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10:50am

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BEFORE THE ARIZONA NAVIGABLE STREAM  
ADJUDICATION COMMISSION

In re Determination of Navigability of )  
the San Pedro River ) Case No. 03-004-NAV  
) Response Memorandum regarding the  
) Navigability of the San Pedro River  
)

Defenders of Wildlife, Donald Steuter, Jerry Van Gasse, and Jim Vaaler (collectively,  
"Defenders") hereby submit their response memorandum regarding the navigability of the San  
Pedro River.

**I. The Daniel Ball Test for Navigability Does Not Require Actual or Commercial Use; Susceptibility is the Proper Test.**

In their opening memoranda, navigability opponents all contend that this Commission must find the San Pedro nonnavigable because historically the San Pedro was not extensively navigated or used for commercial enterprises. After years of litigation, their arguments along these lines are both predictable and familiar. That does not, however, make them any more correct in 2013 than they were in the late 1990s when they posited them to the Court of Appeals in *Defenders v. Hull*,

Appellees assert that "numerous courts, however, have held that a watercourse must be susceptible to *commercial* use in order to be deemed a 'highway for commerce' (i.e., a 'navigable' watercourse)." ... [W]e find Appellees' argument unconvincing....The federal test has been interpreted to neither require both trade and travel together nor that the travel or trade be commercial.

199 Ariz. 411, 416, 18 P.3d 722, 727 (App. 2002)(citations omitted).

That navigability for title can be found based on susceptibility to navigation even where evidence of actual navigation is lacking was recently reinforced by the Oregon Court of Appeals. *Northwest Steelheaders Ass'n v. Simantel* 199 Ore. App. 471, 112 P.3d 383 (2005). In that case, the Oregon Court of Appeals held particular segments of the John Day River navigable based on the reaches' susceptibility to navigation by Indian canoes. *Id.* at 489. Not surprisingly, the navigability opponents in *Northwest Steelheaders* raised arguments almost identical to the arguments asserted by navigability opponents in this case. In seeking review by the United States Supreme Court (which was denied), the Oregon landowners argued that the Oregon Court of Appeals had erred in finding that susceptibility for travel by canoes with drafts of six to eight inches was sufficient in and of itself to support a finding of navigability, because, among other things:

The evidence established that, while Native Americans lived in both the lower and upper reaches of the John Day River, there is no historical evidence documenting any Native American canoe use on the John Day River. . . . Although European trappers and later anthropologists documented canoe use on other rivers by other Native Americans living in the region, no one ever documented such use by Native Americans on the John Day. ....Archeological surveys in the area also did not uncover any evidence of Native American canoe use, although they did document the use of Native American foot trails directly along the banks of the River....

\* \* \*

Evidence of early pioneer use of the John Day River was scant. Brigades from the Hudson Bay Company exploring the John Day River did so by horseback and not by boat. . . . In 1858, the United States Army was looking for an expeditious route to move troops and material against the Mormons in Salt Lake City. . . . The Army explored the region by horseback and not by boat. . . . The explorations led to the building of a wagon road in the vicinity as a means to provide a highway for commerce through the John Day River country. . . .

2005 U.S. S. Ct. Briefs LEXIS 2061. Yet, as the Oregon Court of Appeals properly recognized, [f]irst, with respect to ‘actual use,’ it is not necessary that the historic use made of the river have been either wide-spread or commercially profitable.” 199 Ore. App. at 482. Further, recognizing the historic role that small boats have played in transporting both goods and people, the Oregon court held, “[w]ith respect to the particular mode or means of travel or trade utilized, qualifying travel and trade is not limited to large-scale commercial or multiple passenger vessels of the sort typically engaged in modern commerce. . . .” *Id.* Indeed, as the United States Supreme Court has observed, “[i]t would be a narrow rule to hold that in this country, unless a river was capable of being navigated by steam or sail vessels, it could not be treated as a public highway.” *The Montello*, 87 U.S. (20 Wall) 430, 441 (1874), quoted with approval in *United States v. Utah*, 283 U.S. at 76.

Thus, the fact that the San Pedro was not historically navigated, but was rather used for irrigation and consumptive needs, does not preclude a finding of navigability. The test is not whether the river was used as a “highway for commerce” at the time of statehood, but rather, whether, in its ordinary and natural condition, it was susceptible to such use. Here, as discussed at length in Defenders’ Opening Memorandum, the evidence establishes that in its ordinary and condition at the time of statehood, a significant segment of the San Pedro River had sufficient flow and depth to allow navigation by small watercraft that were customarily used at that time.

