Much of the earlier work on GSL addresses the water quality of the lake without distinguishing between the lake water's natural chemistry and the presence or absence of introduced contaminants which could affect the biology of the lake or its beneficial uses. The salinity and naturally occurring constituents of the water of GSL are discussed in the section entitled "Water - Chemistry." This section addresses biological and other chemical water constituents, nutrients and the regulation and impacts of introduced contaminants on the GSL system.

As an aquatic system, the function and usefulness of GSL is highly dependent upon the chemistry and quality of the lake water. As a terminal basin, the quality of the water in the lake is highly dependent upon the quality of water currently entering the lake, and upon the quality and nature of past inflows and discharges into the lake. A wide variety of organic and inorganic materials enter the lake by both natural and human-induced causes. The sources of potential lake water contaminants include:

Surface and groundwater inflows to the lake
Permitted discharges directly to the lake
Spills/accidental discharges to the lake
Lake sediments which contain non-naturally occurring contaminants
Airborne particulates and precipitants

Because of the lake's high salinity and unique aquatic biology, some contaminants which are of great concern in fresher water systems may not be as problematic in GSL, and some may even help support the aquatic ecosystem. Others may be rendered harmless by the lake water's high salinity, but may become more bioavailable when lake water freshens. Despite a great deal of research on the lake's water chemistry and aquatic organisms, little work has been done directly on the effects of non-natural contaminants on the GSL ecosystem, or on the water quality effects of fluctuations in lake water chemistry.

The "Water Quality" section considers the presence and impacts of lake water constituents other than naturally occurring salts. Internal and external scoping identified five main areas of interest with regard to water quality.

- **Discharges to the lake and watersheds are managed by approval of discharge permits which are determined to be protective of primary and secondary contact recreation, aquatic wildlife and mineral extraction, and by development of non-point source management programs.**

- **The potential for future changes of lake water quality through loss of wetland function, spills or other accidental discharges and nonpoint source management initiatives are not well understood.**

- **The impacts of non-naturally occurring lake water contaminants**

on aquatic wildlife are not well understood.

- **Consider the possibility of establishing a DNR wetland strategy.**

- **Need to improve inter-agency coordination to protect water quality.**

Water Quality Management for Great Salt Lake

The Utah Water Quality Board and DWQ have been charged by the state legislature to maintain, protect and enhance the quality of Utah's surface water and groundwater resources. The statutory authorities of the board and division are located in Chapter 19-5 of the Utah Code. The overall program missions of the board and the division are to protect public health and all beneficial uses of water by maintaining and enhancing the chemical, physical and biological integrity of Utah's waters.

Facilities in Utah that produce, treat, dispose of or otherwise discharge waste water must obtain a discharge permit from the DWQ under the Utah Pollutant Discharge Elimination System (UPDES). UPDES permits are required for all industrial, municipal and federal facilities, except those located on Native American lands. After a discharge application is received, a wasteload evaluation is developed to determine specific discharge limitations, required treatment and monitoring. Each permit includes effluent limitations and requirements for monitoring, reporting and sludge use or disposal requirements. Permit duration is usually five years or less, with provision for renewal.

To establish discharge standards, the Utah Water Quality Board has classified the waters of the state based on their beneficial uses and has defined numerical and narrative standards to those waters to protect beneficial uses. The main water use classes are:

Class 1	Protected for use as a raw water source for domestic water systems.
Class 2	Protected for recreational use and aesthetics.
Class 3	Protected for use by aquatic wildlife.
Class 4	Protected for agriculture uses including irrigation of crops and stock watering.
Class 5	GSL. Protected for primary and secondary contact recreation, aquatic wildlife and mineral extraction.

Most of the main classes are divided into sub-classes which address specific pollutants and beneficial uses. GSL is in its own class (Class 5). Primary and secondary recreation, aquatic wildlife and mineral extraction are the defined beneficial uses of the lake's waters.

