

# APPENDIX A

# APPENDIX A-1



Caution

As of: Mar 26, 2014

**MARICOPA COUNTY MUNICIPAL WATER CONSERVATION DISTRICT  
NUMBER ONE, a Corporation, BEARDSLEY LAND AND INVESTMENT  
COMPANY, a Corporation, and CARL PLEASANT, Appellants, v. SOUTHWEST  
COTTON COMPANY, a Corporation, and VALLEY RANCH COMPANY, a Cor-  
poration, Appellees.**

**Civil No. 2872.**

**Supreme Court of Arizona**

*39 Ariz. 65; 4 P.2d 369; 1931 Ariz. LEXIS 168*

**October 22, 1931, Filed.**

**PRIOR HISTORY:** [\*\*\*1] APPEAL from a judgment of the Superior Court of the County of Maricopa. Joseph S. Jenckes, Judge. Judgment reversed and cause remanded for new trial.

**CASE SUMMARY:**

**PROCEDURAL POSTURE:** Plaintiff corporations filed an action against defendant municipal water conservation district and associated others seeking an injunction prohibiting the district from storing and using for irrigation certain surface waters of a particular river. The Superior Court of the County of Maricopa (Arizona) granted the requested injunction, and the district and associated others appealed.

**OVERVIEW:** The district and associated others were storing the surface waters of a certain river and using them for irrigation purposes. The corporations claimed that the storing of the surface waters interfered with their right acquired by prior appropriation to use the waters of a certain subterranean stream. The court held that the corporations were not entitled to injunctive relief. In so holding, the court ruled that (1) a right to make beneficial use of subterranean streams flowing in definite channels could be established by prior appropriation; and (2) geological theory establishing that a subterranean channel

likely existed was insufficient to establish that the source of water appropriated by the corporations was a subterranean stream flowing in definite channels because it was necessary to prove the location of the channel's banks.

**OUTCOME:** The court reversed the judgment granting an injunction against the district and remanded the case for a new trial.

**LexisNexis(R) Headnotes**

*Governments > State & Territorial Governments > General Overview*

[HN1] In the absence of affirmative action by the United States or its agencies, the territory, and afterwards the state, of Arizona, the law existing in Arizona at the time of its acquisition from the Republic of Mexico is presumed to continue unchanged.

*Constitutional Law > Bill of Rights > General Overview  
Governments > State & Territorial Governments > Water Rights*

[HN2] All streams, lakes, and ponds of water capable of being used for the purposes of navigation or irrigation,

39 Ariz. 65, \*; 4 P.2d 369, \*\*;  
1931 Ariz. LEXIS 168, \*\*\*

are hereby declared to be public property; and no individual or corporation shall have the right to appropriate them exclusively to their own private use, except under such equitable regulations and restrictions as the legislature shall provide for that purpose. Howell's Code, Bill of Rights art. XXII.

***Constitutional Law > Bill of Rights > General Overview  
Governments > State & Territorial Governments > Water Rights***

[HN3] All rivers, creeks, and streams of running water in the Territory of Arizona are hereby declared public, and applicable to the purposes of irrigation and mining, as hereinafter provided. All rights in acequias, or irrigating canals, heretofore established shall not be disturbed, nor shall the course of such acequias be changed without the consent of the proprietors of such established rights. All the inhabitants of this territory, who own or possess arable and irrigable lands, shall have the right to construct public or private acequias, and obtain the necessary water for the same from any convenient river, creek, or stream of running water. Howell's Code ch. 55, §§ 1-3.

***Constitutional Law > Bill of Rights > Fundamental Rights > General Overview  
Governments > Courts > Common Law  
Governments > State & Territorial Governments > General Overview***

[HN4] The common law of England, so far as it is not repugnant to, or inconsistent with, the Constitution and laws of the United States, or the bill of rights or laws of this territory, is hereby adopted, and shall be the rule of decision in all the courts of the territory.

***Business & Corporate Law > Corporations > Formation > Corporate Existence, Powers & Purpose > General Overview  
Governments > State & Territorial Governments > Water Rights***

[HN5] Any person or persons, company or corporation shall have the right to appropriate any of the unappropriated waters or the surplus or flood waters in this territory for delivery to consumers, rental, milling, irrigation, mechanical, domestic, stock or any other beneficial purpose, and such person or persons, company or corporation for the purpose of making such appropriation of waters as herein specified, shall have the right to construct and maintain reservoirs, dams, canals, ditches, flumes and any and all other necessary water ways. And the person or persons, company or corporation first appropriating water for the purposes herein mentioned shall always have the better right to the same. Every person or

persons, company or corporation, who shall desire to appropriate any of the waters of this territory for the uses and purposes mentioned in § 1 of this act shall first post at the place of diversion on the stream or streams as the case may be, a notice of his, their or its appropriation of the amount of water by it or them appropriated. 1893 Ariz. Sess. Laws ch. 86 §§ 1-2.

***Governments > State & Territorial Governments > Water Rights***

***Real Property Law > Water Rights > Riparian Rights***

[HN6] See Ariz. Const. art. XVII, §§ 1-2.

***Governments > State & Territorial Governments > Water Rights***

***Real Property Law > Water Rights > Beneficial Use***

[HN7] The water of all natural streams, or flowing in any canyon, ravine or other natural channel, or in definite underground channel, and of springs and lakes, belongs to the public, and is subject to beneficial use as herein provided. 1919 Ariz. Sess. Laws ch. 164 § 1.

***Governments > State & Territorial Governments > Water Rights***

***Real Property Law > Water Rights > Beneficial Use***

[HN8] The water of all sources, flowing in streams, canyons, ravines or other natural channels, or in definite underground channels, whether perennial or intermittent, flood, waste or surplus water, and of lakes, ponds and springs on the surface, belongs to the public, and is subject to appropriation and beneficial use, as herein provided. Beneficial use shall be the basis, measure and limit to the use of water. Ariz. Rev. Code of 1928 § 3280.

***Governments > State & Territorial Governments > Water Rights***

[HN9] Waters percolating generally through the soil are the property of the owner, but subterranean streams, flowing in natural channels between well-defined banks, are subject to appropriation under the same rule as surface streams.

***Civil Procedure > Judicial Officers > Judges > General Overview***

***Civil Procedure > Appeals > Standards of Review > Substantial Evidence > General Overview***

[HN10] Where there is a reasonable conflict in the evidence as to the existence of a fact, a reviewing court is bound by the decision of the trial judge on that point. It is

39 Ariz. 65, \*; 4 P.2d 369, \*\*;  
1931 Ariz. LEXIS 168, \*\*\*

only where no reasonable man from the evidence could have reached such conclusion that the reviewing court may set aside the decision as to the facts. This rule, however, does not apply to conclusions of law. The latter are always reviewable in the appellate court, and, indeed, that is its purpose.

***Evidence > Procedural Considerations > Burdens of Proof > Clear & Convincing Proof***

***Governments > State & Territorial Governments > Water Rights***

[HN11] The presumption is that underground waters are percolating in their nature. He who asserts that they are not must prove his assertion affirmatively by clear and convincing evidence.

***Governments > State & Territorial Governments > Water Rights***

[HN12] The essential characteristics of a watercourse are a channel, consisting of a well-defined bed and banks, and a current of water. Without all these characteristics there can be no watercourse. The bed of a stream may be defined as that portion of the channel of a watercourse which carries the waters at their ordinary stage. In extremely high water the bed may be much more than submerged; at other times it may not even be covered, but by close examination of the bed and banks of a natural watercourse one may readily distinguish the exact line of demarcation between them. The banks of a watercourse are the elevations of land which confine the waters to their natural channel when they rise to the highest point at which they are confined to a definite course and channel. The third element necessary to a watercourse is not only water from a definite source of supply, but it must be running water, though it need not run continuously.

***Governments > State & Territorial Governments > Water Rights***

[HN13] The element of a current is one of the controlling distinctions between a river or stream, and a pond or lake. In the former case the water has a natural motion or current, while in the latter the water is in its ordinary state substantially at rest, with its surface perpendicular to a radius of the earth. The exit of a lake is a river or stream, having a current, but the lake itself has substantially none. These characteristics are necessary to constitute a river, creek or stream on the surface, and subterranean waters, to come within the same classification, must have substantially like characteristics with surface water.

***Governments > State & Territorial Governments > Water Rights***

[HN14] While surface indications such as trees, shrubs, bushes and grasses growing along the course and the topographical features of the surface are the simplest and surest methods of proof that an alleged subterranean stream has definite banks, a bed and a current, they are by no means exclusive. Other methods may be used, such as a series of wells or borings, tunnels, the color and character of the water, the sound of water passing underneath the earth, the interruption of the flowing of other wells on the line of the alleged subterranean stream, and perhaps others. But all of these, when examined, must be such as to afford clear and convincing proof to the satisfaction of a reasonable man, not only that there are subterranean waters, but that such waters have a definite bed, banks and current within the ordinary meaning of the terms, and the evidence must establish with reasonable certainty the location of such bed and banks. There must be certainty of location as well as of existence of the stream before it is subject to appropriation.

***Governments > State & Territorial Governments > Water Rights***

[HN15] The underflow, subflow or undercurrent, as it is variously called, of a surface stream may be defined as those waters which slowly find their way through the sand and gravel constituting the bed of the stream, or the lands under or immediately adjacent to the stream, and are themselves a part of the surface stream.

***Governments > State & Territorial Governments > Water Rights***

[HN16] The best test which can be applied to determine whether underground waters are as a matter of fact and law part of the surface stream is that there cannot be any abstraction of the water of the underflow without abstracting a corresponding amount from the surface stream, for the reason that the water from the surface stream must necessarily fill the loose, porous material of its bed to the point of complete saturation before there can be any surface flow. Therefore the river bed must continue holding sufficient water to support the surface stream, as it were, for otherwise in drawing on the underground flow of the stream it will necessarily draw upon the waters flowing on the surface.

***Governments > State & Territorial Governments > Water Rights***

***Real Property Law > Water Rights > Appropriation Rights***

***Real Property Law > Water Rights > Beneficial Use***

39 Ariz. 65, \*; 4 P.2d 369, \*\*;  
1931 Ariz. LEXIS 168, \*\*\*

[HN17] Under the doctrine of prior appropriation, an appropriator is required, after his rights have been initiated in accordance with the law in existence at the particular time and locality, to exercise reasonable diligence in every step required to make his appropriation complete, by the actual application of the water to a beneficial use, for until he does this his rights are inchoate. When the water is finally so applied, his perfected rights relate back to the initiation of the appropriation. If however, he fails to use reasonable diligence, his rights commence only as of the time of actual application of the water.

**COUNSEL:** Messrs. Hayes, Stanford, Walton, Allee & Williams and Messrs. Kibbey, Bennett, Gust, Smith & Rosenfeld, for Appellants.

Mr. James R. Moore, for Appellees.

Mr. O. J. Baughn, Messrs. Sloan, Holton, McKesson & Scott, Messrs. Chalmers, Fennemore & Nairn, and Mr. U. T. Clotfelter, *Amici Curiae*.

#### OPINION BY: LOCKWOOD

#### OPINION

[\*70] [\*\*372] LOCKWOOD, J. Southwest Cotton Company, a corporation, and Valley Ranch Company, a corporation, [\*71] hereinafter called plaintiffs, brought suit against Maricopa County Municipal Water Conservation District No. 1, a corporation, Beardsley Land & Investment Company, a corporation, and Carl Pleasant, hereinafter called defendants, for the purpose of enjoining the latter from storing and using for irrigation certain surface waters of the Agua Fria River. A judgment was finally rendered, granting an injunction upon certain terms set forth therein, and from said judgment this appeal has been taken.

The case is one of the most important which has ever come before this court, involving as [\*\*\*2] it does not only property interests of the value of many millions of dollars, but also a declaration of legal principles which will in all probability determine and govern to a great extent the course of future agricultural development within the arid regions of Arizona. The real question involved is the law applicable to the relative rights to the ownership and use of the subterranean waters of the state as against those of the surface waters. We have discussed certain phases of this question in previous cases, but have never made a complete statement of the principles applying thereto, for the reason that theretofore the development of the subterranean waters has been of comparatively minor importance. We think, however, this case is proof that the time has come when it is necessary

for the protection and guidance of future agricultural development in the state that these principles should be enunciated as clearly and definitely as possible, so that our citizens may know how to guide their future procedure. For this reason we treat the matter as though it were of first impression in all respects, not only considering the new issues which have arisen, but reconsidering and redetermining [\*\*\*3] the old ones upon which we have heretofore expressed an opinion. The case has been most carefully [\*72] and exhaustively briefed by counsel so that we feel every possible angle and every authority bearing thereon has been called to our attention. We have considered every point raised and examined every case cited, and, if we have not mentioned and discussed them all, it is because, in view of the conclusions we have reached, it is unnecessary, and would extend this opinion to unreasonable length.

The area which is now the state of Arizona was acquired from the Republic of Mexico in 1848 and 1853. At the time the United States succeeded to the sovereignty which was previously held by Mexico, with the same right to alter or amend the existing laws, or establish new ones, as that previously held by the latter. , affirmed , 29 Supp. Ct. Rep. 493; . On the other hand, [HN1] in the absence of affirmative action by the United States or its agencies, the territory, and afterwards the state, of Arizona, the law existing in Arizona [\*\*\*4] at the time of its acquisition is presumed to continue unchanged. ; . What, then, was the existing law in Arizona at the time of its acquisition by the United States, in regard to the ownership and use of water, surface and subterranean alike?

There are two great systems of law recognized in Western civilization: The common law, pertaining particularly to the English-speaking countries, and the civil law, which is found principally in those nations where the influence of the old Roman law from which it comes is, and has been, the strongest. Both of these systems distinguish between well-defined natural streams and bodies of water on the one hand, and subterranean, percolating waters on the other. So far as the second are concerned, the principle [\*73] governing them was, originally at least, the same under both systems. All rights to subterranean waters not flowing in definite, known channels belonged to the owners of the soil. Dig. 39, title 3, §§ 1, 12, 21; Code 3, title 34, §§ 4, 6; *Acton v. Blundell*, 12 Mees. & W. 324, 152 Eng. Reprint, 1223. But, as far as other waters were concerned, while [\*\*\*5] both laws recognize that the title to the *corpus* of running water could not be acquired by any individual so long as it was in its natural channel, the common law adopted as governing the use of such waters what is known as the doctrine of riparian rights, the fundamental principle of which was that the water could be used by

39 Ariz. 65, \*; 4 P.2d 369, \*\*;  
1931 Ariz. LEXIS 168, \*\*\*

riparian proprietors alone, and by them only in such a manner, aside from strictly domestic purposes, as not to diminish or alter the course or quantity of the waters of the stream to the deprivation or injury of the other riparian proprietors. , 12 Moore, 131. Navigable waters were, under the common law, considered as under the exclusive control of the government, in trust for the general public, so far as the rights of navigation, etc., were concerned, but were otherwise subject to the usual riparian rights of owners of adjoining lands.

The Roman law, while in many respects accepting the same rules as to riparian rights as the common law, also recognized the acquisition, through prescription, deed or [\*\*373] through a grant from the government, of a right to divert the waters of both navigable and non-navigable [\*\*\*6] streams by either riparian or non-riparian proprietors. Code 3, title 34, § 7; Code 11, title 42, § 4; Dig. 8, title 3, § 2, 1 and 2; Dig. 43, title 13, §§ 1-3. Dig. 43, title 20, §§ 1, 40-42. The sole restriction was that, if the stream were originally navigable, such navigability could not be destroyed by the diversion. Dig. 39, title 3, § 10, 2.

[\*74] These principles of the Roman law were followed in Spain for many centuries, though in "Las Siete Partidas," the famous Spanish Code, formulated about 1256, only the rule applying to percolating subterranean water was specifically discussed, and Spanish water law, as modified from time to time, was brought to Mexico, when it was first settled by the Spaniards. Its principles, as modified by local custom and statute, have been exhaustively discussed by the Supreme Court of California in the famous case of , and it would be a work of supererogation for us to attempt to add anything thereto. The conclusions of that court regarding rights to the use of nonpercolating waters, as they existed at the time of the acquisition of the Western territories by the United States, may be summed up as follows: [\*\*\*7]

"It would seem to be in the *power* of the sovereign (except so far as the power is limited by the constitution of government) to authorize such diversions as shall interfere with navigation. . . .

"The waters of innavigable rivers, while they continued such, were subject to the common use of all who could legally gain access to them for purposes necessary to the support of life, but the Mexican government possessed the power of retaining the waters in their natural channel, or of conceding the exclusive use of portions of them to individuals or corporations, upon such terms and conditions, and with such limitations, as it saw fit to establish by law."

These conclusions, so far as they pertain to non-navigable streams, were referred to and quoted approvingly by the Supreme Court of the territory of Ari-

zona in the case of , and in reason we think those referring to navigable waters are equally correct. It appears, then, beyond doubt that the doctrine of prior appropriation was entirely unknown to the common [\*75] law, and under the Mexican law arose *only as a result of a grant from the government*. 1 Kinney on Irrigation, [\*\*\*8] 2d ed., p. 1044. How, then, did it become a part of the law of Arizona?

When the territory of Arizona, which formerly was part of the state of Sonora, Mexico, was first organized, the right of appropriation of surface streams for irrigation purposes was to some extent permitted by local custom as well as by express grant. So far as percolating waters are concerned, there is nothing to show that a right of appropriation of these was ever exercised or claimed to exist as a matter of custom in Arizona or Sonora before its acquisition by the United States, and the only rules specifically touching upon subterranean waters were the principles laid down in Las Siete Partidas to the effect that the owner of the land owned them to the extent that he could draw them from his land at will, even though by so doing it cut off the subterranean supply previously used by other land owners, with the exception that the government could by grant authorize the appropriation of even these waters, if they ran in definite channels. Partidas 3, Tit. 32, § 19; Nov. Recopilacion, Tit. 3; Tit. 11, Lib. 7, Law 27, § 48.

We conclude, therefore, that at the time the territory of Arizona was acquired from [\*\*\*9] Mexico the government of the United States, and its agent, the government of Arizona, had the right to dispose of and regulate the use of all waters of every nature, both surface and subterranean, in the dual capacity as sovereign and as proprietor of the public domain, unhampered by any rules of either the civil or the common law, or by any previous general custom which had theretofore existed, subject only to such vested rights to the use of *specific* waters as had been acquired, either formally from the Mexican government or impliedly as a result of local custom, and to [\*76] the right of use of all percolating, subterranean waters underlying lands then in private hands by the owners of such lands.

The matter was called to the attention of the first legislature of the territory of Arizona by Governor Goodwin, in the following language:

"You may also deem it advisable at this time, before rights become vested, to adopt a permanent policy as to the use of water for agricultural as well as mining purposes. Where water is scarce and valuable it is important to provide against monopolies, and that it should be used as much as possible for the common good."

The legislature [\*\*\*10] responded by adopting article 22 of the Bill of Rights, which reads as follows:

39 Ariz. 65, \*; 4 P.2d 369, \*\*;  
1931 Ariz. LEXIS 168, \*\*\*

[HN2] "All streams, lakes, and ponds of water capable of being used for the purposes of navigation or irrigation, are hereby declared to be public property; and no individual or corporation shall have the right to appropriate them exclusively to their own private use, except under such equitable regulations and restrictions as the Legislature shall provide for that purpose."

In pursuance of this article the same legislature, at the same session, inserted in chapter 55 of Howell's Code the following provision:

[HN3] "Section 1. All rivers, creeks and streams of running water in the Territory of Arizona are hereby declared public, and applicable [\*\*374] to the purposes of irrigation and mining, as hereinafter provided.

"Sec. 2 All rights in acequias, or irrigating canals, heretofore established shall not be disturbed, nor shall the course of such acequias be changed without the consent of the proprietors of such established rights.

"Sec. 3. All the inhabitants of this Territory, who own or possess arable and irrigable lands, shall have the right to construct public or private acequias, and obtain the necessary [\*\*\*11] water for the same from [\*77] any convenient river, creek or stream of running water."

What is the effect of the Bill of Rights and these sections of Howell's Code on the use of water in Arizona?

Bearing in mind the language in the message of Governor Goodwin above quoted, and the fact that the Bill of Rights and Code were adopted by the same legislature, at the same session, we are of the opinion there can be no possible doubt the legislature had in mind the conflicting rules of the common law and the doctrine of prior appropriation, and intended to and did declare the fundamental principles which should govern the use of water in Arizona for the future. This declaration amounted to a statutory repudiation of the doctrine of riparian rights and an establishment of the so-called doctrine of prior appropriation as suited to the conditions prevailing in Arizona, *so far as the waters named in the Bill of Rights are concerned*, and this has been repeatedly and distinctly held by this court consistently for many years. ; ; affirmed .

To what waters was this doctrine applied?

In determining the meaning of words used in a statutory or constitutional provision, we must take into consideration the surrounding circumstances at the time when they were used, and they should be given a definition consonant with ideas then prevailing, rather than a technical meaning which may have attached to them perhaps a generation or more after they were first used. Article 22, *supra*, was adopted in 1864. At that time

there was little, if any, knowledge in regard to subterranean waters, though it was [\*78] recognized that there were occasional cases in which these waters might be "rivers, lakes or ponds," in the same sense as those of that character above ground. Generally speaking, however, they were presumed to be percolating in their nature. It is unreasonable to attribute to the legislature in 1864 a purpose to use nontechnical language to express an idea which would not be anticipated by the men who were to be governed in their actions by that language; and to assume that in the use of the words "rivers, creeks or streams" and "rivers, [\*\*\*13] lakes or ponds" it intended to include something which by the common understanding was given an entirely different classification would be absurd. We hold, therefore, that article 22 of the Bill of Rights applies only to surface rivers, lakes and ponds, as the words are ordinarily understood, and to subterranean waters of a similar character, and that its effect was to establish the doctrine of prior appropriation for such waters, and for them only, leaving percolating subterranean waters of all kinds untouched thereby. What, then, was the status of the latter?

In the same Code in which the Bill of Rights and the provision of the statute regulating the *method* of appropriation of certain waters described in the former were adopted, the legislature provided as follows:

[HN4] "The common law of England, so far as it is not repugnant to, or inconsistent with, the constitution and laws of the United States, or the bill of rights or laws of this Territory, is hereby adopted, and shall be the rule of decision in all the courts of this Territory."

It cannot be contended a specific right to appropriate percolating waters was given by the clause adopting the common law, as above quoted, since [\*\*\*14] no principle found in that law as it existed in England has ever been imagined to adopt affirmatively the doctrine of prior appropriation. Obviously, then, the [\*79] Howell Code left percolating subterranean waters as the property of the owner of the land, subject to the rules of the common law. We therefore should always remember, in discussing the law of prior appropriation as it now exists in Arizona, that, regardless of previous custom, its binding authority as general law and a declaration of the field which it covers is primarily *statutory*, so that many questions which in other jurisdictions have been determined as matters of judicial construction based on necessity, reason, analogy and convenience, with us merely involve an interpretation of the language of our statutes, using the ordinary statutory canons. For this reason many of the decisions from other states, based as they are on the necessity of supplying the lack of a statute on the subject, or on some peculiar local legislation, are not in point. .

39 Ariz. 65, \*; 4 P.2d 369, \*\*;  
1931 Ariz. LEXIS 168, \*\*\*

But, it is suggested, even if this be true, the rule above set forth regarding what waters [\*\*\*15] are subject to appropriation has been changed since by statute. The first change of moment in the language of the statutes referring to irrigation is found in Chapter 86, Session Laws of 1893, which reads as follows:

[HN5] "Section 1. That any person or persons, company or corporation shall have the right to appropriate any of the unappropriated waters or the surplus or flood waters in this Territory for delivery to consumers, rental, milling, irrigation, mechanical, domestic, stock [\*\*\*375] or any other beneficial purpose, and such person or persons, company or corporation for the purpose of making such appropriation of waters as herein specified, shall have the right to construct and maintain reservoirs, dams, canals, ditches, flumes and any and all other necessary water ways. And the person or persons, company or corporation first appropriating water for the purposes herein mentioned shall always have the better right to the same.

"Sec. 2. Every person or persons, company or corporation, who shall desire to appropriate any of [\*80] the waters of this Territory for the uses and purposes mentioned in Section 1 of this Act shall first post at the place of diversion on the stream [\*\*\*16] or streams as the case may be, a notice of his, their or its appropriation of the amount of water by it or them appropriated. . . ."

In 1912 Arizona became a state. Its constitutional provisions regarding water read as follows:

[HN6] "Section 1. The common law doctrine of riparian water rights shall not obtain or be of any force or effect in the State.

"Section 2. All existing rights to the use of any of the water in the State for all useful or beneficial purposes are hereby recognized and confirmed." (See article 17, Ariz. Const.)

In 1919, chapter 164, commonly known as the Water Code, was adopted. Section 1 of that Code reads as follows:

[HN7] "The water of all natural streams, or flowing in any canyon, ravine or other natural channel, or in definite underground channel, and of springs and lakes, belongs to the public, and is subject to beneficial use as herein provided. . . ."

And section 3280, Revised Code of 1928, the latest declaration on the subject, is in the following language:

[HN8] "The water of all sources, flowing in streams, canyons, ravines or other natural channels, or in definite underground channels, whether perennial or intermittent, flood, waste or surplus water, and of [\*\*\*17] lakes, ponds and springs on the surface, belongs to the public,

and is subject to appropriation and beneficial use, as herein provided. Beneficial use shall be the basis, measure and limit to the use of water. . . ."

Reading these successive enactments, we think it is clear the legislature has never specifically made percolating waters subject to appropriation, and, if we apply the usual rule of "*expression unius*," has very carefully excluded them therefrom.

[\*81] But, it may be said, when the legislature enacted paragraph 2935 of the Civil Code in 1887 in the following language: "The common law of England so far only as it is consistent with and adapted to the natural and physical condition of this territory, and the necessities of the people thereof, and not repugnant to, or inconsistent with the constitution of the United States, or bill of rights, or laws of this territory, or established customs of the people of this territory, is hereby adopted and shall be the rule of decision in all the courts of this territory," it in effect abrogated the previously existing common-law rule in regard to percolating waters, making them subject to appropriation by virtue of the [\*\*\*18] language "so far only as it is consistent with and adapted to the natural and physical condition of this territory. . . ." Had the legislature never considered the question of water law specifically, or had it, after such consideration, confined itself to a mere adoption of the common law, either in the language of the Howell Code or the amendment of 1887, we might perhaps, like the courts of many of the western states in such a situation, in order to establish a system of law which we thought suitable to local conditions, have evolved a new common law from the stern school of necessity, and applied the law of prior appropriation to percolating waters.

It is true that the common law is not in its nature and character an absolute, fixed, and inflexible system; it is rather a system of general juridical truths, founded on reason, natural justice, and enlightened public policy, which are conditionally explained with the progress of society, and which adapt themselves to the gradual changes of that society and the conditions, exigencies, and usages of the country. It is never entirely stationary, but is modified and extended by analogous construction and custom so as [\*82] to embrace [\*\*\*19] new relations springing up from time to time from an amelioration or change of society, or different physical conditions arising in the countries to which it is to be applied. Should it ever become so crystallized that its expressions must take the same form, irrespective of physical, social or other conditions, peculiar to the locality or the character and habits of the people, it would cease to be the common law, and become a rigid and arbitrary code. And we think, as suggested by the Supreme Court of the United States in , the doctrine of liberal interpretation set forth in paragraph 2935, *supra*, was equally implied in

39 Ariz. 65, \*; 4 P.2d 369, \*\*;  
1931 Ariz. LEXIS 168, \*\*\*

the Howell Code. But no judicial interpretation of the common law can ever prevail against an explicit declaration of public policy made by the legislature when acting within its jurisdiction. This declaration we have seen was made in the Bill of Rights and the Howell Code, and it has never been changed in substance up to the present.

In 1904, and after the adoption of Chapter 86, Session Laws of 1893, *supra*, and of paragraph 2935, *supra*, the question of the right to appropriate subterranean [\*\*\*20] waters was before us in the case of ; , 26 Sup. Act. Rep. 195, and therein we held that [HN9] waters percolating generally through the soil are the property of the owner, but that [\*\*376] subterranean streams, flowing in natural channels between well-defined banks, are subject to appropriation under the same rule as surface streams. We reaffirmed that holding in the case of .

It is urged by appellee that the statement to that effect in , was but *dicta*, and not binding upon this court, for the reason that it was based on an agreement of the parties to the [\*83] effect that as a matter of law percolating waters were not subject to appropriation. Whether such statement was, strictly speaking, *dicta* or not, it has been accepted as the law of this jurisdiction for so long, and so many rights have been based on it, that only the clearest showing that the rule declared was error would justify us in departing from it. Since the legislative branch of the government in the twenty-five years which have elapsed since the [\*\*\*21] decision in the above case has not seen fit to contradict this interpretation of the law, but rather has confirmed it, we may reasonably assume we correctly stated its meaning.

We have read and carefully considered the various cases on this subject cited by counsel for appellee, such as ; ; , Ann. Cas. 1917C 99, , and others following the rules laid down therein. For the reason above stated, to wit, that our first legislature, having the entire subject brought to its consideration in 1864, and being then practically unhampered by vested rights, made a complete determination of just which waters the doctrine of prior appropriation should be applied to, we decline to follow those cases in so far as they may be in conflict with the principles adopted by our legislative authorities and above stated by us.

Whether percolating waters in Arizona since the adoption of the Howell Code have been governed by the old English common law in its strictest form, or by the American modification known as the rule of correlative [\*\*\*22] rights, as explained and defined in , and the cases which follow it, based on the doctrine of *sic utere tuo* [\*84] *ut alienum non laedas*, we need not now decide. When the matter is properly before us, we will determine the rule which applies.

After carefully reconsidering the statutes from 1864 to the present time, our previous decisions, and the various reasons upon which they were based, we are of the opinion that our holding in , that percolating subterranean waters were not subject to appropriation, was and still is the law of Arizona.

But, while plaintiffs urge most ably and strenuously that percolating waters are subject to appropriation, and for that reason their rights are superior to those of defendants, no matter what the character of the waters used by them, they by no means admit that these waters are percolating in their nature, but insist that they are, on the contrary, subterranean waters running in channels with well-defined and known banks, and therefore of the class of waters admittedly subject to appropriation under the law [\*\*\*23] of Arizona. And the trial judge obviously based his judgment upon this last theory.

The second question for our determination, therefore, is: What is the nature of the waters in question? Are they percolating, in any legal meaning of the term, or are they found running in well-defined channels, with known boundaries? In discussing this question we, of course, accept as axiomatic that, [HN10] where there is a reasonable conflict in the evidence as to the existence of a fact, we are bound by the decision of the trial judge on that point. It is only where no reasonable man from the evidence could have reached such conclusion that we may set aside the decision as to the facts. This rule, however, does not apply to conclusions of law. The latter are always reviewable in the appellate court, and, indeed, that is its purpose. We think the best way to proceed [\*85] is to lay down the standards of law which the trial judge should have used in the case, and then apply them to the evidence as it was presented before him.

In the first place, [HN11] the presumption is that underground waters are percolating in their nature. He who asserts that they are not must prove his assertion affirmatively [\*\*\*24] by clear and convincing evidence. ; .

But, when it comes to the nature and *quantum* of the proof which meets this test, the question is one of great difficulty.

According to the great weight of authority [HN12] the essential characteristics of a watercourse are a channel, consisting of a well-defined bed and banks, and a current of water. And the best reasoned cases go to the extent that without all these characteristics there can be no watercourse. ; Angell on Watercourses, 1877, § 4; 1 Kinney on Irrigation, 2d ed., p. 490. The bed of a stream may be defined as that portion of the channel of a watercourse which carries the waters at their ordinary stage. In extremely high water the bed may be much

39 Ariz. 65, \*; 4 P.2d 369, \*\*;  
1931 Ariz. LEXIS 168, \*\*\*

more than submerged; at other times it may not even be covered, but by close examination of the bed and banks of a natural watercourse one may readily distinguish the exact line of demarcation between them. In all cases it is a natural object, and should be sought for, not merely by the application of abstract rules, but, like **[\*\*377]** other natural objects, by the appearance **[\*\*\*25]** it presents. The banks of a watercourse are the elevations of land which confine the waters to their natural channel when they rise to the highest point at which they are confined to a definite course and channel. 1 Kinney on Irrigation, 2d ed., pp. 492-494; . Although at times these banks may be **[\*86]** overflowed by flood waters, yet they themselves are unchanged, though not necessarily unchangeable.

The third element necessary to a watercourse is not only water from a definite source of supply, but it must be running water, though it need not run continuously. It is not sufficient to constitute a watercourse that there is a mere surface drainage over the face of a tract of land occasioned by unusual freshets or other extraordinary causes. ; ; .

[HN13] This element of a current is one of the controlling distinctions between a river or stream, and a pond or lake. In the former case the water has a natural motion or current, while in the latter the water is in its ordinary **[\*\*\*26]** state substantially at rest, with its surface perpendicular to a radius of the earth. The *exit* of a lake is a river or stream, having a current, but the lake itself has substantially none. These characteristics, we think, are necessary to constitute a river, creek or stream on the surface, and, as we have said, subterranean waters, to come within the same classification, must have substantially like characteristics with surface water. ; ; chapter 164, Session Laws 1919, *supra*; section 3280, *supra*.

What, then, is the nature of the proof required to establish that an alleged subterranean stream has definite banks, a bed and a current?

It is urged by defendants that the only method whereby this may be proved is through such indications as men of ordinary powers could with reasonable diligence ascertain from an examination of the surface, without resort to scientific speculation or surmise, and in support thereof they cite such cases **[\*87]** as ; ; ; . [HN14] While surface indications such as trees, shrubs, bushes and grasses growing along the course and the topographical features of the surface are the simplest and surest methods of proof, we think they are by no means exclusive. Other methods may be used, such as a series of wells or borings, tunnels, the color and character of the water, the sound of water passing underneath the earth, the interruption of the flowing of other wells on

the line of the alleged subterranean stream, geologic formation, and perhaps others. But all of these, when examined, must be such as to afford clear and convincing proof to the satisfaction of a reasonable man, not only that there are subterranean waters, but that such waters have a definite bed, banks and current within the ordinary meaning of the terms as above set forth, and the evidence must establish with reasonable certainty the location of such bed and banks. It is not sufficient that geologic theory or even visible physical facts prove that a stream *may* exist in a certain place, or probably or certainly does exist *somewhere*. **[\*\*\*28]** *There must be certainty of location as well as of existence of the stream before it is subject to appropriation.* With these rules of law for application to the evidence, let us examine the latter and see whether it sustains the findings of ultimate facts made by the trial court.

the vital finding, so far as this phase of the case is concerned, reads as follows:

"At all times there is a surface flow in said river at and for a long distance above a point two or three miles below Camp Dyer, where it sinks in the bed of the river. . .

**[\*88]** "All of said waters so sinking into and absorbed by the bed of said river as aforesaid join the sub-flow of said river and or flow into and through *known, definite, dependent underground channels extending laterally from various points along and beneath the bed of said river to and under the lands, wells and pumping plants of the plaintiffs*, which said known, definite, dependent underground channels run in a general southerly direction and have their ultimate outlets in the Gila River. All of said known, definite, dependent underground channels are interconnected and in contact with and have their sources in the Agua Fria River and **[\*\*\*29]** are dependent on the discharge of said river at Camp Dyer for practically all of their waters. Said known, definite, dependent underground channels may hereinafter be designated as underground channels of the Agua Fria River." (Italics ours.)

Without this finding the judgment of the trial court, so far as it grants a right of appropriation to the waters of the wells pumped by plaintiffs, except perhaps a very few located in or near the surface channel of the Agua Fria River, cannot be sustained. We consider, therefore, the evidence on which the court must have based its findings.

The record in this case is of great length, and we have examined it carefully. We think it unnecessary to quote from the evidence, but, taking it in the most favorable manner on behalf of plaintiffs, as we must do, it shows the following ultimate facts:

39 Ariz. 65, \*; 4 P.2d 369, \*\*;  
1931 Ariz. LEXIS 168, \*\*\*

**[\*\*378]** The great central Arizona plain, commonly known as the Salt River Valley, in its broadest extent stretches, roughly speaking, from the Superstition Mountains on the east to the White Tanks on the west, from the Salt River Mountains on the south to the Hieroglyphic and Cave Creek Mountains on the north, and in the center of this area rise the **[\*\*\*30]** Phoenix Mountains, a small isolated mass. It is approximately a maximum of forty miles in width and sixty miles in length, and the mountains above referred **[\*89]** to do not surround it completely, but are broken by other large valleys, such as the Hassayampa and the Gila, opening into it. A number of surface streams enter it on the northern and northeastern sides, the principal ones being the Salt, the Verde, and the Agua Fria Rivers. The first two naturally flow permanently throughout their entire course in the valley, in greater or lesser amounts. The last named, the one whose waters are in controversy in this case, is intermittent in its character below the place where it debouches from the mountains. The surface waters of all of these streams, if their course is not interrupted, eventually find their way into the Gila, and mingle and pursue a southwesterly course to the Colorado River, and thence to the Gulf of California. Underlying substantially the entire valley at a depth of from a few feet to perhaps a hundred or more is found an immense quantity of subterranean water, which extends downward into the earth to a great distance. There is apparently a slow but steady **[\*\*\*31]** movement of this entire quantity of water southwesterly until it presumably reaches and mingles with the underground waters of the Gila Valley.

So far as surface indications show, there are no underground channels of running water in the sense defined above under or near any of the land of plaintiffs except directly beneath the surface bed of the Agua Fria River. The country is apparently the ordinary Arizona desert, with the usual desert growth, furrowed by occasional torrential rains. Practically the only evidence bearing on the nature of these underground waters is based on the character of the water in various wells in the valley, and presumptions drawn from geologic theories. These theories, if correct, tend to show that ages ago the entire Salt River Valley was a vast depression, surrounded by its present **[\*90]** mountain ranges, and that over a period of countless years the rivers in question, together with other torrential, intermittent streams, have emptied their waters into this great basin, carrying down enormous quantities of boulders, gravel, sand and other detritus, which spread out through the valley in the manner usual under such conditions. The then surface **[\*\*\*32]** channels of these streams apparently changed from time to time, and, as they changed, the character and location of the deposits also changed from fine to coarse, and back again. After a length of time which can only be

estimated in geologic periods, the valley filled to its present level, and during historic times has remained substantially as now. Whenever, therefore, any of the rivers in question carry water enough to flow from the mountains, a great percentage of this water sinks into the more or less permeable material with which the valley is filled, and, since it slopes in a more or less general direction toward the Gila Valley, these waters gradually move in that direction. Since the detritus with which the valley is filled is coarser in some places than in others, the tendency of the water is to accumulate in greater quantity where the material is coarse than where it is fine, and to move more rapidly therein, and these bodies of coarse material, with finer presumably above, beneath, and beside them, are what are called by plaintiffs subterranean watercourses.

But, admitting this theory to be absolutely correct in its deductions, there is not a scintilla of evidence in **[\*\*\*33]** the record from which the ordinary man, or even the trained scientist, could point out definitely a specific place where any one of these so-called subterranean watercourses begins, where it ends, or how far its banks extended. Counsel for plaintiffs contends that the true condition of the underground soil and water in the present case is very similar to that **[\*91]** set forth in the case of :

"There can be no doubt but that it was as clearly proven under the evidence as such matters can be proven that there are underlying a vast territory in the . . . valley -- some . . . miles square -- numerous channels created by the . . . river through its action in ages past when, in the building up and forming of the valley, its waters rushed in enormous quantities from the mountains, changing from one side of the valley to the other, and constantly varying its course in its flow . . . These old channels now lie beneath the surface of the valley at varying depths; channels beside channels, and channels crossing and interconnecting with each other, through each of which the . . . river once flowed in **[\*\*\*34]** its open course, but which are now underground channels filled with loose and coarse gravel, through which waters still flow, supplied to them through percolations from the . . . river, with which these old gravel channels have always been connected, and that the particular underground channel or gravel stratum from which the well of plaintiff is supplied constitutes one of these old channels, which is likewise connected with and supplied from the waters of . . . river. The intake of all these old channels, including that from which the plaintiff derives his water, is in the enormous bed of gravel extending several miles. . . . **[\*\*379]** Into this vast gravel bed during the winter and spring, when the storm waters gather . . . and discharge themselves, . . . there sink into these gravels immense quantities of water, in amount limited only by

39 Ariz. 65, \*; 4 P.2d 369, \*\*;  
1931 Ariz. LEXIS 168, \*\*\*

the extent of the rainfall, but in any season of flood extending largely into hundreds of millions of gallons per day. . . . It is quite clear that these quantities of waters sink into the gravels and fill up the various branch channels underlying the valley, which connect with these gravels by the pressure of the storm waters passing over [\*\*\*35] them, and the supply of these underground channels is obtained in no other way; and it is equally clear that the intake into these gravel beds and the graveled strata along the [\*92] flow of the river generally is in proportion to the height and breadth of the storm waters passing over them, and the consequent pressure they exert to increase the percolation of the waters in the vast gravel bed and gravel strata. That the waters which lie in these old branch channels are supplied by the percolation of waters into the gravel beds and strata from the storm waters of the . . . river is beyond question from the evidence, as it equally appears that the flow of these storm waters during the recurring heavy rains is absolutely necessary to sustain the supply of water thereto which would otherwise and in a few years be exhausted," and that, if we substitute in the appropriate blanks the words "Salt River" and "Agua Fria," the parallelism is complete.

But, even if we admit the statement of the facts in the case just cited is almost exactly like the facts as the evidence shows them to exist herein, as we shall show, the very reasoning used by the California Supreme Court to sustain its [\*\*\*36] judgment demonstrates conclusively that it was based on an interpretation of the doctrine of prior appropriation directly opposed to that prevailing in Arizona. We quote from the opinion as follows:

"But, it is insisted by appellants that this rule only applies as to correlative rights of different persons owning lands overlying the same plane of percolating waters, and does not apply so as to entitle a nonriparian owner, although the stratum underlying his land is directly supplied by waters percolating from the stream to prevent the diversion of the waters of the stream by an appropriator. The precise question as to the respective rights of an appropriator of water to be used beyond the watershed, and of one claiming an uninterrupted flow of these waters to supply, by percolation, a water-bearing stratum underneath his land and connected with the stream, has not been heretofore presented. But there are general principles of law which have been applied as between other appropriators of the stream waters [\*93] and claimants to the flow or to the percolating waters of the stream which are equally applicable as between the parties to this action. It is true in this case that [\*\*\*37] the plaintiff is not a riparian owner, but neither does it appear, as far as their rights are here asserted, that appellants are. They are only asserting rights as appropriators

under a claim that they have appropriated all the surplus waters of the Coyote river, and are entitled to certain impounded waters between the gorges. Be that as it may, however, as far as any waters of the river are concerned (there being no impounded waters), we do not perceive that the fact that the plaintiff is not a riparian owner can affect his rights as against the appellants. As between riparian owners, it is conceded, as the law declares, that one riparian owner is not entitled to divert the waters of a stream for use at some distant point for commercial purposes so as to prevent another riparian owner to whom they would otherwise be available from using them on his lands, and it is established by the authorities to which we have heretofore referred that, as between owners of land overlying a common substratum of percolating water, this cannot be done. This being so, we perceive no reason why the same rule should not be applied as between owners of land overlying a substratum of water directly [\*\*\*38] connected with either the surface or subsurface flow of the stream, and deriving practically its exclusive supply from that source. *The theory upon which the right of a riparian owner to be protected in the use of the waters of a stream to which his lands are riparian is that, nature having given these lands the benefit of the flow, and the natural advantage of its use on the lands, one riparian owner may not divert these waters to lands not riparian, to the injury of another riparian owner who can use them. The same principle has been applied, as we have seen, to the use of waters as between the owners of lands, overlying a common stratum of percolating waters. And we perceive no reason why the same principle should not be applied as between an appropriator of the waters of a stream to be taken beyond the watershed for commercial purposes and the owners of lands overlying an artesian stratum which is conclusively [\*94] shown to be so connected with the stream as to derive its supply of water by percolation therefrom to this stratum. Why, in principle, should there be any distinction? With the common-law doctrine modified to meet the conditions in this state necessitating [\*\*\*39] it, and modified so as to preserve to each owner of lands overlying a common stratum of percolating waters a right to a fair and reasonable use of these waters of which their lands have a natural advantage, no reason suggests itself why the same rule should not apply as between the appropriators of the waters of a stream for use elsewhere than on riparian lands and the owners of lands overlying a water-bearing [\*\*\*380] channel, so directly connected with the stream as to be supplied by percolation from it. The conditions in all cases are analogous as far as the natural supply of waters is available for use upon the lands concerned, whether the lands be riparian to the stream or overlying a common subterranean stratum, or whether the underlying strata are connected and supplied directly from the flow*

39 Ariz. 65, \*; 4 P.2d 369, \*\*;  
1931 Ariz. LEXIS 168, \*\*\*

of the stream itself. *In either case there is a natural supply of water of which the lands by reason of their location, either as riparian or above a common subterranean stratum, or as lying over a water-bearing stratum supplied by percolation from the stream, have a natural advantage to the use of the waters.*" (Italics ours.)

In other words, since one owner of riparian lands [\*\*\*40] had rights in the water against another riparian owner, and one owner of lands over percolating water had rights in the water against another owner of land over the same water-bearing strata, *in both cases by virtue of the location of their lands and under the common law, as modified by the California decisions*, the rights of an appropriator were governed by the same test, viz., *location of lands and common law*. The answer to this is that the fundamental principle of the doctrine of appropriation as it exists in Arizona is that *the location of land and the rules of the common law give no rights as against an appropriator*, so long, at least, as his lands lie [\*95] within the watershed of the stream. And we would further point out that in the case cited the lands of the appropriator of surface water lay *without* the watershed, while in the instant case they lie within it.

The decision in , based as it avowedly is on a theory of the law of appropriation absolutely inconsistent with ours, is of no value as a precedent for sustaining the judgment before us for review. The only theory on which our courts could have reached [\*\*\*41] the same result on the stated facts of that case is that subterranean waters of the nature therein described are subject to appropriation under the law of Arizona. But the statement of facts shows that to be untrue. Without considering the use of the word "percolating" in the opinion as having any bearing on the question, the channels described therein fail to show any definite beginning, end, or location. The most that can be said is that *somewhere* beneath the surface of the Santa Clara Valley geological theory teaches us there are subterranean channels, and the proof in this case leads, at the most, to the same conclusion as to the lands involved herein. This is utterly insufficient under our law to base an appropriation of water on. The decree of the trial court, so far as it adjudges plaintiff a right of prior appropriation to the water of any wells not in or immediately adjacent to the surface channel of the Agua Fria River, cannot be sustained on the ground that such water comes from either dependent or independent underground channels with known and definite banks from which appropriations may be made under the law of Arizona.

But it may be said, even admitting the [\*\*\*42] waters claimed by plaintiffs are not subject to appropriation as those of known and definite independent or dependent underground channels, they are nevertheless subject to appropriation as being the subflow of the Agua [\*96]

Fria River. [HN15] The underflow, subflow or undercurrent, as it is variously called, of a surface stream may be defined as those waters which slowly find their way through the sand and gravel constituting the bed of the stream, or the lands under or immediately adjacent to the stream, and are themselves a part of the surface stream. 2 Kinney on Irrigation, 2d ed., par. 1161.

As the names given to this class of waters indicate, physically they constitute a part of the surface stream itself, and are simply incidental thereto, and also in the main depend on the surface streams to which they are incident for the greater part of their water supply. [HN16] The best test which can be applied to determine whether underground waters are as a matter of fact and law part of the surface stream is that there cannot be any abstraction of the water of the underflow without abstracting a corresponding amount from the surface stream, for the reason that the water from the surface stream [\*\*\*43] must necessarily fill the loose, porous material of its bed to the point of complete saturation before there can be any surface flow. Therefore the river bed must continue holding sufficient water to support the surface stream, as it were, for otherwise in drawing on the underground flow of the stream it will necessarily draw upon the waters flowing on the surface. ; ; .

If the bed of a stream is not solid rock, but gravel or earth, water will always be found many feet beneath its surface, and there may and probably will be corresponding to the flow on the surface a current beneath it. Not only does it move along the course of the river, but it percolates from its banks from [\*97] side to side, and the more abundant the surface water the further will it reach in its percolations on each side. But, considered as strictly a part of the stream, the test is always the same: *Does drawing off the subsurface water tend to diminish appreciably and directly the flow of the [\*\*\*44] surface stream?* If it does, it is subflow, and subject to the same rules of appropriation as the surface [\*\*\*381] stream itself; if it does not, then, although it may originally come from the waters of such stream, it is not, strictly speaking, a part thereof, but is subject to the rules applying to percolating waters. . Nor are we aware of any decision where a right in such percolating waters based on the doctrine of prior appropriation as it exists in Arizona is recognized. Any such rights are necessarily based on some form of riparian rights, as in , on the doctrine of *sic utere tuo*, as in , or a local statute.

In almost all cases the so-called subflow is found within, or immediately adjacent to, the bed of the surface stream itself. ; *Vineland Irr. Dist. v. Azusa, etc., supra*; . The leading case on the subject in California, which state has probably witnessed more disputes over subterranean [\*\*\*45] waters than any other, is , and therein

39 Ariz. 65, \*; 4 P.2d 369, \*\*;  
1931 Ariz. LEXIS 168, \*\*\*

the doctrine of subflow has been extended as far as it can reasonably be carried, if the definitions and tests above set forth are to be adhered to. It appears from the facts therein that the San Fernando Valley, which is about twelve miles wide by twenty-four miles long, is composed of more or less permeable material, which is practically filled with water from rains, mountain torrents, etc. It ends in a lower neck or [\*98] gorge, about two miles wide, through which all the waters of the valley eventually flow, and it was attempted to establish an appropriation under the ancient pueblo right of the city of Los Angeles to the subterranean water *flowing through this two-mile gorge* as being, in effect, the subflow of the Los Angeles River, and a part thereof. The trial court defined subterranean watercourses, and this definition was approved by the Supreme Court, as follows:

"A water course must consist of beds, banks, or sides, and water, and the water must be flowing in a channel or course more or less defined. . . . Water moving by force of gravity in a valley or basin of wide extent, [\*\*\*46] -- say, twenty-four by twelve miles at the extreme extent, -- and moving generally through the whole or through a large portion of the basin, along through the natural voids or interstices of the earth, composed of alluvial or other deposit lying throughout the entire basin, and made up of loam, sand, gravel and boulders, mixed together, and interspersed with irregular and broken strata or masses of clay or cemented sand and gravel, and lying in place as originally deposited by the forces of nature, do not constitute a water course, but are a part of the land, and belong to the owner of land as fully as any other constituent part of it. . . . But if such water does collect underground and flow in certain courses or channels through coarse, permeable material therein, where the existence and general course of the flowing or moving body of water can be easily determined, then the water so moving in such channels would constitute a water course, although not visible on the surface, and although the space through which the channel extends may be largely filled with the material through which the water flows."

And the opinion points out that the evidence showed the water claimed to be [\*\*\*47] subflow complied with the tests above stated, to wit, that it lay substantially beneath the surface of the bed of the Los Angeles River, and that drawing off the underground water [\*99] would diminish the surface flow. We think the body of water shown to exist beneath the lands of plaintiffs, and from which they draw by reason of their wells, even within the liberal doctrine laid down by the Pomeroy case, does not constitute the subflow of the Agua Fria River, for there is not the slightest evidence that their pumping diminishes directly or appreciably the surface flow, no matter how true may be the converse.

It is true that in the later case of , the court said:

"Unquestionably the San Fernando valley is the great natural reservoir and supply of the Los Angeles river. Unquestionably the cutting off of this supply would as completely destroy the Los Angeles river as would the cutting off of the Great Lakes destroy the St. Lawrence. San Fernando valley may indeed be regarded as a great lake filled with loose detritus, into which the drainage from the neighboring mountains flows, and the outlet of which is the [\*\*\*48] Los Angeles river. Impeded by the soils, these waters, of course, move more slowly than they would in an open lake; but unquestionably the general movement of practically all is southeasterly to the Narrows, through and out of which flows the Los Angeles river proper. Unquestionably, also, a serious interruption of or interference with this supply would as certainly impair the volume of water carried by the Los Angeles river as though the interruption and interference were with a surface flowing tributary thereof. The waters of the San Fernando valley therefore are not 'percolating waters' in the common-law sense of the term -- vagrant, wandering drops moving by gravity in any and every direction along the line of least resistance. These waters percolate, it is true, but only in the sense that they form a vast mass of water confined in a basin filled with detritus, always slowly moving downward to the outlet, in the effort, in conformity with physical law, to attain a uniform level.'

[\*100] [\*\*382] This is a positive statement that the waters of the San Fernando basin are not percolating in the common-law sense of the term, but it also by implication denies that they [\*\*\*49] are the subflow of the Los Angeles River. The contention is that the valley is in effect a lake, of which the river is the outlet, and that an appropriation of the waters of a river which is the outlet of a lake is also an appropriation of the waters of the lake. This conclusion of law is of course correct if the waters indeed be those of a lake. ;

But whether or not under the facts the San Fernando Valley is indeed a lake, supplying the Los Angeles River, the evidence in this case shows conclusively one fact which negatives the theory that the water involved herein constitutes a lake of appropriable water under the law of Arizona. The surface of the water underlying plaintiff's lands, and indeed under the entire valley, so far as it is known, instead of being perpendicular to a radius of the earth, as is invariably the case with a surface lake, has a decided slope or dip to the south and west. Whatever this water may be, it is not a "lake" in the sense in which our statutes use the word. Whether it be diffused percolations in the common-law sense of the term, as [\*\*\*50] defined in , so that the extreme English doctrine applies thereto, or whether it be percolating waters whose extraction will tap other waters, and it therefore comes

39 Ariz. 65, \*; 4 P.2d 369, \*\*;  
1931 Ariz. LEXIS 168, \*\*\*

within the doctrine of correlative rights as developed in *Katz v. Walkinshaw*, and other cases which follow it, is immaterial in this instance, for neither class is subject to appropriation under the law of Arizona, which limits that right, so far as subterranean waters are concerned, to those similar to appropriable surface waters. Plaintiffs can claim [\*101] no rights of appropriation to the waters pumped by them as a subflow of the Agua Fria River except such as comply with the test above laid down, to wit, that they are in the bed of the river, or so near thereto that the pumping from them will appreciably deplete the waters of the surface stream.

It is evident from what we have already said that the judgment of the trial court must necessarily be reversed and the case remanded for a new trial. order, however, that all the issues which will arise at such trial may be properly determined, we think it advisable to discuss one or two other points. The waters claimed [\*\*\*51] by plaintiffs may be divided into three classes. First are those pumped from wells not in or immediately adjacent to the bed of the Agua Fria River. To these, as we have stated, plaintiffs can claim no right by reason of *appropriation*, whatever may be their rights under the law applying to percolating waters of the classes we have mentioned in this opinion. The second is of waters of wells in or immediately adjacent to the bed of the Agua Fria River, so that the evidence shows they satisfy the test applying to subflow, or are actually in the subterranean channel of the river itself. So far as these are concerned, if the evidence shows plaintiffs have applied them to beneficial use, and have not since forfeited or abandoned such use in whole or in part, they are entitled to have any rights so acquired protected. The third class consists of surface water alleged to have been diverted at what is known as the Marinette heading. The trial court should determine the amount of water obtained from these two sources and used beneficially in accordance with the principles stated by us, and plaintiffs are entitled either to have sufficient water pass the point of diversion of defendants [\*\*\*52] so that enough will reach the point of diversion of plaintiffs to supply their appropriation [\*102] as it would have been supplied were it not for defendants' dams and canal, or in lieu thereof defendants may, if they desire, under the doctrine of , deliver the proper amount of water to plaintiffs, the cost of such delivery to be no greater to plaintiffs than drawing the water from the original points of diversion has been in the past, or would be in the future were it not for defendants' operations.

Defendants have also urged that their right of appropriation is prior to that of plaintiffs under any theory of the case, and that plaintiffs have not denied this. Whether the denial was formally made in the pleadings or not, doubtless at a retrial of the case they will be

amended to meet that objection, and we think it best to refer to the evidence on this point as though the issue were properly before the trial court. Defendants' predecessor in interest did, at some time during the year 1888 initiate an appropriation of the waters of the Agua Fria River flowing at Frog Tanks and Camp Dyer, and expended considerable money thereafter in the [\*\*\*53] construction of a diversion dam at the last-named place, and a canal for the irrigation of various lands. The diversion dam and canal, however, were practically destroyed, and all work thereon stopped in the year 1895. From that time on until approximately 1925 substantially the only work done in furtherance of these initiated rights was the maintaining of a watchman at the point of diversion and the expenditure of some \$25,000 for surveys and attorney's fees.

[HN17] Under the doctrine of prior appropriation, an appropriator is required, after his rights have been initiated in accordance with the law in existence at the particular time and locality, to exercise reasonable diligence [\*\*\*383] in every step required to make his appropriation complete, by the actual application of the [\*103] water to a beneficial use, for until he does this his rights are inchoate. When the water is finally so applied, his perfected rights relate back to the initiation of the appropriation. ; 2 Kinney on Irrigation, 2d ed., p. 1282. If however, he fails to use reasonable diligence, his rights commence only as of the time of actual application of the [\*\*\*54] water. The time within which the appropriation must be completed varies according to circumstances, as what may be reasonable diligence in one case may be a great lack of diligence in another, and the courts have always considered in the case of *bona fide* settlers that they might take a longer time in the construction of their works for the diversion of water and in the actual application of the water to a beneficial use than was required of those with ample means. But the mere lack of means with which to prosecute the work is never *ipso facto* a sufficient excuse for delay. As was well stated in the case of : "It would be a most dangerous doctrine to hold that ill-health or pecuniary inability of a claimant of a water privilege will dispense with the necessity of actual appropriation within a reasonable time, or the diligence which is usually required in the prosecution of the work necessary for the purpose." See, also, ; . Particularly is this true when the delay is due to the difficulty of [\*\*\*55] financing a large project. ; .

In the case at bar we are satisfied that defendants failed to show due diligence in perfecting their predecessor's appropriation of 1888, and the trial court correctly held that the rights of plaintiffs, so far as such [\*104] rights existed at all, were prior to those of defendants.

There are a number of other assignments of error, but we think we need not refer to them specifically, as what we have said previously will afford sufficient information to the trial court to determine the questions raised thereby. In passing we may say that we recognize the far-reaching effect which this reiteration of the fundamental principles of the water law of Arizona may have on the future development of the state, and the momentous results which may flow therefrom. On the one hand, counsel for plaintiffs have told us that a reversal of this case will in effect be a re-establishment of the doctrine of riparian rights, an abandonment of the law of prior appropriation, and a permanent end to our future agricultural growth, while with equal sincerity and earnestness [\*\*\*56] counsel for defendants insist that an affirmance of the judgment will be a declaration that storage is subservient to pumping, and that this will prevent all future development of our surface waters, thus limiting our agricultural increase to small and uncertain areas. Such appeals, while doubtless legitimate and pertinent if addressed to a legislative body declaring a rule of public policy, cannot be considered by the courts when that public policy already appears plainly in the statutes of the state, and our decision is based solely on the law as it is, and not on what we think it should be or its effect. But could we consider the wisdom of the adoption of the respective principles of law presented by counsel our decision would be the same. When fundamental public policy is to be settled, the final test is well stated in the old Roman maxim of "*salus populi est suprema lex.*" And we are of the opinion that the greatest permanent good of the state of Arizona is best served by the doctrine laid down by our legislatures in the past and explained by us in this decision.

[\*105] Surface waters are plainly visible, definitely ascertainable, and the effect of their appropriation [\*\*\*57] generally easily foreseen and understood by all. Subterranean waters are necessarily more or less uncertain as to their very existence, speculative as to

their character, and frequently incapable of an immediate demonstration of the results of their appropriation of such a nature that investors may safely stake their funds and farmers their future on the success of the project. If percolating waters are subject to the law of prior appropriation, and if appropriations of other subterranean waters may be established by mere surmise, inference or possibility, the field is open to interminable and uncertain litigation from which none will profit in the end but members of the legal profession, and there will in all probability be a complete cessation of extensive development work, due to the impossibility of ascertaining in advance just what rights will be acquired thereby. It may be said that this rule means an end to all future large pumping projects. If these projects are based on the depletion of surface waters, it is far more economical both in money and water, and thus better for the state as a whole, that those surface waters be utilized through surface developments, as they [\*\*\*58] doubtless will be when necessity arises. If, on the other hand, they are based on a use of water which will not affect surface developments, past or future, there are other principles of law, not necessary for the determination of this case, which properly applied, will do justice to the state and to its individual citizens alike. While it may be, and doubtless is, true that the effect of the declaration of public policy made by our legislature so long ago will be to lessen somewhat the number and size of [\*\*384] future irrigation projects depending upon pumped water, in our opinion it is more than compensated by the establishment of certainty [\*106] and security for the vastly more important surface projects now existing, and which will doubtless exist in the future.

The judgment of the superior court of Maricopa county is reversed and the case remanded, with instructions to grant a new trial in accordance with the principles laid down in this opinion.

McALISTER, C. J., and ROSS, J., concur.

# APPENDIX A-2



Caution

As of: Mar 26, 2014

**In re the GENERAL ADJUDICATION OF ALL RIGHTS TO USE WATER IN the  
GILA RIVER SYSTEM AND SOURCE**

**Nos. WC-90-0001-IR, WC-90-0001-IR, WC-90-0002-IR, WC-90-0003-IR,  
WC-90-0004-IR, WC-90-0005-IR, WC-90-0006-IR, WC-90-0007-IR, WC-79-0001,  
WC-79-0002, WC-79-0003, WC-79-0004**

**Supreme Court of Arizona**

*175 Ariz. 382; 857 P.2d 1236; 1993 Ariz. LEXIS 60; 144 Ariz. Adv. Rep. 17*

**July 27, 1993**

**SUBSEQUENT HISTORY:** Related proceeding at *San Carlos Apache Tribe v. Superior Court*, 193 Ariz. 195, 972 P.2d 179, 1999 Ariz. LEXIS 5 (Ariz., 1999)

Appeal after remand at *In re General Adjudication of All Rights to Use Water in the Gila River Sys. & Source*, 198 Ariz. 330, 9 P.3d 1069, 2000 Ariz. LEXIS 94 (Ariz., 2000)

**PRIOR HISTORY:** [\*\*\*1] Maricopa County Nos. W-1, W-2, W-3, W-4 (Consolidated)

*In re General Adjudication of All Rights to Use Water in the Gila River Sys. & Source*, 171 Ariz. 230, 830 P.2d 442, 1992 Ariz. LEXIS 25 (Ariz., 1992)

**DISPOSITION:** REMANDED

**CASE SUMMARY:**

**PROCEDURAL POSTURE:** After hearings to determine whether underground water was to be included in a river system and source, appellant cities filed an interlocutory appeal in a trial court in Maricopa County (Arizona) asking the trial court to exclude groundwater from the adjudication. The trial court issued an order stating that groundwater was included in the river system and source if it was a stream's subflow. The cities appealed.

**OVERVIEW:** Cities and others filed an action under *Ariz. Rev. Stat. § 45-251 et seq.* to determine the extent and priority of the rights of all persons to use water in a river system and source. Hearings were held on the relationship between surface water and percolating groundwater. Following the hearings, the cities filed a motion asking the trial court to exclude groundwater from the adjudication. The trial court issued an order stating that the 50 percent/90 day rule stating that percolating underground water was appropriable if the volume of stream depletion reached 50 percent or more of the total volume pumped during 90 days of continuous pumping. On appeal, the court held that the 50 percent/90 day rule did not apply because it was inconsistent with prior case law which held that percolating groundwater was not subject to appropriation.

**OUTCOME:** The court vacated the trial court's order in part and remanded the case.

**LexisNexis(R) Headnotes**

*Governments > State & Territorial Governments > Water Rights*

*Real Property Law > Water Rights > Beneficial Use*  
[HN1] See *Ariz. Rev. Stat. § 45-141(A)*.

175 Ariz. 382, \*, 857 P.2d 1236, \*\*;  
1993 Ariz. LEXIS 60, \*\*\*; 144 Ariz. Adv. Rep. 17

**Governments > State & Territorial Governments > Water Rights**

[HN2] The purpose of a general stream adjudication under title 45 of Arizona Revised Statutes is to determine the rights of all persons to use the waters of a river system and source. *Ariz. Rev. Stat. § 45-252(A)*. "River system and source" is defined as all water appropriable under *Ariz. Rev. Stat. § 45-141* and all water subject to claims based upon federal law. *Ariz. Rev. Stat. § 45-251(4)*.

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Lewis and Roca by Tom Galbraith and Paul D. Ellsworth, Phoenix, for Paloma Inv. Ltd. Partnership.

David R. Merkel, Tempe City Atty. by Karen S. Gaylord, Tempe, for City of Tempe.

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175 Ariz. 382, \*; 857 P.2d 1236, \*\*;  
1993 Ariz. LEXIS 60, \*\*\*; 144 Ariz. Adv. Rep. 17

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**JUDGES:** En Banc. Feldman, Chief Justice. Moeller, V.C.J., Corcoran and Zlaket, JJ., and William E. Druke, Court of Appeals Chief Judge, concur. Martone, J., did not participate in the determination of this matter; pursuant to Ariz. Const. art. VI, § 3, the Honorable William E. Druke, Chief Judge of Division [\*\*\*5] Two, Arizona Court of Appeals, was designated to sit in his stead.

**OPINION BY: FELDMAN**

**OPINION**

[\*384] [\*\*1238] **OPINION**

This appeal presents the second of six issues accepted for interlocutory review on December 11, 1991. We decide today whether the trial court erred in adopting a test to determine whether the underground water known as subflow is appropriable under A.R.S. § 45-141. We have jurisdiction pursuant to A.R.S. § 45-252 and Ariz. Const. art. 6, § 5(3).

## FACTS AND PROCEDURAL HISTORY

This case is a consolidated general adjudication brought under A.R.S. § 45-251 *et seq.* to determine the extent and priority of the rights of all persons to use water in the Gila River system and source. For the full procedural history of the case, see *Arizona v. San Carlos Apache Tribe of Arizona*, 463 U.S. 545, 103 S. Ct. 3201, 77 L.Ed.2d 837 (1983); *United States v. Superior Court*, 144 Ariz. 265, 270-71, 697 P.2d 658, 663-64 (1985), *In re Rights to the Use of the Gila River*, 171 Ariz. 230, 232-33, 830 P.2d 442, 444-45 (1992). For the present opinion, [\*\*\*6] the relevant facts are brief.

For five days in October 1987, the trial court held hearings on the relationship between surface water and groundwater. [\*385] [\*\*1239] Hydrologists and hydrological engineers testified and submitted reports on the relation between ground and surface water in general, and in the San Pedro and Santa Cruz watersheds in particular. The hearings were for the general education of all parties and the court, but the material adduced at the hearing was to be considered evidence on which the court could rely when appropriate.

Following the hearings, several cities<sup>1</sup> filed a Motion to Exclude Wells From the General Adjudication, asking the trial court to exclude from the adjudication all wells pumping percolating groundwater, and to include only those wells pumping surface flow and subsurface flow, within the meaning of *Maricopa County Municipal Water Conservation District No. One v. Southwest Cotton Co.*, 39 Ariz. 65, 4 P.2d 369 (1931) ("*Southwest Cotton*"). The trial court decided to use the cities' motion, and the information developed at the hearings, as a vehicle to resolve several surface water and [\*\*\*7] groundwater issues. Thus, in January 1988, the trial court ordered the parties to brief eight specific questions it believed it could decide as a matter of law based on the evidence adduced at the October 1987 hearings. In May 1988, the trial court heard argument and in September it issued its order answering those questions.

1 Those cities were Chandler, Tempe, Mesa, Scottsdale, Glendale, Peoria, Goodyear, Casa Grande, Avondale, Nogales, and Prescott.

One of the eight questions the trial court answered in its September order was:

Is ground water included within the phrase "river system and source" as it is used in A.R.S. §§ 45-141 and 45-251(4), and if so, to what extent is it included?<sup>2</sup>

175 Ariz. 382, \*, 857 P.2d 1236, \*\*;  
1993 Ariz. LEXIS 60, \*\*\*; 144 Ariz. Adv. Rep. 17

The trial court concluded that underground water is included in the river system and source if it is a stream's subflow, as that term is used in *Southwest Cotton*. The effect of this ruling was to declare that groundwater pumpers extracting water within the court's definition of "subflow" were diverting water appropriable [\*\*\*8] under A.R.S. § 45-141(A). Therefore, their rights to that water would depend on the priority of their appropriation, rather than on an owner's right to remove water percolating under the surface of the owner's land.

2 A.R.S. § 45-141(A) reads:

[HN1] The waters of all sources, flowing in streams, canyons, ravines or other natural channels, or in definite underground channels, whether perennial or intermittent, flood, waste or surplus water, and of lakes, ponds and springs on the surface, belong to the public and are subject to appropriation and beneficial use as provided in this chapter.

The court then concluded that certain wells withdrawing water from the younger alluvium of a stream basin should be presumed to be pumping appropriable subflow. The court instructed the Department of Water Resources ("DWR") to designate such wells in its hydrographic survey reports<sup>3</sup> as pumping appropriable subflow if:

As to wells located in or close to that younger alluvium, the volume of stream depletion would reach 50% or more [\*\*\*9] of the total volume pumped during one growing season for agricultural wells or during a typical cycle of pumpage for industrial, municipal, mining, or other uses, assuming in all instances and for all types of use that the period of withdrawal is equivalent to 90 days of continuous pumping for purposes of technical calculation.

The court acknowledged that this test (the "50%/90 day rule") appeared to be somewhat arbitrary but explained it was essential for use in instructing DWR in the preparation of its hydrographic survey reports. Well owners would be allowed to prove that their wells were not pumping subflow at the time of their evidentiary hearing.

3 These hydrographic survey reports are to be prepared by DWR pursuant to A.R.S. § 45-256 as part of its role as technical advisor to the trial court.

Many parties sought review of this ruling pursuant to this court's Special Procedural Order Providing for Interlocutory Appeals and Certifications, filed September 26, 1989. We granted review and framed the issue [\*\*\*10] as follows:

[\*386] [\*\*1240] Did the trial court err in adopting its 50%/90 day test for determining whether underground water is "appropriable" under A.R.S. § 45-141?

## THE ISSUE

This issue arises from the way Arizona water law has developed from territorial days. Those seeking a detailed history of the evolution of Arizona water law, going back to the organization of the Arizona Territory, are referred to John D. Leshy & James Belanger, *Arizona Law Where Ground and Surface Water Meet*, 20 Ariz. St.L.J. 657 (1988). As will be seen below, rights associated with water found in lakes, ponds, and flowing streams -- surface water -- have been governed by the doctrine of prior appropriation. This doctrine developed in the western part of the country where the common law riparian rights doctrine was unsuited to prevailing arid conditions. On the other hand, underground water has been governed by the traditional common law notion that water percolating generally through the soil belongs to the overlying landowner, as limited by the doctrine of reasonable use. *Id.*

This bifurcated system of water rights was not unique to Arizona. It was typical [\*\*\*11] of western states until around the turn of the twentieth century. At that time, scientific investigation was revealing that most underground water is hydraulically connected to surface water. As scientific knowledge progressed, most states revised their water laws to provide for unitary management of hydraulically connected underground and surface water. Arizona, however, did not, and continues to adhere to a bifurcated system of water rights, with compelling implications for general stream adjudications. *Id.*

[HN2] The purpose of a general stream adjudication under title 45 is to determine the rights of all persons to use the waters of a river system and source. A.R.S. § 45-252(A). "River system and source" is defined as "all

175 Ariz. 382, \*, 857 P.2d 1236, \*\*;  
1993 Ariz. LEXIS 60, \*\*\*; 144 Ariz. Adv. Rep. 17

water appropriable under [A.R.S.] § 45-141 and all water subject to claims based upon federal law." A.R.S. § 45-251(4). Thus, basic to this case is the extent to which water pumped from wells must be treated as appropriable under § 45-141 or, conversely, as groundwater excluded from the legal rules applying to prior appropriation. The need to resolve the question early in the proceeding impelled us to grant review.

## HISTORICAL PERSPECTIVE

We start with [\*\*\*12] *Southwest Cotton*, this court's early and most important attempt to enunciate the relative rights of groundwater and surface water users. The court's comment in that case applies to the present dispute:

The case is one of the most important which has ever come before this court, involving as it does not only property interests of [great] value . . . but also a declaration of legal principles which will in all probability determine and govern to a great extent the course of future . . . development within the arid regions of Arizona. The real question involved is the law applicable to the relative rights to the ownership and use of the subterranean waters of the state as against those of the surface waters.

*39 Ariz. at 71, 4 P.2d at 372.*

*Southwest Cotton* involved a suit by Southwest Cotton Company and others ("Southwest Cotton") against Maricopa County Municipal Water Conservation District No. 1 and others ("Conservation District"). Southwest Cotton owned a large tract of land west of Phoenix. It drilled almost one hundred wells in and around the Agua Fria River bed<sup>4</sup> to irrigate 19,000 acres. In 1925, plans for a dam on [\*\*\*13] the Agua Fria River upstream of Southwest Cotton's development matured, and the Conservation District floated bonds to finance the project. Southwest Cotton sued to enjoin the project, fearing that the upstream [\*387] [\*\*1241] dam would prevent water from reaching the downstream wells.

4 The Agua Fria River flowed only intermittently. Southwest Cotton's wells were located in an area roughly ten miles wide and twenty miles long. Some were in the river bed, and others ranged from a few feet to six miles from the river.

In the trial court, Southwest Cotton argued that the water it pumped was subject to appropriation under the predecessor of A.R.S. § 45-141(A).<sup>5</sup> The trial court ruled

for Southwest Cotton, holding that the water was appropriable as water flowing in definite underground channels.

5 Southwest Cotton also claimed rights to a surface diversion in connection with a tunnel and canal system at what was known as the Marinette heading.

[\*\*\*14] On appeal, Southwest Cotton advanced three theories: (1) percolating underground water was appropriable; (2) water running in underground channels was appropriable; and (3) subflow of the Agua Fria River was appropriable. This court decided to treat all issues as matters of first impression. First, it addressed Southwest Cotton's claim that percolating groundwater is appropriable. At the time of *Southwest Cotton*, percolating water was defined generally as water that passes through the ground and does not form part of a body of water or a water course. 2 Clesson S. Kinney, *The Law of Irrigation and Water Rights* § 1188, at 2152 (2d ed. 1912). It was further classified with reference to the streams or other bodies of water to which it was tributary. "Diffused percolations" were not tributary to any definite surface or underground stream or body of water. *Id.* "Percolating waters tributary to surface water" were, as the name implies, "waters which infiltrate their way through the adjoining ground to some surface water course or other body of surface water." *Id.* § 1193, at 2162.

The *Southwest Cotton* court examined Arizona statutes from 1864 and its previous decisions [\*\*\*15] and reaffirmed its prior holding that percolating subterranean water was not subject to appropriation. *39 Ariz. at 84, 4 P.2d at 376.* Language in the opinion makes it clear that the court meant that all percolating water, however classified, was not subject to appropriation. While distinguishing certain California cases on which Southwest Cotton relied, the court stated:

Whether [the water underlying Southwest Cotton's land] be diffused percolations in the common law sense of the term . . ., or whether it be percolating waters whose extraction will tap other waters, . . . is immaterial in this instance, for neither class is subject to appropriation under the law of Arizona.

*Id. at 100, 4 P.2d at 382.*<sup>6</sup>

6 Any decision as to what law applied to percolating water was left for another day. *Id. at 83-84, 4 P.2d at 376.* That day arrived more than twenty years later. See *Bristor v. Cheatham*, 75

175 Ariz. 382, \*; 857 P.2d 1236, \*\*;  
1993 Ariz. LEXIS 60, \*\*\*; 144 Ariz. Adv. Rep. 17

Ariz. 227, 255 P.2d 173 (1953), which established the right of the surface owner to reasonable use of the water percolating under his property.

[\*\*16] The court also addressed Southwest Cotton's argument that its water came from underground streams. The court rejected that argument because there was insufficient evidence to show that Southwest Cotton's wells tapped underground channels with known and definite banks from which Arizona law allowed appropriations. *Id. at 95, 4 P.2d at 380.*

Finally, the court addressed the argument that Southwest Cotton was pumping appropriable subflow of the Agua Fria River. The court defined "subflow" as

those waters which slowly find their way through the sand and gravel constituting the bed of the stream, or the lands under or immediately adjacent to the stream, and are themselves a part of the surface stream.

*Id. at 96, 4 P.2d at 380.*

In almost all cases the so-called subflow is found within, or immediately adjacent to, the bed of the surface stream itself.

*Id. at 97, 4 P.2d at 381.*

Subflow "physically . . . constitute[s] a part of the surface stream itself, and [is] simply incidental thereto." *Id. at 96, 4 P.2d at 380.* It is subject to the same rules of appropriation as the surface stream itself. *Id. at 97, 4 P.2d at 380-81.*

[\*388] [\*\*1242] The court [\*\*\*17] set forth a test for determining whether underground water is appropriable subflow. First, it wrote:

The best test which can be applied to determine whether underground waters are as a matter of fact and law part of the surface stream is that *there cannot be any abstraction of the water of the underflow without abstracting a corresponding amount from the surface stream*, for the reason that the water from the surface stream must necessarily fill the loose, porous material of its bed to the point of complete saturation before there can be any surface flow.

*Id. at 96, 4 P.2d at 380* (emphasis added).

In the next paragraph, the court wrote:

Not only does [subflow] move along the course of the river, but it percolates from its banks from side to side, and the more abundant the surface water the further will it reach in its percolations on each side. But, considered as strictly a part of the stream, the test is always the same: *Does drawing off the subsurface water tend to diminish appreciably and directly the flow of the surface stream?* If it does, it is subflow, and subject to the same rules of appropriation as the surface stream itself; if it does not, then, [\*\*\*18] although it may originally come from the waters of such stream, it is not, strictly speaking, a part thereof, but is subject to the rules applying to percolating waters.

*Id. at 96-97, 4 P.2d at 380-81* (emphasis in original).

Concluding that there was no evidence that Southwest Cotton's pumping directly or appreciably diminished the flow of the river, the court reversed and remanded the case for a new trial. *Id. at 99, 106, 4 P.2d at 381, 384.*

Until *Bristor v. Cheatham*, 73 Ariz. 228, 240 P.2d 185 (1952) ("*Bristor I*"), this court consistently applied *Southwest Cotton's* rule that percolating groundwater is not subject to appropriation. In *Bristor I*, the court held by a 3-2 margin that percolating water was subject to appropriation. The court granted rehearing, however, and fourteen months later reversed itself by a 3-2 margin. In *Bristor v. Cheatham*, 75 Ariz. 227, 255 P.2d 173 (1953) ("*Bristor II*"), the majority reaffirmed our prior holdings that percolating water is not subject to appropriation. Arizona's courts have followed *Bristor II* to this day.

## DISCUSSION

[\*\*\*19] The parties in this appeal generally agree that *Southwest Cotton* is at the heart of the issue before us. One group argues that *Southwest Cotton's* concept of subflow is narrow, and that the 50%/90 day rule is too broad, because it includes wells that pump underground water not appropriable under A.R.S. § 45-141(A). Another group argues that *Southwest Cotton's* concept of subflow is broad, and that the 50%/90 rule is too narrow, because it fails to include all wells that pump appropriable subflow. The third group argues that the trial court was correct. Although it seems to agree that the 50%/90 day rule is not faithful to *Southwest Cotton*, the third group contends that the trial court's order should not be

disturbed because it merely creates a rebuttable presumption. We address this argument first.

### A. The presumption

The 50%/90 day rule was formulated to instruct DWR in the preparation of hydrographic survey reports, and merely creates a rebuttable presumption that wells meeting the test are pumping subflow. Nonetheless, if the test is defective, its use would adversely affect the adjudication. It would plant errors in every hydrographic survey report, which [\*\*\*20] would have to be litigated according to the procedures set out in the Rules for Proceedings Before the Special Master, Rules 6.00-16.00. This would exacerbate an already lengthy and costly process. Perhaps even more significantly, use of a flawed test for identifying wells pumping subflow could cause significant injustice. Many surface owners unable to mount a challenge could effectively lose their right to pump percolating groundwater, simply because their wells were improperly presumed to be pumping [\*389] [\*\*1243] appropriable subflow. Considering the time, expense, and importance of accurate hydrographic survey reports, and the complex lawsuits over their correctness, it would be a senseless waste to use a flawed presumption for identifying wells pumping subflow.

### B. Applying the rule of *Southwest Cotton*

#### 1. *Stare decisis*

We now determine whether the trial court's 50%/90 day rule accurately reflects *Southwest Cotton's* subflow rationale. We perceive our role as interpreting *Southwest Cotton*, not refining, revising, correcting, or improving it. We believe it is too late to change or overrule the case. More than six decades have passed since *Southwest* [\*\*\*21] *Cotton* was decided. The Arizona legislature has erected statutory frameworks for regulating surface water and groundwater based on *Southwest Cotton*. Arizona's agricultural, industrial, mining, and urban interests have accommodated themselves to those frameworks. *Southwest Cotton* has been part of the constant backdrop for vast investments, the founding and growth of towns and cities, and the lives of our people. Of course, this court is not absolutely bound by *stare decisis* and may change judge-made law, especially when the need for change is apparent, the error or confusion in previous decisions is evident, and change is possible without causing significant damage. We have done so in the recent past. See *Wiley v. Industrial Commission*, 174 Ariz. 94, 847 P.2d 595 (1993). We do not do so lightly, however, or in the absence of compelling reasons. *State v. Huerta*, 175 Ariz. 262, 855 P.2d 776 (1993); cf. *State v. Lara*, 171 Ariz. 282, 285, 830 P.2d 803, 806 (1992).

If this principle applies to ordinary cases, it must be applied with [\*\*\*22] particular care when the prospective effect of change threatens important vested rights and may affect every Arizonan's well-being. Thus, even though *Southwest Cotton* may be based on an understanding of hydrology less precise than current theories, it would be inappropriate to undo that which has been done in the past. Instead, we will attempt only to resolve as best we can the ambiguities and uncertainties left by that decision. Given the inexact nature of the "direct and appreciable diminution" test laid down by *Southwest Cotton*, that in itself is no small task.

#### 2. *Application*

Those who argue that the 50%/90 day rule is too narrow suggest that *Southwest Cotton's* test is very broad. They argue that pumping underground water from a tributary aquifer <sup>7</sup> causes direct stream depletion, either by intercepting water that otherwise would reach the stream or by dewatering an area, thereby inducing water to flow from the stream to fill the void. Such depletion is "appreciable," the argument goes, if it is "[c]apable of being estimated . . . or recognized . . . [.] perceptible." Citing Oxford English Dictionary (2d ed. 1989). These parties contend that any well pumping [\*\*\*23] from a tributary aquifer is pumping subflow if it causes any measurable stream depletion in a period of one or more decades. <sup>8</sup> Viewed outside the context in which the *Southwest Cotton* test was formulated, that interpretation is plausible. Viewed in context, however, it clearly is too expansive from both geographical and time standpoints.

<sup>7</sup> A tributary aquifer is an aquifer having a direct hydraulic connection with a stream or with another aquifer that has such a connection.

<sup>8</sup> The lead brief for those arguing that the test is too narrow suggests a period of ten years. The brief filed by the Nature Conservancy suggests a period of forty years. Both briefs allow for exclusion of wells that pump de minimis amounts of water or that have de minimis impact on surface streams.

When *Southwest Cotton* was decided, subflow was a well known water law concept. The primary authority on which the *Southwest Cotton* court relied concerning subflow was 2 Kinney, *supra* § 1161. Kinney addressed the concept of [\*\*\*24] subflow in Chapter 60, entitled "Subterranean Water Courses." He subdivided subterranean water courses into two general categories, [\*390] [\*\*1244] known and unknown. Known subterranean water courses were those in which the channel had been identified. Unknown courses were those in which the channel had not been identified. *Id.* § 1155, at 2098-99. Known subterranean water courses were further subdivi-

175 Ariz. 382, \*, 857 P.2d 1236, \*\*;  
1993 Ariz. LEXIS 60, \*\*\*; 144 Ariz. Adv. Rep. 17

vided into independent or dependent. Independent courses were those that flowed "independent of the influence of any surface streams." *Id.* § 1156, at 2100. Dependent courses were "waters . . . dependent for their supply upon the surface streams, or are the 'underflow,' 'sub-surface flow,' 'subflow,' or 'undercurrent,' as they are at times called, of surface streams." *Id.* § 1161, at 2106. Kinney's definition of subflow was the one used in *Southwest Cotton*. See 39 Ariz. at 96, 4 P.2d at 380.<sup>9</sup>

9 See also Black's Law Dictionary 1425 (6th ed. 1990), defining "subflow" as "[t]hose waters which slowly find their way through sand or gravel constituting bed of a stream, or lands under or immediately adjacent to [a] stream."

[\*\*\*25] Kinney specifically discussed subflow in the context of intermittent streams, such as the Agua Fria River, at issue in *Southwest Cotton*. He explained that a large volume of water flows through the sand and gravel underlying most streams in arid regions. During dry seasons, the surface of these streams may be dry, but water flows underneath the surface. This underground water is not a separate underground stream but still a part of the surface stream. 2 Kinney, *supra* § 1161, at 2106-10. Furthermore, speaking again about intermittent streams, Kinney wrote:

[W]aters, in order to constitute the underground flow of surface streams, must be connected with the stream and strictly confined to the river bottom and moving underground, as was stated in a California case, "in connection with it, and a course with a space reasonably well defined." In other words, the water must be within the bed of the surface stream itself. Otherwise such underground waters must be classified with percolating waters, hereinafter discussed.

*Id.* § 1161, at 2110 (footnotes omitted).

In his later discussion of percolating water, Kinney wrote:

Our second class of percolating waters we will [\*\*\*26] define as those waters which infiltrate their way through the adjoining ground to some surface water course or other body of surface water.

*Id.* § 1193, at 2162 (footnote omitted). Kinney described what the parties in this case have referred to as

tributary groundwater. He pointedly distinguished tributary groundwater from subflow:

[Percolating waters tributary to surface waters] differ from the underflow of surface streams in the fact that they have not yet reached the channels of the water courses to which they are tributary; while, upon the other hand, the underflow of surface streams have reached these channels and are therefore dealt with as component parts of such streams.

*Id.* (footnote omitted).

Thus, Kinney defined subflow narrowly and specifically distinguished it from tributary groundwater. It is clear that we adopted that narrow definition in *Southwest Cotton*. The court's discussion of subflow, 39 Ariz. at 96-97, 4 P.2d at 380-81, is a virtual paraphrase of large portions of Kinney's discussion in § 1161, at 2106-10. Furthermore, in its answering brief *Southwest Cotton* made essentially the same argument [\*\*\*27] that is being made in this proceeding. In a section of its brief entitled "Underground Waters Tributary to or Dependent Upon Surface Streams Subject to Appropriation as Part of the Stream," *Southwest Cotton* argued that underground water that is hydraulically connected -- tributary -- to surface water should be considered part and parcel of the surface stream. As such, it should be subject to appropriation as waters of the stream. Brief of Appellees (Conservation District) at 199-200.

The court rejected that argument, holding that all types of percolating water were not subject to appropriation under Arizona law. *Southwest Cotton*, 39 Ariz. at 84, 4 P.2d at 376. Having so held, it is unreasonable [\*391] [\*\*1245] to suppose that the court then turned around and adopted a concept of subflow broad enough to include all underground water hydraulically connected to a surface stream. It seems clear that the court considered subflow and tributary groundwater to be two different classes of underground water. The former is subject to appropriation under the predecessor of A.R.S. § 45-141(A); the latter is not.

The rehearing proceedings [\*\*\*28] in *Southwest Cotton* further indicate the court's narrow view of subflow. In its petition for rehearing, *Southwest Cotton* argued that the court defined subflow too narrowly. It took issue with the use of the term "immediately" in the following portion of the opinion:

The underflow, subflow, or undercurrent, as it is variously called, of a surface stream may be defined as those waters which slowly find their way through the

175 Ariz. 382, \*, 857 P.2d 1236, \*\*;  
1993 Ariz. LEXIS 60, \*\*\*; 144 Ariz. Adv. Rep. 17

sand and gravel constituting the bed of the stream, or the lands under or *immediately* adjacent to the stream, and are themselves a part of the surface stream.

39 Ariz. at 96, 4 P.2d at 380 (emphasis added). Southwest Cotton argued that neither Kinney nor any other text writer used the word "immediately" or any of its synonyms as a limitation on the word "adjacent." Petition for Rehearing at 22. In its opinion on rehearing, the court made no specific mention of this argument but essentially affirmed its original test for identifying subflow. *Maricopa County Mun. Water Conservation Dist. No. One v. Southwest Cotton Co.*, 39 Ariz. 367, 369, 7 P.2d 254, 254 (1932). [\*\*\*29] Obviously, therefore, the court meant it when it said that in almost all cases "subflow is found within, or immediately adjacent to, the bed of the surface stream itself." 39 Ariz. at 97, 4 P.2d at 381. Subflow is a narrow concept. Thus, all water in a tributary aquifer is not subflow.

We believe the *Southwest Cotton* court drew a line between subflow as part of the stream and water in the surrounding alluvium that is either discharging into the stream or being discharged by the stream. That line is relatively close to the stream bed, with variations depending on the volume of stream flow and other variables. Thus, if a well is drawing water from the bed of a stream, or from the area immediately adjacent to a stream, and that water is more closely related to the stream than to the surrounding alluvium, as determined by appropriate criteria, the well is directly depleting the stream. If the extent of depletion is measurable, it is appreciable. This is not an all-or-nothing proposition. For example, if the cone of depression <sup>10</sup> of a well has expanded to the point that it intercepts a stream bed, it almost certainly will be pumping [\*\*\*30] subflow. At the same time, however, it may be drawing water from the surrounding alluvium. Thus, part of its production may be appropriable subflow and part of it may not. Even though only a part of its production is appropriable water, that well should be included in the general adjudication.

