1998 Water Quality Implementation Report

Deer Creek and Jordanelle Reservoirs
Water Quality Management Plan
for the 1997 Calendar Year

Prepared for:
The Wasatch County Commission

In Association with:
Jordanelle Reservoir
Water Quality Technical Advisory Committee

June 1998

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Chapter 1

Introduction

Background

Utah's productivity and economy is largely tied to maintaining access to abundant high quality sources of water. One of Utah's best water resources, the Provo River, provides water for use by over a million Utahns for purposes such as drinking water, agricultural, industrial, and recreational uses, and many other uses. At the same time, the Provo River supports a delicate ecosystem of important species of wildlife.

The construction of Deer Creek and Jordanelle Reservoirs has helped make this water available for public and private use. These reservoirs are vital to the surrounding communities which depend on the Provo River as a resource. Phosphorus is a limiting nutrient of the algae that grows in lakes and reservoirs, the overabundance of which can cause excessive algae growth and seriously threaten the water quality in the reservoirs. In the Provo River Watershed, a variety of natural sources contribute phosphorus. Many human activities and developments increase the pollutant concentrations.

In 1981, the Jordanelle Reservoir Water Quality Technical Advisory Committee (JTAC) was established by Utah Governor Scott Matheson for the purpose of developing a reservoir management plan for Deer Creek and Jordanelle Reservoirs. JTAC is comprised of over twenty federal, state, local, and private agencies. In 1984, the Water Quality Management Plan for Deer Creek and Jordanelle Reservoirs was implemented by JTAC. The plan directs that JTAC conduct a water sampling program to monitor the condition of water quality throughout the year and that the resulting data be analyzed and presented in this yearly implementation report.

Purpose and Scope

The purpose of this report is to analyze the implementation of management practices and water quality monitoring as directed by the 1984 Water Quality Management Plan for Deer Creek and Jordanelle Reservoirs. The annual implementation report is typically supported by the presentation of phosphorus concentrations of the water samples that have been collected throughout the year. Laboratory problems during 1997 resulted in a substantial amount of inaccurate phosphorus data (see appendices D and F). Many of the goals set in 1984 by JTAC refer to phosphorus concentrations and loadings, but because of this given unique situation, this report will be limited to total suspended solids (TSS) concentrations and other reliable parameters for any water quality assessments. TSS is partially related to total phosphorus concentrations since the sediments in Wasatch County are generally phosphorus rich.

The 1998 Wasatch County Water Quality Implementation Report will:

- analyze and summarize the water quality monitoring results for the 1997 calendar year,
- identify exceedences of reliable water quality parameters,
- identify trends in the water quality, and
- recommend action for further progress towards water quality improvement.

Authorization

Psomas & Associates has been contracted by the Wasatch County Commission to fulfill the requirements of the 1984 Water Quality Management Plan for Deer Creek and Jordanelle Reservoirs by compiling information and preparing the 1998 Annual Water Quality Implementation Report.

Source of Data

The 1998 Annual Water Quality Implementation Report is based on data and information collected for the 1997 calendar year, January 1st to December 31st. The 1997 Annual Water Quality Implementation Report, covered the 1996 water year or October 1, 1995 to September 31, 1996. For the purpose of avoiding gaps in the documentation of water quality data, data from October 1 to December 31, 1996 are included in the Appendix E, but the text of this report concentrates on the 1997 calendar year.

The monitoring data has been gathered by the coordination of various agencies participating in JTAC. JTAC through Utah Division of Water Quality has provided Psomas with most of the water quality monitoring data and other pertinent information.

Other agencies have provided additional information for the completion of this report. The United States Geological Survey (USGS) provided data for stream flows at various USGS steam gage locations within the area of study. The Provo River Water Users Association (PRWUA) provided flow data for the Weber-Provo Canal. The United States Bureau of Reclamation (USBR) provided flow data for the water released from the Jordanelle dam. The Utah Division of Water Rights supplied data on the diversion of water from the Provo River into the Timpanogus Canal. The Salt Lake City Metropolitan Water District (MWDSLC) provided flow data for the diversion of water from Deer Creek Reservoir through the Salt Lake Aqueduct. Some of the agencies listed above are part of JTAC and have contributed in other ways as well. We appreciate all agencies that have assisted in providing information.

Chapter 2

Current Activities

Introduction

Land use and various activities within the watershed will have an effect on the water quality in the streams, rivers and reservoirs. In this chapter, current events and activities in the Provo River Watershed that are considered to potentially have an impact on water quality are briefly discussed.

Current Water Users

Municipal

The Provo River is a major source of public drinking water for the growing areas in Salt Lake, Utah, Wasatch and Summit Counties. The Central Utah Water Conservancy District (CUWCD), the Salt Lake County Water Conservancy District (SLCWCD), the Metropolitan Water District of Salt Lake City (MWDSLC), Metropolitan Water District of Orem City (MWDO), and the Metropolitan Water District of Provo City (MWDP) all divert water into water treatment facilities from some point along the Provo River for culinary use. The preservation of good water quality is important to reduce the costs of expensive water treatment and improve the overall drinking water quality.

Agricultural

The Provo River is also a source of irrigation water for agricultural purposes. In Heber Valley, there are fourteen irrigation companies that have water rights to the Provo River. The Provo River Water Users Association (PRWUA) and several irrigation companies in Utah and Salt Lake Valleys also have water rights to much of the water contained in Deer Creek Reservoir.

Recreation and Fisheries

Jordanelle and Deer Creek Reservoirs along with the Provo River and its tributaries are a source of recreation for many. State Parks are located on Jordanelle and Deer Creek Reservoirs to provide basic services for the recreationists that visit. The reservoirs provide water skiing, swimming, boating, fishing and more. Jordanelle opened its waters to fishing in 1995. Deer Creek and Jordanelle Reservoirs along with the Provo River and its tributaries provide excellent fisheries for anglers.

Current Activities

JTAC "Keep Your Water Clean" Logo

A public information subcommittee of JTAC has developed a logo to convey the message that Deer Creek and Jordanelle Reservoirs are primarily storage reservoirs for drinking water. Additionally these reservoirs provide scenic and recreation opportunities and should therefore be protected from unnecessary pollution. To distribute the logo and the concept to the public, litter bags which will be distributed at the Park entrances and signs posted around the reservoirs and along Provo River. The costs of printing were distributed among eight state and local agencies which contributed over $20,000 of cash and in-kind support to this project. The bags and signs are scheduled to be ready for the 1998 recreation season.

In addition, the State Division of Wildlife Resources has published the logo with some explanation in the 1998 Fishing Proclamation and in the winter 1998 Wildlife Review. The State Division of Parks & Recreation has printed the logo and explanation in the spring 1998 Discover. These efforts represent over $10,000 of in-kind contribution to the public education project from the Department of Natural Resources.

Tri-Valley Watershed Project

The Natural Resources Conservation Service (NRCS), through the United States Department of Agriculture's Small Watershed Program (PL-566), is assisting Wasatch Soil Conservation District and Wasatch County in planning a land treatment watershed. The plan will address natural resource problems and opportunities within the 248,000 acre watershed.

Purposes of the Tri-Valley Watershed are water conservation, improved fish and wildlife habitat, and water quality. The on-farm irrigation systems will fulfill the purpose of water conservation and improved fish and wildlife habitat. The on-farm systems will receive a priority because conserved water will be used to enhance in-stream flows to benefit fish habitat. Some water quality improvements may also result from decreased surface runoff and decreased deep percolation.

The final Watershed Plan-Environmental Assessment for the Tri-Valley Watershed was completed and the Watershed Agreements signed by the sponsors and the NRCS. This plan may now be implemented as funds become available.

NRCS and the local sponsors applied for $500,000 from the national watershed funds and $500,000 from a new federal funding program called the Environmental Quality Improvement Program (EQIP). No watershed funds were allocated to Utah for 1998 but NRCS Utah did receive a little over 2 million dollars from EQIP. The Tri-Valley Watershed project received $500,000 from this fund.

The Wasatch County USDA Local Work Group (LWG) voted to use all of these funds toward the first phase of converting flood irrigation systems to sprinkler systems. These funds will be used to pay up to 65% of the cost of installing on-farm sprinkler systems, with a maximum cost share grant not to exceed $500.00 per acre. The majority of construction for phase 1 will take place during the fall of 1998 and the spring of 1999. Phase 2 will be during 1999 and 2000, and Phase 3 will take place in the year 2000 and 2001.

Other funding programs are available for some of the other aspects of the Tri-Valley Watershed projects. However, NRCS's efforts will be targeted toward the on-farm sprinkler conversion during the next three years to coordinate with the timing of the Wasatch County Water Efficiency Project.

A riparian demonstration project was installed along 1500 feet of Spring Creek in April of 1997. The project consisted of 3100 feet of fencing and 1500 shrub and tree plantings. The project can be viewed from Midway Lane at the crossing of Spring Creek. The major funding for this project was furnished by United States Fish & Wildlife Service. The planning was done by NRCS, and the planting was installed during a training exercise sponsored by the Bonneville Team of NRCS. The plantings are very small at this time and access is restricted.

For further information regarding this project, you may contact Ralph Mickelson of NRCS at 435-654-0242.

Small Farm & Pasture Management Guide and Classes

The Wasatch Soil Conservation District recently published *A Pasture & Hayland Management Guide: For Small Farms & Ranches in Wasatch County*. The guide addresses planning, economics, water management, soil conservation, Best Management Practices and other important issues involved with agricultural lands. The District is presenting seminars to educate farmers and ranchers on use of the guide. The class is required for those farmers receiving government financial aid. Classes were presented in January 1998 when the guide was released. The next set of classes is scheduled for Fall 1998. For further information about times and dates of classes, you can contact Ralph Mickelson, soil conservationist at NRCS, 435-654-0242.

Jordanelle Master Plan

Wasatch County Planning Department is proceeding with development of the Jordanelle area. The area has the infrastructure to accommodate approximately 7,200 equivalent residential units around the reservoir. Many developers have begun to submit their requests to begin work on their respective developments. Based solely on inquiries, since no building permit applications have been accepted as of yet, Wasatch County expects most of the available connections to be developed in the next four to five years.

Deer Crest Development

Deer Crest has constructed one ski lift and ski runs. They are currently working on the construction of additional runs and design of a second lift which will connect the Jordanelle area with the Deer Valley Ski Area. These lifts and runs are expected to be open to the public as part of Deer Valley this upcoming winter. Deer Crest has, thus far received a density determination for 516 units, with approval to begin construction on 147 residential lots. Multi-family dwellings and commercial buildings are being designed at this time, and Wasatch County expects application for approval in the next few months.

Other Developments

East Park is the only other development that has received approval for construction other than the portions of Deer Crest just mentioned. East Park has been approved for approximately 70 lots. Staghorn has received preliminary approval for a commercial hotel and about 50 residential lots. There are many other developers that have plans to begin work on their developments as soon as the County can process their applications.

Jordanelle Reservoir

Jordanelle Reservoir retains sediments and phosphorus which helps lowers total phosphorus concentrations in the Provo River and Deer Creek Reservoir below. The 1984 management plan called for the retention of 50% of all phosphorus originating in the Jordanelle Reservoir basin. The Selective Level Outlet Works (SLOW) on Jordanelle Dam was designed to assist in this goal by controlling the depth from which water is released from the reservoir.

Jordanelle Reservoir was filled for the first time in the summer of 1995 and SLOW functioned until November 1996 when additional construction began to improve the gate shaft lining. In August 1997 the SLOW tower was ready for operation again. Although the data available for analysis is limited to just a few years, it is believed that Jordanelle Reservoir has retained approximately 50% of its phosphorus inputs since 1994.

In November 1996, a blue-green algae bloom in Deer Creek Reservoir was observed by Charlie Thompson of the DWR. Jerry Miller of the USBR, remembered observing a bloom on Jordanelle Reservoir in October 1996 that had been blown near the SLOW leading him to the conclusion that the bloom in Deer Creek was a result from part of the Jordanelle bloom being conveyed through the SLOW into the Provo River.

This occurrence may require that the Standard Operating Procedures for the SLOW be reviewed and revised. Jerry Miller is finishing “Jordanelle Dam Selective Outlet Works, Report and Operating Criteria” that analyzes the operation of the SLOW. The draft version of the report was released this year, a summary has been provided courtesy of the USBR and is included in Chapter 4 in the section titled “Jordanelle Selective Withdrawal”. The final report is awaiting comments and review.

Jordanelle State Park

Camping, fishing, boating, hiking and other recreational activities are available at the two developed recreation sites of Jordanelle State Park. A third potential recreation site at the end of the North Arm, "Ross Creek" is still awaiting development funding.

The Rock Cliff Recreation Site is located at the east end of the reservoir and has accommodations which include a nature center, elevated boardwalk systems, modern restrooms with showers, group-use pavilions, 50 walk-in camping sites, and limited non-motorized trails.

The Hailstone Recreation Site and Jordanelle Reservoir opened its park gates and launch ramps at the end of June 1995. The 400 acre tract of land located on the west shore of the reservoir provides facilities for 180 camping units, individual powerboat and personal watercraft launching sites, 30 individual day use cabanas, beach house facility, 3 large group use pavilions, playgrounds, laundromats, visitor center and a convenience store / restaurant.

The perimeter trail system opened in conjunction with the Hailstone facilities. The park now offers 13 miles of trails available for hiking, jogging, mountain biking, equestrian use, and cross-country skiing. A ten mile segment is planned for future development.

The Ross Creek site will be located on the east shore of the north arm of the reservoir. Limited day use access is planned for the Summer of 1998 in the Ross Creek Area. No permanent facilities are being designed at present because of its limited use due to reservoir fluctuation, and because full development cannot proceed until a sewer system is developed and extended to this location.

Jordanelle Special Service District - Water System

Jordanelle Special Service District water system design (including waterlines, pump stations, intake structures, treatment plant, and storage tanks) began in 1997. Construction of some of the tanks and waterlines also began in 1997. Final design of the initial system needed to operate much of the Deer Crest area is expected to be completed in 1998. A substantial amount of the construction of facilities needed for the Deer Crest development is also expected during 1998.

Jordanelle Special Service District - Sewer System

The Jordanelle Special Service District has continued with the design and construction of the sewer systems (including pump stations, main transmission lines, and emergency holding basins) needed to service the areas west and north of Jordanelle Reservoir. It is expected that individual collector mains will also be constructed by each development in 1998 and in subsequent years.

Mayflower Resort

Mayflower Mountain Resort has been monitoring stream flows and water quality parameters in the McHenry Canyon drainage area since 1984, and reporting the results in an annual report to Wasatch County.

The Utah Division of Water Quality (DWQ) has issued a Ground Water Quality Discharge Permit for the stabilization of the three tailing ponds located adjacent to US Highway 40. This 5-year permit is scheduled to expire this year, however, Mayflower has applied for renewal of the permit.

Plans and specifications have been prepared for the stabilization of the tailing ponds. The tailing ponds have not yet been capped because an economical source of random fill has not been obtained. UDOT has committed to providing the required random fill from road repair activities along US 40, which would generate the fill, however, they have not yet established a schedule for the repairs. Mayflower is presently attempting to identify an alternative source of random fill.

In the meantime, Mayflower has implemented interim storm water controls around the tailing ponds to control the migration of tailing material. The interim storm water controls consist of diversion channels and detention basins which are inspected, with DWQ oversight, twice a year and maintained as necessary. Biannual inspection reports are prepared and submitted to the DWQ identifying inspection observations and recommendations, and summarizing any maintenance performed on the interim storm water controls.

Soldier Hollow: 2002 Winter Olympics

In the next few years the Heber Valley will see even more pressure from growth and construction related impacts due to the Olympic activities. Soldier Hollow has been selected for the biathlon and cross country events for the 2002 Winter Olympics. The wetlands issues surrounding this site are paramount because of their location and extent. Another factor is the proximity of Deer Creek Reservoir and its water quality concerns. The Wasatch County staff will be intimately involved in the planning and construction periods for this site.

UPDES Permits

Three entities in the watershed have surface water discharge permits which are part of the Utah Pollutant Discharge Elimination System (UPDES) Permit program administered by the Division of Water Quality (DWQ). These are the Midway Fish Hatchery, Kamas Fish Hatchery, and United Park City Mines.

Midway Fish Hatchery

The UPDES permit was effective on March 1, 1995 and expires February 28, 2000. It specifically limits the total suspended solids (TSS) maximum concentration to 25 mg/l, TSS maximum daily loading to 1398 lbs/day, pH to a range of 6.5 to 9.0, and net increase of total phosphorus to 626 kg/yr. The permit requires the hatchery to monitor the influent springs and the effluent springs for the determination of net increase of total phosphorus. The results of the monitoring as reported in a monthly Discharge Monitoring Report (DMR) indicated that for 1997 the net increase of phosphorus measured was 320 kg and the TSS maximum daily loading was 570.8 kg/day.

Kamas Fish Hatchery

The Kamas Fish Hatchery, although smaller than the one at Midway, is planning to increase their fish production from 80,000 to 140,000 pounds per year. Reconstruction plans scheduled to begin this year will increase the capacity and efficiency of the hatchery. The new plans include concrete lining of the ponds and a string of settling ponds to reduce suspended solids in the effluent. Their current UPDES permit became effective March 1, 1995 and expires February 28, 2000. It was recently amended in August 1997 to allow for higher daily loads of TSS. The original limitations for TSS were a maximum 25 mg/l and 882 lbs/day. The new amended permit holds the maximum concentration of TSS at 25 mg/l, but allows the daily loading limit of TSS to increase to 1741 lbs/day.

The UPDES permit does not require phosphorus monitoring, however, to offset the potential for increased phosphorus discharges, the DWR has included settling ponds in the expansion plans that will contribute to reducing the amount of phosphorus loads that otherwise would have been discharged. The settling ponds at the Midway Fish Hatchery appear to have helped greatly to meet phosphorus limitations.

United Park City Mines

On the west side of Jordanelle Reservoir, the United Park City Mines discharges water from their treatment facilities at Keetley Station. This water originates from old mines in Park City that are drained through the Ontario #2 Drain Tunnel. The UPDES permit sets specific limitations on daily maximum concentrations of TSS, aluminum, copper, lead, mercury, zinc, oil and grease. Limitations are also placed on 30-day average concentrations of TSS, lead and mercury. The drain tunnel is not a significant source of phosphorus and phosphorus is not limited in the permit although JTAC monitors the effluent. The current permit was effective on August 1, 1997 and expires June 30, 2002.

Wasatch County Water Efficiency Project & Daniel's Replacement Project

Design of the Wasatch County Water Efficiency Project has been completed and Central Utah Water Conservancy District (CUWCD) advertised for construction bids. A bid opening is scheduled for April 13, 1998. The project will be constructed over a three year period beginning this summer and will allow 1600 acres of land in the Heber Valley to be irrigated with sprinklers rather than the flood irrigation methods currently used. In addition, the project will allow the delivery of water to Daniel Irrigation Company as a replacement supply for water that they are diverting from the Strawberry River Basin. The Strawberry River flows will remain in the Strawberry Basin to improve fish and wildlife habitat, as required by the mitigation plan for the CUP's Strawberry Aqueduct and Collection System. A total of 23,000 acre feet of water will be used more efficiently in Heber Valley as a result of this project. Following construction, the Wasatch County Special Service Area #1 will operate and manage the system under contract to CUWCD. For more information contact Project Manager Karen Ricks at 801-226-7126.

Provo River Restoration Project

The goal of the Provo River Restoration Project (PRRP) is to restore the Provo River to naturalistic conditions in the Heber Valley. In many areas the river has been straightened due to development of agricultural lands and the construction of flood control levees. This project proposes to create a meandering river path with the purpose of restoring a more naturally functioning river system. Existing levees would be set back to allow for a near natural flood plain that would allow for the river to change course naturally. Also important to the restoration, is the streamside vegetation that provides the necessary environment for healthy fisheries. Construction of side channels and ponds is also part of the proposed mitigation procedures for the improvement of fish habitat.

The Utah Reclamation Mitigation and Conservation Commission, who has proposed this project, completed the FEIS (Final Environmental Impact Statement) in December 1997. The FEIS compares the proposal to other alternatives of in-stream mitigation measures. These alternatives consisted of structures constructed in the existing channel that would facilitate a better fish habitat by creating differential water flows in the channel. With the release of the FEIS, the proposal is awaiting comments from the public and approval by federal government officials.

Groundwater Study

In 1995, the aquifer in the Heber Valley was classified as Class 1A pristine by the State Water Quality Board. From recommendations made in previous implementation reports, JTAC has been working with Wasatch County and the USGS to develop a groundwater monitoring plan. The JTAC monitoring schedule for fiscal year 1999 will include cost-share funding for USGS to collect and analyze one sample from each of ten selected existing observation wells in the valley. This monitoring will be used to help determine groundwater quality returning to Provo River and Deer Creek Reservoir, detect any existing or future problems, and define trends in the groundwater.

Deer Creek Resource Management Plan

The Deer Creek Resource Management Plan (RMP) insures water integrity as a principle source of water supply for the Wasatch Front area, protects and maintains the purposes for which the Provo River Project was authorized by congress, and provides long term management direction information for prospective users as well as interested public.

It describes the activities necessary to achieve the desired future condition of the project, in the following decision areas:

1. Area-wide goals and objectives,
2. Area-wide management requirements,
3. Specific area management direction,
4. Lands suited or not suited for resource use and production, and
5. Monitoring and evaluation requirements.

The Deer Creek RMP is in draft form, ready to be mailed to receive final public comment. It is scheduled for completion in June 1998.

Deer Creek State Park Renovations

Utah State Division of Parks and Recreation and the Bureau of Reclamation are jointly funding the $4 million renovation of recreation facilities at Deer Creek State Park. The improvements include new covered picnic tables, group pavilions, modern restrooms, improved roads and a new launch ramp. Construction at Island Park and Sailboat Beach will extend and reclaim the beaches from the eroded shoreline, also lawn areas will be expanded and improved. These improvements are scheduled to be completed by the end of May 1998. In the second phase of construction, Rainbow Bay and Snow’s Marina are scheduled for renovation as well.

Throughout the renovation, the State Park is ensuring that water quality is protected. New restrooms will require the construction of septic tanks and drain fields. These drain fields are being located at a minimum of 300 feet from the shoreline to prevent contaminated water from leaching into the reservoir. Surface runoff containing oils and other contaminants that originate from asphalt roads and parking lots will not flow directly into the reservoir. Special catchments will allow for the contaminated water to be filtered before reaching Deer Creek. Renovations will also place physical barriers such as rip rap to prevent motorized vehicles from accessing Deer Creek beaches and shoreline areas. New signs will be posted around the reservoir that prohibit dogs and other domestic pets from areas outside of campgrounds.

Lower Provo River Fish Habitat Restoration

The Utah Division of Wildlife Resources (DWR) allocated funding from the habitat stamp program to improve fish habitat in parts of the lower Provo River. In October 1997, ten large tree trunks were installed in the Provo River along the six-mile section from Deer Creek Dam to the Olmsted diversion. The logs were secured in place by thick cables attached to large boulders. It is anticipated that the logs will provide shelter for vulnerable juvenile fish during winter months when shelter is scarce due to the lack of vegetation. After evaluation, if the project appears to have helped conditions in the fishery, then further funding will be approved to put logs in the Provo River below Olmsted.

Wasatch County Water Quality Management Plan

The Wasatch County Water Quality Management Plan was delivered in draft form to members of JTAC in June, 1997. Comments were solicited at that time from members of the Committee as well as the EPA, DNR and other interested parties. These comments were received in December, 1997 and responses to these comments drafted. Based on the comments received, changes and revisions to the Draft Plan are currently being made and a final version of the Plan is expected in May, 1998.

