To: Washington Citizens

From: Megan White, P.E., Manager
Water Quality Program
Department of Ecology

Subject: Proposed Agricultural Water Supply Criteria
Decision Process for Ecology's Proposed Rule

This memorandum describes the decision-making process that resulted in the Washington Department of Ecology's (Ecology) proposal to add new criteria to protect agricultural water supplies to the state's water quality standards.

Proposed Alternative

Ecology's proposal adds new criteria to protect agricultural water supplies used for irrigation. Numeric criteria are being recommended for electrical conductivity, bicarbonate, total suspended solids, radioactive materials, and pH. Since use of waters for irrigated agriculture is widespread, the proposed criteria will be broadly applied to rivers, lakes, and reservoirs throughout the state.

Background

Ecology administers the state's surface water quality standards regulations (Chapter 173-201A WAC). These regulations establish minimum requirements for the quality of water that must be maintained in lakes, rivers, streams, and marine waters. This is done to ensure that all beneficial uses associated with these waterbodies are protected.

As part of a public review of its water quality standards in the early 1990's, Ecology convened a technical work group to determine what, if any, criteria should be established to protect agricultural water supplies.

Basis for Ecology's Proposal

Ecology and the technical work group used a multi-step process to establish recommendations for water quality criteria that provide long-term water quality protection for agricultural water supplies. It began with evaluating literature values for water quality constituents and the levels known to impair the use of water for irrigation. The purpose of this step was to get general agreement on a list of criteria values associated with the protection of irrigation waters, as well as to determine what concerns were more appropriately met by establishing narrative criteria (narrative criteria are statements on the desired condition for the supply waters rather than specific numeric criterion values).

The work group strongly recommended that to avoid unnecessary confusion and water monitoring requirements, Ecology should not adopt water quality criteria for constituents that are not a problem and are unlikely to become a problem. To incorporate this recommendation into the process, the personal knowledge of the technical work group was combined with an examination of water quality sample data for rivers, reservoirs, and canals within the Columbia

Basin and Yakima River Drainages (see Section IV and Appendix A of the discussion document).

Using this multi-step process, the recommendations for numeric criteria values and narrative criteria were developed that address the greatest concerns with the long-term use of agricultural water supplies. While avoiding unnecessary criteria is a good goal, Ecology recognizes that the water quality standards are intended to prevent unusual as well as common problems from developing. If future information suggests other criteria are appropriate, they may, after formal public review, be added to the water quality standards regulation for the protection of agricultural water supplies. Without specific numeric criteria for individual pollutants, Ecology can rely on general narrative criteria statements as a tool to prevent or correct currently unforeseen problems.

It is important to note that developing criteria for the protection of agricultural water supplies was the focus of the technical work group. Protection of agricultural water supplies for livestock was only superficially dealt with in the work group format. The recommendations for the protection of livestock water supplies are based almost exclusively on recommendations provided in the literature and by existing surface water quality criteria that are focused on protecting animals exposed through irrigated fodder and drinking waters.

Technical Work Group Recommendations

While the technical work group assisted in evaluating potential water quality criteria, they were generally opposed to Ecology establishing such criteria. The common opinion of the work group was that establishing criteria to protect agricultural water supplies was unnecessary since most water supplies currently meet the proposed criteria and irrigation water quality is not a significant concern of farmers.

While willing to help identify appropriate criteria, the work group was generally opposed to establishing agricultural water criteria for the following reasons:

- (a) An irrigation district or other water supplier might be held responsible for supplying water that fails to meet the criteria - forcing costly and questionably effective treatment throughout the irrigation districts;
- (b) Efforts required to meet other water quality criteria may also result in protecting the water quality parameters associated with agricultural water supply; therefore, additional criteria may not be necessary;
- (c) It may be confusing where these criteria are to be applied; and
- (d) On-farm management strategies can be used to compensate for inferior water quality.

Ecology recognizes that the proposed criteria are largely preventative in nature, but also believes that maintaining high quality water supplies is important even if the users themselves are currently unconcerned. The proposed criteria create a defined level of expected protection. In doing so, the criteria can be used to prevent the economic and social costs associated with deterioration in water quality and will benefit Washington's farmers and agricultural lands long into the future.

Complexity of Establishing Irrigation Water Criteria

A complex interaction occurs between the soil, water, and plants. This relationship is influenced by changes in water chemistry, the timing of irrigation, and the type of application system used. In addition, plants have different sensitivities to the stress induced from the natural and human added salts and other constituents in irrigation waters. These factors combine to create a situation where detrimental effects of water constituents can be partly or wholly counterbalanced by management measures such as crop selection, and specially designed water application and drainage systems. Such management measures do, however, come at a cost to farmers.

Balancing Human Costs with Human Benefits

The raw water supplies in Washington are typically of naturally high quality. Where minimal human-caused degradation has occurred, our waters can provide for unrestricted use by farmers. In selecting appropriate levels of protection for agricultural water supplies, a unique situation exists. The use of water for agricultural water supplies is often impaired by some of the same pollutants contributed from the agricultural industry itself. Although relatively poor quality water can still be used effectively for irrigation and livestock supplies, the use of such water has costs in terms of needed soil conditioners, drainage and application requirements, and crop selection limitations. Farmers may consider these costs to be counter-balanced to some degree if they can avoid potentially costly farm management measures needed to ensure high quality drainage water. The costs of using inferior quality water may also be viewed as being unavoidable.

In recognition of these unique considerations (unlike what exists with criteria established to protect swimmers or aquatic life and wildlife), allowing broader choices when considering protective criteria for agricultural water supplies seems appropriate. In other words, the farming community may prefer having marginally acceptable standards to protect their crops to avoid the possibility that more fully protective criteria could result in their needing to implement additional farm best management practices (it should be noted, however, that many of the management practices already needed to protect other water quality criteria and uses would also protect the proposed criteria).

Final recommendations by Ecology

In spite of the work group voicing general philosophical opposition to having any agricultural water supply criteria, Ecology believes that it should take the next step of formally proposing criteria for broad public review. This decision is based in part on recognition that:

(a) Maintaining high quality source water will benefit farmers;
(b) Some of the water quality constituents of concern to agriculture are addressed in protecting other types of beneficial water uses; and
(c) The beneficiaries of such standards statewide need to have an opportunity to convey their views on whether such protective criteria are appropriate and desirable.

Ecology will consider changing or retracting the recommended criteria depending on public comment, including widespread and consistent opposition from the farmers who are the intended beneficiaries of these criteria and demonstrations that such criteria would have no practical benefit.

Accompanying Documents & Information

This decision memo is accompanied by a discussion document entitled "Establishing Surface Water Quality Criteria for the Protection of Irrigation Water Supplies."

Draft language for agricultural water supply criteria can be found in the proposed rule at WAC 173-201A-200(3)(b).

A discussion of alternatives for agricultural water supply criteria can be found in the draft Environmental Impact Statement for the proposed rule on page 79.

Additional questions on proposed revisions to the agricultural water supply criteria can be directed to Mark Hicks in the Water Quality Program at (360) 407-6477.

Additional information on proposed revisions to the rule, including draft Administrative Procedures Act (APA) materials and the draft Implementation Plan, can be found by visiting our Web site at www.ecy.wa.gov/programs/wq/swqs.

Recommended Criteria

General criteria that apply to all water supplies for toxics, aesthetics, and nonpoint source pollution can be found in WAC 173-201A-260(1).

Specific proposed language for agricultural water supplies is:

> **Agricultural criteria.** The criteria are applied to all rivers, lakes, and reservoirs that are used for, or designated for use as, agricultural supply water. These criteria are not to be applied on-farm or at individual points of use within irrigation projects that are designed to capture and reuse drainage water from individual agricultural operations. The criteria which follow are to be implemented as an arithmetic average value for the period of April 1–September 30. A minimum of three samples taken during this six-month period is to be used to determine the value for compliance. Since these criteria are not aimed at preventing short-term exceedences, sample values from the last consecutive three-year period may be combined to create a stronger database for determining compliance. To average multiple years, however, the number of samples in each monthly or bi-monthly period must generally be equal so as to reduce the chance of seasonal bias.
>
> (i) Electrical Conductivity is not to exceed 700 microsiemens per centimeter (µS/cm).
> (ii) Bicarbonate is not to exceed 339 milligrams per liter (mg/L).
> (iii) Total Suspended Solids is not to exceed 75 milligrams per liter (mg/L).
> (iv) pH must be within the range of 6.5 to 9.0 standard units.

WASHINGTON STATE
DEPARTMENT OF
ECOLOGY

Establishing Surface Water Quality Criteria For the Protection of Agricultural Water Supplies

Draft Discussion Paper

Revised December 2002
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Establishing Surface Water Quality Criteria For the Protection of Agricultural Water Supplies

Draft Discussion Paper

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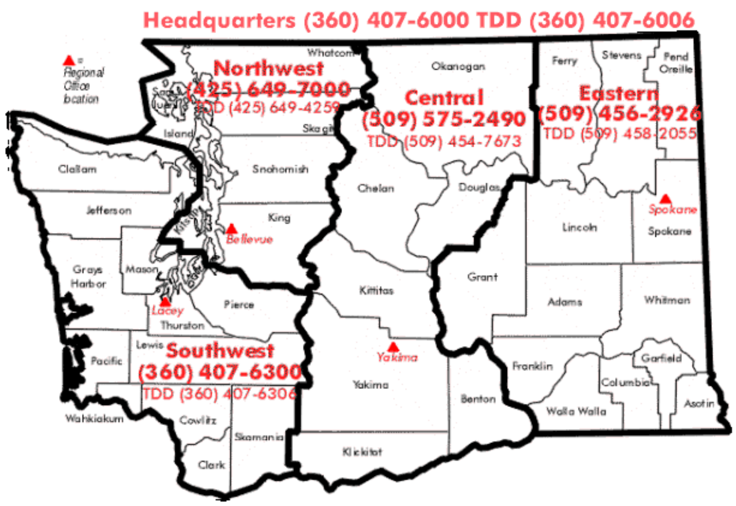

If you have special accommodation needs or require this document in an alternative format, please call Mark Hicks at (360) 407-6477. The TTY number is 711 or 1-800-833-6388. E-mail can be sent to mhic461@ecy.wa.gov.

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Acknowledgments

I want to gratefully acknowledge the assistance provided by the technical work-group convened to discuss the water quality needs of agriculture. The experience and knowledge of the work-group members provided both a good technical foundation as well as a reality check for the recommended irrigation water quality criteria. I want to extend a special thanks to the Bureau of Reclamation for sending a specialist from their Denver Office. Additional thanks to Joe Rinella and Jennifer Morace of the U.S. Geologic Survey for providing important ambient water quality data. The membership of the technical work-group included:

Stan Conway	Bureau of Reclamation
Keith Franklin	Quincy Columbia Basin Irrigation District
Larry King	Washington State University
Shannon McDaniel	South Columbia Basin Irrigation District
Onni Perala	Rosa Irrigation District
Bob Stevens	Washington State Extension Service

Abstract

The Washington State Department of Ecology established a technical work-group to assist in developing recommendations for criteria to protect agricultural supply waters. This paper documents the discussions of that technical work-group and the basis for recommended water quality criteria. This paper is intended to help the public understand and comment on the recommended criteria. If adopted, the criteria would apply to all waterbodies that have agricultural water supply established as a designated use. Criteria to protect agricultural supply would not, however, apply at individual points of use within irrigation projects that are designed to capture and reuse drainage waters from the individual agricultural operations. The recommendations proposed include both general narrative criteria to prevent deleterious effects plus numeric limits for a select list of water quality constituents. The constituents for which numeric criteria are being recommended include electrical conductivity, bicarbonate, total suspended solids, radioactive materials, and pH. Since use of waters for irrigated agriculture is widespread, the proposed criteria will also be broadly applied to rivers, lakes, and reservoirs throughout the state.

The criteria are established to provide a moderate to high level of protection for soils, crops, and irrigation equipment. While the technical work-group assisted in evaluating potential water quality criteria, they were generally opposed to Ecology establishing any criteria. The common opinion of the work-group was that establishing criteria to protect agricultural water supplies was unnecessary since most water supplies currently meet the proposed criteria and irrigation water quality is not a significant concern of farmers. Ecology recognizes that the proposed criteria are largely preventative in nature, but also believes that maintaining high quality water supplies is important. The proposed criteria should help prevent the economic and social costs associated with deterioration in water quality; providing benefits to Washington's farmers long into the future.

