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William Mills, Chairman
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Dear Bill:

Recently, the "Ground Water Protection Task Force Interim Report," dated February 28, 1994, was sent to me and others for our review and comment. As you know from my previous work, I have been concerned for many years about the inadequate approaches being used in California to protect its ground water resources from pollution. My concern was sufficient for me to work for a several-year period to initiate and then help to develop the Ground Water Resources Association of California, the Ground Water Quality Subcommittee of the Source Water Quality Committee of the CA/NV American Water Works Association, and the Ground Water Quality Subcommittee of the ACWA Ground Water Committee.

Further, I have published extensively on the inadequate approaches being taken within California to protect its ground water resources from pollution by contaminants derived from municipal, industrial and agricultural sources. This effort has included developing a review of this topic that was presented as a poster session at the University of California Water Resources Center Ground Water Conference that was held last September (Lee and Jones-Lee 1993a). I have also organized and presented lectures and short-courses on these issues to professional and public groups over the past five years that I have been back in California. I am therefore highly interested in the Ground Water Protection Task Force Interim Report.

From an overall perspective I find that the February 28, 1994 Interim Report does a good job in addressing some particular aspects of ground water quality protection issues in the state. This report, however, fails to adequately address a number of key areas that are vital to the protection of the quality of the ground water resources of the state and in some instances provides inadequate information to the public on issues that are discussed in the report.

One of the problems with the Task Force Interim Report appears to originate with those who developed the topic areas that the Ground Water Protection Task Force was asked to address. Unfortunately, it appears that long-standing political considerations were incorporated into the charge for the Ground Water Protection Task Force activities. As discussed below, there are a number of well-known, wide-spread causes of ground water pollution within the state that are not being addressed by the Task Force. If this situation continues, this represents a

significant deficiency in the Task Force failing to address some of the most important ground water protection issues that exist in the state today.

Solid Waste Landfills

Some of the most important current and longer-term sources of ground water pollution in the state are the municipal, industrial and hazardous waste landfills. According to the State Water Resources Control Board's (SWRCB's) SWAT reports (Mulder and Haven 1995), on the order of 83% of all of the landfills in the state are polluting ground waters in their vicinity. There are over 2,200 known landfills in the state. These landfills are almost all unlined, classical sanitary landfills. At this time, the owners of these landfills, principally municipalities and counties, are not preventing further ground water quality impairment due to leachate pollution of the ground waters. In some cases, leachate-polluted ground waters are spreading at the rate of one to two feet per day. This situation is well-known to the regional water quality control boards' staffs that are responsible for implementing the provisions of Chapter 15 governing the initiation of corrective action once ground water pollution has been found at an existing landfill. The regional boards have not, however, in general required the landfill owners to stop further pollution of ground waters by leachate derived from the landfill and to start remediation of the contaminated ground waters as required by these regulations.

The failure of the current regulatory agencies to stop pollution of the state's ground waters by existing landfills is one of the most significant deficiencies in current SWRCB activities at the state and regional levels that should be addressed in the Ground Water Protection Task Force report. This report should discuss this issue and make specific recommendations on how the state should implement the existing regulations to cause landfill owner/operators, independent of whether they are public or private entities, to take the necessary steps to properly monitor all landfills within the state to determine whether the landfill is releasing contaminants that are in any way impairing the use of ground waters. Where such pollution is found, the landfill owner/operators should, in accord with regulations, be required to define the extent and degree of pollution and develop a corrective action plan that will not only stop further pollution, but clean up the contaminated ground waters and aquifer to the maximum extent practicable.