## **II. The Critiques of Mr. Hjalmarson’s Analysis are Without Merit and Reflect a Lack of Understanding of Basic Hydrology and Scientific Studies on the Part of Navigability Opponents.**

In their opening memoranda and at the hearings before the Commission, navigability opponents spent considerable time attempting to discredit Mr. Hjalmar Hjalmarson, a 31 year veteran of the United States Geological Survey and uncompensated expert witness who

volunteered to analyze the river and testify before the Commission. What is most noteworthy about those efforts, however, is what the criticisms reveal about the critics: a lack of basic understanding of both Mr. Hjalmarson's analysis and scientific studies upon which he relied.

**A. Mr. Hjalmarson Based his Analysis on both Historical Evidence and Objective Scientific Studies.**

Navigability opponents first take issue with Mr. Hjalmarson's decision to use modeling to determine what the San Pedro River looked like in its natural condition. In this regard, they contend that Mr. Hjalmarson disregarded or discounted historical descriptions of the river. However, that assertion is simply false. It was Mr. Hjalmarson's careful and studied consideration of the historical descriptions of the river that led him to conclude that modeling was appropriate and necessary. Instead of simply focusing on descriptions of widths and depths contained in the particular comments and taking those at face value, Mr. Hjalmarson looked for additional information that could be gleaned from the observations and the historic record to clarify whether the river being described was, in fact, in its natural condition. He considered all of the information in both the historical and hydrological context.

For example, as he explained in his testimony, descriptions of the river as "turbid" in 1855 and 1857 suggested a disturbed watershed, possibly due to agriculture. Phoenix PPT, slides 23-26. Historic records, including a 1919 report to Congress, documented that land along the San Pedro River had been continuously irrigated since well before the Gadsden Purchase. *Id.* at slides 27-32. From about 1750 to mid 1800s, before the Anglo explorers arrived, a Mexican land grant program led to large livestock herds along the river—and the cattle remained even after the ranches had been abandoned. Bisbee PPT, slides 24-28. It is because all of these human activities had the potential to impact the river, and in fact, appear to have impacted the river at least as early as 1854 and likely before, that historic descriptions from the early Anglo explorers while informative, cannot be relied upon as describing the river in its natural condition.

Navigability opponents seize upon the fact that scientists cannot say with certainty that the massive entrenchment that occurred prior to statehood is entirely the result of human activity, and use that uncertainty to argue that entrenchment is an entirely natural occurrence. However,

that is a misreading of the scientific literature. As Huckleberry and others concluded in a recent book on the San Pedro, even though “it is difficult to quantify the degree to which humans have caused past and present transformations of the San Pedro River,” it is nonetheless true that “[m]any of the geomorphic changes experienced by the San Pedro River during the last 150 years are undoubtedly linked in part to water depletion, overgrazing, deforestation, and introduction of plant species.” EIN X002 Stromberg & Tellman, p. 266-67. In other words, although changes in natural conditions may be part of the cause, we know that humans have had a significant impact on the river. It is that fundamental recognition that caused Mr. Hjalmarson to conclude that in order to truly evaluate the river in its “natural condition,” it was necessary to do further analysis using hydrologic principles and hydraulic geometry.

**B. Mr. Hjalmarson’s Analysis Was Scientifically Sound and Used Conservative Calculations to Estimate Predevelopment Flow.**

In their critiques of his work, navigability opponents suggest that Mr. Hjalmarson “cherry picked” data and should have used alternative “discharge inputs” for his estimation of predevelopment flow for the San Pedro River. A closer examination of their objections, however, reveals fundamental misunderstandings about hydrologic data.

First, as explained both in his testimony and his executive summary of that testimony, Mr. Hjalmarson used Flow Duration Curves (FDC) to calculate predevelopment flow for the San Pedro River. The first step in his analysis was to identify a representative curve, which he did based on all available discharge data for the Tombstone gage. None of the opponents have raised any objection to this approach or the FDC he used. With respect to his flow calculations, their objections relate to the data he used to plot the FDC on two of the three graphs he prepared to estimate predevelopment flow.