I. Background Discussion

1) Process

The Washington State Department of Ecology administers the state's surface water quality standards regulations (Chapter 173-201A WAC). These regulations establish minimum requirements for the quality of water that must be maintained in lakes, rivers, streams and marine waters. This is done to ensure that all of the beneficial uses associated with these waterbodies are protected. Federal regulations were established under the Clean Water Act to ensure states adopt criteria that protect the beneficial uses of its water bodies (40 CFR part 131). These beneficial uses include aquatic life and wildlife habitat, fishing, shellfish collection, swimming, boating, domestic and agricultural water supplies, and aesthetic enjoyment. The protection of source water for agricultural water supplies is the focus of this paper.

In October 1994, Ecology began a public review of its water quality criteria with the assistance of a large broad-based advisory panel. From October, 1994, through May, 1996, the advisory panel evaluated the relationship between the current water quality standards and their protection of beneficial uses. This work was based on the use of questionnaires that were sent through the mail as part of a project referred to as the Use-Based Reformatting of the Water Quality Standards. One of the outcomes of this process was that Ecology recognized a need to establish specific criteria for individual beneficial uses; such as agricultural water supplies. In response, Ecology set up a work-group of technical specialists to recommend appropriate protective criteria. This paper documents the discussions and recommendations of the technical work-group. The language used in the final recommendation was also influenced by internal and external advisory committees established subsequent to the original technical work-group. It is intended this paper provide sufficient information to help interested members of the public assess the rationale and implications of the recommended agricultural water quality criteria.

2) Complexity of Establishing Irrigation Water Criteria

A complex interaction occurs between the soil, water, and plants. This relationship is influenced by changes in water chemistry, the timing of irrigation, and the type of application system used. In addition, plants have different sensitivities to the stress induced from the natural and human added salts and other constituents in irrigation waters. These factors combine to create a situation where detrimental effects of water constituents can be partly or wholly counterbalanced by management measures such as crop selection, and specially designed water application and drainage systems.

Since agricultural operations are stationary and available croplands are limited, farmers must generally use whatever water is available. Additionally, complex irrigation water supply systems have been engineered to supply water to large networks of farms. These systems, usually managed as a designated irrigation district, essentially recycle water from one farm to another. Thus farms at the lower end of the district's system of canals and wasteways receive waters which have been altered by previous use at up-gradient farms. In this manner the water quality supplied in a district is not fixed, but varies depending on where in the system any particular farm may be located. This degradation of water quality is lessened by good farm management practices and re-mixing with cleaner water. It can never be eliminated, however, because the leaching of salts and chemicals from the soil is actually an important part of maintaining the long-term productivity of the land. Thus, as water moves through a district, the quality will generally be reduced.

While farmers can use application and drainage systems and management practices that allow the use of inferior quality waters, there is a cost to such options. Farmers using inferior waters may be limited in the types of crops they can grow and may need to install expensive drainage and application structures to reduce the build up of salts to harmful levels in the soil. They may also need to replace hardware damaged by suspended sediments and salts, and clean out drainage systems more frequently.

It was noted in discussions with the technical work-group that both establishing and applying criteria for the protection of agricultural water supplies is complicated. The work-group generally did not support establishing agricultural water criteria. The primary reasons cited for this opposition included:

(a) An irrigation district or other water supplier might be held responsible for supplying water that fails to meet the criteria - forcing costly and questionably effective treatment throughout the irrigation districts;
(b) Other water quality criteria are applied to source waters that are adequately protective of agriculture;
(c) It may be confusing where these criteria are to be applied; and
(d) On-farm management strategies can be used to compensate for inferior water quality.

In spite of general opposition by the work-group, Ecology believes that it must take the next step of providing proposed criteria for broad public review. This decision is based in part on recognition that:

(a) Maintaining high quality source water will benefit farmers;
(b) Some of the water quality constituents of concern to agriculture are not duplicated or recognized in the protection of other types of beneficial water uses;
(c) Many of the stated concerns of the technical work-group can be accommodated; and
(c) The beneficiaries of such standards statewide need to have an opportunity to convey their views on whether such protective criteria are appropriate and desirable.

Ecology will consider significantly modifying or fully retracting the recommended criteria if we receive widespread and consistent opposition from the farmers who are the intended beneficiaries of these criteria, or if we find that such criteria would have no practical benefit.

3) Balancing human costs to human benefits

The raw water supplies in the State of Washington are of naturally high quality. Where minimal human caused degradation has occurred, our waters can provide for unrestricted use by farmers. In selecting appropriate levels of protection for agricultural water supplies, a unique situation exists. The use of water for agricultural water supplies is often primarily impaired by pollutants contributed from the agricultural industry itself. Although relatively poor quality water can still be used effectively for irrigation and livestock supplies; the use of such water has costs in terms of needed soil conditioners, drainage and application requirements, and crop selection limitations. Farmers may consider these costs to be counter balanced to some degree, if they can avoid potentially costly farm management measures needed to ensure high quality drainage water.

In recognition of these unique considerations (unlike what exists with criteria established to protect swimmers or aquatic life and wildlife), allowing broader choices when considering protective criteria for agricultural water supplies seems appropriate. In other words, the farming community may prefer having marginally acceptable standards to protect their crops to avoid the possibility that more fully protective criteria could result in their needing to implement additional farm management practices to protect water quality. If that is the case, Ecology may be willing to support such less protective standards for agricultural supply waters. However, there are two very important limitations to Ecology's position. The first is that all other existing and designated uses of waterbodies must be fully and effectively protected. The second is that any agricultural standards must not be so relaxed as to result in an unreasonable level of current or future water use restrictions. These limits to our options come about through the legal and regulatory constraints and directives established in the applicable federal and state laws and regulations (e.g., the Federal Clean Water Act; the Code of Federal Regulations, Title 40, part 131; the State Water Pollution Control Act, Ch. 90.48 RCW, and the Surface Water Quality Standards for the State of Washington, Ch. 173-201A WAC).

II. Criteria Recommendations

The following represents the criteria language being considered for adoption into the state surface water quality standards:

1. Agricultural Supply Waters.

   (a) Application of Criteria. The criteria are applied to all rivers, lakes, and reservoirs that are used for, or designated for use as, agricultural supply water. These criteria are not to be applied on-farm or at individual points of use within irrigation projects that are designed to capture and reuse drainage water from individual agricultural operations.

   (b) Toxic, radioactive, or deleterious materials. Toxic, radioactive, or deleterious material concentrations must be below those which have the potential, either singularly or cumulatively, to adversely affect characteristic water uses, cause acute or chronic conditions to the most sensitive biota dependent upon those waters, or adversely affect public health (see WAC 173-201A-240, Toxic Substances, and 173-201A-250, Radioactive Substances).

   (c) Controlling Pollutants Associated with Runoff. Runoff from nonpoint sources (such as from animal and human wastes or soil erosion from land-use activities) are not allowed to drain or be discharged into surface waterbodies of the state, except when controlled with best management practices or treated with waste treatment technology, as approved by the department.

   (d) Aesthetics. Aesthetic values must not be impaired by the presence of materials or their effects, excluding those of natural origin, which offend the senses of sight, smell, touch, or taste (see WAC 173-201A-230 for guidance on establishing lake nutrient standards to protect aesthetics).

   (e) The criteria which follow are to be implemented as an arithmetic average value for the period of April 1 – September 30. A minimum of three samples taken during this six-month period are to be used to determine the value for compliance. Since these criteria are not aimed at preventing short-term exceedences, sample values from the last consecutive three-year period, may be combined to create a stronger database for determining compliance. To average multiple years, however, the number of samples in each monthly or bi-monthly period must generally be equal so as to reduce the chance of seasonal bias.

      i. Electrical Conductivity is not to exceed 700 microsiemens per centimeter (µS/cm) or micromhos per centimeter (µmhos/cm).
      ii. Bicarbonate is not to exceed 339 milligrams per liter (mg/L).
      iii. Total Suspended Solids is not to exceed 75 milligrams per liter (mg/L).
      iv. pH is to be between 6.5 and 9.0 standard units.

III. Basis for Criteria Recommendations

1) Overview of Process used for Developing Recommended Criteria

Ecology and the technical work-group used a multi-step process to establish recommendations for water quality criteria that provide long-term water quality protection for agricultural water supplies. It began with evaluating literature values for water quality constituents and the levels known to impair the use of water for irrigation. The purpose of this step was to get general agreement on a list of criterion values associated with the protection of irrigation waters, as well as to determine what concerns were more appropriately met by establishing narrative criteria. Narrative criteria are statements on the desired condition for the supply waters rather than specific numeric criterion values. They are used to support taking site-specific action for pollutants and conditions that were not known or were not consistent enough in their effects so as to warrant establishing state-wide criteria.

The work-group strongly recommended that to avoid unnecessary confusion and water quality monitoring requirements, Ecology should not adopt water quality criteria for constituents that are not a problem, and are unlikely to become a problem in our state. To incorporate this work-group recommendation into our process we combined the personal knowledge of our technical work-group with an examination of water quality sample data for rivers, reservoirs, and canals within the Columbia Basin and Yakima River Drainages (see Section IV and Appendix A).

Using this multi-step process we developed the recommendations for numeric criteria values and narrative criteria statements that address the greatest concerns with the long-term use of agricultural water supplies. While avoiding unnecessary criteria is a good goal, Ecology recognizes the water quality standards are intended to prevent unusual as well as common place problems from developing. If future information suggests other criteria are appropriate, they may, after formal public review, be added to the water quality standards regulation for the protection of agricultural water supplies. Without specific numeric criteria for individual pollutants, Ecology can rely on general narrative criteria statements as a tool to prevent or correct currently unforeseen problems.

It is important to note that developing criteria for the protection of irrigation water supplies was the focus of the technical work-group. Protection of agricultural water supplies for livestock was only superficially dealt with in the work-group format. The recommendations for the protection of livestock water supplies are based almost exclusively on recommendations provided in the literature and by existing surface water quality criteria that are focused on protecting animals exposed through irrigated fodder and drinking waters.

2) Review of Literature Values

Several publications on the water quality needs of agriculture were used by the work-group. These appear to be key works as they are widely cited and repeated throughout the literature on irrigated agriculture. Little difference exists between published water quality recommendations and estimates of use-impairment levels. There was no reason to suspect that one publication was more accurate than any other, so it was fortunate that the similarity of the various authors' recommendations made discussions on the appropriate values to use practically unnecessary. The values recommended in two key works (NAS and NAE, 1972; and Ayes and Westcot, 1985) were used as the primary material for work-group debate and for comparison with state ambient water quality data. Recommendations from these two publications are shown in Tables 1 and 2 below.

Table 1. Literature Values for Seven Water Constituents Associated with Two Levels of Typical Use Restrictions. (Ayers and Westcot, 1985).

Constituent	**No Use Restrictions**	**Slight to Moderate Use Restrictions**
Conductivity (Ecw)	< 700 µS/cm	700 - 3,000 µS/cm
Total Dissolved Solids	< 450 mg/L	450 - 2,000 mg/L
Sodium (surface irrigation)	< 69 mg/L	69 - 207 mg/L
Sodium (sprinkler irrigation	< 69 mg/L	> 69 mg/L
Bicarbonate (sprinkler only)	< 91.5 mg/L	91.5 - 586.5 mg/L
Boron	< 700 µg/L	700 - 3,000 µg/L
Chloride	< 106.5 mg/L	106.5 - 355 mg/L
PH	6.5 - 8.4	4.5 to 6.5 and 8.4 to 9.0
TSS	< 50 mg/L	50 - 100 mg/L

<u>Notes on Restriction on Use</u> (cited from Ayers and Westcot, 1985): *The "Restriction on Use" shown in Table 1 is divided into three degrees of sensitivity: none, slight to moderate, and severe. The divisions are somewhat arbitrary since change occurs gradually and there is no clear-cut breaking point. A change of 10 to 20 percent above and below a guideline value has little significance if considered in proper perspective with other factors affecting yield. Field studies, research trials and observations have led to these divisions, but management skill of the water user can alter them. Values shown are applicable under normal field conditions prevailing in most irrigated areas in the arid and semiarid regions of the world.*

Table 2. Literature Values for 18 Water Constituents for Protecting Agricultural Water Supplies (NAS and NAE, 1972).

