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CORE COMPONENT 1: PROPOSED APPROACH FOR DEVELOPING NUMERIC CRITERIA FOR GREAT SALT LAKE

A GREAT SALT LAKE WATER QUALITY STRATEGY


Photo courtesy of Charles Uibel—greatsaltlakephotos.com

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Utah Division of Water Quality

A water quality strategy to ensure Great Salt Lake continues to provide its important recreational, ecological, and economic benefits for current and future generations.

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ACRONYMS AND ABBREVIATIONS

CFR	*Code of Federal Regulations*
CWA	Clean Water Act
EPA	United States Environmental Protection Agency
TMDL	Total Maximum Daily Load
UAC	Utah Administrative Code
UDWQ	Utah Division of Water Quality
UPDES	Utah Pollution Discharge Elimination System
UPRR	Union Pacific Railroad
WET	Whole-effluent Attainability Analysis

CORE COMPONENT 1: PROPOSED APPROACH FOR DEVELOPING NUMERIC CRITERIA FOR GREAT SALT LAKE

UTAH DIVISION OF WATER QUALITY

I. INTRODUCTION

This component of the Great Salt Lake Strategy documents proposes a process for establishing numeric water quality criteria for Great Salt Lake pollutants. Numeric criteria are a cornerstone of the Utah Division of Water Quality's (UDWQ's) programs to protect water quality.

This component explains proposed processes in the following sections:

- ☐ Describes the need for numeric criteria for Great Salt Lake
- ☐ Provides important site-specific context for Great Salt Lake criteria, particularly with regard to linkages between Great Salt Lake's beneficial uses and salinity
- ☐ Describes the proposed process for deriving numeric criteria including resource prioritization

Water Quality Standards versus Water Quality Criteria

The terms "standards" and "criteria" are used interchangeably but technically are not synonymous. Criteria (both numeric and narrative) identify the water quality necessary to protect the beneficial uses. Water quality standards, on the other hand, are all the provisions that provide water quality protection. In addition to criteria, standards also include beneficial uses and antidegradation.

- ☐ Describes how numeric criteria or indicators might be used to inform UDWQ programs, including monitoring, assessment, discharge permits (Utah Pollution Discharge Elimination System [UPDES]), and antidegradation provisions that minimize, wherever practicable, water quality degradation
- ☐ Provides near-term actions for stakeholder participation and a preliminary schedule to derive numeric criteria

II. NEED FOR NUMERIC CRITERIA FOR GREAT SALT LAKE

Efficient and effective management of Great Salt Lake resources requires an understanding of the water quality that must be maintained to ensure long-term protection of the lake's beneficial uses. UDWQ has the regulatory mandate to protect water quality for current and future generations. To meet this regulatory responsibility, UDWQ implements several interrelated programs: sets water quality goals (standards), monitors and assesses attainment of water quality goals, and issues UDPES permits for discharges affecting the lake. Currently, there are few clearly defined water quality benchmarks (i.e.., numeric criteria) for Great Salt Lake that can be used to interpret the potential impacts of existing or proposed pollutant inputs to the lake. This lack of clearly defined water quality protections for Great Salt Lake potentially leads to regulatory decisions that are either over- or underprotective of the lake's important uses. Overprotective water quality regulations are needlessly costly for industry and municipalities. Underprotective regulations are potentially illegal and would be detrimental to the lake's ecosystem, which supports millions of birds, not to mention a multimillion-dollar brine shrimp industry. Clearly, a strategy is needed to fill key knowledge gaps to generate appropriate water quality protections for Great Salt Lake in the most efficient and scientifically defensible way possible.

UDWQ's Objective for Developing Numeric Criteria for the Great Salt Lake

Set clearly defined and defensible pollutant concentrations—numeric criteria—that are needed to ensure that Great Salt Lake continues to provide its important ecological and economic benefits for current and future generations.

How can we improve existing water quality protections for Great Salt Lake?

Under both state law (Utah Administrative Code [UAC] R317) and federal Clean Water Act (CWA) authority, UDWQ is entrusted with the responsibility to restore and maintain the chemical, physical, and biological integrity of Utah's lakes, rivers, and wetlands. Water quality goals specified in Section 101(a) of CWA establishes three minimum requirements for state water quality standards programs: (1) water quality that supports propagation of fish, shellfish, and wildlife; (2) water quality that supports recreation in and on the water; and (3) no discharges of toxics in toxic amounts.

The first CWA requirement to meet these goals is the designation of beneficial uses. Simply put, beneficial uses are descriptions of how a water body will be used by humans and other organisms, or in other words what the water quality is intended to support. The current beneficial uses assigned to Great Salt Lake (UAC R317-2-6.5) include primary and secondary contact recreation (e.g., water quality sufficient to swim at Antelope Island or wade while duck hunting at one of the Wildlife Management Areas) and wildlife protection (a quality sufficient for waterfowl, shorebirds, and other water-oriented wildlife including their necessary food chain).

The second CWA requirement is to establish and enforce water quality criteria. In this context, criteria are simply descriptions of specific water quality objectives that must be met to ensure protection of beneficial uses. Utah uses both narrative and numeric water quality criteria. Narrative criteria are descriptions of conditions that should be avoided (i.e., undesirable odors) or unacceptable activities (i.e., dumping trash or debris). Numeric criteria describe concentrations—and associated averaging periods—of pollutants that should not be exceeded to support specific beneficial uses.

Most surface waters in Utah have numerous numeric criteria to protect several beneficial uses (e.g., aquatic life, recreation, agriculture). Criteria for each pollutant are established by UDWQ based on a review of recommendations from the United States Environmental Protection Agency (EPA). These EPA recommendations are based on a resource intensive process that includes a systematic compilation and analysis of numerous toxicological studies that evaluate the effects of each pollutant on many aquatic organisms—including fish, insects, algae and plants—in several life stages. By leveraging these intensive national investigations, UDWQ has established numeric criteria for several hundred pollutants that together ensure long-term protections for Utah's lakes and streams. Yet, for several reasons discussed here, Great Salt Lake has only a single numeric criterion that describes the maximum selenium concentration in bird eggs necessary to protect the lake's aquatic wildlife beneficial uses. Like all waters, hundreds of pollutants are present within Great Salt Lake, yet with the exception of selenium, insufficient information exists to precisely determine how much is too much.

The lack of numeric criteria does not mean that Great Salt Lake is entirely without water quality protections. All discharges to Great Salt Lake are required to have a UPDES permit. All tributaries to the lake have assigned beneficial uses and associated numeric criteria. Discharges to these tributaries must meet these criteria at the discharge location as well as any downstream criteria. The UPDES permits also require the permittees to conduct periodic whole-effluent toxicity (WET)[1] tests to ensure that the discharges aren't toxic. For direct discharges to the lake or indirect discharges via the tributaries, the beneficial uses of Great Salt Lake are protected with WET testing and Utah's Narrative Standards that apply to all surface waters of the state. This Narrative Standard (UAC R317-2-7.2) states:

> *It shall be unlawful, and a violation of these regulations, for any person to discharge or place any waste or other substance in such a way as will be or may become offensive such as unnatural deposits, floating debris, oil, scum or other nuisances such as color, odor or taste; or cause conditions which produce undesirable aquatic life or which produce objectionable tastes in edible aquatic organisms; or result in concentrations or combinations of substances which produce undesirable physiological responses in desirable resident fish, or other desirable aquatic life, or undesirable human health effects, as determined by bioassay or other tests performed in accordance with standard procedures.*

Narrative standards are inherently subjective but are an important water quality tool because they prohibit undesirable conditions that are sometimes difficult to detect with routine water quality data. For instance, most would agree that it should be unlawful for an individual to dump tires into a lake or stream, but the deleterious effects of this action would be difficult to capture with routine water quality samples. However, the narrative standards are much more difficult to interpret when applied to a water body such as Great Salt Lake that is constantly changing, and the potential effects of pollutants are poorly understood. These uncertainties have resulted in conflicting interpretations regarding whether the lake water quality complies with the Narrative Standard or would continue to comply following proposed municipal or industrial developments. These conflicting interpretations, combined with an additional potential for subjectivity due to scientific uncertainty about the lake's ecological processes, make it more difficult for the regulated community to understand, plan for, and ultimately comply with the Utah Water Quality Act and CWA regulations. Similarly existing regulations are more difficult for UDWQ to fairly enforce.

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[1] WET tests are conducted by exposing standard test organisms to the effluent and determining if toxic effects (e.g., growth, survival, reproduction) are observed. See http://water.epa.gov/scitech/methods/cwa/wet/upload/2004_12_28_pubs_wet_draft_guidance.pdf for more information.