With the adoption of the SWRCB's Subchapter 15, now Chapter 15, regulations in 1984, the State of California became committed to developing landfills that would prevent the impairment of ground waters by waste-derived constituents for as long as the wastes in the landfill represented a threat. In the early 1980's when I was teaching in the University of Texas system, I was asked by the SWRCB staff (G. Torres) to critically review the then proposed Subchapter 15 regulations. These are basically the same regulations, except for Articles 5 and 10, that are now incorporated into the SWRCB's Landfilling Policy that was adopted on June 18, 1993. At the meeting of the Board where the Policy was adopted, the Board staff and Board members reaffirmed the provisions of Chapter 15 to construct, operate, maintain, close and provide post-closure care for landfills within the state that would protect the ground water resources of the state from impaired use for as long as the wastes in the landfill represent a threat. That degree of protection has been required over the last 10 years and continues to be in effect today as state Policy.

In 1989 I returned to California and began to work with various water utilities on landfill issues that were of concern to them because of the threat that they represented to their ground water resources. I was shocked to see how the provisions of the 1984 Subchapter 15 requirements for ground water quality protection from landfill leachate pollution were being implemented at the regional board level. Since 1984 the regional water quality control boards, which have the responsibility for implementing Chapter 15 regulations, have been allowed to interpret minimum engineering design requirements, such as a liner consisting of one foot of compacted soil with a permeability no greater than 1×10^{-6} cm/sec, as equal to the ground water protection standard set forth in Chapter 15 of protecting ground water quality from impaired use for as long as the wastes represent a threat. It is obvious to anyone with even the most rudimentary knowledge of Darcy's Law governing the transport of water (leachate) and its associated pollutants that a one-foot thick compacted soil layer with a permeability of less than 1×10^{-6} cm/sec at the time of construction will not prevent pollution of ground water by landfill-derived leachate, which will impair the use of the ground water for domestic water supply purposes, for more than a couple of years after the landfill is put into operation. The landfills that have been constructed since 1984 with the approval of regional water quality control boards with the minimum liner design standards will obviously not conform to the ground water protection performance standards set forth in Chapter 15, with the result that it is only a matter of time until the landfills in the state that have been constructed since 1984 will also pollute ground waters of the state with landfill leachate, impairing their use for domestic or other purposes.

With the State Board's adoption of the Landfilling Policy last June, the minimum design standard is now a single composite liner equivalent to US EPA Subtitle D regulations. It is important to note that neither the original Subchapter 15 nor today's Landfilling Policy prescribe that the minimum liner design is necessarily equivalent to the ground water protection performance standard of preventing impaired use for as long as the wastes represent a threat. Further, it has been known for many years that municipal solid wastes, many industrial solid wastes and untreated and treated hazardous waste residues of the type that are placed in US EPA Subtitle C landfills (Chapter 15 Class I landfills) will be a threat to ground water quality for as long as the landfill exists, which will be, unless the wastes are exhumed, forever. Anyone who claims otherwise either does not understand the nature of the processes that occur in "dry tomb" lined landfills or is deliberately misrepresenting them.

During the past several years the significant discrepancy between how the regional boards implement Chapter 15 requirements in regulating the design, operation and closure of landfills, compared to the requirements in the regulations adopted by the State Board have been discussed by a number of individuals, including me. The State Board staff, regional board staff and executive officers are all aware of this problem. It was therefore hoped that, with the adoption of the Landfilling Policy last June and the State Board's reaffirming that the ground water quality protection provisions of the Policy of no impaired use for as long as the wastes represent a threat was the Policy of the state, the failure of the regional boards to implement this Policy by allowing landfills to be developed which will obviously not conform to it would be eliminated. Unfortunately, at least one regional board has already approved the expansion of a landfill located in a highly sensitive ground water area which has the minimum Subtitle D single composite landfill liner.

It is well-known that a single composite liner of the Subtitle D type will only postpone when ground water pollution occurs; it will not prevent it. Even the US EPA acknowledges that its Subtitle D landfills will not prevent the pollution of ground waters by landfill leachate, which will prevent the use of these ground waters for domestic purposes. I can, if there is interest, provide substantial documentation from the work of many investigators that a single composite liner of the type that the state now specifies as the minimum design standard, and that is being allowed by at least one regional board, will not conform to the ground water quality protection standard of preventing ground water pollution by landfill leachate for as long as the wastes in the landfill will be a threat.