Constituent	Recommended Upper Limit (μg/L)	Discussion or Rationale for Continued Use on All Soils.
Radionuclides	Use Drinking water criteria	Lack of data on long-term accumulation warrants margin of safety
Aluminum	5,000	Plant toxicity and quantity of soil conditioners needed
Arsenic	100	Plant yields, toxicity, and lack of control measures
Beryllium	100	Plant toxicity
Cadmium	10	Phytotoxicity, accumulation in plants, and lack of soils data
Chromium	100	Plants toxicity, accumulation in soils, and inadequate soils data
Cobalt	50	Plant toxicity
Copper	200	Plant toxicity, accumulation in soils, and inadequate soils data
Flouride	1,000	Plant toxicity, and accumulation in grazers
Iron	5,000	Fixation of other essential elements, not commonly a problem
Lead	5,000	Plant toxicity
Lithium	2,500	Plant toxicity
Manganese	200	Plant toxicity and lack of clear control measures
Molybdenum	10	Toxicity of forage to animals
Nickel	200	Plant toxicity
Selenium	20	Toxicity of forage to animals
Vanadium	100	Plant toxicity and a lack of soils information
Zinc	2,000	Plant toxicity

Table 3. Literature Values for 17 Water Constituents for Protecting Livestock Water Supplies (University of California, 1974).

Constituent	Recommended Upper Limit (μg/l)
Aluminum	5,000
Arsenic	200
Boron	5,000
Cadmium	50
Chromium (Total)	1,000
Cobalt	1,000
Copper	500
Fluoride	2,000
Lead	100
Mercury	10
Molybdenum	500
Nitrate + Nitrite	100,000
Nitrite	10,000
Selenium	50
Vanadium	100
Zinc	25,000
Total Dissolved Solids	10,000,000

3) Review of Ambient Water Quality Data:

Appendix A shows ambient water quality data summarized from a number of USGS stations in the Columbia Basin. Included are the key parameters of electrical conductivity (ECw), total dissolved solids (TDS), sodium, bicarbonate, boron, chloride, total suspended solids (TSS), turbidity, and a number of other trace elements. Most of the data is shown as individual sample values; however, some 90th percentile values have been incorporated for a number of locations on the Yakima system.

The water quality data in Appendix A has been compared against the literature values for irrigation water quality criteria shown above in Table 1 to assess what water quality parameters are likely to be a problem in Washington. No data source was identified that could be used to provide a comprehensive comparison with all of the substances listed in Table 2, so a good, but limited, comparison was made.

4) Synthesis of Available Information into Criteria Recommendations:

In evaluating what would be appropriate criteria for irrigation source waters, one of the issues considered was how well any criteria would be met currently. Agricultural water quality recommendations are often expressed as a range. Effects typically occur somewhere within or outside of a given range, but exact points where effects will occur are not clear. This is because such effects depend on the characteristics of the soils, the crops being watered, the irrigation and drainage system, and the choice of soil conditioners used. Given this situation, selecting a criterion value from within these typical ranges of effects could be partly based on what the quality of the source water is currently. As will be seen below, this is the case with the recommendation for bicarbonate. Rather than selecting a value from the low portion of the range of acceptable bicarbonate levels, it is recommended that the mid-point on the range be used because of the high bicarbonate levels found in the up-gradient source water supplies. The following provides a brief synopsis of each of the water quality constituents evaluated:

Bicarbonate The technical work-group acknowledged that bicarbonate is currently occurring in agricultural source water at concentrations that are impacting the use of the water for overhead irrigation/cooling of orchard crops. Examination of the ambient water quality data shows bicarbonate levels in the upstream reaches of the Yakima and Columbia Rivers to provide for unrestricted use (91.5 μg/L). However, once the rivers have passed through the major agricultural areas, bicarbonate levels in the lower reaches consistently exceed this optimal level of protection. In these lower main-stem reaches, as well as the adjacent supply and return water systems, bicarbonate occasionally exceeds a level which represents a midpoint in the range between slight to moderate use restrictions (339 μg/L). It must be assumed that the observed use impairment by application to crops in the lower portions of the irrigation districts is validating the use-restriction ranges presented in the literature. Further impact to crops, and restrictions on the use of water for orchard crops in particular, is not desirable. In consideration of the limited data showing water supplies that exceed 339 μg/L as a seasonal average, the known effects, and the use restrictions which are already occurring at existing levels, Ecology is proposing to set a numeric criterion for bicarbonate. The criterion proposed is 339 mg/L of bicarbonate (HCO_3) as an arithmetic average value for the 6-month period of April 1 through September 30. It is probably appropriate to set a bicarbonate criterion at a slightly higher level than that associated with "no use restrictions". This is suggested because a) bicarbonate in Billy Clap Lake is already close to this limit, b) the primary effect to crops is spotting when overhead sprinklers are used such as when orchard crops are being cooled; and c) because a criteria of 339 mg/L seems to be achievable in all of our major supply systems.

Electrical Conductivity The members of the technical work-group were concerned about the build up of mineral salts in the soil. The group was of the opinion that the single measure of electrical conductivity would suffice overall to protect against the concern of salt build-up in soil. The work-group suggested the only reason to have criteria for specific salts would be if direct ion toxicity were a likely concern in our state's waters. The use of electrical conductivity or total dissolved solids is also recommended in the literature as measures of the potential for mineral salt build up in general. Examination of the ambient water quality data reveals that the level of electrical conductivity (ECw) associated with no water use restrictions (700 μS/cm) is only occasionally exceeded. Where such exceedence does occur it is seen almost exclusively in the wasteways of the lower portions of the irrigation district systems. The waterbodies that have these ECw exceedences also show high concentrations of other problem constituents, including having sodium ion at levels associated in the literature with use restrictions. With higher than typical levels of chloride, sodium, total dissolved solids, total suspended solids, nutrients, and metals, these systems are likely in need of special attention to prevent impacts to other in-stream and down-stream beneficial uses besides agricultural supplies. Thus they likely represent problem areas that legitimately need attention. In consideration of the overall capability of our waters to meet the level of electrical conductivity associated in the literature with having no long term use restrictions, and in consideration of the tenuous nature of this achievement in many systems, it appears appropriate to set a numeric criterion for conductivity. The criterion proposed is 700 μS/cm. ECw is an arithmetic average value for the 6-month period of April 1 through September 30. It should be noted for reference, that almost all samples which exceeded the ECw recommendations also exceeded recommendations for total dissolved solids. Thus it would appear that having criteria for both conductivity and dissolved solids is unnecessary, and that either would be effective in our state. Since conductivity is easier and less costly to measure, it is the primary recommendation.

Chloride Ecology is not recommending a criterion for chloride. The technical work-group did not believe that direct ion toxicity from chloride was likely to be a problem in Washington's waters. This view was supported by the ambient data for the rivers and agricultural drainage systems we examined. In no sample did chloride approach the upper level associated in the literature with having use restrictions. Not establishing a criterion for chloride is consistent with the work-group recommendation to avoid placing criteria in the standards for constituents that are unlikely to be a problem.

Sodium Ecology is not recommending a criterion for sodium. The technical work-group did not believe that direct ion toxicity from sodium was likely to be a potential problem in Washington's waters. The review of the ambient data suggested that while this was generally a view that could be supported, levels of sodium in some characteristically poor quality drainages did exceed concentrations associated with having potential long term impact to crops. Since these exceedences were never significantly above the upper range of the no use impairment level, and because there was a good correspondence between sodium exceedences and electrical conductivity exceedences, Ecology is not recommending a numeric criterion for sodium at this time. We believe it is acceptable to rely on a criterion for electrical conductivity to protect against direct toxicity from sodium. Controls necessary to meet the ECw criteria will more than likely also bring sodium ion concentrations down below the levels which will prevent use restrictions.

Total Dissolved Solids The work-group recognized control of total dissolved solids (TDS) could be used to generally prevent the build up of mineral salts in the soil to levels that would eventually harm crops. The group recommended, however, that electrical conductivity be used rather than TDS since this data is easier and less expensive to collect and ECw will serve the same purpose as a TDS criterion. The literature suggests that to avoid any use restrictions TDS should remain below 450 mg/L. An examination of the ambient water quality data showed that this level is only occasionally exceeded. Where such exceedence has occurred it is predominately in the wasteways of the lower portions of the irrigation district systems. The waterbodies that have these TDS exceedences also show the highest concentrations of other problem constituents, including having sodium at levels associated in the literature with slight to moderate use restrictions (69-207 mg/L). With higher than typical levels of chloride, sodium, total dissolved solids, total suspended solids, nutrients, and metals; these systems are likely in need of special attention to prevent impacts to other in-stream and down-stream beneficial uses besides agricultural supplies. Thus they likely represent problem areas that need attention. Ecology is not, however, proposing a numeric criterion for Total Dissolved Solids. Instead electrical conductivity (ECw) would be used as the measure to control general mineral salt build up in agricultural water supplies. See the discussion on ECw above.

Total Suspended Solids The technical work-group acknowledged ongoing problems created by sedimentation and erosion of irrigation system nozzles. They did not, however, unanimously support setting a criterion for total suspended solids (TSS) or any other measure of sediment load. Ambient water quality data for total suspended solids was not available for the sample locations representing the Columbia Basin proper, but data was available for the Yakima River system. High variability within a single season is characteristic with TSS at all locations throughout the system. There is a general trend of increasing TSS for the down-stream main-stem river stations and for the lower wasteways. The level associated with having no use restrictions is 50 mg/L TSS. Only the monitoring station at Cle Elum (located in the middle of the watershed) had a seasonal average that remained less than 50 mg/L for the two years examined (i.e., 15.5 and 23.1 mg/L). All but one lower irrigation district wasteway was able to comply with a level of TSS representing the midpoint in the range between slight and moderate use restrictions (75 mg/L). Given that TSS creates current costs to irrigators and impairs the use of the water for irrigation water supplies, Ecology recommends setting a numeric criterion for TSS. The criterion recommended is 75 mg/L of total suspended solids. This is to be calculated as an arithmetic average value for the 6-month period of April 1 through September 30.

Fecal Coliform The work-group generally did not support establishing a numeric criterion for bacteria to protect agricultural water supplies. They did, however, voice opposition to allowing any municipal wastewater to be discharged to irrigation supplies. The primary concern was over the potential for reduced marketability of crops irrigated with water that has known sources of human waste. The issue of bacterial standards is being dealt with in two other formats at this time. A specific review of Ecology's use of fecal coliform to protect water contact recreation and shellfish harvesting is currently being conducted. Additionally, Ecology is developing rules and guidelines for reuse water that may be used for irrigation or for generally supplementing surface and groundwater supplies. Literature dealing with agricultural water supplies are generally more permissive in their recommendations than literature and recommendations to protect recreational contact. It is common to see recommendations of 1,000 colony-forming units per 100 milliliters (cfu/100mL) for fecal coliform in agricultural water supplies. Examining the few sample results for fecal coliform contained in the Appendix shows that concentrations commonly exceed the existing state criteria for Class A waters. The current criterion for Class A waters is 100 cfu/100mL and is the standard most typically applied across the state. Agricultural supply waters that are classified as Class B currently have a 200 cfu/100mL limit, and any lakes or Class AA designated water must meet 50 cfu/100mL. Ecology believes that where recreational contact by humans is very unlikely, a higher criterion may be acceptable. Such a criterion would be intended to help identify and thus prevent the introduction of human and animal waste from sources which have not provided basic controls and treatment. Ecology recommends including a narrative statement on the need to control bacterial pollutants, and including a high trigger value to guide investigations into possible direct discharge of untreated waters.

pH The technical work-group did not believe that pH was a problem or likely to be a potential problem for the agricultural supply waters of our state. This view was not fully supported by the ambient monitoring data. The literature recommendation is not to exceed 8.4 to avoid any use restrictions (i.e., remain between 6.5-8.4). The literature set an alternate maximum pH of 9.0 (i.e., remain between 4.5-9.0 to avoid slight to moderate use restrictions). The data from the ambient monitoring stations show the lower end of the pH recommendation is met at all stations sampled, but that the higher end is frequently exceeded. In the Yakima River system below Ellensburg, pH occasionally exceeds the recommended value of 8.4 but never gets above 8.7. In the Columbia Basin system, pH commonly exceeds 8.4 and at several sites reached 9.0. In the Pasco drainage area pH is frequently in the range of 8.6-9.2. Even taken as a seasonal average the pH recommendation of 8.4 would be commonly exceeded. Since pH seems to present a potential problem, Ecology believes that a criterion may be warranted to properly monitor and control sources that may aggravate the existing situation. In consideration of the fact that pH is high even at the better source water locations (i.e., averages 8.1 units), and that pH was not noted as currently causing problems with irrigated agriculture, Ecology believes setting a less than optimum level of protection is acceptable at this time. The criterion proposed is to have pH between 6.4-9.0 as an arithmetic average value for the 6-month period of April 1 through September 30.

