CALIFORNIA
Water Boards
STATE WATER RESOURCES CONTROL BOARD
REGIONAL WATER QUALITY CONTROL BOARDS

White Paper Discussion On:

ECONOMIC FEASIBILITY ANALYSIS

In Consideration of a

HEXAVALENT CHROMIUM MCL

February 2020

HEXAVALENT CHROMIUM MCL ECONOMIC FEASIBILITY ANALYSIS

I. Introduction

On July 1, 2014, a maximum contaminant level (MCL or drinking water standard) of 10 parts per billion (ppb) for hexavalent chromium (CrVI) was approved by the Office of Administrative Law. The MCL was issued by the California Department of Public Health (CDPH) right before its division of drinking water transferred jurisdiction to the State Water Resources Control Board (State Water Board). On May 31, 2017, the Superior Court of Sacramento County issued a judgment invalidating the MCL on the basis that CDPH had not properly considered the economic feasibility of complying with the MCL. As part of the next steps in reissuing an MCL for CrVI, the State Water Board anticipates stakeholder involvement in developing options for evaluating economic feasibility during the MCL process.

Due to the inherent uncertainty of placing economic value on numerous factors necessary for cost-benefit analyses, the MCL set by the State Water Board will be through a policy decision that considers traditional concepts such as treatment costs and number of cancer cases averted, as well as the costs and benefits of the regulation, as required by the Administrative Procedure Act, particularly as it relates to non-cancer health impacts on individuals, their families and their communities. This document describes challenges faced by the State Water Board in considering economic feasibility during the development of MCLs and concludes there is no simple formula capable of generating an economically feasible MCL.

The State Water Board will hold public workshops to discuss these ideas and hear suggestions by stakeholders and interested persons regarding economic feasibility in the development of drinking water standards. The concepts presented in this document allow stakeholders to engage the MCL development process ahead of the formal public review and comment period required by the Administrative Procedure Act. While this discussion is intended to be specific to the development of an MCL for CrVI, ideas and methodologies arising from the CrVI rulemaking process may be applied in the development of other drinking water standards.

II. Statutory Requirements for Establishing an MCL

Health and Safety Code section 116365 requires the State Water Board set MCLs *"at a level that is as close as feasible to the corresponding public health goal placing primary emphasis on the protection of public health, and that, to the extent technologically and economically feasible..."*

Subsection (b) of 116365 requires the State Water Board to consider: (1) the public health goal for the contaminant published by the Office of Environmental Health Hazard Assessment; (2) the national primary drinking water standard for the contaminant, if any, adopted by U.S. EPA, and (3) the technological and economic feasibility of compliance with the proposed standard. The statute further requires that "*for the purposes of determining economic feasibility…, the state board must consider*

the costs of compliance to public water systems, customers, and other affected parties with the proposed primary drinking water standard, including the cost per customer and aggregate cost of compliance, using best available technology."

In addition to these requirements, the Safe Drinking Water Act (Health & Saf. Code §116270 et seq.)[1] sets out the following directives:

a. "Every resident of California has the right to pure and safe drinking water." (§116270 (a))

b. "It is the policy of the state to reduce to the lowest level feasible all concentrations of toxic chemicals that, when present in drinking water, may cause cancer, birth defects, and other chronic diseases." (§116270 (d))

c. "This chapter is intended to ensure that the water delivered by public water systems of this state shall at all times be pure, wholesome, and potable." (§116270 (e))

d. "…to improve upon the minimum requirements of the federal Safe Drinking Water Act Amendments of 1996, to establish primary drinking water standards that are at least as stringent as those established under the federal Safe Drinking Water Act, and to establish a program under this chapter that is more protective of public health than the minimum federal requirements." (§116270 (f))

III. State Water Board Process for the Development of MCLs

The development of an MCL for California begins with looking at whether a federal MCL for the constituent of concern has been established. If a federal MCL exists, California must adopt a standard at least as stringent as the federal MCL. Since there is no federal MCL for CrVI, California is free to adopt an MCL at a level that adheres to the Health and Safety Code referenced above or not adopt an MCL at all.

Next, the State Water Board looks at the public health goal (PHG) established by the Office of Environmental Health Hazard Assessment (OEHHA). As stated in section 116365, the State Water Board must set the MCL as close to the PHG as is technically and economically feasible. The PHG for CrVI is 0.00002 mg/L.

