:39	1659.14	1654.14	52	824.92	13.99	3.26		1654.14		46.3	63627	45	Time of meas.1605, water beginning to clear up again and drw stabilizing
3/5/2005	17:39	1719.14	1714.14	51.8	824.30	13.37			1714.14					
3/5/2005	18:39	1779.14	1774.14	51.61	824.07	13.14			1774.14					
3/5/2005	19:39	1839.14	1834.14	51.64	824.21	13.28			1834.14					
3/5/2005	20:39	1899.14	1894.14	51.57	824.55	13.63	3.33		1894.14		45.7	745672	45	Time of measurement 2051, only *slt silt in water, meter flow is* accurate when water is clean
3/5/2005	21:39	1959.14	1954.14	51.66	824.53	13.60			1954.14					
3/5/2005	22:39	2019.14	2014.14	51.55	824.62	13.69			2014.14					
3/5/2005	23:39	2079.14	2074.14	51.55	824.69	13.76			2074.14					
3/6/2005	0:39	2139.14	2134.14	51.55	824.82	13.89			2134.14					
3/6/2005	1:39	2199.14	2194.14	51.57	824.71	13.79			2194.14					
3/6/2005	2:39	2259.14	2254.14	51.52	824.73	13.80			2254.14					
3/6/2005	3:39	2319.14	2314.14	51.5	825.02	14.09			2314.14					
3/6/2005	4:39	2379.14	2374.14	51.43	823.99	13.06			2374.14					
3/6/2005	5:39	2439.14	2434.14	51.39	823.93	13.01			2434.14					
3/6/2005	6:39	2499.14	2494.14	51.13	823.92	12.99			2494.14					
3/6/2005	7:39	2559.14	2554.14	51.34	823.91	12.98	3.68		2554.14		47.5	98466	48	Time of meas. 0705, only fine sed in water
3/6/2005	8:39	2619.14	2614.14	51.27	824.17	13.24			2614.14					
3/6/2005	9:39	2679.14	2674.14	51.27	824.08	13.15	3.59		2674.14		47.5	104970	46.9	Time of measurement 0945, clean water, ph=7.26, t=11.0, Cond.=271, drw looks good - leave gpm at ~47
3/6/2005	10:39	2739.14	2734.14	51.13	824.61	13.68			2734.14					
3/6/2005	11:39	2799.14	2794.14	51.68	826.37	15.44	2.94		2794.14		46.1	108146	44.8	Time of measurement 1105, short term silt increase noted, gpm back up to 46.9 by 1121
3/6/2005	12:39	2859.14	2854.14	51.5	825.18	14.25			2854.14					
3/6/2005	13:39	2919.14	2914.14	51.41	824.98	14.05			2914.14					
3/6/2005	14:39	2979.14	2974.14	51.39	825.03	14.10			2974.14					
3/6/2005	15:39	3039.14	3034.14	51.36	824.87	13.94			3034.14					
3/6/2005	16:39	3099.14	3094.14	51.36	824.97	14.04	3.34		3094.14		46.9	120268	46.9	Time of meas. 1615
3/6/2005	17:39	3159.14	3154.14	51.36	825.06	14.13			3154.14					
3/6/2005	18:39	3219.14	3214.14	51.36	825.11	14.18	3.37		3214.14		48	125525	47.6	Time of measurement 1830, clean water
3/6/2005	19:39	3279.14	3274.14	51.36	825.11	14.18			3274.14					
3/6/2005	20:39	3339.14	3334.14	51.34	825.16	14.23			3334.14					
3/6/2005	21:39	3399.14	3394.14	51.34	825.16	14.23			3394.14					
3/6/2005	22:39	3459.14	3454.14	51.36	825.17	14.24			3454.14					
3/6/2005	23:39	3519.14	3514.14	51.34	825.16	14.23			3514.14					
3/7/2005	0:39	3579.14	3574.14	51.34	825.07	14.15			3574.14					
3/7/2005	1:39	3639.14	3634.14	51.34	825.30	14.38			3634.14					
3/7/2005	2:39	3699.14	3694.14	51.32	825.28	14.36			3694.14					
3/7/2005	3:39	3759.14	3754.14	51.36	825.48	14.55			3754.14					
3/7/2005	4:39	3819.14	3814.14	51.36	825.48	14.55			3814.14					
3/7/2005	5:39	3879.14	3874.14	51.34	825.53	14.61			3874.14					
3/7/2005	6:39	3939.14	3934.14	51.34	825.48	14.55			3934.14					
3/7/2005	7:39	3999.14	3994.14	51.34	825.53	14.61	3.26		3994.14		47.6	158616	47.6	Time of meas. 0830, clear water ,no sed.
3/7/2005	8:39	4059.14	4054.14	51.34	825.62	14.69			4054.14					
3/7/2005	9:39	4119.14	4114.14	51.34	825.60	14.68	3.25		4114.14		47.9	160172	47.6	Time of measurement 0905, clear water with slt color, ph=7.25, t=11.0, Cond.270
3/7/2005	10:39	4179.14	4174.14	51.34	825.52	14.59	3.27		4174.14		47.9	162392	47.6	Time of meas. 1005, clean water 2,220gal since last 60min. thus meter/totllizer yields 37gpm, It is 10gpm low in this interval
3/7/2005	11:39	4239.14	4234.14	51.34	825.52	14.59			4234.14					
3/7/2005	12:39	4299.14	4294.14	51.34	825.59	14.66			4294.14					
3/7/2005	13:39	4359.14	4354.14	51.36	825.80	14.87			4354.14					
3/7/2005	14:39	4419.14	4414.14	51.34	825.67	14.75			4414.14					
3/7/2005	15:39	4479.14	4474.14	51.34	825.73	14.80	3.16		4474.14		46	166731	47.6	Time of meas. 1505, meter got stuck during read, cleared and functioning upon departure
3/7/2005	16:39	4539.14	4534.14	51.34	825.73	14.80	3.18		4534.14		46.5	171633	47.6	Time of meas, 1705, clean water
3/7/2005	17:39	4599.14	4594.14	51.32	825.64	14.71	3.27		4594.14		48.5	172854	47.6	Time of meas. 1745, cleaned meter again then read flow.
3/7/2005	18:39	4659.14	4654.14	51.32	825.72	14.80			4654.14					
3/7/2005	19:39	4719.14	4714.14	51.32	825.81	14.88			4714.14					
3/7/2005	20:39	4779.14	4774.14	51.32	825.706	14.78	3.17		4774.14		46.8	178113		Time of meas. 2000
3/7/2005	21:39	4839.14	4834.14	51.32	825.935	15.01			4834.14					
3/7/2005	22:39	4899.14	4894.14	51.25	825.134	14.21			4894.14					
3/7/2005	23:39	4959.14	4954.14	51.23	824.338	13.41			4954.14					
3/8/2005	0:39	5019.14	5014.14	51.07	824.178	13.25			5014.14					
3/8/2005	1:39	5079.14	5074.14	50.95	823.301	12.37			5074.14					
3/8/2005	2:39	5139.14	5134.14	50.88	823.082	12.15			5134.14					
3/8/2005	3:39	5199.14	5194.14	50.91	823.155	12.23			5194.14					
3/8/2005	4:39	5259.14	5254.14	50.93	823.14	12.21			5254.14					
3/8/2005	5:39	5319.14	5314.14	50.88	823.064	12.14			5314.14					
3/8/2005	6:39	5379.14	5374.14	50.88	822.976	12.05	3.93		5374.14		47.1	193077	47.6	Time of meas. 0635, meter cleared again - very fine particles fouling meter pickup, clean water
3/8/2005	7:39	5439.14	5434.14	50.88	823.064	12.14			5434.14					
3/8/2005	8:39	5499.14	5494.14	50.88	822.976	12.05	3.90		5494.14		47.2	196481	46.8	Time of meas. 0820, ph=7.5, t=10.8, cond.=271 , clean water
3/8/2005	9:39	5559.14	5554.14	50.86	823.044	12.12			5554.14					
3/8/2005	10:39	5619.14	5614.14	50.86	822.832	11.90			5614.14					
3/8/2005	11:39	5679.14	5674.14	50.86	822.938	12.01			5674.14					

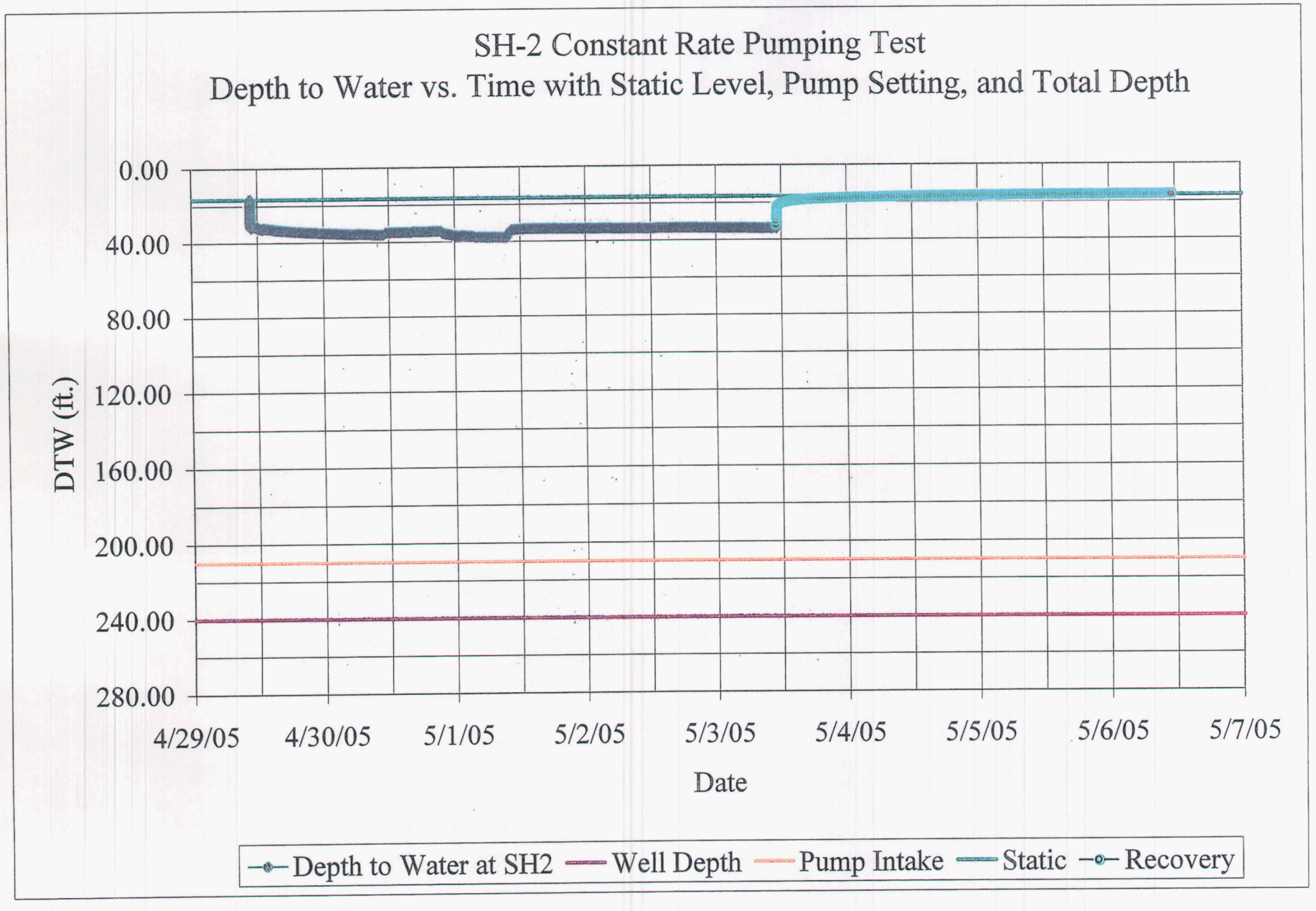
Date	Time	Data Logger ET (min) (pumping then recove	Corrected Data Logger ET (mi	Fahrenheit t then t'	Feet H2O	Drawdown	Sc	Total ET t	t/t'	gpm**	Meter 20026	gpm	Field Notes (gpm,meter,bucket, ph, t, cond.) -- Conducted on the rounded up whole number of the ET minute or at time noted Static of 810.93 read at 1300.
3/8/2005	12:39	5739.14	5734.14	50.84	822.882	11.95		5734.14					
3/8/2005	13:39	5799.14	5794.14	50.86	822.85	11.92		5794.14					
3/8/2005	14:39	5859.14	5854.14	50.86	822.85	11.92		5854.14					
3/8/2005	15:39	5919.14	5914.14	50.86	822.903	11.98	3.97	5914.14		47.6	205446	47.6	Time of meas. 1505, meter stuck again, same fine particle issue, clean water
3/8/2005	16:39	5979.14	5974.14	50.88	822.976	12.05		5974.14					
3/8/2005	17:39	6039.14	6034.14	50.88	823.099	12.17		6034.14					
3/8/2005	18:39	6099.14	6094.14	50.86	823.079	12.15	3.95	6094.14		48	213120		Time of meas. 1800
3/8/2005	19:39	6159.14	6154.14	50.88	823.205	12.28		6154.14					
3/8/2005	20:39	6219.14	6214.14	50.88	823.223	12.30		6214.14					
3/8/2005	21:39	6279.14	6274.14	50.88	823.205	12.28		6274.14					
3/8/2005	22:39	6339.14	6334.14	50.88	823.205	12.28		6334.14					
3/8/2005	23:39	6399.14	6394.14	50.86	823.202	12.27		6394.14					
3/9/2005	0:39	6459.14	6454.14	50.86	823.079	12.15		6454.14					
3/9/2005	1:39	6519.14	6514.14	50.86	823.132	12.20		6514.14					
3/9/2005	2:39	6579.14	6574.14	50.88	823.029	12.10		6574.14					
3/9/2005	3:39	6639.14	6634.14	50.91	823.102	12.17		6634.14					
3/9/2005	4:39	6699.14	6694.14	50.88	823.099	12.17		6694.14					
3/9/2005	5:39	6759.14	6754.14	50.88	823.258	12.33		6754.14					
3/9/2005	6:39	6819.14	6814.14	50.91	823.331	12.40		6814.14					
3/9/2005	7:39	6879.14	6874.14	50.91	823.402	12.47		6874.14					
3/9/2005	8:39	6939.14	6934.14	50.88	823.346	12.42		6934.14					
3/9/2005	9:39	6999.14	6994.14	50.91	823.402	12.47		6994.14					
3/9/2005	10:39	7059.14	7054.14	50.93	823.757	12.83		7054.14					
3/9/2005	11:39	7119.14	7114.14	50.97	823.339	12.41	3.77	7114.14		47.1	253245	46.5	Time of meas. *1105, ph=7.7, t=10.8, cond.=264*, water quality samples collected
3/9/2005	12:39	7179.14	7174.14	50.95	823.566	12.64		7174.14					*continued form above*: late time isotope samples collected
3/9/2005	13:39	7239.14	7234.14	50.93	823.51	12.58		7234.14					
3/9/2005	14:39	7299.14	7294.14	50.88	823.487	12.56		7294.14					
3/9/2005	15:39	7359.14	7354.14	50.91	823.366	12.44		7354.14					
3/9/2005	16:39	7419.14	7414.14	50.91	823.648	12.72	3.77	7414.14		47.9	267134		Time of meas. 1655, clean water
3/9/2005	17:39	7479.14	7474.14	50.91	823.648	12.72		7474.14					
3/9/2005	18:39	7539.14	7534.14	50.88	823.681	12.75		7534.14					
3/9/2005	19:39	7599.14	7594.14	50.88	823.769	12.84		7594.14					
3/9/2005	20:39	7659.14	7654.14	50.91	823.789	12.86		7654.14					
3/9/2005	21:39	7719.14	7714.14	50.91	823.825	12.90		7714.14					
3/9/2005	22:39	7779.14	7774.14	50.88	823.875	12.95		7774.14					
3/9/2005	23:39	7839.14	7834.14	50.88	823.84	12.91		7834.14					
3/10/2005	0:39	7899.14	7894.14	50.91	823.807	12.88		7894.14					
3/10/2005	1:39	7959.14	7954.14	50.91	823.807	12.88		7954.14					
3/10/2005	2:39	8019.14	8014.14	50.91	823.789	12.86		8014.14					
3/10/2005	3:39	8079.14	8074.14	50.91	823.754	12.83		8074.14					
3/10/2005	4:39	8139.14	8134.14	50.91	823.789	12.86		8134.14					
3/10/2005	5:39	8199.14	8194.14	50.91	823.825	12.90		8194.14					
3/10/2005	6:39	8259.14	8254.14	50.91	823.825	12.90		8254.14					
3/10/2005	7:39	8319.14	8314.14	50.91	823.825	12.90		8314.14					
3/10/2005	8:39	8379.14	8374.14	50.88	823.822	12.89	3.64	8374.14		47.6	304158	46.2	Time of meas. 0822, clean water
3/10/2005	9:39	8439.14	8434.14	50.91	823.878	12.95		8434.14					
3/10/2005	10:39	8499.14	8494.14	50.91	823.825	12.90		8494.14					
3/10/2005	11:39	8559.14	8554.14	50.91	823.825	12.90		8554.14					
3/10/2005	12:39	8619.14	8614.14	50.91	823.807	12.88		8614.14					
3/10/2005	13:39	8679.14	8674.14	50.91	823.825	12.90		8674.14					
3/10/2005	14:39	8739.14	8734.14	50.95	824.482	13.55		8734.14					
3/10/2005	15:39	8799.14	8794.14	51.02	824.667	13.74		8794.14					
3/10/2005	16:39	8859.14	8854.14	51.04	824.599	13.67	3.46	8854.14		47.1	322330	47.6	Time of meas. 1605, ph=7.2, t=10.9, cond.=250 (ph/cond/t meter recalibrated)
3/10/2005	17:39	8919.14	8914.14	51.04	824.828	13.90		8914.14					
3/10/2005	18:39	8979.14	8974.14	51.02	824.825	13.90		8974.14					
3/10/2005	19:39	9039.14	9034.14	51.02	824.966	14.04		9034.14					
3/10/2005	20:39	9099.14	9094.14	51.04	825.004	14.08		9094.14					
3/10/2005	21:39	9159.14	9154.14	51.02	825.002	14.07		9154.14					
3/10/2005	22:39	9219.14	9214.14	51.04	825.075	14.15		9214.14					
3/10/2005	23:39	9279.14	9274.14	51.04	825.145	14.22		9274.14					
3/11/2005	0:39	9339.14	9334.14	51.02	825.143	14.22		9334.14					
3/11/2005	1:39	9399.14	9394.14	51.04	825.216	14.29		9394.14					
3/11/2005	2:39	9459.14	9454.14	51.02	825.196	14.27		9454.14					
3/11/2005	3:39	9519.14	9514.14	51.04	825.251	14.32		9514.14					
3/11/2005	4:39	9579.14	9574.14	51.04	825.286	14.36		9574.14					
3/11/2005	5:39	9639.14	9634.14	51.04	825.357	14.43		9634.14					
3/11/2005	6:39	9699.14	9694.14	51.04	825.339	14.41		9694.14					
3/11/2005	7:39	9759.14	9754.14	51.04	825.427	14.50		9754.14					
3/11/2005	8:39	9819.14	9814.14	51.04	825.533	14.61		9814.14					
3/11/2005	9:39	9879.14	9874.14	51.04	825.551	14.62		9874.14					
3/11/2005	10:39	9939.14	9934.14	51.07	825.571	14.64		9934.14					
3/11/2005	11:39	9999.14	9994.14	51.04	825.621	14.69		9994.14					
3/11/2005	12:39	10059.14	10054.14	51.07	825.642	14.71	3.16	10054.14		46.9	372489	46.2	Time of meas. 1255, clean water
3/11/2005	13:39	10119.14	10114.14	51.04	825.621	14.69		10114.14					
3/11/2005	14:39	10179.14	10174.14	51.07	825.606	14.68		10174.14					
3/11/2005	15:39	10239.14	10234.14	51.04	825.727	14.80	3.20	10234.14		47.2	379523	47.6	Time of meas. 1600,ph=7.2, t=10.9, cond.=252
3/11/2005	16:06	10256.00	10261.00	51.07	825.677	14.75	*5.82*	10261.00			379768		**Pump Off at 1606 -- Recovery, Meter totalizer = 359,742gal or 35gpm (~10-12gpm low)**
3/11/2005	16:06	6.27	0.27	51.07	825.677	14.75		10261.27	38532.73				**Total average gpm via bucket and meter = 46gpm or 472,006 gallons pumped**
3/11/2005	16:07	7.03	1.03	51.07	822.204	11.28		10262.03	9917.88				**Total average Specific capacity = 5.8gpm/ft**
3/11/2005	16:07	7.45	1.45	51.18	820.207	9.28		10262.45	7062.94	46		46	Averaged gpms listed at left
3/11/2005	16:07	7.90	1.90	51.27	818.702	7.77		10262.90	5412.06				
3/11/2005	16:08	8.37	2.37	51.39	817.481	6.55		10263.37	4337.31				
3/11/2005	16:08	8.86	2.86	51.45	816.449	5.52		10263.86	3582.88				
3/11/2005	16:09	9.39	3.39	51.48	815.587	4.66		10264.39	3026.68				
3/11/2005	16:09	9.95	3.95	51.5	814.814	3.89		10264.95	2598.92				
3/11/2005	16:10	10.54	4.54	51.5	814.127	3.20		10265.54	2260.49				
3/11/2005	16:11	11.17	5.17	51.48	813.525	2.60		10266.17	1986.49				
3/11/2005	16:11	11.83	5.83	51.48	812.96	2.03		10266.83	1760.64				
3/11/2005	16:12	12.53	6.53	51.45	812.482	1.55		10267.53	1571.23				
3/11/2005	16:13	13.28	7.28	51.45	812.023	1.10		10268.28	1410.54				
3/11/2005	16:14	14.07	8.07	51.43	811.615	0.69		10269.07	1272.55				

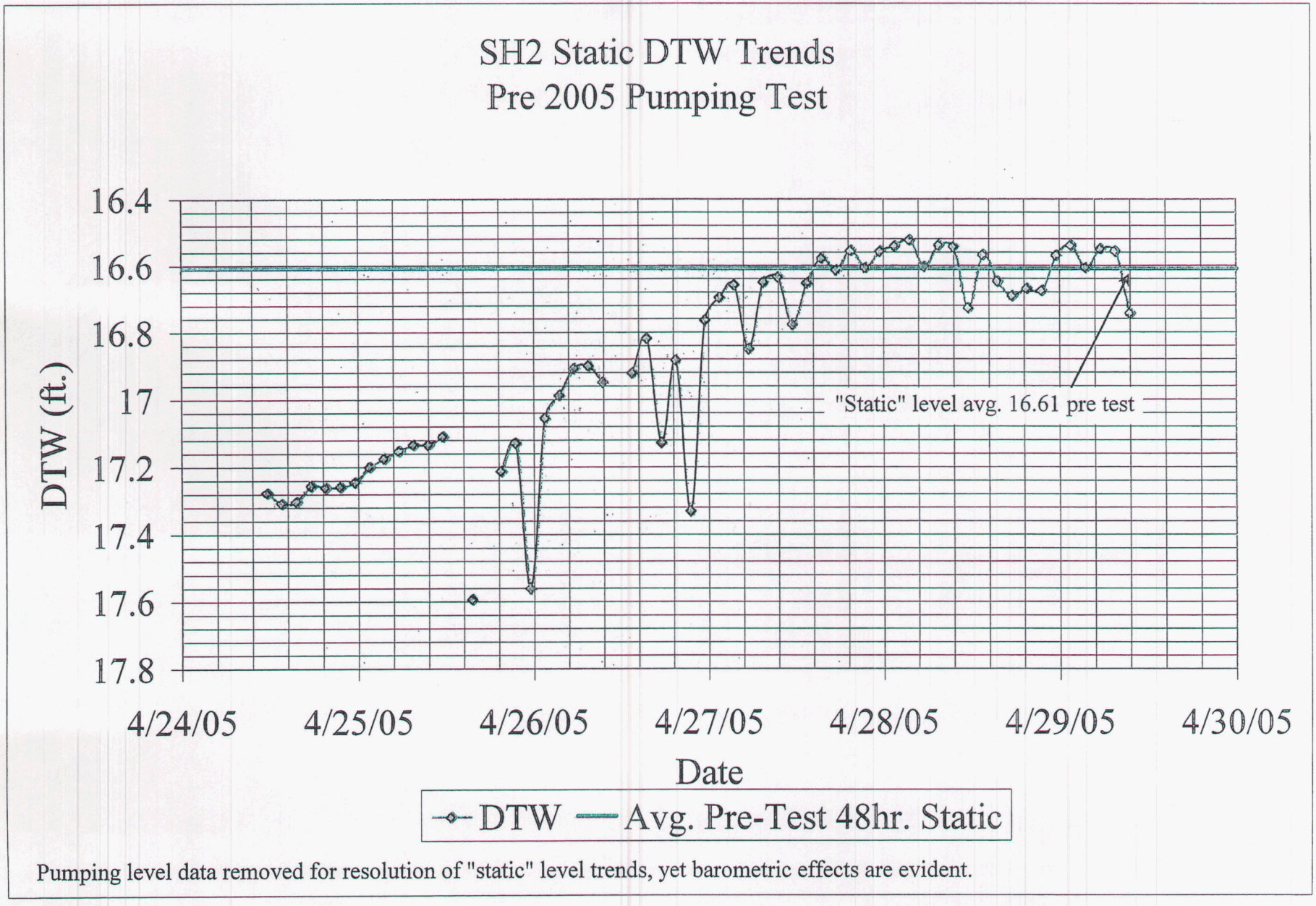
Date	Time	Data Logger ET (min) (pumping than recove	Corrected Data Logger ET (mis t then t'	Fahrenheit	Feet H2O		Drawdown	Sc	Total ET t	t/t'	gpm**	Meter 20026	gpm	Field Notes (gpm,meter,bucket, ph, t, cond.) -- Conducted on the rounded up whole number of the ET minute or at time noted
	3/11/2005 16:14	14.91	8.91	51.41	811.242	0.31			10269.91	1153.11				Static of 810.93 read at 1300.
	3/11/2005 16:15	15.79	9.79	51.39	810.904	-0.02			10270.79	1048.97				
	3/11/2005 16:16	16.73	10.73	51.36	810.602	-0.33			10271.73	957.32				
	3/11/2005 16:17	17.72	11.72	51.34	810.335	-0.59			10272.72	876.29				
	3/11/2005 16:18	18.78	12.78	51.29	810.118	-0.81			10273.78	804.13				
	3/11/2005 16:19	19.89	13.89	51.25	809.936	-0.99			10274.89	739.66				
	3/11/2005 16:21	21.07	15.07	51.2	809.755	-1.17			10276.07	681.75				
	3/11/2005 16:22	22.32	16.32	51.18	809.558	-1.37			10277.32	629.56				
	3/11/2005 16:23	23.65	17.65	51.25	809.39	-1.54			10278.65	582.37				
	3/11/2005 16:25	25.05	19.05	51.32	809.239	-1.69			10280.05	539.50				
	3/11/2005 16:26	26.54	20.54	51.36	809.086	-1.84			10281.54	500.49				
	3/11/2005 16:28	28.12	22.12	51.36	808.962	-1.97			10283.12	464.92				
	3/11/2005 16:29	29.79	23.79	51.29	808.831	-2.10			10284.79	432.38				
	3/11/2005 16:31	31.55	25.55	51.2	808.714	-2.21			10286.55	402.53				
	3/11/2005 16:33	33.43	27.43	51.09	808.595	-2.33			10288.43	375.11				
	3/11/2005 16:35	35.41	29.41	50.97	808.511	-2.42			10290.41	349.88				
	3/11/2005 16:37	37.51	31.51	50.86	808.409	-2.52			10292.51	326.61				
	3/11/2005 16:39	39.74	33.74	50.81	808.316	-2.61			10294.74	305.12				
	3/11/2005 16:42	42.10	36.10	50.79	808.243	-2.68			10297.10	285.25				
	3/11/2005 16:44	44.60	38.60	50.77	808.169	-2.76			10299.60	266.85				
	3/11/2005 16:47	47.24	41.24	50.72	808.093	-2.84			10302.24	249.79				
	3/11/2005 16:50	50.05	44.05	50.66	808.033	-2.89			10305.05	233.96				
	3/11/2005 16:53	53.01	47.01	50.59	807.971	-2.96			10308.01	219.25				
	3/11/2005 16:56	56.16	50.16	50.5	807.908	-3.02			10311.16	205.57				
	3/11/2005 16:59	59.49	53.49	50.43	807.847	-3.08			10314.49	192.83				
	3/11/2005 17:03	63.02	57.02	50.34	807.801	-3.13			10318.02	180.96				
	3/11/2005 17:06	66.76	60.76	50.27	807.757	-3.17			10321.76	169.88				
	3/11/2005 17:10	70.72	64.72	50.2	807.714	-3.21			10325.72	159.55				
	3/11/2005 17:14	74.91	68.91	50.13	807.671	-3.26			10329.91	149.90				
	3/11/2005 17:19	79.35	73.35	50.11	807.65	-3.28			10334.35	140.88				
	3/11/2005 17:24	84.06	78.06	50.06	807.733	-3.20			10339.06	132.45				
	3/11/2005 17:29	89.05	83.05	49.97	807.811	-3.12			10344.05	124.56				
	3/11/2005 17:34	94.33	88.33	49.86	808.238	-2.69			10349.33	117.17				
	3/11/2005 17:39	99.92	93.92	49.86	808.203	-2.73			10354.92	110.25				
	3/11/2005 17:45	105.84	99.84	49.86	808.15	-2.78			10360.84	103.77				
	3/11/2005 17:52	112.12	106.12	49.79	808.071	-2.86			10367.12	97.69				
	3/11/2005 17:58	118.77	112.77	49.76	808.016	-2.91			10373.77	91.99				
	3/11/2005 18:05	125.81	119.81	49.81	807.968	-2.96			10380.81	86.64				
	3/11/2005 18:13	133.27	127.27	49.9	807.996	-2.93			10388.27	81.63				
	3/11/2005 18:21	141.17	135.17	50.02	807.886	-3.04			10396.17	76.91				
	3/11/2005 18:29	149.54	143.54	50.08	807.859	-3.07			10404.54	72.49				
	3/11/2005 18:38	158.40	152.40	50.15	807.867	-3.06			10413.40	68.33				
	3/11/2005 18:47	167.79	161.79	50.22	807.946	-2.98			10422.79	64.42				
	3/11/2005 18:57	177.74	171.74	50.4	808.003	-2.92			10432.74	60.75				
	3/11/2005 19:08	188.27	182.27	50.47	807.958	-2.97			10443.27	57.29				
	3/11/2005 19:19	199.43	193.43	50.63	808.047	-2.88			10454.43	54.05				
	3/11/2005 19:31	211.26	205.26	50.59	808.183	-2.75			10466.26	50.99				
	3/11/2005 19:43	223.78	217.78	50.68	807.947	-2.98			10478.78	48.12				
	3/11/2005 19:57	237.04	231.04	50.68	807.965	-2.96			10492.04	45.41				
	3/11/2005 20:11	251.09	245.09	50.81	807.893	-3.03			10506.09	42.87				
	3/11/2005 20:25	265.98	259.98	51.11	807.928	-3.00			10520.98	40.47				
	3/11/2005 20:41	281.74	275.74	51.25	807.962	-2.97			10536.74	38.21				
	3/11/2005 20:58	298.44	292.44	51.29	807.967	-2.96			10553.44	36.09				
	3/11/2005 21:16	316.13	310.13	51.34	807.972	-2.96			10571.13	34.09				
	3/11/2005 21:34	334.86	328.86	51.64	808.007	-2.92			10589.86	32.20				
	3/11/2005 21:54	354.71	348.71	51.93	807.99	-2.94			10609.71	30.43				
	3/11/2005 22:15	375.73	369.73	50.66	807.962	-2.97			10630.73	28.75				
	3/11/2005 22:38	398.00	392.00	50.06	807.945	-2.98			10653.00	27.18				
	3/11/2005 23:01	421.59	415.59	49.47	807.945	-2.98			10676.59	25.69				
	3/11/2005 23:26	446.58	440.58	49.54	807.953	-2.98			10701.58	24.29				
	3/11/2005 23:53	473.04	467.04	49.47	807.98	-2.95			10728.04	22.97				
	3/12/2005 0:21	501.08	495.08	49.38	807.987	-2.94			10756.08	21.73				
	3/12/2005 0:50	530.78	524.78	49.35	807.967	-2.96			10785.78	20.55				
	3/12/2005 1:22	562.23	556.23	49.4	808.008	-2.92			10817.23	19.45				
	3/12/2005 1:55	595.55	589.55	49.51	808.039	-2.89			10850.55	18.40				
	3/12/2005 2:30	630.85	624.85	49.54	808.041	-2.89			10885.85	17.42				
	3/12/2005 3:08	668.23	662.23	49.51	808.021	-2.91			10923.23	16.49				
	3/12/2005 3:47	707.83	701.83	49.63	808.017	-2.91			10962.83	15.62				
	3/12/2005 4:29	749.78	743.78	49.99	808.007	-2.92			11004.78	14.80				
	3/12/2005 5:14	794.22	788.22	50.24	808.019	-2.91			11049.22	14.02				
	3/12/2005 6:01	841.28	835.28	49.63	808.035	-2.89			11096.28	13.28				
	3/12/2005 6:51	891.14	885.14	49.81	808.039	-2.89			11146.14	12.59				
	3/12/2005 7:43	943.95	937.95	49.81	808.091	-2.84			11198.95	11.94				
	3/12/2005 8:39	999.88	993.88	49.88	808.152	-2.78			11254.88	11.32				
	3/12/2005 9:39	1059.14	1053.14	49.9	808.208	-2.72			11314.14	10.74				
	3/12/2005 10:39	1119.14	1113.14	49.95	808.213	-2.72			11374.14	10.22				
	3/12/2005 11:39	1179.14	1173.14	49.95	808.231	-2.70			11434.14	9.75				
	3/12/2005 12:39	1239.14	1233.14	49.97	808.251	-2.68			11494.14	9.32				
	3/12/2005 13:39	1299.14	1293.14	49.97	808.251	-2.68			11554.14	8.93				
	3/12/2005 14:39	1359.14	1353.14	50.63	808.241	-2.69			11614.14	8.58				
	3/12/2005 15:39	1419.14	1413.14	49.83	808.288	-2.64			11674.14	8.26				
	3/12/2005 16:39	1479.14	1473.14	49.95	808.337	-2.59			11734.14	7.97				
	3/12/2005 17:39	1539.14	1533.14	50.04	808.383	-2.54			11794.14	7.69				
	3/12/2005 18:39	1599.14	1593.14	50.13	808.429	-2.50			11854.14	7.44				
	3/12/2005 19:39	1659.14	1653.14	50.36	808.456	-2.47			11914.14	7.21				
	3/12/2005 20:39	1719.14	1713.14	50.38	808.494	-2.43			11974.14	6.99				
	3/12/2005 21:39	1779.14	1773.14	50.43	808.535	-2.39			12034.14	6.79				
	3/12/2005 22:39	1839.14	1833.14	50.47	808.61	-2.32			12094.14	6.60				
	3/12/2005 23:39	1899.14	1893.14	50.93	808.629	-2.30			12154.14	6.42				
	3/13/2005 0:39	1959.14	1953.14	50.02	808.662	-2.27			12214.14	6.25				
	3/13/2005 1:39	2019.14	2013.14	50.63	808.71	-2.23			12274.14	6.10				