Numerical water quality standards have not been established for GSL. According to DEQ, numerical water quality standards may not provide the highest level of protection for GSL resources since dischargers would then be allowed to pollute up to these levels. Industry usually prefers the development of numeric criteria since this provides allowable effluent guidelines. Numerical standards make administration easier but reduce the ability to escalate discharge permit applications on a case-by-case

basis. DWQ has established narrative standards for the lake and permits for wastewater discharges are established on a case-by-case basis. Applications for wastewater discharges are reviewed and regulated by the Water Quality Board to prevent the addition of pollutants which would be injurious to the defined uses. The general policy is that, to the extent feasible, no pollutants (discharges) should be delivered to the lake in amounts that result in concentrations greater than those already present in the lake. The Environmental Protection Agency (EPA) has approved DWQ's water quality standards for the lake. Some question if this is an effective policy.

Freshwater habitats are very important in a saline environment and wetlands have limited ability to effectively utilize and remove these nutrients. This is why DNR has recommended additional research and study to evaluate if a problem exists. The nitrogen and phosphorus in sewage effluents are not regulated by DWQ unless it can be shown that they are causing an impairment to the beneficial use in the receiving waters. DWQ has stated that significant cost implications are involved (public and industry) in ensuring the highest level of scientific information as a defensible basis to require nitrogen and phosphorous reduction/removal prior to discharging sewage effluent into the lake.

Dischargers are regulated by state and federal effluent limitations for total suspended solids (TSS), biochemical oxygen demand, coliforms, pH and some metals. A public notice process is followed to allow comment on any concerns.

Numerical standards would allow less flexibility in ensuring water quality protection. The cost and complications associated with attempting to develop numerical standards for a saline lake would first require a clearly identified problem.

Permitted Discharges to Great Salt Lake

Permitted discharges to GSL fall into three major classifications; municipal wastewater treatment facility discharges, mineral extraction facility discharges and other industrial facility discharges. Wastewater treatment facilities typically treat high levels of organic materials, which generate high biological oxygen demand (BOD) and bacteria. Nutrient levels (nitrogen and phosphorus) are also relatively high in these wastewater discharges and can lead to eutrophication in fresh waters. Mineral (salt) extraction industries produce bitterns or residual water from their solar evaporation ponds. These facilities withdraw water from GSL and then use solar evaporation to precipitate various salts from this water. Specific effluent guidelines and standards are applicable to discharges from salt extraction industries. The requirement is that the effluent contain only materials originally present in the intake water. Industrial discharges include effluent from the Kennecott Utah Copper (KUC) concentration and smelting operations and from oil refineries located in the North Salt Lake area. The copper mining and refining operations produce heavy metals, total and suspended solids and petroleum. Discharges from oil refineries have limitations on mass BOD, TSS, oil and grease, phenolic compounds, ammonia, sulfide and chromium.

Jordan Valley Water Conservancy District's (JVWCD) charge is to develop and deliver water supplies to meet growing population water demands. JVWCD anticipates a potential discharge from the treatment of Utah Lake/Jordan River water to meet these demands.

All dischargers, including KUC and oil refineries have specific discharge effluent limits, rigorous monitoring requirements and enforcement measures to ensure compliance. Baseline data collection is another requirement for instream and lake dischargers. If, or when, the state decides that numerical criteria are needed due to an identified problem, agencies and researchers with relevant experience will be involved. A listing of existing permits for discharges to GSL and its near-lake tributaries is in Appendix A.

Potential for Changes to Lake Water Quality

The overall quality of GSL water is good. From a biological standpoint, the lake's aquatic biological system is described as nitrogen-limited. Nitrates and phosphates, which are usually characterized as "pollutants" in freshwater aquatic systems, are almost completely consumed by lake organisms and do not pose problems in the open water of GSL that they otherwise can. In wetlands adjacent to the lake, nutrient loading may be adversely affecting buffering capability. Other factors on and near the lake, such as the wetland-marsh complexes on the east shore of the lake, are thought to be beneficial in "treating" nonpoint sources of potential pollution before they reach the lake. Some potential causes for water quality degradation are emergency spills and accidental discharges on and near the lake, possible contaminants in lake-bottom sediments and pollutants from nonpoint sources near the lake and entering tributaries. Managers do not fully understand how reductions in inflows and other water and land uses will affect population dynamics and species interactions.