In the next step the State Water Board examines the concentrations at which a constituent falls within technological feasibility. There are two aspects to this step. First, the State Water Board looks at the concentration laboratories can reliably measure in drinking water matrices. This is known as the "detection level for the purposes of reporting" (DLR). The DLR is established as part of the MCL process. Concentrations lower than the DLR cannot be measured with adequate reliability. Therefore, it is not technologically feasible for the MCL to be set below the DLR. The DLR that was determined for CrVI, as part of the previously established MCL, is 0.001 mg/L.

The State Water Board then assesses the effectiveness of treatment technologies to

[1] Unless otherwise indicated, all references are to the California Health and Safety Code.

remove the constituent of concern. During analysis of the treatment technologies, the State Water Board evaluates performance of full-scale treatment technologies, new and emerging technologies and technologies that are commercially available. From this analysis a treatment process is identified as the Best Available Technology (BAT) as defined by Water Code Section 116370. In the last version of the CrVI MCL development, three BATs were identified: Ion Exchange, Reverse Osmosis and Filtration of the reduced chromium species. Each of these technologies can reliably treat CrVI to less than 0.010 mg/L (the previous MCL).[2] In essence, the BAT designation establishes the lower limit of technological feasibility. No MCL should be set more stringent than what is technologically feasible for treatment technologies to achieve.

The last, multifaceted phase of the State Water Board's determination of an MCL is deciding if it is economically feasible. Simply stated, this has generally been conceived of as an assessment of the costs for water systems to comply with the proposed MCL. Health & Safety Code section 116365(b)(3) requires the State Water Board's assessment of economic feasibility to consider "the costs of compliance to public water systems, customers, and other affected parties with the proposed drinking water standard, including the cost per customer and aggregate cost of compliance using best available technology." The State Water Board identifies a range of potential MCLs based on the technological limits identified above and uses the information in its water quality database to determine the number of affected systems and sources that would require treatment at each of the various MCL levels.[3]

Treatment costs are generated using occurrence data to identify water systems with contaminated sources.[4] Algorithms are used to estimate treatment costs based on numerous factors such as water system size, capacity of source, level of contamination, type of treatment technology required and other factors. This approach has been used to develop treatment costs for several decades.[5] Following this phase

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[2] The State Board will conduct an analysis of emerging technologies currently available to treat CrVI as part of its regulatory rulemaking process.

[3] The previous (2013) CrVI dataset only included data from approximately 60% of the state's water systems. The development of the new MCL will include the current dataset with over 95% of the community and non-transient, non-community public water systems.

[4]Costs of treatment include monitoring, installing treatment and ongoing monitoring and operations and maintenance costs associated with the treatment. The State Water Board plans to conduct an updated analysis of the treatment cost information for CrVI and perform additional surveys of water systems and of industry to identify trends in cost.

[5] Based on previous experience one issue repeatedly appears; a treatment technology that is appropriate for a large water system, may not be suitable for a smaller water system. Hence, the State Water Board's approach to applying the same treatment technology to a water system, regardless of size, is likely to result in an overestimate of treatment costs. However, because this is an assumption made in the economic

of the economic analysis the State Water Board categorizes water systems to estimate costs to public water systems and their customers.

Selecting an economically feasible MCL could include evaluating water system costs, customer affordability, comparing cost of treatment per customer with the median household income or the cost of other utilities, or considering whether there are costs that customers will avert with the implementation of an MCL (such as reduced expenditures on bottled water). Consideration of a natural or anthropogenic origin of a contaminant has not been used in the past but may have relevance to the MCL process, especially if there are responsible parties that could reasonably be anticipated to assist in cleanup or treatment. The State Water Board also evaluates MCL costs at levels near the limits of treatment technology. The economic feasibility phase also examines benefits of an MCL at various levels. As discussed later in this paper, not all health benefits can be accurately monetized, and a qualitative assessment of the other health effects may be the only possible option.

During the economic analysis the State Water Board assumes all water systems exceeding the proposed MCL would implement the best available technology, even though there may be other, potentially less expensive ways for water systems to come into compliance (such as taking a contaminated well out of service, blending, consolidation with another nearby water system or installing point-of-use or point-of-entry treatment systems). Such an assumption probably results in higher overall cost estimates as was illustrated by the comparison of EPA's modelled treatment costs and the actual costs associated with several treatment demonstration projects (U.S. EPA 2014). Experience has demonstrated that water systems explore several compliance alternatives before selecting a course of action. While water systems are highly motivated to follow cost avoidance strategies, they also consider alternatives that fit better with long range plans or existing internal policies.

