1999 Water Quality

Implementation Report

Deer Creek and Jordanelle Reservoirs
Water Quality Management Plan
for 1998

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Water Quality Management Plan
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Prepared for:
The Wasatch County Commission

In Association with:
Jordanelle Reservoir Water Quality
Technical Advisory

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Final Report

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Wasatch Soil Conservation District

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List of Abbreviations

ac-ft	acre-feet
BMPs	Best Management Practices
cfs	cubic feet per second
CUWCD	Central Utah Water Conservancy District
DNR	Utah Department of Natural Resources
DO	Dissolved Oxygen
DTP	Dissolved Total Phosphorus
DWQ	Utah State Division of Water Quality
DWR	Utah State Division of Wildlife Resources
EPA	United States Environmental Protection Agency
EQIP	Environmental Quality Improvement Program
HVSSD	Heber Valley Special Service District
JSSD	Jordanelle Special Service District
JTAC	Jordanelle Reservoir Water Quality Technical Advisory Committee
kg/yr	kilograms per year
MAG	Mountainland Association of Governments
mg/l	milligrams per liter
MWDO	Metropolitan Water District of Orem
MWDP	Metropolitan Water District of Provo
MWDSLC	Metropolitan Water District of Salt Lake City
NOV	Notice of Violation
NRCS	Natural Resources Conservation Service
PRRP	Provo River Reclamation Project
PRWUA	Provo River Water Users Association
QA/QC	Quality Assurance / Quality Control
RMP	Deer Creek Resource Management Plan
SLCWCD	Salt Lake City Water Conservancy District
SLOC	Salt Lake Olympic Committee
SLOW	Selective Level Outlet Works
TMDL	Total Maximum Daily Load
TP	Total Phosphorus
TSI	Carlson Trophic State Index
TSS	Total Suspended Solids
UDOT	Utah Department of Transportation
UPDES	Utah Pollutant Discharge Elimination System
USBR	Bureau of Reclamation
USDA	United States Department of Agriculture
USGS	United States Geological Survey
μg/l	micrograms per liter

Executive Summary

INTRODUCTION

Most are aware of the vital role water plays in the development of the West where productivity and economy are 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, recreational uses, and many other uses. Equally important, the Provo River supports a delicate ecosystem of invaluable living organisms.

Along the Provo River, Deer Creek and Jordanelle Reservoirs have helped make this water available for public and private use. These reservoirs are vital to the surrounding communities that depend on the Provo River as a resource. One of the challenges facing the reservoirs is the control of eutrophication, a natural process that occurs in lakes and reservoirs when an abundance of nutrients spurs algal growth. Excessive algal growth, unfortunately, can seriously deteriorate water quality causing taste and odor problems thus increasing the costs of treatment.

Formation of JTAC

In 1981, because of eutrophication evidences in Deer Creek Reservoir, Utah Governor Scott Matheson established the Jordanelle Reservoir Water Quality Technical Advisory Committee (JTAC) for the purpose of developing a reservoir management plan for Deer Creek Reservoir and the then future Jordanelle Reservoir. 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 JTAC to conduct a water sampling program to monitor the condition of water quality throughout the year and to release this yearly implementation report that analyzes and presents the resulting data.

Phosphorus: Limiting Nutrient

The water sampling program identifies many water quality parameters including metals, physical and chemical properties, and nutrients. The most important water quality constituent, however, is the nutrient phosphorus. Generally, phosphorus is the limiting nutrient that controls the growth of algae. By decreasing the phosphorus loads into the reservoirs, theoretically, algal growth will also decrease.

In the Provo River Watershed, a variety of natural sources contribute phosphorus, which can be difficult to control. But also, many human activities and developments, which are more controllable sources, increase the pollutant concentrations.

CURRENT ACTIVITIES

Land use and various activities within the watershed affect the water quality in streams, rivers and reservoirs, which ultimately affects the water users. Several of these activities are extremely important to future of water quality in the watershed. Described below are some of these 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 and should therefore be protected from unnecessary pollution.

The logo and concept was distributed during 1998 to the public through free litter bags given at the State Parks, posted signs around the reservoirs, and published advertisements in literature distributed by the Division of Wildlife Resources.

Currently, this public information campaign is being assessed and will be reevaluated by JTAC for 1999.

Tri-Valley Watershed Project

Purposes of the Tri-Valley Watershed are water conservation, improved fish and wildlife habitat, and water quality. On-farm irrigation systems will fulfill the purpose of water conservation and improved fish and wildlife habitat. Water quality improvements may also result from decreased surface runoff and decreased deep percolation.

The Tri-Valley Watershed Project received $500,000 federal cost-share funds from the Environmental Quality Improvement Program (EQIP) during 1998. 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. Contracts were signed with 63 participants to use this money.

This year there are $500,000 of watershed cost-share funds and $250,000 of EQIP funds available for the on-farm sprinkler projects. NRCS calculates that these funds will almost complete the on-farm sprinkler conversion project.

Jordanelle Master Plan

Development of the west side of Jordanelle Reservoir is well under way. Much of the needed infrastructure, such as water lines, sewer, and other utilities have been constructed. Wasatch County has adopted the Jordanelle Basin Master Plan and has created zoning regulations for the area in which an equivalent of 7,200 residential units have been planned. Over the next five years, heavy development is expected.

Deer Crest, located just west of the Mayflower Junction on U.S. 40, has already constructed ski lifts and ski runs, which are being operated by Deer Valley. Many other developments are submitting concept plans, with intentions of breaking ground within one to two years, including East Park, The Pointe and The Hollows, Hailstone Village, Staghorn/Elkhorn Village, Jordanelle View, and Deer Mountain. Other projects include Area C, Mayflower, and Jordanelle Heights, which have approved densities.

The eastern portion of the Basin, Area B, might also be developed into recreational areas and be included within the Jordanelle Overlay Zone. While no master plans have been approved yet for this area, development could occur soon or shortly after the development of the western side of the Jordanelle Basin. Also, Wasatch County is making adjustments to zoning designations to include different erosion control measures required depending on the area.

Soldier Hollow: 2002 Winter Olympics

In anticipation of the 2002 Winter Olympics, the Salt Lake Olympic Committee selected Soldier Hollow as the site for all Cross-country, Biathlon, and Nordic combined events. In order to facilitate hosting of these Olympic events it will be necessary to construct 23 kilometers of trail, a shooting range for small caliber rifles, a stadium area and a Competition Management facility.

In the fall of 1998 the first 5 kilometers of trail were constructed, 18 kilometers more of trail remain. The trails consist primarily of 5 to 11 meter wide trails bladed into the hillside, following existing contours. Drainage culverts were installed at drainage crossings and erosion control measures were incorporated to prevent erosion of the newly bladed areas into the existing waterways and streams. The trail areas will be re-seeded using a native seed mixture approved by the Division of Natural Resources (DNR).

Monitoring Soldier Hollow and its impact on the water quality is a very important issue for JTAC to address. Bob Mathis has been appointed to represent Wasatch County in overseeing and coordinating Olympic activities within the county. His role could help JTAC assure water quality mitigation measures are implemented.

Wasatch County Water Efficiency Project

The Wasatch County Water Efficiency Project will be constructed over a three-year period and will allow 1600 acres of land in the Heber Valley to be irrigated with sprinklers rather than the flood irrigation methods currently in use. 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.

Design of the project has been completed and the Central Utah Water Conservancy District advertised for construction bids. To date, the following work has been completed:

the land acquisitions, some of the canal rehabilitation along Timpanogos Canal, excavation for the Timpanogos Regulating Pond, and preliminary placement of filter material and drain lines in the pond.

Deer Creek Resource Management Plan

The Deer Creek Resource Management Plan was completed in 1998 by the U.S. Bureau of Reclamation (USBR) and the environmental assessment was released for public comment. From public comments, USBR has decided to proceed with Alternative 1, the proposed alternative, but with a modification regarding the elimination of grazing on project lands. USBR has decided to allow grazing on project lands east of U.S. Highway 189, opposite side of the reservoir, with best management practices being implemented. Also, USBR has determined that the implementation of the proposed alternative should not require an environmental impact statement because of relatively low environmental impacts of the alternative.

Provo River Restoration Project

The goal of the Provo River Restoration Project (PRRP) is to restore the middle Provo River in the Heber Valley from below Jordanelle Dam to Deer Creek Reservoir. In many areas the river has been straightened due to development of agricultural lands and the construction of flood control levees. The Utah Reclamation Mitigation and Conservation Commission has proposed the PRRP to create a meandering river path with the purpose of restoring a more naturally functioning river system.

The first step in the project will begin with a pilot phase. A small section of the Provo River, near the bridge of US Highway 40, has been selected for this phase. Weather permitting, construction on this section will begin in March 1999 with the creation of side channels and expanded flood plan areas. The main channel will be realigned in the fall following the irrigation season.

The pilot project will be evaluated to determine its effectiveness. Lessons learned will be incorporated into restoring the rest of the river reach. The pilot phase will also help estimate the schedule, construction costs and available resources for the remainder of the project.

Upper Provo River Water Quality Management Plan

The Upper Provo River Water Quality Management Plan is an update to the management plan that was released 15 years ago in 1984. Psomas has prepared the 1999 plan by analyzing the basin characteristics and problems. Accordingly, Psomas has calculated Total Maximum Daily Loads (TMDLs) for problematic stream segments in the basin in terms of annual and monthly phosphorus loading. These TMDLs were developed from procedures given by EPA to comply with the requirements under section 303(d) of the Clean Water Act.

The Upper Provo River 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 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 1999.

Heber Valley Storm Water Management Plan

In response to recommendations from previous years' implementation reports Wasatch County, through a contract with Psomas, has completed the third year of a three year Storm Water Study in Heber Valley. Wasatch County continues to experience increased urbanization that tends to increase natural storm runoff conditions.

Psomas has identified potential sites for construction of new sedimentation basins intended to reduce eroded sediments in surface waters prior to entering Deer Creek Reservoir. By removing sediments, many pollutants including phosphorus will also be removed. The implementation of these basins will help reduce phosphorus loadings from Spring Creek, Daniels Creek, the Lower Charleston Canal, Snake Creek, and the Provo River.

MONITORING PROGRAM

The JTAC monitoring program uses a method of systematically taking samples from streams and reservoirs in the watershed. In 1998, JTAC took nearly 600 samples from 46 locations for the purpose of water quality analysis. The sampling locations were selected with the purpose of analyzing the progress towards the goals set in 1984. There are 18 stream, 23 reservoir, 3 point source, and 2 QA/QC sampling locations.

JTAC Water Quality Standards

The JTAC water quality standards are mostly adopted from standards set by the state with one exception. Since phosphorus is the pollutant of concern, JTAC has adopted a slightly more stringent pollution indicator concentration than the state. Rather than use the state pollution indicator value of 0.05 mg/l TP (Total Phosphorus), JTAC has used 0.04 mg/l TP.

CURRENT CONDITIONS

Good water quality prevailed during 1998 in the Provo River Watershed. Significant improvements were recorded and overall, the water quality showed either average conditions or slightly better than average conditions. Despite the improvements, many water quality problems still exist. In the following sections, the water quality of individual areas of the watershed is discussed starting at the top of the watershed moving down.

Upper Provo River

Figure ES.1 that follows, presents the TSS (Total Suspended Solids), TP, and DTP (Dissolved Total Phosphorus) loadings in the upper Provo River basin area. Loadings were calculated at the Provo River at Woodland, Weber Provo Canal, the Provo River at Hailstone, and the Provo River below the Jordanelle. In Table ES.1, these loads are compared to historical loadings from the previous five years.