Date	Time	Data Logger ET (min) (pumping than recove	Corrected Data Logger ET (mit t then t'	Fahrenheit	Feet H2O	Drawdown	Sc	Total ET t	t/t'	gpm**	Meter 20026	gpm	Field Notes (gpm,meter,bucket, ph, t, cond.) -- Conducted on the rounded up whole number of the ET minute or at time noted Static of 810.93 read at 1300.
3/13/2005	2:39	2079.14	2073.14	50.43	808.728	-2.20		12334.14	5.95				
3/13/2005	3:39	2139.14	2133.14	51.02	808.746	-2.18		12394.14	5.81				
3/13/2005	4:39	2199.14	2193.14	52.09	808.766	-2.16		12454.14	5.68				
3/13/2005	5:39	2259.14	2253.14	52.89	808.861	-2.07		12514.14	5.55				
3/13/2005	6:39	2319.14	2313.14	51.61	808.904	-2.02		12574.14	5.44				
3/13/2005	7:39	2379.14	2373.14	50.84	809.006	-1.92		12634.14	5.32				
3/13/2005	8:39	2439.14	2433.14	49.88	809.052	-1.88		12694.14	5.22				
3/13/2005	9:39	2499.14	2493.14	49.72	809.103	-1.83		12754.14	5.12				
3/13/2005	10:39	2559.14	2553.14	49.74	809.159	-1.77		12814.14	5.02				
3/13/2005	11:39	2619.14	2613.14	49.72	809.227	-1.70		12874.14	4.93				
3/13/2005	12:39	2679.14	2673.14	49.74	809.23	-1.70		12934.14	4.84				
3/13/2005	13:39	2739.14	2733.14	49.79	809.288	-1.64		12994.14	4.75				
3/13/2005	14:39	2799.14	2793.14	49.88	809.316	-1.61		13054.14	4.67				
3/13/2005	15:39	2859.14	2853.14	49.95	809.36	-1.57		13114.14	4.60				
3/13/2005	16:39	2919.14	2913.14	50.02	809.438	-1.49		13174.14	4.52				
3/13/2005	17:39	2979.14	2973.14	50.11	809.502	-1.43		13234.14	4.45				
3/13/2005	18:39	3039.14	3033.14	50.56	809.573	-1.36		13294.14	4.38				
3/13/2005	19:39	3099.14	3093.14	50.13	809.646	-1.28		13354.14	4.32				
3/13/2005	20:39	3159.14	3153.14	50.11	809.696	-1.23		13414.14	4.25				
3/13/2005	21:39	3219.14	3213.14	50.11	809.749	-1.18		13474.14	4.19				
3/13/2005	22:39	3279.14	3273.14	50.13	809.787	-1.14		13534.14	4.13				
3/13/2005	23:39	3339.14	3333.14	50.18	809.933	-1.00		13594.14	4.08				
3/14/2005	0:39	3399.14	3393.14	50.34	809.899	-1.03		13654.14	4.02				
3/14/2005	1:39	3459.14	3453.14	50.4	810.031	-0.90		13714.14	3.97				
3/14/2005	2:39	3519.14	3513.14	50.5	810.147	-0.78		13774.14	3.92				
3/14/2005	3:39	3579.14	3573.14	50.56	810.085	-0.84		13834.14	3.87				
3/14/2005	4:39	3639.14	3633.14	50.56	810.208	-0.72		13894.14	3.82				
3/14/2005	5:39	3699.14	3693.14	50.47	810.056	-0.87		13954.14	3.78				
3/14/2005	6:39	3759.14	3753.14	50.38	810.134	-0.79		14014.14	3.73				
3/14/2005	7:39	3819.14	3813.14	50.34	810.199	-0.73		14074.14	3.69				
3/14/2005	8:39	3879.14	3873.14	50.29	810.264	-0.66		14134.14	3.65				
3/14/2005	9:39	3939.14	3933.14	50.34	810.358	-0.57		14194.14	3.61				
3/14/2005	10:39	3999.14	3993.14	50.34	810.446	-0.48		14254.14	3.57				
3/14/2005	11:39	4059.14	4053.14	50.24	810.523	-0.40		14314.14	3.53				
3/14/2005	12:39	4119.14	4113.14	50.31	810.514	-0.41		14374.14	3.49				
3/14/2005	13:39	4179.14	4173.14	50.29	810.634	-0.29		14434.14	3.46				
3/14/2005	14:39	4239.14	4233.14	50.36	810.731	-0.20		14494.14	3.42				
3/14/2005	15:39	4299.14	4293.14	50.5	810.711	-0.22		14554.14	3.39				
3/14/2005	16:39	4359.14	4353.14	50.56	810.808	-0.12		14614.14	3.36				
3/14/2005	17:39	4419.14	4413.14	50.54	810.893	-0.03		14674.14	3.33				
3/14/2005	18:39	4479.14	4473.14	50.43	811.003	0.08		14734.14	3.29				
3/14/2005	19:39	4539.14	4533.14	50.47	811.114	0.19		14794.14	3.26				
3/14/2005	20:39	4599.14	4593.14	50.43	811.25	0.32		14854.14	3.23				
3/14/2005	21:39	4659.14	4653.14	50.5	811.311	0.38		14914.14	3.21				
3/14/2005	22:39	4719.14	4713.14	50.56	811.46	0.53		14974.14	3.18				
3/14/2005	23:39	4779.14	4773.14	50.61	811.483	0.55		15034.14	3.15				
3/15/2005	0:39	4839.14	4833.14	50.63	811.697	0.77		15094.14	3.12				
3/15/2005	1:39	4899.14	4893.14	50.84	811.774	0.85		15154.14	3.10				
3/15/2005	2:39	4959.14	4953.14	50.86	811.918	0.99		15214.14	3.07				
3/15/2005	3:39	5019.14	5013.14	51.02	812.378	1.45		15274.14	3.05				
3/15/2005	4:39	5079.14	5073.14	51.16	812.464	1.54		15334.14	3.02				
3/15/2005	5:39	5139.14	5133.14	51.68	813.513	2.59		15394.14	3.00				
3/15/2005	6:39	5199.14	5193.14	52.67	813.77	2.84		15454.14	2.98				
3/15/2005	7:39	5259.14	5253.14	52.67	813.893	2.97		15514.14	2.95				
3/15/2005	8:39	5319.14	5313.14	53.17	814.04	3.11		15574.14	2.93				
3/15/2005	9:39	5379.14	5373.14	53.81	814.115	3.19		15634.14	2.91				
3/15/2005	10:39	5439.14	5433.14	54.1	814.203	3.27		15694.14	2.89				
3/15/2005	11:39	5499.14	5493.14	54.15	814.367	3.44		15754.14	2.87				
3/15/2005	12:39	5559.14	5553.14	51.36	814.498	3.57		15814.14	2.85				
3/15/2005	13:39	5619.14	5613.14	51.09	814.607	3.68		15874.14	2.83				
3/15/2005	14:39	5679.14	5673.14	51.13	814.736	3.81		15934.14	2.81				
3/15/2005	15:39	5739.14	5733.14	51.13	814.842	3.91		15994.14	2.79				
3/15/2005	16:39	5799.14	5793.14	51.18	814.953	4.02		16054.14	2.77				
3/15/2005	17:39	5859.14	5853.14	51.27	815.07	4.14		16114.14	2.75				
3/15/2005	18:39	5919.14	5913.14	51.32	815.198	4.27		16174.14	2.74				
3/15/2005	19:39	5979.14	5973.14	51.36	815.257	4.33		16234.14	2.72				
3/15/2005	20:39	6039.14	6033.14	51.55	815.366	4.44		16294.14	2.70				
3/15/2005	21:39	6099.14	6093.14	51.45	815.496	4.57		16354.14	2.68				
3/15/2005	22:39	6159.14	6153.14	51.55	815.683	4.76		16414.14	2.67				
3/15/2005	23:39	6219.14	6213.14	51.66	815.803	4.88		16474.14	2.65				
3/16/2005	0:39	6279.14	6273.14	51.96	815.908	4.98		16534.14	2.64				
3/16/2005	1:39	6339.14	6333.14	51.8	816.03	5.10		16594.14	2.62				
3/16/2005	2:39	6399.14	6393.14	51.89	816.164	5.24		16654.14	2.61				
3/16/2005	3:39	6459.14	6453.14	51.96	816.278	5.35		16714.14	2.59				
3/16/2005	4:39	6519.14	6513.14	52	816.425	5.50		16774.14	2.58				
3/16/2005	5:39	6579.14	6573.14	52.07	816.538	5.61		16834.14	2.56				
3/16/2005	6:39	6639.14	6633.14	52.09	816.682	5.75		16894.14	2.55				
3/16/2005	7:39	6699.14	6693.14	52.07	816.82	5.89		16954.14	2.53				
3/16/2005	8:39	6759.14	6753.14	52.12	816.932	6.00		17014.14	2.52				
3/16/2005	9:39	6819.14	6813.14	52.16	817.096	6.17		17074.14	2.51				
3/16/2005	10:39	6879.14	6873.14	52.19	817.204	6.28		17134.14	2.49				
3/16/2005	11:39	6939.14	6933.14	52.23	817.298	6.37		17194.14	2.48				
3/16/2005	12:39	6999.14	6993.14	52.23	817.421	6.49		17254.14	2.47				
3/16/2005	13:39	7059.14	7053.14	52.28	817.532	6.60		17314.14	2.45				
3/16/2005	14:39	7119.14	7113.14	52.32	817.608	6.68		17374.14	2.44				
3/16/2005	15:39	7179.14	7173.14	52.37	817.684	6.76		17434.14	2.43				
3/16/2005	16:39	7239.14	7233.14	52.37	817.772	6.84		17494.14	2.42				
3/16/2005	17:39	7299.14	7293.14	52.32	817.925	7.00		17554.14	2.41				
3/16/2005	18:39	7359.14	7353.14	52.35	818.087	7.16		17614.14	2.40				
3/16/2005	19:39	7419.14	7413.14	52.39	818.162	7.23		17674.14	2.38				
3/16/2005	20:39	7479.14	7473.14	52.41	818.377	7.45		17734.14	2.37				

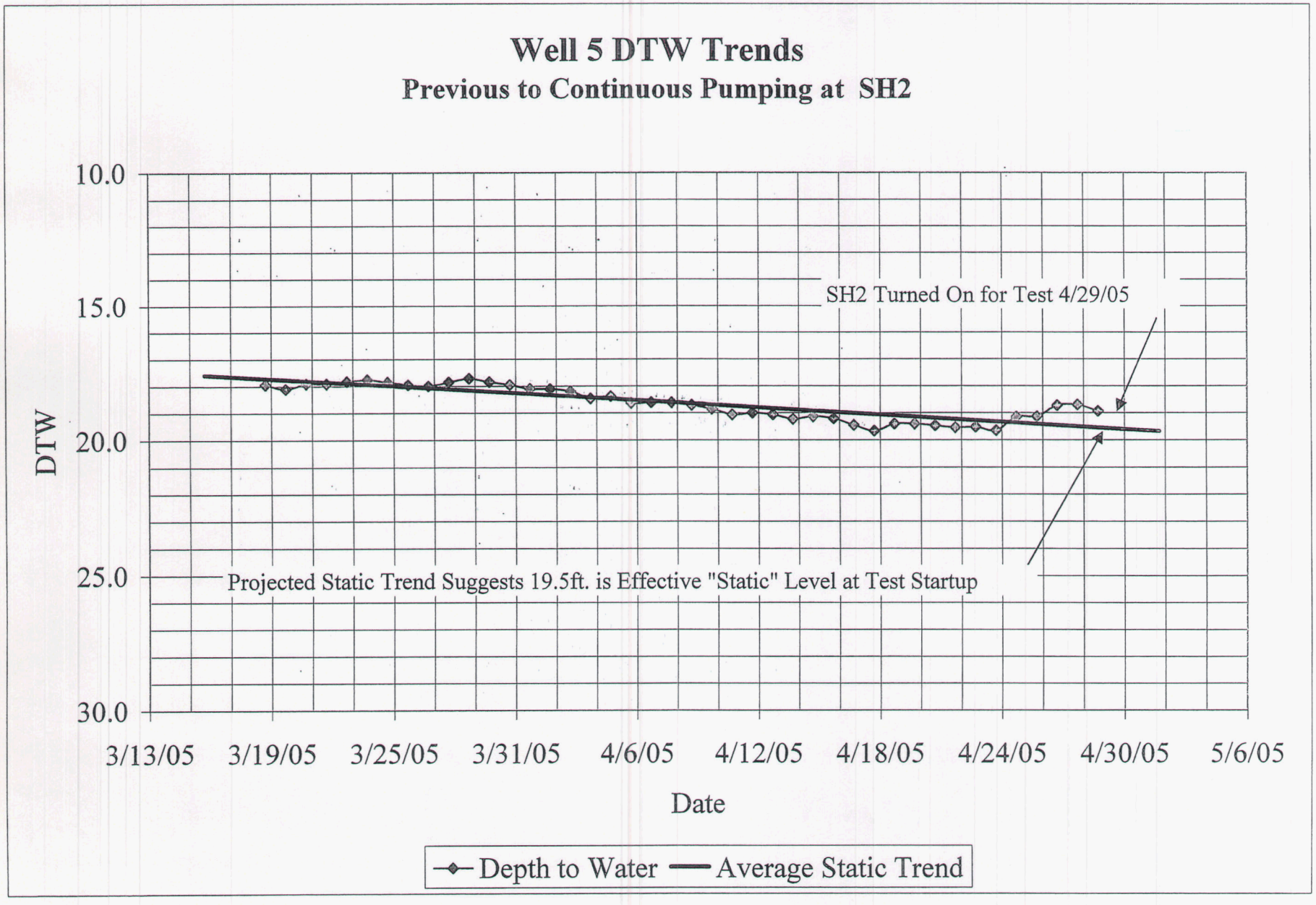
Date	Time	Data Logger ET (min) (pumping than recove	Corrected Data Logger ET (mit t then t'	Fahrenheit	Feet H2O		Drawdown	Sc	Total ET t	t/t'	gpm**	Meter 20026	gpm	Field Notes (gpm,meter,bucket, ph, t, cond.) -- Conducted on the rounded up whole number of the ET minute or at time noted Static of 810.93 read at 1300.
	3/16/2005 21:39	7539.14	7533.14	52.46	818.558	7.63			17794.14	2.36				
	3/16/2005 22:39	7599.14	7593.14	52.51	818.669	7.74			17854.14	2.35				
	3/16/2005 23:39	7659.14	7653.14	52.57	818.818	7.89			17914.14	2.34				
	3/17/2005 0:39	7719.14	7713.14	52.64	818.897	7.97			17974.14	2.33				
	3/17/2005 1:39	7779.14	7773.14	52.69	818.973	8.04			18034.14	2.32				
	3/17/2005 2:39	7839.14	7833.14	52.69	819.061	8.13			18094.14	2.31				
	3/17/2005 3:39	7899.14	7893.14	52.92	819.141	8.21			18154.14	2.30				
	3/17/2005 4:39	7959.14	7953.14	52.8	819.339	8.41			18214.14	2.29				
	3/17/2005 5:39	8019.14	8013.14	52.53	819.448	8.52			18274.14	2.28				
	3/17/2005 6:39	8079.14	8073.14	52.57	819.647	8.72			18334.14	2.27				
	3/17/2005 7:39	8139.14	8133.14	52.67	820.01	9.08			18394.14	2.26				
	3/17/2005 8:39	8199.14	8193.14	52.76	820.056	9.13			18454.14	2.25				
	3/17/2005 9:39	8259.14	8253.14	52.89	820.319	9.39			18514.14	2.24				
	3/17/2005 10:39	8319.14	8313.14	52.98	820.435	9.51			18574.14	2.23				
	3/17/2005 11:39	8379.14	8373.14	53.03	820.458	9.53			18634.14	2.23				
	3/17/2005 12:39	8439.14	8433.14	53.1	820.59	9.66			18694.14	2.22				
	3/17/2005 13:39	8499.14	8493.14	53.74	820.823	9.89			18754.14	2.21				
	3/17/2005 14:39	8559.14	8553.14	53.9	821.388	10.46			18814.14	2.20				
	3/17/2005 15:39	8619.14	8613.14	54.74	821.592	10.66			18874.14	2.19				
	3/17/2005 16:39	8679.14	8673.14	54.79	821.739	10.81			18934.14	2.18				
	3/17/2005 17:39	8739.14	8733.14	54.95	821.881	10.95			18994.14	2.17				
	3/17/2005 18:39	8799.14	8793.14	54.01	822.001	11.07			19054.14	2.17				
	3/17/2005 19:39	8859.14	8853.14	53.4	822.087	11.16			19114.14	2.16				
	3/17/2005 20:39	8919.14	8913.14	53.4	822.193	11.27			19174.14	2.15				
	3/17/2005 21:39	8979.14	8973.14	53.49	822.274	11.35			19234.14	2.14				
	3/17/2005 22:39	9039.14	9033.14	53.56	822.37	11.44			19294.14	2.14				
	3/17/2005 23:39	9099.14	9093.14	53.67	822.454	11.53			19354.14	2.13				
	3/18/2005 0:39	9159.14	9153.14	53.67	822.542	11.61			19414.14	2.12				
	3/18/2005 1:39	9219.14	9213.14	53.74	822.621	11.69			19474.14	2.11				
	3/18/2005 2:39	9279.14	9273.14	53.76	822.712	11.78			19534.14	2.11				
	3/18/2005 3:39	9339.14	9333.14	53.81	822.805	11.88			19594.14	2.10				
	3/18/2005 4:39	9399.14	9393.14	53.85	822.916	11.99			19654.14	2.09				
	3/18/2005 5:39	9459.14	9453.14	53.88	823.025	12.10			19714.14	2.09				
	3/18/2005 6:39	9519.14	9513.14	53.99	823.161	12.23			19774.14	2.08				
	3/18/2005 7:39	9579.14	9573.14	54.08	823.295	12.37			19834.14	2.07				
	3/18/2005 8:39	9639.14	9633.14	54.08	823.436	12.51			19894.14	2.07				
	3/18/2005 9:39	9699.14	9693.14	54.06	823.557	12.63			19954.14	2.06				
	3/18/2005 10:39	9759.14	9753.14	54.04	823.713	12.79			20014.14	2.05				
	3/18/2005 11:39	9819.14	9813.14	54.06	823.839	12.91			20074.14	2.05				
	3/18/2005 12:39	9879.14	9873.14	54.13	823.988	13.06			20134.14	2.04				
	3/18/2005 13:39	9939.14	9933.14	54.19	824.119	13.19			20194.14	2.03				
	3/18/2005 14:39	9999.14	9993.14	54.22	824.245	13.32			20254.14	2.03				
	3/18/2005 15:39	10059.14	10053.14	54.17	824.416	13.49			20314.14	2.02				
	3/18/2005 16:39	10119.14	10113.14	54.17	824.575	13.65			20374.14	2.01				


SH3 Groundwater Elevation History Deep M-X Aquifer
Groundwater Elevation (ftmsl)
4900
4850
4800
4750
4700
4650
4600
4550
4500
4450
4400
Period of intermittent pumping at high rates for development
Periods of Recharge
2/1/03
4/2/03
6/1/03
7/31/03
9/29/03
11/28/03
1/27/04
3/27/04
5/26/04
7/25/04
9/23/04
11/22/04
1/21/05
3/22/05
5/21/05
Date
SH3 Manual
SH3 Logger
Regional Static Level Low

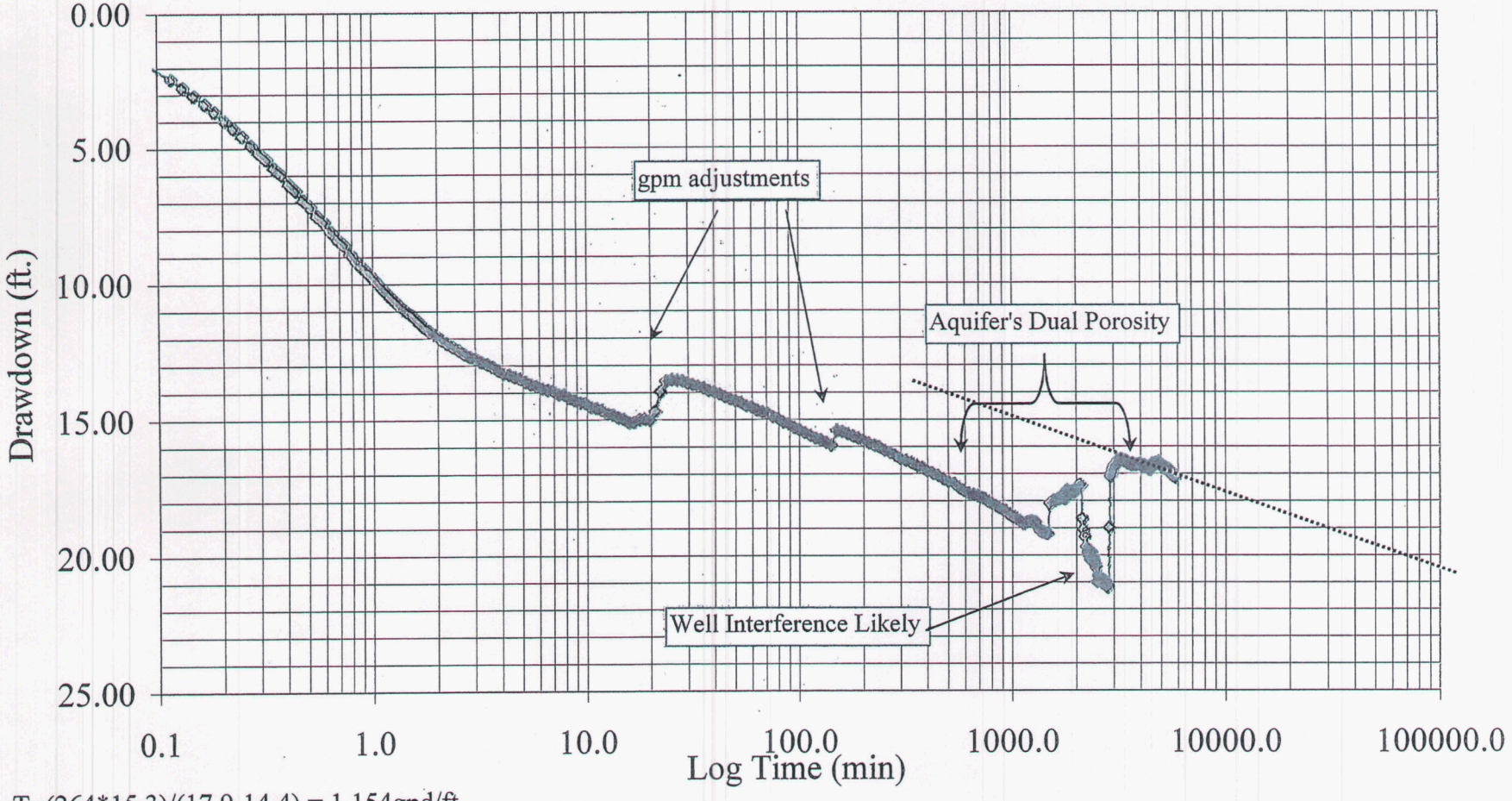

SH-2 Constant Rate Pumping Test
Depth to Water vs. Time with Static Level, Pump Setting, and Total Depth
DTW (ft.)
0.00
40.00
80.00
120.00
160.00
200.00
240.00
280.00
4/29/05
4/30/05
5/1/05
5/2/05
5/3/05
5/4/05
5/5/05
5/6/05
5/7/05
Date
Depth to Water at SH2
Well Depth
Pump Intake
Static
Recovery



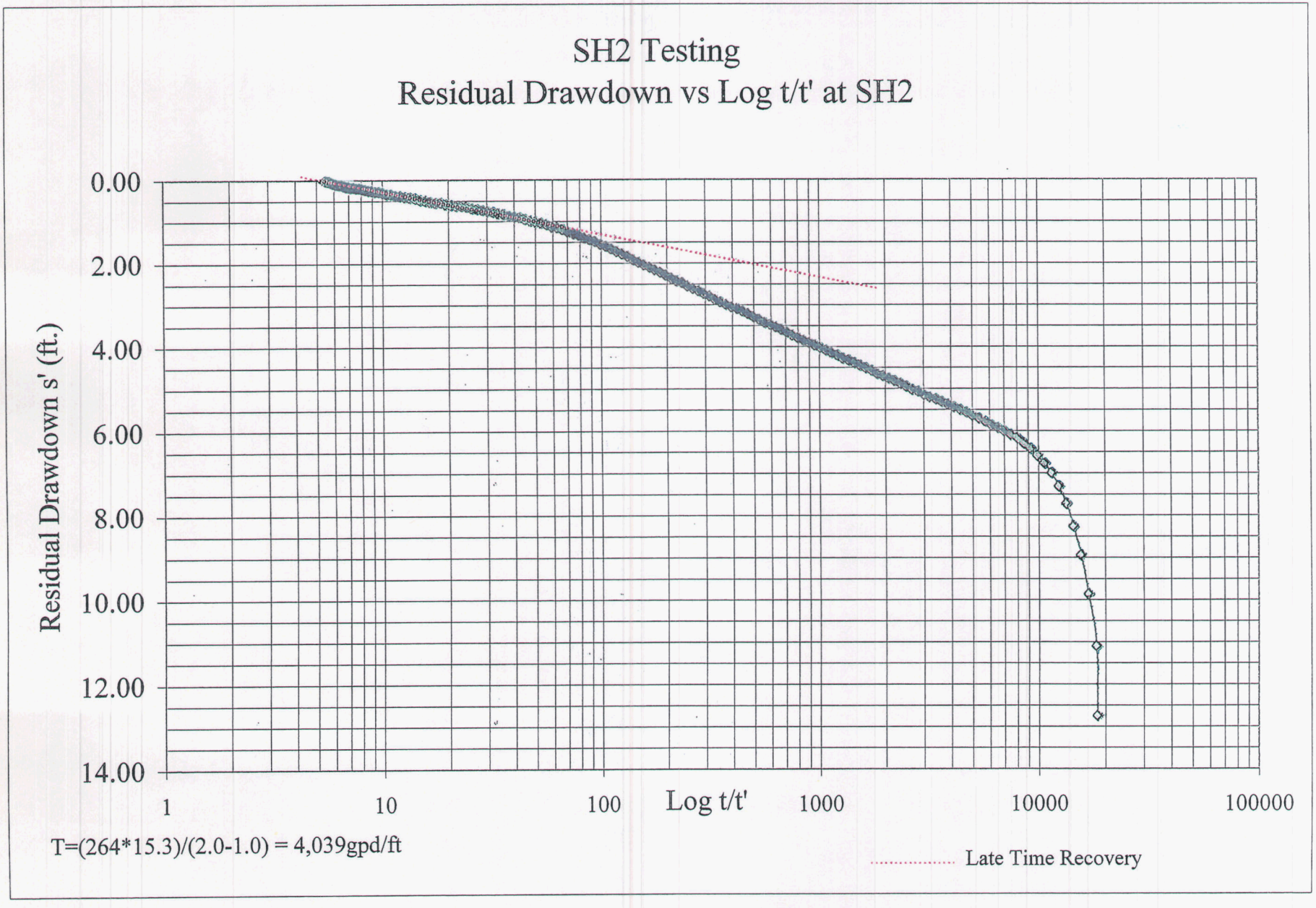
Pumping level data removed for resolution of "static" level trends, yet barometric effects are evident.

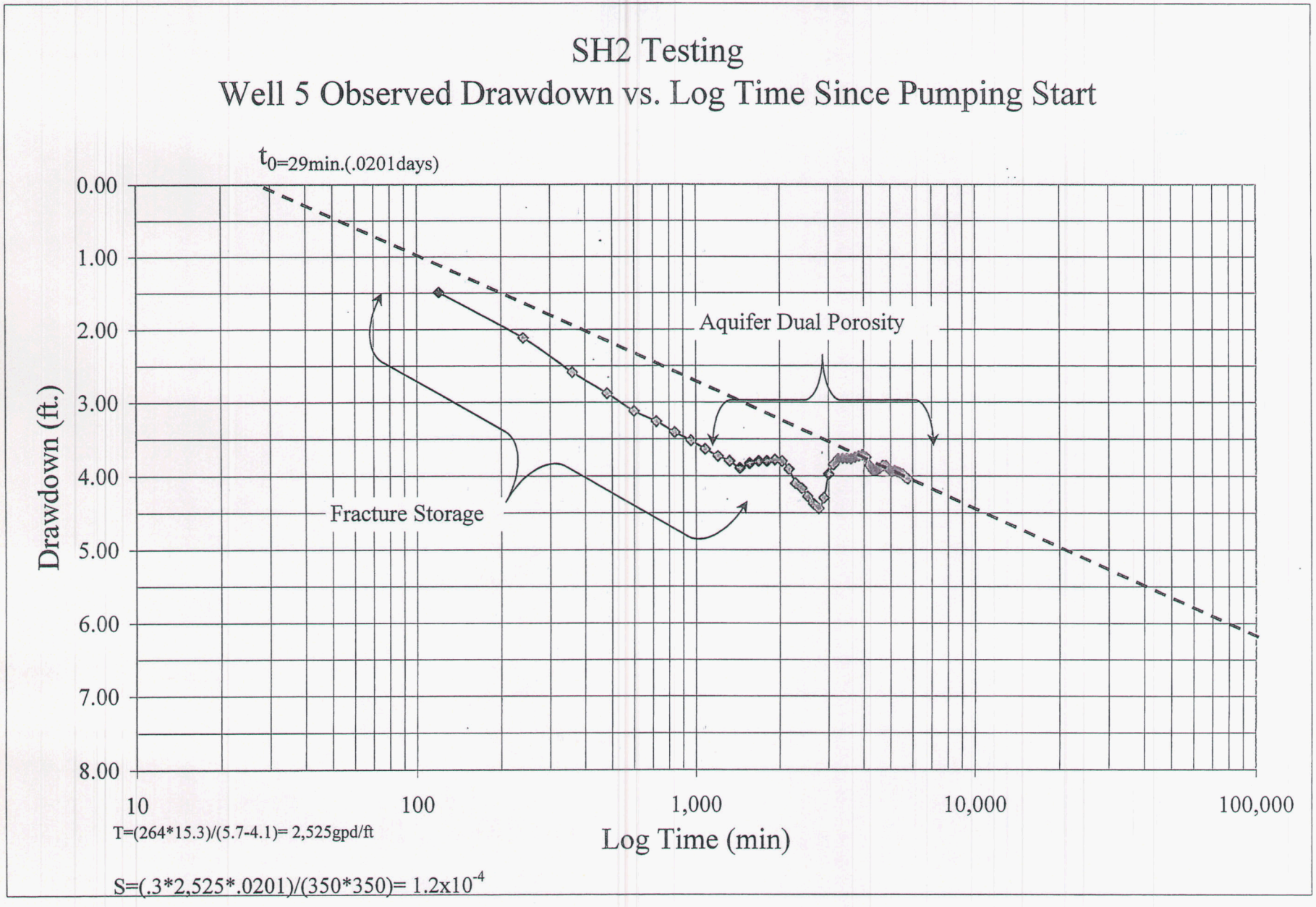

Well 5 DTW Trends
Previous to Continuous Pumping at SH2
10.0
15.0
20.0
25.0
30.0
DTW
SH2 Turned On for Test 4/29/05
Projected Static Trend Suggests 19.5ft. is Effective "Static" Level at Test Startup
3/13/05
3/19/05
3/25/05
3/31/05
4/6/05
4/12/05
4/18/05
4/24/05
4/30/05
5/6/05
Date
Depth to Water
Average Static Trend

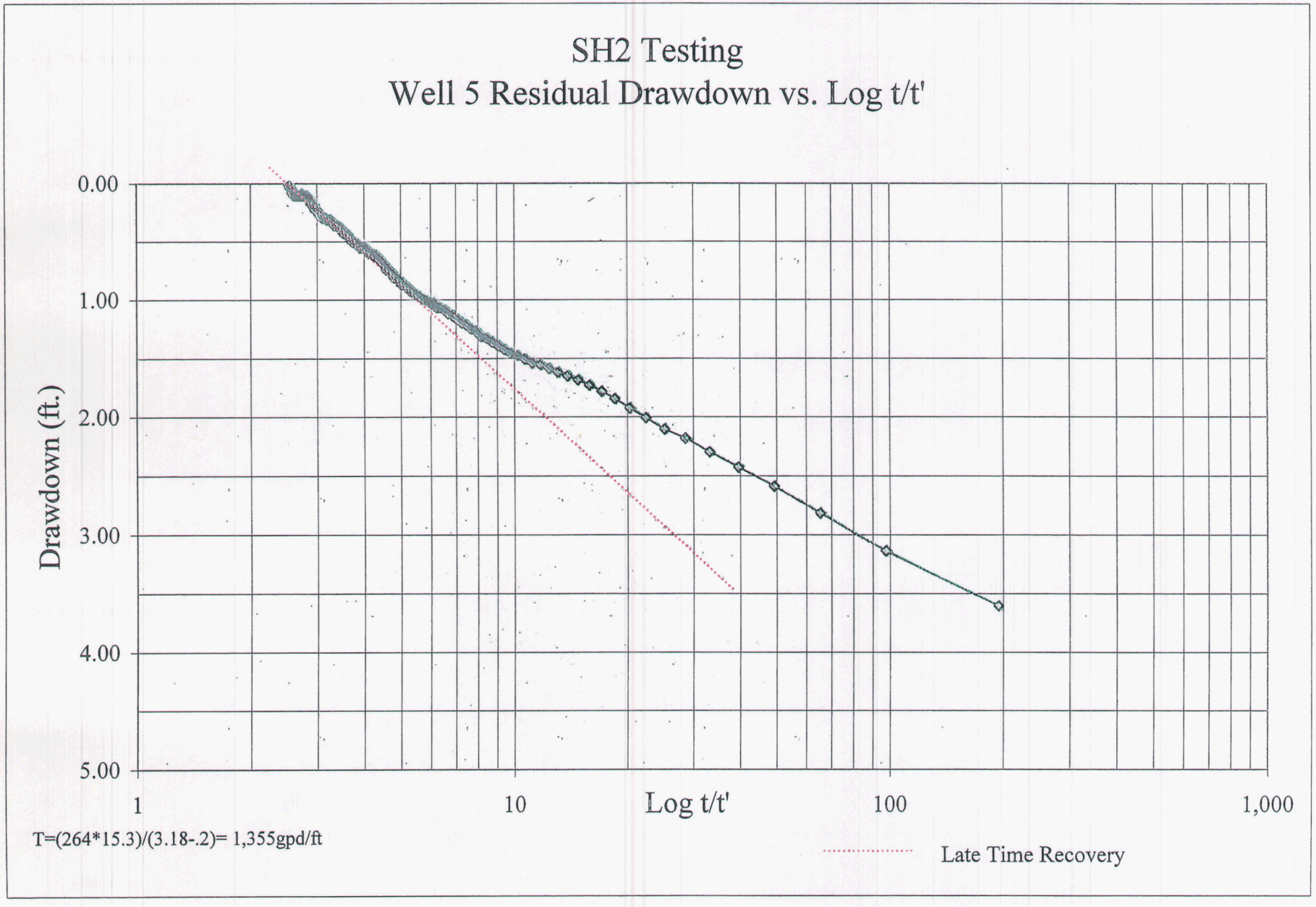
SH2 Constant Rate Testing
Drawdown vs Log Time at SH2



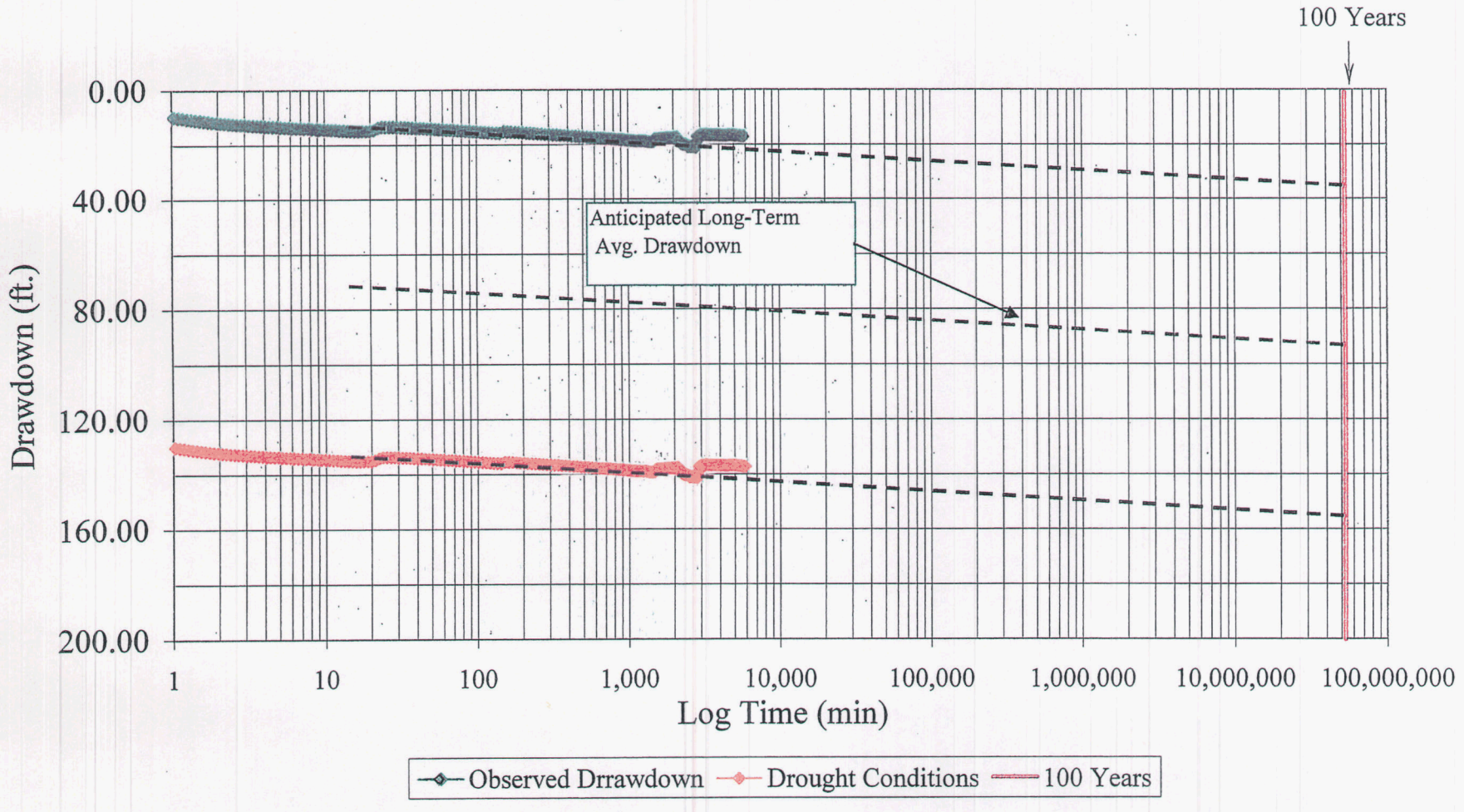
T=(264*15.3)/(17.9-14.4) = 1,154gpd/ft


SH2 Testing
Residual Drawdown vs Log t/t' at SH2
Residual Drawdown s' (ft.)
0.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00
1
10
100
Log t/t'
1000
10000
100000
T=(264*15.3)/(2.0-1.0) = 4,039gpd/ft
Late Time Recovery

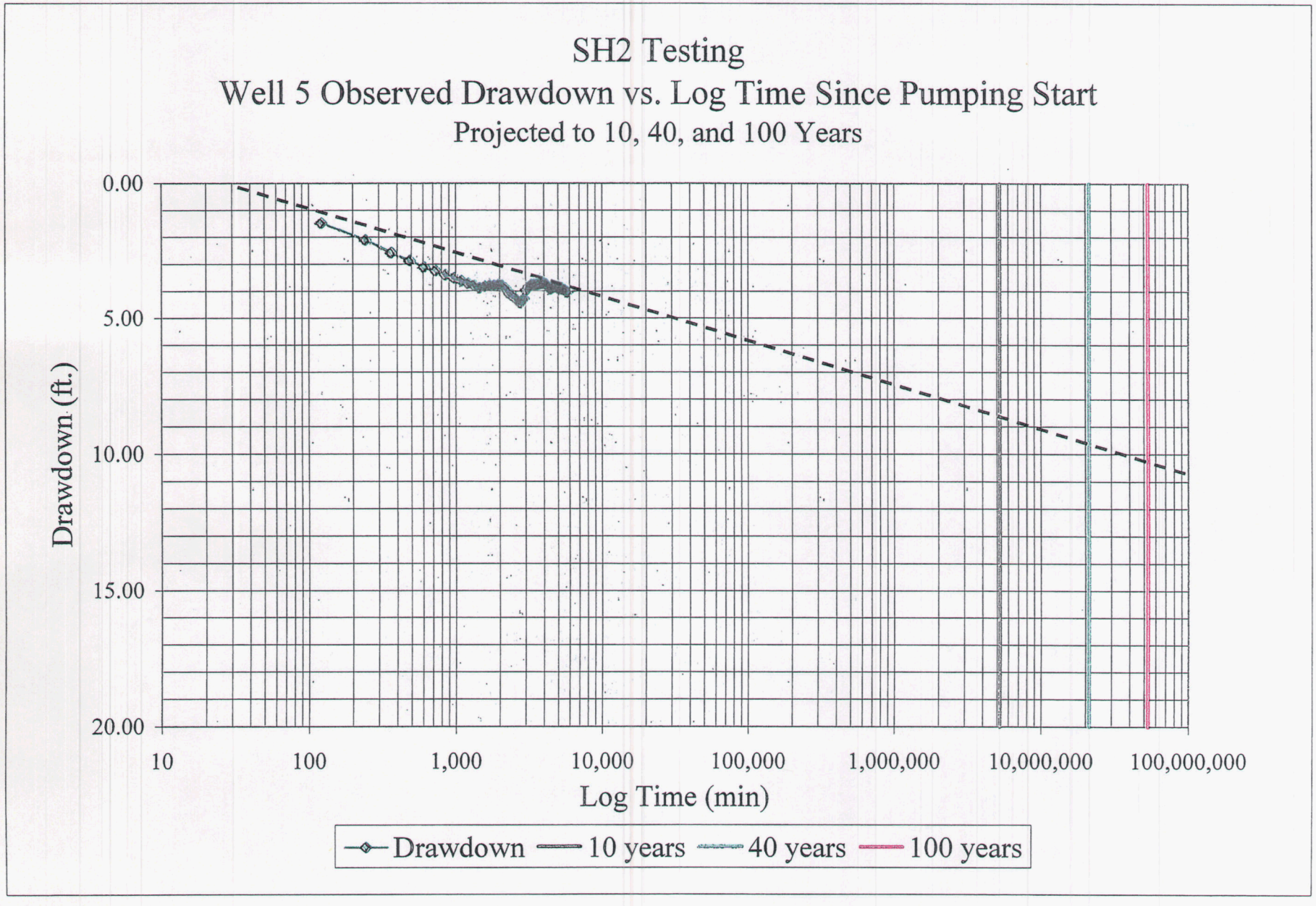

SH2 Testing
Well 5 Observed Drawdown vs. Log Time Since Pumping Start
t_0=29min.(.0201days)
Aquifer Dual Porosity
Fracture Storage
Drawdown (ft.)
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
10
100
1,000
10,000
100,000
Log Time (min)
T=(264*15.3)/(5.7-4.1)= 2,525gpd/ft
S=(.3*2,525*.0201)/(350*350)= 1.2x10-4