10 The cone of depression is the "funnel-shaped area around a well, where the water table has been lowered by the withdrawal of groundwater through the well." 6 Robert E. Beck, ed., *Waters and Water Rights* 503 (1991).

We believe that the trial court's approach is inconsistent with *Southwest Cotton*. The trial court instructed DWR to apply the 50%/90 day test to all wells located in or near the younger alluvium. The record shows, however, that in a given area the younger alluvium may stretch

from ridge line to ridge line so that all wells in the valley would be in or near the younger alluvium. To say that all of an alluvial valley's wells may be pumping subflow is at odds with *Southwest Cotton's* statement that subflow [\*\*\*31] is found within or immediately adjacent to the stream bed.

Likewise, the 50%/90 day "volume-time" test does not find its origin in *Southwest Cotton*. Given enough time, and with certain exceptions, all extractions from a tributary aquifer will cause a more-or-less corresponding depletion from stream flow volume. That, indeed, is the basis of the continuing controversy between groundwater pumpers and surface appropriators. *Southwest Cotton*, however, did not purport [\*392] [\*\*1246] to identify subflow in terms of an acceptable amount of stream depletion in a given period of time. It sought to identify subflow in terms of whether the water at issue was part of the stream or was percolating water on its way to or from the stream.

Furthermore, the actual time and volume elements adopted by the trial court are essentially arbitrary. Under the trial court's test, a pumper extracting 1,000 acre feet, diminishing stream flow by "only" 499 acre feet within 90 days, would be presumed to be pumping groundwater, whereas a well owner extracting 100 acre feet, depleting stream flow by 51 acre feet, would be presumed to be pumping surface water. Nothing in *Southwest Cotton* or [\*\*\*32] the record in this proceeding justifies so arbitrary a classification. The same, of course, is true of application of the 90-day time period. Why not 75 or 100 days?

Whether a well is pumping subflow does not turn on whether it depletes a stream by some particular amount in a given period of time. As we stated above, it turns on whether the well is pumping water that is more closely associated with the stream than with the surrounding alluvium. For example, comparison of such characteristics as elevation, gradient, and perhaps chemical makeup can be made. Flow direction can be an indicator. If the water flows in the same general direction as the stream, it is more likely related to the stream. On the other hand, if it flows toward or away from the stream, it likely is related to the surrounding alluvium. The present record certainly allows neither the trial court nor us to identify a definitive set of criteria. Furthermore, it also is likely that differences in geology and hydrology from location to location may require that different criteria be given more or less emphasis, depending on the area under analysis. The record allows neither the trial court, nor us, to make [\*\*\*33] those determinations.

We conclude, therefore, that the 50%/90 day test for identifying wells presumed to be pumping subflow is

inconsistent with *Southwest Cotton* and should not be used.

### 3. The burden of proof

The trial court's 50%/90 day rule created a presumption that wells meeting the test are pumping appropriable water. The burden of proof then fell on well owners to prove that their wells did not pump appropriable water. Those arguing that the 50%/90 day test is too narrow point out that under Arizona law underground water is presumed to be percolating and that one claiming otherwise has the burden of proving the claim by clear and convincing evidence. *Neal v. Hunt*, 112 Ariz. 307, 311, 541 P.2d 559, 563 (1975); *Southwest Cotton*, 39 Ariz. at 85, 4 P.2d at 376. Thus, they conclude, the trial court's order improperly shifted to well owners the burden of proving that their wells do not pump appropriable water. We disagree. If DWR uses the proper test and relies on appropriate criteria for determining whether a well meets the test, its determination that a well is pumping appropriable [\*\*\*34] subflow constitutes clear and convincing evidence. It is consistent with Arizona law, then, to require the well owner to come forward with evidence that DWR is wrong.

### 4. The future

Finally, we recognize that the line between surface and groundwater drawn by the *Southwest Cotton* court and reaffirmed by this court today is, to some extent, artificial and fluid. As discussed above, however, we do not feel free to redraw or erase that line. It is important to remember that the *Southwest Cotton* court did not create an all-encompassing set of common law principles. It purported, instead, to interpret the relevant statutes codifying the doctrine of prior appropriation and identifying the water sources to which the doctrine applied. Those statutes remain relatively intact. See A.R.S. § 45-141. *Southwest Cotton* argued at the time for a different interpretation of the statutes and the Arizona Constitution. Since *Southwest Cotton*, many have criticized Arizona's adherence to a bifurcated system of water management. See *Leshy & Belanger, supra*, at 657-60. Now, sixty years later, [\*393] [\*\*1247] similar arguments are made that *Southwest Cotton* [\*\*\*35] misinterpreted our statutes and constitution. See *id.* at 767-90. We recognize compelling arguments in favor of unified management of Arizona's water resources. Nonetheless, in the decades since *Southwest Cotton* was decided, the Arizona Legislature has not significantly altered the opinion's reach.

*Southwest Cotton's* concept of subflow added marginally to the statutory definition of water subject to appropriation, but we do not propose to rewrite the statute further by broadening the concept of subflow. We believe the trial court's 50%/90 day rule expands the clear

words of A.R.S. § 45-141(A) to include not only waters flowing in streams but, potentially, waters pumped any place in the younger alluvium. The court's order does not explain the rule's derivation. The 50%/90 day rule does not comport with the tests laid down in *Southwest Cotton*. Water may be considered appropriable underflow if the "abstraction" by pumping results in "abstracting a corresponding amount from the surface stream." Considering subflow as "strictly a part of the stream, the test is always the same: *Does drawing off the subsurface water tend to diminish appreciably and directly the flow [\*\*\*36] of the surface stream?*" 39 Ariz. at 97, 4 P.2d at 380 (emphasis in original).

Thus, we reaffirm *Southwest Cotton's* narrow concept of subflow. We realize this does not solve the problems of equitably apportioning all available water in the state between conflicting interests and claims of groundwater users and surface appropriators. We believe, however, that in this area of the law, as much or more than any other, any appropriate change in existing law must come from the legislature. See *Arizona Groundwater Code*, Title 45, ch. 2; *Chino Valley v. City of Prescott*, 131 Ariz. 78, 638 P.2d 1324 (1981). That is as it should be. As we stated in *Arizona Public Service Co. v. Long*, 160 Ariz. 429, 436, 773 P.2d 988, 995 (1989):

Regulation of water use, . . . especially in a desert state, does not lend itself to case-by-case definition. In this field, we not only confer private rights and interests but deal in the very survival of our society and its economy. Simply put, there is not enough water to go around. All must compromise and some [\*\*\*37] must sacrifice. Definition of those boundaries is peculiarly a function for the legislature. It is plainly not a judicial task. Accordingly, we must look to the legislature to enact the laws they deem appropriate for wise use and management.

### D. Comprehensiveness Requirement

The United States is a party to this case under the McCarran Amendment, which gives consent to suits against the United States in state court adjudications that embrace "rights to the use of water in a river system or other source." 43 U.S.C. § 666(a). The United States argues that unless this adjudication includes all water hydrologically connected to the Gila River system, it will not be comprehensive enough to satisfy the McCarran

175 Ariz. 382, \*; 857 P.2d 1236, \*\*;  
1993 Ariz. LEXIS 60, \*\*\*; 144 Ariz. Adv. Rep. 17

Amendment requirement that it embrace all rights to the use of water in the river system or other source. At oral argument, the United States also asserted that the trial court in this case cannot exclude wells having only a de minimis effect on the river system. We disagree.

The McCarran Amendment recognizes that any decree from a water rights adjudication would be of little value unless it joined all parties owning rights to a stream [\*\*\*38] or water source, including the United States. According to Senator McCarran, who introduced the bill and chaired the reporting committee:

S. 18 is not intended . . . to be used for any other purpose than to allow the United States to be joined in a suit wherein it is necessary to adjudicate all of the rights of various owners on a given stream. This is so because unless all the parties owning or in the process of acquiring water rights on a particular stream can be joined as parties defendant, any subsequent decree would be of little value.

*United States v. District Court in and for Eagle County, Colo.*, 401 U.S. 520, 525, 91 [\*394] [\*\*1248] S. Ct. 998, 1002, 28 L.Ed.2d 278 (1971) (quoting from S.Rep. No. 755, 82d Cong., 1st Sess., at 9 (1951)). The McCarran Amendment was not intended to impose on the states a federal definition of "river system or other source." Rather, as the Court held in *Colorado River Water Conservation District v. United States*, 424 U.S. 800, 819, 96 S. Ct. 1236, 1247, 47 L.Ed.2d 483 (1976):

The consent to jurisdiction [\*\*\*39] given by the McCarran Amendment bespeaks a policy that recognizes the availability of comprehensive state systems for adjudication of water rights as the means for achieving [the goal of avoiding piecemeal adjudication of interdependent water rights by resolving them in a single unified proceeding].

The United States has cited no authority supporting its reading of the McCarran Amendment,<sup>11</sup> but there is contrary precedent. In *United States v. Oregon Water Resources Department*, 774 F. Supp. 1568, 1578 (D.Ore.1991), the court wrote:

Finally, the United States and the Tribe argue that because the adjudicative procedures of the State of Oregon do not call for simultaneous adjudication of rights to

surface water and rights to groundwater within a given river system, the adjudication is not comprehensive within the meaning of the McCarran Amendment. The language of the McCarran Amendment does not support this construction, and the United States and the Tribe point to no provision in the legislative history and no case precedent, state or federal, in support of this construction of the McCarran Amendment.

This correctly states the law.

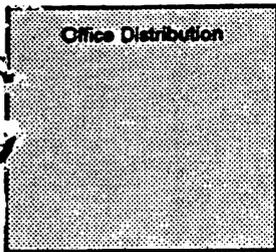
11 The United States provided this court with a copy of an unpublished decision of a California superior court in which the court granted a federal motion to dismiss on the ground that the proceeding was not comprehensive because it did not include groundwater users. We do not find that to be persuasive authority. In any event, the California court did not base its decision on what it perceived to be a rule of general application but on the peculiar facts of the case before it.

[\*\*\*40] We believe that the trial court may adopt a rationally based exclusion for wells having a de minimis effect on the river system. Such a de minimis exclusion effectively allocated to those well owners whatever amount of water is determined to be de minimis. It is, in effect, a summary adjudication of their rights. A properly crafted de minimis exclusion will not cause piecemeal adjudication of water rights or in any other way run afoul of the McCarran Amendment. Rather, it could simplify and accelerate the adjudication by reducing the work involved in preparing the hydrographic survey reports and by reducing the number of contested cases before the special master. Presumably, Congress expected that water rights adjudications would eventually end. It is sensible to interpret the McCarran Amendment as permitting the trial court to adopt reasonable simplifying assumptions to allow us to finish these proceedings within the lifetime of some of those presently working on the case.

## CONCLUSION

We vacate the portion of the trial court's September 8, 1988 order that formulated the 50%/90 day rule. We remand the matter to the trial judge to take evidence and, by applying the principles [\*\*\*41] contained in this opinion, determine the criteria for separating appropriate subflow from percolating groundwater.

# APPENDIX A-3



SUPERIOR COURT OF ARIZONA  
MARICOPA COUNTY

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June 30, 1994

HON. STANLEY Z. GOODFARB

K. Abbott  
Deputy

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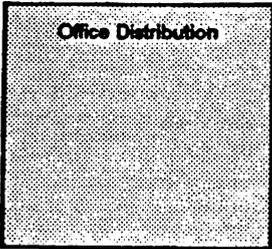
In re the General Adjudication  
of All Rights to Use Water in  
the Gila River System and  
Source

ORDER

THE NATURE OF THESE PROCEEDINGS

On July 27, 1993 the Arizona Supreme Court decided In re the General Adjudication of All Rights to Use Water in the Gila River System and Source, 175 Ariz. 382, 857 P.2d 1236 ("In re Gila") and remanded it back to this Court to make certain evidentiary decisions. That opinion was the second of six issues of law the Court accepted for interlocutory review on December 11, 1991. Those issues were accepted because this action, which adjudicates water rights under the McCarran Act, 43 USCS § 666, will be before the Courts for many years and is exceedingly complex.

Two issues were remanded. First, a test for use by the Arizona Department of Water Resources (ADWR) to determine what is known as "subflow" under Maricopa County Municipal Water Conservation District No. One v. Southwest Cotton, 39 Ariz. 65, 4 P.2d 369 (1931) ("Southwest Cotton"). "Subflow" contains appropriable water under A.R.S. § 45-141 and, therefore, is subject to the jurisdiction of this Court under state law. In this Court's opinion, "In re Gila" requires that the "subflow" zone be defined by physical factors utilizing stable geologic formations, available hydrological information, and/or organic characteristics of the area. Second, a test for use as to wells outside the "subflow" zone which create such a "cone of depression," that they cause water to be lost to or removed from the "subflow" zone, the stream bed, or the stream itself.



SUPERIOR COURT OF ARIZONA  
MARICOPA COUNTY

CLERK OF THE COURT

June 30, 1994

HON. STANLEY Z. GOODFARB

K. Abbott  
Deputy

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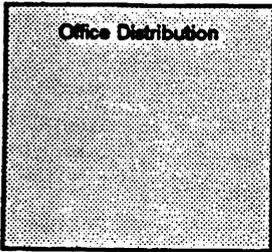
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The parties divide into two groups. The United States, Salt River Project, the Indian Tribes and the Nature Conservancy argue for a "subflow" zone as wide as possible and a "cone of depression" test which provides the greatest protection to stream flow. These parties have an interest in protecting their surface rights in stream flow because they already have appropriation rights or federal reserve rights under Winters v. U.S., 207 U.S. 564, 28 S.Ct. 207, 52 L.Ed 340 (1908). Those who refer to themselves as the "groundwater users" include the mines, several cities who depend more heavily on groundwater sources, plus certain agricultural interests. They argue for a much narrower "subflow" zone, because it provides much more protection for their use of sub-surface water sources they depend on.

On August 27, 1993 this Court took up the issues presented and the resolution process. At least two of the parties, Cyprus Mining and the City of Phoenix, previously presented requests for direction. A briefing schedule was set and request for comment on the issue with argument set for October 7, 1993. By then the Court had received a number of briefs which called for an evidentiary hearing. The Court agreed and provided certain specific orders to ADWR and others on how the evidentiary hearing would be held, how reports were to be prepared, how experts were to be presented and proposed dates and schedules.

On November 5, 1993 there was further discussion as to the contents of the experts' reports filed by December 15, 1993. The next meeting, December 10, 1993, changed the date of the evidentiary hearing from January 10, 1994 to January 31, 1994, spelled out what was expected from the parties as to testimony, and set rules on cross-examination by multiple parties and limits on evidentiary relevance.

On December 22, 1993 the Court held its first Pretrial Management Conference and set down four separate evidentiary rulings which the Court believed all parties were in agreement with, and noted what seemed to be the quality of the ten separate reports filed. The Court then requested an acetate overlay



SUPERIOR COURT OF ARIZONA  
MARICOPA COUNTY

CLERK OF THE COURT

June 30, 1994

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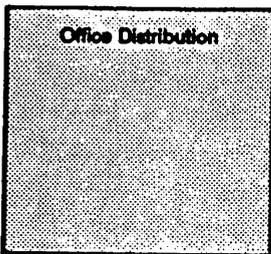
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presentation of how each party's position would show the parameters of the "subflow" zone in two typical study reaches of the San Pedro Basin. They were Reach 1 between Reddington and Mammoth (exhibit 18), and Reach 2 Palominas (exhibit 11). The acetate overlays were mounted over base maps prepared by ADWR and marked as exhibits 12 to 17 for the Palominas Reach (exhibit 11), and exhibits 19 to 25 for the Reddington Mammoth Reach (exhibit 18).

On January 14, 1994 the final details were worked out, the requested exhibits presented, mounted and viewed by all counsel, a schedule of the order of witnesses' presentations arrived at and how cross-examination would be allowed. By then an exchange of exhibits was to have occurred. Between the 14th and the 31st, disclosure statements were filed by the City of Phoenix, Maricopa County, City of Tucson, City of Benson, Apache Nitrogen, Buckeye Irrigation, City of Tempe, Apache Tribes and the Verde Valley who did so to preserve their right of cross-examination but who did not intend to offer any expert testimony and had not submitted reports.

On January 27, 1994 the groundwater users filed a disclosure statement indicating for the first time a claim that the parameters of the "subflow" zone would be defined by the lateral limits of what they called the "post-1880 entrenchment" rather than what they reported previously in Dr. Montgomery's Report of December 14, 1994. During the ten days of the hearing the "post-1880 entrenchment" theory became the focal point of their position.

On Monday, January 31, 1994 this Court commenced ten days of evidentiary testimony taken from ten different geologists and hydrologists. March 3 and 4, 1994 were spent on a field trip to the San Pedro itself. (Two hundred eighteen exhibits were then received in evidence.) Before testimony started, two sides presented oral motions to exclude the other's testimony. The groundwater users requested exclusion of all testimony as to younger alluvium arguing that "In re Gila" precluded it. Salt River Project, the United States and the Tribes argued to exclude any testimony as to the "post-1880 entrenchment" theory because it



SUPERIOR COURT OF ARIZONA  
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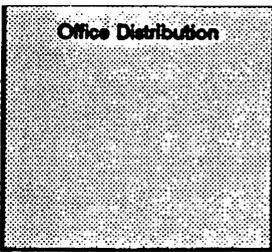
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was revealed only two court days before the hearing. Both motions were denied for the reasons stated on the record.

Testimony started on January 31, 1994 with Jon R. Ford for Salt River Project who was followed by Dr. Thomas Maddock, III, of the University of Arizona for the Nature Conservancy, Oliver S. Page for the United States, and T. Allen Gookin for the Gila River Indian Community. Following them were Dr. Errol L. Montgomery and Dr. Stanley Schumm, a geomorphologist from Colorado State University, who presented the groundwater users' position. William Wellendorf, David Stephenson and Michael Lacey followed for certain cities on February 10, 1994. Testimony then ended on February 15, 1994 with two days of Steve Erb, Chief of the Adjudication Section of ADWR.

In the testimony it soon became apparent that almost none of the experts had done any recent physical investigation on the San Pedro. What they presented largely were literature searches and investigation of their own or others' prior reports. No drilling or soils investigation had occurred. The Court, based on its own prior experience as counsel for the Arizona Department of Transportation (ADOT), recalled that the materials division of ADOT keeps a detailed index of all soils investigation made for highways constructed, bridges built and materials pits utilized for its construction in every part of this state. Since there were highways all over the San Pedro Valley, the Court had ADWR contact ADOT and discovered that it had drill logs available for the two interstate highway bridges at Benson in the San Pedro River, the bridge over the river at Charleston and the bridge at Lewis Springs. These were secured and copies made available to all parties for their use and interpretation. (These were marked as exhibits 236, 237, 238 and 239 and testified to extensively by Dr. Montgomery, Steve Erb and others). While a number of witnesses testified about opinions based upon well-driller logs of record at ADWR, after receiving the ADOT logs the United States, Salt River Project and groundwater users moved extensive drilling equipment into the area and drilled several sites in both the upper and lower reaches of the river. The information derived from these drilling programs plus



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MARICOPA COUNTY

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June 30, 1994

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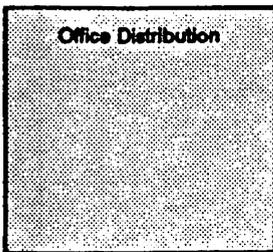
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interpretation of the ADOT drilling logs is contained in the rebuttal affidavits filed by Jon R. Ford, Oliver S. Page and Errol L. Montgomery. These were filed in lieu of further rebuttal testimony.

On March 3 and 4, 1994 the Court and a large number of counsel embarked on a two-day, 595-mile field trip covering the entire San Pedro Valley and visited more than 13 sites. There each expert was permitted to explain the geology and hydrology of the site. This was recorded by audio tape, transcribed and filed of record. It is 258 pages because at nearly every site discussion was lengthy, often at odds, and sometimes heated. The statements were first made by witnesses previously sworn at the hearings; but, by consent, statements were also taken from others including several long-time residents who were witnesses to facts of historical significance with regard to the river. These were Jack Smallhouse, a rancher in the area of Reddington whose family resided and ranched the area since 1880; Barbara Clark, a resident at Cascabel who had resided in the present location adjacent to the river for about twenty years; and Ben Lomeli, a hydrologist for BLM who is a ranger for the San Pedro River Riparian Conservation Area. A detailed discussion of the trip is contained in this Court's minute entry of March 11, 1994.

At the conclusion of the hearing on February 15, 1994, the Court established a schedule for briefing. Principal lead counsel were to file their briefs by March 18, 1994. Others were to reply by March 25, 1994. After this was done, the groundwater users filed a Motion to File a Reply Brief and a request for oral argument. Salt River Project and the United States moved to strike and deny. The Court allowed those late briefs to stand but denied oral argument. More than enough had been said and written.

Later, as will be explained on pages 39 to 42 of this decision, it became necessary that a supplementary evidentiary hearing be held. It related to a comparison of aerial photography of the San Pedro River taken in 1935 and 1990. When this Court became aware of this material, it asked ADWR to carry out a study



SUPERIOR COURT OF ARIZONA  
MARICOPA COUNTY

CLERK OF THE COURT

June 30, 1994

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№ W-1, W-2, W-3, W-4

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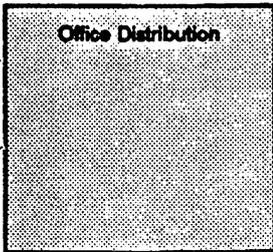
comparing the physical features of the river shown on this aerial photography which was taken fifty-five years apart. The request was to look for any changes in the location or size of the principal channel of the river or the riparian vegetation areas adjacent to the river. This hearing occurred on June 14 and June 15, 1994. Four witnesses were heard from and 83 additional exhibits were admitted.

Prior to and since that hearing this Court has reviewed all of the testimony given, all of the exhibits, participated fully in the field trip and read all of the briefs. It also re-examined the testimony and exhibits of the 1987 evidentiary hearing on the relationship of groundwater to surface water. It finds a sufficient foundation of facts needed to rule on the issues presented. Because one of the criticisms of this Court's prior instruction to ADWR on the "50%/90-day" rule was a lack of evidentiary record to support it, this order will be necessarily lengthy.

THE REASONING PROCESS WHICH LED US HERE

Having discussed the nature of the proceedings from July 27, 1993 to date, it should help to understand the decision which follows to review the thought processes which brought us here.

This McCarran Act adjudication began as a judicial process in 1979. It combines an adjudication of rights under Arizona law of prior appropriation for surface water sources, "Southwest Cotton," with the non-prescriptive right under state law to reasonable use of groundwater, Bristor v. Cheatham, 75 Ariz. 227, 255 P.2d 173 (1953), with federal law on the rights of federal entities and Indian tribes to use both surface and groundwater for the purpose of the federal entity and/or reservation creation. Cappaert v. U.S., 420 U.S. 128, 965 Ct. 2062, 48 L.Ed.2d 523 (1978). It must deal not only with rights derived from actual use under state law, but with priorities of rights reserved to federal



SUPERIOR COURT OF ARIZONA  
MARICOPA COUNTY

CLERK OF THE COURT

June 30, 1994

HON. STANLEY Z. GOODFARB

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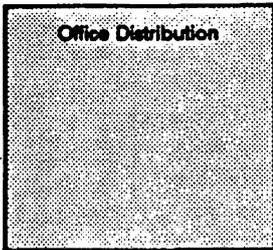
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entities and reservations under federal law because the United States is not only the owner but the Trustee of those lands, Winters v. U.S., supra.

Unfortunately, from 1979 to 1983 this case was involved in a jurisdictional dispute which was not resolved until 1983 in Arizona v. San Carlos Apache Tribe of Arizona, 463 U.S. 545, 103 S.Ct. 3201, 72 L.Ed.2d 837 (1983). After that, it took a great deal of time to bring the Hydrographic Survey Report (HSR) activities of ADWR to the point where the voluminous reports needed could be readied for judicial analysis and decision. Considering the size of the Gila watershed, its numerous sub-watersheds, the number of claimants (approximately 24,000), and the diversity of interests, that should not be surprising. While the investigation for the reports was being carried out and reports prepared, the Court, in order to use its time efficiently, attempted to hear and decide major issues which were not factually oriented. As a result, the Court issued a series of pretrial management orders and decisions including the ruling of September 9, 1988 which included the "50%/90-day" rule. As stated in "In re Gila," P. 384 of 175 Ariz:

"For five days in October, 1987, the trial court held hearings on the relationship between surface water and groundwater. Hydrologists and hydrological engineers testified and submitted reports on the relation between ground and surface water in general, and in the San Pedro and Santa Cruz watersheds in particular. The hearings were for the general education of all parties and the court, but the material adduced at the hearing was to be considered evidence on which the court could rely when appropriate."

A review of the exhibits and testimony of that hearing reflects the issue of "subflow" or how it could be physically located was not the focus of those hearings. Rather, it was a



SUPERIOR COURT OF ARIZONA  
MARICOPA COUNTY

CLERK OF THE COURT

June 30, 1994

HON. STANLEY Z. GOODFARB

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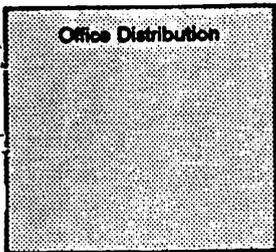
hearing as to the general relationship of surface flow to groundwater of all types. Then, and even at this latest hearing, the consensus of all testimony was that there is a hydraulic connection between nearly all groundwater and the surface flow in its area except where: 1) a confined aquifer is sealed off from surrounding basin fill or floodplain alluvium by substantial impervious layers such as clay which precludes the connection; or, 2) a groundwater aquifer is beneath an ephemeral stream and the "vadose" dry zone between the stream and the top of the aquifer substantially precludes connection.

Following the 1987 hearings, several cities filed a motion to exclude certain wells from the adjudication arguing they pumped percolating groundwater rather than surface flow or "subflow" under "Southwest Cotton." It was at this point that the "subflow" issue first significantly arose in this case and the Court's instruction to ADWR on the "50%/90-day" rule was issued on September 9, 1988. While "In re Gila" is correct in that there was no substantial evidentiary basis for that instruction, the reason for it was that the 1987 hearings did not focus on "subflow."

In dealing with the issue of "subflow" as raised in "Southwest Cotton," the hearings held in January, February, March and June 1994 specifically focused on it. All its testimony related directly to that issue and the issue of "cones of depression."

Another fact needs to be recognized. On page 391 of 175 Arizona Reports, the following statement appears:

"The trial court instructed DWR to apply the 50%/90 day test to all wells located in or near the younger alluvium. The record shows, however, that in a given area the younger alluvium may stretch from ridge line to ridge line so that all wells in the valley would be in or near the younger alluvium." (emphasis supplied)



SUPERIOR COURT OF ARIZONA  
MARICOPA COUNTY

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June 30, 1994

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W-1, W-2, W-3, W-4

In Re The Adjudication of:

Continued

The position of the second sentence that "younger alluvium may stretch from ridge line to ridge line" is factually unsupported. Every witness who testified in this hearing agreed that "younger alluvium" "Holocene alluvium" or "floodplain alluvium" (different names for the same thing) is found only in the center of this broad valley. It does not come even close to the ridge line in the upper or lower basins of this valley. Those ridge lines constitute the top of the Huachuca and Whetstone Mountains to the west and the Dragoon and Mule Mountains to the east in the upper basin from the border to Pomerene. The valley in this area is a basin fifteen to twenty miles wide.

If one proceeds geologically from the ridge line of the mountains down toward the center of the valley one encounters first substantial rock face, then some distance from the top and generally at their base the edge of the basin fill deposits. These divide geologically into an upper and lower basin fill.

Moving further toward the center of the valley one encounters the edge of what this Court will call the floodplain alluvium near the center of the valley. It is made up of those deposits laid down since the end of the "Ice Age." Its width is up to 7,000 feet in the upper basin and much narrower in the lower basin which runs from Pomerene north to Winkelman. There the ridge line is the top of Rincon and Tortilla Mountains to the west and the Winchester and Galloros to the east. The same geologic sequence of ridge line, rock face, basin fill, and finally floodplain alluvium is also found in the lower basin.

Most aquifer recharge occurs at the line of mountain front recharge. This is where the basin fill meets the rock face. It is generally thousands of feet below the ridge line and miles from the floodplain alluvium. The graphic portrayal which follows shows this relationship.

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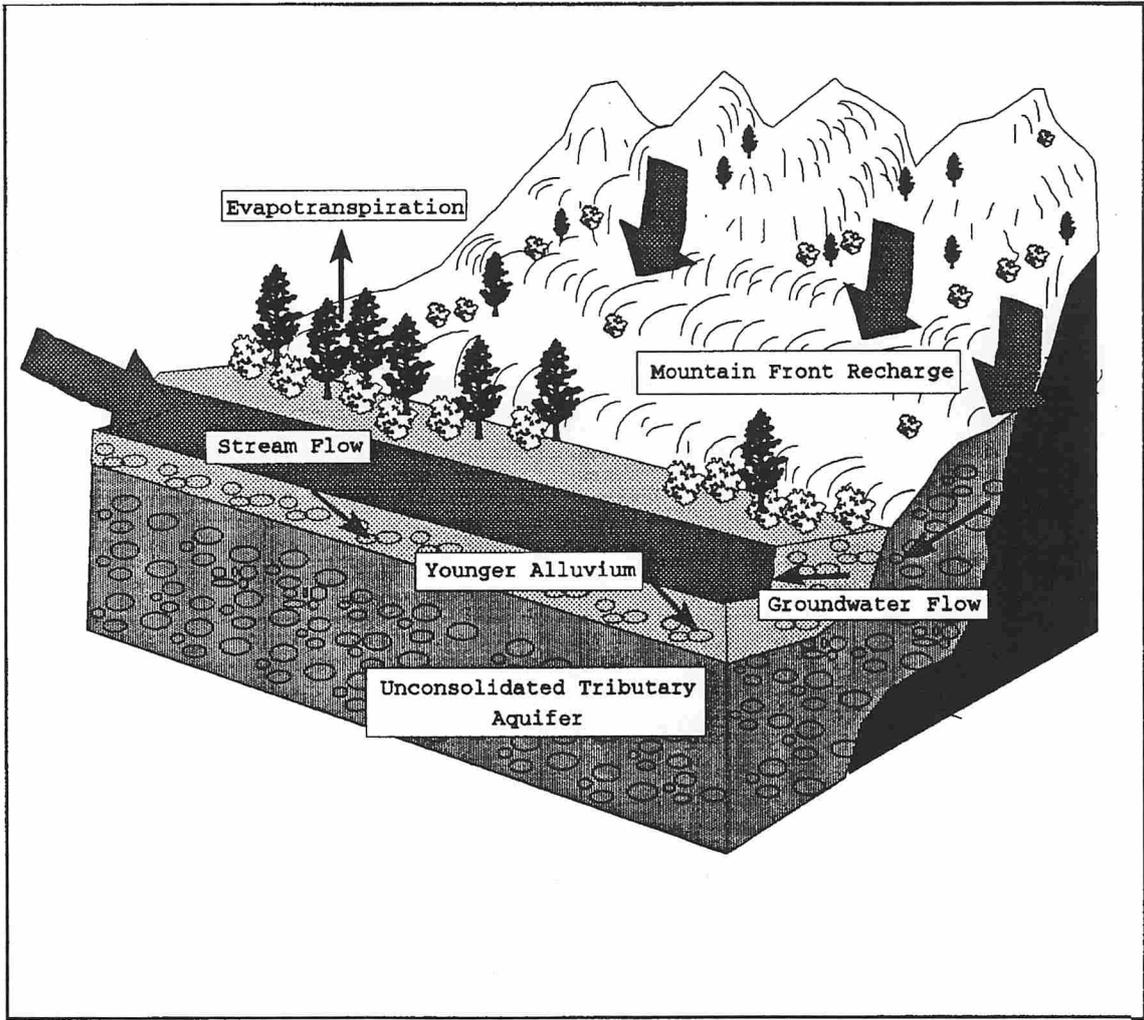
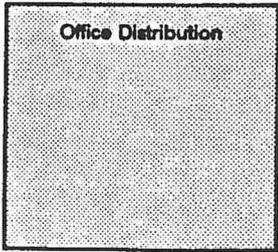


Figure 2-3. Generalized cross-section of aquifers systems.

Copy of Page 13 of Exhibit 10.



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MARICOPA COUNTY

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June 30, 1994

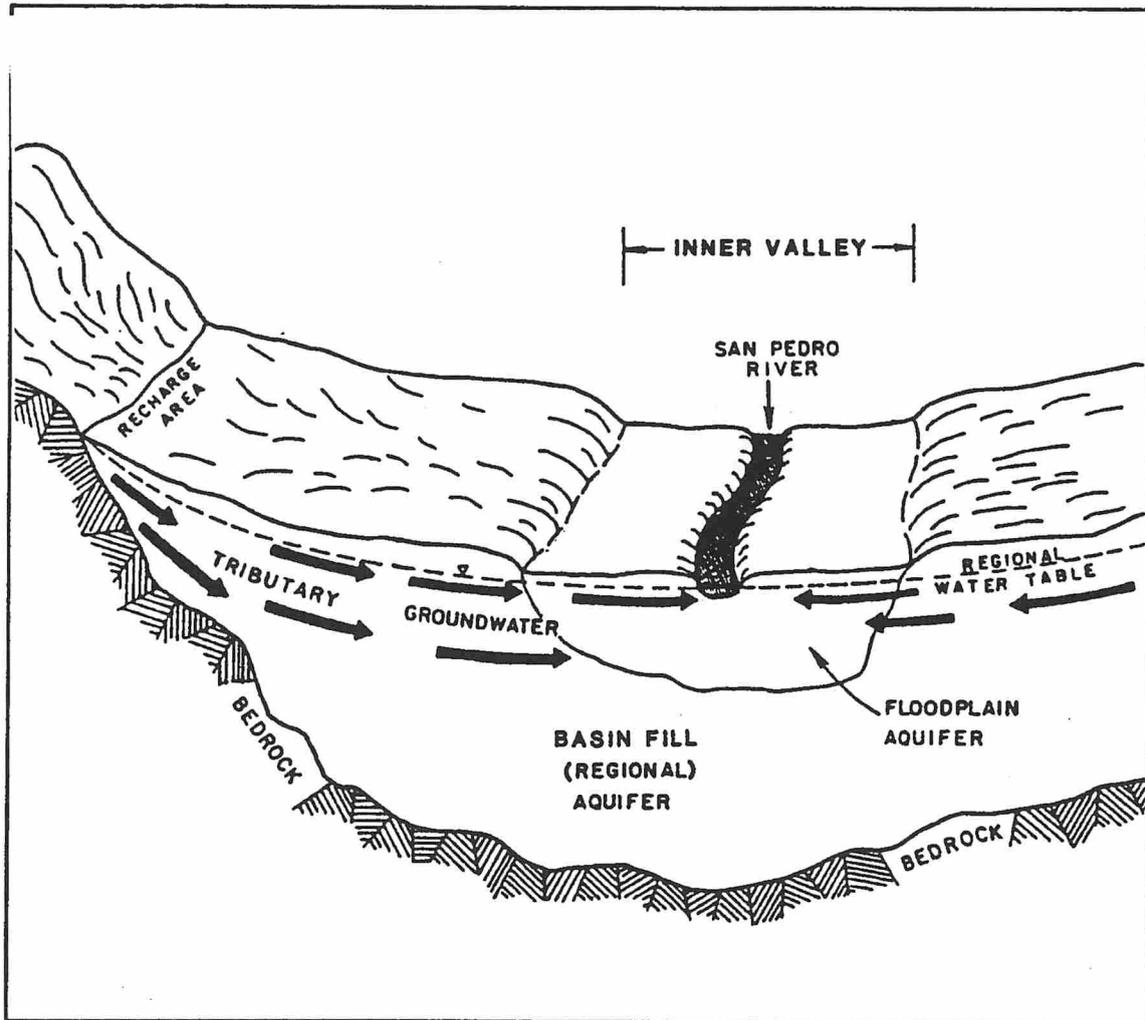
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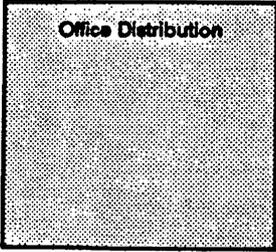
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(Modified from ADWR, 1991)

Copy of figure 4 of Exhibit 2.



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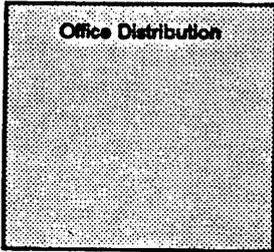
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THE SAN PEDRO RIVER

While the issues to be decided pertain to watersheds all over the Gila River watershed, the facts as to the San Pedro River need to be discussed.

The San Pedro River Valley is in the basin and range portion of southeast Arizona. It is oriented from south to north and flows from Cananea, Sonora, Mexico, to Winkelman. The valley's elevation ranges from 9,500 feet at its mountain tops to 1,920 feet at Winkelman. At the international border it is at 4,275 feet and drops to 3,590 feet at the narrows near Benson. In the United States the San Pedro River runs about 52 miles from the border to Benson and another 80 miles to Winkelman for a total of 132 miles. Its overall rate of drop is about 18 feet per mile but in the upper basin it is 13 feet per mile and 20 feet per mile in the lower basin.

According to the HSR prepared by ADWR, Table 4-12, the river naturally and normally produces approximately 160,000 acre feet of surface water per year. Approximately 64,000 acre feet is used by various cultural uses such as irrigation, mining, domestic, municipal, etc. Another 5,620 acre feet is lost to evaporation and 52,000 acre feet is used by the phreatophytes such as willow, cottonwood and mesquite which make up its riparian forests. This leaves about 58,000 acre feet of outflow both by groundwater and surface water at Winkelman into the Gila River system after recharge and return from some of the cultural and natural uses. Dr. Montgomery, in his October 2, 1987 Report for the earlier hearing (exhibit 11 of that hearing), reported on page 2 that the lower basin of the San Pedro alone had water storage capacity of 30 million acre feet in its aquifers. ADWR estimated in the HSR that the storage capacity of the San Pedro Aquifer both upper and lower



SUPERIOR COURT OF ARIZONA  
MARICOPA COUNTY

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June 30, 1994

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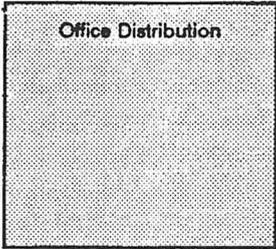
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was 84 million acre feet. Attached as Appendix A is that portion of this river's HSR which estimates its groundwater storage capacity by sub-watersheds and in total. Also attached is the water balance portion of the HSR and the aquifer storage estimate (Appendix B and C-1, C-2, C-3). In comparing these capacities to what appears to be a relatively low surface flow component, it is clear this river value as a water asset is largely in its storage capacity rather than its surface flow.

An important and unexpected bit of evidence in our case was exhibit 190, Geological Society of American monograph entitled "Entrenchment and Widening of the Upper San Pedro River, Arizona" written by Richard Hereford, a direct descendant of the founder of the town of Hereford. He provides an interesting history prior to development and post-development of the upper basin from the border to St. David. Basically what he reports is that prior to 1880 the San Pedro was a slow, swamp-like river running through various cienegas abundantly filled with large buffalo fish and beaver dams. The swamp-like conditions caused malaria in the early St. David settlements until breaching the beaver dams allowed the swamps to drain. The areas beside the river were large grassy plains with little riparian forestation. A picture of the bridge at Hereford in 1908 is shown on page 15 of exhibit 190. It shows no trees in the area and a large grassy plain next to a stream entrenched a few feet below the surface of the adjoining grasslands. On our field trip on March 3, 1994 we found a virtual forest of riparian growth nearly a mile wide.



SUPERIOR COURT OF ARIZONA  
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June 30, 1994

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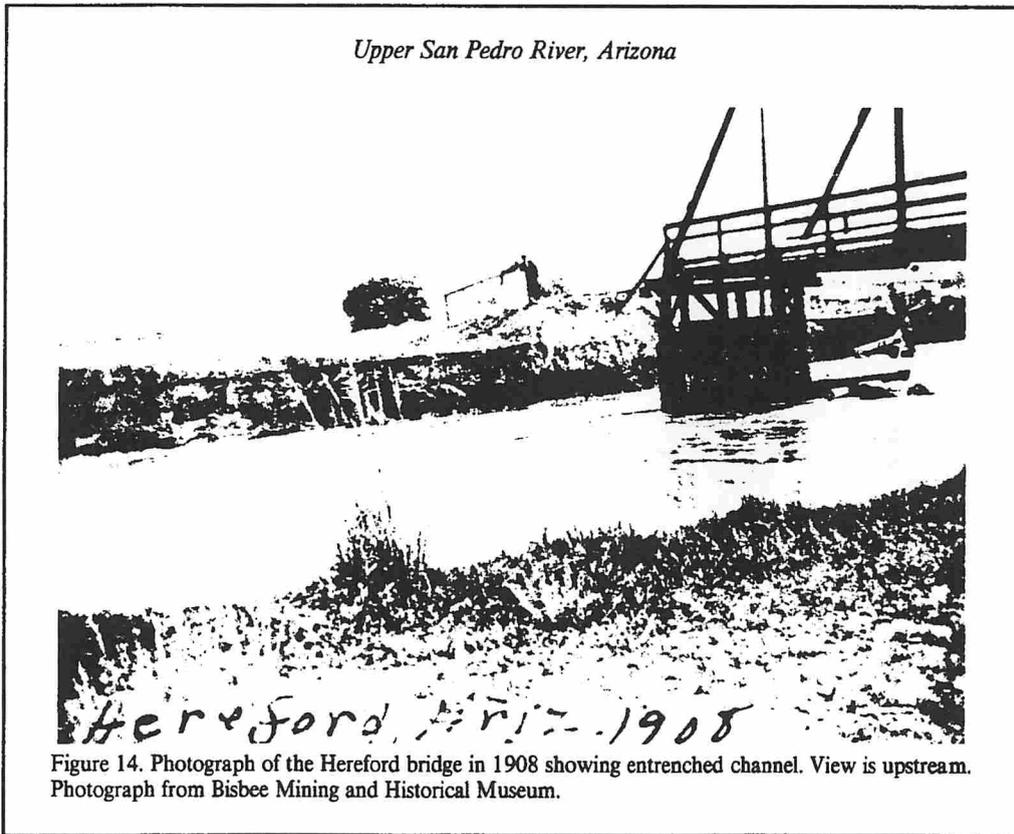
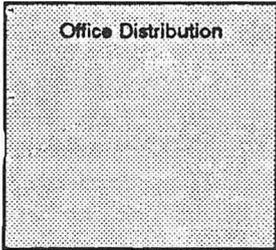


Exhibit 190 page 15.

In Hereford's Report, page 19, there are pictures taken at the Palominas bridge in 1939 and 1991 which also show the very recent heavy phreatophyte forestation. The Court's recent visitation to the area indicated even heavier growth and a channel significantly narrower from that shown even in the 1991 photo. On March 3, 1994 the Court found a lengthy three-span highway bridge,



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but a channel so narrow that one could jump across it, as several did, lodged against the eastern span of the bridge in the two pictures (one taken in 1939 and the other in 1991) that follow.

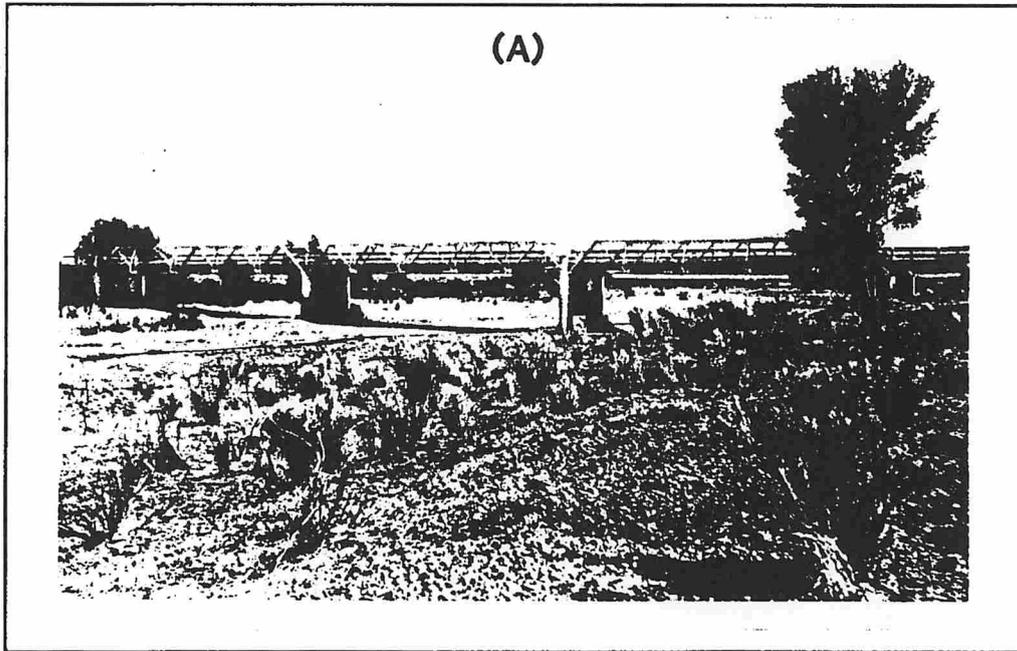


Exhibit 190 page 19.

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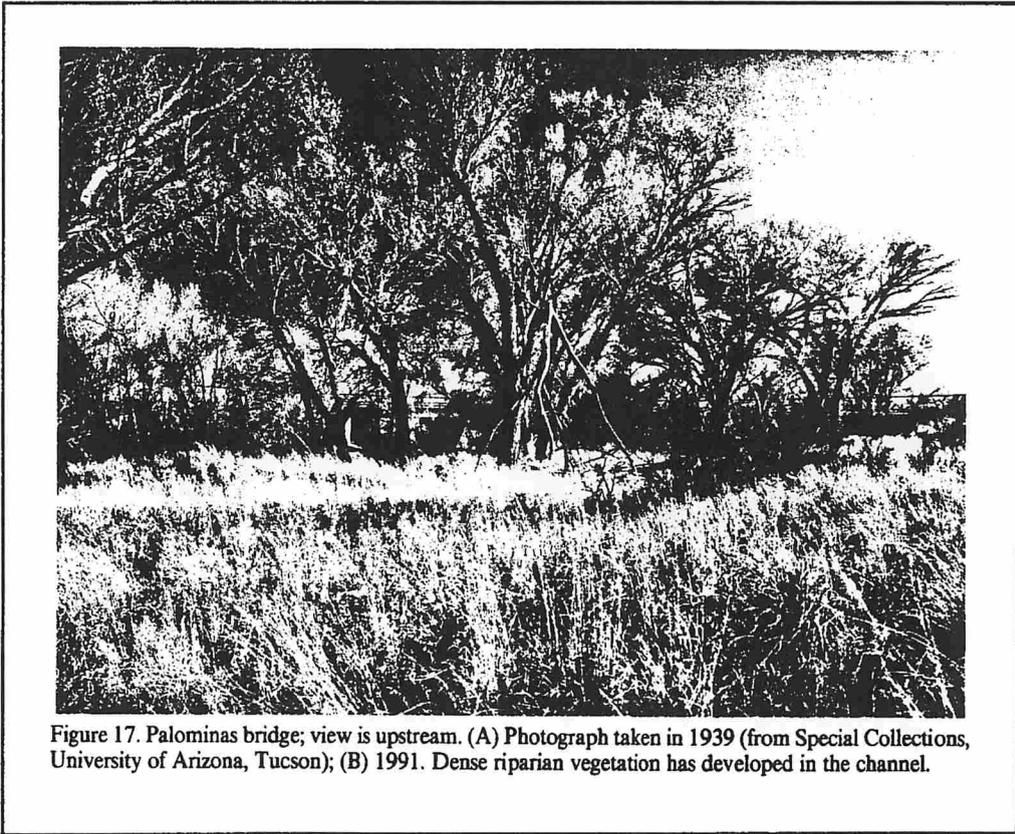
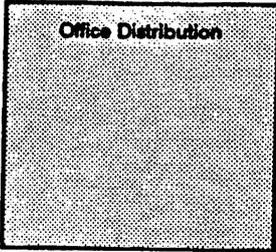


Exhibit 190 page 19.

The reports and testimony all indicate a vastly different river environment up to 1880. Thereafter, significant overgrazing of the grass cover, removal of most of the upland trees for mine and charcoal use, climatic changes, phreatophyte growth and even, it is claimed, an earthquake in Mexico drastically changed this valley. The vast herds of cattle of the late 1800s and early 1900s



SUPERIOR COURT OF ARIZONA  
MARICOPA COUNTY

CLERK OF THE COURT

June 30, 1994

HON. STANLEY Z. GOODFARB

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№ W-1, W-2, W-3, W-4

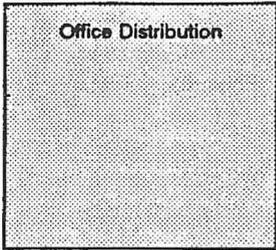
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stripped most of the grassland cover from the adjacent parts of the lower basin allowing significant erosion and phreatophyte infestation. The climate changes and overgrazing helped change the river from a slow-moving, marsh, swamp, cienega-like environment to one where heavy flash floods through narrowed channels could cause deep entrenchment and deposition. However, as Hereford reports, this entrenchment occurred mostly at times of significant flood, and nearly all of the new deposition occurred post-1937.

"The post entrenchment deposits of the San Pedro River are confined entirely within the entrenched channel; most were formed after 1937." (p. 19 of exhibit 190)

A view of the diagrams and photographs of the reports supports the positions of Ford, Page, Gookin and Erb that the "post-1880 entrenchment" of this river is simply the latest subset of a depositional process which began after the "Ice Age" and continued to date. It provides the most recent layer added to what is generally called the "Holocene" alluvium. Of all the photographs of importance in the Hereford Report, figure 11, page 12 clearly show that a deposition of flood-bank alluvium which, according to Hereford, is as recent as 1955. It is not as highly permeable or clay free as witnesses for the groundwater users urged in attempting to contrast the same with the general Holocene alluvium unit in which this latest deposition layer is inset. In a bank of no more than 6 or 7 feet there are six layers of clay showing recurring periods of deposition. Moreover, other photographs which are designated as figures 3, 4, 11 and 12 (exhibit 190) show a high degree of comparability between units of pre- and post-entrenchment depositions. Copies of these photographs follow.



SUPERIOR COURT OF ARIZONA  
MARICOPA COUNTY

CLERK OF THE COURT

June 30, 1994

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In Re The Adjudication of:

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Figure 11. Photograph of cutbank exposure of older floodplain alluvium (unit f<sub>1</sub>) on west side of river 1 km south of Lewis Springs. Downstream to right. Thin dark layers are silty clay. Scale divisions = 10 cm.

EXPLANATION

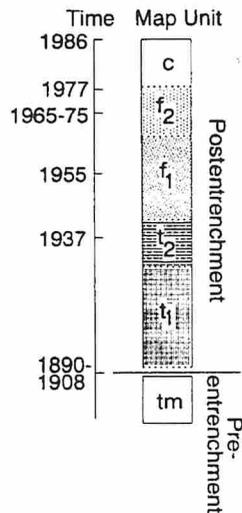


Exhibit 190 pages 8 and 12.

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In Re The Adjudication of:

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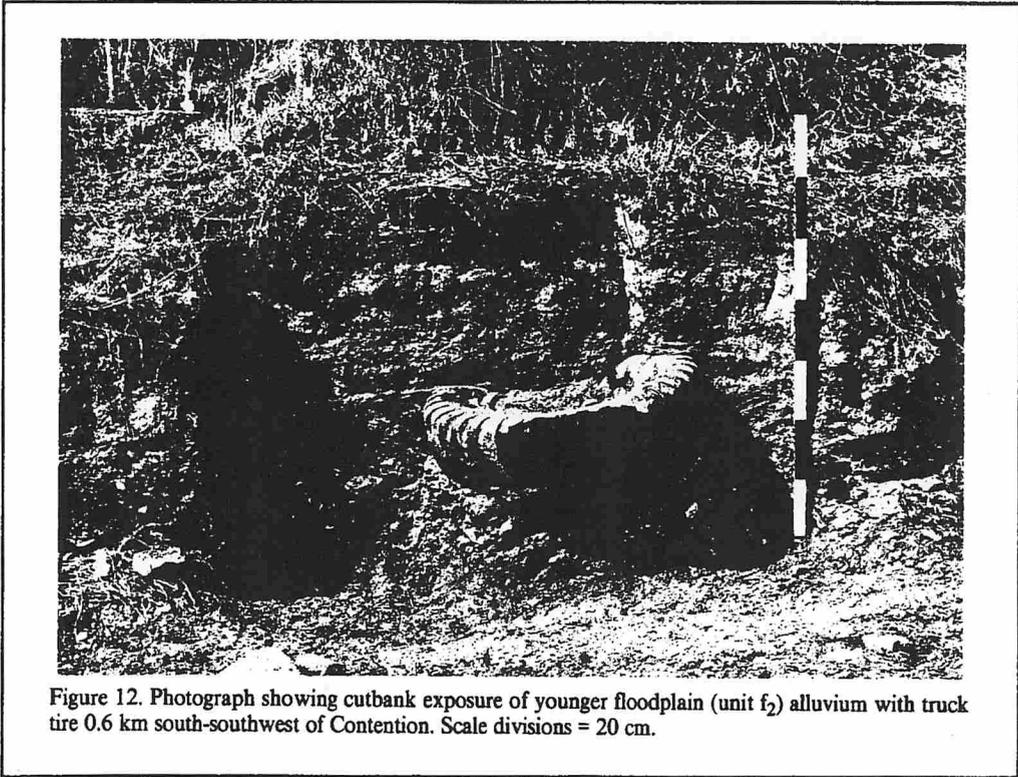


Figure 12. Photograph showing cutbank exposure of younger floodplain (unit  $f_2$ ) alluvium with truck tire 0.6 km south-southwest of Contention. Scale divisions = 20 cm.

Exhibit 190 page 12.

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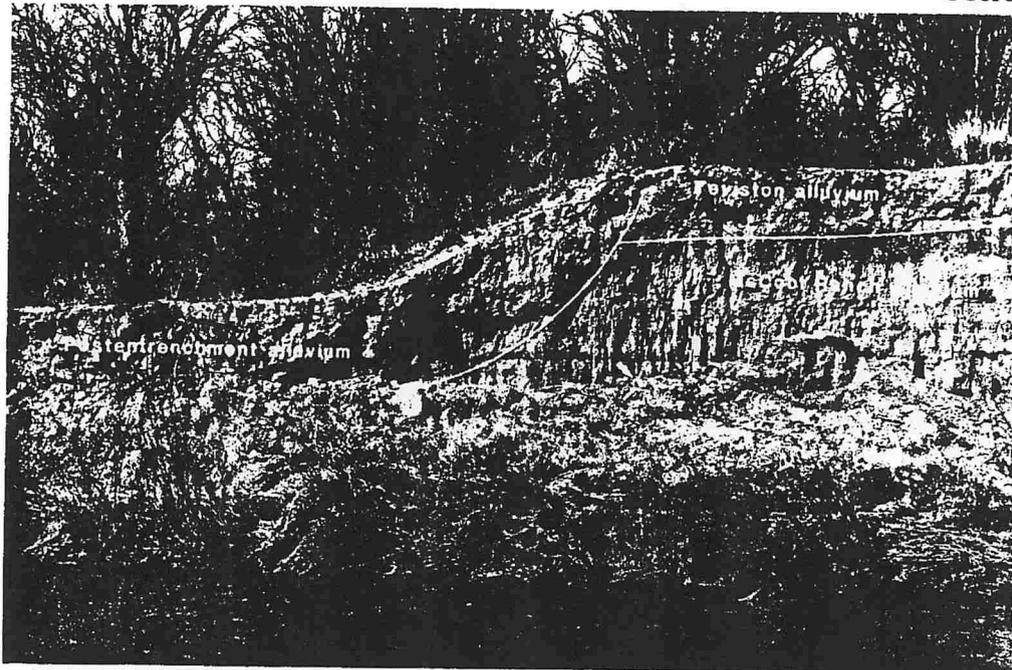


Figure 4. Photograph showing the geomorphic and cut-and-fill stratigraphic relation of the post- and pre-entrenchment alluvium on the east side of the river 3.2 km north of the Charleston gaging station. Postentrenchment alluvium (unit  $t_1$ ) forms the lower surface on the left side of the photograph. Upper surface is the pre-entrenchment McCool Ranch alluvium (unit  $t_m$ ) overlain by Teviston alluvium. Note truncation of beds in the older unit. Map units discussed in text. Scale divisions = 20 cm.

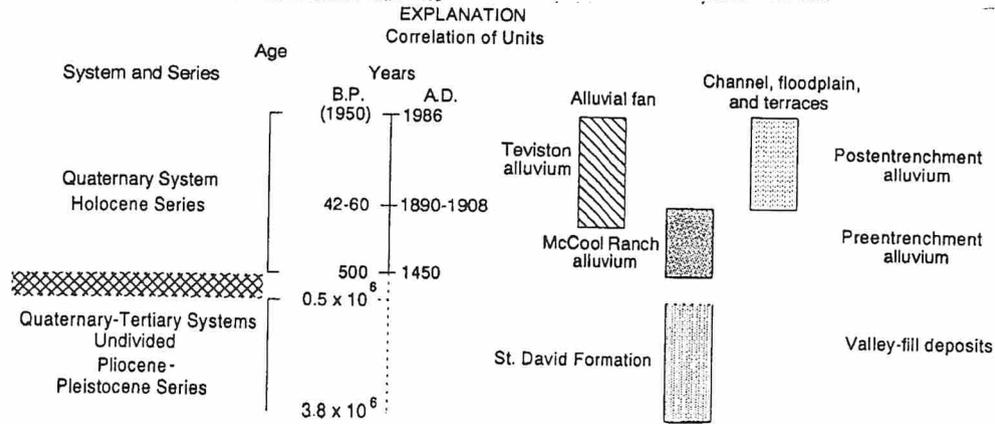


Figure 2. Geologic cross section showing correlation of surficial deposits and geomorphology of the inner valley of the San Pedro River in the vicinity of Lewis Springs. The geologic relations, geomorphology, and deposits are typical of the study area.

Exhibit 190 pages 6 and 8.

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*Upper San Pedro River, Arizona*

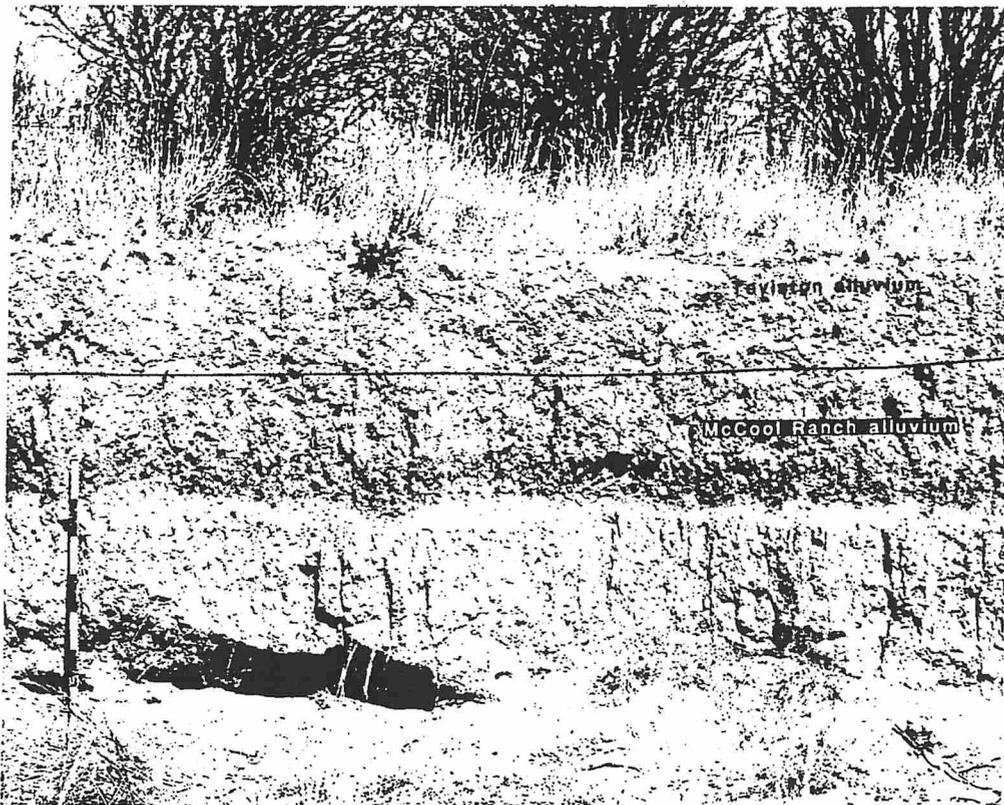
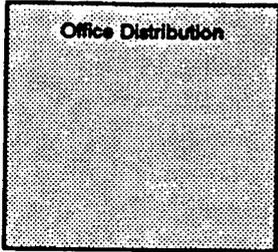


Figure 3. Photograph of a typical exposure of the pre-entrenchment alluvium 4.9 km north of Hereford. Upper Holocene Tevison alluvium overlying the McCool Ranch alluvium of Haynes (1987). Note the dark bed of cienega-type deposits near top of scale. Subhorizontal line shows contact between the alluviums. Scale divisions = 20 cm.

Exhibit 190 page 7.



SUPERIOR COURT OF ARIZONA  
MARICOPA COUNTY

7  
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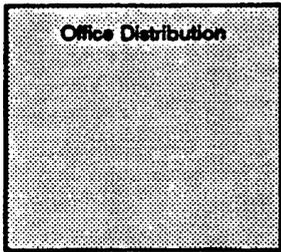
HYDROLOGIC PRINCIPLES

Hydrology is the study of the properties of water. It is a multi-disciplined science encompassing the study of physics, chemistry, geology, geography and climatology. Like many sciences, it depends upon the acceptance of certain principles agreed upon by most hydrologists. To understand the evidence received one should understand the hydrologic principles to which all the witnesses agreed.

ADWR's Report of December 15, 1993 (pages 4 to 19, exhibit 10) states them as follows:

Hydrologic Overview

"The alluvial basins of the arid West are integrated hydrologic systems composed of surface water and groundwater components. Water in these systems flows from areas of high elevation to areas of lower elevation along a path of greatest slope under the influence of gravity. Major perennial or intermittent streams occur in the central portion of the alluvial basin, occupying the lowest areas of the basin floor, flowing along the slope of the basin. The perennial or intermittent stream is typically surrounded by younger alluvium. Surface flow in the stream is derived from runoff from precipitation and groundwater discharge. Groundwater flows in unconsolidated and consolidated aquifers from the mountain fronts at the margins of the basin toward the center, occupied by the younger alluvium and the stream. Upon nearing the center of the basin in the vicinity of the younger alluvium, groundwater flows under the influence of the basin slope, in the same direction as the stream.



SUPERIOR COURT OF ARIZONA  
MARICOPA COUNTY

CLERK OF THE COURT

June 30, 1994

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W-1, W-2, W-3, W-4

In Re The Adjudication of:

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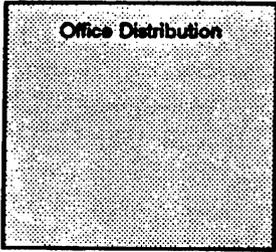
The physical character of groundwater and surface water in the vicinity of the younger alluvium is often identical. Surface water and groundwater in the area occupy the same geologic space and flow in the same direction along the slope of the basin. There is free interaction between groundwater and surface water; groundwater in the younger alluvium contributes to the surface flow and the surface flow recharges the younger alluvium. Distinguishing between groundwater and surface water in the vicinity of the younger alluvium in hydrologic terms to derive a legal standard is problematic and a byproduct of Arizona's bifurcated legal system." (pages 4-5)

Stream Types

"Surface water streams fall into one of three types: perennial, intermittent, or ephemeral. The type of stream is indicative of the extent of groundwater/surface water interactions taking place." (page 6)

"Perennial streams discharge water continuously through the year. Their source of supply is normally comprised of both direct runoff from precipitation events or snow melt, and baseflow derived from the discharge of groundwater into the stream." (page 6)

"Intermittent streams discharge water for long periods of time, but seasonally. For example, an intermittent stream may flow all winter, every winter, but never flow continuously during the summer. During seasons when baseflow is maintained,



SUPERIOR COURT OF ARIZONA  
MARICOPA COUNTY

CLERK OF THE COURT

June 30, 1994

HON. STANLEY Z. GOODFARB

K. Abbott  
Deputy

N<sup>o</sup> W-1, W-2, W-3, W-4

In Re The Adjudication of:

Continued

groundwater is contributing to the stream. During seasons of discontinuous streamflow, natural and cultural losses may be greater than the contribution from groundwater, resulting in a losing stream. Or, the amount of groundwater discharge itself may have decreased due to natural or cultural uses." (page 6)

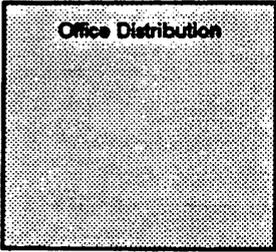
"Ephemeral streams discharge water only in response to precipitation events or snowmelt, and do not have a baseflow component at any time of the year; they flow out sporadically. The groundwater system and surface water system do not establish a hydraulic connection in these systems." (page 9)

Aquifer Types

"Aquifers are saturated geologic units that can transmit significant quantities of water under ordinary hydraulic gradients.... There are three types of aquifers identified in this study: younger alluvium, tributary aquifers, and nontributary aquifers. While these aquifers are distinct hydrogeologic units, they are interrelated parts of the dynamic groundwater system." (page 10)

Younger Alluvium

"In the Gila River system, younger alluvium aquifers are unconsolidated sand and gravel deposited within the channel course of perennial or intermittent streams by the



SUPERIOR COURT OF ARIZONA  
MARICOPA COUNTY

CLERK OF THE COURT

June 30, 1994

HON. STANLEY Z. GOODFARB

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Deputy

№ W-1, W-2, W-3, W-4

In Re The Adjudication of:

Continued

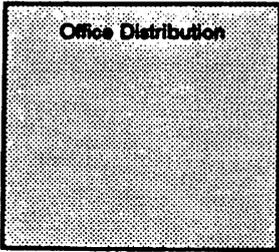
stream itself.... Groundwater in the younger alluvium is derived in large part directly from the stream system. The hydraulic gradients and groundwater flow directions are similar to the associated surface water stream. The groundwater table elevation in the younger alluvium is at or near the surface elevation of the stream.

The younger alluvium is a relatively thin aquifer. In the San Pedro river [sic] watershed, the younger alluvium ranges from approximately 10 to 200 feet thick. Also, the younger alluvium occupies only very narrow portions of the alluvial basins within the Gila River system."

....

"The younger alluvium occurs within, and defines, the channel of perennial and intermittent streams in the Gila River system. It underlies and laterally grounds the associated stream and is a hydrogeologic feature of the stream. The material that comprises the younger alluvium was deposited by the stream in the recent geologic past."  
(page 10)

"Conceptually, the stream builds its channel through scouring and fills it by deposition, thus creating the younger alluvium. Throughout geologic time, river systems have complex scouring and depositional histories as a result of the external and internal forces at work within the system.... These processes proceed at a geologic pace and



SUPERIOR COURT OF ARIZONA  
MARICOPA COUNTY

CLERK OF THE COURT

June 30, 1994

HON. STANLEY Z. GOODFARB

K. Abbott  
Deputy

N<sup>o</sup> W-1, W-2, W-3, W-4

In Re The Adjudication of:

Continued

are continuing today, defining the younger alluvium." (page 11)

Tributary Aquifers

"Tributary aquifers occur between impermeable mountain fronts and younger alluvium. They receive water from mountain front recharge and infiltration from runoff. The aquifers are in direct hydraulic connection with younger alluvium and transmit water to younger alluvium. The tributary aquifers normally have hydraulic gradients distinct from the hydraulic gradient of surface water streams and have flow directions toward surface water streams unless altered by well pumping." (page 11)

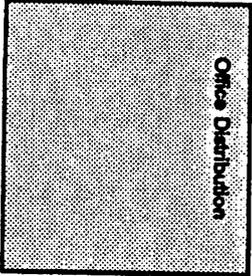
Nontributary Aquifers

"Nontributary aquifers are located in isolated groundwater basins surrounded almost entirely by impermeable hardrock with relatively narrow connections to other groundwater basins and aquifers. Nontributary aquifers have no hydraulic connection with either the younger alluvium or tributary aquifers. Any stream overlying a nontributary aquifer is ephemeral." (page 12)

Aquifer Flow Characteristics

"Aquifers are more than just reservoirs of groundwater. They are dynamic systems that receive inflows of groundwater, transmit

SUPERIOR COURT OF ARIZONA  
MARICOPA COUNTY



June 30, 1994

HON. STANLEY Z. GOODFARB

K. Abbott  
Deputy

W-1, W-2, W-3, W-4

CLERK OF THE COURT

In Re The Adjudication of:

Continued

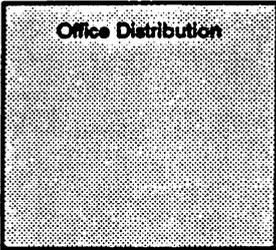
groundwater and, in some cases, discharge groundwater to surface streams.... The inflow of water recharge occurs from the infiltration along mountain fronts and stream channels, and from infiltration of excess water from cultural uses. Aquifers that border high mountains normally receive significant mountain front recharge and recharge from streamflow infiltration. Aquifers that underlie large areas of agricultural irrigation experience significant recharge incidental to the irrigation practices.

Groundwater in transit will eventually discharge to a stream if not first withdrawn by natural (plant life) or cultural uses (pumpage from wells)." (page 12)

"There are four types of groundwater/surface water interactions in the Gila River system: Alluvial valley streams, alluvial valley streams with confined zones, bedrock canyon streams, and mountain front streams." (page 14)

Alluvial Valley Streams

"Alluvial valley streams are perennial or intermittent streams that flow in alluvial basins and are underlain and bounded by younger alluvium. The alluvial basin is a structural trough filled with unconsolidated sediments derived from the adjacent mountains. These unconsolidated sediments are generally referred to as basin fill deposits (Anderson, and Johnson, 1985). The perennial or intermittent stream commonly occupies a narrow



SUPERIOR COURT OF ARIZONA  
MARICOPA COUNTY

CLERK OF THE COURT

June 30, 1994

HON. STANLEY Z. GOODFARB

K. Abbott  
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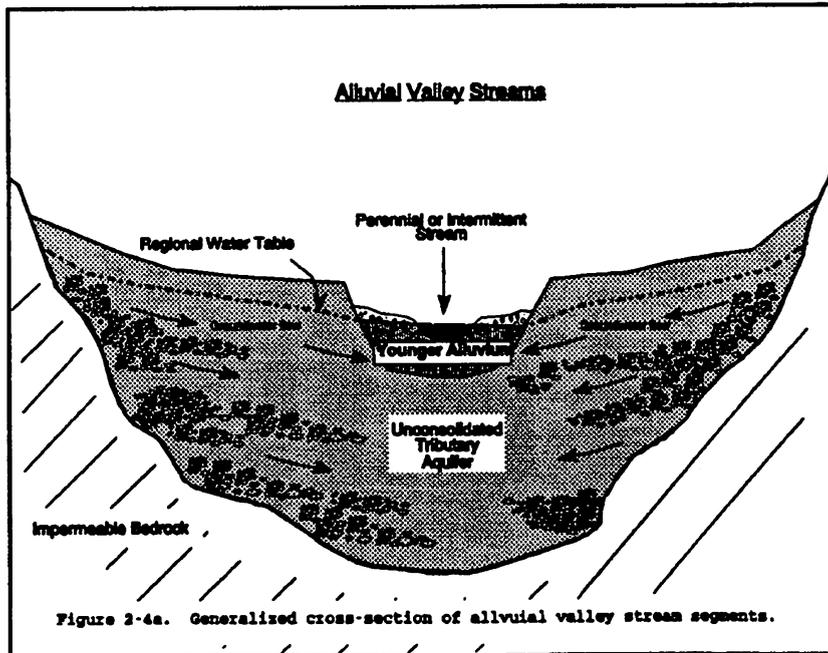
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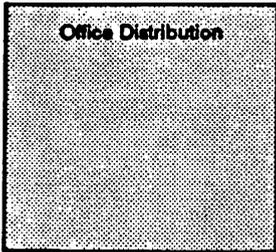
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inner valley, composed of younger alluvium, which includes the dynamic channel of the stream.

A generalized cross-section of an alluvial valley stream segment is shown in Figure 2-4a. As depicted in this figure, the younger alluvium and perennial stream occupy the inner valley.



Page 15 of Exhibit 10.



SUPERIOR COURT OF ARIZONA  
MARICOPA COUNTY

CLERK OF THE COURT

June 30, 1994

HON. STANLEY Z. GOODFARB

K. Abbott  
Deputy

№ W-1, W-2, W-3, W-4

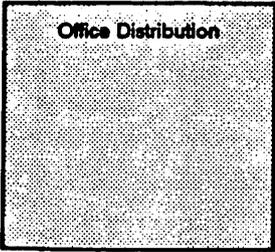
In Re The Adjudication of:

Continued

The overall groundwater system within alluvial valley stream segments has two broad components: groundwater flowing toward the stream system, and groundwater flowing with the stream system. The groundwater flowing toward the stream occurs in the tributary aquifer. Groundwater in the younger alluvium generally flows in the same direction as the stream but, to a lesser degree, also from the adjacent tributary aquifer." (pages 14-16)

Alluvial Valley Streams With Confined Zones

"Alluvial valley stream systems sometimes contain tributary aquifers with underlying confined zones. The confining layers in the tributary aquifer are composed of impermeable silt and clay (Anderson, and Johnson, 1985). The confining layers prevent vertical movement of water from the underlying tributary aquifer to the overlying younger alluvium in particular locations (Figure 2-4b), thus interrupting direct hydraulic connection between the two aquifers. It must be noted, however, that these situations occur only occasionally; whether a particular well withdraws water only from a confined zone should be determined on a well by well basis." (page 16)



SUPERIOR COURT OF ARIZONA  
MARICOPA COUNTY

CLERK OF THE COURT

June 30, 1994

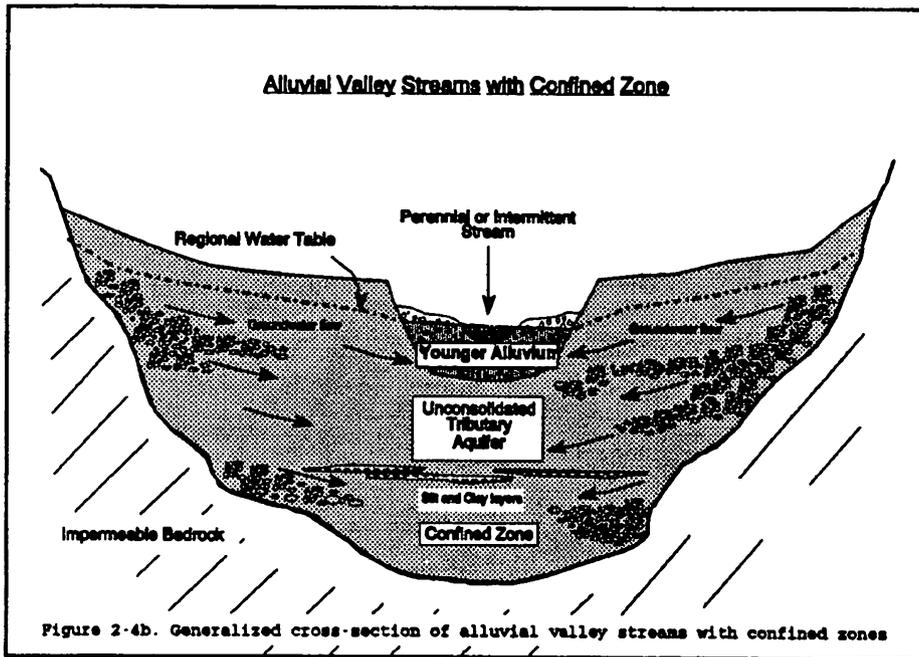
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N<sup>o</sup> W-1, W-2, W-3, W-4

In Re The Adjudication of:

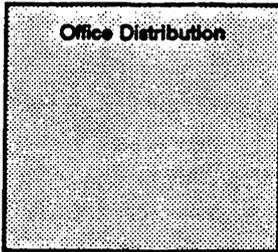
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Page 17 of Exhibit 10.

Bedrock Canyon Streams

"Bedrock canyon streams are perennial or intermittent streams located in canyons bounded by consolidated tributary aquifers or impermeable bedrock." (page 16)



SUPERIOR COURT OF ARIZONA  
MARICOPA COUNTY

CLERK OF THE COURT

June 30, 1994

HON. STANLEY Z. GOODFARB

K. Abbott  
Deputy

N<sup>o</sup> W-1, W-2, W-3, W-4

In Re The Adjudication of:

Continued

Mountain Front Streams

"Mountain front streams are stream segments in transition from bedrock canyons to alluvial basins...." "The streams are perennial or intermittent and are underlain and bounded by younger alluvium. Many streams make a transition from bedrock canyon streams, with narrow younger alluvium bounded by hard rock, to alluvial valley streams with younger alluvium bounded by tributary aquifers."  
(page 19)

Three other definitions need to be set out.

Vadose Zone - An unsaturated (dry) zone above the water table (open to atmosphere) where water pressure is less than the atmospheric pressure.

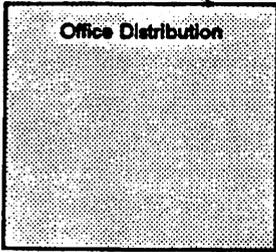
Permeability - The rate of hydraulic conductivity of the material the water is passing through (refers to aquifer).

Transmissivity - The rate of hydraulic conductivity multiplied by the height of the geologic unit it is contained in.

WHAT DOES "IN RE GILA" REQUIRE

Unfortunately, the term "subflow," which "In re Gila" deals with, has no scientific meaning in the vocabulary of hydrologists or geologists. It is a term only lawyers and judges use. Every witness said that. All we can do is apply their scientific principles to find a reasonable factual basis in which to enwrap the legal concept of "subflow." To do that we must review the language of "In re Gila."

On page 388 of 175 Ariz., the Court quoted with approval the following from "Southwest Cotton":



SUPERIOR COURT OF ARIZONA  
MARICOPA COUNTY

7  
L CLERK OF THE COURT J

June 30, 1994

HON. STANLEY Z. GOODFARB

K. Abbott  
Deputy

№ W-1, W-2, W-3, W-4

In Re The Adjudication of:

Continued

"there cannot be any abstraction of the water of the underflow without abstracting a corresponding amount from the surface stream, for the reason that the water from the surface stream must necessarily fill the loose, porous material of its bed to the point of complete saturation before there can be any surface flow."

...

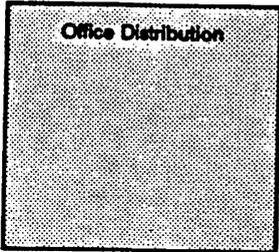
"The test is always the same: Does drawing off the subsurface water tend to diminish appreciably and directly the flow of the surface stream? If it does, it is subflow."

On page 391 it says of "Southwest Cotton":

"It seems clear that the court considered subflow and tributary groundwater to be two different classes of underground water. The former is subject to appropriation under the predecessor of A.R.S. § 45-141(A); the latter is not."

On page 390 the present court quotes Kinney's 1912 work on "The Law of Irrigation and Water Rights" that "subflow" is "strictly confined to the river bottom" and "the water must be within the bed of the surface stream itself." Yet on page 391 of 175 Ariz., the case states an opinion more in conformity with present science and at odds with Kinney's narrow-bed theory:

"We believe the Southwest Cotton court drew a line between subflow as part of the stream and water in the surrounding alluvium that is either discharging into the stream or being discharged by the stream. That line is relatively close to the stream bed, with



SUPERIOR COURT OF ARIZONA  
MARICOPA COUNTY

CLERK OF THE COURT

June 30, 1994

HON. STANLEY Z. GOODFARB

K. Abbott  
Deputy

№ W-1, W-2, W-3, W-4

In Re The Adjudication of:

Continued

variations depending on the volume of stream flow and other variables. Thus, if a well is drawing water from the bed of a stream, or from the area immediately adjacent to a stream, and that water is more closely related to the stream than to the surrounding alluvium, as determined by appropriate criteria, the well is directly depleting the stream. If the extent of depletion is measurable, it is appreciable. This is not an all-or-nothing proposition. For example, if the cone of depression of a well has expanded to the point that it intercepts a stream bed, it almost certainly will be pumping subflow. At the same time, however, it may be drawing water from the surrounding alluvium. Thus, part of its production may be appropriable subflow and part of it may not. Even though only a part of its production is appropriable water, that well should be included in the general adjudication."

Moreover, the present court said on page 391,

"To say that all of an alluvial valley's wells may be pumping subflow is at odds with Southwest Cotton's statement that subflow is found within or immediately adjacent to the stream bed."

The sentence quoted is dependent upon the previous sentence which states,

"The record shows, however, that in a given area the younger alluvium may stretch from ridge line to ridge line so that all wells in the valley would be in or near the younger alluvium."

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MARICOPA COUNTY

CLERK OF THE COURT

June 30, 1994

HON. STANLEY Z. GOODFARB

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W-1, W-2, W-3, W-4

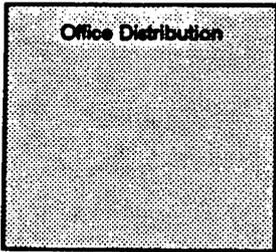
In Re The Adjudication of:

Continued

As stated before, every witness found that statement not scientifically supportable. It violates general principles of geology and hydrology. Therefore, this trial court must suggest, based on the evidence before it, that at least some portion of the wells in a valley's alluvium must be pumping "subflow" or their "cones of depression" have reached the "subflow" area. Therefore, they are depleting the surface flow as indicated by the previous quotation on pages 32 and 33 which discusses the surface flow's tendency to fill the loose, porous material of its bed. The only logical and rational way the "Southwest Cotton" and "In re Gila" theories as to "subflow" can be made consistent with the scientific principles testified to is to turn to the tests on page 392 of 175 Ariz. where the Supreme Court itself urged of flow direction, elevation, gradient and chemical composition.

"Whether a well is pumping subflow does not turn on whether it depletes a stream by some particular amount in a given period of time. As we stated above, it turns on whether the well is pumping water that is more closely associated with the stream than with the surrounding alluvium. For example, comparison of such characteristics as elevation, gradient, and perhaps chemical makeup can be made. Flow direction can be an indicator. If the water flows in the same general direction as the stream, it is more likely related to the stream. On the other hand, if it flows toward or away from the stream, it likely is related to the surrounding alluvium."

If we add to those tests the concept that if a "subflow" zone can be differentiated from adjacent geologic units such as tributary aquifers and the basin-fill aquifer which discharge into it or receive discharge from it, a set of principles can be developed to define "subflow" and still be consistent with "Southwest Cotton" and science.



SUPERIOR COURT OF ARIZONA  
MARICOPA COUNTY

CLERK OF THE COURT

June 30, 1994

HON. STANLEY Z. GOODFARB

K. Abbott  
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NW-1, W-2, W-3, W-4

In Re The Adjudication of:

Continued

DEFINING "SUBFLOW"

A. General Principles

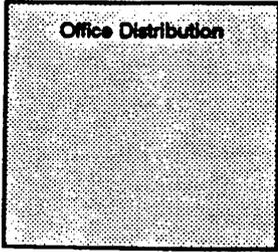
The briefs filed, except for that of the Nature Conservancy, take a position of 1) a narrow band defined by the edge of the river principal channel, or 2) a slightly larger post-1880 depositional layer, or 3) the edge of the central valley's younger alluvium. The Nature Conservancy offers two solutions, the first geologic and the second solution provided by the area's natural vegetation, the growth of phreatophytic plants located in the riparian zone. Consideration of all of these proposals does not require an "either/or" solution. Rather, it provides an opportunity to use a building-block method to find proper parameters of the "subflow" zone laterally and vertically. This Court will attempt to do this by going from the narrowest to the widest zone, and for each asking whether it can be a part of a wider zone or does it define the absolute limits of "subflow."

Before discussing the conflict between different sides or proposals, the Court finds that the opinion of "In re Gila" and the evidence which was uncontested requires that any "subflow" zone must be defined by at least the following principles:

1. The "subflow" zone must be adjacent and beneath a perennial or intermittent stream.

2. It may not be adjacent or beneath an ephemeral stream. However, it may be adjacent or beneath an ephemeral section of a perennial or intermittent stream, if the ephemeral section is caused by adjacent surface water diversion or groundwater pumping. There must, however, be a saturated zone beneath connected to similar zones beneath the upper and lower perennial or intermittent stream sections.

3. Except as set forth in paragraph 2 above, there must be a hydraulic connection between the surface stream and the "subflow" zone.



SUPERIOR COURT OF ARIZONA  
MARICOPA COUNTY

CLERK OF THE COURT

June 30, 1994

HON. STANLEY Z. GOODFARB

K. Abbott  
Deputy

N<sup>o</sup> W-1, W-2, W-3, W-4

In Re The Adjudication of:

Continued

4. The "subflow" zone must be distinguished from adjacent tributary aquifers or connecting basin fill.

5. The parameters of the "subflow" zone, if it is to be defined by reference to the saturated floodplain alluvium, Holocene alluvium, or younger alluvium, must be outside of and not include those tributary alluvial deposits known as "inliers" as indicated in figure 6 of the Stetson Report (exhibit 2).

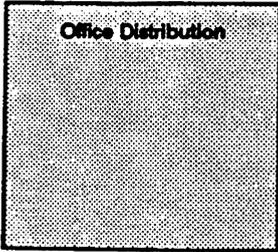
6. Wells which are located in but perforated below the saturated floodplain alluvium aquifer are to be included in the "subflow" component unless these perforations are proven by their owners to be below a confining zone of impermeable material such as clay as the inevitable "draw-down" of the well must affect the "subflow zone" above the perforation.

7. Wells located outside the lateral parameters of the defined "subflow" zone are not included unless it is proven that their "cones of depression" reach the "subflow" zone and the drawdown from the well affects the volume of surface and "subflow" in such an appreciable amount that it is capable of measurement.

B. Edge of the Principal or Dynamic Channel

The reports of Don Young for the State and William G. Wellendorf for the Town of Mammoth and the Gila Valley Irrigation District (exhibits 5 and 8) propose the narrowest of the "subflow" zones, to wit: the edge of the bed of the principal channel which, interestingly enough, Mr. Wellendorf defines as the "Holocene" channel as contrasted to Dr. Montgomery's "post-1880 entrenchment." Within its banks the low-flow stream meanders back and forth in large figure "S" curves. These banks are defined by the highest flows of one- to three-year flood cycles.

The sole merit of these proposals is the banks or edges of the channel are easily found on aerial photography: "just look for the white sand." He frankly admitted on June 1, 1994 that all he did was use the contour lines on the U.S.G.S. quad maps for the



SUPERIOR COURT OF ARIZONA  
MARICOPA COUNTY

CLERK OF THE COURT

June 30, 1994

HON. STANLEY Z. GOODFARB

K. Abbott  
Deputy

W-1, W-2, W-3, W-4

In Re The Adjudication of:

Continued

basin and little else. These contour lines bear no relationship to any geologic difference in the formation. Wellendorf's testimony clearly showed a theory of using the most easily found ground feature and then dealing with the real problems of surface water depletion on a case-by-case method by determining the extent of each well's "cone of depression." The problem with any proposal which emphasizes "cone of depression" solutions over finding an adequate "subflow" zone is that the determination of a well's "cone of depression" is a very complicated, difficult and expensive process. This is seen in the confrontational testimony of Montgomery, Ford and Page on how to use the various computer-program techniques and which program is more accurate or useful. All, however, agreed that "cone of depression" analysis is expensive and complicated, and that the assumptions necessary and the frequent lack of data to support such computer techniques reduce the reliability significantly.

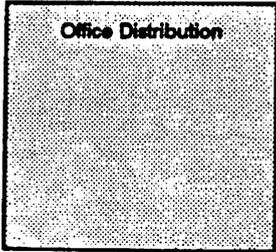
Even witness Wellendorf agrees as is seen in this discussion between himself and the Court as reported on pages 64 and 65 of Volume VIII of the hearing transcript:

THE COURT: Did you not make this statement on page 6 of your report, the last sentence of the middle paragraph: 'While empirical techniques exist to numerically model this technique, heterogeneities known to exist in aquifers quickly reduce the effectiveness of these techniques.'

I probably mispronounced 'heterogeneities.' Is that correct?

THE WITNESS: Yes.

THE COURT: What in fact you're basically telling us is that the technique of determining cones of depression, particularly when the elevation of the water level is not



SUPERIOR COURT OF ARIZONA  
MARICOPA COUNTY

CLERK OF THE COURT

June 30, 1994

HON. STANLEY Z. GOODFARB

K. Abbott  
Deputy

W-1, W-2, W-3, W-4

In Re The Adjudication of:

Continued

flat all the way across but is sloping down to the river and maybe [sic] sloping the other way naturally, is subject to a number of assumptions that make it very difficult.