The level at which the State Water Board sets an MCL is a policy decision. It is not an arbitrary or capricious decision but based on applying available scientific evidence to rulemaking requirements of applicable statutes. Determining an MCL cannot be reduced to a simple formula. Arguments have been advanced advocating the use of cost-benefit analyses to establish MCLs at a point where the cost of the MCL equals its benefit to health. However, this document discusses that a cost-benefit approach is not feasible because of its inability to accurately account for and monetize the benefits and impacts of selecting one MCL versus another.

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feasibility assessment, it is not meant to imply that alternatives to centralized treatment cannot be used to comply with the proposed MCL. In fact, water systems often explore alternatives to centralized treatment before deciding on a course of action. The application of an alternative that could have a reduced financial impact on a water system is an option left open to a water system that is willing and able to demonstrate the efficacy of the alternative.

IV. Limitations of Cost-Benefit Analysis

Focusing solely on treatment costs for complying with an MCL ignores the benefits gained by ending the exposure to a known carcinogen. For example, costs to families who purchase bottled water or install point-of-use treatment because they lack confidence in the quality of their tap water are not accounted. Neither are costs associated with exposure to carcinogens, such as doctor and hospital visits, medication and lost income to seek treatment or take care of an ill family member or friend. While setting a drinking water standard may result in a water system's need to install treatment and incur costs, the present and future customers of that water system benefit from the protection afforded by treatment and no longer experience continued exposure and subsequent future adverse health effects. These and other offsets in costs (i.e. benefits) are extremely difficult to accurately quantify and account for in the development of an MCL regulation.

The State Water Board has received requests that cost-benefit analyses be the primary consideration in developing an MCL. Cost-benefit (C/B) analyses involve comparing the costs of complying with an MCL to the benefits derived from promulgating an MCL. The C/B analysis is performed with various alternative MCLs to determine the point(s) at which the costs of compliance outweighs the benefits. The State Water Board is cognizant of the arguments for C/B analyses and acknowledges the need to consider costs of regulatory compliance with the benefits achieved. However, the problem with such an approach is the inability to accurately account for all the benefits of setting a drinking water standard at one level versus another.

For example, the Public Health Goal (PHG) report published by OEHHA identifies CrVI as a carcinogen (stomach cancer) and is the basis for the PHG (0.00002 mg/L). The CrVI PHG report further identifies the health protective concentration of 0.002 mg/L that is two orders of magnitude higher than the PHG. The health protective concentration is associated with health concerns other than cancer, such as liver toxicity, developmental toxicity and reproductive toxicity (male and female). However, the effects of these health impacts are not detailed in the PHG report making it difficult to measure their associated costs.

To develop a comprehensive cost-benefit analysis the cost of treating CrVI at each proposed MCL level must be contrasted with direct and indirect healthcare costs, loss of productivity in the workforce, cost offsets for alternative water supplies, cost of reduction in quality of life, emotional and psychological costs, loss of business development in a community unable to provide high quality water, etc. Quantifying these costs presents an insurmountable hurdle for the State Water Board and does not include costs associated with the health protective concentration.

Excluding benefits achieved from reduction of these costs skews the cost-benefit analysis toward excessive costs. However, including the economic impact of these costs is not feasible due to the lack of specific information in the PHG report, especially as they relate to liver developmental and how reproductive toxicities manifest themselves in the human population and their subsequent treatment and recovery.

Without that information, the State Water Board is challenged to establish and identify a complete inventory of the benefits (prevention of adverse health effects) or adverse impacts that would be avoided with a proposed MCL. Without a complete accounting of all the potential health benefits any attempt at a traditional cost-benefit analysis would be seriously flawed. As a result, an economic feasibility assessment can only provide a quantitative economic feasibility assessment based on averting stomach cancer without a qualitative consideration of the numerous other health impacts.