The primary impediments to establishing numeric criteria to protect Great Salt Lake's beneficial uses are the lake's unique biology, chemistry, and hydrology, which preclude the use of nationally derived numeric criteria. Great Salt Lake is a terminal lake, meaning there is no outflow. Water that leaves the system can only do so by evaporation, leaving most minerals and metals behind that continue to accumulate. In places, the lake is extremely salty, 3 to 7 times more than the ocean, and only specialized organisms can survive in these hypersaline (i.e., salinity higher than the ocean) conditions. Salinity also affects how a pollutant behaves in the environment and its toxicity to aquatic organisms. Moreover, these conditions vary extensively within the major bays of Great Salt Lake, so the effects of pollutants on beneficial uses likely vary from place to place. Defensible numeric criteria for Great Salt Lake must account for the lake's site-specific characteristics. However, this is not to say that numeric criteria are the optimal approach for every pollutant. A different approach is needed for some of the conventional[2] and unconventional[3] pollutants. For example, dissolved oxygen and pH have numeric criteria for most Utah waters. Although defined as pollutants in regulation, these parameters are responses to pollution. This distinction is highlighted in wetlands. Healthy, fully functioning wetlands typically undergo large swings in dissolved oxygen concentrations and pH that would be considered detrimental in other waters. Therefore, numeric dissolved oxygen and pH criteria alone are poor predictors of wetland health. Accordingly, Utah's water quality standards were recently revised so that a narrative standard for dissolved oxygen and pH applies to the Great Salt Lake impounded wetlands. Another example of effective alternatives to numeric criteria is biological assessment programs that interpret the Narrative Standard with objective and quantitative measures of biological health. UDWQ believes that a holistic approach to Great Salt Lake will result in more reliable and precise water quality protections.

Numeric Criteria

In this strategy, numeric criteria refer to criteria derived using a process similar to *Guidelines for Deriving Numerical National Water Quality Criteria for Protection of Aquatic Organisms and Their Uses* (EPA, 1985). This process evaluates species-specific sensitivity to individual pollutants. Although the alternative methods to numeric criteria discussed (e.g., biological assessments) are likely to have numeric thresholds, the thresholds are derived from an evaluation of multiple stressors (e.g., pollutants, habitat, etc.) and multiple responses (e.g., pH, shift in community structure, etc.).

[2] Pollutants typical of municipal sewage, and for which municipal secondary treatment plants are typically designed; defined by Federal Regulation (40 *Code of Federal Regulations* [CFR] 401.16) as biological oxygen demand, total suspended solids , fecal coliform bacteria, oil and grease, and pH.

[3] All pollutants not included in the list of conventional or toxic pollutants in 40 CFR Part 401. Includes pollutants such as chemical oxygen demand, total organic carbon, nitrogen, and phosphorus.

Adverse impacts to water quality from pollutants can be the result of multiple influences and interactions, and, therefore, individual numeric criteria for these pollutants could be unreliable. For instance, adverse effects to water quality from nutrients such as nitrogen and phosphorus are the result of many complex interactions and are dependent on site-specific conditions. Nutrients are essential for the healthy function of an ecosystem, but too many nutrient inputs result in adverse effects from excessive algal and microbial growth. However, the magnitude of these undesirable responses differs from place to place, which makes it difficult to generalize precisely where to establish regional numeric criteria for nutrients.

Like all environments, nutrients are essential to the ecosystem of Great Salt Lake. Algae, which are the source of food for the brine shrimp and flies, need nutrients for growth. Future development of nutrient criteria for Great Salt Lake will need to evaluate what is necessary to protect the lake's beneficial uses (recreation and wildlife) with an understanding of how these levels affect other competing uses of the lake (e.g., brine shrimp harvests). UDWQ has started work on developing an approach to better determine if nutrients are adversely affecting beneficial uses statewide because these issues are not unique to Great Salt Lake. Since approaches to derive numeric nutrient criteria (e.g., field data, stressor-response models, mechanistic models) typically differ from approaches used for toxic pollutants (e.g., laboratory data, species sensitivity distributions), these efforts are not detailed in this version of the Great Salt Lake Strategy, but they will be incorporated in future versions as nutrient-specific approaches are developed. Instead, this component focuses on the development of numeric criteria for potentially toxic pollutants.

How can we efficiently address these shortcomings?

Over the last decade, UDWQ has been conducting extensive research to improve our understanding of water quality within Great Salt Lake. Knowledge and experience gained through these investigations have provided the underpinning for the approaches described in this document. For instance, a couple of years ago UDWQ concluded several years of investigations aimed at generating a numeric selenium criterion for Great Salt Lake. This research was time consuming and expensive, costing over $2.5 million. To repeat this process with the dozens of potentially toxic compounds within Great Salt Lake would require decades, not to mention an incredible amount of resources that simply does not exist. Fortunately, among the many lessons learned from the selenium research was that, while existing research rarely directly applies to Great Salt Lake, much of it can be modified and adapted to provide a starting point for developing numeric water quality criteria for Great Salt Lake. These experiences also highlight the critical importance of understanding whether research conducted elsewhere applies to the unique biological, chemical, and physical conditions found within Great Salt Lake.

What would be accomplished by developing numeric criteria?

Beneficial uses, numeric and narrative criteria, and antidegradation comprise standards that are the foundation of all UDWQ programs to protect Utah's water quality. Of these, only numeric criteria are lacking for Great Salt Lake. Developing numeric criteria for Great Salt Lake would not only help enhance water quality protection for the ecosystem but would also provide economic support for industries that depend on the lake. From design to implementation, dischargers would know, with certainty, what level of loadings is expected, which is critical for long-term business planning. UDWQ is committed to protecting this ecologically and economically unique ecosystem. Our goal, shared by most of the recreational, industrial, and commercial users, is that water quality remains sufficient to protect and maintain the chemical, physical, and biological integrity of Great Salt Lake and its surrounding wetlands.

To meet water quality goals for Great Salt Lake, UDWQ intends to develop numeric water quality criteria where appropriate and associated assessment methods for Great Salt Lake. The development of numeric water quality criteria is intended to improve the precision and clarity of our management decisions, reduce uncertainty for those we regulate, and improve our confidence that the lake's water quality remains sufficient to support its important beneficial uses.

III. PROVIDING SITE-SPECIFIC CONTEXT TO GREAT SALT LAKE CRITERIA

Great Salt Lake is a unique ecosystem, and water quality regulations must account for these unique characteristics. In particular, consideration must be given to the lake's beneficial uses that are the attributes protected by numeric and narrative criteria and salinity, which is a critical modifier for many of the lake's uses.

Great Salt Lake Beneficial Uses

As mentioned previously, the beneficial uses assigned to Great Salt Lake are primary and secondary contact recreation and aquatic wildlife uses, specifically the protection of waterfowl, shorebirds, and other water-oriented wildlife including their necessary food chain. The development of appropriate numeric water quality criteria for Great Salt Lake requires a more nuanced understanding of these water quality uses, which includes identifying the specific organisms to be protected.

Recreational Uses

Great Salt Lake is protected for primary and secondary contact recreation, which includes activities such as swimming, wading, boating, and fishing. Appropriate numeric criteria associated with these recreational uses would define deleterious thresholds for water-borne pollutants or pathogens that have the potential to be harmful to human health. An example of parameters used to protect recreation uses are microbial pathogens, such as *Escherichia coli* and *Enterococci*. For Utah's rivers/streams and lakes/reservoirs, numeric criteria for *E. coli* bacteria have been established that define concentrations (cell counts) that are not to be exceeded during recreational periods. Elsewhere, particularly for marine and estuarine waters, *Enterococci* bacteria concentrations are used because these bacteria survive longer in saline water than *E. coli* and are better indicators of skin or gastrointestinal problems associated with degraded recreational uses. The utility of using *Enterococci* as a microbial pathogen indicator for waters saltier than marine waters is currently being investigated by UDWQ and the Davis County Health Department.

Aquatic Life Beneficial Uses

Waterfowl, shorebirds, and other water-oriented wildlife including the aquatic organisms in their necessary food chain are the protected aquatic life beneficial uses for Great Salt Lake. The national numeric criteria developed for aquatic life uses are based on biological, ecological, and toxicological data and are designed to protect aquatic organisms from adverse effects resulting from exposure to water pollutants. These criteria specify the magnitude (how much), duration (how long), and frequency (how often) of exposure to hundreds of potentially toxic compounds. The EPA has established national guidelines for both freshwater and saltwater numeric criteria for aquatic life uses because fresh water and salt water have different chemical compositions and because the species for which the criteria are derived rarely inhabit the same water simultaneously[4]. Over the past 40 years, UDWQ has used the EPA's freshwater guidelines as the basis for establishing numeric criteria for all of the state's freshwater lakes and rivers and for many of Utah's wetlands. These freshwater criteria may be appropriate to apply to Great Salt Lake estuaries, but consideration must be given to conditions created by the large, naturally occurring fluctuations in lake level. The EPA's saltwater aquatic life criteria guidelines are based on studies of marine and estuarine organisms and may or may not adequately reflect the tolerance limits of organisms that inhabit Great Salt Lake. Relevance of both freshwater and saltwater criteria to the Great Salt Lake organisms will be evaluated as part of this strategy. Consistent with federal guidance and regulations, numeric criteria for Great Salt Lake will

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[4] http://water.epa.gov/scitech/swguidance/standards/handbook/chapter03.cfm

be developed for key pollutants to ensure protection of sensitive life stages of several important taxonomic groups under varying levels of salinity.