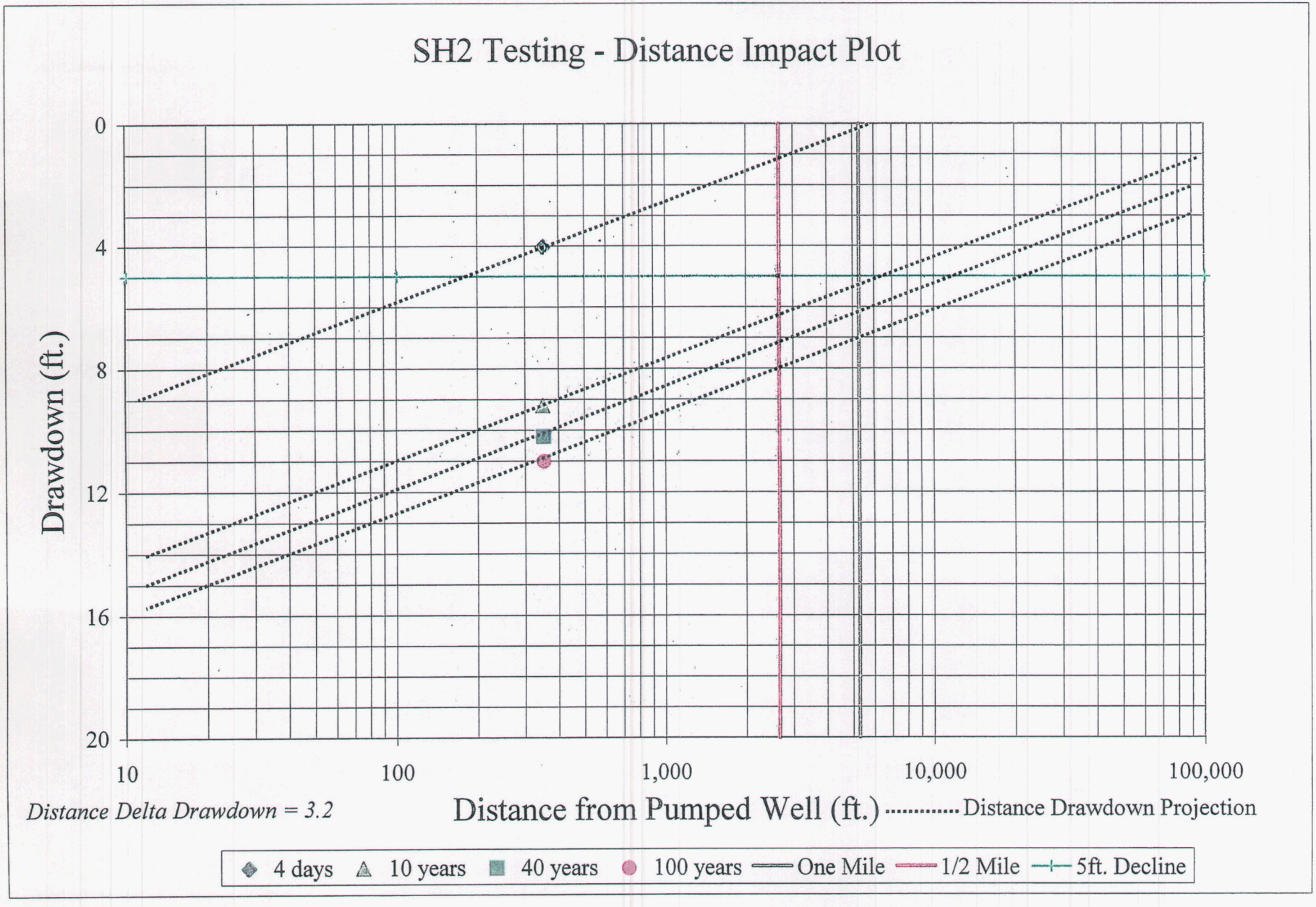

SH2 Testing
Well 5 Residual Drawdown vs. Log t/t'
Drawdown (ft.)
0.00
1.00
2.00
3.00
4.00
5.00
1
10
100
1,000
Log t/t'
T=(264*15.3)/(3.18-.2)= 1,355gpd/ft
Late Time Recovery

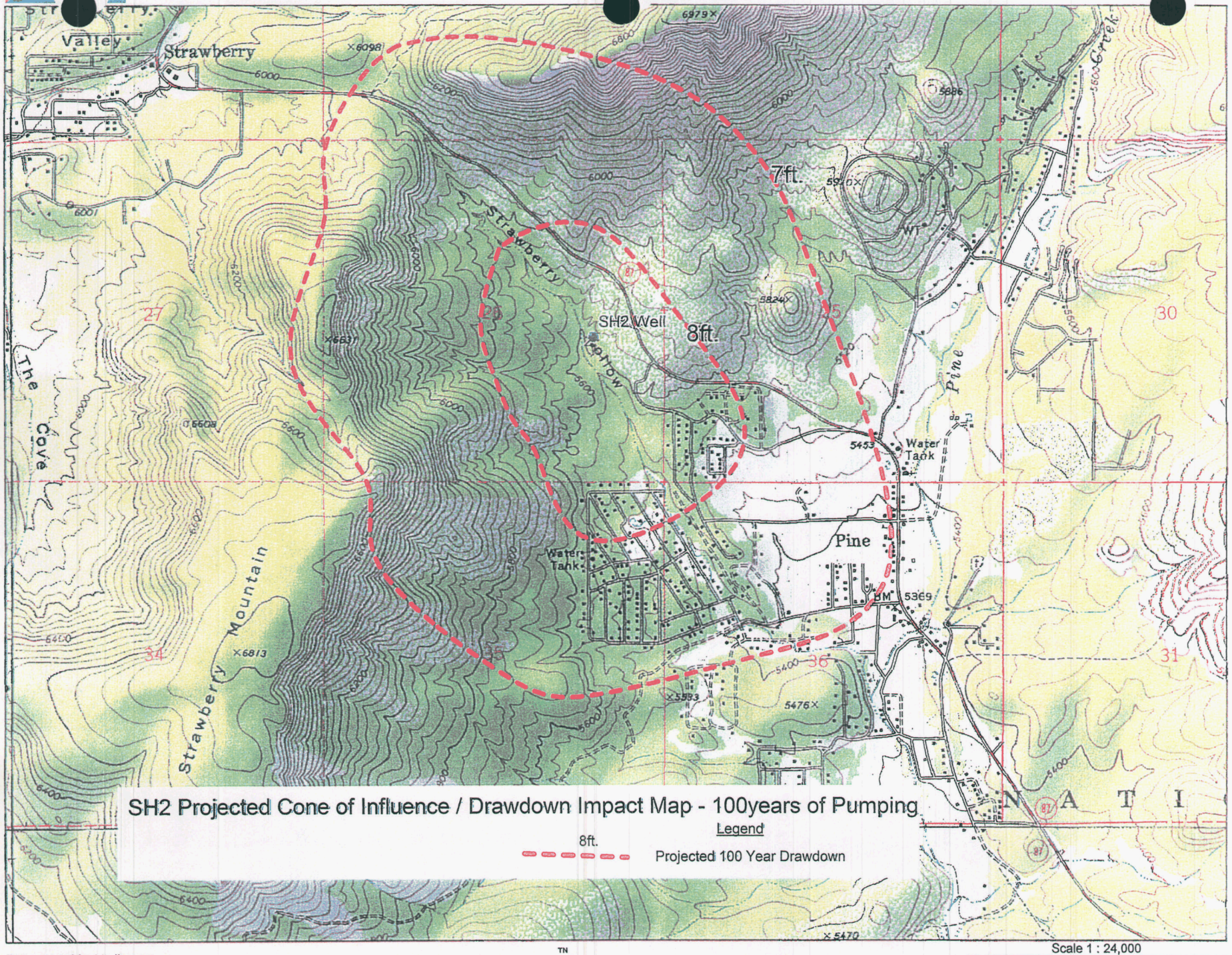
SH2 Constant Rate Testing
Drawdown vs Log Time to 100 Years
with Projected Drought Scenario



Note: Assumes well will not be continuously pumped at more than 15.3gpm and well interference is only intermittent.


SH2 Testing
Well 5 Observed Drawdown vs. Log Time Since Pumping Start
Projected to 10, 40, and 100 Years
Drawdown (ft.)
0.00
5.00
10.00
15.00
20.00
10
100
1,000
10,000
100,000
1,000,000
10,000,000
100,000,000
Log Time (min)
Drawdown
10 years
40 years
100 years


SH2 Testing - Distance Impact Plot
Drawdown (ft.)
0
4
8
12
16
20
10
100
1,000
10,000
100,000
Distance Delta Drawdown = 3.2
Distance from Pumped Well (ft.)
Distance Drawdown Projection
4 days
10 years
40 years
100 years
One Mile
1/2 Mile
5ft. Decline



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HWRC
P.O. Box 891
Payson, AZ 85547
Phone: (928)-468-0252

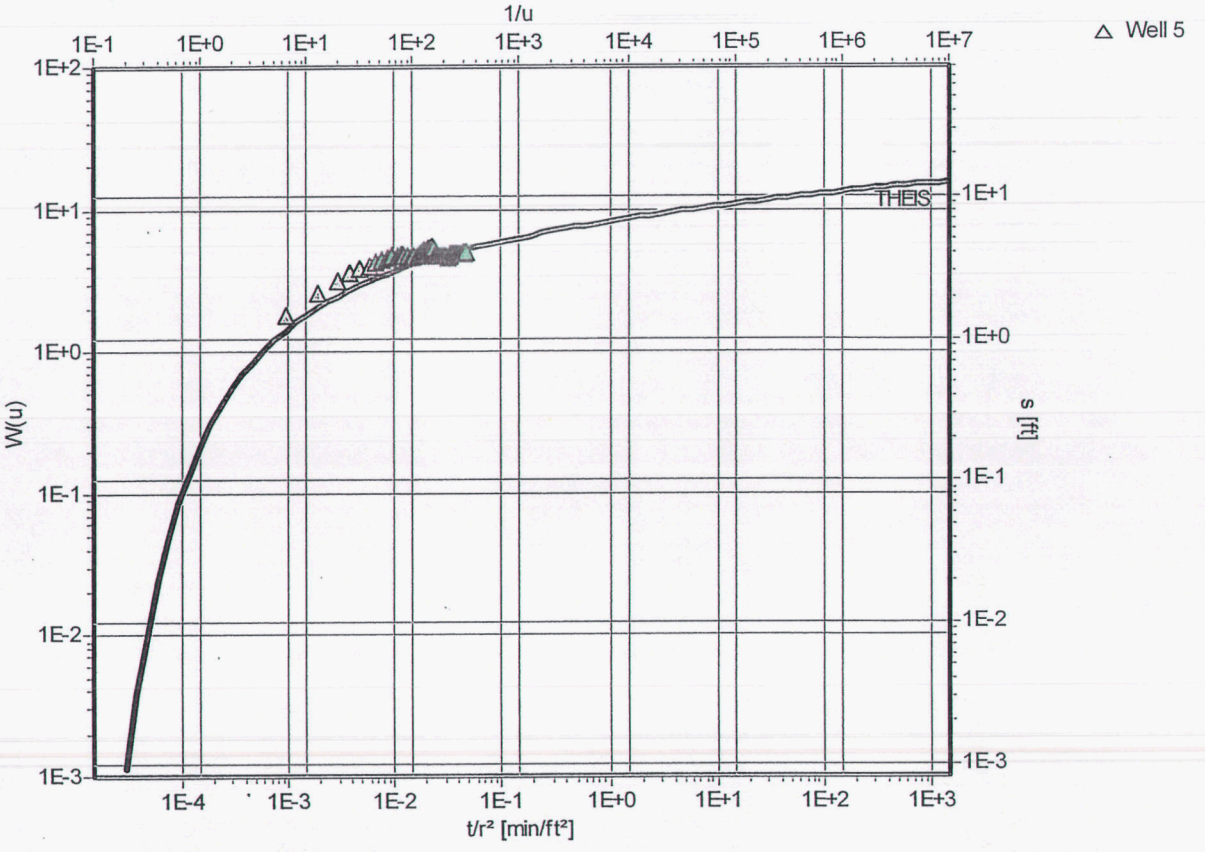
Pumping Test Analysis Report

Project: SH testing

Number:

Client:

SH2 Testing - Well 5 [Theis]



Pumping Test: **SH2 Testing**

Analysis Method: **Theis**

Analysis Results:				
	Transmissivity:	2.88E+2 [ft²/d]	Conductivity:	1.44E+0 [ft/d]
	Storativity:	1.18E-4		

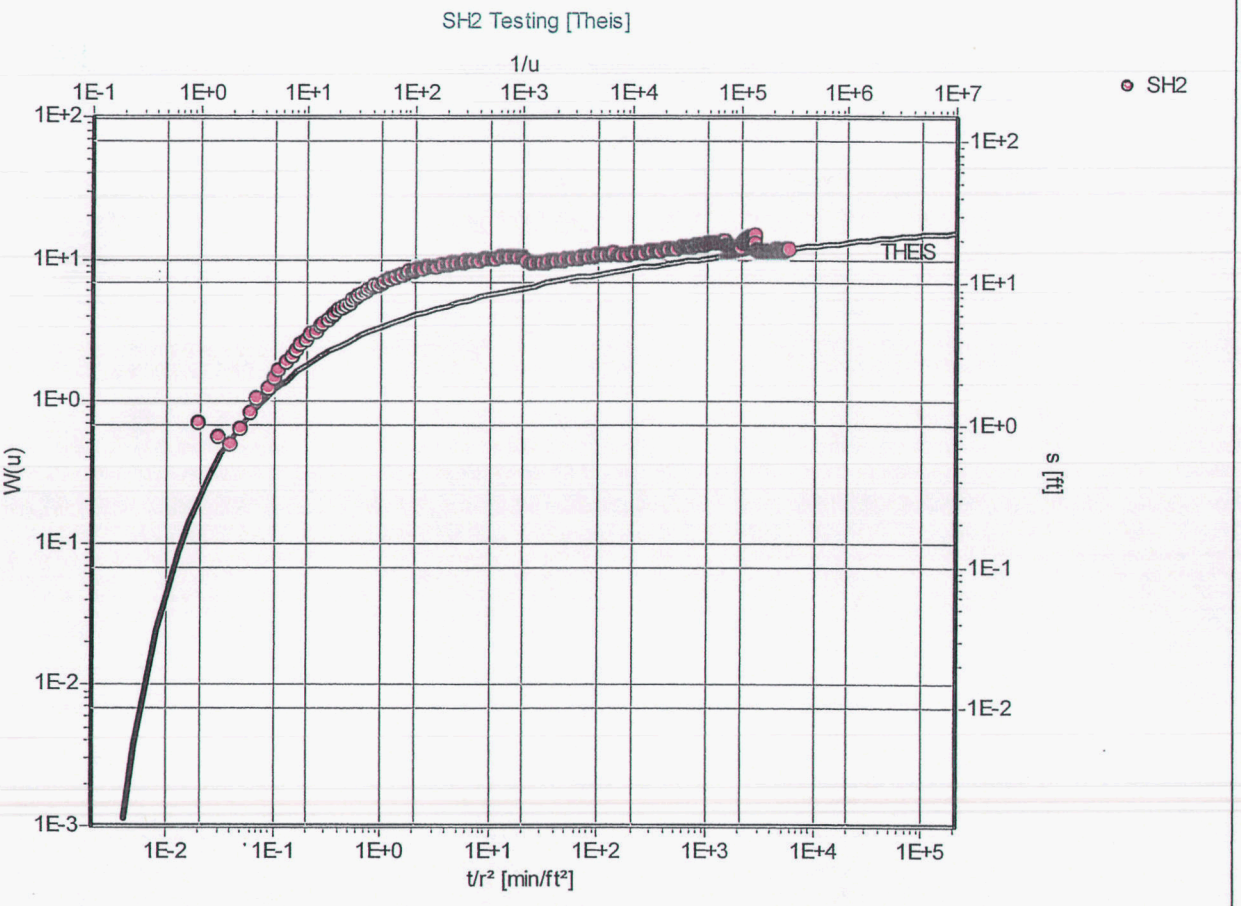
Test parameters:				
	Pumping Well:	SH2	Aquifer Thickness:	200 [ft]
	Casing radius:	0.188 [ft]	Confined Aquifer	
	Screen length:	80 [ft]		
	Boring radius:	0.521 [ft]		
	Discharge Rate:	15.3 [U.S. gal/min]		

Comments: Theis Late Time at Well 5 -- ~350ft. from SH2 pumping well

Evaluated by:

Evaluation Date: 8/10/2005

HWRC	Pumping Test Analysis Report
P.O. Box 891	Project: SH testing
Payson, AZ 85547	Number:
Phone: (928)-468-0252	Client:



Pumping Test: **SH2 Testing**

Analysis Method: **Theis**

Analysis Results:				
	Transmissivity:	1.59E+2 [ft²/d]	Conductivity:	7.97E-1 [ft/d]
	Storativity:	9.06E-3		

Test parameters:				
	Pumping Well:	SH2	Aquifer Thickness:	200 [ft]
	Casing radius:	0.188 [ft]	Confined Aquifer	
	Screen length:	80 [ft]		
	Boring radius:	0.521 [ft]		
	Discharge Rate:	15.3 [U.S. gal/min]		

Comments: Theis Late Time -- SH2 - pumping well

Evaluated by:

Evaluation Date: 8/10/2005

Highland Water Resource Consulting -- Pump Testing Data Record

Well Name: Strawberry Hollow Well SH-2 #55-579973

Test Name/Type: SH-2 Four Day Constant Rate Test

Location: Pine, AZ

Test Type: 7 day test 45gpm, stabilized at 47gpm, total test average of 46gpm

Primary Water Zone(s):1010-1055, 1070-1090, 1240-1260+

ADWR#: 55-579973 | Pumping Rate(s): 15.3gpm | Max. Observed Drawdown: 20.98 (occurred during weekend, private wells likely in use) | Time to 100% Recovery: 9 minutes

Start of Pumping: 4/29/05 at 1030 | Pump Setting: 210 | Drawdown at End of Test: 17.14 | Meter Read Start: 1252810 | Meter Read at Finish: 1341183

End of Pumping: 5/3/05 at 1103 | Static Level: 16.61 | Specific Capacity at End of Test: .89

Duration of Pumping: 5,793 min or 4 days and 33 minutes. | Available Drawdown: 193.39 | Total Volume Pumped: ~88,373 gallons

Mechanical meter in use since water system completed. In excellent condition.

* Data Logger purposefully collected data for almost 10 seconds prior to test start and 3 min prior to recovery to confirm operation. Thus, a correction was applied to logger time to facilitate proper analyses.

Date	Time	Data Logger ET (min) (pumping than recovery)	Corrected Data Logger ET (min)*	Chan[1] Fahrenheit	Chan[2] Feet H2O	Drawdown s and s'	Sc Then t'	Total ET	t/t'	Meter gpm	Meter 1252810	Bucket gpm	Field Notes - Conducted on the rounded up whole number of the ET minute or at time noted
4/29/2005	10:30	0.00		52.7	16.61	Static							
4/29/2005	10:30	0.16	0.01	52.7	18.25	1.64	11.57	0.01		19			adjust q down
4/29/2005	10:30	0.17	0.02	52.67	17.65	1.04		0.02					
4/29/2005	10:30	0.18	0.03	52.67	17.43	0.82		0.03					
4/29/2005	10:30	0.19	0.04	52.67	17.34	0.73		0.04					
4/29/2005	10:30	0.20	0.05	52.65	17.55	0.94		0.05					
4/29/2005	10:30	0.21	0.06	52.65	17.84	1.23		0.06					
4/29/2005	10:30	0.22	0.07	52.65	18.12	1.51		0.07					
4/29/2005	10:30	0.24	0.09	52.65	18.41	1.80		0.09					
4/29/2005	10:30	0.25	0.10	52.65	18.76	2.15		0.10					
4/29/2005	10:30	0.26	0.11	52.65	19.05	2.44		0.11					
4/29/2005	10:30	0.28	0.13	52.65	19.36	2.75		0.13					
4/29/2005	10:30	0.30	0.15	52.65	19.67	3.06		0.15					
4/29/2005	10:30	0.31	0.16	52.65	19.98	3.37		0.16					
4/29/2005	10:30	0.33	0.18	52.65	20.27	3.66		0.18					
4/29/2005	10:30	0.35	0.20	52.65	20.60	3.99		0.20					
4/29/2005	10:30	0.37	0.22	52.65	20.89	4.28		0.22					
4/29/2005	10:30	0.40	0.25	52.63	21.17	4.56		0.25					
4/29/2005	10:30	0.42	0.27	52.65	21.50	4.89		0.27					
4/29/2005	10:30	0.44	0.29	52.65	21.79	5.18		0.29					
4/29/2005	10:30	0.47	0.32	52.65	22.04	5.43		0.32					
4/29/2005	10:30	0.50	0.35	52.63	22.37	5.76		0.35					
4/29/2005	10:30	0.52	0.37	52.63	22.61	6.00		0.37					
4/29/2005	10:30	0.55	0.40	52.65	22.95	6.34		0.40					
4/29/2005	10:30	0.59	0.44	52.63	23.19	6.58		0.44					
4/29/2005	10:30	0.62	0.47	52.63	23.54	6.93		0.47					
4/29/2005	10:30	0.66	0.51	52.63	23.79	7.18		0.51					
4/29/2005	10:30	0.70	0.55	52.63	24.12	7.51		0.55					
4/29/2005	10:30	0.74	0.59	52.63	24.34	7.73		0.59					
4/29/2005	10:30	0.78	0.63	52.61	24.69	8.08		0.63					
4/29/2005	10:30	0.83	0.68	52.61	24.96	8.35		0.68					
4/29/2005	10:30	0.88	0.73	52.61	25.17	8.56		0.73					
4/29/2005	10:30	0.93	0.78	52.58	25.49	8.88		0.78					
4/29/2005	10:30	0.98	0.83	52.58	25.78	9.17		0.83					
4/29/2005	10:31	1.04	0.89	52.56	26.01	9.40		0.89					
4/29/2005	10:31	1.10	0.95	52.56	26.23	9.62		0.95					
4/29/2005	10:31	1.17	1.02	52.54	26.48	9.87	1.82	1.02		18			adjust q down
4/29/2005	10:31	1.24	1.09	52.54	26.75	10.14		1.09					
4/29/2005	10:31	1.31	1.16	52.52	26.97	10.36		1.16					
4/29/2005	10:31	1.39	1.24	52.49	27.19	10.58		1.24					
4/29/2005	10:31	1.47	1.32	52.49	27.42	10.81		1.32					
4/29/2005	10:31	1.56	1.41	52.47	27.60	10.99		1.41					
4/29/2005	10:31	1.65	1.50	52.45	27.77	11.16		1.50					
4/29/2005	10:31	1.75	1.60	52.45	27.97	11.36		1.60					
4/29/2005	10:31	1.86	1.71	52.43	28.20	11.59		1.71					
4/29/2005	10:31	1.97	1.82	52.4	28.36	11.75		1.82					
4/29/2005	10:32	2.08	1.93	52.4	28.48	11.87	1.52	1.93		18			
4/29/2005	10:32	2.21	2.06	52.38	28.66	12.05		2.06					
4/29/2005	10:32	2.34	2.19	52.36	28.81	12.20		2.19					
4/29/2005	10:32	2.48	2.33	52.36	28.93	12.32		2.33					
4/29/2005	10:32	2.63	2.48	52.34	29.05	12.44		2.48					
4/29/2005	10:32	2.79	2.64	52.31	29.19	12.56		2.64					
4/29/2005	10:32	2.95	2.80	52.31	29.30	12.69	1.42	2.80		18			adjust gpm down
4/29/2005	10:33	3.13	2.98	52.29	29.36	12.75		2.98					
4/29/2005	10:33	3.32	3.17	52.27	29.48	12.87		3.17					
4/29/2005	10:33	3.51	3.36	52.27	29.56	12.95		3.36					
4/29/2005	10:33	3.72	3.57	52.25	29.66	13.05		3.57					
4/29/2005	10:33	3.95	3.80	52.25	29.78	13.17		3.80					
4/29/2005	10:34	4.16	4.03	52.22	29.90	13.29		4.03		17			
4/29/2005	10:34	4.43	4.28	52.22	29.95	13.34		4.28					
4/29/2005	10:34	4.69	4.54	52.2	30.03	13.42		4.54					
4/29/2005	10:34	4.97	4.82	52.2	30.09	13.48		4.82					
4/29/2005	10:35	5.27	5.12	52.18	30.21	13.60		5.12					
4/29/2005	10:35	5.58	5.43	52.16	30.31	13.70		5.43					

Date	Time	Data Logger ET (min) (pumping than recovery)	Corrected Data Logger ET (min)*	Fahrenheit	Feet H2O	Drawdown s and s'	Sc Then t'	Total ET	t/t'	gpm	Meter 1252810	gpm	Field Notes - Conducted on the rounded up whole number of the ET minute or at time noted
4/29/2005	10:35	5.91	5.76	52.16	30.37	13.76		5.76					
4/29/2005	10:36	6.27	6.12	52.13	30.45	13.84		6.12					
4/29/2005	10:36	6.64	6.49	52.13	30.51	13.90		6.49					
4/29/2005	10:37	7.03	6.88	52.13	30.53	13.92	1.19	6.88		16.5			adjust q down
4/29/2005	10:37	7.45	7.30	52.11	30.67	14.06		7.30					
4/29/2005	10:37	7.90	7.75	52.09	30.67	14.06		7.75					
4/29/2005	10:38	8.37	8.22	52.09	30.82	14.21		8.22					
4/29/2005	10:38	8.86	8.71	52.06	30.90	14.29		8.71					
4/29/2005	10:39	9.39	9.24	52.04	30.98	14.37		9.24					
4/29/2005	10:39	9.95	9.80	52.04	31.00	14.39		9.80					
4/29/2005	10:40	10.54	10.39	52.02	31.14	14.53		10.39					
4/29/2005	10:41	11.17	11.02	52.02	31.18	14.57		11.02					
4/29/2005	10:41	11.83	11.68	52.02	31.24	14.63		11.68					
4/29/2005	10:42	12.53	12.38	52	31.38	14.77		12.38					
4/29/2005	10:43	13.28	13.13	52	31.42	14.81		13.13					
4/29/2005	10:44	14.07	13.92	51.97	31.52	14.91		13.92					
4/29/2005	10:44	14.91	14.76	51.95	31.58	14.97		14.76					
4/29/2005	10:45	15.79	15.64	51.95	31.71	15.10		15.64					
4/29/2005	10:46	16.73	16.58	51.93	31.71	15.10		16.58					
4/29/2005	10:47	17.72	17.57	51.93	31.80	14.99		17.57					
4/29/2005	10:48	18.78	18.63	51.93	31.58	14.97		18.63					
4/29/2005	10:49	19.89	19.74	51.91	31.62	15.01		19.74					
4/29/2005	10:51	21.07	20.92	51.91	31.29	14.68	1.16	20.92		17			adjust q down
4/29/2005	10:52	22.32	22.17	51.91	30.57	13.96		22.17					
4/29/2005	10:53	23.65	23.50	51.91	30.18	13.57		23.50					
4/29/2005	10:55	25.05	24.90	51.88	30.13	13.52		24.90					
4/29/2005	10:56	26.54	26.39	51.88	30.16	13.55		26.39					
4/29/2005	10:58	28.12	27.97	51.88	30.18	13.57		27.97					
4/29/2005	10:59	29.79	29.64	51.86	30.26	13.65	1.14	29.64		15.5	1253349		539gallons pumped, avg. gpm = 17.9gpm to this point,
4/29/2005	11:01	31.55	31.40	51.86	30.32	13.71		31.40					will try to hold at 15-16gpm
4/29/2005	11:03	33.43	33.28	51.86	30.38	13.77		33.28					
4/29/2005	11:05	35.41	35.26	51.84	30.44	13.83		35.26					
4/29/2005	11:07	37.51	37.36	51.84	30.54	13.93		37.36					
4/29/2005	11:09	39.74	39.59	51.84	30.58	13.97		39.59					
4/29/2005	11:12	42.10	41.95	51.84	30.67	14.06		41.95					
4/29/2005	11:14	44.60	44.45	51.84	30.77	14.16	1.12	44.45		15.9			Time of meas. 1115
4/29/2005	11:17	47.24	47.09	51.84	30.83	14.22		47.09					
4/29/2005	11:20	50.05	49.90	51.84	30.91	14.30		49.90					
4/29/2005	11:23	53.01	52.86	51.84	30.97	14.36		52.86					
4/29/2005	11:26	56.16	56.01	51.84	31.10	14.49		56.01					
4/29/2005	11:29	59.49	59.34	51.84	31.14	14.53		59.34					
4/29/2005	11:33	63.02	62.87	51.84	31.26	14.65		62.87					
4/29/2005	11:36	66.76	66.61	51.84	31.32	14.71		66.61					
4/29/2005	11:40	70.72	70.57	51.84	31.39	14.78		70.57					
4/29/2005	11:44	74.91	74.76	51.84	31.51	14.90		74.76					
4/29/2005	11:49	79.35	79.20	51.84	31.57	14.96		79.20					
4/29/2005	11:54	84.06	83.91	51.84	31.72	15.11		83.91					
4/29/2005	11:59	89.05	88.90	51.84	31.78	15.17		88.90					
4/29/2005	12:04	94.33	94.18	51.84	31.90	15.29		94.18					
4/29/2005	12:09	99.92	99.77	51.84	31.98	15.37		99.77					
4/29/2005	12:15	105.84	105.69	51.84	32.09	15.48		105.69					
4/29/2005	12:22	112.12	111.97	51.84	32.19	15.58		111.97					
4/29/2005	12:28	118.77	118.62	51.84	32.29	15.68		118.62					
4/29/2005	12:35	125.81	125.66	51.84	32.35	15.74		125.66					
4/29/2005	12:43	133.27	133.12	51.86	32.46	15.85		133.12					
4/29/2005	12:51	141.17	141.02	51.84	32.56	15.95	1.00	141.02		16	1255103		Time of meas 1250, adjust q down
4/29/2005	12:59	149.54	149.39	51.84	32.00	15.39		149.39					
4/29/2005	13:08	158.40	158.25	51.84	32.05	15.44		158.25					
4/29/2005	13:17	167.79	167.64	51.84	32.13	15.52		167.64					
4/29/2005	13:27	177.74	177.59	51.86	32.21	15.60		177.59					
4/29/2005	13:38	188.27	188.12	51.86	32.30	15.69		188.12					
4/29/2005	13:49	199.43	199.28	51.86	32.40	15.79		199.28					
4/29/2005	14:01	211.26	211.11	51.86	32.48	15.87		211.11					
4/29/2005	14:13	223.78	223.63	51.86	32.56	15.95		223.63					
4/29/2005	14:27	237.04	236.89	51.86	32.63	16.02		236.89					
4/29/2005	14:41	251.09	250.94	51.86	32.75	16.14		250.94					
4/29/2005	14:55	265.98	265.83	51.86	32.83	16.22		265.83					
4/29/2005	15:11	281.74	281.59	51.86	32.93	16.32		281.59					
4/29/2005	15:28	298.44	298.29	51.86	33.06	16.45		298.29					
4/29/2005	15:46	316.13	315.98	51.86	33.12	16.51		315.98					
4/29/2005	16:04	334.86	334.71	51.86	33.20	16.59		334.71					
4/29/2005	16:24	354.71	354.56	51.86	33.31	16.70		354.56					
4/29/2005	16:45	375.73	375.58	51.86	33.39	16.78		375.58					
4/29/2005	17:08	398.00	397.85	51.86	33.51	16.90		397.85					
4/29/2005	17:31	421.59	421.44	51.86	33.59	16.98		421.44					
4/29/2005	17:56	446.58	446.43	51.86	33.68	17.07		446.43					

Date	Time	Data Logger ET (min) (pumping than recovery)	Corrected Data Logger ET (min)*	Fahrenheit	Feet H2O	Drawdown s and s'	Sc Then t'	Total ET	t/t'	gpm	Meter 1252810	gpm	Field Notes - Conducted on the rounded up whole number of the ET minute or at time noted
4/29/2005	18:23	473.04	472.89	51.86	33.80	17.19		472.89					
4/29/2005	18:51	501.08	500.93	51.86	33.90	17.29		500.93					
4/29/2005	19:20	530.78	530.63	51.86	33.96	17.35		530.63					
4/29/2005	19:50	560.78	560.63	51.86	34.13	17.52		560.63					
4/29/2005	20:20	590.78	590.63	51.86	34.23	17.62		590.63					
4/29/2005	20:50	620.78	620.63	51.86	34.34	17.73	0.87	620.63		15.5	1262400		Time of meas. 2050, 9590gal -- avg. gpm = 15.5gpm
4/29/2005	21:20	650.78	650.63	51.86	34.38	17.77		650.63					
4/29/2005	21:50	680.78	680.63	51.86	34.42	17.81		680.63					
4/29/2005	22:20	710.78	710.63	51.86	34.48	17.87		710.63					
4/29/2005	22:50	740.78	740.63	51.86	34.54	17.93		740.63					
4/29/2005	23:20	770.78	770.63	51.86	34.64	18.03		770.63					
4/29/2005	23:50	800.78	800.63	51.88	34.71	18.10		800.63					
4/30/2005	0:20	830.78	830.63	51.86	34.79	18.18		830.63					
4/30/2005	0:50	860.78	860.63	51.86	34.85	18.24		860.63					
4/30/2005	1:20	890.78	890.63	51.86	34.91	18.30	0.85	890.63		15.5	1277282		Time of meas. 1310
4/30/2005	1:50	920.78	920.63	51.86	34.95	18.34		920.63					
4/30/2005	2:20	950.78	950.63	51.86	35.06	18.47		950.63					
4/30/2005	2:50	980.78	980.63	51.86	35.16	18.55		980.63					
4/30/2005	3:20	1010.78	1010.63	51.86	35.20	18.59		1010.63					
4/30/2005	3:50	1040.78	1040.63	51.86	35.26	18.65		1040.63					
4/30/2005	4:20	1070.78	1070.63	51.86	35.32	18.71		1070.63					
4/30/2005	4:50	1100.78	1100.63	51.86	35.41	18.80		1100.63					
4/30/2005	5:20	1130.78	1130.63	51.86	35.45	18.84		1130.63					
4/30/2005	5:50	1160.78	1160.63	51.86	35.39	18.78		1160.63					
4/30/2005	6:20	1190.78	1190.63	51.86	35.37	18.76		1190.63					
4/30/2005	6:50	1220.78	1220.63	51.86	35.35	18.74		1220.63					
4/30/2005	7:20	1250.78	1250.63	51.86	35.39	18.78		1250.63					
4/30/2005	7:50	1280.78	1280.63	51.86	35.39	18.78		1280.63					
4/30/2005	8:20	1310.78	1310.63	51.86	35.59	18.98		1310.63					
4/30/2005	8:50	1340.78	1340.63	51.86	35.72	19.11		1340.63					
4/30/2005	9:20	1370.78	1370.63	51.86	35.76	19.15		1370.63					
4/30/2005	9:50	1400.78	1400.63	51.86	35.78	19.17		1400.63					
4/30/2005	10:20	1430.78	1430.63	51.88	35.80	19.19		1430.63					
4/30/2005	10:50	1460.78	1460.63	51.88	35.80	19.19		1460.63					
4/30/2005	11:20	1490.78	1490.63	51.86	34.71	18.10		1490.63					
4/30/2005	11:50	1520.78	1520.63	51.84	34.66	18.05		1520.63					
4/30/2005	12:20	1550.78	1550.63	51.84	34.58	17.97		1550.63					
4/30/2005	12:50	1580.78	1580.63	51.84	34.60	17.99		1580.63					
4/30/2005	13:20	1610.78	1610.63	51.84	34.54	17.93		1610.63					
4/30/2005	13:50	1640.78	1640.63	51.84	34.54	17.93		1640.63					
4/30/2005	14:20	1670.78	1670.63	51.84	34.52	17.91		1670.63					
4/30/2005	14:50	1700.78	1700.63	51.84	34.39	17.78		1700.63					
4/30/2005	15:20	1730.78	1730.63	51.84	34.52	17.91		1730.63					
4/30/2005	15:50	1760.78	1760.63	51.84	34.54	17.93		1760.63					
4/30/2005	16:20	1790.78	1790.63	51.82	34.21	17.60		1790.63					
4/30/2005	16:50	1820.78	1820.63	51.82	34.25	17.64		1820.63					
4/30/2005	17:20	1850.78	1850.63	51.82	34.33	17.72		1850.63					
4/30/2005	17:50	1880.78	1880.63	51.82	34.27	17.66		1880.63					
4/30/2005	18:20	1910.78	1910.63	51.82	34.29	17.68		1910.63					
4/30/2005	18:50	1940.78	1940.63	51.82	34.29	17.68		1940.63					
4/30/2005	19:20	1970.78	1970.63	51.82	34.25	17.64		1970.63					
4/30/2005	19:50	2000.78	2000.63	51.82	34.10	17.49		2000.63					
4/30/2005	20:20	2030.78	2030.63	51.82	34.08	17.47		2030.63					
4/30/2005	20:50	2060.78	2060.63	51.82	34.02	17.41		2060.63					
4/30/2005	21:20	2090.78	2090.63	51.82	34.04	17.43		2090.63					
4/30/2005	21:50	2120.78	2120.63	51.82	35.26	18.65		2120.63					
4/30/2005	22:20	2150.78	2150.63	51.86	35.65	19.04		2150.63					
4/30/2005	22:50	2180.78	2180.63	51.86	35.92	19.31		2180.63					
4/30/2005	23:20	2210.78	2210.63	51.86	36.29	19.68		2210.63					
4/30/2005	23:50	2240.78	2240.63	51.86	36.50	19.89		2240.63					
5/1/2005	0:20	2270.78	2270.63	51.88	36.63	20.02		2270.63					
5/1/2005	0:50	2300.78	2300.63	51.88	36.77	20.16		2300.63					
5/1/2005	1:20	2330.78	2330.63	51.86	36.50	19.89		2330.63					
5/1/2005	1:50	2360.78	2360.63	51.86	36.68	20.07		2360.63					
5/1/2005	2:20	2390.78	2390.63	51.86	36.81	20.20		2390.63					
5/1/2005	2:50	2420.78	2420.63	51.86	36.91	20.30		2420.63					
5/1/2005	3:20	2450.78	2450.63	51.88	37.06	20.45		2450.63					
5/1/2005	3:50	2480.78	2480.63	51.86	37.59	20.98		2480.63					
5/1/2005	4:20	2510.78	2510.63	51.88	37.35	20.74		2510.63					
5/1/2005	4:50	2540.78	2540.63	51.88	37.47	20.86		2540.63					
5/1/2005	5:20	2570.78	2570.63	51.88	37.55	20.94		2570.63					
5/1/2005	5:50	2600.78	2600.63	51.88	37.63	21.02		2600.63					
5/1/2005	6:20	2630.78	2630.63	51.88	37.61	21.00		2630.63					
5/1/2005	6:50	2660.78	2660.63	51.88	37.68	21.07		2660.63					
5/1/2005	7:20	2690.78	2690.63	51.88	37.55	20.94		2690.63					
5/1/2005	7:50	2720.78	2720.63	51.88	37.59	20.98	0.72	2720.63		15.2	1294310		Time of meas. 0750, adjust q up