In order to understand why their objections are without merit, it is necessary to understand what data Mr. Hjalmarson used and how he used it. Using the representative FDC, Mr. Hjalmarson was able to estimate the predevelopment flow at three sites: the Charleston gage, the narrows (or join) and the mouth. He did so by plotting the FDC on a graph using two data

points: **predevelopment base flow** and **average annual runoff**. Once the FCD was plotted based on those two data points, he was then able to determine median annual flow for each site.

Base flow or base runoff, as Mr. Hjalmarson explained, is that portion of stream flow that comes from under the ground. In the case of the San Pedro, predevelopment base runoff was derived from groundwater discharge to the river from the regional and alluvial aquifer. For the predevelopment base runoff for each of the three sites, Mr. Hjalmarson used the base runoff calculations from USGS HA-664, prepared in 1986 by G. W. Freethey and T. W. Anderson of the U.S. Geological Survey. Although, as discussed *supra*, navigability opponents have taken issue with this Report's conclusion that the predevelopment San Pedro was perennial for its entire length, none have raised any objection to the predevelopment base runoff calculations it contains. And, in fact, as Mr. Hjalmarson pointed out in his testimony, the USGS HA-664 estimate of predevelopment base runoff at the Charleston gage was the lowest of five independent estimates of that base runoff in the scientific literature between 1982 and 2006.

The confusion comes in with the second data point used by Mr. Hjalmarson, average annual runoff. Runoff is that part of precipitation that naturally appears in surface streams if there were no diversions—which is the same as predevelopment stream flow. Runoff includes both direct flow and base flow. For his analysis, Mr. Hjalmarson needed the average annual runoff for each of the three sites he had identified. For two of those sites, the narrows and the mouth, he used USGS Open File Report 87-535 (“Krug Report”) which computed the average annual runoff for each of the 2, 148 hydrologic cataloging units in the entire United States and Puerto Rico. The two hydrologic cataloging units for the San Pedro River are 15050202 (upper basin) which ends at the join and 15050203 (lower basin) which ends at the mouth. However, because of the way the Krug Report was prepared, using its calculation of average annual runoff at each location was not simply a matter of plucking a number off of a chart. A stated objective of the Krug Report was to determine the “average runoff near its source, rather than the cumulative runoff...” Bisbee PPT, slide 89. Thus the calculations in the Krug Report represent the annual average runoff for each particular unit, even though the river, as it flows through that unit, may already contain cumulative runoff from other units.

Because of this feature of the Krug Report, Mr. Hjalmarson had to make two adjustments in order to ensure that the annual average runoff calculations he used at the join and the mouth were accurate. (His method for both adjustments are explained in detail in the Executive Summary.) First, Unit 15050202 does not include that portion of the upper basin that is located in Mexico, although runoff from that area is in the river as it flows through Unit 15050202. Consequently, Mr. Hjalmarson had to make an adjustment to include that additional runoff in the calculation of annual average runoff at the join—the end point of the unit.

The second adjustment was for the mouth. Again, because the Krug Report only calculated runoff for the unit and not the cumulative runoff, it was necessary to add the runoff from the upper basin (Unit 15050202) to the runoff for the lower basin (Unit 15050203)(after also adjusting for loss due to ET). Navigability opponents took exception to this calculation, and claim that Mr. Hjalmarson should have instead used the discharge figures from the Winkelman gage at the mouth. *See, e.g.* Freeport McMoRan Memo. p. 13. What the opponents fail to realize, however, is that although the Krug Report includes and relies upon gage discharge data as part of its calculation of runoff, the gage data are simply one component of runoff and not a substitute for the Report's final calculation, which includes both direct and base flow. Therefore, the criticism that Mr. Hjalmarson should have used gage data for the average annual runoff at the mouth fails to grasp this important distinction. Mr. Hjalmarson used the Krug Report as it was intended to be used to calculate the average annual runoff at the mouth and was absolutely correct in doing so.

This same confusion between gage discharge data and runoff also fuels the navigability opponents' objection to the calculation used by Mr. Hjalmarson at the Charleston gage site. First, it is important to recognize that the Krug Report did not calculate annual average runoff at the location of the Charleston gage (which is above the join and toward the middle of Unit 15050202). Therefore, using the Krug Report for that location was not an option that Mr. Hjalmarson rejected as opponents contend. Instead, he performed a calculation similar to what Krug and others had done for each hydrologic unit throughout the entire United States. He

averaged gage data to estimate direct flow (52.1 cfs.) and then adjusted for lost base flow (10 cfs.), because as noted above, runoff is comprised of both direct flow *and* base flow.

