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**SUBJECT: COMMENTS ON DRAFT ORDER DETERMINING
LEGAL CLASSIFICATION OF GROUND WATER
ELK PRAIRIE, NORTH FORK GUALALA RIVER**

Dear Chairman Baggett and Mr. Murphey:

In response to the invitation to submit written comments on the subject Draft Order, which was included in the November 27, 2002 notice of Draft Order, we have reviewed the Draft Order and prepared the following technical comments. For reference, our comments are summarized in the next paragraph; the expanded, detailed comments are then delineated with reference to specific sections or paragraphs of the Draft Order.

Summary Comments On Draft Order

All of our comments concern technical details related to ground water and its occurrence and movement through permeable earth materials, and the interpretation or application of fundamental principles of ground-water hydrology. One principal comment and concern with the Draft Order is that it reaches an incorrect conclusion regarding what a "permeability difference" will cause, in this case at the boundary of a subterranean channel.¹ The Draft Order concludes that a difference in permeability between bedrock and alluvium "creates a channel of preferential groundwater flow" and "prevents the movement of groundwater out of the channel". Permeability and permeability differences are intrinsic properties of earth materials and, by definition, permeability permits flow through earth materials. However, permeability is not

¹Here, and throughout this letter, "subterranean channel" refers to a physical feature that has a channel configuration; "subterranean stream channel" refers to a subterranean channel through which ground-water flow is occurring.

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directional. Consequently, the Draft Order violates a fundamental ground-water flow principle when it concludes, based solely on permeability or permeability differences, that ground-water flow direction is limited such that it can only be "into" a subterranean channel, and not out of such a channel. Ground-water flow direction in permeable materials is dictated by water level differences, and ground-water flow direction in permeable materials can and does change in response to changes in water levels. Ground-water flow direction is **not** determined by permeability differences.

A second principal comment on, and concern with, the Draft Order is its conclusion that there is flow in the subterranean channel beneath the entire Elk Prairie when there is no data on which to base any conclusion about ground-water flow beneath Elk Prairie except specifically beneath North Gualala Water Company's property (which represents only a fraction of Elk Prairie). The Draft Order concludes that ground-water flow is occurring in the subterranean channel beyond North Gualala's property, but there is no technical basis to support that conclusion, which is thus inconsistent with the fundamental rule that ground water is presumed to be percolating groundwater, and not ground-water flowing in a subterranean stream. Those who advocated the existence of a subterranean stream provided no data or other technical support to "prove" that there actually is flow in what the Draft Order concludes is a subterranean stream.

Our other comments relate to the technically unsupported conclusion in the Draft Order regarding ground-water flow above Elk Prairie, the Draft Order's discussion of recharge and ground-water flow outside the channel, and the Draft Order's incorrect statement that "the practical question to be answered by the test stated in D-1639 is whether the subterranean stream is behaving like a surface stream".

Specific Comments On Draft Order

Section 4.1.1, ¶1 - The statement about a "geophysical survey of the area" follows and precedes discussions of the entire North Fork Gualala River. The statement should be edited so that it is clear that the only geophysical survey was specifically of the Elk Prairie and not, as stated, of "the area", which could be interpreted to be the entire North Fork Gualala River area.

Section 4.1.1, ¶5 - The statement that "*The difference in permeability between the bedrock and the alluvium creates a subsurface channel of preferential groundwater flow*" is unsupported by the only evidence regarding ground-water flow directions in the subject area beneath Elk Prairie, which shows ground-water flow perpendicular to the channel, and also is inconsistent with the basic principle that permeability differences do not determine ground-water flow directions.