Date	Time	Data Logger ET (min) (pumping than recovery)	Corrected Data Logger ET (min)*	Fahrenheit	Feet H2O	Drawdown s and s'	Sc Then t'	Total ET	t/t'	gpm	Meter 1252810	gpm	Field Notes - Conducted on the rounded up whole number of the ET minute or at time noted
5/1/2005	8:20	2750.78	2750.63	51.88	37.66	21.05		2750.63					
5/1/2005	8:50	2780.78	2780.63	51.88	37.80	21.19		2780.63					
5/1/2005	9:20	2810.78	2810.63	51.88	37.76	21.15		2810.63					
5/1/2005	9:50	2840.78	2840.63	51.86	35.59	18.98		2840.63					
5/1/2005	10:20	2870.78	2870.63	51.75	33.73	17.12		2870.63					
5/1/2005	10:50	2900.78	2900.63	51.75	33.60	16.99		2900.63					
5/1/2005	11:20	2930.78	2930.63	51.75	33.46	16.85		2930.63					
5/1/2005	11:50	2960.78	2960.63	51.75	33.38	16.77		2960.63					
5/1/2005	12:20	2990.78	2990.63	51.73	33.29	16.68		2990.63					
5/1/2005	12:50	3020.78	3020.63	51.73	33.27	16.66		3020.63					
5/1/2005	13:20	3050.78	3050.63	51.75	33.23	16.62		3050.63					
5/1/2005	13:50	3080.78	3080.63	51.75	33.25	16.64		3080.63					
5/1/2005	14:20	3110.78	3110.63	51.73	33.13	16.52		3110.63					
5/1/2005	14:50	3140.78	3140.63	51.73	33.15	16.54		3140.63					
5/1/2005	15:20	3170.78	3170.63	51.75	33.11	16.50		3170.63					
5/1/2005	15:50	3200.78	3200.63	51.75	33.07	16.46		3200.63					
5/1/2005	16:20	3230.78	3230.63	51.75	33.07	16.46		3230.63					
5/1/2005	16:50	3260.78	3260.63	51.75	33.11	16.50	0.94	3260.63		15.5	1302651		Time of meas. 1700
5/1/2005	17:20	3290.78	3290.63	51.75	33.13	16.52		3290.63					
5/1/2005	17:50	3320.78	3320.63	51.75	33.15	16.54		3320.63					
5/1/2005	18:20	3350.78	3350.63	51.75	33.11	16.50		3350.63					
5/1/2005	18:50	3380.78	3380.63	51.75	33.17	16.56		3380.63					
5/1/2005	19:20	3410.78	3410.63	51.73	33.15	16.54		3410.63					
5/1/2005	19:50	3440.78	3440.63	51.75	33.23	16.62		3440.63					
5/1/2005	20:20	3470.78	3470.63	51.75	33.21	16.60		3470.63					
5/1/2005	20:50	3500.78	3500.63	51.75	33.23	16.62		3500.63					
5/1/2005	21:20	3530.78	3530.63	51.75	33.25	16.64		3530.63					
5/1/2005	21:50	3560.78	3560.63	51.75	33.25	16.64		3560.63					
5/1/2005	22:20	3590.78	3590.63	51.75	33.29	16.68		3590.63					
5/1/2005	22:50	3620.78	3620.63	51.75	33.27	16.66		3620.63					
5/1/2005	23:20	3650.78	3650.63	51.75	33.29	16.68		3650.63					
5/1/2005	23:50	3680.78	3680.63	51.75	33.25	16.64		3680.63					
5/2/2005	0:20	3710.78	3710.63	51.73	33.27	16.66		3710.63					
5/2/2005	0:50	3740.78	3740.63	51.75	33.27	16.66		3740.63					
5/2/2005	1:20	3770.78	3770.63	51.75	33.29	16.68		3770.63					
5/2/2005	1:50	3800.78	3800.63	51.75	33.29	16.68		3800.63					
5/2/2005	2:20	3830.78	3830.63	51.75	33.27	16.66		3830.63					
5/2/2005	2:50	3860.78	3860.63	51.73	33.25	16.64		3860.63					
5/2/2005	3:20	3890.78	3890.63	51.75	33.25	16.64		3890.63					
5/2/2005	3:50	3920.78	3920.63	51.75	33.25	16.64		3920.63					
5/2/2005	4:20	3950.78	3950.63	51.75	33.23	16.62		3950.63					
5/2/2005	4:50	3980.78	3980.63	51.75	33.31	16.70		3980.63					
5/2/2005	5:20	4010.78	4010.63	51.75	33.31	16.70		4010.63					
5/2/2005	5:50	4040.78	4040.63	51.75	33.31	16.70		4040.63					
5/2/2005	6:20	4070.78	4070.63	51.75	33.31	16.70		4070.63					
5/2/2005	6:50	4100.78	4100.63	51.75	33.29	16.68		4100.63					
5/2/2005	7:20	4130.78	4130.63	51.73	33.29	16.68		4130.63					
5/2/2005	7:50	4160.78	4160.63	51.75	33.33	16.72		4160.63					
5/2/2005	8:20	4190.78	4190.63	51.73	33.35	16.74		4190.63					
5/2/2005	8:50	4220.78	4220.63	51.73	33.35	16.74		4220.63					
5/2/2005	9:20	4250.78	4250.63	51.75	33.40	16.79		4250.63					
5/2/2005	9:50	4280.78	4280.63	51.75	33.40	16.79		4280.63					
5/2/2005	10:20	4310.78	4310.63	51.75	33.38	16.77	0.92	4310.63		15.5	1318715		Time of meas. 1030, 65,905gal pumped -- 15.26avg. gpm,
5/2/2005	10:50	4340.78	4340.63	51.75	33.46	16.85		4340.63					downloaded ducers
5/2/2005	11:20	4370.78	4370.63	51.75	33.44	16.83		4370.63					
5/2/2005	11:50	4400.78	4400.63	51.75	33.46	16.85		4400.63					
5/2/2005	12:20	4430.78	4430.63	51.75	33.44	16.83		4430.63					
5/2/2005	12:50	4460.78	4460.63	51.73	33.39	16.78		4460.63					
5/2/2005	13:20	4490.78	4490.63	51.73	33.23	16.62		4490.63					
5/2/2005	13:50	4520.78	4520.63	51.73	33.23	16.62		4520.63					
5/2/2005	14:20	4550.78	4550.63	51.73	33.25	16.64		4550.63					
5/2/2005	14:50	4580.78	4580.63	51.73	33.25	16.64		4580.63					
5/2/2005	15:20	4610.78	4610.63	51.73	33.23	16.62		4610.63					
5/2/2005	15:50	4640.78	4640.63	51.73	33.21	16.60		4640.63					
5/2/2005	16:20	4670.78	4670.63	51.73	33.23	16.62		4670.63					
5/2/2005	16:50	4700.78	4700.63	51.73	33.25	16.64		4700.63					
5/2/2005	17:20	4730.78	4730.63	51.73	33.21	16.60		4730.63					
5/2/2005	17:50	4760.78	4760.63	51.73	33.21	16.60	0.92	4760.63		15.2	1325509		Time of meas. 1755
5/2/2005	18:20	4790.78	4790.63	51.73	33.23	16.62		4790.63					
5/2/2005	18:50	4820.78	4820.63	51.73	33.17	16.56		4820.63					
5/2/2005	19:20	4850.78	4850.63	51.73	33.19	16.58		4850.63					
5/2/2005	19:50	4880.78	4880.63	51.73	33.23	16.62		4880.63					
5/2/2005	20:20	4910.78	4910.63	51.73	33.27	16.66		4910.63					
5/2/2005	20:50	4940.78	4940.63	51.73	33.29	16.68		4940.63					
5/2/2005	21:20	4970.78	4970.63	51.73	33.31	16.70		4970.63					
5/2/2005	21:50	5000.78	5000.63	51.73	33.35	16.74		5000.63					

Date	Time	Data Logger ET (min) (pumping than recovery)	Corrected Data Logger ET (min)*	Fahrenheit	Feet H2O	Drawdown s and s'	Sc Then t'	Total ET	t/t'	gpm	Meter 1252810	gpm	Field Notes - Conducted on the rounded up whole number of the ET minute or at time noted
5/2/2005	22:20	5030.78	5030.63	51.73	33.35	16.74		5030.63					
5/2/2005	22:50	5060.78	5060.63	51.73	33.33	16.72		5060.63					
5/2/2005	23:20	5090.78	5090.63	51.73	33.37	16.76		5090.63					
5/2/2005	23:50	5120.78	5120.63	51.73	33.41	16.80		5120.63					
5/3/2005	0:20	5150.78	5150.63	51.73	33.39	16.78		5150.63					
5/3/2005	0:50	5180.78	5180.63	51.73	33.37	16.76		5180.63					
5/3/2005	1:20	5210.78	5210.63	51.73	33.41	16.80		5210.63					
5/3/2005	1:50	5240.78	5240.63	51.73	33.41	16.80		5240.63					
5/3/2005	2:20	5270.78	5270.63	51.73	33.41	16.80		5270.63					
5/3/2005	2:50	5300.78	5300.63	51.73	33.46	16.85		5300.63					
5/3/2005	3:20	5330.78	5330.63	51.73	33.46	16.85		5330.63					
5/3/2005	3:50	5360.78	5360.63	51.73	33.48	16.87		5360.63					
5/3/2005	4:20	5390.78	5390.63	51.73	33.43	16.82		5390.63					
5/3/2005	4:50	5420.78	5420.63	51.73	33.48	16.87		5420.63					
5/3/2005	5:20	5450.78	5450.63	51.73	33.48	16.87		5450.63					
5/3/2005	5:50	5480.78	5480.63	51.73	33.56	16.95		5480.63					
5/3/2005	6:20	5510.78	5510.63	51.73	33.60	16.99		5510.63					
5/3/2005	6:50	5540.78	5540.63	51.73	33.64	17.03		5540.63					
5/3/2005	7:20	5570.78	5570.63	51.73	33.64	17.03		5570.63					
5/3/2005	7:50	5600.78	5600.63	51.73	33.68	17.07		5600.63					
5/3/2005	8:20	5630.78	5630.63	51.73	33.68	17.07		5630.63					
5/3/2005	8:50	5660.78	5660.63	51.73	33.66	17.05		5660.63					
5/3/2005	9:20	5690.78	5690.63	51.73	33.62	17.01		5690.63					
5/3/2005	9:50	5720.78	5720.63	51.73	33.70	17.09		5720.63					
5/3/2005	10:20	5750.78	5750.63	51.73	33.72	17.11	0.89	5750.63		15.3	1340702		Time of meas. 1030
5/3/2005	11:00		5790.00	51.73	33.75	17.14	t'	5790.00	t/t'				Data Merge -- Well Off -- Recover
5/3/2005	11:03	3.1297	0.1297	51.75	31.706	15.10	0.1297	5793.1297	44665.61		1341183		Total gal pumped = 86,373gal. -- Total avg. gpm = 15.3
5/3/2005	11:03	3.3163	0.3163	51.73	29.354	12.74	0.3163	5793.29	18315.82				
5/3/2005	11:03	3.5147	0.5147	51.73	27.705	11.10	0.32	5793.32	18121.11				
5/3/2005	11:03	3.7247	0.7247	51.73	26.469	9.86	0.35	5793.35	16729.27				
5/3/2005	11:03	3.9463	0.9463	51.75	25.544	8.93	0.37	5793.37	15461.37				
5/3/2005	11:04	4.1813	1.1813	51.75	24.864	8.25	0.40	5793.40	14315.31				
5/3/2005	11:04	4.4295	1.4295	51.75	24.328	7.72	0.44	5793.44	13278.56				
5/3/2005	11:04	4.693	1.693	51.75	23.916	7.31	0.47	5793.47	12292.53				
5/3/2005	11:04	4.973	1.973	51.75	23.607	7.00	0.51	5793.51	11409.03				
5/3/2005	11:05	5.2697	2.2697	51.75	23.381	6.77	0.55	5793.55	10605.06				
5/3/2005	11:05	5.583	2.583	51.75	23.195	6.59	0.59	5793.59	9863.041				
5/3/2005	11:05	5.9147	2.9147	51.75	23.03	6.42	0.63	5793.63	9177.303				
5/3/2005	11:06	6.2663	3.2663	51.75	22.907	6.30	0.68	5793.68	8545.248				
5/3/2005	11:06	6.6397	3.6397	51.73	22.78	6.17	0.73	5793.73	7977.043				
5/3/2005	11:07	7.0347	4.0347	51.75	22.7	6.09	0.78	5793.78	7447.015				
5/3/2005	11:07	7.453	4.453	51.75	22.618	6.01	0.83	5793.83	6955.382				
5/3/2005	11:07	7.8963	4.8963	51.75	22.536	5.93	0.89	5793.89	6500.495				
5/3/2005	11:08	8.3663	5.3663	51.75	22.474	5.86	0.95	5793.95	6079.699				
5/3/2005	11:08	8.8647	5.8647	51.73	22.389	5.78	1.02	5794.02	5691.57				
5/3/2005	11:09	9.3913	6.3913	51.75	22.309	5.70	1.09	5794.09	5325.449				
5/3/2005	11:09	9.9497	6.9497	51.75	22.247	5.64	1.16	5794.16	4989.375				
5/3/2005	11:10	10.5413	7.5413	51.75	22.165	5.58	1.24	5794.24	4673.905				
5/3/2005	11:11	11.168	8.168	51.75	22.103	5.49	1.32	5794.32	4379.685				
5/3/2005	11:11	11.8313	8.8313	51.75	22.041	5.43	1.41	5794.41	4105.726				
5/3/2005	11:12	12.5347	9.5347	51.75	21.979	5.37	1.50	5794.50	3850.937				
5/3/2005	11:13	13.2797	10.2797	51.75	21.917	5.31	1.60	5794.60	3614.849				
5/3/2005	11:14	14.0697	11.0697	51.73	21.853	5.24	1.71	5794.71	3392.686				
5/3/2005	11:14	14.9063	11.9063	51.75	21.814	5.20	1.82	5794.82	3187.469				
5/3/2005	11:15	15.7913	12.7913	51.75	21.752	5.14	1.93	5794.93	2995.263				
5/3/2005	11:16	16.7297	13.7297	51.75	21.67	5.06	2.06	5795.06	2813.546				
5/3/2005	11:17	17.723	14.723	51.75	21.629	5.02	2.19	5795.19	2644.757				
5/3/2005	11:18	18.7763	15.7763	51.75	21.546	4.94	2.33	5795.33	2485.88				
5/3/2005	11:19	19.8913	16.8913	51.75	21.485	4.88	2.48	5795.48	2337.17				
5/3/2005	11:21	21.073	18.073	51.75	21.423	4.81	2.64	5795.64	2198.398				
5/3/2005	11:22	22.3247	19.3247	51.75	21.361	4.75	2.80	5795.80	2067.714				
5/3/2005	11:23	23.6497	20.6497	51.75	21.299	4.69	2.98	5795.98	1945.155				
5/3/2005	11:25	25.0547	22.0547	51.75	21.258	4.65	3.17	5796.17	1830.58				
5/3/2005	11:26	26.543	23.543	51.75	21.175	4.57	3.36	5796.36	1722.699				
5/3/2005	11:28	28.118	25.118	51.75	21.114	4.50	3.57	5796.57	1621.556				
5/3/2005	11:29	29.7863	26.7863	51.75	21.052	4.44	3.80	5796.80	1526.959				
5/3/2005	11:31	31.5547	28.5547	51.75	20.99	4.38	4.03	5797.03	1438.005				
5/3/2005	11:33	33.428	30.428	51.77	20.931	4.32	4.28	5797.28	1354.663				
5/3/2005	11:35	35.4112	32.4112	51.79	20.892	4.28	4.54	5797.54	1276.149				
5/3/2005	11:37	37.513	34.513	51.82	20.812	4.20	4.82	5797.82	1202.12				
5/3/2005	11:39	39.7397	36.7397	51.84	20.753	4.14	5.12	5798.12	1132.512				
5/3/2005	11:42	42.098	39.098	51.86	20.693	4.08	5.43	5798.43	1067.262				
5/3/2005	11:44	44.5963	41.5963	51.88	20.634	4.02	5.76	5798.76	1005.909				
5/3/2005	11:47	47.243	44.243	51.91	20.575	3.97	6.12	5799.12	948.1412				
5/3/2005	11:50	50.0463	47.0463	51.93	20.516	3.91	6.49	5799.49	893.6453				
5/3/2005	11:53	53.0147	50.0147	51.95	20.456	3.85	6.88	5799.88	842.431				

Date	Time	Data Logger ET (min) (pumping than recovery)	Corrected Data Logger ET (min)*	Fahrenheit	Feet H2O	Drawdown s and s'	Sc Then t'	Total ET	t/t'	gpm	Meter 1252810	gpm	Field Notes - Conducted on the rounded up whole number of the ET minute or at time noted
5/3/2005	11:56	56.1597	53.1597	51.97	20.397	3.79	7.30	5800.30	794.2357				
5/3/2005	11:59	59.4913	56.4913	52	20.338	3.73	7.75	5800.75	748.8409				
5/3/2005	12:03	63.0197	60.0197	52.02	20.258	3.65	8.22	5801.22	706.0619				
5/3/2005	12:08	66.758	63.758	52.02	20.196	3.59	8.71	5801.71	665.7389				
5/3/2005	12:10	70.716	67.716	52.04	20.137	3.53	9.24	5802.24	627.8599				
5/3/2005	12:14	74.9113	71.9113	52.04	20.075	3.47	9.80	5802.80	592.1405				
5/3/2005	12:19	79.3547	76.3547	52.04	20.034	3.42	10.39	5803.39	558.4856				
5/3/2005	12:24	84.0613	81.0613	52.06	19.954	3.34	11.02	5804.02	526.776				
5/3/2005	12:29	89.0463	86.0463	52.09	19.894	3.28	11.68	5804.68	496.9208				
5/3/2005	12:34	94.3263	91.3263	52.13	19.817	3.21	12.38	5805.38	468.7546				
5/3/2005	12:39	99.9197	96.9197	52.13	19.755	3.15	13.13	5806.13	442.2134				
5/3/2005	12:45	105.8447	102.8447	52.16	19.696	3.09	13.92	5806.92	417.1728				
5/3/2005	12:52	112.1197	109.1197	52.18	19.657	3.05	14.76	5807.76	393.5781				
5/3/2005	12:58	118.768	115.768	52.18	19.595	2.99	15.64	5808.64	371.3656				
5/3/2005	13:05	125.8097	122.8097	52.2	19.536	2.93	16.58	5809.58	350.4032				
5/3/2005	13:13	133.268	130.268	52.2	19.474	2.86	17.57	5810.57	330.6534				
5/3/2005	13:21	141.168	138.168	52.22	19.394	2.78	18.63	5811.63	312.0118				
5/3/2005	13:29	149.5363	146.5363	52.25	19.335	2.73	19.74	5812.74	294.4457				
5/3/2005	13:38	158.4013	155.4013	52.25	19.273	2.66	20.92	5813.92	277.8723				
5/3/2005	13:47	167.7913	164.7913	52.29	19.217	2.61	22.17	5815.17	262.2437				
5/3/2005	13:57	177.738	174.738	52.31	19.157	2.55	23.50	5816.50	247.5138				
5/3/2005	14:08	188.2747	185.2747	52.31	19.075	2.47	24.90	5817.90	233.6067				
5/3/2005	14:19	199.4347	196.4347	52.34	19.036	2.43	26.39	5819.39	220.49				
5/3/2005	14:31	211.2563	208.2563	52.27	18.967	2.36	27.97	5820.97	208.1296				
5/3/2005	14:43	223.778	220.778	52.22	18.9	2.29	29.64	5822.64	196.4697				
5/3/2005	14:57	237.043	234.043	52.29	18.825	2.22	31.40	5824.40	185.4628				
5/3/2005	15:11	251.093	248.093	52.34	18.768	2.16	33.28	5826.28	175.079				
5/3/2005	15:25	265.9763	262.9763	52.31	18.704	2.09	35.26	5828.26	165.2882				
5/3/2005	15:41	281.7413	278.7413	52.36	18.647	2.04	37.36	5830.36	156.0464				
5/3/2005	15:58	298.4397	295.4397	52.38	18.588	1.98	39.59	5832.59	147.3259				
5/3/2005	16:16	316.128	313.128	52.36	18.523	1.91	41.95	5834.95	139.0996				
5/3/2005	16:34	334.8647	331.8647	52.38	18.444	1.83	44.45	5837.45	131.3371				
5/3/2005	16:54	354.7113	351.7113	52.43	18.387	1.78	47.09	5840.09	124.0119				
5/3/2005	17:15	375.7347	372.7347	52.45	18.328	1.72	49.90	5842.90	117.1008				
5/3/2005	17:38	398.003	395.003	52.43	18.263	1.65	52.86	5845.86	110.5816				
5/3/2005	18:01	421.5913	418.5913	52.45	18.204	1.59	56.01	5849.01	104.4285				
5/3/2005	18:26	446.578	443.578	52.43	18.16	1.55	59.34	5852.34	98.62172				
5/3/2005	18:53	473.0447	470.0447	52.49	18.085	1.48	62.87	5855.87	93.14296				
5/3/2005	19:21	501.0797	498.0797	52.47	18.042	1.43	66.61	5859.61	87.97153				
5/3/2005	19:50	530.7763	527.7763	52.52	18.005	1.40	70.57	5863.57	83.09103				
5/3/2005	20:20	560.7763	557.7763	52.54	17.946	1.34	74.76	5867.76	78.48661				
5/3/2005	20:50	590.7763	587.7763	52.54	17.905	1.30	79.20	5872.20	74.1396				
5/3/2005	21:20	620.7763	617.7763	52.52	17.861	1.25	83.91	5876.91	70.03719				
5/3/2005	21:50	650.7763	647.7763	52.54	17.802	1.19	88.90	5881.90	66.16582				
5/3/2005	22:20	680.7763	677.7763	52.52	17.758	1.15	94.18	5887.18	62.51229				
5/3/2005	22:50	710.7763	707.7763	52.54	17.74	1.13	99.77	5892.77	59.06372				
5/3/2005	23:20	740.7763	737.7763	52.56	17.681	1.07	105.69	5898.69	55.8088				
5/3/2005	23:50	770.7763	767.7763	52.63	17.647	1.04	111.97	5904.97	52.73721				
5/4/2005	0:20	800.7763	797.7763	52.56	17.619	1.01	118.62	5911.62	49.83744				
5/4/2005	0:50	830.7763	827.7763	52.56	17.598	0.99	125.66	5918.66	47.1007				
5/4/2005	1:20	860.7763	857.7763	52.56	17.557	0.95	133.12	5926.12	44.51778				
5/4/2005	1:50	890.7763	887.7763	52.54	17.513	0.90	141.02	5934.02	42.07986				
5/4/2005	2:20	920.7763	917.7763	52.58	17.498	0.89	149.39	5942.39	39.77866				
5/4/2005	2:50	950.7763	947.7763	52.61	17.48	0.87	158.25	5951.25	37.60833				
5/4/2005	3:20	980.7763	977.7763	52.58	17.436	0.83	167.64	5960.64	35.55592				
5/4/2005	3:50	1010.7763	1007.7763	52.58	17.415	0.81	177.59	5970.59	33.62045				
5/4/2005	4:20	1040.7763	1037.7763	52.67	17.384	0.77	188.12	5981.12	31.7934				
5/4/2005	4:50	1070.7763	1067.7763	52.7	17.366	0.76	199.28	5992.28	30.06897				
5/4/2005	5:20	1100.7763	1097.7763	52.63	17.338	0.73	211.11	6004.11	28.44115				
5/4/2005	5:50	1130.7763	1127.7763	52.63	17.317	0.71	223.63	6016.63	26.90463				
5/4/2005	6:20	1160.7763	1157.7763	52.65	17.299	0.69	236.89	6029.89	25.45408				
5/4/2005	6:50	1190.7763	1187.7763	52.63	17.256	0.65	250.94	6043.94	24.08492				
5/4/2005	7:20	1220.7763	1217.7763	52.67	17.24	0.63	265.83	6058.83	22.79243				
5/4/2005	7:50	1250.7763	1247.7763	52.65	17.238	0.63	281.59	6074.59	21.57237				
5/4/2005	8:20	1280.7763	1277.7763	52.65	17.217	0.61	298.29	6091.29	20.42072				
5/4/2005	8:50	1310.7763	1307.7763	52.67	17.199	0.59	315.98	6108.98	19.33355				
5/4/2005	9:20	1340.7763	1337.7763	52.67	17.158	0.55	334.71	6127.71	18.30728				
5/4/2005	9:50	1370.7763	1367.7763	52.7	17.16	0.55	354.56	6147.56	17.3385				
5/4/2005	10:20	1400.7763	1397.7763	52.67	17.137	0.53	375.58	6168.58	16.42395				
5/4/2005	10:50	1430.7763	1427.7763	52.65	17.114	0.50	397.85	6190.85	15.56065				
5/4/2005	11:20	1460.7763	1457.7763	52.65	17.093	0.48	421.44	6214.44	14.74569				
5/4/2005	11:50	1490.7763	1487.7763	52.65	17.052	0.44	446.43	6239.43	13.97634				
5/4/2005	12:20	1520.7763	1517.7763	52.7	17.037	0.43	472.89	6265.89	13.25008				
5/4/2005	12:50	1550.7763	1547.7763	52.7	17.016	0.41	500.93	6293.93	12.5645				
5/4/2005	13:20	1580.7763	1577.7763	52.7	16.995	0.39	530.63	6323.63	11.91729				
5/4/2005	13:50	1610.7763	1607.7763	52.65	16.99	0.38	560.63	6353.63	11.33309				

Date	Time	Data Logger ET (min) (pumping than recovery)	Corrected Data Logger ET (min)*	Fahrenheit	Feet H2O	Drawdown s and s'	Sc Then t'	Total ET	t/t'	gpm	Meter 1252810	gpm	Field Notes - Conducted on the rounded up whole number of the ET minute or at time noted
5/4/2005	14:20	1640.7763	1637.7763	52.67	16.952	0.34	590.63	6383.63	10.80823				
5/4/2005	14:50	1670.7763	1667.7763	52.65	16.949	0.34	620.63	6413.63	10.33412				
5/4/2005	15:20	1700.7763	1697.7763	52.7	16.913	0.30	650.63	6443.63	9.903729				
5/4/2005	15:50	1730.7763	1727.7763	52.7	16.892	0.28	680.63	6473.63	9.511279				
5/4/2005	16:20	1760.7763	1757.7763	52.67	16.89	0.28	710.63	6503.63	9.151984				
5/4/2005	16:50	1790.7763	1787.7763	52.65	16.867	0.26	740.63	6533.63	8.821758				
5/4/2005	17:20	1820.7763	1817.7763	52.63	16.864	0.25	770.63	6563.63	8.517262				
5/4/2005	17:50	1850.7763	1847.7763	52.63	16.844	0.23	800.63	6593.63	8.235585				
5/4/2005	18:20	1880.7763	1877.7763	52.65	16.825	0.22	830.63	6623.63	7.974255				
5/4/2005	18:50	1910.7763	1907.7763	52.67	16.807	0.20	860.63	6653.63	7.731145				
5/4/2005	19:20	1940.7763	1937.7763	52.7	16.81	0.20	890.63	6683.63	7.504412				
5/4/2005	19:50	1970.7763	1967.7763	52.72	16.792	0.18	920.63	6713.63	7.292455				
5/4/2005	20:20	2000.7763	1997.7763	52.76	16.797	0.19	950.63	6743.63	7.093877				
5/4/2005	20:50	2030.7763	2027.7763	52.81	16.781	0.17	980.63	6773.63	6.907449				
5/4/2005	21:20	2060.7763	2057.7763	52.74	16.774	0.16	1010.63	6803.63	6.732089				
5/4/2005	21:50	2090.7763	2087.7763	52.72	16.751	0.14	1040.63	6833.63	6.56684				
5/4/2005	22:20	2120.7763	2117.7763	52.67	16.725	0.12	1070.63	6863.63	6.410852				
5/4/2005	22:50	2150.7763	2147.7763	52.67	16.725	0.12	1100.63	6893.63	6.263367				
5/4/2005	23:20	2180.7763	2177.7763	52.63	16.72	0.11	1130.63	6923.63	6.123709				
5/4/2005	23:50	2210.7762	2207.7762	52.67	16.704	0.09	1160.63	6953.63	5.991271				
5/5/2005	0:20	2240.7762	2237.7762	52.72	16.689	0.08	1190.63	6983.63	5.865506				
5/5/2005	0:50	2270.7762	2267.7762	52.7	16.666	0.06	1220.63	7013.63	5.745924				
5/5/2005	1:20	2300.7762	2297.7762	52.7	16.645	0.04	1250.63	7043.63	5.632079				
5/5/2005	1:50	2330.7762	2327.7762	52.63	16.637	0.03	1280.63	7073.63	5.523568				
5/5/2005	2:20	2360.7762	2357.7762	52.7	16.624	0.01	1310.63	7103.63	5.420024				
5/5/2005	2:50	2390.7762	2387.7762	52.72	16.606	0.00	1340.63	7133.63	5.321115				
5/5/2005	3:20	2420.7762	2417.7762	52.72	16.606	0.00	1370.63	7163.63	5.226535				
5/5/2005	3:50	2450.7762	2447.7762	52.72	16.565	-0.04	1400.63	7193.63	5.136007				
5/5/2005	4:20	2480.7762	2477.7762	52.76	16.591	-0.02	1430.63	7223.63	5.049275				
5/5/2005	4:50	2510.7762	2507.7762	52.76	16.57	-0.04	1460.63	7253.63	4.966107				
5/5/2005	5:20	2540.7762	2537.7762	52.79	16.552	-0.06	1490.63	7283.63	4.886286				
5/5/2005	5:50	2570.7762	2567.7762	52.76	16.55	-0.06	1520.63	7313.63	4.809614				
5/5/2005	6:20	2600.7762	2597.7762	52.79	16.532	-0.08	1550.63	7343.63	4.73591				
5/5/2005	6:50	2630.7762	2627.7762	52.79	16.532	-0.08	1580.63	7373.63	4.665003				
5/5/2005	7:20	2660.7762	2657.7762	52.79	16.511	-0.10	1610.63	7403.63	4.596737				
5/5/2005	7:50	2690.7762	2687.7762	52.79	16.511	-0.10	1640.63	7433.63	4.530969				
5/5/2005	8:20	2720.7762	2717.7762	52.76	16.508	-0.10	1670.63	7463.63	4.467562				
5/5/2005	8:50	2750.7762	2747.7762	52.76	16.488	-0.12	1700.63	7493.63	4.406392				
5/5/2005	9:20	2780.7762	2777.7762	52.76	16.488	-0.12	1730.63	7523.63	4.347343				
5/5/2005	9:50	2810.7763	2807.7763	52.67	16.478	-0.13	1760.63	7553.63	4.290306				
5/5/2005	10:20	2840.7763	2837.7763	52.74	16.465	-0.15	1790.63	7583.63	4.235181				
5/5/2005	10:50	2870.7763	2867.7763	52.74	16.465	-0.16	1820.63	7613.63	4.181872				
5/5/2005	11:20	2900.7763	2897.7763	52.74	16.444	-0.17	1850.63	7643.63	4.130292				
5/5/2005	11:50	2930.7763	2927.7763	52.72	16.421	-0.19	1880.63	7673.63	4.080357				
5/5/2005	12:20	2960.7763	2957.7763	52.76	16.405	-0.20	1910.63	7703.63	4.03199				
5/5/2005	12:50	2990.7763	2987.7763	52.76	16.385	-0.22	1940.63	7733.63	3.985119				
5/5/2005	13:20	3020.7763	3017.7763	52.76	16.385	-0.22	1970.63	7763.63	3.939675				
5/5/2005	13:50	3050.7763	3047.7763	52.79	16.367	-0.24	2000.63	7793.63	3.895593				
5/5/2005	14:20	3080.7763	3077.7763	52.81	16.369	-0.24	2030.63	7823.63	3.852814				
5/5/2005	14:50	3110.7763	3107.7763	52.74	16.341	-0.27	2060.63	7853.63	3.811281				
5/5/2005	15:20	3140.7763	3137.7763	52.74	16.341	-0.27	2090.63	7883.63	3.77094				
5/5/2005	15:50	3170.7763	3167.7763	52.76	16.344	-0.27	2120.63	7913.63	3.73174				
5/5/2005	16:20	3200.7763	3197.7763	52.79	16.326	-0.28	2150.63	7943.63	3.693634				
5/5/2005	16:50	3230.7763	3227.7763	52.81	16.328	-0.28	2180.63	7973.63	3.656576				
5/5/2005	17:20	3260.7763	3257.7763	52.83	16.331	-0.28	2210.63	8003.63	3.620524				
5/5/2005	17:50	3290.7763	3287.7763	52.81	16.328	-0.28	2240.63	8033.63	3.585436				
5/5/2005	18:20	3320.7763	3317.7763	52.76	16.302	-0.31	2270.63	8063.63	3.551279				
5/5/2005	18:50	3350.7763	3347.7763	52.72	16.297	-0.31	2300.63	8093.63	3.51801				
5/5/2005	19:20	3380.7763	3377.7763	52.72	16.297	-0.31	2330.63	8123.63	3.485598				
5/5/2005	19:50	3410.7763	3407.7763	52.7	16.315	-0.29	2360.63	8153.63	3.45401				
5/5/2005	20:20	3440.7763	3437.7763	52.72	16.297	-0.31	2390.63	8183.63	3.423214				
5/5/2005	20:50	3470.7763	3467.7763	52.72	16.318	-0.29	2420.63	8213.63	3.393182				
5/5/2005	21:20	3500.7763	3497.7763	52.7	16.315	-0.29	2450.63	8243.63	3.363886				
5/5/2005	21:50	3530.7763	3527.7763	52.76	16.323	-0.29	2480.63	8273.63	3.335297				
5/5/2005	22:20	3560.7763	3557.7763	52.81	16.307	-0.30	2510.63	8303.63	3.307392				
5/5/2005	22:50	3590.7763	3587.7763	52.81	16.307	-0.30	2540.63	8333.63	3.280147				
5/5/2005	23:20	3620.7763	3617.7763	52.83	16.289	-0.32	2570.63	8363.63	3.253537				
5/5/2005	23:50	3650.7763	3647.7763	52.85	16.292	-0.32	2600.63	8393.63	3.22754				
5/6/2005	0:20	3680.7763	3677.7763	52.83	16.269	-0.34	2630.63	8423.63	3.202137				
5/6/2005	0:50	3710.7763	3707.7763	52.83	16.248	-0.36	2660.63	8453.63	3.177307				
5/6/2005	1:20	3740.7763	3737.7763	52.81	16.246	-0.36	2690.63	8483.63	3.15303				
5/6/2005	1:50	3770.7763	3767.7763	52.76	16.241	-0.37	2720.63	8513.63	3.129289				
5/6/2005	2:20	3800.7763	3797.7763	52.72	16.215	-0.40	2750.63	8543.63	3.106066				
5/6/2005	2:50	3830.7763	3827.7763	52.7	16.233	-0.38	2780.63	8573.63	3.083344				
5/6/2005	3:20	3860.7763	3857.7763	52.67	16.21	-0.40	2810.63	8603.63	3.061106				
5/6/2005	3:50	3890.7763	3887.7763	52.72	16.215	-0.40	2840.63	8633.63	3.039339				