US-189 Highway Construction

The widening of US-189 in Provo Canyon from Upper Falls to Wildwood that began in the Spring of 1996 continued through 1997. As well as road construction, the work also consists of tunnel construction that includes drilling and blasting. The contractor is using several erosion control measures including; straw bales, check dams, sediment fencing, seeding, wetland mitigation, detention basins, watering for dust control, and silt fences. The project is scheduled for completion at the end of Fall 1998.

Chapter 3

1997 Water Quality Monitoring Program

Introduction

JTAC has established a monitoring program that is described in this Chapter, providing the methodologies and assumptions used for calculations and presentations of data.

JTAC Monitoring Program

The JTAC Monitoring Program has a method of systematically taking samples from the streams and reservoirs in the watershed. For 1997, JTAC has taken numerous samples from 46 locations for the purpose of water quality analysis. The locations were chosen with the purpose of analyzing the progress towards the goals set in 1984. Each is identified by a six digit STORET number. Tables 3.1 and 3.2 on the following pages lists the 46 sites with their STORET number and descriptions. These locations are graphically shown on Maps 1-4 located at the end of this chapter.

Stream Monitoring

There are 18 locations along Provo River and the basin's tributary streams where stream samples were taken. Most stream locations were sampled approximately on a monthly basis. Field data is gathered that describe many physical properties. Further analyses is then conducted at the State Laboratory for nutrients and dissolved metals, refer to Tables 3.1 and 3.2.

Reservoir Monitoring

There are four locations on Deer Creek Reservoir and three on Jordanelle Reservoir where reservoir sampling occurred. The samples have been typically taken at four different depths where possible. Accounting for the varying depths, there are a total of 23 reservoir sampling points. Field data is gathered, along with Secchi depths (transparency tests) that were measured for determination of water clarity of the reservoir. Further analyses is then conducted at the State Laboratory for nutrients and dissolved metals refer to Tables 3.1 and 3.2.

Insert Table 3.1 FY 1996-1997 JTAC Monitoring Program

Insert Table 3.2 FY 1997-1998 FY Monitoring Program

<u>Reservoir Profiles</u>

In addition to the normal reservoir sampling, temperature, dissolved oxygen, specific conductance, redox potential, and pH data were gathered at approximately twenty depths to produce a profile of the reservoir for these parameters. The most critical parameter is the dissolved oxygen (DO) concentration with reference to the thermocline determined from the temperature readings. Low DO concentrations are an indication of poor water quality and can result in anaerobic activity, loss of aquatic wildlife and undesired taste and odor in the water. For lakes and reservoirs, algae growth is many times deemed responsible for DO depletion. This is due to dying algae that consequently sinks to the bottom of the reservoir and aerobically decays in the hypolimnion consuming the DO. In severe conditions, which occur seasonally in Deer Creek Reservoir, the decay of algae will entirely consume DO which creates an anaerobic environment. These profiles help determine the concentrations of DO and the distribution with depth.

Other Monitoring

The remaining five sampling locations account for three point source effluents (Midway Fish Hatchery, Kamas Fish Hatchery, and United Park City Mines), and two Quality Assurance/Quality Control (QA/QC) locations. The QA/QC locations are described later in this chapter. For next fiscal year, JTAC has included funding for the monitoring of groundwater in existing wells in Heber Valley.

Data Coordination

The Department of Environmental Quality, Division of Water Quality (DWQ) is responsible to coordinate the field sampling and laboratory analysis of the data. The samples are collected by various agencies which report the field data to the DWQ and deliver the water samples to the State Laboratory. The DWQ then returns the results of the laboratory analysis to JTAC. Appendix E contains the water quality raw data that is a result from this process.

Report Organization

For the purpose of report organization, the watershed has been divided into four major sub-basins. Each sub-basin is analyzed in its own separate chapter. The sub-basins and their corresponding chapters are listed below:

- **Chapter 4**. The Upper Provo River and Jordanelle Reservoir Basin
- **Chapter 5**. The Provo River through the Heber Valley
- **Chapter 6.** The Deer Creek Reservoir Basin
- **Chapter 7.** The Provo River below Deer Creek

Also, Appendix A presents the water quality data in the order given by the segmented sub-basins above.

Quality Assurance/Quality Control (QA/QC)

The DWQ has established the method of duplicate sampling for QA/QC. The method consists of taking duplicate samples that are labeled with a separate STORET number and a dummy description for unbiased comparisons. The laboratory results of the duplicate sample are compared with the actual site sample. Any discrepancy found in the samples is weighed against a 95% confidence interval generated through a statistical methodology.

There were two sites from which duplicate samples were taken. One was located on the Provo River below Deer Creek Reservoir with a dummy description of Provo River at Utah County Line. The other was located on Deer Creek Reservoir near the dam with a dummy description of Deer Creek Reservoir 100 meters west of outhouse. For further information regarding the methodology and results, refer to Appendix D.

QA/QC 1997 Results

Some problems occurred during 1997 regarding the analysis of phosphorus. The QA/QC program was able to identify the inaccuracies and has taken steps intended to reduce the potential for a reoccurrence of these problems in future years. Information regarding the QA/QC results can be found in Appendix D. The following excerpt was taken from the QA/QC report issued by Arne Hultquist of the DWQ on January 12, 1998:

> The phosphorus analyses showed significant differences in several duplicate samples. The percentage of blind duplicate phosphorus results that did not fall within the 95% confidence interval was 17.9%. Furthermore, the percentage of dissolved phosphorus values that were greater than total phosphorus values was 38.5%. (See Appendix D of the Implementation Report)

The DWQ and the State Laboratory have narrowed down the problems of the laboratory phosphorus testing to those samples taken on and after April 28, 1997. Further investigations of the problems in the State Laboratory were conducted to determine which samples that were taken after April 28 may be considered to have reliable phosphorus data. Appendix F contains the resulting report by the State Laboratory.

The repercussions of the phosphorus testing problems are severe in the preparation this year's implementation report. Due to the incomplete set of phosphorus data, JTAC decided to concentrate on TSS and the other reliable parameters. The reliable phosphorus data that is has been included in the appendix but no analysis or commentary will be made on the unreliable phosphorus data. Yearly phosphorus loads cannot be calculated nor compared with previous years. TSS will be the basis of most conclusions derived from the report.

Surface Water Classifications and Standards

Each stream and reservoir in the State of Utah is classified according to its beneficial uses. The classifications are used to determine the required standards for water quality parameters. The following classifications have been assigned to the surface waters pertinent to this report:

Description	Classification
• Provo River and tributaries	1C, 2B, 3A, 4
• Deer Creek Reservoir	1C, 2A, 2B, 3A, 4
• Jordanelle Reservoir	1C, 2A, 3A, 4

The classifications are defined as:

Class 1C:	Protected for domestic purposes with prior treatment processes as required by Utah Department of Health.
Class 2A:	Protected for primary contact recreation such as swimming.
Class 2B:	Protected for secondary contact recreation such as boating, wading and similar uses.
Class 3A:	Protected for cold water species of game fish and other cold water aquatic life, including the necessary aquatic organisms in the food chain.
Class 4:	Protected for agricultural uses including stock watering and irrigation of crops.

This information can be found in detail in Utah Administrative Code R317-2 Standards of Quality for Waters of the State.

General Water Quality Standards

Standards have been set by the State of Utah regarding water quality parameters based upon the beneficial uses as determined by classification.

The State of Utah has set bacteria standards for surface waters that are classified for domestic or recreational uses (Classes 1 & 2). The standards set for Class 1 domestic use water is 5000 maximum total coliforms per 100 mL and 2000 total maximum fecal coliforms per 100 mL. The standards set for Class 2 recreational use water is 1000 maximum total coliforms per 100 mL and 200 maximum total fecal coliforms per 100 mL. The results of the bacteriological laboratory tests on the samples can be found in the complete data in Appendix E.

According to state standards, the pH for waters of all classifications must remain in the range from 6.5 to 9.0. For cold water species of fish (Class 3A) the maximum water temperature is 20 degrees Celsius. Maximum water temperature and minimum dissolved oxygen (DO) levels have been set for aquatic life. Minimum DO levels have been determined based upon the presence of early stages of life. When present, 8.0 mg/L is the minimum limit, otherwise it is 4.0 mg/L. The DWQ, rather than perform an investigation at each location for early stages of life, has established the practice of using 6.5 mg/L as an indicator of a low DO level. For deep lakes and reservoirs, lower DO levels are anticipated and accepted. JTAC, for this report, has established the value of 2.0 mg/L to be used as the minimum DO limit in Deer Creek and Jordanelle Reservoirs.

The State's standards regarding phosphorus are limited for recreational, and aquatic wildlife uses (Classes 2 & 3). The State maximum limit for phosphorus as P is 0.05 mg/L for streams and 0.025 mg/L for reservoirs. The 1984 Watershed Management Report by JTAC recommended that the phosphorus concentration limit be reduced to a more stringent 0.04 mg/L for the areas rivers and streams.

Table 3.3 below is summary of the standards that were used to analyze the water quality data and identify potential problems.

Table 3.3 Water Quality Standards.

Parameter	Value
Minimum Dissolved Oxygen (mg/L)	6.5/2.0*
pH Range	6.5-9.0
Maximum Temperature (deg C)	20
Total Suspended Solids (mg/L)	35
Total Phosphorus as P (mg/L)	.04/.025*
Dissolved Phosphorus as P (mg/L)	.04/.025*

* First value is used for streams and rivers, second value is used for reservoirs

Ammonia Standards

For protection of aquatic life, the State has set standards for allowable ammonia concentrations. The toxicity of ammonia varies according to pH and temperature. The State has established charts for the determination of ammonia standards. The chart used for this report is for Class 3A waters as given below in Table 3.4.

Table 3.4. 1-Hour average allowable concentrations (mg/L) of ammonia as N for Class 3A waters.

	TEMPERATURE (C)						
pH	**0**	**5**	**10**	**15**	**20**	**25**	**30**
6.5	0.008	0.011	0.015	0.021	0.03	0.03	0.03
7.0	0.019	0.027	0.038	0.054	0.076	0.076	0.076
7.5	0.037	0.053	0.075	0.105	0.149	0.149	0.149
8.0	0.054	0.076	0.107	0.151	0.214	0.214	0.214
8.5	0.054	0.076	0.107	0.151	0.214	0.214	0.214
9.0	0.054	0.076	0.107	0.151	0.214	0.214	0.214

Dissolved Metals

An analysis of dissolved metals was performed on some samples. The standards used for dissolved metals are from the state restrictions for domestic, aquatic life, and irrigation uses. Recreational and aesthetic uses have very few set standards on dissolved metal concentrations. Table 3.5 below summarizes the limits for each use based on 1-hr averages of measurements. The bold numbers indicate the most stringent of the standards that were used for identifying exceedences.

Table 3.5 Dissolved Metals Allowable Concentrations for 1-hr average measurements

	Allowable Concentration (μg/l)		
Dissolved Metal	**Class 1C**	**Class 3A**	**Class 4**
Aluminum		**750**	
Arsenic	**50**	360	100
Barium	**1000**		
Cadmium	10	**3.9**	10
Chromium	50	**16**	100
Copper		**18**	200
Iron		**1000**	
Lead	**50**	82	100
Mercury	**2**	2.4	
Selenium	**10**	20	50
Silver	50	**4**	
Zinc		**120**	

Loading Calculations and Assumptions

In previous implementation reports, stream loadings were calculated for phosphorus and TSS. This year is unique because of the problems discovered by the DWQ in the State Laboratory and the resulting unreliability of the phosphorus data. Therefore, the loads could only be calculated from TSS concentrations. Appendix C contains the spreadsheets used to determine TSS loads. As previously mentioned, the TSS loads are calculated based on calendar year instead of water year used in previous implementation reports.

The loading calculations were based on the water quality data gathered by JTAC and an average daily flow measurement typically taken from a USGS gage station. In locations where no USGS flow gages were present then other methods were used as indicated on the spreadsheets in Appendix C. The calculations used the TSS mass concentrations (mg/l) and average daily flow rate in the stream (cfs) to determine the TSS daily mass loading rate (tons/day). Each daily mass loading rate was then averaged with the mass loading rate of the previous sampling date and multiplied by the number of days between samples to obtain the total mass load for that period. This assumes that the mass loading rates are steady and that increases and decreases are relatively gradual. This calculation method is in accordance with the statistical report published in the 1992 implementation report.

Map 1

Map 2

Map 3

Map 4

Chapter 4

The Upper Provo River and Jordanelle Reservoir Basin

Introduction

This chapter will present and analyze the water quality monitoring for the Upper Provo River and Jordanelle Reservoir.

Monitoring Sites

The monitoring plan for this year included nine sites in this area. Below is listed the description of each site with its STORET number.

STORET No.	Location Description
• 499840	Provo River above Woodland at USGS gage
• 492900	Kamas Fish Hatchery effluent
• 499814	Weber Provo Canal Diversion at US 189
• 499813	Provo River above Hailstone
• 591404	Jordanelle Reservoir – Provo River arm
• 591403	Jordanelle Reservoir – north arm
• 591401	Jordanelle Reservoir – above dam
• 499804	Ontario #2 Drain Tunnel (Park City Ventures)
• 499767	McHenry Creek below Mayflower

Each site is described in the following sections with a summary table of the water quality monitoring. For more complete tables showing actual data from the 1997 water quality monitoring, refer to Appendix A.

The Provo River above Woodland, STORET # 499840

This monitoring location represents water coming from the headwaters of the Provo River in the Uinta Mountains. It is located on the Provo River approximately 4 miles upstream of Woodland near USGS flow gage #10154200. A summary of the water quality data for this location is shown below in Table 4.1.

Table 4.1 Provo River above Woodland, STORET # 499840 – Water Quality Summary

Date	Temp Deg C	pH	D.O. mg/l	T.Sus.Sol mg/l	Ammonia N mg/l	T. Phos. mg/l	D-T Phos. mg/l
Minimum	1.2	7.7	8.5	0	0.00	0.01	0.01
Maximum	13.6	8.6	11.7	17	0.54	0.02	0.03
Median	6.4	8.1	10.0	0	0.00	0.02	0.02
Mean	7.0	8.1	10.0	4	0.05	0.02	0.02
Number	10	10	10	10	10	2	2
Exceedences	0	0	0	0	1	0	0

The location was monitored ten times during 1997. The phosphorus data was unreliable for eight of ten samples. Historically the location has good water quality with few exceedences in phosphorus. Ammonia logged one exceedence in April. There were no other exceedences. The TSS concentrations for this year are comparable to past years which show the clarity of the Provo River at this site.

Kamas Fish Hatchery Effluent, STORET # 492900

The Kamas Fish Hatchery discharges into Beaver Creek, approximately 3 miles east of Kamas which is historically a tributary to the Weber River. During high spring runoff flows, a portion of the water is diverted into the Weber-Provo Canal which brings it into the Provo River Basin. Also, during the agricultural growing season, much water is diverted for irrigation and the return flows are discharged into the Provo River Basin. For this reason, the Kamas Fish Hatchery may be considered a point source of phosphorus loading for the Provo River. The current UPDES permit does not require phosphorus monitoring despite efforts by Wasatch County to persuade the DWQ to establish phosphorus limits. A summary of the water quality data for the effluent is shown below in Table 4.2.

Table 4.2 Kamas Fish Hatchery Effluent, STORET # 492900 – Water Quality Summary

Date	Temp Deg C	pH	D.O. mg/l	T.Sus.Sol mg/l	Ammonia N mg/l	T. Phos. mg/l	D-T Phos. mg/l
Minimum	6.3	7.5	4.1	0	0.11	0.00	0.00
Maximum	16.2	8.2	8.6	12	0.38	0.05	0.03
Median	11.3	7.8	7.4	0	0.16	0.03	0.02
Mean	11.2	7.8	7.3	2	0.20	0.03	0.02
Number	12	12	12	12	8	2	2
Exceedences	0	0	1	0	7	1	0

The location was sampled twelve times during 1997. Four of twelve samples were only monitored for field parameters. The other eight were sent to the lab for analysis. The phosphorus data was unusable for most of the samples. For the two reliable samples, phosphorus was in exceedence once. There were numerous exceedences in ammonia which indicates a possible toxicity problem in Beaver Creek. One sample also recorded a low dissolved oxygen concentration.

Weber Provo Canal Diversion, STORET # 499814

This monitoring site is located where the Weber-Provo Canal flows into the Provo River at a point approximately 3 miles south of Kamas. The Weber-Provo Canal diverts water from the Weber River into the Provo River. A summary of the data is shown below in Table 4.3.

Table 4.3 Weber Provo Canal Diversion, STORET # 499814 – Water Quality Summary

Date	*Temp Deg C*	*pH*	*D.O. mg/l*	*T.Sus.Sol mg/l*	*Ammonia N mg/l*	*T. Phos. mg/l*	*D-T Phos. mg/l*
Minimum	0.1	7.4	7.4	0	0.00	0.01	0.01
Maximum	16.3	8.4	12.4	7.6	0.00	0.036	0.02
Median	5.9	8.1	10.3	0	0.00	0.02	0.02
Mean	7.3	8.0	9.9	2.6	0.00	0.02	0.03
Number	9	9	9	9	9	2	2
Exceedences	0	0	0	0	0	0	0

The location was monitored on ten occasions during 1997 of which nine samples were gathered because during June no flow was present to collect a sample. Only two samples had phosphorus data that was reliable of which there were no exceedences Historically the canal records one or two exceedences in phosphorus each year. All other parameters monitored gave results within the set JTAC standards.

Provo River above Hailstone, STORET # 499813

This monitoring site is located just upstream of the mouth of the Provo River into Jordanelle Reservoir near USGS flow gage #10155000. This location represents the water that discharges into Jordanelle Reservoir from the Provo River. A summary of the data is shown below in Table 4.4.

Table 4.4 Provo River above Hailstone, STORET # 499813 – Water Quality Summary

Date	*Temp Deg C*	*pH*	*D.O. mg/l*	*T.Sus.Sol mg/l*	*Ammonia N mg/l*	*T. Phos. mg/l*	*D-T Phos. mg/l*
Minimum	0.2	7.8	7.2	0	0.00	0.02	0.01
Maximum	16.4	8.7	12.8	66	0.00	0.03	0.02
Median	5.7	8.3	10.1	4.0	0.00	0.02	0.02
Mean	7.0	8.3	10.0	10.8	0.00	0.02	0.02
Number	11	11	11	11	11	2	2
Exceedences	0	0	0	1	0	0	0

The location was monitored eleven times during 1997. The phosphorus data was unusable for nine of the eleven samples. Historically, one or two exceedences in phosphorus are present. On May 13th, 66 mg/l of TSS was measured in the sample taken. For the other parameters, no exceedences were recorded.

Jordanelle Reservoir – Provo River Arm, STORET # 591404

The Provo River Arm of Jordanelle Reservoir was sampled six times during 1997. All six included a sample taken from the reservoir surface and a sample taken from the bottom of the reservoir at a depth of approximately 39 meters. A combined summary of the water quality data for the surface and bottom is shown below in Table 4.5.

Table 4.5 Jordanelle Reservoir – Provo Arm, STORET # 591404 – Water Quality Summary

Date	*Temp Deg C*	*pH*	*D.O. mg/l*	*T.Sus.Sol mg/l*	*Ammonia N mg/l*	*T. Phos. mg/l*	*D-T Phos. mg/l*
Minimum	3.7	7.0	3.7	0	0.00	-	-
Maximum	20.9	8.4	10.4	5	0.00	-	-
Median	7.9	7.5	6.8	0	0.00	-	-
Mean	10.7	7.6	6.7	0	0.00	-	-
Number	12	12	12	12	12	0	0
Exceedences	1	0	0	0	0	0	0

No phosphorus data was reliable for analysis. There were no exceedences in any parameters except one instance of high water temperature which is not uncommon for the surface of the reservoir during warm summer months. Dissolved oxygen levels remained high for all sampling dates. DO and temperature profiles taken at this site are presented later in this chapter.

Jordanelle Reservoir – North Arm, STORET # 591403

The north arm of Jordanelle Reservoir was also sampled on six occasions during 1997. Samples were taken at the surface of the reservoir and the reservoir bottom approximately 42 meters deep. A combined summary of the water quality data for the surface and bottom is shown below in Table 4.6.

Table 4.6 Jordanelle Reservoir – North Arm, STORET # 591403 – Water Quality Summary

Date	*Temp Deg C*	*pH*	*D.O. mg/l*	*T.Sus.Sol mg/l*	*Ammonia N mg/l*	*T. Phos. mg/l*	*D-T Phos. mg/l*
Minimum	4.9	7.1	3.6	0	0.00	-	-
Maximum	20.8	8.2	10.3	0	0.00	-	-
Median	6.6	7.7	6.7	0	0.00	-	-
Mean	10.7	7.6	6.6	0	0.00	-	-
Number	12	12	12	12	12	0	0
Exceedences	1	0	0	0	0	0	0

All phosphorus data was unreliable for analysis. Similar to the previous location, only one exceedence of high surface temperature was recorded which is normal. Dissolved oxygen concentrations remained well above JTAC standards during all sampling dates. DO and temperature profiles taken at this site are presented later in this chapter.

Jordanelle Reservoir – Above Dam, STORET # 591401

Above the dam of Jordanelle Reservoir, there were samples taken on seven occasions during 1997. There were a total of 51 samples taken from nine different depths at this site. Samples were collected from the surface, mid-depth, bottom as well as from the six gates at different depths on the SLOW tower. All six sampling dates include samples from the surface and bottom and on one occasion a sample was taken from mid-depth. On all the sampling dates except April, samples were also taken from the six gates on the SLOW tower. A combined summary of the water quality data at all depths is provided below in Table 4.7.

Table 4.7 Jordanelle Reservoir – Above Dam, STORET # 591403 – Water Quality Summary

Date	*Temp Deg C*	*pH*	*D.O. mg/l*	*T.Sus.Sol mg/l*	*Ammonia N mg/l*	*T. Phos. mg/l*	*D-T Phos. mg/l*
Minimum	3.5	7.1	2.9	0.0	0.0	-	-
Maximum	20.6	8.1	9.7	0.0	0.1	-	-
Median	7.0	7.4	6.5	0.0	0.0	-	-
Mean	8.7	7.5	6.2	0.0	0.0	-	-
Number	51	51	51	51	51	0	0
Exceedences	1	0	0	0	0	0	0

Unfortunately, all of the phosphorus data was unreliable for analysis. The dissolved oxygen concentrations are all well above standards. DO and temperature profiles taken at this site are presented later in this chapter.

Ontario #2 Drain Tunnel (Park City Ventures), STORET # 499804

This monitoring site is located on the west side of Jordanelle Reservoir where the United Park City Mines discharges from treatment facilities at the Keetley Station. A summary of the water quality data is provided below in Table 4.8.

Table 4.8 Ontario #2 Drain Tunnel, STORET # 499804 – Water Quality Summary

Date	*Temp Deg C*	*pH*	*D.O. mg/l*	*T.Sus.Sol mg/l*	*Ammonia N mg/l*	*T. Phos. mg/l*	*D-T Phos. mg/l*
Minimum	6.1	8.8	5.4	0	0.00	0.01	0.00
Maximum	12.7	9.1	9.0	16	0.09	0.03	0.02
Median	9.7	8.9	8.3	8	0.06	0.02	0.01
Mean	9.5	8.9	8.1	8	0.05	0.02	0.01
Number	8	8	8	8	8	2	2
Exceedences	0	1	1	0	0	0	0

There was a sample taken from this location on eight occasions during 1997. Six of the eight samples had phosphorus data that was unusable for analysis. Historically the drain tunnel has no problems with phosphorus, but has had problems with high pH. This year recorded one sample with pH above the 9.0 standard. Also, it is noted that the tunnel recorded a high average of total hardness at 316.3 mg/l as $CaCO_3$ (refer to Appendix A).