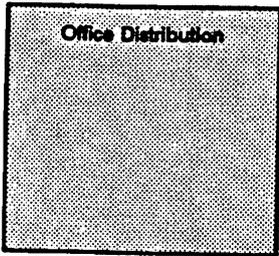
THE WITNESS: Correct.

THE COURT: So from your standpoint of what you've done, you've given us the narrowest subflow zone and set up the most complex method of determining what we're going to set up in this adjudication, because you are going to have to determine individually whether or not each well has a cone of depression which hits either your subflow zone or the stream flow, isn't that correct?

THE WITNESS: Yes."

Also, witnesses agreed no one with any common sense locates a well in the channel where the flooding expected on a one-to three-year basis can destroy the well's mechanical and electrical functions. Therefore, to utilize a method which would put every single well in the basin outside the "subflow" zone--even where a well sits on the banks of the river 10 to 20 feet from its flow--presents a danger of turning this adjudication into a totally meaningless activity while the river is slowly sucked dry like the Santa Cruz River.

While Mr. Young suggests the vertical limits of his "subflow" zone are the top of the older alluvium or bedrock where no older alluvium exists, Wellendorf's vertical limit is almost impossible to find especially if one looks at his figure 2 exhibit of "Holocene Cross Channel Cross Section and Complete Fining Upward Sequence" (see exhibit 8). He appears to place his vertical bottom at bedrock. The testimony of this hearing indicated deep alluvial and basin-fill deposition. There was no testimony of how far it is to bedrock. The only limit is the HSR use of a 1,200 foot fill to



SUPERIOR COURT OF ARIZONA  
MARICOPA COUNTY

CLERK OF THE COURT

June 30, 1994

HON. STANLEY Z. GOODFARB

K. Abbott  
Deputy

N<sup>o</sup> W-1, W-2, W-3, W-4

In Re The Adjudication of:

Continued

determine the aquifer capacity of 85 million acre feet. The question then must be asked, "Why not the same basis for choosing the lateral limits as those used to choose the vertical limits?" When we note that what these two experts had done was draw a hypothetical line down the middle of the same geological unit, we must realize that their lateral limits have no geological, hydrological or riparian basis.

If that weren't enough, the real problem of this proposal is that the location of today's principal channel boundaries have no stability all as admitted by Mr. Wellendorf on page 78, line 8 to 23:

"THE COURT: Let me ask you two other questions because of what she brought up. Dr. Montgomery suggested that the principal channel, while probably somewhat stabilized today, has previously had and does still have some meander effect as compared to his theory of post-entrenchment alluvium. Would you agree with that?

THE WITNESS: Yes.

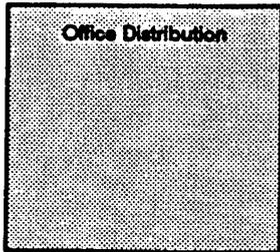
THE COURT: So that the channel is subject to being moved by high floods, high flows and things of that nature.

THE WITNESS: Yes, I think it would take a pretty major event.

THE COURT: Like some of the floods that are mentioned in Hereford's report?

THE WITNESS: Yes."

At the Paul Sale property near Winkelman on March 4, 1994, Mr. Sale explained how the 1983 flood had moved the channel 1,000 feet



SUPERIOR COURT OF ARIZONA  
MARICOPA COUNTY

CLERK OF THE COURT

June 30, 1994

HON. STANLEY Z. GOODFARB

K. Abbott  
Deputy

W-1, W-2, W-3, W-4

In Re The Adjudication of:

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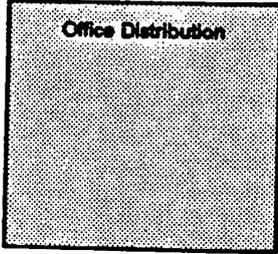
westward and wiped out 90 acres of his farm land. In 1993 the channel moved once more. This time it ended up 500 feet eastward after it moved westward again and took out 15 additional acres of his pecan orchard. Further, he also pointed out the several locations the principal channel had occupied since he had begun farming there in 1970 and how it had moved after the 1979, 1980, 1983 and 1993 floods.

On the last day of court testimony Steve Erb testified how a comparison of the 1935 aerial photograph to the more recent 1990 aerial photograph showed significant changes in location of the river channel from Pomerene north for several miles (see exhibits 260 and 261). During his cross-examination there was a discussion of an overall review of the 1935 aerial photography and a comparison to the latest 1990 photographs. This was also reviewed in a discussion on our field trip at the beginning of March 4, 1994.

Also in the Hereford report (exhibit 190), page 8, figure 5, there is presented a clear representation of channel migration in a large meander about 2 miles north of the Hereford bridge. It illustrates channel movement of approximately 1,500 feet.

As a result of this, the Court requested that ADWR compare its 1935 aerial photography with its latest 1990 photos along the entire river and report any channel changes found. That report now completed indicates the channel is not stable. It often narrows and shifts significantly. The results of that study, exhibit 365 and Appendix E1 to E3 and the map of the area of the study (Appendix D) are attached. The study shows a single channel widening of up to 168 feet and a narrowing in 27 locations of from 67 feet to 976 feet. It also shows 28 shifts in overall channel location of from 66 feet to 1,200 feet.

Unfortunately none of the 1935 aerial photography was then placed in evidence during the ten-day hearing. The same was true of most of the 1990 aerial photography except for exhibits 260 and 261. This Court, therefore, brought the matter up at its



SUPERIOR COURT OF ARIZONA  
MARICOPA COUNTY

CLERK OF THE COURT

June 30, 1994

HON. STANLEY Z. GOODFARB

K. Abbott  
Deputy

W-1, W-2, W-3, W-4

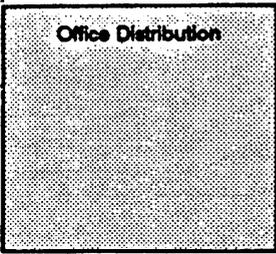
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Continued

monthly hearing on April 29, 1994 in the following manner as indicated by its minute entry of that date.

"The Court, while working on the ruling for the trial, recalled the testimony of Steve Erb and the discussion with Mr. Sales regarding the movement of the river at Pomerene during the 1970, 1983 and 1993 floods. The Court requested that ADWR compare the 1935 and 1990 aerial photographs to determine the movement of the channel as well as what happened to the riparian areas along the river. The photos from 1935 are the earliest photos except for some old historical photos found in exhibit 190, the Hereford Report, and the book entitled The Changing Mile. ADWR did 26 transects on the river and found a substantial narrowing of the channel. The widest widening of the channel from 1935 to 1990 was 100 feet; the greatest narrowing was 900 feet. There was only one instance of widening but 25 instances of narrowing and 26 instances of substantial shifts, the largest of which was approximately 1,000 feet. The photographs will be available after the hearing and Chuck Cullom will answer questions from counsel. ADWR will have the materials available for the next 10 days and copies are available. The Court intends to use these studies for its ruling. If counsel wish to contest the results of this study, affidavits may be filed as was done with the rebuttal affidavits at the evidentiary hearing."

Thereafter several parties filed affidavits. Salt River Project filed an Affidavit of Jon Ford who supports the conclusions of ADWR and opines what appears to be a rational reason for the narrowing of the channel to wit: vegetative growth during periods



SUPERIOR COURT OF ARIZONA  
MARICOPA COUNTY

CLERK OF THE COURT

June 30, 1994

HON. STANLEY Z. GOODFARB

K. Abbott  
Deputy

№ W-1, W-2, W-3, W-4

In Re The Adjudication of:

Continued

of low water flow, consisting of phreatophytes above the "subflow" zone, attempts to fill in all but the low-flow channel. However, during periods of high flow the erosive force of the floods "clean out" these vegetative obstructions. William G. Wellendorf also filed an Affidavit which basically criticized ADWR's technique of photo interpretation.

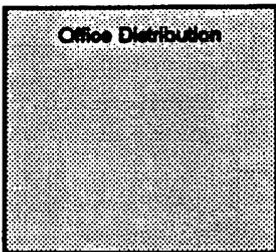
Dr. Errol Montgomery also filed an Affidavit which also attempts to critique ADWR's photo comparison method, but basically agrees with ADWR's substantial conclusions that there is substantive evidence of a narrowing of the principal channel from 1935 to 1990 and some shifting of its location. Basically Dr. Montgomery's Affidavit was directed to showing that most, if not all, of these shifts in location and size took place within the boundaries of what he proposes for the "post-1880 entrenchment" and deposition zone.

As the affidavits increased, there was a further request for an evidentiary hearing and the Court agreed to hold such and did on June 14 and 15, 1994.

The hearing produced testimony from Charles Cullom of ADWR who did all of its reports on the comparative aerial photo interpretation, Jon Ford for SRP, William Wellendorf for the Town of Mammoth and Drs. Schumm and Montgomery for the groundwater users.

While all agreed that an attempt to compare early aerial photography (1935) to recent photography (1990) was a difficult scientific process which could not produce exact comparisons, all agreed that experienced analysts could determine important information if carefully done. This Court believes all who testified were very experienced, did a careful job and the results were very important in that it showed:

1. The principal channel in nearly every instance where a comparison could be made was narrowed often significantly between 1935 and 1990.



SUPERIOR COURT OF ARIZONA  
MARICOPA COUNTY

CLERK OF THE COURT

June 30, 1994

HON. STANLEY Z. GOODFARB

K. Abbott  
Deputy

N<sup>o</sup> W-1, W-2, W-3, W-4

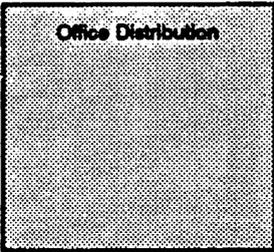
In Re The Adjudication of:

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2. When that narrowing occurred, there was often a shift in location of the whole channel to the east or west. In several instances this shift took it beyond the channel parameters of either Wellendorf, Young, Schumm or Montgomery. See exhibits 260, 261, 313, 317, 319, 320, 324, 325, 328, 330, 331, 332, 333, 334, 335, 338, 339 and 365.

Exhibits 313 and 365 are the latest ADWR calculations of the channel changes on the 28 transects mentioned previously. Exhibit 331 is the calculation made by Errol L. Montgomery and Associates, Inc. from the same aerial photography. The latter two exhibits (365 and 331) are also attached as Appendix E-4 to E-8. In addition to those calculations, this Court made its own comparison of each of the aerial photographs and based on all of the above finds:

CHANNEL MOVEMENT				
TRANSECT LOCATION	CHANNEL SIZE	FEET	DIRECTION OF MOVEMENT	FEET
1a	widen	168'	east	500'
2a	narrowed	207'	west	491'
2b	narrowed	307'	east	656'
2c	narrowed	477'	east	288'
2d	narrowed	104'	east	143'
3a	narrowed	170'	east	449'
3b	narrowed	439'	west	429'
3c	narrowed	398'	east	530'
3d	narrowed	134'	east	107'



SUPERIOR COURT OF ARIZONA  
MARICOPA COUNTY

CLERK OF THE COURT

June 30, 1994

HON. STANLEY Z. GOODFARB

K. Abbott  
Deputy

N<sup>o</sup> W-1, W-2, W-3, W-4

In Re The Adjudication of:

Continued

CHANNEL MOVEMENT				
TRANSECT LOCATION	CHANNEL SIZE	FEET	DIRECTION OF MOVEMENT	FEET
4a	narrowed	236'	east	190'
4b	narrowed	337'	west	557'
5a	narrowed	100'	west	64'
5b	narrowed	630'	west	541'
5c	narrowed	62'	east	964'
6a	narrowed	134'	west	234'
6b	narrowed	100'	west	1200'
6c	narrowed	0'	west	667'
6d	narrowed	300'	east	466'
7a	narrowed	367'	west	700'
7b	narrowed	200'	east	500'
7c	narrowed	100'	east	100'
7d	narrowed	133'	east	133'
8a	narrowed	966'	west	900'
8b	narrowed	400'	east	366'
8c	narrowed	200'	east	233'
9a	narrowed	500'	east	433'
9b	narrowed	800'	east	500'
9c	narrowed	399'	east	566'

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SUPERIOR COURT OF ARIZONA  
MARICOPA COUNTY

CLERK OF THE COURT

June 30, 1994

HON. STANLEY Z. GOODFARB

K. Abbott  
Deputy

W-1, W-2, W-3, W-4

In Re The Adjudication of:

Continued

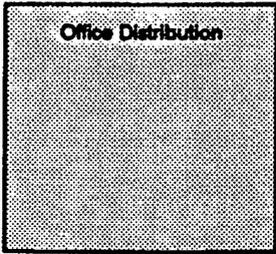
In spite of all of the protestations of Mr. Wellendorf and Dr. Montgomery that, in their opinions, the channel from 1935 to 1990 was "stable," any view of the channel location as shown on these two sets of aerial photographs taken fifty-five years apart shows the invalidity of those opinions.

While the Court clearly finds that the Wellendorf and Young proposal of the principal channel as the extent of the "subflow" zone is without merit, the Court does find that the parameter of that channel does constitute the innermost portion of that zone.

C. "Post-1880 Entrenchment" and Deposition

The principal theory proposed by the "groundwater users" and its supporters is the theory of Drs. Montgomery and Schumm that "subflow" is best defined by use of the lateral limits of what they claim is the post-1880 depositional layer and the vertical limit is the bottom of the Holocene or the top of the basin fill. Unfortunately, neither of their reports filed on December 14, 1993 (exhibits 6 or 7) mentioned this theory. Dr. Montgomery proposed basically the same lateral limits as Dr. Wellendorf and Mr. Young-- a smoothed principal channel--and Dr. Schumm proposed nothing as 17 of the 19 pages of his expert report were taken up with his "curriculum vitae." Only two court days before trial, the new theory was revealed in a "Disclosure Statement" which presenters of witnesses including the groundwater users did not have to file. In spite of its late disclosure, the Court permitted the theory to be presented and it still thinks it appropriate because the entrenchment and deposition theory is supported by the work of Richard Hereford (exhibit 190). However, the Hereford Report only discusses a portion of the upper San Pedro basin. There is no mention of the lower basin from Pomerene north. His work probably related to the part of the basin he knew best. A copy of the map of the area in which he worked is attached as Appendix G.

The lower basin is quite different physically and geographically. This was quite evident from the field trip. The



SUPERIOR COURT OF ARIZONA  
MARICOPA COUNTY

CLERK OF THE COURT

June 30, 1994

HON. STANLEY Z. GOODFARB

K. Abbott  
Deputy

W-1, W-2, W-3, W-4

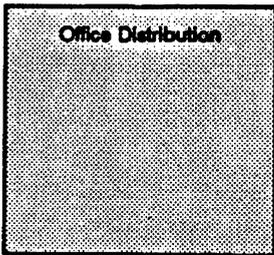
In Re The Adjudication of:

Continued

lower river valley is much narrower. The gradient of the stream is steeper. There are more areas of thicker vegetation. The mountains and adjacent foothills encroach closer to the river. The Court has attached seven oblique aerial photographs as Appendix H, I, J, K, L, M, and N. The first three are typical views of the upper basin and the last four are typical of the lower basin. The differences between the basins are quite evident in comparing the different sets. With regard to the lower basin, the last four photographs present a fairly clear view of where the basin fill meets the floodplain alluvium and how the riparian vegetation can be used to define the "subflow" zone in some areas.

This Court will not comment on the charges of lack of credibility that the opponents of the groundwater users seem to dwell on because of their late disclosure. This Court assumes that Drs. Montgomery and Schumm became aware of the Hereford Report after their initial investigation and decided that the geologic unit which that report presented made a lot more sense than the edges of a stream channel. This was probably for the same reasons this Court pointed out previously. It was also easier to defend; and one can hardly fault them for that.

Having said that, the Court believes the lack of channel stability discussion previously set forth on pages 39 to 43 of this Order applies equally to Montgomery and Schumm's theory as to Wellendorf and Young's theory of the edge of the principal channel. The "post-1880 entrenchment" and deposition theory is entirely dependent on the deeper entrenchment of the channel after 1880. If that channel lacks stability, it is difficult to understand how the deposition, which takes place after such flooding entrenchment, can have any more stability than the channel it follows. Moreover, if as Hereford suggests, most depositional layers occurred after 1937 while the entrenchment started 50 to 57 years earlier, that geologic unit's lateral stability must be considerably less than that of the Holocene which started after the "Ice Age" and has been in place 10,000 or more years. A post-1937 depositional era, at best, is a minuscule portion of geologic time.



SUPERIOR COURT OF ARIZONA  
MARICOPA COUNTY

CLERK OF THE COURT

June 30, 1994

HON. STANLEY Z. GOODFARB

K. Abbott  
Deputy

W-1, W-2, W-3, W-4

In Re The Adjudication of:

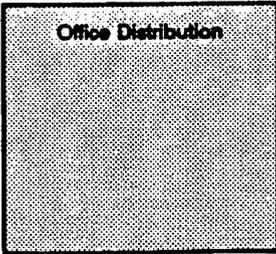
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When cross-examined about the lack of channel stability as discussed previously on pages 39 to 43, Dr. Montgomery's position was that such stability problems related only to the physical channel itself and since he relied on the parameters of the "post-1880 entrenchment," the problem did not affect the validity of his opinion. However, after viewing the 1969 infrared aerial photograph of the area north of Benson and past Pomerene, his exhibits 340 and 341, he had to agree that the 1935 channel was significantly different and much of it outside of his defined "post-entrenchment" boundaries from the Benson railroad bridge north to Pomerene and in the Cascabel area.

Much as Drs. Montgomery and Schumm might desire the Court to accept these variations from where they first located this "post-1880 entrenchment" corridor, there are other facts which further erode their "stability" claim for this "post-1880 entrenchment" theory which are as follows:

1. The location of the original dam for the Pomerene Canal was located in Township 17S, Range 20-21E, section 25. It is obvious that the original dam had to be located in the channel of the river as it was the source of the community of Pomerene's irrigation water at that time. However, when the 1921 flood destroyed and moved that dam downstream, it was replaced with a newer dam in section 36 to the southwest. Yet, the Montgomery designation of the "post-1880 entrenchment" defines a different channel and fails to recognize the old channel where the first dam was. (See exhibits 86 and 319.) By measurement it is clear Dr. Montgomery's "post-1880 entrenchment" leaves out at least 4,000 feet of old channel, some of which is 700 to 800 feet east of their designated "post-1880 entrenchment" corridor.

2. Also, in sections 3 and 4 of Township 15S, Range 20E, there is another large area missed in the original designation of exhibit 88. It is now shown on exhibit 320 and was referred to in the testimony of June 14, 1994 as an area of probably an early attempt at an orchard.



SUPERIOR COURT OF ARIZONA  
MARICOPA COUNTY

CLERK OF THE COURT

June 30, 1994

HON. STANLEY Z. GOODFARB

K. Abbott  
Deputy

W-1, W-2, W-3, W-4

In Re The Adjudication of:

Continued

3. Another important area of misdesignation is the area of the Paul Sale property, sections 5, 6 and 8 of Township 6S, 12 and 16E. (See exhibit 321 to 325 which are transparencies of the channels boundaries as shown on the 1935, 1947, 1955 and 1990 and most recent evolution after the 1993 floods.) In comparing these exhibits with exhibit 91, the map on which Dr. Montgomery or his associates drew the parameters of the "post-1880 entrenchment" channel, it is clear they missed by nearly 1,000 feet in some places, the east edge of channel in sections 5, 6 and 8 as shown on the 1935 aerial photography.

Attached as Appendix O-1 to O-5 are exhibits 317, 319, 320, 325 and 338 which indicate the misdesignations of the channel in the areas of the Benson railroad bridge to the north, the dam for the Pomerene Canal, Cascabel and the Paul Sale property.

Also, if one examines the exhibits prepared by Dr. Montgomery's firm which are exhibits 332, 333, 334 and 335, and the enlargements of the first three which are exhibits 347, 348 and 349, it is clear that even he agrees that at transects 2a, 2c, 3b, 3c, 3d, 5a, 5b, 5c, 6b, 6c, 6d, 8a, 8b, 8c and 9b the 1935 aerial photography shows the channels of the river as located outside of those parameters of what he calls his "post-1880 entrenchment." Copies of exhibits 332 to 335 are attached as Appendix O-6 through O-9.

Another problem with this "post-1880 entrenchment" theory is the lack of consistency between the lateral and vertical limits of the proposed "subflow" zone as discussed previously. Also, it must be pointed out that with a knowledge that this post-1937 depositional layer has a thickness of from 4 to 13 feet and some of it is "vadose" or non-saturated, we have at best a saturated post-1937 layer of from 0 to 10 feet. In most of the river's length it sits above or is inset in the Holocene layer. Therefore, the Holocene layer below it must be totally saturated for the balance of its 40 to 200 feet of depth. In spite of this, Drs. Montgomery and Schumm as well as Mr. Young propose a vertical limit of "subflow" at the bottom of the Holocene and admit that any well

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SUPERIOR COURT OF ARIZONA  
MARICOPA COUNTY

CLERK OF THE COURT

June 30, 1994

HON. STANLEY Z. GOODFARB

K. Abbott  
Deputy

W-1, W-2, W-3, W-4

In Re The Adjudication of:

Continued

which has perforations below it and in the basin fill will quite quickly draw down water from the Holocene. The water pulled from any "subflow" zone will quickly affect the volume of the surface stream above.

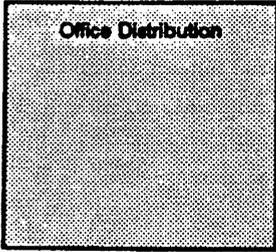
A "subflow" zone defined by this post-1937 depositional layer theory has very few wells located within its lateral limits. This, of course, increases the number of the "cone of depression" analyses which must be made. The problems associated with this analysis have been previously discussed.

At the end of the first 10 days of hearings, Drs. Montgomery and Schumm finally hung their hats on two principal claims:

1. The post-1880 or post-1937 depositional layers are significantly more permeable than the Holocene; and,
2. The Holocene is cemented in a way that bonds the sand, gravel and boulders into a consolidated mass through which less water can pass.

However, the testimony of Dr. Maddock, Steve Erb, Jon Ford, Oliver Page and Allan Gookin are all in direct conflict with those claims. Further, the drill logs of the recent drilling by Ford and Page disprove this theory as did ADWR's interpretation of the ADOT drill logs on the bridges on I-10 at Benson and the Charleston and Lewis Springs bridges. This is also true of other well logs in the area including the well logs of the Magma wells at site number 11 on our field trip 5 miles south of Mammoth (see the rebuttal affidavits of Ford and Page, exhibits B, C and D attached to the Salt River Project Post-Hearing Brief of March 18, 1994 and exhibits 262, 271 and 281 from the trial).

Probably the most confrontational of all the field trip discussions between Drs. Montgomery and Schumm and Jon Ford and Oliver Page occurred on the afternoon of March 4, 1994 at site 11. It was at the southwest corner of the cultivated field and in the



SUPERIOR COURT OF ARIZONA  
MARICOPA COUNTY

CLERK OF THE COURT

June 30, 1994

HON. STANLEY Z. GOODFARB

K. Abbott  
Deputy

N<sup>o</sup> W-1, W-2, W-3, W-4

In Re The Adjudication of:

Continued

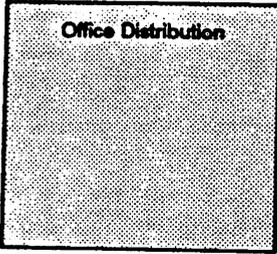
river bed adjacent thereto shown on exhibit 78 in evidence and attached as Appendix M. Here Drs. Montgomery and Schumm tried to explain why the field just east of the river and the wells located adjacent thereto were not in the "subflow" zone. This was, they claimed, because the "post-1880 entrenchment" deposits which were only in the sandy areas adjacent to the river, were more permeable and less cemented than the Holocene alluvium which underlay the cultivated fields and large phreatophytic areas of mesquite out of which those fields extracted. A look at the photograph (Appendix M) shows the physical relationships. To the knowledgeable eye it probably shows the edge of the "subflow" zone where the phreatophytes meet the basin fill rather than simply the sandy banks of the river as claimed by Drs. Montgomery and Schumm. Further, in spite of all their claims of new kinds of tests as to permeability and cementational differences between the post-1937 depositional layer and the Holocene it was inset into, three Magma wells drilled in 1991 in this very area and shown in ADWR well log registration records reveal the true underground record when they showed the following:

Well #1, registration #55-529969, drilled 2/26/91  
sand, gravel and cobbles from 0 to 45 feet  
clay from 45 to 47 feet  
sand gravel and cobbles from 47 to 63 feet

Well #2, registration #55-529971, drilled 2/26/91  
sand, gravel and clay from 0 - 32 feet  
sand, gravel and cobbles from 32 - 65 feet

Well #3, registration #55-530124, drilled 1/28/91 to  
2/8/91, to 1000 feet of depth  
sand and gravel from 0 - 70 feet

This last well was drilled by Dr. Montgomery's firm. (See the attachments to the Salt River Project Post-Hearing Brief all of which are copies of drill log records filed with ADWR as required by statute.



SUPERIOR COURT OF ARIZONA  
MARICOPA COUNTY

CLERK OF THE COURT

June 30, 1994

HON. STANLEY Z. GOODFARB

K. Abbott  
Deputy

W-1, W-2, W-3, W-4

In Re The Adjudication of:

Continued

Obviously, Magma's own well-drilling logs do not support the Montgomery/Schumm theory of higher permeability and less cementation of this post-1937 depositional layer.

In the opinion of the Court, the weight of the evidence clearly fails to indicate any significant difference in permeability between what Drs. Montgomery and Schumm contend is a "post-1880 entrenchment" depositional layer and the balance of the Holocene floodplain alluvium of which it is a part. The Court finds the testimony of Messrs. Erb, Ford, Page and Gookin have the greater weight and the exhibits presented showed no indication of any claimed differences.

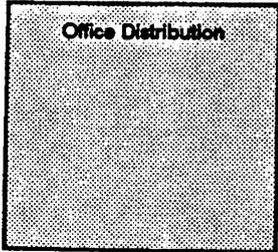
It is incongruous for the groundwater users to first claim that there is a great disparity between the lithology, hydraulic conductivity, and other characteristics of the post-entrenchment alluvium and the Holocene, and then advocate that the post-entrenchment alluvium be used only to define the lateral limits of "subflow" with the Holocene to be utilized to set its vertical extent. This is particularly true when the entrenchment is only 5% to 10% of the Holocene depth.

Even Dr. Montgomery's own Report on October 2, 1987 (exhibit 11 of the 1987 hearings) describes the floodplain alluvium of the San Pedro in the following terms:

"FLOODPLAIN ALLUVIUM

Geologic Feature

Floodplain alluvium occurs along the San Pedro river and its major tributaries.... Records of water wells which penetrate the unit near San Manuel indicate that the thickness of the floodplain alluvial deposits ranges from about 30 to 205 feet. The



SUPERIOR COURT OF ARIZONA  
MARICOPA COUNTY

CLERK OF THE COURT

June 30, 1994

HON. STANLEY Z. GOODFARB

K. Abbott  
Deputy

N<sup>o</sup> W-1, W-2, W-3, W-4

In Re The Adjudication of:

Continued

floodplain alluvium is commonly coarse-grained and consists chiefly of non-consolidated sand, gravel, and boulders. (emphasis added)

Groundwater Features

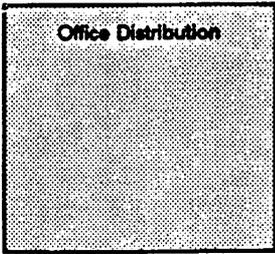
In the Lower San Pedro Basin, the groundwater level commonly occurs above the base of the floodplain alluvial deposits, and the lower parts of the unit are saturated. The deposits are highly permeable, comprise efficient infiltration media, and yield large amounts of groundwater to wells that are completed in the unit. Because the deposits are commonly coarse-grained and non-consolidated, the floodplain alluvial deposits are usually the most permeable of the hydrogeologic units in the basin. The floodplain alluvium accepts and transmits recharge water from streamflow. Groundwater in the unit generally occurs under confined conditions." (emphasis added)

There is no mention therein of any "post-1880 entrenchment" or depositional unit, its high degree of permeability or lack of cementation.

This Court finds the groundwater users theory of limitation of the parameters of the "subflow" zone to be without merit. However, like the principal-channel boundary theory out of which it evolved, the Court believes the lateral bounds of this theoretical unit are within the parameters of a broader "subflow" zone wider than these groundwater users propose.

D. The Nature Conservancy Riparian Zone

The position of the Nature Conservancy is urged by an attorney and hydrologist whose efforts were *pro bono*. It is a



SUPERIOR COURT OF ARIZONA  
MARICOPA COUNTY

7  
L  
J  
CLERK OF THE COURT

June 30, 1994

HON. STANLEY Z. GOODFARB

K. Abbott  
Deputy

№ W-1, W-2, W-3, W-4

In Re The Adjudication of:

Continued

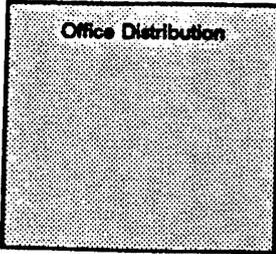
pleasure to have such people involved and to be able to largely agree with their position. Their proposed alternatives were:

"It is clear from all of the evidence that the only reasonably acceptable geologic unit by which subflow may be defined is the holocene alluvium by whatever norm referred to." (p. 2)

Alteratively they submitted:

"...it is not necessary to resolve the geologic debate in order to define the subflow zone. Fortunately, nature has already provided readily observable surface indicators of where this underground water is located, those being the phreatophytic plants located in the riparian area or zone immediately adjacent to the river." (p. 5)

If we were limited to only physical evidence of water use at a particular location which had an observable effect on the height of the flow in the stream itself, only the testimony about phreatophytes would meet that test. During our field trip there were anecdotal accounts by Messrs. Lomeli and Smallhouse and Ms. Clark about observable water use by phreatophytes that had a direct, immediate and measurable impact on the surface flow of the adjacent stream. These impacts occurred on a daily or diurnal basis and changes in stream flow were readily observable as were seasonal variations, all relating to the metabolic functions of the plants. The testimony was that the fall and winter seasonal changes could double the stream flow because the leaves were off the trees and there was no transpiration occurring. While daily changes between daylight and dark were not as great, they were clearly discernable. Even Dr. Montgomery agreed when cross-examined by Steven Weatherspoon about a camping experience where the flow was non-existent when he and his son went to sleep, but the stream flowed in the morning because the stream recharged itself at night when the phreatophytes' pumping mechanism was not



SUPERIOR COURT OF ARIZONA  
MARICOPA COUNTY

CLERK OF THE COURT

June 30, 1994

HON. STANLEY Z. GOODFARB

K. Abbott  
Deputy

N<sup>o</sup> W-1, W-2, W-3, W-4

In Re The Adjudication of:

Continued

in effect. No one can be surprised by such facts when the water balance of the San Pedro previously discussed showed that of its total produced supply of 158,610 acre feet, approximately 1/4 or 52,600 acre feet went into phreatophytic use.

The evidence is undisputed that riparian plants directly draw off and diminish the surface flow of adjacent streams. Riparian forestation meets the test of "In re Gila" which asks, "Does the drawing off the surface water tend to diminish appreciably and directly the flow of the surface stream" (p. 393 of 179 Ariz.) Moreover, this Court accepts that we have a readily usable definition of "Riparian Area" in A.R.S. § 45-101(b):

"'Riparian area' means a geographically delineated area with distinct resource values, that is characterized by deep-rooted plant species that depend on having roots in the water table or its capillary zone and that occurs within or adjacent to a natural perennial or intermittent stream channel or within or adjacent to a lake, pond or marsh bed maintained primarily by natural water sources. Riparian area does not include areas in or adjacent to ephemeral stream channels, artificially created stockponds, man-made storage reservoirs constructed primarily for conservation or regulatory storage, municipal and industrial ponds or man-made water transportation, distribution, off-stream storage and collections systems."

Unfortunately, this Court does not believe that delineation of all riparian areas in their predevelopment stage, as advocated by the Nature Conservancy, will be as easy as it thinks. A look at the 1935 aerial photography of the area does not easily show the boundaries of riparian area in a predevelopment stage. Even then there were large areas of agricultural field development, particularly in the St. David and Pomerene areas. The same is also

SUPERIOR COURT OF ARIZONA  
MARICOPA COUNTY

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June 30, 1994

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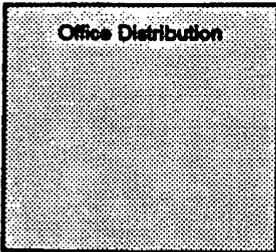
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true in the lower basin where Jack Smallhouse told us his family once farmed 2,000 acres along the river. The field trip in the Hereford and Palominas areas shows fields long cultivated but now unused with limited phreatophyte invasion. Another problem is that in the true predevelopment age before the significant overgrazing of the late 1800s and early 1900s, the heavy grass cover of the upper basin prevented much phreatophication. (See exhibit 190, page 15.) The other side of the coin is that as cultivated fields along the river went out of production, phreatophication increased. (See figures 16 to 19 of exhibit 190.) This is clearly shown by the pictures of the Palominas Bridge taken in 1939 and 1991 which were attached. This shows the problem of phreatophication increases, resultant channel narrowing and later highly erosive effects of flooding when high flows are forced through narrower and narrower channels all as described in the Affidavits of Ford and Wellendorf.

In addition to the study of channel changes and shifts, this Court also requested ADWR to also analyze any change in riparian habitat along the San Pedro River from 1935 to 1990. The study indicated significant riparian changes from reductions of "up to 3,100 feet along one transect to an additional 1,900 feet along another transect." (A copy of that analysis, also a part of exhibit 365, is attached as Appendix F-1, F-2 and F-3.) A study of the 1990 aerial photography shows nearly all reductions to be the result of cultural development such as new agricultural fields.

Figure 5, page 8 of exhibit 190, which is reproduced in Oliver Page's Report for Stetson Engineering in exhibit 2 as its figure 7, and is attached here as Appendix P, shows the lateral migration of this river from 1890 to date in a large meander about 2 miles north of Hereford. Based on our March 4, 1994 field trip, that area is one of many old and new channels. There is nearly a mile of phreatophytic width in this area.

To the extent that phreatophication exists or can be documented in the areas adjacent to the principal channel, it does mark that portion of the area of the "subflow" zone. If it extends



SUPERIOR COURT OF ARIZONA  
MARICOPA COUNTY

CLERK OF THE COURT

June 30, 1994

HON. STANLEY Z. GOODFARB

K. Abbott  
Deputy

W-1, W-2, W-3, W-4

In Re The Adjudication of:

Continued

to the lateral edge of the saturated floodplain Holocene alluvium, then it is a vital marker. However, even phreatophytes cannot tell the difference between floodplain alluvium and tributary aquifer alluvium and, therefore, can be a false marker. The boundaries of the riparian zones are helpful and certainly within the "subflow" zones if they do not extend over onto the top of tributary aquifer or basin fill. After consideration of flow direction, water level elevation, the gradation of water levels over a stream reach, the chemical composition if available, and lack of hydraulic pressure from tributary aquifer and basin fill recharge which is perpendicular to stream and "subflow" direction, the Court finds the most accurate of all the markers is the edge of the saturated floodplain Holocene alluvium.

E. The Saturated Floodplain Holocene Alluvium

Throughout the hearings, field trip and later briefing, the parties have used the terms Holocene, younger alluvium, and floodplain alluvium interchangeably. This Court believes the proper terminology for the geologic unit which defines "subflow" is the "saturated floodplain Holocene alluvium." That term is used deliberately. Both the Holocene or younger alluvium and the basin fill are descended from the same source, the rock of uplifting mountains. While the depositional processes were somewhat different, where these units meet it is sometimes difficult to discern the differences between one type of eroded, depositional debris from another, particularly when they may both be saturated and water bearing. Moreover, water, when it fills the porosity of a geologic unit, doesn't know the difference between what is "subflow," younger alluvium or basin fill. However, only the younger Holocene alluvium can pass the test of "subflow" as it is the only stable geologic unit which is beneath and adjacent to most rivers and streams, except those in the mountains where bedrock surrounds the flow.

Also, in order to fulfill the definition of "subflow," the geologic unit must be saturated because of the need for a hydraulic connection between the stream and the "subflow." Further

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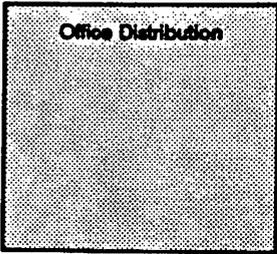
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definition requires "subflow" to be a part of the surrounding floodplain of the stream basin. Those parts of the alluvial plain which it may be a part of or which it is connected to must be the alluvial plain of a perennial or intermittent stream and not an ephemeral stream or a part of the alluvial plain of a tributary aquifer even if there is an alluvial connection. Where the alluvial plain of tributary aquifers or ephemeral streams connects to the floodplain Holocene alluvium of the stream itself and provides tributary or basin fill recharge, that tributary aquifer must also be excluded because its flow direction is different and often perpendicular to the stream-flow direction.

The evidence here shows that the only true geologic unit which is beneath and adjacent to the stream is the floodplain Holocene alluvium. When it is saturated, that part of the unit qualifies as the "subflow" zone, where the water which makes up the saturation flows substantially in the same direction as the stream, and the effect of any side discharge from tributary aquifers and basin fill is overcome or is negligible. Because low-flow streams like the San Pedro meander back and forth in a series of "S" curves within a wider principal or dynamic channel, flow direction must be the general overall direction of the stream. As Steve Erb testified, as long as the subflow's direction is within 45 degrees of that general stream flow direction, the flow direction requirement is met.

If we add the following additional criteria, then even more certainty and reliability is provided. First, the water level elevation of the "subflow" zone must be relatively the same as the stream flow's elevation. Second, the gradient of these elevations for any reach must be comparable with that of the levels of the stream flow. Third, there must be no significant difference in chemical composition that cannot be explained by some local pollution source which has a limited effect. Fourth, where there are connecting tributary aquifers or floodplain alluvium of ephemeral streams, the boundary of the "subflow" zone must be at least 200 feet inside of that connecting zone so that the hydrostatic pressure effect of the side recharge of this tributary



SUPERIOR COURT OF ARIZONA  
MARICOPA COUNTY

CLERK OF THE COURT

June 30, 1994

HON. STANLEY Z. GOODFARB

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N<sup>o</sup> W-1, W-2, W-3, W-4

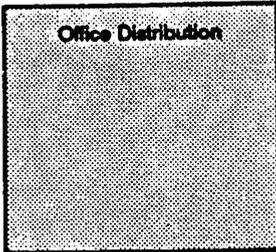
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aquifer is negligible and the dominant direction of flow is the stream direction. Fifth, where there is a basin-fill connection between saturated zones of the floodplain Holocene alluvium and a saturated zone of basin fill, the boundary of the "subflow" zone must be 100 feet inside of the connecting zone so that the hydrostatic pressure effect of the basin-fill's side discharge is overcome and the predominant direction of flow of all of the "subflow" zone is the same as the stream's directional flow. The different distances used to overcome the side pressure of the tributary aquifer and basin fill are based on the testimony of Steve Erb given on February 14, 1994 and the different rates of permeability and transmissivity of the different geological units. Appendix Q attached is a copy of exhibit 266 received at trial which represents the best illustration of the relationship of the "subflow" within a reach of floodplain alluvium and basin fill. Appendix R attached shows the relationship of the saturated stream alluvium of the San Pedro and its two tributaries, the Bobocamari and the Aravaipa, to the entire basin of the San Pedro.

The weight of the evidence points to the saturated floodplain Holocene alluvium as the most credible "subflow" zone. Its lateral and vertical limits have existed for some 10,000 or more years. It has far more stability of location than any other proposal including the principal channel which changes approximately every three years, or the post-1880 depositional layer which is really "post-1937" at best, or "post-1955" as indicated in the Hereford Report (exhibit 190 page 8).

It may be true that the surface of the latest layer of deposition resulting from the January 1993 flood is more permeable than the overall permeability of the entire Holocene. But, as Ford, Page, Gookin and Erb testified, and all the drill log results show, there is no significant difference in permeability between the post-1937 layer and the balance of the Holocene. Even the claims by the groundwater users of cementation in the Holocene do not stand up. Not a single drill log supports it. All the claims of the use of the wrong drilling bit do not support it. Even Dr. Montgomery's Report of October 2, 1987 refutes it. While there may



SUPERIOR COURT OF ARIZONA  
MARICOPA COUNTY

CLERK OF THE COURT

June 30, 1994

HON. STANLEY Z. GOODFARB

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W-1, W-2, W-3, W-4

In Re The Adjudication of:

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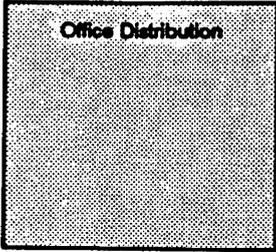
be some evidence of cementation in certain layers, there is no evidence it is unit-wide, or that it makes any significant difference in permeability or transmissivity. Therefore, regardless of claims to the contrary, the weight of this evidence supports the saturated floodplain Holocene alluvium as the "subflow" zone.

"CONES OF DEPRESSION"

"In re Gila," page 391 of 175 Ariz., describes a "cone of depression" as the "funnel-shaped area around a well, where the water table has been lowered by the withdrawal of groundwater through the well." That clinical description of a "cone of depression" tells us little of the destructive ability of wells upon basin and range streams in a desert or semi-desert environment such as the Santa Cruz River and the San Pedro River.

On February 1, 1994 Dr. Maddock discussed the "cone of depression" in the Sierra Vista area. He referred to it as "notorious." His computer modeling predicted that 37% of the water which comes from the well systems which serve the area comes out of the San Pedro which is either in the stream or on the way to the stream. He estimated the latter portion to be 1%. Exhibit 163 in evidence is his illustration of how the "cone of depression" in that area has grown since 1968. It clearly shows and the testimony was that the "cone" is in excess of five miles. A copy of Dr. Maddock's exhibit is attached as Appendix S. In his opinion, the "cone of depression" has clearly intersected the stream.

Mr. Erb testified on February 15 that the Tenneco agricultural wells, shown on exhibit 271 in evidence, which location runs from the border twenty miles north, were shut down in the mid-1980s when Tenneco sold its holdings to the BLM for the creation of the San Pedro River National Conservation Area. The drawdown of these wells had turned some parts of the river in this area from perennial to intermittent, and some sections were even ephemeral. After more than eight years of shut down, only one mile



SUPERIOR COURT OF ARIZONA  
MARICOPA COUNTY

CLERK OF THE COURT

June 30, 1994

HON. STANLEY Z. GOODFARB

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Deputy

W-1, W-2, W-3, W-4

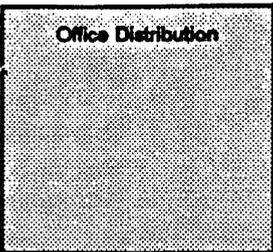
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of the river is now more perennial than before. On our field trip, however, we found no ephemeral sections and all were at least intermittent. Local residents explain that the large January 1993 flood created large basin-wide recharge and the higher flows observed may be the result of that recharge. A copy of exhibit 271 is attached as Appendix T showing the relationships of the wells in the area to the river. The wells adjacent to the areas of discontinued irrigation are the former Tenneco wells.

What these facts show is that "cones of depression" have long-term effects even after the wells are shut down. Two recent Colorado cases make that clear. Danielson v. Castle Meadows, 791 P.2d 1106 (Colo. 1990) and State Engineer v. Castle 6 Meadows, 856, P.2d 406 (Colo. 1993) discuss the long-term effect of post-pumping depletion. In the "Danielson" case the trial court had found that post-pumping depletions could continue up to and after 200 years. In the remanded trial which took place in 1991, the trial court found the post-pumping depletions could continue up to and after 400 years. In both cases the Colorado Supreme Court found that these post-pumping depletions had to be remedied by the pumps to protect surface water users under COLO. REV. STAT. § 37-90-137(9)(c). In Colorado, augmentation plans, which are approved by the water decree, are used to remedy possible harm to other appropriations.

All of the principal witnesses agreed that even wells located outside of a stream's "subflow" could, over time, build up extensive "cones of depression" which could severely affect the volume of stream flow and the "subflow" which supported it. Even Dr. Montgomery agreed the Santa Cruz was a dead river except where Nogales' effluent created some perennial but polluted flow. This, all agreed, was the result of overpumping, often outside of anyone's "subflow" parameters. Often those wells had extensive and interconnecting "cones of depression." Appendix U, V, W, X, Y and Z attached, are copies of diagrams from exhibit 1 received in evidence at trial and illustrate the effects of "cones of depression."



SUPERIOR COURT OF ARIZONA  
MARICOPA COUNTY

CLERK OF THE COURT

June 30, 1994

HON. STANLEY Z. GOODFARB

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Deputy

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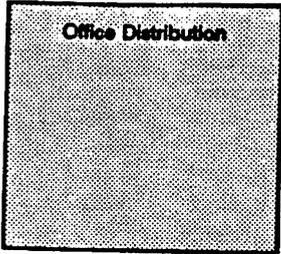
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In the "In re Gila" opinion only one paragraph relates to "cones of depression." It is worth repeating:

"For example, if the cone of depression of a well has expanded to the point that it intercepts a stream bed, it almost certainly will be pumping subflow. At the same time, however, it may be drawing water from the surrounding alluvium. Thus, part of its production may be appropriable subflow and part of it may not. Even though only a part of its production is appropriable water, that well should be included in the general adjudication." (p. 391 of 175 Ariz.) (emphasis supplied)

The testimony seemed unanimous that consistent with the Supreme Court's pronouncement, if a "cone of depression" of a well intercepts what is eventually defined as the "subflow" zone, then at least some percentage of the water discharged by the well is water subject to the adjudication. As Montgomery admitted, stream depletion occurs as soon as the "cone of depression" reaches the stream, even though it may be some time before the hydraulic gradient at the river is reversed, and may be many years before a particle travels from the stream to the well. See Tr. VI at 14, 49-50. Ford and Page contend that streamflow depletion first takes place when the cone intersects the stream, not when the hydraulic gradient is reversed or the molecule of streamflow is ejected by the well. Tr. I at 47 (Ford); Tr. II at 182 (Page). It is beyond dispute that even before the gradient is reversed, a measurable drawdown at the stream's "subflow" zone necessarily results in water leaving the zone in order to fill the void which has been created by the well. Ford's Report, exhibit 1, at 51 [when the cone intersects the "subflow" zone, it "induce[s] subflow to leave (deplete the Subflow Zone and the stream)"]. This is true even where the gradient has not been reversed everywhere between the well and the stream. (Ford's Report at 63-67, especially Fig. 9.3 and Table 9.3)



SUPERIOR COURT OF ARIZONA  
MARICOPA COUNTY

CLERK OF THE COURT

June 30, 1994

HON. STANLEY Z. GOODFARB

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W-1, W-2, W-3, W-4

In Re The Adjudication of:

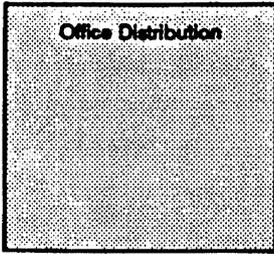
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The groundwater pumpers' position cannot be reconciled with the Supreme Court's unequivocal conclusion that when a "cone of depression" is intersecting the stream bed, it "almost certainly" is "pumping subflow." Apart from their molecule and gradient arguments, no serious opposition has been offered to the approach which was proposed by Ford or Page for handling wells located outside the "subflow" zone. In fact, there appears to be substantial agreement on most points.

For example, Montgomery agreed with Ford that various analytical or modeling methods are appropriate to calculate "cones of depression." Tr. I at 52 (Ford); Ford's Report at 3, 51, C-1 - C-7; Tr. IV at 18-19 and Tr. VI at 13 (Montgomery). Similarly, Ford and Montgomery agree that the calculation of the cone should be based upon the well's entire history of pumping. Tr. I at 52, 54-57 (Ford); Tr. VI at 128-29 (Montgomery). They also agreed that individual analysis of wells is the most appropriate method to compute drawdown at the "subflow" zone. Tr. I at 85 (Ford); Ford's Report, p. 37; Tr. VI at 24 (Montgomery). How this is to be done must be left to the discretion of ADWR as this Court finds there was not testimony of how technically certain determinations were to be made scientifically.

While Salt River Project proposes that a drawdown of 0.1 foot be used for purposes of calculating the "cone of depression," this Court believes such close measurements are difficult, at best, in the field. Rather, it believes that whatever test ADWR finds is realistically adaptable to the field and whatever method is the least expensive and delay-causing, yet provides a high degree of reliability, should be acceptable. While several of the experts arrived at different conclusions, Ford, Page, Montgomery, Erb and Stephenson all testified to a degree that the Court feels assured that scientific method is available to determine below-ground saturation, water level, elevation, gradient, flow direction and extent of "cones of depression."

The Court finds, subject to any *de minimis* standard later to be adopted by the Court, that any well located outside the



SUPERIOR COURT OF ARIZONA  
MARICOPA COUNTY

CLERK OF THE COURT

June 30, 1994

HON. STANLEY Z. GOODFARB

K. Abbott  
Deputy

W-1, W-2, W-3, W-4

In Re The Adjudication of:

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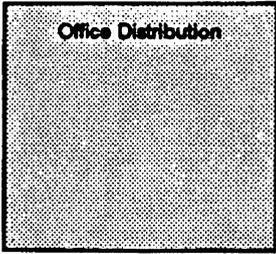
"subflow" zone that now pumps any percentage of water either from the stream itself or its "subflow" zone, should be included in the adjudication and the total amount of water withdrawn subjected to this proceeding. If we wait until actual water molecules from the San Pedro River are discharged from the many wells which surround it but are not in the "subflow" zone, there may not be sufficient stream flow left to justify this entire adjudication.

PRESUMPTION AND BURDEN OF PROOF

"In re Gila" on page 392 of 179 Ariz. says:

"If DWR uses the proper test and relies on appropriate criteria for determining whether a well meets the test, its determination that a well is pumping appropriable subflow constitutes clear and convincing evidence. It is consistent with Arizona law, then, to require the well owner to come forward with evidence that DWR is wrong."

This Court agrees that the entire process of the adjudication requires that the independent evaluations of ADWR are entitled to a presumption in their favor and the property owner or an objector to a claim supported by an HSR has the duty to come forward with evidence to overcome that presumption. However, there are questions in the mind of this Court after hearing long periods of evidence over the last fourteen years. They are whether the quality of geologic or hydrologic opinion, the frequent lack of data, and the many assumptions which cannot be fully proven support a requirement that the property owner or objectors should have to overcome a clear and convincing level of burden of proof. Every expert who has attempted to develop opinions as to "cones of depression" often relies on assumptions which are not provable or are only partially provable. The conflicts between Montgomery, Schumm, Ford, Page and Erb in that specific area raise real concern as to the fairness of raising the evidentiary level of burden of



SUPERIOR COURT OF ARIZONA  
MARICOPA COUNTY

CLERK OF THE COURT

June 30, 1994

HON. STANLEY Z. GOODFARB

K. Abbott  
Deputy

N<sup>o</sup> W-1, W-2, W-3, W-4

In Re The Adjudication of:

Continued

proof to clear and convincing for a property owner or objector to overcome a DWR opinion in an HSR. Even if we eliminate many of our *pro per* claimants with a proper *de minimis* rule, this is probably too formidable a barrier for the remainder of those *pro per* parties. It is often too much for represented parties of modest wealth. Only when we get to parties such as the mines, United States, Salt River Project, the State of Arizona and cities of major size are there sufficient assets to fund such evidentiary battles. At least in the area of "cones of depression" a burden of proof of preponderance seems fairer. The same is probably also true in the area of a "subflow" zone determination.

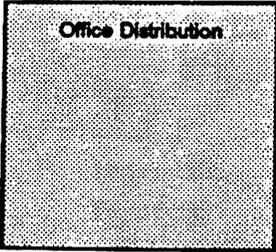
CONCLUSION

The issues here are geologically, hydrologically and factually complex. While courts often deal with complex issues, reviewing appellate courts sometimes are unable to glean from the briefs little more than a summary of the complex evidentiary background and the scientific principles which led to the trial court's decision. To overcome this limitation in this proceeding, this Court believes it has a duty to provide as much detail as it can to explain the factual decisions made, the scientific principles relied on, as well as to provide copies of many of the exhibits considered. It has done that here.

Finally, the length and complexity of this decision requires a summarization of the Court's findings as to "subflow" and dealing with "cones of depression."

1. A "subflow" zone is adjacent and beneath a perennial or intermittent stream and not an ephemeral stream.

2. There must be a hydraulic connection to the stream from the saturated "subflow" zone.



SUPERIOR COURT OF ARIZONA  
MARICOPA COUNTY

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CLERK OF THE COURT

June 30, 1994

HON. STANLEY Z. GOODFARB

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In Re The Adjudication of:

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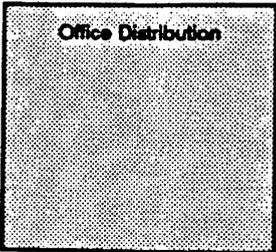
3. Even though there may be a hydraulic connection between the stream and its floodplain alluvium to an adjacent tributary aquifer or basin-fill aquifer, neither of the latter two or any part of them may be part of the "subflow" zone.

4. That part of the floodplain alluvium which qualifies as a "subflow," beneath and adjacent to the stream, must be that part of the geologic unit where the flow direction, the water level elevations, the gradations of the water level elevations and the chemical composition of the water in that particular reach of the stream are substantially the same as the water level, elevation and gradient of the stream.

5. That part of the floodplain alluvium which qualifies as a "subflow" zone must also be where the pressure of side recharge from adjacent tributary aquifers or basin fill is so reduced that it has no significant effect on the flow direction of the floodplain alluvium. (i.e., a 200-foot setback from connecting tributary aquifers and a 100-foot setback from the basin-fill deposits).

6. Riparian vegetation may be useful in marking the lateral limits of the "subflow" zone particularly where there is observable seasonal and/or diurnal variations in stream flow caused by transpiration. However, riparian vegetation on alluvium of a tributary aquifer or basin fill cannot extend the limits of the "subflow" zone outside of the lateral limits of the saturated floodplain Holocene alluvium.

7. All wells located in the lateral limits of the "subflow" zone are subject to the jurisdiction of this adjudication no matter how deep or where these perforations are located. However, if the well owners prove that perforations are below an impervious formation which preclude "drawdown" from the floodplain alluvium, then that well will be treated as outside the "subflow" zone.



SUPERIOR COURT OF ARIZONA  
MARICOPA COUNTY

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June 30, 1994

HON. STANLEY Z. GOODFARB

K. Abbott  
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W-1, W-2, W-3, W-4

In Re The Adjudication of:

Continued

8. No well located outside the lateral limits of the "subflow" zone will be included in the jurisdiction of the adjudication unless the "cone of depression" caused by its pumping has now extended to a point where it reaches an adjacent "subflow" zone, and by continual pumping will cause a loss of such "subflow" as to affect the quantity of the stream.

Dated this 30th day of June, 1994.

  
Hon. Stanley Z. Goodfarb

June 30, 1994

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Within an aquifer, the types of material and the geologic and chemical history determine the number of pores and open spaces that will exist. When saturated, these voids determine the volume of water and that will be held in storage within the aquifer. However, not all of the water that is stored within an aquifer is free to be released from storage. Some water is retained in the voids by molecular attraction. The amount that will actually be released is of more concern from a water supply standpoint than the total volume held. The total volume of recoverable groundwater held in storage in the regional aquifer within the San Pedro River watershed to a depth of 1,200 feet below the land surface is estimated to be approximately 83.5 million acre-feet. Table 2-1 breaks this value down by subwatershed. The volume of storage is based on estimated basin fill surface areas, derived from geographic information, average depths of the basin fill alluvium, and average specific yield estimates derived from literature. APPENDIX A describes further the methodology used in calculating storage estimates.

TABLE 2-1

RECOVERABLE GROUNDWATER HELD IN REGIONAL AQUIFER STORAGE  
SAN PEDRO RIVER WATERSHED

<u>SUBWATERSHED</u>	<u>GROUNDWATER IN STORAGE (IN MILLION ACRE-FEET)</u>
Sierra Vista	31.8
Benson	27.1
Redington	13.0
Aravaipa	6.2
Winkelman	<u>5.4</u>
Total	83.5

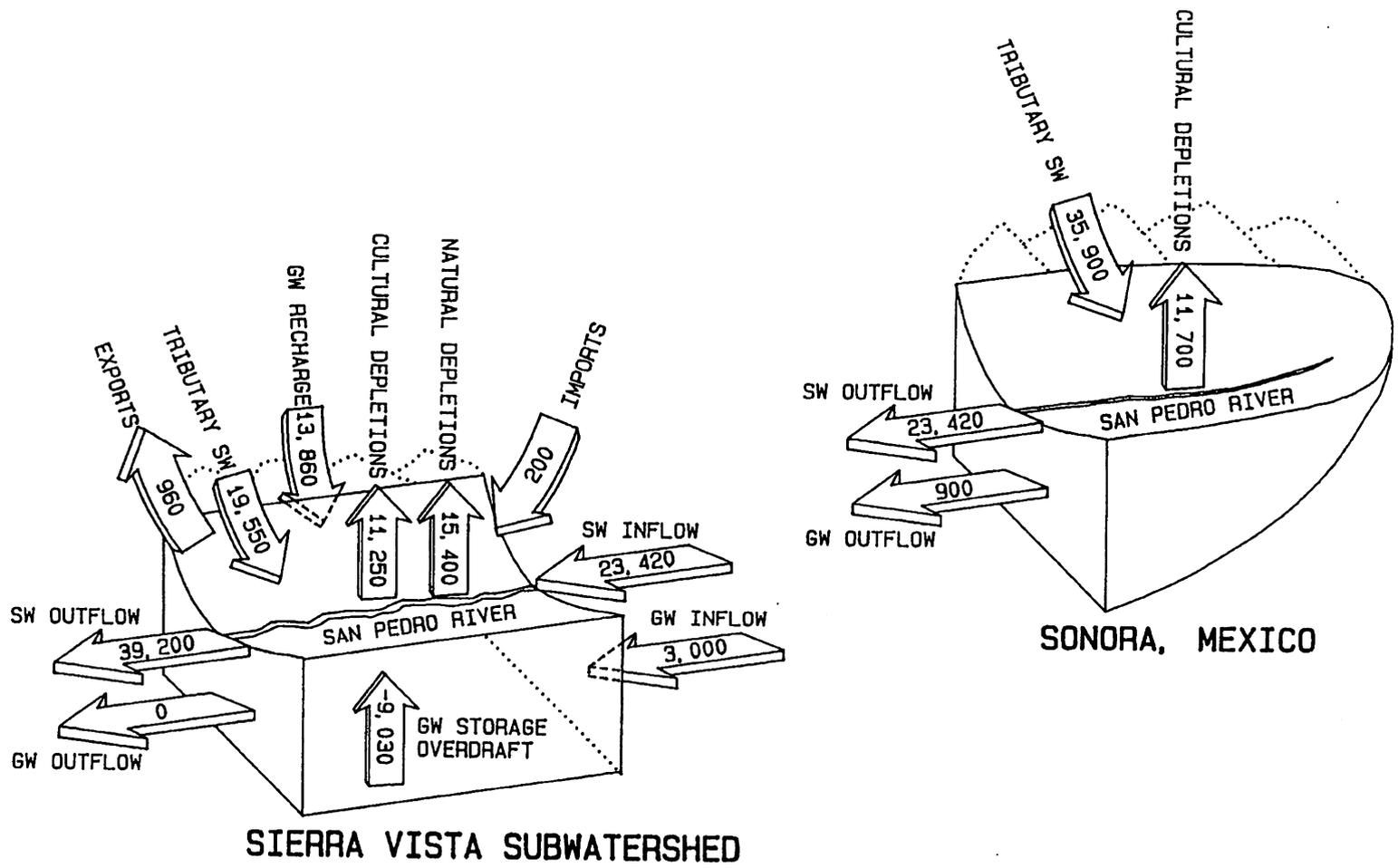
Appendix A.

TABLE 4-12

**WATER BUDGET ANALYSIS OF THE SAN PEDRO RIVER WATERSHED  
1990 DEVELOPMENT CONDITIONS  
(ACRE-FEET PER YEAR) (1)**

	<u>MEXICO</u>	<u>SIERRA VISTA</u>	<u>BENSON</u>	<u>REDINGTON</u>	<u>WINKELMAN</u>	<u>ARAVAIPA</u>	<u>TOTAL (2)</u>
<b>SUPPLY (+)</b>							
SW Inflow	-	23,420	39,200	25,500	32,100	0	23,420 (3)
GW Inflow	-	3,000	0	120	150	0	3,000 (4)
Tributary SW	35,900	17,300	11,800	15,710	34,070 (5)	1,500	78,880 (6)
GW Recharge	- (7)	13,860	11,760	20,350	9,650	-	55,620 (8)
Imports	-	200 (9)	0	310 (10)	0	0	510
Exports	-	-960 (11)	0	0	-1,860 (12)	0	-2,820
<b>TOTAL</b>	<b>35,900</b>	<b>56,820</b>	<b>62,760</b>	<b>61,990</b>	<b>74,110</b>	<b>1,500</b>	<b>158,610 (13)</b>
<b>WATER USE (-)</b>							
<b>Cultural</b>							
Irrigation	5,000	4,590	14,230	8,480	3,360	1,810	30,660
Domestic	300	460	260	130	170	30	1,020
Municipal	2,300	4,530	750	1,220 (14)	10	0	6,510
Stockpond	1,000	1,460	870	780	160	600	3,270
Reservoirs	-	160	270	80	110	100	620
Mining	3,000	-	0	19,560	0	0	19,560
Industrial	100	50	380	30	0	0	460
<b>TOTAL</b>	<b>11,700</b>	<b>11,250</b>	<b>16,760</b>	<b>30,280</b>	<b>3,810</b>	<b>2,540</b>	<b>62,100</b>
<b>Natural</b>							
Channel Evap	-	950	770	2,220	1,680	970	5,620
Phreatophytes	-	14,450	17,690	13,400	7,060	1,500	52,600
<b>TOTAL</b>	<b>11,700</b>	<b>15,400</b>	<b>18,460</b>	<b>15,620</b>	<b>8,740</b>	<b>2,470</b>	<b>58,220</b>
<b>TOTAL USE</b>		<b>26,650</b>	<b>35,220</b>	<b>45,900</b>	<b>12,550</b>	<b>5,010</b>	<b>120,320 (15)</b>
<b>SURPLUS (=)</b>							
GW Outflow	900	0	120	150	1,570	800	1,570 (16)
SW Outflow	23,420	39,200	25,500	32,100	56,540 (17)	27,559 (18)	56,540 (19)
Change in storage	-120	-9,030	1,920	-16,160	3,450	-	-19,820 (20)

See continuation table for explanation of footnotes.



ALL VALUES ARE IN ACRE-FEET PER YEAR

Figure 4-24. Schematic of the water budget components as they relate to the Mexico and Sierra Vista subwatershed portions of the San Pedro River watershed

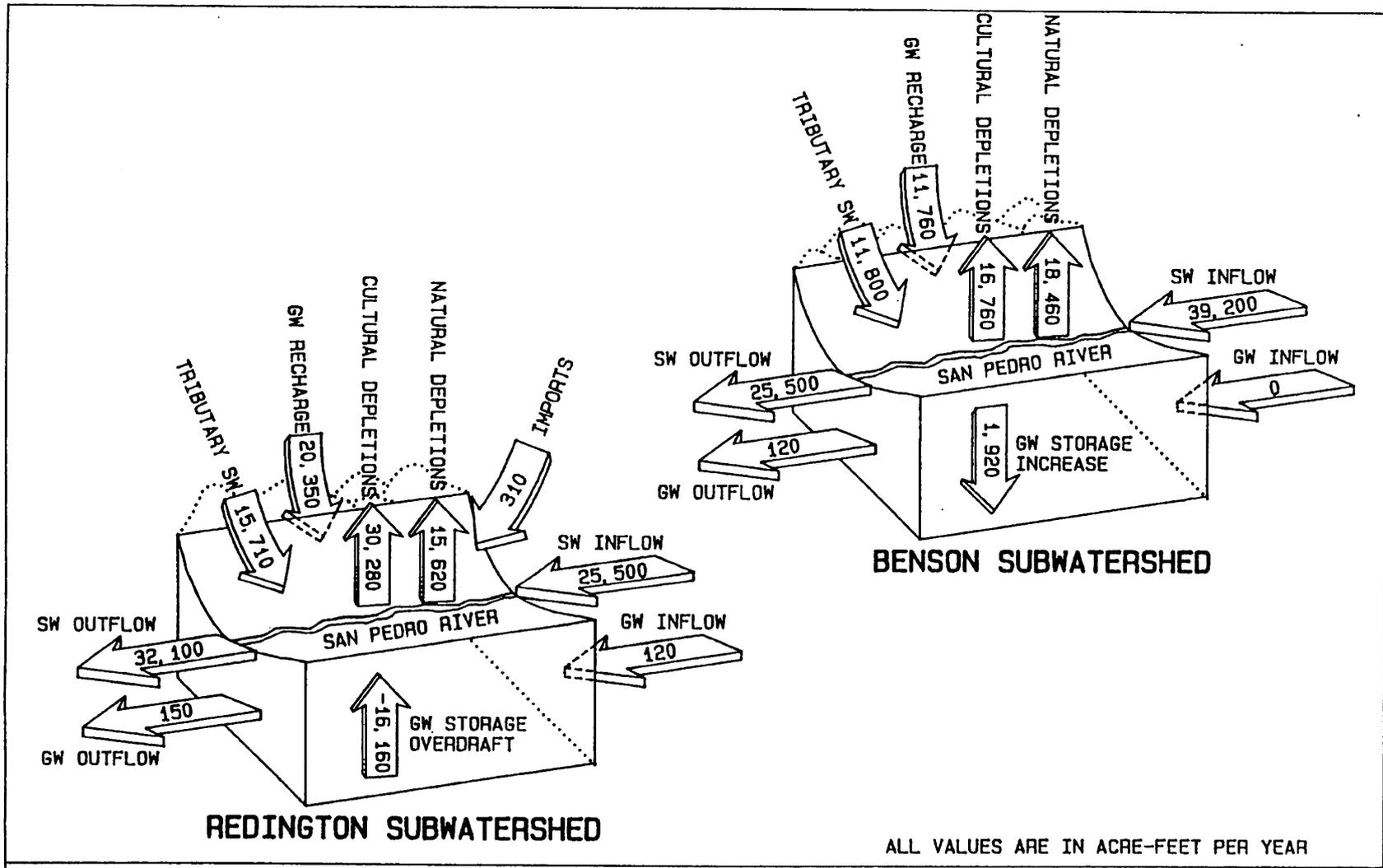
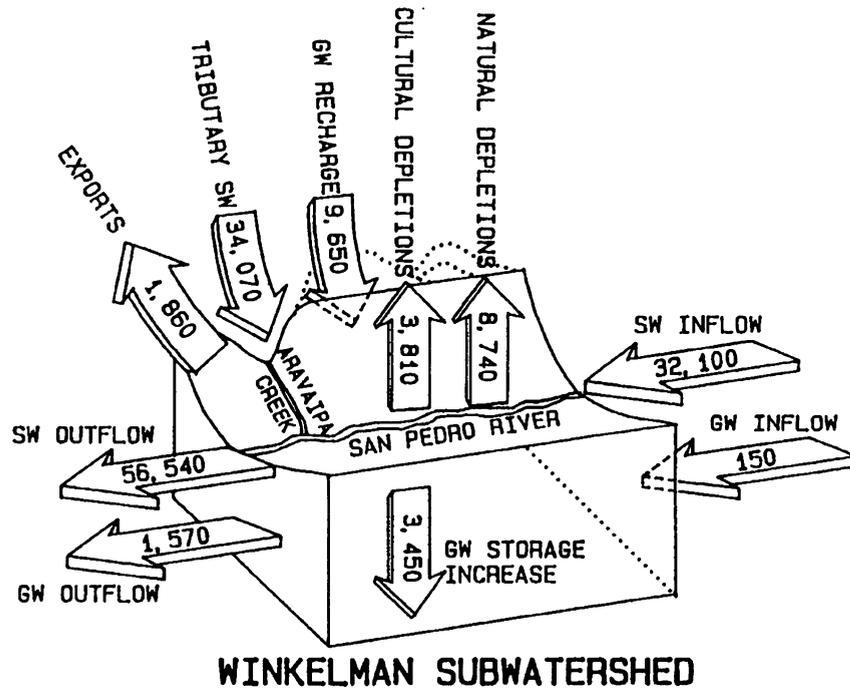
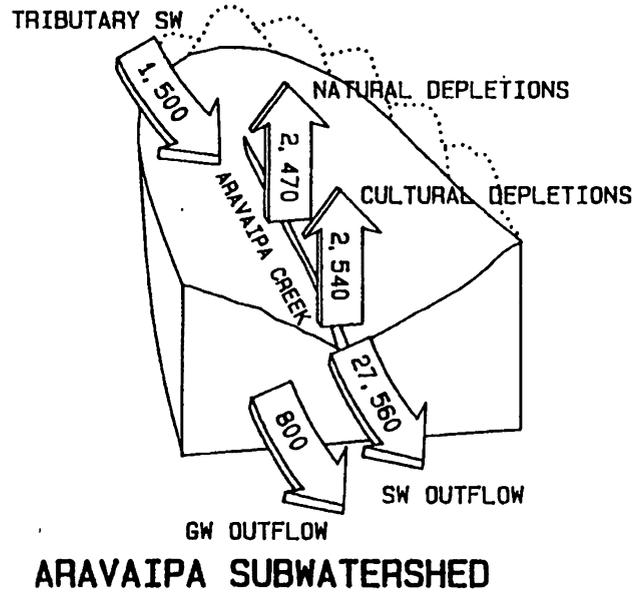


Figure 4-25. Schematic of the water budget components as they relate to the Benson and Redington subwatersheds of the San Pedro River watershed



ALL VALUES ARE IN ACRE-FEET PER YEAR

Figure 4-26. Schematic of the water budget components as they relate to the Aravaipa and Winkelman subwatersheds of the San Pedro River watershed

# San Pedro Watershed Study Transects

R 14 E R 15 E R 16 E R 17 E R 18 E R 19 E R 20 E

T 15 S  
T 16 S  
T 17 S  
T 18 S  
T 19 S

T 10 S  
T 11 S

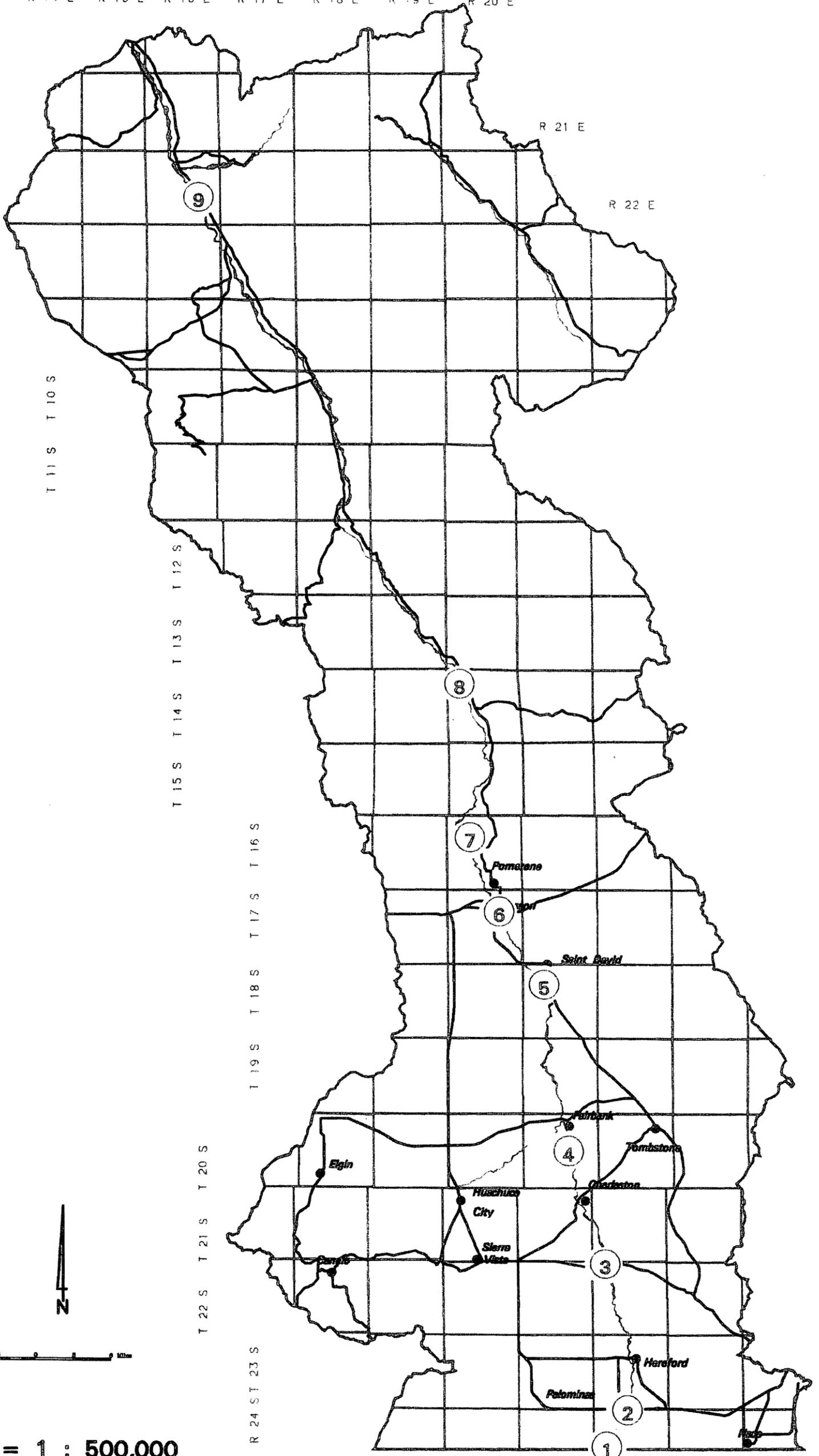
T 12 S  
T 13 S  
T 14 S  
T 15 S

T 16 S  
T 17 S  
T 18 S  
T 19 S

T 20 S  
T 21 S  
T 22 S

T 23 S  
T 24 S

R 18 E R 19 E R 20 E R 21 E R 22 E R 23 E R 24 E



SCALE = 1 : 500,000

**DWR analysis of San Pedro River channel changes from 1935 to 1990.**

DWR analyzed the historical aerial photography data base of selected areas of the San Pedro River watershed to document channel change. Channel change was of two types, channel shift (avulsion) and channel narrowing. The channel shifts range from 0 to approximately 1,200 feet as shown in the following table. Channel narrowing ranges from -170 (widening) to 970 feet. The channel was defined for this study as the "sandy wash" described by Dr. Montgomery. The following tables describe the results of the analysis.

The assessment was conducted by locating identical physical or cultural points on the east and west side of the San Pedro River on the 1990 and 1935 photography. A transect line was then drawn to connect the points on each photo. The distance from each point to the "sandy wash" as well as the width of the wash was measured. The difference in width of the "sandy wash" defines narrowing and is rounded to the nearest 10 ft. The shift is defined by the maximum difference in distance from the point to the wash on each side of the wash. The shift is the absolute value of the maximum distance and is rounded to the nearest 100 ft.

<b>Photo 1 - Hereford SW (Mexico to Palominas)<sup>1</sup></b>		
<b>Transect</b>	<b>Narrowing</b>	<b>Shift</b>
1a	-170	500

<b>Photo 2 - Hereford (Palominas to Lewis Spring)<sup>1</sup></b>		
<b>Transect</b>	<b>Narrowing</b>	<b>Shift</b>
2a	210	500
2b	310	700
2c	480	300
2d	100	100

<b>Photo 3 - Lewis Spring (Lewis Spring to Charleston)<sup>1</sup></b>		
<b>Transect</b>	<b>Narrowing</b>	<b>Shift</b>
3a	170	400
3b	440	400
3c	400	500
3d	130	100

<b>Photo 4 - Fairbank (Charleston to Fairbank)<sup>1</sup></b>		
<b>Transect</b>	<b>Narrowing</b>	<b>Shift</b>
4a	240	200
4b	340	600

<b>Photo 5 - Land (Fairbank to St. David)<sup>1</sup></b>		
<b>Transect</b>	<b>Narrowing</b>	<b>Shift</b>
5a	100	100
5b	630	500
5c	70	1,000

<b>Photo 6 - Benson (St. David to Pomerene)<sup>1</sup></b>		
<b>Transect</b>	<b>Narrowing</b>	<b>Shift</b>
6a	130	200
6b	100	1,200
6c	0	700
6d	300	500

<b>Photo 7 - Galleta Flats East (Pomerene to Narrows)<sup>1</sup></b>		
<b>Transect</b>	<b>Narrowing</b>	<b>Shift</b>
7a	370	700
7b	200	500
7c	100	100
7d	130	100

<b>Photo 8 - Wildhorse Mnt<sup>1</sup></b>		
<b>Transect</b>	<b>Narrowing</b>	<b>Shift</b>
8a	970	900
8b	400	400
8c	200	300

<b>Photo 9 - Clark Ranch (Mammoth area)<sup>1</sup></b>		
<b>Transect</b>	<b>Narrowing</b>	<b>Shift</b>
9a	500	400
9b	800	500
9c	400	600

<sup>1</sup> all values in feet

**Paul L. Sale Property Channel Shift approximately 950 feet as determined from previous mapping and communication with the property owner.**

DWR San Pedro River Study Transects - Channel Change  
 TRANSECTS (values in feet)

1a	West	Channel	East	TOTAL	%
1935	1000	366	3000	4366	
1990	1332	534	2500	4366	100.0
Difference	332	-168	-500		

2a	West	Channel	East	TOTAL	%
1935	2571	372	3315	6258	
1990	2284	165	3806	6255	100.0
Difference	287	207	-491		

2b	West	Channel	East	TOTAL	%
1935	4432	472	3518	8422	
1990	5088	165	3111	8364	100.7
Difference	-656	307	407		

2c	West	Channel	East	TOTAL	%
1935	6428	609	3789	10826	
1990	6675	132	4077	10884	99.5
Difference	-247	477	-288		

2d	West	Channel	East	TOTAL	%
1935	4296	203	3518	8017	
1990	4439	99	3452	7990	100.3
Difference	-143	104	66		

3a	West	Channel	East	TOTAL	%
1935	7605	303	5276	13184	
1990	7302	133	5725	13160	100.2
Difference	303	170	-449		

3b	West	Channel	East	TOTAL	%
1935	7437	505	4812	12754	
1990	7866	66	4647	12579	101.4
Difference	-429	439	165		

3c	West	Channel	East	TOTAL	%
1935	4609	572	706	5887	
1990	5139	174	937	6250	94.2
Difference	-530	398	-231		

3d	West	Channel	East	TOTAL	%
1935	908	269	2086	3263	
1990	1012	135	2193	3340	97.7
Difference	-104	134	-107		

4a	West	Channel	East	TOTAL	%
1935	1282	337	4487	6106	
1990	1448	101	4677	6226	98.1
Difference	-166	236	-190		

4b	West	Channel	East	TOTAL	%
1935	4352	472	5196	10020	
1990	4230	135	5753	10118	99.0
Difference	122	337	-557		

5a	West	Channel	East	TOTAL	%
1935	3517	469	2814	6800	
1990	3453	369	2850	6672	101.9
Difference	64	100	-36		

5b	West	Channel	East	TOTAL	%
1935	737	837	1234	2808	
1990	737	207	1775	2719	103.3
Difference	0	630	-541		

5c	West	Channel	East	TOTAL	%
1935	469	569	4421	5459	
1990	1150	502	3457	5109	106.9
Difference	-681	67	964		

6a	West	Channel	East	TOTAL	%
1935	2066	267	2166	4499	
1990	1965	133	2400	4498	100.0
Difference	101	134	-234		

6b	West	Channel	East	TOTAL	%
1935	3633	333	800	4766	
1990	2533	233	2000	4766	100.0
Difference	1100	100	-1200		

6c	West	Channel	East	TOTAL	%
----	------	---------	------	-------	---

1935	5500	233	1533	7266	
1990	5684	233	2200	8117	89.5
Difference	-184	0	-667		

6d	West	Channel	East	TOTAL	%
1935	1200	367	4167	5734	
1990	1666	67	4000	5733	100.0
Difference	-466	300	167		

7a	West	Channel	East	TOTAL	%
1935	3733	500	2233	6466	
1990	3065	133	2933	6131	105.5
Difference	668	367	-700		

7b	West	Channel	East	TOTAL	%
1935	4833	667	5666	11166	
1990	5333	467	5366	11166	100.0
Difference	-500	200	300		

7c	West	Channel	East	TOTAL	%
1935	5633	200	3833	9666	
1990	5733	100	3833	9666	100.0
Difference	-100	100	0		

7d	West	Channel	East	TOTAL	%
1935	4300	266	666	5232	
1990	4433	133	666	5232	100.0
Difference	-133	133	0		

8a	West	Channel	East	TOTAL	%
1935	1267	1133	3833	6233	
1990	1067	167	4733	5967	104.5
Difference	200	966	-900		

8b	West	Channel	East	TOTAL	%
1935	1567	500	2667	4734	
1990	1933	100	2900	4933	96.0
Difference	-366	400	-233		

8c	West	Channel	East	TOTAL	%
1935	3267	400	2900	6567	
1990	3600	200	2667	6467	101.5

Difference      -333          200          233

9a	West	Channel	East	TOTAL	%
1935	733	767	1500	3000	
1990	1166	267	1567	3000	100.0
Difference	-433	500	-67		

9b	West	Channel	East	TOTAL	%
1935	500	1566	2200	4266	
1990	1000	766	2500	4266	100.0
Difference	-500	800	-300		

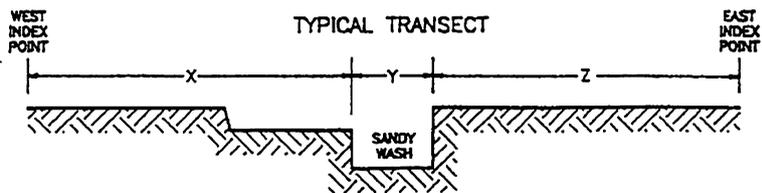
9c	West	Channel	East	TOTAL	%
1935	667	1066	3667	5400	
1990	1233	667	3500	5400	100.0
Difference	-566	399	167		

AVG                      100.0

TABLE OF REPORTED DISTANCES ALONG 28 TRANSECTS  
IDENTIFIED BY ARIZONA DEPARTMENT OF WATER RESOURCES  
FROM 1935 AND 1990 AERIAL PHOTOGRAPHS  
OF THE SAN PEDRO RIVER

TRANSECT IDENTIFIER	1935 .....DISTANCES (feet)*.....				1990 .....DISTANCES (feet).....			
	X	Y	Z	TOTAL	X	Y	Z	TOTAL
1a	1,000	366	3,000	4,366	1,332	534	2,500	4,366
2a	2,571	372	3,315	6,258	2,284	165	3,806	6,255
2b	4,432	304	3,518	8,254	4,666	165	3,111	7,942
2c	6,428	609	3,789	10,826	6,675	132	4,077	10,884
2d	4,296	203	3,518	8,017	4,439	99	3,452	7,990
3a	7,605	303	5,216	13,124	7,302	133	5,742	13,177
3b	7,437	505	4,812	12,754	7,866	66	4,647	12,579
3c	4,543	572	673	5,788	5,139	174	937	6,250
3d	908	269	2,086	3,263	1,012	135	2,193	3,340
4a	1,282	337	4,487	6,106	1,447	101	4,677	6,225
4b	4,352	472	5,196	10,020	4,230	135	5,753	10,118
5a	3,517	469	2,814	6,800	3,453	369	2,850	6,672
5b	737	837	1,239	2,813	737	270	1,775	2,782
5c	469	569	4,421	5,459	1,072	502	3,751	5,325
6a	2,066	267	2,166	4,499	1,965	133	2,400	4,498
6b	3,633	333	800	4,766	2,533	233	2,000	4,766
6c	5,500	233	2,533	8,266	5,833	233	2,200	8,266
6d	1,200	367	4,166	5,733	1,666	67	4,000	5,733
7a	3,733	500	2,233	6,466	3,065	133	2,933	6,131
7b	4,833	667	5,666	11,166	5,333	467	5,366	11,166
7c	5,633	200	3,833	9,666	5,733	100	3,833	9,666
7d	4,300	266	666	5,232	4,433	133	666	5,232
8a	1,267	1,133	3,833	6,233	1,067	167	4,733	5,967
8b	1,867	500	2,667	5,034	1,933	100	2,900	4,933
8c	3,267	400	2,900	6,567	3,600	200	2,667	6,467
9a	733	767	1,500	3,000	1,166	267	1,567	3,000
9b	500	1,566	2,200	4,266	1,000	766	2,500	4,266
9c	667	1,066	3,667	5,400	1,233	667	3,500	5,400

\* Distances "X", "Y", and "Z" are from ADWR overlays for 1935 and 1990 aerial photographs of the San Pedro River. Distance "X" is from an index point at the west end of transect to west bank of "Sandy Wash"; distance "Y" is width of "Sandy Wash"; and distance "Z" is from east bank of "Sandy Wash" to an index point at the east end of transect.



**DWR analysis of change in riparian habitat along the San Pedro River from 1935 to 1990.**

DWR analyzed the historical aerial photography data base of selected areas of the San Pedro River watershed to document change in the extent of riparian vegetation. The change in riparian vegetation along the San Pedro River channel varies widely across the watershed. The magnitude of change is shown in feet along a study transect. The changes are summarized in the following tables.

DWR used the same general methods as outlined for channel changes. The amount of riparian change is defined as the sum of riparian change on the west and east sides of the wash. The riparian change was calculated by subtracting the riparian distance on the 1990 photos from the riparian distance on the 1935 photos. All values are rounded to the nearest 100 feet.

<b>Photo 1 - Hereford SW (Mexico to Palominas)<sup>1</sup></b>	
<b>Transect</b>	<b>Riparian Change</b>
1a	+100 ft

<b>Photo 2 - Hereford (Palominas to Lewis Spring)<sup>1</sup></b>	
<b>Transect</b>	<b>Riparian Change</b>
2a	+500 ft
2b	-300 ft
2c	no change 0
2d	no change 0

<b>Photo 3 - Lewis Spring (Lewis Spring to Charleston)<sup>1</sup></b>	
<b>Transect</b>	<b>Riparian Change</b>
3a	-300 ft
3b	+ 200 ft
3c	-100 ft
3d	-200 ft

<b>Photo 4 - Fairbank (Charleston to Fairbank)<sup>1</sup></b>	
<b>Transect</b>	<b>Riparian Change</b>
4a	-100 ft
4b	-500 ft

<b>Photo 5 - Land (Fairbank to St. David)<sup>1</sup></b>	
<b>Transect</b>	<b>Riparian Change</b>
5a	-1900 ft
5b	no change 0 ft
5c	-200 ft

<b>Photo 6 - Benson (St. David to Pomerene)<sup>1</sup></b>	
<b>Transect</b>	<b>Riparian Change</b>
6a	+ 800 ft
6b	+ 800 ft
6c	+ 200 ft
6d	-200 ft

<b>Photo 7 - Galleta Flats East (Pomerene to Narrows)<sup>1</sup></b>	
<b>Transect</b>	<b>Riparian Change</b>
7a	no change 0 ft
7b	+ 600 ft
7c	-300 ft
7d	-500 ft

<b>Photo 8 - Wildhorse Mnt<sup>1</sup></b>	
<b>Transect</b>	<b>Riparian Change</b>
8a	+ 3100 ft
8b	+ 1800 ft
8c	+ 1900 ft

<b>Photo 9 - Clark Ranch (Mammoth area)<sup>1</sup></b>	
<b>Transect</b>	<b>Riparian Change</b>
9a	-500 ft
9b	+ 700 ft
9c	-500 ft

Copy of the foregoing report  
 mailed this \_\_\_\_ day of  
 June, 1994, to all persons  
 on the Court approved mailing  
 list dated June 6, 1994

Upper San Pedro River, Arizona

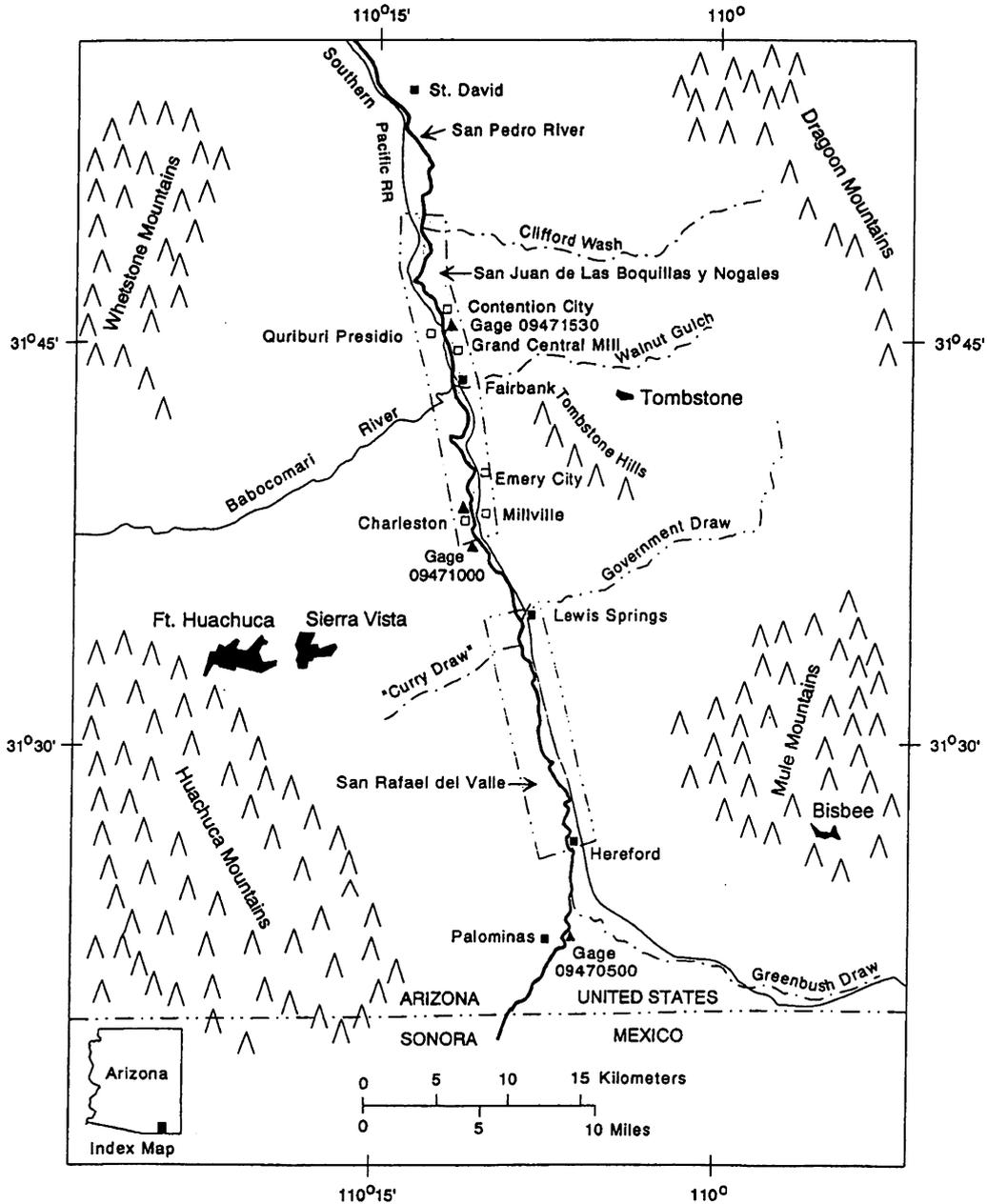


Figure 1. The study area in southeast Arizona. Field studies were undertaken in the river valley between Hereford and just north of Clifford Wash.