Spills/Accidental Discharges

In the past, de-icing fluids at SLCIA have been controlled by disposal to a storm water collection area and then to wastewater treatment facilities. Due to a recent increase in the stringency of de-icing requirements imposed by the Federal Aviation Administration (FAA) regulations, the holding capacity is no longer adequate for proper containment and overloading of local treatment facilities has resulted in operational problems, including accidental discharges. The planned development of a process to recover and recycle glycols (the main component in deicing/anti-icing fluids) to eliminate the overflow discharge of contaminated storm water should be able to handle airport storm water and contaminants of concern. Biomonitoring is required where effluent toxicity is an existing or potential concern. SLCIA is considered a minor facility and its discharge is not likely to be toxic since the deicing/anti-icing diversion/recovery system is fully implemented and will not require biomonitoring.

Minor fuel spills involving less than 25 gallons must be contained by the party causing the spill. In the event that fuel reaches the storm sewer it can be removed by oil/water separators located at the discharge points to the City Drain, Surplus Canal and at the entrance to the

aeration lagoon of the storm water pretreatment system. All material entering the storm sewer passes through these separators. Fuel spills greater than 25 gallons must be reported to the fire department, state Health Department, DWQ and the Salt Lake City County Health Department. Upon notification the responsible party will immediately begin containment of the spill and the Airport Authority Operations Division, Maintenance Division and the Airport Environmental Specialist will provide necessary assistance.

Reporting and Cleanup of Spills

With the proximity of large industrial, transportation and sewage treatment facilities to GSL, accidental unpermitted discharges to the lake and the lake environs have occurred in the past and are likely to occur in the future. Emergency spill reporting and response is handled by several agencies with different jurisdictional responsibilities. The unpermitted release of any substance which may pollute surface or ground water must be reported immediately to DEQ, followed by a written report summarizing the incident and remedial actions taken to respond. These include releases greater than 25 gallons of used oil, damaged radiation sources, lost or stolen radioactive materials spills or releases of radioactive materials to the environment or other events causing significant human exposure or property damage. This reporting is required by both state and federal statutes. If an incident involves potential health or environmental effects which require immediate action by local authorities, the local emergency response access number should also be called. Some spills also may require notification of the National Response Center (NRC), depending on the type and amount of the release. In addition, spills, leaks, fires and other events at oil or gas drilling or production facilities must be reported within 24 hours to the Division of Oil, Gas & Mining (DOGM) followed by a written report.

Releases involving oil causing a sheen on surface water, depositing sludge under the surface, or any substance that violates water quality standards must be reported to NRC. Releases to the sewer system in violation of a permit must be reported to the local sewer authority. The U.S. Fish and Wildlife Service (USFWS) receives notification through the NRC when a spill occurs that has implications for protected fish and wildlife resources.

DEQ and the Utah Department of Public Safety require that releases of substances or wastes which could be hazardous to human health or the environment must be cleaned up and the wastes disposed of, in accordance with applicable standards. This requirement includes releases which are below thresholds requiring notification to local, state or federal authorities. The conduct of response and cleanup of spills is governed by contingency plans developed cooperatively among the affected resource management agencies, and depends upon the type, extent and location of the spill. Federal and state agencies respond on site and consult with the on-scene coordinator.

Potential Flood and Drought Impacts on Water Quality

Lake levels above expected highs can adversely affect existing sewage treatment facilities around the lake.

During the flooding in the 1980s, several treatment plants were forced to take steps to protect their facilities from flooding. Substantial costs were incurred to protect facilities, keep them operating and prevent the discharge of millions of gallons of raw sewage into the lake. For example, the dikes of the Perry Lagoons were raised, rip rap was placed on the outside of the dikes to prevent erosion and a pump station was installed. The South Davis Sewer District built dikes around their plant and installed pumping facilities to lift the treated effluent into the lake. Although those protective structures remain in place, lakeside sewage treatment facilities are at risk from high lake levels. Also, some industries adjacent to the lake raised or relocated sediment and waste holding ponds. Magcorp relocated their wastewater holding pond further from the shoreline and put it behind a dike to provide additional protection.