Radionuclides The technical work-group did not discuss the issue of radioactive substances in agricultural waters. The literature, however, typically expresses concern with radionuclide build up in soils and plants, and suggests using the federal drinking water standards as criteria to determine acceptability. In Washington, the State Department of Health has developed regulations on radionuclides. Specific criteria limits are provided in Chapter 246-221 WAC for concentrations in water. Ecology currently supports the Department of Health regulations by duplicating its requirements in the surface water quality standards regulation (Chapter 173-201A WAC). We are proposing to continue this practice by recognizing the application of the radionuclide criteria to agricultural supply waters.

Aluminum The technical work-group did not believe that aluminum was a problem or likely to be a potential problem for the agricultural supply waters of our state. This view was upheld by the ambient monitoring data that showed aluminum concentrations to be below 20 µg/L at all stations sampled. The literature recommendation for aluminum is 5,000 µg/L. Given the consistently low concentrations of aluminum and the recommendation of the work-group not to adopt criteria that appear unnecessary, Ecology is not proposing a numeric criteria at this time.

Arsenic The technical work-group did not believe that arsenic was a problem or a real potential problem for the agricultural supply waters of our state. This view was upheld by the ambient monitoring data that showed arsenic concentrations to be below 12 µg/L at all stations sampled with most below 6 µg/L. The literature recommendation for arsenic is 100 µg/L. Given the consistently low concentrations of arsenic in comparison to the literature values and the recommendation of the work-group not to adopt criteria that appear unnecessary, Ecology is not proposing a numeric criteria at this time.

Beryllium The technical work-group did not believe that beryllium was a problem or likely to be a potential problem for the agricultural supply waters of our state. This view was upheld by the ambient monitoring data that showed beryllium concentrations to be below 0.5 µg/L at all stations sampled. The literature recommendation for beryllium is 100 µg/L. Given the consistently very low concentrations of beryllium and the recommendation of the work-group not to adopt criteria that appear unnecessary, Ecology is not proposing a numeric criterion at this time.

Boron The technical work-group did not believe that boron was a problem or likely to be a potential problem for the agricultural supply waters of our state. This view was supported by ambient monitoring data that showed boron concentrations to be below 100 µg/L at all stations sampled with most below 50 µg/L. The literature recommendation for boron is 700 µg/L. Given the consistently low concentrations of boron and the recommendation of the work-group not to adopt criteria that appear unnecessary, Ecology is not proposing a numeric criterion at this time.

Cadmium The technical work-group did not believe that cadmium was a problem or likely to be a potential problem for the agricultural supply waters of our state. This view was supported by the ambient monitoring data that showed cadmium concentrations to be below the common detection limit of 1.0 μg/L at all stations sampled with many samples below the alternate detection limit of 0.1 μg/L. The literature recommendation for cadmium is 10 μg/L. Given the consistently very low concentrations of cadmium and the recommendation of the work-group not to adopt criteria that appear unnecessary, Ecology is not proposing a numeric criterion at this time.

Chromium The technical work-group did not believe that chromium was a problem or likely to be a potential problem for the agricultural supply waters of our state. This view was supported by the ambient monitoring data that showed chromium concentrations to be below the common detection limit of 1.0 μg/L at all stations sampled with many measured concentrations below the alternate detection limit of 0.1 μg/L. The highest measured concentration was 10 μg/L in Crab Creek with the next highest measured value being 0.7 μg/L. The literature recommendation for chromium is 100 μg/L. Given the consistently low concentrations of chromium and the recommendation of the work-group not to adopt criteria that appear unnecessary, Ecology is not proposing a numeric criterion at this time.

Cobalt The technical work-group did not believe that cobalt was a problem or likely to be a potential problem for the agricultural supply waters of our state. This view was supported by the ambient monitoring data that showed cobalt concentrations to be below the common detection limit of 3.0 μg/L at all stations sampled. The literature recommendation for cobalt is 50 μg/L. Given the consistently low concentrations of cobalt and the recommendation of the work-group not to adopt criteria that appear unnecessary, Ecology is not proposing a numeric criterion at this time.

Copper The technical work-group did not believe that copper was a problem or likely to be a potential problem for the agricultural supply waters of our state. This view was supported by the ambient monitoring data that showed most samples to have low copper concentrations. The highest concentration measured was 20 μg/L with the next highest being 7.4 μg/L. The literature recommendation for copper is 200 μg/L. Given the consistently low concentrations of copper and the recommendation of the work-group not to adopt criteria that appear unnecessary, Ecology is not proposing a numeric criterion at this time.

Fluoride The technical work-group did not believe that fluoride was a problem or likely to be a potential problem for the agricultural supply waters of our state. This view, however, was not as well supported by the ambient monitoring data. The ambient data showed concentrations to approach the literature recommendation of 1000 μg/L. The highest measured value of 700 μg/L occurred on numerous occasions and concentrations above 400 μg/L were common. The lowest water quality measurement occurred in the Yakima River in the headwaters near Cle Elum. There it had a seasonal maximum average of 34 μg/L. At Billy Clap Lake, the effective headwaters of the Columbia Basin irrigation system, the highest seasonal average was 150 μg/L. Thus initial concentrations of fluoride are moderate compared to many other trace elements. The literature suggests that less concern exists with neutral to alkaline soils which have a high capacity to inactivate fluoride. In consideration of these factors plus the still relatively good margin of safety between the highest concentrations measured and the upper limit of the range assumed to result in no use restrictions (see Table 2), Ecology is persuaded not to establish a numeric criterion for fluoride at this time.

Iron The technical work-group did not believe that iron was a problem or likely to be a potential problem for the agricultural supply waters of our state. This view was supported by the ambient monitoring data that showed iron concentrations to be below 53 µg/L at all stations sampled. The literature recommendation for iron is 5000 µg/L. Given the consistently very low concentrations of iron and the recommendation of the work-group not to adopt criteria that appear unnecessary, Ecology is not proposing a numeric criterion for iron at this time.

Lead The technical work-group did not believe that lead was a problem or likely to be a potential problem for the agricultural supply waters of our state. This view was supported by the ambient monitoring data which showed lead concentrations to be below the common detection limit of 1.0 µg/L at most of the stations sampled, with many other stations below the alternate detection limit of 0.5 µg/L. Only a few of the many samples tested for lead exceeded 1.0 µg/L. The highest measured concentration was 28 µg/L in Crab Creek with the next highest measured value being 3 µg/L. The literature recommendation for lead is 100 µg/L. Given the consistently low concentrations of lead and the recommendation of the work-group not to adopt criteria that appear unnecessary, Ecology is not proposing a numeric criterion at this time.

Lithium The technical work-group did not believe that lithium was a problem or likely to be a potential problem for the agricultural supply waters of our state. This view was supported by the ambient monitoring data which showed lithium concentrations to be below the common detection limit of 4.0 µg/L at all but one of the stations sampled. That one highest station value was 6.0 µg/L. The literature recommendation for lithium is 2500 µg/L. Given the consistently very low concentrations of lithium and the recommendation of the work-group not to adopt criteria that appear unnecessary, Ecology is not proposing a numeric criteria for lithium at this time.

Manganese The technical work-group did not believe that manganese was a problem or likely to be a potential problem for the agricultural supply waters of our state. This view was supported by the ambient monitoring data that showed manganese concentrations to be below 12 µg/L at all of the stations sampled. The literature recommendation for manganese is 200 µg/L. Given the consistently very low concentrations of manganese and the recommendation of the work-group not to adopt criteria that appear unnecessary, Ecology is not proposing a numeric criterion for manganese at this time.

Mercury The technical work-group did not believe that mercury was a problem or likely to be a potential problem for the agricultural supply waters of our state. This view was supported by the ambient monitoring data that showed mercury concentrations to be below the detection limit of 0.1 µg/L at almost all of the many stations sampled. Of the stations that were above the detection limit, the highest was 3 µg/L with the next two being at 0.6 µg/L, and one other at 0.4 µg/L. The literature recommendation for mercury is 10 µg/L to protect livestock. Except for the one high sample, all other samples were well below the level recommended in the literature. While Ecology's concern for mercury is generally high, we can support not setting a numeric criteria to protect agricultural water supplies at this time. However, if information is developed which shows the 3 µg/L value not to be an anomaly, the department's position may change.

Molybdenum The technical work-group did not believe that molybdenum was a problem or likely to be a potential problem for the agricultural supply waters of our state. This view was not well supported by the ambient monitoring data that showed molybdenum concentrations to approach the lower end of the values presented in the literature for protecting livestock. However, the literature recommendations for molybdenum varied from 10 to 500 µg/L. This disagreement is greater than with any other of the substances examined. Ambient data show that upstream source waters consistently have molybdenum concentrations below 1.0 µg/L, but that concentrations in the wasteways particularly frequently rise to 5-7 µg/L. In an effort to reduce the number of criteria assigned to protect agricultural waters supplies and in recognition that no sample stations ever exceeded the recommended 10 µg/L limit, Ecology is not proposing to establish a numeric criteria for molybdenum at this time. However, if unreviewed or future data shows molybdenum concentrations are commonly higher or are increasing beyond what we have currently observed, the department's position on this issue will likely change.

Nickel The technical work-group did not believe that nickel was a problem or likely to be a potential problem for the agricultural supply waters of our state. This view was supported by the ambient monitoring data which showed measured nickel concentrations to be below 2 µg/L dissolved metal at all of the stations sampled. One sample analyzed for total recoverable nickel showed a measured value of 6 µg/L. The literature recommendation for nickel is 200 µg/L. Given the consistently very low concentrations of nickel and the recommendation of the work-group not to adopt criteria that appear unnecessary, Ecology is not proposing a numeric criterion for nickel at this time.

Nitrate+Nitrogen The technical work-group did not believe that total nitrate and nitrogen was a problem or likely to be a potential problem for the agricultural supply waters of our state. This view was supported by the ambient monitoring data that showed measured concentrations to be below 12,000 µg/L at all of the stations sampled. The literature recommendation is 100,000 µg/L. Given this almost ten fold level of safety between the highest concentration measured and the literature recommendation associated with having no use restrictions, Ecology is not proposing a numeric criteria at this time.

Nitrite The technical work-group did not believe that nitrite was a problem or likely to be a potential problem for the agricultural supply waters of our state. This view was supported by the ambient monitoring data that showed measured concentrations to be below 30 µg/L at all of the stations sampled. The literature recommendation is 10,000 µg/L. Given the consistently very low concentrations of nitrite and the recommendation of the work-group not to adopt criteria that appear unnecessary, Ecology is not proposing a numeric criterion for nitrate at this time.

Selenium The technical work-group did not believe that selenium was a problem likely to be a potential problem for the agricultural supply waters of our state. This view was supported by the ambient monitoring data that showed selenium concentrations to generally be below 1.0 µg/L at almost all stations sampled. Only two were higher, one of these was 1.0 and the other was 4.0 µg/L. The literature recommendation to protect livestock and other animals that would graze on irrigated crops is 20 µg/L. Given the consistently very low concentrations of selenium and the recommendation of the work-group not to adopt criteria that appear unnecessary, Ecology is not proposing a numeric criterion at this time.

Turbidity The technical work-group did not support establishing a numeric criterion for turbidity to protect agricultural water supplies. Their recommendation seems largely based on turbidity being related more to a measure of light transmission rather than directly related to particulate levels. Also, a criterion for total suspended solids would serve the same purpose as one for turbidity, and literature values for turbidity have not been found. Data on turbidity were not available for the Columbia Basin proper, but were available on the Yakima River system. For the stations reviewed by the USGS in the Yakima system, the 90th percentile value for turbidity was below 22 at all stations except for the Sulphur Creek Drain near Sunnyside which had a 90th percentile of 54 NTU turbidity. For the reasons suggested above and to avoid unnecessary criteria, Ecology is not proposing a numeric criterion at this time.