Upper San Pedro River, Arizona

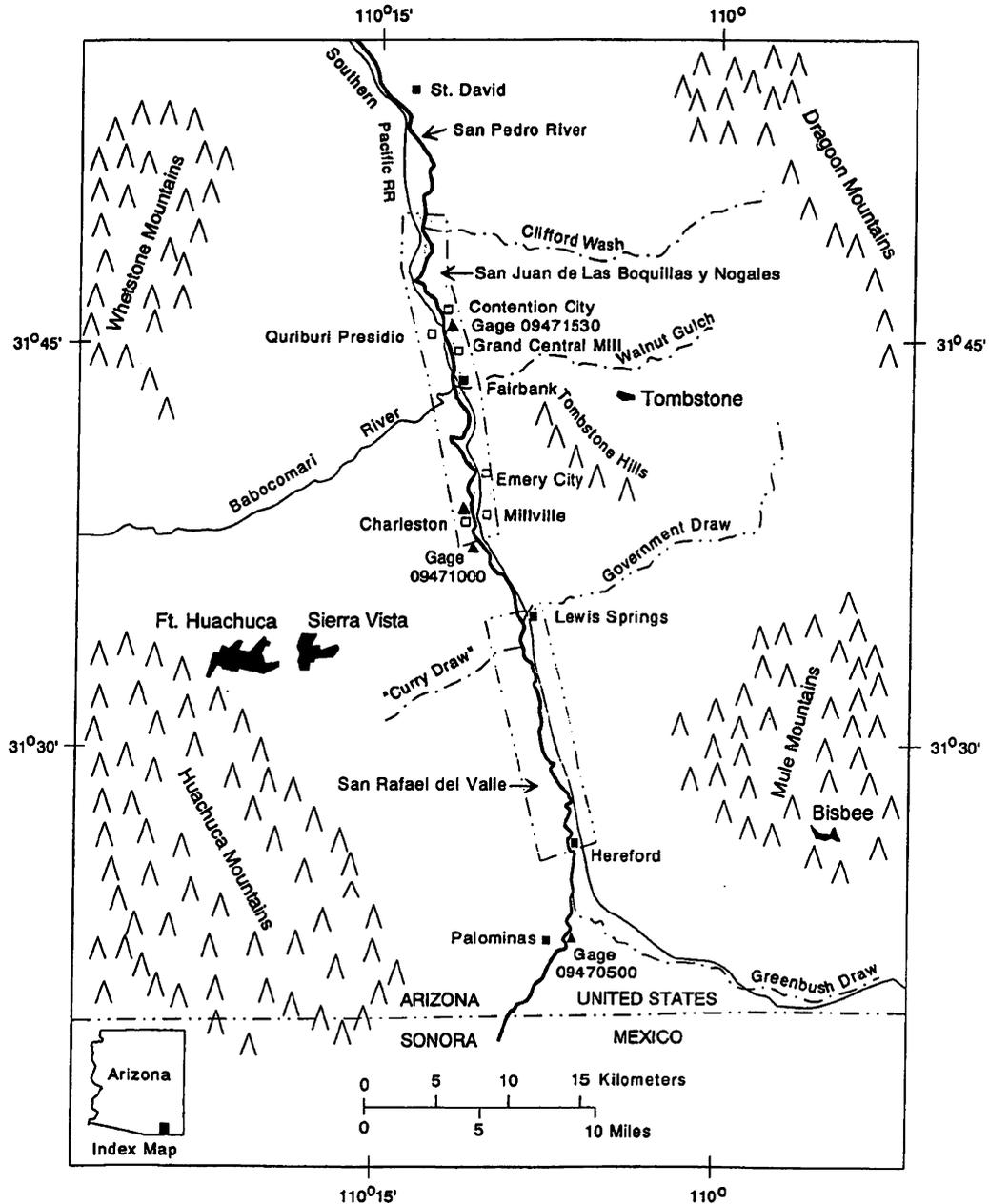
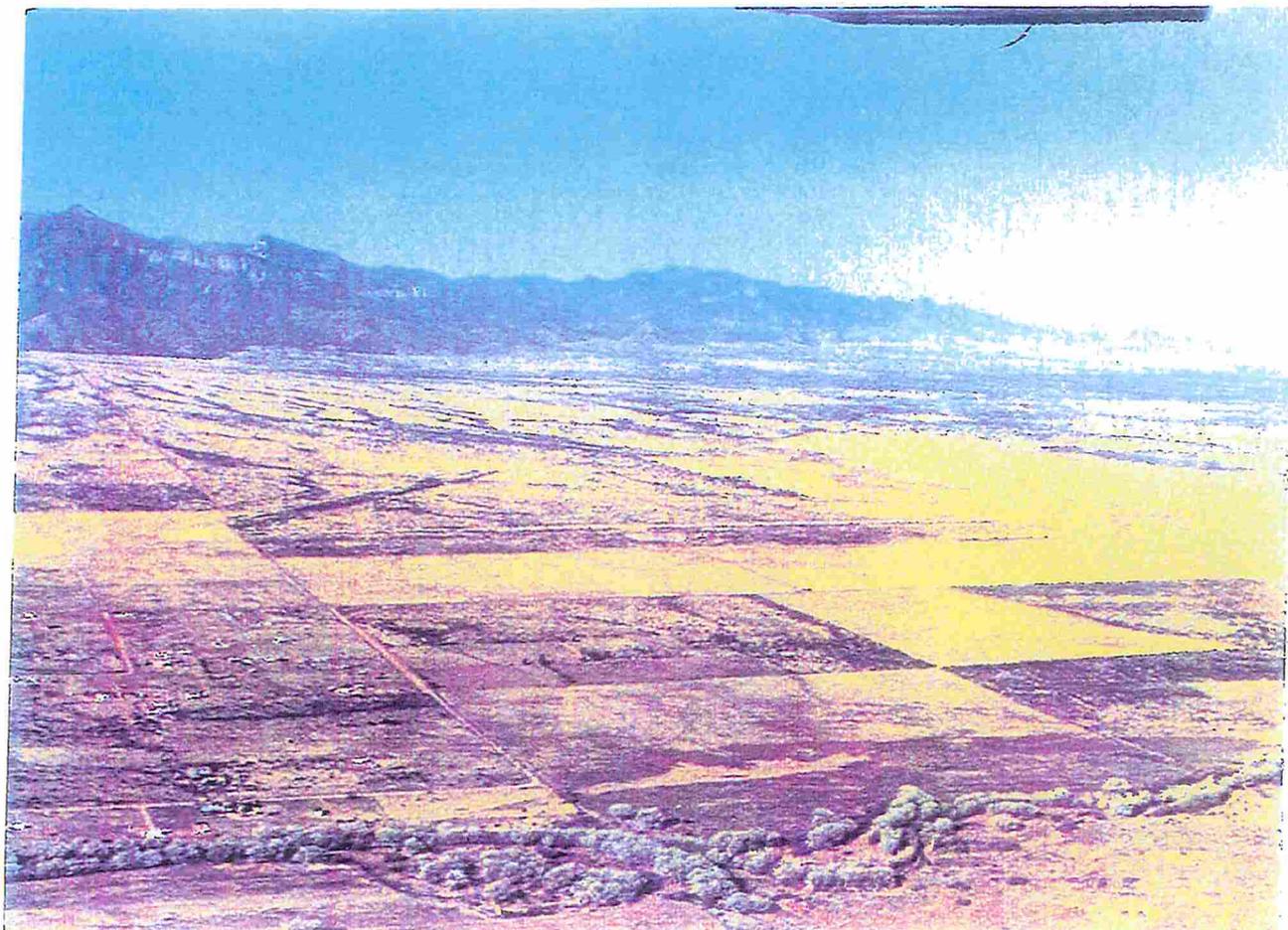


Figure 1. The study area in southeast Arizona. Field studies were undertaken in the river valley between Hereford and just north of Clifford Wash.

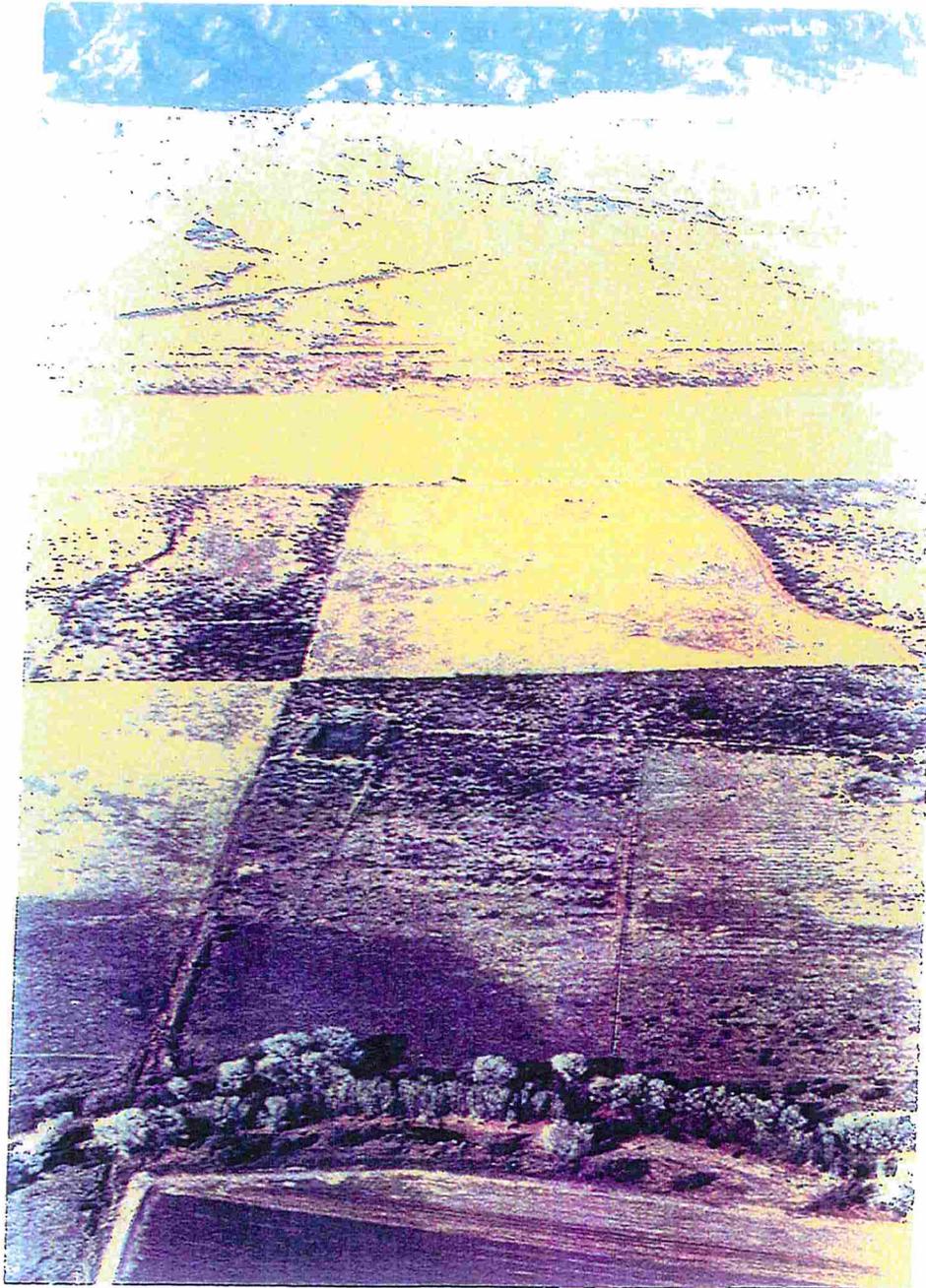


## **PHOTOGRAPH 4**

**SAN PEDRO RIVER MAP 1 (NEAR PALOMINAS) ABOUT 2 MILES  
NORTHEAST FROM PALOMINAS, VIEW TOWARD WEST.**

Exhibit 69 in envelope.

Appendix H.

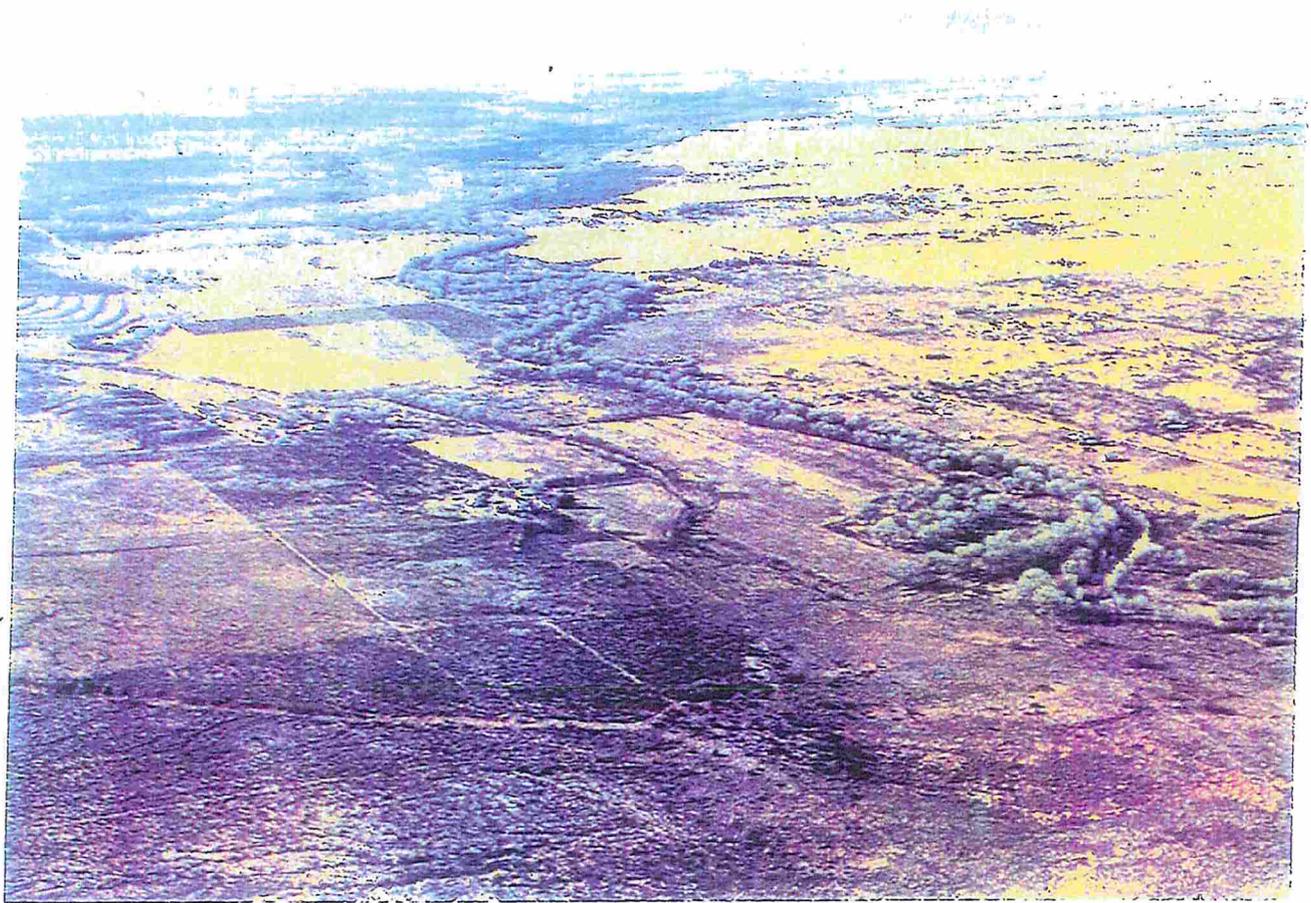


## PHOTOGRAPH 6

SAN PEDRO RIVER MAP 1 (NEAR PALOMINAS) ABOUT 2 MILES  
NORTHEAST FROM PALOMINAS, VIEW TOWARD WEST.

Exhibit 71 in envelope.

Appendix I.



## PHOTOGRAPH 7

SAN PEDRO RIVER MAP 1 (NEAR PALOMINAS) ABOUT 1 MILE  
SOUTH FROM HEREFORD, VIEW TOWARD SOUTHWEST.

Exhibit 72 in envelope.

Appendix J.

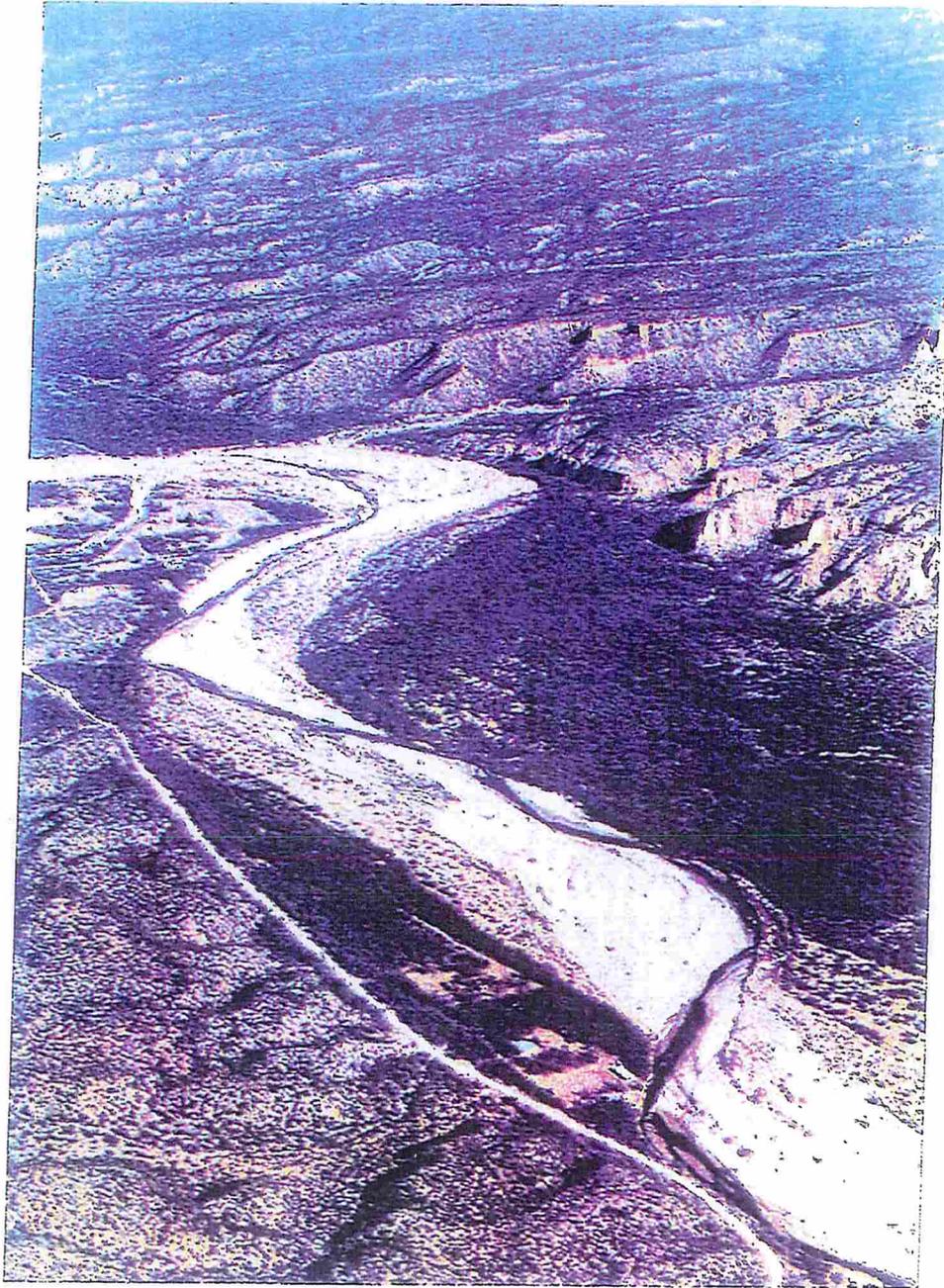


## PHOTOGRAPH 11

SAN PEDRO RIVER MAP 5 (NEAR CASCABEL) ABOUT 7 MILES  
SOUTHEAST FROM CASCABEL, VIEW TOWARD EAST.

Exhibit 76 in envelope.

Appendix K.

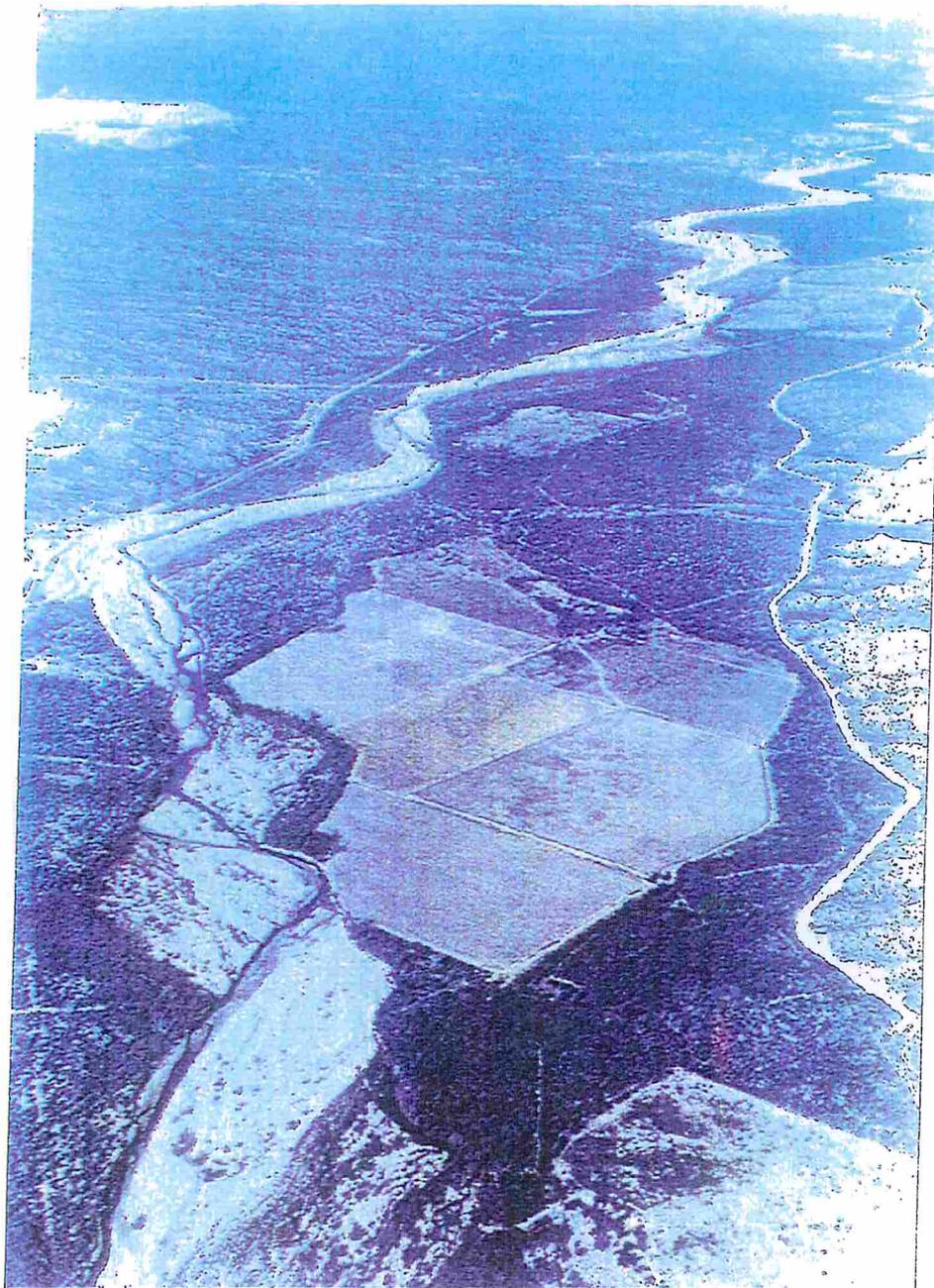


**PHOTOGRAPH 12**

**SAN PEDRO RIVER MAP 6 (NEAR REDINGTON) ABOUT 8 MILES  
NORTH FROM REDINGTON, VIEW TOWARD NORTH.**

Exhibit 77 in envelope.

Appendix L.

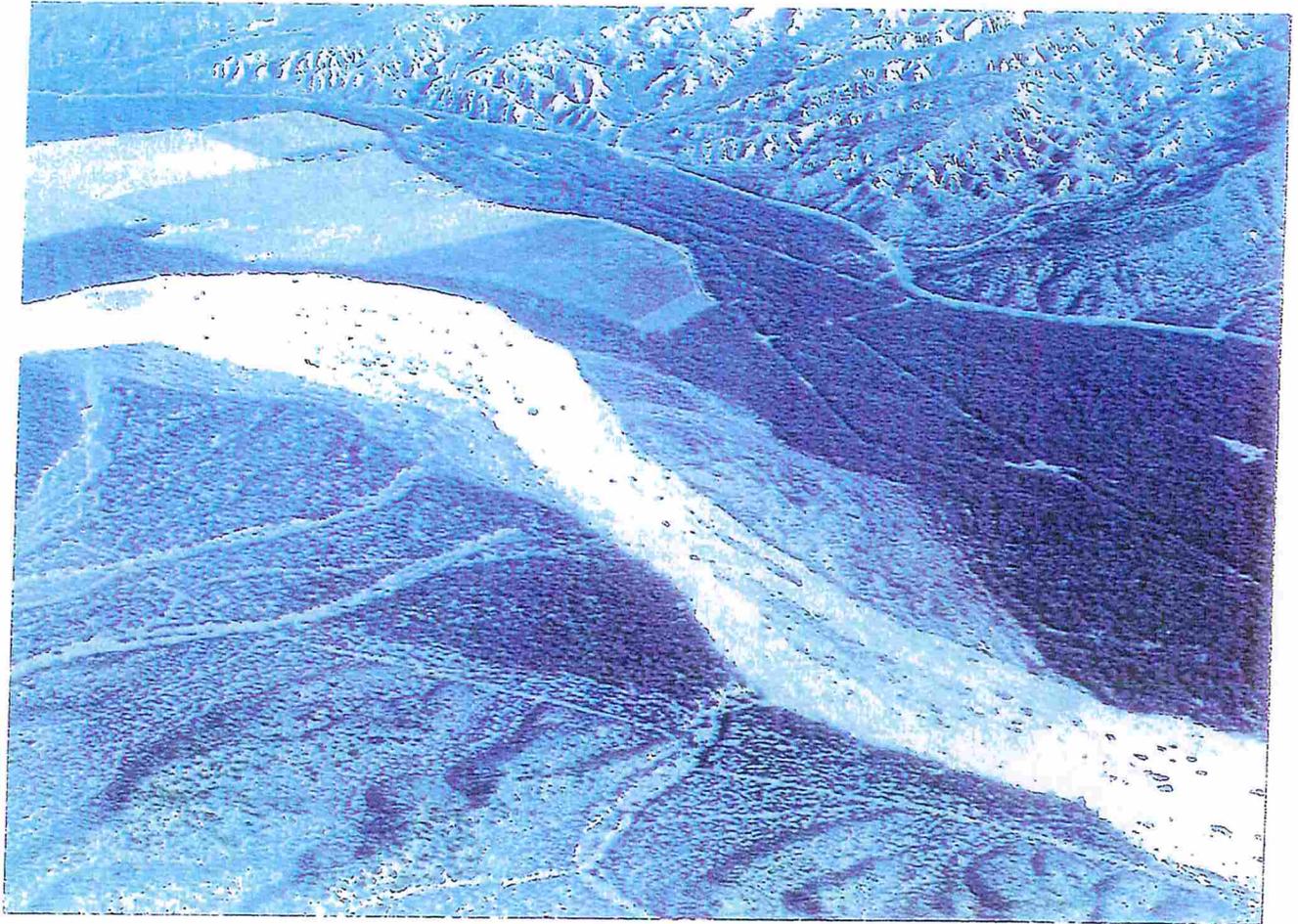


**PHOTOGRAPH 13**

**SAN PEDRO RIVER MAP 7 (NEAR SAN MANUEL) ABOUT 3 MILES  
NORTHEAST FROM SAN MANUEL, VIEW TOWARD NORTHWEST.**

Exhibit 78 in envelope.

Appendix M.

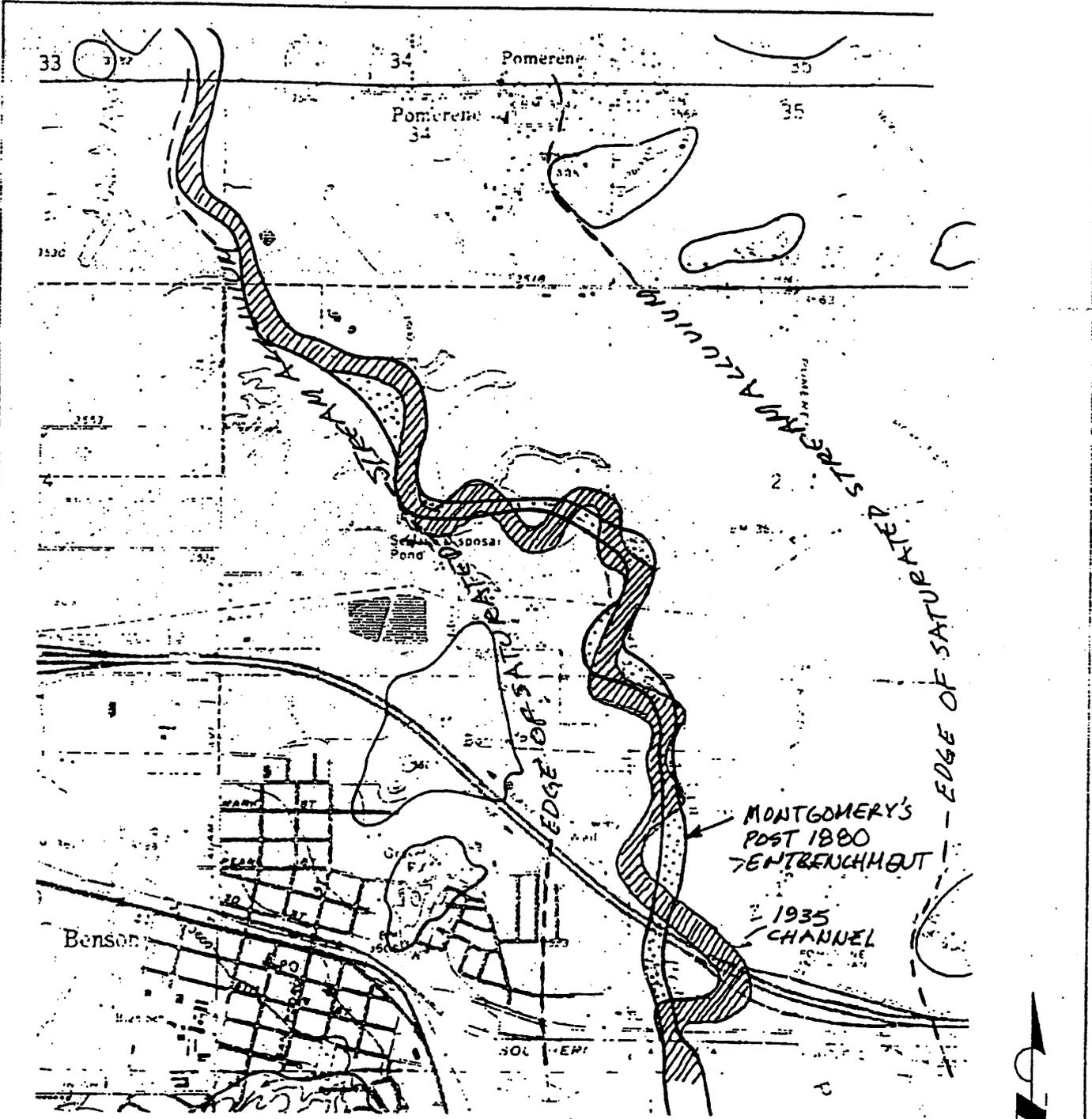


## **PHOTOGRAPH 14**

**SAN PEDRO RIVER MAP 7 (NEAR SAN MANUEL) ABOUT 1 MILE  
SOUTH FROM MAMMOTH, VIEW TOWARD NORTHEAST.**

Exhibit 79 in envelope.

Appendix N.



NOTE: Shift in CHANNEL location of as much as 1100 feet since 1935. Further notice Montgomery's mapping using recent air photos does not agree well with earlier channel location. Since the entrenchment has supposedly enlarged around the original entrenchment location the 1935 channel should wholly be located within the current limits of the Post 1880 Entrenchment.

Scale 1" = 2000'

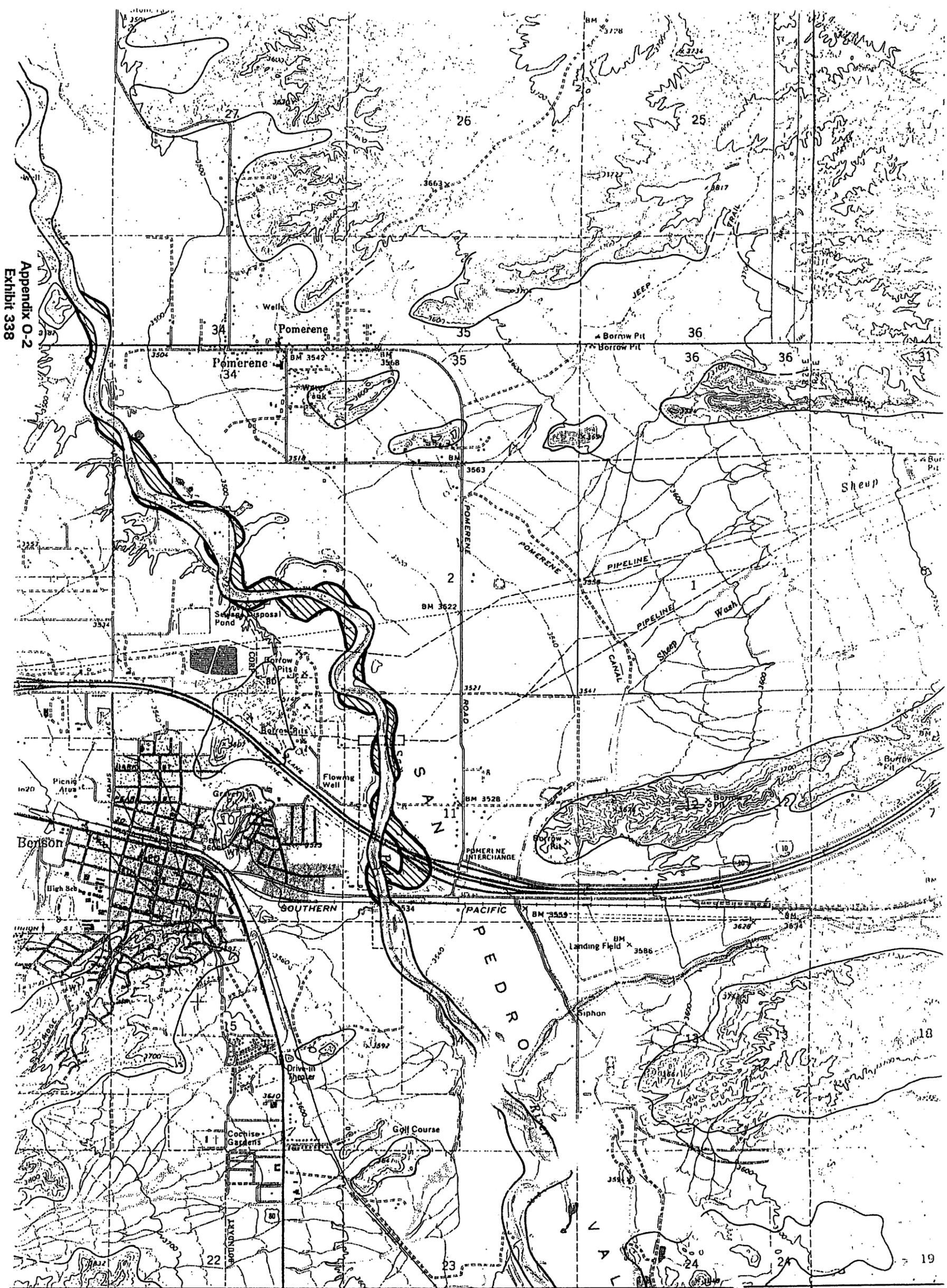
**EXPLANATION**

-  Edge of Saturated Stream Alluvium from SRP Map (Trial Exhibit)
-  Location of 1935 River Channel from Air Photo
-  Location of Post 1880 Entrenchment from Montgomery's Map (Trial Exhibit)

**COMPARISON OF 1935 SAN JUAN RIVER CHANNEL AND MONTGOMERY'S POST 1880 ENTRENCHMENT - NEAR BENSON**

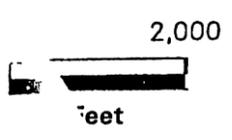
LEONARD RICE CONSULTING WATER ENGINEERS, INC.  
 2401 Fifteenth Street, Suite 300  
 Denver, Colorado 80202-1143 U.S.A.  
 (303) 455-9589 \* Fax (303) 455-0115

DWN: JRF    DATE: 5/6/94    PROJECT: 968GLE01    FIGURE: 2



Appendix O-2  
Exhibit 338

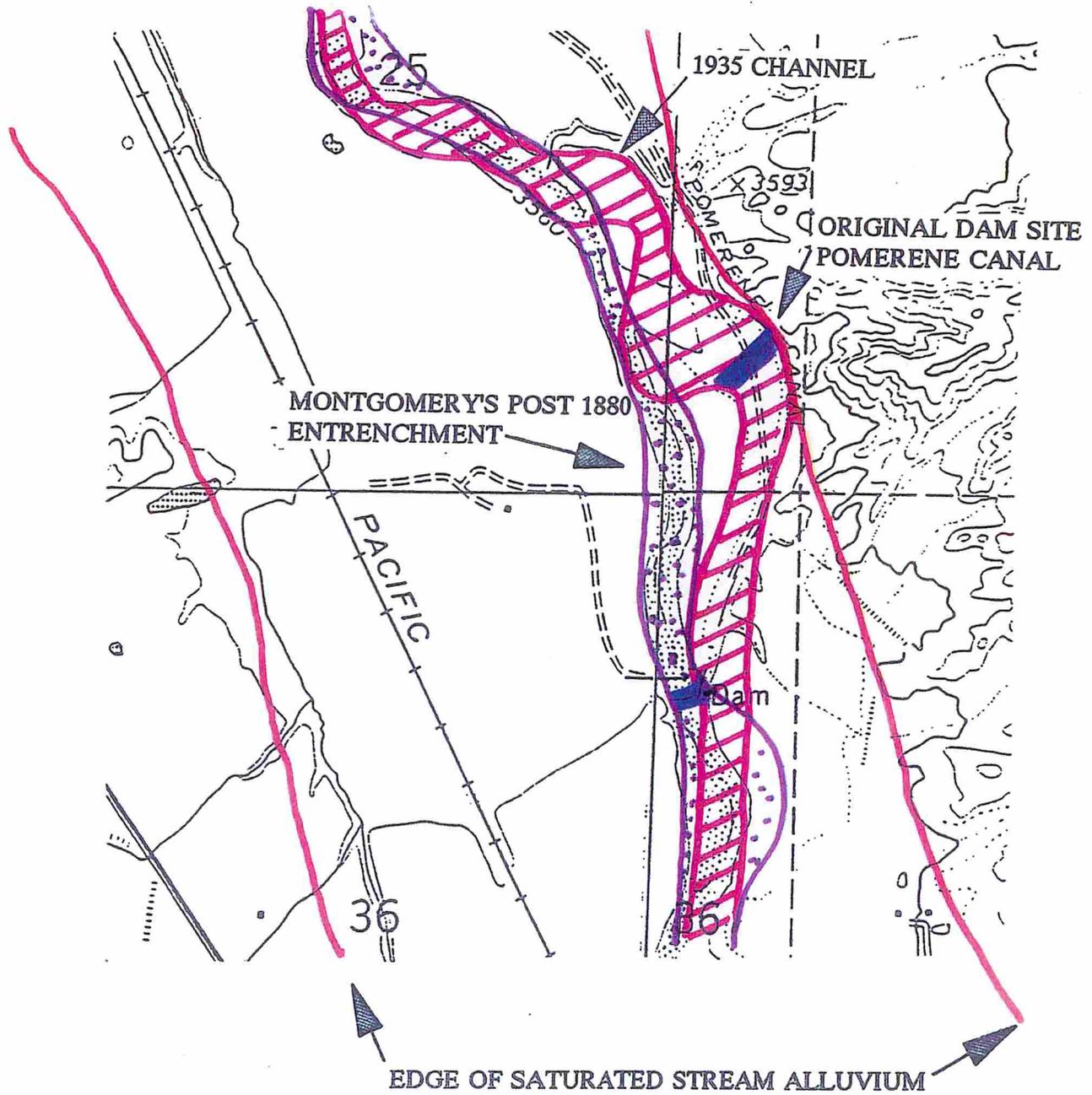
R. 20 E



EXTENT OF ENTRENCHMENT OF SAN PEDRO RIVER

VICINITY OF POMERENE CANAL COMPANY DAM

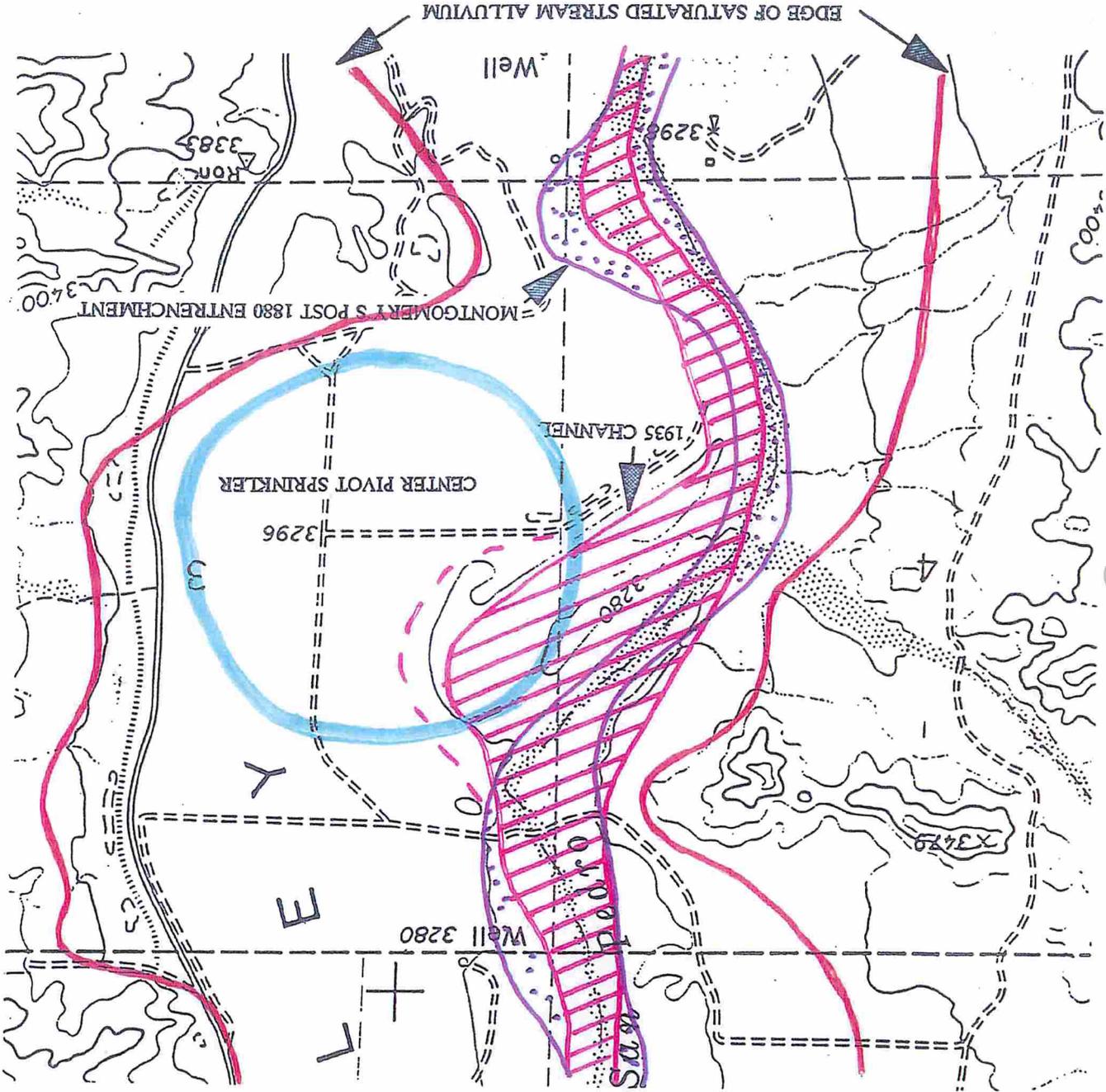
T.17S., R.20-21E.



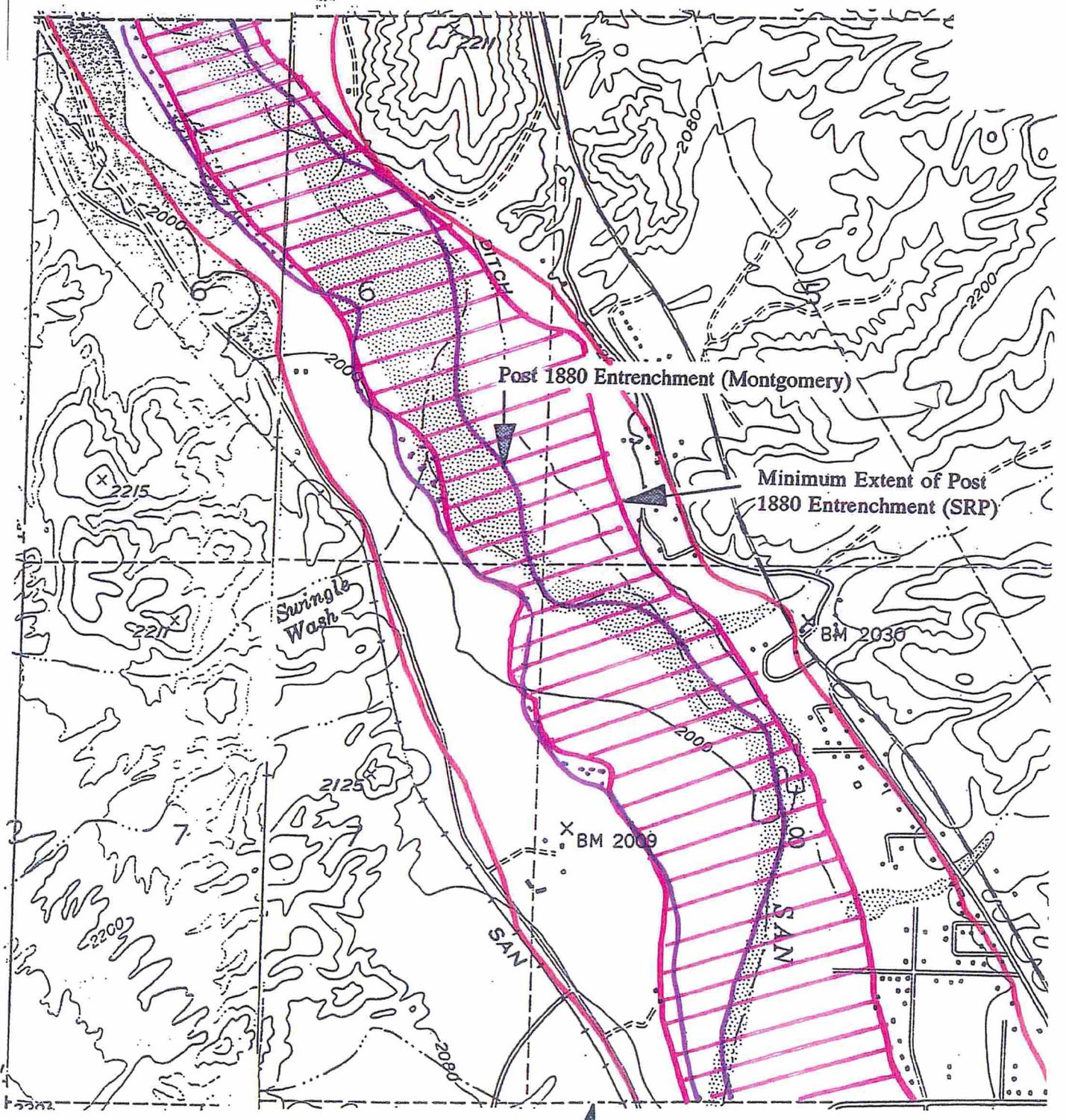
EXTENT OF ENTRENCHMENT OF SAN PEDRO RIVER

VICINITY OF AWDR EXHIBIT 260

T.14-15 S., R.20E.

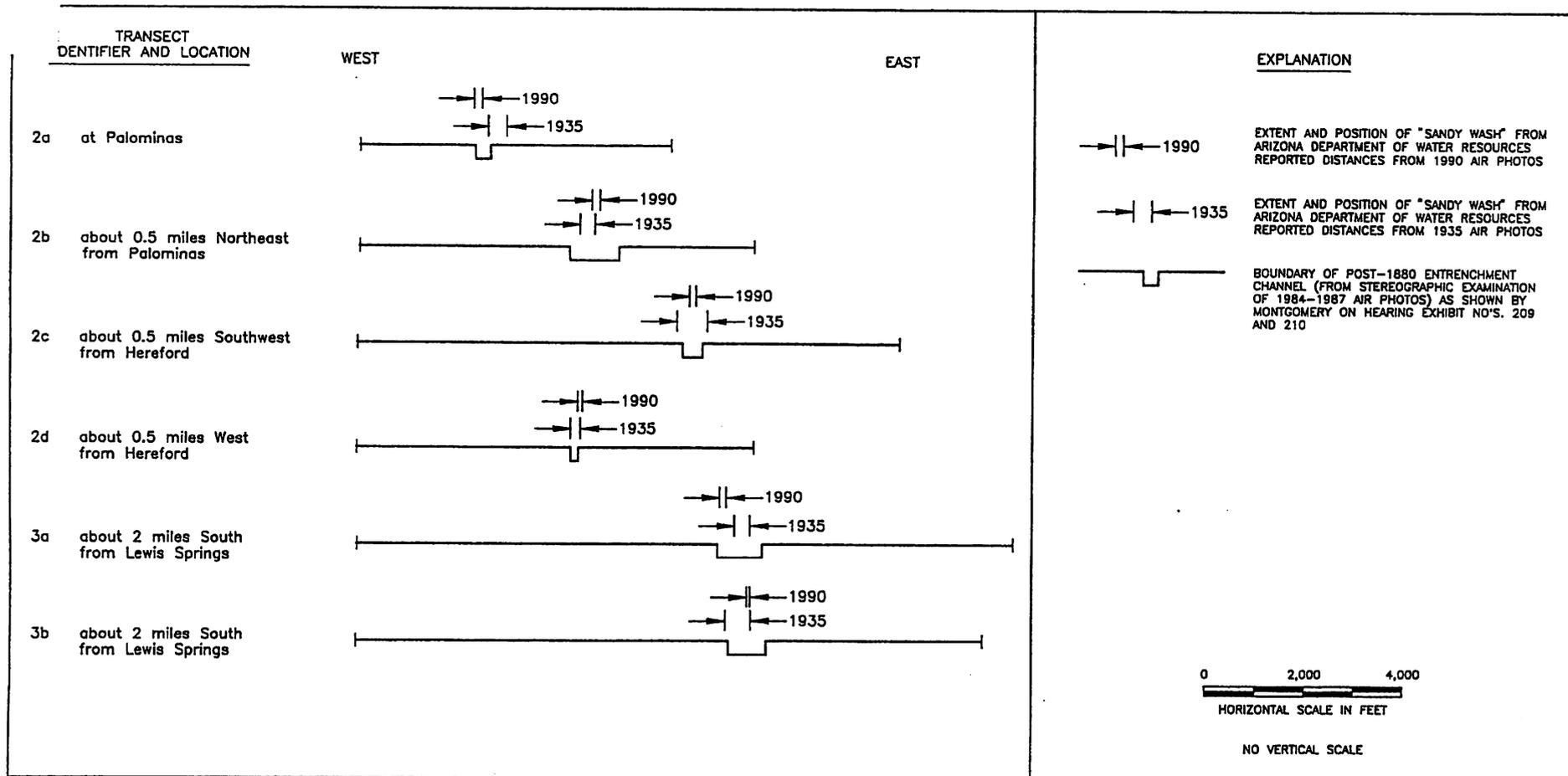


EXTENT OF ENTRENCHMENT OF SAN PEDRO RIVER  
VICINITY OF PAUL SALE PROPERTY  
T.6S., R.16E.

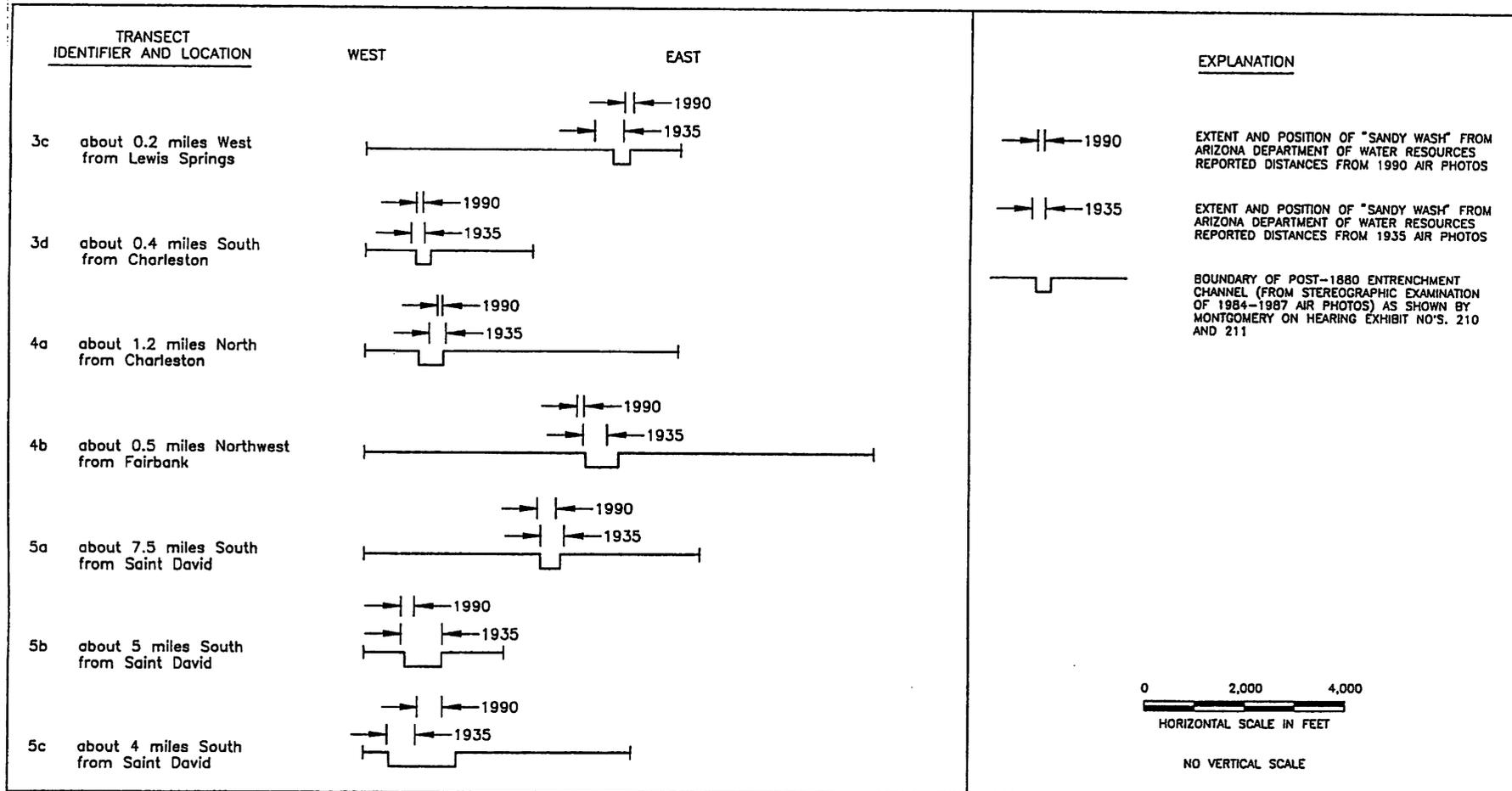


Appendix O-5  
Exhibit 325

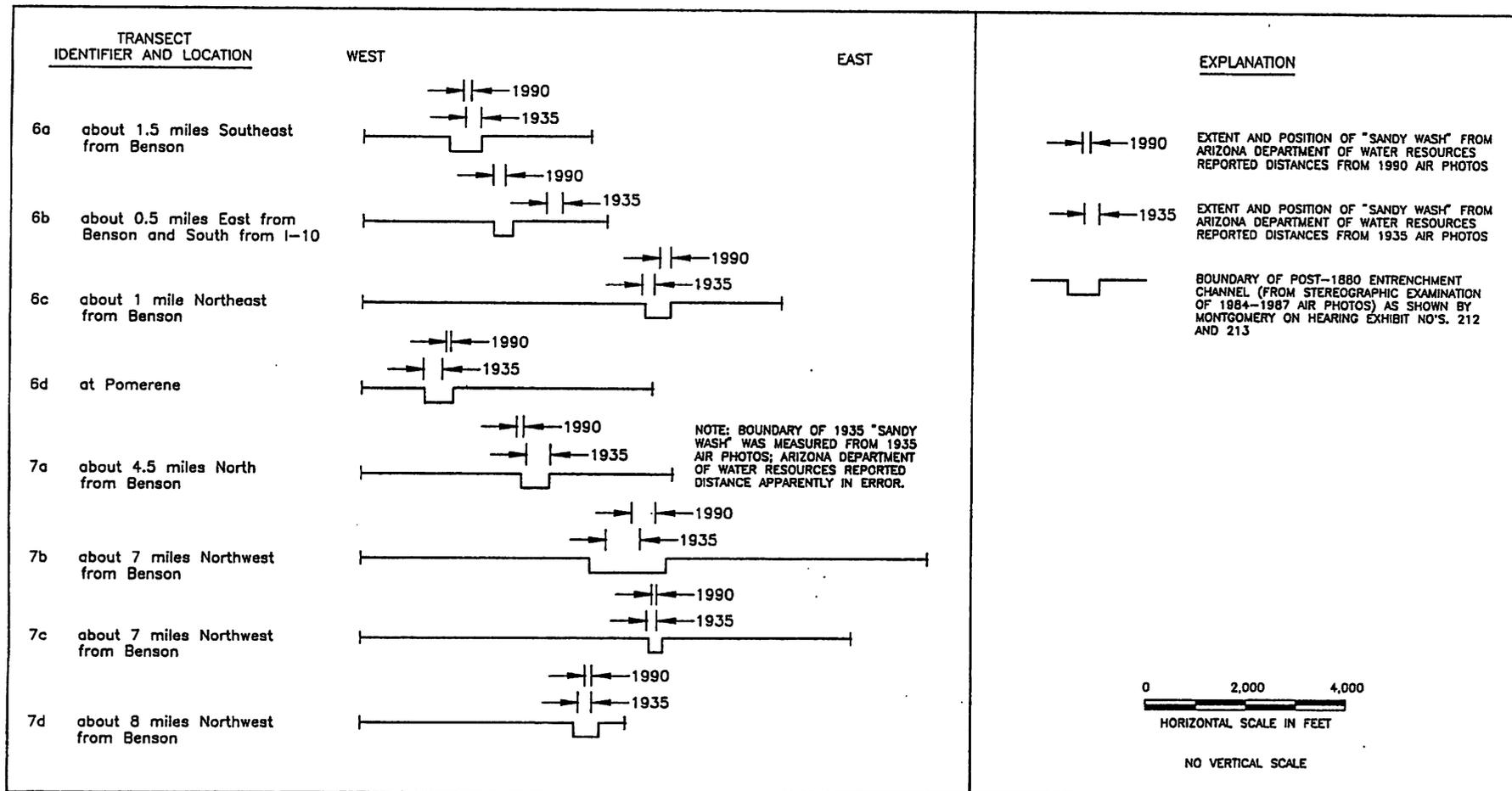
EDGE OF SATURATED STREAM ALLUVIUM



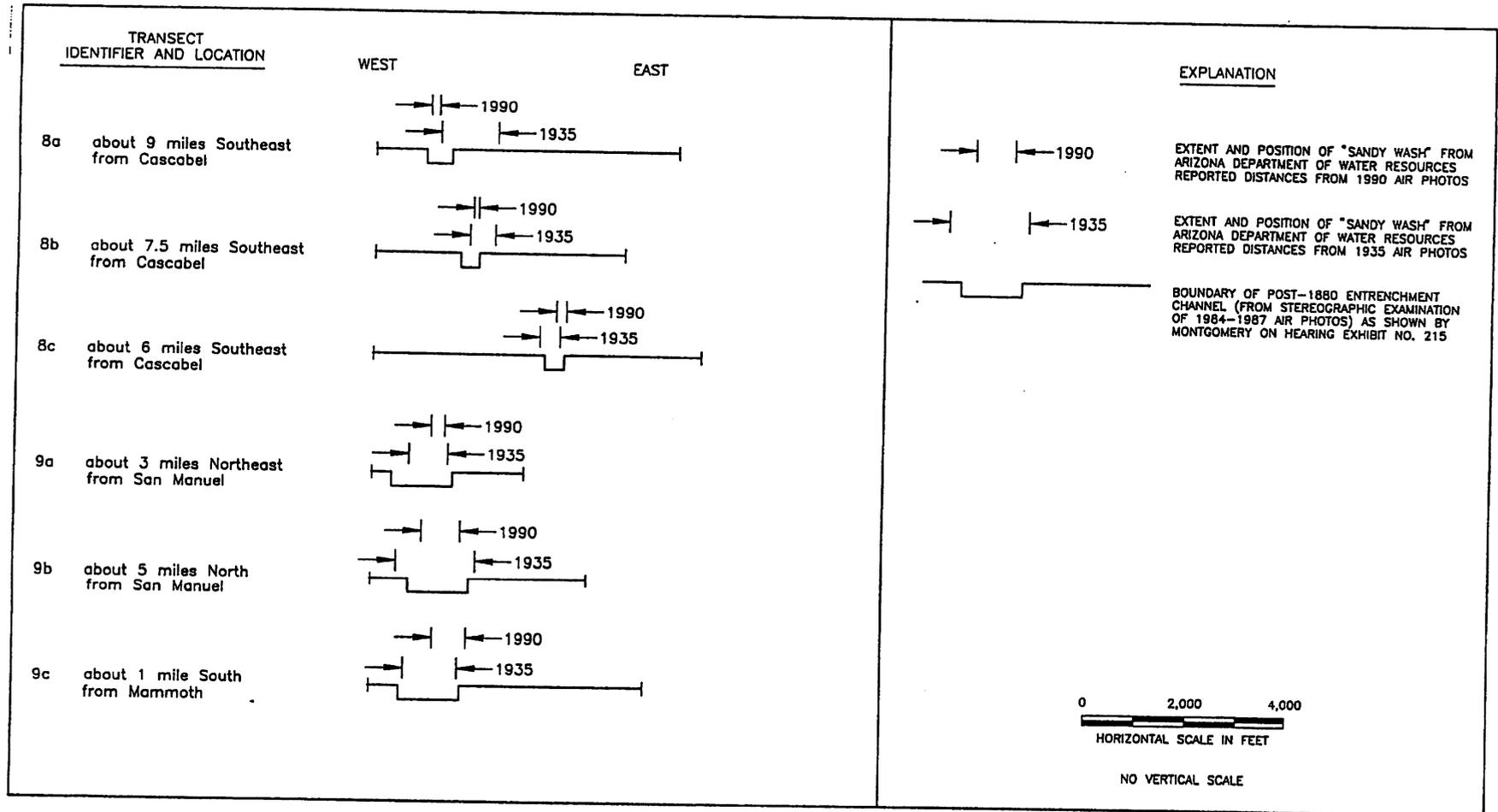
PHYSICAL RELATION BETWEEN "SANDY WASH" LOCATIONS IN 1935 AND 1990 BASED ON ARIZONA DEPARTMENT OF WATER RESOURCES REPORTED DISTANCES IN FEET, AND LATERAL EXTENT OF POST-1880 ENTRENCHMENT CHANNEL BASED ON HEARING EXHIBIT NUMBERS 209 AND 210 FOR TRANSECTS 2a, 2b, 2c, 2d, 3a, AND 3b.



PHYSICAL RELATION BETWEEN "SANDY WASH" LOCATIONS IN 1935 AND 1990 BASED ON ARIZONA DEPARTMENT OF WATER RESOURCES REPORTED DISTANCES IN FEET, AND LATERAL EXTENT OF POST-1880 ENTRENCHMENT CHANNEL BASED ON HEARING EXHIBIT NUMBERS 210 AND 211 FOR TRANSECTS 3c, 3d, 4a, 4b, 5a, 5b, AND 5c

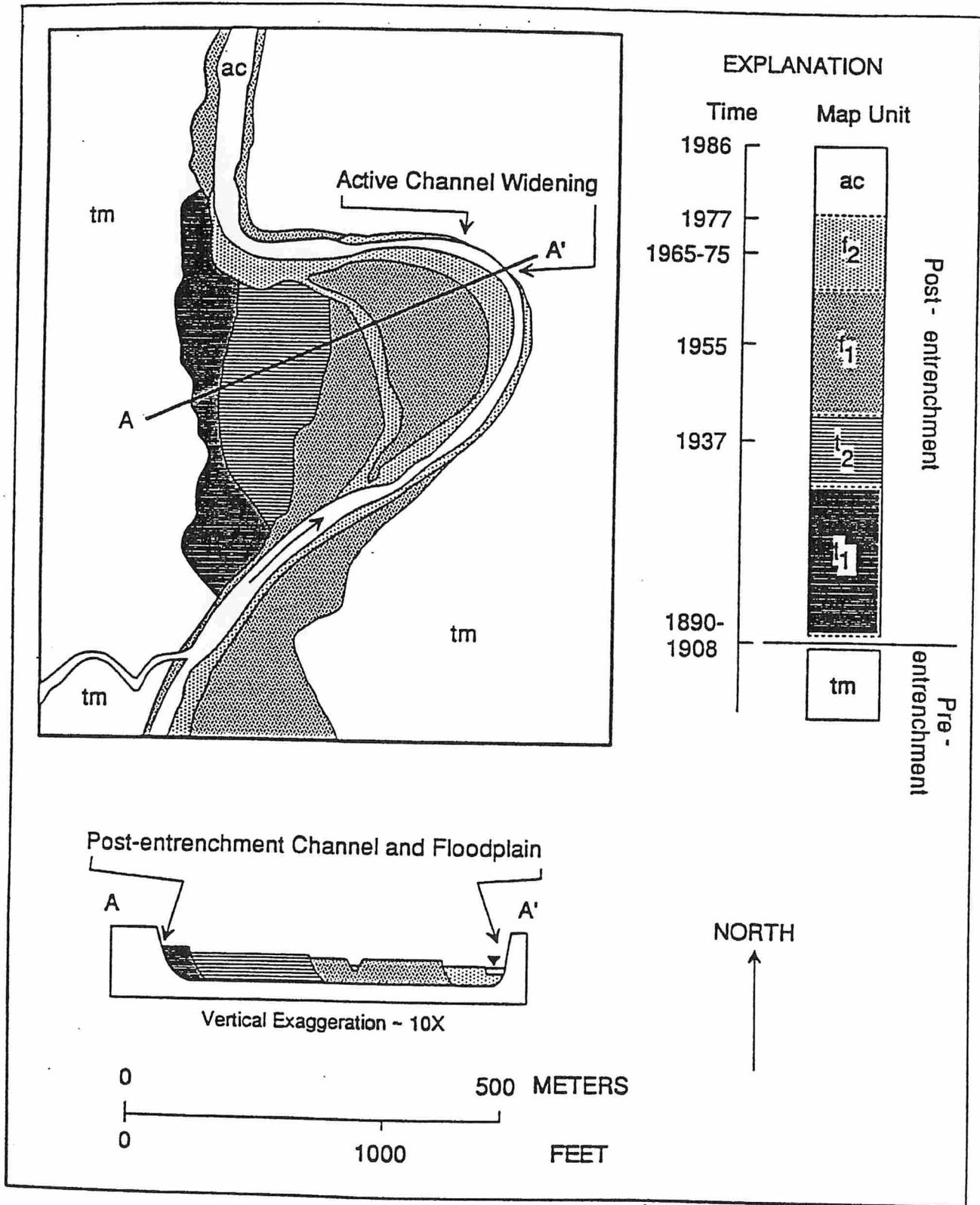


PHYSICAL RELATION BETWEEN "SANDY WASH" LOCATIONS IN 1935 AND 1990 BASED ON ARIZONA DEPARTMENT OF WATER RESOURCES REPORTED DISTANCES IN FEET, AND LATERAL EXTENT OF POST-1880 ENTRENCHMENT CHANNEL BASED ON HEARING EXHIBIT NUMBERS 212 AND 213 FOR TRANSECTS 6a, 6b, 6c, 6d, 7a, 7b, 7c, AND 7d,



PHYSICAL RELATION BETWEEN "SANDY WASH" LOCATIONS IN 1935 AND 1990 BASED ON ARIZONA DEPARTMENT OF WATER RESOURCES REPORTED DISTANCES IN FEET, AND LATERAL EXTENT OF POST-1880 ENTRENCHMENT CHANNEL BASED ON HEARING EXHIBIT NUMBER 215 FOR TRANSECTS 8a, 8b, 8c, 9a, 9b, AND 9c

FIGURE 7

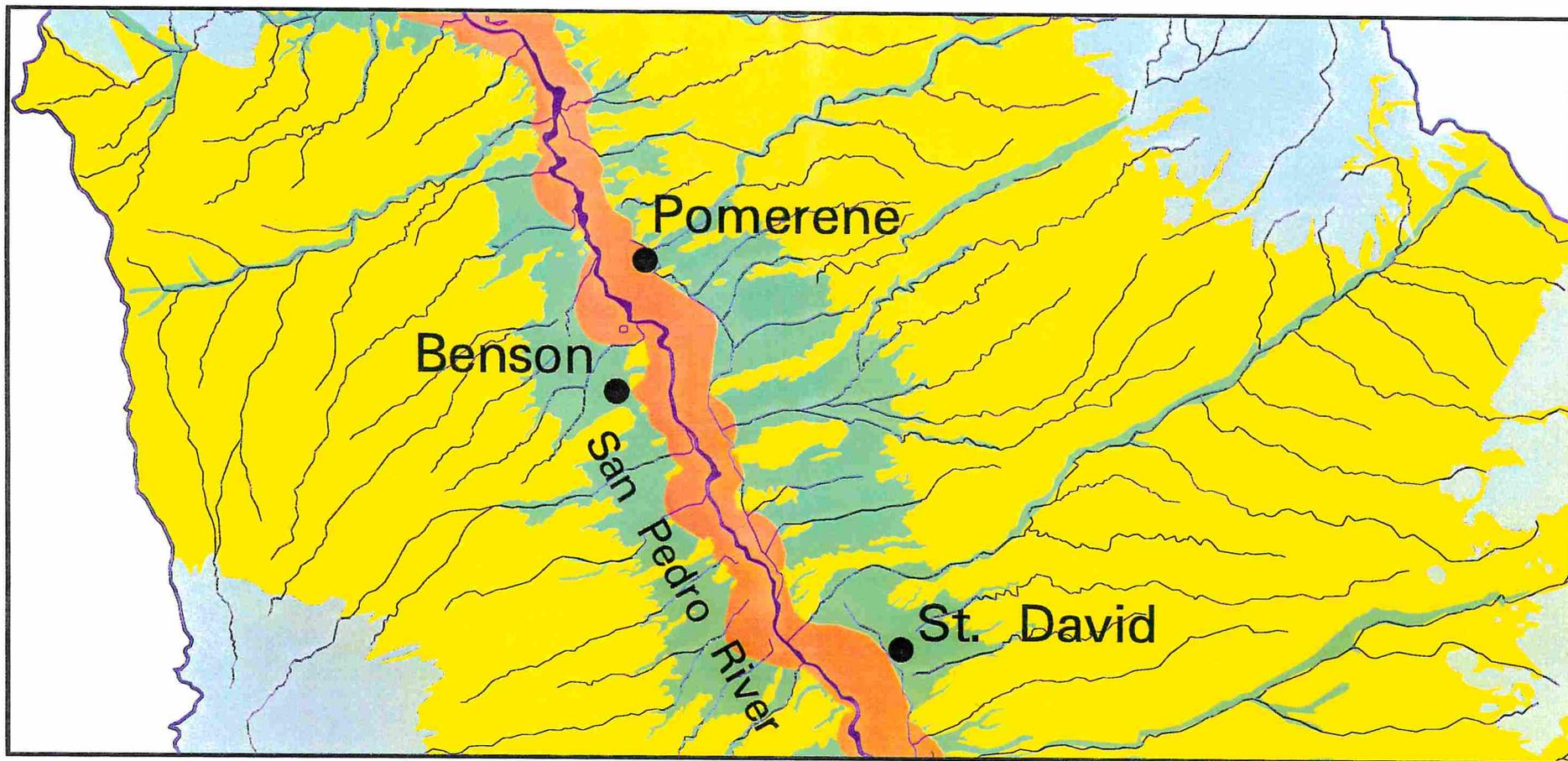


(Modified from Hereford, 1993)

# LATERAL CHANNEL MIGRATION IN THE SAN PEDRO RIVER

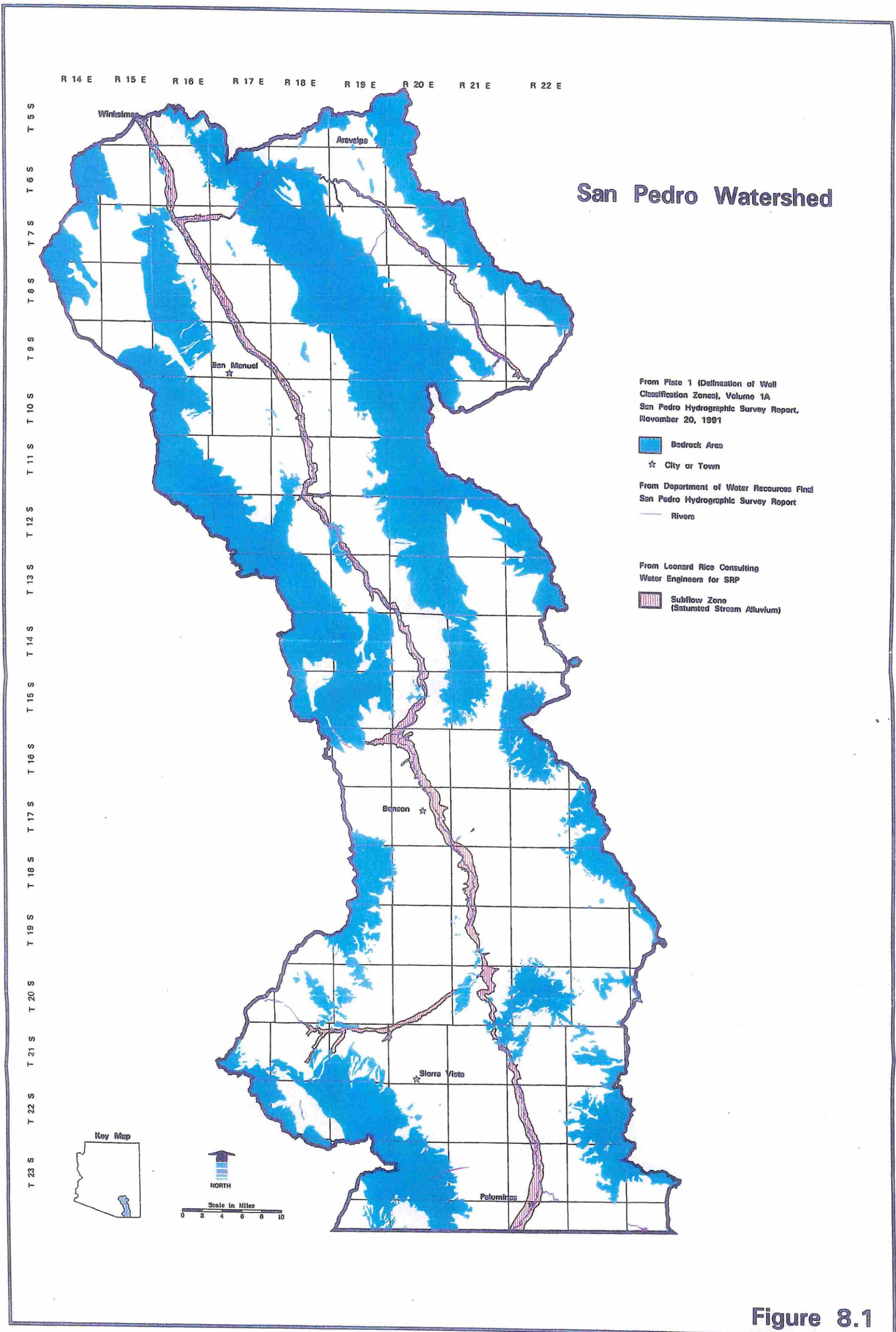
# Hydrogeology of the Benson Area

Appendix Q  
Exhibit 266



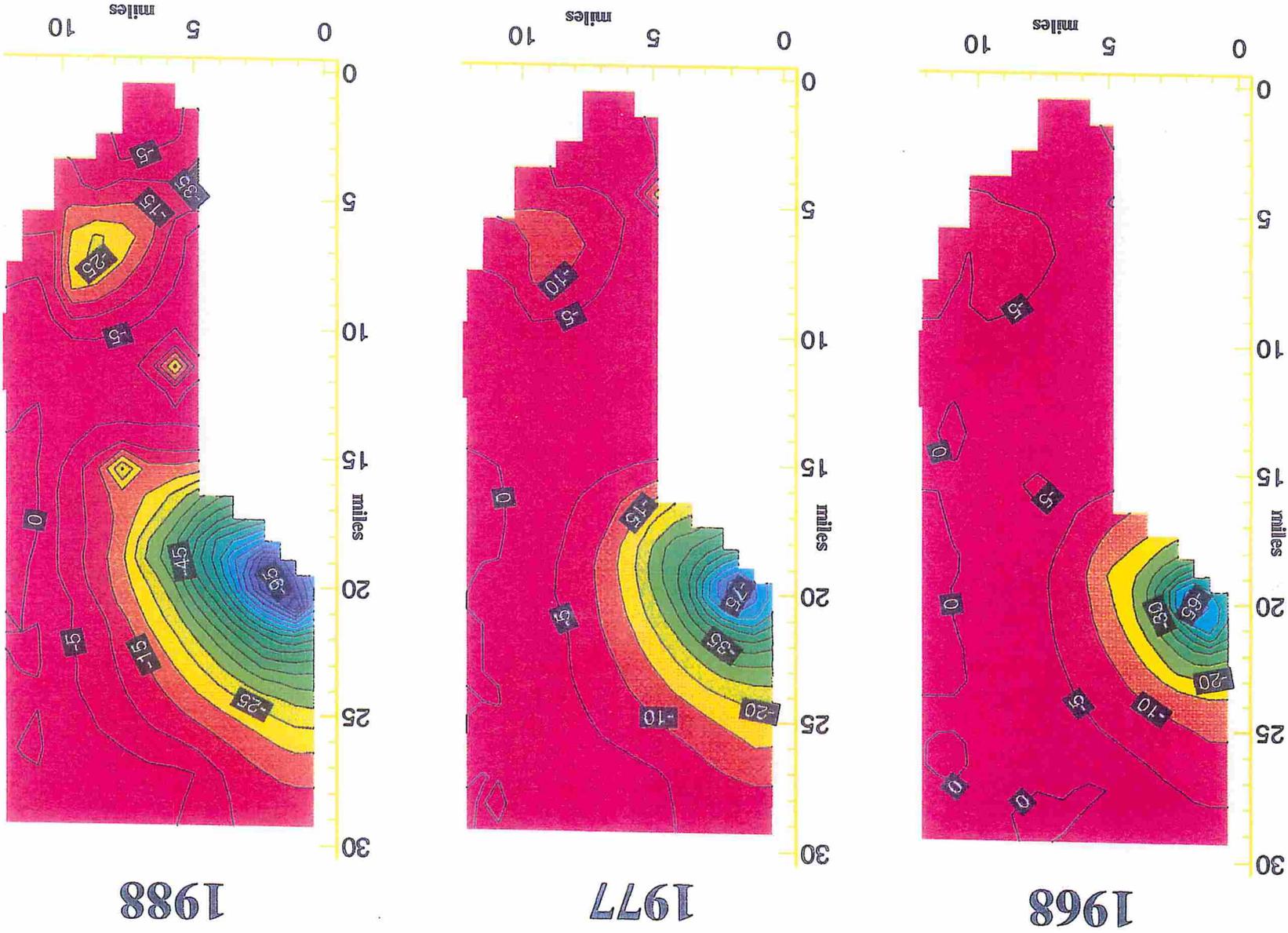
-  Hardrock
-  Basin Fill
-  Younger Alluvium Formation
-  Proposed Interior Formation
-  Water Courses



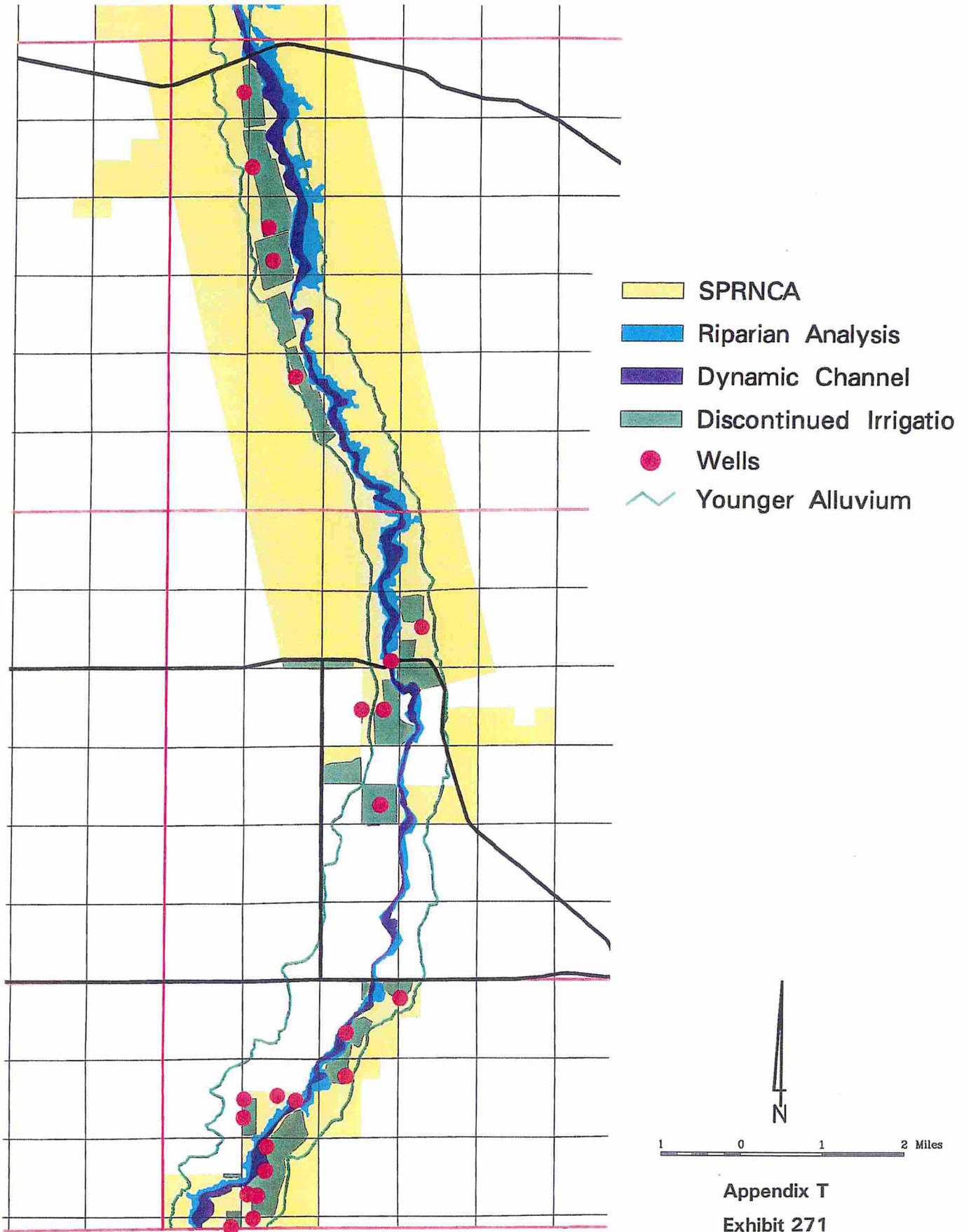


**Figure 8.1**

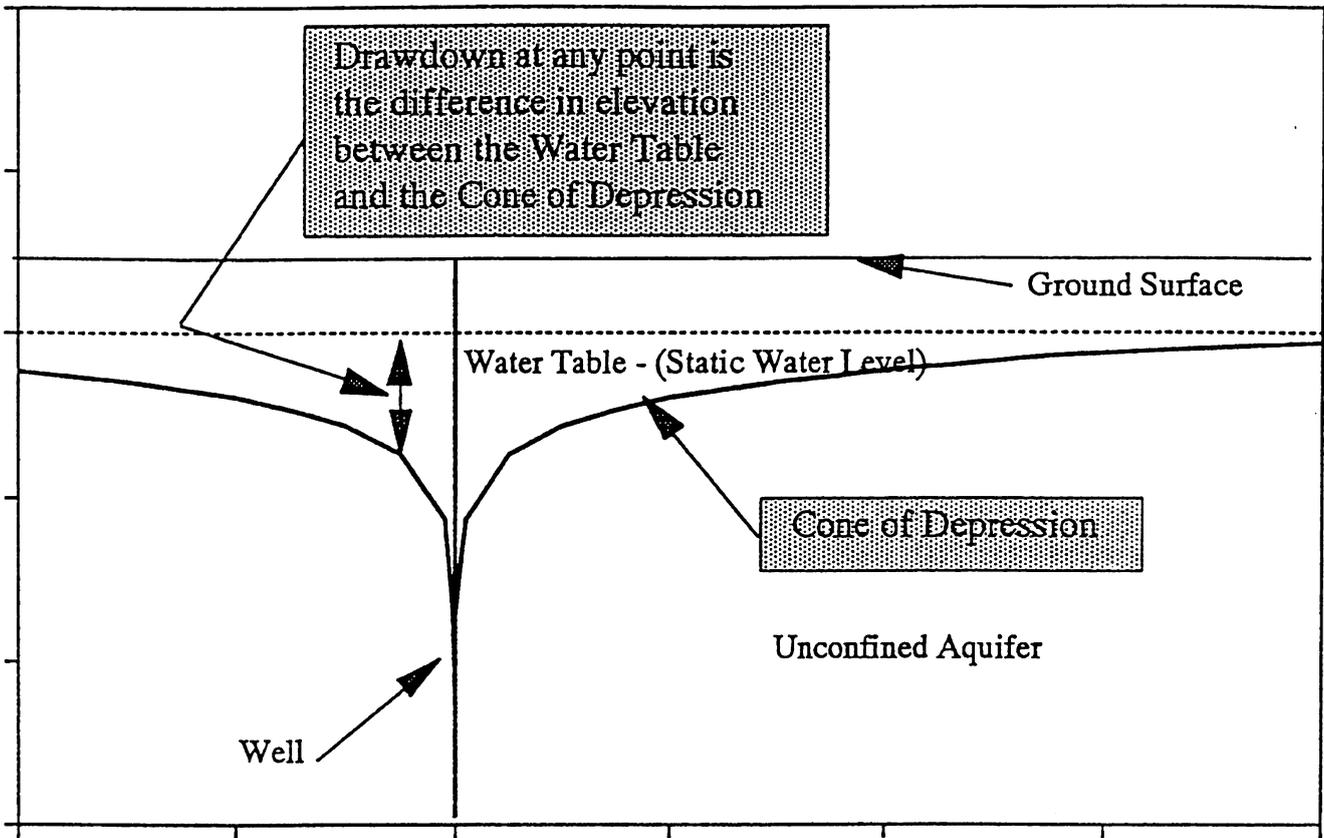
Drawdown since substantial pumping started in 1940  
(model predicted)



# Discontinued Irrigation within SPRNCA



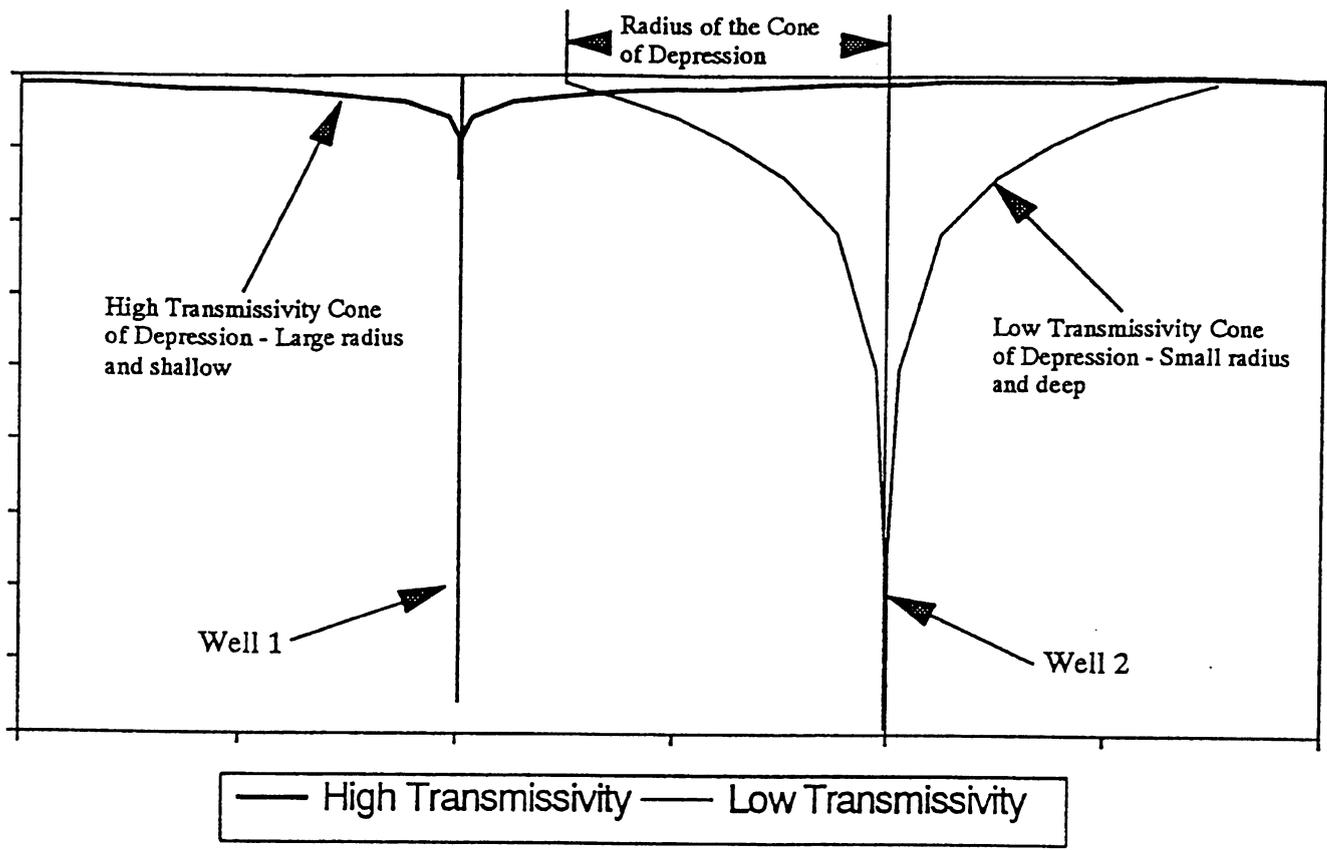
Appendix T  
Exhibit 271



CONE OF DEPRESSION AND DRAWDOWN

FIGURE 4.1





CONES OF DEPRESSION FOR HIGH AND LOW TRANSMISSIVITY AQUIFERS

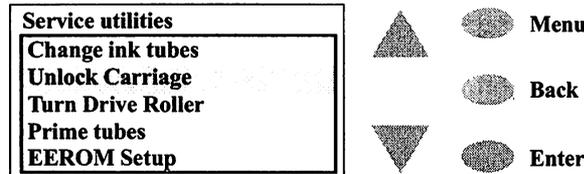
FIGURE 4.2

## Unlock Carriage

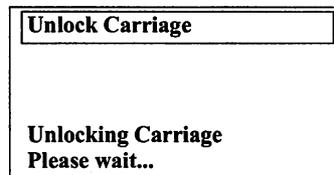
The purpose of this Service Utility is to unlock the Carriage Assembly which is normally locked by the Service Station in order to cap the Printheads. Once unlocked, the Carriage Assembly can then be moved freely along the Printer by hand.