Drought conditions may expose discharge effluent outfalls for longer periods due to low lake level. Effluents may be unable to mix with the lake and therefore expose pollutants to the environment and wildlife.

Lake Bottom Sediment Contaminants

Concerns that potential lake water contaminants may be contained in lake bottom sediments have occurred on several occasions due to past discharges to Farmington Bay, the south shore and other areas of the lake. Several studies have been initiated to determine the levels of heavy metals, organic pesticides, dioxin and furans by DEQ. The USFWS, USGS and Utah State University (USU) have also conducted studies related to lake bottom sediments and water quality (Discussions follow).

Farmington Bay

The Davis County Causeway, constructed in the 1960s, inhibited the free exchange of brines between Farmington Bay and the main arm of GSL, resulting in a gradual freshening of the brines in Farmington Bay. Because of the many years of discharge of untreated sewage into Farmington Bay, concerns emerged in the late 1960s that the freshening of the bay might allow aerobic bacteriological decomposition of organic materials previously "fixed" by the lake water's high salinity. In 1965, the Utah Department of Health reported "...positive evidence of sewage pollution in the [Farmington Bay] lake water to such an extent that bathing should not be approved of in any of these areas for this reason." A study completed in 1971 confirmed organics comprised up to 37 percent of some bottom sediment samples in the south end of the bay, and found unacceptably high counts of *E. coli* and other coliforms at salinities up to 5.5 percent (Carter, 1971). It was subsequently suggested that an accumulated sludge layer in the bottom of Farmington Bay could be a major water quality concern if sediments were disturbed or if the water continued to freshen (DWRe, 1974b).

In 1985, USU conducted an investigation to determine the potential for contamination of Farmington Bay water from bay sediments in different water freshening scenarios. The study suggested the potential for contamination exists in two sediment core samples which contained freshwater soluble heavy metal accumulations. The study also concluded that more information on

the potential for release of toxic metals and organic materials should be gathered before any bay freshening proposals should be considered. It was suggested that if the salinity of Farmington Bay were lowered, the "consequences might be dramatic," and result in large algal blooms and resulting odors due to high nutrient levels.

Past sediment surface core sample analyses in Farmington Bay have indicated metal accumulations in bottom sediments. (USU Water Lab, 1988)

Initial results for Farmington Bay show generally low concentrations of contaminants. Lead concentrations peaked at 130 ppm about 1978 and have declined to near 70 ppm in recent years. This is likely due to declining use of leaded gasoline and lead shot for hunting.

South Arm

In 1994, USFWS conducted a limited evaluation of trace elements in brine shrimp and brine flies from the south arm of GSL. The report concluded that some trace elements are elevated to levels of concern and further study was recommended. Currently USFWS is evaluating contaminants including trace elements, polycyclic aromatic hydrocarbons (PAH), polychlorinated biphenyls (PCB), and pesticides in wetlands associated with the lake as well as its tributaries. Although sampling has focused on biota from these areas, some sediment samples have also been collected. This current study is also expanding on the study completed in 1994 to include sediment samples as well as brine shrimp to further characterize contaminants in the food chains of the south arm of the lake.