For Great Salt Lake, a critical first step for defining the aquatic life beneficial use is identifying the specific organisms currently present and those that would be considered "existing uses,"[5] or those that occurred on or after November 28, 1975. This list will define the **specific** aquatic and aquatic-dependent species relevant for Great Salt Lake that must be protected. In addition, this list of species will help evaluate the extent to which national EPA guidelines are appropriate to Great Salt Lake and where modifications to existing guidelines are necessary.

Use Attainability Analysis (UAA)

A Use Attainability Analysis is a structured scientific assessment of the factors affecting the attainment of uses specified in Section 101(a)(2) of the CWA (the so-called fishable/swimmable uses). The factors to be considered in such an analysis include the physical, chemical, biological, and economic use removal criteria described in the EPA's water quality standards regulations (40 CFR 131.10(g)(1)-(6))

Use Attainability Analyses

As previously discussed, the CWA requires water quality goals that include the propagation of fish, shellfish, and wildlife and water quality that supports recreation in and on the water (i.e., the fishable/swimmable goal). The CWA also recognizes that these goals are not universally achievable. Utah has the authority to remove a designated beneficial use, if it is not an existing use, or establish subcategories of a use that have less stringent water quality requirements if a Use Attainability Analysis (UAA) demonstrates that the designated beneficial use is infeasible to achieve. The infeasibility of meeting the use must be attributable to at least one of the following factors:

1. Naturally occurring pollutant concentrations prevent the attainment of the use.
2. Natural, ephemeral, intermittent, or low- flow conditions or water levels prevent the attainment of the use, unless these conditions may be compensated for by the discharge of sufficient volume of effluent discharges without violating state water conservation requirements to enable uses to be met.
3. Human-caused conditions or sources of pollution prevent the attainment of the use and cannot be remedied or would cause more environmental damage to correct than to leave in place.

[5] http://www.rules.utah.gov/publicat/code/r317/r317-001.htm#T1

4. Hydrologic modifications preclude the attainment of the use, and it is not feasible to restore the water body to its original condition or to operate such modification in a way that would result in the attainment of the use.

5. Physical conditions related to the natural features of the water body, such as the lack of a proper substrate, cover, flow, depth, pools, riffles, and the like, unrelated to [chemical] water quality, preclude attainment of aquatic life protection uses.

6. Controls more stringent than those required by Sections 301(b)(I)(A) and (B) and 306 of the CWA would result in substantial and widespread economic and social impact.

The hydrology and habitat of Great Salt Lake are extensively modified by dikes and diversions. These modifications have altered the aquatic habitat, sometimes extensively. Gunnison Bay is an example of where a UAA may be applicable. Gunnison Bay was isolated from Gilbert Bay by the construction of the railroad causeway and has subsequently caused extremely high salt concentrations (near saturation) in Gunnison Bay. This higher salinity supports a different ecosystem than what is found in adjacent Gilbert Bay. Anecdotal reports suggest that the high salinity adversely affects water contact recreation within Gunnison Bay because of the irritant effects of the extremely high salt. However, the aquatic life (primarily algae and bacteria) supported by the high salinity waters of Gunnison Bay are existing uses and must be protected. UDWQ anticipates that Gunnison Bay will be a candidate for a UAA if it is determined that salinity restricts the aquatic life or recreation beneficial uses to a condition that would be considered less than the CWA fishable/swimmable goal.

Great Salt Lake's impounded wetlands or other hydraulically modified wetlands may also be candidates for UAAs. These wetlands provide valuable habitat and contribute to the support of the lake's beneficial uses, but they are not natural systems and may not be readily comparable to natural systems. The hydraulic modifications must be considered when determining achievable beneficial uses and associated criteria.

In addition to providing the rationale for not being able to achieve the default uses required by the CWA, the UAA process is intended to identify the best attainable conditions and may include interim goals. Currently, Utah's water quality standards do not have tiered aquatic life uses, which are needed to define best attainable uses and interim water quality goals[6]. UDWQ is engaged in research to develop tiered aquatic life uses statewide. Tiered aquatic life uses and UAAs will be important tools for establishing statewide water quality goals and critical for defining the appropriate beneficial uses to be protected for some habitats at Great Salt Lake.

[6] For example, see http://water.epa.gov/scitech/swguidance/standards/uses/upload/2002_06_13_standards_uses_symposium_abstracts_yoder.pdf or http://www.cdphe.state.co.us/op/wqcc/New/10-1.pdf

Ancillary Benefits for Commercial Brine Shrimp Uses

Protecting the beneficial uses assigned to Great Salt Lake will have the ancillary benefit of helping to ensure the long-term vitality of the commercial brine shrimp harvests in the lake that generates $56.7 million to Utah's economy (Bioeconomics, Inc., 2012). Commercial harvest of brine shrimp cysts is used by the aquaculture industry for feed for fish, shrimp, and other crustaceans, which are then used for human consumption. Commercial water quality and contaminant residue standards for aquaculture have been established by organizations such as the World Health Organization and the European Union. As part of this strategy, the standards for the commercial use of brine shrimp cyst for aquaculture will be compiled and examined to ensure that the standards derived to protect the beneficial uses are sufficiently protective of the existing Great Salt Lake commercial fishery.

Salinity

The waters of Great Salt Lake exhibit a continuum of salt concentrations up to saturation. The health of the Great Salt Lake ecosystem depends on these variations in salinity that fluctuates greatly from place to place and over time. Specific salt concentrations, at a specific place and time, control what specific organisms survive and reproduce and, therefore, which organisms should be protected. The response of lake biota to changing salinity can be abrupt, such as for mayflies[7] that generally are not tolerant of increases in salinity, or gradational, such as for many algae species that tolerate a wide range of salinities (Belovsky et al., 2011). Similarly, different organisms are expected to vary in their sensitivity to pollutants, which will require Great Salt Lake to be partitioned into classes based on specifically defined ranges in salinity.

While water salinity is an important determinant of the species present, other factors including sediment and physical habitat will also affect the specific organisms supported. For instance, fresh water may cross saline sediment in the transitional waters between 4,208 feet and the open waters (Use Class 5E), resulting in an ecosystem more representative of a saline ecosystem than a freshwater ecosystem. Substrate and plant community can also influence which species are supported. These additional influences must be considered when defining ecosystem communities based on salinities.

Several causeways have been constructed on the lake that affect circulation within the lake and the salinity found within the major bays of the lake. Bridge openings and culverts in the causeways allow for limited exchange flow between the bays. Differences in density and the water surface elevation between the bays results in bidirectional flow of a deep dense brine layer overlaid by a less dense clearer brine layer. Specifically, the denser brine layer flows in one direction while the less dense

[7] http://www.epa.gov/caddis/ssr_ion_wtl.html

layer flows in the opposite direction. Brine flowing to a bay of less salinity tends to resist mixing with the fresher water and remains in a fairly coherent "tongue," which can extend some distance into a fresher bay. This forms a stratified brine condition (a deep brine layer overlaid by a shallow brine layer) within the central, deeper portions of Gilbert, Bear River, and Farmington Bays (Gwynn, 1998). The deep brine layer is characterized by extremely high salinity and anoxic conditions, and thus few organisms can survive. The dense brine layer also affects the fate and transport of pollutants because this layer creates reducing (anoxic) conditions that alter the cycling of phosphorous, nitrogen, and metals. Mixing of the deep brine and shallow brine layers occurs during large frequent wind events.

For criteria development purposes, three ranges or classes of salinity will initially be evaluated: fresh water, marine, and hypersaline. Salinity has relatively little influence on the lake's birds but does affect the aquatic organisms that are their primary food source. To warrant protection at a given salinity, the aquatic organisms observed under these conditions should reproduce and thrive and not just survive. For instance, brine shrimp tolerate a wide range of salinity, but they successfully reproduce and thrive in a narrower range, and this narrower range would determine the appropriate salinity class.