Navigability opponents claim that by adjusting for base flow by adding 10 cfs, Mr. Hjalmarson is “double counting” those 10 cfs and overstating the average annual runoff at the Charleston site at 62 cfs. They claim that even though it is largely recognized that modern groundwater pumping has diverted most, if not all, of the San Pedro’s predevelopment base flow to the point that in recent years the river has gone completely dry at the Charleston gage for the first time ever, the fact that during several months of the year, there are at least 10 cfs at the Charleston gage proves that the predevelopment base flow has not disappeared. Of course, they offer no proof that the source of these 10 cfs is groundwater—which is by definition a requirement of base flow. Nor do they attempt to reconcile the fact that the river level at the Charleston gage is often well below 10 cfs in recent years—something that would not occur if the base flow remained at predevelopment levels. Nonetheless they accuse Mr. Hjalmarson of bad faith or at least bad counting.

The irony of this accusation is that if Mr. Hjalmarson had been interested in using the highest possible average annual runoff at the Charleston gage, all he had to do was use the U. S. Bureau of Reclamation Report from 1952 which estimated the average annual runoff at the Charleston gage to be 80 cfs. Phoenix PPT, slide 11. However, he did not do that. Instead he made a good faith estimate using the same professional standards that he used throughout his career at USGS. The fact that his estimate was lower than the USBR Report and yet he still used it in his analysis reveals his commitment to sound science and honest analysis.

**C. Mr. Hjalmarson’s Channel Estimates of Channel Size and Shape Are Supported by the River’s Geomorphology.**

“Prior to the mid-1800s, the San Pedro River flowed over an unincised surface and had a larger area prone to flooding. It contained a single meandering channel and marshes were common.” Stromberg & Tellman, p. 260. Streams with natural alluvial channels, like the San Pedro once was, form their own geometry. This “hydraulic geometry” is related to water flow and sediment characteristics. The amount of flow is the principal control of channel size and the



sediment characteristics largely determine channel shape. Bisbee PPT, slide 112. In modeling the channel shape and size of the San Pedro River in its natural condition, Mr. Hjalmarson relied upon the recent research by Cook and others which indicates that unlike the present channel, the natural channel and floodplain of the San Pedro were composed of finer material that consisted of fine sand, silt, and clay with interspersed pebble to gravel beds. *Id.* at slides 115, 116.

The suggestion by Mr. Burtell that Mr. Hjalmarson should have used the channel shapes shown in the Fuller report in his modeling ignores the purpose of the analysis—which is to estimate what the river channel would look like in its *natural* condition. The cross sections in the Fuller report reflect the channel of the river post-development. When asked about the dichotomy of using the post-development channel shape to model the natural river channel, Mr. Burtell asserted that human impacts on the river, such as diversion, did not alter channel shape. Transcript, 8/2/2013 at 76-78. This assertion, however, is completely contrary to accepted geological principles. For example, as Huckleberry and others explain in Ecology and Conservation of the San Pedro River, “[r]ivers like the San Pedro are complex, open systems that adjust channel size, shape, and configuration in response to changes in runoff and sediment yield from drainage basins. Such changes can have multiple causes, and it may not be possible to determine to what degree river metamorphosis is human induced.” Stromberg & Tellman, p. 259. Thus, the suggestion that Mr. Hjalmarson should have used the cross-sections in the Fuller report in his model is completely contrary to basic geomorphology.

After modeling the channel shape, Mr. Hjalmarson compared his results with measurements of channel width along section lines of Federal land surveys between 1877 and 1879. Even though these surveys were done after the channel had been subject to anthropogenic effects, they still agreed reasonably well with the modeled widths. Navigability opponents attempt to discredit this cross-check of Mr. Hjalmarson’s modeling by claiming that the channels were not measured from bank to bank. Therefore they contend that Mr. Hjalmarson was comparing “apples to oranges.” However, surveyor notes from a survey of the Gila River during the same time frame shows that measurements were taken from the rivers’ banks. X0013, Field

Notes. Thus, contrary to Mr. Burtell's claim, Mr. Hjalmarson, a registered civil engineer who has himself performed hundreds of surveys, was, in fact, comparing "apples to apples."<sup>1</sup>

**D. Mr. Hjalmarson's Conclusion that the San Pedro River in its Natural Condition was Perennial Is Supported by Scientific and Historical Data.**