McHenry Creek Below Mayflower, STORET # 499767

This monitoring site is located on the west side of Jordanelle Reservoir where McHenry Creek flows into Jordanelle Reservoir. A summary of the water quality data is provided below in Table 4.9.

Table 4.9 McHenry Creek below Mayflower, STORET # 499767 – Water Quality Summary

Date	*Temp Deg C*	*pH*	*D.O. mg/l*	*T.Sus.Sol mg/l*	*Ammonia N mg/l*	*T. Phos. mg/l*	*D-T Phos. mg/l*
Minimum	3.7	7.9	8.5	0	0.00	0.03	0.03
Maximum	6.2	8.1	11.2	33	0.50	0.03	0.03
Median	4.5	7.9	10.5	18	0.00	0.03	0.03
Mean	4.8	8.0	10.1	17	0.17	0.03	0.03
Number	3	3	3	3	3	1	1
Exceedences	0	0	0	0	1	0	0

This location was monitored on nine occasions during 1997. Of the nine occasions, only three times (during March, April, and May) there was enough flow in the creek for sampling. Only the March sample was usable for phosphorus data. Historically this creek has a few exceedences in phosphorus concentrations. Of the remaining parameters, there was one exceedence of ammonia but no major indication of water quality problems. TSS concentrations were slightly less than past years.

TSS Loadings in the Upper Provo River

The TSS loads were calculated for four of the JTAC monitoring locations as seen in the following table, Table 4.10, which summarizes the results (see Appendix C for complete calculations).

Table 4.10 1997 TSS Loading Summary for Upper Provo River

	TSS concentration		Flow		TSS Loading Rate		1997
	Average (mg/l)	Peak (mg/l)	Average (cfs)	Peak (cfs)	Average (tons/day)	Peak (tons/day)	TSS Load (kg/yr)
Provo River at Woodland	7.4	16.8	229.3	997	4.6	45	**1,517,482**
Kamas Fish Hatchery Effluent	3.7	11.6	6.9	13	0.07	0.4	**22,816**
Weber-Provo Canal Diversion	3.6	7.6	23.9	49	0.2	1.0	**76,622**
Provo River at Hailstone	15.1	184	382.3	1,480	21.4	142	**7,076,823**

The Provo River at Woodland is relatively pristine and mostly free of TSS. Figure 4.1 below shows the significant increase of TSS loads from Woodland to Hailstone. The 1994 Tri-Valley Watershed Report from the NCRS identified several potential sediment sources in this area. These included natural soil conditions, vegetation type, channel gradient, and intense grazing. The TSS loading at Hailstone was low compared to previous years (see Table 4.11). The Kamas Fish Hatchery produced an average amount of TSS and the Weber-Provo Canal input much less TSS than its usual loading.

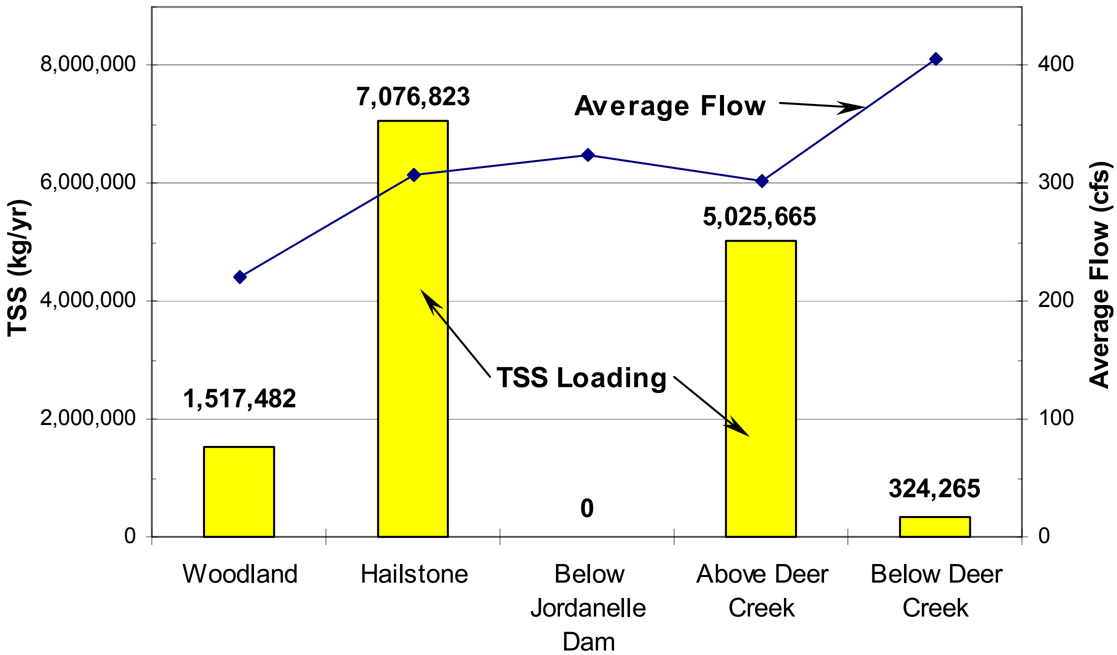


Figure 4.1 1997 Provo River TSS Loading throughout Wasatch County

Figure 4.1 shows the monitoring location below Jordanelle Reservoir having a yearly TSS load of 0 kg for 1997. This calculation shows that very little TSS is released from Jordanelle Reservoir, but it is unreasonable to assume that the TSS loading was zero for 1997. The reason for the zero calculation is due to all the samples yielding undetectable concentrations of TSS. TSS is undetectable below concentrations of 4.0 mg/l. When the concentration is below detection limits, the concentration is assumed to be zero. Very small concentrations of TSS can transmit a significant TSS load if the stream flow is great.

Table 4.11 below shows the historical water quality data of the Provo River at Hailstone and Woodland for the past five years. The Woodland monitoring site had low TSS loading in 1997 and the Hailstone monitoring site had a slightly low TSS loading in 1997 compared to the previous 4 years.

Table 4.11 Historical Water Quality Data 1993-1997

	1993*	1994*	1995*	1996*	1997**
Provo River at Woodland					
Average Flow (cfs)	336	134	301	239	**220**
Average T. Phosphorus (mg/l)	0.02	0.017	0.025	0.009	-
Average D. Phosphorus (mg/l)	-	-	0.009	0.004	-
Total Phosphorus Load (kg/yr)	6,118	2,122	6,878	2,033	-
D. Phosphorus Load (kg/yr)	-	-	2423	988	-
TSS Load (kg/yr)	7,693,845	1,716,324	10,334,714	2,486,544	**1,517,482**
Provo River at Hailstone					
Average Flow (cfs)	475	224	383	286	**308**
Average T. Phosphorus (mg/l)	0.052	0.038	0.04	0.022	-
Average D. Phosphorus (mg/l)	-	-	0.005	0.01	-
Total Phosphorus Load (kg/yr)	23,096	7,946	14,124	5,852	-
D. Phosphorus Load (kg/yr)	-	-	1754	2729	-
TSS Load (kg/yr)	15,266,237	8,245,837	14,552,043	5,595,323	**7,076,823**

* Water year ** Calendar year

Dissolved Metals Analysis

The dissolved metal concentrations were analyzed in the laboratory for some of the water samples that were taken. JTAC did not test the samples from the Fish Hatchery effluent or the Ontario #2 Drain Tunnel discharge for dissolved metals. The other locations were tested one to three times during 1997. In Table 4.12 below, a summary of the monitoring results is provided.

Table 4.12 Dissolved Metals Summary for Upper Provo River and Jordanelle Sampling Sites.

Date	Al µg/l	As µg/l	Ba µg/l	Cd µg/l	Cr µg/l	Cu µg/l	Fe µg/l	Pb µg/l	Hg µg/l	Mn µg/l	Se µg/l	Ag µg/l	Zn µg/l
Storet #499840, Provo River above Woodland @ USGS gage													
27-May-97	130	<5.0	44	<1.0	<5.0	<12.0	300	<3.0	<0.2	5.8	<1.0	<2.0	<30.0
26-Aug-97	<30.0	<5.0	48	<1.0	<5.0	<12.0	70	<3.0	<0.2	7.4	<1.0	<2.0	<30.0
29-Oct-97	<30.0	<5.0	47.0	<1.0	<5.0	<12.0	61.6	<3.0	<0.2	9.2	<1.0	<2.0	<30.0
Storet #499814, Weber Provo Canal Diversion at US 189													
27-May-97	85	<5.0	44	<1.0	<5.0	<12.0	113	<3.0	<0.2	28	<1.0	<2.0	<30.0
26-Aug-97	<30.0	<5.0	65	<1.0	<5.0	<12.0	89.1	<3.0	<0.2	28	<1.0	<2.0	<30.0
29-Oct-97	<30.0	<5.0	79.0	<1.0	<5.0	<12.0	20.8	<3.0	<0.2	6.0	<1.0	<2.0	<30.0
Storet #499813, Provo River at Hailstone Junction below Weber Provo Canal													
27-May-97	120	<5.0	50	<1.0	<5.0	<12.0	148	<3.0	<0.2	11	<1.0	<2.0	<30.0
26-Aug-97	<30.0	<5.0	59	<1.0	<5.0	<12.0	90	<3.0	<0.2	11	<1.0	<2.0	<30.0
29-Oct-97	<30.0	<5.0	59.0	<1.0	<5.0	<12.0	69.6	<3.0	<0.2	9.9	<1.0	<2.0	<30.0
Storet #591404, Jordanelle Reservoir - Provo Arm													
28-May-97	<30.0	<5.0	49	<1.0	<5.0	<12.0	40.6	<3.0	<0.2	<5.0	<1.0	<2.0	<30.0
6-Aug-97	36	<5.0	45	<1.0	<5.0	<12.0	53.1	<3.0	<0.2	<5.0	<1.0	<2.0	<30.0
8-Oct-97	<30.0	<5.0	43.0	<1.0	<5.0	<12.0	51.3	<3.0	<0.2	<5.0	<1.0	<2.0	<30.0
Storet #591403, Jordanelle Reservoir - North Arm													
28-May-97	<30.0	<5.0	43	<1.0	<5.0	<12.0	40.7	<3.0	<0.2	<5.0	<1.0	<2.0	<30.0
6-Aug-97	<30.0	<5.0	39.84	<1.0	<5.0	<12.0	35.3	<3.0	<0.2	<5.0	<1.0	<2.0	<30.0
8-Oct-97	30.0	<5.0	38.0	<1.0	<5.0	<12.0	44.3	<3.0	<0.2	5.4	<1.0	<2.0	<30.0
Storet #591401, Jordanelle Reservoir - Above Dam													
28-May-97	<30.0	<5.0	46	<1.0	<5.0	<12.0	<20.0	<3.0	<0.2	<5.0	<1.0	<2.0	<30.0
6-Aug-97	<30.0	<5.0	44.35	<1.0	<5.0	<12.0	<20.0	<3.0	<0.2	<5.0	<1.0	<2.0	<30.0
8-Oct-97	<30.0	<5.0	41.0	<1.0	<5.0	<12.0	21.1	<3.0	<0.2	8.8	<1.0	<2.0	<30.0
Storet #499767, McHenry Creek below Mayflower													
27-May-97	47	<5.0	44	<1.0	<5.0	<12.0	46.2	<3.0	<0.2	52	<1.0	<2.0	120

The results show that there were very small concentrations of dissolved metals compared to the standards set in Table 3.5. One minor exceedence of zinc was recorded at the McHenry Creek location on the 27th of May.

Jordanelle Reservoir DO Monitoring

At three reservoir monitoring sites on the Jordanelle, JTAC took measurements of temperature, pH, and dissolved oxygen (DO) at varying depths for the generation of water parameter profiles. The profiles provided here plot the temperature and dissolved oxygen concentration with respect to depth for the purpose of analysis of stratification in the reservoir. The profiles graphically show the thermocline in the reservoir where the temperature significantly drops off and the depth at which dissolved oxygen levels decrease. If anoxic conditions exist in the reservoir, it will be apparent in the generated profiles.

The reservoir goes through cycles of stratification each year as the seasons change. Stratification begins when the warm summer air begins to warm the surface of the reservoir. Then as the temperatures decrease in the late fall, the reservoir begins to turnover from convection currents, destratification is the result. The switch from water year to calendar year benefits the presentation of reservoir profiles. This is because of the additional presentation of reservoir conditions during October (and sometimes November) which completes the reservoir cycle for the current year.

During 1997, Profile data was gathered six times at the three monitoring locations. They were gathered in the months of April, May, June, August, September, and October (an additional profile was collected in November at the monitoring site above the dam).

Provo Arm, STORET #591404

The Provo River arm of Jordanelle Reservoir was sampled for profiles on the six occasions mentioned. The resulting profiles from the collected data for the Provo Arm are given in Figures 4.2 – 4.7. The profiles show no concentrations less than the 2.0 mg/l minimum DO limit for this area. The lowest recorded DO level occurred on September 9, 1997 at 2.1 mg/l DO concentration at a depth just below the thermocline at 16.4 m (refer to Fig 4.6).

North Arm, STORET #591403

The North Arm of Jordanelle Reservoir was sampled for profiles on the six occasions. The resulting profiles from the collected data for the Provo Arm are given in Figures 4.8 – 4.13. The profiles show no concentrations less than the 2.0 mg/l minimum DO limit for this area. The lowest recorded DO level occurred on October 8, 1997 at 3.01 mg/l DO concentration at a depth of 29.4 m (refer to Fig 4.13).

Above Dam, STORET #591401

Above the dam of Jordanelle Reservoir, the water was sampled for profiles on seven occasions. The resulting profiles from the collected data are given in Figures 4.14 – 4.20. The profiles show no concentrations less than the 2.0 mg/l minimum DO limit for this area. The lowest recorded DO level occurred on November 24, 1997 at 2.87 mg/l DO concentration at the bottom depth of 76.1 m (refer to Fig 4.20).