Currently, no comprehensive list of organisms inhabiting Great Salt Lake has been compiled, and filling this data gap is a critical first step in criteria development. In addition, the life cycle of each organism found within Great Salt Lake will be summarized to help ascertain conditions where each species may be particularly sensitive to lake pollutants. For each species it will also be important to establish the specific salinity tolerances and saline conditions to which they are best adapted so that this information can be related back to specific conditions found within Great Salt Lake. Definitive salinity levels to support three classes of salinity have yet to be determined. Determining appropriate demarcation points for the proposed salinity classes is complex and will require consultation with wildlife officials, scientists, and other knowledgeable stakeholders. Conceptually, the three classes and associated preliminary salinity ranges are as follows:

Fresh water—Fresh water refers to salinities up to 0.05 percent based on the low salt concentrations where freshwater organisms thrive. Aquatic organisms in Great Salt Lake are expected to include freshwater fish, invertebrates, and algae similar to other fresh waters in the state.

Marine—Marine refers to salinities similar to the oceans (approximately 3.5 percent). Conceptually, marine waters (including estuaries) may range from 0.05 to 4.0 percent. However, the aquatic organisms in Great Salt Lake are very different from oceans and estuaries. The most obvious differences are the limited number of species and an absence of fish (to be verified) in Great Salt Lake waters with marine salinity.

Hypersaline—Hypersaline refers to salinities higher than the oceans. Conceptually, hypersaline may be salinities from 4.0 to 12.0 percent. Hypersaline aquatic organisms are dominated by algae, brine shrimp, and brine flies. Brine shrimp thrive and reproduce in this range (Belovsky and Larson, 2002). Less is known about the optimum salinity for the brine flies.

MAJOR SALINITY CHARACTERISTICS OF GREAT SALT LAKE

Each class of salinity previously described (freshwater, marine, and hypersaline) exists in different areas of the lake and can vary with time at a given location dependent on lake levels, freshwater inputs, and the causeways that divide the lake (Figure 1).

Gunnison Bay (also called the North Arm) is extremely saline when compared with other areas of the lake. This is due to the limited freshwater inputs to the bay coupled with limited salt exchange with the rest of the lake that resulted from the 1959 construction of the Union Pacific Railroad (UPPR) Causeway that separates this bay from Gilbert Bay (the South Arm). With limited freshwater inflows to Gunnison Bay, the average salinity is 27 percent. At this level, relatively few species can survive, and it supports mainly halophilic bacteria that give the bay its red hue.

Gilbert Bay (South Arm) is considered hypersaline with salinity levels ranging from 7 to 15 percent historically. The primary productivity is higher in this bay compared with Gunnison Bay due to lower salinities and supports an assemblage of algae and bacteria that are the food source for brine flies and brine shrimp. On average, the salinity of both Bear River and Farmington Bay is similar to the ocean, but there is also significant variation from place to place within these bays due to significant freshwater inputs. The majority of freshwater inflow to Great Salt Lake is from the Bear River to Bear River Bay. Bear River Bay has limited exchange flow with the rest of the lake due to the UPPR Causeway and is the freshest of the bays. Salinity within Bear River Bay varies from 1 to 6 percent depending on location within the bay and underlying lake level. Similarly, Farmington Bay has limited exchange flow with the rest of the lake due to the Antelope Island Causeway. Farmington Bay also has several significant freshwater inputs from the Jordan River, numerous smaller creeks, and treated wastewater. Salinity within Farmington Bay varies from 2 to 7 percent. The lower salt concentrations found within these bays support more invertebrate diversity than the Gunnison Bay and Gilbert Bay. During the spring runoff period, fish are carried out into Bear River and Farmington Bays from the freshwater wetlands and rivers and can potentially continue to thrive near these freshwater inputs, but little is understood about resident fish populations.

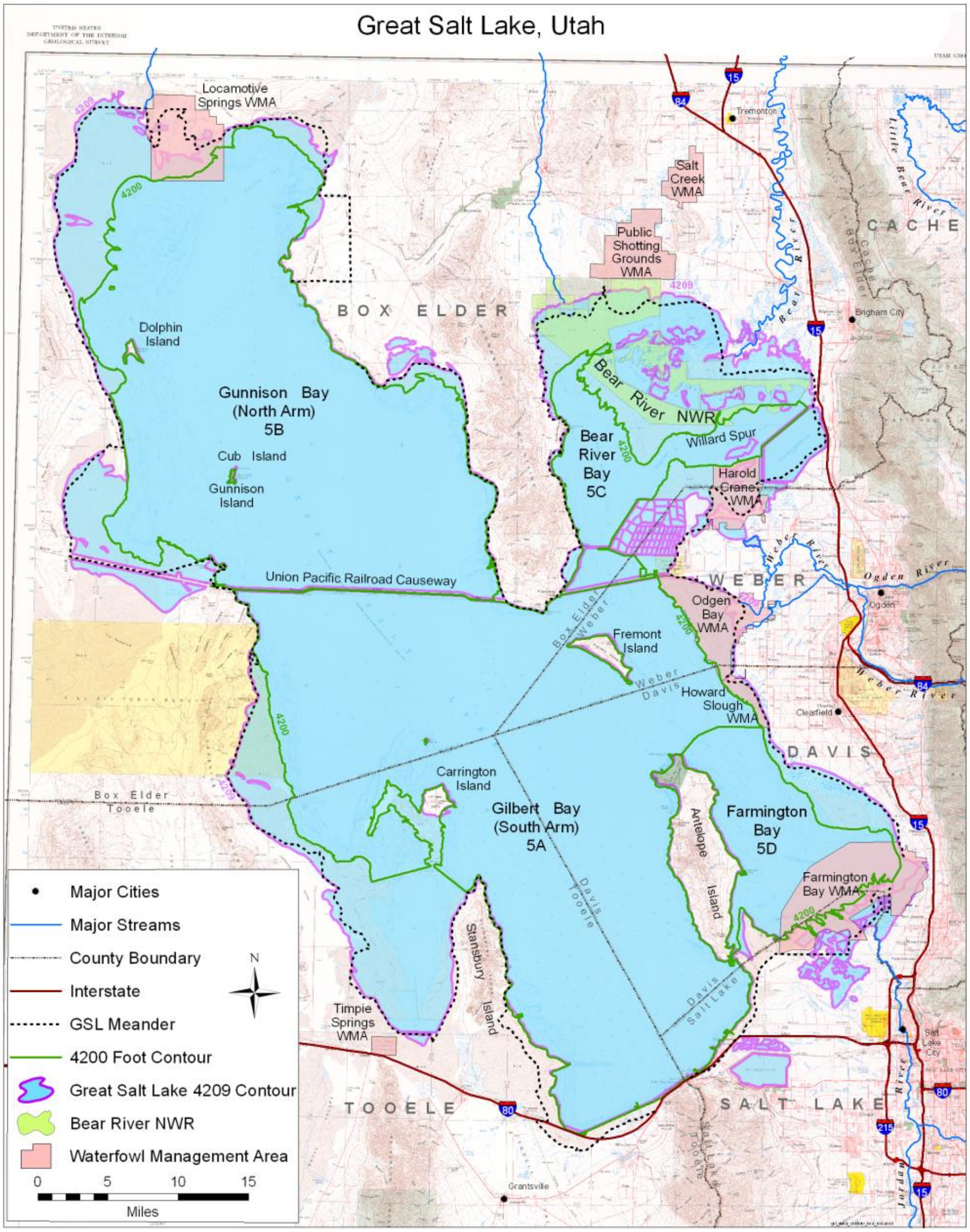


FIGURE 1. GREAT SALT LAKE, UTAH

Great Salt Lake is a saline terminal lake located in Northern Utah. The primary sources of water to the lake are from precipitation and the Bear, Ogden, Weber, and Jordan Rivers. The lake spans across five county boundaries (Box Elder, Weber, Davis, Tooele, and Salt Lake). The Great Salt Lake meander line represents the boundary of sovereign lands managed by the Utah Division of Forestry, Fire, and State Lands. The historic (1847–1986) average elevation of the lake is 4,200 feet (United States Geological Survey, 2009). Utah Water Quality Act beneficial uses for Great Salt Lake (Classes 5A through 5E) extend to an elevation of 4,208 feet. Since this contour is not available spatially, the 4,209-foot contour is shown.

IV. NUMERIC CRITERIA FOR PRIORITY POLLUTANTS

UDWQ will develop numeric criteria for all EPA priority pollutants[8] with the potential to adversely affect Great Salt Lake water quality and beneficial uses. This potential will be determined in accordance with the requirements of 40 *Code of Federal Regulations* (CFR) 131.11(2). As previously discussed in the Great Salt Lake Beneficial Uses section, alternate approaches to numeric criteria based on biological condition gradients and associated biological assessments will be pursued to ensure protection for pollutants that aren't well described by numeric criteria or for those pollutants where numeric criteria development is not immediately practicable. The following approach focuses on priority pollutants and provides an adaptive process that allows UDWQ to continually improve the numeric criteria as our knowledge of the effects of pollutants on the lake's beneficial uses continues to improve. This process allows UDWQ to capitalize, to the greatest extent possible, on previously conducted scientific investigations by outlining a process for ensuring that interpretation of existing data is appropriate for Great Salt Lake's unique conditions. The process also provides UDWQ with tools to improve the scientific underpinnings of regulatory decisions over the short and long term through a clearly defined process for prioritizing ongoing research needs.