Section 4.2, ¶16 - The conclusion that "*this difference in permeability is adequate to prevent the dispersal or wandering of the water, once it is in the channel, into the surrounding bedrock*" is a

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technically indefensible interpretation of permeability. The Draft Order ignores the basic fact that the reason that "water may flow from the bedrock, but it does not flow back into the bedrock from the subterranean stream (R.T., pp. 256-257)" is entirely the result of the water level differences between ground-water in the bedrock and ground-water in the alluvium. The question at the cited point in the transcript was whether water is leaving the channel, not whether it could leave the channel. Under the prevailing hydraulic conditions at Elk Prairie, ground-water levels are higher in the bedrock than in the alluvium, thus resulting in flow from the bedrock into the alluvium. Water is not flowing from the alluvium to the bedrock because it cannot flow out of the channel (from low level to high level) at the same time that it is flowing into the channel (from a high level to a low level). However, that does not mean that it could not ever flow out of the channel. Permeability is an intrinsic property of earth materials. The fact that there is permeability means that, under hydraulic conditions where there are water level differences in any given direction, there will be flow in a downgradient direction, i.e. from high level toward low level. Permeability and permeability differences are not directional; that is, they do not permit flow in one direction but not in another. In permeable materials, flow directions will change in response to changing ground-water levels. It is thus technically flawed for the Draft Order to conclude that permeability, or a difference in permeability, in any way prevents ground-water flow in any given direction, particularly while also acknowledging that the same permeability permits flow in the opposite direction.

Section 4.3.1, ¶2 - The last sentence that "Groundwater discharges into the alluvium under the North Fork Gualala River and then moves downstream to Elk Prairie in a southwesterly direction" is unsupported by any evidence. There are no data on which to base any conclusion about a "downstream" or "southwesterly" direction of ground-water flow upstream of Elk Prairie. The only scientific data related to hydrologic conditions upstream of Elk Prairie are the stream flow measurements that show a sustained base flow and overall gaining reach conditions upstream of Elk Prairie. The only conclusion related to ground-water flow direction that can be drawn from those data is that there is some component of ground-water flow toward the surface stream (to support base flow and the gaining reach). Any conclusion regarding any other ground-water flow direction, i.e. "southwesterly", or confinement in a channel, upstream of Elk Prairie is unsupported by any data.

Section 4.3.1, ¶3 - The opening sentence is an incorrect characterization of North Gualala's "argument" as regards the significance of ground-water flow direction. North Gualala's observation was that the ground-water flow direction deviates from the alignment of the subsurface channel, not that it deviates from the direction of surface flow. In fact, the existence of surface flow has no bearing on the legal classification of ground water in a subterranean stream. While the relative directions of surface flow and ground-water flow might be applicable to a question of underflow of the surface stream, the Draft Order characterizes the matter as a subterranean stream question, and not as an underflow question, so these relative directions are

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not relevant here.

The fact that *"the DFG, however, points out that the subsurface water level measurements are taken only in the subterranean channel alluvium"* is exactly on point. The issue is whether ground water is flowing in a subterranean stream, so measurement of ground-water levels in the "subterranean channel alluvium", and determination of ground-water flow directions from those data, are key to the determination of whether ground water is flowing in such a channel. The statement that *"Thus, the direction of groundwater gradient North Gualala infers from well water levels applies only to the relatively small area of the alluvium in the immediate vicinity of North Gualala's well field"* also is exactly on point. The key question is the flow direction **in the channel** at the point where the issue of a subterranean stream is being addressed.

Interpretation of ground-water flow direction from actual water level measurements in the alluvium in the subsurface channel is exactly the correct method of determining whether or not ground water is flowing in a subterranean stream channel. Further on that same point, it should be emphasized that the **only** location where ground-water flow direction is known, based on measured data, is beneath North Gualala's property (only a fraction of Elk Prairie), and that flow direction there is predominately perpendicular to the subterranean channel. The directions of ground-water flow beneath the rest of Elk Prairie and elsewhere throughout the North Fork Gualala River system are unknown.