Vanadium The technical work-group did not believe that vanadium was a problem likely to be a potential problem for the agricultural supply waters of our state. This view was supported by the ambient monitoring data that showed measured concentrations of vanadium to be below 37 µg/L at all of the stations sampled. The literature recommendation is 100 µg/L to prevent any agricultural use restrictions. Given the consistently low concentrations of vanadium and the recommendation of the work-group not to adopt criteria that appear unnecessary, Ecology is not proposing a numeric criterion at this time.

Zinc The technical work-group did not believe that zinc was a problem or likely to be a potential problem for the agricultural supply waters of our state. This view was supported by the ambient monitoring data that showed measured concentrations of zinc to be below 13 µg/L at all of the stations sampled. The literature recommendation is 2000 µg/L. Given the consistently very low concentrations of zinc and the recommendation of the work-group not to adopt criteria that appear unnecessary, Ecology is not proposing a numeric criterion for zinc at this time.

5) Criteria Duration

We need to specify the duration of time for which the criterion values are intended to apply. It is clear the detrimental affects we want to avoid are the outcome of longer-term exceedences of the recommended values. Thus, setting a criterion duration as a one-hour or even 24-hour average concentration may not be necessary to protect agricultural supply waters. What seems more appropriate is to base the criteria recommendations on an arithmetic average of the water quality occurring over an entire month or even the entire irrigation season. The recommendation is to set averaging periods as April 1 through September 30. The average of a minimum of three samples would be required from this 6-month period to qualify as a violation of water quality criteria. The period of April 1 through September 30 was selected because it generally coincides with the portion of the year where most of the irrigation water use occurs.

IV. Criteria in Use by Other States

It is often useful to compare what standards exist in other states to identify unique criteria or to recognize trends of consistency. Table 4 below summarizes the criteria applied in Colorado, Nevada, and New Mexico to protect agricultural water supplies.

Two immediate observations are noted when we compare the criteria established in these three other western states. First, while there is general similarity between most of the criteria used by the three states, there are also a couple unique differences (see lead, selenium, and zinc). Second, most of the criteria follow the literature recommendations cited in Tables 1- 3 above.

Table 4. Water Quality Criteria for Agricultural Water Supplies for the States of Nevada, New Mexico, and Colorado. Values Shown are in µg/L, Except for Dissolved Oxygen (mg/L),Fecal Coliform (cfu/100mL), and radioactive materials (pCi/l).

Criteria Type	Colorado		Nevada		New Mexico	
	Crops	Livestock	Crops	Livestock	Crops	Livestock
Aluminum					5,000	5,000
Arsenic	100	200	100		100	200
Berillium	100		100			
Boron	500	5,000	700		750	5,000
Cadmium	10	50	10		10	50
Chlorides		1,500,000				
Chromium (Total)		1,000	100		100	1,000
Chromium III						
Chromium VI	100					
Cobalt					50	1,000
Copper	200	500	200		200	500
Cyanide						
Dissolved Oxygen	3	Aerobic				
Fecal Coliform		1,000	1,000		1,000	
Fluoride		2,000	1,000			
Iron			5,000			
Lead	10	100	5,000		5,000	100
Mercury		10				10
Manganese	20		200			
Molybdenum					1,000	
Nickel	20		200			
Nitrate		100,000				
Nitrite	1,000	10,000				
PH		5-9	4.5-9			
Selenium	20		50		130/250	50
Total Dissolved Solids		3,000,000				
Vanadium					100	100
Zinc	200	25,000	2,000		2,000	25,000
Radium-226 and 228						30
Tritium						20,000
Gross alpha radiation						15

In general, the criteria in use in these three other western states to protect irrigation water supplies are. more comprehensive than the list of criteria being recommended by Ecology. Some important differences, however, are worth pointing out. In the Washington proposal, electrical conductivity is used as a surrogate measure for protection from many of the specific salt ions; bacteria control is focused on the use of technology-based control efforts; and the recommendations include criteria for total suspended solids.

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Appendix A

Water Sample Data from Rivers and Irrigation Drains and Wasteways in the Columbia Basin, Yakima, and Pasco Regions of Washington State

<u>Notes to tables:</u> In the tables which follow, the measurement units for all of the sample values have been standardized. Bicarbonate, chloride, sodium, total suspended solids, total dissolved solids, nitrite, and nitrate + nitrogen are in milligrams per liter (mg/L). Electrical conductivity is in microsiemens/centimeter (µS/cm). Turbidity is in nephelometric turbidity units (NTU). pH is in standard units. Fecal coliform is in colony forming units per 100 mL (cfu/100 mL). All other trace elements listed are in micrograms per liter (µg/L). Values for metals are for filtered samples unless scripted "tr" meaning total recoverable analysis was performed.

Samples that were above the criteria recommendation values are highlighted for the convenience of the reader.

Ambient Water Quality Data for the Columbia Basin Project

Field measurements and results per liter of analyses for inorganic constituents in filtered water samples from the Columbia Basin Project, November 1991, March 1992, and July 1992.

		Bicarbonate *mg/l*	**Conductivity – Ecw** *µS/cm*	**Chloride** *mg/l*	**Sodium** *mg/l*	**Total Suspended Solids** *mg/l*	**Total Dissolved Solids** *mg/l*	**Turbidity** *ntu*	**Selenium** *µg/l*
Possible Criteria Values :		***339***	***700***	***106.5***	***69***	***75***	***450***	***None***	***20***
Location	Date	Bicarbonate	Conductivity – Ecw	Chloride	Sodium	Total Suspended Solids	Total Dissolved Solids	Turbidity	Selenium
Billy Clap Lake	Nov	73	140	1.6	2.2		88		<1
	Mar	69	133	1.5	2.3		91		<1
	Jul	76	136	1	2.2		82		<1
Rocky Ford KC. Parker H.	Nov	200	385	6	22		252		1
	Mar	195	381	6.3	23		247		<1
	Jul	192	378	5	25		241		<1
Upper Crab Creek	Jul	303	485	1.2	18		275		<1
Moses Lk. Rocky Ford	Nov	146	312	4.4	19		182		<1
	Mar	143	314	7.2	23		201		<1
	Jul	112	241	2.7	12		135		<1
Moses Lk. Parker Horn	Jul	155	290	3.2	14		174		<1
Moses Lk. South End	Nov	143	287	4.2	15		182		<1
	Mar	178	363	8	23		210		<1
	Jul	123	238	2.6	11		129		<1
Potholes Res. West Arm	Nov		552						<1
	Mar		383						<1
	Jul		599						<1
Potholes Res. East Arm	Jul	139	294	5.6	15		161		<1
Winchester Wasteway	Nov	257	496	12	30		314		<1
	Mar	231	504	13	30		323		<1
	Jul	172	326	6.4	17		216		<1
Frenchmen Hills WW	Nov	240	591	18	33		376		<1
	Mar	254	656	22	40		415		<1
	Jul	160	347	9.8	18		201		<1
Lind Coulee WW	Nov	240	614	18	52		398		<1
	Mar	242	640	21	52		403		<1
	Jul	144	301	6.8	17		177		<1
Soda Lake	Nov	197	366	8.2	22		215		<1
	Mar	179	380	9.1	23		217		<1
	Jul	140	310	8.9	19		168		<1
Lower Crab Ck. McManamon	Jul	123	271	6.9	18		156		<1

		Bicarbonate *mg/l*	Conductivity – Ecw *µS/cm*	Chloride *mg/l*	Sodium *mg/l*	Total Suspended Solids *mg/l*	Total Dissolved Solids *mg/l*	Turbidity *ntu*	Selenium *µg/l*
Possible Criteria Values :		***339***	***700***	***106.5***	***69***	***75***	***450***	***None***	***20***
Lower Goose Lake	Jul	142	307	11	22		168		<1
Sand Hollow Crk. Mouth	Nov	262	693	26	29		452		<1
Sand Hollw Road S, SW	Mar	269	689	26	35		447		<1
	Jul						243		<1
Crab Creek, Beverly	Nov	343	821	25	79		516		<1
	Mar	334	831	32	84		520		<1
	Jul	238	540	17	46		320		<1
Saddle Mtn WW	Jul	146	377	13	26		214		<1
EL68D WW	Nov	316	733	21	64		475		<1
	Mar	298	947	41	72		584		4
	Jul	146	325	5.2	19		194		<1
Wahluke Br. 10 WW	Nov	439	959	30	87		608		<1
	Mar	415	982	34	95		615		<1
	Jul	226	509	17	40		312		<1
PE16.4 WW	Nov	243	573	18	41		358		<1
	Mar	339	776	23	70		452		2
	Jul	199	487	15	35		290		1
Esquatzel Coulee WW	Nov	261	599	20	43		373		<1
	Mar	284	765	31	56		478		2
	Jul	185	420	14	28		249		<1

		Aluminum *µg/l*	Arsenic *µg/l*	Beryllium *µg/l*	Boron *µg/l*	Cadmium *µg/l*	Chromium *µg/l*	Cobalt *µg/l*	Copper *µg/l*	Flouride *µg/l*	Iron *µg/l*
Possible Criteria Values:		***5000***	***100***	***100***	***700***	***10***	***100***	***50***	***200***	***1000***	***5000***

Location	Date	Aluminum	Arsenic	Beryllium	Boron	Cadmium	Chromium	Cobalt	Copper	Flouride	Iron
Billy Clap Lake	Nov		<1		<10	<1	<1		1	200	
	Mar		<1		30	<1	<1		4	100	
	Jul		<1		<10	<1	<1		1	100	
Rocky Ford Ck Parker H.	Nov.		2		20	<1	<1		<1	400	
	Mar		2		20	<1	<1		<1	500	
	Jul		2		<10	<1	<1		<1	400	
Upper Crab Creek	Jul		2		20	<1	<1		<1	400	
Moses Lk. Rocky Ford	Nov		3		10	<1	<1		<1	200	
	Mar		3		40	<1	<1		2	400	
	Jul		2		10	<1	<1		<1	200	
Moses Lk. Parker Horn	Jul		2		<10	<1	<1		1	300	
Moses Lk. South End	Nov		2		10	<1	<1		1	200	
	Mar		2		10	<1	<1		<1	300	
	Jul		2		<10	<1	<1		<1	300	
Potholes Res. West Arm	Nov		3		30	<1	<1		1	300	
	Mar		3		20	<1	<1		<1	400	
	Jul		2		30	<1	<1		<1	400	
Potholes Res. East Arm	Jul		3		<10	<1	<1		<1	300	
Winchester Wasteway	Nov		<1		20	<1	<1		<1	300	
	Mar		8		20	<1	<1		<1	400	
	Jul		4		10	<1	<1		<1	300	
Frenchmen Hills WW	Nov		7		20	<1	<1		<1	500	
	Mar		9		150	<1	<1		1	600	
	Jul		4		20	<1	<1		1	300	
Lind Coulee WW	Nov		7		30	<1	<1		<1	700	
	Mar		12		10	<1	<1			700	
	Jul		4		<10	<1	<1		2	300	
Soda Lake	Nov		3		20	<1	<1		1	300	
	Mar		4		20	<1	<1		<1	400	
	Jul		4		10	<1	<1		1	300	
Lower Crab Ck. McManamon	Jul		2		<10	<1	<1		2	300	
Lower Goose Lake	Jul		2		10	<1	<1		1	200	
Sand Hollow Crk. Mouth	Nov		3		30	<1	<1		<1	500	
Sand Hollw Road S, SW	Mar		<1		30	<1	<1		<1	500	
	Jul		2			<1	<1		2	400	
Crab Creek, Beverly	Nov		6		40	<1	10		5	500	
	Mar		8		20	<1	1		<1	700	
	Jul		5		30	<1	<1		1	500	
Saddle Mtn WW	Jul		4		20	<1	<1		1	400	