Given that the EPA has hundreds of priority pollutants, many of which are likely to exist within Great Salt Lake, standards development is not tractable without a defined process for prioritizing the pollutants. UDWQ proposes an iterative process for prioritizing pollutants for development of numeric criteria (Figure 2):

1. Compile a list of species inhabiting Great Salt Lake
2. Determine what priority pollutants are known to be present in the lake or in discharges to the lake.
3. Compile readily available toxicity benchmarks relevant to Great Salt Lake species for all CWA Section 304(a) pollutants for each salinity class
4. Prioritize pollutants of concern by comparing existing lake concentrations with benchmarks
5. Repeat steps 1 through 4 for the next pollutant

After compiling the list of Great Salt Lake species, available data will be reviewed for priority pollutant concentrations within the lake or present in point source discharges or from important nonpoint sources to the lake. If not found in the lake or sources, the pollutants will be designated low

[8] http://www.epa.gov/region1/npdes/permits/generic/prioritypollutants.pdf

priority. For those present, readily available toxicity benchmarks will be compiled for the remaining pollutants.

Readily available toxicity benchmarks are estimates of no-effects concentrations and will be compared to existing lake concentrations. These benchmarks will be summarized by a range of values (when available) that define concentrations that could adversely affect Great Salt Lake species. Readily available benchmarks may include regulatory numeric criteria, values from the primary literature, and bioassays (toxicity tests). If the lake concentrations are less than the benchmarks divided by 10, the pollutant will be classified as high priority. The high priority pollutants will be the focus of initial efforts to derive numeric criteria.

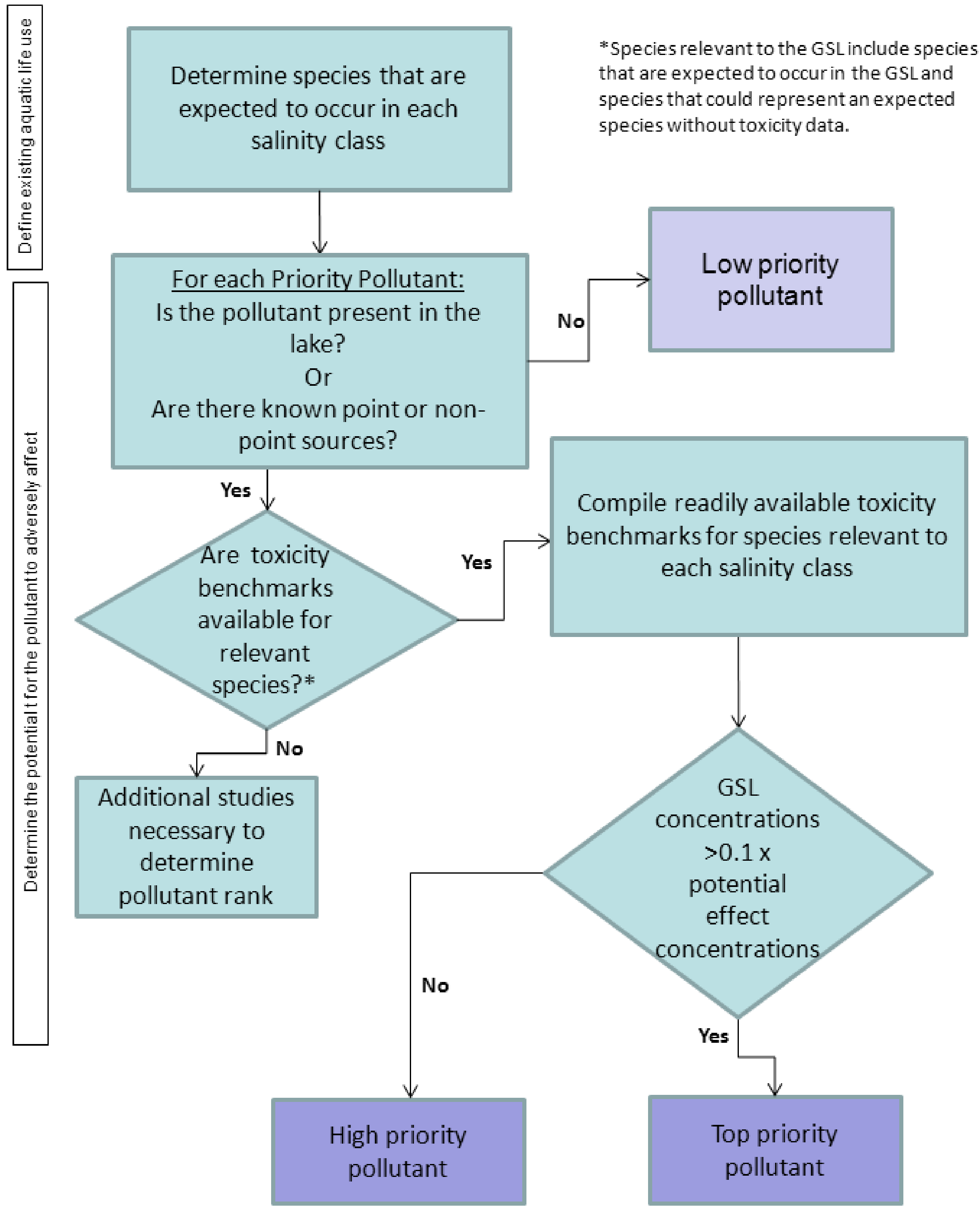


FIGURE 2. PROCESS FOR DETERMINING WHICH POLLUTANTS WILL BE INITIALLY SELECTED FOR CONSIDERATION IN DERIVING NUMERIC CRITERIA

Top- and high-priority pollutants will be addressed first for numeric criteria derivation.

DEVELOPMENT OF NUMERIC CRITERIA

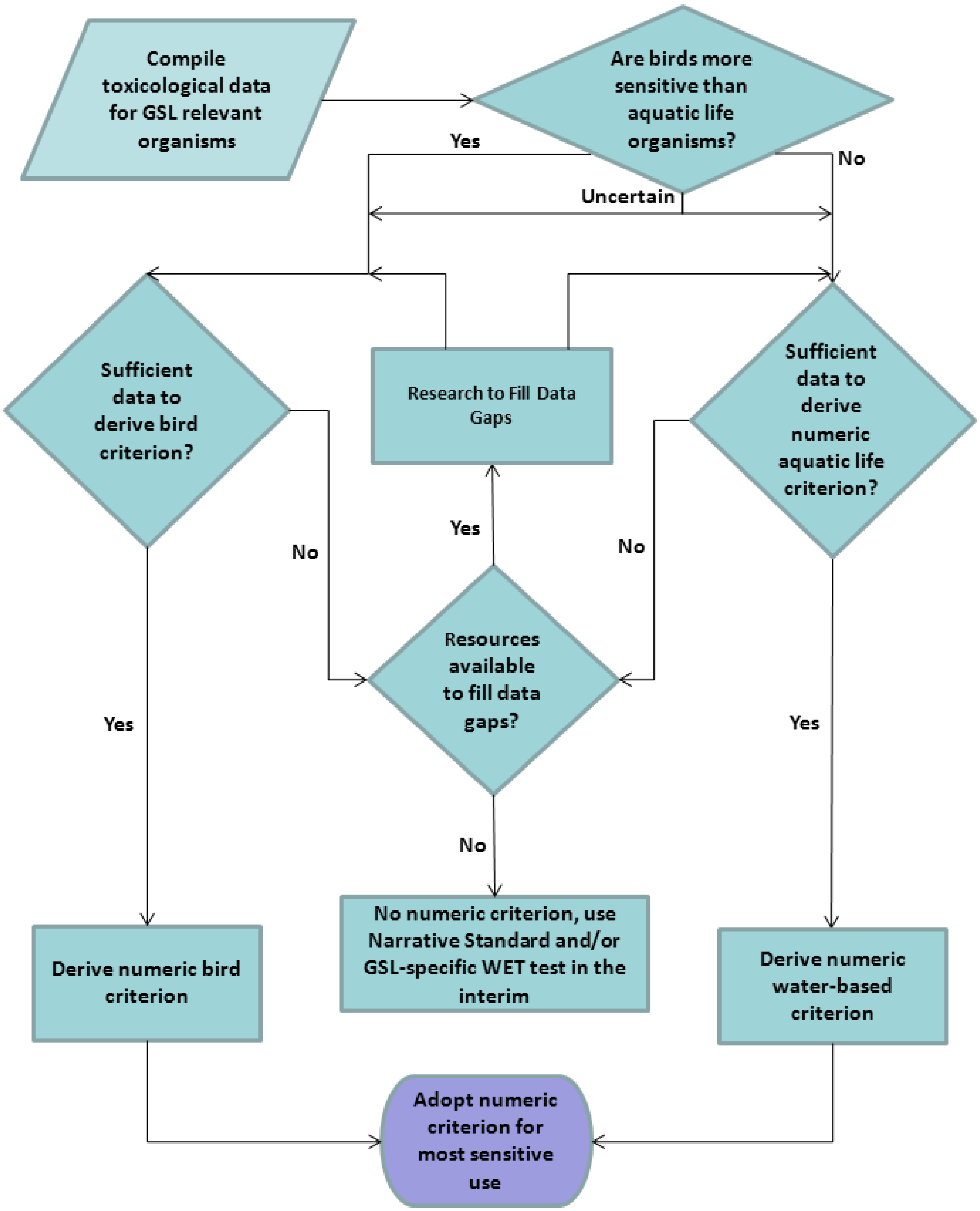
Under CWA regulations, when waters are protected for more than one beneficial use, the water quality criteria necessary to protect the most sensitive use is applied. For instance, criteria developed to protect primary contact recreation for Great Salt Lake would be presumed to also protect secondary contact recreation. Similarly, numeric criteria are typically developed to protect the most sensitive life stage of the most sensitive species within a water body. For example, the selenium standard is based on concentrations within shorebird egg tissue because this is the first deleterious effect of increasing selenium concentrations that is likely to be observed among the many potential deleterious effects to lake biota. This selenium criterion directly protects shorebird reproduction but has the ancillary benefit of protecting other groups of birds and their food chain organisms that are less sensitive to selenium exposure. When national criteria are developed to protect aquatic life, all toxicological studies are evaluated, but the proposed criteria are ultimately based on the requirements of the most sensitive life stages of several of the most sensitive species. Moreover, each sensitive species is selected to represent different types of organisms (i.e., algae, bugs, fish) under the assumption that their disparate life histories will capture the range of potential exposure pathways for a pollutant. A similar approach for Great Salt Lake criteria development requires an understanding of how all Great Salt Lake biota use lake resources. This knowledge will help define the weight given to previously conducted research and will help prioritize specific research needed to generate scientifically defensible criteria.