Date	Time	Data Logger ET (min) (pumping than recovery)	Corrected Data Logger ET (min)*	Fahrenheit	Feet H2O	Drawdown s and s'	Sc Then t'	Total ET	t/t'	gpm	Meter 1252810	gpm	Field Notes - Conducted on the rounded up whole number of the ET minute or at time noted
5/6/2005	4:20	3920.7763	3917.7763	52.76	16.199	-0.41	2870.63	8663.63	3.018027				
5/6/2005	4:50	3950.7763	3947.7763	52.83	16.207	-0.40	2900.63	8693.63	2.997155				
5/6/2005	5:20	3980.7763	3977.7763	52.85	16.21	-0.40	2930.63	8723.63	2.976711				
5/6/2005	5:50	4010.7763	4007.7763	52.79	16.181	-0.43	2960.63	8753.63	2.956681				
5/6/2005	6:20	4040.7763	4037.7763	52.83	16.186	-0.42	2990.63	8783.63	2.937052				
5/6/2005	6:50	4070.7763	4067.7763	52.85	16.189	-0.42	3020.63	8813.63	2.917814				
5/6/2005	7:20	4100.7763	4097.7763	52.85	16.189	-0.42	3050.63	8843.63	2.898954				
5/6/2005	7:50	4130.7763	4127.7763	52.83	16.186	-0.42	3080.63	8873.63	2.880462				
5/6/2005	8:20	4160.7763	4157.7763	52.79	16.181	-0.43	3110.63	8903.63	2.862326				
5/6/2005	8:50	4190.7763	4187.7763	52.79	16.181	-0.43	3140.63	8933.63	2.844537				
5/6/2005	9:20	4220.7763	4217.7763	52.76	16.179	-0.43	3170.63	8963.63	2.827084				
5/6/2005	9:50	4250.7763	4247.7763	52.76	16.179	-0.43	3200.63	8993.63	2.809958				
5/6/2005	10:20	4280.7763	4277.7763	52.79	16.181	-0.45	3230.63	9023.63	2.793151				
5/6/2005	10:50	4310.7763	4307.7763	52.83	16.186	-0.44	3260.63	9053.63	2.776653				
5/6/2005	11:20	4340.7763	4337.7763	52.85	16.188	-0.44	3290.63	9083.63	2.760455				

Well 5 Data Logger Record -- SH2 pumping test

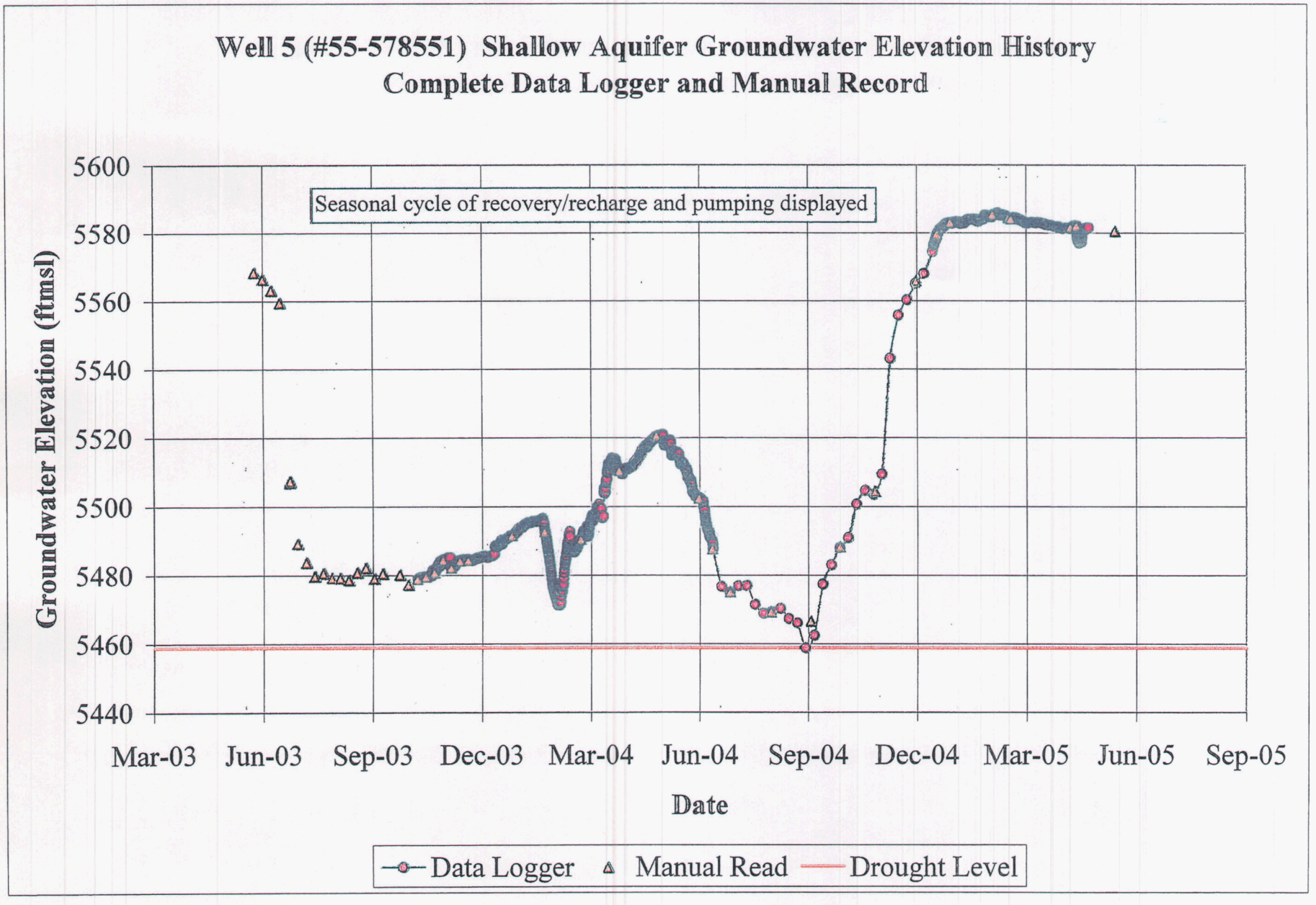
Date	Time	ET (min)	Corrected ET (min) (for recovery portion)	t'	t/t'	Chan[1] Fahrenheit	Chan[2] Feet H2O	Drawdown
	4/29/2005 10:30	0				54.11	18.77	
	4/29/2005 12:30	120				54.11	20.99	1.49
	4/29/2005 14:30	240				54.11	21.62	2.12
	4/29/2005 16:30	360				54.11	22.09	2.59
	4/29/2005 18:30	480				54.11	22.38	2.88
	4/29/2005 20:30	600				54.11	22.62	3.12
	4/29/2005 22:30	720				54.11	22.76	3.26
	4/30/2005 0:30	840				54.11	22.91	3.41
	4/30/2005 2:30	960				54.11	23.02	3.52
	4/30/2005 4:30	1080				54.11	23.13	3.63
	4/30/2005 6:30	1200				54.12	23.23	3.73
	4/30/2005 8:30	1320				54.11	23.30	3.80
	4/30/2005 10:30	1440				54.11	23.39	3.89
	4/30/2005 12:30	1560				54.11	23.33	3.83
	4/30/2005 14:30	1680				54.11	23.30	3.80
	4/30/2005 16:30	1800				54.12	23.30	3.80
	4/30/2005 18:30	1920				54.11	23.28	3.78
	4/30/2005 20:30	2040				54.11	23.30	3.80
	4/30/2005 22:30	2160				54.12	23.41	3.91
	5/1/2005 0:30	2280				54.12	23.60	4.10
	5/1/2005 2:30	2400				54.11	23.67	4.17
	5/1/2005 4:30	2520				54.12	23.78	4.28
	5/1/2005 6:30	2640				54.12	23.87	4.37
	5/1/2005 8:30	2760				54.11	23.94	4.44
	5/1/2005 10:30	2880				54.12	23.79	4.29
	5/1/2005 12:30	3000				54.11	23.47	3.97
	5/1/2005 14:30	3120				54.12	23.34	3.84
	5/1/2005 16:30	3240				54.11	23.26	3.76
	5/1/2005 18:30	3360				54.13	23.26	3.76
	5/1/2005 20:30	3480				54.13	23.26	3.76
	5/1/2005 22:30	3600				54.12	23.26	3.76
	5/2/2005 0:30	3720				54.13	23.25	3.75
	5/2/2005 2:30	3840				54.12	23.23	3.73
	5/2/2005 4:30	3960				54.1	23.21	3.71
	5/2/2005 6:30	4080				54.11	23.25	3.75
	5/2/2005 8:30	4200				54.11	23.36	3.86
	5/2/2005 10:30	4320				54.11	23.43	3.93
	5/2/2005 12:30	4440				54.11	23.43	3.93
	5/2/2005 14:30	4560				54.11	23.39	3.89
	5/2/2005 16:30	4680				54.12	23.36	3.86
	5/2/2005 18:30	4800				54.11	23.36	3.86

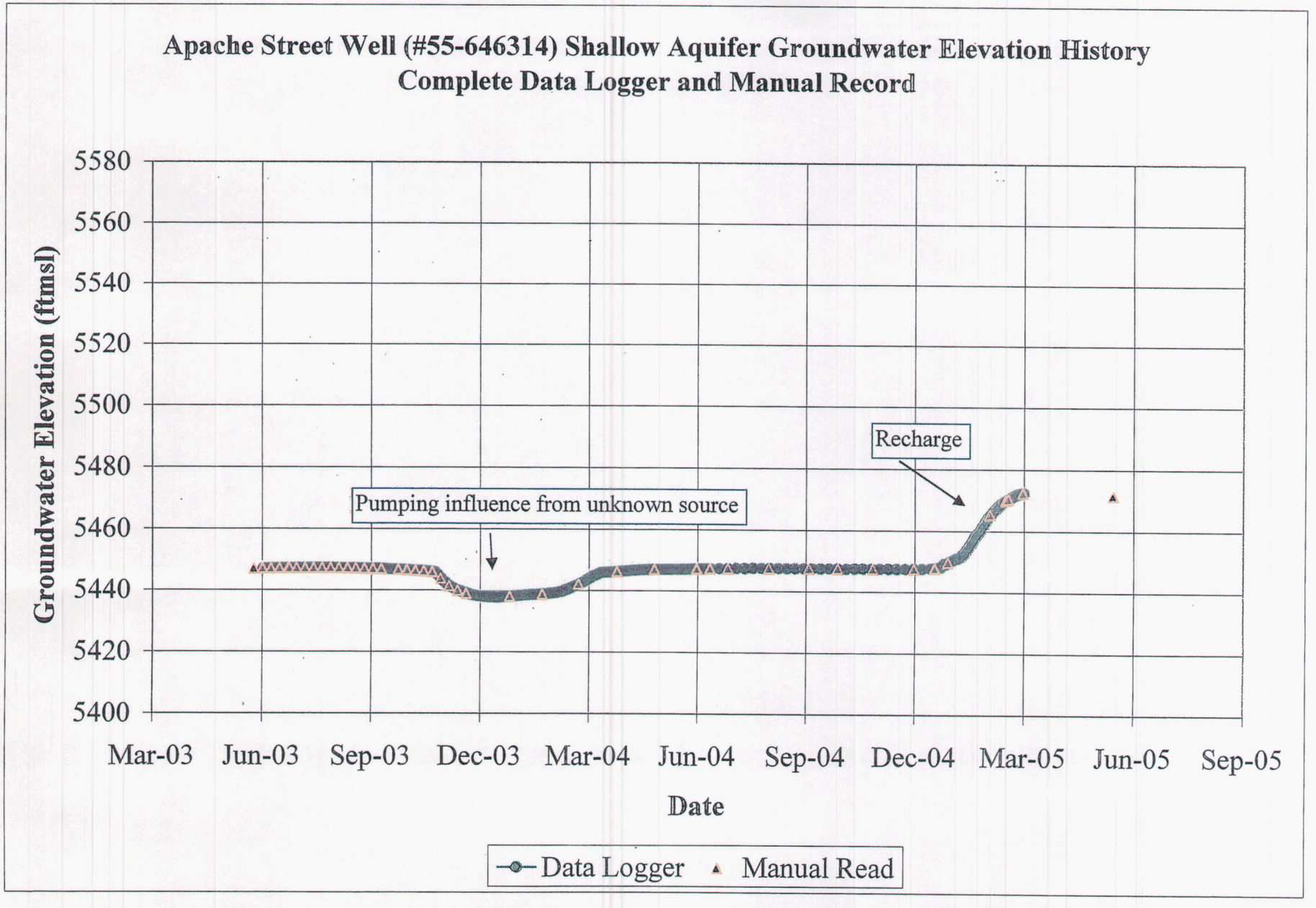
Date	Time	ET (min)	Corrected ET (min) (for recovery portion)	t'	t/t'	Chan[1] Fahrenheit	Chan[2] Feet H2O	Drawdown	
	5/2/2005 20:30	4920				54.11	23.41	3.91	
	5/2/2005 22:30	5040				54.11	23.44	3.94	
	5/3/2005 0:30	5160				54.11	23.43	3.93	
	5/3/2005 2:30	5280				54.11	23.44	3.94	
	5/3/2005 4:30	5400				54.11	23.46	3.96	
	5/3/2005 6:30	5520				54.11	23.47	3.97	
	5/3/2005 8:30	5640				54.12	23.52	4.02	
	5/3/2005 10:30	5760		t'	t/t'	54.11	23.54	4.04	
	5/3/2005 11:03	**0**	**5793**	**0**		**54.31**	**23.53**	**4.03**	**recovery data**
	5/3/2005 11:34	30	5823	30	194.10	54.11	23.10	3.60	
	5/3/2005 12:04	60	5853	60	97.55	54.1	22.64	3.14	
	5/3/2005 12:34	90	5883	90	65.37	54.1	22.31	2.81	
	5/3/2005 13:04	120	5913	120	49.28	54.1	22.09	2.59	
	5/3/2005 13:34	150	5943	150	39.62	54.11	21.93	2.43	
	5/3/2005 14:04	180	5973	180	33.18	54.11	21.80	2.30	
	5/3/2005 14:34	210	6003	210	28.59	54.1	21.68	2.18	
	5/3/2005 15:04	240	6033	240	25.14	54.11	21.60	2.10	
	5/3/2005 15:34	270	6063	270	22.46	54.11	21.51	2.01	
	5/3/2005 16:04	300	6093	300	20.31	54.11	21.42	1.92	
	5/3/2005 16:34	330	6123	330	18.55	54.11	21.34	1.84	
	5/3/2005 17:04	360	6153	360	17.09	54.11	21.28	1.78	
	5/3/2005 17:34	390	6183	390	15.85	54.11	21.23	1.73	
	5/3/2005 18:04	420	6213	420	14.79	54.11	21.18	1.68	
	5/3/2005 18:34	450	6243	450	13.87	54.11	21.15	1.65	
	5/3/2005 19:04	480	6273	480	13.07	54.11	21.12	1.62	
	5/3/2005 19:34	510	6303	510	12.36	54.11	21.09	1.59	
	5/3/2005 20:04	540	6333	540	11.73	54.11	21.05	1.55	
	5/3/2005 20:34	570	6363	570	11.16	54.11	21.04	1.54	
	5/3/2005 21:04	600	6393	600	10.66	54.11	21.01	1.51	
	5/3/2005 21:34	630	6423	630	10.20	54.11	20.98	1.48	
	5/3/2005 22:04	660	6453	660	9.78	54.11	20.96	1.46	
	5/3/2005 22:34	690	6483	690	9.40	54.11	20.92	1.42	
	5/3/2005 23:04	720	6513	720	9.05	54.11	20.89	1.39	
	5/3/2005 23:34	750	6543	750	8.72	54.11	20.86	1.36	
	5/4/2005 0:04	780	6573	780	8.43	54.12	20.83	1.33	
	5/4/2005 0:34	810	6603	810	8.15	54.11	20.81	1.31	
	5/4/2005 1:04	840	6633	840	7.90	54.11	20.76	1.26	
	5/4/2005 1:34	870	6663	870	7.66	54.11	20.75	1.25	
	5/4/2005 2:04	900	6693	900	7.44	54.11	20.72	1.22	
	5/4/2005 2:34	930	6723	930	7.23	54.11	20.70	1.20	
	5/4/2005 3:04	960	6753	960	7.03	54.11	20.67	1.17	
	5/4/2005 3:34	990	6783	990	6.85	54.11	20.63	1.13	

Date	Tim e	ET (min)	Corrected ET (min) (for recovery portion)	t'	t/t'	Chan[1] Fahrenheit	Chan[2] Feet H2O	Drawdown
	5/4/2005 4:04	1020	6813	1020	6.68	54.11	20.62	1.12
	5/4/2005 4:34	1050	6843	1050	6.52	54.11	20.59	1.09
	5/4/2005 5:04	1080	6873	1080	6.36	54.11	20.57	1.07
	5/4/2005 5:34	1110	6903	1110	6.22	54.11	20.57	1.07
	5/4/2005 6:04	1140	6933	1140	6.08	54.11	20.52	1.02
	5/4/2005 6:34	1170	6963	1170	5.95	54.11	20.52	1.02
	5/4/2005 7:04	1200	6993	1200	5.83	54.11	20.51	1.01
	5/4/2005 7:34	1230	7023	1230	5.71	54.11	20.49	0.99
	5/4/2005 8:04	1260	7053	1260	5.60	54.11	20.47	0.97
	5/4/2005 8:34	1290	7083	1290	5.49	54.11	20.46	0.96
	5/4/2005 9:04	1320	7113	1320	5.39	54.11	20.44	0.94
	5/4/2005 9:34	1350	7143	1350	5.29	54.11	20.43	0.93
	5/4/2005 10:04	1380	7173	1380	5.20	54.11	20.39	0.89
	5/4/2005 10:34	1410	7203	1410	5.11	54.11	20.38	0.88
	5/4/2005 11:04	1440	7233	1440	5.02	54.11	20.38	0.88
	5/4/2005 11:34	1470	7263	1470	4.94	54.11	20.33	0.83
	5/4/2005 12:04	1500	7293	1500	4.86	54.11	20.31	0.81
	5/4/2005 12:34	1530	7323	1530	4.79	54.11	20.31	0.81
	5/4/2005 13:04	1560	7353	1560	4.71	54.11	20.27	0.77
	5/4/2005 13:34	1590	7383	1590	4.64	54.11	20.25	0.75
	5/4/2005 14:04	1620	7413	1620	4.58	54.12	20.25	0.75
	5/4/2005 14:34	1650	7443	1650	4.51	54.11	20.20	0.70
	5/4/2005 15:04	1680	7473	1680	4.45	54.11	20.18	0.68
	5/4/2005 15:34	1710	7503	1710	4.39	54.11	20.15	0.65
	5/4/2005 16:04	1740	7533	1740	4.33	54.11	20.14	0.64
	5/4/2005 16:34	1770	7563	1770	4.27	54.11	20.12	0.62
	5/4/2005 17:04	1800	7593	1800	4.22	54.12	20.12	0.62
	5/4/2005 17:34	1830	7623	1830	4.17	54.12	20.10	0.60
	5/4/2005 18:04	1860	7653	1860	4.11	54.11	20.10	0.60
	5/4/2005 18:34	1890	7683	1890	4.07	54.11	20.07	0.57
	5/4/2005 19:04	1920	7713	1920	4.02	54.11	20.05	0.55
	5/4/2005 19:34	1950	7743	1950	3.97	54.11	20.05	0.55
	5/4/2005 20:04	1980	7773	1980	3.93	54.11	20.05	0.55
	5/4/2005 20:34	2010	7803	2010	3.88	54.11	20.05	0.55
	5/4/2005 21:04	2040	7833	2040	3.84	54.11	20.02	0.52
	5/4/2005 21:34	2070	7863	2070	3.80	54.11	20.02	0.52
	5/4/2005 22:04	2100	7893	2100	3.76	54.12	20.01	0.51
	5/4/2005 22:34	2130	7923	2130	3.72	54.12	20.01	0.51
	5/4/2005 23:04	2160	7953	2160	3.68	54.11	19.99	0.49
	5/4/2005 23:34	2190	7983	2190	3.65	54.11	19.97	0.47
	5/5/2005 0:04	2220	8013	2220	3.61	54.11	19.94	0.44
	5/5/2005 0:34	2250	8043	2250	3.57	54.11	19.94	0.44

Date	Time	ET (min)	Corrected ET (min) (for recovery portion)	t'	t/t'	Chan[1] Fahrenheit	Chan[2] Feet H2O	Drawdown
	5/5/2005 1:04	2280	8073	2280	3.54	54.11	19.93	0.43
	5/5/2005 1:34	2310	8103	2310	3.51	54.11	19.93	0.43
	5/5/2005 2:04	2340	8133	2340	3.48	54.11	19.90	0.40
	5/5/2005 2:34	2370	8163	2370	3.44	54.11	19.88	0.38
	5/5/2005 3:04	2400	8193	2400	3.41	54.11	19.88	0.38
	5/5/2005 3:34	2430	8223	2430	3.38	54.11	19.86	0.36
	5/5/2005 4:04	2460	8253	2460	3.35	54.11	19.86	0.36
	5/5/2005 4:34	2490	8283	2490	3.33	54.11	19.86	0.36
	5/5/2005 5:04	2520	8313	2520	3.30	54.12	19.85	0.34
	5/5/2005 5:34	2550	8343	2550	3.27	54.11	19.83	0.33
	5/5/2005 6:04	2580	8373	2580	3.25	54.11	19.81	0.31
	5/5/2005 6:34	2610	8403	2610	3.22	54.11	19.81	0.31
	5/5/2005 7:04	2640	8433	2640	3.19	54.11	19.81	0.31
	5/5/2005 7:34	2670	8463	2670	3.17	54.11	19.81	0.31
	5/5/2005 8:04	2700	8493	2700	3.15	54.11	19.80	0.30
	5/5/2005 8:34	2730	8523	2730	3.12	54.11	19.80	0.30
	5/5/2005 9:04	2760	8553	2760	3.10	54.11	19.80	0.30
	5/5/2005 9:34	2790	8583	2790	3.08	54.11	19.80	0.30
	5/5/2005 10:04	2820	8613	2820	3.05	54.11	19.78	0.28
	5/5/2005 10:34	2850	8643	2850	3.03	54.1	19.77	0.27
	5/5/2005 11:04	2880	8673	2880	3.01	54.11	19.75	0.25
	5/5/2005 11:34	2910	8703	2910	2.99	54.11	19.73	0.23
	5/5/2005 12:04	2940	8733	2940	2.97	54.11	19.73	0.23
	5/5/2005 12:34	2970	8763	2970	2.95	54.11	19.72	0.22
	5/5/2005 13:04	3000	8793	3000	2.93	54.11	19.68	0.18
	5/5/2005 13:34	3030	8823	3030	2.91	54.11	19.67	0.17
	5/5/2005 14:04	3060	8853	3060	2.89	54.11	19.67	0.17
	5/5/2005 14:34	3090	8883	3090	2.87	54.11	19.67	0.17
	5/5/2005 15:04	3120	8913	3120	2.86	54.1	19.64	0.14
	5/5/2005 15:34	3150	8943	3150	2.84	54.11	19.62	0.12
	5/5/2005 16:04	3180	8973	3180	2.82	54.11	19.62	0.12
	5/5/2005 16:34	3210	9003	3210	2.80	54.11	19.61	0.11
	5/5/2005 17:04	3240	9033	3240	2.79	54.11	19.61	0.11
	5/5/2005 17:34	3270	9063	3270	2.77	54.11	19.61	0.11
	5/5/2005 18:04	3300	9093	3300	2.76	54.11	19.61	0.11
	5/5/2005 18:34	3330	9123	3330	2.74	54.11	19.61	0.11
	5/5/2005 19:04	3360	9153	3360	2.72	54.11	19.59	0.09
	5/5/2005 19:34	3390	9183	3390	2.71	54.11	19.61	0.11
	5/5/2005 20:04	3420	9213	3420	2.69	54.11	19.61	0.11
	5/5/2005 20:34	3450	9243	3450	2.68	54.11	19.61	0.11
	5/5/2005 21:04	3480	9273	3480	2.66	54.11	19.61	0.11
	5/5/2005 21:34	3510	9303	3510	2.65	54.11	19.61	0.11

Date	Time	ET (min)	Corrected ET (min) (for recovery portion)	t'	t/t'	Chan[1] Fahrenheit	Chan[2] Feet H2O	Drawdown	
	5/5/2005 22:04	3540	9333	3540	2.64	54.12	19.61	0.11	
	5/5/2005 22:34	3570	9363	3570	2.62	54.12	19.61	0.11	
	5/5/2005 23:04	3600	9393	3600	2.61	54.11	19.61	0.11	
	5/5/2005 23:34	3630	9423	3630	2.60	54.11	19.61	0.11	
	5/6/2005 0:04	3660	9453	3660	2.58	54.12	19.59	0.09	
	5/6/2005 0:34	3690	9483	3690	2.57	54.11	19.57	0.07	
	5/6/2005 1:04	3720	9513	3720	2.56	54.11	19.55	0.05	
	5/6/2005 1:34	3750	9543	3750	2.54	54.11	19.54	0.04	
	5/6/2005 2:04	3780	9573	3780	2.53	54.11	19.54	0.04	
	5/6/2005 2:34	3810	9603	3810	2.52	54.11	19.52	0.02	
	5/6/2005 3:04	3840	9633	3840	2.51	54.11	19.49	-0.01	
	5/6/2005 3:34	3870	9663	3870	2.50	54.11	19.49	-0.01	
	5/6/2005 4:04	3900	9693	3900	2.49	54.11	19.49	-0.01	
	5/6/2005 4:34	3930	9723	3930	2.47	54.11	19.48	-0.02	
	5/6/2005 5:04	3960	9753	3960	2.46	54.11	19.48	-0.02	
	5/6/2005 5:34	3990	9783	3990	2.45	54.11	19.48	-0.02	
	5/6/2005 6:04	4020	9813	4020	2.44	54.11	19.48	-0.02	
	5/6/2005 6:34	4050	9843	4050	2.43	54.11	19.48	-0.02	
	5/6/2005 7:04	4080	9873	4080	2.42	54.11	19.48	-0.02	
	5/6/2005 7:34	4110	9903	4110	2.41	54.11	19.48	-0.02	
	5/6/2005 8:04	4140	9933	4140	2.40	54.11	19.48	-0.02	
	5/6/2005 8:34	4170	9963	4170	2.39	54.11	19.48	-0.02	
	5/6/2005 9:04	4200	9993	4200	2.38	54.1	19.48	-0.02	
	5/6/2005 9:34	4230	10023	4230	2.37	54.11	19.48	-0.02	
	5/6/2005 10:04	4260	10053	4260	2.36	54.11	19.48	-0.02	
	5/6/2005 10:34	4290	10083	4290	2.35	54.11	19.48	-0.02	
	5/6/2005 11:04	4320	10113	4320	2.34	54.11	19.46	-0.04	
	5/6/2005 11:34	4350	10143	4350	2.33	54.1	19.46	-0.04	
	5/6/2005 12:30	**0**	**10197**	**4403**	2.32	**54.11**	**19.88**	0.38	**Data Merge**
	5/6/2005 20:30	480	10677	4883	2.19	54.11	19.49	-0.01	
	5/7/2005 4:30	960	11157	5363	2.08	54.11	19.35	-0.15	
	5/7/2005 12:30	1440	11637	5843	1.99	54.11	19.54	0.04	
	5/7/2005 20:30	1920	12117	6323	1.92	54.11	19.35	-0.15	
	5/8/2005 4:30	2400	12597	6803	1.85	54.11	19.31	-0.19	
	5/8/2005 12:30	2880	13077	7283	1.80	54.11	19.46	-0.04	
	5/8/2005 20:30	3360	13557	7763	1.75	54.11	19.41	-0.09	
	5/9/2005 4:30	3840	14037	8243	1.70	54.11	19.28	-0.22	


Well 5 (#55-578551) Shallow Aquifer Groundwater Elevation History
Complete Data Logger and Manual Record
Seasonal cycle of recovery/recharge and pumping displayed
Groundwater Elevation (ftmsl)
5600
5580
5560
5540
5520
5500
5480
5460
5440
Mar-03
Jun-03
Sep-03
Dec-03
Mar-04
Jun-04
Sep-04
Dec-04
Mar-05
Jun-05
Sep-05
Date
Data Logger
Manual Read
Drought Level


Apache Street Well (#55-646314) Shallow Aquifer Groundwater Elevation History
Complete Data Logger and Manual Record
Groundwater Elevation (ftmsl)
5580
5560
5540
5520
5500
5480
5460
5440
5420
5400
Recharge
Pumping influence from unknown source
Mar-03
Jun-03
Sep-03
Dec-03
Mar-04
Jun-04
Sep-04
Dec-04
Mar-05
Jun-05
Sep-05
Date
Data Logger
Manual Read

ATTACHMENT 1

STRAWBERRY HOLLOW

- Phase I Final Plats
- Phase II Final Plats
- ADWR Water Adequacy Report Determinations for Phases I and II
- Strawberry Hollow Domestic Water Improvement District Description

Gila, AZ, 2005-2006 - , Sheet: 1 of 3

PT SE 1/4 SECTION 26 AND PT NE 1/4 SECTION 35
T 12 N R 8 E

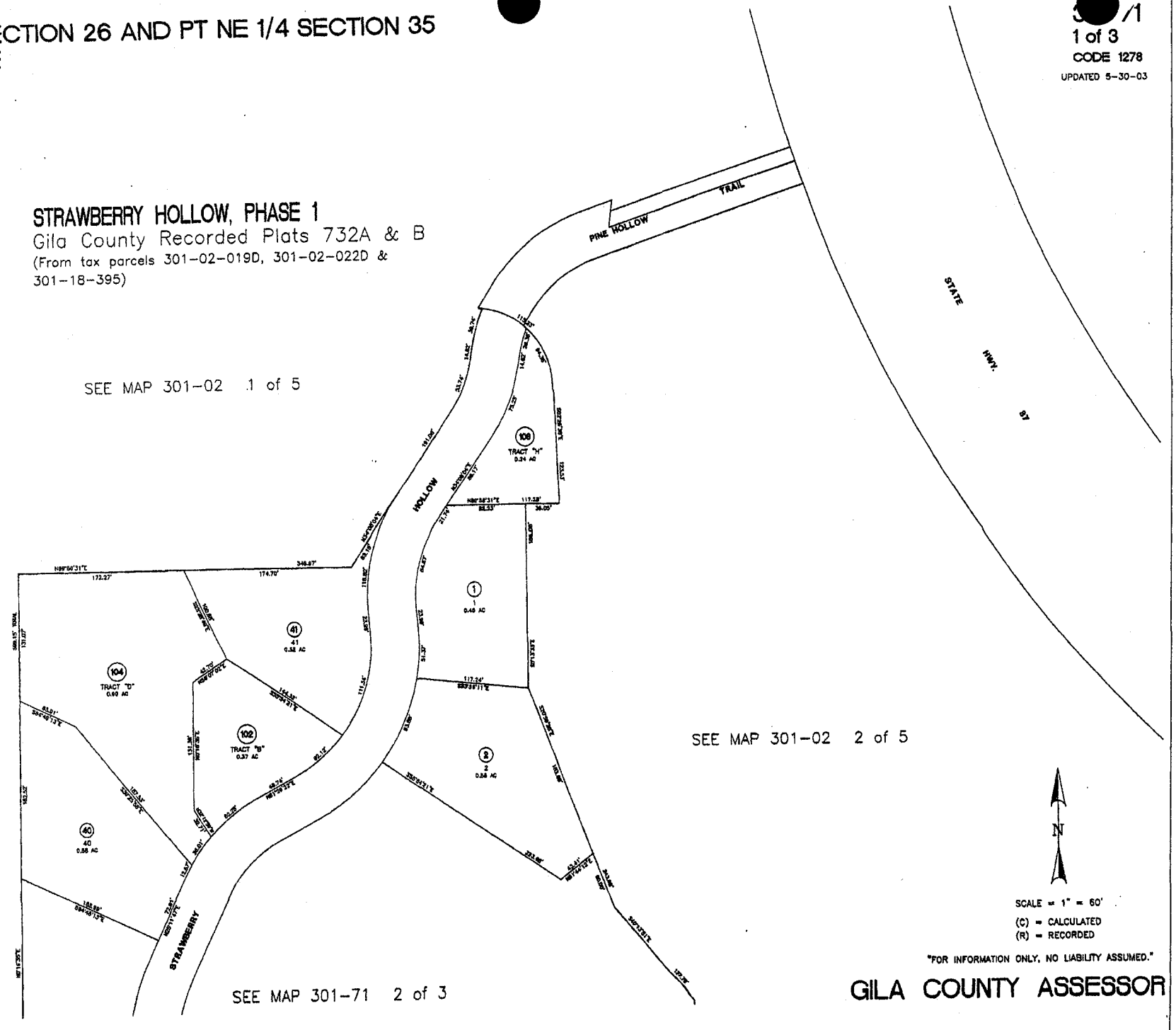
CODE 1278

UPDATED 5-30-03

STRAWBERRY HOLLOW, PHASE 1

Gila County Recorded Plats 732A & B

(From tax parcels 301-02-019D, 301-02-022D & 301-18-395)



SEE MAP 301-02 1 of 5

TONTO NATIONAL FOREST

SEE MAP 301-02 1 of 5

SEE MAP 301-02 2 of 5

SEE MAP 301-71 2 of 3

N

"FOR INFORMATION ONLY, NO LIABILITY ASSUMED."

GILA COUNTY ASSESSOR

Gila, AZ, 2005-2006 - , Sheet: 2 of :

PT SE 1/4 SECTION 26 AND PT NE 1/4 SECTION 35
T 12 N R 8 E

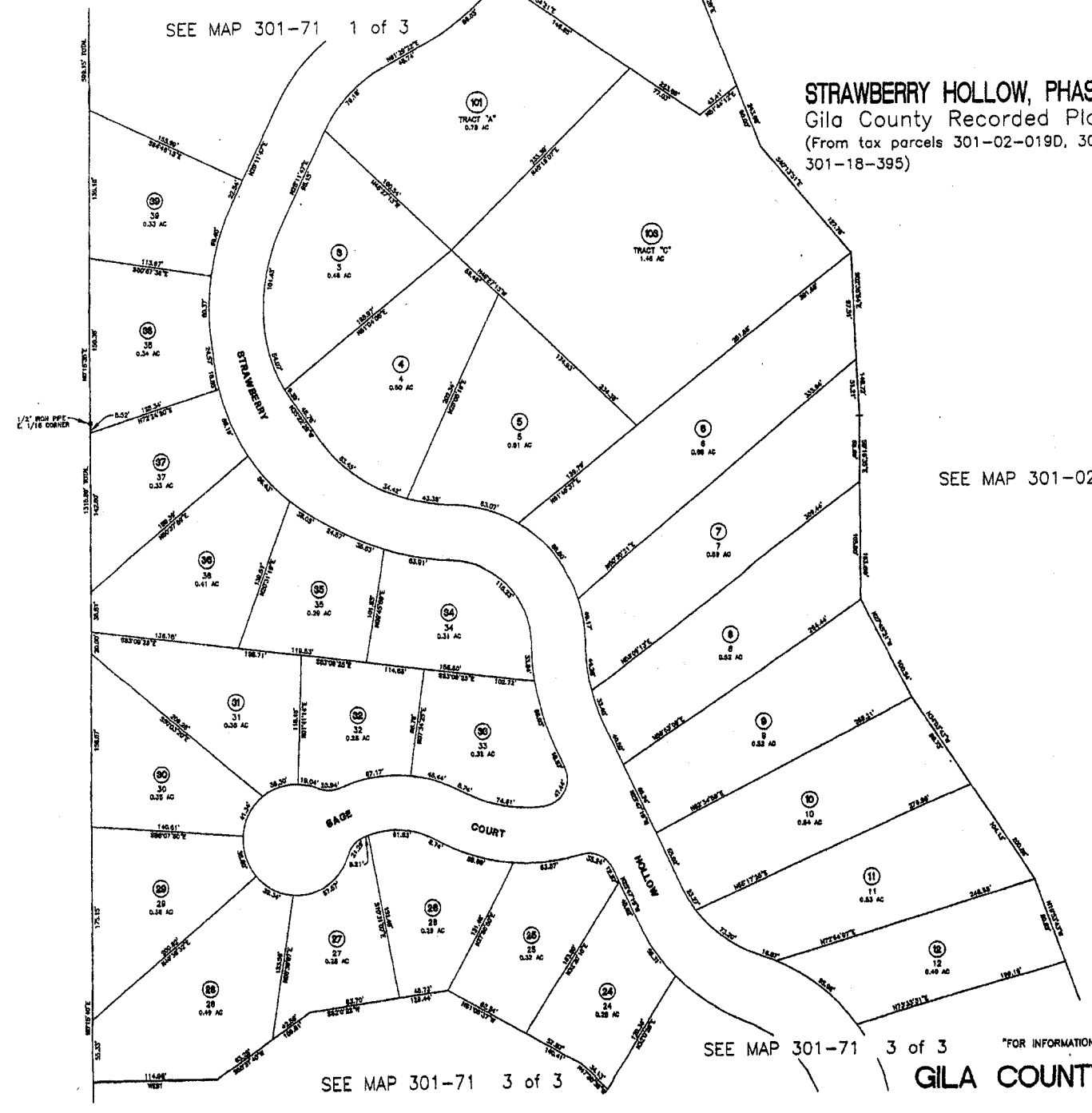
CODE 1278

UPDATED 5-30-03

STRAWBERRY HOLLOW, PHASE 1

Gila County Recorded Plats 732A & B

(From tax parcels 301-02-019D, 301-02-022D & 301-18-395)



"FOR INFORMATION ONLY, NO LIABILITY ASSUMED."