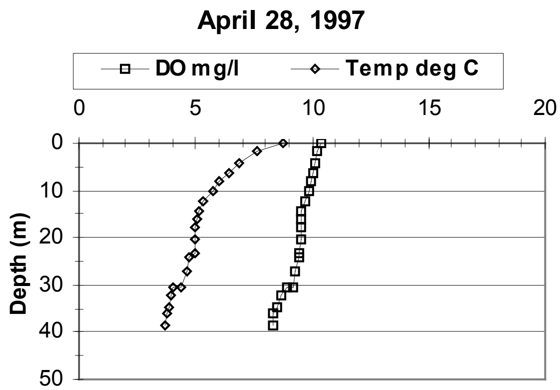


Figure 4.2 Jordanelle – Provo Arm, Profile 4-28-97

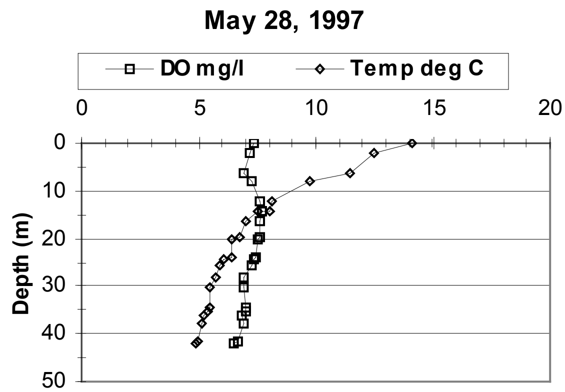


Figure 4.3 Jordanelle – Provo Arm, Profile 5-24-97

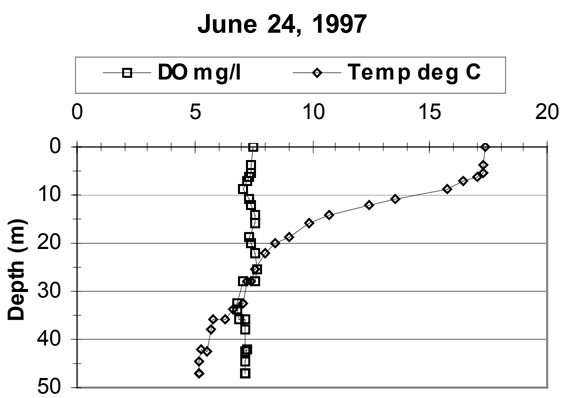


Figure 4.4 Jordanelle – Provo Arm, Profile 6-24-97

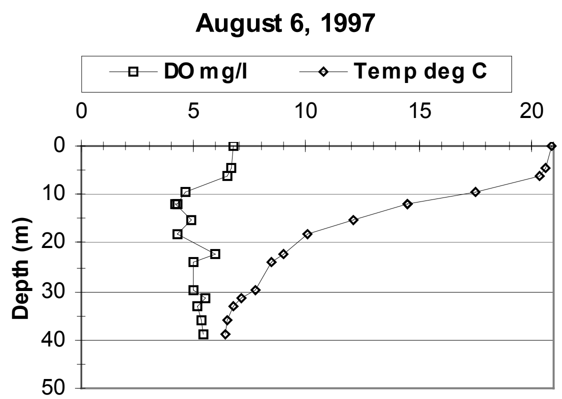


Figure 4.5 Jordanelle – Provo Arm, Profile 8-6-97

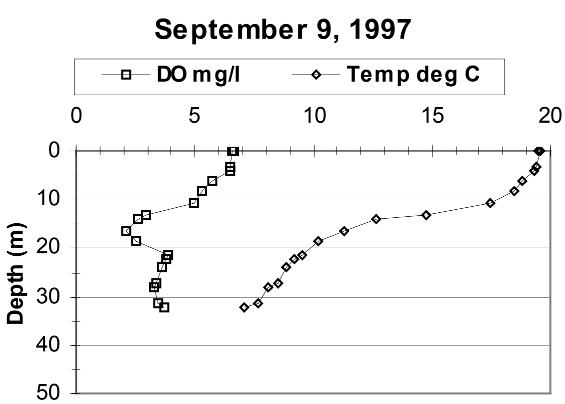


Figure 4.6 Jordanelle – Provo Arm, Profile 9-9-97

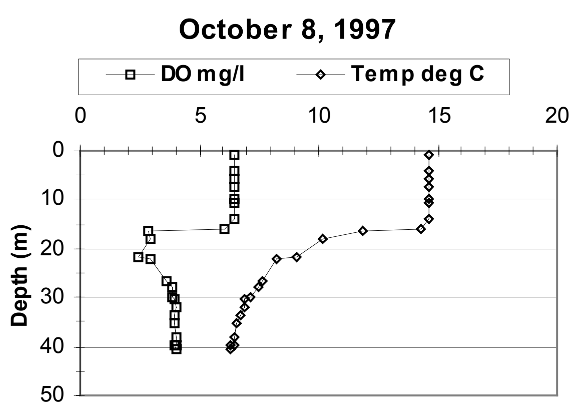


Figure 4.7 Jordanelle – Provo Arm, Profile 10-8-97

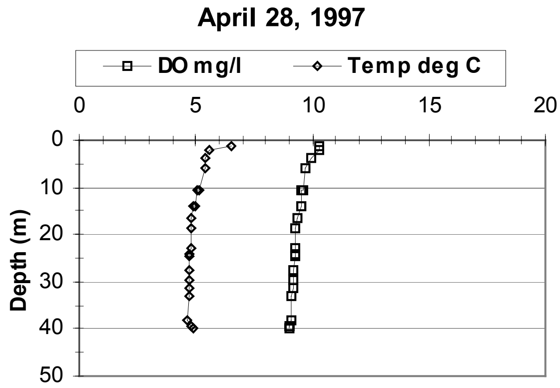


Figure 4.8 Jordanelle – North Arm, Profile 4-28-97

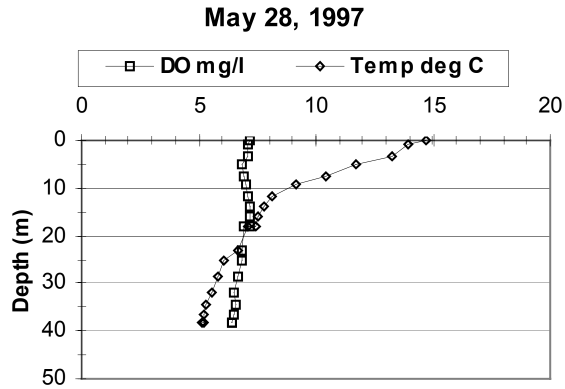


Figure 4.9 Jordanelle – North Arm, Profile 5-28-97

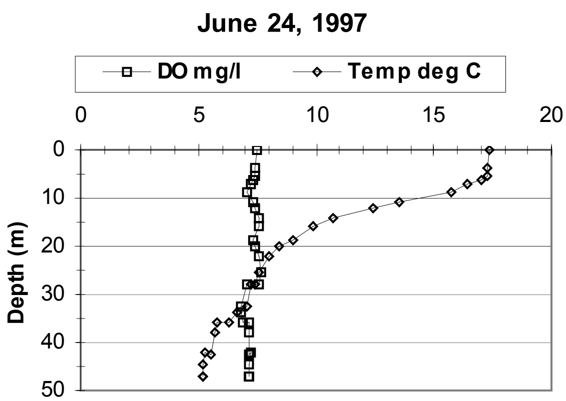


Figure 4.10 Jordanelle – North Arm, Profile 6-24-97

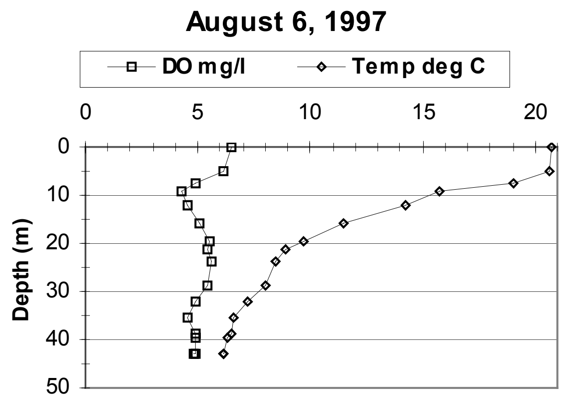


Figure 4.11 Jordanelle – North Arm, Profile 8-6-97

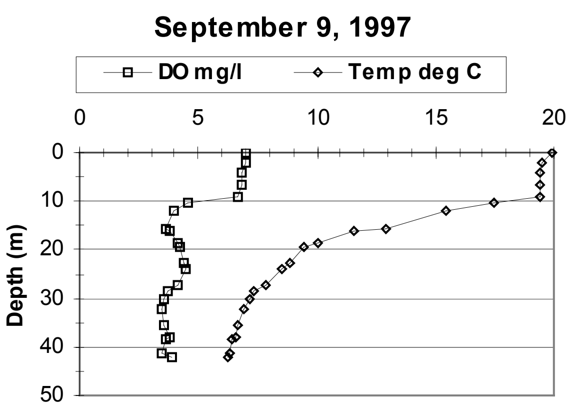


Figure 4.12 Jordanelle – North Arm, Profile 9-9-97

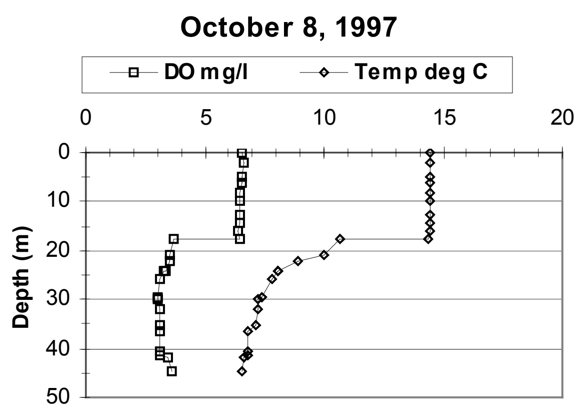


Figure 4.13 Jordanelle – North Arm, Profile 10-8-97

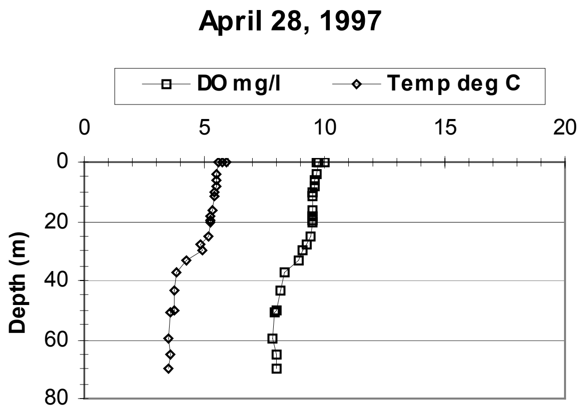


Figure 4.14 Jordanelle – Above Dam, Profile 4-28-97

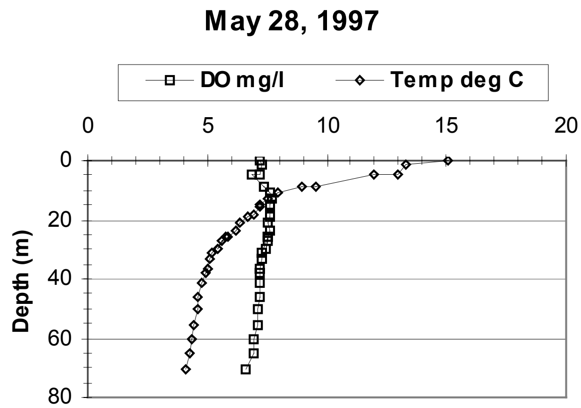


Figure 4.15 Jordanelle – Above Dam, Profile 5-28-97

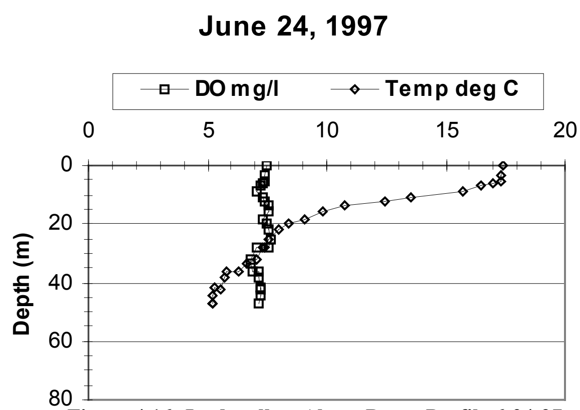


Figure 4.16 Jordanelle – Above Dam, Profile 6-24-97

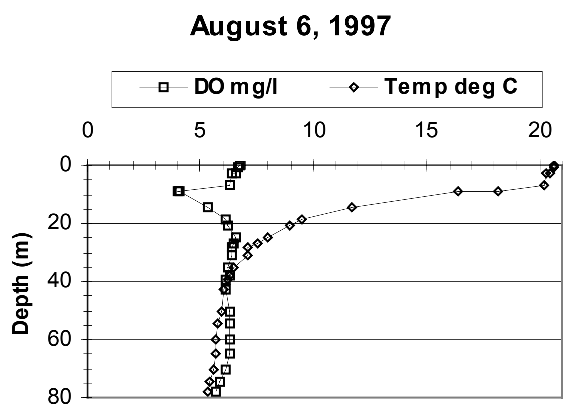


Figure 4.17 Jordanelle – Above Dam, Profile 8-6-97

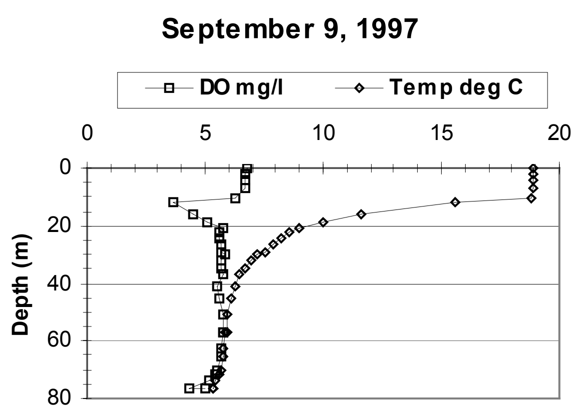


Figure 4.18 Jordanelle – Above Dam, Profile 9-9-97

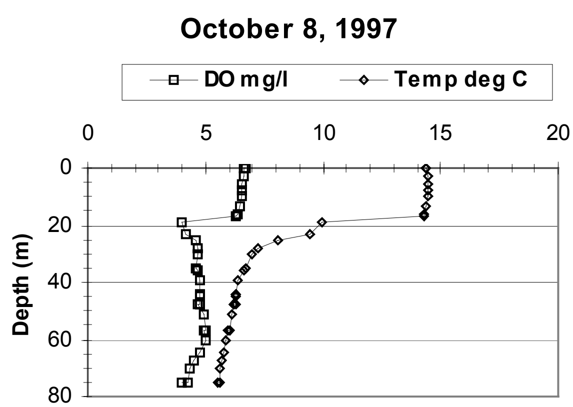


Figure 4.19 Jordanelle – Above Dam, Profile 10-8-97

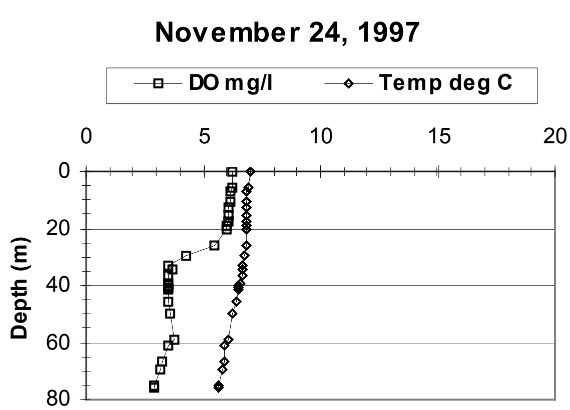


Figure 4.20 Jordanelle – Above Dam, Profile 11-24-97

Analysis of Jordanelle Oxygen Levels

The profiles show that Jordanelle Reservoir had excellent DO levels which did not drop below the JTAC standard of 2.0 mg/l. The following chart, Figure 4.21, shows the bottom depth DO concentration for each of the three monitoring sites for 1997.

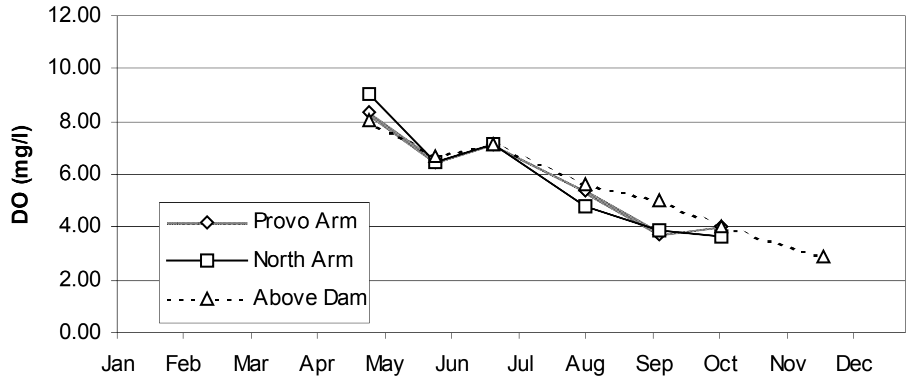


Figure 4.21 Jordanelle Reservoir Bottom DO Concentrations for 1997

The three monitoring locations on the Jordanelle remarkably follow each other very precisely. Previous years have shown DO levels in the North Arm to be less than the other two locations, this is not the case for 1997. The first sample of the year taken in April shows the highest DO concentrations which occur because of the spring runoff. The DO concentrations then steadily decline as the year continues. The graph indicates a trend that DO levels would continue to decline into the winter months when no sampling is occurring on the reservoir due to unpredictable ice conditions. It is unknown how low the DO levels drop before they begin to rise again with the spring runoff. It is possible very low DO conditions exist during some of those winter months.

Jordanelle Trophic State Index

The Carlson Trophic State Index (TSI) has been used by the State of Utah to rank and compare the trophic status of lakes and reservoirs within the state. This index uses data from May to September of three parameters: Secchi disk transparency depth, total phosphorus, and Chlorophyll A. Unfortunately, only the transparency depth and Chlorophyll A were useable for this calculation because of problems with the phosphorus data as previously mentioned. Table 4.13 shows the calculation results for Jordanelle Reservoir.

Table 4.13 1997 Carlson Trophic State Index (TSI) calculation for Deer Creek

Sample Date	North Arm		Provo Arm		Above Dam	
	Transp. m	Chlor-A µg/l	Transp. m	Chlor-A µg/l	Transp. m	Chlor-A µg/l
28-Apr-97	2.1	5.1	0.9	5.3	2.4	6.1
28-May-97	2.4	4.7	2.1	6.3	2.7	4.5
24-Jun-97	1.5	3.9	1.5	3.9	1.5	5.1
6-Aug-97	2.1	6.6	2.2	6.6	2.3	4.6
9-Sep-97	3.1	2.8	2.6	2.8	2.7	3.6
Average	2.2	4.6	1.9	5.0	2.3	4.8
TSI	**48.4**	**45.6**	**51.1**	**46.3**	**47.9**	**45.9**
TSI Average	**47.0**		**48.7**		**46.9**	

Average TSI for Jordanelle ⟶ 47.5

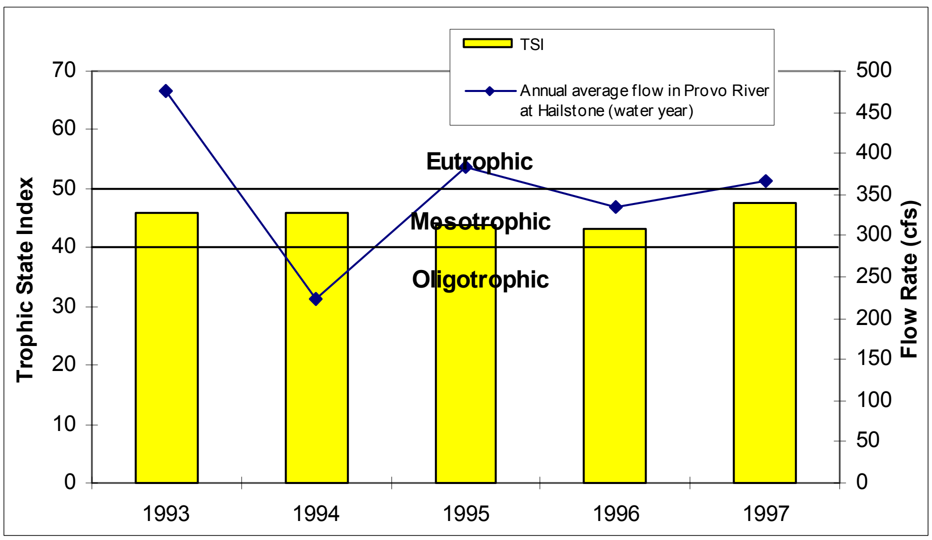


Figure 4.22 Jordanelle Reservoir TSI and Provo River Average Flow 1993-1997

The TSI was calculated to be 47.5 which classifies Jordanelle as a mesotrophic reservoir. This number is slightly higher than 1996 which recorded a TSI of 43. The lack of phosphorus data may have increased this year's TSI slightly; for example, the 1996 TSI would have been 47 rather than 43 and 1995 would have been 46 rather than 44 if the phosphorus data had been excluded in the calculations. Figure 4.22 above shows the TSI classification of Jordanelle reservoir since 1993 when the reservoir first began to fill. The reservoir's trophic status has remained considerably stable during the five years since.

Phytoplankton Floras from Jordanelle Reservoir

Dr. Samuel T. Rushforth, a professor of Botany at Brigham Young University, conducts an annual study on the phytoplankton floras of Jordanelle Reservoir as well as Deer Creek. The abstract to this year's report is as follows (refer to actual report for details):

A study of the algal plankton flora of Jordanelle Reservoir, Wasatch County, Utah was performed through the calendar year of 1997. Quantitative net plankton and total plankton samples were collected and studied. A total of 37 taxa was identified in the plankton flora. In addition, the two categories, centric diatoms and pennate diatoms, each contained many additional taxa.

The most important algae in all Jordanelle plankton samples (combined net and total plankton samples) for 1997 as determined by presence and biomass and presented here in descending order were the diatoms Fragilaria crotonensis and Stephanodiscus niagarae, the desmid Staurastrum gracile the chlorophyte Sphaerocystis schroeteri, the category centric diatoms, the diatoms Melosira granulata var. angustissima, Asterionella formosa and the category pennate diatoms. These taxa and categories all had ISI's greater than or equal to 1.0 and comprised nearly 87% of the sum importance value for all taxa in the reservoir during 1997. The ISI determination is an assessment of algal standing crop and distribution through the year as reflected in our samples.

The flora of Jordanelle Reservoir continued to be dominated by diatoms during 1997. The flora was comprised of approximately 62% diatoms, 30% Chlorophyta, 6% Cyanophyta, 1% Chrysophyta and 2% Pyrrhophyta.

Similar to earlier studies, biomass and species richness of Jordanelle Reservoir were quite low for the study period. No large blooms of noxious cyanophytes occurred in the reservoir during 1997. (Rushforth, 1998)

Jordanelle Selective Withdrawal

Jordanelle Reservoir has the capability removing water at various levels to control chemistry and temperature. The USBR is in the process of analyzing the results of the performance on the reservoir in the past few years since the dam has been in operation. This year the USBR will release "Jordanelle Selective Level Outlet Works, Report and Operating Criteria" that will detail the operation. A summary of that report has been provided here courtesy of the USBR.

Jordanelle Selective Level Outlet Works, Report and Operating Criteria

The 1984 Plan called for a Selective Level Outlet Works (SLOW) on Jordanelle Dam to help retain 50% of the phosphorus flowing into Jordanelle Reservoir. This was to result in approximately a 25 % total phosphorus reduction into Deer Creek Reservoir based on the original 1984 plan of phosphorus wasteload allocation. Jordanelle Dam essentially completed filling in 1995 and 1996. The Selective Level outlet works was operated from mid-June through November 1996. Additional construction in the outlet works chamber at Jordanelle Dam prevented operation in 1997 until Mid August. Nevertheless, the data indicates that about 50% of the total phosphorus has been retained since about 1994. It is believed that at least 50% was retained in 1997 as well.

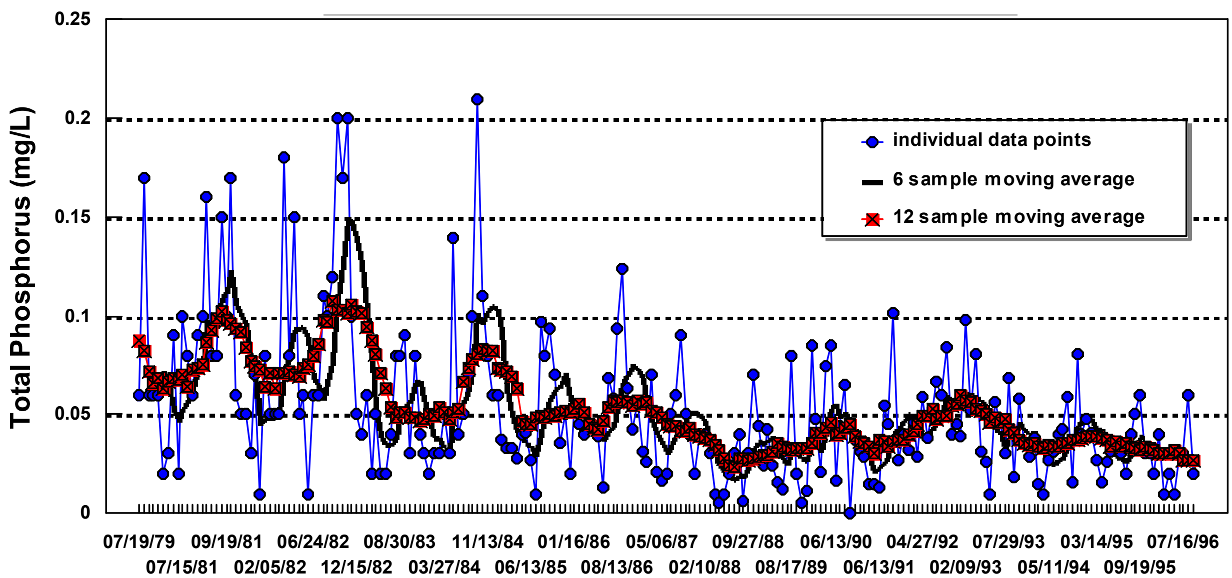
There was an extensive blue-green algal bloom in Deer Creek Reservoir observed by Charlie Thompson, Utah Dep7artment of Wildlife Resources in mid November, 1996 A combination of early cool weather and reservoir fall turnover, followed by an extended warm period to the end of November, probably contributed to this bloom. Jerry Miller, U.S. Bureau of Reclamation (USBR) observed that a blue-green bloom had wind-blown to the Jordanelle dam and SLOW tower embayment in late October in 1996. Mr. Miller felt that there was a significant probability that a portion of the blue-green algal bloom observed in Deer Creek Reservoir in November 1996 may actually have been exported out of Jordanelle Reservoir as a result of the top gates of the SLOW tower having been open. Mr. Miller, USBR, is preparing a model to determine how much water, its temperature, and the phosphorus concentration that would be withdrawn from Jordanelle through each individually opened gate on the SLOW tower. As a result of the observation that a blue-green algae can be accumulated by wind events near the SLOW tower in October-November, Mr. Miller drafted a Jordanelle Dam Selective Level Outlet Works operation review that recommended that the top SLOW gate be closed starting about the end of September. This operation was in opposition to the Standard Operating Procedures written for the SLOW for hydraulic protections of the gates. Therefore, the recommendation that the top gate(s) be closed requires rewriting the Jordanelle SLOW standard operating procedures. This recommendation is being reviewed by Reclamation and the Central Utah Water Conservancy District. It is anticipated that this change will be made, and the final Jordanelle Slow Tower operating criteria will presented to JTAC.

The SLOW model is calibrated and verified against the 1996 and 1997 temperature data collected daily at each gates mid elevation, and in the Provo River below the dam. A phosphorus model could also be developed once sufficient reservoir data is available to assign at least monthly concentrations to the different reservoir elevations. Because there is not phosphorus data for 1997, this portion of the model could not be completed at this time. The selective withdrawal will accomplish the goal of 50% total phosphorus retention annually over the long term. In years of extended drought when the reservoir is drawn down below the SLOW gates functional operational range, only hypolimnion withdrawal will be feasible. This would be about 1-2 years/20 years based on hydrology the past century. Temperature objectives for fish in the river below Jordanelle will also be addressed with little or no conflict with the phosphorus objectives.

The extensive blue-green algal blooms on Deer Creek Reservoir have been essentially eliminated since about 1984-85. The 1984 plan was based on a model developed by Reclamation which showed that significant average annual weighted Chlorophyll *a* reductions would occur in Deer Creek Reservoir if the mean annual total phosphorus concentration was reduced to less than 0.040mg/L measured below Deer Creek Dam. The watershed phosphorus wasteload allocation program is based on this same 0.040 mg/l number. Figure 4.23 indicates that the phosphorus wasteload allocation program began approaching this goal in about 1985. This is about when Dr. Rushforth's algal studies on Deer Creek Reservoir indicate that the noxious blue-green algal were no longer dominant in the reservoir. Significantly, this occurred well before the Jordanelle dam phosphorus reductions were in place. All total phosphorus reductions now in place probably amount to about a total 50% reduction over the long term based on outflow from Deer Creek Reservoir. Deer Creek Reservoir has been reduced from a eutrophic/hypereutrophic status to a mesotrophic status. Dissolved oxygen, fishery, recreation, and raw water treatability have all significantly improved since the conditions observed throughout the 1960-85 period. Treatment with copper sulfate was discontinued in about 1983.

Hopefully, over the next several years some additional improvements in Deer Creek Reservoir will occur. Monitoring the conditions in the Provo River and in Jordanelle

Figure 4.23 Total Phosphorus below Deer Creek Reservoir



Jerry Miller, U.S. Bureau of Reclamation, Draft Jordanelle Dam Selective Level Outlet Works Operating Report, 1998.

and Deer Creek Reservoirs is critical to documenting the affects of the Provo River phosphorus wasteload allocation program. Additional improvements may occur in the next few years as a result of phosphorus decreases realized since Jordanelle Dam operation started providing additional phosphorus reductions. A most beneficial benefit would be if total oxygen demand decreased and the dissolved oxygen in Deer Creek's hypolimnion increased from July - October. Future refinements in the Jordanelle SLOW operating criteria and indeed in the entire watershed phosphorus wasteload allocation program needs to look at improvements in dissolved oxygen in Deer Creek Reservoir in July-October, and taste and odor problems to water treatment plants in the valley. Future refinements in the SLOW operation need to be tied directly to new goals set in the Provo River watershed. For example, is a year round standard of 0.040 mg/L total phosphorus adequate, or does the standard need to be seasonally adjusted. A dissolved bioavailable phosphorus of 0.03-04 mg/L into Deer Creek Reservoir with the new minimum flows could drive up blue-green algal population dynamics. Therefore, the initial 0.040 mg/L standard may be to high a standard in July-November.

Monitoring by Mayflower Resort

Through agreements with Wasatch County, Mayflower Mountain Resort is required to monitor and analyze the water quality of two sites near Mayflower along McHenry Creek. As of yet, Mayflower has not completed this year's annual report. When Mayflower delivers their water quality monitoring report, a brief summary will be included here.

Monitoring by Deer Valley Resort

In 1980, Deer Valley Ski Resort constructed ski runs and lifts in the McHenry and Mayflower drainage basins. Erosion controls and revegetation have followed to reduce the impact on the water quality. As part of an agreement with Wasatch County each year during the spring runoff (approximately April to June) Deer Valley monitors the water effluents of their detention basins in each drainage. The monitoring program analyzes flow rate, TKN (Total Kjeldahl Nitrogen), total phosphate, orthophosphate, TSS, and pH. Flow rate is measured continually while water samples are taken weekly for constituent analyses.

Deer Valley's Water Quality and Sediment Control Report for the 1997 Runoff Season was completed in August 1997 and includes the following statements in the executive summary. For further information, refer directly to the report.

- Deer Valley recorded 220 inches, or 125% of its 16 year average snowfall during the 1996/1997 season.
- The peak flow and total runoff in 1997 were slightly above average.
- The TKN concentrations were in the lower level of the normal range.
- Both basins exhibited continuing stabilized performance trends regarding downstream concentrations of constituents.
- Deer Valley should continue with their current maintenance program.
- Yearly site inspections should be performed.
- Deer Valley personnel should visit each site at least twice weekly to ensure operation of gauges, but samples should still be taken weekly. The staff gauge depth should be indicated on the charts every time the charts are reset.
- Deer Valley intends to remove accumulated sediment from the McHenry's Basin this summer. They will perform this with back hoes and front loaders, and place the sediment within the drainage area of the basin (similar to the way they did Mayflower in 1996).

Deer Valley water monitoring results for 1997 Runoff Season are summarized below in Table 4.14.