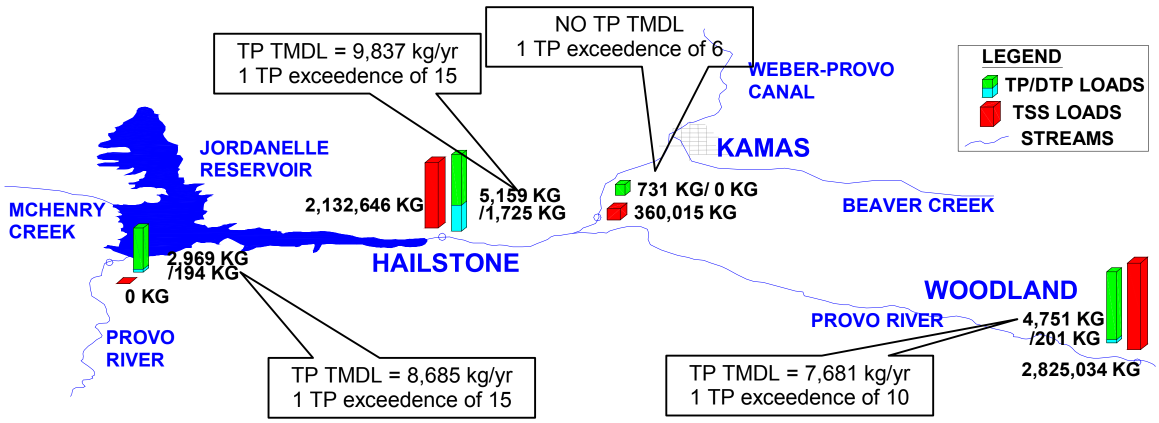


Figure ES. 1 Upper Provo River 1998 River Loadings

Table ES. 1 Upper Provo River Historical River Loadings

	1993	1994	1995	1996	1997	1998	Averages
Provo River at Woodland, STORET 499840							
Weighted Average Flow (cfs)	339	139	303	242	220	**296**	257
TP Annual Load (kg/yr)	6,094	2,008	7,053	1,955	-	**4,762**	4,374
DTP Annual Load (kg/yr)	-	-	2,499	1,955	-	**201**	1,552
TSS Annual Load (kg/yr)	7,682,847	1,704,960	10,334,714	2,486,544	1,517,482	**2,825,034**	4,425,264
Weber Provo Canal, STORET 499814							
Weighted Average Flow (cfs)	110	52	57	82	21	**57**	63
TP Annual Load (kg/yr)	8,079	1,923	2,432	1,594	-	**731**	2,952
DTP Annual Load (kg/yr)	-	-	733	526	-	**0**	420
TSS Annual Load (kg/yr)	4,417,245	2,039,486	1,937,566	2,287,441	76,622	**366,015**	1,854,063
Provo River at Hailstone, STORET 499813							
Weighted Average Flow (cfs)	474	225	385	284	308	**288**	327
TP Annual Load (kg/yr)	22,992	7,721	14,267	5,825	-	**5,159**	11,193
DTP Annual Load (kg/yr)	-	-	1,926	2,528	-	**1,725**	2,060
TSS Annual Load (kg/yr)	15,252,858	8,245,837	14,552,043	5,571,686	7,076,823	**2,132,646**	8,805,316
Provo River TP Increase Ratio	3.8	3.8	2.0	3.0	-	**1.1**	2.6
Provo River below Jordanelle, STORET 499733							
Weighted Average Flow (cfs)	317	139	238	270	324	**350**	273
TP Annual Load (kg/yr)	10,271	2,722	4,272	3,496	-	**2,969**	4,746
DTP Annual Load (kg/yr)	-	-	4,367	2,876	-	**194**	2,479
TSS Annual Load (kg/yr)	3,286,183	648,241	0	19,957	0	**0**	659,063
Jordanelle Res. TP Retention	55%	65%	70%	40%	-	**42%**	58%

TMDLs (Total Maximum Daily Loads) for TP have been established by the 1999 Upper Provo River Water Quality Management Plan in accordance with EPA requirements. Figure ES.1 above gives these TMDLs. None of the stream segments exceeded the TMDL in 1998. All of the 1998 loadings in the upper Provo River were either average or below average and each location only had one exceedence in TP.

At Woodland, the Provo River had average TP loadings but low DTP and TSS loadings. Interestingly, the TP load does not increase much between Woodland and Hailstone as Hailstone recorded a TP load significantly lower than its average. Table ES.1 above shows the usual increase ratio in TP between these two locations to vary between 2 and 4 and to average approximately 2.6. In 1998, this ratio was 1.1. In the past, the increases have been attributed to high sediment tributaries and agricultural non-point sources. The lack of increase is notably promising. To declare an improvement, however, may be premature; future monitoring will determine this.

Jordanelle Reservoir

Continuing down the watershed, the Jordanelle Reservoir has served as an excellent tool to reduce phosphorus loading into Deer Creek Reservoir. The TSS, TP and DTP loadings into and out of the Jordanelle Reservoir have been previously shown in Figure ES.1. The retention of each constituent is evident. The figure shows that in 1998 the Jordanelle Reservoir retained approximately 40% of TP loading, 89% of DTP, and 100% of TSS. It released 2,969 kg of TP, this value is significantly below the TMDL of 8,685 kg.

Although the 1999 water quality management plan calls for additional retention (an additional 2,800 kg/yr), it would be difficult reduce TP export to much less than 2,000 kg/yr. With only 5,159 kg entering the reservoir, the SLOW (Selective Level Outlet Works) tower did an excellent job in 1998 of retaining 40% of TP. Although the average retention, as shown in Table ES.1, is 58%, the average amount of annual loading from the Provo River is more than 11,000 kg/yr of TP. The SLOW tower's capability is better tested when higher phosphorus loading occurs.

Within Jordanelle, the reservoir also showed low concentrations of phosphorus. Of the 102 reservoir samples that were taken, there were 12 exceedences of the 0.025 mg/l TP pollution indicator, slightly less than 12%.

<u>Dissolved Oxygen Monitoring</u>

Dissolved Oxygen (DO) levels as well as TP concentrations are an important part of water quality monitoring. Figure ES.2 shows the 1998 results of DO monitoring at three locations on the reservoir. Each of the three reservoir monitoring locations was sampled seven times in 1998.

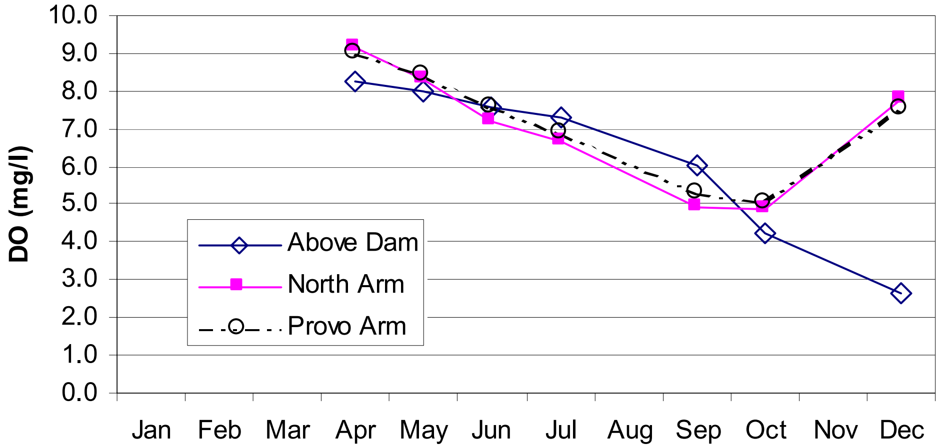


Figure ES. 2 Jordanelle Reservoir 1998 DO Concentrations Bottom Layer

Again in 1998, similar to 1997, the Jordanelle Reservoir had excellent DO conditions. The reservoir never recorded DO levels below the indicator value of 2.0 mg/l. Problems have occurred in past years in the North Arm due to poor water circulation, but this year the North Arm never dropped below 4.0 mg/l. The lowest DO concentration occurred in December above the dam, 2.6 mg/l DO.

Jordanelle Reservoir 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. TSI ranks the reservoirs into one of three categories: eutrophic or an overabundance of nutrients; mesotrophic, a healthy level of nutrients; and oligotrophic, a lack of nutrients. Figure ES.3 shows the 1998 calculated value of TSI in the Jordanelle Reservoir as compared to historical TSI values for the Jordanelle Reservior.

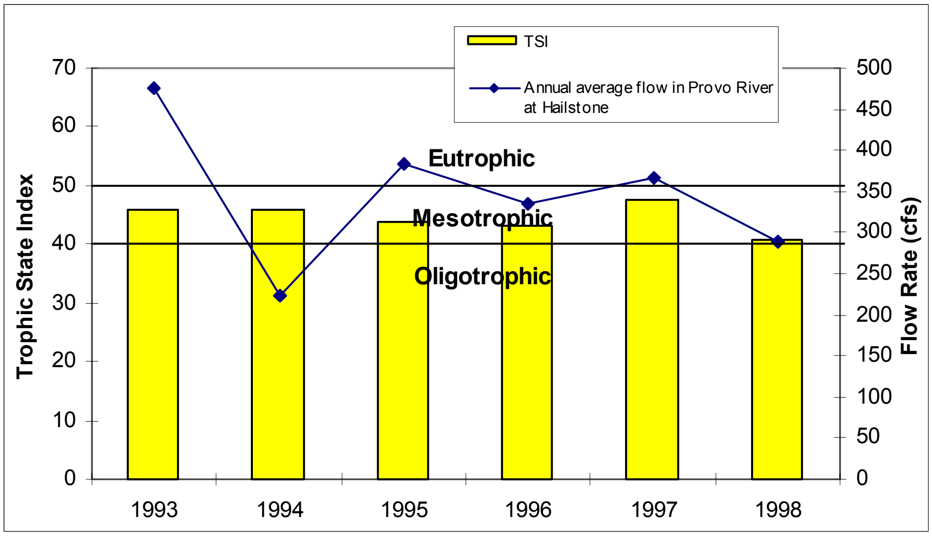


Figure ES. 3Jordanelle Reservoir TSI 1993-1998

The TSI was calculated to be 40.9, which classifies the reservoir as mesotrophic, indicating a healthy balance of nutrients. The TSI is the lowest calculated TSI since the reservoir began to operate and is very close to an oligotrophic state. The ecosystem of the reservoir has not quite established itself, however it appears to be stabilizing as mesotrophic.

Heber Valley/Round Valley Streams

Streams flowing through the Heber Valley, mainly Snake Creek, Provo River and Daniels Creek, contribute the majority of the water to Deer Creek Reservoir. Main Creek flows into Deer Creek Reservoir from Round Valley to the east. These four streams are the most important tributaries of Deer Creek Reservoir. The 1998 stream loading results from water quality monitoring of these streams are shown in Figure ES.4.

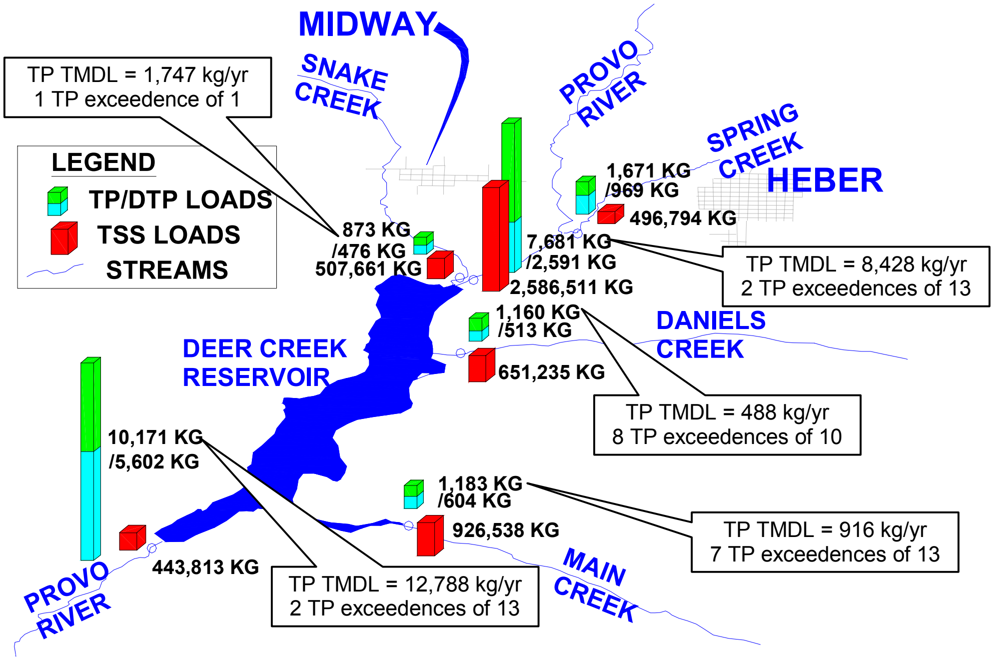


Figure ES. 4 Heber Valley/Round Valley 1998 Stream Loadings

Table ES. 2 Heber Valley/Round Valley 1993-1998 Stream Loadings

	1993	1994	1995	1996	1997	1998	Averages
Provo River above Deer Creek, STORET 591363							
Weighted Average Flow (cfs)	314	138	198	262	303	**332**	258
TP Annual Load (kg/yr)	21,671	4,975	10,472	10,866	-	**7,681**	11,133
DTP Annual Load (kg/yr)	-	-	4,478	5,773	-	**2,591**	4,281
TSS Annual Load (kg/yr)	6,778,611	944,936	4,774,856	2,629,371	5,025,665	**2,586,511**	3,789,992
Snake Creek above Deer Creek, STORET 591016							
Weighted Average Flow (cfs)	45	38	50	54	48	**57**	48
TP Annual Load (kg/yr)	2,259	1,934	2,690	1,860	-	**873**	1,923
DTP Annual Load (kg/yr)	-	-	1,270	1,134	-	**476**	960
TSS Annual Load (kg/yr)	213,742	369,582	616,915	421,925	431,283	**507,661**	426,851
Daniels Creek above Deer Creek, STORET 591352							
Weighted Average Flow (cfs)	24	8	18	14	22	**19**	18
TP Annual Load (kg/yr)	6,517	702	1,645	1,047	-	**1,160**	2,214
DTP Annual Load (kg/yr)	-	-	732	625	-	**513**	623
TSS Annual Load (kg/yr)	5,257,412	247,102	1,390,923	801,933	1,801,933	**651,235**	1,691,756
Main Creek above Deer Creek, STORET 591346							
Weighted Average Flow (cfs)	23	11	28	65	30	**23**	30
TP Annual Load (kg/yr)	2,570	437	3,452	7,154	-	**1,183**	2,959
DTP Annual Load (kg/yr)	-	-	964	5,669	-	**605**	2,413
TSS Annual Load (kg/yr)	2,136,137	243,025	2,750,898	1,146,639	3,727,492	**926,538**	1,821,788
Provo River below Deer Creek, STORET 499733							
Weighted Average Flow (cfs)	343	201	240	358	406	**462**	335
TP Annual Load (kg/yr)	12,999	10,331	8,887	8,099	-	**10,171**	10,097
DTP Annual Load (kg/yr)	-	-	7,432	6,711	-	**5,603**	6,582
TSS Annual Load (kg/yr)	1,640,831	515,278	365,927	164,330	324,265	**443,813**	575,741

The TMDLs calculated in the 1999 Wasatch County Water Quality Management Plan are shown together with the 1998 loading in Figure ES.4. Only TP loading in Daniels Creek and Main Creek exceed the TMDL. Table ES.2 shows how these loading values compare to the previous five years. Snake Creek and Provo River both, on average, would exceed the TMDL for TP loading, but in 1998 they did not. Overall, the TP input into Deer Creek Reservoir appears to have improved slightly. However, looking at the TP export through the dam outlet, even though the TP load was less than the TMDL, it was still slightly higher than the average.