Figure 3 shows the process for deriving numeric criteria for each pollutant and salinity class. The critical initial step in prioritization and criteria development is identifying the composition and abundance of the expected biological organisms within each of the three salinity classes: hypersaline, marine, and freshwater. While transition zones certainly exist, these salinity classes roughly determine the composition and abundance of species at different locations around the lake. In general, the biological composition of the lake defines the lake's aquatic life use because these organisms are either explicitly protected (e.g., waterfowl and shorebirds) or implicitly protected as items in the food chain for the birds. Subsequent research will focus on a more detailed understanding of how each of these species uses the lake and its surrounding wetlands, which provides insight into exposure pathways and highlights areas where sensitivity to a pollutant is likely to be greatest.

Next, UDWQ will compile a comprehensive review of previously conducted toxicity studies for each pollutant and Great Salt Lake relevant species to supplement the data compiled for prioritizing the pollutants. The toxicity data will be reviewed to determine if upper trophic levels (i.e., birds) are more sensitive to the pollutant than lower trophic levels (e.g., brine shrimp). If birds are more sensitive, then the criterion will be based on the concentration of pollutants found within bird tissue i.e., tissue criterion.

Otherwise, a water-based criterion based on other aquatic life in the bird's necessary food chain will be the goal. If the outcome of this determination is uncertain, then both tissue- and water-based criteria will be developed for both birds and aquatic organisms, respectively. The most protective of these criteria will be recommended for adoption as a numeric criterion for each salinity class.

UDWQ proposes that newly adopted numeric criteria for Great Salt Lake have delayed implementation. The purpose of the delaying implementation is to provide time for permittees to comply with the new criteria or to collect additional data that could be used to modify the criteria. UDWQ proposes a 6-month delay in implementation, but this time interval may be adjusted based on comments. The delayed implementation will be codified in R317-2, which requires adoption by the Water Quality Board and additional public comment solicitations.



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477 **FIGURE 3. PROCESS FOR DERIVING NUMERIC CRITERIA FOR TOP- AND HIGH-PRIORITY POLLUTANTS**

Bird-based Criteria

If birds are more sensitive than aquatic life organisms or the data is inadequate to make this determination, the available toxicity data for birds and the pollutant will be compiled. The increased sensitivity can be from higher exposures because the pollutant biomagnifies or because the higher trophic levels are toxicologically more sensitive. When the higher trophic levels are more sensitive to a pollutant, the numeric criteria can be based on a tissue concentration (e.g., selenium in bird eggs) or a water column concentration when there is sufficient information to translate the tissue concentration. The available toxicological studies will be reviewed and a tissue or concentration or dose that is equivalent to a no-observed-adverse effects level will be derived, if the data are adequate. If adequate data are not available, the critical data gaps will be identified and filled depending on pollutant prioritization and available resources. If resources are currently unavailable, water quality will remain protected by the existing narrative standard. WET testing used by the UPDES program to monitor the toxicity of effluents using standardized protocols is generally not applicable for evaluating potential effects to higher trophic levels because the standard WET testing organisms are not representative of higher trophic levels.

Prior to the adoption of a tissue-based criterion, UDWQ will follow the EPA's *Guidance for Implementing the 2001 Methylmercury Water Quality Criterion*[9] to develop a detailed plan that describes how the criterion will be applied to decision making in key water quality programs. Specifically, these implementation plans will determine how compliance with the tissue-based criterion will be monitored, assessed, and interpreted in the context of water quality programs such as setting UDPES permit effluent limits (Section V). Such implementation plans are critical because it is difficult to apply tissue-based criteria to UDWQ's UPDES permits and other water quality programs that are intrinsically based on direct measures of water column concentrations. The implementation plan may also identify alternative monitoring or compliance points for the numeric criterion. For instance, for the selenium tissue-based egg criterion for Gilbert Bay, potential alternative measurement points are selenium in water or waterfowl food (e.g., brine flies). Alternative measurement endpoints may require that the relationships between selenium in water, food, and egg be well characterized.

Water-based Criteria

When higher trophic levels are not the most sensitive to a pollutant, the methods outlined by the EPA (1985) will be modified for application to Great Salt Lake (Figure 3). A review of the toxicological studies used to derive Utah's existing freshwater numeric criteria and any new data available in the

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[9] http://water.epa.gov/scitech/swguidance/standards/criteria/aqlife/pollutants/methylmercury/upload/mercury2010.pdf

literature will determine if they can be directly adopted for the freshwater salinity class. For instance, many of these existing criteria were initially derived to protect species that are more sensitive than those that inhabit freshwater environments within Great Salt Lake. Similarly, standards intended to protect early life stages of fish would not be appropriate if a given fish species resides in but does not reproduce in Great Salt Lake. Modifications to freshwater standards will be made when sufficient data are available to make these changes.

For the marine salinity class, toxicity data used to develop the EPA saltwater criteria will be compiled for organisms relevant to Great Salt Lake and supplemented by any more recent studies. UDWQ will identify from the literature review those studies that are directly relevant to Great Salt Lake biota. This subset of investigations will allow UDWQ to use a recalculation-based approach to translate existing marine criteria into goals appropriate for Great Salt Lake (EPA, 1994)[10]. Data gaps will be identified and numeric criteria calculated when the database is sufficiently robust. For the hypersaline waters, a literature search will be conducted for the species that are expected to occur (e.g., brine shrimp, brine flies, algae) and if toxicity data are adequate, numeric criteria will be calculated.

UDWQ anticipates that limited toxicity data for the hypersaline class will be available. For some pollutants, no data may be available. For others, test results for an incomplete number of species representative of hypersaline waters will be available. When the database is not representative of all species, the primary concern is that the untested species could be more sensitive to the pollutant than the tested species, resulting in an inadequately protective criterion. In other words, a criterion based on an incomplete toxicity database will never be lower than a criterion based on a complete toxicity database but may be higher. UDWQ proposes to derive *interim criteria* if at least one technically sound toxicology study is available and by applying uncertainty factors (Eastern Research Group, Inc., 2005) to reduce the probability of underestimating the potential effects on untested organisms. The specific methodology for deriving interim and final criteria will be developed after the existing toxicity database is complete for the highest priority pollutants.

Filling data gaps in the toxicity database for Great Salt Lake organisms is anticipated to require substantial resources to conduct the bioassays (laboratory toxicity tests). An appropriate suite of tests will need to be developed for Great Salt Lake priority pollutants. Resources required to conduct these tests is dependent on how many tests need to be run, which is currently unknown. If the resources to fill

[10] The recalculation procedure methods are found in Appendix L: Interim Guidance on Determination of Use of Water-Effect Ratios for Metals.

these data gaps are not available, in the interim, the pollutant will continue to be evaluated using the existing narrative standard, potentially supplemented with WET testing.