It is with this background that I feel that the Task Force has failed to address one of the most significant causes of the failure of the state to protect its ground water resources -- namely, the inability of the regional boards to carry out, in a technically valid manner, the regulations developed by the State Board governing the landfilling of wastes. This issue needs to be addressed by the Ground Water Protection Task Force. The Task Force should make specific recommendations on how the state should proceed to get the existing landfilling regulations expeditiously and reliably implemented by the regional boards. It appears from the statements made on page 2-3 of the Interim Report that the Task Force was not required to address this important issue. Further, the Task Force members did not, based on the report, choose to address it on their own. This is a significant deficiency in the Task Force's current efforts.

Page 2-30 presents a discussion of the so-called overlap between the State Water Board and DTSC. Having worked with both groups over the past five years I find that this overlap is minimal and feel that there is need for greater ground water quality protection than either of these agencies independently are providing.

Beginning on page 2-45 is a discussion of the need to revise ground water monitoring provisions within the state in order to adopt more sensitive provisions for detecting releases, which will be more protective of water quality. The discussion on page 2-46, second paragraph, focuses on statistical issues. In the third paragraph the statement is made,

"Chapter 15 regulations will require amendment in the near further [sic] to be consistent with the statewide policy and new federal requirements. Further, considerable effort is ongoing with the American Society of Testing and Materials (ASTM) and other groups in coordination with the United State [sic] Environmental Protection Agency (EPA) to develop improved water and ground water monitoring methodology."

First, one not knowledgeable in the topic area would gain the impression from reading the Task Force Interim Report that the problems of monitoring waste management units are currently associated with statistics and that the US EPA and ASTM's current efforts to improve water and ground water monitoring methodology will eliminate or greatly reduce the current ground water monitoring problems associated with landfills or other sources of contaminants. The Task Force's efforts in this area are deficient compared to the magnitude of the problem that exists today in reliably monitoring landfills that will be developed under its Landfill Policy.

It has been known for many years and well published in the technical literature since 1989 that the monitoring of lined landfills, as being practiced today under US EPA Subtitle C and Subtitle D regulations, as well as those set forth in Subchapter 15, is based on a fundamentally flawed approach. The approach that is being used, involving one or more up-ground-water-gradient vertical monitoring well(s) and a few down-ground-water-gradient wells at the point of compliance with these vertical monitoring wells being spaced hundreds to one thousand or so feet apart, has virtually no possibility of detecting incipient ground water pollution from the inevitable leaks through the landfill liner before widespread groundwater pollution occurs. Chapter 15 mandates that any ground water monitoring program be able to detect incipient ground water pollution at the point of compliance for the ground water monitoring program.

The topic of adequate ground water monitoring for landfills has been of concern to me for many years. I have published extensively on this topic. The basic problem, which is obvious to anyone who examines the reliability of the monitoring approach being used, is that the vertical-monitoring-wells-based ground water monitoring program was designed for unlined landfills which pollute ground waters under essentially all of the landfill area. Plastic sheeting lined landfills of the type being developed today will initially leak through holes in the liner. As discussed by Cherry (1990), this will result in point-source leaks with narrow plumes of leachate-contaminated ground water. With ground water monitoring wells at the point of compliance having zones of capture of only about one foot, and with these wells spaced hundreds to one thousand or so feet apart, it is almost pure chance that the monitoring well system being used today will detect leachate-polluted ground waters before widespread ground water pollution occurs.

Neither the US EPA nor ASTM is addressing this issue. Their efforts are focused on improving the reliability of the vertical monitoring wells to detect contamination of ground water within the foot or so zone of capture of the well. It is important to note that some states, such as Michigan, recognize this problem and have proposed a change in regulations which would make use of a full landfill area pan lysimeter of the type discussed in the enclosed paper. A member of the State Water Resources Control Board staff informed the State Board last June that a MI landfill area pan lysimeter approach was the approach that they recommended. However, the State Board did not adopt this approach, with the result that at this time the Landfilling Policy of the state utilizes a flawed technological approach for protection of the ground waters of the state from pollution by landfill leachate from the new landfills or landfill expansions that will be constructed in accord with the requirements set forth in the Landfilling Policy.