Deer Creek Reservoir

Deer Creek Reservoir has, throughout the years, suffered from the effects of eutrophication due to high nutrient loading. One of these effects is low DO during summer months. In the following chart, Figure ES.5 shows the tracking of DO levels at different locations of Deer Creek Reservoir during 1998.

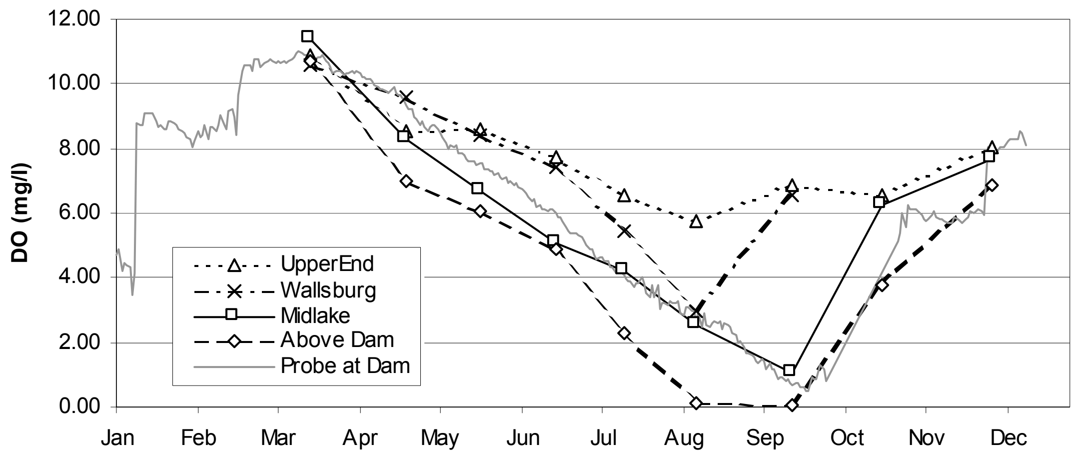


Figure ES. 5 Deer Creek Reservoir 1998 DO Concentrations Bottom Layer

As shown in the figure above, anoxic conditions existed in Deer Creek Reservoir just above the dam during August and September. Also, at midlake, anoxic conditions existed in September. This represents a fairly typical year at Deer Creek despite decreased phosphorus loads.

The next figure shows the anoxic conditions that have existed in the late summer months, July, August and September from 1986 to 1998. This figure tracks the progress of improvements to the reservoir in DO conditions.

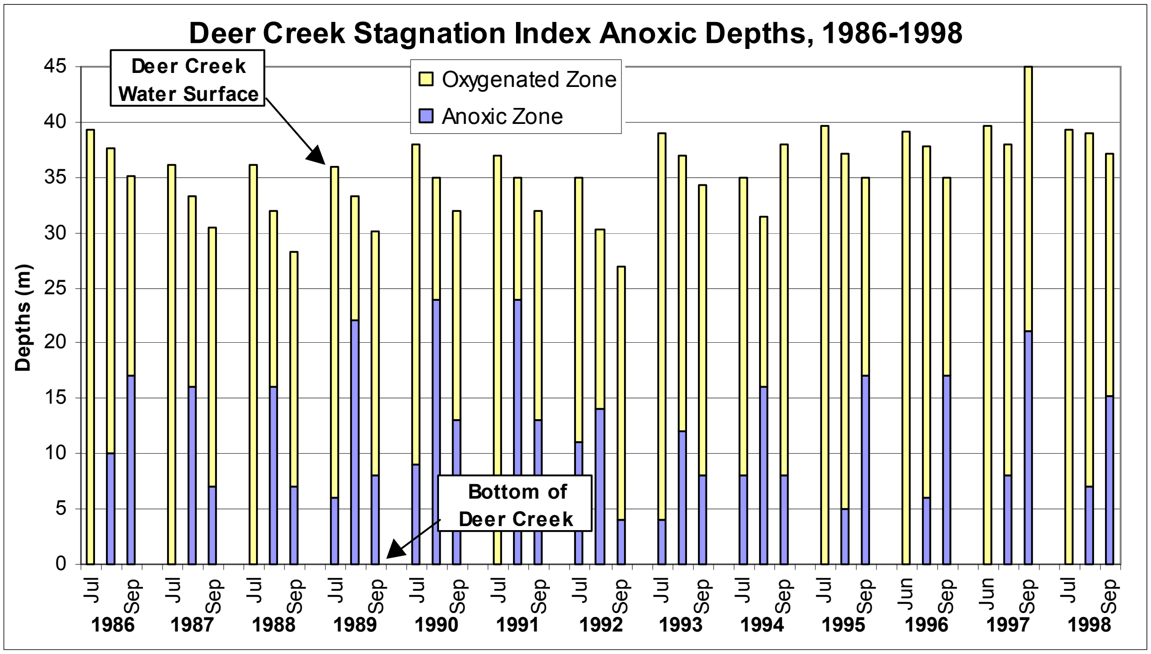


Figure ES. 6 Deer Creek Reservoir Stagnation Index above Dam 1986-1998

This figure shows that the worst DO conditions occurred in 1989-1991 and that some improvements have been achieved since that period of time. However, these minor improvements are still no better than DO conditions that occurred in 1986-1988.

In the next graph, Figure ES.7, the TSI from 1981 to 1998 is shown which tracks the trophic status of the Deer Creek Reservoir.

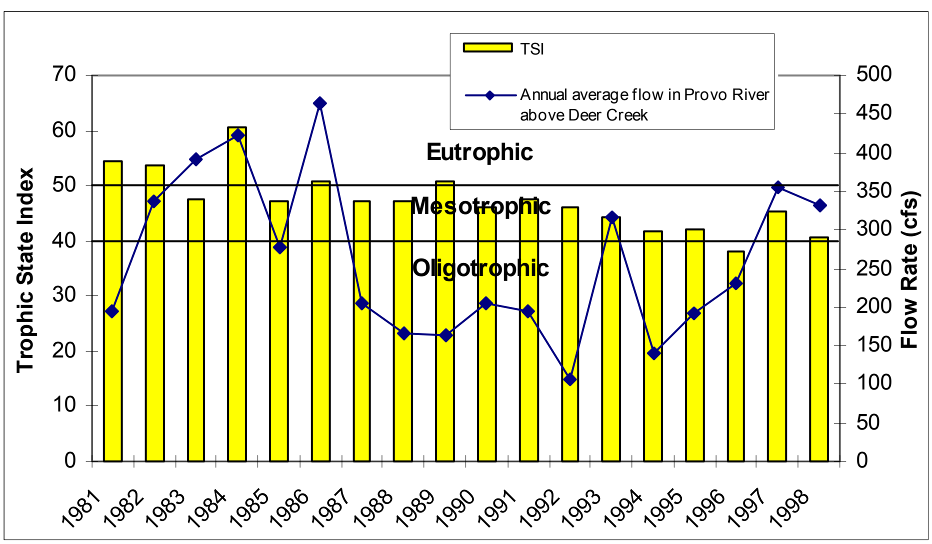


Figure ES. 7 Deer Creek Reservoir TSI 1981-1998

In 1998, the TSI was calculated to be 40.8, almost the lowest calculated TSI on record. The trend in Figure ES.7 above is substantial evidence of constant improvements to Deer

Creek Reservoir as the reservoir has improved from eutrophic to mesotrophic status. The efforts by cooperating agencies to achieve improved water quality should be partially credited. Despite this excellent evidence of improvements, there is still a need for additional improvements as evidenced by DO data in Figure ES.6.

PROBLEM AREAS

Despite great improvements in many areas, the 1998 monitoring program detected several water quality problems in the watershed. As a summary, the problems detected are as follows:

Table ES. 3 1998 Water Quality Problem Areas

Location	Problem	Exceedence Rate
Ontario Drain Tunnel #2 (UPCM)	High Zinc Concentrations	33%
	High pH	40%
Kamas Fish Hatchery	High Ammonia Concentration	90%
	High Phosphorus Concentration	90%
Midway Fish Hatchery	High Ammonia Concentration	67%
Deer Valley Mayflower Basin	High Phosphorus Concentration	N/A
Spring Creek	High Phosphorus Concentration	100%
Lower Charleston Canal	High Phosphorus Concentration	100%
Daniels Creek	High Phosphorus Concentration	82%
Main Creek	High Phosphorus Concentration	57%
Deer Creek Reservoir	Low Dissolved Oxygen	N/A
Little Deer Creek	High Phosphorus Concentration	36%

RECOMMENDATIONS

This report recommends the following eight items as suggestions for JTAC to continue to improve on water quality management and reduce the problems shown in Table ES.3.

1. Heber Valley Storm Water Controls

In response to recommendations from previous years' implementation reports Wasatch County, through a contract with Psomas, has completed the third year of a three year Storm Water Study in Heber Valley. Wasatch County continues to experience increased urbanization which tends to increase natural storm runoff conditions. The study has identified potential sites for construction of new sedimentation basins intended to reduce eroded sediments in surface waters prior to entering Deer Creek Reservoir. By removing sediments, many pollutants including phosphorus will also be removed. The implementation of these basins will help reduce phosphorus from Spring Creek, Daniels Creek, the Lower Charleston Canal, and Snake Creek. As shown previously in Table ES.1, all of these creeks except Snake Creek had phosphorus problems in 1998.

JTAC should support and encourage Wasatch County in its implementation of the recommended stormwater controls.

Implementation of this recommendation may mitigate the water quality problems listed in Table ES.3 for the following locations:

- Spring Creek
- Daniels Creek
- Lower Charleston Canal
- Snake Creek

2. 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 and TP 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. And JTAC should continue to work with the DWQ to encourage phosphorus limits in the hatchery's UPDES permit. In addition, high ammonia concentrations are occurring at both the Kamas Fish Hatchery and the Midway Fish Hatchery; JTAC should encourage ammonia limits as well.

Implementation of this recommendation may mitigate the water quality problems listed in Table ES.3 for the following locations:

- Kamas Fish Hatchery
- Midway Fish Hatchery

3. EPA Cleanup of Mine Sites

The mining industry once thrived in the Park City area of Summit County. Some of the mining activities spilled into Wasatch County, especially on the west side of Jordanelle Reservoir. The mine waste that remains contains hazardous levels of certain metals particularly arsenic and lead. Due to the potential hazards of these materials and plans for residential developments, the Utah Division of Environmental Response and Remediation requested that EPA, Region VIII, reevaluate the Mayflower Mountain Tailings Pond and evaluate other nearby mining-related sites which may pose risks to human health and the environment. EPA's reevaluation of these sites is expected to commence in the near future.

JTAC should support mitigation of these potential water quality hazards. JTAC should also closely monitor these sites for discharges of contaminated water that may pose a risk to drinking water sources such as the Jordanelle Reservoir.

Implementation of this recommendation may mitigate the water quality problems listed in Table ES.3 for the following locations:

- Ontario Drain Tunnel #2

4. 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 has 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.

5. 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.

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.

6. Agricultural – Non-Point Source Erosion

Agriculture appears to continue to have an impact on water quality. There are many ongoing programs that will help to reduce these impacts such as the Tri-Valley Watershed Project, Wasatch County Water Efficiency Project, and the Deer Creek Reservoir Resource Management Plan. In addition the NRCS is working with farmers on an individual basis to help them manage lands with Best Management Practices (BMPs) which will also favorably impact water quality. Better management practices in the Heber Valley will reduce non-point source phosphorus loading resulting in improved water quality.