WET testing is already part of the UDPES permitting program. Dischargers are required to test the toxicity of their effluent using standardized protocols. The existing WET program for Great Salt Lake dischargers will be reviewed for applicability to any refinements in interpreting the species that represent Great Salt Lake's beneficial uses. WET testing can augment numeric criteria or provide another tool for evaluating effluent limits in the absence of numeric criteria.

DEVELOPMENT OF RECREATION USE CRITERIA

In concept, the logic behind the development of numeric criteria for recreation uses is not appreciably different than the logic that underlies the process for aquatic life uses. Numerous indicators have been used to derive recreational water quality criteria. Site-specific investigations will be needed to determine whether thresholds and indicator microbes used to develop the statewide and EPA marine recreational water quality criteria are applicable to Great Salt Lake. However, interim screening numbers are needed to help prioritize these site-specific investigations. For instance, there is little need to prioritize epidemiological studies that relate *Enterococci* counts to deleterious effects on human health if these bacteria are consistently below levels of concern for marine waters elsewhere.

Programs for creating numeric aquatic life criteria will have greater priority than those for recreational uses, until data are available to suggest that threats to recreation uses within Great Salt Lake are greater than currently believed. Over the short term, UDWQ proposes using existing fecal indicators: *E. coli* for the freshwater class and *Enterococci* for marine and hypersaline classes. Data will continue to be collected and interpreted using these existing numeric benchmarks. If these benchmarks are exceeded, then UDWQ will develop an approach for determining whether these existing benchmarks are appropriate for Great Salt Lake and, if not, what alternative numeric criteria would be protective of Great Salt Lake's recreation uses.

V. APPLYING NUMERIC CRITERIA TO WATER QUALITY PROGRAMS

Water quality criteria (both numeric and narrative) are the foundation for UDWQ's water quality protection programs. The criteria are used to determine effluent permit limits for point source dischargers, assess condition (fully supporting or impaired) for protection of the beneficial uses, and implement antidegradation to prevent unnecessary increases in pollution. Following is a brief description of our water quality programs and how criteria are applied to the lake.

Monitoring

Component 2 of the Strategy provides details for UDWQ's monitoring programs for Great Salt Lake to support the development of numeric criteria. The following is a brief overview of the Monitoring Program for Great Salt Lake that is described in much greater detail in Component 2 of the Strategy. UDWQ has been monitoring lake water quality since the early 1990s. Field measurements such as pH, specific conductance, water temperature, and dissolved oxygen levels have been collected, as well as water quality samples of nutrients and metals. However, for some metals and nutrients, the salinity of the water has been shown to interfere with chemical analysis, and, consequently, there are concerns about the validity of historical data. As sampling techniques and laboratory instrumentation have been refined, so has the program for monitoring lake water quality. The baseline sampling plan in Component 2 incorporates updated sampling protocols and includes quality assurance and quality protection measures to ensure accurate data. This baseline sampling plan is designed to address overall condition of water quality by identifying the potential contaminants of concern, the concentration of those contaminants in the water, and how those concentrations vary spatially, seasonally, and annually. The plan specifies pollutants that will be measured in several media (i.e., water, tissue). Total selenium and total mercury will be measured from water brine shrimp and bird eggs, whereas other trace metals (i.e., arsenic, lead, zinc and thallium) will be measured in the water but not in eggs until evidence exists that a specific metal potentially threatens birds. Nutrients and other chemical constituents will be measured in concert with other physical measures in the water column, including: dissolved oxygen, pH, temperature, conductivity, Secchi depth (water clarity), water depth, and depth to the deep brine layer. UDWQ will continue to develop the chemical and biological techniques that are precise, accurate, representative, complete, and comparable for saline waters. The numeric criteria developed through this strategy will be compared with both historical and present data for applicability to Great Salt Lake.

Assessment (305(b) and 303(d))

Both state and federal regulations require UDWQ to assess support of Great Salt Lake's beneficial uses every other year (305(b) *Integrated Report*). These assessments involve compilation of all existing and readily available data to develop a report to congress that identifies waters that are impaired or not meeting their beneficial use goals (sometimes referred to as the 303(d) list). Assessments are typically done by either comparing water quality data against numeric criteria or with other tools that quantify biological health (i.e., biological assessments or Trophic State Indices). In the case of Great Salt Lake, UDWQ's strategy is to create assessment frameworks based on biological, physical, and chemical parameters and use the frameworks to document if the beneficial uses are attained when compared with the Narrative Standard. These efforts are documented in the 2008 and 2010

Integrated Reports. For instance, the 2010 Integrated Report documents UDWQ's progress toward an ecological risk assessment to evaluate if mercury is adversely affecting the lake biota. To date, Great Salt Lake has been placed in Integrated Report Assessment Category 3B, which includes waters where data and information are insufficient to determine an assessment status. The available data to determine if the lake is supporting its beneficial uses are inconclusive and may even appear to be conflicting. Some stakeholders believe the data support that lake water quality is meeting its beneficial uses, whereas others argue the opposite.

Numeric criteria, and the additional understanding of lake processes that will result from their development, will provide a concise way to assess the lake and ensure protection of the beneficial uses. Water quality data from the lake will be compared with the numeric criteria to determine if the lake is meeting its beneficial uses. However, adoption of numeric criteria by salinity class will require development of unique assessment methods. As previously discussed, the salinity at a given location can vary with time as the salinity-specific numeric criteria presumably will. Determining criteria to apply is critical to avoid erroneous conclusions regarding beneficial use support. Erroneous conclusions regarding beneficial use support may result in inadequate protection of the lake's water quality or incur substantial unnecessary costs as described in the following section.

Total Maximum Daily Load Program

Water bodies that are determined to be impaired are required to have a total maximum daily load (TMDL) analysis conducted for the pollutant causing the impairment. The TMDL identifies and quantifies all sources of the pollutant. For a watershed like Great Salt Lake's, this process will take many years and require substantial staff and monitoring resources. The research needs presented in Component 2 anticipate some of the monitoring needed to support TMDL development.

Once the pollutant loading is characterized, the TMDL calculates the reduction in load necessary to reduce the pollutant concentrations to meet numeric criteria and subsequently protect the uses. This reduction is allocated among all pollutant sources. These required reductions sometimes result in additional treatment requirements for UPDES permittees or also potentially limits growth potential of these discharges, which can both be expensive. Affected UPDES permittees rightly demand that conclusions be based on technically rigorous methods. Clearly, erroneous conclusions regarding beneficial use support are highly undesirable because they may result in inadequate protection of the lake's water quality or incur substantial unnecessary costs.

Utah Pollution Discharge Elimination System

UDWQ issues UPDES permits to all entities that discharge pollutants to surface waters, including discharges of domestic and industrial wastewater, and more diffuse sources like stormwater. In the case of domestic and industrial dischargers, these permits establish allowable concentrations of pollutants and monitoring requirements for industry to ensure that beneficial uses are protected and the discharge is consistent with the antidegradation policy (UAC R317-2-3). In the case of stormwater discharges, permits establish best management practices to ensure beneficial uses are protected. As previously discussed, the development of allowable concentrations (i.e., permit limits) for Great Salt Lake discharges has been complicated by the lack of numeric criteria. Permit limits are based on the most stringent of (1) technology-based effluent limits (which includes, but is not limited to, secondary treatment standards for municipal wastewater treatment plants and/or categorical effluent limits prescribed for a given industry), (2) numeric criteria, and (3) application of the Narrative Standard. Many of the existing permit limits for discharges directly to Great Salt Lake are based on technology-based effluent limits, which some believe to be underprotective of the lake's beneficial uses or fail to comply with the Narrative Standard. The result is repeated appeals of new Great Salt Lake permits or permit renewals that are required every 5 years for existing permits. These differing opinions result in costly uncertainty and delays for UDWQ and the regulated community. Permit limits based on numeric criteria will reduce these uncertainties and delays.

Applying numeric criteria to Great Salt Lake UPDES permits also requires the adoption of implementation methods. Implementation methods are required to ensure that the appropriate salinity-based standard is applied when developing water-quality-based effluent limits. In situations where multiple salinity classes may apply, depending on the season or climatic variation, the most conservative criteria will generally be applied and used to determine permit limits and to assess compliance. However, in some situations facilities could be allowed sufficient flexibility to adapt their discharge to varying conditions, which is evaluated on a case-by-case basis. As with assessments (see above), selection of the appropriate salinity class, or classes, is critical to avoid erroneous compliance determinations and permit limits that are too restrictive or not restrictive enough. UDWQ proposes to address the critical issue of establishing methods for assigning the salinity-based classes with significant stakeholder input.