Table 4.14 Deer Valley Water Quality Monitoring Results for 1997 Runoff Season

	McHenry Basin			Mayflower Basin		
	Total	**Peak**	**Average**	**Total**	**Peak**	**Average**
Runoff	70.4 ac-ft	3.53 cfs	0.77 cfs	14.2 ac-ft	0.70 cfs	0.15 cfs
TKN	7.38 kg	0.09 mg/l	0.085 mg/l	1.49 kg	0.09 mg/l	0.085 mg/l
Total P	11.29 kg	0.30 mg/l	0.13 mg/l	1.40 kg	0.21 mg/l	0.08 mg/l
Ortho P	3.47 kg	0.05 mg/l	0.04 mg/l	0.53 kg	0.05 mg/l	0.03 mg/l
TSS	1910 kg	40 mg/l	22 mg/l	70.1 kg	8 mg/l	4 mg/l

Chapter 5

The Provo River Through Heber Valley

Introduction

This chapter will present and analyze the water quality monitoring for Snake Creek, Spring Creek, and the Provo River through the Heber Valley.

Monitoring Sites

The monitoring plan for this year included five sites in this area. Below is listed the description of each site with its STORET number.

STORET No.	Location Description
• 499733	Provo River below Jordanelle Dam
• 499725	Spring Creek at entrance to Provo River east of WWTP
• 591363	Provo River at McKeller Bridge above Deer Creek
• 499713	Midway Fish Hatchery effluent
• 591016	Snake Creek above Deer Creek Reservoir at RR Crossing

Each site is described in the following sections with a summary table of the water quality monitoring. For more complete tables showing actual data from the 1997 water quality monitoring, refer to Appendix A.

Provo River below Jordanelle Dam, STORET # 499733

This station is located below the outlet works of Jordanelle Dam and samples the water that is released from Jordanelle Reservoir. A summary of the water quality data for this location is shown below in Table 5.1.

Table 5.1 Provo River below Jordanelle, STORET # 499733 – Water Quality Summary

Date	Temp Deg C	pH	D.O. mg/l	T.Sus.Sol mg/l	Ammonia N mg/l	T. Phos. mg/l	D-T Phos. mg/l
Minimum	2.9	7.6	8.5	0	0.00	0.02	0.02
Maximum	13.5	8.5	12.1	0	0.05	0.02	0.02
Median	6.9	8.2	9.9	0	0.00	0.02	0.02
Mean	7.3	8.1	10.1	0	0.01	0.02	0.02
Number	11	11	11	11	11	2	2
Exceedences	0	0	0	0	0	0	0

This location was monitored on eleven occasions during 1997. The phosphorus data was unreliable for nine of the eleven samples. Since completion of the dam, this location has had low levels of phosphorus with few exceedences. No samples recorded TSS above detectable limits which is evident of the settling of sediment in Jordanelle Reservoir and comparable to past years.

Spring Creek at entrance to Provo River east of WWTP, STORET # 499725

This monitoring site samples Spring Creek where it enters into the Provo River at a point approximately 2 miles north of Deer Creek Reservoir and 2 miles west of Heber City. Spring Creek drains most of the northeastern portion of Heber Valley. A summary of the water quality data for this location is shown below in Table 5.2.

Table 5.2 Spring Crk at entrance to Provo R., STORET # 499725 – Water Quality Summary

Date	Temp Deg C	pH	D.O. mg/l	T.Sus.Sol mg/l	Ammonia N mg/l	T. Phos. mg/l	D-T Phos. mg/l
Minimum	3.5	7.5	7.7	4	0.00	0.06	0.03
Maximum	16.4	8.2	12.0	61	0.08	0.12	0.07
Median	8.5	8.1	10.3	24	0.00	0.09	0.05
Mean	9.3	8.0	10.0	25	0.01	0.09	0.05
Number	10	10	10	10	10	2	2
Exceedences	0	0	0	2	1	2	1

This location was monitored on ten occasions during 1997. The phosphorus data was unreliable for eight of the ten samples. Of the two samples with reliable phosphorus data, both had phosphorus exceedences. Historically, Spring Creek has recorded high phosphorus levels that exceed JTAC standards. TSS measurements are historically high for Spring Creek and contribute to the high phosphorus loadings, one exceedence of TSS was recorded. This site also recorded an exceedence in ammonia concentration.

Provo River at McKeller Bridge above Deer Creek, STORET # 591363

This monitoring site is located on the Provo River near USGS flow gage #10155500 approximately one half mile upstream from Deer Creek Reservoir. The sampling represents the loadings into Deer Creek Reservoir from the Provo River and its tributaries. A summary of the water quality data for this location is shown below in Table 5.3.

Table 5.3 Provo River above Deer Creek, STORET # 591363 – Water Quality Summary

Date	Temp Deg C	pH	D.O. mg/l	T.Sus.Sol mg/l	Ammonia N mg/l	T. Phos. mg/l	D-T Phos. mg/l
Minimum	2.0	7.5	8.3	0	0.00	0.02	0.02
Maximum	15.0	8.7	11.9	184	3.00	0.05	0.04
Median	8.5	8.1	10.5	6	0.00	0.03	0.03
Mean	8.6	8.1	10.1	25	0.29	0.03	0.03
Number	11	11	11	11	11	2	2
Exceedences	0	0	0	2	1	1	1

This location was monitored on eleven occasions during 1997. Nine of the eleven samples have unreliable phosphorus data. Of the two reliable samples, one recorded high phosphorus levels. Historically, the Provo River at this location, has a record of high concentrations of phosphorus that exceed JTAC standards. This year monitoring recorded levels of TSS concentrations are slightly higher than in years past. The ammonia concentration is considered an aberration or laboratory error.

Midway Fish Hatchery Effluent, STORET # 499713

As Utah's largest fish hatchery, Midway produces 180,000 pounds of fish per year, mainly rainbow trout. The effluent water from the Midway Fish Hatchery discharges from two 24-inch pipes into Snake Creek after passing through a series of settling ponds approximately 1 mile from the mouth of the creek at Deer Creek Reservoir. The facility receives the water from several nearby springs. The Hatchery has a UPDES permit that requires the hatchery to monitor the influent springs and the effluent springs for the determination of net increase of total phosphorus not to exceed 626 kg/yr. The results of the monitoring as reported in a monthly Discharge Monitoring Report (DMR) indicated that for 1997 the net increase of phosphorus measured was 320 kg. Also in the DMR, the TSS maximum daily loading was 570.8 kg/day which is well below the limit of 1398 lbs /day. A summary of the water quality data from JTAC monitoring for this location is shown below in Table 5.4.

Table 5.4 Midway Fish Hatchery Effluent, STORET # 499713 – Water Quality Summary

Date	Temp Deg C	pH	D.O. mg/l	T.Sus.Sol mg/l	Ammonia N mg/l	T. Phos. mg/l	D-T Phos. mg/l
Minimum	5.6	7.1	5.4	0	0.12	0.00	0.00
Maximum	16.3	7.6	9.4	11	0.33	0.08	0.03
Median	12.5	7.4	7.7	0	0.14	0.04	0.01
Mean	11.6	7.4	7.5	1	0.16	0.04	0.01
Number	19	19	19	19	8	6	2
Exceedences	0	0	1	0	8	4	0

This location was sampled 19 times during 1997. Analysis for total phosphorus and TSS was taken each time but only 8 samples were tested in the laboratory for other constituents such as dissolved total phosphorus. Of the 19 samples taken for total phosphorus analysis only six are reliable. Of the 8 samples taken for dissolved phosphorus analysis only two are reliable. The hatchery consistently discharges water with high ammonia concentrations into Snake Creek. On one instance, a low DO concentration was recorded.

Snake Creek above Deer Creek at RR Crossing, STORET # 591016

This monitoring site is located on Snake Creek slightly upstream from its mouth into the Provo River above Deer Creek Reservoir. Snake Creek winds in a southerly direction through the west side of Heber Valley and drains most of that area of the valley. The Midway Fish Hatchery discharges into Snake Creek slightly above this monitoring site. A summary of the water quality data for this location is shown below in Table 5.5.

Table 5.5 Snake Creek above Deer Creek, STORET # 591016 – Water Quality Summary

Date	*Temp Deg C*	*pH*	*D.O. mg/l*	*T.Sus.Sol mg/l*	*Ammonia N mg/l*	*T. Phos. mg/l*	*D-T Phos. mg/l*
Minimum	8.3	7.2	7.8	0	0.00	0.02	0.02
Maximum	15.7	8.1	10.2	32	0.10	0.05	0.04
Median	11.8	7.6	9.5	8	0.06	0.04	0.03
Mean	11.9	7.6	9.4	11	0.06	0.04	0.03
Number	11	11	11	11	11	2	2
Exceedences	0	0	0	0	2	1	1

The location was monitored on eleven occasions during 1997. Of the eleven samples taken only two have reliable phosphorus data. Of those two samples one recorded phosphorus in exceedence of the JTAC standards. Historically this location has numerous exceedences in total phosphorus concentrations. The TSS measurements were comparable to previous years. Furthermore, ammonia concentrations were found to be toxic for two samples during cold winter months.

TSS Loading from Heber Valley

The TSS loads were calculated for all five of the JTAC monitoring locations. The following table, Table 5.6, summarizes the results (see Appendix C for complete calculations).

Table 5.6 1997 TSS Loading Summary for Heber Valley

	TSS concentration		Flow		TSS Loading Rate		1997
	Average (mg/l)	Peak (mg/l)	Average (cfs)	Peak (cfs)	Average (tons/day)	Peak (tons/day)	TSS Load (kg/yr)
Provo River below Jordanelle	0	0	403.6	1,643	0	0	**0**
Spring Creek at Provo River	27.2	61	28.4	68	1.9	6.0	**634,393**
Provo River above Deer Creek	15.1	184	382.3	1,480	15.2	142	**5,025,665**
Midway Fish Hatchery Effluent	0.7	11	24.2	26	0.05	0.8	**15,305**
Snake Creek above Deer Creek	9.3	32	55.2	67	1.3	4.8	**431,283**

At the Provo River below the Jordanelle, none of the samples collected had detectable traces of TSS, therefore, the table above shows that no TSS was released from Jordanelle Reservoir. This is consistent with past years since most of the TSS will settle in the reservoir and minor amounts of TSS are discharged (see Table 5.7). The Provo River as it travels through the Heber Valley accumulates TSS from natural sedimentation processes plus inputs from tributaries and storm runoff. Note that Spring Creek is a major contributor of TSS to the Provo River and accounted for over 13% of its total 1997 TSS load into Deer Creek. The Provo River is the largest source of sediment into Deer Creek Reservoir.

5.7 Historic Water Quality Data (1993-1997)

	1993*	1994*	1995*	1996*	1997**
Provo River below Jordanelle					
Average Flow (cfs)	324	137	232	234	**324**
Average T. Phosphorus (mg/l)	0.036	0.018	0.021	0.014	-
Average D. Phosphorus (mg/l)	-	-	0.018	0.013	-
Total Phosphorus Load (kg/yr)	10,824	2,259	4,638	3,072	-
D. Phosphorus Load (kg/yr)	-	-	3926	2872	-
TSS Load (kg/yr)	5,631,342	548,751	126,139	33,178	**0**
Provo River above Deer Creek					
Average Flow (cfs)	315	140	193	231	**303**
Average T. Phosphorus (mg/l)	0.072	0.04	0.063	0.04	-
Average D. Phosphorus (mg/l)	-	-	0.023	0.022	-
Total Phosphorus Load (kg/yr)	21,246	5,238	11,344	8,566	-
D. Phosphorus Load (kg/yr)	-	-	4207	4729	-
TSS Load (kg/yr)	6,758,591	942,721	4,696,854	2,455,059	**5,025,665**
Snake Creek above Deer Creek					
Average Flow (cfs)	44	38	47	52	**48**
Average T. Phosphorus (mg/l)	0.056	0.058	0.063	0.042	-
Average D. Phosphorus (mg/l)	-	-	0.034	0.022	-
Total Phosphorus Load (kg/yr)	2,297	2,036	2,767	2,005	-
D. Phosphorus Load (kg/yr)	-	-	1482	1083	-
TSS Load (kg/yr)	169,959	446,084	537,857	539,966	**431,283**

* Water year ** Calendar year

Table 5.7 above compares these yearly loads to past years in previous reports for the Provo River below Jordanelle, Provo River above Deer Creek, and Snake Creek above Deer Creek. This table shows that Provo River above Deer Creek had a TSS loading in 1997 slightly above average and that Snake Creek above Deer Creek was approximate average in 1997compared to previous years.

Dissolved Metal Analysis

The dissolved metal concentrations were analyzed in the laboratory for some of the water samples that were taken. JTAC did not test the samples from the Midway Fish Hatchery effluent for dissolved metals. The other locations were tested three times during 1997. Very few dissolved metals were detectable and the dissolved metals that were detected were in very small concentrations. There were no exceedences of the standards set in Table 3.5. The following table, Table 5.8, summarizes the results of the monitoring.

Table 5.8 Dissolved Metals Summary for Provo River through Heber Valley Sampling Sites.

Date	Al µg/l	As µg/l	Ba µg/l	Cd µg/l	Cr µg/l	Cu µg/l	Fe µg/l	Pb µg/l	Hg µg/l	Mn µg/l	Se µg/l	Ag µg/l	Zn µg/l
Storet #499733, Provo River below Jordanelle Dam													
27-May-97	<30.0	<5.0	43	<1.0	<5.0	<12.0	40.4	<3.0	<0.2	<5.0	<1.0	<2.0	<30.0
26-Aug-97	68	<5.0	37	<1.0	<5.0	<12.0	81.1	<3.0	<0.2	<5.0	<1.0	<2.0	<30.0
29-Oct-97	<30.0	<5.0	39.0	<1.0	<5.0	<12.0	47.2	<3.0	<0.2	<5.0	<1.0	<2.0	<30.0
Storet #499725, Spring Creek at entrance to Provo River east of WWTP													
27-May-97	<30.0	<5.0	87	<1.0	<5.0	<12.0	64.3	<3.0	<0.2	22	<1.0	<2.0	<30.0
26-Aug-97	38	<5.0	110	<1.0	<5.0	<12.0	146	<3.0	<0.2	71	<1.0	<2.0	<30.0
29-Oct-97	<30.0	<5.0	160.0	<1.0	<5.0	<12.0	32.9	<3.0	<0.2	22.0	<1.0	<2.0	<30.0
Storet #591363, Provo River at McKeller Bridge above Deer Creek Reservoir													
27-May-97	<30.0	<5.0	58	<1.0	<5.0	<12.0	56.2	<3.0	<0.2	6.5	<1.0	<2.0	<30.0
26-Aug-97	40	<5.0	60	<1.0	<5.0	<12.0	78.7	<3.0	<0.2	14	<1.0	<2.0	<30.0
29-Oct-97	<30.0	<5.0	72.0	<1.0	<5.0	<12.0	35.9	<3.0	<0.2	7.4	<1.0	<2.0	<30.0
Storet #591016, Snake Creek above Deer Creek Reservoir at RR crossing													
27-May-97	<30.0	12	38	<1.0	<5.0	<12.0	21.5	<3.0	<0.2	11	<1.0	<2.0	<30.0
26-Aug-97	<30.0	17	47	<1.0	<5.0	<12.0	<20.0	<3.0	<0.2	11	<1.0	<2.0	<30.0
29-Oct-97	<30.0	14.0	42.0	<1.0	<5.0	<12.0	<20.0	<3.0	<0.2	7.9	<1.0	<2.0	<30.0

Chapter 6

Deer Creek Reservoir Basin

Introduction

This chapter will present and analyze the water quality monitoring for Deer Creek Reservoir and the major tributaries not analyzed in previous chapters, Daniels Creek and Main Creek.

Monitoring Sites

The monitoring plan for this year included eight sites in this area. Below is listed the description of each site with its STORET number.

STORET No.	Location Description
• 591002	Lower Charleston Canal abv confluence w/ Daniels Creek
• 591352	Daniels Creek 100 feet below confluence with the LCC
• 591346	Main Creek at bridge on US 189 above reservoir
• 591027	Sagebrush-Spring Creek Canal above Daniels Creek
• 591324	Deer Creek Reservoir at upper end
• 591323	Deer Creek Reservoir at Midlake
• 591345	Deer Creek Reservoir at Wallsburg Bay
• 591322	Deer Creek Reservoir above the dam

Each site is described in the following sections with a summary table of the 1997 water quality monitoring. For more complete tables showing actual data from the 1997 water quality monitoring, refer to Appendix A.

Lower Charleston Canal above confluence with Daniels Creek, STORET # 591002

The Lower Charleston Canal is irrigation water that has been diverted from Upper Charleston Canal which has been diverted from Spring Creek. The canal then passes by the west side of the city of Charleston before it combines with Daniels Creek just south of Charleston. A significant portion of the water discharging into Daniels Creek is return flows from agricultural lands. A summary of the water quality data is provided below in Table 6.1.

Table 6.1 Lower Charleston Canal at Daniels Crk, STORET # 591002 – Water Quality Summary

Date	Temp Deg C	pH	D.O. mg/l	T.Sus.Sol mg/l	Ammonia N mg/l	T. Phos. mg/l	D-T Phos. mg/l
Minimum	4.0	7.7	9.6	0	0.00	0.05	0.04
Maximum	12.0	8.2	10.8	14	0.09	0.05	0.04
Median	8.4	7.9	10.5	6	0.00	0.05	0.04
Mean	8.3	7.9	10.4	5	0.02	0.05	0.04
Number	5	5	5	5	5	1	1
Exceedences	0	0	0	0	1	1	1

The canal was monitored on eight occasions during 1997. On three occasions, June, July, and August, there was no flow in the canal for a sample to be taken. Only one sample had reliable phosphorus data, and that sample was in exceedence of JTAC standards. Historically this canal has reported very high phosphorus concentrations throughout the year. The TSS concentrations are very comparable to past years.

Daniels Creek 100 feet below confluence with the LCC, STORET # 591352

This monitoring site is located on Daniels Creek just before it flows into Deer Creek Reservoir near USGS gage #10157500. After spring snow melt is completed, in Daniels Canyon, much of the water in Daniels Creek is from return flows of agricultural lands of the east side of Heber Valley. A summary of the water quality data is given below in Table 6.2.

Table 6.2 Daniels Creek 100' below LCC, STORET # 591352 – Water Quality Summary

Date	Temp Deg C	pH	D.O. mg/l	T.Sus.Sol mg/l	Ammonia N mg/l	T. Phos. mg/l	D-T Phos. mg/l
Minimum	3.0	7.7	8.6	0	0.00	0.10	0.06
Maximum	16.6	8.6	11.3	147	0.19	0.10	0.06
Median	6.7	8.2	10.2	9	0.05	0.10	0.06
Mean	8.9	8.2	10.0	28	0.05	0.10	0.06
Number	9	9	9	9	9	2	2
Exceedences	0	0	0	2	1	2	2

This location was sampled on nine occasions during 1997. Only two of the nine samples had reliable phosphorus data for analysis. Both of these samples showed high concentrations of phosphorus. Historically this monitoring site has generally recorded high phosphorus concentrations. This year's TSS concentrations are comparable to previous years.

Main Creek at bridge on US 189 above reservoir, STORET # 591346

This monitoring site is located on Main Creek just before it discharges into Wallsburg Bay of Deer Creek Reservoir. Main Creek drains a large area to the southeast of Deer Creek including Round Valley. A summary of the water quality data is shown below in Table 6.3.

Table 6.3 Main Creek above Deer Creek, STORET # 591324 – Water Quality Summary

Date	Temp Deg C	pH	D.O. mg/l	T.Sus.Sol mg/l	Ammonia N mg/l	T. Phos. mg/l	D-T Phos. mg/l
Minimum	3.6	7.7	7.1	6	0.00	0.03	0.03
Maximum	19.1	8.3	11.6	267	0.12	0.11	0.07
Median	9.0	8.0	9.7	14	0.06	0.07	0.05
Mean	10.1	8.0	9.5	69	0.05	0.07	0.05
Number	11	11	11	11	11	2	2
Exceedences	0	0	0	3	2	1	1

This location was monitored on eleven occasions during 1997. Only two of the samples taken were reliable for phosphorus data analysis. Of the two samples, one had high concentrations of phosphorus. Historically, this site has generally recorded high concentrations of phosphorus. TSS concentrations appear to be comparable to past years.

Sagebrush-Spring Creek Canal above Daniels Creek, STORET # 591027

This monitoring site is located on Sagebrush and Spring Creek Canal just upstream from where it discharges into Daniels Creek. This canal starts on the northeast end of Heber Valley and diverts some of the headwaters from Spring Creek into the canal. From there the canal runs in a southerly direction and passes on the west side of Heber City on its way to Daniels Creek. In addition to irrigation conveyance, most of the water is urban runoff and return flows from agricultural lands. A summary of the water quality data is shown below in Table 6.4.

Table 6.4 Sagebrush-Spring Creek Canal, STORET # 591027 – Water Quality Summary

Date	Temp Deg C	pH	D.O. mg/l	T.Sus.Sol mg/l	Ammonia N mg/l	T. Phos. mg/l	D-T Phos. mg/l
Minimum	1.6	7.1	6.9	0	0.00	0.11	0.04
Maximum	15.0	8.3	11.8	106	0.22	0.20	0.08
Median	7.2	7.9	8.9	19	0.00	0.15	0.06
Mean	7.8	7.8	9.1	35	0.03	0.15	0.06
Number	9	9	9	9	9	2	2
Exceedences	0	0	0	3	1	2	2

This location was monitored on ten occasions during 1997. The November monitoring period found no flow present in the canal. Only two water samples have reliable phosphorus data both of which recorded high concentrations above JTAC standards. Historically this location has generally shown high levels of phosphorus. TSS monitoring was very comparable to previous years.

Deer Creek Reservoir at upper end, STORET # 591324

The north end of Deer Creek Reservoir near the inlet of the Provo River and Snake Creek is relatively shallow. The location where the samples were collected was an average of ten meters deep. Samples were collected from the surface and the bottom. A combined summary of the water quality data for the surface and bottom is shown below in Table 6.5.

Table 6.5 Deer Creek Reservoir at Upper End, STORET # 591324 – Water Quality Summary

Date	Temp Deg C	pH	D.O. mg/l	T.Sus.Sol mg/l	Ammonia N mg/l	T. Phos. mg/l	D-T Phos. mg/l
Minimum	7.2	7.4	3.1	0	0.00	-	-
Maximum	23.9	8.8	9.1	8	0.10	-	-
Median	15.9	8.0	7.9	0	0.03	-	-
Mean	15.5	8.1	7.4	1	0.03	-	-
Number	16	16	16	14	16	0	0
Exceedences	4	0	0	0	0	0	0

The site was sampled on eight occasions during 1997. Two samples were taken each time for a total of 16 samples. None of the samples have reliable phosphorus data to report. The DO levels remained above the JTAC standard.

Deer Creek Reservoir at Midlake, STORET # 591323

The midlake monitoring site was approximately 24 meters deep. Samples were collected at as many as five separate depths; ("surface", "above thermocline", "mid-depth", "below thermocline" and "bottom") depending on the strength of the stratification. The location was sampled on eight occasions during 1997. A combined summary of the water quality data is provided below in Table 6.6.

Table 6.6 Deer Creek Reservoir at Midlake, STORET # 591323 – Water Quality Summary

Date	Temp Deg C	pH	D.O. mg/l	T.Sus.Sol mg/l	Ammonia N mg/l	T. Phos. mg/l	D-T Phos. mg/l
Minimum	6.9	7.2	0.9	0	0.00	-	-
Maximum	23.5	8.8	10.3	19	0.13	-	-
Median	16.0	7.9	6.6	0	0.06	-	-
Mean	14.9	7.9	6.0	2	0.05	-	-
Number	23	23	23	21	23	0	0
Exceedences	5	0	1	0	2	0	0

All the phosphorus data was unreliable for data analysis. The exceedence of temperature was only on the surface depth and occurs seasonally for this reservoir. The DO concentration dropped well below the JTAC standard on August 7th to 0.9 mg/l at the bottom depth. Curiously, a measurement was taken the day before and recorded 2.3 mg/l (refer to Appendix A). The variance may be due to the fact that it is impossible to sample the exact same location on the reservoir each time.

