

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

Fennemore Craig, P.C. Phoenix

By: James W. Johnson
Lauren J. Caster
Jeffrey C. Thacker
Timothy Berg

Attorneys for Cyprus Climax Metals Company and its Subsidiaries
Cyprus Christmas Mine Corporation, Cyprus Miami Mining
Corporation, Cyprus Pima Mining Corporation, Cyprus Sierrita
Corporation, and Cyprus Twin Buttes Corporation

Snell & Wilmer, L.L.P. Phoenix

By: Robert B. Hoffman
Carlos D. Ronstadt
Jeffrey W. Crockett

Attorneys for Magma Copper Company

Apker, Apker, Haggard & Kurtz, P.C. Phoenix

By: Burton M. Apker
Gerrie Apker Kurtz

Attorneys for ASARCO Incorporated

Ellis, Baker & Porter, Ltd. By: William D. Baker Paul R. Orme Attorneys for Central Arizona Irrigation and Drainage District, Maricopa-Stanfield Irrigation & Drainage District, and New Magma Irrigation & Drainage District	Phoenix
Janet Napolitano, Arizona Attorney General By: Charlotte Benson Joseph E. Clifford Mary Mangotich Grier Attorneys for State of Arizona	Phoenix
Brown & Brown By: David A. Brown Michael J. Brown Attorneys for Little Colorado Water Association and St. David Irrigation District	Pinetop
Broening, Oberg & Woods By: Marilyn D. Cage Attorneys for the City of Goodyear	Phoenix
Ryley, Carlock & Applewhite By: George Read Carlock Michael J. Brophy Sheryl A. Taylor Attorneys for Roosevelt Water Conservation District and Arizona Public Service Company	Phoenix
Lewis and Roca By: Tom Galbraith Randall H. Warner Attorneys for Paloma Investment Limited Partnership	Phoenix
Apker, Apker, Haggard & Kurtz, P.C. By: Jerry L. Haggard Cynthia M. Chandley Attorneys for Phelps Dodge Corporation	Phoenix
Michael B. House, Tucson City Attorney By: Loretta Humphrey Attorneys for City of Tucson	Tucson

O'Connor, Cavanagh, Anderson, Westover, Killingsworth & Beshears,
P.A. Phoenix

By: Ralph E. Hunsaker
Attorneys for Church of Jesus Christ of Latter-day Saints

Burch & Cracchiolo, P.A. Phoenix

By: Daryl Manhart
Edwin C. Bull
Attorneys for Roosevelt Irrigation District

Gallagher & Kennedy, P.A. Phoenix

By: Dalva L. Moellenberg
D. Lee Decker
Attorneys for Apache Nitrogen Products, Inc. and Arizona Rock
Products Association

Ronald N. Rovey Sedona
Attorney for Verde Valley Claimants

Arizona Public Service Company Phoenix

By: Shiela B. Schmidt
Attorney for Arizona Public Service Company

Meyer, Hendricks, Victor, Osborn & Maledon, P.A. Phoenix

By: Lee A. Storey
Joan S. Burke
Attorneys for Rio Rico Properties, Inc.

Strickland & O'Hair, P.C. Tucson

By: Jennele Morris O'Hair
Attorneys for Cities of Sierra Vista, Benson, and Globe; Towns of
Mammoth and Patagonia; and Gila Valley Irrigation District and
Franklin Irrigation District

Martinez & Curtis, P.C. Phoenix

By: William P. Sullivan
Attorneys for Town of Wickenburg, Arlington Canal Company, Bella
Vista Ranches Limited Partnership, Bella Vista Water Company,
Inc., Cortaro Water Users' Association, Cortaro-Marana Irrigation
District, Pima County, Town of Gilbert, and Valencia Water
Company, Inc.

Jennings, Strouss & Salmon, P.L.C. Phoenix

By: M. Byron Lewis
John B. Weldon, Jr.
Stephen E. Crofton

Attorneys for Salt River Project Agricultural Improvement and Power District, and Salt River Valley Water Users' Association

United States Department of Justice

Washington, D.C.

By: Lois J. Schiffer
Robert L. Klarquist
David C. Shilton
Gary B. Randall
F. Patrick Barry

Attorneys for United States

Cox and Cox

Phoenix

By: Alfred S. Cox
Alan S. Cox

and

Rodney B. Lewis

Chandler

Attorneys for Gila River Indian Community and Silas Kisto

Chandler, Tullar, Udall & Redhair

Tucson

By: Stephen B. Weatherspoon

Attorneys for The Nature Conservancy

Sparks & Siler, P.C.

Scottsdale

By: Joe P. Sparks
John H. Ryley
Kevin T. Tehan

Attorneys for San Carlos Apache Tribe, Tonto Apache Tribe, and Yavapai Apache Tribe

Roderick G. McDougall, Phoenix City Attorney

Phoenix

By: M. James Callahan

Attorneys for City of Phoenix

Office of the Tempe City Attorney

Tempe

By: David R. Merkel
Karen S. Gaylord

Attorneys for City of Tempe

Riney B. Salmon II, P.C.

Phoenix

By: Riney B. Salmon II

Attorney for Maricopa County Municipal Water Conservation District No. 1 and San Carlos Irrigation & Drainage District

John S. Schaper

Phoenix

Attorney for Buckeye Irrigation Company and Buckeye Water Conservation and Drainage District

Ulrich & Anger, P.C.

Phoenix

By: William H. Anger

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).¹

¹Section 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.

¶12 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'"² 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.

²"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").

¶15 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.

¶16 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

¶17 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.³

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*

³The 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.

¶120 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.

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

⁴Some 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.⁵ Thus,

⁵Specifically, 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.

¶125 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

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.

¶127 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.

¶128 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.⁶

⁶Contrary 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.

¶132 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.

¶133 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

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.⁷ In

⁷According 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.

¶136 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.

¶137 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).⁸ 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

¶138 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

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

adjudication if "it is proven that their 'cones of depression'⁹ 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."

¶139 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."

¶140 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

⁹The 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.¹⁰ 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.

¹⁰We 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.").

¶146 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.").

¶147 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.