		Aluminum µg/l	Arsenic µg/l	Beryllium µg/l	Boron µg/l	Cadmium µg/l	Chromium µg/l	Cobalt µg/l	Copper µg/l	Flouride µg/l	Iron µg/l
Possible Criteria Values:		***5000***	***100***	***100***	***700***	***10***	***100***	***50***	***200***	***1000***	***5000***
EL68D WW	Nov		7		60	<1	<1		<1	600	
	Mar		6		40	<1	<1		<1	300	
	Jul		2		20	<1	<1		2	300	
Wahluke Br. 10 WW	Nov		6		100	<1	<1		1	700	
	Mar		6		80	<1	1		1	700	
	Jul		5		40	<1	<1		1	400	
PE16.4 WW	Nov		3		40	<1	<1		<1	400	
	Mar		8		50	<1	<1		<1	600	
	Jul		5		30	<1	<1		1	400	
Esquatzel Coulee WW	Nov		4		40	<1	<1		<1	400	
	Mar		7		30	<1	<1		<1	500	
	Jul		4		30	<1	<1		1	300	

		Lead µg/l	Lithium µg/l	Manganese µg/l	Mercury µg/l	Molyb-denum µg/l	Nickel µg/l	Nitrate + Nitrogen mg/l	Nitrite mg/l	pH	Vanadium µg/l	Zinc µg/l
Possible Criteria Values:		***100***	***2500***	***200***	***10***	***10***	***200***	***100,000***	***10,000***	***6.5-9.0***	***100***	***2000***
Location	Date	Lead	Lithium	Manganese	Mercury	Molyb-denum	Nickel	Nitrate + Nitrogen	Nitrite	pH	Vanadium	Zinc
Billy Clap Lake	Nov	<1			<0.1	<1		<50		7.9	1	<3
	Mar	<1			<0.1	<1		<50		8.1	1	5
	Jul	<1			<0.1	<1		<50		8.2	1	<3
Rocky Ford Ck Parker H.	Nov.	<1			<0.1	1		1700		7.8	11	5
	Mar	<1			0.2	1		1500		8.0	12	<3
	Jul	<1			<0.1	1		190		8.3	19	<3
Upper Crab Creek	Jul	<1			<0.1	<1		890		8.3	13	<3
Moses Lk. Rocky Ford	Nov	<1			<0.1	<1		290		9.0	15	4
	Mar	<1			<0.1	1		320		9.2	17	<3
	Jul	<1			<0.1	<1		<50		9.0	8	<3
Moses Lk. Parher Horn	Jul	<1			<0.1	1		170		8.9	12	<3
Moses Lk. South End	Nov	3			<0.1	1		200		8.9	11	6
	Mar	<1			<0.1	1		330		9.0	14	<3
	Jul	<1			<0.1	<1		<50		8.8	7	<3
Potholes Res. West Arm	Nov	<1			<0.1	2		920		8.6	12	7
	Mar	<1			<0.1	1		300		8.6	10	<3
	Jul	<1			<0.1	<1		<50		8.2	3	<3
Potholes Res. East Arm	Jul	<1			<0.1	<1		<50		8.8	8	<3
Winchester Wasteway	Nov	<1			0.2	5		2000		8.3	20	<3
	Mar	<1			<0.1	3		1900		8.6	29	<3
	Jul	<1			<0.1	1		350		8.2	25	4
Frenchmen Hills WW	Nov	<1			<0.1	4		5400		8.5	31	8
	Mar	<1			<0.1	4		6000		8.7	37	7
	Jul	<1			<0.1	1		2100		8.2	16	<3
Lind Coulee WW	Nov	<1			<0.1	1		4300		8.4	30	3
	Mar	<1			<0.1	6		4700		8.4	33	<3
	Jul	<1			<0.1	2		1700		8.1	13	<3
Soda Lake	Nov	<1			<0.1	2		560		8.1	11	5
	Mar	<1			<0.1	1		660		8.6	9	<3
	Jul	<1			<0.1	2		270		8.5	10	4
Lower Crab Ck. McManamon	Jul	<1			<0.1	1		<50		8.7	5	<3
Lower Goose Lake	Jul	<1			<0.1	1		110		8.0	4	<3
Sand Hollow Crk. Mouth	Nov	<1			<0.1	3		10000		8.6	17	<3
Sand Hollw Road S, SW	Mar	<1			<0.1	2		12000		8.8	17	<3
	Jul	<1			<0.1	1		5500		8.4	8	<3
Crab Creek, Beverly	Nov	29			<0.1	5		2900		8.4	16	13
	Mar	<1			<0.1	5		2700		8.6	17	<3
	Jul	<1			<0.1	3		1100		8.6	13	<3
Saddle Mtn WW	Jul	<1			<0.1	2		1300		8.7	12	<3
EL68D WW	Nov	<1			<0.1	3		7700		8.6	32	5
	Mar	<1			3.0	2		7600		8.7	13	<3
	Jul	<1			<0.1	1		3800		8.1	12	<3
Wahluke Br. 10 WW	Nov	<1			<0.1	6		8400		8.3	11	8
	Mar	<1			<0.1	7		9700		8.4	11	<3
	Jul	<1			0.1	2		3100		8.4	11	<3

		Lead	Lithium	Manganese	Mercury	Molyb-denum	Nickel	Nitrate + Nitrogen	Nitrite	pH	Vanadium	Zinc
Possible Criteria Values:		***100 μg/l***	***2500 μg/l***	***200 μg/l***	***10 μg/l***	***10 μg/l***	***200 μg/l***	***100,000 mg/l***	***10,000 mg/l***	***6.5-9.0***	***100 μg/l***	***2000 μg/l***
PE16.4 WW	Nov	<1			<0.1	2		3400		8.6	12	4
	Mar	<1			<0.1	3		7900		8.5	31	<3
	Jul	<1			<0.1	2		2000		8.6	13	<3
Esquatzel Coulee WW	Nov	<1			0.6	3		4500		8.4	14	4
	Mar	<1			0.4	3		6800		8.4	19	13
	Jul	<1			<0.1	2		2400		8.2	11	<3

Ambient Water Quality Data for the Yakima River and Selected Drains

		Bicarbonate mg/l	Conductivity – Ecw *μS/cm*	Chloride mg/l	Sodium mg/l	Total Suspended Solids mg/l	Total Dissolved Solids mg/l	Turbidity ntu	Selenium *μg/l*	Fecal Coliform cfu
Possible Criteria Values:		**339**	**700**	**106.5**	**69**	**75**	**450**	**None**	**20**	**None**

Location	Date of Sample	Bicarbonate	Conductivity - ECw	Chloride	Sodium	Total Suspended Solids	Total Dissolved Solids	Turbidity	Selenium	Fecal Coliform
Yakima River at Cle Elum	1988 - 1989									
	Oct 11	37	60	0.7	1.8	1	39	0.3		
	Nov 08	35	62	1.0	2.3	4	43	4.0		
	Dec 13	31	61	1.1	2.5	25	41	6.0		
	Jan 12	40	70	0.9	2.8	1	45	0.4		
	Jan 13	67	126	1.4	13	25	78	11		
	Feb 14	47	81	1.0	3.9	2	52	1.2		
	Mar 14	52	90	1.1	5.3	3	57			
	Apr 06	35	69	0.9	3.2	85	42	14		
	Apr 11	39	69	0.5	3.9	5	46	2.0		
	May09	29	51	0.5	2.1	6	34	2.0		
	Jun 13	32	54	0.4	1.4		34	0.5		
	Jun 29		47		1.2	6				
	Jul 11	27	46	0.2	1.2	4	29			
	Aug 09	27	48	0.4	1.2	2	30	0.7		
	Sep 12	33	61	0.4	1.8	<1	38	0.6		
	1989-1990									
	Oct 11		61	0.4	1.8	1		0.3		
	Nov 14	32	58	0.9	2.1	6	39	4.0		
	Dec 12	34	63	0.9	2.5	3	42	3.0		
	Jan 09	34	59	0.9	2.5	12	41	5.0		
	Jan 10	28	49	0.9	2.3	130	36	26	<1	
	Jan 10		49		2.3					
	Feb 13	39	72	1.0	4.1	8	47	0.3		
	Mar 13	46	75	1.3	3.7	2	51	5.0		
	Sep 17		62					0.8		
Yakima River 10 miles south of Ellensburg	1988-1989									
	Oct 12	88	166	2.5	6.9	3	108	2.0		
	Nov 09	70	121	1.9	4.6	6	79	3.0		
	Dec 14	57	99	1.4	3.4	17	65	6.0		
	Jan 11	71	123	2.1	5.3	2	81	0.6		
	Jan 31	56	101	1.0	3.9	70	65	24		
	Feb 15	81	142	1.8	5.8	3	86	1.5		
	Mar 15	82	130	2.2	6.2	22	94			
	Apr 06	56	98	1.2	3.7	109	64	18		
	Apr 12	59	104	0.7	3.9	34	68	7.0		
	May10	48	82	0.8	2.5	97	55	10		
	Jun 14	66	98	0.6	3.4	17	68	2.0		

	Jun 28		88		3.2	25				
	Jun 28					25				
	Jul 12	54	79	0.4	2.5	26	49			

		Bicarbonate mg/l	Conductivity – Ecw µS/cm	Chloride mg/l	Sodium mg/l	Total Suspended Solids mg/l	Total Dissolved Solids mg/l	Turbidity ntu	Selenium µg/l	Fecal Coliform cfu
Possible Criteria Values:		**339**	**700**	**106.5**	**69**	**75**	**450**	**None**	**20**	**None**
	Aug 10	47	88	0.6	3.0	9	55	1.7		
	Sep 13	76	144	1.8	6.0	11	93	3.0		
	1989-1990									
	Oct 12	92	156	1.6	5.8	6	98	2.0		
	Oct 22		160							
	Nov15	62	109	1.6	4.4	25	72	2.0		
	Dec 05	53	92	1.2	3.0	48	59	12	<1	
	Dec 05		92							
	Dec 13	69	118	1.9	4.6	4	78	2.0		
	Jan 10	45	102	1.7	3.9	108	61	20		
	Feb 14	61	104	1.8	4.8	6	70	0.5		
	Mar 14	77	128	2.0	5.7	3	83	5.0		
Yakima River at Kiona	1988-1989									
	Oct 20	138	272	5.7	14	24	171	7.0		
	Nov 17	125	245	5.6	15	10	164	1.8	<1	41
	Nov 17		245							
	Dec 21	113	222	4.7	12	6	142	2.0		
	Jan 19	119	229	5.5	14	16	151	2.8		
	Jan 19		229							
	Feb 23		249	5.7	14	9	153	3.0		
	Mar 08		277			103				
	Mar 23	109	208	5.0	12	76	144	18	<1	110
	Mar 23		208							
	Apr 09	65	129	1.7	6.7	193	86	38		
	Apr 20	70	132	2.1	6.4	122	90	18		
	May 8	85	149	3.3	9.0	36	114	8.1		510
	May18		149							
	Jun 22	130	270	5.0	14	21	171	6.0	<1	
	Jun 26		267		15	30				
	Jul 20	141	272	5.5	15	31	176	13	<1	140
	Jul 20		272							
	Aug 17	139	290	5.7	16	27	180	8.0		
	Sep 21	145	291	6.1	17	19	185	4.7		
	Sep 21		291							
	1989-1990									
	Oct 26	153	300	6.5	17	16	193	5.0		
	Nov 21	135	252	5.9	16	20	171	4.9	<1	K63
	Nov 21		252							
	Dec 06	127	251	5.5	13	71	161	12	<1	
	Dec 06		251		15					
	Dec 06	92	185	4.0	9.4	71	118	14		
	Dec 07	76	152	2.9	6.9	57	95	14		
	Dec 21	115	234	4.8	13	4	147	2.0		
	Jan 18	91	180	4.3	11	40	122	3.8		130
	Feb 22	97	193	4.0	10	8	124	2.5		
	Mar 22	92	171	3.4	9.4	70	111	16	<1	52
	Mar 22		171							
	Apr 22	58	132	2.2	6.4	23	83	15		
	May10	90	163	3.7	9.1	36	108	10	<1	35
	May10		163							
	Jun 30	104	201	5.1	10		127	6.5		
	Jul 18	133	290	4.8	16	23	173	7.0	<1	130
	Jul 18		290							