GILA COUNTY ASSESSOR

Gila, AZ, 2005-2006 - , Sheet: 3 of 3

PT SE[illegible] SECTION 26 AND PT NE 1/4 SECTION 35
T 12 N[illegible] 8 E

SEE [illegible]01-71 2 of 3

3[illegible].71
3

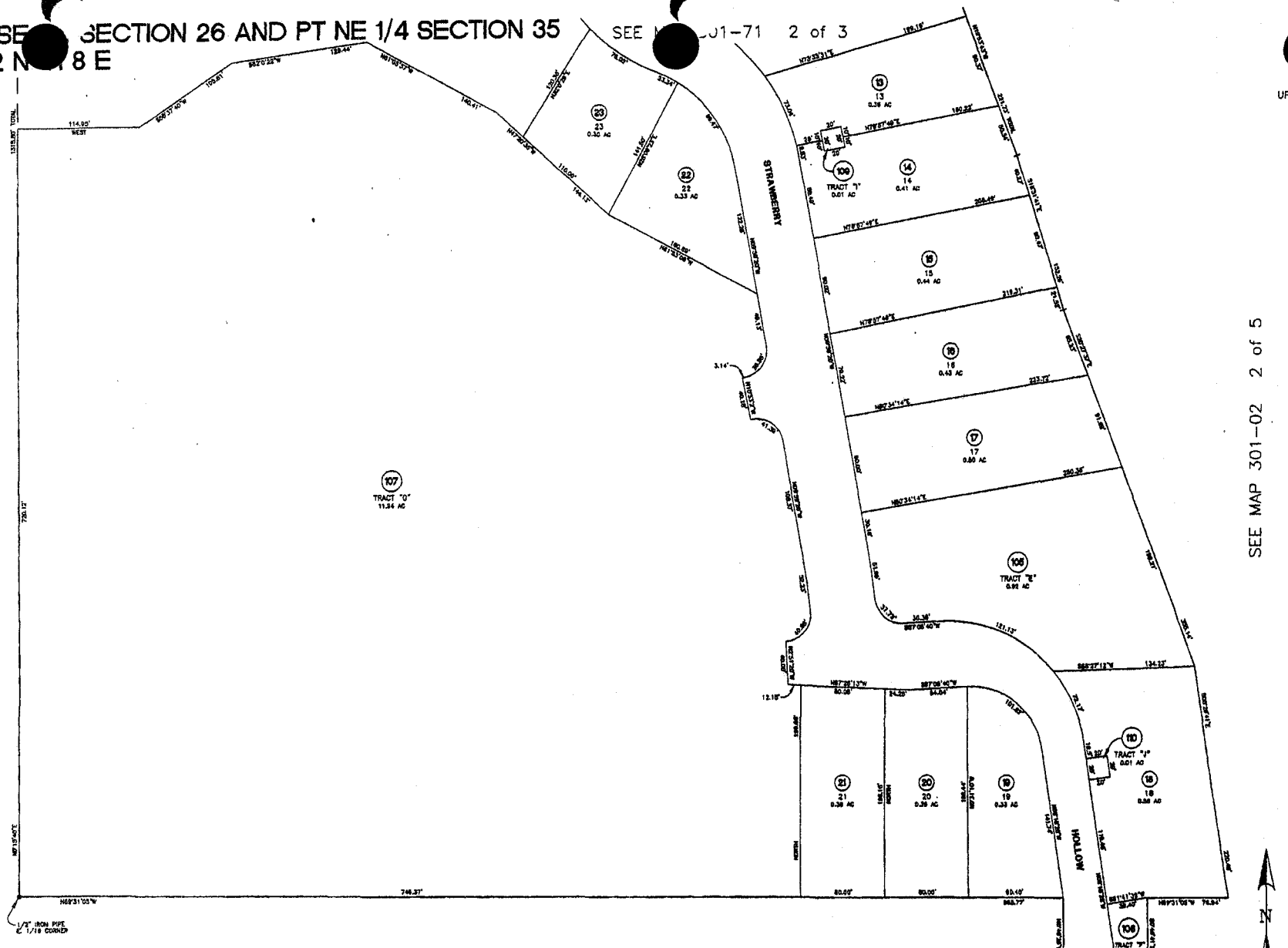
CODE 1278

UPDATED 5-30-03

SEE MAP 301-02 1 of 5

TONTO NATIONAL FOREST

SEE MAP 301-02 2 of 5



SEE MAP 301-18

STRAWBERRY HOLLOW, PHASE 1

Gila County Recorded Plats 732A & B

(From tax parcels 301-02-019D, 301-02-022D & 301-18-395)

SCALE = 1" = 60'

(C) = CALCULATED

(R) = RECORDED

"FOR INFORMATION ONLY, NO LIABILITY ASSUMED."

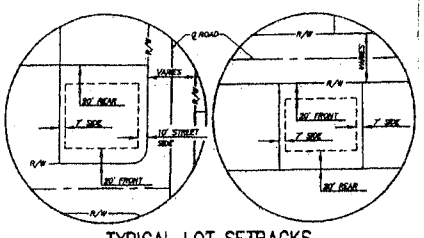
GILA COUNTY ASSESSOR

FINAL PLAT
for
STRAWBERRY HOLLOW, PHASE 2

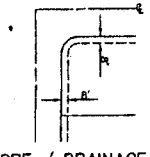
BEING TRACT "G" OF STRAWBERRY HOLLOW, PHASE ONE, MAP NO. 732A & 732B, AS REVISED BY THAT RECORD OF SURVEY – LOT LINE ADJUSTMENT MAP NO. 2800, GILA COUNTY RECORDS. LOCATED IN THE SE 1/4 OF SECTION 26, T.12 N., R.8 E. OF THE GILA AND SALT RIVER MERIDIAN, GILA COUNTY, ARIZONA.

OWNER / DEVELOPER

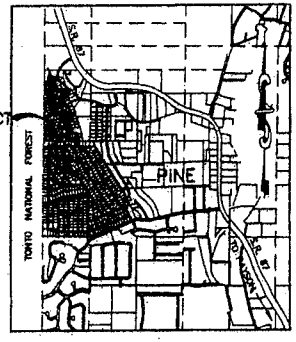
STRAWBERRY HOLLOW DEVELOPMENT, INC.
P.O. BOX 2141
PINE, ARIZONA 85544
928-472-4477



TYPICAL LOT SETBACKS
(TYPICAL ALL LOT FRONTAGES) N.T.S.



TYPICAL SLOPE / DRAINAGE AND P.U.E.
(TYPICAL ALL LOT FRONTAGES) N.T.S.



VICINITY MAP
N.T.S.

GENERAL NOTES

1. DEVELOPER HOLDS GILA COUNTY, ITS SUCCESSORS AND ASSIGNS, HARMLESS IN THE EVENT OF FLOODING.
2. NO FURTHER SUBDIVIDING WILL BE DONE WITHOUT THE WRITTEN CONSENT OF THE GILA COUNTY BOARD OF SUPERVISORS.
3. ALL IMPROVEMENTS WILL BE MADE IN ACCORDANCE WITH GILA COUNTY SUBDIVISIONS ORDINANCE, UNLESS OTHERWISE SPECIFIED AND APPROVED.
4. THE POTABLE WATER SYSTEM WILL BE OWNED AND OPERATED BY THE PROPERTY OWNERS. THE SEWER COLLECTION AND DISPOSAL SYSTEM WILL BE OWNED AND OPERATED BY THE STRAWBERRY HOLLOW SEWER IMPROVEMENT DISTRICT.
5. EXISTING DRAINAGE CONVEYANCES WILL REMAIN IN THEIR NATURAL STATE AND WILL NOT BE ALTERED, DISTURBED OR OBSTRUCTED OTHER THAN AS SHOWN ON THIS PLAT AND IN THE DRAINAGE REPORT WITHOUT THE WRITTEN APPROVAL OF GILA COUNTY AND THE GILA COUNTY FLOOD CONTROL DISTRICT.
6. ALL LOT AND TRACT CORNERS, BEGINNING AND ENDING OF CURVES WILL BE MONUMENTED WITH A 1/2 INCH REBAR WITH BRASS TAG, STAMPED RLS #24516.
7. ALL LABELED DISTANCES ALONG CURVES ARE ARC LENGTH(S) OF CURVE.
8. STRAWBERRY HOLLOW, PHASE 2 IS BEING DEVELOPED AS A SUBDIVISION USING R1-D12 ZONING AS ESTABLISHED BY GILA COUNTY.
9. A DECLARATION OF COVENANTS, CONDITIONS AND RESTRICTIONS FOR STRAWBERRY HOLLOW, PHASE 2, ("DECLARATION") HAS BEEN RECORDED IN THE OFFICE OF THE GILA COUNTY RECORDER, FEE NO. _____ SETTING FORTH THE RESTRICTIONS AND GENERAL PLAN OF IMPROVEMENT FOR THE PROPERTY DESCRIBED IN THIS PLAT. CAPITALIZED TERMS NOT OTHERWISE DEFINED IN THIS PLAT SHALL HAVE THE MEANINGS ASCRIBED TO SUCH TERMS IN THE DECLARATION.
10. ALL UTILITIES WITHIN STRAWBERRY HOLLOW, PHASE 2, SHALL BE UNDERGROUND.

LEGAL DESCRIPTION

A PORTION OF SE ¼ OF SECTION 26, TOWNSHIP 12 NORTH, RANGE 8 EAST OF THE GILA AND SALT RIVER MERIDIAN, GILA COUNTY, ARIZONA, MORE PARTICULARLY DESCRIBED AS FOLLOWS:

TRACT "G" OF RECORD OF SURVEY – LOT LINE ADJUSTMENT, ACCORDING TO THE MAP OF RECORD IN THE OFFICE OF THE COUNTY RECORDER OF GILA COUNTY, ARIZONA, RECORDED IN MAP NO. 2800.

ENCLOSES 520,310. SQUARE FEET / 11.94 ACRES.

LEGEND

○	FOUND 1/2" IRON PIPE, UNLESS NOTED
●	CENTERLINE CONTROL – NOT SET
(R)	RECORDED DISTANCE
(M)	MEASURED DISTANCE
S.E.	SLOPE EASEMENT
P.U.E.	PUBLIC UTILITY EASEMENT
N.V.A.E.	NON VEHICULAR ACCESS EASEMENT
	BOUNDARY LINE
	RIGHT OF WAY LINE
	CENTER LINE
	LOT LINE
	BUILDING SETBACK LINE
	EASEMENT LINE
302-23-038P	ASSESSOR'S PARCEL NO.
	EXISTING DRAINAGE CONVEYANCE (SEE NOTE 5)

Prepared by

TETRA TECH, INC.
INFRASTRUCTURE SOUTHWEST GROUP
431 N. Beeline Highway, Payson, AZ 85541
(928) 474-4638 FAX (928) 474-4887

Project No. 2577.0002

&

NORTHSTAR SURVEYING
INCORPORATED
1100 N. BEELINE, SUITE B ✦ PAYSON, ARIZONA 85541 ✦ (928) 474-9646

Project No. 04-159

CERTIFICATION

That I, John F. Davis, certify that the survey and subdivision of the premises described and platted hereon were made under my direction during the months of November & December, 2004, and that the survey reflected by this Plat is true and complete as shown, and that the monuments shown actually exist or will be set as shown and that their positions are correctly shown and that said monuments are sufficient to enable the survey to be retraced.

John F. Davis, R.L.S. NO. 24516

4-18-06
Date

BASIS OF BEARINGS

N 00° 12' 51" W = THE LINE BETWEEN THE EAST QUARTER (1/4) CORNER – FOUND STONE AND SOUTH-NORTH (S-N) (1/64) CORNER – FOUND ALUMINUM CAP OF SECTION 26, T-12-N, R-8-E OF THE G.& S.R.M.

SHEET INDEX

NO.	DESCRIPTION
1	COVER SHEET
2	FINAL PLAT

APPROVALS

APPROVED BY THE BOARD OF SUPERVISORS OF GILA COUNTY, ARIZONA THIS 3rd DAY OF MAY 2006.

BY: _____ CHAIRMAN

ATTEST: _____ Deputy CLERK OF THE BOARD

APPROVED BY THE ENGINEERING DEPARTMENT OF GILA COUNTY, ARIZONA, THIS 21st DAY OF APRIL 2006.

BY: _____ ENGINEERING MANAGER

APPROVED BY THE PLANNING AND ZONING COMMISSION OF GILA COUNTY, ARIZONA, THIS 17th DAY OF MARCH 2006.

BY: _____ CHAIRMAN

ATTEST: _____ PLANNING DEPARTMENT MANAGER

SEE DEED RESTRICTIONS RECORDED IN FEE NO. 2001-3946 Phase 1 2005-007972 PHASE 2 OFFICIAL SEAL
GILA COUNTY RECORDER'S OFFICE

DEDICATION

State of Arizona)
) SS:
County of GILA)

KNOW ALL MEN BY THESE PRESENTS:

That the undersigned, STRAWBERRY HOLLOW DEVELOPMENT, INC, an Arizona Corporation, as owner of, and has subdivided under the name of "STRAWBERRY HOLLOW, PHASE 2", being that Tract "G" of STRAWBERRY HOLLOW, PHASE 1, Map No. 732A & 732B, as revised by that Record of Survey – Lot Line Adjustment, Map No. 2800, Gila County Records.

Located in a portion of the Southeast (SE) 1/4 of Section 26, Township 12 North, Range 8 East of the Gila and Salt River Meridian, Gila County, Arizona, as shown hereon and hereby publishes this Plat as and for the Plat of said "STRAWBERRY HOLLOW, PHASE 2", and declares that said Plat sets forth the location and gives the measurements and dimensions of the lots, tracts and streets constituting same and that each lot, tract and street shall be known by the number or name that is given to each respectively on said Plat, and that STRAWBERRY HOLLOW DEVELOPMENT, INC. hereby dedicates to the public for use as such, the streets and easements as shown hereon and included in the above described premises.

Easements are hereby reserved for the purpose shown hereon. Construction within easements, except by Public Agencies and Utility companies, shall be limited to utilities and wood, wire or removable section type fencing.

IN WITNESS WHEREOF: STRAWBERRY HOLLOW DEVELOPMENT, INC, an Arizona Corporation, as owner, has hereunto caused its name to be affixed and the same to be attested by the signature of the undersigned officer thereunto duly authorized this 18th day of APRIL, 2006.

STRAWBERRY HOLLOW DEVELOPMENT, INC., as owner

By: _____ Its: PRESIDENT

ACKNOWLEDGMENT

State of Arizona)
) SS:
County of GILA)

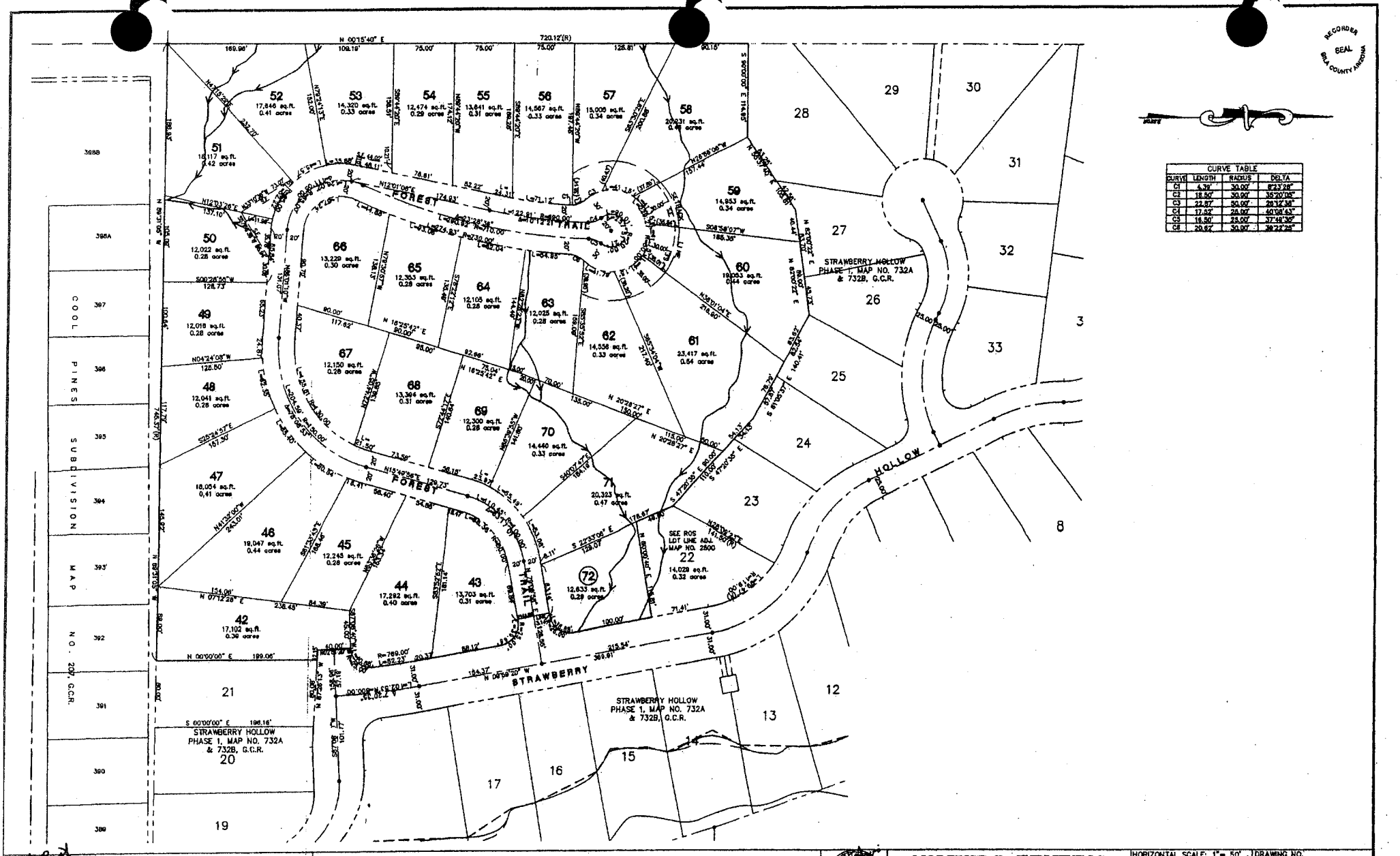
On this 18 day of April 2006 before me the undersigned officer, appeared Lorne Peterson who acknowledged himself to be the PRESIDENT of STRAWBERRY HOLLOW DEVELOPMENT, INC. an Arizona Corporation, and further acknowledged that he as such officer, being duly authorized so to do, executed the foregoing instrument for the purposes therein contained by signing the name of the corporation, as owner, by himself as such officer.

By: _____ My Commission expires: 8-10-08

OFFICIAL SEAL
SANDY L. JOHNAN
NOTARY PUBLIC - State of Arizona
GILA COUNTY
My Comm. Expires Aug. 10, 2008

SHEET 1 OF 2

732A



TETRA TECH, INC.
INFRASTRUCTURE SOUTHWEST GROUP

STRAWBERRY HOLLOW, PHASE 2
PINE / GILA COUNTY, ARIZONA

NORTHSTAR SURVEYING INCORPORATED
1100 N. BEELINE HWY., SUITE B ✦ PAYSON, ARIZONA 85541 ✦ (928) 474-8644

HORIZONTAL SCALE: 1" = 50'
CONTOUR INTERVAL: N/A
DATE: 04-13-2005
PROJECT NO. 04-159

DRAWING NO. FP2
SHEET NO. 2 OF: 2

ARIZONA DEPARTMENT OF WATER RESOURCES
HYDROLOGY DIVISION
500 North Third Street, Phoenix, Arizona 85004
Telephone 602-417-2448
Fax 602-417-2425

JANE DEE HULL
Governor

RITA PEARSON
MAGUIRE
Director

September 12, 2000

Mr. Roy Tanney
Department of Real Estate
2910 North 44th Street
Phoenix, Arizona 85018

Re: Water Adequacy Report #22-400383
Strawberry Hollow, Gila County

Pursuant to A.R.S. §45-108, Mr. Ralph Bossert, ASL Consulting Engineers, has provided the Department of Water Resources with information on the water supply for the proposed subdivision, Strawberry Hollow, Phase I, occupying a portion of Section 26, T12N, R8E, G&S R B&M.

Water for domestic use will be provided to each of the 41 lots in the subdivision by the Strawberry Hollow Development Inc.. Adequacy of the water supply was reviewed by the Department with regard to quantity, quality, and dependability.

Because a 100 year water supply could not be demonstrated as being available to each lot based on the Department's physical availability criteria, the Department of Water Resources must find the water supply to be ***inadequate*** for the proposed use.

A.R.S. §32-2181.F. requires a summary of the Department's report for a dry lot subdivisions or those with an inadequate water supply be included in all promotional material and contracts for sales of lots in the subdivision. We suggest the following synopsis:

> "Strawberry Hollow Phase I, is being sold with the domestic water supply to be provided by the Strawberry Hollow Development, Inc. water distribution system as a homeowner's association or improvement district which has yet to be established. Groundwater is being produced from the Redwall limestone. The limited availability of data associated with this formation as an aquifer does not allow for determination of the amount of the groundwater in storage, nor the dependability of supply. Additionally, this general area has been determined to be drought-sensitive. The depth to groundwater may range from 21 to over 1200 feet below land surface depending on topography. Groundwater quality is unknown. Because a 100-year adequate water supply has not been demonstrated, the Department of Water Resources must find the water supply to be ***inadequate***."

The developer, pursuant to A.R.S. §32-2181.F., may suggest a different summary of this report, but it must contain the above elements and/or the Department's findings. Any change to the above subdivision or water supply plans may invalidate this decision.

This letter constitutes the Department of Water Resources' report on the subdivision's water supply and is being forwarded to your office as required by A.R.S. §45-108. This law requires the developer to hold recordation of the above subdivision's plats until receipt of the Department's report on the subdivision's water supply. By copy of the report, the Gila County Recorder is being officially notified of the developer's compliance with the law.

This is an appealable agency action. The applicant is entitled to appeal this action. Rights to appeal are described in the Notice of Right of Appeal.

If you have any questions regarding this report, please call Andy Kurtz at 602-417-2448.

Sincerely,

Greg Wallace
Chief Hydrologist

GW/AK/ef
2059

cc: Ralph Bossert, ASL Consulting Engineers
Strawberry Hollow Development, Inc.
Linda H. Ortega , Gila County Recorder
Robert J. Mawson, Gila Planning & Zoning
Steve Rossi, Office of Assured & Adequate Water Supply

2277.0002

ARIZONA DEPARTMENT OF WATER RESOURCES
Office of Assured and Adequate Water Supply
500 North Third Street, Phoenix, Arizona 85004-3921
Telephone 602 417-2465
Fax 602 417-2467

JANET NAPOLITANO
Governor

HERB GUENTHER
Director

January 12, 2005

Mr. Roy Tanney
Arizona Department of Real Estate
2910 N. 44th Street
Phoenix, Arizona 85018

Water Adequacy Report #22-4016170000
Subdivision Name: Strawberry Hollow Phase II
Owner: Strawberry Hollow Development, LLC
Number of lots: 31
County: Gila
Township 12 N **Range** 08 E **Section** 26

Water provided by: Strawberry Hollow Water Improvement District
Water Type: Groundwater
Current water depth: No Information
Estimated 100-year depth: No Information
Current decline rate: No Information
Basin: Verde Valley

Dear Mr. Tanney:

Pursuant to A.R.S. § 45-108, the Department of Water Resources has reviewed the available information pertaining to the water supply for the above-referenced subdivision. This letter constitutes the Department's report on the subdivisions water supply as required by A.R.S. § 45-108(A).

Adequacy of the 100-year water supply was reviewed by the Department with regard to physical, legal and continuous availability, and to determine if the water supply is of adequate quality. No information has been provided to the Department that indicates that the applicant has satisfied the adequate water supply requirements as set forth in A.A.C. R12-15-715 *et seq.* Therefore, the Department of Water Resources finds the water supply to be *inadequate* to meet the subdivision's projected needs.

Pursuant to A.R.S. §32-2181.F. a summary of the Department's report for those with an inadequate water supply be included in all promotional material and contracts for sale of lots in the subdivisions. We suggest the following synopsis:

> "Strawberry Hollow Phase II subdivision is being served groundwater by Strawberry Hollow Water Improvement District. The developer has chosen not to demonstrate a 100-year adequate water supply. The criteria for physical, legal and continuous availability as set forth in A.A.C. R12-15-717 were not demonstrated, and proof of adequate water quality as set forth in A.A.C. R12-15-718 was not provided. Therefore the Department must find the water supply to be *inadequate*. For additional information please contact the Arizona Department of Water Resources at (602) 417-2465."

The developer, pursuant to A.R.S. §32-2181.F., may suggest a different summary of this report, but it must contain the above elements and/or the Department's findings. Any change to the above subdivision or water supply plans may invalidate this decision.

This letter is being forwarded to your office as required by A.R.S. § 45-108. This law requires the developer to hold the recordation of the subdivision's plat until receipt of the Department's report on the subdivision's water supply. By copy of this report, the Gila County Recorder is being officially notified of the developer's compliance with the law.

Sincerely,

Frank Putman

Frank Putman
Assistant Director

FP/PS/cf
700097

cc: Gila County Planning and Zoning
Gila County Recorder
Ralph O. Bossert
Alan R. Dulaney, ADWR

GILA CO, AZ, LINDA HAUGHT ORTEGA - RECORDER, BY: GILA COUNTY BOARD OF SUP
DATE: 08/17/2001 TIME: 02:24 PAGE #: 0001 OF 0012 FEE #: 2001 12717 **

Order

Establishing the Strawberry Hollow Domestic Water Improvement District

WHEREAS, a petition requesting the establishment of the Strawberry Hollow Domestic Water Improvement District was presented to the Clerk of the Gila County Board of Supervisors; and

WHEREAS, the said petition was signed by one hundred percent of the persons owning real property within the boundaries the proposed district; and

WHEREAS, the petitioners provided a copy of a record search that shows the names of the owners of all the property located within the boundaries of the proposed district, pursuant to the provisions of Arizona Revised Statutes §48-905(C); and

WHEREAS, the public convenience, necessity and welfare will be promoted by the establishment of the proposed district; and

WHEREAS, the area included within the boundaries of the proposed district as those boundaries described in the petition, will be benefited by the acquisition of certain improvements within the district.

NOW, THEREFORE, It is Ordered as follows:

1. The Board of Supervisors finds that:

   a. The Board of Directors of the Pine-Strawberry Water Improvement District met in an open meeting on the 11th day of August, 2001. At such time Resolution No. 01-08-11, attached hereto and incorporated herein by reference as Exhibit C, was passed and adopted deleting the property known as Strawberry Hollow Development from the boundaries of the Pine-Strawberry Water Improvement District.

   b. The property located within the boundaries of the proposed domestic water improvement district is the property known as Strawberry Hollow Development, as those set forth in Exhibits A and B attached hereto and incorporated herein by reference.

   c. The petition requesting the establishment of the district conforms with all legal requirements relating to the formation of a domestic water improvement district, and the definition and establishment of the boundaries of a domestic water improvement district.

   d. The petition is signed by one hundred percent of the persons owning real property within the boundaries of the district, as provided by Arizona Revised Statutes §48-905(C);

e. The public convenience, necessity and welfare will be promoted by the establishment of the district and the property included within the district will be benefited thereby.

2. That the district shall be known in all proceedings as the Strawberry Hollow Domestic Water Improvement District.

3. That the boundaries of the Strawberry Hollow Domestic Water Improvement District shall be those set forth in Exhibits A and B, attached hereto and incorporated herein by reference.

4. That by virtue of the authority set forth in Arizona Revised Statutes §48-906 the Strawberry Hollow Domestic Water Improvement District is hereby established and formed, and shall be a body corporate with the powers of a municipal corporation for the purposes of carrying out the provisions of Title 48, Chapter 6, Article 1 of the Arizona Revised Statutes.

5. That in accordance with Arizona Revised Statutes §48-915, the Strawberry Hollow Domestic Water Improvement District is authorized to incur debt or expenses for property, materials and services that are reasonably necessary for District purposes.

6. That in accordance with Arizona Revised Statutes §48-1012 the Strawberry Hollow Domestic Water Improvement District shall be governed by an elected three member board of directors. The first election shall be held on the first Tuesday after the first Monday in November, 2002, with subsequent elections being held in even-numbered years on the first Tuesday after the first Monday in November. The initial governing board of directors is appointed as follows:

   1. Loren B. Peterson 2. Diane F. Peterson 3. Sarah D. Peterson

7. That on or before November 1, 2001, request be made to the Property Valuation Division of the Arizona State Department of Revenue, that the established Strawberry Hollow Domestic Water Improvement District be approved for assessment and tax levy authority.

ADOPTED This 14th day of August, 2001, at Globe, Gila County, Arizona.

Cruz Salas, Chairman
Gila County Board of Supervisors

Attest:

Steven L. Besich, Clerk
Gila County Board of Supervisors

Approved as to form:

James W. Hazel, Jr.
Gila County Attorney

GILA CO, AZ, LINDA HAUGHT ORTEGA - RECORDER, BY: GILA COUNTY BOARD OF SUP
DATE: 08/17/2001 TIME: 02:24 PAGE #: 0009 OF 0012 FEE #: 2001 12717

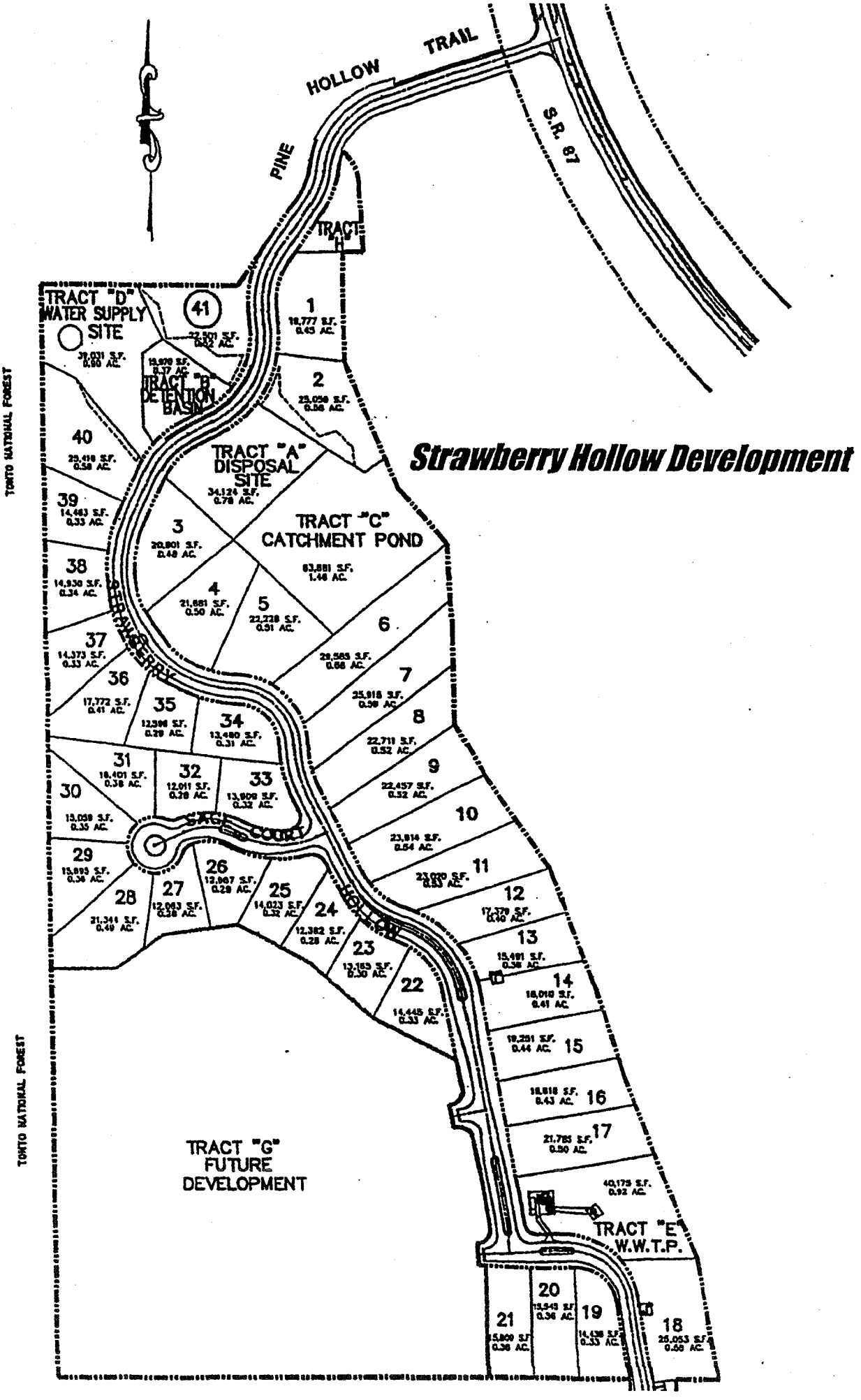
Exhibit A

Strawberry Hollow

Lots 1 through 41, and Tracts A through J, of STRAWBERRY HOLLOW, PHASE 1, according to the plat of record in the office of the County Recorder of Gila County, Arizona, recorded in Map No. 732 A & B.

GILA CO, AZ, LINDA HAUGHT ORTEGA - RECORDER, BY: GILA COUNTY BOARD OF SUP
DATE: 08/17/2001 TIME: 02:24 PAGE #: 0011 OF 0012 FEE #: 2001 12717

Exhibit B



GILA CO, AZ, LINDA HAUGHT ORTEGA - RECORDER, BY: GILA COUNTY BOARD OF SUP
DATE: 08/17/2001 TIME: 02:24 PAGE #: 0012 OF 0012 FEE #: 2001 12717

GILA CO, AZ, LINDA HAUGHT ORTEGA - RECORDER, BY: GILA COUNTY BOARD OF SUP
DATE: 08/17/2001 TIME: 02:24 PAGE #: 0007 OF 0012 FEE #: 2001 12717

Exhibit C

GILA CO, AZ, LINDA HAUGHT ORTEGA - RECORDER, BY: GILA COUNTY BOARD OF SUP
DATE: 08/17/2001 TIME: 02:24 PAGE #: 0008 OF 0012 FEE #: 2001 12717

RESOLUTION NO. 01-08-11

A RESOLUTION OF THE BOARD OF DIRECTORS OF THE PINE-STRAWBERRY WATER IMPROVEMENT DISTRICT APPROVING THE DELETION OF PROPERTY KNOWN AS THE STRAWBERRY HOLLOW DEVELOPMENT FROM THE BOUNDARIES OF THE PINE-STRAWBERRY WATER IMPROVEMENT DISTRICT

WHEREAS, the Board of Directors ("Board") of the Pine-Strawberry Water Improvement District met in an open meeting on the 11th day of August, 2001, at which a quorum was present; and

WHEREAS, the Board has considered the petition of the owners of real property known as the Strawberry Hollow Development, which is legally described on Exhibit "A," and which is further depicted on the map labeled Exhibit "B," and both of which are attached hereto and incorporated by this reference herein; and

WHEREAS, the petitioners request this Board of Directors to summarily authorize the deletion of the Strawberry Hollow Development from the boundaries of the District; and

WHEREAS, the petition is signed by all of the owners of the real property to be deleted from the District; and

WHEREAS, the Pine-Strawberry Water Improvement District does not have the ability to provide domestic water to the Strawberry Hollow Development; and

WHEREAS, the Board of Supervisors of Gila County, Arizona has passed a resolution dated July 24, 2001 supporting the deletion of the Strawberry Hollow Development from the District; and

WHEREAS, the Board finds that the petition conforms with all legal requirements relating to the deletion of property from the District, and that the public convenience, necessity and welfare will be promoted by the deletion of the Strawberry Hollow Development from the District.

NOW, THEREFORE, BE IT RESOLVED that the Board of Directors of the Pine-Strawberry Water Improvement District approves the deletion of the property depicted and described in the attached Exhibits A and B from the boundaries of the District.

Passed and adopted by the Board of Directors of the Pine-Strawberry Water Improvement District, Gila County, Arizona, this 11th day of August, 2001.

William J. Johnson, Chairman
Pine-Strawberry Water Improvement District

Attest:

Dolores Roepke, Secretary
Pine-Strawberry Water Improvement District

ATTACHMENT 2

TOWN OF PAYSON 2005 WATER STATUS REPORT

MRWRMS HYDROGEOLOGICAL STUDY
PRELIMINARY RESULTS PRESENTED

TOWN OF PAYSON
WATER RESOURCES MANAGEMENT

2005 STATUS REPORT

APRIL 6th, 2005

Prepared By:
Town of Payson Water Department

2005 PAYSON WATER RESOURCES STATUS REPORT
EXECUTIVE SUMMARY

The recent passage by Congress of the Arizona Water Rights Settlement Act resulted in clarification for many water rights issues within Arizona, including the use of Blue Ridge Reservoir. Located within the written details of the Act is a historically vital piece of the Town of Payson's water future. The Act anticipates that the Town of Payson will access up to 3,000 acre-feet per year of renewable surface water from the Blue Ridge Reservoir. In the future, water is expected to be delivered to Payson via the facilities of the Salt River Project, the Bureau of Reclamation, and a pipeline constructed, owned, and operated by the Town of Payson.

Operating a municipal water supply comes with many responsibilities but the most basic is to continually meet demands while also balancing such needs with responsible water resources management practices and efficient use. Until Blue Ridge water is delivered, which could take approximately ten years, the sole source of Payson's water supply remains groundwater from a fractured granite aquifer. Because of inherently low aquifer storage, minimizing demands for this groundwater has always been and will continue to be a priority for the Town of Payson. As a practical matter, it is desirable that water withdrawn from the aquifer for public use is replaced on a yearly basis by rain and preferably snowfall that falls within the town limits and seeps through the overlying soils into the aquifer. This ideal situation is referred to as "Safe Yield" wherein the amount of water that seeps into the local aquifer on a long-term basis is equal to, or greater than, the amount that is withdrawn for local water supply.

It is the policy of the Town of Payson local government that the town will make attempts to manage its water supply and take efforts relating to water development and water conservation to achieve "Safe Yield" water supply goals each year. In 2004, Payson residents consumed local groundwater resources in an amount equal to 88% of "Safe Yield". The fact that water consumption for 2004 was reduced by 4%, from a 2003 annual consumption of 92% of safe yield, is yet another indication that the Department's conservation section is running an outstanding and award-winning conservation program. Amazingly, per capita usage for 2004 was reduced to only 86gpcd.

The natural environment in which the Town of Payson resides is clearly one of extremes. Never in recent memory has the reality of this been so evident. In less than a few weeks what was a parched local landscape literally turned to mud slides and scouring flood waters. The region's aquifers, previously stressed to record lows, soaked up rainfall as fast as they could, resulting in groundwater levels not observed in several years or even decades. As rainfall quickly exceeded the grounds ability to soak up water, record runoff has restored Roosevelt Lake to levels never before observed since the dam was raised in 1996. Yet, the return of drought is a common theme in the discussion of experts. Though record rainfall totals for Summer 04 thru Winter 04-05 have been recorded, it is the observed reality of extremes that forces responsible water resources managers to plan accordingly. This is precisely why the Town of Payson utilizes the concept of "Safe Yield" to maintain its groundwater supplies as a renewable resource.

The Town of Payson is committed to utilizing strategies to maintain a low consumption rate of local water supplies via modern and innovative conservation methods. The Town's conservation ordinance has been utilized to mandate water conservation methods for new and existing businesses and homes. A key component of the ordinance is the possible institution of water use restrictions based on the status of our water resources. Each spring water restrictions are recommended by the department in order to achieve reduced water consumption commensurate with observed water resource status trends. The Town of Payson will implement Water Conservation Level II water use restrictions for the period of April 2005 to May 2006. These water use restrictions include a ban on washing paved areas such as sidewalks or drives and limiting outside water use to certain days of the week. Complete details are available at the Payson Water Department. These efforts in combination with increased water conservation education, special conservation programs, and the assistance provided to homes and businesses are a meaningful attempt by Town government to achieve the Town's goals of "Safe Yield" in the management of its public water supply.