Deer Creek Reservoir at Wallsburg Bay, STORET # 591345

On the east side of Deer Creek Reservoir where Main Creek discharges into the reservoir is Wallsburg Bay. This monitoring site is approximately 11 meters deep.

Samples were only collected from the surface and only field data was gathered. A summary of the water quality data is provided below in Table 6.7.

Table 6.7 Deer Creek Reservoir at Wallsburg Bay, STORET # 591345 – Water Quality Summary

Date	Temp Deg C	pH	D.O. mg/l	T.Sus.Sol mg/l	Ammonia N mg/l	T. Phos. mg/l	D-T Phos. mg/l
Minimum	7.8	7.8	6.0	-	-	-	-
Maximum	21.9	8.5	8.1	-	-	-	-
Median	19.7	8.1	7.3	-	-	-	-
Mean	17.4	8.1	7.2	-	-	-	-
Number	5	5	5	0	0	0	0
Exceedences	1	0	0	0	0	0	0

This location was sampled five times during 1997. Since only field data was gathered there was no analysis of TSS, ammonia, or phosphorus.

Deer Creek Reservoir above the dam, STORET # 591322

The water was approximately 37 meters deep at the monitoring station just above the dam in Deer Creek Reservoir. Samples were collected at five separate depths ("surface", "above thermocline", "mid-depth", "below thermocline" and "bottom"). The location was sampled on nine occasions during 1997. On two occasions the reservoir was stratified enough that samples were taken from all five depths. A combined summary of the water quality data is provided below in Table 6.8.

Table 6.8 Deer Creek Reservoir above dam, STORET # 591322 – Water Quality Summary

Date	Temp Deg C	pH	D.O. mg/l	T.Sus.Sol mg/l	Ammonia N mg/l	T. Phos. mg/l	D-T Phos. mg/l
Minimum	5.0	7.0	0.1	0	0.00	-	-
Maximum	22.9	8.7	12.5	16	0.24	-	-
Median	14.0	7.9	6.7	0	0.06	-	-
Mean	13.9	7.8	6.2	2	0.06	-	-
Number	30	30	30	24	30	0	0
Exceedences	4	0	4	0	8	0	0

All phosphorus data was unreliable for data analysis. During the late summer months of August through September into part of October anoxic conditions existed in the hypolimnion. Not only were there low DO concentrations recorded but also high levels of ammonia, both typical of anoxic conditions.

TSS Loading into Deer Creek Reservoir

The TSS loads were calculated for Provo River, Snake Creek, Daniels Creek, and Main Creek that directly discharge into Deer Creek Reservoir. Table 6.9 summarizes the TSS loading analysis of the four streams (see Appendix C for complete calculations). The TSS analysis of Provo River and Snake Creek has also been reported in Chapter 5.

Table 6.9 1997 TSS Loading Summary for Deer Creek

	TSS concentration Average (mg/l)	TSS concentration Peak (mg/l)	Flow Average (cfs)	Flow Peak (cfs)	TSS Loading Rate Average (tons/day)	TSS Loading Rate Peak (tons/day)	1997 TSS Load (kg/yr)
Daniels Crk above Deer Creek							
	84.5	147	23.9	99	5.4	39	**1,801,933**
Main Creek above Deer Creek							
	127.2	267	33.0	239	11.3	117.9	**3,727,492**
*Provo River above Deer Creek**							
	15.1	184	382.3	1,480	15.2	142	**5,025,665**
*Snake Crk above Deer Creek**							
	9.3	32	55.2	67	1.3	4.8	**431,283**
Total Input into Deer Creek					**33.2**		**10,986,373**

* *as previously reported in Chapter 5*

From the loading calculations, Main Creek and Daniels Creek reported TSS loadings slightly above normal as compared to previous years. As seen in Table 6.9 above and Figure 6.1, the 1997 calculated TSS loadings into Deer Creek show that the majority of sediment entering the reservoir originated from the Provo River and Main Creek. Those rivers made up 80% of the TSS deposited in Deer Creek. Although Main and Daniels Creek TSS concentrations were comparable to previous years, the loadings were slightly higher than previous years due to larger stream flows.

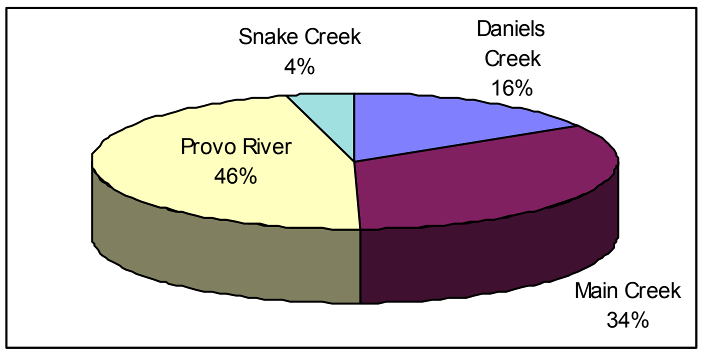


Figure 6.1 1997 TSS Loading Distribution into Deer Creek Reservoir

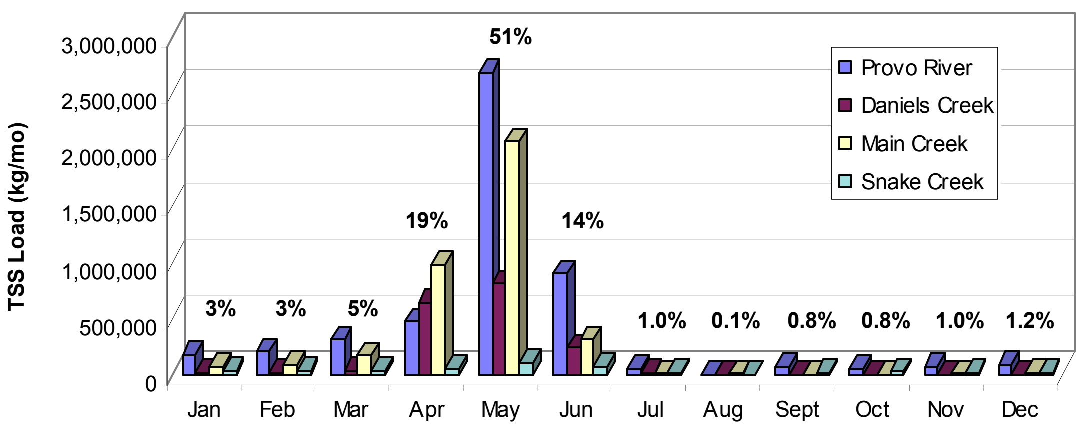


Figure 6.2 Monthly Distribution of TSS Loading into Deer Creek for 1997.

Further analysis of the loadings demonstrates that most of the TSS flows into Deer Creek during the spring runoff. Figure 6.2 above shows the monthly loads from each of the four streams. This graph shows that 51% of the TSS loads were contributed during the month of May. And 89% of the load occurred during the spring runoff months March, April, May, June.

Table 6.10 shows the water quality data of the over the last five years for the four stream/river inputs to Deer Creek Reservoir. The annual TSS loading from the Provo River was slightly above average. From Snake Creek, the annual TSS loading was approximately average. Main Creek contributed a high amount of TSS compared to previous years and Daniels Creek contributed an average TSS loading.

Table 6.10 Historic Water Quality Data (1993-1997)

	1993*	**1994***	**1995***	**1996***	**1997****
Provo River above Deer Creek***					
Average Flow (cfs)	315	140	193	231	**303**
Average T. Phosphorus (mg/l)	0.072	0.04	0.063	0.04	-
Average D. Phosphorus (mg/l)	-	-	0.023	0.022	-
Total Phosphorus Load (kg/yr)	21,246	5,238	11,344	8,566	-
D. Phosphorus Load (kg/yr)	-	-	4207	4729	-
TSS Load (kg/yr)	6,758,591	942,721	4,696,854	2,455,059	**5,025,665**
Snake Creek above Deer Creek***					
Average Flow (cfs)	44	38	47	52	**48**
Average T. Phosphorus (mg/l)	0.056	0.058	0.063	0.042	-
Average D. Phosphorus (mg/l)	-	-	0.034	0.022	-
Total Phosphorus Load (kg/yr)	2,297	2,036	2,767	2,005	-
D. Phosphorus Load (kg/yr)	-	-	1482	1083	-
TSS Load (kg/yr)	169,959	446,084	537,857	539,966	**431,283**
Main Creek above Deer Creek					
Average Flow (cfs)	23	9	31	20	**30**
Average T. Phosphorus (mg/l)	0.121	0.053	0.121	0.072	-
Average D. Phosphorus (mg/l)	-	-	0.031	0.043	-
Total Phosphorus Load (kg/yr)	2,552	455	3,437	1,306	-
D. Phosphorus Load (kg/yr)	-	-	896	779	-
TSS Load (kg/yr)	2,133,099	246,679	2,603,917	877,802	**3,727,492**
Daniels Creek above Deer Creek					
Average Flow (cfs)	24	10	19	14	**22**
Average T. Phosphorus (mg/l)	0.289	0.079	0.092	0.079	-
Average D. Phosphorus (mg/l)	-	-	0.04	0.048	-
Total Phosphorus Load (kg/yr)	6,504	705	1,627	1,047	-
D. Phosphorus Load (kg/yr)	-	-	712	633	-
TSS Load (kg/yr)	5,264,927	266,650	1,370,557	803,024	**1,801,933**
Total TSS Load into Deer Creek Reservoir (kg/yr)	**14,326,576**	**1,902,134**	**9,209,185**	**4,675,851**	**10,986,373**

* Water year ** Calendar year ***Previously reported in Chapter 5

The total annual TSS load that was input into Deer Creek Reservoir each year is shown in the table above. The 1997 TSS loading into Deer Creek was 10,986,373 kg which was approximately average as compared to the previous four years. The TSS loadings are related to the stream flows. 1997 in comparison to previous years, had above average flows, yet fortunately, the total TSS loading into Deer Creek was only slightly above average.

Dissolved Metals Analysis

The dissolved metal concentrations were analyzed in the laboratory for some of the water samples that were taken. Dissolved metals were analyzed at all sites in this basin except for Deer Creek at Wallsburg Bay. The other locations had samples that were tested two to three times during 1997. Very few dissolved metals were detectable and the ones that were detected occurred in very small concentrations. There were no exceedences of the standards set in Table 3.5. The following table, Table 6.11, summarizes the results of the monitoring.

Table 6.11 Dissolved Metals Summary for Deer Creek Reservoir Sampling Sites.

Date	Al µg/l	As µg/l	Ba µg/l	Cd µg/l	Cr µg/l	Cu µg/l	Fe µg/l	Pb µg/l	Hg µg/l	Mn µg/l	Se µg/l	Ag µg/l	Zn µg/l
Storet #591324, Deer Creek Reservoir at upper end													
28-May-97	<30.0	<5.0	58	1	<5.0	<12.0	20.8	<3.0	<0.2	5	<1.0	<2.0	<30.0
6-Aug-97	<30.0	<5.0	68.94	<1.0	<5.0	<12.0	<20.0	<3.0	<0.2	<5.0	<1.0	<2.0	<30.0
8-Oct-97	<30.0	<5.0	72.0	<1.0	<5.0	<12.0	<20.0	<3.0	<0.2	<5.0	<1.0	<2.0	<30.0
Storet #591323, Deer Creek Reservoir at Midlake													
28-May-97	<30.0	<5.0	62	<1.0	<5.0	<12.0	26.7	<3.0	<0.2	16	<1.0	<2.0	<30.0
6-Aug-97	<30.0	<5.0	62.69	<1.0	<5.0	<12.0	<20.0	<3.0	<0.2	96.32	<1.0	<2.0	<30.0
8-Oct-97	<30.0	<5.0	87.0	<1.0	<5.0	<12.0	22.4	<3.0	<0.2	10.0	<1.0	<2.0	<30.0
Storet #591322, Deer Creek Reservoir above the dam													
28-May-97	<30.0	<5.0	60	<1.0	<5.0	<12.0	<20.0	<3.0	<0.2	24	<1.0	<2.0	<30.0
6-Aug-97	<30.0	<5.0	60.27	<1.0	<5.0	<12.0	<20.0	<3.0	<0.2	17.41	<1.0	<2.0	<30.0
7-Aug-97	<30.0	<5.0	58	<1.0	<5.0	<12.0	<20.0	<3.0	<0.2	<5.0	<1.0	<2.0	<30.0
8-Oct-97	<30.0	<5.0	80.0	<1.0	<5.0	<12.0	20.6	<3.0	<0.2	200.0	<1.0	<2.0	<30.0
Storet #591002, Lower Charleston Canal above confluence with Daniels Creek													
27-May-97	<30.0	<5.0	120	<1.0	<5.0	<12.0	<20.0	<3.0	<0.2	<5.0	<1.0	<2.0	<30.0
29-Oct-97	<30.0	<5.0	120.0	<1.0	<5.0	<12.0	<20.0	<3.0	<0.2	<5.0	<1.0	<2.0	<30.0
Storet #591352, Daniels Creek 100 feet below confluence with the LCC													
27-May-97	120	<5.0	74	<1.0	<5.0	<12.0	121	<3.0	<0.2	9.8	<1.0	<2.0	<30.0
26-Aug-97	<30.0	<5.0	130	<1.0	<5.0	<12.0	109	<3.0	<0.2	7.3	<1.0	<2.0	<30.0
29-Oct-97	<30.0	<5.0	130.0	<1.0	<5.0	<12.0	21.7	<3.0	<0.2	<5.0	<1.0	<2.0	<30.0
Storet #591346, Main Creek at bridge on US 189 above reservoir													
27-May-97	90	<5.0	64	<1.0	<5.0	<12.0	82.6	<3.0	<0.2	20	<1.0	<2.0	<30.0
26-Aug-97	<30.0	<5.0	130	<1.0	<5.0	<12.0	43	<3.0	<0.2	63	<1.0	<2.0	<30.0
29-Oct-97	<30.0	<5.0	100.0	<1.0	<5.0	<12.0	24.5	<3.0	<0.2	25.0	<1.0	<2.0	<30.0
Storet #591027, Sage Brush-Spring Creek Canal above Daniels Creek													
27-May-97	<30.0	<5.0	110	<1.0	<5.0	<12.0	46.1	<3.0	<0.2	16	<1.0	<2.0	<30.0
26-Aug-97	<30.0	<5.0	180	<1.0	<5.0	<12.0	36.2	<3.0	<0.2	5.7	<1.0	<2.0	<30.0
29-Oct-97	<30.0	<5.0	140.0	<1.0	<5.0	<12.0	27.7	<3.0	<0.2	<5.0	<1.0	<2.0	<30.0

Deer Creek Reservoir DO Monitoring

At four reservoir monitoring sites on Deer Creek Reservoir, JTAC took measurements of temperature, pH, and dissolved oxygen (DO) at varying depths for the generation of water parameter profiles. The profiles provided here plot the temperature and dissolved oxygen concentration with respect to depth for the purpose of analysis of stratification in the reservoir. The profiles graphically show the thermocline in the reservoir where the temperature significantly drops off and the depth at which dissolved oxygen levels decrease. If anoxic conditions exist in the reservoir, it will be apparent in the generated profiles.

The reservoir goes through cycles of stratification each year as the seasons change. Stratification begins when the warm summer air begins to warm the surface of the reservoir. Then as the temperatures decrease in the late fall, the reservoir begins to turnover from convection currents, destratification is the result. The switch from water year to calendar year benefits the presentation of reservoir profiles. This is because of the additional presentation of reservoir conditions during October and November. These months complete the reservoir cycle for the current year.

In 1997, profile data was gathered seven times from the JTAC monitoring locations. They were gathered in the months of April, May, June, August, September, October and November. For the month of April, problems occurred with the sampling boat and profile samples were only taken at the dam.

In addition to the sample profiles, water being released from the dam into the Provo River is monitored continually for field parameters. (See figure 6.28 & 6.30) The outlet works for Deer Creek dam draw water near the bottom of the reservoir. Monitoring data from this site would be representative of the lower levels of the reservoir.

Upper End, STORET #591324

On the north end of the reservoir near the inlet of the Provo River, water profile samples were taken on six occasions. The resulting profiles from the collected data for the Upper End are given in Figures 6.3 – 6.8. This location on the reservoir is too shallow for reservoir stratification and remains relatively well mixed throughout the year. The profiles show no concentration less than the 2.0 mg/l minimum DO limit for this area. The lowest recorded DO level occurred on October 8, 1997 and recorded a 7.06 mg/l DO concentration at a bottom depth of 5.0 meters.

Midlake, STORET #591323

Deer Creek Reservoir at Midlake was sampled for profiles on six occasions. The resulting profiles from the collected data are given in Figures 6.9 – 6.14. This location on the reservoir shows that some stratification occurred during the year. The profiles show DO concentrations below the 2.0 mg/l minimum on one occasion, September 9, 1997 (see Figure 6.12), on the bottom layer with a DO concentration of 1.7 mg/l.

Wallsburg Bay, STORET #591345

Profiles were sampled at Wallsburg Bay near the inlet of Main Creek on the east side of the reservoir on six occasions in water approximately 11 meters deep. The results from the collected data are given in figures 6.15 – 6.20. The profiles show no concentration less than the 2.0 mg/l minimum DO limit for this area. The lowest recorded DO level occurred on August 6, 1997 and recorded a 3.48 mg/l DO concentration at a depth of 5.0 meters.

Above Dam, STORET #591322

Above the dam, Deer Creek Reservoir was sampled for profiles on seven occasions. The resulting profiles from the collected data for the Provo Arm are given in Figures 6.21 – 6.27. Stratification of Deer Creek Reservoir is most apparent at this location. The profiles show DO concentrations below the 2.0 mg/l minimum on three occasions, August 6th, September 9th, and October 8th, on the bottom layer (see Figures 6.24, 6.25, 6.26). On all three occasions the reservoir reached anoxic conditions. The lowest recorded DO level occurred on September 9, 1997 and recorded a 0.09 mg/l at a bottom depth of 45.0 m.