JTAC should continue to support projects that will reduce pollutant contributions from non-point sources and support the education of local farmers and ranchers in BMPs.

Implementation of this recommendation may mitigate the water quality problems listed in Table ES.3 for the following locations:

- Spring Creek
- Daniels Creek
- Lower Charleston Canal
- Snake Creek
- Deer Creek Reservoir

7. Additional Monitoring of Provo Canyon

Many of the Provo River culinary water diversions are in the Provo Canyon. Increased monitoring in this area for drinking water specific constituents would help identify some of the problems more specific to drinking water. Drinking water treatment plants generally are concerned with phosphorus, algae, dissolved oxygen, total organic carbon, Cryptosporidium, Giardia, and metals.

JTAC should consider increased efforts to monitor many of these constituents within the Provo Canyon.

8. 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 water quality concerns such as proper storm water management, sediment controls, erosion controls, revegetations, restoration and drainage.

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

Implementation of this recommendation may mitigate the water quality problems listed in Table ES.3 for the following locations:

- Deer Valley Mayflower Basin

CHAPTER 1

Introduction

BACKGROUND

Most are aware of the vital role water plays in the development of the West. Productivity and economy are closely 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, recreational, and many other uses. Equally important, the Provo River supports a delicate ecosystem of invaluable living organisms.

Along the Provo River, Deer Creek and Jordanelle Reservoirs have helped make this water available for public and private use. These reservoirs are vital to the surrounding communities that depend on the Provo River as a resource. One of the challenges facing managers controlling the reservoirs is the control of eutrophication. Eutrophication is a natural process that occurs in lakes and reservoirs when an abundance of nutrients spurs algal growth. Excessive algal growth, unfortunately, can seriously deteriorate water quality causing taste and odor problems which in turn increase the treatment costs.

Formation of JTAC

In 1981, because of eutrophication evidences in Deer Creek Reservoir, Utah Governor Scott Matheson established the Jordanelle Reservoir Water Quality Technical Advisory Committee (JTAC) for the purpose of developing a reservoir management plan for Deer Creek Reservoir and the then future Jordanelle Reservoir. Thus JTAC was created with representation of over twenty federal, state, local agencies, and private companies.

In 1984, the Water Quality Management Plan for Deer Creek and Jordanelle Reservoirs was implemented by JTAC. The plan directs JTAC to conduct a water sampling program to monitor the condition of water quality throughout the year and to release a yearly implementation report that analyzes and presents the resulting data.

Phosphorus: Limiting Nutrient

The water sampling program identifies many water quality parameters including metals, physical and chemical properties, and nutrients. The most important water quality constituent, however, is the nutrient phosphorus. Generally, phosphorus is the limiting nutrient that controls the growth of algae. By decreasing the phosphorus loads into the reservoirs, theoretically, algal growth will also decrease.

In the Provo River Watershed, a variety of natural sources contribute phosphorus, which can be difficult to control. But also, many human activities and developments, which are more controllable sources, increase the pollutant concentrations. The goal of JTAC is to work to reduce pollution from these sources by encouraging the implementation of projects, management practices, and smart planning.

PURPOSE AND SCOPE

The 1999 Wasatch County Water Quality Implementation Report is released to fulfill the requirement by the 1984 Water Quality Management Plan for Deer Creek and Jordanelle Reservoirs. As directed by the plan, this report will:

- present the results of 1998 water quality sampling,
- identify exceedences of JTAC water quality parameter standards,
- identify trends in the water quality,
- analyze the effectiveness of current management practices, 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 monitoring data has been gathered by the coordination of various agencies participating in JTAC. JTAC through the Utah State 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. And, 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 affect the water quality in streams, rivers and reservoirs, which ultimately affects the water users. This chapter briefly discusses individual activities in the Provo River Watershed that potentially may favorably or unfavorably impact the water quality.

CURRENT WATER USERS

Water users that are currently dependent on the Provo River can be separated into three categories: Municipal, Agricultural, and Recreational. Each is described as follows.

Municipal

Municipal water users are water districts in Salt Lake, Utah, Wasatch and Summit Counties that provide safe drinking water to residents and industries through the region. 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) treat and distribute water from the Provo River. Water quality is especially important to these water districts to control the expensive costs of water treatment and to provide the highest quality drinking water.

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. Water Quality is important to maintain healthy crops and livestock.

Recreational

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 thousands of recreationists that visit the two reservoirs. The reservoirs provide water skiing, swimming, boating and more. Deer Creek and Jordanelle Reservoirs along with the Provo River and its tributaries provide excellent fisheries for anglers. Water quality is important in regards to the safety of recreational activities. Also, the preservation of wildlife such as birds, fish and hosts of additional wildlife common in the area may depend on good water quality.

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.

For the 1998 recreation season, the logo and concept were presented to the public through litter bags and signs that were distributed to the State Parks at both reservoirs. The litter bags were to be distributed at the entrances and the signs were to be posted around the parks. 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.

In addition, the State Division of Wildlife Resources published the logo with a brief explanation in the 1998 Fishing Proclamation and in the winter 1998 Wildlife Review. The State Division of Parks & Recreation 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.

Currently, this public information campaign is being assessed and will be reevaluated by JTAC for 1999.

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 addresses natural resource problems and opportunities within the 248,000 acre watershed.

Purposes of the Tri-Valley Watershed Project are water conservation, improved fish and wildlife habitat, and water quality. 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 Tri-Valley Watershed Project received $500,000 federal cost-share funds from the Environmental Quality Improvement Program (EQIP) during 1998. 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. Contracts were signed with 63 participants to use this money.

This year there is $500,000 of watershed cost-share funds and $250,000 of EQIP funds available for the on-farm sprinkler projects. NRCS calculates that these funds will almost complete the on-farm sprinkler conversion project.

In order to participate with the cost-share program, a Resource Management Plan must be developed by the participants. NRCS will assist with this plan by holding planning seminars. There is a seminar scheduled for February and June. Those interested in attending must pre-register with NRCS two days before the seminar.

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

Jordanelle Basin Master Plan and Developments

Wasatch County has adopted the Jordanelle Basin Master Plan. Since the adoption of this plan, a Jordanelle Basin Overlay Zone has also been adopted. The Overlay Zone will supplement existing county zoning regulations for lands within this overlay zone. These regulations will guide development within the Basin and provide the vision for what is to come.

Sewer, water lines, and water treatment plants are currently being constructed within the Jordanelle Special Service District to service developments within the Jordanelle Basin. Approximately 7,200 equivalent residential units have been approved. A fire station is also currently being constructed. Construction of some of the roads will begin this summer. It is anticipated that the Jordanelle Basin will grow rapidly within the next five years.

Deer Crest, located just west of the Mayflower Junction on U.S. 40, has already constructed and is operating ski lifts and ski runs in conjunction with Deer Valley. Infrastructure for this development is nearing completion. Wasatch County has issued three building permits for single family dwellings at Deer Crest. Future phases of approval may include commercial and multi-family structures.

Many other developments are submitting concept plans, with intentions of breaking ground within one to two years, including East Park, Pointe and Hollows, Hailstone Village, Staghorn/Elkhorn, Jordanelle View, and Deer Mountain. Other projects include Area C, Mayflower, and Jordanelle Heights, which have approved densities.

The eastern portion of the Basin, Area B, might also be developed into recreational areas and be included within the Jordanelle Overlay Zone. While no master plans have been approved yet for this area, development could occur soon or shortly after the development of the western side of the Jordanelle Basin.

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 1999 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

The Jordanelle Special Service District (JSSD) has been created to provide water and sewer services to the imminent developments on the west side of the Jordanelle Reservoir. JSSD has completed the design for a water and sewer system that includes waterlines, sewerlines, pump stations, intake structures, treatment facilities, and storage tanks. Construction of some of these facilities began in 1997. This water and sewer system for Area A, which will serve Deer Crest and other nearby developments should be completed during 1999-2000. JSSD has begun a water and sewer feasibility study that will cover other areas within the district: Ross Creek, Area B, Area C and four potential annexation properties.

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) had 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 expired in 1998, but because of failure by Mayflower to address a Notice of Violation (NOV) issued in 1996, DWQ did not renew the permit.

The NOV addressed the issue of stabilizing the tailing ponds. During the 5-year permit period, Mayflower monitored the surface water and groundwater and prepared plans and specifications for capping the three tailing ponds. Wasatch County and the DWQ have reviewed these plans and specifications. According to Mayflower, however, the tailing ponds have not yet been capped because an economical source of random fill has not yet been obtained.

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.

Wasatch County is working together with Mayflower to ensure that the hazardous site is contained before future developments occur in the area.

Park City Ski Resort Expansion into Pine Canyon

Park City Mountain Resort proposes to construct 2 chairlifts to serve the ski terrain on the north and east sides of the 10420 peak in Wasatch County. The ski terrain would consist of approximately 135 acres on 10420 peak and 60 acres on Tri-County peak. The ski terrain would be managed in a similar manner to the existing Jupiter Bowl terrain.

Tree and vegetation removal would be minimal and grading only on the access road and top and bottom terminals. Tree removal would be approximately 25 acres, mostly on the lower reaches of the terrain. Approximately .5 acres of grading would be required at the top and bottom terminal of each lift. (total 2 acres) No other run grading is planned. The access road from the existing McConkey's lift to the lower terminal of 10420 would be approximately 3,900 feet long and 25 feet cleared width. (approximately 4 acres) Appropriate water diversion and erosion control and revegetation would be installed on the road and at terminal sites.

Soldier Hollow: 2002 Winter Olympics

In anticipation of the 2002 Winter Olympics, the SLOC selected Soldier Hollow as the site for all Cross-country, Biathlon, and Nordic combined events. The site is located on the southern end of Wasatch Mountain State Park and directly west of the northern tip of Deer Creek Reservoir. In order to facilitate hosting of these Olympic events it will be necessary to construct 23 kilometers of trails, a shooting range for small caliber rifles, a stadium area and a Competition Management facility. The venue is currently under design. It is anticipated that construction of most of the improvements will occur during the 1999 construction season.

In the fall of 1998 the first 5 kilometers of trail were constructed. The trails consist primarily of 5 to 11 meter wide trails bladed into the hillside, following existing contours. Drainage culverts were installed at drainage crossings and erosion control measures were incorporated to prevent erosion of the newly bladed areas into the existing waterways and streams. The trail areas will be re-seeded using a native seed mixture approved by the Division of Natural Resources (DNR).

Plans for the 1999 construction season will include the construction of the remaining 18 kilometers of trail; installation of a snow making system; installation of water, sewer, gas, electrical and telecommunications lines; and the construction of a shooting range and a Competition Management building. Bridges and culverts will be built to bridge streams and trail crossings. The design team has been working with the Army Corps of Engineers to obtain the necessary permits to allow construction of trails across existing wetlands and streams. It is anticipated that minor drainage channel improvements will need to be made to keep surface flows in drainage channels and away from the shooting range and stadium areas.

The majority of water flows through the venue site have traditionally come from irrigation canals. There are currently two irrigation ditches bringing flows to the site. The West Bench Ditch and the Epperson Ditch carry flows from the Midway Irrigation Company to service farm lands on the west side of the Heber Valley. Midway Irrigation Company will construct a new, winterized water line that will provide 8 ft^3/sec of secondary water for snowmaking at the Olympic site and irrigation water for the future golf course. Currently, Midway Irrigation Company has completed a preliminary design for the aforementioned water line. The proposed 18-inch diameter waterline will end at the Cascade Springs Road. From this point, an additional 2,200 feet of water line is needed to reach the Olympic stadium. Midway Irrigation Company estimates completion of this project in the Fall of 1999.

As part of the snow making system, a small holding pond will be constructed at the end of the Midway Irrigation Company pipeline. This pond will serve as a cooling pond for snow making and as a holding pond for irrigation of the proposed future golf course located just north of the Olympic venue.

With the completion of the Midway Irrigation piping, the West Bench Ditch will be abandoned and will serve only as a storm drainage collection ditch. The ditch has been breached just north of the main drainage channel running through the venue to prevent flows north of the drainage from contributing to the erosion potential along the newly constructed trails south of the drainage.

Overflows from the Midway Irrigation Piping will be allowed to flow through the Epperson to the main drainage just east of the stadium area, where they will join with natural flows running through an existing detention basin before flowing into Deer Creek Reservoir.

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 1998 the net increase of phosphorus measured was 190 kg/year, well below its allowed load in the permit. TSS maximum daily loading was also very low at 555 kg/day on June 2, 1998.

Kamas Fish Hatchery

The Kamas Fish Hatchery, although smaller than the one at Midway, is in the process of expansion to increase its fish production from 80,000 to 140,000 pounds per year. Reconstruction began last year and 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. Because of expansion, 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 1,741 lbs/day.