The Ground Water Protection Task Force's discussion of deficiencies in ground water monitoring needs to be changed significantly to address the most significant problem in ground water monitoring at landfills and other waste management units associated with the basically flawed nature of the current approaches, in order to stimulate the state to adopt a significantly different approach for ground water monitoring near lined landfills than is being practiced today. Tweaking the statistics of monitoring is not the issue of concern as set forth in the Task Force Report. Such tweaking will do nothing to improve the ability to detect pollution of ground waters from lined landfills before widespread pollution occurs.

On page 2-48 a discussion is presented on current problems with the definitions of waste types as set forth in Chapter 15. The focus of this discussion is on so-called "designated waste." Mention is made on page 2-48 of inert waste, yet no discussion is presented on the significant problem that exists today in how the regional water quality control boards are determining the wastes that are classified as "inert." Chapter 15, in its original development in 1984 and today, requires that inert wastes have no soluble components that can impair water quality. It would seem appropriate therefore, based on this definition, that the State of California would have a leaching test that could be used to determine whether a waste has no "soluble" components and therefore may be properly classified as inert, and therefore can be disposed of at essentially any location. However, neither the State Water Resources Control Board nor the regional boards have developed such a test. All regional water quality control boards' classifications of wastes as inert are arbitrary. There is no technical foundation for the classification approach used by the regional boards. From my experience, the inert waste issue is far more important than the designated waste issue to the ground water resources of the state. This is an issue that should be discussed in the Ground Water Protection Task Force Report.

Other Significant Ground Water Quality Problems

There are a number of other significant ground water quality problems in the state that should be reviewed as part of the Ground Water Protection Task Force activities. These include,

- Inadequate ability to regulate agricultural use of fertilizers to prevent ground water pollution by nitrate;
- Inadequate ability to protect the state's ground waters from pollution by pesticides used by commercial and agricultural interests;
- Inadequate implementation of regulations governing dairy and feedlot operations to prevent ground water pollution by nitrate and salts;
- Inadequate pre-operational and operational evaluation and management of enhanced ground water recharge projects.

All four of these areas are known to be significant threats to the ground water resources of the state. It is also well-known that the State Water Resources Control Board, the Department of Health Services nor Cal EPA has the regulatory authority today to prevent the further pollution of ground waters by nutrients and pesticides.

Ag Fertilizer

A significant gap exists in the state's regulatory authority to control agricultural use of ammonia and nitrate in the fertilization of crops to prevent the pollution of ground waters by nitrate. A number of the ground water basins in the state have been polluted by nitrate through excessive use of fertilizers on crops. Last summer, as a result of research that was conducted at the University of California, Davis, it was found that some areas of the state that are not now experiencing excessive nitrate in their ground waters, such as Yolo County, can expect this problem to occur in the future. This led to the publication of a series of articles in *The Davis Enterprise* devoted to "Fertilizer by the Glass," which discussed the findings that significant pollution of ground waters is occurring in this and other areas of the state through excessive use

of nitrogen fertilizers in the development of ag crops. Agricultural interests can utilize nitrogen-based fertilizers to the extent that they wish without any regulatory review of this use. It is well-known that many agricultural interests use far more nitrogen fertilizers on their crops than are necessary for good crop yield. While attempts are being made to educate agricultural interests to more appropriately utilize nitrogen-based fertilizers on their crops, the likelihood of a voluntary success is no better in this area than has been achieved with voluntary approaches for protection of surface and ground waters from others sources of contaminants, such as municipal and industrial waste waters. All sources of contaminants that could significantly adversely affect the quality of the state's ground waters should be under strict regulatory control.