The Town of Payson Water Department continues to play a primary role in the regional studies of the Mogollon Rim Water Resources Management Study, sponsored by the Bureau of Reclamation along with Gila County. Water Department staff, in collaboration with consulting geologists and the University of Arizona, is leading the development of a conceptualization of the region's groundwater systems and their hydrogeological framework. Supported by facts developed via on-going geologic mapping, groundwater chemistry and isotope sampling, and groundwater and spring elevations surveys (via Gila County), the conceptualization and framework are coming together and painting a picture of both opportunity and restraint concerning the groundwater resources available to the communities within the study area. Preliminary results are encouraging and indicate that many of the persistent water resources challenges of the study area can readily be addressed through the sensible exploration and development of dominantly untapped groundwater resources coupled with conjunctive use and responsible water resources management strategies. Within this context, for the Town of Payson, the role of Blue Ridge Reservoir and conservation remain a priority alongside efforts to develop aquifer storage and recovery capabilities for both Blue Ridge water and reclaimed water sources.

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1.0 Introduction

The water status report for 2005 presents up-to-date information regarding the status of the Town of Payson's water supply for the coming year. Current information relative to water development/exploration projects, water usage and production, water levels, precipitation and recharge, and the overall 2005 water supply outlook is briefly presented. As always, maintaining diligence in the monitoring and best management of our water resources continues to be a priority for the Water Department.

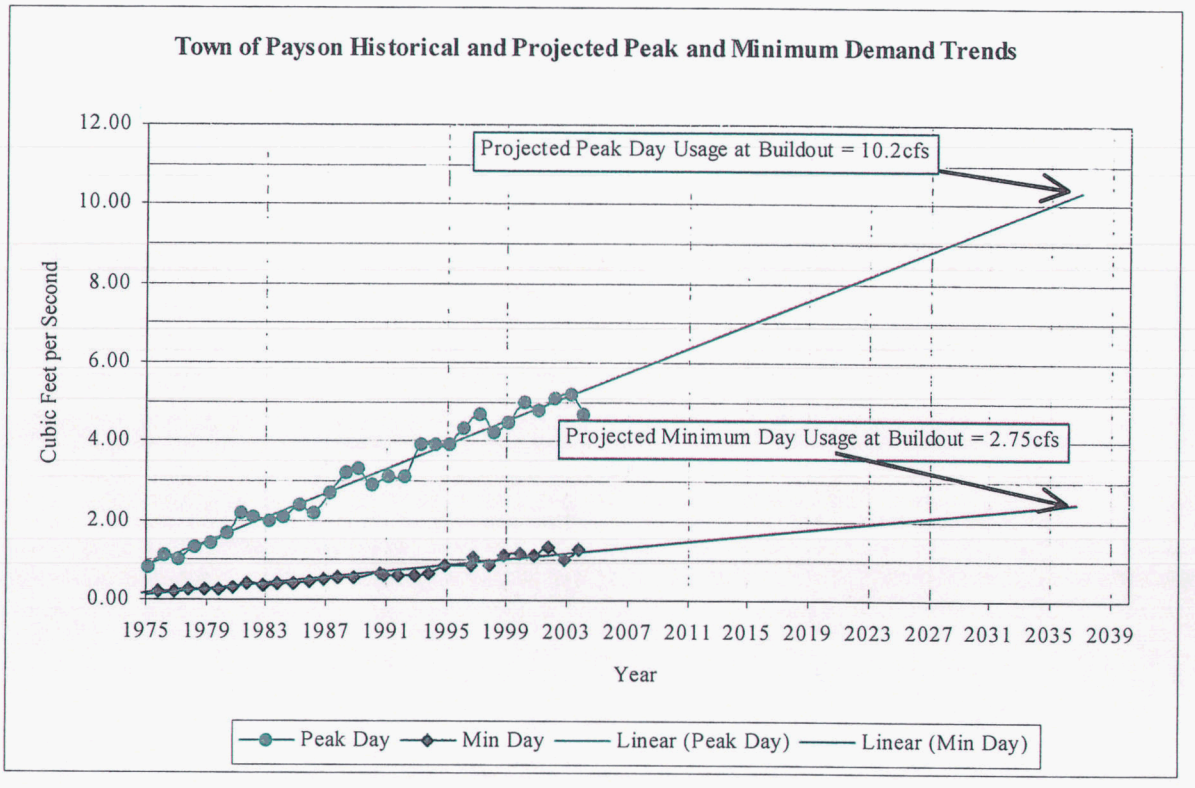
2.0 Water Resources Development and Exploration

2.0 Blue Ridge Reservoir and Planning

The recent passage by Congress of the Arizona Water Rights Settlement Act anticipates the delivery of Blue Ridge Reservoir to the Town of Payson. Specifically, the Act anticipates that the Town of Payson will access up to 3,000 acre-feet per year of renewable surface water from the Blue Ridge Reservoir. In the future, this water is expected to be delivered to Payson via the facilities of the Salt River Project, the Bureau of Reclamation, and a pipeline constructed by the Town of Payson.

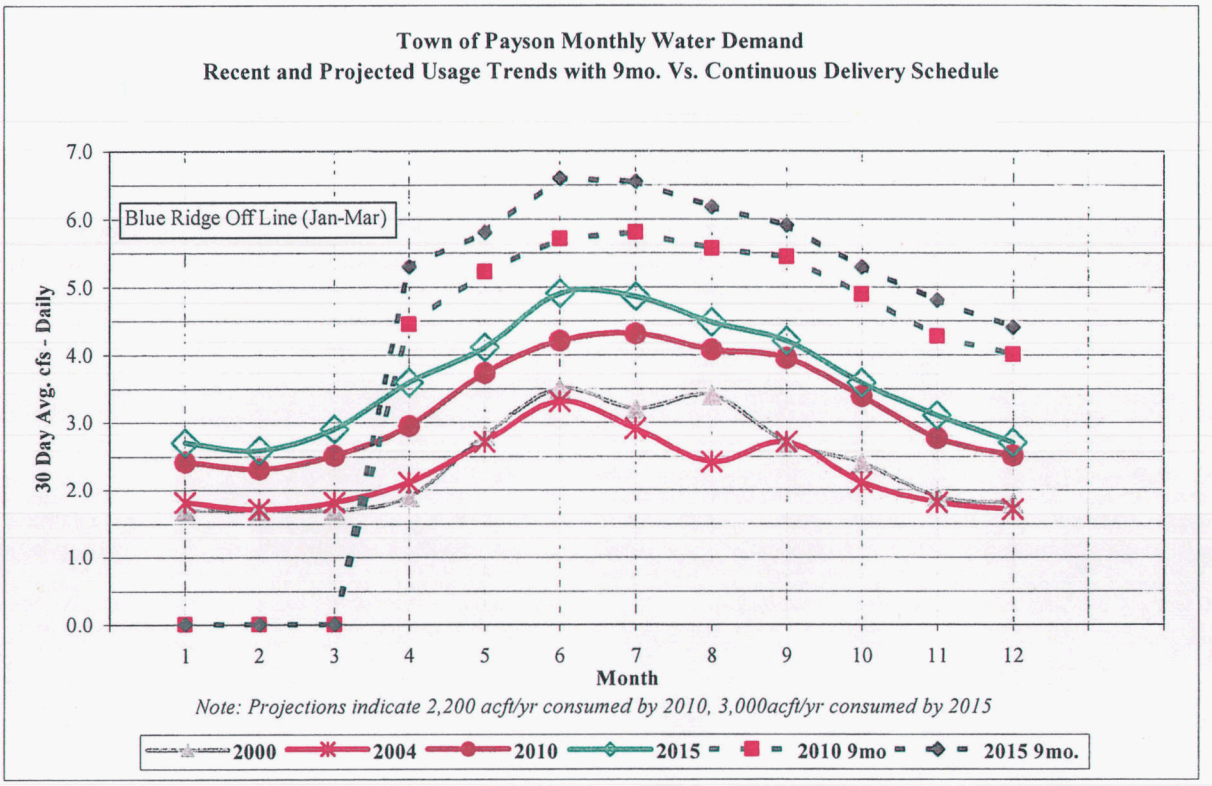
Planning for the delivery of Blue Ridge has been underway for over twenty years. In recent studies, it became apparent that the Town of Payson would require a place to store and recover Blue Ridge water to facilitate an ability to accept variable flows both over and below demands due to the complicated nature of the envisioned delivery schedule. Most importantly, it was identified that the Town needs to develop an operational flexibility for the treatment and delivery of Blue Ridge water because of the communities highly variable demand expected to range from as low as 3cfs to as much as 10cfs (1cfs = 448.8gpm) at the projected buildout population of 44,000. See Figure I below.

Figure I



From prior bench-scale injections tests conducted by the Town of Payson, the possibilities of Aquifer Storage and Recover (ASR) wells to meet the challenges in evidence above are considered viable. The drought sensitive fractured granite aquifer system on which the Town currently relies is prime for artificial recharge, particularly in historically over-pumped areas where the upper, more permeable fractured granite of higher storage capacity has been drained. In consequence, the Town of Payson is developing a recharge and recovery concept to both meet SRP's delivery capabilities and utilize depleted areas of the aquifer system for short-term storage and recovery while creating intrinsic operational flexibility. Still, the delivery of Blue Ridge water is further complicated by the planned operation of facilities on a nine-month schedule. Such a delivery scenario will require an ability to store an intended surplus ranging from 1-2cfs above projected demands while also providing for seasonal recovery of the resultant stored water. See Figure II below.

Figure II



The proposed ASR well concept allows surplus supplies (flows in excess of demands) of treated Blue Ridge water to be stored in the aquifer at selected existing high yield drinking water production well sites. Treated Blue Ridge water would be delivered to the ASR wells automatically when demands are not sufficient to consume the delivered water and whenever surplus Blue Ridge supplies are intentionally delivered for ASR. When demands exceed delivered Blue Ridge water amounts and/or when Blue Ridge deliveries are seasonally suspended, the drinking water ASR wells would automatically turn on and recover the stored Blue Ridge water and groundwater blend for delivery. Ideally, the existing water distribution system would be used to deliver both stored and recovered waters from the selected ASR locations. In this way, both the desires to store Blue Ridge water for seasonal recovery and provide operational flexibility could be met.

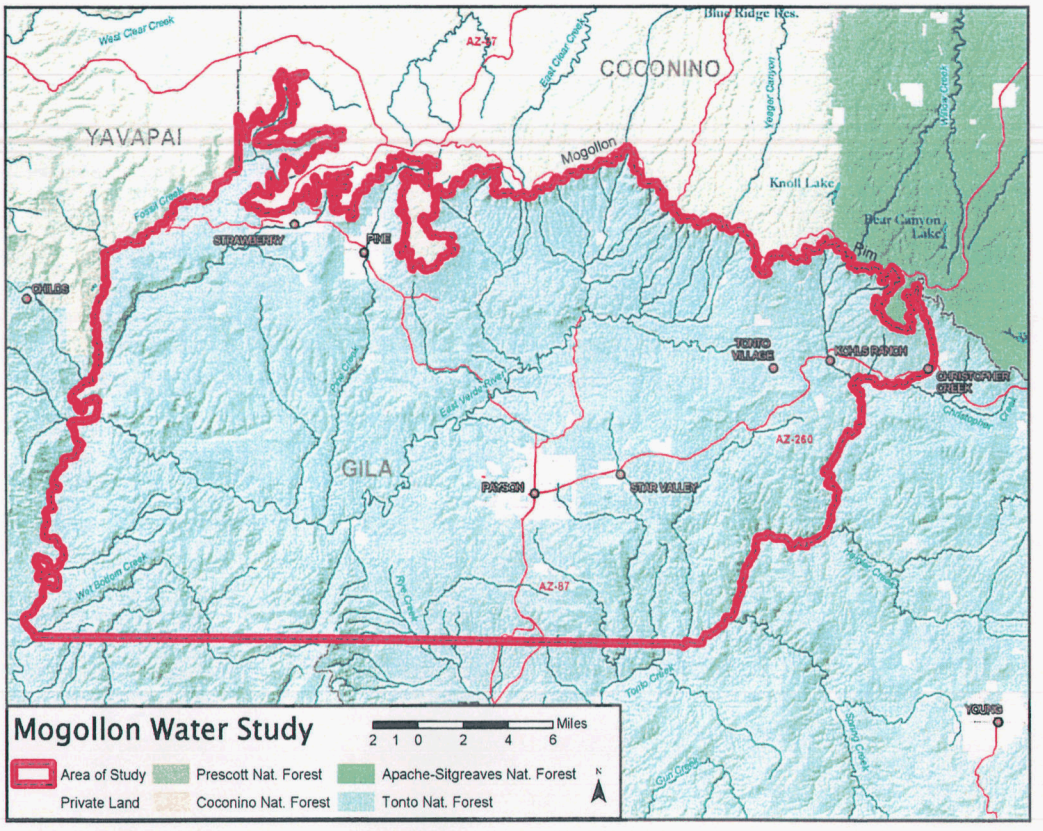
The Town of Payson has contracted with HydroSystems Inc. "HSI" to assist in the testing of selected existing production wells for the potential application of ASR. HSI will also be considering the geochemical interactions of treated Blue Ridge water both within the aquifer and within the distribution system itself, to ensure efficient and trouble free operation. In addition, HSI will be assisting in the eventual retrofitting and permitting of selected drinking water production wells for the eventual application of ASR in time for Blue Ridge deliveries. Finally, the Town may expand the ASR well program to reclaimed water sources as well.

Assuming no additional surface water supplies are obtained either via Blue Ridge or other potential sources, along with many other more complex assumptions, the Town may be consuming 100% of its available surface water supplies by the year 2015. At this time, the pumping of local groundwater supplies, augmented with the artificial recharge of reclaimed waters for drought reserve, may again be required to meet annual demand totals. It is expected that the policy of the Town will remain unchanged in that this groundwater will only be consumed within the safe yield of 1,826acft/yr, in addition to any groundwater resources developed outside of the Town limits.

2.1 Mogollon Rim Water Resources Management Study

The Mogollon Rim Water Resources Management Study or "MRWRMS" is sponsored by the United States Bureau of Reclamation and is in partnership with the Town of Payson and Gila County. Ultimately, the primary goal of the group is to clearly define a "toolbox" of realistic water resources alternatives consisting of all viable water sources that could be used in concert to benefit water users within the study area. See Figure III Below.

Figure III



Study Area Map Provided by USBR

2.2 MRWRMS -- Hydrogeologic Framework

Early in the Mogollon study it was identified that reasonable recommendations on water resources solutions could not immediately be made because existing data resources concerning the vast majority of the study area were severely lacking information upon which to base rational recommendations. The study partners agreed that more data was needed. Along with a comprehensive water demand analysis for the study area it was desired that additional hydrogeological data be acquired to facilitate a better understanding of the region's aquifer systems and hydrogeologic framework. Once collected, this information can be used to build an accurate conceptual model of the groundwater systems within the study area.

Under contract with the Town of Payson and in cost share with Gila County, Clay Conway Ph.D., Geologist with Gaeaorma Inc., is currently wrapping up extensive mapping of the geology within the study area. The mapping work is essentially an extension of the work already completed in support of the Town's past investigations and the more recent Diamond Rim water resources study. In addition to the geological mapping being completed, groundwater, surface water, and spring chemistry and stable isotope studies are also being conducted. Again, this work is also an expansion of studies already undertaken by Town staff in support of the historical and current groundwater investigations. Chris Eastoe, Ph.D., Scientist of the University of Arizona in collaboration with Town staff and Gaeaorama Inc, is providing assistance with the interpretations of the isotopic data. Portions of the isotopic data collection are being funded via the partnerships formed through the MRWRMS along with a contribution from Salt River Project.

Data MRWRMS is collecting, as it relates to the major springs of the region, Fossil Springs, Tonto Natural Bridge, Webber Springs, Cold Springs, and the Tonto Hatchery Spring is clearly of great importance to the study. The overall interest expressed by study participants is in the preservation of these natural resources through better understanding their source or sources. Regionally, study partners wish to know what groundwater systems exist and how they contribute or not to the major springs within the study area. In result, the value of the effort is in gathering accurate data so that regional water management professionals can have a toolbox of reasonable options to both meet water resources needs for the future and also minimize and/or eliminate the potential for negative impacts. In addition, the data being collected will be shared with Northern Arizona University along with consideration of additional support from study partners to assist them in their efforts at building a Fossil Springs 3-D Digital Hydrogeologic Framework Model in the coming years.

2.2.1 Preliminary Results

The facts currently being gathered and finalized (geological and structural geology mapping, general groundwater chemistry, isotopes, tritium, and groundwater and spring elevations) are confirming the complicated nature of the region's aquifer systems. The information is indicating that the study area can be divided into at least three distinct groundwater basins from south to north and at least three divisions of these basins from west to east across the study area. These groundwater basins and sub-basins are preliminarily being defined utilizing data collected from the sources listed in the following table.

Table 1

2001 thru 2005 Data Locations -- MRWRMS Regional Groundwater Studies -- Town of Payson

Site Name	Source*	Well Depth	ADWR #	Aquifer** Hydrogeological System	Groundwater System and/or Sub-Basin[1]
87 and Cavern - Runoff	SW			Recharges to R/M/X	Central Mogollon Basin
Beeline	GW	1000	620867	X -- Payson Granite	Central Highlands
Blue Ridge	SW			Leakage into Upper C	Colorado Plateau
CC #3	GW	760	565297	X -- Payson Granite / Gibson Diorite	Central Highlands
Cold Springs	SP			Martin Aquifer Discharge	East Mogollon Basin
CPN-13	GW	400	544348	X -- Payson Granite	Central Highlands
DB-2	GW	992	597574	X -- Gibson Diorite/Gabro	Rye Basin
DB-Shallow	GW	80		TG - Gravels	Rye Basin
Deep Pine - SH-3	GW	1320	587628	Martin	Central Mogollon Basin
Deep Strawberry	GW	700	203413	Supai - Lower C	Central Mogollon Basin
Ellison	GW	560	581836	Martin thru X (Granite)	East Mogollon Basin
ish Hatchery Spring	SP			Upper C Aquifer System Discharge	East Mogollon Basin
ossil Springs Lower	SP			Lower C Aquifer System Discharge	West Mogollon Basin
Fossil Springs Upper	SP			Lower C Aquifer System Discharge	West Mogollon Basin
Goat Camp	GW	925	565426	X -- Gneissic Granite	Central Highlands
Hunter Creek Well	GW	95	508554	Alluvium and Upper X -- Quartzite	Eastern Highlands
Lake Drive	GW	500	558391	X -Payson Granite	Central Highlands
Luke	GW	860	575304	X -- Payson Granite	Central Highlands
McKamey	GW	860	509870	X -- Payson Granite	Central Highlands
Mt. View	GW	280	512759	X -- Payson Granite	Central Highlands
NP-2	GW	1000	577329	X -- Payson Granite	Central Highlands
Payson Pines 4	GW	400	564016	X -- Payson Granite	Central Highlands
Pine Creek	SW			Recharges to R/M/X	Central Mogollon Basin
Reclaimed	RW			X -- Payson Granite	Central Highlands
Round Valley	GW	160		X -- Gibson Diorite/Gabro	Central Highlands
Rye HI-4	GW	840	590440	X -- Gibson Diorite/Gabro	Rye Basin
Shallow Pine - SH-2	GW	240	579973	Supai - Lower C	Central Mogollon Basin
Skypark	GW	815	568624	X -- Payson Granite	Central Highlands
Deep Sky Run Well	GW	1000		X -- Payson Granite	Central Highlands
Strawberry Shallow	GW	400	588181	Supai - Lower C	Central Mogollon Basin
Summer Precipitation 03	P				
Summer Precipitation 04	P				
Summit	GW	970	576872	X -- Gibson Diorite/Gabro	Central Highlands
Tonto Bridge	SP			Martin	Central Diamond Rim Basin
TOP-19	GW	340	519459	X -- Payson Granite	Central Highlands
Turtle Rock	GW	365	564467	X -- Payson Granite	Central Highlands
Webber	SP			Martin and X (Granite)	Central Diamond Rim Basin
Winter Precipitation 02-03	P				
Winter Precipitation 03-04	P				
Winter Precipitation 04-05	P				
Woodland #1	GW	925	503323	X -- Payson Granite	Central Highlands
PSWID Strawberry Borehole	GW	1,872	581081	Redwall-Martin	Central Mogollon Basin

* GW = Groundwater, SP= Spring, P= Precipitation, SW= Surface Water, RW= Reclaimed Wastewater

** X = Any Precambrian Formation, R = Redwall, M = Martin

[1] = Subdivisions of ADWR Defined Verde River and Tonto Creek Basins, Excluding Colorado Plateau

As mentioned previously, the relationships between the sources to the major springs and the aquifers within the study area are of primary interest. When considered in light of the groundwater systems and sub-basin concepts above, along with isotope and chemistry data and geological mapping, the sources to the major springs can be discerned. The common factors associated with all of the major springs are faults, the edges of groundwater systems or sub-basins, and geology. With this information in hand the hydrogeological framework is now being developed and the conceptualized groundwater model described.

Information relating to the source and/or sources to Fossil Springs has been a great topic of interest and is important to the study participants. Results of the data collected appear to be confirming that the source of Fossil Springs is dominantly drainage from the "C" aquifer system and is largely supporting the United States Geological Survey Water Resources Division reports by Hart, Robert J., (Doc.#02-4026), and Bills, Donald (Doc.#J, 00-4122) with only few minor exceptions to details. The "C" aquifer system, as described in the documents listed prior, essentially is comprised of the Kiabab Limestone down to the Naco Formation (Lower Supai) at the base. These formations constitute the bulk of the exposed edge of the Mogollon Rim that can be seen immediately north of all study area communities. The C aquifer is only present north of the regionally extensive Diamond Rim Fault and above the Naco Formation to the edge of, and beneath, the Colorado Plateau. The Redwall/Martin/X aquifer exists stratigraphically below the "C" aquifer and below the confining shale beds of the Naco formation. (See Figures IV and V Below) The Redwall itself is dominantly unsaturated over the entire study area except in areas immediately adjacent to or at some distance to the north, beneath the Colorado Plateau. Though leakage between the "C" and Redwall – Martin-X aquifers "RMX" may occur beneath the Plateau, it is perceived to be relatively minor, else additional large and consistent discharges (geochemically similar to Fossil Springs) would be occurring out of the RMX below the elevation of Fossil Springs or below the Naco Formation throughout the study area.

Note that in Figure V the exact horizon of Fossil Springs discharges are now clearly visible along the west bank of Fossil Creek and on the western side of a previously unmapped fault. The geology out of which the springs flow has been hidden behind thick blackberry vines and calcium spring deposits along the west bank of Fossil Creek for many years. The recent flooding has scoured the blackberry vines from around the springs and has broken off sections of calcium carbonate that had previously prevented close inspection of the exact discharge points. At this time, a majority of the springs can clearly be observed discharging atop a confining red shale bed horizon in the Naco Formation.

Figure IV
Geological Cross-Section

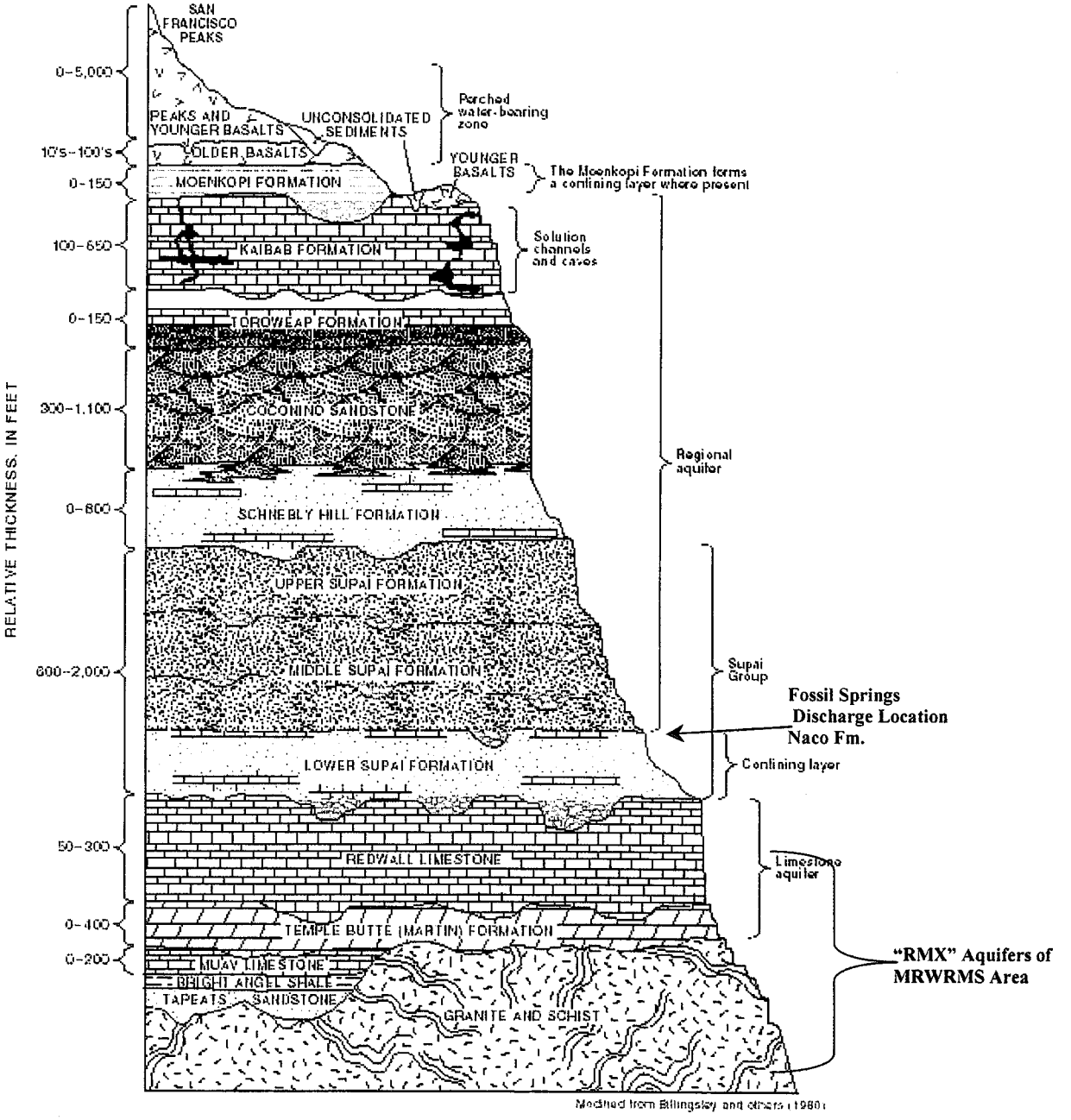
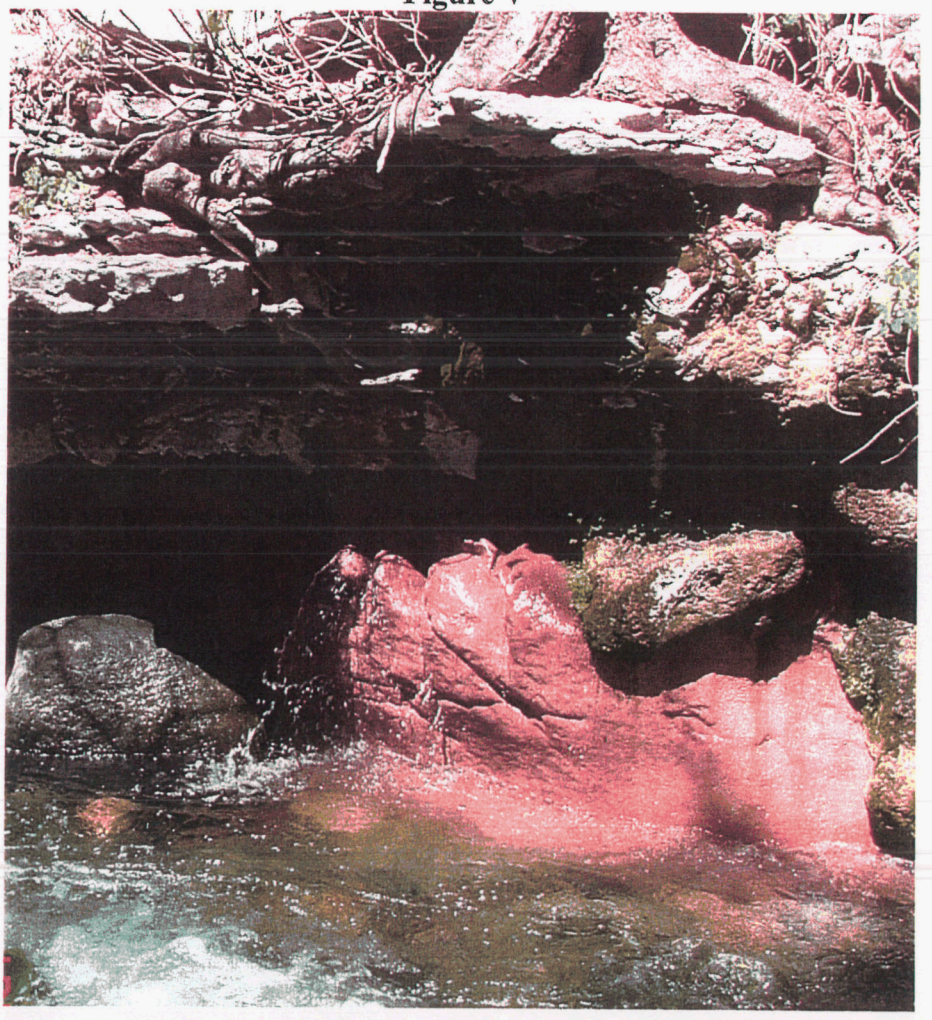


Figure 11 Generalized stratigraphic section of rock units, Flagstaff, Arizona

Modified from Figure 11 of USGS Doc. 00-4122, Bills and others.

Figure V



Fossil Springs Discharges from Shale/Limestone Horizon in the Naco Formation

Isotope and tritium sampling results appear to support the observations presented above. Tritium, for example, is currently contained in rainfall at levels ranging from 5.3 – 7.3 tritium units within the study area. Naturally occurring tritium levels in water were considered to be around 1 tritium unit the 1950's thru early 1970's when atomic bomb testing resulted in a large increase of tritium in the environment to more than 10 units. Therefore, the lower the tritium number in the sample the older the water likely is. This fact can be related to groundwater and spring systems. For example, Fossil Springs has a very low tritium value of 1.5 while Webber and Cold Springs contain 4.0. Similarly, wells constructed into the edge of C aquifer within the study area like the Shallow Strawberry and Shallow Pine wells contain 1.6 to 2.6 tritium units while the Deep Strawberry and Deep Pine wells contain tritium at 4.0 with Payson's shallow wells around 4.0 as well.

Along with the tritium sampling, stable isotopes of Hydrogen (Deuterium, "D") and Oxygen (^{18}O) are also being considered. The values of these components in water relate to snowmelt as opposed to rainfall and similarly to elevation and evaporation. The "meteoric water line" represents the typical region on which all the earth's waters would plot relative to the D and ^{18}O isotopes. Typically, the farther to the left on the figure below, the higher the elevation the water likely originated from as snowmelt. In addition, if the data plots above the meteoric water line shown, it is likely dominated by winter precipitation. However, if the data plots below the meteoric water line shown, it is likely dominated by summer precipitation and originated as rainfall, as it is subject to evaporation. Though complicated by the mixing of precipitation types within the aquifers and long-term seasonal variations in rainfall content of the isotopes themselves (Rye and Doll Baby deep groundwater is very old), valuable information and relationships can be gleaned from this data when considered in light of the complete set of data being collected by the study. On Figure VI below, a selection of results is plotted from study area sources and is followed by Table II which presents the results of Tritium and D and ^{18}O (permil units, ‰) sampling from the within the study area.

FIGURE VI

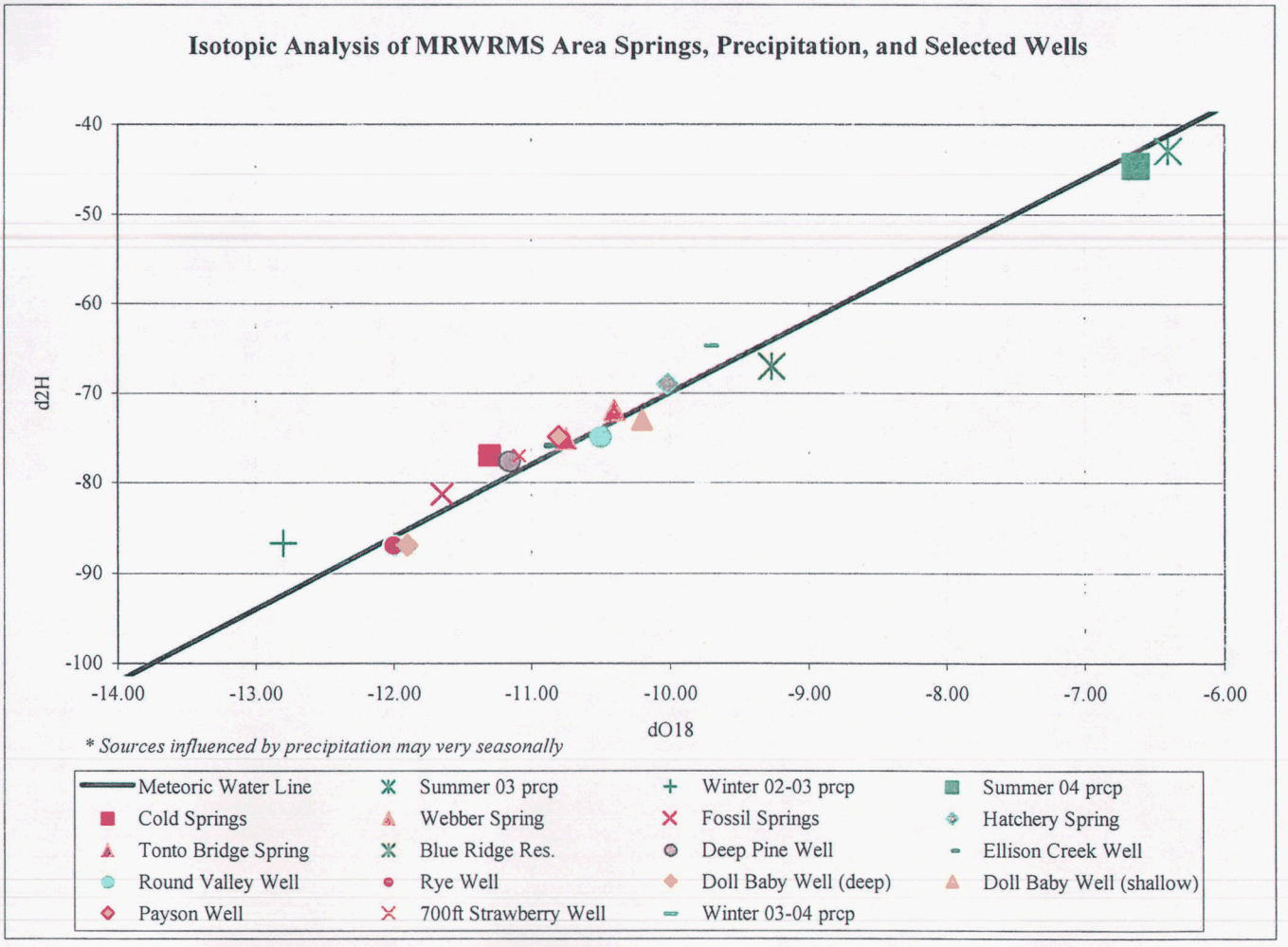


Table-2

Selected Hydrogen Oxygen and Tritium Results -- MRWRMS -- Town of Payson				
Well / Site	Year	δ18O ‰	δD ‰	Tritium, TU
CPN-13	2004	-9.9	-71	3.6
NW Pine Deep	2004	-11.2	-78	4.0
NW Pine Shallow	2004	-11.1	-78	2.3
Fossil Springs Upper	2004	-11.6	-81	1.7
Pine Creek	2004	-10.1	-70	5.4
87 and Cavern	2004	-9.7	-68	6.0
Round Valley	2004	-10.5	-75	3.5
CC #3	2004	-10.0	-71	3.7
Woodland #1	2004	-10.0	-73	2.2
Payson Pines 4	2004	-10.9	-77	1.4
Winter 03-04	2004	-9.7	-65	6.1
Fossil Springs Lower	2004	-11.6	-79	1.5
Cold Springs	2004	-11.4	-77	4.0
Webber Springs	2004	-10.4	-72	4.1
Hunter Creek	2004	-8.9	-60	5.1
Fish Hatchery	2004	-10.0	-69	2.6
Ellison	2004	-10.9	-76	5.9
Tonto Bridge Spring	2004	-10.7	-75	2.0
Deep Strawberry (700ft)	2004	-11.1	-77	4.0
Shallow Strawberry	2004	-11.3	-77	1.6
Blue Ridge	2004	-9.3	-67	10.2
Summer Precip. 2004	2004	-6.6	-45	5.8
DB-2	2003	-11.9	-87	0.5
DB-Shallow	2003	-10.2	-73	2.7
Summer Precip. 2003	2003	-6.4	-43	7.3
Cold Springs	2003	-11.2	-77	4
Winter precip 02-03	2003	-12.8	-86.7	4.7
Rye 03 HI-4	2003	-12	-87	0.6
McKamey	2003	-10.4	-72	3
Turtle Rock	2003	-10.9	-75	0.5
CPN-13	2003	-9.7	-70	3.4
GC-1	2003	-10.8	-76	1.3
Luke	2003	-11	-76	2.9
TOP-19	2003	-10.2	-70	4.3
Payson Pines 4	2003	-10.9	-76	0.7
Skypark	2003	-10.2	-74	1.6
Woodland #1	2003	-10.4	-73	2
Beeline	2003	-10.8	-75	1.9
CC-3	2003	-10.2	-71	3.5
Lake Drive	2003	-9	-66	3.6
Mt. View	2003	-9	-71	4.2
Reclaimed	2003	-10.3	-72	3.1
Summit	2001	-11.7	-81	n/s
McKamey	2001	-10.6	-72	n/s
Turtle Rock	2001	-11.2	-78	n/s
CPN-13	2001	-10.1	-73	n/s
GC-1	2001	-11.2	-77	n/s
Luke	2001	-11.2	-77	n/s
TOP-19	2001	-10.5	-72	n/s
Payson Pines 4	2001	-11.3	-78	n/s
NP-2	2001	-11.2	-77	n/s
Skypark	2001	-10.6	-75	n/s
Woodland #1	2001	-10.6	-75	n/s
Beeline	2001	-11.1	-78	n/s
CC-3	2001	-10.5	-73	n/s
Lake Drive	2001	-9.4	-69	n/s

n s = no sample

To further aid in defining the conceptualization of groundwater systems in the region, the MRWRMS partners and Salt River Project agreed to fund the collection of Strontium isotope data. This data is proving to be very valuable in consideration with all of the information being gathered. Strontium isotopic ratios contained in groundwater are directly related to the geology the water passed through before collection. The history of the water from its point of precipitation and entrance into the groundwater system to its discharge at a spring or well/aquifer collection point is essentially recorded. In consequence, similar strontium ratios indicate a similar history and/or source. Additional strontium samples, including formation sampling, are pending collection and analyses. The following table presents the strontium data. The strontium results below are supporting the preliminary hydrogeological framework as presented herein.