The UPDES permit does not require phosphorus monitoring. To offset the potential for increased phosphorus and TSS discharges, however, 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 Park City mines 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

Design of the Wasatch County Water Efficiency Project has been completed and Central Utah Water Conservancy District (CUWCD) advertised for construction bids. The project was awarded to Barnard Construction Company, Inc and received a Notice to Proceed on October 8, 1998. To date, the following work has been completed: land acquisitions, some of the canal rehabilitation along Timpanogos Canal, excavation for the Timpanogos Regulating Pond, and placement of filter material and drain lines in the pond.

The project will be constructed over a three year period 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 in the Heber Valley from below Jordanelle Dam to Deer Creek Reservoir. In many areas the river has been straightened due to development of agricultural lands and the construction of flood control levees. The Utah Reclamation Mitigation and Conservation Commission has proposed the PRRP to create a meandering river path with the purpose of restoring a more naturally functioning river system.

Existing levees would be set back to create 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 first step in the project will begin with a pilot phase. A small section of the Provo River, near the bridge of US Highway 40, has been selected for this phase. Weather permitting, construction on this section will begin in March 1999 with the creation of side channels and expanded flood plain areas. The main channel will be realigned in the fall following the irrigation season. The CUWCD is cooperating by planning to rebuild the diversion facilities as part of the Wasatch County Water Efficiency Project.

The pilot project will be evaluated to determine its effectiveness. Lessons learned will be incorporated into restoring the rest of the river reach. The pilot phase will also help estimate the schedule, construction costs and available resources for the remainder of the project.

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. It protects and maintains the purposes for which the Provo River Project was authorized by congress, as well as 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 was completed in 1998 and the environmental assessment was released for public comment. From public comments, the Bureau of Reclamation (USBR) has decided to implement Alternative 1, the proposed alternative, but with a modification regarding the elimination of grazing on project lands. USBR has decided to allow grazing on project lands east of U.S. Highway 189, opposite side of the reservoir, with best management practices being implemented. Also, USBR has determined that the implementation of the proposed alternative should not require an environmental impact statement because of relatively low environmental impacts of the alternative.

Deer Creek State Park Renovations

Utah State Division of Parks and Recreation and the Bureau of Reclamation are jointly funding the $4.5 million renovation of recreation facilities at Deer Creek State Park. The first phase of the project is now complete with the development of Island Beach, Sailboat Beach, and a new park office.

The second phase of the project is currently under construction. This phase will develop the Rainbow Bay Day Use Area, Wallsberg Bay Overnight Group Use Area, a new campground, and also improve the maintenance area and Main Park launching ramp. These improvements should be complete by September 30, 1999.

The new developments of the second phase include construction of an entrance station, modern restrooms, group pavilions, picnic shelters, docks, a new water system, and new campsites with and without full utility hookups.

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.

And 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.

Upper Provo River Water Quality Management Plan

The Upper Provo River Water Quality Management Plan analyzes the basin characteristics and problems. Accordingly, Total Maximum Daily Loads (TMDLs) have been developed for the basin in terms of annual phosphorus loading for selected stream segments. These TMDLs were developed from procedures given by EPA to comply with the requirements under section 303(d) of the Clean Water Act.

The yearly TMDLs for phosphorus are listed below in Table 2.1:

Table 2. 1 Upper Provo River Annual TMDLs for TP Loadings

WATERSHED NAME	ANNUAL TMDL'S TP – kg/yr
Provo @ Woodland	7,681
Kamas Fish Hatchery	173
Provo @ Hailstone	9,837
Provo @ Jordanelle	8,685
Provo @ Charleston	8,428
Provo @ Deer Creek	12,788
Snake Creek	1,747
Daniels Creek	488
Main Creek	916

The Upper Provo River 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 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 March 1999.

Heber Valley Storm Water Management Plan

In response to recommendations from previous years' implementation reports Wasatch County, through a contract with Psomas, has completed the third year of a three year Storm Water Study in Heber Valley. Wasatch County continues to experience increased urbanization that tends to increase natural storm runoff conditions.

The study has identified potential sites for construction of new sedimentation basins intended to reduce eroded sediments in surface waters prior to entering Deer Creek Reservoir. By removing sediments, many pollutants including phosphorus will also be removed. The implementation of these basins will help reduce phosphorus loadings from Spring Creek, Daniels Creek, the Lower Charleston Canal, Snake Creek, and the Provo River.

US-40 Highway Construction

The section of US-40 between the River Road/SR-32 intersection and Heber City is a two-lane facility with marginal shoulders. It was scheduled for reconstruction to a five-lane road in 1996 but funding was transferred to a higher priority project.

The existing road received an overlay in 1997 to preserve it until funding was again available. This section of US-40 is once again on-track for reconstruction and rehabilitation in 2000. The money will come from the Olympic funding. To realize the value of the overlay and reduce costs of the project, the concept has changed from total reconstruction to reconstruction and rehabilitation. The widening will be on the west side of US-40 and then an additional overlay over the existing road.

The completed project will be a five lane facility, two lanes in each direction, a permissive left turn lane and ten foot shoulders on both sides of the road. The project will include new drainage and irrigation culverts, some intersection improvements, and enhancement of a wetland mitigation site purchased for the 1996 project.

The concept change has required that the plans are redrawn and the contract package is prepared again. This work has commenced and will continue through the summer of 1999 with advertisement for bid planned for September 1999 and construction work in 2000.

US-189 Highway Construction

Widening of US-189 in Provo Canyon from Upper Falls to Wildwood that began in the spring of 1996 has continued through 1998. Most of the construction has been completed. Some smaller tasks, however, remain to finish up the project such as landscaping, painting, and wetlands mitigation.

The project has been plagued by problems during construction. On April 21, 1998, the Utah Water Quality Board issued a notice of violation to UDOT because of poor stormwater management. This citation occurred because of failure to notify the board about changes to the stormwater pollution prevention plan, and silt fencing that was uninstalled.

Also, in another violation, a 1000-foot section of the road encroached the 8-foot buffer zone for wetlands next to the Provo River, thus violating the wetlands permit issued by the U.S. Army Corps of Engineers. This incident required that the section be demolished and realigned outside of the 8-foot buffer. UDOT was fined $140,000 for the violation.

Also, UDOT has been fined by the state Division of Water Quality for failing to channel construction site runoff away from the Provo River.

1998 Water Quality Monitoring Program

CHAPTER 3

INTRODUCTION

This chapter describes the JTAC program that has been established to monitor water quality in the Provo River Watershed. Also, this chapter provides the methodology and assumptions used for presentation, calculations, and analyses of the water quality data.

JTAC MONITORING PROGRAM

The JTAC monitoring program uses a method of systematically taking samples from streams and reservoirs in the watershed. In 1998, JTAC took nearly 600 samples from 46 locations for the purpose of water quality analysis. The sampling locations were selected with the purpose of analyzing the progress towards the goals set in 1984. Each is identified by a six digit STORET number for the State's system of identification. 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 describes many physical properties. Further analyses are 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 are then conducted at the State Laboratory for nutrients and dissolved metals refer to Tables 3.1 and 3.2.

Insert Table 3.1 JTAC Monitoring Plan Fiscal Year 1997-1998

Table 3. 1 JTAC Monitoring Plan Fiscal Year 1997-1998

Table 3.2 JTAC Monitoring Plan Fiscal Year 1998-1999

Table 3. 2 JTAC Monitoring Plan Fiscal Year 1998-1999

Reservoir Profiles
In addition to the reservoir sampling as described above, temperature, dissolved oxygen, specific conductance, redox potential, and pH data were gathered at 4 sites at various depths to produce a profile of the reservoir for these parameters. The most critical parameter is 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 odors. For lakes and reservoirs, algae growth is 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 creating an anaerobic environment. These profiles help monitor the oxygen conditions in the reservoir throughout the year.

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 the first time, JTAC has included funding for the monitoring of groundwater in existing wells in Heber Valley.

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.

QA/QC PROGRAM

The DWQ has established the method of duplicate sampling for QA/QC (Quality Assurance/Quality Control). 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.

1998 QA/QC Results

The following excerpt is from a memorandum from Arne Hultquist, Division of Water Quality, reporting on the 1998 QA/QC results. The entire memo, which includes attached QA/QC data, may be referred to in Appendix D.

> Few of the analyses showed significant differences in several analyses. The large number of replicate NO_2 + NO_3 analyses that did not fall within the confidence interval is probably due to a greater percentage variation in results near reporting limits. The quality of phosphorus results has greatly improved from the previous water year's quality assurance analyses. None of the replicate phosphorus results were outside the confidence interval. For the other analyses, some reported values outside the confidence interval might be attributed to samples exceeding the holding time for that analysis. For all analyses most of the reported values outside the confidence interval might be attributed to normal error associated with sampling and laboratory analyses. For some values near the detection limit the confidence interval may not be appropriate because the data used to generate the regression equations does not include data in that range. The percentage of values that did not fall within the interval was 4.6%.

The QA/QC program has determined that the water quality data received from the State Laboratory is relatively reliable. Specifically encouraging, are the phosphorus analyses, which appear to have been fixed from the problems that eliminated the previous year's phosphorus data.

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.

Water Quality Standards

The State of Utah has established water quality standards that are based upon the beneficial uses as determined by previously described classifications.

State Bacterial Standards

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.

State Physical Properties Standards

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.

State Phosphorus Standards

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 target be reduced to 0.04 mg/L for the Provo River Watershed because of problems relating to eutrophication.

JTAC General Standards

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

Table 3. 3 JTAC 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

State 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

The State standard for ammonia has also been adopted by JTAC to monitor water quality conditions.

State Dissolved Metal Standards

Part of the JTAC monitoring plan analyzes dissolved metal concentrations for select locations. The standards used for dissolved metals are from state restrictions for domestic, aquatic life, and irrigation uses. Recreational and aesthetic uses, however, 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 problem locations.

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

Loading calculations are based on the water quality data gathered by JTAC and average daily flow measurements, typically taken from a USGS gage station. Loading is determined at each location for three important water quality parameters, total suspended solids (TSS), total phosphorus (TP), and dissolved total phosphorus (DTP). All samples with constituent concentrations below the detectable limit were assumed to have no concentration of that constituent.

Loads were calculated by multiplying the mass concentration of the substance (mg/l) by the daily flow rate (cfs) in the stream to determine the daily mass loading rate. TSS daily loading was determined in units of tons/day; total phosphorus and total dissolved phosphorus was determined in lbs/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. Loading for the period between January 1st and the first sampling date was calculated using the daily loading rate for the first sampling date and multiplying it by the number of days between January 1st and the first sampling date. Likewise, the loading for the period between the year's last sampling date and December 31st was calculated in the same manner.

The annual mass loading rate was determined by summing the load for each period. This methodology assumes that mass loading rates are steady and that fluctuations are relatively gradual. This calculation method is in accordance with the statistical report published in the 1992 implementation report.

Insert Map 1

Figure 3. 1 Map 1 of Provo River Watershed Area

Insert Map 2

Figure 3. 2 Map 2 of Provo River Watershed Area

Insert Map 3

Figure 3. 3 Map 3 of Provo River Watershed Area

Insert Map 4

Figure 3. 4 Map 4 of Provo River Watershed Area

Upper Provo River and Jordanelle Reservoir

CHAPTER 4

INTRODUCTION

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

STREAM MONITORING RESULTS

In the area of the Upper Provo River and Jordanelle Reservoir Basins, JTAC monitored five stream sampling locations and two point source discharge locations during the year of 1998. The monitoring locations are as follows:

	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
•	499804	Ontario #2 Drain Tunnel (Park City Ventures)
•	499767	McHenry Creek below Mayflower

Each stream monitoring location is discussed individually in the sections that follow. A summary table of the water quality monitoring results is presented, which lists maximums, minimums, averages, and number of exceedences for temperature, dissolved oxygen, pH, TSS, ammonia, dissolved phosphorus and total dissolved phosphorus. A more complete analysis of the data is included in 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, 499840 – Water Quality Summary

Date	*Temp* Deg C	*pH*	*D.O.* mg/l	*T.S.S.* mg/l	*Ammonia N* mg/l	*T. Phos.* mg/l	*D-T Phos.* mg/l
Minimum	0.3	7.5	7.8	0	0	0	0
Maximum	14.3	8.3	11.6	22.4	0	0.062	0.014
Median	4.2	7.8	11	0	0	0	0
Mean	5.7	7.8	10.2	4.1	0.00	0.013	0.002
Number	11	11	11	11	11	11	11
Exceedences	0	0	0	0	0	1	0

Note: Highlighted information exceeds stream water quality standards or guidelines.

The location was sampled eleven times during 1998. The phosphorus data shows that one sample, collected on June 24th exceeded the JTAC indicator value of 0.04 mg/l. No other exceedences were recorded. Historically, few exceedences are recorded at this location indicating the excellent water quality at this location. The 1998 data is relatively average compared to historical data.