Perform the Unlock Carriage utility as follows:

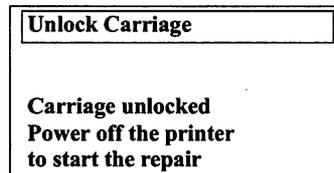
- 1 In the Service Utilities submenu, scroll to "Unlock Carriage" and press **Enter**.



- 2 Once the utility starts, the printer will begin to unlock the Carriage Assembly and the following message will be displayed on the front panel.

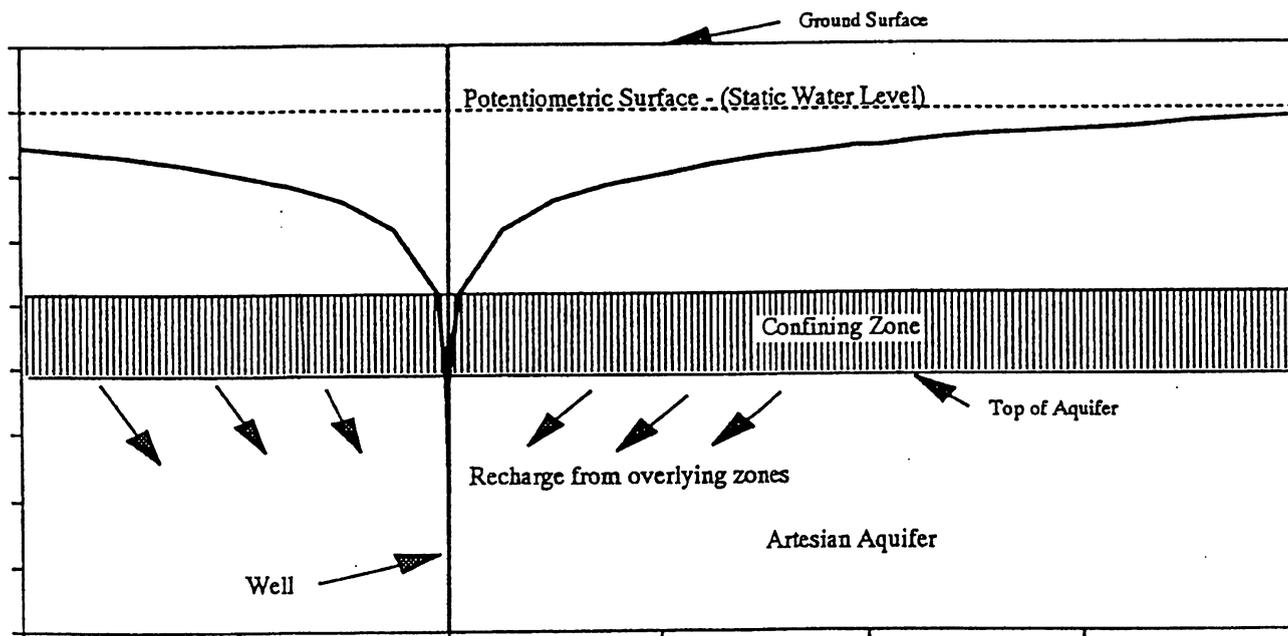
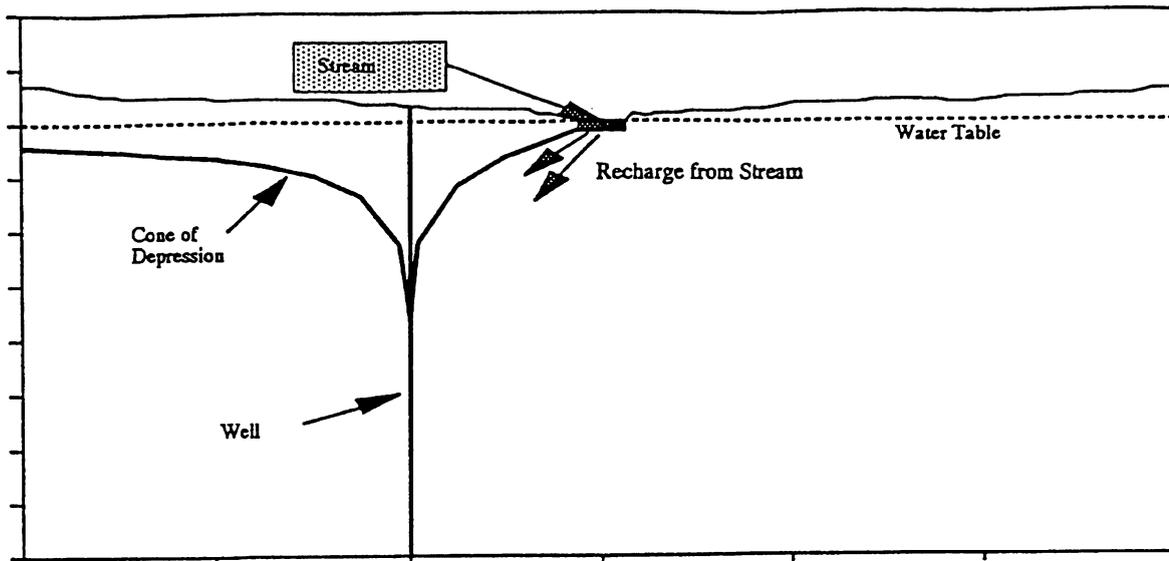


- 3 Once the Carriage is unlocked (Printheads have been uncapped) the following message will appear on the front panel:



### NOTE

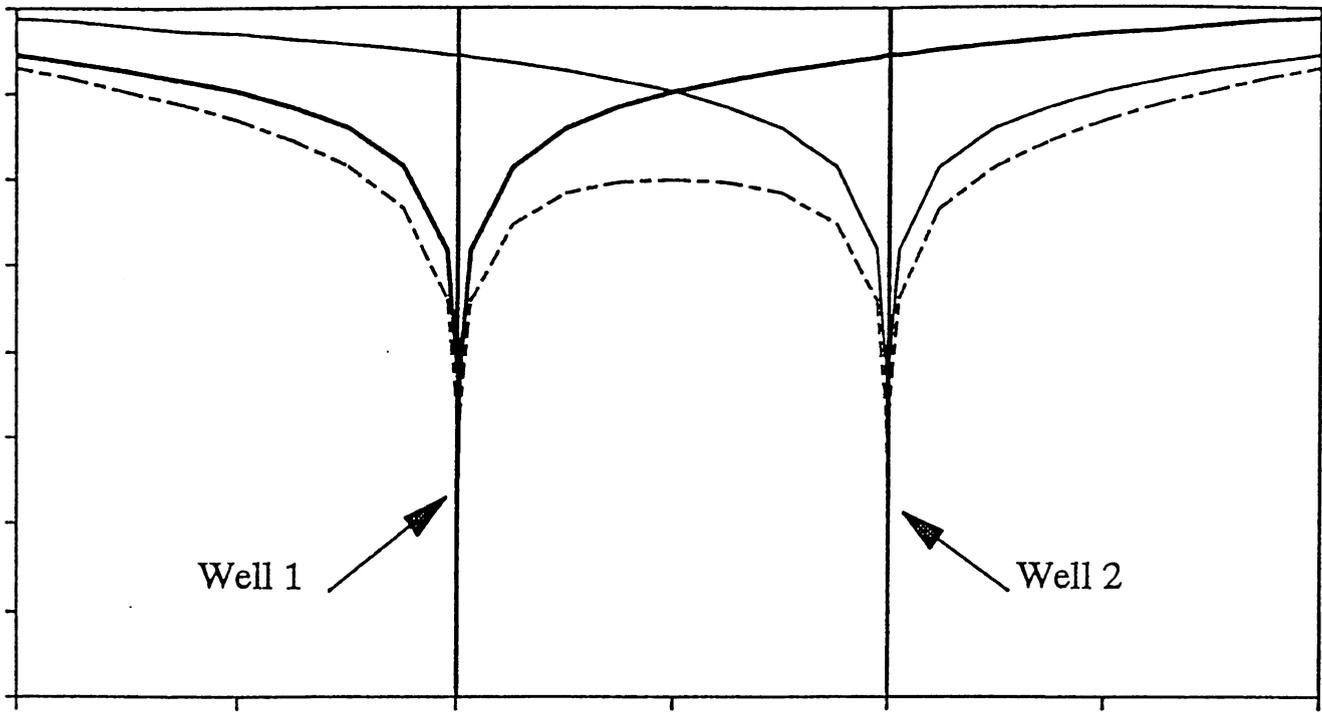
The Carriage will remain uncapped until another action (e.g. loading paper or replacing Printheads) is selected which returns the Printer to normal operation. Make sure you leave the Carriage in a locked position once the repair is completed.



SOURCES OF RECHARGE TO AQUIFERS

FIGURE 4.3





Cone of Well 1   
  Cone of Well 2   
  Combined Cone

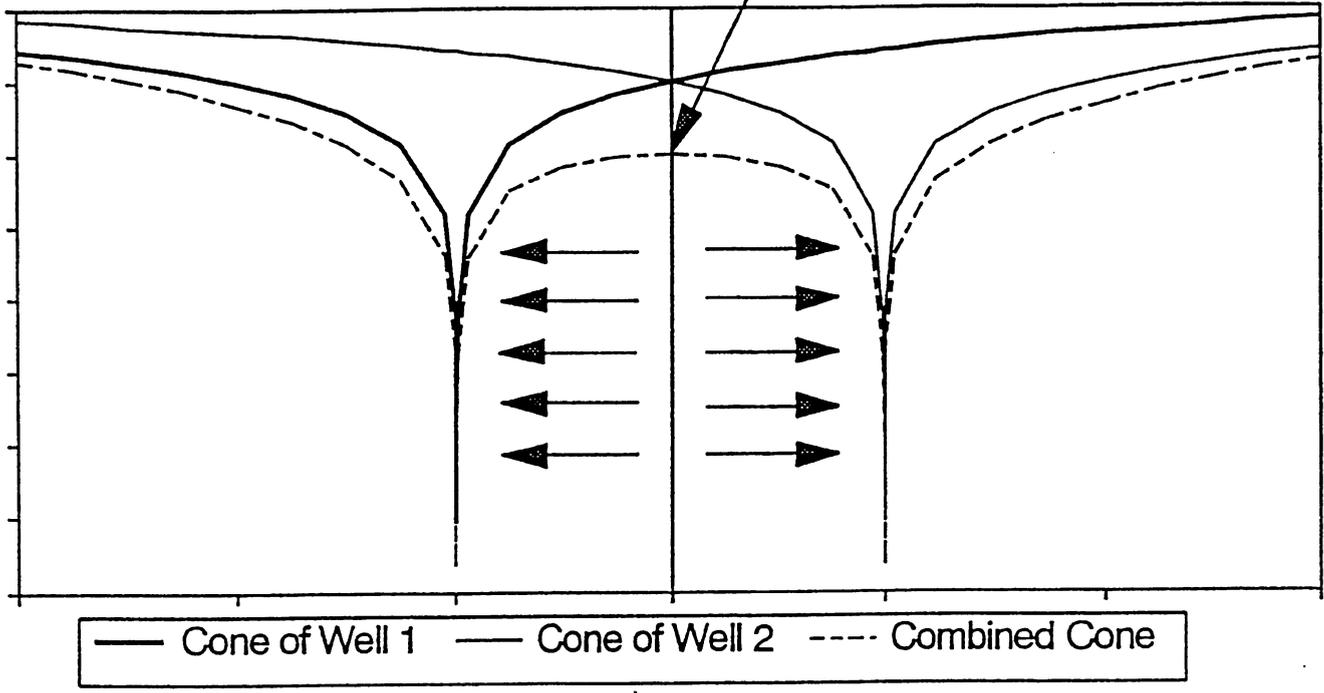
NOTE: TOTAL DRAWDOWN AT ANY POINT IS THE SUM OF THE DRAWDOWNS FOR EACH WELL.

DRAWDOWN THAT RESULTS WHEN CONES OF DEPRESSION OVERLAP

FIGURE 4.6



Ground water divide that forms between two wells with overlapping cones of depression and prevents water from flowing from one cone to another

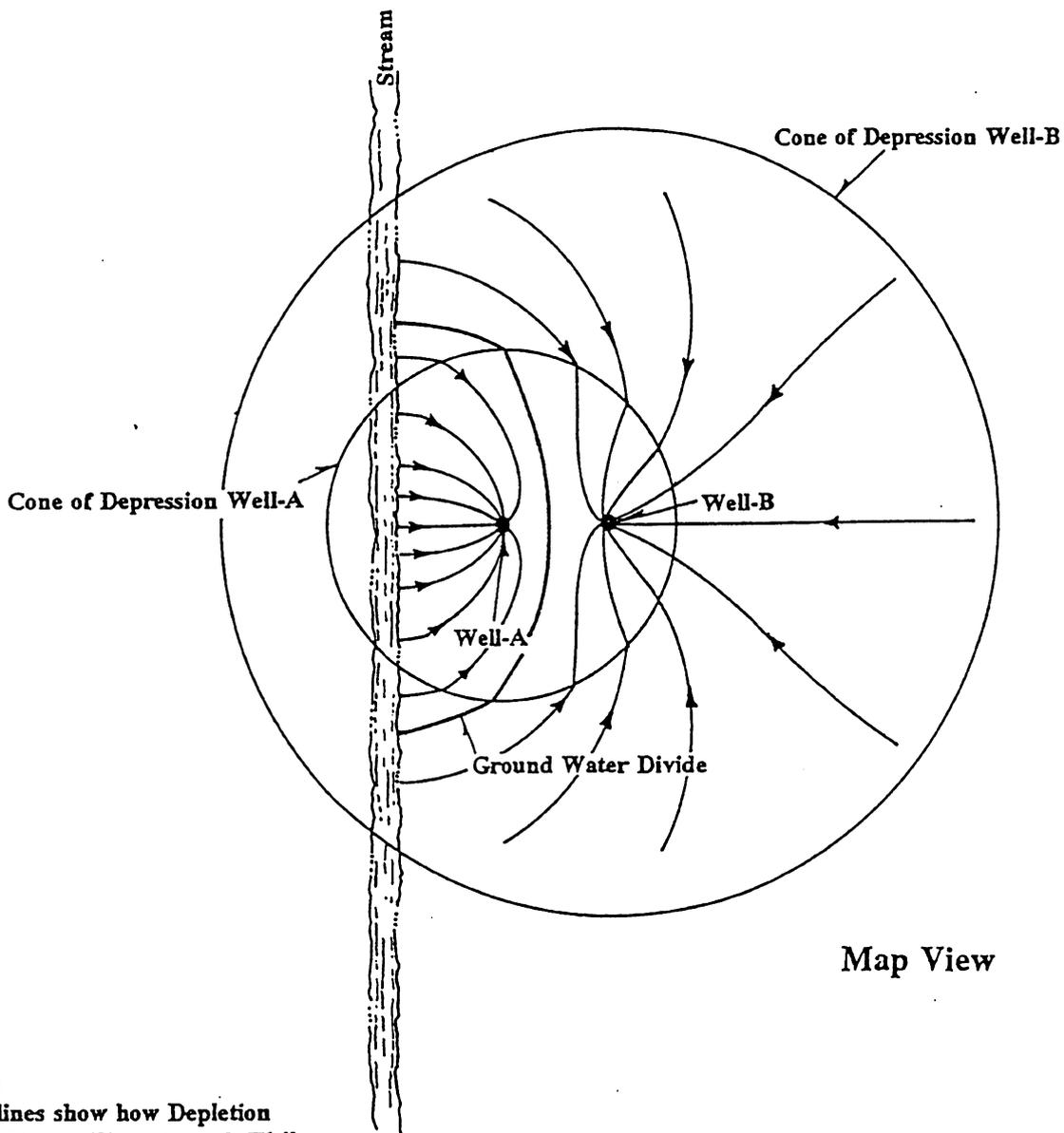


NOTE: TOTAL DRAWDOWN AT ANY POINT IS THE SUM OF THE DRAWDOWNS FOR EACH WELL.

GROUND WATER DIVIDE BETWEEN TWO WELLS

FIGURE 4.7





**Note:**  
 Flowlines show how Depletion  
 from Stream Flows to each Well.

## Overlapping Cones of Depression Near a Stream

Figure 4.10



# APPENDIX A-4

SUPREME COURT OF ARIZONA

IN RE THE GENERAL ADJUDICATION )  
OF ALL RIGHTS TO USE WATER IN ) Supreme Court  
THE GILA RIVER SYSTEM AND SOURCE ) Nos. WC-90-0001-IR,  
) WC-90-0002-IR,  
) WC-90-0003-IR,  
) WC-90-0004-IR,  
) WC-90-0005-IR,  
) WC-90-0006-IR,  
) WC-90-0007-IR,  
) WC-79-0001,  
) WC-79-0002,  
) WC-79-0003,  
) WC-79-0004.  
)  
)  
\_\_\_\_\_ )

The Honorable Stanley Z. Goodfarb, Judge (Retired)

AFFIRMED

\_\_\_\_\_

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Jeffrey C. Thacker  
Timothy Berg

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Corporation, Cyprus Pima Mining Corporation, Cyprus Sierrita  
Corporation, and Cyprus Twin Buttes Corporation

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Paul G. Ulrich

Attorneys for the Cities of Chandler, Glendale, Mesa, and  
Scottsdale

---

P E L A N D E R, Judge.

¶1 This appeal again presents the second of six issues on which we granted interlocutory review in the Gila River general stream adjudication. The facts and procedural history of this case are set forth in detail in *In re the General Adjudication of All Rights to Use Water in the Gila River System and Source*, 175 Ariz. 382, 384-86, 857 P.2d 1236, 1238-40 (1993) ("*Gila River II*"), and in *In re Rights to the Use of the Gila River*, 171 Ariz. 230, 232-33, 830 P.2d 442, 444-45 (1992) ("*Gila River I*"). In short, the primary issue we consider here is whether, after remand in *Gila River II*, the trial court properly determined what underground water constitutes "subflow" of a surface stream, thus making it appropriable under A.R.S. § 45-141(A).<sup>1</sup>

---

<sup>1</sup>Section 45-141(A), A.R.S., states:

The waters of all sources, flowing in streams, canyons, ravines or other natural channels, or in definite underground channels, whether perennial or intermittent, flood, waste or surplus water, and of lakes, ponds and springs on the surface, belong to the public and are subject to appropriation and beneficial use as provided in this chapter.

¶2 Based on its consideration of extensive evidence presented on remand, including the opinions of multiple experts, the trial court defined "subflow" as the "'saturated floodplain Holocene alluvium'"<sup>2</sup> because "[t]he weight of the evidence" pointed to that geological unit "as the most credible 'subflow' zone." We conclude, and the parties conceded at oral argument, that the record reasonably supports that central finding as well as the trial court's related findings. We further conclude that the trial court's ruling is not invalidated by this court's prior decisions relating to subflow. See *Gila River II; Maricopa County Mun. Water Conservation Dist. No. One v. Southwest Cotton Co.*, 39 Ariz. 65, 4 P.2d 369 (1931). Finally, the ruling comports with hydrological reality as it is currently understood. See *In re the General Adjudication of All Rights to Use Water in the Gila River System and Source*, 195 Ariz. 411, ¶9, 989 P.2d 739, ¶9 (1999) ("*Gila River III*"). For these reasons, we affirm the trial court's order in its entirety.

---

<sup>2</sup>"Holocene" refers to the Holocene epoch, which is that part of the Quaternary period that covers approximately the most recent 10,000 years. During that time frame, floods caused rivers to carry and deposit certain materials that originated from erosion of bedrock and basin fill deposits. The "Holocene alluvium," also referred to as the younger or floodplain alluvium, is the sedimentary material in a river valley that resulted from that process. See American Geological Institute, *Glossary of Geology* 17, 301 (Julia A. Jackson, ed., 1997).

## I. GENERAL PRINCIPLES OF SUBFLOW

¶3 In *Gila River II*, we explained the importance of distinguishing between groundwater and surface water. 175 Ariz. at 386, 857 P.2d at 1240. Essentially, our bifurcated system of allocating water rights differentiates groundwater users from surface water users. By statute, surface water is subject to the doctrines of prior appropriation and beneficial use. See A.R.S. §§ 45-141(A), 45-251(7). Percolating groundwater, on the other hand, is not appropriable and may be pumped by the overlying landowner, subject to the doctrine of reasonable use, *Gila River II*, 175 Ariz. at 386, 857 P.2d at 1240; *Bristor v. Cheatham*, 75 Ariz. 227, 255 P.2d 173 (1953), and the federal reserved water rights doctrine discussed in *Gila River III*.

¶4 The boundary between surface water and groundwater is not at all clear. Most surface streams not only flow above the ground but also have "subflow." As the parties correctly point out, "subflow" is not a scientific, hydrological term. But for almost seventy years, this court has defined "subflow," for legal purposes, as "those waters which slowly find their way through the sand and gravel constituting the bed of the stream, or the lands under or immediately adjacent to the stream, and are themselves a part of the surface stream." *Southwest Cotton*, 39 Ariz. at 96, 4 P.2d at 380. See also *Gila River II*, 175 Ariz. at 390 n.9, 857

P.2d at 1244 n.9, quoting *Black's Law Dictionary* 1425 (6th ed. 1990); 2 Clesson S. Kinney, *A Treatise on the Law of Irrigation and Water Rights* § 1161, at 2106-07 (2d ed. 1912) ("subflow" is "the broad and deep subterranean volume of water which slowly flows through the sand and gravel underlying most, if not all, of the streams which traverse the country adjacent to the mountain systems of the arid region").

¶5 As we noted in *Gila River III*, "[t]he notion of 'subflow' is significant in Arizona law, for it serves to mark a zone where water pumped from a well so appreciably diminishes the surface flow of a stream that it should be governed by the same law that governs the stream." 195 Ariz. 411, ¶8, 989 P.2d 739, ¶8. In addition, "subflow" is "probably much greater in volume in some cases than the water upon the surface, and [is] . . . a valuable portion of the well-defined surface stream." Kinney, *supra* at 2107. Because subflow is considered part of the surface stream, it is appropriable as such under § 45-141(A). See *Gila River II*, 175 Ariz. at 387, 857 P.2d at 1241. See also *Gila River III*, 195 Ariz. 411, ¶8, 989 P.2d 739, ¶8. Under Arizona's bifurcated system of managing surface and groundwater, the concept of subflow serves to protect appropriable surface water rights against interference caused by the pumping of groundwater. Because water is a very

precious and limited commodity in Arizona, much turns on how "subflow" is determined.

¶6           Underground waters are presumed to be percolating and, therefore, not appropriable as subflow. *Southwest Cotton*, 39 Ariz. at 85, 4 P.2d at 376. One who asserts that underground water is a part of a stream's subflow must prove that fact by clear and convincing evidence. *Id.* "If [the Department of Water Resources (DWR)] uses the proper test and relies on appropriate criteria for determining whether a well meets the test, its determination that a well is pumping appropriable subflow constitutes clear and convincing evidence." *Gila River II*, 175 Ariz. at 392, 857 P.2d at 1246. Thus, it is critical that any test used for determining the boundaries of a subflow zone be as accurate and reliable as possible. Otherwise, use of an inaccurate test to determine whether a well is pumping subflow would not satisfy the clear and convincing evidentiary standard and would improperly shift the burden to the groundwater user to show that its well is not pumping subflow. *See id.* at 388-89, 857 P.2d at 1242-43.

## II.    **GILA RIVER II**

¶7           In *Gila River II*, we considered whether the trial court had erred "in adopting its 50%/90 day test for determining whether underground water is 'appropriable' under A.R.S. § 45-141." 175 Ariz. at 386, 857 P.2d at 1240. Under that test, a well would be

presumed to be pumping appropriable subflow if "the volume of stream depletion would reach 50% or more of the total volume pumped during . . . [a] period of withdrawal [that] is equivalent to 90 days of continuous pumping for purposes of technical calculation." *Id.* at 385, 857 P.2d at 1239. Holding that "the 50%/90 day test for identifying wells presumed to be pumping subflow is inconsistent with *Southwest Cotton* and should not be used," *id.* at 392, 857 P.2d at 1246, we vacated that portion of the trial court's order and remanded the case for the court "to take evidence and, by applying the principles contained in [the *Gila River II*] opinion, determine the criteria for separating appropriable subflow from percolating groundwater." *Id.* at 394, 857 P.2d at 1248.

¶8 In so holding, we reaffirmed the principles set forth in *Southwest Cotton*, noting that our role was to interpret, not to expand or in any way change, the holdings in that case. *Id.* at 389, 857 P.2d at 1243. The *Southwest Cotton* court observed that, "[i]n almost all cases the so-called subflow is found within, or immediately adjacent to, the bed of the surface stream itself." 39 Ariz. at 97, 4 P.2d at 381. The court articulated the following test for determining whether a well is pumping subflow:

*Does drawing off the subsurface water tend to diminish appreciably and directly the flow of the surface stream? If it does, it is subflow, and subject to the same rules of appropriation as the surface stream itself; if it does not,*

then, although it may originally come from the waters of such stream, it is not, strictly speaking, a part thereof, but is subject to the rules applying to percolating waters.

*Id.* at 97, 4 P.2d at 380-81.

¶9 In *Gila River II*, we adhered to that test and reaffirmed what we described as "Southwest Cotton's narrow concept of subflow." 175 Ariz. at 393, 857 P.2d at 1247. We rejected the trial court's 50%/90 day test in part because of the potential that, under that test, all wells in an alluvial valley could be said to be pumping appropriable subflow. *Id.* at 391, 393, 857 P.2d at 1245, 1247. The 50%/90 day test was "broad enough to include all underground water hydraulically connected to a surface stream." *Id.* at 391, 857 P.2d at 1245. Thus, the test was "at odds with *Southwest Cotton's* statement that subflow is found within or immediately adjacent to the stream bed." *Id.*

¶10 We discussed that problem at some length in *Gila River II*. See 175 Ariz. at 390-92, 857 P.2d at 1244-46. Specifically, the 50%/90 day test did not distinguish between wells pumping groundwater from tributary aquifers and those pumping actual subflow of the river. Tributary aquifers are

those waters which infiltrate their way through the adjoining ground to some surface water course or other body of surface water. These waters differ from the [sub]flow of surface streams in the fact that *they have not yet reached the channels of the water courses*

to which they are tributary; while, upon the other hand, the [sub]flow of surface streams ha[s] reached these channels and are therefore dealt with as component parts of such streams.

Kinney, *supra* § 1193, at 2162 (footnotes omitted) (emphasis added). See also *Gila River II*, 175 Ariz. at 389 n.7, 857 P.2d at 1243 n.7 ("A tributary aquifer is an aquifer having a direct hydraulic connection with a stream or with another aquifer that has such a connection."). Water in underground tributary aquifers is not a part of the surface stream and may not be considered subflow. See *Gila River II*, 175 Ariz. at 391, 857 P.2d at 1245 (noting that, under *Southwest Cotton*, subflow and tributary groundwater are "two different classes of underground water. The former is subject to appropriation . . . ; the latter is not."). But, "[g]iven enough time, and with certain exceptions, all extractions from a tributary aquifer will cause a more-or-less corresponding depletion from stream flow volume." *Id.* Thus, under the 50%/90 day test, the water in underground tributary aquifers would have been included as subflow if the volume and time requirements were met, even though that water is specifically excluded under *Southwest Cotton*.

¶11 The arbitrariness of the 50%/90 day test also influenced our decision in *Gila River II*. *Id.* at 392, 857 P.2d at 1246. We stated that "[w]hether a well is pumping subflow does not turn on whether it depletes a stream by some particular amount in a given

period of time. . . . [I]t turns on whether the well is pumping water that is more closely associated with the stream than with the surrounding alluvium." *Id.* We also suggested that a proper test might compare "such characteristics as elevation, gradient, and perhaps chemical makeup" of the surface stream and underground water. *Id.* In addition, "[f]low direction can be an indicator. If the water flows in the same general direction as the stream, it is more likely related to the stream." *Id.*

¶12 In sum, we rejected the trial court's 50%/90 day rule because it conflicted with *Southwest Cotton* and arbitrarily set time and volume limits rather than determining the nature of the water being pumped. *Id.* at 391-92, 857 P.2d at 1245-46. In contrast, as discussed below, the order at issue here resulted from the trial court's exhaustive effort, based on application of the pertinent factors set forth in *Gila River II*, to determine "whether the well is pumping water that is more closely associated with the stream than with the surrounding alluvium." *Id.* at 392, 857 P.2d at 1246.

### III. PROCEEDINGS AND ORDER AFTER REMAND

¶13 On remand, the trial court held a ten-day evidentiary hearing, during which ten experts in the fields of geology and hydrology testified. The court also spent two days traveling almost 600 miles in the San Pedro River basin. A "large number of

counsel" and several experts accompanied the court on that trip. At each of the thirteen sites visited, each expert was allowed to explain the geology and hydrology of the site. In its order, the trial court noted that a transcript prepared from audio tapes made on the trip "is 258 pages because at nearly every site discussion was lengthy, often at odds, and sometimes heated." In addition, statements were taken from several long-time residents of the valley "who were witnesses to facts of historical significance with regard to the river." Four months after the field trip, the trial court held a two-day supplemental evidentiary hearing, the purpose of which was to evaluate "any changes in the location or size of the principal channel of the river or the riparian vegetation areas adjacent to the river," as shown in aerial photographs taken fifty-five years apart.

¶14 In its order after remand, the trial court stated:

[T]his Court has reviewed all of the testimony given, all of the exhibits, participated fully in the field trip and read all of the briefs. It also re-examined the testimony and exhibits of the 1987 evidentiary hearing on the relationship of groundwater to surface water. It finds a sufficient foundation of facts needed to rule on the issues presented.

The comprehensive, detailed order itself confirms those statements.

It is sixty-six pages long, with thirty-six additional pages of exhibits. The order and the record as a whole clearly reflect that

the trial court allowed the parties to fully present evidence and to advocate their positions and thoughtfully considered the complex issues presented here.<sup>3</sup>

#### IV. DISCUSSION

##### A. Definition of subflow zone

¶15 Although "subflow" is a purely legal, not scientific, term, defining its boundaries is not only difficult at best but also turns ultimately on resolution of factual questions. We, of course, must defer to the trial court's factual findings as long as the record supports them. See Ariz. R. Civ. P. 52(a), 16 A.R.S. ("Findings of fact . . . shall not be set aside unless clearly erroneous, and due regard shall be given to the opportunity of the trial court to judge the credibility of witnesses."); *Scottsdale Unified Sch. Dist. No 48 v. KPNX Broadcasting Co.*, 191 Ariz. 297, ¶20, 955 P.2d 534, ¶20 (1998).

¶16 The trial court's order describes in detail the evidence presented at the hearings and fully explains the reasons for its conclusions. Moreover, the record reflects that the court based its ruling on evaluation of the pertinent factors set forth in *Gila*

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<sup>3</sup>The record includes not only transcripts of the evidentiary hearings, but also numerous reports, drawings, charts, and other exhibits.

River II for delineating the subflow zone. For example, the order states:

After consideration of flow direction, water level elevation, the gradation of water levels over a stream reach, the chemical composition if available, and lack of hydraulic pressure from tributary aquifer and basin fill recharge which is perpendicular to stream and "subflow" direction, the Court finds the most accurate of all the markers is the edge of the saturated floodplain Holocene alluvium.

¶17 The trial court found that the younger Holocene alluvium "is the only stable geologic unit which is beneath and adjacent to most rivers and streams, except those in the mountains where bedrock surrounds the flow." The court then elaborated:

Also, in order to fulfill the definition of "subflow," the geologic unit must be saturated because of the need for a hydraulic connection between the stream and the "subflow." Further definition requires "subflow" to be a part of the surrounding floodplain of the stream basin. Those parts of the alluvial plain which it may be a part of or which it is connected to must be the alluvial plain of a perennial or intermittent stream and not an ephemeral stream or a part of the alluvial plain of a tributary aquifer even if there is an alluvial connection. Where the alluvial plain of tributary aquifers or ephemeral streams connects to the floodplain Holocene alluvium of the stream itself and provides tributary or basin fill recharge, that tributary aquifer must also be excluded because its flow direction is different and often perpendicular to the stream-flow direction.

The evidence here shows that the only true geologic unit which is beneath and adjacent to the stream is the floodplain Holocene alluvium. When it is saturated, that part of the unit qualifies as the "subflow" zone, where the water which makes up the saturation flows substantially in the same direction as the stream, and the effect of any side discharge from tributary aquifers and basin fill is overcome or is negligible. Because low-flow streams like the San Pedro meander back and forth in a series of "S" curves within a wider principal or dynamic channel, flow direction must be the general overall direction of the stream. As [DWR expert] Steve Erb testified, as long as the subflow's direction is within 45 degrees of that general stream flow direction, the flow direction requirement is met.

If we add the following additional criteria, then even more certainty and reliability is provided. First, the water level elevation of the "subflow" zone must be relatively the same as the stream flow's elevation. Second, the gradient of these elevations for any reach must be comparable with that of the levels of the stream flow. Third, there must be no significant difference in chemical composition that cannot be explained by some local pollution source which has a limited effect. Fourth, where there are connecting tributary aquifers or floodplain alluvium of ephemeral streams, the boundary of the "subflow" zone must be at least 200 feet inside of that connecting zone so that the hydrostatic pressure effect of the side recharge of this tributary aquifer is negligible and the dominant direction of flow is the stream direction. Fifth, where there is a basin-fill connection between saturated zones of the floodplain Holocene alluvium and a saturated zone of basin fill, the boundary of the "subflow" zone must be 100 feet inside of the connecting zone so that the hydrostatic pressure effect of the basin-fill's side

discharge is overcome and the predominant direction of flow of all of the "subflow" zone is the same as the stream's directional flow. . . .

The weight of the evidence points to the saturated floodplain Holocene alluvium as the most credible "subflow" zone. Its lateral and vertical limits have existed for some 10,000 or more years. It has far more stability of location than any other proposal including the principal channel which changes approximately every three years, or the post-1880 depositional layer which is really "post-1937" at best, or "post-1955" as indicated in the Hereford Report . . . .

¶18 In sum, the trial court complied with *Gila River II* by applying the factors set forth therein to the various theories advanced by the parties. The court ultimately concluded:

1. A "subflow" zone is adjacent [to] and beneath a perennial or intermittent stream and not an ephemeral stream.
2. There must be a hydraulic connection to the stream from the saturated "subflow" zone.
3. Even though there may be a hydraulic connection between the stream and its floodplain alluvium to an adjacent tributary aquifer or basin-fill aquifer, neither of the latter two or any part of them may be part of the "subflow" zone.
4. That part of the floodplain alluvium which qualifies as a "subflow," beneath and adjacent to the stream, must be that part of the geologic unit where the flow direction, the water level elevations, the gradations of the water level elevations and the chemical composition of the water in that particular reach of the stream are substantially the same

as the water level, elevation and gradient of the stream.

5. That part of the floodplain alluvium which qualifies as a "subflow" zone must also be where the pressure of side recharge from adjacent tributary aquifers or basin fill is so reduced that it has no significant effect on the flow direction of the floodplain alluvium. . . .

6. Riparian vegetation may be useful in marking the lateral limits of the "subflow" zone[,] particularly where there is observable seasonal and/or diurnal variations in stream flow caused by transpiration. However, riparian vegetation on alluvium of a tributary aquifer or basin fill cannot extend the limits of the "subflow" zone outside of the lateral limits of the saturated floodplain Holocene alluvium.

7. All wells located in the lateral limits of the "subflow" zone are subject to the jurisdiction of this adjudication no matter how deep or where these perforations are located. However, if the well owners prove that perforations are below an impervious formation which preclude[s] "drawdown" from the floodplain alluvium, then that well will be treated as outside the "subflow" zone.

8. No well located outside the lateral limits of the "subflow" zone will be included in the jurisdiction of the adjudication unless the "cone of depression" caused by its pumping has now extended to a point where it reaches an adjacent "subflow" zone, and by continual pumping will cause a loss of such "subflow" as to affect the quantity of the stream.

¶19 As they did in the trial court, most of the groundwater users urge us to limit the subflow zone to the post-1880

entrenchment channel, which resulted from a process in which a stream eroded downward so as to form a trench. The entrenchment channel is part of and lies within the younger alluvium. According to the groundwater users, that channel extends downward to the vertical boundary of the post-entrenchment alluvium and is laterally narrower than the younger alluvium.

¶20 Relying primarily on the testimony of their principal expert, Dr. Errol Montgomery, the groundwater users contend the post-1880 entrenchment channel is a well-known, well-documented, and easily identifiable geological unit found throughout the Southwest and is the only reliable marker of the subflow zone. They argue that only that channel satisfies *Gila River II* because it is more closely related to the stream than to the surrounding alluvium, it transports underground water beneath and immediately adjacent to the surface stream, and pumping from it has a direct and appreciable impact on the stream flow.

¶21 The trial court rejected the post-1880 entrenchment channel and other alternative proposals for defining the subflow zone.<sup>4</sup> Those who urge the post-1880 entrenchment channel as the

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<sup>4</sup>Some groundwater users proposed that the subflow zone be defined by the banks or edge of the stream's principal channel. And, The Nature Conservancy proposed, inter alia, that the subflow zone should be defined by the riparian zone, that is, the geographic area that phreatophytes had occupied in predevelopment times. The trial court rejected those proposals.

most appropriate subflow zone essentially contend that the weight of the evidence supported that result and that the trial court misinterpreted the evidence in rejecting it.

¶22 We note, however, that Montgomery testified that his master's thesis did not even mention or map the post-1880 entrenchment area because it would not be "called out" in most geological investigations that address the principal geological units. Rather, Montgomery stated, "it's only for special purposes, special studies that a unit like the post-1880 would be delineated." He also expressed doubt that DWR would be able to recognize the distinction. Montgomery further testified that "the boundary that can be recognized below the subsurface is going to be the boundary between the Holocene alluvium and the basin fill deposits, because there's not only a lithologic or textural change there, but there's a cementation change."

¶23 In addition, other expert testimony refuted the reliability of the post-1880 entrenchment as the designation of subflow zone. For example, Steve Erb of DWR testified that, although any of the proposals presented to the trial court might possibly satisfy this court's criteria in *Gila River II*, the younger alluvium is as close as anything to a natural boundary where subflow occurs. He further testified that DWR anticipated difficulty in identifying a subflow zone based on post-1880

entrenchment due to the lack of lithologic distinction between the ages of the younger alluvium. Similarly, Allen Gookin, who testified on behalf of the Gila River Indian Community, recommended not using the post-1880 entrenchment channel as the defining marker for subflow zone because (1) it does not occur throughout the entire Gila River basin, (2) movement of rivers over time would demand redefinition and redetermination of subflow zone on a continuing basis, and (3) there is no geological difference between the channel and the rest of the younger alluvium.

¶24 Moreover, the groundwater users conceded at oral argument, and the record reflects, that sufficient evidence supports the trial court's factual findings, which adopted the saturated floodplain Holocene alluvium as the subflow zone.<sup>5</sup> Thus,

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<sup>5</sup>Specifically, the record, including expert testimony and reports admitted at the hearing on remand, reflects the following:

A. The saturated floodplain Holocene alluvium has a definable bed and banks and has current from the flow of underground water in response to gradient.

B. The methodology and procedure for delineating the subflow zone are not based on volume or time, but rather, on a geological feature that is a distinct, mapable, geological unit.

C. The saturated floodplain Holocene alluvium is more closely related to the stream than to surrounding alluvium, exists immediately adjacent to and beneath the stream bed, and does not extend from ridge line to ridge line. It is in direct hydraulic connection with the surface stream.

D. The groundwater table elevation in the saturated

the groundwater users' argument largely boils down to a disagreement with the trial court's resolution of disputed facts and conflicting expert opinions. Such issues, however, are solely and peculiarly within the province of the trial court.

¶25 The parties presented conflicting evidence, including expert opinions, to support their theories relating to subflow and its parameters. The trial court, not this court, weighs the evidence and resolves any conflicting facts, expert opinions, and inferences therefrom. *In re Estate of Pouser*, 193 Ariz. 574, ¶13, 975 P.2d 704, ¶13 (1999). The record reflects that the trial court carefully and thoroughly performed those functions and then made findings that, although disputed, are fully supported by the evidence. Under these circumstances, we will not second-guess the

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floodplain Holocene alluvium is at or near the surface of the stream.

E. Gradient and flow direction within the saturated floodplain Holocene alluvium generally are more closely associated with the river than with surrounding aquifers. The boundaries of the subflow zone set by the trial court are adequate to eliminate from the equation areas of connecting tributary aquifers, floodplain alluvium of ephemeral streams, or saturated basin fill.

F. The chemical composition of surface water and of water contained in the saturated floodplain Holocene alluvium is virtually identical.

G. Using the saturated floodplain Holocene alluvium for identifying subflow zone is not arbitrary, but rather, is scientifically based on geology and associated aquifer characteristics.

court's factual findings, but rather, will uphold them unless they are shown to be clearly erroneous. See Ariz. R. Civ. P. 52(a). No such showing has been made here.

¶26 As they did in *Gila River II* with respect to the 50%/90 day rule, the groundwater users also contend the trial court's order after remand "is wrong as a matter of law" because its definition of subflow is too broad and is incompatible with *Gila River II* and *Southwest Cotton*. In support of that argument, they point to language in those opinions variously describing subflow as underground water that is "'a part of the surface stream,'" 175 Ariz. at 387, 857 P.2d at 1241, quoting *Southwest Cotton*, 39 Ariz. at 96, 4 P.2d at 380; "'found within, or immediately adjacent to, the bed of the surface stream itself,'" 175 Ariz. at 387, 391, 857 P.2d at 1241, 1245, quoting *Southwest Cotton*, 39 Ariz. at 97, 4 P.2d at 381; "'connected with the stream[,] . . . strictly confined to the river bottom and moving underground'" "'within the bed of the surface stream itself,'" 175 Ariz. at 390, 857 P.2d at 1244, quoting *Kinney*, *supra* § 1161, at 2110; and "relatively close to the stream bed." 175 Ariz. at 391, 857 P.2d at 1245. According to the groundwater users, the trial court's adoption of the saturated floodplain Holocene alluvium as the subflow zone cannot be squared with those prior pronouncements.

¶27 As the groundwater users correctly observe, this court "adopted [Kinney's] narrow definition [of subflow] in *Southwest Cotton*," *Gila River II*, 175 Ariz. at 390, 857 P.2d at 1244, and again characterized subflow as "a narrow concept" in *Gila River II*. *Id.* at 391, 857 P.2d at 1245. Although those abstract, general statements hold true, we also observed in *Gila River II* that variations may affect where the line is drawn between subflow and nonappropriable percolating water, "depending on the volume of stream flow and other variables." *Id.* Thus, defining subflow in any particular area is a relative endeavor, "not an all-or-nothing proposition." *Id.* And, although "the line between surface and groundwater . . . is, to some extent, artificial and fluid," *id.* at 392, 857 P.2d at 1246, our various descriptions of subflow in *Gila River II* and *Southwest Cotton* should not serve as a straitjacket that restricts us from reaching in the direction of the facts and, so far as possible under those decisions, conforming to hydrological reality.

¶28 Our dissatisfaction with the 50%/90 day test in *Gila River II* stemmed largely from its arbitrary volume and time components, contrary to *Southwest Cotton's* mandate to define subflow "in terms of whether the water at issue was part of the stream or was percolating water on its way to or from the stream." *Gila River II*, 175 Ariz. at 392, 857 P.2d at 1246. The 50%/90 day

test included no such inquiry, as the trial court acknowledged in its subsequent order after remand: "A review of the exhibits and testimony of [the 1987] hearing reflects the issue of "subflow" or how it could be physically located was not the focus of those hearings. Rather, it was a hearing as to the general relationship of surface flow to groundwater of all types." The court further stated that, "[w]hile [*Gila River II*] is correct in that there was no substantial evidentiary basis for [the 50%/90 day rule], the reason for it was that the 1987 hearings did not focus on 'subflow.'"

¶29 In contrast, the trial court's order after remand stated: "In dealing with the issue of 'subflow' as raised in 'Southwest Cotton,' the hearings held in . . . 1994 specifically focused on it. All [the] testimony related directly to that issue and the issue of 'cones of depression.'" The voluminous record confirms those statements.

¶30 The resolution of this case should not hinge on the semantics used in either *Gila River II* or *Southwest Cotton* to generally describe subflow. In short, those decisions were not intended to establish hard and fast, artificial parameters for subflow based solely on its geographic reach or on some arbitrary distance from a streambed. See *Southwest Cotton*, 39 Ariz. at 87, 4 P.2d at 377 (factors relevant to determining subflow include

"geologic formation"); *City of Los Angeles v. Pomeroy*, 57 P. 585, 598 (Cal. 1899) (facts supported jury finding that underground water flowing through a pass one and one-half to two and one-half miles wide constituted subflow), *cited with approval in Southwest Cotton*, 39 Ariz. at 97-99, 4 P.2d at 381. Rather, as we stated in *Gila River II*, the determination of whether a particular well is pumping subflow depends on "whether the well is pumping water that is more closely associated with the stream than with the surrounding alluvium," 175 Ariz. at 392, 857 P.2d at 1246, and whether "'drawing off the subsurface water tend[s] to diminish appreciably and directly the flow of the surface stream.'" *Id.* at 393, 857 P.2d at 1247, quoting *Southwest Cotton*, 39 Ariz. at 97, 4 P.2d at 380. That determination, in turn, necessitates a comparative evaluation of such factors as "elevation, gradient, [flow direction,] and perhaps chemical makeup." *Gila River II*, 175 Ariz. at 392, 857 P.2d at 1246.

¶31 Using those pertinent criteria, the trial court held extensive evidentiary hearings for the purpose of "separating appropriable subflow from percolating groundwater," 175 Ariz. at 394, 857 P.2d at 1248, with the ultimate aim of establishing a workable and reasonably accurate definition of subflow.<sup>6</sup>

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<sup>6</sup>Contrary to the suggestion of some of the parties at oral argument, the trial court did not exceed the scope of this court's

Resolution of that issue was necessarily fact intensive. As noted above, the record reflects, and the parties now concede, that sufficient evidence supports the trial court's factual findings.

¶32 Unlike the 50%/90 day test we rejected in *Gila River II*, the trial court's order after remand is not arbitrary. Nor does it include tributary aquifers in its definition of subflow. Although the saturated floodplain Holocene alluvium may appear to be inconsistent with the "narrow concept" of subflow described in *Gila River II*, 175 Ariz. at 391, 857 P.2d at 1245, and suggested in *Southwest Cotton*, we reject the argument that the trial court's findings and conclusions, as a matter of law, so violate the fundamental principles of those cases that they cannot stand. Nor does affirmance of the trial court's order require us to overrule *Gila River II* or *Southwest Cotton*, and we do not do so.

¶33 At oral argument, the groundwater users questioned how the "saturated" younger alluvium is to be defined and identified and what role, if any, the criteria that we set forth in *Gila River II* and that the trial court used will play in determining subflow in different locations. The criteria that the trial court

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remand in *Gila River II*. We specifically instructed the court to "take evidence" and "apply[] the principles contained" in *Gila River II* for purposes of "separating appropriable subflow from percolating groundwater." 175 Ariz. at 394, 857 P.2d at 1248. We did not intend to limit the trial court to merely determining useful criteria for that task.

articulated were elaborations of, but consistent with, the more general criteria set forth in *Gila River II*. The trial court properly applied these criteria to the San Pedro River basin in order to determine the most appropriate subflow zone, and the weight of the evidence supports the trial court's identification of that zone as the "saturated" floodplain Holocene alluvium.

¶34 The record reflects that the saturated floodplain Holocene alluvium is readily identifiable; that DWR can quickly, accurately, and relatively inexpensively determine the edge of that zone; and that some of the work already has been done. For example, the Salt River Project's (SRP) expert, Jon Ford, presented a proposal that identified subflow for the entire San Pedro River watershed and conducted a field check of his map to refine the boundaries. DWR may use such data accumulated during these proceedings to aid in its task. DWR also may use, but is not limited to, topographic maps, aerial photographs, phreatophyte presence, drilling records (or other descriptions of materials encountered during drilling), water table maps, seismic data, and field mapping techniques.

¶35 The entire saturated floodplain Holocene alluvium, as found by DWR, will define the subflow zone in any given area.<sup>7</sup> In

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<sup>7</sup>According to Erb, DWR does not include as part of a floodplain aquifer any area where the floodplain alluvium is above the water table.

the effort to determine that zone in other areas, the detailed criteria set forth in the trial court's order, insofar as they apply and are measurable, must be considered, but we do not preclude the consideration of other criteria that are geologically and hydrologically appropriate for the particular location.

¶36 Contrary to the groundwater users' argument, the saturated floodplain Holocene alluvium does not automatically or necessarily encompass the entire younger alluvium. Equating the two would fail to take into account the pertinent criteria that must be applied and satisfied for determining the "saturated" subflow zone in a particular area. See *Southwest Cotton*, 39 Ariz. at 96, 4 P.2d at 380 (noting that "the water from the surface stream must necessarily fill the loose, porous material of its bed to the point of complete saturation before there can be any surface flow"). It also would conflict with our rejection in *Gila River II* of any unqualified, blanket rule that invariably would include "all of an alluvial valley's wells" or all "waters pumped any place in the younger alluvium" in the definition of subflow. 175 Ariz. at 391, 393, 857 P.2d at 1245, 1247. But, contrary to the groundwater users' argument that the trial court's definition of subflow is broader than *Gila River II* and *Southwest Cotton* permit, the record reflects that saturated floodplain Holocene alluvium occupies only very narrow portions of the alluvial basins.

¶37 Moreover, as Ford explained and as the trial court acknowledged, the Holocene or floodplain alluvium is only the most recent portion of "stream alluvium." The entire younger alluvium is of Quaternary age, which includes materials deposited during both the Pleistocene era (approximately 1.8 million to 10,000 years ago) as well as the Holocene era (approximately the past 10,000 years to date).<sup>8</sup> And, as Montgomery acknowledged, modern floodplain alluvium underlies and is adjacent to nearly all large streams. Finally, the trial court's order does not preclude, but rather contemplates, future adoption of "a rationally based exclusion for wells having a de minimus effect on the river system," an approach we continue to endorse. *Gila River II*, 175 Ariz. at 394, 857 P.2d at 1248. See also *San Carlos Apache Tribe v. Superior Court*, 193 Ariz. 195, ¶¶35-40, 972 P.2d 179, ¶¶35-40 (1999).

**B. Cones of depression**

¶38 The trial court's order limits the subflow zone to the saturated floodplain Holocene alluvium. Thus, wells outside that area are presumed not to be pumping subflow. The trial court ruled, however, that "[w]ells located outside the lateral parameters of the defined 'subflow' zone" may be included in the

---

<sup>8</sup>According to Montgomery, Holocene describes material deposited during approximately the last 8,000 years.

adjudication if "it is proven that their 'cones of depression'<sup>9</sup> reach the 'subflow' zone and the drawdown from the well affects the volume of surface and 'subflow' in such an appreciable amount that it is capable of measurement." In other words, the trial court ruled, a well may be subject to the adjudication if its "'cone of depression' caused by its pumping has now extended to a point where it reaches an adjacent 'subflow' zone, and by continual pumping will cause a loss of such 'subflow' as to affect the quantity of the stream."

¶39 The trial court did not attempt to establish a test for determining a well's cone of depression because the court lacked pertinent evidence on that issue. Instead, the court recognized that each well must be separately evaluated "to compute drawdown at the 'subflow' zone" and that "whatever test ADWR finds is realistically adaptable to the field and whatever method is the least expensive and delay-causing, yet provides a high degree of reliability, should be acceptable."

¶40 We agree with the trial court. DWR may seek to establish that a well located outside the limits of the saturated floodplain alluvium is in fact pumping subflow and is therefore subject to the

---

<sup>9</sup>The cone of depression is the funnel-shaped area around a well where the withdrawal of groundwater through the well has lowered the water table. *Gila River II*, 175 Ariz. at 391 n.10, 857 P.2d at 1245 n.10.

adjudication, by showing that the well's cone of depression extends into the subflow zone and is depleting the stream. And, as we stated in *Gila River II*, although a cone of depression may result in only part of a well's production being appropriable subflow, "that well should be included in the general adjudication." 175 Ariz. at 391, 857 P.2d at 1245.

**C. Burdens of proof**

¶41 The trial court's order and the parties' briefs addressed the standard of proof a well owner must meet to rebut DWR's assessment that a well is pumping subflow. As noted in ¶6 above, a well pumping underground water is presumed initially to be pumping percolating groundwater, not appropriable subflow. When DWR determines and establishes that a well is in the subflow zone by using the pertinent criteria or that it is pumping subflow by reason of its cone of depression, DWR provides clear and convincing evidence of that fact. See *Gila River II*, 179 Ariz. at 392, 857 P.2d at 1246. The burden then shifts to the well owner to show that a well is either outside the subflow zone or is not pumping subflow. *Id.*

¶42 In its order after remand, the trial court stated that, "[a]t least in the area of 'cones of depression[,]'" a burden of proof of preponderance seems fairer. The same is probably also true in the area of a 'subflow' zone determination." The court

noted that, in determining cones of depression, experts "often rel[y] on assumptions which are not provable or are only partially provable" and that a clear and convincing standard for rebuttal purposes probably would be "too formidable a barrier" for pro se parties and often would be "too much for represented parties of modest wealth."

¶43 Given the strong initial presumption that a well is pumping percolating groundwater, we agree with the trial court that a preponderance of the evidence standard is more appropriate and should apply to well owners' efforts to rebut DWR's determination that a well is pumping subflow.<sup>10</sup> If a well owner presents sufficient evidence to meet that standard, it necessarily reduces DWR's proof to something less than clear and convincing.

#### D. Other Issues

¶44 We summarily dispose of the parties' remaining arguments relating to the trial court's determination of subflow. In *Gila River II*, we stated that "[r]egulation of water use," enactment of appropriate laws for the "wise use and management" of water, and effecting "any appropriate change in existing law" to accommodate "conflicting interests and claims of groundwater users and surface appropriators," are peculiarly legislative functions.

---

<sup>10</sup>We did not state or suggest otherwise in *Gila River II*.

175 Ariz. at 393, 857 P.2d at 1247, quoting *Arizona Pub. Serv. Co. v. Long*, 160 Ariz. 429, 436, 773 P.2d 988, 995 (1989). Based on that language, the groundwater users and the state contend that judicially redefining subflow to encompass percolating, nonappropriable groundwater violates those principles by improperly usurping the legislative role. That argument, however, overlooks three basic points.

¶45 First, for nearly seven decades, this court has established the parameters of subflow without legislative action or direction. Second, as discussed above, the trial court did not change existing law concerning subflow or otherwise improperly encroach on the state's Groundwater Code, A.R.S. §§ 45-401 through 45-704. Rather, the court merely applied the criteria set forth in *Gila River II* to the evidence presented on remand. As SRP correctly notes, the trial court's order "addresses only appropriable water and wells that pump such water," without "chang[ing] the legal status of underground water that is not appropriable." Third, this court must decide issues that are squarely presented to it, particularly when, as here, the trial court, at the parties' request, specifically certified the questions raised in this matter. See *San Carlos Apache Tribe*, 193 Ariz. 195, ¶37, 972 P.2d 179, ¶37 ("The power to define existing

law, including common law, and to apply it to facts rests exclusively within the judicial branch." ).

¶46 Given the over quarter-century history of, and specific statutory authorization for, this complex general stream adjudication, see *id.* at ¶2, 972 P.2d 179, ¶2, the judiciary clearly is not only empowered but also expected to determine, based on a complete evidentiary record, issues relating to subflow. Resolution of such issues is integral to our statutorily recognized role of determining "the nature, extent and relative priority of the water rights of all persons in the river system and source." A.R.S. § 45-252(A). That function, in turn, includes identification of "waters of all sources, flowing in streams, . . . other natural channels, or in definite underground channels" that "are subject to appropriation and beneficial use." § 45-141(A). See also § 45-251(7). In sum, this is not an area in which we must await or necessarily defer to legislative action. Cf. *Law v. Superior Court*, 157 Ariz. 147, 155, 755 P.2d 1135, 1143 (1988) ("We are furthering the statutory objectives in this area, not contradicting them." ).

¶47 We also reject the groundwater users' assertion that the trial court's order amounts to an unconstitutional taking of their private property, in violation of the Fifth Amendment. In remanding this matter in *Gila River II* for the trial court to

establish an evidentiary and principled basis for differentiating appropriable subflow from percolating groundwater, we implicitly rejected the groundwater users' identical argument in that case. Moreover, because a well owner does not own underground water, *Town of Chino Valley v. City of Prescott*, 131 Ariz. 78, 82, 638 P.2d 1324, 1328 (1981), and because landowners have "no legally recognized property right in potential, future groundwater use," *Gila River I*, 171 Ariz. at 239, 830 P.2d at 451, the constitutional argument is substantively without merit.

#### V. CONCLUSION

¶48 We affirm the trial court's order after remand in all respects. The subflow zone is defined as the saturated floodplain Holocene alluvium. DWR, in turn, will determine the specific parameters of that zone in a particular area by evaluating all of the applicable and measurable criteria set forth in the trial court's order and any other relevant factors. See ¶¶33-35, *supra*. All wells located within the lateral limits of the subflow zone are subject to this adjudication. In addition, all wells located outside the subflow zone that are pumping water from a stream or its subflow, as determined by DWR's analysis of the well's cone of depression, are included in this adjudication. Finally, wells that, though pumping subflow, have a de minimus effect on the river

system may be excluded from the adjudication based on rational guidelines for such an exclusion, as proposed by DWR and adopted by the trial court.

---

JOHN PELANDER, Judge

CONCURRING:

---

THOMAS A. ZLAKET, Chief Justice

---

STANLEY G. FELDMAN, Justice

---

WILLIAM E. DRUKE, Judge

---

NOEL FIDEL, Judge

Vice Chief Justice Charles E. Jones and Justices Frederick J. Martone and Ruth V. McGregor recused themselves; pursuant to Ariz. Const. art. VI, § 3, Judge Noel Fidel of Division One, Arizona Court of Appeals, Judge William E. Druke, and Judge John Pelander of Division Two, Arizona Court of Appeals, were designated to sit in their stead.

# APPENDIX A-5

1 GEORGE A. SCHADE, JR.  
Special Master  
2 Arizona General Stream Adjudication  
Arizona State Courts Building, Suite 228  
3 1501 W. Washington Street  
Phoenix, AZ 85007  
4 (602) 542-9600  
State Bar No. 003289  
5

6 IN THE SUPERIOR COURT OF THE STATE OF ARIZONA

7 IN AND FOR THE COUNTY OF MARICOPA

8 IN RE THE GENERAL ADJUDICATION  
9 OF ALL RIGHTS TO USE WATER IN THE  
GILA RIVER SYSTEM AND SOURCE

W-1 (Salt)  
W-2 (Verde)  
W-3 (Upper Gila)  
W-4 (San Pedro)  
(Consolidated)

11 CIVIL NO. W1-103

12 REPORT OF THE SPECIAL MASTER ON  
13 THE ARIZONA DEPARTMENT OF  
14 WATER RESOURCES' SUBFLOW  
15 TECHNICAL REPORT, SAN PEDRO  
RIVER WATERSHED; MOTION FOR  
APPROVAL OF REPORT; AND NOTICE  
OF SUBSEQUENT PROCEEDINGS

16  
17 CONTESTED CASE NAME: *In re Subflow Technical Report, San Pedro River Watershed.*

18 HSR INVOLVED: None.

19 DESCRIPTIVE SUMMARY: The Special Master submits a report to the Court under Arizona Rule  
of Civil Procedure 53 pursuant to an order of reference. The report contains recommendations  
20 regarding whether the *Subflow Technical Report, San Pedro River Watershed*, prepared by the  
Arizona Department of Water Resources, should be adopted in whole or in part or modified.  
21 Objections to the Special Master's report must be filed with the Superior Court on or before  
**Wednesday, September 1, 2004**. Responses to objections shall be filed on or before **Friday,**  
22 **October 1, 2004**, and replies shall be filed by **Friday, October 29, 2004**.

23 NUMBER OF PAGES: 100; Attachment A - 4 pgs.; Total 104 pgs.

24 DATE OF FILING: July 16, 2004.

**TABLE OF CONTENTS**

1

2 I. CHRONOLOGY OF PROCEEDINGS ..... 6

3 A. The Technical Reports ..... 7

4 B. Order of Reference to the Special Master ..... 11

5 C. Issues Set for Briefing and Hearing ..... 11

6 D. Discovery ..... 13

7 E. Rebuttal Declarations ..... 14

8 F. Special Master’s Proposed Rulings ..... 14

9 G. ADWR’s Proposed Use of Soil Surveys and Expert Declarations ..... 17

10 H. Prehearing Proceedings ..... 19

11 I. Participation of the Verde Valley Water Users, Inc. .... 21

12 J. Hearing ..... 22

13 K. Posthearing Proceedings ..... 23

14 II. SUBFLOW ZONE (Chapter 2 of the Subflow Report) ..... 24

15 A. Are ADWR’s recommendations for locating perennial, intermittent, and  
16 effluent-fed streams valid? ..... 24

17 Recommendation 1 ..... 28

18 Recommendation 2 ..... 28

19 B. Is ADWR’s recommended assumption for effluent-fed streams that were  
20 not previously perennial, or recently perennial or intermittent, “that the  
21 sediments immediately beneath these reaches are unsaturated due to  
22 clogging layers” valid? ..... 29

23 Recommendation 3 ..... 31

24 C. Should ADWR use the soil survey maps prepared by the Natural  
Resources Conservation Service to delineate the lateral limits of the  
subflow zone? ..... 31

1	Recommendation 4 .....	38
2	Recommendation 5 .....	38
3	Recommendation 6 .....	38
4	Recommendation 7 .....	38
5	Recommendation 8 .....	38
6	Recommendation 9 .....	39
7	Recommendation 10 .....	39
8	D. Should ADWR consider the criteria specified in <i>Gila IV</i> to identify the	
9	subflow zone or have the criteria already been taken into account in the	
10	Arizona Supreme Court's holding that the saturated floodplain Holocene	
11	alluvium is the subflow zone?.....	39
12	Recommendation 11 .....	42
13	Recommendation 12 .....	42
14	E. Should ADWR's subflow analysis consider predevelopment or current	
15	stream flow conditions? .....	43
16	Recommendation 13 .....	52
17	Recommendation 14 .....	52
18	Recommendation 15 .....	52
19	F. Does ADWR's recommendation that the entire lateral extent of the	
20	floodplain Holocene alluvium be assumed to be saturated comport with	
21	<i>Gila IV</i> ?.....	52
22	Recommendation 16 .....	58
23	Recommendation 17 .....	58
24	G. Are ADWR's recommendations sufficient to identify and exclude	
	tributary aquifers, basin fill saturated zones, and ephemeral streams?.....	58
	Recommendation 18 .....	60
	Recommendation 19 .....	60

1	III.	CONE OF DEPRESSION (Chapter 3 of the Subflow Report) .....	60
2	A.	Does ADWR’s recommended drawdown of greater than or equal to 0.1	
3		foot, where the cone of depression has reached the edge of the subflow	
4		zone, comport with <i>Gila IV</i> ? .....	60
5		Recommendation 20 .....	69
6		Recommendation 21 .....	69
7	B.	Does ADWR’s recommended condition that the water level in a well be	
8		below the water level in the subflow zone during pumping comport with	
9		<i>Gila IV</i> ? .....	69
10		Recommendation 22 .....	74
11		Recommendation 23 .....	74
12	C.	What is the accuracy and reliability of analytical (THWELLS) and	
13		numerical (MODFLOW) models for the cone of depression test? .....	74
14		Recommendation 24 .....	79
15		Recommendation 25 .....	79
16		Recommendation 26 .....	79
17		Recommendation 27 .....	80
18	D.	Is ADWR’s recommendation that the impact of a well be measured ‘ <i>at</i>	
19		<i>the time of the modeling</i> ’ scientifically valid? .....	80
20		Recommendation 28 .....	85
21		Recommendation 29 .....	85
22	E.	Should ADWR recommend a methodology to evaluate the impact of wells	
23		perforated below an impervious formation within the limits of the subflow	
24		zone? .....	85
		Recommendation 30 .....	86
	F.	In addition to analyzing a well’s drawdown at the subflow zone, should	
		ADWR report the cumulative effect of wells or of groups of wells? .....	86
		Recommendation 31 .....	89

1	Recommendation 32 .....	89
2	Recommendation 33 .....	89
3	Recommendation 34 .....	89
4	IV. <i>DE MINIMIS</i> USES (Chapter 4 of the Subflow Report) .....	90
5	Recommendation 35 .....	94
6	V. IMPLEMENTATION OF PROCEDURES (Chapter 5 of the Subflow Report).....	94
7	A. Should ADWR’s findings be reported in supplemental contested case	
8	hydrographic survey reports (HSRs) (“case-by-case”) or in a supplemental	
9	San Pedro River Watershed HSR (“the entire watershed”), which	
10	identifies the subflow zone, wells reaching and depleting a stream, and <i>de</i>	
11	<i>minimis</i> water rights? .....	94
12	Recommendation 36 .....	97
13	Recommendation 37 .....	98
14	Recommendation 38 .....	98
15	Recommendation 39 .....	98
16	VI. AVAILABILITY OF REPORT.....	98
17	VII. MOTION FOR ADOPTION OF SPECIAL MASTER’S REPORT.....	99
18	VIII. NOTICE OF SUBSEQUENT PROCEEDINGS .....	99

Attachments

18	A. Gila River Adjudication Court-Approved Mailing List (Oct. 6, 2003)	
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21  
22  
23  
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1 **I. CHRONOLOGY OF PROCEEDINGS**

2 This report addresses the objections filed to the *Subflow Technical Report, San Pedro River*  
3 *Watershed* (2002) (“Subflow Report”) prepared by the Arizona Department of Water Resources  
4 (“ADWR”).<sup>1</sup> ADWR filed the Subflow Report pursuant to the trial court’s directive to supplement  
5 the department’s prior *Report Concerning Implementation of the Arizona Supreme Court’s Decision*  
6 *on Subflow* (2001). The reports recommend procedures to implement the subflow criteria and a cone  
7 of depression test in accordance with the Arizona Supreme Court’s *Gila II*<sup>2</sup> and *Gila IV*<sup>3</sup> decisions.  
8 Those decisions, arising from the same interlocutory review appeal, deal with subflow, an issue  
9 extensively litigated in this adjudication since 1987.

10 The Gila River Adjudication will determine or establish “the extent and priority of the rights  
11 of all persons to use water in [the Gila] river system and source.”<sup>4</sup> A “river system and source”  
12 includes “all water appropriable” under A.R.S. § 45-141.<sup>5</sup> The Arizona Supreme Court has held that  
13  
14  
15

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16 <sup>1</sup> The pleadings and orders filed in the proceedings before the Special Master are available at the office of the  
17 Clerk of the Maricopa County Superior Court, 601 West Jackson Street, Phoenix, Arizona 85003, under Civil  
18 No. W1-103 (contact Tina Barrett or Veronica Olivas at 602-506-1351). Electronic copies of the orders are  
19 posted at <http://www.supreme.state.az.us/wm/> on the page titled *Gila River Adjudication (In re Subflow*  
20 *Technical Report, San Pedro River Watershed)*.

21 <sup>2</sup> *In re the General Adjudication of All Rights to Use Water in the Gila River System and Source*, 175 Ariz.  
22 382, 857 P.2d 1236 (1993) (“*Gila II*”). The Supreme Court framed the interlocutory review issue as, “Did the  
23 trial court err in adopting its 50%/90 day test for determining whether underground water is ‘appropriable’  
24 under A.R.S § 45-141.” 175 Ariz. at 386, 857 P.2d at 1240.

<sup>3</sup> *In re the General Adjudication of All Rights to Use Water in the Gila River System and Source*, 198 Ariz.  
330, 9 P.3d 1069 (2000), *cert. denied sub nom. Phelps Dodge Corp. v. U.S.*, 533 U.S. 941 (2001) (“*Gila IV*”).  
In *Gila II*, the Arizona Supreme Court remanded to the trial court, which after further hearings issued a ruling  
whose appeal to the Supreme Court resulted in *Gila IV*. *Gila II* and *Gila IV* sought to resolve “the ambiguities  
and uncertainties left by” the Court’s decision in *Maricopa County Mun. Water Conservation Dist. No. 1 v.*  
*Southwest Cotton Co.*, 39 Ariz. 65, 4 P.2d 369 (1931), *modified and reh’g. denied*, 39 Ariz. 367, 7 P.2d 254  
(1932) (“*Southwest Cotton*”). 175 Ariz. at 389, 857 P.2d at 1243.

<sup>4</sup> A.R.S. § 45-251(2).

<sup>5</sup> A.R.S. § 45-251(7).

1 “[b]ecause subflow is considered part of the surface stream, it is appropriable as such under § 45-  
2 141(A).”<sup>6</sup> Therefore, a well pumping subflow is subject to the adjudication.

3 In *Gila IV*, the Supreme Court defined the subflow zone as the saturated floodplain Holocene  
4 alluvium and set forth three tests to determine if a well is subject to the adjudication because it  
5 pumps subflow:

- 6 1. All wells located within the lateral limits of the subflow zone are subject to this  
7 adjudication;
- 8 2. [A]ll wells located outside the subflow zone that are pumping water from a stream  
9 or its subflow, as determined by DWR’s analysis of the well’s cone of depression, are  
10 included in this adjudication; and
- 11 3. [W]ells that, though pumping subflow, have a *de minimis* effect on the river system  
12 may be excluded from the adjudication based on rational guidelines for such an  
13 exclusion, as proposed by DWR and adopted by the trial court.<sup>7</sup>

14 Whether ADWR’s proposed procedures to delineate the lateral limits of the subflow zone,  
15 implement a cone of depression test, and set rational guidelines for *de minimis* water uses comport  
16 with the Supreme Court’s decisions are the central issues addressed in this report.

17 Chapter I of this report describes the proceedings. Chapters II, III, IV, and V address the  
18 issues raised in Chapters 2, 3, 4, and 5, respectively, of the Subflow Report. Chapters VI, VII, and  
19 VIII relate to future proceedings before the trial court regarding this report. The Special Master has  
20 considered all the papers, declarations, testimony, thirty-eight admitted exhibits, and oral arguments.

#### 21 **A. The Technical Reports**

22 At the trial court’s hearing held on September 27, 2001, counsel inquired as to ADWR’s  
23 plans to propose criteria for determining the subflow zone. ADWR answered it had “internally been

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24 <sup>6</sup> 198 Ariz. at 334, 9 P.3d at 1073.

<sup>7</sup> 198 Ariz. at 344, 9 P.3d at 1083.

1 discussing the issues related to developing subflow criteria.”<sup>8</sup> The court directed ADWR to file a  
2 report describing its “proposals for determining the subflow criteria for purposes of this  
3 adjudication.”<sup>9</sup> The court allowed parties to file responses to the report and set a hearing on January  
4 8, 2002, to consider the report and responses.

5 On December 18, 2001, ADWR filed a *Report Concerning Implementation of the Arizona*  
6 *Supreme Court’s Decision on Subflow*. The San Carlos Apache Tribe, Tonto Apache Tribe, and  
7 Yavapai-Apache Nation (collectively “Apache Tribes”); Arizona Public Service (“APS”); Phelps  
8 Dodge Corporation (“Phelps Dodge”); ASARCO Incorporated (“ASARCO”); BHP Copper, Inc.  
9 (“BHP”); Inscription Canyon Ranch; Baca Float Water Company; Cities of Chandler, Glendale,  
10 Mesa, and Scottsdale (collectively “Cities”); City of Phoenix (“Phoenix”); Gila River Indian  
11 Community (“GRIC”); Gila Valley and Franklin Irrigation Districts (collectively “Upper Valley  
12 Irrigation Districts”); Salt River Project (“SRP”); State of Arizona Agency Claimants (“State of  
13 Arizona”); United States; and The Nature Conservancy (“Nature Conservancy”) filed responses to  
14 the report or joinders to others’ comments.<sup>10</sup>

15 On January 8, 2002, during the hearing of ADWR’s report and the responses, the trial court  
16 directed “ADWR to prepare another more specific and detailed report pertaining to the San Pedro  
17 River watershed...”<sup>11</sup> The court’s order issued later stated:

18 To promote an efficient and accurate determination of the jurisdictional subflow  
19 zones, ADWR shall prepare a supplemental report specifically identifying and  
20 describing the procedures and processes it proposes to use to establish the limits of the  
subflow zone within the San Pedro River watershed. This report shall include the  
following:

21 1. A proposal for determining the subflow zone that includes more than just  
consideration of the saturated lateral extent of the Holocene alluvium. The Court has

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22 <sup>8</sup> Sept. 27, 2001 Minute Entry 4 (Oct. 25, 2001).

23 <sup>9</sup> *Id.*

24 <sup>10</sup> Several parties filed jointly, but each party will be listed separately in this report.

<sup>11</sup> Jan. 8, 2002 Minute Entry 2 (Jan. 22, 2002).

1 considered ADWR's position that the decision of the Arizona Supreme Court in "Gila  
2 IV" requires that the subflow zone be initially delineated by simply mapping the  
3 saturated lateral limits of the floodplain of this alluvium. Many claimants object to  
4 this procedure and assert that ADWR's current proposal is not legally sufficient. The  
5 Court notes that the guidelines set forth in Gila IV direct ADWR to use all criteria  
6 geologically and hydrologically appropriate for subflow determination in each  
7 watershed. Even if ADWR is correct about the tasks mandated by Gila IV to  
8 determine the subflow zone, the work required to address the other considerations  
9 mentioned in Gila IV will serve to confirm the accuracy of ADWR's determinations.  
10 Therefore, in determining the subflow zone in the San Pedro River watershed ADWR  
11 shall use a methodology that addresses the appropriate use, if any, of each of the  
12 criterion listed in Gila IV, as well as any other relevant factors that will be helpful  
13 in insuring that ADWR's subflow zone determination is completed using all reasonable  
14 means to arrive at results that are as accurate as possible;

15 2. A test for determining if a well's cone of depression is withdrawing water from the  
16 subflow zone;

17 3. A set of rational guidelines for determining whether a given well, though pumping  
18 subflow, has a de minimis effect on the river system;

19 4. A method for including both perennial and intermittent streams as part of the  
20 subflow analysis, including streams that historically contained perennial or  
21 intermittent flows, but which now are ephemeral due to development and other human  
22 initiated actions. The Court recognizes this direction makes ADWR's task more  
23 complicated and expects the department to formulate a proposal using readily  
24 available historical data that will permit determination of water levels and locations as  
of date(s) prior to widespread diversion and depletion of Arizona's stream flows.  
Effluent-fed streams are also to be included as part of ADWR's analysis; and

5. A timeline for completion of the tasks outlined in the report. A similar timeline for  
the Upper Gila River and Verde River watersheds is also to be submitted.

ADWR's supplemental report shall be filed on or before March 29, 2002 and shall  
contain a certification by the ADWR Director that he has read and is familiar with the  
proposal set forth in the report.

After the report is filed, claimants and parties shall have until May 13, 2002 [*note: on  
May 7, 2002, upon motion, the Court granted additional time to respond until June  
17, 2002*] to file objections or requested revisions to the report. These comments may  
be presented by legal memorandum, exhibits and/or sworn declarations of experts.

After receipt of all timely filed objections, the Court will review ADWR's proposal  
and party comments. It is likely the Court will enter an order after this review  
directing ADWR as to how it is to proceed. Should the Court determine that further  
information or explanation is needed, the matter will be referred [to] the Special

1 Master for hearing. The declarations submitted by the parties will serve as the direct  
2 testimony at any hearing scheduled by the Special Master. The only testimony to be  
3 received at any scheduled hearing will be by way of cross-examination (and, perhaps,  
4 some limited redirect examination).<sup>12</sup>

5 On March 29, 2002, ADWR filed the Subflow Report. The report sets forth ADWR's  
6 proposed procedures to delineate the lateral extent of the subflow zone, implement a cone of  
7 depression test, establish guidelines for *de minimis* water uses, and schedules to implement the  
8 methodologies in the Gila River Adjudication.<sup>13</sup>

9 On June 17, 2002, comments, objections, and joinders were filed by the Apache Tribes;  
10 Arizona Geological Survey; APS; Phelps Dodge; ASARCO; Arizona Water Company; Bella Vista  
11 Water Company ("Bella Vista"); BHP; Cities; City of Flagstaff; City of Safford ("Safford"); DYM,  
12 Inc.; Painted Rock Ranches; Paloma Ranch Investments, Inc. ("Paloma Ranch"); Rio Rico  
13 Properties, Inc. ("Rio Rico"); Tonopah Irrigation District ("Tonopah"); GRIC; Upper Valley  
14 Irrigation Districts; City of Goodyear; George E. Price on behalf of the Long Meadow Ranch  
15 Property Owners Association; City of Benson; Valory Strausser individually and on behalf of Lower  
16 San Pedro River Landowners; Phoenix; SRP; State of Arizona; United States; City of Sierra Vista  
17 ("Sierra Vista"); City of Tucson ("Tucson"); City of Sedona, Town of Jerome, Town of Clarkdale,  
18 City of Cottonwood, and Town of Camp Verde (collectively "Verde Valley Communities"); Verde  
19 Valley Water Users Association, Inc. by officers and directors Ray Wrobley, Mary Margaret  
20 Kovacovich, and John Kovacovich; and the County of Yavapai.

21 The following expert witnesses filed sworn declarations on June 17, 2002:

22 1. Kirk C. Anderson, Ph.D. (Upper Valley Irrigation Districts).

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23 <sup>12</sup> Minute Entry (Jan. 22, 2002) ("Ballinger Order").

24 <sup>13</sup> The report has six chapters: Chapter 1 Introduction; Chapter 2 Subflow Zone; Chapter 3 Cone of  
Depression; Chapter 4 *De Minimis* Uses; Chapter 5 Summary and Implementation; and Chapter 6 References  
Cited. The attachments include one table, five figures, six plates, and nine appendices. An electronic copy of  
the report is posted at <http://www.water.az.gov> under *Publications* and *Adjudications*.

- 1 2. Philip C. Briggs, P.E. (Verde Valley Water Users Association, Inc. by officers and  
2 directors Ray Wrobley, Mary Margaret Kovacovich, and John Kovacovich).
- 3 3. Jon R. Ford (SRP).
- 4 4. T. Allen J. Gookin, P.E., R.L.S., P.H. (GRIC).
- 5 5. Eric J. Harmon, P.E. and Mark R. Palumbo (APS and Phelps Dodge).
- 6 6. W. Gerald Matlock, P.E., Ph.D. (Upper Valley Irrigation Districts).
- 7 7. Peter A. Mock, Ph.D., R.G. (GRIC).
- 8 8. Errol L. Montgomery, Ph.D., P.G. and Thomas W. Anderson, P.H. (BHP).
- 9 9. Oliver S. Page, R.G., Peter M. Pyle, R.G., C.Hg., and Jean M. Moran, R.G., C.Hg. (United  
10 States).
- 11 10. Doug Toy, P.E. (Cities).

#### 11 **B. Order of Reference to the Special Master**

12 Following a hearing held on January 22, 2003, the trial court referred ‘the consideration of  
13 the responses and objections filed to the Subflow Report to the Special Master,’ who “[a]fter  
14 reviewing the matter and holding such hearings as he deems necessary...shall prepare a report to the  
15 Court setting forth his recommendations as to whether the Subflow Report should be adopted in  
16 whole or in part or modified.’<sup>14</sup> The order of reference did not direct the Special Master to make  
17 findings of fact and conclusions of law.<sup>15</sup>

#### 18 **C. Issues Set for Briefing and Hearing**

19 On April 10, 2003, the Special Master held a conference to discuss the scope of the Special  
20 Master’s report and establish procedures to comply with the order of reference. SRP, Upper Valley  
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22 <sup>14</sup> Order 1 (Feb. 21, 2003).

23 <sup>15</sup> Ariz. R. Civ. P. 53(h) states, “The master shall prepare a report upon the matters submitted to the master by  
24 the order of reference and, if required to make findings of fact and conclusions of law, the master shall set  
them forth in the report.” This matter does not involve the determination of any individual water uses.

1 Irrigation Districts, and the Verde Valley Communities submitted proposed issues for resolution.  
2 APS and Phelps Dodge filed comments to the proposed issues.

3 The Special Master considered all the comments and proposed issues, and on April 25, 2003,  
4 issued an order:

5 1. Setting the following issues for briefing prior to the cross-examination of witnesses:

6 a. Should ADWR's subflow analysis consider predevelopment or current  
7 stream flow conditions?

8 b. Should ADWR consider the criteria specified in *Gila IV* to identify the  
9 subflow zone or have the criteria already been taken into account in the Arizona  
10 Supreme Court's holding that the saturated floodplain Holocene alluvium is the  
11 subflow zone?

12 c. In addition to analyzing a well's drawdown at the subflow zone, should  
13 ADWR report the cumulative effect of wells or of groups of wells?

14 d. Should ADWR's findings be reported in supplemental contested case  
15 hydrographic survey reports (HSRs) ("case-by-case") or in a supplemental San Pedro  
16 River Watershed HSR ("the entire watershed"), which identifies the subflow zone,  
17 wells reaching and depleting a stream, and *de minimis* water rights?

18 2. Allowing parties to file sworn rebuttal declarations on or before June 27, 2003,  
19 limited to rebutting the opinions or information contained in the initial sworn  
20 declarations and not presenting any new matters not contained in those declarations.

21 3. Setting a hearing for the cross-examination of witnesses on October 21 and 22,  
22 2003.

23 4. Directing that the cross-examination of witnesses would address, but would not be  
24 limited to, the following matters:

*Location of Subflow Zone*

a. Are ADWR's recommendations for locating perennial, intermittent, and  
effluent-fed streams valid?

b. Does ADWR's recommendation that the entire lateral extent of the  
floodplain Holocene alluvium be assumed to be saturated comport with *Gila IV*?

1 c. Is ADWR's recommended assumption for effluent-fed streams "that the  
2 sediments immediately beneath these reaches are unsaturated due to clogging layers"  
valid?

3 d. Are ADWR's recommendations sufficient to identify and exclude tributary  
4 aquifers and basin fill saturated zones?

5 *Cone of Depression Test*

6 a. Does ADWR's recommended drawdown of greater than or equal to 0.1 foot,  
7 where the cone of depression has reached the edge of the subflow zone, comport with  
8 *Gila IV*?

9 b. Does ADWR's recommended condition that the water level in a well be  
10 below the water level in the subflow zone during pumping comport with *Gila IV*?

11 c. What is the accuracy and reliability of analytical (THWELLS) and  
12 numerical (MODFLOW) models for the cone of depression test?

13 d. Is ADWR's recommendation that the impact of a well be measured "*at the*  
14 *time of the modeling*" scientifically valid?

15 e. Should ADWR recommend a methodology to evaluate the impact of wells  
16 perforated below an impervious formation within the limits of the subflow zone?<sup>16</sup>

17 The Special Master indicated the four issues set for briefing would be ruled upon prior to the  
18 cross-examination of the expert witnesses. Memoranda, responses, and replies were filed between  
19 June 6, 2003, and August 11, 2003. Oral argument was not set.

20 **D. Discovery**

21 A discovery issue arose prior to the submission of briefs. The United States requested  
22 clarification of permissible discovery after being served with a request for documents by the Upper  
23 Valley Irrigation Districts. The request sought copies of forty documents listed by the United States'  
24 expert witnesses in their credentials.