V. The Small Water System Economic Feasibility Dilemma

The State Water Board acknowledges the complicated balance between protecting public health and ensuring scarce public funds are not over-extended on water quality objectives disproportionately expensive compared to the public health protection provided. The State's Safe Drinking Water Plan (2015) identified that the majority of systems out of compliance with drinking water standards are small community water systems. Analysis of the approximately 2,950 community water systems shows that the median community system serves 95 service connections. This means more than half of the water systems have fewer than 100 households over which to spread the cost.

Many small public water systems already struggle with compliance and routine maintenance such that any new or more stringent drinking water standard will be difficult for those systems to comply with. Current water rates are difficult for disadvantaged populations to bear, but in many cases, those rates barely cover basic operational needs and do not address additional funding requirements such as infrastructure maintenance and replacement.

Setting new or revised drinking water standards only to what is economically feasible for the most disadvantaged public water systems will restrict the development of new or more protective standards. More than 95% of Californians are served by systems with more than 3,300 connections that meet most drinking water standards and have the means to upgrade treatment processes when needed. Additional costs can be spread over a greater number of individuals and the net effect is a slight increase in water rates. Establishing economic feasibility criteria based on less than 5% of the State's population jeopardizes health protection for the remaining 95% and is not an acceptable public health policy.

As described above, small water systems feel the financial impact most acutely from new regulations because they have a smaller customer base amongst whom they can spread the cost of compliance. For example, the annual per capita costs of the CrVI regulation for systems under 200 connections was estimated at $5,600 while the costs for systems over 10,000 connections, which serve approximately 80% of Californians, was only $65. A preliminary analysis of source water quality data on water systems serving 200 or fewer service connections with one or more well with CrVI above 10 parts per billion (ppb) show that there are 80 systems with one or more source exceeding 10 ppb. However, these 80 systems serve a total population of 15,879

people through 4,829 service connections.[6] This is less than 1/10th of 1% of the current total population of California.

That said, the State Water Board recognizes that meeting drinking water standards presents very real technical and financial challenges for impacted small communities. A decision to limit the impact small system costs have in determining the level to set an MCL should not be construed as implying the State Water Board is forgoing compliance of that system. There are a range of strategies and funding sources available to achieve compliance, and water system consolidation and regionalization can significantly improve the economy of scale. The State Water Board will continue to provide technical support, as well as support identifying funding options as new regulations are promulgated to provide greater protection of public health.

In fact, the 2019 Safe, Affordable Drinking Water program's prime consideration will be the needs of small, disadvantaged communities that deliver water exceeding drinking water standards and systems at high risk of failure to meet standards in the future.

To overcome the reality that treatment costs for small systems are usually much higher than the costs for systems that serve more than 10,000 connections, the State Water Board needs to limit the impact these systems exert in the determination of economic feasibility. One option is to exclude per system costs for water systems with less than 200 connections from the economic feasibility analyses. This option recognizes that the State Water Board allows compliance strategies such as consolidations, point-of-use (POU) point-of-entry (POE) treatment[7] or additional time to comply through exemptions or variances.

Another option is to include small water systems in the economic analysis but estimate State aggregate water rates based on a per-service-connection average cost of treatment. Such an estimate would take the statewide treatment cost and divide it by the total number of service connections in all water systems impacted. This means the total annual cost of treatment for any given water system, regardless of size or impacted sources, will be added to the annual cost of treatment for all the other water systems impacted by the proposed MCL.

The result represents the statewide aggregate annual cost of treatment for the proposed MCL. This type of analysis results in statewide cost of the proposed regulation weighted or skewed toward a lower annual service connection cost by spreading the

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[6] The median system serves 43 connections (approximately 105 persons).

[7] It appears that use of POU devices to comply with the CrVI MCL can provide a significant reduction in the per service connection cost. A review of the device registration database shows that several POU devices (mostly reverse osmosis [RO]) could be used to meet an MCL for CrVI once the MCL is adopted. The test conditions and reported results need to be reviewed as part of the technical feasibility assessment, but if appropriate, the POU devices could reduce the capital costs of treatment significantly. Administration and maintenance costs need to be identified and added to the annual cost, but initial estimates appear promising as the per service connection costs will align with per service connection costs to larger water systems.

cost of treatment over a greater number of service connections. Although the weighted average cost does not provide specific costs for individual public water systems, it alleviates the State Water Board's concern that public health protection for the majority of the State's population is constrained by the inability of small water systems to afford regulations protective of public health.