	Aug 27	112	222	5.6	11	44	140	13		
	Sep 06	135	265	6.4	14	16	164	5.5		77

		Bicarbonate mg/l	Conductivity - ECw	Chloride mg/l	Sodium mg/l	Total Suspended Solids mg/l	Total Dissolved Solids mg/l	Turbidity ntu	Selenium µg/l	Fecal Coliform cfu
Possible Criteria Values:		**339**	**700 µS/cm**	**106.5**	**69**	**75**	**450**	**None**	**20**	**None**
Sulphur Creek Wasteway @ Sunnyside	1988-1989									
	Oct 18	190	388	9.2	22	31	252	6.0		
	Nov 14	286	676	19	44	14	444	4.0		
	Nov 17					19				
	Dec 19	301	681	18	43	42	447	8.0		
	Dec 30	305	724	23	52	83	466	15		
	Jan 17	308	714	21	46	44	465	7.0		
	Feb 21	297	697	21	45	13	453	7.0		
	Feb 24		800	29	60	50	505	10		
	Mar 08		693			108				
	Mar 21	130	300	8.7	18	620	193	84		
	Apr 18	99	211	5.1	13	59	138	14		
	May16	88	185	3.5	9.9	144	117	19		
	Jun 20	117	252	5.2	14	199	158	25		
	Jun 26		259		15	245				
	Jun 26					217				
	Jul 12		315	7.0	18	191	193	39		
	Aug 15	125	270	5.7	15	154	168	16		
	Sep 18	124	262	5.7	15	103	168	10		
	1989-1990									
	Oct 23		587					14		
	Oct 24	284	649	19	43	20	426	4		
	Nov 20	298	681	20	45	17	449	4		
	Dec 19	303	677	19	46	92	450	11		
	Jan 16	309	706	21	47	34	462	8		
	Feb 20	309	695	20	47	13	463	5		
	Mar 20	99	224	5.5	12	377	137	16		

		Aluminum µg/l	Arsenic µg/l	Beryllium µg/l	Boron µg/l	Cadmium µg/l	Chromium µg/l	Cobalt µg/l	Copper µg/l	Flouride µg/l	Iron µg/l
Possible Criteria Values:		**5000**	**100**	**100**	**700**	**10**	**100**	**50**	**200**	**1000**	**1000**

Location	Date of Sample	Aluminum	Arsenic	Beryllium	Boron	Cadmium	Chromium	Cobalt	Copper	Flouride	Iron
Yakima River at Cle Elum	1988 - 1989										
	Oct 11					0.2 diss			0.8 diss	20	
	Nov 08					0.2			1.2	20	
	Dec 13					0.2			0.9	30	
	Jan 12					0.2			<0.5	30	
	Jan 13					0.1			1.5	50	
	Feb 14					<0.1			0.6	40	
	Mar 14					0.4			1.6	30	
	Apr 06		<1 dis			<0.2			0.9	30	
	Apr 11		<1			<0.2			1.0	30	
	May 09		<1			0.4			2.0	30	
	Jun 13		<1			<0.1			1.2	20	
	Jul 11		<1			<0.1			1.1	10	
	Aug 09		<1			<0.1			0.5	20	
	Sep 12		<1			<0.1			<0.5	20	
	1989-1990										
	Oct 11					<0.1			0.6	20	
	Nov 14		<1			0.7			14	20	
	Dec 12		<1			<0.1			7.4	40	

	Jan 09		<1			0.1			5.3	30	
	Jan 10		<1			0.1			3.0	30	
	Jan 10	3300 tr		<0.5	40 tr	<1.0	<5	<3	<10		44

		Aluminum *µg/l*	**Arsenic** *µg/l*	**Beryllium** *µg/l*	**Boron** *µg/l*	**Cadmium** *µg/l*	**Chromium** *µg/l*	**Cobalt** *µg/l*	**Copper** *µg/l*	**Flouride** *µg/l*	**Iron** *µg/l*
Possible Criteria Values:		**5000**	**100**	**100**	**700**	**10**	**100**	**50**	**200**	**1000**	**1000**
	Feb 13		<1			<0.1			6.3	30	
	Mar 13		<1			<0.1			2.8	30	
Yakima River 10 miles south of Ellensburg	1988-1989										
	Oct 12					0.2			1.3	100	
	Nov 09					0.3			0.5	60	
	Dec 14					0.3			1.0	40	
	Jan 11					0.1			1.4	60	
	Jan 31					2.1			1.6	50	
	Feb 15					<0.1			<0.5	70	
	Mar 15					0.5			1.9	70	
	Apr 06		<1			<0.2			1.3	50	
	Apr 12		<1			<0.2			1.6	50	
	May 10		<1			0.1			1.4	0.04	
	Jun 14					<0.1			0.7	0.05	
	Jul 12		<1			<0.1			<0.5	40	
	Aug 10		<1			0.1			2.2	50	
	Sep 13		<1			<0.1			0.8	100	
	1989-1990										
	Oct 12					0.2			20	100	
	Oct 22										
	Nov15		<1			0.2			7.0	60	
	Dec 05	20	<1	<0.5	10	0.2	0.6	<3	4.6	40	53
	Dec 05					<1.0	<5		<10		
	Dec 13					<0.1			4.1	60	
	Jan 10					<0.1			2.5	40	
	Feb 14		<1			0.1			3.7	50	
	Mar 14					<0.1			0.7	60	
Yakima River at Kiona	1988-1989										
	Oct 20					<0.1			1.2	20	
	Nov 17	<10	4	<0.5		0.6	<1	<3	1.0	20	32
	Nov 17					1.0			1.2		
	Dec 21					0.2			1.5	100	
	Jan 19					<0.1			5.5	200	
	Feb 23					<0.1			0.6	100	
	Mar 23	20	1	<0.5		<0.1	<1	<3	<0.5	200	34
	Mar 23					<1.0			<2.0		
	Apr 09		1			<0.2			1.1	80	
	Apr 20		1			<0.1			2.9	80	
	May 18	10	2	<0.5		<0.1	<1	<3	0.6	100	37
	May 18		1			<1.0			1.0		
	Jun 22		1			<0.1				200	
	Jul 20	<10	2	<0.5		<0.1	<1	<3	1.4	200	16
	Jul 20		2			<1.0			1.1		
	Aug 17		2			<0.1				200	
	Sep 21					<0.1			0.8	200	
	Sep 21		2								
	1989-1990										
	Oct 26		2			<0.1			<0.5	200	
	Nov 21	<10	1	<0.5		<0.1	1	<3	<0.5	200	16
	Nov 21					<1.0			<1.0		
	Dec 06	<10	1	<0.5	20	<0.1	0.5	<3	0.9	100	13
	Dec 06					<1.0	<5		<10		
	Dec 06		<1			<0.1			0.9	100	
	Dec 07		<1			<0.1			1.1	90	
	Dec 21		2			<0.1			0.9	100	
	Jan 18		<1			<0.1			<0.5	100	
	Feb 22		1			<0.1			0.6	100	
	Mar 22	10	<1	<0.5		<0.1	<1	<3	0.6	<100	22
	Mar 22		1						<10		
	Apr 22		1			<0.1			0.6	70	

		Aluminum	Arsenic	Beryllium	Boron	Cadmium	Chromium	Cobalt	Copper	Flouride	Iron
Possible Criteria Values:		**5000 µg/l**	**100 µg/l**	**100 µg/l**	**700 µg/l**	**10 µg/l**	**100 µg/l**	**50 µg/l**	**200 µg/l**	**1000 µg/l**	**1000 µg/l**
	May 10	<10	1	<0.5		<0.1	<1	<3	0.6	200	29
	May 10					<1.0			1.0		
	Jun 30		1			<0.1			17	300	
	Jul 18	<10	2	<0.5		<0.1	<1	<3	1.9	200	12
	Jul 18					1.0			2		
	Aug 27		2			<0.1			5	200	
	Sep 06		2			<0.1			13	<100	
Sulphur Creek Wasteway @ Sunnyside	1988-1989										
	Oct 18					<0.1			1.9	200	
	Nov 14					<0.1			1.5	400	
	Dec 19					<0.1			0.7	400	
	Dec 30					<0.1			1.3	400	
	Jan 17					<0.1			1.4	400	
	Feb 21					<0.1			1.2	400	
	Feb 24					<0.1			1.5	400	
	Mar 21					0.3			1.6	200	
	Apr 18		2			<0.2			<0.5	100	
	May 16		2			<0.1			0.6	100	
	Jun 20		2			<0.1			1.1	200	
	Jul 12		3			<0.1			1.1	200	
	Aug 15		2			<0.1			1.0	200	
	Sep 18		2			<0.1			1.3	200	
	1989-1990										
	Oct 23										
	Oct 24		7			<0.1			0.8	400	
	Nov 20		7			<0.1			0.8	500	
	Dec 19		8			<0.1			0.9	500	
	Jan 16		8			<0.1			0.7	500	
	Feb 20		2			<0.1			0.7	500	
	Mar 20					<0.1			0.7	100	

		Lead µg/l	Lithium µg/l	Manganese µg/l	Mercury µg/l	Molyb-denum µg/l	Nickel mg/l	Nitrate + Nitrogen mg/l N	Nitrite mg/l	pH	Vanadium µg/l	Zinc µg/l
Possible Criteria Values:		**100L**	**2500**	**200**	**10**	**10**	**200**	**100,000**	**10,000 L**	**6.5-9.0**	**100**	**2000**
Location	Date of Sample	Lead	Lithium	Manganese	Mercury	Molyb-denum	Nickel	Nitrate + Nitrogen	Nitrite	pH	Vanadium	Zinc
Yakima River at Cle Elum	1988 - 1989											
	Oct 11	<0.5 diss			<0.1 diss			10		7.8		
	Nov 08	<0.5			<0.1			40		7.6		
	Dec 13	<0.5			0.2			60		7.3		
	Jan 12	<0.5			<0.1			20		7.1		
	Jan 13	<0.5			<0.1			230		7.8		
	Feb 14	<0.5			<0.1			50		7.6		
	Mar 14	<0.5			<0.1			140		7.2		
	Apr 06	<0.5			<0.1			40		7.7		
	Apr 11	<0.5			<0.1			50		8.0		
	May09	<0.5			<0.1			20		7.6		
	Jun 13	<0.5			<0.1			20		7.8		
	Jun 29							40		7.7		
	Jul 11	<0.5			<0.1			30		7.8		
	Aug 09	<0.5			<0.1			80		7.2		
	Sep 12	<0.5			<0.1			10		8.0		
	1989-1990											
	Oct 11	0.7			<0.1			10				

	Nov 14	<0.5			<0.1			70		6.8		
	Dec 12	<0.5			<0.1			40		6.3		

		Lead µg/l	Lithium µg/l	Manganese µg/l	Mercury µg/l	Molyb-denum µg/l	Nickel µg/l	Nitrate + Nitrogen mg/l N	Nitrite mg/l	pH	Vanadium µg/l	Zinc µg/l
Possible Criteria Values:		**100L**	**2500**	**200**	**10**	**10**	**200**	**100,000**	**10,000 L**	**6.5-9.0**	**100**	**2000**
	Jan 09	<0.5			<0.1			170		7.1		
	Jan 10	<0.5	<4	7	<0.1	<10	6 tr	80		7.2		
	Jan 10	<10								7.2	<6	8
	Feb 13	<0.5			<0.1			70		6.6		
	Mar 13	<0.5			<0.1			10		7.8		
	Sep 17											
Yakima River 10 miles south of Ellensburg	1988-1989											
	Oct 12	<0.5			<0.1			400		8.4		
	Nov 09	<0.5			<0.1			200		7.4		
	Dec 14	<0.5			<0.1			130		8.2		
	Jan 11	<0.5			0.2			230		8.2		
	Jan 31	<0.5			<0.1			180		7.8		
	Feb 15	<0.5			<0.1			200		7.5		
	Mar 15	<0.5			<0.1			270		8.2		
	Apr 06	<0.5			0.6			40		7.6		
	Apr 12	<0.5			<0.1			80		8.0		
	May10	<0.5			<0.1			230		7.6		
	Jun 14	<0.5			<0.1			210		7.8		
	Jun 28							460		8.1		
	Jun 28											
	Jul 12	<0.5			<0.1			160		7.8		
	Aug 10	<0.5			<0.1			150		7.4		
	Sep 13	1.8			<0.1			222		8.5		
	1989-1990											
	Oct 12	<0.5			<0.1			320		7.9		
	Oct 22							350		7.7		
	Nov15	<0.5			<0.1			180		7.4		
	Dec 05	<0.5	<4	6	<0.1	<10	<10	111		6.9	<6	<3
	Dec 05	<10								6.9		
	Dec 13	<0.5			<0.1			200		7.7		
	Jan 10	<0.5			<0.1			230		7.3		
	Feb 14	<0.5			<0.1			180		7.1		
	Mar 14	<0.5			<0.1			100		7.6		
Yakima River at Kiona	1988-1989											
	Oct 20	<0.5			<0.1			1300		8.3		
	Nov 17	<0.5	<4	10	<0.1	<10	1	1200	20	8.2	10	11
	Nov 17	<5.0								8.2		
	Nov 17											
	Dec 21	<0.5			<0.1			1100		8.3		
	Jan 19	0.6			<0.1			1000	10	8.2		
	Jan 19									8.2		
	Feb 23	0.5			<0.1			1100		8.7		
	Mar 08									8.4		
	Mar 23	<0.5	<4	10	<0.1	<10	2	750	20	8.2	<6	<3
	Mar 23	<5.0								8.2		
	Apr 09	<0.5			<0.1			350		8.1		
	Apr 20	<0.5			<0.1			360		8.2		
	May18	<0.5	<4	11	<0.1	<10	<1	570	<10	8.2	7	<3
	May18	<1.0								8.2		
	Jun 22	<0.5			<0.1			1100		8.7		
	Jun 26							1100		8.6		
	Jul 20	<0.5	<4	2	<0.1	<10	1	1200	20	8.2	9	<3
	Jul 20	<0.1								8.2		
	Aug 17	<0.5			<0.1			1100		8.9		