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 from Beaver Creek for irrigation and the return flows are discharged into the Provo River Basin. For this reason, the Kamas Fish Hatchery is 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, 492900 – Water Quality Summary

Date	*Temp* Deg C	*pH*	*D.O.* mg/l	*T.S.S.* mg/l	*Ammonia N* mg/l	*T. Phos.* mg/l	*D-T Phos.* mg/l
Minimum	7.8	7.4	5.8	0	0	0	0
Maximum	14.14	8.68	9.37	0	0.21	0.058	0.044
Median	10.59	7.75	7.15	0	0.15	0.044	0.011
Mean	10.9	7.9	7.3	0.0	0.14	0.038	0.016
Number	8	8	8	8	5	5	4
Exceedences	0	0	2	0	4	4	1

The location was sampled eight times during 1998. Of those eight samples only five were tested in the lab. These five samples showed high levels of phosphorus and ammonia despite having low total suspended solids. The high level of ammonia indicates potential toxic conditions. Also, low DO was detected in two samples.

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 through Kamas into the Provo River. A summary of the data is shown below in Table 4.3.

Table 4. 3 Weber Provo Canal Diversion, 499814 – Water Quality Summary

Date	Temp Deg C	pH	D.O. mg/l	T.S.S. mg/l	Ammonia N mg/l	T. Phos. mg/l	D-T Phos. mg/l
Minimum	0.6	7.8	7.6	0	0	0	0
Maximum	18	8.2	12.4	18.8	0	0.074	0
Median	7.35	8.05	10.1	2.8	0	0	0
Mean	7.6	8.0	10.0	5.1	0.00	0.017	0.000
Number	6	6	6	6	6	6	6
Exceedences	0	0	0	0	0	1	0

This location was monitored eleven times during 1998, of which only six samples were collected due to no flow conditions during part of the year. Only one sample, collected on June 24th, recorded an exceedence in phosphorus concentration.

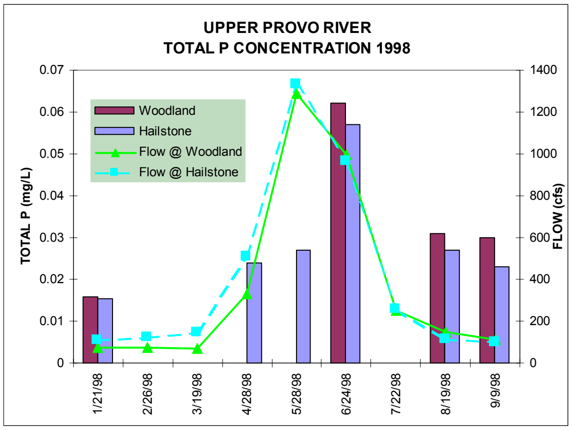
Provo River above Hailstone, STORET # 499813

This monitoring site is located in the Provo River just upstream of the Jordanelle Reservoir near USGS flow gage #10155000. This location represents the water that flows 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, 499813 – Water Quality Summary

Date	Temp Deg C	pH	D.O. mg/l	T.S.S. mg/l	Ammonia N mg/l	T. Phos. mg/l	D-T Phos. mg/l
Minimum	0	7.5	7.7	0	0	0	0
Maximum	17.1	8.8	12.4	24	0	0.057	0.022
Median	6	8	10.35	2	0	0.00765	0
Mean	7.5	8.0	10.1	4.8	0.00	0.014	0.003
Number	16	16	16	16	16	16	16
Exceedences	0	0	0	0	0	1	0

This location was monitored 16 times during 1998. Only one sample, collected on June 24th, exceeded the phosphorus concentration indicator. The location showed phosphorus concentrations slightly lower than historical data. The following charts, Figures 4.1 and 4.2 compare the total suspended solid and total phosphorus concentrations at Hailstone to those upstream 10 miles at the Woodland monitoring location.



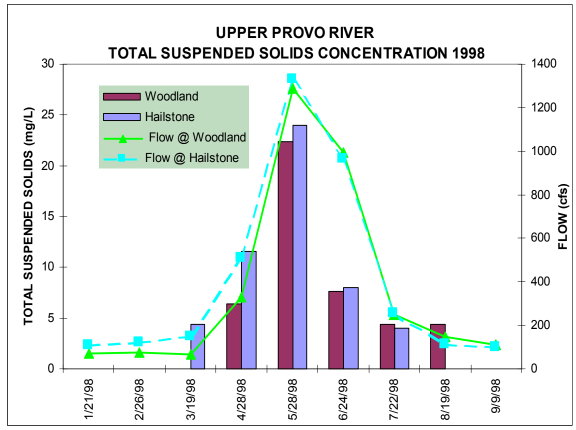


Figure 4. 1 Upper Provo River 1998 TP Concentrations
Figure 4. 2 Upper Provo River 1998 TSS Concentrations

The charts show that some increases in TP and TSS concentrations occur between the two locations. This is indicative of the non-point source loading throughout this 10-mile stretch from agricultural lands and small tributaries. Notable is the fact that high TSS concentrations were present in May, yet strangely high TP concentrations did not coincide with this high level of TSS. Rather, high TP concentrations occurred in June when TSS concentrations were lower.

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 4.5.

Table 4. 5 Ontario #2 Drain Tunnel, 499804, Water Quality Summary

Date	*Temp* Deg C	*pH*	*D.O.* mg/l	*T.S.S.* mg/l	*Ammonia N* mg/l	*T. Phos.* mg/l	*D-T Phos.* mg/l
Minimum	8.58	8.95	7.89	6.4	0	0	0
Maximum	13.75	9.16	10.58	26.8	0.105	0	0
Median	9.43	9	9.6	14.8	0	0	0
Mean	10.3	9.0	9.4	15.7	0.02	0.000	0.000
Number	5	5	5	4	5	5	3
Exceedences	0	2	0	0	0	0	0

This location was monitored five times during 1998. None of the samples collected detected any traces of phosphorus. Historically the drain tunnel has had no problems with phosphorus concentrations, but has had problems with high pH. This year two of the five samples recorded high pH (above 9.0). The remaining three samples were just under 9.0.

McHenry Creek below Mayflower, STORET # 499767

This monitoring site is located on the west side of Jordanelle Reservoir where McHenry Creek flows into the reservoir. This creek lies in the same drainage as the Mayflower mine and tailings ponds that pose a risk of contamination. Also further up in the drainage lies development activities by Deer Valley Ski Resort. A summary of the water quality data is provided below in Table 4.6.

Table 4. 6 McHenry Creek below Mayflower, 499767 – Water Quality Summary

Date	Temp Deg C	pH	D.O. mg/l	T.S.S. mg/l	Ammonia N mg/l	T. Phos. mg/l	D-T Phos. mg/l
Minimum	2.3	7.5	9	0	0	0	0
Maximum	9.8	7.9	10.6	16.4	0	0.048	0.079
Median	6.5	7.8	9.9	9.2	0	0.028	0.019
Mean	6.1	7.8	9.8	7.7	0.00	0.024	0.029
Number	6	6	6	6	6	6	6
Exceedences	0	0	0	0	0	1	2

The location was monitored six times during 1998. Some phosphorus exceedences were detected in two of the samples. Historically the location has a few exceedences in phosphorus concentrations. This year appears to be typical as compared to past years. Some discrepancy appears to exist between the TP and DTP maximum concentrations since DTP should not exceed TP. This can be attributed to common laboratory error.

STREAM LOADINGS & TMDLS IN UPPER PROVO RIVER

The data from stream samples that were collected are used with flow data to calculate river loadings of three important constituents: TSS, TP, DTP. In the Upper Provo River area these loads are calculated in three stream locations: Provo River near Woodland, Weber-Provo Canal Diversion, Provo River near Hailstone; and one point source location being the Kamas Fish Hatchery Effluent. The spreadsheets of these calculations can be found in Appendix C. Figure 4.3, as follows, illustrates the results.

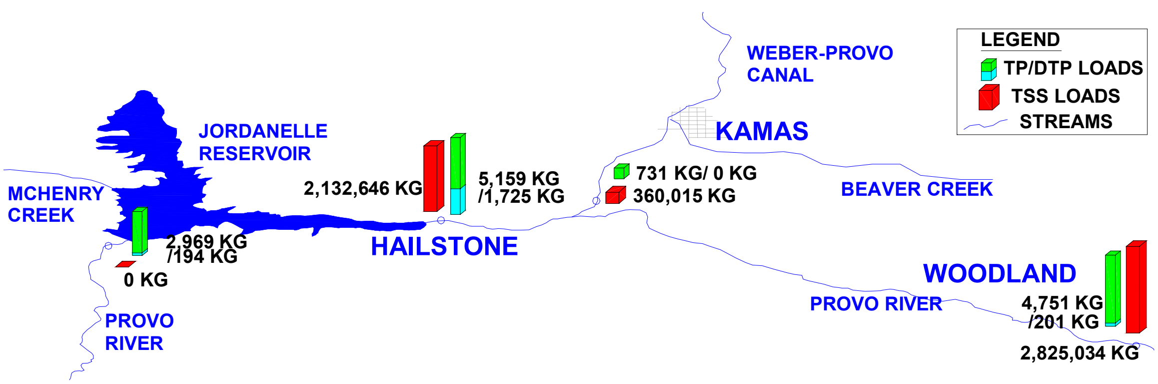


Figure 4. 3 Upper Provo River TSS/TP/DTP Loading Overview

As shown in the map, the Provo River near Woodland showed fairly typical loading values. The location near Hailstone, however, has unusually low loadings in TP and TSS. These observations are apparent in Table 4.7, which compares the 1998 loading results to the previous 5 years.

Table 4. 7 Upper Provo River Loading Summary

	1993	1994	1995	1996	1997	1998
Provo River at Woodland, STORET 499840						
Weighted Average Flow (cfs)	339	139	303	242	220	296
TP Weighted Average (mg/l)	0.020	0.016	0.026	0.009	-	0.018
TP Annual Load (kg/yr)	6,094	2,008	7,053	1,955	-	4,762
DTP Weighted Average (mg/l)	-	-	0.009	0.004	-	0.001
DTP Annual Load (kg/yr)	-	-	2,499	1,955	-	201
TSS Weighted Average (mg/l)	25.4	14.5	38.2	11.5	7.7	10.7
TSS Annual Load (kg/yr)	7,682,847	1,704,960	10,334,714	2,486,544	1,517,482	2,825,034
Kamas Fish Hatchery, STORET 492900						
Weighted Average Flow (cfs)	5.2	4.9	6.2	5.8	6.2	6.5
TP Weighted Average (mg/l)	0.083	0.078	0.06	0.046	-	0.023
TP Annual Load (kg/yr)	388	337	327	237	-	135
DTP Weighted Average (mg/l)	-	-	0.039	0.025	-	0.016
DTP Annual Load (kg/yr)	-	-	214	130	-	91
TSS Weighted Average (mg/l)	2.5	1.4	1.5	0.0	4.1	0.0
TSS Annual Load (kg/yr)	11,516	6,008	8,122	0	22,816	0
Weber Provo Canal, STORET 499814						
Weighted Average Flow (cfs)	110	52	57	82	21	57
TP Weighted Average (mg/l)	0.082	0.042	0.048	0.022	-	0.014
TP Annual Load (kg/yr)	8,079	1,923	2,432	1,594	-	731
DTP Weighted Average (mg/l)	-	-	0.014	0.007	-	0
DTP Annual Load (kg/yr)	-	-	733	526	-	0
TSS Weighted Average (mg/l)	44.9	44	37.8	31.1	4.2	7.2
TSS Annual Load (kg/yr)	4,417,245	2,039,486	1,937,566	2,287,441	76,622	366,015
Provo River at Hailstone, STORET 499813						
Weighted Average Flow (cfs)	474	225	385	284	308	288
TP Weighted Average (mg/l)	0.054	0.039	0.042	0.023	-	0.02
TP Annual Load (kg/yr)	22,992	7,721	14,267	5,825	-	5,159
DTP Weighted Average (mg/l)	-	-	0.006	0.010	-	0.007
DTP Annual Load (kg/yr)	-	-	1,926	2,528	-	1,725
TSS Weighted Average (mg/l)	36.1	41.1	42.4	22.0	25.8	8.3
TSS Annual Load (kg/yr)	15,252,858	8,245,837	14,552,043	5,571,686	7,076,823	2,132,646
Provo River TP Increase Ratio	3.8	3.8	2.0	3.0	-	1.1

Typically increases in TP and TSS occur through this 10-mile stretch between the two locations; TP loadings usually increase on the order of a ratio varying from 2.0 to 3.8. In the past, these increases have been attributed to the erodibility of soil through this area and also agricultural activities that increase loadings. 1998 appears to show improvements to the TP loadings, as such large increases were not observed. Even stranger, TSS loadings decreased between the two locations. This event has never happened in the entire period of record.