On August 7, 2003, the Special Master issued an order stating that formal discovery of other  
than the disclosure of the sworn declarations, by means of depositions, interrogatories, production of

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<sup>16</sup> Special Master's Order Setting Briefing Schedule and Hearing 3-4 (Apr. 25, 2003).

1 documents or things, inspections, examinations, and requests for admissions was not contemplated in  
2 this proceeding, but informal discovery of not more than eight reports described or listed in the  
3 declarations would be allowed. Informal discovery was to be completed by October 7, 2003.

4 **E. Rebuttal Declarations**

5 On June 27, 2003, the following expert witnesses filed rebuttal declarations:

- 6 1. Mr. Briggs (Verde Valley Water Users Association, Inc. by officers and directors Ray  
7 Wrobley, Mary Margaret Kovacovich, and John Kovacovich).
- 8 2. Mr. Ford (SRP).
- 9 3. Mr. Gookin (GRIC).
- 10 4. Messrs. Harmon and Palumbo (APS and Phelps Dodge).
- 11 5. Mr. Michael J. Lacey (Bella Vista and Pueblo Del Sol Water Company (“Pueblo Del  
12 Sol”)).
- 13 6. Mr. Ralph P. Marra, Jr. (Tucson).
- 14 7. Dr. Mock (GRIC).
- 15 8. Dr. Matlock (Upper Valley Irrigation Districts, Verde Valley Communities, and the  
16 Maricopa-Stanfield and Central Arizona Irrigation and Drainage Districts).
- 17 9. Dr. Montgomery and Mr. Anderson (BHP).
- 18 10. Messrs. Page and Pyle (United States).
- 19 11. Mr. Toy (Cities).

20 **F. Special Master’s Proposed Rulings**

21 On September 8, 2003, the Special Master issued proposed rulings for the four issues briefed  
22 prior to the hearing. The order stated the rulings “may be modified in accordance with relevant  
23  
24

1 testimony, credible evidence, or persuasive argument presented during the examination of witnesses  
2 on October 21 and 22, 2003.”<sup>17</sup>

3 The issues and a summary of the rulings are as follows:

4 Issue 1: Should ADWR’s subflow analysis consider predevelopment or current stream  
5 flow conditions?

- 6 1. ADWR’s subflow analysis shall consider predevelopment stream flow conditions.
- 7 2. The date of predevelopment shall be a chronological year or a range of years  
8 immediately prior to widespread diversion and depletion of the stream’s flows as a  
9 result of any human activity.

10 Issue 2: Should ADWR consider the criteria specified in *Gila IV* to identify the  
11 subflow zone or have the criteria already been taken into account in the Arizona  
12 Supreme Court’s holding that the saturated floodplain Holocene alluvium is the  
13 subflow zone?

- 14 1. The criteria specified in *Gila IV* to identify or delineate the subflow zone have  
15 already been taken into account in the Arizona Supreme Court’s holding that the  
16 saturated floodplain Holocene alluvium is the subflow zone.
- 17 2. If ADWR is unable by using the means it proposes to identify or delineate the  
18 subflow zone in a stream segment, ADWR is directed to use the criteria specified in  
19 *Gila IV* and any other relevant factors that are appropriate for the particular location to  
20 delineate the subflow zone.

21 Issue 3: In addition to analyzing a well’s drawdown at the subflow zone, should  
22 ADWR report the cumulative effect of wells or of groups of wells?

- 23 1. A well’s drawdown at the subflow zone shall be analyzed individually for each  
24 well.
2. The Special Master will not decide in this order whether ADWR should report the  
cumulative effect of wells or of groups of wells. A ruling will be made after  
considering the evidence presented at the October hearing.

Issue 4: Should ADWR’s findings be reported in supplemental contested case  
hydrographic survey reports (HSRs) (“case-by-case”) or in a supplemental San Pedro  
River Watershed HSR (“the entire watershed”), which identifies the subflow zone,  
wells reaching and depleting a stream, and *de minimis* water rights?

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<sup>17</sup> Special Master’s Order Determining Issues 1 Through 4, 11 (Sept. 8, 2003).

1 1. The Special Master recommends the following schedule for the San Pedro River  
2 Watershed:

3 A. After the Superior Court adopts or modifies the Special Master's report  
4 recommending the procedures and processes to delineate the subflow zone within the  
5 San Pedro River Watershed and a cone of depression test, ADWR is directed to  
6 prepare a map delineating the subflow zone for the entire San Pedro River Watershed.  
7 ADWR shall submit this map and related information in a technical report and not in  
8 any form of HSR. The scope of the technical report shall be limited to delineating the  
9 subflow zone.

10 B. Upon filing its technical report with the Superior Court, ADWR shall send a notice  
11 to all claimants in the San Pedro River Watershed and the parties listed in the Gila  
12 River Adjudication Court-Approved Mailing List informing them of the scope and  
13 availability of the report and of a claimant's right to file written objections to the  
14 report and of the deadline for filing objections.

15 C. Any claimant in the San Pedro River Watershed may file a written objection to  
16 ADWR's technical report within 120 days of the date on which the report was filed.  
17 Objections shall be limited to ADWR's findings regarding the subflow zone.

18 D. After considering the objections, the Superior Court will approve the map that  
19 delineates and establishes the subflow zone for the San Pedro River Watershed.

20 E. Using the cone of depression test adopted by the Superior Court, ADWR will  
21 analyze wells located outside the lateral limits of the subflow zone to determine if the  
22 well's cone of depression reaches an adjacent subflow zone, and if continuing  
23 pumping will cause a loss of such subflow as to affect the quantity of the stream.  
24 ADWR will examine the other water right claims to determine *de minimis* water rights  
in the San Pedro River Watershed in accordance with the Superior Court's September  
26, 2002, order. ADWR will investigate and supplement, as needed, its findings  
reported in the 1991 Final San Pedro River Watershed HSR.

25 F. ADWR publishes a Supplemental Final San Pedro River Watershed HSR reporting  
26 its findings on a claim by claim basis, in accordance with A.R.S. § 45-256(B),  
27 including wells withdrawing subflow, cone of depression analyses, *de minimis* water  
28 rights, and all other updated information.

29 G. ADWR shall send a notice of the filing of the Supplemental Final San Pedro River  
30 Watershed HSR to all claimants in the Gila River Adjudication, who may file  
31 objections within 180 days of the date on which the report was filed.

32 2. The Special Master will direct ADWR to file the supplemental contested case HSR  
33 for *In re Fort Huachuca* after the Superior Court has approved the map delineating the  
34 subflow zone for the San Pedro River Watershed.

1 3. The Special Master recommends that this schedule be adopted for all the  
2 watersheds in the Gila River Adjudication subject to modifications that may be proper  
as a result of experience with this process.<sup>18</sup>

3 **G. ADWR’s Proposed Use of Soil Surveys and Expert Declarations**

4 On September 25, 2003, ADWR filed a notice stating it had recently become aware of soil  
5 survey maps published for a portion of Cochise County that ADWR believes should be used to  
6 determine the lateral limits of the subflow zone. ADWR proposes to use the soil survey maps,  
7 prepared under the auspices of the Natural Resources Conservation Service (“NRCS”) (part of the  
8 United States Department of Agriculture) working with other federal, state, and local agencies, to  
9 delineate the lateral extent of the subflow zone. The soil survey maps would be used instead of the  
10 surficial geology maps described in section 2.4 of the Subflow Report. ADWR indicated that soil  
11 survey maps will in the future be available for the entire San Pedro River Watershed and for other  
12 areas of the Gila River Adjudication.

13 The *Soil Survey of Cochise County, Arizona, Douglas-Tombstone Part* (2002) was based on  
14 major field work, cropland mapping, and rangeland mapping completed in 2000.<sup>19</sup> The “soil survey  
15 is an inventory and evaluation of the soils in the survey area” that “can be used to identify the  
16 potentials and limitations of each soil for specific land uses and to help prevent construction failures  
17 caused by unfavorable soil properties.”<sup>20</sup> The 734-page report describes 152 soil map units within the  
18 survey area. One unit was not mapped because the landowner denied access. The report contains  
19 maps of the soil units with the classification of the soil series and their morphology found within  
20 each unit. Appendix A of ADWR’s notice contains copies of several pages of the report that describe  
21 how the survey was completed.

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22 <sup>18</sup> *Id.*

23 <sup>19</sup> An electronic copy of the report is posted at <http://www.water.az.gov> under *Publications and Adjudications*.

24 <sup>20</sup> ADWR Notice of Recently Published Soil Survey Maps for Cochise Co. app. A (NRCS Soil Survey Report 187) (Sept. 25, 2003) (“ADWR Notice of Recently Published Soil Survey Maps”).

1 ADWR proposes to use NRCS survey AZ671 to delineate the lateral extent of the floodplain  
2 Holocene alluvium along the San Pedro River between the International Border and St. David,  
3 Arizona. ADWR submitted soil survey maps covering the Hereford, Fairbank, and Land 7.5-minute  
4 Quadrangles for this river segment (Appendices C, D, and E, respectively). The State Soil Scientist  
5 provided the approximate geologic age of each soil unit shown on the three maps (Appendix F).

6 On October 8, 2003, APS and Phelps Dodge requested additional time to analyze and submit  
7 expert testimony on ADWR's proposed use of the soil surveys. BHP, Casa Grande, and the Verde  
8 Valley Communities filed joinders to the motion. SRP and the United States opposed the motion.  
9 During the conference held on October 10, 2003, the Special Master stated he would take up the  
10 request after the hearing.

11 At the conclusion of the hearing on October 22, 2003, the Special Master granted the request  
12 for additional time. The ruling was memorialized in an order issued on October 28, 2003. The order  
13 allowed parties to file sworn declarations that would "serve as the direct testimony of the expert  
14 witness if a hearing is held," and to file sworn rebuttal declarations "limited to rebutting the opinions  
15 or information contained in the sworn declarations filed on or before December 8, 2003, and shall not  
16 present any new matters not contained in those declarations."<sup>21</sup> A hearing to cross-examine the  
17 expert declarants was not set or held.

18 The following experts filed sworn declarations on December 8, 2003:

- 19 1. Marshall P. Brown, P.E. (Cities).
- 20 2. Mr. Ford (SRP).
- 21 3. Mr. Gookin (GRIC).
- 22 4. Mr. Harmon (APS and Phelps Dodge).

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23 <sup>21</sup> Special Master's Order Allowing Filing of Sworn Declarations Regarding the Proposed Use of Soil Surveys  
24 2 (Oct. 28, 2003).

1 5. Dr. Mock (GRIC).

2 6. Dr. Montgomery (BHP).

3 7. Mr. Page (United States).

4 The Upper Valley Irrigation Districts, Casa Grande, and the Verde Valley Communities filed  
5 jointers to Mr. Harmon's declaration.

6 On January 12, 2004, Mr. Ford (SRP), Mr. Gookin (GRIC), Dr. Mock (GRIC), and Mr. Page  
7 (United States) filed sworn rebuttal declarations. At the October 21, 2003, hearing, ADWR presented  
8 the direct testimony of Richard T. Burtell, P.G. regarding the proposed use of the soil surveys.

9 **H. Prehearing Proceedings**

10 On October 8, 2003, the Special Master held a telephonic conference "to consider any matters  
11 that will facilitate the orderly and efficient conduct of cross-examination at the hearing set on  
12 October 21 and 22, 2003."<sup>22</sup> Procedural matters and two prehearing motions were taken up during  
13 the conference. A deadline was set to file responses to (1) the request of APS and Phelps Dodge for  
14 additional time to analyze and submit expert testimony on ADWR's proposed use of the soil surveys,  
15 and (2) a motion in limine filed a week earlier. A request to reschedule the cross-examination of  
16 witnesses was denied. Parties were directed to premark exhibits, exchange copies of exhibits, and  
17 reintroduce as a new exhibit any exhibit that had been introduced during a prior hearing in this  
18 adjudication. ADWR was requested to present additional information in the form of direct testimony  
19 regarding the proposed use of the soil surveys.

20 On October 3, 2003, the Upper Valley Irrigation Districts, Casa Grande, Central Arizona  
21 Irrigation and Drainage District, and the Verde Valley Communities filed a Motion in Limine to  
22 Exclude All Expert Testimony Re Legal Issues and To Exclude T. Allen J. Gookin's Rebuttal

23 \_\_\_\_\_  
24 <sup>22</sup> Special Master's Order Setting Prehearing Telephonic Conference 2 (Sept. 29, 2003).

1 Reports and Testimony. ASARCO filed a joinder. APS, Phelps Dodge, and the State of Arizona  
2 supported the motion, which the Apache Tribes, GRIC, SRP, and the United States opposed. The  
3 movants argued that Messrs. Ford, Gookin, and Page, and Dr. Mock had in their declarations stated  
4 opinions on legal issues, or outside their areas of expertise, or beyond the scope allowed by the  
5 Special Master.

6 At the start of the hearing on October 21, 2003, the Special Master granted the motion in part  
7 and denied it in part. The ruling announced in open court was as follows:

8 1. None of the sworn declarations, reports, and affidavits will be excluded in its  
9 entirety on the grounds of inadmissibility of expert opinions on questions of law,  
10 opinions outside the scope of the expert's competency, and relevance.

11 2. The Special Master will determine the weight and credibility to give to a sworn  
12 declaration, report, affidavit, or testimony that states an expert's understanding or  
13 views of a legal opinion or holding.

14 3. Any sworn declaration or testimony that in the opinion of the Special Master rises  
15 to the level of being a conclusion of law will be disregarded.

16 4. Any testimony that is based on pure speculation or conjecture will be disregarded.

17 5. Little, if any, weight would be given to any testimony about perceived inequities in  
18 Arizona's or other states' water laws, the future of Arizona's water laws or water  
19 resources management, the unstated intent and goals of court decisions, judges, and  
20 statutes, and how the Arizona Supreme Court should have or could have defined the  
21 subflow zone differently than it did in *Gila IV*.<sup>23</sup>

22 On October 14, 2003, reiterating an oral request made during the telephonic conference,  
23 GRIC filed a Motion for Reciprocal Treatment of All Expert Witness Reports, Declarations, Rebuttal  
24 Declarations, Affidavits, and/or Testimony with Regard to the October 3, 2003, Motion In Limine.  
The Upper Valley Irrigation Districts and the Verde Valley Communities opposed the motion. At the  
hearing on October 21, 2003, the Special Master adopted the ruling on the motion in limine as the

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<sup>23</sup> Hrg. Tr. 11:17-12:11 (Oct. 21, 2003).

1 ruling on this motion and granted GRIC's motion to the extent that the relief requested was granted  
2 in the ruling on the motion in limine.

3 **I. Participation of the Verde Valley Water Users, Inc.**

4 Mr. Ray Wrobley, Ms. Mary Margaret Kovacovich, and Mr. John Kovacovich, "as officers  
5 and directors of Verde Valley Water Users, Incorporated, an Arizona non-profit corporation," filed a  
6 response to the Subflow Report which included Mr. Briggs' sworn declaration.<sup>24</sup> During the October  
7 10, 2003, telephonic conference, Phoenix objected that because the corporation is neither a claimant  
8 nor a party in the Gila River Adjudication it should not be allowed to participate in this proceeding.

9 The Verde Valley Water Users, Inc. has not filed a statement of claimant in this adjudication.  
10 Mr. Wrobley, Ms. Kovacovich, and Mr. Kovacovich have, however, filed statements of claimant for  
11 their individual water uses.<sup>25</sup> After further discussion, counsel for the Verde Valley Water Users, Inc.  
12 stated that "he did not object to Mr. Briggs' testimony being offered on behalf of the persons who  
13 filed the statements of claimant listed in the filings of Mr. Briggs' declarations."<sup>26</sup>

14 The issue was again taken up at the end of the first day of hearing. No evidence was  
15 presented showing that the Verde Valley Water Users, Inc. has been served with a summons or has  
16 filed a statement of claimant in this adjudication. The adjudication statutes provide that only a  
17 "claimant" "may file written objections" to ADWR's reports, "have a fair and reasonable opportunity  
18 to present evidence in support of or in opposition to [ADWR's] recommendations," and "may enter  
19 into agreements regarding the attributes, satisfaction or enforcement" of water rights in relation to  
20

21  
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<sup>24</sup> Verde Valley Water Users, Inc.'s Response 1 (June 17, 2002).

23 <sup>25</sup> At the conference, it was unclear who had filed the statements of claimant listed in the response. At the  
24 hearing, it was clarified that these individuals have filed claims, and the correct numbers are for Mr. Wrobley  
39-05-55886, and for Ms. Kovacovich and Mr. Kovacovich 39-05-50030 through 39-05-50034, inclusive.

<sup>26</sup> Special Master's Corrected Minute Entry 2 (Oct. 16, 2003).

1 other claimants.<sup>27</sup> Under the pretrial orders in this adjudication a claimant is a person who has filed a  
2 statement of claimant.<sup>28</sup> A corporation which has not been served a summons or has not filed a  
3 statement of claimant may not participate as a party in the adjudication. The Special Master ruled  
4 that Mr. Briggs would be allowed to testify on behalf of Mr. Wrobley, Ms. Kovacovich, and Mr.  
5 Kovacovich as individual claimants but not on behalf of the corporation.<sup>29</sup>

## 6 **J. Hearing**

7 The Apache Tribes, APS, Phelps Dodge, Bella Vista, Pueblo Del Sol, BHP, Cities, GRIC,  
8 Upper Valley Irrigation Districts, Verde Valley Communities, Mr. Wayne D. Klump, Mr. Ray  
9 Wrobley, Ms. Mary Margaret Kovacovich, Mr. John Kovacovich, Safford, Paloma Ranch, Rio Rico,  
10 Tonopah, SRP, Tucson, and the United States participated in the cross-examination of the expert  
11 witnesses. Thirty-eight exhibits were admitted. The order of appearance of the expert witnesses was  
12 as follows:

13 On October 21, 2003: 1. Richard T. Burtell, P.G. (ADWR).

14 2. Dale A. Mason (ADWR).

15 3. Dr. Montgomery (BHP).

16 4. Mr. Page (United States).

17 5. Dr. Matlock (Upper Valley Irrigation Districts).

18 On October 22, 2003: 6. Mr. Ford (SRP).

19 7. Mr. Briggs (Mr. Wrobley, Ms. Kovacovich, and Mr. Kovacovich).

20 8. Mr. Gookin (GRIC).

21 9. Mr. Harmon (Phelps Dodge).

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22 <sup>27</sup> A.R.S. §§ 45-256(B) and 45-257(C).

23 <sup>28</sup> See Gila River Adjudication Pretrial Orders No. 4 (Jan. 24, 2000) and 5 (Mar. 29, 2000); see also Rules for  
Proceedings Before the Special Master §§ 1.04 (definition of “claimant”) and 1.16 (definition of “parties”).

24 <sup>29</sup> Hrg. Tr. 240:15-19 (Oct. 22, 2003).

1 10. Mr. Toy (Cities).

2 11. Dr. Mock (GRIC).

3 12. Mr. Lacey (Bella Vista and Pueblo Del Sol).

4 13. Mr. Marra (Tucson).

5 **K. Posthearing Proceedings**

6 On December 8, 2003, the Upper Valley Irrigation Districts, Verde Valley Communities, and  
7 Casa Grande requested to cross-examine Mr. Burtell of ADWR regarding the proposed use of the  
8 soil surveys and to allow the parties to present legal arguments and their positions.

9 On January 28, 2004, the Special Master denied the request to cross-examine Mr. Burtell for  
10 the reasons that claimants had prior opportunities to file expert declarations and rebuttal declarations  
11 regarding ADWR's proposed use of the soil surveys, and the expert witnesses who had submitted  
12 declarations had available to them ADWR's proposal, Mr. Burtell's testimony, and the extensive  
13 testimony and evidence presented in this matter. The Special Master ruled that sufficient evidence  
14 had been presented regarding the appropriateness of using the soil surveys as proposed by ADWR.

15 The request for parties to present legal arguments and their positions on all the proposed  
16 procedures was granted. Parties were allowed to file memoranda, responses, and replies on any issue  
17 arising from ADWR's recommended procedures and on any of the proposed rulings issued on  
18 September 8, 2003. Oral argument was set on May 20, 2004.

19 The following parties filed a brief or a joinder: Apache Tribes, State of Arizona, APS, Phelps  
20 Dodge, ASARCO, Arizona Water Company, Tucson Electric Power Company, Bella Vista, Pueblo  
21 Del Sol, Sierra Vista, Cities, GRIC, Safford, Paloma Irrigation and Drainage District, Rio Rico,  
22 Roosevelt Water Conservation District ("Roosevelt"), SRP, Upper Valley Irrigation Districts, Verde  
23  
24

1 Valley Communities, Maricopa-Stanfield Irrigation and Drainage District, Central Arizona Irrigation  
2 and Drainage District, Casa Grande, and the United States.

3 Prior to the last day to file responses, SRP filed objections and a motion for expedited  
4 consideration of its request to exclude eleven exhibits attached to the Cities' opening brief. The  
5 Special Master took up the request on an expedited basis, and on April 7, 2004, granted in part and  
6 overruled in part SRP's objections to the exhibits. The objections to five exhibits and a portion of one  
7 exhibit were overruled on the grounds the Special Master had already considered the exhibits as the  
8 documents were first filed on June 17, 2002. The objections to three exhibits were overruled, but the  
9 consideration the Special Master would give to these exhibits was limited to a specific issue on  
10 which the Cities offered argument. The objections to two exhibits were granted on the grounds they  
11 were cumulative evidence.

12 On May 20, 2004, oral argument lasting almost two and one-half hours was heard, after  
13 which the matter was deemed submitted.

14 **II. SUBFLOW ZONE (Chapter 2 of the Subflow Report)**

15 **A. Are ADWR's recommendations for locating perennial, intermittent, and**  
16 **effluent-fed streams valid?**

17 The trial court directed ADWR to propose:

18 A method for including both perennial and intermittent streams as part of the  
19 subflow analysis, including streams that historically contained perennial or  
20 intermittent flows, but which now are ephemeral due to development and other human  
21 initiated actions. The Court recognizes this direction makes ADWR's task more  
22 complicated and expects the department to formulate a proposal using readily  
23 available historical data that will permit determination of water levels and locations as  
24 of date(s) prior to widespread diversion and depletion of Arizona's stream flows.  
Effluent fed streams are also to be included as part of ADWR's analysis.<sup>30</sup>

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30 Ballinger Order 2.

1 ADWR proposes to identify perennial, intermittent, and effluent-fed streams in the Gila River  
2 Adjudication area by using information contained in eleven streamflow maps and several technical  
3 reports. The published maps and reports identify predevelopment perennial streams and recent  
4 perennial and intermittent streams. ADWR was unable to find a published map that shows  
5 predevelopment intermittent streams.

6 The predevelopment perennial streams are shown in the Hydrologic Investigations Atlas  
7 (“Atlas,” 1986) compiled by the United States Geological Survey (“USGS”). The recent perennial  
8 and intermittent streams are depicted on maps prepared by the Arizona Game and Fish Department  
9 (“AGFD”) dated 1981, 1993, and 1997. ADWR plans to combine information contained in these  
10 sources to create a composite map of predevelopment and recent perennial and intermittent streams.

11 Using the surface water quality rules of the Arizona Department of Environmental Quality  
12 (“ADEQ”), ADWR identified three major and 21 minor “effluent dependent waters” within the Gila  
13 River system, including two reaches in the San Pedro River Watershed.<sup>31</sup>

14 In its June 30, 1994, order regarding subflow, the trial court adopted from ADWR’s  
15 Technical Assessment<sup>32</sup> these definitions of “perennial,” “intermittent,” and “ephemeral” streams:

16 Perennial streams discharge water continuously through the year. Their source  
17 of supply is normally comprised of both direct runoff from precipitation events or  
snow melt, and baseflow derived from the discharge of groundwater into the stream.

18 Intermittent streams discharge water for long periods of time, but seasonally.  
19 For example, an intermittent stream may flow all winter, every winter, but never flow  
20 continuously during the summer. During seasons when baseflow is maintained,  
groundwater is contributing to the stream. During seasons of discontinuous  
21 streamflow, natural and cultural losses may be greater than the contribution from  
groundwater, resulting in a losing stream. Or, the amount of groundwater discharge  
itself may have decreased due to natural or cultural uses.

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23 <sup>31</sup> Subflow Report, app. D; *see* Ariz. Admin. Code R18-11-113 (Effluent Dependent Waters).

24 <sup>32</sup> *Technical Assessment of the Arizona Supreme Court Interlocutory Appeal Issue No. 2 Opinion* (Dec. 15,  
1993, ADWR) (“Technical Assessment”).

1 Ephemeral streams discharge water only in response to precipitation events or  
2 snowmelt, and do not have a baseflow component at any time of the year; they flow  
3 out sporadically. The groundwater system and surface water system do not establish a  
4 hydraulic connection in these systems.<sup>33</sup>

5 *Gila IV* affirmed the trial court’s order “in its entirety” and “in all respects.”<sup>34</sup>

6 Dr. Mock recommended that the definitions of perennial and intermittent streams be refined  
7 by limiting intermittent streams to those which are “groundwater-fed,” and by “arbitrarily” defining a  
8 perennial stream as one that flows “at least 11 months out of each year,” and an intermittent stream  
9 as one flowing “at least one month per year and less than 11 months per year of flow.”<sup>35</sup> He posited  
10 that “[f]or this adjudication, we are only interested in groundwater-fed intermittent streams,” and  
11 “arbitrary but useful thresholds of time [will] allow ADWR to make expedient progress in their  
12 analysis.”<sup>36</sup>

13 There has not been a judicial determination that the Gila River Adjudication is, or should be,  
14 only interested in groundwater-fed intermittent streams. An intermittent stream may be spring-fed or  
15 in high altitude areas carry flows from melting snow. Second, adoption of time frames to classify  
16 streams could render determinations indefensible due to arbitrariness. Furthermore, the fact these  
17 definitions were provided to the trial court in a technical report addressing subflow warrants  
18 recognition that ADWR considered generally accepted hydrology principles when it submitted these  
19 definitions.

20 There is general agreement that the maps ADWR selected to identify perennial, intermittent,  
21 and effluent-fed streams are a good start, but the maps have limitations that require ADWR to

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22 <sup>33</sup> Order 23-24 (June 30, 1994) (“Goodfarb Order”) quoting the Technical Assessment 6, 9.

23 <sup>34</sup> 198 Ariz. at 334, 344, 9 P.3d at 1073, 1083.

24 <sup>35</sup> Peter A. Mock Decl. 17 (June 17, 2002).

<sup>36</sup> *Id.*

1 undertake additional verification. Limitations include the quality of the sources of information and  
2 inconsistencies, inaccuracies, and omissions in the maps.

3 Regarding the USGS Atlas, Dr. Montgomery and Mr. Anderson declared that:

4 [S]everal of these maps were based chiefly on observations recorded in journals of  
5 pioneers traveling through the area, early government survey field notes, and initial  
6 hydrologic investigations for selected basins. Some of the reports are from casual  
7 observations recorded by nonprofessionals whose reliability for technical observations  
8 has not been established; others represent only a single point in time and possibly only  
9 a limited reach of a stream.<sup>37</sup>

10 Regarding the AGFD maps, Mr. Page declared that:

11 1. There are inconsistencies in the 1993 and 1997 AGFD maps, and “[v]erification is needed  
12 where reaches are not classified and where definitions in the AGFD classification vary somewhat  
13 from that of the Trial Court;”

14 2. “A more precise definition of the dates of data collection would be helpful” to understand  
15 the 1993 and 1997 AGFD maps because overlaps of perennial and intermittent streams appear in two  
16 areas in the San Pedro River Watershed, and the dates “may represent the report or map publication  
17 date, rather than the date the data actually represents;” and

18 3. A 1997 AGFD report relied on by ADWR indicates some stream segments are “in  
19 dispute,” but these “are not shown or discussed in the ADWR report and need to be clarified.”

20 4. A 1998 AGFD map of perennial and intermittent reaches “differ[s] significantly from the  
21 1993 and 1997 AGFD stream classifications for the San Pedro River, suggesting that the  
22 classifications are subject to change due to seasonal variation, short term climatic cycles, effects of  
23 development or other factors. Some discussion of the cause of variations affecting the length and  
24 permanence of each reach is needed to define the uncertainty associated with the classifications.”<sup>38</sup>

Dr. Montgomery and Mr. Anderson declared that ADWR should carefully review certain  
reaches along the Santa Cruz River near Tucson because these reaches “are indicated to contain  
perennial or intermittent flow when, in fact, they previously were reported to be ephemeral flow  
reaches.”<sup>39</sup>

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<sup>37</sup> Errol L. Montgomery and Thomas W. Anderson Decl. 11 (June 17, 2002).

<sup>38</sup> Oliver S. Page, Peter M. Pyle, and Jean M. Moran Decl. 6-7 (June 17, 2002).

<sup>39</sup> Errol L. Montgomery and Thomas W. Anderson Decl. 12 (June 17, 2002).

1 Mr. Gookin identified twelve rivers and creeks and one wash that “historic documentation  
2 indicates...were, in fact, live rivers,” but under ADWR’s methodology they would not be classified  
3 “as perennial and/or intermittent.”<sup>40</sup> He declared that ADWR needs to obtain additional historical  
4 evidence to classify these streams. Dr. Mock expressed the same view.<sup>41</sup>

5 ADWR is aware the maps it has identified do not show some current perennial stream  
6 reaches, that intermittent reaches currently exist that were not previously identified as perennial, and  
7 that some intermittent reaches depicted on the 1997 AGFD map are “questionable” and are believed  
8 to be ephemeral based on recent stream gage data. The maps and reports ADWR has identified are a  
9 very good start, but additional work must be done to locate perennial, intermittent, and effluent-fed  
10 streams with more accuracy and reliability. The work could be as narrow as verifying stream  
11 segments. The tasks could include searching the literature for additional historical and current maps  
12 and reports; examining notices of appropriation recorded in county recorders’ offices; reviewing  
13 court records of prior decrees; reviewing geological reports; field investigations; and interpreting  
14 aerial photography.

15 In this work, ADWR must be guided by *Gila IV*’s holding that “it is critical that any test used  
16 for determining the boundaries of a subflow zone be as accurate and reliable as possible.”<sup>42</sup> The trial  
17 court likewise directed ADWR to “arrive at results that are as accurate as possible.”<sup>43</sup>

18 **Recommendation 1:** The Court should direct ADWR to use the definitions of perennial,  
19 intermittent, and ephemeral streams set forth in the trial court’s June 30, 1994, order.

20 **Recommendation 2:** The Court should direct ADWR to investigate additional sources,  
21 including historical and current documents, scientific reports, mapping projects, aerial photography,

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22 <sup>40</sup> T. Allen J. Gookin Decl. sec. 1 at 3, 2 (June 17, 2002).

23 <sup>41</sup> Peter A. Mock Decl. 13-14 (June 17, 2002).

24 <sup>42</sup> 198 Ariz. at 335, 9 P.3d at 1074; *see* 175 Ariz. at 388-9, 857 P.2d at 1242-3.

<sup>43</sup> Ballinger Order 2.

1 and field investigations to locate perennial, intermittent, and effluent-fed streams with as much  
2 accuracy and reliability as possible.

3 **B. Is ADWR’s recommended assumption for effluent-fed streams that were not**  
4 **previously perennial, or recently perennial or intermittent, “that the sediments immediately**  
5 **beneath these reaches are unsaturated due to clogging layers”<sup>44</sup> valid?**

6 In its directions to ADWR, the trial court directed that “[e]ffluent fed streams are also to be  
7 included as part of ADWR’s analysis.”<sup>45</sup> In the Subflow Report, ADWR lists three major and 21  
8 minor “effluent dependent waters” within the Gila River system, including two reaches in the San  
9 Pedro River Watershed.

10 ADWR proposes that for effluent-fed streams that were not previously perennial, or recently  
11 perennial or intermittent, “it be assumed that the sediments immediately beneath these reaches are  
12 unsaturated due to clogging layers.”<sup>46</sup> Therefore, these streams would not undergo subflow analysis.  
13 According to ADWR, “it is common for low permeability” clogging layers to be formed by the  
14 “elevated nutrient and/or organic content of most effluent,” and as layers form along the bed of  
15 effluent-fed streams, the layers “can restrict the seepage of streamflow and, as a result, can cause the  
16 sediments beneath the stream to be unsaturated.”<sup>47</sup> Bower’s textbook is cited for the observation  
17 that clogging “is primarily a surface phenomenon that rarely extends more than 10 cm [*note:*  
18 *approximately 4 inches*] into the soil and often is restricted to the top centimeter or less [*note: less*  
19 *than ½ inch*].”<sup>48</sup> The “area adjacent to and beneath such streams would not, by definition, be  
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22 <sup>44</sup> Subflow Report 9.

23 <sup>45</sup> Ballinger Order 2.

24 <sup>46</sup> Subflow Report 9.

<sup>47</sup> *Id.* at 8.

<sup>48</sup> *Id.* at 9 quoting H. BOUWER, GROUNDWATER HYDROLOGY (McGraw-Hill 1978).

1 characteristic of a jurisdictional subflow zone due to the lack of a hydraulic connection between the  
2 subflow and the stream.”<sup>49</sup>

3 ADWR further states, “[d]etailed geologic and hydrologic data are needed to confirm the  
4 presence or absence of clogging layers along effluent fed streams, and the occurrence of unsaturated  
5 flow beneath these streams. The Department believes these data are generally unavailable at this time  
6 and would require considerable time and resources to collect in the future.”<sup>50</sup>

7 The basis of the assumption is “the lack of a hydraulic connection” between an effluent-fed  
8 stream and the subflow. Mr. Gookin declared that “[s]tudies have suggested that effluent does tend to  
9 lead to plugging, which restricts, but does not eliminate the recharge to the groundwater.”<sup>51</sup> In his  
10 opinion, a clogging layer acts as a restriction only during one of four conditions, namely, periods of  
11 low flow and when the water table is below the stream. As for the other three conditions:

12 If the water table is up to the river, then water flows from the groundwater into the  
13 river, and the muck at the bottom of the river does not form an appreciable  
14 restriction... The third and fourth conditions are periods of high flow with and  
15 without a high water table. During periods of greater than normal flow, due to storm  
16 run off or some other event, this layer of muck is rapidly scoured away and recharge  
17 immediately begins in large amounts, if the aquifer has room to accept the water.  
18 These recharge amounts can be huge. Further, once the flood has passed, it takes time  
19 for this effluent plugging to occur again. During that time, the low flow will continue  
20 to recharge. I am unaware of any situation where effluent has caused recharge to cease  
21 in a natural environment. It slows it down. It does not stop it.<sup>52</sup> (Emphasis added.)

22 According to Mr. Gookin, there is a hydraulic connection between an effluent-fed stream and  
23 the subflow, which can be greater than normal during periods of high flow and varies under other  
24 conditions. This opinion accords with ADWR’s description that clogging layers have “low  
permeability” (rather than being impermeable).

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<sup>49</sup> Subflow Report 9.

<sup>50</sup> *Id.*

<sup>51</sup> T. Allen J. Gookin Rebuttal Decl. ch. IX, 2 (June 27, 2003).

<sup>52</sup> *Id.*

1 In *Gila II*, the Supreme Court approved the trial court’s adoption of “reasonable simplifying  
2 assumptions” which would facilitate the conclusion of the adjudications.<sup>53</sup> The assumption proposed  
3 for effluent-fed streams due to clogging layers is not reasonable because it cannot be concluded that  
4 there is a lack or absence of hydraulic connection in effluent-fed reaches between the stream and the  
5 subflow. The evidence that there is no hydraulic connection due to clogging layers is not conclusive.

6 **Recommendation 3:** The Court should not adopt ADWR’s assumption for effluent-fed  
7 streams that were not previously perennial, or recently perennial or intermittent, that the sediments  
8 immediately beneath these reaches are unsaturated due to clogging layers.

9 **C. Should ADWR use the soil survey maps prepared by the Natural Resources  
10 Conservation Service to delineate the lateral limits of the subflow zone?**

11 ADWR’s proposed use of the NRCS soil survey maps to delineate the subflow zone modifies  
12 Section 2.4 of the Subflow Report. In that section, ADWR proposed using the best available  
13 Holocene maps to delineate the lateral extent of the floodplain Holocene alluvium. ADWR believes  
14 that the NRCS soil survey maps are a better tool. The proposal raised four principal objections:

- 15 1. The maps include soil types “that are of mixed alluvial fan, floodplain, or stream terrace  
16 origin, not definitively of floodplain origin.”<sup>54</sup>
- 17 2. The maps include soil types which are not associated with Holocene alluvium.
- 18 3. The maps include ephemeral streams.
- 19 4. The maps contain little site-specific information regarding depth, saturation, or aquifer  
20 characteristics because soil profiles are described down to 60 inches.

21 The first two objections are evident in two of the 7.5-minute quadrangle maps ADWR  
22 prepared to show the soil survey units. Mr. Burtell testified that the Hereford Quadrangle shows

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23 <sup>53</sup> 175 Ariz. at 394, 857 P.2d at 1248.

24 <sup>54</sup> Eric J. Harmon Soil Surveys Decl. 3 (Dec. 8, 2003).

1 areas of (1) floodplain alluvium of Holocene age and (2) “mixed floodplain and alluvial fan materials  
2 of Holocene age,” and both areas “would be considered for at least determining where the subflow  
3 zone is.”<sup>55</sup> In the Land Quadrangle,<sup>56</sup> Mr. Burtell identified “relic fan deposits” that have been  
4 preserved within the channel of the San Pedro River, and described an “island” of material that is  
5 “either not of Holocene age or if it is, it’s not related to floodplain deposits.”<sup>57</sup> The soil survey map  
6 shows that the “island” Mr. Burtell described in the Land Quadrangle (in Soil Unit 2) consists of  
7 “Pre-Pleistocene to Holocene Non-Floodplain Deposits,” and another island on the same map (in Soil  
8 Unit 35) is identified as “Pleistocene Stream Deposits and Non-Floodplain Deposits of Various  
9 Ages.”<sup>58</sup>

10 Mr. Harmon declared that of the eleven soil map units ADWR had identified “as being  
11 definitive of the floodplain Holocene alluvium,” seven are associated with alluvial fans in addition to  
12 floodplains, and two units are associated with stream terraces.<sup>59</sup> “Alluvial fans are distinctly different  
13 from floodplain alluvium.”<sup>60</sup> The soil survey maps, in short, (1) show the presence of Pre-  
14 Pleistocene, Pleistocene, Holocene non-floodplain, and non-floodplain deposits of various ages  
15 within the areas ADWR will investigate to determine the lateral extent of the subflow zone, and (2)  
16 in some areas do not distinguish between floodplain and alluvial fan deposits.

17 A group of parties argues that the subflow zone includes all of the floodplain alluvium  
18 deposited by a river or stream and not just the portion that is of Holocene age. Accordingly, the  
19 floodplain alluvium may contain Pleistocene deposits and not just Holocene alluvium. Other parties

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21 <sup>55</sup> Hrg. Tr. 25:18-26:1 (Oct. 21, 2003); ADWR Notice of Recently Published Soil Survey Maps, app. C.

22 <sup>56</sup> ADWR Notice of Recently Published Soil Survey Maps, app. E.

23 <sup>57</sup> Hrg. Tr. 27:17-20 (Oct. 21, 2003).

24 <sup>58</sup> ADWR Notice of Recently Published Soil Survey Maps, app. E.

<sup>59</sup> Eric J. Harmon Soil Surveys Decl. 6 (Table 1), 7 (Dec. 8, 2003); *see also* Marshall P. Brown Soil Surveys Decl. ¶¶ 10-12 (Dec. 8, 2003).

<sup>60</sup> Marshall P. Brown Soil Surveys Decl. ¶ 10 (Dec. 8, 2003).

1 argue that *Gila IV* explicitly affirmed the trial court’s ruling that the subflow zone is the saturated  
2 floodplain Holocene alluvium, and therefore, the subflow zone cannot include Pleistocene deposits.

3 After considering the opinions of the parties and their experts, the trial court ruled:

4 Throughout the hearings, field trip and later briefing, the parties have used the  
5 terms Holocene, younger alluvium, and floodplain alluvium interchangeably. This  
6 Court believes the proper terminology for the geologic unit which defines “subflow”  
7 is the “saturated floodplain Holocene alluvium.” That term is used deliberately.<sup>61</sup>

8 The court noted the potential difficulty of discerning different materials:

9 While the depositional processes were somewhat different, where [the Holocene or  
10 younger alluvium and the basin fill] meet it is sometimes difficult to discern the  
11 differences between one type of eroded, depositional debris from another, particularly  
12 when they may both be saturated and water bearing.... However, only the younger  
13 Holocene alluvium can pass the test of “subflow” as it is the only stable geologic unit  
14 which is beneath and adjacent to most rivers and streams, except those in the  
15 mountains where bedrock surrounds the flow.<sup>62</sup>

16 The trial court clearly stated subflow is found within the floodplain Holocene alluvium. The  
17 classification “Holocene” is uniformly used throughout its order to describe the floodplain alluvium  
18 associated with subflow. *Gila IV* affirmed the trial court’s rulings in their entirety. The Supreme  
19 Court defined the term “Holocene” to refer “to the Holocene epoch, which is that part of the  
20 Quaternary period that covers approximately the most recent 10,000 years. During that time frame,  
21 floods caused rivers to carry and deposit certain materials that originated from erosion of bedrock  
22 and basin fill deposits....”<sup>63</sup> The trial court’s rulings and *Gila IV* cannot be interpreted to mean  
23 anything other than the floodplain Holocene alluvium is where ADWR must start to delineate the  
24 lateral limits of the subflow zone.<sup>64</sup>

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22 <sup>61</sup> Goodfarb Order 56.

23 <sup>62</sup> *Id.*

24 <sup>63</sup> 198 Ariz. at 334 n.2, 9 P.3d at 1073 n.2.

<sup>64</sup> “The entire saturated floodplain Holocene alluvium, as found by DWR, will define the subflow zone in any given area.” 198 Ariz. at 342, 9 P.3d at 1081.

1 ADWR may find areas where it will be “difficult to discern the differences” between  
2 materials, and in those, it must exercise its best technical analysis and evaluation to delineate the  
3 lateral extent of the floodplain Holocene alluvium. If other materials such as Pleistocene or relic fan  
4 deposits are found, ADWR should report their presence and extent.

5 The third main objection is that the soil survey maps include ephemeral streams. Mr. Harmon  
6 declared that Soil Unit 123 in the Fairbank Quadrangle is “associated with streams that are partly  
7 ephemeral and partly perennial.”<sup>65</sup> Mr. Brown listed seven ephemeral washes whose alluvium “has  
8 been inappropriately delineated as saturated floodplain Holocene alluvium associated with the San  
9 Pedro River.”<sup>66</sup> Mr. Ford identified fourteen ephemeral tributaries whose inclusion in the subflow  
10 zone is questionable.<sup>67</sup> The parties and other experts who filed declarations agree that under *Gila IV*  
11 the ephemeral streams shown on the soil survey maps must be excluded from the subflow analysis.<sup>68</sup>

12 The fourth main objection is that the NRCS used soil borings to define and map the soil  
13 types, but the boreholes generally did not exceed three to four feet and only in exceptional situations  
14 went down six or seven feet. The soil maps, therefore, contain little site-specific information about  
15 depth, saturation, or aquifer characteristics in the floodplain Holocene alluvium.

16 This objection evinces a concern that the soil survey maps will be used as the exclusive  
17 means to delineate the lateral limits of the subflow zone. The Special Master has previously stated,  
18 “[i]t is clear from the evidence heard that there is no single or exclusive available indicator that  
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22 <sup>65</sup> Eric J. Harmon Soil Surveys Decl. 8 (Dec. 8, 2003) (quoting the NRCS Soil Survey Report 156).

23 <sup>66</sup> Marshall P. Brown Soil Surveys Decl. ¶ 14 (Dec. 8, 2003).

24 <sup>67</sup> Jon R. Ford Soil Surveys Decl. ¶ 8 (Dec. 8, 2003).

<sup>68</sup> The exclusion of ephemeral streams is discussed in chapter 2, section G, and an exception is described in chapter 2, section E, of this report.

1 delineates the subflow zone as defined in *Gila IV*. Delineating the entire subflow zone in a watershed  
2 will require using more than one indicator.”<sup>69</sup>

3 The Special Master adheres to this view, and the experts stated similar opinions. Mr. Brown  
4 declared, “[i]t may be appropriate to use soil survey results as a supplemental resource to assist in  
5 delineation of the saturated floodplain Holocene alluvium,” but they “should not be used as the  
6 primary basis....”<sup>70</sup> Mr. Ford “agree[s] with the use of NRCS soil data as an additional source of data  
7 to be used to delineate the Subflow Zone, but [does] not support the use of NRCS soil data as the  
8 exclusive delineation method.”<sup>71</sup> Dr. Mock declared the maps “would serve as but a supplemental  
9 source of data for some interpretations.”<sup>72</sup> Dr. Montgomery opined the maps “should be used in  
10 conjunction with other maps and resources previously identified by” ADWR.<sup>73</sup> Mr. Page declared  
11 that “the soil information can and should be used as one of many tools.”<sup>74</sup>

12 Although the NRCS surveys evaluate soils for purposes of land use planning and  
13 management, the surveys can provide useful information to delineate the subflow zone. The surveys  
14 “collect data on erosion, droughtiness, flooding, and other factors that affect soil uses and  
15 management.” The surveys may not qualify as the exclusive indicator to delineate the lateral limits of  
16 the floodplain Holocene alluvium in accordance with *Gila IV*, but they should be used as they  
17 contain relevant and useful information.

18 ADWR specifically recommends that certified NRCS survey AZ671, released in 2003, be  
19 used to determine the lateral extent of the floodplain Holocene alluvium along the San Pedro River  
20 between the International Border and St. David, Arizona. The Hereford, Fairbank, and Land

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21 <sup>69</sup> Special Master’s Order 2 (Jan. 28, 2004).

22 <sup>70</sup> Marshall P. Brown Soil Surveys Decl. ¶ 20 (Dec. 8, 2003).

23 <sup>71</sup> Jon R. Ford Soil Surveys Decl. ¶ 13 (Dec. 8, 2003).

24 <sup>72</sup> Peter A. Mock Soil Surveys Decl. 3 (Dec. 8, 2003).

<sup>73</sup> Errol L. Montgomery Soil Surveys Decl. 4 (Dec. 8, 2003).

<sup>74</sup> Oliver S. Page Soil Surveys Decl. 9 (Dec. 8, 2003).

1 Quadrangles are part of survey AZ671. The survey includes soil maps for most of the Babocomari  
2 River and stream reaches within Ramsey, Garden, and Miller Canyons.

### 3 *Mapping*

4 Before ADWR presented its proposal to use the NRCS soil survey maps, some experts  
5 pointed out limitations of the surficial geology maps ADWR proposed to use to delineate the lateral  
6 extent of the subflow zone. Because ADWR may consult some or all of these maps as additional  
7 sources of information, those concerns are addressed.

8 First, ADWR proposes to utilize four criteria to evaluate the adequacy of the surficial maps,  
9 for the areas with perennial and intermittent streams, which delineate floodplain Holocene alluvium:  
10 field work, map coverage, dating methods, and map scale. Mr. Page recommended that mapping  
11 methods be added to the selection criteria. Mapping methods include aerial photography analysis,  
12 geomorphic (topographic map) interpretation, phreatophyte mapping, and infrared image  
13 interpretation. The recommendation is appropriate.

14 Second, Messrs. Harmon, Palumbo, Anderson, and Page commented on map scale. They  
15 favor using larger scale maps than ADWR proposes and agree that a scale of 1:24,000 is the  
16 preferred scale. Concerning ADWR's proposed use of the Pool and Coes map<sup>75</sup> to delineate the  
17 floodplain Holocene alluvium within the Sierra Vista Subwatershed, Messrs. Harmon and Palumbo  
18 declared:

19 The Pool and Coes map is published at a scale of 1:135,000.... In our experience,  
20 using a map at this scale does not provide sufficient detail to allow accurate  
21 determination of a geologic contact on the ground. If ADWR's proposal to use the  
22 Pool and Coes map is adopted, we believe this will lead to inaccurate conclusions  
23 regarding the location of the edge of the jurisdictional subflow zone.... [A] better  
24 choice of map for use in defining the subflow zone would be the published USGS

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24 <sup>75</sup> D. R. Pool and A. L. Coes (USGS, 1999).

1 1:24,000 topographic map series. These maps provide a significantly more detailed  
2 scale, with one mile being depicted as 2.64 inches.<sup>76</sup>

3 Mr. Anderson declared, “[i]f I were given the task of accurately and reliably identifying the  
4 Holocene alluvium, I would attempt to locate a map focused on the Holocene alluvium with a scale  
5 of 1:24,000 (or larger, even 1:12,000) because the level of detail provided by such maps is probably  
6 necessary to identify the different surficial deposits.”<sup>77</sup> Mr. Ford recommended “DWR should obtain  
7 large-scale draft mapping (typically at a scale of 1 inch = 2,000 feet)... Once a particular map is  
8 selected, DWR should obtain the largest scale version of that map that is available.”<sup>78</sup>

9 The recommendation that ADWR should obtain the largest scale version of a map whenever  
10 possible is appropriate. When area is the same, a large scale map will show items in greater detail  
11 than a small scale map. The Special Master will not recommend a minimum or maximum map scale,  
12 as the decision is within ADWR’s professional judgment.

13 Third, Mr. Ford recommended that ADWR “should take special care in ensuring that the edge  
14 of the Holocene alluvium is properly transferred from the authors’ published or draft mapping, so  
15 that it is accurately re-projected to the current datum used on the DWR base maps.”<sup>79</sup> Any substantial  
16 error in transferring or re-projecting a depiction from a surficial map to ADWR’s base map will  
17 negate the department’s efforts to select the proper map. The NRCS report contains a similar caution,  
18 if large copies of the soil survey maps are made: “Enlargement of these maps, however, could cause  
19 misunderstanding of the detail of mapping. If the maps are enlarged, distortion will occur. Enlarged  
20  
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22 <sup>76</sup> Eric J. Harmon and Mark R. Palumbo Decl. 10-11 (June 17, 2002).

23 <sup>77</sup> Kirk C. Anderson Decl. ¶ 6 (June 17, 2002).

24 <sup>78</sup> Jon R. Ford Decl. ¶ 11a (June 17, 2002).

<sup>79</sup> *Id.* at ¶ 11b.

1 maps do not show the small areas of contrasting soils that could have been shown at a larger scale.”<sup>80</sup>

2 The recommendation regarding technical mapping is appropriate.

3 The experts who submitted declarations concerning the soil surveys provided technical  
4 information, and some addressed characteristics in specific soil units. *Gila IV*'s invitation is pertinent  
5 and should be accepted: “DWR may use such data accumulated during these proceedings to aid in its  
6 task.”<sup>81</sup>

7 **Recommendation 4:** The Court should adopt ADWR's proposal to use the NRCS soil survey  
8 maps to delineate the lateral extent of the floodplain Holocene alluvium but should direct ADWR to  
9 use the maps as one source or indicator - but not the exclusive means - to delineate the lateral limits  
10 of the subflow zone.

11 **Recommendation 5:** The Court should direct ADWR to limit its subflow analysis to the  
12 floodplain Holocene alluvium. If other deposits or materials (such as Pleistocene) are found within  
13 the floodplain alluvium of a stream, the presence and extent of those deposits shall be reported, but  
14 the criterion is the floodplain Holocene alluvium.

15 **Recommendation 6:** The Court should direct ADWR to exclude from the subflow analysis  
16 the ephemeral streams shown on the NRCS soil survey maps.

17 **Recommendation 7:** The Court should adopt ADWR's proposal to use NRCS survey AZ671  
18 as a source of information to determine the lateral extent of the floodplain Holocene alluvium in the  
19 San Pedro River and its reaches between the International Border and St. David, Arizona.

20 **Recommendation 8:** The Court should direct ADWR to consider mapping methods as a  
21 criterion to evaluate the adequacy of a surficial map which depicts floodplain Holocene alluvium.

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23 <sup>80</sup> ADWR Notice of Recently Published Soil Survey Maps, app. A (NRCS Soil Survey Report 2).

24 <sup>81</sup> 198 Ariz. at 342, 9 P.3d at 1081. Such information would include the comments submitted by the Arizona  
Geological Survey to ADWR, which ADWR filed with the Court on June 17, 2002.

1           **Recommendation 9:** The Court should direct ADWR to obtain the largest scale version of a  
2 map whenever possible.

3           **Recommendation 10:** The Court should direct ADWR to take special care in transferring or  
4 re-projecting any depiction on a surficial map to a base map.

5           **D. Should ADWR consider the criteria specified in *Gila IV* to identify the subflow  
6 zone or have the criteria already been taken into account in the Arizona Supreme Court’s  
7 holding that the saturated floodplain Holocene alluvium is the subflow zone?**

8           This question was briefed prior to the hearing. On September 8, 2003, a ruling was issued  
9 subject to modification after considering the evidence presented during the hearing. The proposed  
10 ruling is adopted as the evidence is not sufficient to modify it.

11           In *Gila II*, the Supreme Court held that in order to determine “[w]hether a well is pumping  
12 subflow...comparison of such characteristics as elevation, gradient, and perhaps chemical makeup  
13 can be made. Flow direction can be an indicator.”<sup>82</sup> After remand, the trial court found that if  
14 elevation, gradient, chemical composition, and flow direction are added to the concept that the  
15 subflow zone can be differentiated from adjacent tributary aquifers and the basin fill aquifer that  
16 contribute or receive discharge from the subflow zone, “a set of principles can be developed to define  
17 ‘subflow.’”<sup>83</sup> The trial court found that combining the four factors with this concept was “[t]he only  
18 logical and rational way” to make *Southwest Cotton* and *Gila II* “consistent with the scientific  
19 principles” presented by the expert witnesses.<sup>84</sup>

20           Before discussing the “different sides or proposals” presented to the trial court, Judge  
21 Goodfarb found that *Gila II* and the uncontested evidence he had heard required that the subflow  
22 zone “be defined by at least the following principles:”

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23 <sup>82</sup> 175 Ariz. at 392, 857 P.2d at 1246.

24 <sup>83</sup> Goodfarb Order 34.

<sup>84</sup> *Id.*

1 1. The “subflow” zone must be adjacent and beneath a perennial or intermittent  
2 stream.

3 2. It may not be adjacent or beneath an ephemeral stream. However, it may be  
4 adjacent or beneath an ephemeral section of a perennial or intermittent stream, if the  
5 ephemeral section is caused by adjacent surface water diversion or groundwater  
6 pumping. There must, however, be a saturated zone beneath connected to similar  
7 zones beneath the upper and lower perennial or intermittent stream sections.

8 3. Except as set forth in paragraph 2 above, there must be a hydraulic connection  
9 between the surface stream and the “subflow” zone.

10 4. The “subflow” zone must be distinguished from adjacent tributary aquifers or  
11 connecting basin fill.

12 5. The parameters of the “subflow” zone, if it is to be defined by reference to the  
13 saturated floodplain alluvium, Holocene alluvium, or younger alluvium, must be  
14 outside of and not include those tributary alluvial deposits known as “inliers” as  
15 indicated in [a figure in an expert’s report]. (Numbers 6 and 7 are omitted because  
16 they are not germane to this discussion).<sup>85</sup>

17 The trial court then took up the different proposals for defining the subflow zone and  
18 concluded:

19 After consideration of flow direction, water level elevation, the gradation of water  
20 levels over a stream reach, the chemical composition if available, and lack of  
21 hydraulic pressure from tributary aquifer and basin fill recharge which is  
22 perpendicular to stream and “subflow” direction, the Court finds the most accurate of  
23 all the markers is the edge of the saturated floodplain Holocene alluvium.<sup>86</sup>

24 The court gave the reasons for this determination. First, the floodplain Holocene alluvium “is  
the only stable geologic unit which is beneath and adjacent to most rivers and streams....”<sup>87</sup> Second,  
when the floodplain Holocene alluvium is saturated, “that part of the unit qualifies as the ‘subflow’  
zone, where the water which makes up the saturation flows substantially in the same direction as the  
stream, and the effect of any side discharge from tributary aquifers and basin fill is overcome or is

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<sup>85</sup> *Id.* at 35-36.

<sup>86</sup> *Id.* at 56; *see also* 198 Ariz. at 337, 9 P.3d at 1076.

<sup>87</sup> Goodfarb Order 56.

1 negligible.”<sup>88</sup> The subflow zone must be saturated because there must be a hydraulic connection  
2 between the stream and the subflow.

3 In further support of the determination that the subflow zone is the saturated floodplain  
4 Holocene alluvium, the trial court stated:

5 If we add the following additional criteria, then even more certainty and  
6 reliability is provided. First, the water level elevation of the “subflow” zone must be  
7 relatively the same as the stream flow’s elevation. Second, the gradient of these  
8 elevations for any reach must be comparable with that of the levels of the stream flow.  
9 Third, there must be no significant difference in chemical composition that cannot be  
10 explained by some local pollution source which has a limited effect. Fourth, where  
11 there are connecting tributary aquifers or floodplain alluvium of ephemeral streams,  
12 the boundary of the “subflow” zone must be at least 200 feet inside of that connecting  
13 zone so that the hydrostatic pressure effect of the side recharge of this tributary  
14 aquifer is negligible and the dominant direction of flow is the stream direction. Fifth,  
15 where there is a basin-fill connection between saturated zones of the floodplain  
16 Holocene alluvium and a saturated zone of basin fill, the boundary of the “subflow”  
17 zone must be 100 feet inside of the connecting zone so that the hydrostatic pressure  
18 effect of the basin-fill’s side discharge is overcome and the predominant direction of  
19 flow of all of the “subflow” zone is the same as the stream’s directional flow.<sup>89</sup>  
20 (Underlining in original.)

21 The Supreme Court held that “the [trial] court based its ruling on evaluation of the pertinent  
22 factors set forth in *Gila River II* for delineating the subflow zone.”<sup>90</sup> The Court, foreshadowing  
23 similar arguments made in this proceeding, held:

24 At oral argument, the groundwater users questioned...what role, if any, the  
criteria that we set forth in *Gila River II* and that the trial court used will play in  
determining subflow in different locations. The criteria that the trial court articulated  
were elaborations of, but consistent with, the more general criteria set forth in *Gila  
River II*. The trial court properly applied these criteria to the San Pedro River basin in  
order to determine the most appropriate subflow zone, and the weight of the evidence  
supports the trial court’s identification of that zone as the “saturated” floodplain  
Holocene alluvium.<sup>91</sup>

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<sup>88</sup> *Id.* at 57.

<sup>89</sup> *Id.* at 57-58; *see* 198 Ariz. at 337-8, 9 P.3d at 1076-7.

<sup>90</sup> 198 Ariz. at 337, 9 P.3d at 1076.

<sup>91</sup> 198 Ariz. at 341-2, 9 P.3d at 1080-1.

1 The trial court considered each of the criteria specified in *Gila II*, and determined they are  
2 met within the saturated floodplain Holocene alluvium. The trial court did not simply identify or  
3 formulate a set of more specific criteria or parameters to delineate the subflow zone. The Supreme  
4 Court affirmed this order in all respects.

5 The Special Master finds that the criteria specified in *Gila IV* to delineate the subflow zone  
6 have already been taken into account in the Supreme Court's holding that the saturated floodplain  
7 Holocene alluvium is the subflow zone.

8 This determination means that ADWR is required to apply the same criteria when it cannot  
9 delineate the subflow zone utilizing the procedures approved by the trial court. ADWR may find  
10 stream segments where the procedures approved by the trial court are insufficient to delineate the  
11 subflow zone with the requisite accuracy and reliability. In those situations, *Gila IV* directs that  
12 ADWR must consider "insofar as they apply and are measurable," the "detailed criteria set forth in  
13 the trial court's order," and may consider "other criteria that are geologically and hydrologically  
14 appropriate for the particular location."<sup>92</sup> ADWR should report the reasons for selecting any other  
15 criteria it found appropriate for the location.

16 **Recommendation 11:** The Court should adopt the finding that the criteria specified in *Gila*  
17 *IV* to delineate the subflow zone have been taken into account in the Supreme Court's holding that  
18 the saturated floodplain Holocene alluvium is the subflow zone.

19 **Recommendation 12:** The Court should direct ADWR to use the criteria specified in *Gila IV*  
20 and any other criteria that are geologically and hydrologically appropriate for the particular location  
21 to delineate the subflow zone, if ADWR is unable to do so with the requisite accuracy and reliability  
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23 \_\_\_\_\_  
24 <sup>92</sup> 198 Ariz. at 342, 9 P.3d at 1081.

1 utilizing the procedures approved by the Court. ADWR should report the reasons for selecting any  
2 other criteria it found appropriate for the location.

3 **E. Should ADWR’s subflow analysis consider predevelopment or current stream**  
4 **flow conditions?**

5 This question was briefed prior to the hearing. On September 8, 2003, a proposed ruling was  
6 issued subject to modification after considering the evidence presented at the hearing. The ruling is  
7 modified based on subsequent evidence and arguments.

8 Parties argue that Judge Goodfarb, the Arizona Supreme Court, and Judge Ballinger have  
9 decided this issue. One party argues Judge Ballinger decided the issue in his January 22, 2002, order  
10 directing ADWR to prepare a report that:

11 shall include...a method for including both perennial and intermittent streams as part  
12 of the subflow analysis, including streams that historically contained perennial or  
13 intermittent flows, but which now are ephemeral due to development and other human  
14 initiated actions. The Court...expects the department to formulate a proposal using  
readily available historical data that will permit determination of water levels and  
locations as of date(s) prior to widespread diversion and depletion of Arizona’s stream  
flows.<sup>93</sup>

15 Judge Ballinger’s directions to ADWR to present a “method” and “formulate a proposal” to  
16 delineate the lateral limits of the subflow zone in the San Pedro River Watershed do not constitute a  
17 ruling on this issue. Even considered in its entirety, the January 22, 2002, order cannot be interpreted  
18 to say that the trial court ruled predevelopment conditions should be used for the subflow analysis.  
19 The trial court gave directions to ADWR as to what the department was to present in its  
20 recommendations. The trial court did not decide this issue in that order.

21 In the proposed ruling, the Special Master stated that a close reading of the trial court’s  
22 orders, *Gila II*, and *Gila IV* does not show this issue was presented to the trial court or to the Arizona  
23 Supreme Court or “that it was decided by either court with definiteness and clarity, that it can be said

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24 <sup>93</sup> Ballinger Order 1-2.

1 the law of the case was set.”<sup>94</sup> The parties arguing that the issue of predevelopment vs. current  
2 conditions was presented to the trial court and to the Supreme Court, and both courts decided the  
3 issue, point to what has been called the “ephemeral stream exclusion” or “exception” and to the trial  
4 court’s definition of an intermittent stream. The Special Master believes exception fits better than  
5 exclusion.

#### 6 *The Ephemeral Stream Exception*

7 The exception is set forth in the second principle Judge Goodfarb found was necessary to  
8 define the subflow zone:

9 [The subflow zone] may not be adjacent or beneath an ephemeral stream.  
10 However, it may be adjacent or beneath an ephemeral section of a perennial or  
11 intermittent stream, if the ephemeral section is caused by adjacent surface water  
12 diversion or groundwater pumping. There must, however, be a saturated zone beneath  
13 connected to similar zones beneath the upper and lower perennial or intermittent  
14 stream sections.<sup>95</sup>

15 The Cities argue that ADWR and they presented expert reports and testimony to the trial  
16 court, during the 1987 and 1994 hearings, indicating that in some river segments the  
17 groundwater/surface water connection had ceased to exist or had been severed due to development of  
18 water resources, and therefore, wells within these ephemeral reaches should be excluded from the  
19 adjudication. Furthermore, it is implicit in the ephemeral stream exception that current conditions  
20 must be used for the subflow analysis because the exception applies “if the ephemeral section is  
21 caused by adjacent surface water diversion or groundwater pumping,” and these activities did not  
22 occur in predevelopment times. According to the Cities, the exception requires, at a minimum,  
23 determination of its applicability, and at a maximum, delineation of the subflow zone using current,  
24 not predevelopment, stream flow conditions. Because the Supreme Court affirmed the trial court’s

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<sup>94</sup> Special Master’s Order Determining Issues 1 Through 4, 3.

<sup>95</sup> Goodfarb Order 35.

1 order in its entirety including the principles, it is argued the law of the case was set, and the point of  
2 law is binding on the trial court under the doctrine of *stare decisis*.<sup>96</sup>

3 In his 66-page ruling with 36 pages of exhibits, Judge Goodfarb did not amplify or explain  
4 the exception, and he did not repeat it in the summary of his findings. The order does not shed light  
5 on the reasons for the exception.

6 The Cities presented copies of pages of some of the briefs they and the Nature Conservancy  
7 filed in the Arizona Supreme Court related to the *Gila II* and *Gila IV* appeals.<sup>97</sup> The Nature  
8 Conservancy's *Gila II* opening brief (May 15, 1992) stated in pertinent part:

9 It would be a difficult task at best for the trial court to attempt now to reconstruct what  
10 happened to surface water appropriations as a result of subflow withdrawals  
11 throughout the Gila River System. Put another way, practicalities make it difficult to  
12 apply the proper test for "subflow" back to the point of restoring streams long ago  
13 depleted without formal objection registered (or litigation brought) by those who had  
14 prior appropriations in those streams. Instead, the most practical approach may simply  
15 be to exclude from the adjudication those wells in areas where the surface streams  
16 have already been completely, essentially permanently, depleted. Such areas would  
17 include, for example, the Santa Cruz River near Tucson, the lower Salt, and the lower  
18 Gila Rivers.<sup>98</sup>

19 The Cities' briefs filed in the Arizona Supreme Court in *Gila II* (May 15, 1992) and *Gila IV*  
20 (May 15, 1995) discussed the lack of hydraulic connection in ephemeral streams as a result of  
21 surface water diversions and groundwater pumping. The pages of the *Gila II* opening brief described  
22 the severing of hydraulic connection in the Lower Salt River due to the construction of dams,  
23 urbanization, and groundwater pumping. The pages from the *Gila IV* brief described how ephemeral  
24 streams can be caused by the severing of hydraulic connection as a result of human activity, and

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21 <sup>96</sup> The doctrine embodies the "principle that a decision made in one case will be followed in the next." A.  
22 SCALIA, A MATTER OF INTERPRETATION: FEDERAL COURTS AND THE LAW 7 (1997).

23 <sup>97</sup> Cities' Subflow Post-Hearing Opening Brief, exs. 9, 10, 11 (Mar. 3, 2004). SRP's objections to these  
24 exhibits were denied, but consideration of exhibits 10 (May 15, 1992, brief) and 11 (May 15, 1995, brief) was  
limited to the Cities' assertion that the issue of applying current, not predevelopment, stream conditions to the  
ephemeral stream exception was presented to the Arizona Supreme Court.

<sup>98</sup> *Id.* ex. 9 at 57-58.

1 argued that because there is no hydraulic connection between the stream and a groundwater aquifer,  
2 wells pumping within these ephemeral reaches do not impact subflow or stream flow.

3 The Supreme Court did not discuss the ephemeral stream exception in *Gila IV*. The word  
4 “predevelopment” appears only once in that opinion, in footnote 4 referring to the Nature  
5 Conservancy’s proposal to define the subflow zone by the geographic area phreatophytes had  
6 occupied in predevelopment times. “Current” also appears once in footnote 5 used as a noun.

7 Next the Cities claim that the trial court’s definition of an intermittent stream (adopted from  
8 ADWR’s Technical Assessment as stated on page 25 of this report) shows the court ruled subflow  
9 analysis must use current conditions. The pertinent portion of the definition states that intermittent  
10 streams may have periods of reduced groundwater discharge as a result of “natural and cultural  
11 losses” or “uses.”<sup>99</sup> The Special Master finds that the trial court adopted a commonly accepted  
12 definition of an intermittent stream.

13 The Special Master has carefully reviewed the papers, reports, and exhibits and has spent  
14 much time on this issue. The conclusion is that the Cities, the Nature Conservancy, and ADWR  
15 discussed before the trial court and, except ADWR, before the Arizona Supreme Court the  
16 requirement of hydraulic connection between the surface stream and the groundwater aquifer to  
17 define the subflow zone and the lack of hydraulic connection in certain streams, for example, the  
18 Lower Salt River and the Santa Cruz River near Tucson, as a result of surface water diversions and  
19 groundwater pumping. The Cities asserted their position that hydraulic connection between the  
20 surface water and the groundwater aquifer in the Lower Salt River has been altered as a result of

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24 <sup>99</sup> Goodfarb Order 24.

1 human activities, and therefore, wells within the ephemeral reaches of the Lower Salt River are not  
2 withdrawing subflow.<sup>100</sup>

3 The Special Master concedes the Cities have argued, and well, this position not only before  
4 the trial court but also before the Supreme Court and the Special Master.<sup>101</sup> The Special Master  
5 cannot find, however, that the trial court ruled, and was affirmed by the Supreme Court, that subflow  
6 analysis must consider current and not predevelopment stream flow conditions, entitling the affirmed  
7 ruling to *stare decisis*. Judge Goodfarb’s order shows he was deliberate with words and analysis,  
8 respectful of the needs for explanations of “reviewing appellate courts,” and cognizant of the trial  
9 court’s “duty to provide as much detail as it can to explain the factual decisions made.”<sup>102</sup> The trial  
10 court did not explain the exception, and *Gila IV* provides no assistance with the search for an answer.  
11 The Special Master cannot conclude that the unexplained exception decided this issue as a principle,  
12 precedent, or point of law in this adjudication.<sup>103</sup> Neither the trial court nor *Gila IV* has decided  
13 whether ADWR’s subflow analysis should consider predevelopment or current conditions.

14 The Special Master believes that in order to give effect to the plain language of the exception,  
15 and incorporate it into the subflow analysis, the applicability of the exception must be determined  
16 using post-development conditions. Under this view, a well will not be subject to the adjudication, if  
17 it meets all of the following conditions:

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19 <sup>100</sup> The condition described in the Lower Salt River may not exist to the same degree in other watersheds. Mr.  
20 Briggs declared, “[i]n the Verde Valley this is not a significant issue as there are no major upstream dams, nor  
21 has there been major groundwater development and overdraft.” Philip C. Briggs Rebuttal Decl. ¶ 11a (June  
22 27, 2003).

21 <sup>101</sup> See Affidavit of Doug Toy, P.E. in Cities’ Response to ADWR’s Subflow Report ex. 2 (June 17, 2002).

22 <sup>102</sup> Goodfarb Order 64.

23 <sup>103</sup> *Francis v. Ariz. Dept. of Transp., Mot. Veh. Div.*, 192 Ariz. 269, 271, 963 P.2d 1092, 1094 (Ariz. App.  
24 1998); *City of Bisbee v. Cochise Co.*, 52 Ariz. 1, 6, 78 P.2d 982, 984 (1938); see *State ex rel. La Prade v. Cox*,  
43 Ariz. 174, 30 P.2d 825 (1934). An instructive decision on the law of the case doctrine is *State v. King*, 180  
Ariz. 268, 278-9, 883 P.2d 1024, 1034-5 (1994), *cert. denied*, 516 U.S. 880 (1995). Arizona recognizes the  
law of the case doctrine as a rule of procedure not substance.

1 1. The well is located within an ephemeral section of a perennial or intermittent  
2 stream,

3 2. The ephemeral section of the perennial or intermittent stream is or was caused by  
4 adjacent surface water diversion or groundwater pumping and not by climate or  
5 watershed changes,<sup>104</sup> and

6 3. There is no saturated zone beneath the ephemeral section that is connected to  
7 similar saturated zones beneath the upstream and downstream perennial or  
8 intermittent sections.

9 The Special Master recommends that ADWR investigate and tabulate all wells that are or  
10 may be subject to the ephemeral stream exception. In this manner, the exception is reconciled with  
11 using predevelopment conditions for the subflow analysis.

12 *Predevelopment Conditions*

13 The parties who favor using current stream flow conditions argue that information of  
14 predevelopment conditions is unavailable, inconsistent, unverifiable, and unreliable making subflow  
15 determinations uninformed guesswork that does not satisfy the clear and convincing evidentiary  
16 standard; predevelopment conditions cannot be recreated after decades of surface water diversions  
17 and groundwater pumping; and using predevelopment conditions will result in an expanded subflow  
18 zone at odds with the “narrow concept” of subflow long adhered to by the Arizona Supreme Court.<sup>105</sup>

19 Those in favor of predevelopment conditions argue that additional evidence is available in  
20 other sources such as historical reports and maps; using current conditions would unfairly advantage  
21 claimants who have been pumping subflow without water rights, with unquantified water rights, or  
22 without regard for prior vested surface water rights; and if current conditions are used, claimants at  
23 the end of ADWR’s watershed investigations would gain an unfair position because their claims will  
24 be adjudicated years from now when the subflow zone may be depleted.

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23 <sup>104</sup> Mr. Michael J. Lacey discussed the exception in his rebuttal declaration and pointed out the distinction  
24 between human activity and natural changes. Michael J. Lacey Rebuttal Decl. 6 (June 27, 2003).

<sup>105</sup> 175 Ariz. at 391, 857 P.2d at 1245.

1 A standard that satisfies all of these objections is a chronological point of reference:

2 1. That can be applied consistently, although the specific time period may vary from  
3 watershed to watershed;

4 2. For which evidence is available to delineate the lateral extent of the subflow zone  
5 as accurately and reliably as possible; and

6 3. That overcomes unfair practicalities due to the slow progress of the adjudication.

7 Predevelopment conditions are a consistent chronological point of reference that meets these  
8 criteria. The discrete time period will not be the same for all watersheds, but predevelopment  
9 conditions are the most consistent and fairest reference point for sub flow analysis.

10 The experts expressed different opinions about the quality and quantity of available evidence  
11 to evaluate predevelopment stream flow conditions. An example are the views about the USGS Atlas  
12 (which ADWR proposes to use) that shows the location of predevelopment perennial streams and  
13 predevelopment water level contours. Dr. Montgomery and Mr. Anderson expressed concerns about  
14 the quality of the sources of information used to compile the Atlas.<sup>106</sup> On the other hand, Mr. Briggs  
15 used the Atlas as a source of predevelopment groundwater elevations data.<sup>107</sup> Mr. Gookin  
16 recommended that additional sources be studied and professional historians retained to assist with  
17 this part of the investigations. Mr. Briggs declared, “I disagree that a predevelopment subflow zone  
18 cannot be delineated. There is ample scientific and [anecdotal] evidence available to use to delineate  
19 a predevelopment subflow zone in the Salt River Valley.”<sup>108</sup> The Special Master concludes that more  
20 and better evidence of predevelopment conditions can be obtained, and the effort to obtain it must be  
21 made.

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23 <sup>106</sup> Errol L. Montgomery and Thomas W. Anderson Decl. 11 (June 17, 2002).

24 <sup>107</sup> Philip C. Briggs Decl. ¶ 7i (June 17, 2002).

<sup>108</sup> Philip C. Briggs Rebuttal Decl. ¶ 11a(2) (June 27, 2003).

1 ADWR has not had an opportunity to obtain and review additional maps, reports, and  
2 documents suggested by the experts who submitted declarations; conduct field investigations;  
3 analyze drilling records; and run models. After ADWR submitted the Subflow Report, it found the  
4 NRCS soil survey maps which Mr. Burtell testified “would be very useful for our work in the  
5 adjudications.”<sup>109</sup> ADWR should be directed and allowed to obtain more concrete and useful  
6 information. Moreover, if adopted by the trial court, many of this report’s recommendations will  
7 improve the investigations. It is premature to conclude that ADWR cannot obtain reliable evidence  
8 of predevelopment stream flow conditions.

9 Using predevelopment conditions precludes claimants whose water use claims will be  
10 adjudicated in the later phases of ADWR’s watershed investigations from gaining an unfair position.  
11 If current conditions are used, claimants at “the back of the line”<sup>110</sup> who are pumping subflow would  
12 benefit because they could continue to withdraw subflow, and years from now their wells could be  
13 found to be outside the subflow zone delineated under then current conditions. This concern is  
14 heightened when claimants who are pumping subflow or stream flows without an appropriative water  
15 right are considered. The slow progress of investigations and adjudication of water uses is a reality  
16 that must be weighed in this discussion.

17 The concern that using predevelopment conditions might result in more wells included in the  
18 adjudication than under current conditions is unmerited. The subflow zone will remain as narrow as  
19 the saturated floodplain Holocene alluvium.

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22 <sup>109</sup> Hrg. Tr. 15:25 (Oct. 21, 2003).

23 <sup>110</sup> SRP’s Opening Brief on Legal Issues 4 (June 6, 2003). While SRP argues claimants would “race to” the  
24 back of the investigations line, the fact is that at the pace this adjudication has been proceeding due to a  
variety of factors, there is not much immediacy for claimants outside of the San Pedro River Watershed “to  
race.”

1 The time period selected to define predevelopment conditions will influence the accuracy and  
2 reliability of subflow determinations. Parties have suggested various years or periods to define  
3 predevelopment conditions:

4 1. 1848, the year the United States and Mexico signed the Treaty of Guadalupe  
5 Hidalgo (on February 2, 1848).

6 2. Post-1865 (after the Civil War).

7 3. Prior to about 1900 for surface water in highly developed watersheds.

8 4. 1931, the year *Southwest Cotton* was decided.

9 5. Prior to about 1940 for groundwater in highly developed watersheds.

10 6. February 17, 1978, the date Phelps Dodge filed a petition with the Arizona State  
11 Land Department to adjudicate water rights in portions of the Lower Gila River  
Watershed and the Upper Gila River Watershed including the San Francisco River,  
Chase Creek, and Eagle Creek.<sup>111</sup>

12 Selection of a date or period must consider the feasibility of obtaining the requisite technical  
13 data and evidence; potential delay and expense of those efforts and of subsequent investigations;  
14 level of accuracy and reliability of the subflow analysis; confidence of meeting the clear and  
15 convincing evidentiary standard; and fairness.

16 In its January 22, 2002, order, the trial court provided an appropriate time frame for defining  
17 predevelopment conditions that satisfies these concerns, namely, “prior to widespread diversion and  
18 depletion of Arizona’s stream flows.”<sup>112</sup> The word “widespread” is defined as “widely

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23 <sup>111</sup> On April 19, 1978, Phelps Dodge supplemented this petition to include additional lands in the Lower Gila  
River and Upper Gila River Watersheds. In 1979, the petitions were transferred to the Arizona Superior Court.  
1979 Ariz. Sess. Laws, ch. 139, § 39 (effective Apr. 17, 1979).

24 <sup>112</sup> Ballinger Order 2.

1 extended...occurring over a wide area or extent.”<sup>113</sup> The term indicates greater than minimal,  
2 localized, or sporadic diversion and depletion of stream flows as a result of human activity.

3 The evidence is not sufficient to select one of the dates or periods advocated by the parties.  
4 The Special Master believes the evidence together with the factors listed above favor selecting a date  
5 or period after 1865 and before 1940. The Special Master recommends that the discrete time period  
6 be an approximate chronological year or a range of years immediately prior to widespread diversion  
7 and depletion of a stream’s flows as a result of human activity. The chronological year or range of  
8 years will not be the same for all watersheds.

9 **Recommendation 13:** The Court should direct ADWR to use predevelopment stream flow  
10 conditions for subflow analysis.

11 **Recommendation 14:** The Court should direct ADWR to investigate and tabulate all wells  
12 subject to the ephemeral stream exception set forth in the trial court’s June 30, 1994, order.

13 **Recommendation 15:** The Court should define predevelopment stream flow conditions, for  
14 the purpose of subflow analysis, to mean a chronological year or a range of years immediately prior  
15 to widespread diversion and depletion of the stream’s flows as a result of human activity.

16 **F. Does ADWR’s recommendation that the entire lateral extent of the floodplain**  
17 **Holocene alluvium be assumed to be saturated comport with *Gila IV*?**

18 ADWR recommends “that the entire lateral extent of the floodplain Holocene alluvium be  
19 assumed to be saturated for the purpose of delineating the jurisdictional subflow zone.”<sup>114</sup> The  
20 recommendation is based on the limitations of available data, variability of saturation of the  
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22 <sup>113</sup> WEBSTER’S NEW WORLD DICTIONARY OF AMERICAN ENGLISH 1526 (3d ed. 1988); *cf.* A.R.S. § 1-213 relating to  
23 statutory construction (“Words and phrases shall be construed according to the common and approved use of  
the language.”).

24 <sup>114</sup> Subflow Report 13.

1 floodplain Holocene alluvium, and the trial court’s request to consider predevelopment stream flow  
2 conditions. ADWR explains:

3 Determination of the saturated portion of the floodplain Holocene alluvium requires  
4 data on two subsurface conditions:

- 5 • The thickness of the floodplain Holocene alluvium; and
- 6 • The depth to the water table beneath the floodplain.

7 ...

8 However, the two conditions indicated above cannot be determined with  
9 reasonable means in the San Pedro River watershed or elsewhere in the Gila River  
10 adjudication area. The thickness of the floodplain Holocene alluvium and the depth to  
11 the water table beneath the floodplain are highly variable, both spatially and  
12 temporally, and this makes the determination of saturation difficult. In many areas of  
the Gila River adjudication, detailed subsurface data for the floodplain simply do not  
exist or are limited, and additional data would have to be collected and analyzed at  
considerable cost and time. In the few areas where extensive subsurface data have  
been collected, it is often still difficult to define variations in the thickness of the  
Holocene alluvium across the floodplain and changes in the elevation of the water  
table over time.<sup>115</sup>

13 Concerning the thickness of the floodplain Holocene alluvium, ADWR gives an example of a  
14 “very costly” USGS hydrogeologic project in the Sierra Vista Subwatershed. Although the USGS  
15 used “very sophisticated and expensive geophysical and lithological data, the actual thickness of the  
16 Holocene alluvium could not be determined with any degree of certainty.”<sup>116</sup> In “the remainder of the  
17 San Pedro River watershed and most of the Gila River adjudication area, well driller’s logs will  
18 likely be the only source, if any, of subsurface geologic data for the floodplain,” and “[t]he accuracy  
19 of this data is questionable.”<sup>117</sup> “This lack of reliable data prevents the thickness of the floodplain  
20 Holocene alluvium from being determined with any certainty.”<sup>118</sup>

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21  
22 <sup>115</sup> *Id.*

23 <sup>116</sup> *Id.* at 14.

24 <sup>117</sup> *Id.*

<sup>118</sup> *Id.* at 15.

1           Regarding the water table beneath the floodplain, ADWR states there “is a lack of reliable  
2 data concerning the depth to the water table,” which “is further exacerbated by the dynamic nature of  
3 the floodplain aquifer system,” as “the water table sometimes chang[es] rapidly in response to storm  
4 runoff events and evapotranspiration by plants, and sometimes chang[es] slowly due to the effects of  
5 droughts and wet periods, seasonal differences, and pumping.”<sup>119</sup> These “variations are not unique to  
6 recent times, but apparently also occurred during predevelopment conditions.”<sup>120</sup>

7           Saturation or how much water is stored in the floodplain Holocene alluvium can vary. Dr.  
8 Matlock defined the terms as follows:

9           “Saturated alluvium would be alluvium of which the pores are completely filled with  
10 water. Unsaturated would be a condition in which they’re not completely filled with  
water.”<sup>121</sup>

11 Mr. Burtell testified, “[t]here are times when it will be saturated and there are times when it’s  
12 possible that it will not be saturated.”<sup>122</sup> Mr. Harmon testified that the saturated extent of the  
13 floodplain Holocene alluvium “can change from year to year. It can change within a season with all  
14 types of recharge, inputs, discharge, different inflows and outflows....can change maybe from day to  
15 day....perhaps [from hour to hour] if you have a lot of wells turning on and off.”<sup>123</sup> Saturation is  
16 dynamic.

17           ADWR believes its proposal is consistent with using predevelopment stream flow conditions  
18 for subflow analysis because “[b]y definition, floodplain Holocene alluvium was saturated at some  
19 point in predevelopment time.”<sup>124</sup> The floodplain Holocene alluvium consists of sediments deposited  
20 under flood flow conditions. It, therefore, was saturated at the time floods deposited the sediments,

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21 <sup>119</sup> *Id.*

22 <sup>120</sup> *Id.*

23 <sup>121</sup> Hrg. Tr. 211:6-8 (Oct. 21, 2003).

24 <sup>122</sup> *Id.* at 43:9-11.

<sup>123</sup> *Id.* at 359:18-25 (Oct. 22, 2003).

<sup>124</sup> Subflow Report 17.

1 but for how long thereafter and to what extent the saturation lasted is debated. Mr. Ford declared that  
2 “the only processes that reduce the lateral extent of saturation from the historic maximum limit are  
3 human activity and climate cycles.”<sup>125</sup> On the other side, Mr. Lacey testified, “[i]t would not have  
4 been saturated once the flood flows had receded.”<sup>126</sup>

5 Mr. Page declared that ADWR’s recommendation “is reasonable based on available water  
6 level data that suggests the depth to water in the floodplain Holocene alluvium is very shallow,  
7 indicating only a thin margin along the edges of this unit may be unsaturated.... [O]nly a thin upper  
8 portion of the floodplain Holocene alluvium is unsaturated....”<sup>127</sup>

9 Resolving this issue is not easy. It would be wasteful to direct ADWR to do something that is  
10 not feasible, but it would be foolish to sidestep the law in a rush to expediency. The issue is whether  
11 the recommendation comports with *Gila IV*. The Special Master finds it does not.

#### 12 *The Clear and Convincing Evidentiary Standard*

13 After reviewing the trial court’s order which had sought “to determine the most appropriate  
14 subflow zone,” the Supreme Court affirmed the order holding that “the weight of the evidence  
15 supports the trial court’s identification of that zone as the ‘saturated’ floodplain Holocene  
16 alluvium.”<sup>128</sup> *Gila II* and *Gila IV* emphasize that the test to delineate the lateral extent of the subflow  
17 zone must not be “defective” or “flawed.” *Gila II* admonishes that using a defective test “would  
18 adversely affect the adjudication” because “errors in every HSR” would have to be litigated,  
19 exacerbating “an already lengthy and costly process,” and a flawed test “could cause significant  
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22 <sup>125</sup> Jon R. Ford Decl. ¶ 14c (June 17, 2002).

23 <sup>126</sup> Hrg. Tr. 417:7-8 (Oct. 22, 2003).

24 <sup>127</sup> Oliver S. Page, Peter M. Pyle, and Jean M. Moran Decl. 16 (June 17, 2002).

<sup>128</sup> 198 Ariz. at 342, 9 P.3d at 1081.

1 injustice.”<sup>129</sup> *Gila IV* is more direct - “it is critical that any test used for determining the boundaries  
2 of a subflow zone be as accurate and reliable as possible.”<sup>130</sup>

3 The test must be so robust because one “who asserts that underground water is a part of a  
4 stream’s subflow must prove that fact by clear and convincing evidence.”<sup>131</sup> Only clear and  
5 convincing evidence will rebut the presumption that underground waters are percolating, and are  
6 therefore, not appropriable as subflow. If ADWR uses the proper test to delineate the lateral extent of  
7 the subflow zone, “its determination that a well is pumping appropriable subflow constitutes clear  
8 and convincing evidence.”<sup>132</sup>

9 Parties have argued throughout this proceeding that ADWR’s proposed procedures, in whole  
10 or in part, do not satisfy the clear and convincing evidentiary standard associated with the  
11 presumption that underground waters are percolating and are not appropriable as subflow. Of all the  
12 issues litigated, this is the only one that, in the Special Master’s opinion, requires that its resolution  
13 closely review the clear and convincing standard.

14 In Arizona, a party who has a burden of proof by clear and convincing evidence must show  
15 that the claim is “highly probable.”<sup>133</sup> In the adjudication, when ADWR reports a well is pumping  
16 appropriable subflow, the report is considered to be a determination that it is highly probable the well  
17 is pumping appropriable subflow from the saturated floodplain Holocene alluvium. The standard “is  
18 more exacting than the standard of more probably true than not true but is less exacting than the  
19

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21 <sup>129</sup> 175 Ariz. at 388, 857 P.2d at 1242.

<sup>130</sup> 198 Ariz. at 335, 9 P.3d at 1074.

<sup>131</sup> *Id.*; see also 39 Ariz. at 85, 4 P.2d at 376 (*Southwest Cotton*).

<sup>132</sup> 175 Ariz. at 392, 857 P.2d at 1246.

<sup>133</sup> *State v. Renforth*, 155 Ariz. 385, 388, 746 P.2d 1315, 1318 (Ariz. App. 1987); *State v. King*, 158 Ariz. 419,  
23 763 P.2d 239 (1988); Recommended Arizona Jury Instructions (Civil) 3d Standard 10 (“A party who has the  
24 burden of proof by clear and convincing evidence must persuade you by the evidence that the claim is highly  
probable....”) (“RAJI Civil Standard 10”).

1 standard of proof beyond a reasonable doubt.”<sup>134</sup> Under *Renforth* and *King*, the highly probable  
2 standard does not require that ADWR’s determination be either certain or unambiguous.

3 The Special Master finds that the recommended assumption will not satisfy the clear and  
4 convincing standard. The assumption is expedient and likely less costly to implement than  
5 alternatives. The evidence, however, shows saturation fluctuates even in predevelopment conditions,  
6 and a thin upper portion of the floodplain Holocene alluvium is unsaturated.

7 To include a well in the adjudication, it is not enough to determine it is highly probable the  
8 entire lateral extent of the floodplain Holocene alluvium was saturated at some point. It must be  
9 shown it is highly probable the well is pumping subflow from the saturated floodplain Holocene  
10 alluvium. If the well owner disputes this assessment, the owner has the burden of proving by a  
11 preponderance of the evidence that the well is outside the subflow zone or is not withdrawing  
12 subflow.