Finally on the preceding point, it is interesting that *"the DFG, however, points out that the subsurface water level measurements are taken only in the subterranean channel alluvium"*, and that *"the direction of groundwater gradient... applies only to the relatively small area of the alluvium in the immediate vicinity of North Gualala's well field"*. This statement is correct. Neither the DFG, nor any other advocate of the existence of a subterranean stream, provided **any** data on which to base any conclusion regarding ground-water flow beyond the limited confines of North Gualala's property. There is no data and consequently no proof regarding ground-water flow direction beneath any of the Elk Prairie besides North Gualala's property. The Draft Order's conclusion that ground water is flowing in the subterranean channel beneath the entire Elk Prairie therefore is technically unsupported.

The final sentence in this paragraph, that *"the DFG witness testified that if recharge of the subterranean stream occurs from the bedrock, it is only a minor amount"*, is unrelated to the subject of ground-water flow direction in the channel alluvium. The actual measured ground-water levels in the channel alluvium define the ground-water flow direction. Whether or not recharge is from bedrock, or whether it is a major or minor amount, are simply not issues. Flow direction is whatever it is, as defined by actual ground-water levels. The source of recharge may help explain why the flow direction is whatever it is, but knowledge of the source and amount of recharge is not necessary to interpret ground-water flow direction in a channel; only ground-water levels are required, and those are exactly what have been measured and interpreted to

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conclude that ground water flows across, and not parallel to or otherwise aligned with, the physical channel beneath Elk Prairie.

Section 4.3.1, ¶4 - It is not correct to say that *"the practical question to be answered by the test stated in D-1639 is whether the subterranean stream is behaving like a surface stream. In this case, the evidence shows that it is behaving like a surface stream"*. The technical tests in D-1639 have to do with geologic and hydrologic descriptions and interpretations of ground water in a given setting. There is nothing about "behaving like a surface stream" in those tests, and "behavior" comparisons between surface and ground water are far too subjective to be a basis for determining the legal classification of ground water.

Section 4.3.2 - In the first paragraph of this section, the Draft Order states that *"discharge of groundwater from springs and seeps emanating from fractured rock aquifers within the Franciscan bedrock surrounding the Elk Prairie may add significant quantities of surface water flow to the adjacent streams and rivers... however, any water that discharges into the subterranean stream flows in the stream from a higher to a lower elevation after it enters the stream. Thus, the water gathers in the subterranean stream from the surrounding bedrock, much as water on the surface gathers in a surface stream, and flows from that point in the stream"*. This appears to say that one possible source of ground water at Elk Prairie is subsurface inflow from a subterranean stream upgradient of Elk Prairie. If that is the case, the existence of a subterranean stream upstream of Elk Prairie is entirely an assumption (in conflict with the presumption that ground water is percolating ground water unless proven to be otherwise); there was no discussion and there is no evidence to support any conclusion that a subterranean stream exists upgradient of Elk Prairie. As noted above, the only evidence about flow above Elk Prairie is that there is a continuously and perennially gaining reach of the North Fork of the Gualala River above Elk Prairie. The only conclusion relating to ground water that can be derived from those gaining stream observations is that there is a ground-water flow component discharging to the River. Whether or not there is any ground-water flow down the presumed channel is completely unknown. Any conclusion about the existence of a subterranean stream above Elk Prairie is a conclusion unsupported by any technical facts.

The second paragraph of Section 4.3.2 discusses *"another possible source of water in the subterranean stream is the water-bearing fractures within the Franciscan bedrock"*. It is not clear how this source is different from that discussed in the preceding paragraph, where the possible source was described to be "fractured rock aquifers within the Franciscan bedrock surrounding the Elk Prairie site". However, it appears, as noted above, that the first paragraph describes possible subterranean stream inflow from upgradient of Elk Prairie; thus, in order for the second paragraph to be interpreted as "another" possible source of water that also emanates from fractured bedrock, it appears that it is describing the flow of ground water from immediately adjacent bedrock into the alluvium beneath Elk Prairie. This, of course, is what the

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only evidence related to ground-water flow directions shows; there must be a source of water to establish and maintain the ground-water levels and the flow direction beneath North Gualala's property (which is not aligned with any subsurface channel). There is no other possible source of water that can accomplish this. Interestingly, even if an upgradient subterranean stream existed, it could not provide inflow that would establish and maintain the **measured** ground-water levels, and resultant ground-water flow direction, beneath North Gualala's property at Elk Prairie. The ultimate technical problem with this paragraph, however, is that it draws an unsupported conclusion about ground-water flow after "*it passes the boundary of the channel and flows into the subterranean stream*". As discussed above with regard to Section 4.3.1, the measured data show that ground water is flowing across the physical channel, and not parallel to or otherwise aligned with it, as would be required for a subterranean stream.