The Ground Water Protection Task Force should address the regulation of agricultural use of fertilizers and formulate an approach to prevent further pollution of the state's ground waters by nitrogen fertilizers used on crops.

Pesticides and Herbicides

At this time, commercial, agricultural and other interests can utilize pesticides and herbicides in a particular area until the ground waters of that area are polluted by the specific pesticide/herbicide. In the fall of 1992, Cal EPA proposed a change in pesticide regulations that would enable the Agency to take a pro-active approach toward preventing pesticide/herbicide pollution of ground waters in the state based on the potential for a particular pesticide/herbicide use in a particular area to cause ground water pollution. Basically, the Agency wanted to be able to prescreen use of these chemicals to evaluate whether their use would likely cause ground water pollution, rather than have to wait to regulate their use until ground water pollution has actually occurred. Lee (2003) submitted comments to the Department of Pesticide Regulation in support of the Cal EPA's proposed pro-active regulation of pesticides/herbicides. At the Cal EPA hearing on this matter that was held in November 1992 there were a number of commercial interests that opposed these regulations. As of yet, these regulations have not been adopted. This situation represents a significant regulatory gap in controlling one of the most important sources of contaminants of the nation's and state's ground waters (pesticides/herbicides). The Ground Water Quality Protection Task Force should review this situation and develop recommendations on the approach that should be used in this state to prevent ground water pollution by pesticide/herbicide use in a pro-active manner rather than the current approach of having to be re-active to pesticide/herbicide-polluted ground waters. By then the damage is already done; in many instances, it will take many generations and in some cases, forever, to clean up the contaminated ground waters from inappropriate use of pesticides and herbicides within the state.

Dairy and Feedlot Pollution of Ground Water

Several areas of the state have experienced significant pollution of ground waters by dairies. Similar problems exist for feedlots and other areas where large numbers of animals are kept in a confined space. The animal manures produced are frequently a source of contaminants (nitrogen and salts) for the ground waters of a region. While the management of wastes at dairies can be regulated by the regional water quality control boards, significant ground water pollution is still occurring from dairies because of the inability of the regional boards to

implement programs that will prevent further pollution of the state's ground waters by wastes generated at dairy operations. If the dairy operations that are causing ground water pollution were a municipality or industry, the regional boards would likely have taken action to prevent ground water pollution. However, dairies have been allowed to continue to operate in many areas without developing approaches that reliably monitor the ground waters in their vicinity and, where pollution is occurring, taking steps to stop further pollution and begin remediation of the contaminated groundwater. An interesting paradox exists between how the state is implementing the underground tanks program associated with gasoline service stations, where a fairly strict enforcement program is underway, including putting a gasoline service station operator out of business if they do not have the funds to address the problem, while dairies, which cause an equal if not greater ground water pollution problem in many areas, are not being forced to even monitor whether pollution is occurring, much less take steps to stop pollution and clean up the contaminated ground waters.

The importance of the pollution of ground waters by dairy operations is of sufficient magnitude in several parts of the state so that the Ground Water Protection Task Force should address this issue and develop recommendations on how the state should begin to address this problem in an effective manner.

Enhanced Ground Water Recharge

During the past two years that I have been a member of the American Society of Civil Engineers Enhanced Ground Water Recharge Task Force, I have become aware of some of the ground water quality problems that exist with enhanced ground water recharge activities in California and other states. The ASCE committee is developing a guidance manual on enhanced ground water recharge that hopefully will address some of these problems.