13 Valid technical efforts must be undertaken to determine the saturated portion of the  
14 floodplain Holocene alluvium. The department avows it “has very limited resources available” to  
15 fund ongoing hydrogeologic projects or to obtain data.<sup>135</sup> Mr. Burtell described projects ADWR is  
16 undertaking or funding to collect more data in the San Pedro River Watershed and testified, “there is  
17 a tremendous amount of information that continues to be collected for that area.”<sup>136</sup> Mr. Briggs  
18 declared “ADWR’s proposed approach to delineation of the subflow zone to be far too conservative,  
19 pleading lack of data. While these data may not currently exist for every mile of Holocene alluvium,  
20 the data exist where there are wells (and hence a need to know). Where these data exist, they should

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22 <sup>134</sup> RAJI Civil Standard 10.

23 <sup>135</sup> Subflow Report 14.

24 <sup>136</sup> Hrg. Tr. 54:23-25 (Oct. 21, 2003). “The Sierra Vista subwatershed has been, and continues to be, one of the most studied areas in Arizona by geologists and hydrologists.” Subflow Report 13.

1 be used.”<sup>137</sup> ADWR may not have at this point sufficient information with the desirable level of  
2 detail, but it is striving to remedy this situation. This campaign must continue, and if necessary  
3 intensified. The task will not be simple, but the Special Master believes, after considering all the  
4 evidence, that the saturated portion of the floodplain Holocene alluvium can be established by clear  
5 and convincing evidence.

6 **Recommendation 16:** The Court should not adopt the recommendation that the entire lateral  
7 extent of the floodplain Holocene alluvium be assumed to be saturated for the purpose of delineating  
8 the subflow zone.

9 **Recommendation 17:** The Court should direct ADWR to determine the saturated portion of  
10 the floodplain Holocene alluvium as accurately and reliably as possible.

11 **G. Are ADWR’s recommendations sufficient to identify and exclude tributary  
12 aquifers, basin fill saturated zones, and ephemeral streams?**

13 The subflow zone must “be differentiated from adjacent geologic units such as tributary  
14 aquifers and the basin-fill aquifer which discharge into it or receive discharge from it...”<sup>138</sup> The trial  
15 court found this concept is necessary to define subflow consistent with *Southwest Cotton, Gila II*,  
16 and the scientific evidence the court had heard.

17 Subflow must be part of the surrounding floodplain of a stream but cannot be part of the  
18 alluvial plains of either a tributary aquifer (even if there is an alluvial connection between the  
19 tributary aquifer and the floodplain Holocene alluvium of the stream) or of an ephemeral stream. The  
20 trial court ruled:

21 Those parts of the alluvial plain which [subflow] may be a part of or which it is  
22 connected to must be the alluvial plain of a perennial or intermittent stream and not an  
ephemeral stream or a part of the alluvial plain of a tributary aquifer even if there is an  
alluvial connection. Where the alluvial plain of tributary aquifers or ephemeral

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23 <sup>137</sup> Philip C. Briggs Decl. ¶ 7g (June 17, 2002).

24 <sup>138</sup> Goodfarb Order 34.

1 streams connects to the floodplain Holocene alluvium of the stream itself and provides  
2 tributary or basin fill recharge, that tributary aquifer must also be excluded because its  
3 flow direction is different and often perpendicular to the stream-flow direction.<sup>139</sup>  
(Emphasis in order.)

4 The trial court added these two criteria so that “more certainty and reliability” would be  
5 provided to the definition of subflow:

6 Fourth, where there are connecting tributary aquifers or floodplain alluvium of  
7 ephemeral streams, the boundary of the “subflow” zone must be at least 200 feet  
8 inside of that connecting zone so that the hydrostatic pressure effect of the side  
9 recharge of this tributary aquifer is negligible and the dominant direction of flow is  
10 the stream direction. Fifth, where there is a basin-fill connection between saturated  
zones of the floodplain Holocene alluvium and a saturated zone of basin fill, the  
boundary of the “subflow” zone must be 100 feet inside of the connecting zone so that  
the hydrostatic pressure effect of the basin-fill’s side discharge is overcome and the  
predominant direction of flow of all of the “subflow” zone is the same as the stream’s  
directional flow.<sup>140</sup> (Underlining in order.)

11 Flow direction in the subflow zone must not be significantly affected by the pressure of side  
12 discharge from adjacent tributary aquifers or the basin fill aquifer. The water in the subflow zone  
13 must flow “substantially in the same direction as the stream, and the effect of any side discharge  
14 from tributary aquifers and basin fill is overcome or is negligible.”<sup>141</sup> The 100-foot and 200-foot  
15 setbacks overcome or substantially reduce the effects of side discharge. *Gila N* affirmed these  
16 rulings.

17 ADWR does not explicitly recommend procedures to exclude tributary aquifers, areas of  
18 basin fill recharge, and the alluvial plains of ephemeral streams. A group of parties argues that  
19 ADWR should be directed to propose procedures that take into account these exclusions from the  
20 subflow analysis.

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23 <sup>139</sup> *Id.* at 57.

24 <sup>140</sup> *Id.* at 57-58.

<sup>141</sup> *Id.* at 57.

1 The Subflow Report sets forth ADWR's proposed procedures to identify perennial,  
2 intermittent, and effluent-fed streams and delineate the lateral extent and saturated portion of the  
3 floodplain Holocene alluvium.<sup>142</sup> Because methodologies to locate tributary aquifers, areas of basin  
4 fill recharge, and ephemeral streams are not proposed, and ADWR's recommendations relate to the  
5 floodplain Holocene alluvium of a stream and its saturated portion, it can reasonably be concluded  
6 that ADWR will exclude tributary aquifers, areas of basin fill recharge, and ephemeral streams from  
7 the subflow analysis. The Special Master believes ADWR understands the exclusions described in  
8 the trial court's order and affirmed in *Gila IV*, but for certainty recommends that ADWR exclude  
9 from the subflow zone connecting tributary aquifers, areas of basin fill recharge, and the alluvial  
10 plains of ephemeral streams.

11 **Recommendation 18:** The Court should direct ADWR to exclude tributary aquifers, areas of  
12 basin fill recharge, and the alluvial plains of ephemeral streams from the subflow zone.

13 **Recommendation 19:** The Court should adopt Chapter 2 of the Subflow Report to the extent  
14 it does not conflict with any other recommendation made in this report.

### 15 **III. CONE OF DEPRESSION (Chapter 3 of the Subflow Report)**

#### 16 **A. Does ADWR's recommended drawdown of greater than or equal to 0.1 foot, 17 where the cone of depression has reached the edge of the subflow zone, comport with *Gila IV*?**

18 ADWR proposes to include a well in the adjudication if, at the time of the modeling, two  
19 conditions are met. The "first condition is that the simulated cone of depression has reached the edge  
20 of the jurisdictional subflow zone and drawdown at that point is greater than or equal to 0.1 foot, an  
21 amount that can be accurately measured in the field using standard water level measuring  
22

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24 <sup>142</sup> Subflow Report 5.

1 equipment.”<sup>143</sup> The second condition is discussed in the next section. The distance of 0.1 foot is 1  
2 and 1/5 (or 1.2) inch.

3 *Gila IV* affirmed the trial court’s order that wells located outside the lateral extent of the  
4 subflow zone “may be included in the adjudication if ‘it is proven that their ‘cones of depression’  
5 [footnote omitted] reach the ‘subflow’ zone and the drawdown from the well affects the volume of  
6 surface and ‘subflow’ in such an appreciable amount that it is capable of measurement.”<sup>144</sup>  
7 ADWR’s recommendation addresses how to measure an appreciable amount.

8 Because it lacked pertinent evidence, the trial court did not establish a test for determining a  
9 well’s cone of depression but ruled that “whatever test ADWR finds is realistically adaptable to the  
10 field and whatever method is the least expensive and delay-causing, yet provides a high degree of  
11 reliability, should be acceptable.”<sup>145</sup> As *Gila IV* affirmed the trial court’s order in its entirety,  
12 ADWR’s recommendation will comport with *Gila IV* if it satisfies these criteria.

13 Computer modeling is generally accepted in the scientific community to measure water  
14 impacts.<sup>146</sup> Messrs. Briggs, Ford, Harmon, Lacey, Page, Marra, Dr. Mock, Dr. Montgomery, and  
15 ADWR have, and use, computer modeling in their professional work. These experts and ADWR  
16 have used analytical and numerical models for a variety of projects, and different models are used for  
17 different purposes, but the point is that professionals, including most of the experts who testified in  
18 this proceeding, use modeling as a tool to measure hydrologic impacts.

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22 <sup>143</sup> Subflow Report 31. “The cone of depression is the funnel-shaped area around a well where the withdrawal  
of groundwater through the well has lowered the water table.” 198 Ariz. at 342-3 n.9, 9 P.3d at 1081-2 n.9; see  
*also* 175 Ariz. at 391 n.10, 857 P.2d at 1245 n.10.

23 <sup>144</sup> 198 Ariz. at 342-3, 9 P.3d at 1081-2.

24 <sup>145</sup> *Id.* at 343, 1082 (quoting Goodfarb Order 62).

<sup>146</sup> Hrg. Tr. 79:18-25 - 80:1:5 (Oct. 21, 2003); 315:8-11 (Oct. 22, 2003).

1 ADWR recommends using computer modeling to measure the impact of a well's cone of  
2 depression on the subflow zone. ADWR does not give reasons for selecting a 0.1 foot drawdown  
3 level, but Mr. Ford posited that:

4 ADWR is proposing it because the Theis equation extends the cone of depression an  
5 infinite distance with an infinitesimally small drawdown. Thus, some practical  
6 drawdown cutoff is required. Using professional judgment, ADWR decided that the  
radius at 0.1 foot of drawdown represents the practical limit of the cone of  
depression.<sup>147</sup>

7 According to Mr. Ford, a well's cone of depression extends beyond the point where an impact of 0.1  
8 foot is measured. ADWR has simply selected 0.1 foot to represent the limit of the cone of depression.

#### 9 *Reliability of Modeling a 0.1 Foot Drawdown*

10 The principal objections against ADWR's proposal go to the reliability of modeling a 0.1 foot  
11 drawdown at the edge of the subflow zone. First, although a computer program, like the THWELLS  
12 model ADWR proposes to use, will simulate a 0.1 foot drawdown, this predicted or simulated  
13 drawdown will not match the actual drawdown measured in the field. Second, it is not possible to  
14 determine that a drawdown of 0.1 foot is due to a specific well's pumping because recharge,  
15 phreatophytes, pumping from other wells, surface water diversions, changes in river stage, and  
16 diurnal flow variations can cause aquifer drawdowns that cannot be isolated from the impact of a  
17 particular well. The objectors argue that this lack of reliability will not satisfy the clear and  
18 convincing evidentiary standard ADWR must meet to determine that a well's cone of depression has  
19 reached the subflow zone.

20 ADWR cautions that:

21 It is important to remember that the accuracy of model simulations will in most, if not  
22 all, cases be far less accurate than the ability to measure drawdown in the field.

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23 <sup>147</sup> Jon R. Ford Rebuttal Decl. ¶ 21 (June 27, 2003). ADWR proposes to use the THWELLS model, an  
24 analytical model described in chapter 3, section C, of this report, which is based on the Theis equation. The  
other model is a numerical model named MODFLOW also described in the same section.

1 Simulated water levels from even the most carefully calibrated MODFLOW models  
2 are typically no closer than  $\pm 5$  to 10 feet from the actual water levels measured in the  
3 field. And, unless water level data are available at the pumping well and at the edge of  
4 the jurisdictional subflow zone, it will be difficult to determine if the model  
5 simulations are overestimating or underestimating the true drawdown at these  
6 points.<sup>148</sup> (Emphasis added.)

7 The objectors focus on the underlined sentence to show the disparity between simulated and  
8 measured drawdowns even when using the most carefully calibrated MODFLOW model. It is not  
9 argued that field technicians cannot measure a drawdown of 0.1 foot in the field with standard  
10 hydrologic instruments. Although the trial court stated in 1994 that it “believes such close  
11 measurements [as a 0.1 foot drawdown] are difficult, at best, in the field,”<sup>149</sup> the testimony did not  
12 substantiate this belief. Mr. Mason testified that ADWR’s technicians can measure in the field a  
13 well’s drawdown to 0.1 foot, and in some cases, even down to 0.01 or .05 of a foot.<sup>150</sup> The objection  
14 is that a computer model’s simulated drawdown will not match the field measured true drawdown.

15 The MODFLOW model divides an aquifer into rectangular blocks which are then organized  
16 by rows, columns, and layers. Each block is called a cell. MODFLOW can consider numerous cells.  
17 Mr. Ford declared that:

18 [E]ach cell can have only a single value for each required parameter. The model  
19 assumes the water level in a given cell is everywhere the same. Therefore, if the cell  
20 size is such that the actual water level varies five to ten feet across the cell, the model  
21 cell value would vary from field values by the five to ten feet cited.<sup>151</sup>

22 A difference between a value representing a cell and a field measurement “does not imply error” but  
23 “means that the average value for the area represented by the cell size is different than at a point  
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22 <sup>148</sup> Subflow Report 31-32.

23 <sup>149</sup> Goodfarb Order 62.

24 <sup>150</sup> Hrg. Tr. 68:9-14 (Oct. 21, 2003). Dr. Montgomery testified, “[i]t’s easy to measure a change in water level  
of a tenth of a foot if that change occurs over a short period.” *Id.* at 120:6-7.

<sup>151</sup> Jon R. Ford Rebuttal Decl. ¶ 66 (June 27, 2003).

1 within the model cell.”<sup>152</sup> Dr. Mock likewise opined, “I doubt that the 5-10 foot number is from the  
2 comparison of simulated to measured drawdowns, as opposed to the comparison of simulated to  
3 measured water-level elevations for a specific location.”<sup>153</sup> A difference of five to ten feet in  
4 drawdown may not necessarily be found at every location within the cell or test area.

5 Mr. Ford expressed his opinion about the reliability of the MODFLOW model as follows:

6 If MODFLOW could not be more accurate than plus or minus 10 feet in its  
7 ability to predict the head distribution or drawdown in an aquifer, it would be of little  
8 use. However, MODFLOW is widely used in both the environmental engineering and  
9 ground water supply communities to analyze extremely complex situations. Federal  
agencies...rely upon the ability and accuracy of MODFLOW. So do many state  
agencies that are concerned about ground water contamination and water rights  
administration.<sup>154</sup>

10 Dr. Montgomery and Mr. Anderson declared:

11 While model projections have a high level of precision, they are not necessarily  
12 accurate. Model projections can only be as accurate as the hydraulic parameter values  
used for model input. Relatively small changes in input parameters may result in  
substantial changes in model projections for drawdown.<sup>155</sup>

13 Dr. Mock similarly declared about the importance of reliable parameter values:

14 Theis and MODFLOW...models can accurately calculate drawdowns to the  
15 hundredth of a foot or better, given acceptable parameter inputs. The real concern  
16 should be for the parameters used in these models.<sup>156</sup>

17 According to Mr. Mason, a computer model’s uncertainty arises from the many parameters  
18 the modeler is adjusting such as hydraulic conductivity, saturated thickness, and storage coefficient,  
19  
20

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21 <sup>152</sup> *Id.* at ¶ 51.

<sup>153</sup> Peter A. Mock Rebuttal Decl. 7 (June 27, 2003).

<sup>154</sup> Jon R. Ford Rebuttal Decl. ¶ 52 (June 27, 2003).

<sup>155</sup> Errol L. Montgomery and Thomas W. Anderson Rebuttal Decl. 17 (June 27, 2003).

<sup>156</sup> Peter A. Mock Rebuttal Decl. 7 (June 27, 2003). Messrs. Harmon and Palumbo declared, “Briggs recommends that well information [in ADWR’s records] such as well depth, water levels, water quality, should be used in helping to determine whether any individual well should be subject to the Adjudication. We agree with this statement.” Eric J. Harmon and Mark R. Palumbo Rebuttal Decl. 32 (June 27, 2003).

1 but once these are defined by calibration, Mr. Mason agreed that “drawdown can be fairly accurately  
2 predicted.”<sup>157</sup>

3 *Gila IV* requires that the cone of depression test must yield results with a high degree of  
4 reliability. Under the clear and convincing evidentiary standard, ADWR’s determination that a well’s  
5 cone of depression impacts the subflow zone means it is highly probable the cone of depression has  
6 reached the edge of the subflow zone. The Special Master finds that a computer model’s simulation  
7 of a greater than or equal to 0.1 foot drawdown can satisfy the degree of reliability required by *Gila*  
8 *IV* and the highly probable standard of clear and convincing evidence. The requisite reliability will  
9 depend, as Dr. Mock and Dr. Montgomery stated, on the quality and quantity of parameter inputs. A  
10 focused and reasonable effort to collect and use reliable data and information must be made if a high  
11 degree of reliability is to be attained.

#### 12 *Alternatives to a 0.1 Foot Drawdown*

13 Dr. Montgomery and Messrs. Harmon, Palumbo, and Anderson suggested a drawdown of ten  
14 feet. This level is based on ADWR’s well spacing and impact standards, for wells in active  
15 management areas, of ten feet of drawdown over the first five years of operations, to determine well-  
16 to-well impacts.<sup>158</sup> Dr. Montgomery also suggested five to ten feet based on the drawdown that can  
17 be reliably simulated with MODFLOW according to ADWR’s statements in the Subflow Report.

18 Mr. Ford declared that:

19 In the case of well-to-well interference, the usual issue is whether a new well would  
20 significantly reduce the yield of a nearby existing well. In that case, well yield is not  
21 particularly sensitive to (affected by) drawdown, so a 10-foot criterion may be  
22 appropriate. In the case of determining the radius of the cone of depression, a 10-foot  
23 criterion is not appropriate because...the radius of the cone of depression is very  
24 different if the drawdown criterion is different by only a small amount.<sup>159</sup>

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23 <sup>157</sup> Hrg. Tr. 72:18-21 (Oct. 21, 2003).

24 <sup>158</sup> Temporary Rule R12-15-830 (Well Spacing and Well Impact) (Mar. 11, 1983); see A.R.S. § 45-598(A).

<sup>159</sup> Jon R. Ford Rebuttal Decl. ¶ 69 (June 27, 2003).

1 According to Mr. Ford, ADWR's well spacing standards are not intended to determine if a  
2 well's cone of depression impacts the subflow zone, but to determine if a well will interfere with  
3 another well. The standards relate to a well's pumping lift. Measuring a well's potential interference  
4 with a nearby well is, however, not the same as measuring the impact of a cone of depression on the  
5 subflow zone in accordance with *Gila IV*.

6 Mr. Gookin testified that if a ten-foot drawdown standard were adopted, "[b]y the time this  
7 adjudication is done, it would destroy the stream."<sup>160</sup> Mr. Page declared that "if all wells were  
8 subject to this standard the San Pedro River would become an ephemeral stream."<sup>161</sup> This  
9 consequence is due to the fact that a well's cone of depression extends farther out than the point  
10 where a ten-foot drawdown is measured. A well will withdraw water from the subflow zone long  
11 before a ten-foot drawdown level is reached.

12 Mr. Gookin suggested a maximum drawdown of 0.25 foot, but only if 0.1 foot is found "to be  
13 too tight a measurement."<sup>162</sup> Because the Special Master does not find that 0.1 foot is too tight a  
14 measurement for a cone of depression test, a 0.25 foot drawdown is not considered.

15 Mr. Briggs recommended implementing a concept often used to investigate the feasibility of  
16 recovering contaminated groundwater called "capture zone." The capture zone is the area where  
17 pumping the well depresses water levels. "All groundwater within the capture zone ultimately  
18 reaches the pumped well," but "[a]ll groundwater outside the capture zone, even if within the 'cone  
19 of depression,' escapes the effect of the well and continues down gradient."<sup>163</sup> Mr. Briggs posited  
20 that "drawdown" is not the issue, but "capture" of water by a well is the trial court's concern.

21 \_\_\_\_\_  
22 <sup>160</sup> Hrg. Tr. 315:23-24 (Oct. 22, 2003).

23 <sup>161</sup> Oliver S. Page Rebuttal Decl. 10 (June 27, 2003).

24 <sup>162</sup> T. Allen J. Gookin Rebuttal Decl. ch. XI, 2 (June 27, 2003); *see also* Peter A. Mock Rebuttal Decl. 8 (June 27, 2003).

<sup>163</sup> Philip C. Briggs Decl. ¶ 8a (June 17, 2002).

1 Messrs. Harmon and Palumbo found the concept “confusing in the context of this  
2 Adjudication,” although it “does appear to be valid.”<sup>164</sup> Mr. Ford declared that:

3 Although capture analysis would demonstrate that a well is depleting the  
4 Subflow Zone, capture analysis is not by itself sufficient, because places likely exist  
5 where a pumping well located outside the Subflow Zone induces water to leave the  
6 Subflow Zone that is not captured by the well even though the Subflow Zone is still  
7 depleted. Furthermore, Mr. Briggs does not provide a method for performing the  
8 capture zone analysis. In my experience, some sort of drawdown analysis is first  
9 required in performing a capture zone analysis. Thus, Mr. Briggs’ suggestion that  
10 ADWR perform capture zone analysis would require more effort, not less.<sup>165</sup>

11 Dr. Montgomery and Mr. Anderson opined that capture zone analysis considers the “presence or  
12 absence of a groundwater divide” rather than “drawdown at the edge of the subflow zone.”<sup>166</sup> The  
13 issue of a groundwater divide in the cone of depression analysis is discussed in the next section. The  
14 Special Master finds that although capture zone analysis may be a method to measure the impact of a  
15 well on the subflow zone, there is insufficient evidence in the record to conclude that ADWR’s  
16 recommended procedures should be rejected in favor of capture zone analysis.

#### 17 *Economy and Expediency*

18 ADWR’s proposed cone of depression test must also be evaluated alongside the alternatives  
19 in order to determine which is the least expensive and delay-causing method. Alternatives presented  
20 consisted of using monitoring wells rather than modeling, and second, adopting higher drawdown  
21 levels that allegedly can be simulated more accurately than 0.1 foot.

22 Dr. Montgomery and Mr. Anderson recommended that “monitor wells should be used to  
23 determine if, and or when, the hydraulic gradient is inclined downward from the subflow zone  
24 toward a pumping well.”<sup>167</sup> To determine if the hydraulic gradient is continuously inclined

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22 <sup>164</sup> Eric J. Harmon and Mark R. Palumbo Rebuttal Decl. 33 (June 27, 2002).

23 <sup>165</sup> Jon R. Ford Rebuttal Decl. ¶ 27 (June 27, 2003).

24 <sup>166</sup> Errol L. Montgomery and Thomas W. Anderson Rebuttal Decl. 16 (June 27, 2003).

<sup>167</sup> *Id.* at 18.

1 downward from the subflow zone to a well, according to Dr. Montgomery, ADWR should drill  
2 monitor wells near the subflow zone and measure water levels in these and other wells. He estimated  
3 two monitor wells for each existing well would be appropriate to determine if the hydraulic gradient  
4 has reversed.<sup>168</sup> Dr. Montgomery could not estimate the number of wells that would have to be  
5 drilled and at what cost. As there are nearly 6,500 wells in the San Pedro River Watershed,<sup>169</sup> at least  
6 more than 6,500 monitor wells would have to be drilled. Mr. Marra testified that determining the cost  
7 of drilling and setting up a monitor well is “a difficult question to answer because monitor wells can  
8 be designed for different reasons and they can be designed at different depths and all of these factors  
9 will be involved in making an estimate of the cost,” but he estimated the cost of drilling two wells to  
10 monitor a one thousand gallons per minute well with a depth to water of 300 feet “could range from  
11 \$25,000 to \$30,000.”<sup>170</sup> A consideration for such a project is that landowners might deny access for  
12 drilling wells.

13 ADWR has stated it “does not currently have the resources to conduct cone of depression  
14 tests across wide areas of the Gila River adjudication” even using modeling.<sup>171</sup> During the past three  
15 years, ADWR has made the trial court, Special Master, and parties well aware of its weak budget  
16 situation. The Special Master finds that for reasons of cost, implementation, and delay such a well  
17 monitoring project is neither feasible nor practical and would not satisfy *Gila IV*'s criteria of  
18 economy and expediency.

19 After considering the extensive evidence presented on this issue, the Special Master finds that  
20 computer modeling is an appropriate, workable, and reliable method to conduct cone of depression

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21  
22 <sup>168</sup> Hrg. Tr. at 133:24 - 136:13; 154:20 - 155:2 (Oct. 21, 2003).

23 <sup>169</sup> Oliver S. Page, Peter M. Pyle, and Jean M. Moran Decl. 30, 32 (June 17, 2002). Dr. Mock characterized  
24 this alternative as “the largest hydrogeologic field investigation program in human history...” Peter A. Mock  
Rebuttal Decl. 36 (June 27, 2003).

<sup>170</sup> Hrg. Tr. 443:3-12 (Oct. 22, 2003); cf. W. Gerald Matlock Rebuttal Decl. ¶ 11(m) (June 27, 2003).

<sup>171</sup> Subflow Report 22.

1 tests, and second, ADWR’s recommended drawdown of greater than or equal to 0.1 foot drawdown  
2 comports with *Gila IV*. The modeling of a simulated drawdown of greater than or equal to 0.1 foot is  
3 realistically adaptable to the field, is the least expensive and delay-causing method, and provides a  
4 high degree of reliability. This finding is valid as long as ADWR strives to obtain reliable data and  
5 information to safeguard the requisite reliability of the cone of depression test. The cone of  
6 depression tests must not be allowed to become unreasonably theoretical exercises. There must be an  
7 ongoing reasonable effort to obtain and use reliable data for the model’s parameters.

8 **Recommendation 20:** The Court should adopt ADWR’s recommended drawdown of greater  
9 than or equal to 0.1 foot where a well’s cone of depression has reached the edge of the subflow zone.

10 **Recommendation 21:** The Court should direct ADWR to obtain and use reliable data and  
11 information on an ongoing basis to safeguard the reliability of the cone of depression test.

12 **B. Does ADWR’s recommended condition that the water level in a well be below the**  
13 **water level in the subflow zone during pumping comport with *Gila IV*?**

14 ADWR recommends that a well be included in the adjudication if at the time of modeling,  
15 “the water level in the well is *below* the water level in the jurisdictional subflow zone during  
16 pumping. If the water level in the well is *above* the water level in the jurisdictional subflow zone  
17 during pumping, the well cannot be pumping subflow.”<sup>172</sup> (Italics in report.)

18 Messrs. Harmon and Palumbo declared that, “[i]n order for a well to withdraw appropriate  
19 subflow, the groundwater gradient must flow from the subflow zone to the well over the entire  
20 distance between the subflow zone and the well.”<sup>173</sup> Dr. Montgomery and Mr. Anderson declared  
21 that ADWR “has incorrectly indicated that if the cone of depression reaches a stream, and if [the]  
22 pumping groundwater level at the well is lower than the stream, then the well is drawing

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23 <sup>172</sup> Subflow Report 31.

24 <sup>173</sup> Eric J. Harmon and Mark R. Palumbo Decl. 36, Figs. 1-3 (June 17, 2002).

1 groundwater from the stream” because “[e]ven if the cone of depression reaches the stream, water is  
2 not drawn from the stream and/or subflow, unless an inclination of hydraulic gradient is  
3 demonstrated to occur continuously across the distance from the stream to the pumping well.”<sup>174</sup>  
4 (Underlining in declaration.) These experts submitted conceptual diagrams showing situations where  
5 the water level in a well is below the water level in the subflow zone, or a well’s cone of depression  
6 has reached the subflow zone, but the well is not withdrawing subflow.

7 Messrs. Harmon, Palumbo, Anderson, and Dr. Montgomery believe ADWR must show that  
8 the hydraulic gradient between the well and the subflow zone has reversed. In other words, the  
9 gradient flows downward continuously from the subflow zone to the well rather than flowing from  
10 the well down to the stream. Another way of expressing this point is to say that the groundwater  
11 divide, “the point at which groundwater either goes to the well or to the river, has reached the  
12 subflow zone.”<sup>175</sup> In short, whether a well’s cone of depression depletes subflow or stream flow  
13 depends on the direction and magnitude of the hydraulic gradient between the stream and the well.

14 To determine if the hydraulic gradient is continuously inclined downward from the subflow  
15 zone to a well, according to Dr. Montgomery, ADWR should drill monitor wells near the subflow  
16 zone and measure water levels in these and other wells. Dr. Montgomery estimated two monitor  
17 wells for each existing well would be appropriate to determine if the hydraulic gradient has  
18 reversed.<sup>176</sup> Dr. Montgomery could not estimate the number of wells that would have to be drilled  
19 and at what cost. As there are nearly 6,500 wells in the San Pedro River Watershed,<sup>177</sup> at least more  
20 than 6,500 monitor wells would have to be drilled. This well monitoring project has been previously  
21 described, and the Special Master has found that for reasons of cost, implementation, and delay, such

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22 <sup>174</sup> Errol L. Montgomery and Thomas W. Anderson Decl. 20, Figs. 1-8 (June 17, 2002).

23 <sup>175</sup> Hrg. Tr. 116:14-16 (Oct. 21, 2003).

24 <sup>176</sup> *Id.* at 133:24 - 136:13; 154:20 - 155:2 (Oct. 21, 2003).

<sup>177</sup> Oliver S. Page, Peter M. Pyle, and Jean M. Moran Decl. 30, 32 (June 17, 2002).

1 a project is neither feasible nor practical and would not satisfy *Gila IV's* criteria of economy and  
2 expediency.

3 Mr. Ford disagrees with ADWR's second condition because pumping from a well whose  
4 cone of depression reaches the subflow zone, even if the hydraulic gradient has not been reversed,  
5 "will induce some amount of water to exit the subflow zone."<sup>178</sup> That amount of water will not enter  
6 a well whose water level is above that of the subflow zone, but will travel downstream generally  
7 parallel to the subflow zone. According to this view, because some appropriable water has been  
8 induced out of the subflow zone, even when the water does not flow toward the well whose cone of  
9 depression has entered the subflow zone, the well should be included in the adjudication. Dr.  
10 Montgomery and Mr. Anderson disagreed with Mr. Page's declaration that subflow leaves the  
11 subflow zone as soon as a well's cone of depression expands to the subflow zone.

12 Mr. Ford declared that adoption of ADWR's condition "would require DWR to measure the  
13 water levels in each individual well, which is problematic" because "[p]umping levels are somewhat  
14 difficult to measure, and they often vary seasonally and with irrigation return flows or other  
15 recharge," and "the construction of many wells makes it virtually impossible to measure their  
16 pumping levels."<sup>179</sup>

17 Mr. Mason, manager of ADWR's Groundwater Modeling Section, testified regarding  
18 ADWR's proposed cone of depression test. He testified that ADWR proposes "three criteria," the  
19 first two being the two previously stated conditions, and the third is that the groundwater divide has  
20 reached the subflow zone.<sup>180</sup>

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23 <sup>178</sup> Jon R. Ford Decl. ¶ 19b (June 17, 2002).

24 <sup>179</sup> *Id.* at ¶ 19c.

<sup>180</sup> Hrg. Tr. 116:10-16; 77:5-10 (Oct. 21, 2003).

1 Dr. Mock and Mr. Gookin did not find ADWR's second condition useful and suggested a  
2 way to make it less confusing. Dr. Mock declared that the condition "is acceptable" only "[a]s long  
3 as the level of the jurisdictional subflow zone up to its entrance into the basin of interest is  
4 considered."<sup>181</sup> It "is difficult to conceive of a well that won't meet this 'second condition'" because  
5 "all wells in a basin containing a subflow zone will have water levels below the stage of the river at  
6 the point where it enters the basin."<sup>182</sup> Mr. Toy declared that this concept ignores the existence of  
7 natural hydraulic boundaries "such as bedrock boundaries" that "can limit or prevent subflow from  
8 the head of a basin ever reaching certain basin areas," and secondly, natural, incidental, and artificial  
9 recharge (such as Central Arizona Project water and effluent).<sup>183</sup> Dr. Matlock declared the "concept  
10 ignores the fact that wells draw water from several other sources."<sup>184</sup>

11 The trial court found seven principles necessary to define the subflow zone (the first five are  
12 discussed in chapter 2, section D). The seventh principle, which covers this issue, is: "Wells located  
13 outside the lateral parameters of the defined 'subflow' zone are not included unless it is proven that  
14 their 'cones of depression' reach the 'subflow' zone and the drawdown from the well affects the  
15 volume of surface and 'subflow' in such an appreciable amount that it is capable of measurement."<sup>185</sup>  
16 This principle has two elements, first, the well's cone of depression has reached the subflow zone,  
17 and second, the well's drawdown affects subflow and stream flow in a measurable amount.

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19 <sup>181</sup> Peter A. Mock Decl. 26 (June 17, 2002).

20 <sup>182</sup> *Id.* at 27. Mr. Gookin shares this view declaring that "[a]ny well outside the subflow zone should be  
21 deemed to be taking subflow once the piezometric (water table) surface of that well drops below the water  
elevation of the river entering the individual valley in consideration." T. Allen J. Gookin Decl. sec. 3, 3 (June  
17, 2002).

22 <sup>183</sup> Doug Toy Rebuttal Decl. 2, 3 (June 27, 2003).

23 <sup>184</sup> W. Gerald Matlock Rebuttal Decl. ¶ 15(1) (June 27, 2003).

24 <sup>185</sup> Goodfarb Order 36. In the summary of its findings, the trial court stated that in order to include in the  
adjudication a well located outside the subflow zone, there must be a finding that the well's cone of depression  
"has now extended to a point where it reaches an adjacent 'subflow' zone, and by continual pumping will  
cause a loss of such 'subflow' as to affect the quantity of the stream." *Id.* at 66.

1 The trial court described the testimony of Dr. Montgomery and Messrs. Ford and Page  
2 regarding reversal of hydraulic gradient:

3 As Montgomery admitted, stream depletion occurs as soon as the “cone of  
4 depression” reaches the stream, even though it may be some time before the hydraulic  
5 gradient at the river is reversed, and may be many years before a particle travels from  
6 the stream to the well. (citation to transcript omitted). Ford and Page contend that  
7 streamflow depletion first takes place when the cone intersects the stream, not when  
8 the hydraulic gradient is reversed or the molecule of streamflow is ejected by the well.  
9 (citations to transcript omitted). It is beyond dispute that even before the gradient is  
reversed, a measurable drawdown at the stream’s “subflow” zone necessarily results  
in water leaving the zone in order to fill the void which has been created by the well.  
Ford’s Report, (citation omitted) [when the cone intersects the “subflow” zone, it  
“induce[s] subflow to leave (deplete the Subflow Zone and the stream”)]. This is true  
even where the gradient has not been reversed everywhere between the well and the  
stream.<sup>186</sup> (Emphasis added.)

10 *Gila IV* affirmed the trial court’s order in all respects and held that a well located outside the  
11 subflow zone will be included in the adjudication if “the well’s cone of depression extends into the  
12 subflow zone and is depleting the stream.”<sup>187</sup>

13 The Special Master interprets the trial court’s ruling and its affirmance in *Gila IV* to hold that  
14 hydraulic gradient reversal, or that the gradient is continuously inclined from the subflow zone to the  
15 well, is not required to determine if a well’s cone of depression is withdrawing appropriable subflow.  
16 A cone of depression test, however, must yield results with a high degree of reliability, and although  
17 gradient reversal is not required under *Gila IV* to include a well in the adjudication, its consideration  
18 will increase the reliability of a questionable cone of depression test. ADWR should proceed with its  
19 proposal to investigate water levels in wells and in the subflow zone during pumping and the extent  
20 of hydraulic gradient reversal, but the trial court should not adopt ADWR’s second condition as a  
21 requisite for including a well in the adjudication.

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22  
23 <sup>186</sup> *Id.* at 61.

24 <sup>187</sup> 198 Ariz. at 343, 9 P.3d at 1082.

1           **Recommendation 22:** The Court should not adopt as a condition to include a well in the  
2 adjudication that the water level in the well is below the water level in the subflow zone during  
3 pumping.

4           **Recommendation 23:** The Court should not adopt as a condition to include a well in the  
5 adjudication that the hydraulic gradient is continuously inclined from the subflow zone to the well.

6           **C. What is the accuracy and reliability of analytical (THWELLS) and numerical  
7 (MODFLOW) models for the cone of depression test?**

8           ADWR proposes to use both analytical and numerical models for the cone of depression tests.  
9 Models are sets of mathematical flow equations whose solutions yield simulations of the behavior of  
10 aquifers in response to stresses. ADWR recommends using an analytical computer-based program  
11 called THWELLS (van der Heijde, version 4.01, 1996) to evaluate a well’s cone of depression where  
12 “the aquifer system is less complex and the flow equations can be solved directly using calculus.”<sup>188</sup>  
13 ADWR recommends that a numerical model called MODFLOW (McDonald and Harbaugh, 1988;  
14 Harbaugh and McDonald, 1996) “only be used to evaluate the cone of depression of a well in special  
15 circumstances where, based on the conceptual model, the aquifer system is exceedingly complex and  
16 the flow equations can only be solved by recasting them in algebraic form.”<sup>189</sup> ADWR does not  
17 indicate what percentage of the cone of depression tests will be done using each model.

18           ADWR has considered economy and expediency to select a computer-based model it believes  
19 will yield simulations with a high degree of reliability in different aquifer systems. In support of its  
20 recommendations, the department explains that:

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23 <sup>188</sup> Subflow Report 28; app. G of the report contains a description of the THWELLS program.

24 <sup>189</sup> *Id.* at 29; app. H of the report contains a description of the MODFLOW program. “Currently, MODFLOW is the most widely used program in the world for simulating ground-water flow.” *Id.* app G, Fact Sheet, 1.

1           1. Analytical models “can be constructed relatively quickly” using commercially available  
2 computer software such as THWELLS.<sup>190</sup>

3           2. “[D]evelopment of numerical models is still a very time consuming process that requires  
4 substantial field data to justify its use and to properly calibrate.”<sup>191</sup>

5           3. Both models will give approximate solutions to the mathematical flow equations used in  
6 each program.

7           The testimony elicited the following regarding THWELLS and MODFLOW:

8           1. Mr. Mason, manager of ADWR’s Groundwater Modeling Unit, testified that an analytical  
9 model assumes an isotropic homogeneous aquifer (as opposed to heterogeneous).<sup>192</sup> There are  
10 aquifers in the San Pedro River Watershed that are not homogeneous. In aquifers where the “geology  
11 or the hydrology [is] complicated,” ADWR would use a numerical model.<sup>193</sup>

12           2. Mr. Mason testified that an analytical model assumes an aquifer has an infinite areal  
13 extent.<sup>194</sup> On the other hand, a numerical model divides an aquifer into rectangular blocks which are  
14 then organized by rows, columns, and layers. Each block is called a cell. THWELLS assumes a  
15 single model cell or block in infinite dimensions, while MODFLOW can consider numerous cells.  
16 Dr. Montgomery and Mr. Anderson declared that “both tributary aquifers and Holocene alluvial  
17 aquifers in Arizona stream valleys are of limited rather than infinite extent.”<sup>195</sup>

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20 <sup>190</sup> *Id.* at 29.

21 <sup>191</sup> *Id.*

22 <sup>192</sup> Hrg. Tr. 98:16-18 (Oct. 21, 2003).

23 <sup>193</sup> *Id.* at 93:16-18; 116:3-5. Mr. Burtell, for example, testified that in a preliminary appraisal of the water  
development potential of a mine in Tombstone, located in the San Pedro River Watershed, he had  
recommended using a numerical model due to the mine’s bedrock aquifer system. *Id.* at 45:19-46:5.

24 <sup>194</sup> *Id.* at 98:19-20.

<sup>195</sup> Errol L. Montgomery and Thomas W. Anderson Decl. 23 (June 17, 2002). They also declared that “[f]ew  
aquifers may approach homogeneous conditions.” *Id.*

1           3. A greater number of cells allows a numerical model to account better than an analytical  
2 model for geologic deposits (such as inliers, relic fan deposits, or bedrock) that come through but are  
3 not floodplain Holocene alluvium because these deposits can be anticipated with individual cells.<sup>196</sup>

4           4. In a numerical model, each well can be placed in its own cell and its cone of depression  
5 analyzed. Such a cell “could be very small.”<sup>197</sup>

6           5. The greater the number of cells used in a numerical model the higher is the likelihood of  
7 data entry errors and the difficulty of managing the information.<sup>198</sup>

8           6. In a numerical model, although it would be difficult to implement, cells can be included or  
9 excluded (“turned on and off”) from different test runs.<sup>199</sup>

10          7. Mr. Mason testified that “with THWELLS” the modeler uses “whatever data you have  
11 available,” and “you really can’t calibrate” THWELLS.<sup>200</sup> Calibration is a way to see if the model  
12 applied to a field situation is an acceptable representation.

13          8. A numerical model such as MODFLOW is calibrated with hydrologic or well information  
14 obtained from field investigations or reliable sources, and is run until its results agree with the  
15 calibrating data (“until the model agrees with the real world”).<sup>201</sup>

16          9. Dr. Mock declared it is not true “that only numerical models should be calibrated,” and  
17 “[c]alibration should be required of both analytical and numerical models.”<sup>202</sup>

18          10. Both THWELLS and MODFLOW “require information for aquifer hydraulic parameters  
19 of hydraulic conductivity and storage coefficient, saturated thickness of the aquifer, pumping rate of  
20

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21 <sup>196</sup> Hrg. Tr. 165:14-23 (Oct. 21, 2003).

22 <sup>197</sup> *Id.* at 166:2-9; 88:7-11.

23 <sup>198</sup> *Id.* at 88:7-11; *see also* Jon R. Ford Rebuttal Decl. ¶¶ 12, 13 (June 27, 2003).

24 <sup>199</sup> Hrg. Tr. 88:17-23; 166:22-167-6 (Oct. 21, 2003).

<sup>200</sup> *Id.* at 81:20-21.

<sup>201</sup> *Id.* at 69:23-24; 81:23.

<sup>202</sup> Peter A. Mock Decl. 26 (June 17, 2002); Messrs. Harmon and Palumbo agreed with this opinion.

1 the well, duration of pumping, and distance from the well to the point where drawdown is to be  
2 estimated.”<sup>203</sup> The Subflow Report describes how the department plans to obtain and use these data.  
3 The information is not always available or reliable, and its interpretation may require considerable  
4 professional judgment and expertise.

5 11. Mr. Ford testified that THWELLS “doesn’t take into account very well the effects of  
6 phreatophytes” or of recharge from either precipitation or basin fill aquifers.<sup>204</sup> Recharge includes  
7 artificial recharge.

8 12. Dr. Mock testified it could cost “in the range of \$250,000 to \$500,000 to develop” a  
9 MODFLOW model for either the upper or lower portions of the San Pedro River Watershed.<sup>205</sup> This  
10 estimate is to develop the model and does not include some operational costs such as sensitivity  
11 analysis. His “rough approximation” for a similar THWELLS model is “[p]erhaps half the cost.”<sup>206</sup>

12 The parties split between those who favor using exclusively a numerical model for the cone  
13 of depression test, and those who believe ADWR has the expertise to select the appropriate model for  
14 an aquifer system and should be allowed to do so. ADWR uses both analytical and numerical models  
15 in its statutory activities. It has developed numerical models for the San Pedro River Watershed. In  
16 the Final San Pedro River Watershed HSR (1991), ADWR presented a MODFLOW analysis  
17 assessing the cumulative impact of eight municipal water companies on the aquifers near Fort  
18 Huachuca and the San Pedro Riparian National Conservation Area.

19 Mr. Harmon testified that:

20 There may be physical situations where the geology is fairly simple. The hydrology is  
21 not complex. There are not a lot of recharge inputs or discharge outputs; and in that  
22 case the analytic model might be just fine....

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23 <sup>203</sup> Errol L. Montgomery and Thomas W. Anderson Decl. 21 (June 17, 2002).

24 <sup>204</sup> Hrg. Tr. 260:7-18 (Oct. 22, 2003); 107:1-5 (Oct. 21, 2003).

<sup>205</sup> *Id.* at 405:17 (Oct. 22, 2003).

<sup>206</sup> *Id.* at 406:14-16.

1 In other instances and I think in my opinion many instances the geology is  
2 complex, heterogeneous. There are lots of inputs and outputs, gradients to the water  
3 table which may be in multiple directions and slopes. In that instance, it would  
4 probably take a well-calibrated MODFLOW model with good data to back it up....

5 QUESTION. So it will be different depending on the situation.

6 ANSWER. I believe it would.<sup>207</sup>

7 Responding to when THWELLS or MODFLOW should be used, Mr. Ford testified:

8 [I]t depends on the situation. There may be places where it makes very little  
9 difference whether you use THWELLS, MODFLOW. THWELLS in my view would  
10 be far less expensive to utilize. I think in those cases then THWELLS should be used.

11 I think DWR has the ability to make those professional decisions....<sup>208</sup>

12 Because ADWR recommends modeling for the cone of depression test, whether an analytical  
13 or a numerical model will be used is a critical component of the cone of depression test. The  
14 selection must be subjected to the criteria set forth in *Gila IV* for the cone of depression test, namely,  
15 the model should be (1) “realistically adaptable to the field,” (2) “is the least expensive,” (3) the least  
16 “delay-causing,” and (4) “provides a high degree of reliability.”<sup>209</sup>

17 The evidence does not support a finding that ADWR should use a numerical model or  
18 MODFLOW as the exclusive model for the cone of depression test. The evidence shows an  
19 analytical model is valid for a cone of depression test where the aquifer system is homogeneous,  
20 hydrologic conditions are simple, and the required information is reliable. For those aquifer systems,  
21 an analytical model like THWELLS would be the least expensive and delay-causing model,  
22 realistically adaptable to the field, that will provide highly reliable results.

23 <sup>207</sup> *Id.* at 368:17-369:5.

24 <sup>208</sup> *Id.* at 266:17-20; Messrs. Harmon and Palumbo declared, “[t]he possible use of these two models in cone of  
depression analyses is not an issue. However, the proper selection of one model or the other in the analysis of  
a particular well is a significant issue.” Eric J. Harmon and Mark R. Palumbo Decl. 30 (June 17, 2002).

<sup>209</sup> 198 Ariz. at 343, 9 P.3d at 1082 (quoting Goodfarb Order 62).

1 The evidence, however, shows that a numerical model such as MODFLOW will provide a  
2 higher degree of reliability than an analytical model when the aquifer system is heterogeneous or  
3 when an analytical model cannot take into account very well certain conditions, for example,  
4 phreatophytes and artificial or natural recharge.

5 ADWR has the expertise and experience to conduct cone of depression tests. The department  
6 should be allowed to exercise its best professional judgments and technical analysis to utilize the  
7 most appropriate model that satisfies *Gila IV's* criteria for the cone of depression test. ADWR  
8 should, however, undertake an ongoing program to collect and obtain reliable information to use in  
9 the cone of depression tests. Regarding calibration, the Special Master finds that analytical and  
10 numerical models can be calibrated, calibration increases the reliability of results, and accordingly,  
11 ADWR should calibrate both models whenever feasible.

12 The majority of the experts expressed a preference for numerical models. The Special Master  
13 believes ADWR should use MODFLOW or a numerical model whenever there is professional doubt  
14 that THWELLS will not yield reliable results. Economy and expediency should not win over  
15 appropriate and prudent professional decisions, as what is gained today could be lost tomorrow in  
16 increased litigation over flawed assumptions or inadequate work. The decision to switch from an  
17 analytical to a numerical model in a particular situation should not be finessed.

18 **Recommendation 24:** The Court should adopt ADWR's proposal to use both analytical  
19 (THWELLS) and numerical (MODFLOW) models for the cone of depression tests.

20 **Recommendation 25:** The Court should direct ADWR to implement promptly any new  
21 versions of THWELLS or MODFLOW, if they will provide more reliable results.

22 **Recommendation 26:** The Court should direct ADWR to calibrate whenever feasible both  
23 the analytical and numerical models used for the cone of depression tests.

1           **Recommendation 27:** The Court should direct ADWR as part of its investigations to collect  
2 and obtain reliable information for the cone of depression tests.

3           **D.     Is ADWR’s recommendation that the impact of a well be measured “at the time**  
4 **of the modeling”<sup>210</sup> scientifically valid?**

5           ADWR recommends that the impact of a well on the subflow zone be measured at the time  
6 ADWR does the cone of depression test. ADWR proposes to run the cone of depression test for a  
7 well beginning on the date the well was constructed and ending on the date the modeling is done.<sup>211</sup>  
8 The test will not measure the future impact of a cone of depression. After the time of modeling, the  
9 well’s cone of depression could stabilize, expand into the subflow zone, or decrease if, for example,  
10 the well is capped. These effects occur gradually.<sup>212</sup> ADWR’s test is called transient state modeling.

11           The Subflow Report does not give ADWR’s reasons for the recommendation. Mr. Mason  
12 provided a reason when he testified that ADWR’s proposal does not include future impacts of a well  
13 “because we don’t know what’s going to happen in the future.”<sup>213</sup>

14           The parties favoring measuring future impacts argue that a well may not impact the subflow  
15 zone on the day ADWR does the cone of depression test, but the well may do so in the near future.  
16 Therefore, not measuring future impacts will result in many wells being excluded from the  
17 adjudication even though they will pump subflow at a future time. Although these wells could be  
18 retested later, these parties argue that ADWR may not have the resources to do ongoing cone of  
19 depression tests in the same watershed, and second, claimants should not be burdened with  
20 prosecuting enforcement actions to bring those wells into the adjudication.

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23 <sup>210</sup> Subflow Report 31.

24 <sup>211</sup> Hrg. Tr. 115:18-23 (Oct. 21, 2003).

<sup>212</sup> See Goodfarb Order 59-60; see also T. Allen J. Gookin Decl. sec. 3, 1-2 (June 17, 2002).

<sup>213</sup> Hrg. Tr. 90:1-5; 102:22-23 (Oct. 21, 2003).

1 The parties on the other side of this issue argue that, as Mr. Mason testified, the future is  
2 unknown, and pumping histories and water uses can vary over time; consideration of time of  
3 pumping is not necessary as long as data obtained from monitoring wells shows the groundwater  
4 gradient has reversed; and wells presently not pumping appropriable subflow would be improperly  
5 included in the adjudication on the ground they may impact the subflow zone at a future time.

6 Parties presented three alternatives for the length of simulations that will account for future  
7 impacts: (1) a fixed period such as five, ten, or twenty years,<sup>214</sup> (2) the timing of maximum  
8 drawdown at the subflow zone,<sup>215</sup> and (3) modeling to steady state conditions.<sup>216</sup>

9 The five-year period is related to ADWR's well spacing standard of ten feet of drawdown  
10 over five years to determine if a well will interfere with another well in an active management area.  
11 Measuring a well's potential interference with a nearby well is, however, not the same as measuring  
12 the impact of a cone of depression on the subflow zone in accordance with *Gila IV's* holdings, and  
13 moreover, a ten-foot drawdown would be measured long after a well's cone of depression has  
14 induced water out of the subflow zone.

15 Only Dr. Montgomery and Mr. Anderson declared in favor of using a period of ten or twenty  
16 years, and their evidence was limited to the statement that, "this period is sufficiently long to exclude  
17 wells that pump small amounts but is sufficiently long to assure that most large-scale pumping wells  
18 would be included in the adjudication if the cone of depression reaches the edge of subflow."<sup>217</sup> Dr.

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20 <sup>214</sup> Errol L. Montgomery and Thomas W. Anderson Decl. 8, 25 (five years) (June 17, 2002); Errol L.  
21 Montgomery and Thomas W. Anderson Rebuttal Decl. 25 (ten and twenty years) (June 27, 2003).

22 <sup>215</sup> Peter A. Mock Decl. 26 (June 17, 2002); *see* Errol L. Montgomery and Thomas W. Anderson Rebuttal  
Decl. 24 (June 27, 2003) for their opinion that Dr. Mock "believes...model projections should be run until at  
least the year 2100."

23 <sup>216</sup> Oliver S. Page, Peter M. Pyle, and Jean M. Moran Decl. 25 (June 17, 2002). Mr. Toy testified, "[i]f you  
wanted to see the ultimate effect a well had, you would pump it to steady state." Hrg. Tr. 397:4-5 (Oct. 22,  
2003).

24 <sup>217</sup> Errol L. Montgomery and Thomas W. Anderson Rebuttal Decl. 25 (June 27, 2003).

1 Mock recommended the timing of maximum drawdown with the declaration that it “would be a  
2 better measure of minimum time for simulation and should be, as the impact on flows will be,  
3 dependent on the local conditions.”<sup>218</sup> No further evidence was presented on these alternatives.

4 Mr. Page and Dr. Mock criticized ADWR’s time of the modeling and assigning a fixed period  
5 to all simulations because these periods are arbitrary. Underlying this argument is the position that  
6 cones of depression can expand over time, and expanding cones of depression can have substantial  
7 impacts on the subflow zone and aquifers. In its 1994 order, the trial court described some of the  
8 “destructive ability” of cones of depression in desert and semi-desert environments.<sup>219</sup> Under these  
9 experts’ view, a test that does not consider the future impact of a cone of depression is arbitrary and  
10 “unrealistic” because it “ignores the concept that, eventually, impacts will be felt.”<sup>220</sup>

11 More evidence was presented regarding the proposal that all simulations be run as steady  
12 state or long enough to approximate steady state conditions. Mr. Page explained the benefits of using  
13 a steady state model:

14 The term steady-state refers to an equilibrium hydrologic condition where...an  
15 equilibrium is established between the pumping well, and the amount of water they  
16 pump that is obtained from streams, recharge and underground water storage. In  
17 steady-state, these are constant and do not change over time. Usually long term  
18 average hydrology is used as input. Time is not an input to the model, eliminating the  
19 need to define a specific time period.

20 This approach...addresses the fact that the period of future use of wells (or  
21 their replacements) cannot be predicted, but is important to the cumulative impact of  
22 wells on subflow. This approach also simplifies the issue of how to assess the impact  
23 of future wells drilled due to growth...

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23 <sup>218</sup> Peter A. Mock Decl. 26 (June 17, 2002).

24 <sup>219</sup> Goodfarb Order 59-60.

<sup>220</sup> T. Allen J. Gookin Rebuttal Decl. ch. XIV 1, 2 (June 27, 2003).

1           The use of steady-state simulations as a means for evaluating wells will result  
2 in a greater number of wells that have cones of depression that intersect the subflow  
boundary.<sup>221</sup>

3           Mr. Page declared that steady state simulations are “available to all numerical and some  
4 analytical models.”<sup>222</sup> (Emphasis added.) It is not known if the steady state simulations are available  
5 for the THWELLS analytical model ADWR proposes to use.

6           Regarding a steady state model, Messrs. Harmon and Palumbo declared that:

7           1. The calibration of a steady state model “is, in general, not nearly so rigorous  
8 as the time-varying calibration done in transient modeling” because “time-varying  
inputs are simply averaged,” so “generally there is less reliability with the result;”

9           2. A steady state model “is not able to simulate [the] dynamic [hydrologic]  
10 system” in Southwestern deserts, where “streamflow, precipitation, long-term climate  
variation, and water level changes” are dynamic; and

11           3. A steady state model “ha[s] no provision for simulating the changes in  
12 ground water storage” resulting “from changes in ground water level and artesian  
head.”<sup>223</sup>

13           The resolution of this issue turns not only on the evidence but also on *Gila IV*'s holdings. In  
14 *Gila IV*, the Supreme Court affirmed the trial court's ruling that:

15           [A] well may be subject to the adjudication if its “‘cone of depression’ caused by its  
16 pumping has now extended to a point where it reaches an adjacent ‘subflow’ zone,  
and by continual pumping will cause a loss of such ‘subflow’ as to affect the quantity  
17 of the stream.”

18           DWR may seek to establish that a well located outside the limits of the saturated  
19 floodplain alluvium is in fact pumping subflow and is therefore subject to the  
adjudication, by showing that the well's cone of depression extends into the subflow  
zone and is depleting the stream.<sup>224</sup> (Emphasis added.)

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22 <sup>221</sup> Oliver S. Page, Peter M. Pyle, and Jean M. Moran Decl. 25-26 (June 17, 2002).

23 <sup>222</sup> *Id.* at 25.

24 <sup>223</sup> Eric J. Harmon and Mark R. Palumbo Rebuttal Decl. 22 (June 27, 2003).

<sup>224</sup> 198 Ariz. at 343, 9 P.3d at 1082 (quoting Goodfarb Order 66). The ruling is based on the trial court's seventh principle discussed in chapter 3, section B, of this report.

1           The Special Master interprets this holding and the pivotal underlined words to mean that a  
2 well will be subject to the adjudication if (1) ADWR determines the well’s cone of depression has  
3 already extended, and not that it may in the future extend, into the subflow zone, and (2) if the well,  
4 after its cone of depression has extended into the subflow zone, continues to be pumped, stream flow  
5 will be affected appreciably and directly. This holding does not support using a cone of depression  
6 test that projects the future impact of a cone of depression. The cone of depression test, under *Gila*  
7 *IV*, is to determine if a well’s cone of depression has “now” extended to the subflow zone and “is  
8 depleting the stream.”

9           Considering the evidence only, the Special Master finds that it is insufficient to conclude that  
10 cone of depression simulations using a fixed period of five, ten, or twenty years projected into the  
11 future will yield more reliable results than either ADWR’s time of the modeling or any other set  
12 period of years. The Special Master further finds that if the future impact of a cone of depression is  
13 excluded as a consideration, the evidence is insufficient to conclude that a steady state model will  
14 yield more reliable results than ADWR’s proposed time of the modeling cone of depression test. The  
15 Special Master finds that ADWR’s recommendation to measure the impact of a well at the time of  
16 the modeling is scientifically valid.

17           Although *Gila IV* and the evidence do not support rejecting ADWR’s recommendation, the  
18 impact of expanding cones of depression must be taken into account. The hydrologic reality that  
19 cones of depression can grow and substantially impact the subflow zone and aquifers cannot be  
20 overlooked.

21           The Special Master recommends that ADWR be directed to complete additional cone of  
22 depression tests in a watershed at a time to be determined by the trial court or the Special Master that  
23 is appropriate to identify old or new wells that impact the subflow zone at that time. Because cone of  
24

1 depression tests are labor intensive, the additional tests may exclude wells, even ones previously  
2 tested, under guidelines adopted by the trial court or the Special Master.

3 **Recommendation 28:** The Court should adopt ADWR’s recommendation that the impact of  
4 a well be measured at the time of the modeling.

5 **Recommendation 29:** The Court should direct ADWR to complete additional cone of  
6 depression tests in a watershed at a time to be determined by the trial court or the Special Master that  
7 is appropriate to identify old or new wells that impact the subflow zone at that time. The additional  
8 tests may exclude wells, even ones previously tested, pursuant to guidelines adopted by the trial court  
9 or the Special Master.

10 **E. Should ADWR recommend a methodology to evaluate the impact of wells  
11 perforated below an impervious formation within the limits of the subflow zone?**

12 The department does not recommend a methodology. The parties who briefed this issue do  
13 not believe ADWR needs to recommend a methodology, and no evidence was presented which could  
14 provide one. Mr. Page declared that a “method is needed,” and “[s]tudies by the USGS and others  
15 have shown that wells are likely to affect the flow of the river, but may not result in identifiable  
16 drawdown in the floodplain alluvium,” but hardly any evidence was presented on this issue.<sup>225</sup>

17 The genesis of this issue is *Gila IV*’s holding that:

18 All wells located in the lateral limits of the “subflow” zone are subject to the  
19 jurisdiction of this adjudication no matter how deep or where these perforations are  
20 located. However, if the well owners prove that perforations are below an impervious  
21 formation which preclude[s] “drawdown” from the floodplain alluvium, then that well  
22 will be treated as outside the “subflow” zone.<sup>226</sup>

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21 <sup>225</sup> Oliver S. Page, Peter M. Pyle, and Jean M. Moran Decl. 26 (June 17, 2002).

22 <sup>226</sup> 198 Ariz. at 338, 9 P.3d at 1077. This holding stemmed from the sixth of the seven principles the trial court  
23 deemed necessary to define the subflow zone. The principle was, “[w]ells which are located in but perforated  
24 below the saturated floodplain alluvium aquifer are to be included in the ‘subflow’ component unless these  
perforations are proven by their owners to be below a confining zone of impermeable material such as clay as  
the inevitable ‘draw-down’ of the well must affect the ‘subflow zone’ above the perforation.” Goodfarb Order  
36. The six principles are discussed in chapter 2, section D, and in chapter 3, section B, of this report.

1 Because *Gila IV* makes it clear that the well owner has the burden of proving that a well  
2 though punched in the subflow zone is not withdrawing water from the saturated floodplain  
3 Holocene alluvium but from an aquifer below an impervious formation, the well owner should  
4 formulate and present a methodology. The fact the well owner has this burden of proof does not  
5 mean that the trial court or the Special Master cannot ask ADWR to provide them technical  
6 assistance concerning the merits of a particular methodology.

7 **Recommendation 30:** The Court should not direct ADWR to recommend a methodology to  
8 evaluate the impact of wells perforated below an impervious formation within the subflow zone.

9 **F. In addition to analyzing a well’s drawdown at the subflow zone, should ADWR**  
10 **report the cumulative effect of wells or of groups of wells?**

11 This question was briefed prior to the hearing. A ruling was issued on September 8, 2003,  
12 subject to modification after considering the evidence presented during the hearing. The proposed  
13 ruling is adopted in part and modified in part.

14 The Special Master determined that a well’s drawdown at the subflow zone shall be analyzed  
15 individually for each well but deferred ruling on whether ADWR should report the cumulative effect  
16 of wells or of groups of wells until after considering the evidence presented at the hearing.

17 In *Gila IV*, the Supreme Court stated that the trial court “recognized that each well must be  
18 separately evaluated ‘to compute drawdown at the “subflow” zone’... We agree with the trial  
19 court.”<sup>227</sup> The trial court had considered the testimony of Mr. Ford and Dr. Montgomery, who had  
20 “agreed that individual analysis of wells is the most appropriate method to compute drawdown at the  
21 ‘subflow’ zone.”<sup>228</sup> Therefore, under *Gila IV* a well’s impact on the subflow zone must be  
22 individually evaluated for each well, and this portion of the proposed ruling is not modified.

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23 <sup>227</sup> 198 Ariz. at 343, 9 P.3d at 1082.

24 <sup>228</sup> Goodfarb Order 62.

1 The challenging inquiry is whether ADWR should go further after analyzing each well and  
2 report the cumulative effect of wells or of groups of wells. *Gila IV* is silent on this issue. Dr. Mock’s  
3 declaration highlights the concern some parties emphasize: “The potential exists for hundreds of  
4 wells to individually pass ADWR’s proposed cone of depression test at the current time and yet the  
5 group of wells could collectively have significant impacts on river flows at a later time.”<sup>229</sup> Mr. Page  
6 declared that “[w]hile individual wells may not have an instantaneous and measurable effect on  
7 stream flow, they can have a significant impact over time, particularly when combined with the  
8 effects of hundreds of other wells.”<sup>230</sup>

9 Implicit in an answer to the question are the expectations that ADWR will be able to obtain  
10 reliable information about cumulative effect, if any, and that it will be able to do so with a test that  
11 “is realistically adaptable to the field and...is the least expensive and delay-causing, yet provides a  
12 high degree of reliability...”<sup>231</sup> The realities of these expectations are not clearer today than they  
13 were prior to the hearing.

14 The Subflow Report does not contain scientific or technical information to form the basis of a  
15 methodology to evaluate cumulative effect, as the report does not directly address this issue, and the  
16 evidence is insufficient to formulate criteria to analyze cumulative effect. The desire of some parties  
17 that ADWR report cumulative effect is well-stated, but how ADWR should undertake the analysis  
18 that “provides a high degree of reliability” is not clear.

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20 <sup>229</sup> Peter A. Mock Decl 4 (June 17, 2002); *see also* T. Allen J. Gookin Decl sec. 3, 1-2 (June 17, 2002). After  
21 describing the testimony about wells located outside the subflow zone whose cones of depression “could  
22 severely affect the volume of stream flow and the ‘subflow’ which supported it,” the trial court noted that  
23 “[o]ften those wells had extensive and interconnecting ‘cones of depression.’” Goodfarb Order 60. Tucson  
commented that the “collective impact of many *de minimis* users” concentrated in areas with an unusually  
narrow and very shallow subflow zone “could have an appreciable effect on a subflow zone” and  
appropriate water right holders. Response to ADWR’s Subflow Report 5 (June 17, 2002).

24 <sup>230</sup> Oliver S. Page Rebuttal Decl. 11 (June 27, 2003).

<sup>231</sup> 198 Ariz. at 343, 9 P.3d at 1082 (quoting Goodfarb Order 62).

1 In this discussion, other important considerations must be weighed. The complexity of cone  
2 of depression analysis involving “numerous assumptions and considerable judgment,”<sup>232</sup> the number  
3 of wells that may require individual analysis,<sup>233</sup> and the time-sensitivity of cone of depression tests  
4 dictate that the task not be overly complicated. ADWR estimates that within the San Pedro River  
5 Watershed “several hundred cone of depression tests would have to be performed,” and “it takes one  
6 person working full time to make about 50 to 60 model runs using THWELLS in one year.”<sup>234</sup> The  
7 cone of depression tests should be completed within a practical period of time and must yield results  
8 with a high degree of reliability. Undertaking a comprehensive analysis of cumulative effect, in  
9 addition to individual effects, could impracticably expand the technical investigations and thwart  
10 their success.

11 In its closing brief, the United States indicated the USGS expects to finish in 2005 a study of  
12 the hydrology of the Sierra Vista Subwatershed that “once completed,” ADWR could use “to  
13 examine the effects of pumping from individual wells and the cumulative effects of pumping from  
14 groups of wells (footnote omitted).”<sup>235</sup> (Underlining in original.) The United States submits that the  
15 study “may provide the answer to the Special Master’s remaining question” about ADWR reporting  
16 cumulative effect.<sup>236</sup>

17 At the oral argument, the idea of ADWR doing certain analyses of cumulative effect and  
18 reporting its findings was discussed. The purpose would be to collect data regarding cumulative  
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20 <sup>232</sup> Subflow Report 21-22.

21 <sup>233</sup> According to Mr. Page, using 2001 data, there are 5,370 *de minimis* domestic wells (out of 5,413 wells) and  
22 1,066 *de minimis* stockwatering wells (out of 1,076 wells). In the Final San Pedro River Watershed HSR,  
23 ADWR, using 1990 data, reported 2,990 *de minimis* domestic wells and 72 *de minimis* other uses wells. The  
24 number of wells has increased significantly since 1990. Oliver S. Page, Peter M. Pyle, and Jean M. Moran  
Decl. 30, 32 (June 17, 2002).

<sup>234</sup> Subflow Report 22, 43.

<sup>235</sup> U.S. Memo. on Issues Related to ADWR’s Subflow Technical Report 5-6 (Mar. 3, 2004).

<sup>236</sup> *Id.* at 6.

1 effect so that the court's and the parties' understanding would be increased. Whether the findings  
2 will be, or should be, used to adjudicate any water uses is not addressed in this report. If ADWR is  
3 going to do cone of depression analyses, doing a cumulative effect analysis on selected groups of  
4 wells and obtaining observational and scientific information would be useful.

5 The Special Master recommends that ADWR select more than one group of wells, analyze  
6 their cumulative effect using the most accurate and reliable analytical or numerical models, and  
7 report the findings regarding cumulative effect, if any. The wells may be owned or used by one or  
8 several claimants, and the cone of depression analysis should provide information and data about  
9 cumulative effect. ADWR should research the scientific literature, review studies such as those the  
10 USGS expects to complete for the Sierra Vista Subwatershed, and build a body of knowledge.

11 **Recommendation 31:** The Court should direct ADWR to analyze a well's drawdown at the  
12 subflow zone individually for each well.

13 **Recommendation 32:** The Court should not direct ADWR to report the cumulative effect of  
14 wells or of groups of wells except as suggested in the next recommendation.

15 **Recommendation 33:** The Court should direct ADWR to select more than one group of  
16 wells, analyze their cumulative effect using the most accurate and reliable analytical or numerical  
17 models, and report the findings. The wells may be owned or used by one or several claimants, and  
18 the cone of depression analysis should provide information and data about cumulative effect. The  
19 purpose of these analyses is to build a body of knowledge about the cumulative effect of wells,  
20 including methodologies and findings. Whether the findings will be, or should be, used to adjudicate  
21 water uses is not determined in this report.

22 **Recommendation 34:** The Court should adopt Chapter 3 of the Subflow Report to the extent  
23 it does not conflict with any other recommendation made in this report.

1 **IV. DE MINIMIS USES (Chapter 4 of the Subflow Report)**

2 The trial court directed ADWR to submit a “set of rational guidelines for determining  
3 whether a given well, though pumping subflow, has a de minimis effect on the river system.”<sup>237</sup>  
4 Little posthearing briefing was submitted regarding guidelines for *de minimis* water uses in the San  
5 Pedro River Watershed, the reason most likely being that after ADWR filed the Subflow Report, the  
6 trial court ruled on this issue with respect to instream stockwatering, stockponds of a certain size and  
7 beneficial use, and household domestic water uses.

8 In the Subflow Report, ADWR summarizes the proceedings Special Master John E. Thorson  
9 held from 1993 to 1995 addressing *de minimis* stockwatering, stockponds, and domestic water uses  
10 within the San Pedro River Watershed.<sup>238</sup> Special Master Thorson determined that instream  
11 stockwatering and stockponds and domestic uses meeting certain criteria should be considered *de*  
12 *minimis* water uses. The Subflow Report focuses on the determinations regarding *de minimis*  
13 domestic water uses because Special Master Thorson found that 97% of domestic uses in the San  
14 Pedro River Watershed were supplied from wells.<sup>239</sup>

15 ADWR believes that the “special master’s proposed definition of *de minimis* domestic uses  
16 with a uniform quantification...is an acceptable definition,” but disagrees with “the special master’s  
17 determination that these *de minimis* uses should be summarily adjudicated with water rights  
18 characteristics.”<sup>240</sup> ADWR recommends that *de minimis* domestic water uses “should be excluded  
19  
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21 <sup>237</sup> Ballinger Order 2.

22 <sup>238</sup> The contested case was *In re Sands Group of Cases (W1-11-19) and Other Related Cases (Consolidated)*.  
Special Master Thorson issued a Memorandum Decision, Findings of Fact, and Conclusions of Law for Group  
23 1 Cases Involving Stockwatering, Stockponds, and Domestic Uses (Nov. 14, 1994) (“Memorandum  
Decision”), and a Modifying Memorandum Decision (Feb. 23, 1995).

24 <sup>239</sup> Memo. Decision 19 (Finding of Fact No. 22).

<sup>240</sup> Subflow Report 38.

1 from the adjudication and catalogued in the decrees.”<sup>241</sup> Domestic wells determined to be *de minimis*  
2 would be listed in a catalog with basic descriptive information,<sup>242</sup> and “[a]s long as these catalogued  
3 domestic uses continued to satisfy the definition of a *de minimis* use adopted by the trial court, these  
4 uses would not be subject to post-decree administration or enforcement.”<sup>243</sup> *De minimis* “uses would  
5 not receive a decreed water right.”<sup>244</sup>

6 On September 26, 2002, nearly six months after ADWR filed the Subflow Report, the trial  
7 court adopted in part, rejected in part, and modified in part Special Master Thorson’s memorandum  
8 decisions on *de minimis* stockwatering, stockponds, and domestic water uses in the San Pedro River  
9 Watershed. The trial court adopted the special master’s definition of a *de minimis* domestic water use  
10 and the quantity to be adjudicated for the right. Special Master Thorson defined *de minimis* domestic  
11 water uses as “[i]ndividual domestic uses for single residences, when serving household purposes  
12 and associated outdoor activities on adjoining land not exceeding (=) 0.2 acres,” and determined that  
13 “[t]he quantity of ‘not to exceed 1 ac-ft/yr’ of water will be adjudicated for” those rights.<sup>245</sup>

14 The trial court also adopted Special Master Thorson’s definitions and quantifications for  
15 instream stockwatering and stockponds having a capacity of not more than 15 acre-feet used solely  
16 for stock or wildlife. The trial court directed ADWR to prepare future HSRs in accordance with the  
17 determinations adopted in the September 26, 2002, order.

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19 <sup>241</sup> *Id.* at 40.

20 <sup>242</sup> “The *de minimis* category would list the name of the present well owner, the well location to the nearest ¼  
21 ¼ section, the type of use (domestic *de minimis*), the place of use, and the quantity of use.” *Id.* The  
22 proposed catalog appears to be similar to Volume 8: *Catalogued Wells* of the Final San Pedro River  
23 Watershed HSR. Volume 8, however, reported for each listed well, if available, a “claimed date of first  
24 beneficial water use” and the “data source” of the reported information. Vol. 8, 6. Bella Vista agrees with  
ADWR but recommends that every well be catalogued using only the information required by A.R.S. § 45-  
596 to be set forth in a notice of intention to drill well. Comments on ADWR’s Subflow Report 9 (June 17,  
2002). The statute enumerates more information than ADWR recommends reporting in its proposed catalog.

<sup>243</sup> Subflow Report 40.

<sup>244</sup> *Id.* at 44.

<sup>245</sup> Memo. Decision 33 (Conclusions of Law No. 24 and No. 25).

1 ADWR recommends that *de minimis* water uses be catalogued and not be summarily  
2 adjudicated with water right attributes. It points to the holdings in *Gila II* that “the trial court may  
3 adopt a rationally based exclusion for wells having a de minimis effect on the river system,”<sup>246</sup> and in  
4 *Gila IV* that wells though pumping subflow which “have a de minimis effect on the river system may  
5 be excluded from the adjudication based on rational guidelines for such an exclusion....”<sup>247</sup> In *Gila*  
6 *II*, the Supreme Court held that “[a] properly crafted de minimis exclusion will not cause piecemeal  
7 adjudication of water rights or in any other way run afoul of the McCarran Amendment...it could  
8 simplify and accelerate the adjudication by reducing the work involved in preparing the hydrographic  
9 survey reports and by reducing the number of contested cases before the special master.”<sup>248</sup> ADWR  
10 submits that a catalog listing *de minimis* water rights is consistent with *Gila II* and *Gila IV* because  
11 exclusion does not include summary adjudication.

12 Special Master Thorson had the benefit of *Gila II* when he began (one month after *Gila II*  
13 was issued) the consolidated case that resulted in his memorandum decisions. In *Gila II*, the Supreme  
14 Court held that “a de minimis exclusion effectively allocates to those well owners whatever amount  
15 of water is determined to be de minimis. It is, in effect, a summary adjudication of their rights.”<sup>249</sup>  
16 (Emphasis added.) Special Master Thorson adopted procedures for the “summary adjudication” of *de*  
17 *minimis* uses. The procedures provided for the preparation of water right abstracts showing the  
18 characteristics or attributes of *de minimis* uses; incorporation of the abstracts into the special master’s  
19 catalog of proposed water rights for the watershed; allowing claimants to file objections to the  
20 abstracts but precluding resolution of objections concerning quantity of water; and incorporation of

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22 <sup>246</sup> 175 Ariz. at 394, 857 P.2d at 1248.

23 <sup>247</sup> 198 Ariz. at 344, 9 P.3d at 1083.

24 <sup>248</sup> 175 Ariz. at 394, 857 P.2d at 1248.

<sup>249</sup> *Id.*

1 all *de minimis* water rights in the final decree which would subject the rights to post-decree  
2 administration and enforcement against other water uses.<sup>250</sup>

3 Special Master Thorson concluded that these “summary procedures for *de minimis* uses  
4 accomplish the statutory purposes of the general stream adjudication to “[d]etermine the extent and  
5 priority date of and adjudicate any interest in or right to use the water of the river system and source  
6 .... ARIZ. REV. STAT. ANN. § 45-257(B)(1).”<sup>251</sup> He defined the term “summary adjudication” to  
7 mean “those procedures used by the court to adjudicate *de minimis* water uses in a simplified and  
8 expedited manner while safeguarding the statutory and due process rights of the litigants  
9 involved.”<sup>252</sup>

10 In its September 26, 2002, order the trial court specifically adopted Special Master Thorson’s  
11 definition of “summary adjudication” and ruled that “summary adjudication is appropriate to  
12 determine the attributes and characteristics of water uses that do not individually affect the water  
13 supply available to other claimants.”<sup>253</sup> The trial court has answered the issue ADWR’s  
14 recommendation raises. *De minimis* water uses within the San Pedro River Watershed will be  
15 summarily adjudicated with water right attributes and will receive a decreed water right.

16 A group of parties urges that ADWR be directed to propose guidelines for excluding  
17 agricultural, municipal, industrial, and other wells, not just domestic wells, which may have a *de*  
18 *minimis* effect on the river system.<sup>254</sup> This issue will best be considered at such time as ADWR and  
19 the parties have more new or updated data.

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22 <sup>250</sup> Memo. Decision 34-8 (What Summary Adjudication Procedures Are Appropriate?).

23 <sup>251</sup> *Id.* at 37; see A.R.S. § 45-252(A).

24 <sup>252</sup> *Id.* at 5.

<sup>253</sup> Order n.2, 2.

<sup>254</sup> Upper Valley Irrigation Districts’ Objection to ADWR’s Subflow Report 11 (June 17, 2002).

1 *Other Watersheds*

2 The argument has been made that the definitions of *de minimis* water uses “should be based  
3 on watershed specific tests to reflect the unique characteristics of each watershed....”<sup>255</sup> Special  
4 Master Thorson held a hearing to receive evidence specific to the San Pedro River Watershed  
5 regarding water availability in the watershed and to downstream users; the number of stockwatering,  
6 stockpond, and domestic uses; the number and impact of these uses; and the costs and benefits of  
7 adjudicating these water uses.<sup>256</sup> That matter integrated into the adjudication a practical concept of *de*  
8 *minimis* water uses and established procedures to define and adjudicate them. It is realistic to believe  
9 that a similar evidentiary hearing will be required in the other watersheds. The time to take up those  
10 issues is after the watershed HSR is filed. Some of the ground Special Master Thorson covered will  
11 not be revisited, but it is reasonable to believe that a watershed specific hearing will be necessary.

12 **Recommendation 35:** The Court should adopt Chapter 4 of the Subflow Report except the  
13 recommendation that *de minimis* uses not be summarily adjudicated with water right attributes, and  
14 to the extent Chapter 4 does not conflict with any other recommendation made in this report.

15 **V. IMPLEMENTATION OF PROCEDURES (Chapter 5 of the Subflow Report)**

16 **A. Should ADWR’s findings be reported in supplemental contested case**  
17 **hydrographic survey reports (HSRs) (“case-by-case”) or in a supplemental San Pedro River**  
18 **Watershed HSR (“the entire watershed”), which identifies the subflow zone, wells reaching and**  
19 **depleting a stream, and *de minimis* water rights?**

20 This was the fourth question briefed prior to the hearing, and a ruling was issued on  
21 September 8, 2003, subject to modification after considering the evidence presented during the  
22 hearing. The proposed ruling is adopted as the evidence is insufficient to modify it.

23 \_\_\_\_\_  
24 <sup>255</sup> Philip C. Briggs Decl. ¶ 9 (June 17, 2002). Claimants in the Verde River Watershed raised this issue.

<sup>256</sup> Order 3 (Sept. 26, 2002).

1           The trial court directed ADWR to include “[a] timeline for completion of the tasks outlined in  
2 the report” and to submit “[a] similar timeline for the Upper Gila River and Verde River  
3 watersheds....”<sup>257</sup> In the proposed ruling, the Special Master found that the term timeline connotes a  
4 reporting schedule and with the desire to move the adjudication forward, set a schedule for ADWR to  
5 file a technical report containing a map of the lateral extent of the subflow zone within the entire San  
6 Pedro River Watershed; investigate and supplement, as needed, the Final San Pedro River Watershed  
7 HSR; and publish a supplemental final HSR. Claimants would have one hundred and twenty days to  
8 file objections to ADWR’s report showing the map of the subflow zone, and one hundred and eighty  
9 days to file objections to the supplemental final HSR.

10           Some parties argue that under A.R.S. § 45-256(B) the technical assistance provided by  
11 ADWR must be set forth in a report filed with the trial court or the Special Master, and a claimant  
12 may file an objection to the report or any part of it within one hundred and eighty days of the date on  
13 which the report is filed. A.R.S. § 45-256(B) states in pertinent part:

14           The technical assistance rendered by the director shall be set forth in summary form  
15 on a claim by claim basis in a report prepared by the director and filed with the court  
16 or the master.... The report shall list all information that is obtained by the director  
17 and that reasonably relates to the water right claim or use investigated. The report  
18 shall also include the director's proposed water right attributes for each individual  
water right claim or use investigated.... If no water right is proposed in connection  
with an individual water right claim or use, the director's recommendations shall so  
indicate.... An objection shall specifically address the director's recommendations  
regarding the particular water right claim or use investigated. (Emphasis added.)

19           The Special Master interprets A.R.S. § 45-256(B) to mean that the 180-day objection period  
20 applies to a report that contains the information ADWR has compiled during its investigations and  
21 sets forth the department’s proposed attributes for each water right claim or use investigated. The  
22 180-day period applies to a watershed or a supplemental contested case HSR that reports on

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23  
24 <sup>257</sup> Ballinger Order 3.

1 individual water right claims. The technical report to which all claimants in the San Pedro River  
2 Watershed will have one hundred and twenty days to file objections will not contain ADWR's  
3 proposed water right attributes for any claim or use. The report will contain ADWR's map of the  
4 subflow zone and related analysis. A report that covers a discrete, albeit important, technical issue is  
5 not subject to the time periods prescribed by A.R.S. § 45-256(B).

6 One party does not disagree with the Special Master's proposed schedule, but requests that it  
7 be recommended that in other watersheds ADWR divide a stream into manageable segments and  
8 publish a supplemental HSR that contains the subflow analysis for each stream segment. The  
9 "segment-by-segment" approach, is suggested, would be fair, efficient, and speedy.

10 A great amount of experience will be gained from going through the process of delineating  
11 the subflow zone in the San Pedro River Watershed. The segment-by-segment approach may have  
12 merit in other watersheds, but a decision in that respect should await the experience gained by going  
13 through the process in the San Pedro River Watershed. Although a recommendation regarding this  
14 approach is not made in this report, the parties may make suggestions when ADWR begins, or is in a  
15 position that it can undertake concurrently, the subflow analysis in another watershed.

16 ADWR recommends that for each watershed the subflow zone be identified first, followed by  
17 the identification of *de minimis* water uses, and concluding with the cone of depression tests. The  
18 second and third phases "should only be implemented when the watershed is ready to be  
19 litigated...."<sup>258</sup> This implementation sequence is reasonable.

20 ADWR does not propose a sequential watershed schedule, but based on the trial court's  
21 February 21, 2003, order and Pre-Trial Order No. 1 Re: Conduct of Adjudication ¶ 12(B)(4) (May  
22 29, 1986), the Special Master recommends the following sequence for completing the subflow and

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23  
24 <sup>258</sup> Subflow Report 45.

1 cone of depression analysis in each watershed: San Pedro River; Verde River; Upper Gila River;  
2 Upper Salt River; Upper Agua Fria River; Lower Gila River; and Upper Santa Cruz River.

3 **Recommendation 36:** The Court should implement the following schedule in the San Pedro  
4 River Watershed:

5 A. After the Court considers the Special Master's report recommending the procedures and  
6 processes to delineate the subflow zone within the San Pedro River Watershed and a cone of  
7 depression test, ADWR is directed to prepare a map delineating the subflow zone for the entire San  
8 Pedro River Watershed. ADWR shall submit this map and related information in a technical report  
9 whose scope shall be limited to delineating the subflow zone and shall not set forth ADWR's  
10 proposed water right attributes for any individual water right claim or use.

11 B. Upon filing the technical report with the Court, ADWR shall send a notice to all claimants  
12 in the San Pedro River Watershed and to the persons listed in the Gila River Adjudication Court-  
13 Approved Mailing List informing them of the scope and availability of the report and of a claimant's  
14 right to file written objections to the report and of the deadline for filing objections.

15 C. Any claimant in the San Pedro River Watershed may file objections to ADWR's technical  
16 report within one hundred and twenty days of the date on which the report is filed. Objections shall  
17 be limited to ADWR's findings regarding the lateral extent of the subflow zone.

18 D. After considering the objections, the Court will approve a map that delineates the subflow  
19 zone within the San Pedro River Watershed.

20 E. Using the cone of depression test adopted by the Court, ADWR will analyze all wells  
21 located outside the lateral limits of the subflow zone to determine if a well's cone of depression  
22 reaches an adjacent subflow zone, and if continuing pumping will cause a loss of such subflow as to  
23 affect the quantity of the stream. ADWR will examine all water right claims to determine *de minimis*  
24

1 water rights in the San Pedro River Watershed in accordance with the Court's September 26, 2002,  
2 order. ADWR will investigate and supplement, as needed, its findings reported in the Final San  
3 Pedro River Watershed HSR.

4 F. ADWR will publish a Supplemental Final San Pedro River Watershed HSR reporting its  
5 findings and proposed water right attributes on a claim by claim basis, in accordance with A.R.S. §  
6 45-256(B), including wells withdrawing subflow, cone of depression analyses, *de minimis* water  
7 rights, and all other new or updated information.

8 G. ADWR shall send a notice of the filing of the Supplemental Final San Pedro River  
9 Watershed HSR to all claimants in the Gila River Adjudication, who may file objections within one  
10 hundred and eighty days of the date on which the report was filed.

11 **Recommendation 37:** The Court should adopt the same schedule for completing the subflow  
12 and cone of depression analysis in all the other watersheds in the Gila River Adjudication subject to  
13 modifications that may be proper as a result of experience with this process.

14 **Recommendation 38:** The Court should adopt the following sequence for completing the  
15 subflow and cone of depression analysis in each watershed: San Pedro River; Verde River; Upper  
16 Gila River; Upper Salt River; Upper Agua Fria River; Lower Gila River; and Upper Santa Cruz  
17 River.

18 **Recommendation 39:** The Court should adopt Chapter 5 of the Subflow Report to the extent  
19 it does not conflict with any other recommendation made in this report.

## 20 **VI. AVAILABILITY OF REPORT**

21 This report will be filed with the Clerk of the Maricopa County Superior Court, and a copy  
22 will be mailed to all persons listed on the Gila River Adjudication Court-Approved Mailing List and  
23 on those additional persons appearing in the certificate of service. An electronic copy will be posted  
24

1 at <http://www.supreme.state.az.us/wm/> on the *Gila River Adjudication* page. A transcript of the  
2 October 21-22, 2003, hearing and of the evidence and the original exhibits are at the Clerk's office.  
3 A printed copy of this report can be purchased from the office of the Special Master for \$8.00  
4 payable by check or money order.

## 5 **VII. MOTION FOR ADOPTION OF SPECIAL MASTER'S REPORT**

6 The Special Master recommends adoption of the recommendations made in this report and  
7 moves the Court, under Arizona Rule of Civil Procedure 53(h), to adopt each recommendation. A  
8 proposed order of adoption will be lodged as the Court may order upon consideration of the report.

## 9 **VIII. NOTICE OF SUBSEQUENT PROCEEDINGS**

10 Any claimant in the Gila River Adjudication may file a written objection to this report on or  
11 before September 1, 2004.<sup>259</sup> Responses to objections must be filed on or before October 1, 2004.  
12 Replies must be filed on or before October 29, 2004. Each objection should identify the related  
13 recommendation. Objections, responses, and replies must be filed with the Clerk of the Maricopa  
14 County Superior Court, Attn: Water Case, 601 West Jackson Street, Phoenix, Arizona 85003. Copies  
15 of pleadings must be served personally or by mail on all persons appearing on the most recent Gila  
16 River Adjudication Court-Approved Mailing List and on those additional persons named in the  
17 certificate of service. The hearing on the Special Master's motion to approve the report and on any  
18 objections to the report will be taken up as ordered by the Court. The "court after hearing may adopt  
19

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20 <sup>259</sup> The periods for filing objections to the report, responses, and replies are calculated under Ariz. R. Civ. P.  
21 53(h). As this report does not contain determinations of the relative water rights of any claimant, the time  
22 periods prescribed by A.R.S. § 45-257(A)(2) do not apply. The period for filing objections includes the ten-  
23 day period provided by Rule 53(h), not including intermediate Saturdays, Sundays, and legal holidays as  
24 specified by Ariz. R. Civ. P. 6(a). The ten-day period for filing responses and the five-day period for filing  
replies are specified in Ariz. R. Civ. P. 7.1(a). An additional five-day period when service has been made by  
mail is specified in Ariz. R. Civ. P. Rule 6(e). In order to allow time for the distribution of the monthly docket  
sheet to subscribers and reasonable time for all filings, the Special Master has added thirty days for objections  
and fifteen days for responses and replies.

1 the report or modify it or may reject it in whole or in part or may receive further evidence or may  
2 recommit it with instructions.”<sup>260</sup>

3 Submitted this 16th day of July, 2004.

4  
5 /s/ George A. Schade, Jr.  
6 GEORGE A. SCHADE, JR.  
*Special Master*

7 The original report was filed with the Clerk of the  
8 Maricopa County Superior Court on July 16, 2004,  
9 and was delivered to the Distribution Center for  
10 mailing to the persons listed on the Gila River  
Adjudication Court-Approved Mailing List dated  
October 6, 2003 (Attachment A) and to the  
following persons:

11 City of Benson  
12 Jennele Morris O’Hair, P.C.  
13 P. O. Box 568  
Vail AZ 85641-0568

14 Long Meadow Ranch Property Owners Association  
15 George E. Price, President  
12110 N. Antelope Run  
Prescott AZ 86305

16 Valory Strausser  
17 Lee A. Storey and Steve Wene  
18 Moyes Storey, Ltd.  
1850 N. Central Ave., Suite 1100  
Phoenix AZ 85004

19 Yavapai County Attorney’s Office  
20 M. Randolph Schurr  
255 East Gurley St., 3rd Floor  
Prescott AZ 86301

21 /s/ KDolge  
22 Kathy Dolge

23 \_\_\_\_\_  
24 <sup>260</sup> Ariz. R. Civ. P. 53(h).