The table on the following page calculates the weighted average cost of treating CrVI using the data from CDPH's 2014 Initial Statement of Reasons (ISOR). The weighted average is for all systems identified in the ISOR as having one or more sources exceeding a potential MCL value.

Annual Cost per Service Connection ($ per year)

MCL (mg/L)	**Less than 200 Services**	**200 to 999 Services**	**1,000 to 10,000 Services**	**10,000 or more Services**	**Weighted Average ANNUAL Cost per Connection for all impacted systems**	Monthly Weighted Average Cost
0.001	$7,160	$1,220	$483	$300	$348	$29
0.005	$6,680	$1,090	$398	$117	$154	$13
0.010	$5,630	$857	$326	$64	$91	$8
0.015	$5,870	$1,310	$280	$37	$58	$5
0.020	$5,470	$1,040	$190	$25	$37	$3
0.025	$4,240	NA	$184	$17	$22	$2
0.030	$4,140	NA	$200	$11	$14	$1

The weighted costs shown in this table are clearly within the range of what is economically feasible even for the smallest water systems. Because of this, the State Water Board proposes systems with less than 200 connections either not be factored into an economic analysis of a regulation or the costs be averaged over all affected systems.

VI. Consideration of Incremental Cost in Establishing an MCL

For some constituents (such as 1,2,3-TCP or DBCP) setting the MCL at a more stringent level does not significantly change treatment costs for impacted systems. The reason for this is that the typical treatment choice for such constituents may be Granular Activated Carbon (GAC) which can often reduce organic chemicals to not only the proposed MCL but to the laboratory detection level. For these situations, the statewide increase in costs from a lower MCL is not due to increased treatment costs but rather due to the increased number of systems requiring treatment as the MCL is lowered. A lower MCL provides the entire risk reduction benefit to a significantly greater population as more systems comply with a lower drinking water standard.

Therefore, when the incremental treatment cost of setting the MCL at a more stringent level is negligible on a per connection basis, the State Water Board proceeds to set the MCL "at a level that is as close as feasible to the corresponding public health goal placing primary emphasis on the protection of public health" and follows the Statewide policy to "reduce to the lowest level feasible all concentrations of toxic chemicals that, when present in drinking water, may cause cancer, birth defects, and other chronic diseases" (Cal. Health & Saf. Code §§116365(a);116270, respectively). It is also noted that the establishment of an MCL can provide additional risk-reduction benefits (beyond what is predicted) since the GAC treatment will often reduce the contaminant to levels well below the selected MCL.

VII. A Look at Affordability and Economic Feasibility

In this document, affordability refers to the ability of an individual household to pay their own water bill and economic feasibility refers to the ability of the general state population served by public water systems to pay for compliance to a drinking water standard.

Many people are exploring the challenge of providing affordable drinking water, but no one has come up with a formula that everyone agrees upon. For example, the Southern California Water Coalition suggests looking at the "Guidelines for Preparing Economic Analysis for Water Recycling Projects" (Guidelines), dated April 2011, which were developed "to inform selection and funding of water recycling projects." Others have suggested looking at how many hours at minimum wage would someone have to work to afford their water bill[8] or comparing what individuals in certain communities pay for other utilities, such as electricity, sewer/garbage, or internet.

Another way to measure affordability involves assessing the water cost burden at a specific volume of water, factoring in the cost of living, and taking into account the extent of economic stress customers face. That approach is explained in the 2019 draft OEHHA report on Human Right to Water indicators. In its draft report, OEHHA (2019) develops three indicators to address different limitations of conventional affordability ratios. The first indicator is the affordability ratio at the MHI, which portrays the water cost burden for a particular amount of water by the median household. Two additional indicators focus on more economically vulnerable sub-populations within a water system, by comparing water bills to county poverty levels, and deep poverty levels. The fraction of people within these different income levels are factored in.

Another method used to evaluate affordability is comparing the incremental cost of treatment to the median household income (MHI) in communities with drinking water containing CrVI. Such an approach is similar to the historical approach used by USEPA, where a percentage of the MHI is used. Either taking a percentage of the MHI or using the MHI in a ratio results in a "bright line", which has been criticized because it only examines affordability for half of the population. In addition, as Gingerich et al

[8]This metric was developed by Manny Teodoro at Texas A&M, who is a national expert on water affordability.

(2017) point out, the process does not account for the impact due to multiple water quality regulations.