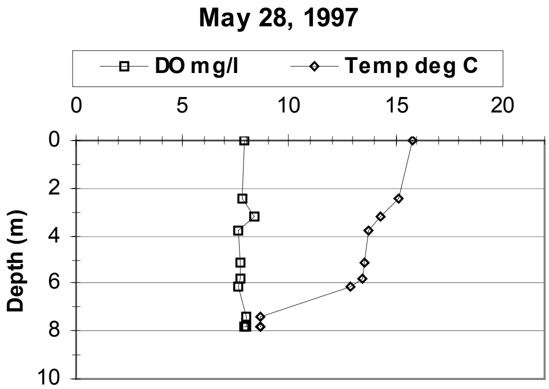


Figure 6.3 Deer Creek – Upper End, Profile 5-28-97

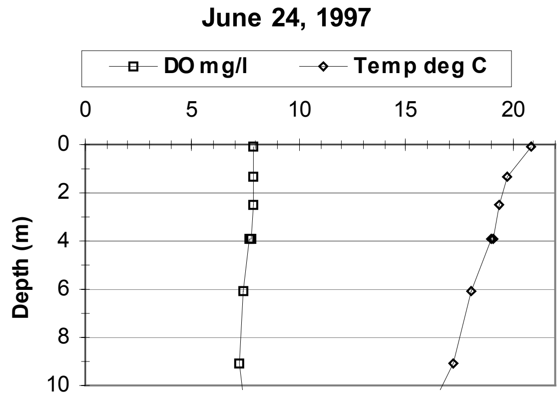


Figure 6.4 Deer Creek – Upper End, Profile 6-24-97

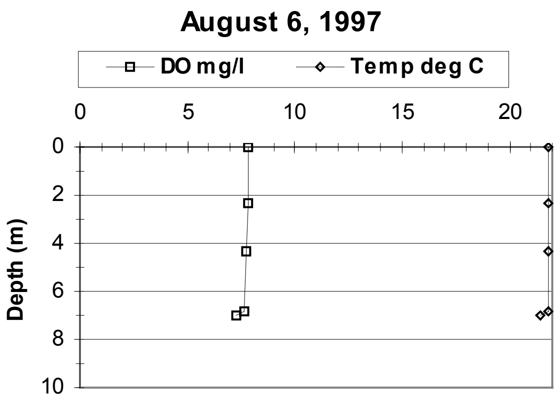


Figure 6.5 Deer Creek – Upper End, Profile 8-6-97

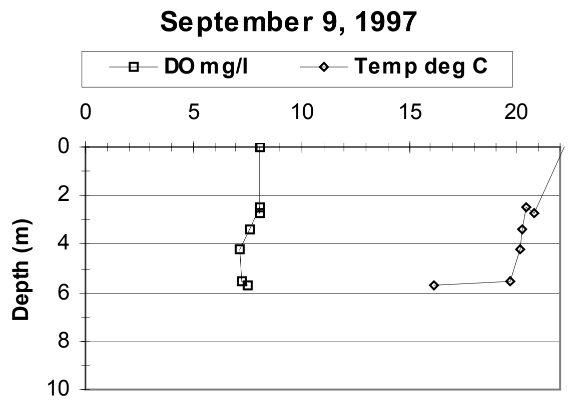


Figure 6.6 Deer Creek – Upper End, Profile 9-9-97

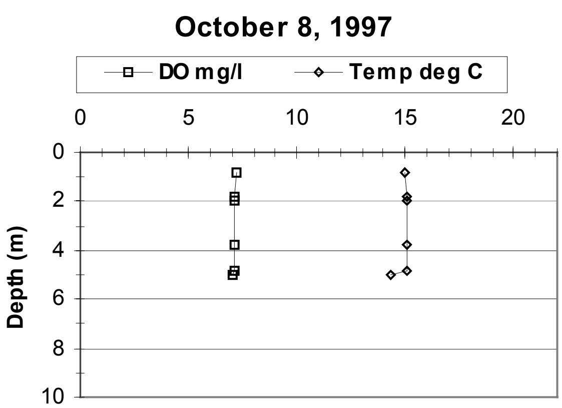


Figure 6.7 Deer Creek – Upper End, Profile 10-8-97

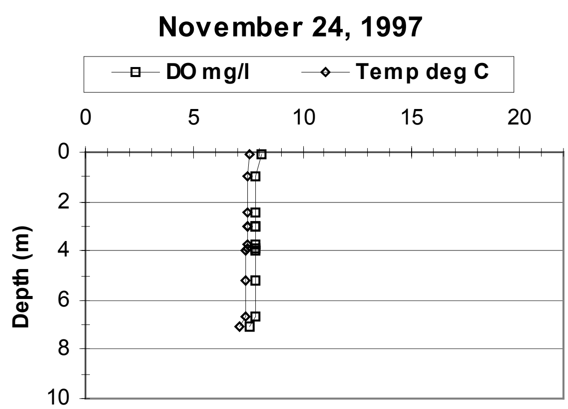


Figure 6.8 Deer Creek – Upper End, Profile 11-24-97

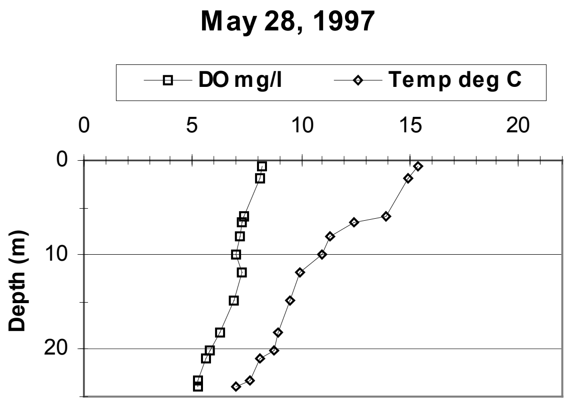


Figure 6.9 Deer Creek – Midlake, Profile 5-28-97

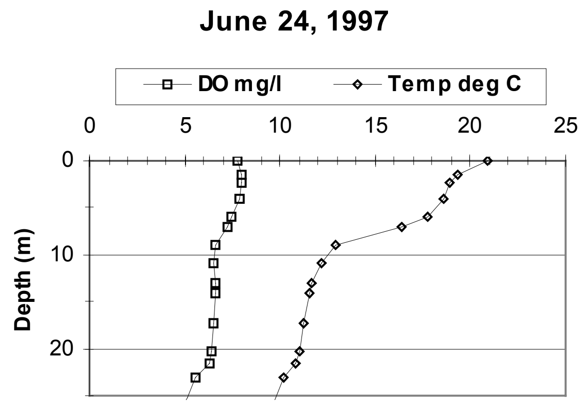


Figure 6.10 Deer Creek – Midlake, Profile 6-24-97

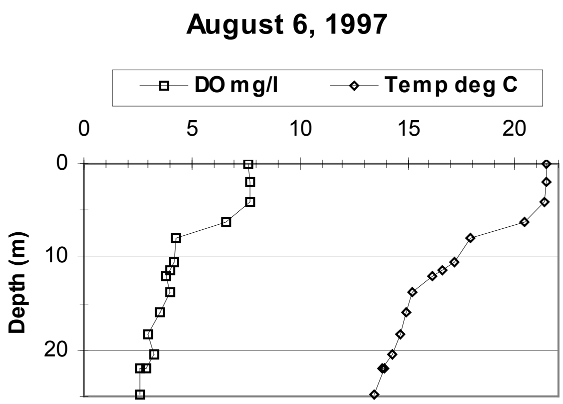


Figure 6.11 Deer Creek – Midlake, Profile 8-6-97

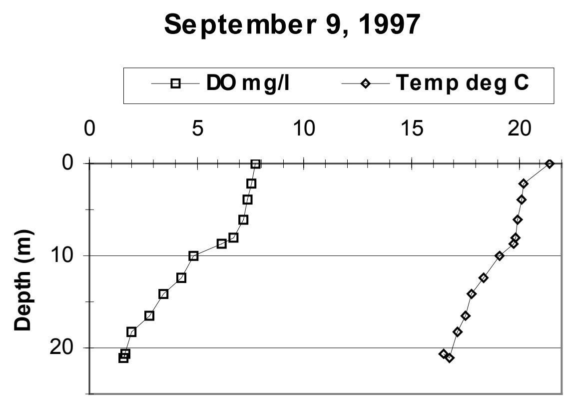


Figure 6.12 Deer Creek – Midlake, Profile 9-9-97

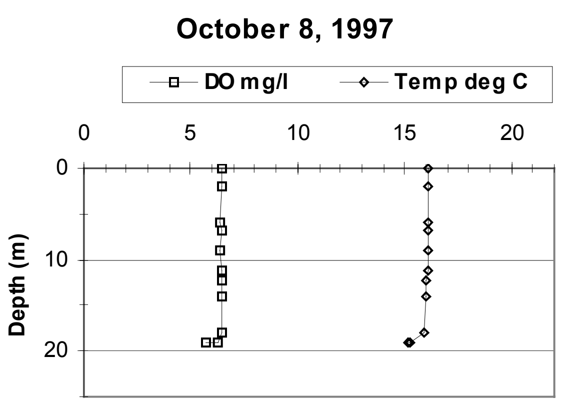


Figure 6.13 Deer Creek – Midlake, Profile 10-8-97

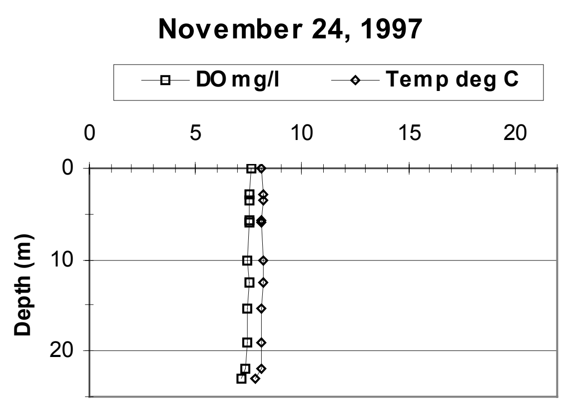


Figure 6.14 Deer Creek – Midlake, Profile 11-24-97

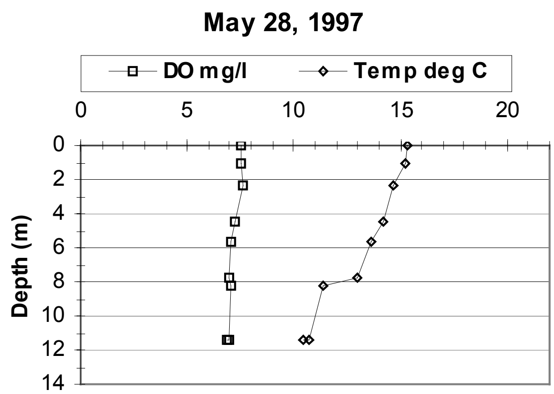


Figure 6.15 Deer Creek – Wallsburg, Profile 5-28-97

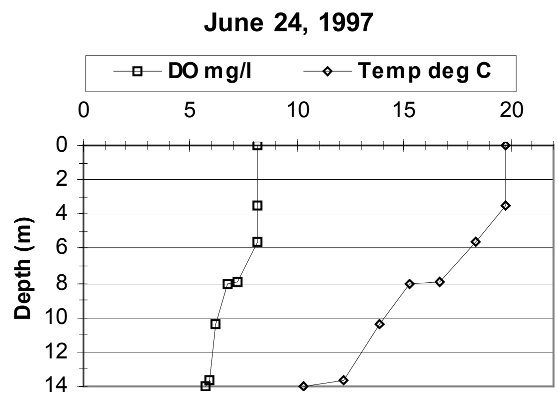


Figure 6.16 Deer Creek – Wallsburg, Profile 6-6-97

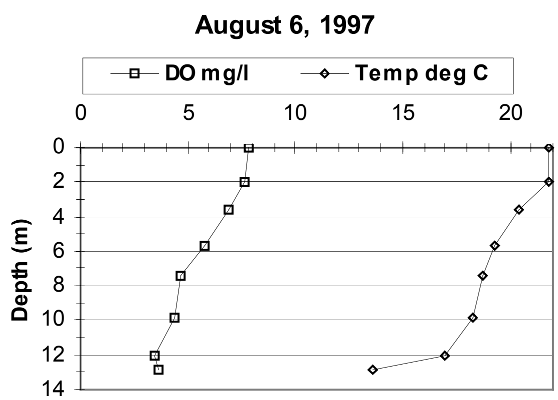


Figure 6.17 Deer Creek – Wallsburg, Profile 8-6-97

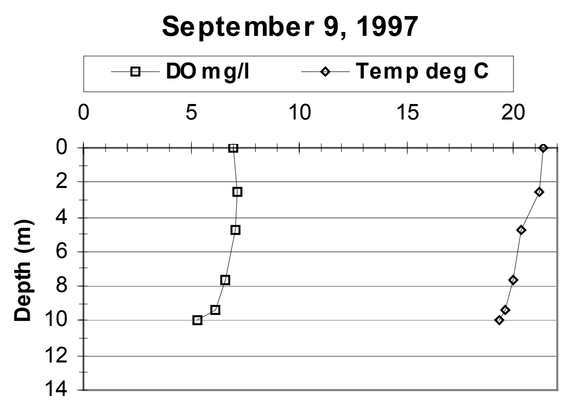


Figure 6.18 Deer Creek – Wallsburg, Profile 9-9-97

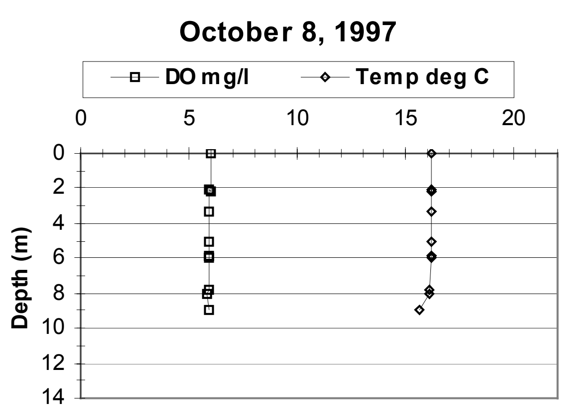


Figure 6.19 Deer Creek – Wallsburg, Profile 10-8-97

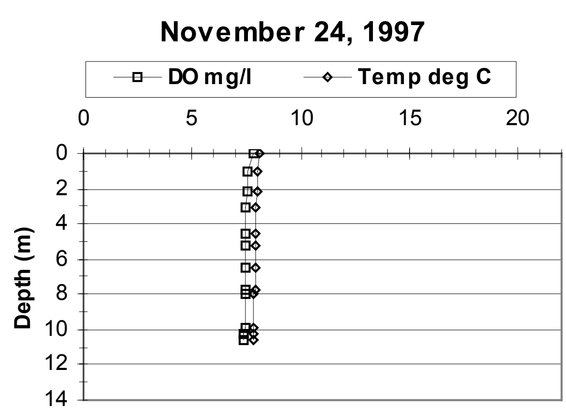


Figure 6.20 Deer Creek – Wallsburg, Profile 11-24-97

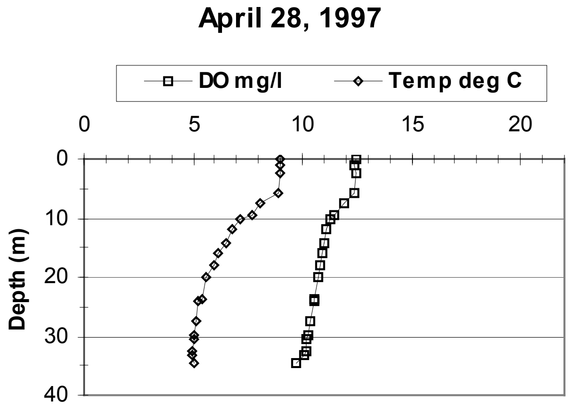


Figure 6.21 Deer Creek – Above Dam, Profile 4-28-97

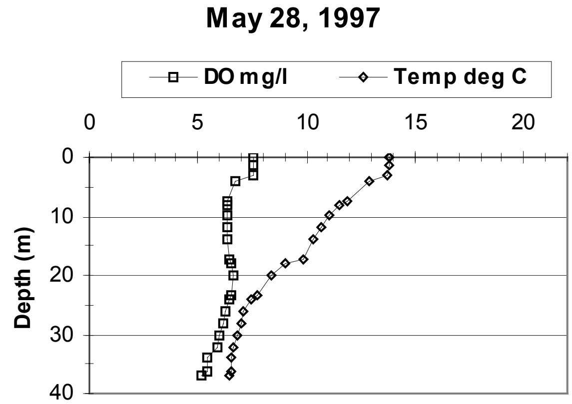


Figure 6.22 Deer Creek – Above Dam, Profile 5-28-97

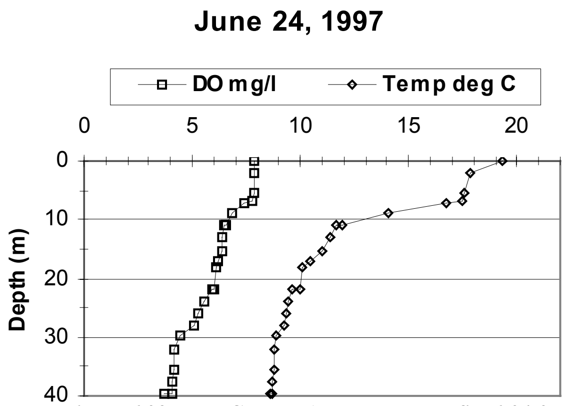


Figure 6.23 Deer Creek – Above Dam, Profile 6-24-97

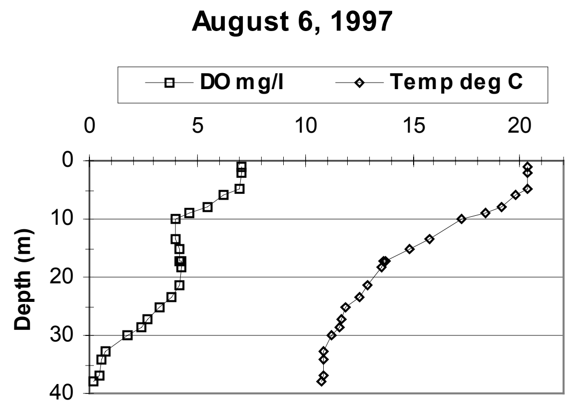


Figure 6.24 Deer Creek – Above Dam, Profile 8-6-97

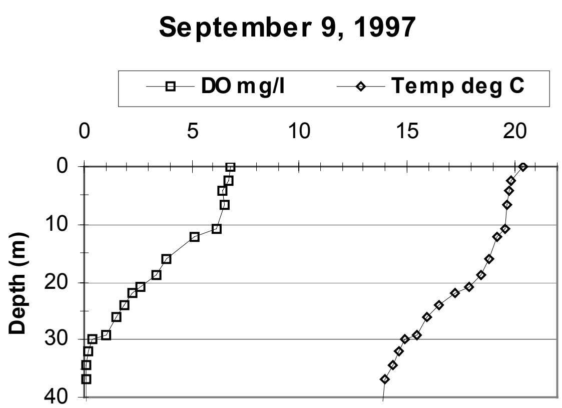


Figure 6.25 Deer Creek – Above Dam, Profile 9-9-97

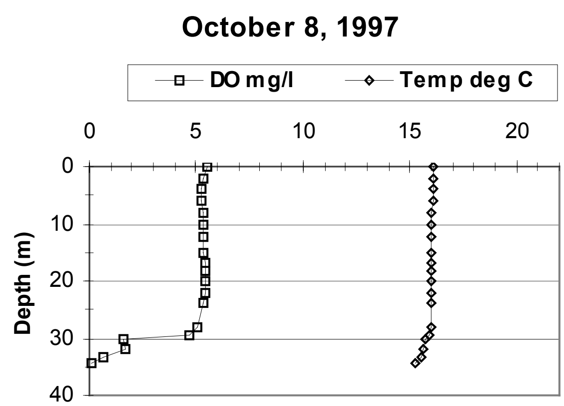


Figure 6.26 Deer Creek – Above Dam, Profile 10-8-97

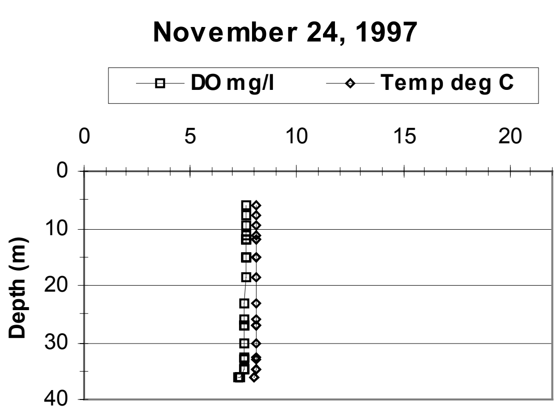


Figure 6.27 Deer Creek – Above Dam, Profile 11-24-97

Deer Creek Reservoir DO Analysis

The profiles show that some sites on Deer Creek Reservoir had many DO concentrations that were below the standard of 2.0 mg/l during the late summer and early fall. The following chart, Figure 6.28, shows the 1997 reservoir bottom DO concentrations for each of the four monitoring sites plus the monitoring probe that measures DO along with other parameters in the water released from the reservoir into the lower Provo River.

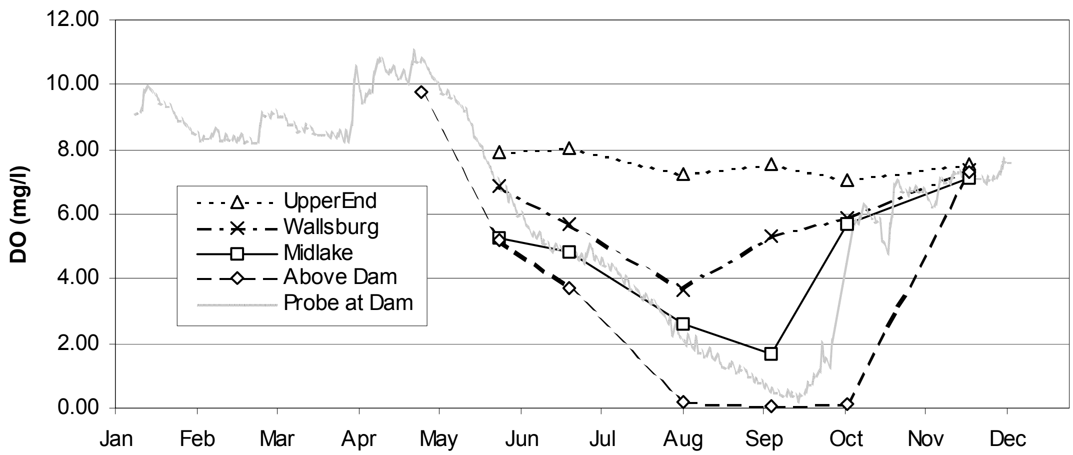


Figure 6.28 Deer Creek Reservoir bottom DO Concentrations for 1997

The four monitoring locations and the monitoring probe show varying degrees of DO concentrations. The reason for the variance is related to the depth of each location. The locations at the Upper End, Wallsburg Bay, Midlake, and above the dam have approximate depths of 7, 11, 22, and 37 meters respectively. This general relationship is seen in Figure 6.28 with respect to DO levels. The low DO levels only occur at locations of sufficient depth for stratification. The monitoring shows that an anoxic condition existed in the hypolimnion of the reservoir during August and September which is typical for Deer Creek. These conditions are harmful to the habitat in the reservoir. The lack of oxygen also causes taste and odor problems in the water taken for culinary purposes. Better control of algae growth by reduction of phosphorus should help reduce the effects of this problem.

Deer Creek Trophic State Index

The Carlson Trophic State Index has been used by the State of Utah to rank and compare the trophic status of lakes and reservoirs within the state. This index uses data from May to September of three parameters: Secchi disk transparency depth, total phosphorus, and Chlorophyll A. Unfortunately, only the transparency depth and Chlorophyll A were useable for this year's calculation. Table 6.12 shows the calculation results for Deer Creek Reservoir.

Table 6.12 1997 Carlson Trophic State Index (TSI) calculation for Deer Creek

Sample Date	Upper End Transp. m	Upper End Chlor-A µg/l	Midlake Transp. m	Midlake Chlor-A µg/l	Above Dam Transp. m	Above Dam Chlor-A µg/l
28-May-97	2.4	5.1	2.4	11.4	3.3	9.7
3-Jun-97	3.8		4.3		3.45	6.8
24-Jun-97	4.5	3.4	5.1	1.1	4.5	3
6-Aug-97	1.8	7.1	2	4.6	1.8	5
7-Aug-97	2.8		2.5		2.1	2.2
9-Sep-97	2.2	7.3	3.7	3.9	3.7	5.7
Average	2.9	5.7	3.3	5.3	3.1	5.4
TSI	**44.6**	**47.7**	**42.7**	**46.9**	**43.5**	**47.1**
TSI Average	**46.1**		**44.8**		**45.3**	
Average TSI for Reservoir →			**45**			

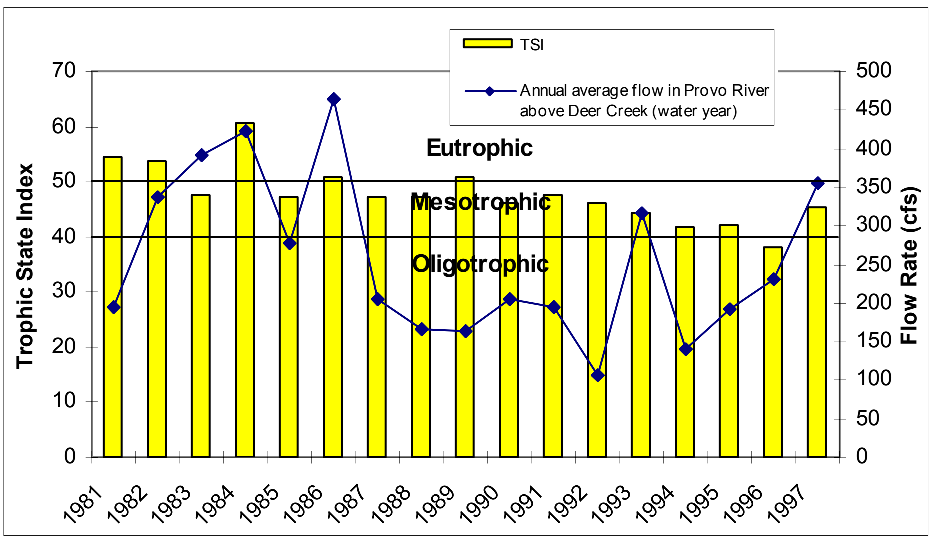


Figure 6.29 Deer Creek Reservoir TSI and Provo River average flow rate 1981-1997

The TSI was averaged to be 45 which classifies Deer Creek as a mesotrophic reservoir. Figure 6.29 above shows the TSI classification of Deer Creek reservoir since 1981. This number is higher than 1996 which recorded Deer Creek's lowest TSI at 38. It is noted that the hydrologic conditions have some effect on this number as seen in the figure above.

Also the lack of phosphorus data may have increased the number slightly. For example, the 1996 TSI would have been 41 rather than 38, and the 1995 TSI would have been 44 rather than 41 if the phosphorus data had not been included in the calculation. Nevertheless, Deer Creek has made substantial improvements since the early 1980's when the reservoir was at higher eutrophic levels.

In comparing the average flow with previous years, this year's runoff was similar to the runoff in 1982. Both 1982 and 1997 have approximately the same average flow and are preceded by a year with a lower average flow. Using this comparison, the improvement of Deer Creek Reservoir is apparent. In 1982 the reservoir was eutrophic with TSI of 54 whereas in 1997 the reservoir has established itself in the mesotrophic range.

Deer Creek Monitoring Probe

A monitoring probe has been located in Deer Creek dam since March 1992 and makes daily readings of field parameters of the water released from Deer Creek. Figure 6.30 below shows the data recorded from March of 1992 to December 1997. The graph shows the annual cycles in the reservoir with respect to temperature, dissolved oxygen and pH. 1997 shows no significant changes in these parameters as compared with previous years.