Comparisons to TMDLs

TMDLs were calculated in the Wasatch County Water Quality Management Plan 1999. In the Upper Provo River they were calculated for the Provo River at Woodland, Kamas Fish Hatchery, and Provo River at Hailstone. Table 4.8 shows the comparisons of 1998 loadings to the annual TMDLs. As shown in the table, none of the 1998 loads exceed the annual TMDLs.

Table 4. 8 Upper Provo River TMDLs

Location	TMDL (kg/yr)	1998 Load (kg)
Provo River at Woodland	7,681	4,751
Kamas Fish Hatchery	173	135
Provo River at Hailstone	9,837	5,159

JORDANELLE RESERVOIR MONITORING

On the Jordanelle Reservoir, JTAC monitored three locations during the year of 1998. Reservoir monitoring included samples taken at various depths in each location as well as profiles of physical characteristics at multiple depths to generate a profile of the water characteristics, the most important characteristic being dissolved oxygen (DO). The three monitoring locations listed are as follows:

STORET No.	Location Description
• 591404	Jordanelle Reservoir – Provo River arm
• 591403	Jordanelle Reservoir – north arm
• 591401	Jordanelle Reservoir – above dam

Each location is discussed individually in the sections that follow. A summary table of the water quality monitoring results is presented, which lists maximums, minimums, averages, and number of exceedences for temperature, dissolved oxygen, pH, TSS, ammonia, dissolved phosphorus and total dissolved phosphorus.

Provo Arm, STORET #591404

The Provo River Arm of Jordanelle Reservoir was sampled nine times during 1998. All nine 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 4.9.

Table 4. 9 Jordanelle Reservoir-Provo Arm, 591404 – Water Quality Summary

Date	*Temp* Deg C	*pH*	*D.O.* mg/l	*T.S.S.* mg/l	*Ammonia N* mg/l	*T. Phos.* mg/l	*D-T Phos.* mg/l
Minimum	4.5	7.1	3.5	0	0	0	0
Maximum	21	8.4	10.6	0	0	0.024	0.036
Median	7	7.65	7.35	0	0	0.000	0.000
Mean	10.0	7.6	7.3	0.0	0.00	0.005	0.005
Number	18	18	18	15	18	18	18
Exceedences	2	0	0	0	0	0	2

High water temperatures on the surface of the reservoir are not uncommon as there were two exceedences. On June 24th, there were also two incidents of DTP concentrations exceeding the JTAC indicator value of 0.025 mg/l in the surface sample and the bottom sample. Despite the DTP exceedences, none of the samples recorded TP concentrations that exceeded JTAC indicator value. Obviously, this is due to laboratory error.

North Arm, STORET #591403

The north arm of Jordanelle Reservoir was also sampled on nine occasions during 1998. 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 4.10.

Table 4. 10 Jordanelle Reservoir-North Arm, 591403 – Water Quality Summary

Date	Temp Deg C	pH	D.O. mg/l	T.S.S. mg/l	Ammonia N mg/l	T. Phos. mg/l	D-T Phos. mg/l
Minimum	4.9	7	4	0	0	0	0
Maximum	21.5	8.2	10.3	0	0	0.117	0.037
Median	6.35	7.75	7.25	0	0	0.000	0.000
Mean	9.9	7.6	7.2	0.0	0.00	0.013	0.005
Number	18	18	18	16	18	18	18
Exceedences	1	0	0	0	0	2	2

Similar to the Provo Arm of the reservoir there was an exceedence of maximum temperture. Also exceedences in phosphorus levels occurred. These exceedences occurred in Late Summer between July and October.

Above Dam, STORET #591401

Above the dam of Jordanelle Reservoir, there were samples taken on ten occasions during 1998. There were a total of 69 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 ten sampling dates include samples from the surface, bottom and gates 2 and 5. A combined summary of the water quality data at all depths is provided below in Table 4.11.

Table 4. 11 Jordanelle Reservoir-Above Dam, 591401 – Water Quality Summary

Date	Temp Deg C	pH	D.O. mg/l	T.S.S. mg/l	Ammonia N mg/l	T. Phos. mg/l	D-T Phos. mg/l
Minimum	3.5	7.1	3.8	0	0	0	0
Maximum	20.4	8.1	10	0	0	0.402	0.080
Median	6	7.4	7	0	0	0	0
Mean	8.4	7.5	7.1	0.0	0.00	0.014	0.003
Number	69	69	69	60	66	66	61
Exceedences	2	0	0	0	0	4	1

As expected there were two exceedences in temperature from the surface samples. Some phosphorus exceedences were also detected. These exceedences were minimal.

Jordanelle DO Monitoring

At the 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. Graphs of these profiles, located in Appendix F, 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 and the depth at which dissolved oxygen levels decrease. If anoxic conditions exist in the reservoir, it will be apparent in the generated profiles.

During 1998, Profile data was gathered 7-8 times at the three monitoring locations. They were gathered between months of April and December. Figure 4.4 below tracks the DO concentration throughout 1998 at the lowest depth of each profile.

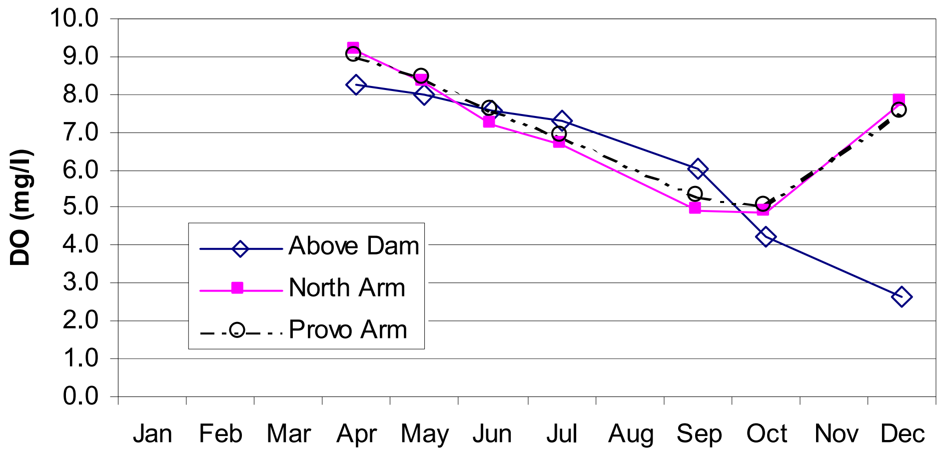


Figure 4. 4 Jordanelle 1998 DO Concentrations at Bottom Depth

The figure shows how the reservoir goes through annual cycle of stratification. 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. Presentation of the profiles in a calander year shows the complete cycle of mixed to stratified back to mixed. The figure above, however, shows the December sample taken above the dam did not destratify as did the other two locations. This December sample had the lowest concentration of DO for 1998.

Jordanelle SLOW and Reservoir Phosphorus Retention

At the dam of the Jordanelle Reservoir, water is released into the Provo River through a SLOW (Selective Level Outlet Works) Tower. This feature of the dam allows for certain parameters of the released water to be controlled, based on the depth from which water enters the intake. Temperature and phosphorus concentrations are some of the major concerns that may be controlled.

It is important that the Jordanelle Reservoir retain phosphorus in the reservoir to reduce phosphorus loadings and thus further improve water quality in Deer Creek Reservoir. Retention will occur naturally because suspended sediments that have attached phosphorus settle in the reservoir. But, dissolved portions will remain. The SLOW tower must selectively change depth to release water with lower concentrations of phosphorus. The Wasatch County Water Quality Management Plan of 1999, has set the goal that Jordanelle Reservoir retain an additional 2,800 kg/yr using 1996 as a baseline. Table 4.12 shows the retention of TP in the reservoir since 1993.

Table 4. 12 Jordanelle Reservoir Retention 1993-1998

Jordanell Reservoir TP Retention	1993	1994	1995	1996	1997	1998
Provo River Input (kg/yr)	22,992	7,721	14,267	5,825	-	5,159
Provo River Release (kg/yr)	10,271	2,722	4,272	3,496	-	2,969
Retention (kg/yr)	12,721	4,999	9,995	2,329	-	2,190
% Retained	55.3%	64.7%	70.1%	40.0%	-	42.4%

The table shows that in 1998 the Jordanelle Reservoir retained approximately 40% of TP load. It released 2,969 kg of TP, this value is significantly below the TMDL of 8,685 kg. Although the water quality management plan calls for additional retention, it would be difficult to export any less than 2,000 kg of TP. With only 5,159 kg entering the reservoir, the tower has done an excellent job in 1998 of retaining phosphorus. The true test of the tower, however, will be retention during years of higher loadings such as one similar to 1995 when 14,000 kg entered the reservoir.

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. A TSI value can be calculated individually from each of these parameters. In this report, we have taken an average of the TSIs calculated from each. Table 4.13 shows the calculation results for Jordanelle Reservoir. And Figure 4.5 compares the calculated TSI value to historical values that have been calculated since 1993 when the reservoir first began to fill.

Table 4. 13 Carlson Trophic State Index (TSI) calculation for Jordanelle Reservoir

Sample	North Arm			Provo Arm			Above Dam		
Date	Transp.	Chlor-A	TP	Transp.	Chlor-A	TP	Transp.	Chlor-A	TP
	m	μg/l	mg/l	m	μg/l	μg/l	m	μg/l	μg/l
20-May-98	3.2	3.9	0	1.7	6.6	0.024	3.7	2	0
18-Jun-98	3.7	3.9	0	3.6	2.6	0.02	3.2	3.3	0.229
7-Jul-98	2.5	4.4	0.025	2.4	3.7	0	2.4	4.9	0.021
14-Jul-98	2.6	4	0	2.3	4.4	0	2.3	6.7	0
11-Aug-98							4.7	2.5	0
3-Sep-98	4.3	1.6	0	4	3	0	4.9	2	0
17-Sep-98	5.6	2.4	0	4.4	2.7	0	5	2.4	0
Average	3.7	3.4	0.004	3.1	3.8	0.007	3.7	3.4	0.036
TSI	**41.3**	**42.5**	**24.7**	**43.9**	**43.8**	**32.9**	**41.0**	**42.6**	**55.7**
TSI Average		**36.2**			**40.2**			**46.4**	

Average TSI for Reservoir → **40.9**

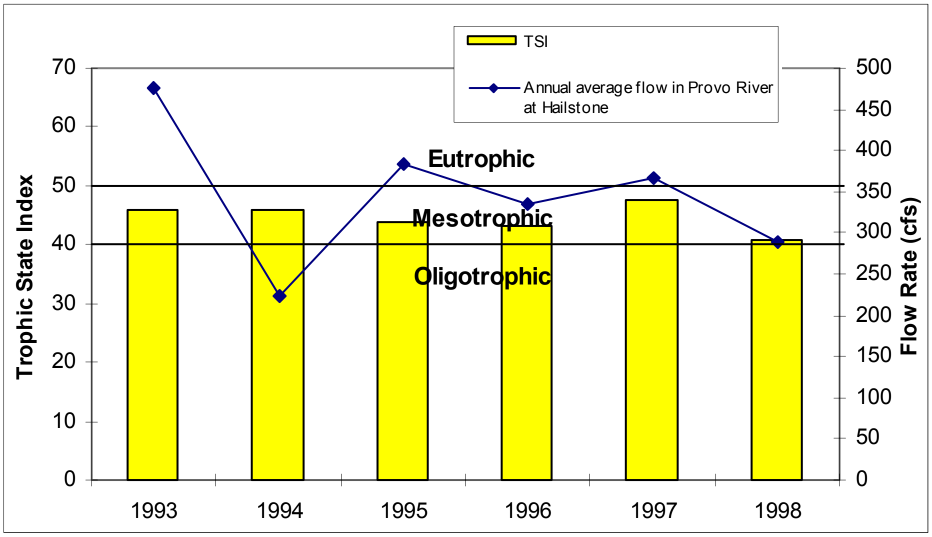


Figure 4. 5 Jordanelle Reservoir TSI and Provo River Average Flow 1993-1998

The TSI was calculated to be 40.9, which classifies the reservoir as mesotrophic indicating a healthy balance of nutrients. This value is the lowest calculated TSI since the reservoir began to operate and is very close to an oligotrophic state, which would indicate a lack of nutrients. The ecosystem of the reservoir has not quite established itself, however it appears to be heading towards a stable mesotrophic status.

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 1998. Quantitative net plankton and total plankton samples were collected and studied. A total of 34 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 1998 as determined by presence and biomass and presented here in descending order were the diatoms Stephanodiscus niagarae (ISI=19.65), Fragilaria crotonensis (ISI=15.75), centric diatoms (ISI=5.21), pennate diatoms (ISI=4.95), and Asterionella formosa (ISI=1.71); the chrysophyte Dinobryon divergens (ISI=1.70); chlorophytes Ankistrodesmus falcatus (ISI=1.36) and Staurstrum gracile (ISI=0.91) and the dinoflagellate Ceratium hirundinella (ISI=0.10). These seven taxa and two categories comprised about 98% of the sum importance value for all taxa in the reservoir during 1998. 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 1998. The flora was comprised of approximately 92% diatoms, 5% Chlorophyta, 3% Chrysophyta, 1% Pyrrhophyta and 0% Cyanophyta.