As discussed by Lee and Jones-Lee (1993b), poor-quality surface waters and waste waters, which are being incidentally and through enhanced groundwater recharge projects recharged to ground waters, are or will at sometime in the future adversely impact ground water quality for use for domestic or other purposes. The State of California is the leading state in the country on enhanced ground water recharge. The situation in California is somewhat different than in many other states in that a large part of the recharged waters is formerly domestic waste waters. It is recognized by those familiar with the topic area that at this time there are significant gaps in California in regulating the quality of the recharged waters, including domestic waste waters, that are recharged to supplement the ground water resources of a region. At this time essentially no attention is being given in many areas to prevention of the pollution of an aquifer from incidental ground water recharge that normally takes place in streambeds. On the other hand, the California Department of Health Services (DHS) is proposing to require extensive domestic waste water treatment, including the use of reverse osmosis and activated carbon, to improve the quality of waste waters that are directly injected into aquifers through wells for the purpose of trying to protect aquifer and ground water quality. At the same time, DHS is allowing enhanced ground water recharge within streambeds of what are essentially 100% waste waters and agricultural runoff, with no regulation of the composition of these waters. Similarly, DHS is allowing waste water and water supply authorities to recharge domestic waste waters through infiltration ponds that have essentially only received secondary treatment and therefore

contain large amounts of a variety of chemical and microbial contaminants that could be adverse to recovered water quality and aquifer quality.

Secondarily treated domestic waste waters and many industrial waste waters, urban stormwater drainage and agricultural and rural stormwater runoff and irrigation return waters contain high concentrations of a wide variety of inorganic and organic, dissolved, particulate and colloidal contaminants that when recharged to an aquifer will have to be removed within the aquifer in order to produce recovered waters of sufficient quality to enable them to be used for domestic purposes. Further, many of these contaminants can adversely affect the longevity of the recharge recovery project since ultimately the aquifer's waste (contaminant) assimilative capacity will be exceeded.

In developing a ground water recharge project, particular attention should be given to the build-up of contaminants in the aquifer that are derived from surface water and/or waste water sources. These contaminants could necessitate the remediation of the contaminated part of the aquifer which was used for contaminant removal as part of the recharge project. The introduction of inadequately treated recharge waters could readily lead to substantial, long-term, "Superfund"-like liabilities for the recharge project owner/operator, as well as loss of ground water resources in the region for use by future generations. It is therefore imperative, in the development and operation of a ground water recharge project, that a critical evaluation be made of potential water quality problems that could occur in the recovered waters as well as in the aquifer and any aquifer waste treatment zone that is associated with the recharge project. Recently, Lee and Jones-Lee (1993b) have developed a paper discussing the potential water quality and aquifer quality problems associated with the recharge of inadequately treated surface waters and waste waters as part of enhanced ground water recharge projects.

Because of the plans for a significant increase in the amount of domestic waste water recharge to the state's ground waters, it is important that a pro-active approach be taken to evaluating ground water quality, prior to the operation of the project and to a much greater degree than is currently required for all ground water recharge projects, to detect potential ground water problems that could occur. Further, a significant increase in the monitoring and evaluation of the groundwater project should take place in order to detect potential problems before they become of sufficient magnitude to damage the storage capacity of the aquifer and its water quality. This is a topic area that the Ground Water Protection Task Force should address as part of finalizing its report on the issues of importance to the protection of the ground waters of the state. Of particular importance should be recommendations to significantly improve the regulation of the quality of the recharge waters for incidental and enhanced recharge in those areas that are not now receiving adequate attention.

I fully appreciate that many of the specific ground water protection issues discussed above are political, where special interest groups have been and continue to block the development of a ground water protection policy and its implementation to stop the further pollution of the state's ground waters. However, since the future development of the water resources of the state will be dependent primarily on having high-quality ground waters available, it is essential that efforts be made to address these problems in the immediate future, irrespective of political or other considerations. The Ground Water Protection Task Force should

address each of these areas and develop specific recommendations on how the state should begin to stop the ground water pollution that is now occurring or will occur in the future because of inadequate waste management practices, such as landfills that only postpone when ground water pollution occurs. Future generations of this state are entitled to a ground water quality that is no worse than what it is today and, hopefully, could be improved.

If you have any questions on this discussion of the Task Force Interim Report or the enclosed materials, please contact me.

Sincerely yours,

G. Fred Lee, PhD, DEE

cc: Gino Lera
Ken Wiseman

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