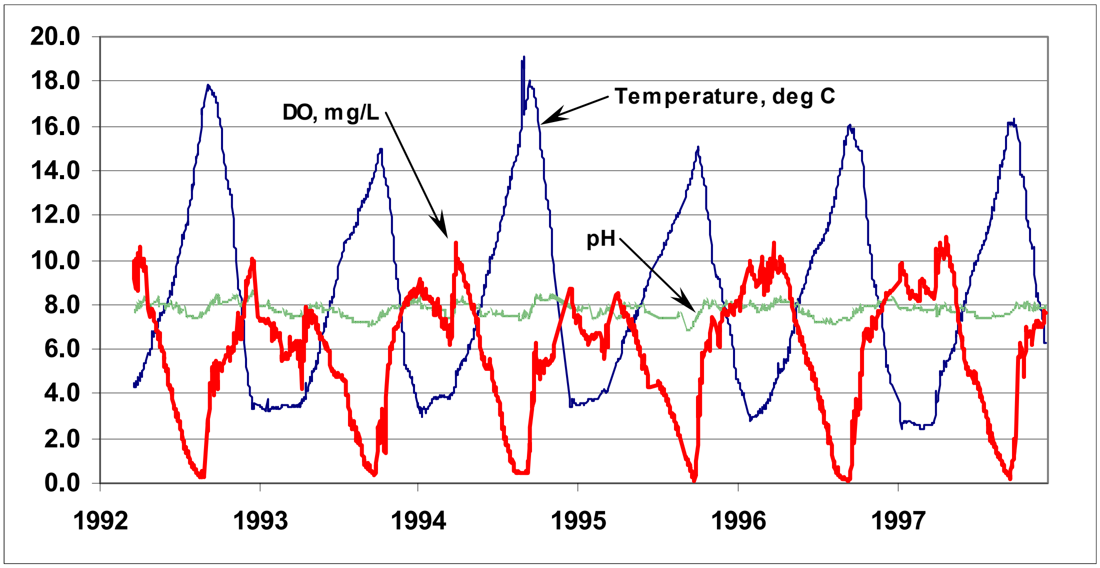


Figure 6.30 Deer Creek Dam Probe Measurements, 1992 – 1997.

Phytoplankton Floras from Deer Creek Reservoir

Dr. Samuel T. Rushforth, a professor of Botany at Brigham Young University, conducts an annual study on the phytoplankton floras of Deer Creek Reservoir as well as Jordanelle. The abstract to this year's report is as follows (refer to actual report for details):

> The algal plankton flora of Deer Creek Reservoir, Wasatch County, Utah was studied through the 1997 calendar year. Quantitative net plankton and total plankton samples were examined. A total of 38 taxa was identified in the plankton flora. In addition, the two common categories, centric diatoms and pennate diatoms, each contained many additional taxa.
>
> The most important plankters as determined by calculating Important Species Indices (ISI's) from all Deer Creek Reservoir combined net and total plankton samples collected during 1997 in descending order were Sphaerocystis schroeteri,

Fragilaria crotonensis, Asterionella formosa, Microcystis incerta, Anabaena spiroides var. crassa, Stephanodiscus niagarae, Aphanizomenon flos-aquae, Microcystis aeruginosa, the category pennate diatoms, Ceratium hirundinella, and Melosira granulata. These taxa (and the category pennate diatoms) all had ISI's greater than or equal to 1.0 and comprised about 91% of the phytoplankton flora (as determined by summing importance values) of Deer Creek Reservoir for the 1997 year. This measurement is an assessment of algal standing crop and distribution through the year as reflected in our samples.

As measured by summing important species indices, the decrease in Cyanophyta noted for Deer Creek Reservoir over the past several years appeared to be reversed during 1997. The 1997 level of about 27% was substantially greater than the 9% noted for 1996 and similar or lower levels for most other years in the 1990's. The 1997 level for Cyanophyta of 27% represents the highest level of this decade, substantially greater than the value for 1991 when cyanophytes comprised slightly more than 17% of the flora.

It is important to note that this increase in Cyanophyta is based upon relative density data and may be due to a decrease in abundance of Chlorophyta and diatoms rather than a substantial increase in Cyanophyta. Further research will illuminate this issue.

Microcystis incerta was the most important cyanophyte in the reservoir for 1997 with an important species index of 3.81. This taxon was the fourth most important in the reservoir for 1997 (as determined by summing ISI's from net and total plankton samples). Anabaena spiroides var. crassa, Aphanizomenon flos-aquae and Microcystis aeruginosa were fifth, seventh and eighth most important in the reservoir for 1997.

Diatoms continued to dominate the algal flora of the reservoir during 1997. Even so, as in 1996 they continued to be less important overall than in the past several years. The most important diatoms in the reservoir (as measured by ISI's) were Frafilaria crotonensis and Asterionella formosa.

The most important alga in the ecosystem for 1997 was Sphaerocystis schroeteri, a green alga. Even so, Chlorophyta were less important in Deer Creek Reservoir for 1997 than in 1996. The sum ISI for all Deer Creek chlorophytes in 1997 comprised somewhat about 25% of the sum ISI's in comparison to 34% of the total sum ISI for 1996.

Four of the top 10 taxa in Deer Creek Reservoir for 1997 were Cyanophyta that have the potential to create taste and odor problems. The important presence of these taxa in the reservoir is problematic and should be monitored in future years. (Rushforth, 1998)

Chapter 7

Provo River Below Deer Creek

Introduction

This chapter will present and analyze the water quality monitoring for a six mile stretch of the Provo River and its tributaries starting below Deer Creek Reservoir to the Murdock Diversion.

Monitoring Sites

This year's monitoring plan included six sites in this area. Below is listed the description of each site with its STORET number.

STORET No.	Location Description
• 591321	Provo River below Deer Creek Dam
• 499687	Little Deer Creek above confluence with Provo River
• 499685	Lower North Fork of Provo River at Wildwood
• 499683	Lower South Fork Provo River at Vivian Park
• 499681	Provo River at Olmsted Diversion
• 499678	Provo River at Murdock Diversion

Each site is described in the following sections with a summary table of the water quality monitoring. For more complete tables showing actual data from the 1997 water quality monitoring, refer to Appendix A.

Provo River below Deer Creek Dam, STORET # 591321

This monitoring site is immediately below Deer Creek dam near to the USGS gage station # 10159500. The water released from the reservoir is sampled here for analysis. A summary of the data is shown below in Table 7.1.

Table 7.1 Provo River below Deer Creek Dam, STORET # 591321 – Water Quality Summary

Date	*Temp Deg C*	*pH*	*D.O. mg/l*	*T.Sus.Sol mg/l*	*Ammonia N mg/l*	*T. Phos. mg/l*	*D-T Phos. mg/l*
Minimum	2.6	7.6	4.5	0	0.00	0.02	0.02
Maximum	16.1	8.3	10.8	5	0.09	0.08	0.038
Median	9.5	8.1	8.7	0	0.03	0.04	0.03
Mean	8.9	8.0	8.6	1	0.04	0.05	0.03
Number	12	12	12	12	12	3	3
Exceedences	0	0	1	0	1	1	0

The location was sampled on twelve occasions during 1997. Three of the samples had reliable phosphorus data for analysis of which one showed an exceedence in total phosphorus. Historically this location has three or four exceedences of phosphorus each year. The TSS concentrations are comparable to past years. Also, there was one exceedence in each ammonia concentration and DO concentration.

Little Deer Creek above confluence with Provo River, STORET # 499687

This monitoring site is located on Little Deer Creek near its confluence with the Provo River just below Deer Creek Dam. This creek drains a large mountainous area nestled in the Wasatch Mountains directly to the north. A summary of the data is shown below in Table 7.2.

Table 7.2 Little Deer Creek above Provo River, STORET # 499687 – Water Quality Summary

Date	*Temp Deg C*	*pH*	*D.O. mg/l*	*T.Sus.Sol mg/l*	*Ammonia N mg/l*	*T. Phos. mg/l*	*D-T Phos. mg/l*
Minimum	1.7	8.1	7.8	0	0.00	0.05	0.02
Maximum	13.8	8.6	11.3	89	0.06	0.05	0.03
Median	8.4	8.4	9.4	11	0.00	0.05	0.03
Mean	8.7	8.4	9.6	18	0.01	0.05	0.03
Number	10	10	10	10	10	2	2
Exceedences	0	0	0	1	0	2	0

This location was monitored on ten occasions during 1997. Eight of the ten samples taken had unreliable phosphorus data and of the two reliable samples both recorded phosphorus levels in exceedence of JTAC standards. Historically, this location is known to have few phosphorus problems. The sample's TSS concentrations were slightly higher than previous years. In addition, the sample taken on January 30th showed high bacteria levels with 350 maximum total fecal coliforms per 100 mL and 680 maximum total coliforms per 100 mL. No other exceedences were recorded.

Lower North Fork of Provo River at Wildwood, STORET # 499685

This site monitors the North Fork of the Provo River at the point of confluence with the Provo River near Wildwood. The North Fork drains the northern mountainous areas surrounding Sundance Ski Resort and Aspen Grove. A summary of the monitoring data is shown below in Table 7.3.

Table 7.3 Lower North Fork of Provo River, STORET # 499685 – Water Quality Summary

Date	Temp Deg C	pH	D.O. mg/l	T.Sus.Sol mg/l	Ammonia N mg/l	T. Phos. mg/l	D-T Phos. mg/l
Minimum	2.4	8.1	8.1	0	0.00	0.03	0.02
Maximum	10.6	8.5	11.2	70	0.39	0.05	0.02
Median	7.6	8.4	10.0	2	0.00	0.04	0.02
Mean	7.3	8.4	10.0	12	0.04	0.04	0.02
Number	10	10	10	10	10	2	2
Exceedences	0	0	0	1	1	1	0

This location was monitored ten times during 1997. Eight of the ten samples had unreliable phosphorus data. One of the two reliable phosphorus samples recorded an exceedence of the JTAC standards. Historically, this area has rarely had occasions of phosphorus exceedences. The TSS concentrations recorded are comparable to past years monitoring. The one exceedence of high ammonia concentration is inconsistent with past years. In addition, two samples showed high bacteria levels. The sample taken on July 28 had 1490 maximum total coliforms per 100 mL but only 22 maximum total fecal coliforms per 100 mL. The sample taken on June 26 had 920 maximum total coliforms per 100 mL and 228 maximum total fecal coliforms per 100 mL.

Lower South Fork Provo River at Vivian Park, STORET # 499683

This monitoring site is located in Provo Canyon on the Lower South Fork of the Provo River near its confluence with the Provo River by Vivian Park. This creek drains a large mountainous area to the south which includes some residential/cabin areas and regular recreational activities. A summary of the monitoring data is shown below in Table 7.4.

Table 7.4 Lower South Fork Provo River, STORET # 499683 – Water Quality Summary

Date	Temp Deg C	pH	D.O. mg/l	T.Sus.Sol mg/l	Ammonia N mg/l	T. Phos. mg/l	D-T Phos. mg/l
Minimum	2.7	8.1	7.9	0	0.00	0.02	0.02
Maximum	12.2	8.6	10.8	53	0.05	0.05	0.02
Median	8.6	8.4	9.7	5	0.00	0.037	0.02
Mean	8.5	8.3	9.4	10	0.01	0.037	0.02
Number	10	10	10	10	10	2	2
Exceedences	0	0	0	1	0	1	0

This location was monitored ten times during 1997. There were only two samples that have reliable phosphorus data of which one of them recorded an exceedence with respect to JTAC standards. Historically, it has not been common to have more than one exceedence per year recorded at this location. The TSS concentrations are comparable to past years. No other exceedences were recorded at this location in 1997.

Provo River at Olmsted Diversion, STORET # 499681

This site monitored the water quality in the Provo River at the location of the Olmsted Diversion about one mile downstream from the South Fork at Vivian Park. This water quality data represents the combination of the Lower Provo River with its major tributaries. A summary of the monitoring data is shown below in Table 7.5.

Table 7.5 Provo River at Olmsted Diversion, STORET # 499681 – Water Quality Summary

Date	Temp Deg C	pH	D.O. mg/l	T.Sus.Sol mg/l	Ammonia N mg/l	T. Phos. mg/l	D-T Phos. mg/l
Minimum	2.0	7.9	7.6	0	0.00	0.03	0.02
Maximum	14.4	8.7	13.6	27	0.08	0.06	0.03
Median	10.6	8.3	9.8	2	0.00	0.04	0.03
Mean	9.4	8.3	10.0	5	0.02	0.04	0.03
Number	10	10	10	10	10	2	2
Exceedences	0	0	0	0	1	1	0

This site was monitored ten times during 1997. Only two samples had reliable phosphorus data of which one exceeded JTAC phosphorus standards. Historically, this location on the Provo River has shown to have approximately half of its phosphorus measurements in exceedence. The TSS concentrations for this site are consistent with past years. There was one exceedence in ammonia concentration.

Provo River at Murdock Diversion, STORET # 499678

This site monitored the water quality in the Provo River at the Murdock Diversion located approximately one mile from the mouth of Provo Canyon. This represents the water in the Provo River leaving Provo Canyon entering into Utah Valley. A summary of the monitoring data is shown below in Table 7.6.

Table 7.6 Provo River at Murdock Diversion, STORET # 499678 – Water Quality Summary

Date	Temp Deg C	pH	D.O. mg/l	T.Sus.Sol mg/l	Ammonia N mg/l	T. Phos. mg/l	D-T Phos. mg/l
Minimum	2.4	8.1	8.2	0	0.00	0.03	0.02
Maximum	14.5	8.9	11.2	14	0.07	0.07	0.025
Median	10.0	8.5	9.2	2	0.00	0.05	0.025
Mean	9.3	8.5	9.6	4	0.02	0.05	0.02
Number	10	10	9	10	10	2	2
Exceedences	0	0	0	0	1	1	0

This location was monitored on ten occasions during 1997. Only two samples had reliable phosphorus data for analysis of which one was in exceedence of JTAC standards. Historically this site has one or two exceedences each year. TSS concentrations were at levels comparable to past years. There was one exceedence of ammonia concentration and no other exceedences in the year.

TSS Loadings in the Lower Provo River

The TSS loads were calculated at only one JTAC monitoring location in this basin, directly below the Deer Creek dam on the Provo River. The following table, Table 6.10, summarizes the results (see Appendix C for complete calculations).

Table 7.7 1997 TSS Loading Summary for Lower Provo River

	TSS concentration		Flow		TSS Loading Rate		1997
	Average (mg/l)	Peak (mg/l)	Average (cfs)	Peak (cfs)	Average (tons/day)	Peak (tons/day)	TSS Load (kg/yr)
Provo River below Deer Creek							
	0.8	4.4	464.2	1,070	1.0	6.6	**324,265**

This location is directly below the dam of Deer Creek which is evident with low concentrations of TSS hence a lower yearly load of sediment. This load is comparable to previous years as shown below in Table 7.8.

Table 7.8 Historic Water Quality Data (1993-1997)

	1993*	1994*	1995*	1996*	1997**
Provo River below Deer Creek					
Average Flow (cfs)	324	206	248	318	**406**
Average T. Phosphorus (mg/l)	0.037	0.051	0.037	0.027	-
Average D. Phosphorus (mg/l)	-	-	0.031	0.021	-
Total Phosphorus Load (kg/yr)	11,109	9,843	8,593	8,002	-
D. Phosphorus Load (kg/yr)	-	-	7232	6081	-
TSS Load (kg/yr)	1,453,790	464,989	335,445	216,334	**324,265**

* Water year ** Calendar year

Dissolved Metals Analysis

The dissolved metal concentrations were analyzed in the laboratory for some of the water samples that were taken. Dissolved metals were analyzed at all sampling sites in this area four times each during 1997. Very few dissolved metals were detectable and those detected were in very small concentrations. There were no exceedences of the standards set in Table 3.5. The following table, Table 7.7, summarizes the results of the monitoring.

Table 7.8 Dissolved Metals Summary for Provo River below Deer Creek Sampling Sites.

Date	Al µg/l	As µg/l	Ba µg/l	Cd µg/l	Cr µg/l	Cu µg/l	Fe µg/l	Pb µg/l	Hg µg/l	Mn µg/l	Se µg/l	Ag µg/l	Zn µg/l
Storet #591321, Provo River below Deer Creek Reservoir													
30-Jan-97	<30.0	<5.0	72	<1.0	7	<12.0	<20.0	<3.0	<0.2	19	<1.0	<2.0	<30.0
27-May-97	<30.0	<5.0	59	<1.0	<5.0	<12.0	28.3	<3.0	<0.2	<5.0	<1.0	<2.0	<30.0
26-Aug-97	<30.0	<5.0	73	<1.0	<5.0	<12.0	<20.0	<3.0	<0.2	34	<1.0	<2.0	<30.0
29-Oct-97	<30.0	<5.0	66.0	<1.0	<5.0	<12.0	<20.0	<3.0	<0.2	5.3	<1.0	<2.0	<30.0
Storet #499687, Little Deer Creek above confluence with the Provo River													
30-Jan-97	<30.0	<5.0	65	<1.0	8	<12.0	<20.0	<3.0	<0.2	<5.0	1.1	<2.0	<30.0
27-May-97	<30.0	<5.0	79	<1.0	<5.0	<12.0	<20.0	<3.0	<0.2	<5.0	<1.0	<2.0	<30.0
26-Aug-97	<30.0	<5.0	74	<1.0	<5.0	<12.0	<20.0	<3.0	<0.2	<5.0	1.1	<2.0	<30.0
29-Oct-97	<30.0	<5.0	67.0	<1.0	<5.0	<12.0	<20.0	<3.0	<0.2	<5.0	<1.0	<2.0	<30.0
Storet #499685, Lower North Fork of Provo River at Wildwood													
30-Jan-97	<30.0	<5.0	46	<1.0	8.7	<12.0	<20.0	<3.0	<0.2	<5.0	1.4	<2.0	<30.0
27-May-97	<30.0	<5.0	49	<1.0	<5.0	<12.0	<20.0	<3.0	<0.2	<5.0	<1.0	<2.0	<30.0
26-Aug-97		<5.0	37	<1.0	<5.0	<12.0	<20.0	<3.0	<0.2		1	<2.0	<30.0
29-Oct-97	<30.0	<5.0	34.0	<1.0	<5.0	<12.0	<20.0	<3.0	<0.2	<5.0	1.1	<2.0	<30.0
Storet #499683, Lower South Fork Provo River at Vivian Park													
30-Jan-97	<30.0	<5.0	61	<1.0	8	<12.0	<20.0	<3.0	<0.2	<5.0	1	<2.0	<30.0
27-May-97	<30.0	<5.0	56	<1.0	<5.0	<12.0	<20.0	<3.0	<0.2	<5.0	<1.0	<2.0	<30.0
26-Aug-97	<30.0	<5.0	58	<1.0	<5.0	<12.0	<20.0	<3.0	<0.2	<5.0	<1.0	<2.0	<30.0
29-Oct-97	<30.0	<5.0	63.0	<1.0	<5.0	<12.0	<20.0	<3.0	<0.2	<5.0	<1.0	<2.0	<30.0
Storet #499681, Provo River at Olmstead Diversion													
30-Jan-97	<30.0	<5.0	70	<1.0	6.4	<12.0	<20.0	<3.0	<0.2	13	<1.0	<2.0	<30.0
27-May-97	<30.0	<5.0	58	<1.0	<5.0	<12.0	30.8	<3.0	<0.2	6.2	<1.0	<2.0	<30.0
26-Aug-97	<30.0	<5.0	62	<1.0	<5.0	<12.0	<20.0	<3.0	<0.2	20	<1.0	<2.0	<30.0
29-Oct-97	<30.0	<5.0	68.0	<1.0	<5.0	<12.0	<20.0	<3.0	<0.2	13.0	<1.0	<2.0	<30.0
Storet #499678, Provo River at Murdock Diversion													
30-Jan-97	<30.0	<5.0	68	<1.0	5.4	<12.0	<20.0	<3.0	<0.2	7	<1.0	<2.0	<30.0
27-May-97	<30.0	<5.0	57	<1.0	<5.0	<12.0	<20.0	<3.0	<0.2	5.5	<1.0	<2.0	<30.0
26-Aug-97	<30.0	<5.0	60	<1.0	<5.0	<12.0	<20.0	<3.0	<0.2	8.7	<1.0	<2.0	<30.0
29-Oct-97	<30.0	<5.0	67.0	<1.0	<5.0	<12.0	<20.0	<3.0	<0.2	<5.0	<1.0	<2.0	<30.0

Chapter 8

Recommendations

The Provo River System is a great resource that provides benefits to many people throughout the area. The resolutions made to improve the ecology in the Provo River are helping to sustain the good water quality. The recommendations provided herein are suggestions to further protect the water quality in the Provo River, and Jordanelle and Deer Creek Reservoirs.

I. Jordanelle Reservoir – Management of Releases

The Jordanelle Reservoir has helped improve the water quality in the Provo River by retaining phosphorus rich sediments, regulating temperature of outlet water, and controlling dissolved phosphorus levels in outlet water. Many of these benefits are due to the Selective Level Outlet Works (SLOW) which is operated by the Bureau of Reclamation (USBR). The USBR is in the process of revising the Standard Operating Procedures of the SLOW to maximize its benefit (see Chapter 4).

JTAC should continue to work with the USBR to ensure that the operation of Jordanelle Reservoir will not only accommodate the distribution of water rights, but also favorably impact the water quality in the Provo River.

II. Kamas Fish Hatchery

The Kamas Fish Hatchery is expanding its operation to almost double the output of fish. The expansion plans incorporate features such as settling ponds and concrete linings which will greatly aid in reducing TSS in the effluent. These features will help water quality as the fish operation expands.

JTAC should continue to work with the Division of Wildlife Resources to ensure that these features are completed with the expansion. Also JTAC should continue to work with the DWQ to encourage phosphorus limits in the hatchery's UPDES permit.

III. Heber Valley – Storm Water Controls

In response to recommendations from previous years' implementation reports, JTAC and Wasatch County are currently completing the second year of a three year Storm Water Study in Heber Valley. The valley continues to experience increased urbanization which tends to increase natural storm runoff conditions. This study will identify potential sites for construction of new sedimentation basins intended to reduce eroded sediments in surface waters prior to entering Deer Creek Reservoir.

JTAC should complete this study during the upcoming year and then support Wasatch County in its implementation of the recommended storm water controls.

IV. Agricultural – Non-Point Source Erosion

In coordination with the Tri-Valley Watershed Project, the Natural Resources Conservation Service (NRCS) has developed a guide for farmers and ranchers called *A Pasture & Hayland Management Guide: For Small Farms & Ranches in Wasatch County*. The guide addresses planning, economics, water management, soil conservation, and other important issues involved with agricultural lands. Best Management Practices are encouraged to reduce erosion and pollution entering into the local streams. The NRCS is offering free seminars to farmers interested in using the guide for management of their farms.

JTAC should continue to coordinate with the NRCS and the Tri-Valley Watershed Project to ensure that the process of educating local farmers and ranchers.

V. Water Quality Management Plan

Wasatch County began preparation of an updated water quality management plan in 1995. This plan identifies Total Maximum Daily Loads (TMDL's) which can be assimilated by the Provo River. A draft of the plan was submitted in 1997 and received comments from several agencies. The final report will be released in May 1998.

JTAC should continue to participate with Wasatch County in encouraging implementation of Best Management Practices to control water quality.

VI. Soldier Hollow – Monitor Olympic Activities

Soldier Hollow has been selected for the biathlon and cross country events for the 2002 Winter Olympics. Construction of the needed Olympic facilities and surrounding developments have the potential to impact water quality in Deer Creek Reservoir. Wasatch County will be intimately involved in the planning and construction phases of this work.

JTAC should continue to support Wasatch County in its effort to promote erosion and sedimentation controls associated with these developments.

VII. Ordinances around Jordanelle

Heavy development is expected within the next 4-5 years in the Jordanelle area. Wasatch County is in the process of adopting county ordinances which will address the specific needs of the Jordanelle basin developments. These ordinances should address such water quality concerns as proper storm water management, sediment controls, erosion controls, revegetation, restoration and drainage.

JTAC should continue to support Wasatch County it adopts and implements county ordinances which are sensitive to water quality concerns.

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APPENDIX A:

WATER QUALITY DATA

APPENDIX B:

FLOW DATA

APPENDIX C:

LOADING CALCULATIONS

APPENDIX D:

QUALITY ASSURANCE

APPENDIX E:

WATER QUALITY RAW DATA

APPENDIX F:

STATE LABORATORY REPORT ON PHOSPHORUS DATA