The navigability opponents go to great lengths to dispute the findings of HA 664 that the predevelopment San Pedro River was perennial through its entire length. They attempt to discredit this peer-reviewed, exhaustive scientific study by respected and experienced hydrologists by pointing to an earlier map prepared by David E. Brown, Neil B. Carmony and Raymond M. Turner for the Arizona Game and Fish Department which concluded that major segments of the San Pedro River were perennial, but identified some reaches that were intermittent. Notably, HA 664 based its conclusions on existing literature, including the map by Brown and others (1981), numerical groundwater models, and water budget data compiled by the USGS and other agencies from the early 1900s to about 1940. Thus, its findings built upon the work of Brown and others and, quite obviously, improved upon it. The suggestion that the Commission should reject the conclusions of the USGS Report in favor of an earlier, less comprehensive study ignores fundamental principles of the scientific method.

Moreover, there is ample historic evidence to support the conclusion that the entire River was perennial. For example, the prolific beaver that James O. Pattie found on the river in the early 1800s indicated that the river was perennial for its entire length. Similarly, early explorers, including Parke, reported that, "water is abundant and convenient in the entire valley of the Rio San Pedro." Phoenix PPT slide 39. *See also* 1857 Report on the U.S. Mexican Boundary Survey, Vol 1, p. 94 ("Throughout the whole course of the San Pedro there are beautiful valleys susceptible of irrigation and capable of producing large crops of wheat, corn, cotton and

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<sup>1</sup> In his testimony, Mr. Burtell also seems to suggest that in performing this cross check, Mr. Hjalmarson compared widths measured in meters with widths measured in feet. Transcript 8/2/2013 at 78-79; however, the channel measurements set forth in the Fuller Report Table 5-3 used by Mr. Hjalmarson very clearly shows the widths in feet. Moreover, when the Fuller average widths in feet are compared with the average surveyed widths in meters (see EIN X005 Huckleberry Appendix A) it is clear that the distances are accurately expressed in feet and correlate when converted to meters. So, there was no "confusion" on the part of Mr. Hjalmarson.

grapes...”) and Vol. 2, p. 18 (“[T]he San Pedro is the only branch of the Gila River, coming from the south which furnishes an uninterrupted stream of running water along its whole course”) Phoenix PPT slides 39, 40. These early explorers also reported an abundance of fish, some of which grew up to 3 feet long. As Tellman observed, the presence of this fish this size is consistent with a perennial river. Bisbee PPT slide 30. Finally, when the river was first surveyed by Federal Land Surveyors (Harris) in 1877-79, it appears to have had water throughout its length at the time of the survey (November and December 1879). Phoenix PPT, slides 34, 35.

**E. Mr. Hjalmarson Properly Considered the Impacts of Beavers and Cattle.**

The arguments by navigability opponents that Mr. Hjalmarson failed to adequately consider the impact of beavers but overestimated the impact that thousands of cattle had on the river are similarly without merit. Beavers, which are native to the San Pedro, do have the potential to create temporary obstacles. However, those obstacles are easily overcome. *See Northwest Steelheaders Ass'n*, 199 Ore. App. at 484 (“Navigability based on either actual use or susceptibility to use may be established despite the presence of obstacles to free passage, such as rapids, riffles, or occasional areas of low water requiring portage.”) Moreover, beaver also contribute to navigability by slowing the flow and creating deeper pools. Therefore, the greater concern is the removal of beavers by humans, which allowed more flood damage and contributed to the alteration of the natural condition of the river. Stromberg & Tellman, p. 266.

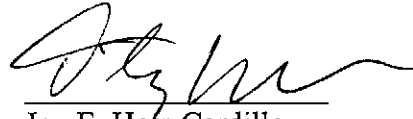
In contrast, cattle are not indigenous to the San Pedro River basin and only arrived at the shores of the San Pedro because of humans. Their presence along the river with the overgrazing of the watershed clearly caused, or contributed to, channel incision, erosion of the river banks and increased sediment yield to the river. The associated entrenchment began shortly after cattle arrived and it may be many years before the full impact is realized.

**III. Conclusion.**

For all of the foregoing reasons, as well as the reasons set forth in the Opening Memorandum and Proposed Findings of Facts and Conclusions of Law filed by Defenders in this matter, Defenders urge this Commission to find that segment of San Pedro River that extends from one mile below Lewis Springs to the mouth navigable at the time of statehood.

Respectfully Submitted this 27th day of September, 2013.

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A handwritten signature in black ink, appearing to be 'SJM', written over a horizontal line.