# APPENDIX A-6

SUPERIOR COURT OF ARIZONA  
MARICOPA COUNTY

09/15/2005

CLERK OF THE COURT  
FORM V000

HONORABLE EDDWARD BALLINGER, JR.

M. Wetherell  
Deputy

W-1, W-2, W-3, W-4(Consolidated)  
Contested Case No. W1-103

FILED: September 28, 2005

In Re the General Adjudication  
of All Rights to Use Water in  
The Gila River System and Source

In Re Subflow Technical Report,  
San Pedro River Watershed

Order Re: Report of the Special Master on the Arizona Department  
of Water Resources' Subflow Technical Report, San Pedro River  
Watershed and Motion for Approval of Report

**Procedural Background**

In 2001, this Court requested that the Arizona Department of Water Resources ("ADWR" or the "Department") file a report describing how it proposed to determine the extent of stream subflow for purposes of setting the jurisdictional limits of this adjudication. On January 8, 2002, a hearing was held to consider ADWR's "Report Concerning Implementation of the Arizona Supreme Court's Decision on Subflow." On January 22, 2002, the Court directed the Department to prepare more specific and detailed recommendations addressing the following issues arising in the San Pedro River Watershed:

1. A proposal for determining the subflow zone including more than just consideration of the saturated lateral extent of the Holocene alluvium.

SUPERIOR COURT OF ARIZONA  
MARICOPA COUNTY

09/15/2005

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M. Wetherell  
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W-1, W-2, W-3, W-4(Consolidated)  
Contested Case No. W1-103

2. A test for determining if a well's cone of depression is withdrawing appropriable subflow.
3. A set of rational guidelines for determining whether a given well, though pumping subflow, has a *de minimis* effect on the river system.
4. A method for including both perennial and intermittent streams as part of the subflow analysis, including streams that were historically perennial or intermittent, but are now ephemeral due to development and other human actions.
5. A timeline for completing the tasks outlined in its report.<sup>1</sup>

ADWR's second subflow report was filed on March 29, 2002 (the "Subflow Report"). It specifically addressed each of the requests identified in the January 22, 2002, order. Various parties filed comments and objections to the report, some of which were supported by expert declarations. The Court referred consideration of Subflow Report issues to the Special Master with direction to consider the comments and objections, hold any necessary hearings, and make recommendations as to whether the report should be adopted or modified.<sup>2</sup>

After supervising discovery among the parties, considering expert declarations, and resolving a number of pre-hearing issues, the Special Master held a two-day evidentiary hearing at which the parties and their experts presented their positions on

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<sup>1</sup> Minute Entry ("M. E.") (Jan. 22, 2002).

<sup>2</sup> Order (Feb. 21, 2003).

SUPERIOR COURT OF ARIZONA  
MARICOPA COUNTY

09/15/2005

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W-1, W-2, W-3, W-4(Consolidated)  
Contested Case No. W1-103

the procedures proposed in the Subflow Report. Following post-hearing briefing and supplemental oral argument, the Special Master filed his "Report of the Special Master on the Arizona Department of Water Resources' Subflow Technical Report, San Pedro River Watershed; Motion for Approval of Report; and Notice of Subsequent Proceedings" (the "Special Master's Report"), which thoroughly evaluated the Subflow Report, summarized the parties' positions, and set forth the Special Master's recommendations. The Court received additional comments and objections to the report and held a hearing on July 13, 2005, to consider whether it should adopt the Special Master's recommendations and approve or modify the Subflow Report.

**The Subflow Zone**

This adjudication is charged with determining the rights of all persons to use the waters of the Gila River system and its sources pursuant to A.R.S. § 45-251 *et seq.* This task is complicated by Arizona's bifurcated system of water rights management. While all surface water is subject to this Court's jurisdiction, for decades Arizona courts have protected the rights of groundwater users by holding that surface water appropriation cannot extend to percolating subterranean water. *Maricopa County Mun. Water Conservation Dist. No. 1 v. Southwest*

SUPERIOR COURT OF ARIZONA  
MARICOPA COUNTY

09/15/2005

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W-1, W-2, W-3, W-4(Consolidated)  
Contested Case No. W1-103

*Cotton Co.*, 39 Ariz. 65, 4 P.2d 369 (1931), *modified and reh'g. denied*, 39 Ariz. 367, 7 P.2d 254 (1932) ("*Southwest Cotton*").<sup>3</sup>

If setting jurisdictional limits were as simple as declaring that surface water is appropriable while water found underground is not, the adjudication would be much nearer to completing its initial tasks of identifying and prioritizing appropriable water rights. But, although underground water is generally not part of this adjudication, it becomes appropriable if it can be characterized as subflow of a stream. Our Supreme Court has declared that subflow consists of "those waters which slowly find their way through the sand and gravel constituting the bed of the stream, or the lands under or immediately adjacent to the stream, and are themselves a part of the surface stream."<sup>4</sup>

As to how water is to be characterized as subflow, in *Gila II* the Arizona Supreme Court quoted with approval the test first announced in *Southwest Cotton*:

The best test which can be applied to determine whether underground waters are as a matter of fact and

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<sup>3</sup> In lieu of appropriative rights, groundwater users are permitted to withdraw water underlying their land subject only to the doctrine of reasonable use and federal reserved water rights. *In re the General Adjudication of All Rights to Use Water in the Gila River System and Source*, 175 Ariz. 382, 857 P.2d 1236 (1993) ("*Gila II*"); *In re the General Adjudication of All Rights to Use Water in the Gila River System and Source*, 195 Ariz. 411, 989 P.2d. 739 (1999) ("*Gila III*").

<sup>4</sup> *Southwest Cotton*, 39 Ariz. at 96, 4 P.2d at 380. The *Southwest Cotton* court explained that subflow "[i]n almost all cases ... is found within, or immediately adjacent to, the bed of the surface stream.... [and] physically ... constitute[s] a part of the subsurface stream itself, and [is] simply incidental thereto.... It is subject to the same rules of appropriation as the surface stream itself." *Gila II*, 175 Ariz. at 387, 857 P.2d at 1241 (quoting *Southwest Cotton*, 39 Ariz. at 96-97, 4 P.2d at 380-81).

SUPERIOR COURT OF ARIZONA  
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W-1, W-2, W-3, W-4(Consolidated)  
Contested Case No. W1-103

law part of the surface stream is that *there cannot be any abstraction of the water of the underflow without abstracting a corresponding amount from the surface stream*, for the reason that the water from the surface stream must necessarily fill the loose, porous material of its bed to the point of complete saturation before there can be any surface flow. (Emphasis in *Gila II*.)

. . . .

Not only does [subflow] move along the course of the river, but it percolates from its banks from side to side, and the more abundant the surface water the further will it reach in its percolations on each side. But, considered as strictly a part of the stream, the test is always the same: *Does drawing off the subsurface water tend to diminish appreciably and directly the flow of the surface stream?* If it does, it is subflow, and subject to the same rules of appropriation as the surface stream itself; if it does not, then, although it may originally come from the waters of such stream, it is not, strictly speaking, a part thereof, but is subject to the rules applying to percolating waters.<sup>5</sup> (Emphasis in *Southwest Cotton*.)

In 1987, the judge then assigned to this adjudication, the Honorable Stanley Z. Goodfarb (Retired), issued his first ruling as to which underground waters were to be considered appropriable subflow. The trial judge attempted to craft a practical subflow definition. He held extensive evidentiary hearings that included testimony from hydrologists and

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<sup>5</sup> *Gila II*, 175 Ariz. at 388, 857 P.2d at 1242 (quoting *Southwest Cotton*, 39 Ariz. at 96-97, 4 P.2d. at 380-81).

SUPERIOR COURT OF ARIZONA  
MARICOPA COUNTY

09/15/2005

CLERK OF THE COURT  
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W-1, W-2, W-3, W-4(Consolidated)  
Contested Case No. W1-103

hydrological engineers. He solicited memoranda of law from interested parties and utilized the services of the Department to arrive at a definition he believed would permit the adjudication to move forward. Because a number of parties objected to Judge Goodfarb's subflow determination, the Supreme Court accepted an interlocutory appeal of his order due to "the need to resolve the [subflow] question early in the proceeding."<sup>6</sup>

The Arizona Supreme Court rejected Judge Goodfarb's initial subflow definition and remanded consideration of the issue. It also provided guidance as to how the trial court should undertake to revise its subflow definition by setting forth specific criteria to be used in making this determination:

Whether a well is pumping subflow does not turn on whether it depletes a stream by some particular amount in a given period of time... [I]t turns on whether the well is pumping water that is more closely associated with the stream than with the surrounding alluvium... [C]omparison of such characteristics as elevation, gradient, and perhaps chemical makeup can be made. Flow direction can be an indicator. If the water flows in the same general direction as the stream, it is more likely related to the stream. On the other hand, if it flows toward or away from the stream, it likely is related to the surrounding alluvium.<sup>7</sup>

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<sup>6</sup> *Id.* at 386, 1244.

<sup>7</sup> *Id.* at 392, 1246. The specific factors listed in *Gila II* to determine whether water flows constitute subflow are referred hereinafter as the "*Gila II* Criteria".

SUPERIOR COURT OF ARIZONA  
MARICOPA COUNTY

09/15/2005

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W-1, W-2, W-3, W-4(Consolidated)  
Contested Case No. W1-103

Upon remand, Judge Goodfarb proceeded to hold additional hearings. He, along with party representatives and experts, traveled within the San Pedro River Watershed to learn about the area's hydrology and geology. After considering additional evidence relating to the relationship of groundwater to surface water, he issued a comprehensive order redefining "subflow."<sup>8</sup> Objections followed, causing the Arizona Supreme Court to expedite consideration of "whether, after remand in *Gila River II*, the trial court properly determined what underground water constitutes 'subflow' of a surface stream, thus making it appropriable under A.R.S. § 45-141(A)."<sup>9</sup>

In *Gila IV*, the Supreme Court approved Judge Goodfarb's second iteration of a subflow description. Twelve years after the Supreme Court's attempt "to resolve the question early," the adjudication court finds itself conducting hearings and considering arguments directed to the question of what is a fair and practical definition of subflow that will permit the Court to define its jurisdictional limits and fairly protect the rights of both surface and groundwater users.

The Subflow Report recommends adopting a number of procedures and assumptions in connection with mapping the subflow zone. Three questions related to these proposals have sparked the most controversy:

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<sup>8</sup> June 30, 1994, Order (the "Goodfarb Order").

<sup>9</sup> *Gila IV*, 198 Ariz. at 333, 9 P.3d at 1072.

SUPERIOR COURT OF ARIZONA  
MARICOPA COUNTY

09/15/2005

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FORM V000

HONORABLE EDDWARD BALLINGER, JR.

M. Wetherell  
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W-1, W-2, W-3, W-4(Consolidated)  
Contested Case No. W1-103

- Whether the Court should declare the entire saturated floodplain Holocene alluvium as comprising the limits of the subflow zone without further reference to the criteria announced in *Gila II*.<sup>10</sup>
- Should the Court assume, for jurisdictional purposes, that the entire floodplain Holocene alluvium is saturated?<sup>11</sup>
- Should the Court adopt the Special Master's recommendation that ADWR's subflow analysis be based upon predevelopment stream flow conditions?

**1. Extent of the Subflow Zone**

Those objecting to the first recommendation - that the Court find that the saturated floodplain Holocene alluvium is the subflow zone - argue that this proposal permits ADWR to ignore the *Gila II* Criteria approved by the Arizona Supreme Court.<sup>12</sup> They rely primarily on two related arguments to support this objection. First, they point to specific language in *Gila IV* that purportedly requires continued application of the *Gila II* Criteria when mapping subflow limits. They also claim that

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<sup>10</sup> ADWR answered this question affirmatively:

Upon remand from the Arizona Supreme Court, the trial court engaged in a lengthy hearing process, involving expert testimony on complex hydrogeologic principles, that culminated in a 66-page detailed order with 36 additional pages of exhibits. [citing *Gila IV*] The trial court applied the criteria described in *Gila II* and concluded that the saturated floodplain Holocene alluvium was the 'most credible' subflow zone....

Subflow Report at 2.

<sup>11</sup> ADWR urges adoption of this assumption. *Id.* at 17. ("The Department ... recommends that the entire lateral extent of the floodplain Holocene alluvium be assumed to be saturated for the purpose of delineating the jurisdictional subflow zone.")

<sup>12</sup> See, e.g., Arizona Public Service Company's and Phelps Dodge Corporation's Objections to the Special Master's Report on ADWR's Subflow Technical Report, San Pedro River Watershed (Oct. 1, 2004) ("APS/PD Objection") at 7.

SUPERIOR COURT OF ARIZONA  
MARICOPA COUNTY

09/15/2005

CLERK OF THE COURT  
FORM V000

HONORABLE EDDWARD BALLINGER, JR.

M. Wetherell  
Deputy

W-1, W-2, W-3, W-4(Consolidated)  
Contested Case No. W1-103

the *Gila IV* court did not intend to uphold a trial court ruling that the saturated floodplain Holocene alluvium constitutes the subflow zone. Instead, the Supreme Court simply held that this area comprised the outer limits within which the subflow zone exists. Within this announced area, ADWR is required to apply the *Gila II* Criteria to ascertain the subflow zone.<sup>13</sup> These objectors believe that the *Gila IV* decision requires ADWR to begin anew and undertake an extensive review of data that might prove relevant in mapping the subflow zone within the San Pedro River Watershed.<sup>14</sup>

As to the latter argument, the question is: In *Gila IV*, did the Arizona Supreme Court merely direct ADWR as to how and where to commence its inquiry regarding the extent of subflow within the San Pedro River Watershed? Or did the court adopt a standard permitting ADWR to map this Court's jurisdictional limits in an expeditious manner? The Special Master found that "the criteria specified in *Gila IV* to delineate the subflow zone have already been taken into account in the Supreme Court's holding that the

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<sup>13</sup> *Id.* at 8. ("The fact that the [Arizona Supreme Court] quoted and approved the [*Gila II* Subflow Criteria] does not ... support a conclusion that ADWR need not apply the criteria when it delineates the subflow zone. To the contrary, the Court's approval of the criteria makes them binding on ADWR. These criteria *define* the subflow zone, and they *must* be used by ADWR to identify its boundaries.") (Emphasis in original.)

<sup>14</sup> *Id.* at 10. ("ADWR should be instructed to obtain accurate and reliable data for purposes of identifying the subflow zone in *all circumstances.*") (Emphasis in original.)

SUPERIOR COURT OF ARIZONA  
MARICOPA COUNTY

09/15/2005

CLERK OF THE COURT  
FORM V000

HONORABLE EDDWARD BALLINGER, JR.

M. Wetherell  
Deputy

W-1, W-2, W-3, W-4(Consolidated)  
Contested Case No. W1-103

saturated floodplain Holocene alluvium is the subflow zone."<sup>15</sup>  
This Court agrees with this conclusion.

The *Gila IV* opinion explicitly recognizes that the trial court considered and applied each of the *Gila II* Criteria in connection with defining how the concept of subflow should be used to set jurisdictional limits:

[T]he record reflects that the court based its ruling on evaluation of the pertinent factors set forth in *Gila River II* for delineating the subflow zone. For example, the order states:

After consideration of flow direction, water level elevation, the gradation of water levels over a stream reach, the chemical composition if available, and lack of hydraulic pressure from tributary aquifer and basin fill recharge which is perpendicular to stream and "subflow" direction, the Court finds the most accurate of all the markers is the edge of the saturated floodplain Holocene alluvium.<sup>16</sup>

The Supreme Court noted that, "groundwater users conceded at oral argument, and the record reflects, that sufficient evidence supports the trial court's factual findings, which adopted the saturated floodplain Holocene alluvium as the subflow zone."<sup>17</sup>  
The objectors cannot overcome the opinion's directive that

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<sup>15</sup> Special Master's Report at 42.

<sup>16</sup> *Gila IV*, 198 Ariz. at 337, 9 P.3d at 1076.

<sup>17</sup> *Id.* at 339, 1078. The Court's footnote reference (n.5) approving the factual finding that the saturated floodplain Holocene alluvium is the subflow zone shows that the trial court's subflow zone definition incorporated the *Gila II* Criteria.

SUPERIOR COURT OF ARIZONA  
MARICOPA COUNTY

09/15/2005

CLERK OF THE COURT  
FORM V000

HONORABLE EDDWARD BALLINGER, JR.

M. Wetherell  
Deputy

W-1, W-2, W-3, W-4(Consolidated)  
Contested Case No. W1-103

"[t]he entire saturated floodplain Holocene alluvium, as found by DWR, will define the subflow zone in any given area."<sup>18</sup> The opinion makes clear that ADWR is not to generally consider again the *Gila II* Criteria in an effort to undertake again the work that resulted in the trial court's factual findings. To the contrary, the Supreme Court anticipated that mapping the jurisdictional limits of the subflow zone would be relatively simple:

The record reflects that the saturated floodplain Holocene alluvium is readily identifiable; that DWR can quickly, accurately, and relatively inexpensively determine the edge of that zone; and that some of the work already has been done.<sup>19</sup>

**2. Assuming Floodplain Holocene Alluvium Saturation**

In mapping the subflow zone, ADWR proposes to assume that the entire extent of the floodplain Holocene alluvium is

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<sup>18</sup> *Id.* at 342, 1081.

<sup>19</sup> *Id.* The objectors claim their position is supported by the fact that in concluding that the subflow zone is comprised of the saturated floodplain Holocene alluvium, the *Gila IV* court also added that ADWR "will determine the specific parameters of that zone in a particular area by evaluating all of the applicable and measurable criteria set forth in the trial court's order and any other relevant factors." *Gila IV*, 198 Ariz. at 344, 9 P.3d at 1083. But *Gila IV* dealt with an order delineating the limits of the subflow zone in the San Pedro River Watershed. The quoted language merely demonstrates the Supreme Court's openness to ADWR considering data, in addition to that found by the trial court, when evaluating other watersheds. *Id.* at 342, 1081. (The entire saturated floodplain Holocene alluvium defines the subflow zone in the San Pedro River Watershed. As to other watersheds, "[i]n the effort to determine [the subflow zone] in other areas, the detailed criteria set forth in the trial court's order, insofar as they apply and are measurable, must be considered, but we do not preclude the consideration of other criteria that are geologically and hydrologically appropriate for the particular location."). As the Special Master's Report recognizes, even within the San Pedro watershed there may be discrete stream segments where ADWR is required to supplement its findings based upon sound and appropriate geological and hydrological principles. Special Master's Report at 42; see *Gila IV*, 198 Ariz. at 342, 9 P.3d at 1081, n.7.

SUPERIOR COURT OF ARIZONA  
MARICOPA COUNTY

09/15/2005

CLERK OF THE COURT  
FORM V000

HONORABLE EDDWARD BALLINGER, JR.

M. Wetherell  
Deputy

W-1, W-2, W-3, W-4(Consolidated)  
Contested Case No. W1-103

saturated.<sup>20</sup> The Department believes this assumption is required because the two factors determining the extent of saturation - the thickness of the floodplain Holocene alluvium and the depth to the water table beneath the floodplain - are highly variable, both spatially and temporally.<sup>21</sup> Attempts to measure floodplain geology or the depth of the water table at any given point in time are frustrated due to the lack of reliable, contemporaneous data. The Subflow Report states:

[A]n accurate determination of the saturated portion of the floodplain Holocene alluvium is impractical for three reasons:

- Difficulties in defining the thickness of the floodplain Holocene alluvium;
- The general lack of detailed and long-term water level data from the floodplain; and
- The dynamic nature of the floodplain aquifer system.

The Department, therefore, recommends that the entire lateral extent of the floodplain Holocene alluvium be assumed to be saturated for the purpose of delineating the jurisdictional subflow zone.<sup>22</sup>

Some opposing adoption of the Department's saturation assumption stress that:

1. The floodplain Holocene alluvium is not stable. At numerous times, it is not fully saturated; and

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<sup>20</sup> Special Master's Report at 52; Subflow Report at 13 & 17.

<sup>21</sup> Subflow Report at 13.

<sup>22</sup> *Id.* at 16-17.

SUPERIOR COURT OF ARIZONA  
MARICOPA COUNTY

09/15/2005

CLERK OF THE COURT  
FORM V000

HONORABLE EDDWARD BALLINGER, JR.

M. Wetherell  
Deputy

W-1, W-2, W-3, W-4(Consolidated)  
Contested Case No. W1-103

2. The lack of data regarding the extent of saturation within the floodplain Holocene alluvium does not justify adopting an inaccurate assumption.<sup>23</sup>

The Special Master agrees with the objectors and recommends that the Court not approve and adopt ADWR's saturation assumption recommendation. He concluded that ADWR's recommendation does not comport with the directive in *Gila IV* "that any test used for determining the boundaries of a subflow zone be as accurate and reliable as possible."<sup>24</sup> Accuracy is paramount because in *Gila II*, the Supreme Court held that if ADWR uses an appropriate test to delineate the subflow zone, its determination would constitute clear and convincing evidence that a well within the zone is pumping appropriable water.<sup>25</sup> Because saturation fluctuates within the floodplain Holocene alluvium, the Special Master found ADWR's assumption inconsistent with *Gila IV*.<sup>26</sup> He concluded that the question of whether a segment of the floodplain Holocene alluvium is saturated is only relevant on the date a well is tested:

The evidence ... shows saturation fluctuates even in predevelopment conditions, and a thin upper portion of the floodplain Holocene alluvium is unsaturated.

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<sup>23</sup> See ASARCO Incorporated's and Arizona Water Company's Response to Other Parties' Objections to the Report of the Special Master (Nov. 1, 2004) ("ASARCO's Response") at 5-9.

<sup>24</sup> Special Master's Report at 56 (quoting *Gila IV*, 198 Ariz. at 335, 9 P.3d at 1074).

<sup>25</sup> In *Gila IV*, the Court stated, "it is critical that any test used for determining the boundaries of a subflow zone be as accurate and reliable as possible. Otherwise, use of an inaccurate test to determine whether a well is pumping subflow would not satisfy the clear and convincing evidentiary standard...." *Gila IV*, 198 Ariz. at 335, 9 P.3d at 1074; Special Master's Report at 56, n.130.

<sup>26</sup> Special Master's Report at 57.

SUPERIOR COURT OF ARIZONA  
MARICOPA COUNTY

09/15/2005

CLERK OF THE COURT  
FORM V000

HONORABLE EDDWARD BALLINGER, JR.

M. Wetherell  
Deputy

W-1, W-2, W-3, W-4(Consolidated)  
Contested Case No. W1-103

To include a well in the adjudication, it is not enough to determine it is highly probable the entire lateral extent of the floodplain Holocene alluvium was saturated at some point. It must be shown it is highly probable the well is pumping subflow from the saturated floodplain Holocene alluvium. (Emphasis supplied.)<sup>27</sup>

Both at the time the trial court issued the Goodfarb Order declaring the lateral extent of the subflow zone, and later when *Gila IV* affirmed that order, the dynamic nature of river channels and alluvial basins was well known. The Goodfarb Order reflects that the trial court was fully aware of this characteristic when it was considering subflow issues. The order recites examples of flow changes (e.g., stream channel migration and shifting) that caused the trial court to conclude that river channels are not stable.<sup>28</sup> The trial and appellate courts held that, notwithstanding these variables, the floodplain Holocene alluvium "is the only stable geologic unit which is beneath and adjacent to most rivers and streams ... [and] in order to fulfill the definition of 'subflow,' the geologic unit must be saturated because of the need for a hydraulic connection between the stream and the 'subflow'."<sup>29</sup>

*Gila IV* embodies the Supreme Court's decision that the jurisdictional limits of this adjudication extend to the

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<sup>27</sup> *Id.*

<sup>28</sup> Goodfarb Order at 40.

<sup>29</sup> Goodfarb Order at 56; *Gila IV*, 198 Ariz. at 337, 9 P.3d at 1076.

SUPERIOR COURT OF ARIZONA  
MARICOPA COUNTY

09/15/2005

CLERK OF THE COURT  
FORM V000

HONORABLE EDDWARD BALLINGER, JR.

M. Wetherell  
Deputy

W-1, W-2, W-3, W-4(Consolidated)  
Contested Case No. W1-103

floodplain Holocene alluvium determined at a time of saturation. In upholding the trial court's subflow standard, the Supreme Court quoted with approval the finding that:

The evidence ... shows that the only true geologic unit which is beneath and adjacent to the stream is the floodplain Holocene alluvium. When it is saturated, that part of the unit qualifies as the "subflow zone"....<sup>30</sup>

After more than a decade of dispute, study, and argument, the Arizona Supreme Court provided this adjudication with the following practical (at least with respect to the San Pedro River Watershed) jurisdictional boundary: All surface streams, their sources, and the subflow found within the saturated floodplain Holocene alluvium.

The Goodfarb Order's subflow definition strikes an appropriate balance between surface water and groundwater rights by initially setting the parameters of the subflow zone narrowly.<sup>31</sup> It also employs reasonable assumptions based upon reliable data to include water uses within this limited area in the adjudication. To insure that groundwater users are not unfairly included within the adjudication, our courts have rejected attempts to expand the scope of the subflow zone to

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<sup>30</sup> *Gila IV*, 198 Ariz. at 337, 9 P.3d at 1076.

<sup>31</sup> In *Gila IV*, the Supreme Court commented on the trial court's compliance with the direction in *Gila II* that the subflow zone be narrowly construed: "contrary to the groundwater users' argument that the trial court's definition of subflow is broader than *Gila River II* and *Southwest Cotton* permit, the record reflects that saturated floodplain Holocene alluvium occupies only very narrow portions of the alluvial basins." *Gila IV*, 198 Ariz. at 342, 9 P.3d at 1081.

SUPERIOR COURT OF ARIZONA  
MARICOPA COUNTY

09/15/2005

CLERK OF THE COURT  
FORM V000

HONORABLE EDDWARD BALLINGER, JR.

M. Wetherell  
Deputy

W-1, W-2, W-3, W-4(Consolidated)  
Contested Case No. W1-103

include the entire floodplain alluvium underlying surface waterways and have limited the adjudication's jurisdiction to the Holocene alluvium because it constitutes "the only stable geologic unit which is beneath and adjacent to most rivers and streams..."<sup>32</sup>

It is important to note that determination of the subflow zone does not adversely affect substantive rights of surface or groundwater users. It merely sets parameters with respect to the Court's water use inquiry. As some parties have mentioned, "Arizona is currently in the depths of an extended and severe drought. This drought, a natural and recurring event, has undoubtedly had an effect on the saturated extent of the Holocene alluvium."<sup>33</sup> Should the dynamic nature of a river or stream exclude water users from this Court's jurisdiction who would have been subject to having their rights declared when the proceeding was initiated?<sup>34</sup> While the Special Master and the objectors are correct that the Supreme Court has directed that ADWR and this Court insure that determinations are as accurate

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<sup>32</sup> Goodfarb Order at 56; Special Master's Report at 33.

<sup>33</sup> Arizona Public Service Company's and Phelps Dodge Corporation's Response to Objections to the Special Master's Report on ADWR's Subflow Technical Report, San Pedro River Watershed (Nov. 1, 2004) ("APS/PD Response") at 6-7.

<sup>34</sup> The Apache Tribes correctly point out that Arizona's river systems' dynamic nature, coupled with the fact that ADWR must map various subflow zones in phases, dictates that any temporally limited measurement would be arbitrary. Apache Tribes' Response to the Objections of Certain Parties to the Report of the Special Master on Arizona Department of Water Resources' Subflow Technical Report (Nov. 1, 2004) ("Apache Tribes' Response") at 8-9.

SUPERIOR COURT OF ARIZONA  
MARICOPA COUNTY

09/15/2005

CLERK OF THE COURT  
FORM V000

HONORABLE EDDWARD BALLINGER, JR.

M. Wetherell  
Deputy

W-1, W-2, W-3, W-4(Consolidated)  
Contested Case No. W1-103

as possible, it also has consistently acknowledged that "subflow" is an "artificial and fluid" term that has purely legal, as opposed to scientific or hydrological relevance.<sup>35</sup> The Supreme Court has made clear that the adjudication court is authorized to adopt reasonable assumptions in order to permit the adjudication to fulfill its functions.<sup>36</sup>

ADWR's saturation assumption is reasonable, practical, and consistent with the goal of permitting this adjudication to be completed "within the lifetime[s] of some of those presently working on the case"<sup>37</sup> (or at least their children's). And the Supreme Court's requirement that subflow be narrowly defined, coupled with the specific recognition that even wells pumping *de minimis* amounts of subflow may be excluded from the

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<sup>35</sup> *Gila II*, 175 Ariz. at 392, 857 P.2d at 1246; *Gila IV*, 198 Ariz. at 334, 9 P.3d at 1073.

<sup>36</sup> *Gila IV* explicitly recognized this Court's duty to balance accuracy and expediency in undertaking adjudication tasks when it discussed establishing a test for determining the cone of depression created by withdrawals from a well:

The [trial] court recognized that each well must be separately evaluated "to compute drawdown at the 'subflow' zone" and that "whatever test ADWR finds is realistically adaptable to the field and whatever method is the least expensive and delay-causing, yet provides a high degree of reliability, should be acceptable."

We agree with the trial court.

*Gila IV*, 198 Ariz. at 343, 9 P.3d at 1082 (quoting Goodfarb Order at 62).

Likewise, in rejecting the argument that even water claims having a *de minimis* effect on stream flow must be subject to the lengthy adjudication process, the Supreme Court noted, "[p]resumably, Congress expected that water rights adjudications would eventually end. It is sensible to interpret the McCarran Amendment as permitting the trial court to adopt reasonable simplifying assumptions to allow us to finish these proceedings within the lifetime of some of those presently working on the case." *Gila II*, 175 Ariz. at 394, 857 P.2d at 1248.

<sup>37</sup> *Gila II*, 175 Ariz. at 394, 857 P.2d at 1248.

SUPERIOR COURT OF ARIZONA  
MARICOPA COUNTY

09/15/2005

CLERK OF THE COURT  
FORM V000

HONORABLE EDDWARD BALLINGER, JR.

M. Wetherell  
Deputy

W-1, W-2, W-3, W-4(Consolidated)  
Contested Case No. W1-103

adjudication, ensures that groundwater users' rights will be protected.

**3. Use of Predevelopment or Current Conditions**

Assuming the floodplain Holocene alluvium is saturated requires adopting a standard not entirely tied to current geological and hydrological conditions. The subflow definition incorporating this assumption uses historical data to prevent hydrological conditions during a specific timeframe from having a disproportionate impact on the adjudication's jurisdictional limits.<sup>38</sup> Some claimants urge the Court to expand on this concept when mapping the subflow zone. They believe that it would be unfair for ADWR to undertake an analysis that determines stream flows based solely upon current conditions. These parties argue that utilizing only current conditions runs the risk of "allow[ing] those who are wrongfully and illegally using appropriable water to continue to do so and would make it more likely that the hydrologic connection between the underground

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<sup>38</sup>ADWR states:

Due to variations in the depth of the water table, the portion of the floodplain Holocene alluvium that is saturated changes over time, making the determination of the jurisdictional subflow zone difficult. And these variations are not unique to recent times, but apparently also occurred during predevelopment conditions....

.....  
The variety of conditions ... were present ... during both predevelopment and recent times making a determination of the water levels only possible at a particular point in time.

SUPERIOR COURT OF ARIZONA  
MARICOPA COUNTY

09/15/2005

CLERK OF THE COURT  
FORM V000

HONORABLE EDDWARD BALLINGER, JR.

M. Wetherell  
Deputy

W-1, W-2, W-3, W-4(Consolidated)  
Contested Case No. W1-103

water and the surface stream is broken."<sup>39</sup> They suggest that using a current conditions methodology will promote disparate treatment between those whose claims are adjudicated earlier vs. later in the adjudication process.<sup>40</sup>

Those objecting to ADWR's use of the alternative to a current conditions methodology - predevelopment stream flow analysis - argue that "predevelopment" is an ambiguous, indeterminate standard, and that there is no accurate, reliable data available to establish appropriate predevelopment conditions.<sup>41</sup> They also point to a portion of the Goodfarb Order's definition of subflow they contend establishes that only current stream flow conditions are relevant.<sup>42</sup>

The Special Master considered whether predevelopment or current conditions data should be used when calculating stream flows. The issue was separately briefed and a provisional ruling issued. After considering additional arguments and evidence, the

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<sup>39</sup> Salt River Project's Response to Objections to Special Master's Subflow Report (Nov. 1, 2004) ("SRP's Response") at 14.

<sup>40</sup> *Id.* at 14-15 ("If the [effective] date is when ADWR performs [its subflow] analysis, each pumper would have [a] substantial incentive to make sure that the watershed in which its well is located would be analyzed as close to the end of these proceedings as possible.") Apache Tribes' Response at 9-10 (It would be unjust "for a claimant to be able to 'pump his way out' of ... the jurisdiction of the Court by depleting the subflow zone ... in order to create 'current stream conditions' that are ephemeral").

<sup>41</sup> APS/PD Objections at 12; Objections of ASARCO Incorporated and Arizona Water Company to the Report of the Special Master on the Arizona Department of Water Resource's Subflow Technical Report (Oct. 1, 2004) ("ASARCO's Objections") at 8-11; Bella Vista Water Co., Inc., Pueblo Del Sol Water Co. and City of Sierra Vista Objections to the Report of the Special Master on the Arizona Department of Water Resource's Subflow Technical Report (Oct. 1, 2004) ("Bella Vista's Objections") at 4-6.

<sup>42</sup> See, e.g., APS/PD Objections at 18-19.

SUPERIOR COURT OF ARIZONA  
MARICOPA COUNTY

09/15/2005

CLERK OF THE COURT  
FORM V000

HONORABLE EDDWARD BALLINGER, JR.

M. Wetherell  
Deputy

W-1, W-2, W-3, W-4(Consolidated)  
Contested Case No. W1-103

Special Master expanded on and modified his original determination.<sup>43</sup> His report lists various timeframes targeting periods beginning as early as 1848 to as late as 1978, which some parties suggested as appropriate predevelopment reference points. The Special Master recognized that any period selected "must consider the feasibility of obtaining the requisite technical data and evidence; potential delay and expense of those efforts and of subsequent investigations; level of accuracy and reliability of the subflow analysis; confidence of meeting the clear and convincing evidentiary standard; and fairness."<sup>44</sup> He found that ADWR has not yet had the opportunity to obtain and review maps, reports, and other documents evidencing predevelopment conditions and, therefore, "[i]t is premature to conclude that ADWR cannot obtain reliable evidence of predevelopment stream flow conditions."<sup>45</sup>

In 2002, this Court stated its belief that a proper analysis of subflow required consideration of stream conditions "prior to widespread diversion and depletion of Arizona's stream

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<sup>43</sup> The Special Master's Report discusses the claim that both the adjudication and appellate courts have already ruled that current conditions must be used in making subflow zone determinations. After a thorough review of the relevant history of the adjudication, the Special Master properly rejected the argument that "the trial court ruled, and was affirmed by the Supreme Court, that subflow analysis must consider current and not predevelopment stream flow conditions, entitling the affirmed ruling to *stare decisis*." Special Master's Report at 47.

<sup>44</sup> *Id.* at 51.

<sup>45</sup> *Id.* at 50.

SUPERIOR COURT OF ARIZONA  
MARICOPA COUNTY

09/15/2005

CLERK OF THE COURT  
FORM V000

HONORABLE EDDWARD BALLINGER, JR.

M. Wetherell  
Deputy

W-1, W-2, W-3, W-4(Consolidated)  
Contested Case No. W1-103

flows.”<sup>46</sup> The Special Master’s Report correctly recognizes that “widespread diversion” does not refer to every activity occurring within a water system. The predevelopment stream flow conditions ADWR considers in its stream flow analysis should be those existing during an identifiable chronological year or range of years immediately prior to regular, discernable diversion or depletion of stream flows resulting from human activity.

The Court agrees with those suggesting ADWR should take a practical approach and adopt the earliest predevelopment timeframe for which accurate and reliable data is available. The Department may find the appropriate predevelopment period differs even within various watersheds due to the quantity and quality of available data. The Department may use its discretion in excluding from its analysis human generated depletions or diversions it concludes were minimal, localized, or sporadic. This approach will ensure the adjudication adopts a jurisdictional standard that assures surface water users that their rights are not prejudiced by the mere passage of time, while recognizing the legal protections supplied groundwater users.

Objectors arguing that the adopted subflow definition restricts stream flow analysis to current conditions rely on the following two guidelines found in the Goodfarb Order:

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<sup>46</sup> M. E. 2, n.1, *supra*.  
Docket Code 000

SUPERIOR COURT OF ARIZONA  
MARICOPA COUNTY

09/15/2005

CLERK OF THE COURT  
FORM V000

HONORABLE EDDWARD BALLINGER, JR.

M. Wetherell  
Deputy

W-1, W-2, W-3, W-4(Consolidated)  
Contested Case No. W1-103

1. The "subflow" zone must be adjacent and beneath a perennial or intermittent stream.
2. *It may not be adjacent or beneath an ephemeral stream. However, it may be adjacent or beneath an ephemeral section of a perennial or intermittent stream, if the ephemeral section is caused by adjacent surface water diversion or groundwater pumping.* There must, however, be a saturated zone beneath connected to similar zones beneath the upper and lower perennial or intermittent stream sections. (Emphasis supplied.)<sup>47</sup>

Some parties refer to the italicized language above as the "ephemeral stream exception."

Those urging use of current conditions assert that the "ephemeral stream exception language demonstrates that the trial judge intended that the subflow exception be adjudicated under current and not predevelopment conditions because no groundwater pumping or surface water diversion existed" in the predevelopment era.<sup>48</sup> They believe that any proposed definition of "predevelopment" is automatically at odds with the ephemeral stream exception because the diversions and depletions mentioned in the exception could not have occurred in a predevelopment period.<sup>49</sup>

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<sup>47</sup> Goodfarb Order at 35.

<sup>48</sup> Cities' [of Chandler, Glendale, Mesa, and Scottsdale] Response to Comments and Objections to Special Master's Subflow Report on the Arizona Department of Water Resources' Subflow Technical Report (Nov. 1, 2004) ("Cities' Response") at 5.

<sup>49</sup> APS/PD Objections at 19.

SUPERIOR COURT OF ARIZONA  
MARICOPA COUNTY

09/15/2005

CLERK OF THE COURT  
FORM V000

HONORABLE EDDWARD BALLINGER, JR.

M. Wetherell  
Deputy

W-1, W-2, W-3, W-4(Consolidated)  
Contested Case No. W1-103

Although finding that no court has resolved the predevelopment or current conditions dispute, the Special Master found "that in order to give effect to the plain language of the exception, and incorporate it into the subflow analysis, the applicability of the ephemeral stream exception must be determined using post-development conditions."<sup>50</sup> This Court believes that when read in proper context, the ephemeral stream exception supports use of predevelopment conditions to delineate the subflow zone.

At its core, the Goodfarb Order provides that the subflow zone may only be comprised of areas related to perennial and intermittent streams. That is the rule. No ephemeral streams may be included. The exception to this rule arises when evaluating streams that would legitimately be categorized as ephemeral, but only because of the effect of surface water diversions or groundwater pumping. The exception requires, in effect, that these streams be considered in a predevelopment state. That is, if one assumes away the effects of diversions and pumping, would the subject streams share the characteristics of an adjacent intermittent or perennial stream? If the answer is "yes," they can be included within the subflow zone due to their predevelopment attributes. Instead of an admonition to use only current conditions, the ephemeral stream exception is evidence that the Goodfarb Order contemplated that ADWR would outline the

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<sup>50</sup> Special Master's Report at 47.  
Docket Code 000

SUPERIOR COURT OF ARIZONA  
MARICOPA COUNTY

09/15/2005

CLERK OF THE COURT  
FORM V000

HONORABLE EDDWARD BALLINGER, JR.

M. Wetherell  
Deputy

W-1, W-2, W-3, W-4(Consolidated)  
Contested Case No. W1-103

subflow zone without having to be concerned that human generated water diversions or depletions might artificially divest jurisdiction over water right claims this Court is charged with adjudicating.

The remainder of the Special Master's recommendations concerning subflow analysis, namely Recommendation Nos. 1 through 10, 18, and 19, provide guidance as to how ADWR should map the subflow zone and are less controversial than those discussed above. The parties and this Court generally agree that the Department should incorporate the definitions of "perennial, intermittent and ephemeral streams" announced in the Goodfarb Order, consider a wide variety of resources (e.g., historical data, scientific reports, aerial photography, and field studies) when attempting to locate all the streams within a watershed, and take special care to ensure that the mapping methods used are as accurate as possible.<sup>51</sup>

### **The Cone of Depression Test**

In *Gila IV*, the Arizona Supreme Court held that the rights to withdraw water from some wells located outside of the jurisdictional subflow zone are to be adjudicated by this Court. The included wells are those:

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<sup>51</sup> *Id.* at 24-39. In approving the Special Master's Report Recommendation No. 6, which provides that "[t]he Court should direct ADWR to exclude from the subflow analysis the ephemeral streams shown in the NRCS soils survey maps," the Court does not intend to modify its ruling as to how ADWR is to apply the ephemeral stream exception when mapping the subflow zone.

SUPERIOR COURT OF ARIZONA  
MARICOPA COUNTY

09/15/2005

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M. Wetherell  
Deputy

W-1, W-2, W-3, W-4(Consolidated)  
Contested Case No. W1-103

[L]ocated outside the lateral parameters of the defined 'subflow' zone ... [whose] 'cones of depression' reach the 'subflow' zone and the drawdown from the well affects the volume of surface and 'subflow' in such an appreciable amount that is capable of measurement... [A] well may be subject to the adjudication if its 'cone of depression' caused by its pumping has now extended to a point where it reaches an adjacent 'subflow' zone, and by continual pumping will cause a loss of such 'subflow' as to affect the quantity of the stream.<sup>52</sup>

In response to this Court's request, ADWR devised a method for determining whether water pumped from a well located outside the subflow zone creates a cone of depression that intercepts and withdraws subflow. The second series of issues discussed in the Special Master's Report address the recommendations for implementing the Department's proposals for measuring cones of depression created by well pumping.

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<sup>52</sup> *Gila IV*, 198 Ariz. 342-43, 9 P.3d 1081-82.

SUPERIOR COURT OF ARIZONA  
MARICOPA COUNTY

09/15/2005

CLERK OF THE COURT  
FORM V000

HONORABLE EDDWARD BALLINGER, JR.

M. Wetherell  
Deputy

W-1, W-2, W-3, W-4(Consolidated)  
Contested Case No. W1-103

**1. Testing Standards and Techniques**

ADWR proposes an eleven-step cone of depression test.<sup>53</sup> The Department recommends that determinations should be made on a well-by-well basis, but that some components of its test should be combined to permit more efficient collection of data relating to wells located within a general area. To increase efficiency and reliability, the Department desires to use analytical and numerical models as part of its testing process. The Special Master's Report describes these models as "sets of mathematical flow equations whose solutions yield simulations of the behavior of aquifers in response to stresses."<sup>54</sup> Use of models is intended to provide ADWR with a simplified representation of an aquifer based upon available hydrogeologic information concerning local conditions and aquifer properties. When mapping the subflow zone in an area comprised of simple geology, ADWR proposes to use an

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<sup>53</sup> The Department will:

1. Determine well location, elevation, and distance from jurisdictional subflow zone;
2. Determine pumping history;
3. Determine frequency of pumping;
4. Determine how the well was constructed;
5. Characterize local hydrogeologic conditions;
6. Define local aquifer properties;
7. Construct a conceptual model of the aquifer system;
8. Select a mathematical model;
9. Input data and run a simulation using mathematical model;
10. Analyze model output; and
11. Determine whether a well should be adjudicated.

Subflow Report at 23.

<sup>54</sup> Special Master's Report at 74

SUPERIOR COURT OF ARIZONA  
MARICOPA COUNTY

09/15/2005

CLERK OF THE COURT  
FORM V000

HONORABLE EDDWARD BALLINGER, JR.

M. Wetherell  
Deputy

W-1, W-2, W-3, W-4(Consolidated)  
Contested Case No. W1-103

analytical computer program to determine a well's cone of depression. When confronted with areas in which an aquifer is more complex, the Department will shift to a numerical model, the use of which is more time consuming and requires supplemental field data for proper calibration.

In order for a well to be included in the adjudication, ADWR suggests that two conditions must be met as of the time of the modeling:

1. The well's "simulated cone of depression has reached the edge of the jurisdictional subflow zone and drawdown at that point is greater than or equal to 0.1 foot;" and
2. The "water level in the well is *below* the water level in the jurisdictional subflow zone during pumping..." (Emphasis in Subflow Report.)<sup>55</sup>

Criticism of the 0.1 foot standard focuses on the claim that ADWR's computer models cannot provide consistently accurate measurements of the extent of drawdown at the edge of the subflow zone.<sup>56</sup> Objectors concede it is possible to obtain accurate water level measurements at 0.1 foot increments, but argue these results cannot be acquired solely by using the

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<sup>55</sup> Subflow Report at 31.

<sup>56</sup> One claimant asserts that the Goodfarb Order held that the 0.1 foot criterion couldn't be used. ASARCO's Objections at 13. The Court agrees with the Special Master that the trial court's belief in 1994 that drawdown measurements at 0.1 foot increments would be "difficult" proved to be incorrect and, in any event, does not serve as an impediment to adopting an appropriate method for evaluating a cone of depression. Special Master's Report at 63.

SUPERIOR COURT OF ARIZONA  
MARICOPA COUNTY

09/15/2005

CLERK OF THE COURT  
FORM V000

HONORABLE EDDWARD BALLINGER, JR.

M. Wetherell  
Deputy

W-1, W-2, W-3, W-4(Consolidated)  
Contested Case No. W1-103

models endorsed by the Department.<sup>57</sup> They claim that absent field test corroboration, ADWR's use of computer modeled simulated water levels will fail to satisfy the requisites for cone of depression measurements announced in *Gila IV*.

The Special Master carefully considered arguments for and against ADWR's proposal and concluded:

*Gila IV* requires that the cone of depression test must yield results with a high degree of reliability. Under the clear and convincing evidentiary standard, ADWR's determination that a well's cone of depression impacts the subflow zone means it is highly probable the cone of depression has reached the edge of the subflow zone. The Special Master finds that a computer model's simulation of a greater than or equal to 0.1 foot drawdown can satisfy the degree of reliability required by *Gila IV* and the highly probable standard of clear and convincing evidence. The requisite reliability will depend ... on the quality and quantity of parameter inputs. A focused and reasonable effort to collect and use reliable data and information must be made if a high degree of reliability is to be attained.<sup>58</sup>

In evaluating the Department's proposed cone of depression test, the Court must keep in mind both that absolute accurate quantification is not possible, and a hodgepodge system of uncertain reliability is not acceptable. Even though some requisite data for accurate cone of depression measurements

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<sup>57</sup> BHP Copper Inc.'s Objection to Report of the Special Master on the Arizona Department of Water Resources' Subflow Technical Report, San Pedro Watershed (Oct. 1, 2004) ("BHP's Objection") at 5-9; APS/PD Objection at 22-27.

<sup>58</sup> Special Master's Report at 65.

SUPERIOR COURT OF ARIZONA  
MARICOPA COUNTY

09/15/2005

CLERK OF THE COURT  
FORM V000

HONORABLE EDDWARD BALLINGER, JR.

M. Wetherell  
Deputy

W-1, W-2, W-3, W-4(Consolidated)  
Contested Case No. W1-103

"will often be either unknown or poorly known,"<sup>59</sup> ADWR is charged with adopting a test that is "realistically adaptable to the field" and measurement standards that are "the least expensive and delay-causing" efficient methods that provide "a high degree of reliability."<sup>60</sup> In judging whether the Department has satisfied these directions, the Court accepts that "[c]onducting cone of depression tests requires numerous assumptions and considerable judgment and, in many cases, the test results will only provide a rough approximation of actual field conditions."<sup>61</sup>

ADWR's modeling proposal, as clarified by the Special Master's Report, is an affordable, delay-avoiding, adaptable method of determining cones of depression that provides an acceptable degree of reliability and accuracy. The parties agree that the 0.1 foot drawdown criterion comports with the "appreciable" and "measurable" standards put in place as a result of the decisions in *Southwest Cotton* and *Gila II*. The only legitimate concern is whether computer models can accurately reflect a well's drawdown.

At the hearing held on this issue, testifying experts uniformly acknowledged that they "use analytical and numerical computer models to estimate drawdown to 0.1 foot (or smaller) and that they report such results to their clients with the

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<sup>59</sup> Subflow Report at 21.

<sup>60</sup> *Gila IV*, 198 Ariz. at 343, 9 P.3d at 1083.

<sup>61</sup> Subflow Report at 21-22.

SUPERIOR COURT OF ARIZONA  
MARICOPA COUNTY

09/15/2005

CLERK OF THE COURT  
FORM V000

HONORABLE EDDWARD BALLINGER, JR.

M. Wetherell  
Deputy

W-1, W-2, W-3, W-4(Consolidated)  
Contested Case No. W1-103

expectation that the clients will rely upon those results."<sup>62</sup>  
While this observation is not determinative, it is instructive as to how those in the industry regard the use of modeling. More important, the evidence before the Special Master established that any error potential can be dramatically reduced by paying close attention to the accuracy of the data relied upon when setting the parameters used by the computer models. The Special Master's recommendation with respect to cone of depression measurements addresses the objectors' concerns by making clear that ADWR's proposed methods will satisfy the requirements of *Gila IV* and the "highly probable" clear and convincing evidentiary standard only if the Department implements a focused and reasonable mechanism for obtaining highly reliable data which are used in setting model parameters.<sup>63</sup>

ADWR's second condition for including a well within the adjudication is that the well's water level is below the water level in the jurisdictional subflow zone during pumping. The Department believes that a well should not be included in the adjudication if it is not located within a topographic area conducive to causing water to flow from the subflow zone to the well. Under this definition, subflow drawdown potential would be

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<sup>62</sup> SRP's Response at 22; see Special Master's Report at 61.

<sup>63</sup> Special Master's Report at 65. The Court also agrees with the Special Master's rejection of the alternative methods suggested for determining a well's cone of depression because due to inaccuracy, cost, problems with implementation, and delay, they do not satisfy the economy, expediency, and reliability criteria set forth in *Gila IV. Id.* at 68 & 70-71.

SUPERIOR COURT OF ARIZONA  
MARICOPA COUNTY

09/15/2005

CLERK OF THE COURT  
FORM V000

HONORABLE EDDWARD BALLINGER, JR.

M. Wetherell  
Deputy

W-1, W-2, W-3, W-4(Consolidated)  
Contested Case No. W1-103

determined based upon the hydraulic gradient between a stream and a well.<sup>64</sup> Making these determinations regarding the nearly 6,500 wells in the San Pedro River Watershed would be costly and potentially delay subflow zone determination for some time. The Special Master concluded this process was neither feasible nor practical and would not comply with *Gila IV's* economy and expediency criteria.<sup>65</sup>

The Special Master also noted that tying a well's inclusion in this adjudication to hydraulic gradient reversal is not consistent with the following findings made in the Goodfarb Order:

[S]tream depletion occurs as soon as the "cone of depression" reaches the stream, even though it may be some time before the hydraulic gradient at the river is reversed, and may be many years before a particle travels from the stream to the well. (Citation to transcript omitted). [Expert witnesses] Ford and Page contend that streamflow depletion first takes place when the cone intersects the stream, not when the hydraulic gradient is reversed or the molecule of streamflow is ejected by the well. (Citations to transcript omitted). It is beyond dispute that even before the gradient is reversed, a measurable drawdown at the stream's "subflow" zone necessarily results in water leaving the zone in order to fill the void which has been created by the well. Ford's Report, (citation omitted) [when the cone intersects the "subflow" zone,

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<sup>64</sup> Under this test, ADWR would determine if there was hydraulic gradient reversal over the entire distance between a well and a stream. That is, does the gradient flow downward continuously from the stream to the well? *Id.* at 70.

<sup>65</sup> See n.64, *supra*.

SUPERIOR COURT OF ARIZONA  
MARICOPA COUNTY

09/15/2005

CLERK OF THE COURT  
FORM V000

HONORABLE EDDWARD BALLINGER, JR.

M. Wetherell  
Deputy

W-1, W-2, W-3, W-4(Consolidated)  
Contested Case No. W1-103

it "induce[s] subflow to leave (deplete the Subflow Zone and the stream" )]. This is true even where the gradient has not been reversed everywhere between the well and the stream. (Emphasis by Special Master.)<sup>66</sup>

The *Gila IV* court's affirmance of the Goodfarb Order, which included the language quoted above, mandates that it is the effect on a stream and its subflow, not additions to a well's output, that is to be measured when deciding which wells are subject to this Court's jurisdiction.

## **2. Transient or Steady State Modeling**

Having approved the use of analytical and numerical computer modeling, the Court must address the temporal parameters to be used when testing. ADWR suggests that only the time of modeling be considered when applying the cone of depression test. This test method is called "transient state modeling." Its major deficiency is that it is a snapshot approach that does not account for the fact that a well's cone of depression is dynamic. The parties agree that a well's cone of depression generally stabilizes gradually, expanding or decreasing after the period of modeling. Transient state models do not account for the prospective impact of well withdrawals. This testing approach may result in wells that will impact the subflow zone for only the briefest portion of the next millennium being included in the adjudication, while other wells

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<sup>66</sup> Special Master's Report at 73 (quoting Goodfarb Order at 61).  
Docket Code 000

SUPERIOR COURT OF ARIZONA  
MARICOPA COUNTY

09/15/2005

CLERK OF THE COURT  
FORM V000

HONORABLE EDDWARD BALLINGER, JR.

M. Wetherell  
Deputy

W-1, W-2, W-3, W-4(Consolidated)  
Contested Case No. W1-103

that will have a dramatic impact on the subflow zone (but not during the relatively short modeling period) are not included.

Those criticizing ADWR's proposed approach urge the Court to direct the Department to use a steady state model.<sup>67</sup> While no one can predict with certainty the future use of wells, the steady state model does not have a temporal limit and purports to account for the future impact of withdrawals by using long-term average hydrologic data to establish an equilibrium between a pumping well and the amount of water the well withdraws from streams and underground sources.<sup>68</sup> The weakness of steady state modeling is that it does not as accurately account for conditions during a specific time period and, according to its critics, cannot effectively simulate either the dynamic hydrologic systems in Southwestern deserts or changes in groundwater storage.<sup>69</sup>

It is clear that if a more accurate result is desired with respect to a relatively narrow timeframe, transient state modeling is preferable, but if long-term accuracy is needed, the steady state model will, over time, be more useful. Which approach is more appropriate for the adjudication?

The Special Master resolved this issue by focusing on the following excerpt from *Gila IV*:

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<sup>67</sup> Special Master's Report at 82.

<sup>68</sup> *Id.*

<sup>69</sup> *Id.* at 83.

SUPERIOR COURT OF ARIZONA  
MARICOPA COUNTY

09/15/2005

CLERK OF THE COURT  
FORM V000

HONORABLE EDDWARD BALLINGER, JR.

M. Wetherell  
Deputy

W-1, W-2, W-3, W-4(Consolidated)  
Contested Case No. W1-103

[A] well may be subject to the adjudication if its " 'cone of depression' caused by its pumping has now extended to a point where it reaches an adjacent 'subflow' zone, and by continual pumping will cause a loss of such 'subflow' as to affect the quantity of the stream."

... DWR may seek to establish that a well located outside the limits of the saturated floodplain alluvium is in fact pumping subflow and is therefore subject to the adjudication, by showing that the well's cone of depression extends into the subflow zone and is depleting the stream. (Emphasis by Special Master.)<sup>70</sup>

Relying on the language above, the Special Master concluded that the steady state model's attempt to consider the future impact of a well's cone of depression does not comport with the requirements announced in *Gila IV* because to be included within this Court's jurisdiction, a well's cone of depression must extend into the subflow zone, and the well must be *currently* depleting a stream.<sup>71</sup> Review of relevant sections of the Goodfarb Order and the *Gila IV* opinion cause this Court to reach a contrary conclusion.

After narrowly defining the area in which subflow may be found, the Arizona Supreme Court adopted a more expansive standard with respect to who, within this narrow zone, is

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<sup>70</sup> *Id.* (quoting *Gila IV*, 198 Ariz. at 343, 9 P.3d at 1082).

<sup>71</sup> Even though he viewed ADWR's transient state modeling proposal favorably, the Special Master was apparently uncomfortable with the potential unjust results that can flow from snapshot measurements. *Id.* at 84 ("Although *Gila IV* and the evidence do not support rejecting ADWR's recommendation, the impact of expanding cones of depression must be taken into account.").

SUPERIOR COURT OF ARIZONA  
MARICOPA COUNTY

09/15/2005

CLERK OF THE COURT  
FORM V000

HONORABLE EDDWARD BALLINGER, JR.

M. Wetherell  
Deputy

W-1, W-2, W-3, W-4(Consolidated)  
Contested Case No. W1-103

subject to the adjudication.<sup>72</sup> Adopting the reasonable assumptions made in steady state modeling is consistent with the principles announced in the Goodfarb Order and approved by the *Gila IV* court. The Goodfarb Order explicitly recognized that cones of depression expand over time and can have a long-term effect on subflow even after well pumping ceases:

[The] facts show ... that "cones of depression" have long-term effects even after the wells are shut down. Two recent Colorado cases make that clear. Danielson v. Castle Meadows, 791 P.2d 1106 (Colo. 1990) and State Engineer v. Castle 6 Meadows, 856 P.2d 406 (Colo. 1993) discuss the long-term effect of post-pumping depletion. In the "Danielson" case the trial court had found that post-pumping depletions could continue up to and after 200 years. In the remanded trial which took place in 1991, the trial court found the post-pumping depletions could continue up to and after 400 years. In both cases the Colorado Supreme Court found that these post-pumping depletions had to be remedied by the pumps to protect surface water users...

All of the principal witnesses agreed that even wells located outside of a stream's "subflow" could, over time, build up extensive "cones of depression" which could severely affect the volume of stream flow and the "subflow" which supported it.<sup>73</sup>

The trial court's finding that "stream depletion occurs as soon as the 'cone of depression' reaches the stream, even though it may be some time before the hydraulic gradient at the river

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<sup>72</sup> *Gila IV*, 198 Ariz. at 343, 9 P.3d at 1082.

<sup>73</sup> Goodfarb Order at 60.

SUPERIOR COURT OF ARIZONA  
MARICOPA COUNTY

09/15/2005

CLERK OF THE COURT  
FORM V000

HONORABLE EDDWARD BALLINGER, JR.

M. Wetherell  
Deputy

W-1, W-2, W-3, W-4(Consolidated)  
Contested Case No. W1-103

is reversed, and may be many years before a particle travels from the stream to the well" evidences that the court intended for future pumping consequences to be considered when setting the adjudication court's jurisdiction.<sup>74</sup> When this ruling is read in conjunction with the quote from *Gila IV* relied upon by the Special Master, an alternative interpretation appears:

[A] well may be subject to the adjudication if its " 'cone of depression' caused by its pumping has now extended to a point where it reaches an adjacent 'subflow' zone, and by continual pumping will cause a loss of such 'subflow' as to affect the quantity of the stream." (Emphasis supplied.)

The language cited above is consistent with the Goodfarb Order and requires that a well with a cone of depression reaching the subflow zone be subject to adjudication if the extent of the well's current or prospective depletive effect on the stream is measurable by reasonably accurate means. Only steady state modeling adequately addresses the need to consider the future consequences of existing well characteristics that was contemplated by the Goodfarb Order.

### **3. Cumulative Effect of Multiple Well Drawdowns**

The *Gila IV* opinion requires that wells must be individually evaluated to determine if they are subject to the adjudication. The Special Master's Report asks whether, in

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<sup>74</sup> *Id.* at 61.

SUPERIOR COURT OF ARIZONA  
MARICOPA COUNTY

09/15/2005

CLERK OF THE COURT  
FORM V000

HONORABLE EDDWARD BALLINGER, JR.

M. Wetherell  
Deputy

W-1, W-2, W-3, W-4(Consolidated)  
Contested Case No. W1-103

addition to this individual analysis, the cumulative drawdown effect of groups of wells should be reviewed.<sup>75</sup> Parties favoring cumulative testing claim that available numerical models easily and accurately calculate the cumulative impact of clusters of wells.<sup>76</sup> They argue that the Court must direct ADWR to undertake individual and cumulative analysis in order to adequately protect surface water rights. Other parties argue that cumulative testing will detract from the Department's efforts to complete higher priority tasks directly related to statutorily mandated tasks.<sup>77</sup> The Special Master's Report adopts a hybrid position and recommends that ADWR select one or more groups of wells to test whether cumulative analysis is warranted.

Because the jurisdictional limits of the subflow zone are strictly drawn, the better approach is to undertake such analysis as is required to identify all wells within this narrow region that are affecting subflow. The Special Master's Report indicates that an anticipated hydrological study of the Sierra Vista Subwatershed may provide additional relevant information regarding the individual and cumulative effects of well

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<sup>75</sup> Special Master's Report at 86.

<sup>76</sup> Apache Tribes' Objections to the Report of the Special Master on Arizona Department of Water Resources' Subflow Technical Report (Oct. 1, 2004) ("Apache Tribes' Objections") at 21-22; United States' Response to Exceptions to the Report of the Special Master on the Arizona Department of Water Resources' Subflow Technical Report, San Pedro River Watershed (Nov. 1, 2004) ("U.S. Response") at 14-15.

<sup>77</sup> ASARCO Incorporated's and Arizona Water Company's Reply in Support of Objections to the Report of the Special Master on the Arizona Department of Water Resources' Subflow Technical Report, San Pedro River Watershed (Dec. 1, 2004) ("ASARCO's Reply") at 9.

SUPERIOR COURT OF ARIZONA  
MARICOPA COUNTY

09/15/2005

CLERK OF THE COURT  
FORM V000

HONORABLE EDDWARD BALLINGER, JR.

M. Wetherell  
Deputy

W-1, W-2, W-3, W-4(Consolidated)  
Contested Case No. W1-103

pumping.<sup>78</sup> At least with respect to the San Pedro watershed, the Department should ascertain whether significant withdrawals of subflow occur as the result of pumping by one well or a group of wells.

***De Minimis Uses***

With one limitation, the *Gila IV* decision requires wells located within the lateral limits of a subflow zone to be subject to this adjudication. The exception excuses those wells "that, though pumping subflow, have a *de minimis* effect on the river system.... [Those wells] may be excluded from the adjudication based on rational guidelines for such an exclusion, as proposed by DWR and adopted by the trial court."<sup>79</sup> *Gila II* also sanctions summary adjudication of *de minimis* water rights.<sup>80</sup>

The Subflow Report describes the work done by then Special Master John Thorson to determine if certain stockwatering, stockponds, or domestic water uses in the San Pedro River Watershed qualified for summary adjudication. Special Master Thorson concluded that when measured individually these uses had a *de minimis* impact on the watershed, and even though their cumulative impact was not *de minimis*, he found that the resources required to individually adjudicate and administratively manage these water rights justified summary

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<sup>78</sup> Special Master's Report at 88.

<sup>79</sup> *Gila IV*, 198 Ariz. at 344, 9 P.3d at 1083.

<sup>80</sup> *Gila II*, 175 Ariz. at 394, 857 P.2d at 1248.

SUPERIOR COURT OF ARIZONA  
MARICOPA COUNTY

09/15/2005

CLERK OF THE COURT  
FORM V000

HONORABLE EDDWARD BALLINGER, JR.

M. Wetherell  
Deputy

W-1, W-2, W-3, W-4(Consolidated)  
Contested Case No. W1-103

adjudication. ADWR accepted the Special Master's definitions of what constitutes a *de minimis* domestic, stockpond, or stockwatering use, but the Department did not agree with the Special Master that these uses should be adjudicated summarily. Because the Subflow Report was filed on March 29, 2002, the Department's discussion did not reflect that on September 26, 2002, this Court approved Special Master Thorson's proposed *de minimis* definitions and adopted his recommended summary adjudication procedures.<sup>81</sup>

Some claimants suggest that the Court direct ADWR to propose guidelines for determining when non-domestic water uses (e.g., agricultural, municipal, industrial, and other uses) have a *de minimis* effect on a watershed.<sup>82</sup> They believe the Department should propose a set of *de minimis* criteria that apply irrespective of the type of water use.<sup>83</sup> The Court agrees with these parties that a prime consideration when determining if a water use has a *de minimis* effect on a watershed is its quantifiable impact on the subflow zone. Until ADWR proposes an accurate and reliable method for determining quantifiable impacts, its *de minimis* proposal will be deficient."<sup>84</sup>

The Special Master's Report and some comments indicate that the parties did not extensively brief this issue, and it may

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<sup>81</sup> Memo. Dec. (Sept. 26, 2002).

<sup>82</sup> Special Master's Report at 93.

<sup>83</sup> APS/PD Objections at 37.

<sup>84</sup> *Id.*

SUPERIOR COURT OF ARIZONA  
MARICOPA COUNTY

09/15/2005

CLERK OF THE COURT  
FORM V000

HONORABLE EDDWARD BALLINGER, JR.

M. Wetherell  
Deputy

W-1, W-2, W-3, W-4(Consolidated)  
Contested Case No. W1-103

"best be considered at such time as ADWR and the parties have more new or updated data."<sup>85</sup> The Special Master will be directed to seek input from the Department and claimants, and conduct such proceedings as he deems necessary to craft a workable, reasonably accurate *de minimis* standard that can be applied to non-domestic water users.

### Implementation of Procedures

The Department and the Special Master have supplied a number of recommendations responding to the Court's request that ADWR propose a schedule for completing the tasks outlined in its report. The Court agrees with the Special Master that ADWR's proposal of first mapping the subflow zone in a watershed, then identifying *de minimis* uses, and finally conducting cone of depression tests is appropriate.<sup>86</sup> The parties generally agree with this plan, although some disagree with the Special Master's recommendation of a period of one hundred twenty (120) days for filing objections to ADWR's technical report delineating the subflow zone.<sup>87</sup> The Court does not challenge the Special Master's analysis of the applicable statutory authority governing the filing of objections, but it will accommodate the desire of claimants requesting a one hundred eighty (180) day period for the timely filing of objections and comments to a technical

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<sup>85</sup> Special Master's Report at 93; see SRP's Response at 36-37.

<sup>86</sup> Subflow Report at 45; Special Master's Report at 96.

<sup>87</sup> APS/PD Objections at 38-39.

SUPERIOR COURT OF ARIZONA  
MARICOPA COUNTY

09/15/2005

CLERK OF THE COURT  
FORM V000

HONORABLE EDDWARD BALLINGER, JR.

M. Wetherell  
Deputy

W-1, W-2, W-3, W-4(Consolidated)  
Contested Case No. W1-103

report. The Court agrees with the remainder of the Special Master's recommendations regarding the implementation of procedures.

The foregoing discussion constitutes the Court's findings of fact and conclusions of law with respect to the Special Master's Report and the Department's Subflow Report. Based upon these findings and conclusions,

**IT IS ORDERED**, approving the Subflow Report as modified by this Order.

**IT IS FURTHER ORDERED**, that with respect to the recommendations set forth in the Special Master's Report:

1. The Court approves and adopts, as modifications to the Subflow Report, Recommendation Nos. 1, 2, 3, 4, 5, 7, 8, 9, 10, 11, 13, 14, 20, 21, 22, 23, 24, 25, 26, 27, 30, and 31.
2. With respect to Recommendation No. 6, the Court approves and adopts this recommendation, but notes that ADWR shall include as part of the subflow zone any areas determined to fall within the ephemeral stream exception discussed above.
3. If ADWR determines, with respect to any specific area, it cannot delineate a reasonably accurate and reliable subflow zone, it shall proceed in accordance with Recommendation No. 12.

SUPERIOR COURT OF ARIZONA  
MARICOPA COUNTY

09/15/2005

CLERK OF THE COURT  
FORM V000

HONORABLE EDDWARD BALLINGER, JR.

M. Wetherell  
Deputy

W-1, W-2, W-3, W-4(Consolidated)  
Contested Case No. W1-103

4. Recommendation No. 15, as clarified by this Order, is approved and adopted.
5. Recommendation Nos. 16, 17, and 32 are not approved and adopted.
6. Recommendations Nos. 18, 19, 29, 33, 34, 36, 37, 38, and 39 are approved and adopted to the extent consistent with this Order.
7. Recommendation No. 28 is not approved and adopted. ADWR shall utilize a reasonably reliable steady state model for use in evaluating the effect of cones of depression.
8. The Court approves and adopts Special Master's Recommendation No. 35 to the extent modified by this Court's holdings.
9. The Special Master is directed to seek input from the Department and claimants and take such other necessary steps to fashion standards for identifying non-domestic *de minimis* water uses.

**IT IS FURTHER ORDERED,** that claimants shall be provided a period of one hundred eighty (180) days from the filing date to file timely objections and comments to technical reports containing ADWR's subflow zone determinations.

DATED: September 28, 2005.

/s/ Eddward P. Ballinger, Jr.  
EDDWARD P. BALLINGER, JR.  
Judge of the Superior Court

SUPERIOR COURT OF ARIZONA  
MARICOPA COUNTY

09/15/2005

CLERK OF THE COURT  
FORM V000

HONORABLE EDDWARD BALLINGER, JR.

M. Wetherell  
Deputy

W-1, W-2, W-3, W-4(Consolidated)  
Contested Case No. W1-103

\* \* \* \*

A copy of this minute entry is mailed to all parties on the Court-approved W-1, W-2, W-3 and W-4 mailing list dated June 15, 2005, and the parties listed below.

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# APPENDIX A-9

RECEIVED

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AUG 25 '10

AUG 25 '10

SUPERIOR COURT OF ARIZONA  
MARICOPA COUNTY

TRUSTEE

Clark of the Court

08/16/2010

CLERK OF THE COURT  
FORM V000

HONORABLE EDDWARD BALLINGER, JR.

R. Tomlinson  
Deputy

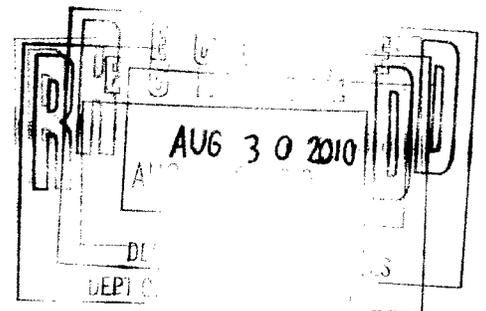
W-1, W-2, W-3, W-4 (Consolidated)

COPY

FILED: 08/24/2010

In Re the General Adjudication  
of All Rights to Use Water in  
The Gila River System and Source

In Re ADWR's Subflow Zone Delineation  
Report for the San Pedro River Watershed



**ORDER**

On June 30, 2009, the Arizona Department of Water Resources ("ADWR") filed its Subflow Zone Delineation Report for the San Pedro River Watershed. The report was prepared pursuant to the Court's order dated September 28, 2005. The order provided claimants 180 days to file objections and comments to the report.

The Court has reviewed the twenty-six objections and comments filed. The papers filed by ASARCO LLC, Freeport-McMoRan Corporation, Salt River Project, Bella Vista Water Co., Inc., Pueblo Del Sol Water Company, and the City of Sierra Vista (collectively, the "Sierra Vista Parties"), The Nature Conservancy, and the United States present substantive legal and technical issues. The Court will hear these objections and comments in a hearing to be held on **March 15, 2011, at 2:30 p.m.** before:

**The Honorable Eddward P. Ballinger, Jr.**  
**Superior Court of Arizona**  
**Juvenile Court Center - Durango Facility**  
**3131 West Durango, Courtroom 6**  
**Phoenix, AZ 85009-6292**  
**602.506.8551**

**IT IS ORDERED** that the affidavits or sworn declarations of expert witnesses submitted with the objections and comments of the foregoing parties shall be considered to be direct testimony. At the hearing, the testimony of the affiants and of the representatives of ADWR shall be limited to cross-examination except for new information in response to ADWR's report due on December 31, 2010.

**IT IS FURTHER ORDERED** directing ADWR to submit a report on or before **December 31, 2010**, identifying the objections or comments of the foregoing parties with which ADWR agrees or does not take issue and providing information in response to a specific objection or comment.

**IT IS FURTHER ORDERED** referring to the Special Master the task of proceeding in the best manner to organize and determine the remaining objections and comments.

A. Proceedings before the Special Master may include consideration of disclosures and discovery, including matters arising under Arizona Rules of Civil Procedure 26 and 26.1, briefing of issues, and conducting hearings and conferences. The Special Master is empowered with all the powers enumerated in Arizona Rule of Civil Procedure 53.

B. The Special Master shall submit findings of fact, conclusions of law, and recommendations in a report to the Court (the "Special Master's Report").

C. Objections and comments to the Special Master's Report may be filed within seventy-five (75) days after the report is filed with the Court. Responses to objections and comments shall be filed within sixty (60) days thereafter, with replies to be filed not later than forty (40) days after the response due date. Filing times are exclusive of the additional period authorized by Arizona Rule of Civil Procedure 6(e).

**IT IS FURTHER ORDERED** signing this entry as an order of the Court.

/s/ Eddward P. Ballinger, Jr.  
EDDWARD P. BALLINGER, JR.  
Judge of the Superior Court

A copy of this order is mailed to all parties on the Court approved mailing list for the Gila River Adjudication, W-1, W-2, W-3, W-4 (Consolidated), dated July 29, 2010.

# APPENDIX A-:

SUPERIOR COURT OF ARIZONA  
MARICOPA COUNTY

08/22/2012

CLERK OF THE COURT  
FORM V000

HONORABLE EDDWARD BALLINGER, JR.

L. Nevenhoven  
Deputy

W-1, W-2, W-3, W-4 (Consolidated)

**COPY**

Contested Case No. W1-103

FILED: 08/23/2012

In Re the General Adjudication  
of All Rights to Use Water in  
The Gila River System and Source

W-1, W-2, W-3, W-4 (Consolidated)

In Re Subflow Zone Delineation  
Methodology for the San Pedro River  
Watershed Report (April, 2012) Prepared by  
The Arizona Department of Water Resources

W1-103

MINUTE ENTRY

A number of parties have filed objections, comments and motions relating to the April, 2012, report of the Arizona Department of Water Resources concerning the proposed methodology to be used to determine the extent of the subflow zone of the San Pedro River Watershed ("ADWR's April, 2012, Report"). To aid in resolving the issues raised,

**IT IS ORDERED** setting Oral Argument on matters related to ADWR's April, 2012, Report, to be held on Thursday, November 8, 2012, at 2:00 p.m. (MST), at the Southeast Juvenile Court Building, 1810 South Lewis, Mesa, Arizona 85210, Courtroom 9.

If you wish to appear telephonically, please follow instructions below:

1. Dial 1-877-820-7831
2. Dial participant passcode 2743132#
3. (for assistance, if needed, dial 1-800-485-0844 / option 2)

A copy of this order is mailed to all parties on the court-approved mailing list (Court) for Contested Case No. W1-103 dated July 17, 2012.

# APPENDIX A-;

SUPERIOR COURT OF ARIZONA  
MARICOPA COUNTY

10/12/2012

HONORABLE EDDWARD BALLINGER, JR.

W-1, W-2, W-3, W-4 (Consolidated)

Contested Case No. W1-103

FILED: October 12, 2012

In Re the General Adjudication  
of All Rights to Use Water in  
the Gila River System and Source

Findings of Fact and Conclusions of Law  
Regarding the Evidentiary Hearing held  
January 24, 25 and 26, 2012, in re the  
Subflow Zone Delineation Report for the  
San Pedro River Watershed (June 2009)  
Prepared by the Arizona Department of  
Water Resources

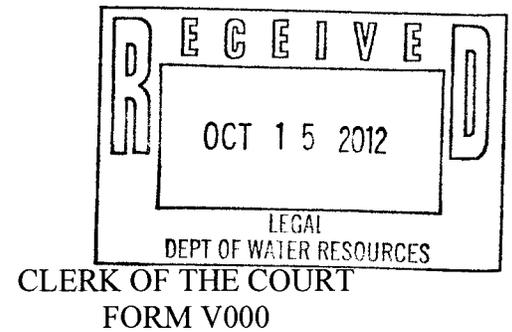
Order Entered re Pending Objection, Motion  
to Strike and Request

MINUTE ENTRY

**FINDINGS OF FACT AND CONCLUSIONS OF LAW**

1. Pursuant to this Court's Order of September 28, 2005, on June 30, 2009, the Arizona Department of Water Resources ("ADWR") issued its "Subflow Zone Delineation Report for the San Pedro River Watershed ("2009 Report").

2. The Court permitted the parties to submit objections to the 2009 Report. Those objections were submitted between July 31, 2009, and December 31, 2009.



L. NEVENHOVEN  
Deputy

W-1, W-2, W-3, W-4 (Consolidated)

W1-103

October 12, 2012

Page Two

3. In January 2011, pursuant to this Court's Order, ADWR issued its Response to Comments and Objections filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed ("2011 Report"), addressing the comments and objections filed to the 2009 Report.

4. On January 24, 25 and 26, 2012, the Court heard evidence relating to the ADWR reports and the objections.

5. Following the hearing, ADWR submitted its report entitled, "Subflow Delineation Methodology Report for the San Pedro River Watershed" ("April 2012 Report").

6. The Court finds that Arizona Geological Survey ("AGS"), 2008, has appropriately mapped the surficial geology along the San Pedro River.

7. The AGS mapping of surface geologic units is not determinative of the subflow zone because it does not provide important subsurface information for the floodplain Holocene alluvium ("FHA"), specifically, the thickness of each of the units and the subsurface lateral extent of FHA underlying other FHA.

8. The determination of the distribution of geologic units alone, as reflected in the AGS mapping, is not dispositive in delineating the subflow zone.

9. ADWR's analysis understates the extent of the floodplain because it does not appropriately take into account the fact that extensive alluvial fans cover much of the floodplain and adjacent basin fill.

10. ADWR has only delineated a portion of the saturated FHA, which is not a stable geologic feature, but rather one that meanders and changes course over time. This meandering process removed and redistributed alluvial fans and other deposits brought onto the floodplain by tributary streams. Eventually this process resulted in the formation of the current floodplain.

11. ADWR improperly *uniformly* excluded certain geologic units, at least some of which constitute temporary deposits that will eventually be washed away.

12. The conclusions in ADWR's 2009 Report are inaccurate in that they incorrectly exclude portions of the FHA, which lie beneath what is sometimes referred to as "tributary" alluvium.

13. Analysis of the existence of riparian vegetation may be a useful tool in the identification of the subflow in some areas.

14. In its future reports, ADWR should modify its position on the use of borehole and aquifer data to ensure that reliable lithologic data is utilized.

15. Those areas identified in the 2009 Report as “islands of floodplain Holocene alluvium” and the areas covered by a thin veneer of alluvium overlying portions of the FHA are part of the subflow zone.

16. The parameters used by ADWR in the 2009 Report with respect to use of routine applications of setbacks resulted in exclusion of areas within the subflow zone.

17. Without dictating the procedure to be used prospectively, the Court finds that the methods used in the 2009 Report with respect to wells, improperly excluded areas likely to be within the subflow zone.

18. ADWR’s 2009 subflow zone delineation proposal for the San Pedro River is too narrow, as would be any mapping that relies too heavily on surface mapping. ADWR must have at its discretion use of a number of several tools in delineating the lateral extent of the FHA at a given location. Not every tool can or necessarily should be used at each location. ADWR must use its technical expertise to utilize all of the resources available to it in delineating the subflow zone.

19. The Court agrees with and adopts the following portions of the 2009 Report:

- a. The estimate of phreatophyte evapotranspiration.
- b. The summary of cultural depletions in Section 3.1.4.
- c. The analysis of predevelopment flows and water levels described in Sections 3.2 through 3.4.
- d. The method for using existing maps, consideration of mapping methods for previous work, using the largest scale maps possible, and taking special care in transfers and projections of maps summarized in Section 2.2 of the report so long as consistent with the Court’s findings of fact.

W-1, W-2, W-3, W-4 (Consolidated)

W1-103

October 12, 2012

Page Four

- e. The assumption, for subflow mapping purposes, that the entire lateral extent of FHA is saturated.
- f. The hydrologic criteria and procedures described in Section 2.1, including the definitions of perennial, intermittent and ephemeral streams, and the use of predevelopment flow conditions.

20. In determining the lateral extent of the FHA areas in which tributaries have recently deposited alluvium on top of the floodplain, which may be subject to being washed away during future flooding, are to be considered part of the FHA.

21. Two-hundred (200) foot setback assumptions may not be used in locations where thin veneers of tributary alluvium overlie the FHA. Except at the mouths of larger ephemeral streams or washes (those which have relatively frequent surface and underground flow), the setbacks shall be one hundred (100) feet from the edge of the FHA. Setback assumptions shall not be used in bedrock canyons.

22. When a hydraulic connection exists between the underground flow associated with tributary and surface flow of the primary watercourse, the following adjustments are permitted:

- a. Apply 100-foot setbacks everywhere except for large ephemeral streams that have relatively frequent surface and underground flow.
- b. Modify the setbacks to include the active river channel.
- c. When setbacks cross or where basin fill is adjacent to the active channel, continue the subflow zone using the active channel.
- d. Evaluate disturbed ground based upon the likely underlying geologic unit.

23. ADWR may not universally exclude mountain front streams when delineating the subflow zone because these sources are of short length, are isolated from major streams, and/or are difficult to access. Streams may be excluded from the subflow analysis if they were ephemeral under predevelopment conditions and there is not a connection of FHA between the ephemeral stream and a perennial or intermittent stream.

Based upon the foregoing findings of fact and conclusions of law,

IT IS ORDERED:

1. The parties' objections to the 2009 ADWR Report and the resulting subflow zone determination are sustained in part and overruled in part, consistent with the findings of fact and conclusions of law set forth herein.
2. The revised subflow zone delineation must:
  - a. result in a continuous subflow zone;
  - b. result in a stable geologic feature;
  - c. include the entire current active channel of each watercourse;
  - d. include the Historical Composite Active Floodplain (1935-2007) for each watercourse;
  - e. accurately reflect the full extent of the FHA; and,
  - f. to the extent possible, interpret judicial pronouncements in a manner consistent with scientific fact.
3. In determining what areas to include within the subflow zone, ADWR should use its professional judgment and should consider, as and to the extent appropriate, a combination of the following: (a) Arizona Geological Survey mapping to identify the surface exposure of the boundary between either bedrock or Pleistocene and Tertiary basin fill and Holocene alluvium; (b) topographic slope breaks (which may be considered, when appropriate, the edge of the subflow zone); (c) vegetation patterns; and, (d) aerial photographs to determine the boundary between basin fill or bedrock and Holocene alluvium where alluvial fans and channel deposits are deposited on the floodplain. ADWR should not rely solely upon surface data.
4. ADWR shall apply setbacks only in those instances where a hydraulic connection exists between the subflow zone and the surrounding material. ADWR need not apply setbacks in instances in which it reasonably finds that no such hydraulic connection exists.

W-1, W-2, W-3, W-4 (Consolidated)

W1-103

October 12, 2012

Page Six

5. ADWR shall prepare a revised Subflow Zone Delineation Report for the San Pedro River Watershed on or before a date to be set at the conclusion of the hearing to be held on November 8, 2012.

The Court has reviewed the pending objection to the request that the Court adopt the proposed subflow delineation, motion to strike the Surface Water Users' New Subflow Zone Delineation and request that the Court provide special instructions to the ADWR in connection with preparation of future subflow reports. As a result of this Court's October 12, 2012, Order regarding ADWR's 2009 Report,

IT IS ORDERED deeming the pending objection, motion and request moot.

/s/ Eddward P. Ballinger, Jr.

JUDICIAL OFFICER OF THE SUPERIOR COURT

A copy of this order is mailed to all parties on the court-approved mailing list (Court) for Contested Case No. W1-103 dated July 17, 2012.

# APPENDIX A-32

SUPERIOR COURT OF ARIZONA  
MARICOPA COUNTY

RECEIVED

JAN 22 2013

01/10/2013

CLERK OF ~~THE~~ COURT  
FORM V000

HONORABLE MARK H. BRAIN

A. Melchert  
Deputy  
COPY

W-1, W-2, W-3, W-4 (Consolidated)

Contested Case No. W1-103

FILED: 01/15/2013

In Re the General Adjudication  
of All Rights to Use Water in  
The Gila River System and Source

W-1, W-2, W-3, W-4 (Consolidated)

In Re Subflow Zone Delineation  
Methodology for the San Pedro River  
Watershed Report (April, 2012) Prepared by  
The Arizona Department of Water Resources

W1-103

MINUTE ENTRY

1:30 p.m. This is the time set for Oral Argument set for January 10, 2013 at 1:30 p.m. (MST) regarding ADWR's April 2012 report. Appearing telephonically are: R. Lee Leininger on behalf of U. S. Department of Justice, Environment and Natural Resources Division; Stephen C. Cann on behalf of The Nature Conservancy; and Lucas Shaw on behalf of Salt River Project ("SRP"); and Laurel A. Herrmann on behalf of the San Carlos Apache Tribe and Tonto Apache Tribe. In the courtroom are: Thomas L. Murphy on behalf of the Gila River Indian Community; Joe P. Sparks and Julia M. R. Kolsrud on behalf of the San Carlos Apache Tribe and Tonto Apache Tribe; Mark A. McGinnis, John B. Weldon, Jr., Steve Westwood and Patrick B. Sigl on behalf of SRP; Rhett A. Billingsley, Sean T. Hood, Shilpa Hunter-Patel, and John C. Lemaster on behalf of Freeport McMoRan Corporation; F. Patrick Barry on behalf of the U. S. Department of Justice; L. William Staudenmaier and L. Anthony Fines on behalf of Arizona Public

Service Company; Gregory L. Adams and Lauren J. Caster on behalf of ASARCO LLC; Janet L. Ronald, Ayesha Vohra, Michael Johnson, and David Kendle on behalf of the Arizona Department of Water Resources (“ADWR”); Theresa M. Craig on behalf of the Arizona Attorney General’s Office, Natural Resources Section; David A. Brown and Douglas E. Brown on behalf of various Little Colorado River claimants; Lee A. Storey on behalf of the City of Flagstaff; Cynthia S. Campbell on behalf of the City of Phoenix; Harlan C. Agnew on behalf of Pima County; Cynthia J. Haglin on behalf of the City of Chandler; Michael J. Pearce on behalf of Buckeye Irrigation Company and Buckeye Water Conservation and Drainage District; Sally Worthington on behalf of Maricopa County; Margaret LaBianca on behalf of BHP Cooper, Inc.; William P. Sullivan on behalf of Bella Vista Water Company, Inc., Pueblo Del Sol Water Company, and the City of Sierra Vista; William H. Anger on behalf of Cities of Avondale, Chandler, Glendale, Mesa, and Scottsdale; Douglas C. Nelson on behalf of Paloma Irrigation and Drainage District and Gila Bend-Dendora Valley Water Users’ Association; Charles L. Cahoy on behalf of the City of Tempe; and Robert Harding and Cynthia Stefanovic on behalf of Arizona State Land Department. Observers Vincent Yazzie and Annie Walker are present. Also present are Special Master, George A. Schade, Jr., and assistant Barbara K. Brown.

Court reporter, Kim Hannan, is present, and a record of the proceedings is also being made by FTR.

The parties discuss the objections and comments.

IT IS ORDERED taking this matter under advisement.

2:29 p.m. Matter concludes.

**LATER:**

This matter came before the Court for a discussion of the various objections to and comments on the April 2012 report by ADWR titled, Subflow Zone Delineation Methodology for the San Pedro River Watershed. Essentially, the parties are divided into two camps. One group believes that the Department should respond to the objections and comments in writing, after which the Court can hold further hearings to discuss the methodology to be used by the Department in completing its mapping of the subflow zone. The other group (including the Department) believes that the Court has adequately instructed the Department on how to proceed, particularly given Judge Ballinger’s Minute Entry of October 12, 2012, and that the Department should be instructed to proceed without further preliminary hearings regarding its methodology. Although there is something to be said for both positions, the Court concludes that the latter group’s position is preferable. Accordingly,

IT IS ORDERED that the Department prepare a revised Subflow Zone Delineation Report for the San Pedro River Watershed on or before April 1, 2014, consistent with Judge Ballinger's Minute Entry of October 12, 2012.

The Department raised one potential stumbling block presented by the October 12, 2012 minute entry; specifically, Judge Ballinger's finding in paragraph 23 that it may not universally exclude mountain front streams. The problem is not that the Department disagrees with this finding; it is that the Department may not have sufficient information to include those streams in the report in the time allotted. The Court requests that the Department do its best to prepare a complete report, but it will understand if the report comes with a caveat that this work is continuing.

IT IS FURTHER ORDERED signing this minute entry as a formal written Order of the Court.

/ s / HONORABLE MARK H. BRAIN

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HONORABLE MARK H. BRAIN  
JUDICIAL OFFICER OF THE SUPERIOR COURT

A copy of this order is mailed to all persons listed on the Court approved mailing list (Court) for Contested Case No. W1-103 dated January 10, 2013.