Bear River Bay

An investigation by USFWS near the BRMBR between 1989-90 discovered no indications of the presence of hazardous materials (DNR, 1995 and Waddell et al., 1990). There is currently underway a National Water Quality Assessment (NAWQA) study to determine trends in water quality using a variety of methods including sediment coring to determine magnitude and trends in contamination. This will be part of a wetlands study of chemical processes, and will include comparisons of sediment core samples taken at Red Butte Reservoir, a protected watershed, Farmington Bay, and Decker Lake, an urban flood control basin, to evaluate and detect peaks in pesticides, heavy metals and selected organics (USGS, 1998). GSL sediment core samples were collected (1995-96) for a global climate study to provide insight into GSL Basin climate changes and evaluate environmental signals which could provide information regarding anthropogenic influences and trends in lake level and climate over time. (USGS, 1999)

South Shore

During 1995, the U.S. Bureau of Reclamation was directed by EPA to conduct a soil and sediment sampling program to determine trace metal concentrations across the mud and alkali flats beach area of the south arm of GSL. The study area was located between Black Rock and the Davis-Salt Lake County line north of the C-7 Ditch and Goggin Drain. This study was a response to concerns regarding the migration of heavy trace metals to the south arm beaches. Other possible sources of heavy metals are the Jordan River and Goggin Drain, which flow through several active

and inactive landfills, junk yards and several sewage treatment facilities. The purpose of this sampling program was to identify and determine the extent and the concentrations of heavy metals which might present a hazard to human health and the ecosystem. Arsenic and lead were targeted along with 22 other elements and this group wanted to identify the source of the metals. One hundred and twenty-five locations were sampled in a series of transects across the three main water channels, the C-7 ditch, Lee Creek and the Goggin Drain. The study concluded that concentrations of all contaminants of concern were below levels of biological concern.

Nonpoint Pollution Sources

A major source of pollution to all waters of the state, including GSL, is nonpoint source runoff, primarily from agricultural drainage and urban runoff. Because the lake receives overland flow and inflow from streams and irrigation/drainage ditches in addition to the three major river systems feeding the lake, nonpoint sources of water pollution are significant. Effective management of lake water quality is dependent upon effective nonpoint source management upstream.

In fiscal year 1999, a Phase II stormwater implementation component of the National Pollutant Discharge Elimination System (NPDES) will focus on reducing water pollution from urban runoff. The Total Maximum Daily Load (TMDL) is the quantity of pollutant allowable in a water body to meet water quality standards and avoid impairment of the water body's assigned beneficial uses. When TMDLs are established, the allowable pollutant loads will be allocated among all point and nonpoint sources to the water body in question. DEQ has determined that approximately 467 TMDLs will need to be developed during the next 12 years. Based on the proposed fiscal year 2000 303(d) list, there are 21 stream segments and 12 lakes/reservoirs which need to have TMDLs prepared in the GSL watershed (Pitkin, 2000).

Drinking Water

The Division of Drinking Water, in DEQ, is the state agency responsible for regulating and monitoring drinking water. Future development for drinking water depends on demand, supply, and cost effectiveness. Water uses associated with drinking water development projects could have GSL and tributary water quality implications. The primary responsibility for actions to conserve water and alleviate shortages resides with local government.

Establishment of a Department of Natural Resources' Wetland Strategy

COE regulates placement of fill in jurisdictional wetlands. DNR agencies generally enforce only COE permit requirements when issuing land use authorizations that affect wetlands. DNR is considering establishment of policy that goes beyond COE requirements. This could include actions such as mitigation requirements, grazing, burning, herbicide and pesticide application and actions in non-jurisdictional wetlands.

Inter-agency Coordination to Protect Water Quality

The planning team and DNR would like to improve coordination between local, state and federal entities in protecting water quality. According to statutory code requirements (Utah Code 65A-10-8), DFFSL is responsible to "promote water quality management for the lake and its tributary streams." However, the state's GSL jurisdiction includes below meander line and extends out to other adjacent state lands. DWQ focuses their efforts and resources on high priority streams and waters where the beneficial use is impaired. This is required by law under the *Clean Water Act*.

Protecting GSL water quality and ensuring public trust resource sustainability will require ongoing political support funding and enhanced coordination. DNR will focus resources to improve knowledge of water quality impacts on wildlife and other resources, improve understanding of chemistry and ecology to better understand lake processes and investigate how to define or determine appropriate effluent limits. This will help identify serious problems requiring response (lake and tributaries). Based on water quality monitoring results, DNR will consider GSL public trust beneficial uses and discharge effluent limits implications.