To determine water-quality-based effluent limits for UPDES-permitted discharges directly to Great Salt Lake, UDWQ proposes the following:

1. Determine the salinity class(es) of the receiving water
2. Determine the most protective numeric criteria from the applicable salinity classes

Conduct a Waste Load Analysis assuming limiting conditions and the most protective numeric

UDWQ initially proposes an approach for assigning salinity classes that is based on Great Salt Lake-specific averaging times and limiting conditions. As previously discussed, salinity determines the specific organisms that are present in different areas of the lake and defines the beneficial uses. Numeric criteria are expected to vary for the different salinity class/beneficial use/organism combinations. Therefore, assignation of the correct salinity is extremely important. Assigning the correct salinity class for a given location in the lake is complicated by the lake's dynamic nature with salt concentrations varying over time. Averaging times are intended to make this selection process manageable and are defined as the minimum duration that must exist for a salinity class to apply. Different averaging times will likely be needed for evaluating acute and chronic effects. The averaging times must be linked to protecting the specific organisms represented by the beneficial use. For instance, the averaging period for chronic criteria should consider the time necessary for the aquatic organism to thrive and reproduce. The goal is to protect the biological integrity of the waters while avoiding unnecessary regulatory burdens to protect organisms that are transient and not critical to the ecosystem's biological integrity. Averaging times could also be used to support seasonal limits (different effluent limits based on different receiving water conditions) to provide flexibility and potential cost savings to industry while still protecting the lake.

Limiting conditions are used to develop permit limits for discharges to Utah's rivers and streams in the UPDES program by using the last 10 years of flow data for a stream to estimate worst case, or limiting conditions. The permit limits are reviewed every 5 years, but modifications due to changes in the limiting conditions are generally small and rarely require a significant permit limit change or treatment method. However, the impacts of changing salinity classes for Great Salt Lake are potentially much greater. UDWQ proposes to develop alternative methods to determine limiting conditions for Great Salt Lake with regard to determining applicable salinity classes. Historical records can be used to predict potential salinity changes for the design life of a treatment system based on past changes over the same time period. This will provide the regulated community with consistent expectations regarding the level of treatment required and to ensure that plausible future uses remain protected.

Ensuring that permit limits are appropriate will also require review of existing UDWQ mixing zone policies. Existing mixing zone policies do not take into consideration the unique characteristics of Great Salt Lake. For instance, a fresher-water discharge to the lake on a calm day is expected to initially disperse as a thin layer on top of the saltier lake water. This situation is not unique to Great Salt Lake.

Most coastal discharges in the United States would be similar with the density differences between the effluent and receiving water. Site-specific factors and existing programs in other states will be reviewed and considered when developing Great Salt Lake-specific mixing zone policies.

In addition, Great Salt Lake-specific mixing zone policies need to address discharges to Class 5E transitional waters (between 4,208 feet and the open waters). Discharges to Class 5E waters may be effluent dominated (i.e., the effluent is source of all or the majority of flow). These artificially created habitats may not be well described by the ecosystems used to define the salinity classes. One applicable tool is a UAA, but UDWQ is seeking input on other potential methods to address these unique waters.

Antidegradation

Antidegradation (UAC R317-2-3) rules encompass several requirements that are intended to maintain the existing water quality to prevent unnecessary increases in pollution to Great Salt Lake. First, these provisions prohibit permitting any new or expanded discharge to Great Salt Lake or its inflows if these inputs would impair the lake's existing uses. Second, these provisions require a demonstration that any new or expanded discharge is necessary to accommodate social or economic growth and that the least-degrading alternative was selected, provided that it is feasible to implement. If these first two conditions are met, then a new or increased discharge is permissible.

However, for antidegradation to be effective, it is necessary to prioritize pollutants by identifying those pollutants likely to be present in a proposed discharge that are most likely to threaten Great Salt Lake biota or recreation uses. To date, efforts to apply these procedures for the lake have been hampered by the lack of numeric criteria and understanding of the linkage between water chemistry parameters and the lake's uses.

The antidegradation policy is intended to preserve assimilative capacity. Assimilative capacity is the difference between existing concentrations and concentrations that would impair the beneficial use. When available, numeric criteria clearly define the available assimilative capacity. Without numeric criteria, pollutants are difficult to prioritize based on how much assimilative capacity will be used or how much remains. Numeric criteria would provide greater confidence that degradation is minimized as required.

VI. NEAR TERM ACTIONS

Developing numeric water quality criteria will not be easy or quick. Significant scientific uncertainty exists about the fate and transport of pollutants and the effects that these pollutants have on the recreation uses and biological health of the lake. Filling key knowledge gaps will require several years and multidisciplinary expertise. To successfully navigate this long-term program, UDWQ will create a process for prioritizing, implementing, and applying research to meet regulatory needs. Stakeholder input, review, and participation will be sought throughout the process. Partnering with key state and federal agencies to secure and maximize resources will be paramount for success.

Stakeholder Participation

Component 4 of the Great Salt Lake water quality strategy will be a public outreach plan to be developed with stakeholders as the strategy unfolds. The following discussion focuses on stakeholder participation and communication for developing numeric criteria, whereas a more comprehensive communication strategy will be developed in Component 4. UDWQ has previously followed a steering committee and science panel paradigm for the Great Salt Lake Selenium Project and Willard Spur projects. A similar approach will be used when UDWQ encounters complex technical or regulatory problems. Less complex issues may be addressed at the workgroup level. UDWQ has already successfully used workgroups to address complex or controversial issues. Relevant to efforts to derive numeric criteria are the existing Water Quality Standards[11] and Mercury[12] Workgroups.

At a minimum, all proposed changes to Utah's water quality standards are vetted by the Water Quality Standards Workgroup. After review by the Standards Workgroup, the Utah Water Quality Board[13] must formally adopt the changes. This process is governed by the Utah Administrative Procedures Act that provides minimum requirements for public participation during rule making and imposes deadlines to completing rule making. To successfully adopt changes to the rules within these deadlines, UDWQ understands that stakeholder concerns must be addressed before the commencement of formal rule making. UDWQ will add additional opportunities for stakeholder involvement (e.g., outreach meetings, soliciting expert opinion) as necessary depending on the specific situation. UDWQ is proactively committed to an open process to meet its regulatory obligations and to ensure that all stakeholders' concerns are identified and addressed. These outreach efforts will be further developed with stakeholder input and documented in future iterations of the strategy.

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[11] http://www.waterquality.utah.gov/WQS/workgroup/index.htm#wqsmtgs
[12] http://www.deq.utah.gov/Issues/Mercury/workgroup.htm
[13] http://www.waterquality.utah.gov/WQBoard/index.htm

Finally, once the Water Quality Board adopts any changes to Utah's Water Quality Standards, the EPA must review the revisions and take action (approve or disapprove) on the changes.

Schedule

Too many uncertainties currently exist to estimate the resources needed to complete these efforts. In addition to the intrinsic level of effort required, the schedule is directly dependent on the resources available. The following schedule assumes that current resource levels are maintained. An increase in available resources will allow the schedule to be accelerated. Note that the following schedule specifically pertains to the development of numeric criteria and does not include other concurrent UDWQ efforts for Great Salt Lake. Clearly, significant additional resources will be needed to meet the goals of this strategy within the next 20 years.

Proposed Implementation Schedule (dependent on resources):

3 Years

1. Compile the list of Great Salt Lake-relevant organisms including life stage information.
2. Compile readily available toxicity data from the scientific literature relevant to the marine and hypersaline classes for all CWA Section 304(a) pollutants (limited data are available).
3. Summarize existing research by defining a range of concentrations that could adversely affect resident organisms.
4. Develop guidance for Great Salt Lake WET testing.

5 Years

1. Establish salt ranges and specific organisms for each salinity class.
2. Prioritize pollutants of concern in each salinity class by comparing existing lake concentrations with the adverse effects concentrations from the literature and select up to 10[14]. Pollutants that are present at concentrations closer to, or above, the adverse effects concentrations will be prioritized higher than those with concentrations well below the adverse effects concentrations.
3. Conduct literature search and compile toxicity database for freshwater and marine Great Salt Lake species for prioritized pollutants.
4. Identify data gaps that preclude developing numeric criteria and identify the resources necessary to fill the data gaps for prioritized pollutants.

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[14] UDWQ has reviewed the available analytical data for GSL and conducted a cursory review of the literature for toxicity benchmarks. Based on this review, the number of highest priority pollutant and salinity combinations is anticipated to be less than 10.

10 Years

1. When adequate data are available, derive numeric criteria for prioritized pollutants.
2. Identify locations that are candidates for UAAs.
3. Establish tiered aquatic life uses to support UAAs.
4. Adopt specific uses and numeric criteria where adequate data are available.
5. Establish salinity ranges for UPDES discharge locations.

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