Table 3

Strontium 87SR/86SR in Water

Sample	Type	Result	Error +/-
Blue Ridge Reservoir	SW	0.710073	0.000007
Cold Springs	SP	0.710572	0.000007
Deep Pine	GW	Pending	Pending
Deep Strawberry (700ft)	GW	0.708746	0.000013
Ellison Creek Well	GW	Pending	Pending
Fossil Springs	SP	0.708971	0.000009
Hatchery Spring	SP	0.710715	0.000009
HI-4 (Rye)	GW	0.712800	0.000009
Hunter Creek Well	GW	0.710342	0.000009
Pine Creek	SW	Pending	Pending
Pine Shallow	GW	Pending	Pending
PSWID Deep Borehole	GW	Pending	Pending
Sky Run Deep (Star Valley	GW	Pending	Pending
Strawberry Shallow	GW	0.709627	0.000009
Tonto Bridge Spring	SP	0.709096	0.000009
Webber Spring	SP	0.711285	0.000009
Woodland #1 (Payson)	GW	0.711630	0.000006

Samples Analyzed by Geochron Laboratories, MA - in Collaboration with MIT

GW = Groundwater, SW = Surface Water, SP = Spring

Efforts to finalize the data collection and thoroughly interpret all the data together, with other water chemistry and elevation data, are currently underway. The University of Arizona and Gaeaorama Inc. are assisting the MRWRMS in this effort. The finalization of the MRWRMS Hydrogeological Framework and conceptual groundwater model are anticipated to be completed within the 2005 calendar year. As such, information presented herein remains subject to final revision.

2.2.2 Sustainability of Regional Groundwater Resources

Most of the major springs that discharge within the Diamond Rim, Mogollon, and Central Highland basins have been observed to respond rapidly to precipitation as do the groundwater levels of wells constructed within these basins. This indicates that the groundwater sources are readily recharged, dominantly young, locally derived, susceptible to contaminants and are likely of low storage; not unlike the aquifer that currently supplies the Town of Payson at a safe yield of 1,826acft/yr.. This also implies that any groundwater resources developed within the study area may be drought sensitive and therefore restraint in keeping demands on these aquifers within their estimated long-term "Safe Yield" is advisable. Sustainable withdrawal rates have been estimated via 10-16% of annual precipitation over the aquifers recharge area. Utilizing 17-20 inches per year is recommended to account for droughts. In this manner, the region's groundwater systems, where developed, can be maintained as renewable water supplies through responsible development.

Applying the same assumptions that lead to Payson's estimate of 1,826acft/yr "Safe Yield" (See [1] Section 5), to the areas of Pine and Strawberry for example, the deep aquifer accessible below those communities can be estimated to yield no less than 900acft/yr within a renewable state or "Safe Yield". When used conjunctively with existing shallow resources this number can then be raised to approximately 1,200acft/yr. Utilizing more realistic precipitation values, the safe yield of the entire system should range between 1,200acft/yr to 1,780acft/yr. The MRWRMS demand analyses preliminarily estimates that approximately 1,200 acft/yr will be required to supply Pine and Strawberry at buildout. This estimate was based on a buildout population of 7,259 with a range of demand between 120 and 250gpcd (gallons per capita day). As a practical matter, actual gpcd values in the region are typically less than 120gpcd and could be maintained at or below this number via demand-side management. With this in mind, a more realistic annual demand would be closer to 980 acft/yr. As such 1,200 – 980acft/yr is the expected range of demand for the Pine Strawberry area at buildout. This range of values falls within the estimated safe yield of the aquifers in Pine and Strawberry. The same logic presented above can be applied throughout the study area to conservatively estimate groundwater sustainability and associated availability.

The vast majority of the surface area available for recharge to the region's aquifers is contained within the public lands of the Tonto National Forest. The relatively small amount of private land in comparison to the size of the region's watershed and recharge areas points to built-in limits on the development of groundwater resources and therefore minimization of potential impacts to surface water and springs. In fact, overgrowth of forest vegetation results in higher than normal consumptive use of available water resources. This situation may be more of a threat to sustainability than very localized and responsible withdrawals of groundwater from within an otherwise huge and untapped groundwater system. For perspective, see Figure III. In addition to this reality, the importation of surface water from Blue Ridge Reservoir clearly will decrease future demands on the overall groundwater system.

2.3 Diamond Rim Water Resources Investigations

The Diamond Rim, or DR, study has demonstrated the extent of the Town's efforts in regional water resources studies. A significant portion of the geological mapping within the MRWRMS area was available up front to the Mogollon study, as more than fifty square miles of mapping was already completed. With the pending installation of test wells in the DR area an even better understanding of the region's aquifer systems can be developed and lead to more informed water resources planning throughout northern Gila County. In addition, the Town of Payson has invested in cultural and biological surveys within this study area aimed at identifying and minimizing potential impacts, if any, to such resources. In turn, these efforts should help streamline the Town's working through the National Environmental Policy Act or NEPA process for the Blue Ridge pipeline construction. All preliminary investigations are complete for the proposed DR study and the final draft of the Environmental Assessment is nearing completion for public comment. A decision from the USFS on the permit application to explore the Diamond Rim areas groundwater resources is expected this calendar year.

SECTION 3 – RECHARGE AND PRECIPITATION

3.0 Winter Recharge and Precipitation

Before this winter, precipitation has been dominantly below normal for the past 20 years. The winter recharge season of November 2004 to March 2005 is the wettest on record. This above-normal period has recharged groundwater over a majority of the aquifer system; thus, reaffirming the concept of sustainability in the long-term. Table 4 below displays the winter precipitation totals for recent recharge years.

Table 4

Totals for Recharge Months (Nov-Mar)	
November 97 - March 98 = 14.5	**Recharge**
November 98 - March 99 = 4.24	**Decline**
November 99- March 00 = 4.99	**Decline**
November 00 - March 01 = 7.85	**Slt. Recharge***
November 01 - March 02 = 2.16	**Decline**
November 02 - March 03 = 11.4	**Decline***
November 03 - March 04 = 5.96	**Decline**
November 04 - March 05 = 25.1	**Recharge****

Recharge = Precipitation resulting in an overall rise in groundwater levels to elevations equal to or above the previous year.

On average a min. of 9" required Nov-Mar for observable recharge.

*Due to above normal precipitation in a single month. ** Record

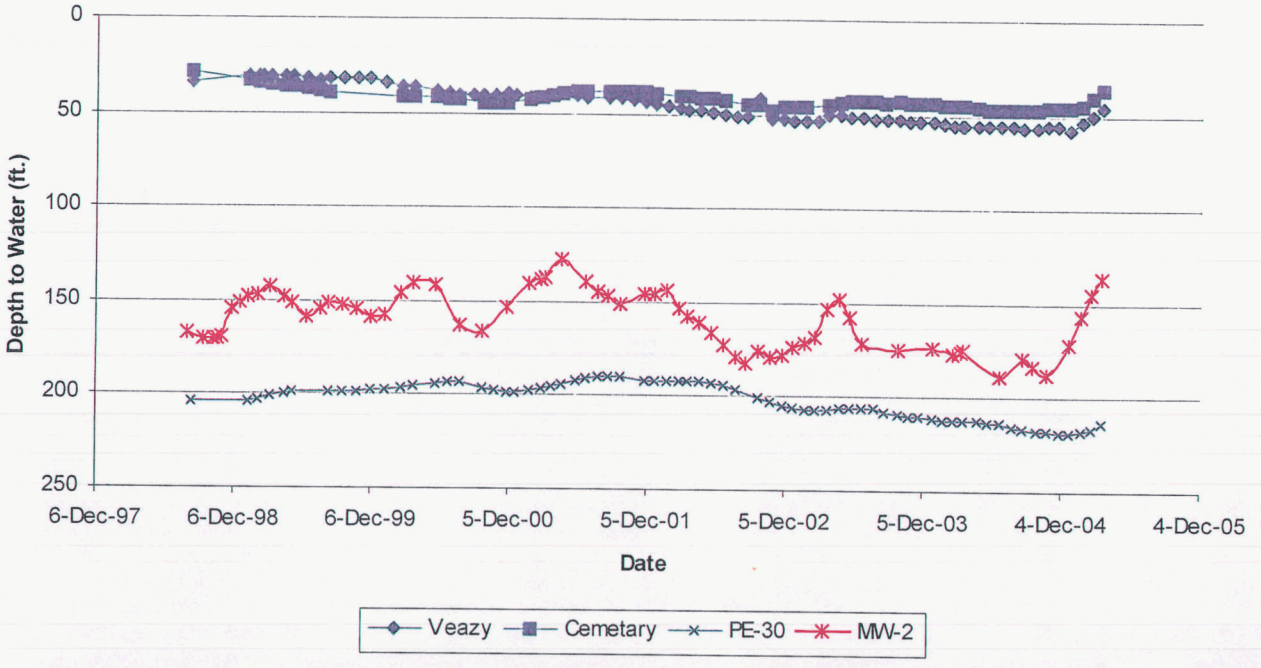
Sources: National Oceanic and Atmospheric Administration "NOAA" National Climatic Data Center ,NWS, ASU Climatology, and Anna Mae Demming -Payson NWS

Some data is preliminary and may be approximate

3.1 WEST PAYSON / VERDE WATERSHED

In the West Payson / Verde Watershed or the American Gulch portion of the aquifer system, recharge has resulted in higher groundwater levels than observed for many years. Above-average precipitation for the winter of 04-05 has clearly resulted in recharge to this portion of the Town's groundwater supply. Each observation well has recorded groundwater recharge of a magnitude not observed in recent records. At well MW-2 groundwater levels have retuned to depths not observed since March 2001 while groundwater levels near the Cemetery have recharged to levels not observed since the spring of 1999. Well PE-30 is responding much more slowly, as is would be expected from historical data. See Chart I below.

Chart I - West Payson / Verde Watershed Depth to Water Trends



The recharge of the winter 04-05 season has been sufficient to rebound nearly all groundwater levels in the American Gulch system to better than March 2004. Table 5 below present's groundwater level and precipitation data for the past five recharge years. For 2004 to 2005, water production from the American Gulch System was less than both natural and artificial recharge (Green Valley Recharge Project).

TABLE 5

American Gulch System

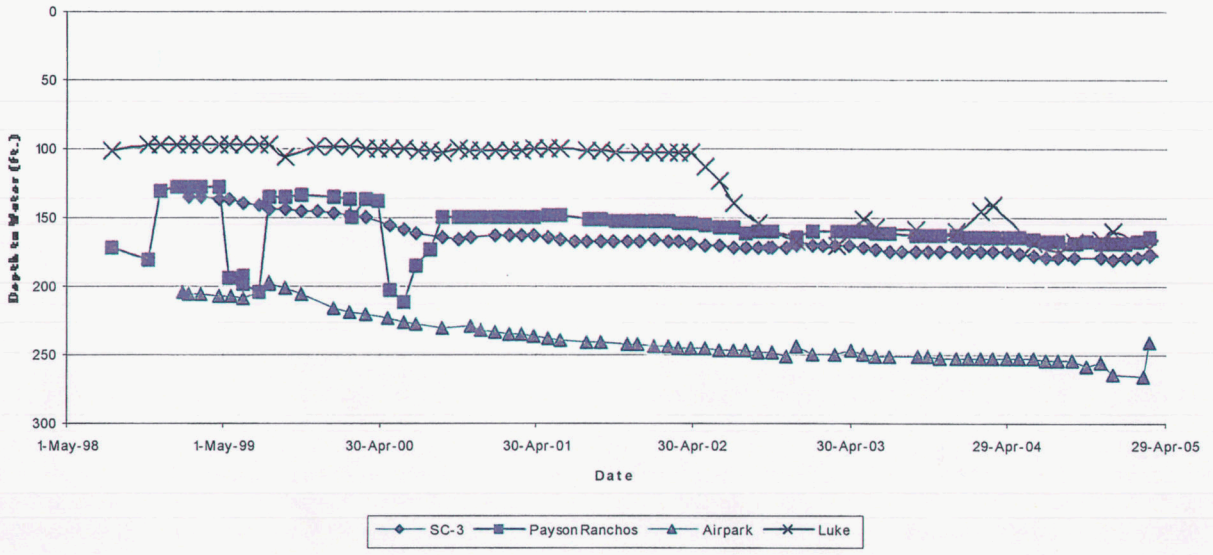
Month Of March	Total RechargeYear* Precipitation	South Tributary Veazy Well Depth to Water (ft.)		South Tributary Cemetery Well Depth to Water (ft.)		North Tributary MW-2 Well Depth to Water (ft.)		North Tributary PE-30 Depth to Water (ft.)	
2001	7.85	40.4	Decline	41.1	Recharge	136.9	Recharge	195.2	Recovery
2002	2.16	48.0	Decline	41.0	Stable	157.3	Decline	192.0	Recovery
2003	11.4	50.7	Decline	45.6	Decline	153.6	Recharge	206.9	Decline
2004	5.96	55.7	Decline	45.6	Stable	174.5	Decline	212.4	Decline
2005	25.1	46.5	Recharge	36.0	Recharge	135.8	Recharge	214.1	Decline

**Recharge year = November to March*

3.2 NORTH PAYSON / VERDE WATERSHED

The North Payson /Verde Watershed or North Payson system appears to be showing the first signs of recharge since the system was developed. However, it is not clear if the previous state of decline is over. See Chart II below.

Chart II - North Payson / Verde Watershed
Depth to Water Trends



Production in the North Payson may not have been in excess of natural recharge, particularly in light of the above normal precipitation of the past few months. The groundwater system is deeper than other aquifer production areas utilized. It may simply take much longer for recharge to reach the water table in the north Payson area due to the overall depth to groundwater. It should be noted that the Luke well had recovered to 160ft. in December 04, prior to the nearby pumping of the New Luke well. Table 6 below outlines data collected relative to this area.

TABLE 6

North Payson System

Month Of March	Total RechargeYear* Precipitation	North Payson SC-3 Depth to Water (ft.)		North Payson Payson Ranchos Well Depth to Water (ft.)		North Payson Airpark #1 Depth to Water (ft.)		North Payson Old Luke** Depth to Water (ft.)	
2001	7.85	163.0	Decline	149.9	Decline	235.9	Decline	100.8	Decline
2002	2.16	167.7	Decline	154.4	Decline	245.2	Decline	103.1	Decline
2003	11.4	170.3	Decline	160.2	Decline	249.7	Decline	170.2	Decline
2004	5.96	174.8	Decline	164.4	Decline	253.2	Decline	141	Recovery
2005	25.1	178.5	Decline	165.1	Decline	241.7	Recharge	172.4	Decline

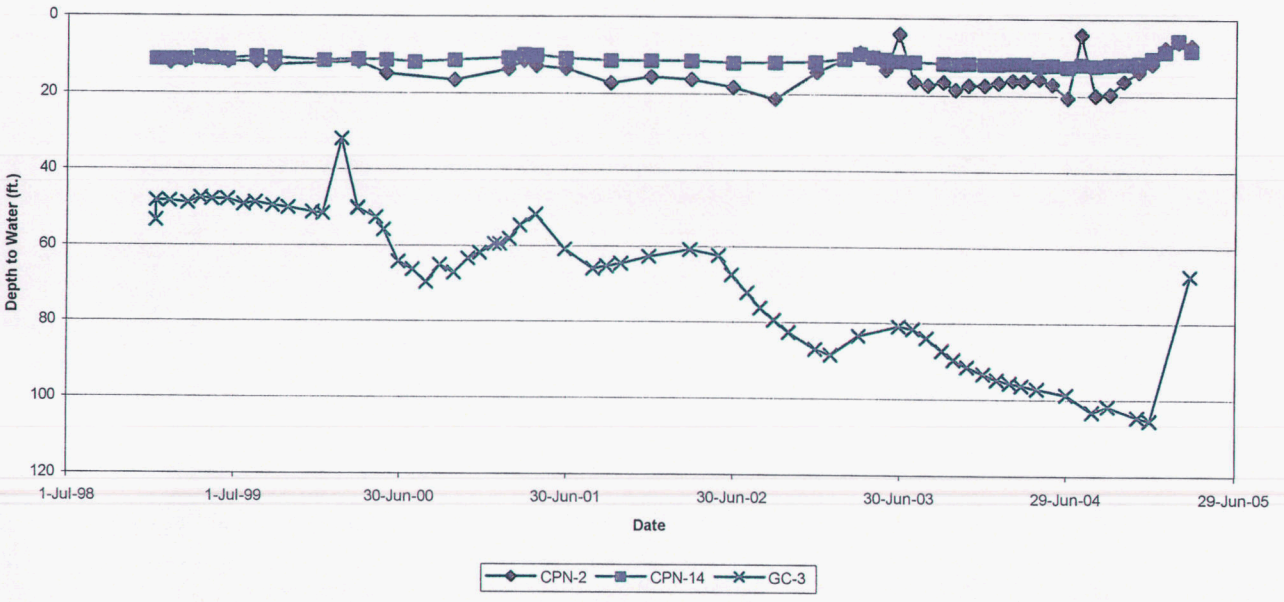
**Recharge year consists of the months from November - March*

*** DTW variances post 2002 due to nearby pumping*

3.3 EAST PAYSON / SALT RIVER WATERSHED

The East Payson / Salt River Watershed or Chaparral Pines and Goat Camp systems experienced recharge overall. Recharge observed in the Goat Camp area was sufficient to restore groundwater levels to those not observed since June 2002 while levels in the Chaparral Pines area are higher than previously recorded. See Chart III below.

CHART III -- East Payson / Salt River Watershed
Depth to Water Trends



The Chaparral Pines system continues to be relatively stable with water levels continuing to rise in spite of on-going pumping. Payson Water Department predictions, that the Goat Camp system should recover quickly when precipitation is normal or above, were confirmed by this year's winter precipitation. Data relevant to the Goat Camp and Chaparral Pines systems are presented in Table 7 below.

TABLE 7

Goat Camp / Chaparral Pines Systems

Month Of March	Total Recharge Year* Precipitation	Chaparral Pines CPN-14 Well Depth to Water (ft.)		Chaparral Pines CPN-2 Well Depth to Water (ft.)		Goat Camp GC#3 Well Depth to Water (ft.)	
2001	7.85	9.9	Recharge	11.55	Recharge	54.72	Decline
2002	2.16	11.52	Decline	16.4	Decline	60.87	Decline
2003	11.4	9.45	Recharge	9.13	Recharge	83.4	Decline
2004	5.96	11.9	Decline	16.4	Decline	96.5	Decline
2005	25.1	8.25	Recharge	6.92	Recharge	67.6	Recharge

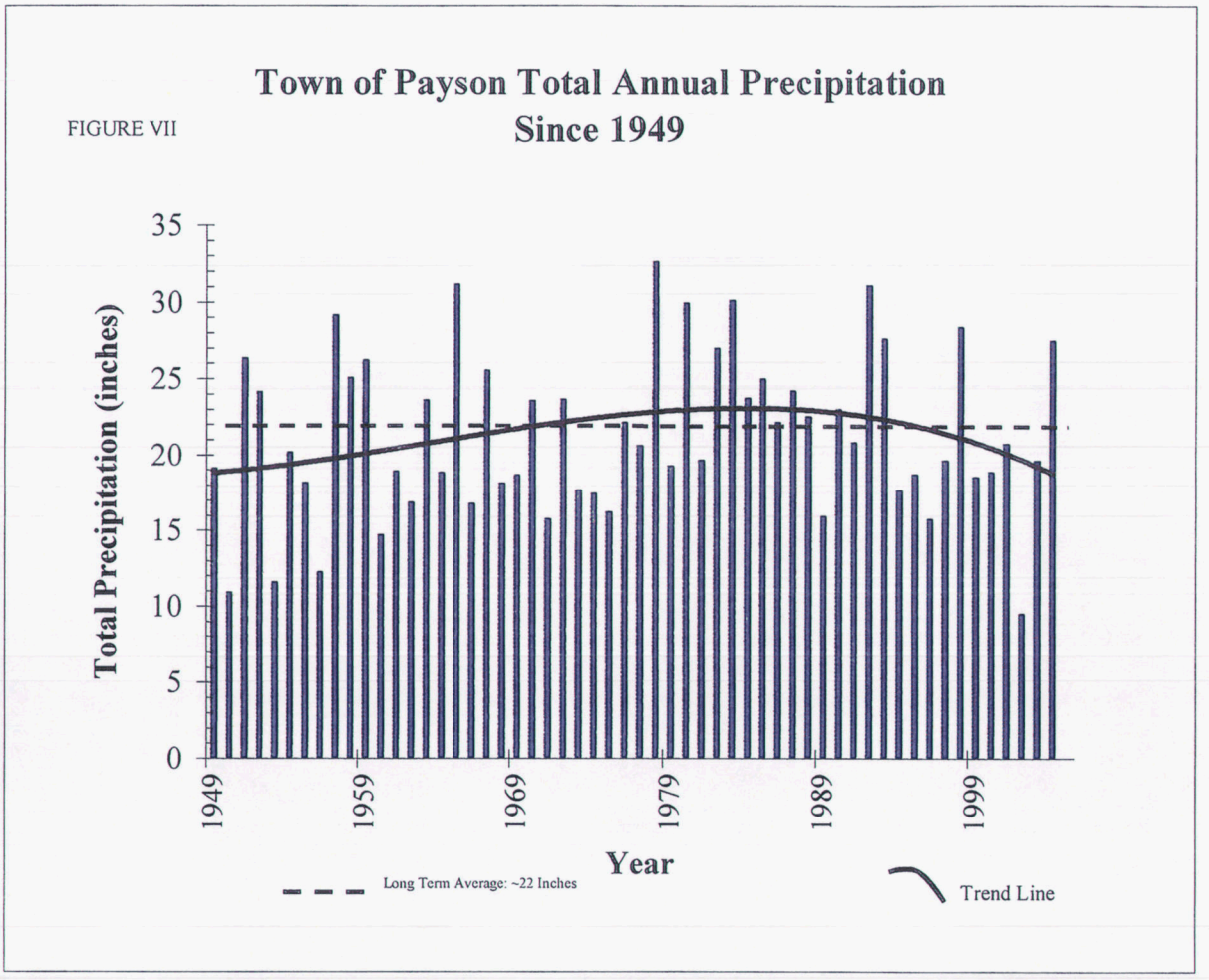
3.4 RECHARGE SUMMARY

Groundwater levels recharged to levels not observed for three to five years throughout the system. The severity of the recent drought coupled with annual demand approaching safe yield and recent precipitation being rainfall as opposed to snowfall, still hampers the ability of the aquifer system to fully recharge to original static levels. Consecutive wet years and maintaining of demand below safe yield could result in additional gains. The drought may not yet be over and the observed gains from this year's recharge to groundwater could diminish rapidly if demands increase.

3.5 PRECIPITATION

Precipitation in the Payson area is necessary to sustain the aquifer that the Town of Payson relies on. The long-term annual precipitation average is about 22 inches per year. Figure III, below, displays recorded precipitation history from 1949 thru 2004. Since 1989, annual precipitation levels have been dominantly below the long-term averages. In 2004, annual precipitation reached approximately 27.5 inches or 25% above normal. The wet period began in July 2004 and continues to date. Most meteorologists and hydrologists theorize this year's rainfall to be a brief and wet time period within an otherwise long-term drought cycle. The long-term trend as presented in Figure VII also indicates that future dry years await the Town of Payson and surrounding environs. However, the brief wet periods, as observed this past year, are clearly very important in sustaining the aquifer thru the drought cycle. Groundwater levels have been observed to recover significantly during these times. This has made up for consecutive years of decline. Still, the benefits may be short-lived. Clearly, keeping demands low will also play a key role in making up for nature's shortfalls into the future.

FIGURE VII



This winter 04-05 was the wettest on record. Brief wet periods within a drought cycle are common but their advantage to the local environment is short-lived. Typically, the wetter months within drought cycles result in the rapid growth of annuals (forbs and grasses) and brush. Much of this vegetation often dies and dries out quickly in prolonged drought, resulting in hazardous conditions in the forests, as is demonstrated in Figure VIII bellow.

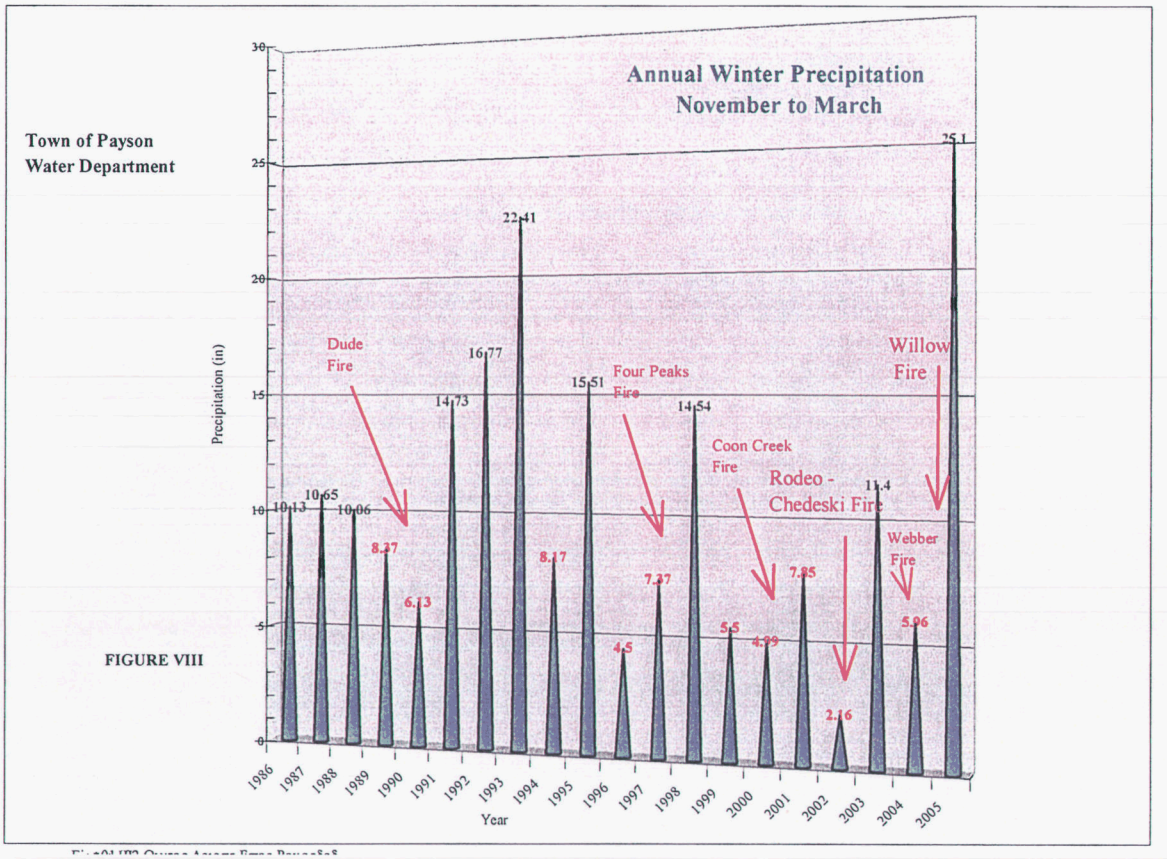


FIGURE VIII

SECTION 4 – CONSERVATION and DEMAND

4.0 CONSERVATION PROGRAMS and DEMAND

Comprehensive water resource management including water conservation continues to be an important focus of the Town of Payson. The Town is experiencing the wettest winter on record, which some are calling "the end of the drought," but long-range forecasts are calling for a continuation of "abnormally dry" to "moderately dry" conditions, with "above average temperatures" through September. It is very unlikely that we will see another drought relief event like this winter in the near future. This year, the Town will continue to rely on its award-winning water conservation program to lessen water demand on the Town's water production and distribution system facilities.

Through the conservation programs and the implementation of Level III water use restrictions, the customers of the Payson Water Department successfully reduced the per-capita day water use for 2004 to 86 gallons per-capita day (gpcd). For 2003, the gpcd was 90. The gpcd has not been at this level since 1986. Typical gpcd values for the Phoenix Metro communities is 187 gpcd and above. The Town continues to successfully reduce annual water consumption even while the customer base has grown.

Water conservation efforts by Town of Payson water customers have been mostly voluntary. Most non-compliance enforcement, by Town personnel, of the water use restrictions have been for violations of Town Resolution No. 1742, Title V: Public Works, specifically commercial customers who have not met the January 1st, 2005 deadline for retrofitting their commercial restrooms to low use fixtures, for fugitive water issues, and for water waste.

The continuation of water conservation program efforts, public outreach and education, water audits, low water use landscaping, innovative technologies and the appointment of a water use enforcement officer are methods the Town will use to maintain and/or further reduce the gpcd.

4.1 CONSERVATION LEVEL

The Town of Payson has adopted water conservation strategies to manage water demand in an amount necessary to lessen the effects of a reduced annual water supply due to the effects of a continuing drought. Water conservation requirements pursuant to Resolution No. 1742 anticipate that Water Conservation Level requirements be imposed according to the deficit or surplus of precipitation that occurred in the twelve month period immediately preceding the annual water report. Other factors such as water production capabilities and groundwater levels may be considered when setting the Water Conservation Level requirements for any given year.

Precipitation for Payson's water year of 2004-05 (April 04-March 05) was in the amount of approximately 42 inches. This amount is nearly 200% above the long-term average of 22 inches per year as referenced in conservation ordinances. If the Water Conservation Level were set using only this criterion, we would implement Water Conservation Level I, which is the least restrictive of the four water conservation levels. Additional considerations are the likelihood of drought resuming with the associated decline of local groundwater levels in addition to the degree of success relative to previously mandated water conservation requirements.

Groundwater levels have recovered to levels not observed in several years but did not recover as much as anticipated. This is partially due to the precipitation being mostly rainfall as apposed to snowfall. Groundwater levels at key indicator wells were observed to come up an average of 7ft. by February of the 2004-05 water year and continued to rise through March. (See Figure A in Attachments). Level II water use restrictions were in effect for local water users in 2003. Due to the success in 2003 of an approximate 7% decrease in local water use and to the fact that drought conditions are expected to return while adequate peak day water production capacity is available for 2005 (See Section 5), it is determined that Water Conservation Level II is the appropriate measure to implement for the period of April, 2005 through May, 2006. It is anticipated that implementation of Level II water use restrictions will maintain a water use at the current 2004 level.

SECTION 5 – WATER SUPPLY

5.0 PRODUCTION

Water production capabilities are monitored on a regular basis as production rates vary depending on demand, weather, and equipment function. Typically, well production rates will drop as demand increases beginning around the month of April. Due to the persistence of drought conditions, a 15 percent drought factor had been applied to projected summer production rates. However, due to the recharge of 04-05 summer 2005 maximum production capability is expected to be no less than the observed capacity in 2004. As such ~4,043gpm or ~5.8mgd is the estimated production capacity for 2005. This rate is expected to be sufficient to meet projected summer 2005 peak month daily demand as well as peak day demands of 2.83mgd and 4.0mgd respectively.

5.1 WATER DEMAND

Water demand for the 2004 year decreased a total average of 4% over 2003. This decrease can be attributed to the conservation efforts of the Water Department and the overall cooperation of the majority of its customers. Still, precipitation was a factor in reducing the demand as rain began to fall in July and remains above normal to date. However, in September demand jumped 12% above the previous year. This is likely the result of a lack of adherence to the conservation ordinance under a false perception of the end of drought and a rumored lifting of restrictions. The increases observed in both March and September hints at the possibility of significant increases in demand for summer 2005 if consumers choose not to adhere to conservation restrictions. See Table 8 below.

TABLE 8

Water Consumption 2004

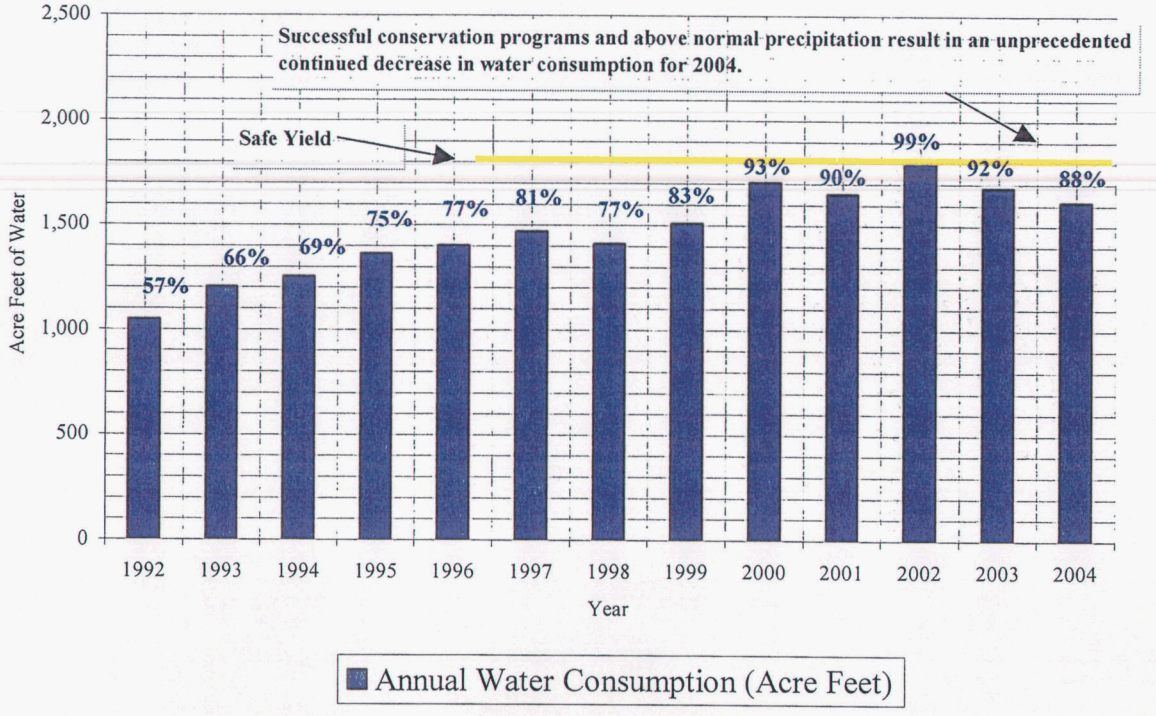
Month 2004	Monthly Consumption	Percent Change From 2003	Special Notes
Jan	35569000	-12%	
Feb.	32831600	0%	
March	**34537000**	**14%**	**Increase in Usage Prior to Level III**
April	40104100	-4%	**Level III Restrictions in Place**
May	52330600	6%	
June	63537400	-5%	
July	**56979700**	**-28%**	**Heavy Rains**
August	47222900	-8%	
Sept.	**52991500**	**12%**	
Oct.	41430400	-16%	
Nov.	35705200	-1%	
Dec	33194400	-3%	
Total Usage (gal)	**526433800**	**-4%**	**Water Use Drops Due to**
Total Usage (ac/ft)	**1615**	**-4%**	**Level III Conservation and Rainfall**
Percent Safe Yield	**88**	**-4%**	

5.2 SAFE YIELD

Safe Yield is a term commonly used to define the amount of groundwater that is naturally and artificially replenished via deep percolation of precipitation into the local aquifer. In Payson, this value has been estimated to be 1,826ac-ft/yr (not including artificial recharge).[1] This means that so long as no more than 1,826ac-ft/yr of groundwater is consumed, the Town of Payson is within its long-term average safe yield. In the year 2004, ground-water consumption decreased to 1,615ac-ft or 88% of safe yield from 92% in 2003. With drought conditions likely to return, conservation measures are being relied upon to maintain annual water consumption below safe yield. If wise water usage is not practiced and new water supplies are not obtained to support continuing growth, it remains possible that demands could rebound and safe yield be exceeded in 2005. See Figure IX below.

FIGURE IX

Town of Payson Annual Groundwater Consumption Since 1992 Relative to % of Safe Yield



[1] Southwest Groundwater Consultants, Inc., Long Term Management Program of the Town of Payson's Water Resources. June 1, 1998.

6.0 CONCLUSION

With the passage of the Arizona Water Rights Settlement Act, planning for Blue Ridge water is the primary focus of the Water Department. Though eventual deliveries of surface water are expected, efforts to understand the extent of groundwater resources within the region, including the public lands of the National Forest, remain a close second. The Mogollon Study partners are leading the way towards developing regionally sound water resources planning options, based on scientific facts. The Town of Payson Water Department is pursuing a vision for the utilization of Blue Ridge's renewable surface water as an overall means of reducing demands on the local groundwater system and in providing for the capability of conjunctive use and sustainability.

Fortunately, the 04-05 recharge season was the wettest on record for Payson and has resulted in an overall increase in the groundwater reservoir. As such, production capabilities are expected to be sufficient to meet demands for the 2005 summer season. However, drought conditions are expected to return and therefore reinforces that only the wisest and efficient uses of our existing groundwater resources be encouraged.

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Brooke Utilities, Inc.

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Customer Call Center • P.O. Box 9005 • San Dimas, California 91773-9016 • (800) 270-6084

ROBERT T. HARDCASTLE
(661) 633-7526
Fax (781) 823-3070
RTH@brookeutilities.com

October 27, 2005

Loren Peterson
Strawberry Hollow Domestic Water Improvement District
P.O. Box 244
Pine, AZ 85544

Re: ***Water Availability***

Dear Mr. Petersen,

Pursuant to the information contained in the recent *Application for Water Adequacy Report for Strawberry Hollow* submitted to the Arizona Department of Water Resources earlier this month, please be advised that Pine Water Co. hereby expresses interest in initiating negotiations for purchase and delivery of excess water from the District's SH3 well described by the Application to be as much as 25 gallons per minute. While I understand the Application is currently being processed by ADWR, please advise when we can begin this process to secure additional water for our customers.

Thanking you in advance.

Sincerely,

FILE COPY

Robert T. Hardcastle
President

ec: RTH correspondence file
MJ, MB