The last paragraph of Section 4.3.2 is the apparent lynchpin of the decision: "*North Gualala's witness specifically stated, in response to cross-examination, that no flow goes back into the bedrock (R.T., pp. 256-257.) Therefore, the Franciscan bedrock prevents the movement of groundwater out of the channel. This establishes that the water in the channel is not percolating groundwater, despite the possibility that it may have been percolating groundwater until it entered the channel*" (emphasis added). Everything following the word "Therefore" is not technically defensible. As discussed above, I ("North Gualala's witness") said that no flow was going back into the bedrock; the technical basis for that answer is because the measured ground-water gradient is away from the bedrock and toward the River. Under such hydraulic conditions (which are perennially present and thus support the perennially gaining River conditions throughout the area), ground water cannot flow hydraulically uphill, i.e. out of the alluvium and into the bedrock. However, I did not say that ground water **could not** flow out of the alluvium and into the bedrock, nor was there any implication in my testimony that any physical feature or characteristic of the aquifer system "prevents" the movement of water out of the channel. In fact, as discussed above, the fact that there is sufficient permeability to allow ground water to flow into the channel establishes that the same permeability, which is not directional (i.e. it does not allow flow in one direction and preclude flow in another or opposite direction), will allow flow in a different direction if the water levels change. It is technically flawed to conclude that, because water is flowing in any given direction, it is "prevented" from flowing in some other direction by differences in permeability. It is clear that the bedrock is "relatively" impermeable in comparison to the alluvium. However, the technical evidence shows, and the Draft Order acknowledges that there is some bedrock permeability. With that intrinsic property (permeability), the materials have the ability to transmit ground-water flow in any direction, and the actual flow direction will be determined by the water level differences. It is a violation of fundamental ground-water flow principles to conclude that a permeability difference "prevents" flow in any particular direction. The fact that ground water is flowing into the channel, and not out of it, all in response to prevailing hydraulic (water level) conditions, does not "establish that the water in the channel is not percolating ground water".

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Section 5.0 - As discussed above, the conclusion that ground-water flows "in" the channel beneath Elk Prairie is unsupported. Also, the Draft Order contains some further discussion here about the relative flow directions of the subterranean stream and the surface stream, none of which is relevant to the physical occurrence of a subterranean stream (as discussed in Section 4.3.1 of the Draft Order). As was presented to the State Board as part of the recent lengthy process to reexamine its jurisdiction over ground water, the classic illustrations of subterranean streams are solution channels and lava tubes. Neither of those is associated with a surface channel, and surface water would have nothing to do with the physical occurrence of ground water in those types of subterranean streams. For consistency, in the case of Elk Prairie, the application of the test needs to consider what the flow direction is in the subterranean channel; the direction of surface water flow is irrelevant. If the question were whether flow in the alluvium was the underflow of the surface river, then the relative direction of surface water and ground-water flow would be applicable. However, this entire matter was heard as a subterranean stream question, not as an underflow question, so the relative surface water and ground-water flow directions are not relevant.

In closing, we appreciate the opportunity to submit the preceding comments. Because the conclusion in the Draft Order regarding the legal classification of ground-water beneath North Gualala's wells is based on several technical factors that either violate fundamental ground-water hydrologic principles or is based on assumptions or conditions which are unknown or irrelevant, both the discussion and the conclusion in the Draft Order need to be amended. We would be pleased to have the opportunity to discuss those technical details with you as appropriate.

Sincerely,

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