	Sep 21							1200	20	8.2		
	Sep 21	0.7			<0.1					8.2		
	1989-1990											
	Oct 26	<0.5			<0.1			1500		8.5		
	Nov 21	<0.5	<4	12	<0.1	<10	<1	1200	30	8.1	<6	<3

		Lead *µg/l*	Lithium *µg/l*	Manganese *µg/l*	Mercury *µg/l*	Molyb-denum *µg/l*	Nickel *µg/l*	Nitrate + Nitrogen *mg/l N*	Nitrite *mg/l*	pH	Vanadium *µg/l*	Zinc *µg/l*
Possible Criteria Values:		**100L**	**2500**	**200**	**10**	**10**	**200**	**100,000**	**10,000 L**	**6.5-9.0**	**100**	**2000**
	Nov 21	<1.0								8.1		
	Dec 06	<0.5	<4	2	<0.1	<10	<10	1200		8.0	<6	<3
	Dec 06	<10								8.0		
	Dec 06	<0.5			<0.1			760		8.0		
	Dec 07	<0.5			<0.1			620		7.9		
	Dec 21	<0.5			<0.1			1100		8.3		
	Jan 18	<0.5			<0.1			750	<10	8.0		
	Feb 22	<0.5			<0.1			760		8.1		
	Mar 22	<0.5	<4	11	0.2	<10	<10	5000	<10	8.1	<6	5
	Mar 22	<10								8.1		
	Apr 22	<0.5			<0.1			520		8.1		
	May10	<0.5	<4	8	<0.1	<10	1	500	<10	8.0	<6	<3
	May10	<1.0								8.0		
	Jun 30	<0.5			<0.1			700	<10	8.5		
	Jul 18	<0.5	6	4	<0.1	<10	1	900	20	8.4	9	<3
	Jul 18	1.0								8.4		
	Aug 27	<1.0			<0.1			1000	10	8.4		
	Sep 06	<1.0			<0.1			1000	10	8.3		
Sulphur Creek Wasteway @ Sunnyside	1988-1989											
	Oct 18	<0.5			<0.1			2700		8.4		
	Nov 14	<0.5			<0.1			5900		8.5		
	Nov 17											
	Dec 19	<0.5			<0.1			6500		8.6		
	Dec 30	<0.5			<0.1			6200		8.4		
	Jan 17	<0.5			<0.1			6500		8.4		
	Feb 21	<0.5			<0.1			6500		8.5		
	Feb 24	<0.5			<0.1			6100		8.6		
	Mar 08									8.4		
	Mar 21	1.0			<0.1			2000		8.4		
	Apr 18	<0.5			<0.1			1300		8.3		
	May16	<0.5			<0.1			980		8.3		
	Jun 20	<0.5			<0.1			1600		8.2		
	Jun 26							1800		8.1		
	Jul 12	<0.5			<0.1			2300		8.5		
	Aug 15	<0.5			<0.1			1500		8.3		
	Sep 18	<0.5			<0.1			1500		8.4		
	1989-1990											
	Oct 23							4900		8.0		
	Oct 24	0.9			<0.1			5200		8.5		
	Nov 20	<0.5			<0.1			6000		8.5		
	Dec 19	<0.5			<0.1			6500		8.4		
	Jan 16	<0.5			<0.1			6400		8.1		
	Feb 20	<0.5			<0.1			6700		8.3		
	Mar 20	<0.5			<0.1			1200		8.2		

Ambient Water Quality Data for the Yakima River and Drains

90th percentile values from 1974-1981:

	Ecw *µS/cm*	Sodium mg/l	Chloride mg/l	TSS mg/l	*Calcium mg/l	*Magnesium mg/l	Turbidity ntu
Possible Criteria Values:	***700***	***69***	***106.5***	***75***	***None***	***None***	***None***
Cle Elum RM. 183.1 and 191.1	87	4.2	4.6	16	8.2	1.4	8
Thorp Hwy RM 165.4		3.4	2.7		7.6	2.5	
Ellensburg RM. 148.0	114			20			13
Umtanum RM. 140.4	155			32			14

Terrace Heights 113.2	156	8	3.3	32	11	3.4	16
Toppenish RM. 93.0		10	4.4		12	4.4	
Granger RM. 82.7	318			60			16
Mabton RM. 59.8	323	18	6.7	59	22	7.7	17
Kiona RM. 29.9	350	20	7.8	113	21	7.7	22
	Ecw ***µS/cm***	**Sodium mg/l**	**Chloride mg/l**	**TSS mg/l**	***Calcium mg/l**	***Magnesium mg/l**	**Turbidity ntu**
Possible Criteria Values:	***700***	***69***	***106.5***	***75***	***None***	***None***	***None***
Wilson Cr. Drain	248			38			12
Sulpur Cr. Drain	712			285			54

*Calcium and Magnesium values are show to allow computation of Sodium Adsorption Ratio by interested Reviewers

Ambient Water Quality Data for the Pasco Basin

Surface water samples from the eastern part of Pasco Basin, Washington Data from April, June, and September 1988

	Ecw ***µS/cm***	**Chloride mg/l**	**pH**
Possible Criteria Values:	***700***	***106.5***	***6.4-9.0***
KID Canal near Chandler	258	5.4	8.55
	380	5.9	8.45
	282	5.7	8.22
KID Canal near Kiona	243	5.4	8.69
	275	5.8	8.96
	275	5.7	8.17
KID Canal near Kennewick	235	5.2	8.79
	275	5.8	9.20
	272	5.7	8.24
KID Div 4 Canal - Amon and Hover Rds	225	5.3	9.03
	252	7.7	9.22
	268	5.6	9.04
KID Division 4 Canal - mouth	228	5.3	8.92
	252	5.8	8.69
	282	6.4	8.89
KID Badger E. Lateral - Richlnd	234	5.2	9.13
	265	5.8	8.58
	285	5.7	8.64
KID Badger E. Lateral -end	225	5.1	9.52
	255	5.7	8.83
	268	5.6	9.23
Amon Wstwy below KID pump	236	5.1	8.33
	270	5.8	8.52
	269	5.9	8.29
Amon Wstwy Trib - Meadow Springs	720	39	8.15
	682	34	8.31
	675	31	8.24
Amon Wstwy Trib nr mouth - Richlnd	320	10	8.28
	380	12	9.10
	359	9.7	8.50
KID Highlift Canal near Kennewick	218	5.0	8.68
	269	5.9	8.95
	277	6.0	8.92
Zintel Canyon Wstwy mouth	328	9.7	8.25
	372	9.9	8.43
	410	11	8.62
CID Canal at Horn Rapids Dam	240	5.5	8.40
	289	6.4	9.20
	288	6.1	8.92
CID Canal at Grant St Bridge	225	5.2	8.30
	278	6.4	9.55
	285	6.2	8.46
CID #2 Canal - Wstwy near Finley	228	4.9	8.28
	283	6.5	9.27
	290	6.1	8.86
CID # 2 Canal at end	220	4.9	8.69
	268	6.1	9.30
	289	6.3	8.81
CID #3 Canal at Nine Canyon Rd	250	7.2	8.13
	323	9.2	8.83

	343	9.6	8.16
CID #3 Canal at end	288	9.0	8.21
	341	9.7	8.64
	347	11	7.95
CID #3 Canal Trib below Eliot	940	46	8.15

	Ecw $\mu S/cm$	Chloride mg/l	pH
Possible Criteria Values:	***700***	***106.5***	***6.4-9.0***
	872	48	8.36
	875	50	8.27
McWhorter Canal near W. Richlnd	250	6.9	9.13
	271	6.3	9.16
	970	51	8.40
	292	6.3	8.88
Yakima Rvr Trib at I182 bridge	1000	52	8.69
	1000	53	8.20
SCBID IL 85JJ at head	135	0.90	8.22
	159	1.1	8.58
	139	0.90	8.46
Esquatzel Coulee at Connell	190	1.5	9.34
	176	1.5	9.19
Esquatzel Coulee at Mesa	386	13	8.29
	289	8.3	8.20
	265	6.5	8.21
Esquatzel Coulee at Eltopia	320	9.5	8.91
	347	8.0	8.47
Esquatzel Coulee at Diversion pump	639	22	8.56
	580	17	8.15
	635	23	8.10
SCBID Esquatzel Wstwy near end		15	8.47
	450	12	8.72
	508	14	8.28
SCBID Potholes E. Canal below Scooteney Res	373	9.9	8.99
	319	7.1	8.71
	340	7.2	8.66
SCBID Pasco Wstwy near Richlnd	328	10	8.85
	372	7.4	8.79
SCBID PE 27L Lateral at Hendricks Rd	352	9.9	8.63
	315	7.4	9.14
	332	7.6	8.87
SCBID PE 41.2 Lateral below siphon	369	9.8	8.96
	319	7.0	9.10
	342	7.4	8.86
SCBID PE41.2 lateral at end	469	16	8.77
	490	15	8.92
	551	16	8.72
SCBID PE 41.2D lateral at end	352	11	8.62
	309	8.4	9.01
	341	9.0	8.83
Eltopia Branch Canal at Ironwood Rd	368	9.9	8.75
	320	7.1	9.18
	340	7.8	8.99
SCBID Eltopia Branch Canal above falls	373	10	9.02
	333	7.9	9.21
	364	8.3	8.92
SCBID PE 54.9 Lateral at Birch Rd	360	8.3	8.77
SCBID PE 54.9 Lateral at farm unit 205	370	8.5	9.07
Pasco Pump Lateral Wstwy	330	10	8.54
	379	7.5	8.55
SCBID PE 16.4 Wstwy below Eagle Lakes	615	8.6	8.68
	540	25	8.63
	560	19	8.92
SCBID PE 16.4 Wstwy at Hwy 170	601	16	8.73
	555	24	8.45
	560	19	8.78
SCBID PE 16.4 Wstwy near Rickert	495	16	8.59
	450	15	8.54
	560	12	8.70
SCBID Wahluke Br Canal below siphon	382	10	8.57

	320	7.9	8.44
	339	7.8	9.00
SCBID Wahluke Br Canal at Franklin Co.	317	9.4	8.46
	338	7.5	8.46
SCBID WB 5 Wstwy at drop 14 near Ringold	512	15	8.95
	455	11	8.80
	515	13	8.49
	Ecw *μS/cm*	**Chloride mg/l**	**pH**
Possible Criteria Values:	***700***	***106.5***	***6.4-9.0***
SCBID WB 10 Wstwy near mouth	788	38	9.07
	815	39	8.86
	590	18	8.57
FCID Wstwy at Pasco	173	1.9	8.76
	138	1.3	8.64
	151	1.0	8.62
Ringold Springs South	708	25	8.73
	625	20	9.65
	660	19	8.92
Baxter Canyon Springs near Richlnd	799	35	8.55
	752	30	8.49
	845	41	7.97