Suggestions have been made that economic feasibility not only look at treatment costs, but also at how those additional costs are added to already strained budgets. In addition to the requirements of a specific regulation, public water systems have existing expenses associated with their infrastructure, operation and management of system facilities. These costs include operation and maintenance and eventual replacement costs for aging infrastructure. Similarly, households and individuals have many other costs besides water bills. The balance between increased protection of public health and personal living expenses, such as housing, utility bills and luxury services versus basic needs may be part of the State Water Board MCL policy decision.

Other issues that come into the discussion of affordability and economic feasibility are whether there are ways to mitigate those impacts through grants, redesigned rate structures or bill payment assistance programs. Although the State Water Board and other government agencies provide grant and loan funding to assist water systems with financing new infrastructure, until recently, there has been no funding available for on-going operation and maintenance costs, and the state has not yet been able to create a statewide low-income rate assistance program. The criteria to qualify for funding varies with the type of project proposed, the water system ownership type and other criteria. In general, water systems that are public agencies are eligible for a wider range of funding types, especially grants.

The connection between affordability and economic feasibility is complex and beyond the scope of this document. While affordability considers the impact on the individual, economic feasibility focuses on the impact to the community of water systems as a whole and includes the following concepts:

- Public water system managers and decision-makers are stewards of customers' health and the financial sustainability of the system. The customers' ability to pay for water is considered in the development of budgets and water rates. Rate structures must be equitable and sufficiently cover the short-term operation and maintenance needs of the system and the long-term capital improvements necessary for a sustainable water system.
- Public water systems face a wide range of financial needs with varying degrees of urgency. Protection of public health and the cost to maintain that is an absolute priority. Infrastructure maintenance, operational expenses, debt service, maintaining a rainy-day fund, planning future capital expenditures, inflationary fluctuations, revenue losses, unaccounted water, emergency repairs, payments in-lieu of taxes, security and litigation are just a few of the issues public water systems account for when developing budgets.
- Treatment technology has developed to the point that almost any contaminant can be removed from water. However, this does not necessarily equate to an economically feasible water delivered to the customer's home. Costs of treatment

for contaminant removal includes energy, waste disposal, supplies and materials, labor, facilities maintenance and infrastructure.

- A lower MCL results in two appreciable increases in costs. The first economic consideration is more water systems will exceed a drinking water standard as the MCL is lowered. The second is the cost of treatment increases proportional to the MCL. This proportionality is dependent on the type of contaminant and the method of treatment.
- Public water system must work closely with their customers to balance affordability with economic feasibility. The public water system develops an understanding and sense of the social and economic conditions of their customers including concerns and impacts about affordability. For an impacted water system, an additional compound or lower MCL of an existing compound will likely result in a general rate increase.
- The percent increase in costs associated with a new MCL experienced by water systems.
- Economic feasibility and affordability will be addressed when considering compliance options such as grants, loans, regionalization and consolidation (both full consolidation and various forms of administrative consolidation) as well as the establishment of lifeline rates.

The State Water Board will take a multi-faceted approach to assess economic feasibility in the MCL development process. Depending on the circumstances and what information is available, the State Water Board may look at all such lines of evidence, or perhaps limit the information that it considers because of each unique situation.

The cost analysis will include the use of a sensitivity analysis to explore the impact of small variations in potential MCL values on costs as well as the number of systems and population impacted and their characteristics. The sensitivity analysis will facilitate discussion of the cost impacts to communities of various sizes and characteristics as the potential MCL values are evaluated.

VIII. Conclusion

The State Water Board understands competing needs between protecting public health and keeping water affordable. Water systems struggle to maintain infrastructure and meet drinking water standards, but assistance is available to offset costs of new regulations (grants, low or no-interest loans, point-of-use or point-of-entry treatment, variances, exemptions and consolidations). Statewide protection of public health cannot be limited to what is affordable to the smallest systems serving only a small fraction of the State's total population. Economic feasibility cannot be determined by a simple formula. Even if such a formula existed, accurately ascribing value on the costs and benefits of reducing exposure to known carcinogens is limited. Therefore, the State Water Board must take a multi-faceted approach to looking at economic feasibility when setting drinking water standards, considering multiple lines of evidence. Some of those

lines of evidence have been set out here, and the State Water Board would like to engage stakeholders in what additional information should be considered.

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