Similar to earlier studies, biomass and species richness of Jordanelle Reservoir were quite low for the study period. The complete absence of cyanophytes and the increased dominance of diatoms were noteworthy events of the 1998 collection year. (Rushforth, 1999)

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 for dissolved metals, but the other locations were tested one to six times during 1998. In Table 4.12 below, a summary of the monitoring results is provided.

Table 4. 14 Upper Provo River and Jordanelle Reservoir Dissolved Metals Summary

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													
21-Jan-98	<30.0	<5.0	53.0	<1.0	<5.0	<12.0	46.0	<3.0	<0.2	7.8	<1.0	<2.0	<30.0
19-Aug-98	<30.0	<5.0	48.0	<1.0	<5.0	<12.0	81.7	<3.0	<0.2	8.7	<1.0	<2.0	<30.0
14-Oct-98	<30.0	<5.0	47.0	<1.0	<5.0	<12.0	66.4	<3.0	<0.2	9.5	<1.0	<2.0	<30.0
Storet #499813, Provo River at Hailstone Junction below Weber Provo Canal													
21-Jan-98	<30.0	<5.0	65.0	<1.0	<5.0	<12.0	43.1	<3.0	<0.2	14.0	<1.0	<2.0	<30.0
19-Aug-98	<30.0	<5.0	60.0	<1.0	<5.0	<12.0	146.0	<3.0	<0.2	13.0	<1.0	<2.0	<30.0
14-Oct-98	<30.0	<5.0	53.0	<1.0	<5.0	<12.0	104.0	<3.0	<0.2	11.0	<1.0	<2.0	<30.0
Storet #499804, Ontario Drain Tunnel #2													
29-Jan-98	100	5.4	18.0	<1.0	<5.0	<12.0	<20.0	<3.0	<0.2	120.0	3.7	<2.0	52.0
4-Mar-98	290	11.0	17.0	<1.0	<5.0	<12.0	156.0	3.5	<0.2	100.0	3.1	<2.0	160.0
14-Apr-98	89	5.9	21.0	<1.0	<5.0	<12.0	<20.0	<3.0	<0.2	96.0	2.8	<2.0	35.0
5-Aug-98	164	11.0	20.0	<1.0	<5.0	<12.0	<20.0	<3.0	<0.2	138.0	3.6	<2.0	54.0
7-Oct-98	99	6.9	16.0	<1.0	<5.0	<12.0	<20.0	<3.0	<0.2	110.0	3.5	<2.0	60.0
18-Nov-98	220	11.0	18.0	<1.0	<5.0	<12.0	209.0	<3.0	<0.2	160.0	3.5	<2.0	310.0
Storet #591404, Jordanelle Reservoir - Provo Arm													
20-May-98	<30.0	<5.0	44.0	<1.0	<5.0	<12.0	23.6	<3.0	<0.2	<5.0	<1.0	<2.0	<30.0
20-Oct-98	<30.0	<5.0	43.0	<1.0	<5.0	<12.0	<20.0	<3.0	<0.2	<5.0	<1.0	<2.0	<30.0
Storet #591403, Jordanelle Reservoir - North Arm													
20-May-98	<30.0	<5.0	43.0	<1.0	<5.0	<12.0	31.5	<3.0	<0.2	<5.0	<1.0	<2.0	<30.0
20-Oct-98	<30.0	<5.0	42.0	<1.0	<5.0	<12.0	<20.0	<3.0	<0.2	<5.0	<1.0	<2.0	<30.0
Storet #591401, Jordanelle Reservoir - Above Dam													
20-May-98	<30.0	<5.0	43.0	<1.0	<5.0	<12.0	21.2	<3.0	<0.2	<5.0	<1.0	<2.0	<30.0
11-Aug-98	<30.0	<5.0	42.0	<1.0	<5.0	<12.0	<20.0	<3.0	<0.2	<5.0	<1.0	<2.0	<30.0
3-Sep-98	<30.0	<5.0	42.0	<1.0	<5.0	<12.0	30.9	<3.0	<0.2	13.0	<1.0	<2.0	<30.0
20-Oct-98	<30.0	<5.0	39.0	<1.0	<5.0	<12.0	<20.0	<3.0	<0.2	<5.0	<1.0	<2.0	<30.0

The results of metals testing shows that the Ontario Drain Tunnel #2 had high levels of zinc, two of the samples exceeded the state standard of 120 µg/l for class 3A waters. However, its UPDES permit only limits daily maximum zinc concentrations at 370 µg/l, thus it did not exceed the limit imposed by the permit. Class 3A waters are protected for fish habitat. Although the Drain Tunnel Creek is not a Class 3A body of water, it does discharge into Jordanelle Reservoir that is. The remaining results show that there were no other exceedences for any of the constituents (refer to Table 3.5 for values of allowable concentrations).

MONITORING BY MAYFLOWER RESORT

Mayflower Mountain Resort has been responsible for a monitoring program since 1984. The program has been governed by agreements with Wasatch County since 1985. Mayflower provides analysis of water quality in an annual report to Wasatch County.

The two sites monitored by Mayflower Mountain Resort are both on McHenry Creek. Site A is located at the outlet works of the Utah Department of Transportation (UDOT) and Mayflower Mountain Resort's Detention Basin, located east of U.S. 40. Site 1 is located on the west side of U.S. 40 on McHenry Creek.

The monitoring included weekly water quality sampling at both sites during the spring runoff (May 6 – June 30, 1998). A total of eight samples were taken for each site. The samples were tested for TKN (Total Kjeldahl Nitrogen), Total Phosphate, Ortho Phosphate, TSS (Total Suspended Solids), and pH.

The water quality monitoring results for the 1998 runoff period are listed in the following summary table:

Table 4. 15 Mayflower Monitoring Program Water Quality Summary

	Mayflower Site A			Mayflower Site 1		
	Total	**Peak**	**Minimum**	**Total**	**Peak**	**Minimum**
Runoff	631 ac-ft	6.8 cfs	N/A	498 ac-ft	8.5 cfs	N/A
TKN	330 kg	0.8 mg/l	0.4 mg/l	300 kg	0.8 mg/l	0.4 mg/l
Total P	97 kg	0.65 mg/l	.05 mg/l	80 kg	0.40 mg/l	.06 mg/l
Ortho P	19 kg	0.05 mg/l	.02 mg/l	18 kg	0.04 mg/l	.02 mg/l
TSS	41,414 kg	370 mg/l	6 mg/l	33,532 kg	222 mg/l	9 mg/l

The total phosphate measurements at Mayflower show exceedence of the 0.04 mg/l indicator limit.

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 1998 Runoff Season was completed in August 1998 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 backhoes 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 1998 Runoff Season are summarized below in Table 4.16.

Table 4. 16 Deer Valley Water Quality Monitoring Results for 1998 Runoff Season

	McHenry Basin			Mayflower Basin		
	Total	**Peak**	**Average**	**Total**	**Peak**	**Average**
Runoff	510 ac-ft	7.3 cfs	4.6 cfs	60.5 ac-ft	1.58 cfs	.78 cfs
TKN	314 kg	0.7 mg/l	0.5 mg/l	39 kg	0.8 mg/l	0.52 mg/l
Total P	78.1 kg	0.22 mg/l	0.124 mg/l	5.1 kg	0.17 mg/l	0.068 mg/l
Ortho P	16.4 kg	0.04 mg/l	0.026 mg/l	1.3 kg	0.03 mg/l	0.018 mg/l
TSS	22,347 kg	106 mg/l	35.5 mg/l	336 kg	9 mg/l	4.5 mg/l

Deer Valley also showed phosphorus measurements above the 0.04 mg/l indicator limit.

Middle Provo River through Heber Valley

CHAPTER 5

INTRODUCTION

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

STREAM MONITORING RESULTS

In the area of the Heber Valley Basin, JTAC monitored four stream sampling locations and one point source location during the year of 1998 as follows:

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

Each monitoring location is discussed individually in the sections that follow. A summary table of the water quality monitoring results is presented, which lists maximums, minimums, averages, and number of exceedences for temperature, dissolved oxygen, pH, TSS, ammonia, dissolved phosphorus and total dissolved phosphorus. A more complete analysis of the data is included in 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 Dam, 499733 – Water Quality Summary

Date	*Temp* Deg C	*pH*	*D.O.* mg/l	*T.S.S.* mg/l	*Ammonia N* mg/l	*T. Phos.* mg/l	*D-T Phos.* mg/l
Minimum	1.8	7.8	8.7	0	0	0	0
Maximum	13.8	9.1	12.1	0	0	0.045	0.014
Median	7.4	7.95	10.05	0	0	0	0
Mean	7.4	8.0	10.1	0.0	0.00	0.006	0.001
Number	14	14	14	14	14	14	14
Exceedences	0	1	0	0	0	1	0

Note: Highlighted information exceeds stream water quality standards or guidelines.

The location was monitored fourteen times during 1998. Testing did not detect phosphorus in most of the samples. But, there was one exceedence in TP recorded on June 24th. Since operation of the dam in 1992, this location has had low levels of phosphorus and very few exceedences. None of the samples had detectable concentrations of TSS, which is evidence of sediment settling in the reservoir and is comparable to previous years. Figure 5.1 compares the TP and TSS average concentrations to previous years.

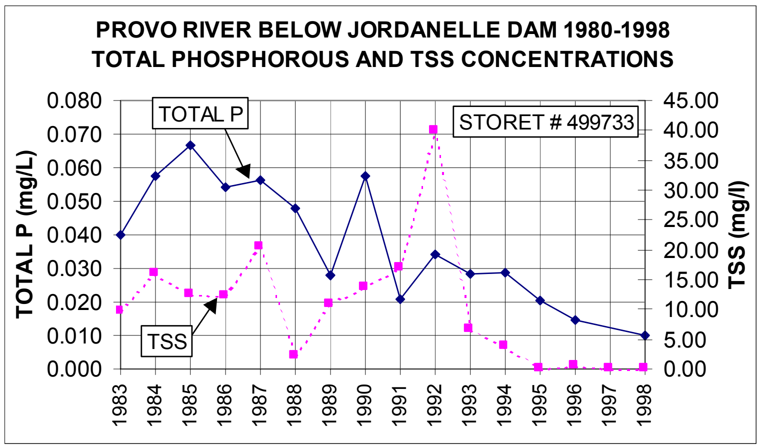


Figure 5. 1 Provo River below Jordanelle TP & TSS Concentrations 1980-1998

The graph illustrates the significant reduction in TP and TSS since operation of Jordanelle Reservoir in 1992. The 1998 TP and TSS concentration levels are the lowest in period of record.

Spring Creek at Entrance to Provo River East of WWTP, STORET #499725

This monitoring site is located on 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 Creek at entrance to Provo River, 499725 – Water Quality Summary

Date	*Temp* Deg C	*pH*	*D.O.* mg/l	*T.S.S.* mg/l	*Ammonia N* mg/l	*T. Phos.* mg/l	*D-T Phos.* mg/l
Minimum	1.7	7.5	7.6	7.6	0	0.042	0.025
Maximum	15.7	8.3	11.6	57.2	0.058	0.121	0.072
Median	8.45	7.95	10.25	18.4	0	0.078	0.052
Mean	8.5	7.9	10.3	23.7	0.006	0.084	0.049
Number	10	10	10	10	10	10	10
Exceedences	0	0	0	2	0	10	7

This location was monitored ten times during 1998. All ten samples exceeded the JTAC pollution indicator value of 0.04 mg/l. There were also two exceedences in TSS. This location has historically contained large phosphorus concentrations. This creek is an area where improvements to water quality are still needed.

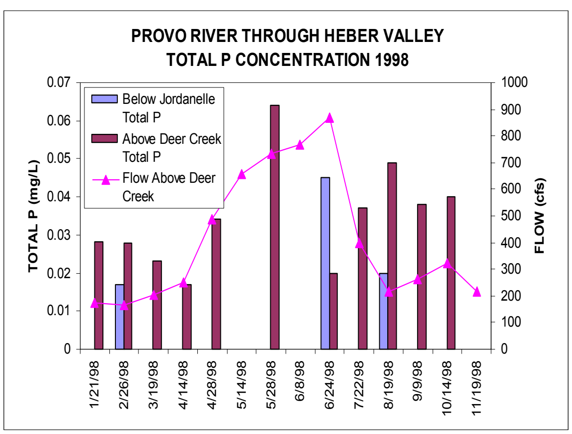
Provo River at McKeller Bridge above Deer Creek, STORET #591363

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. A summary of the water quality data for this location is shown below in Table 5.3.

Table 5. 3 Provo River at McKeller Bridge above Deer Creek, 591363 – Water Quality Summary

Date	*Temp* Deg C	*pH*	*D.O.* mg/l	*T.S.S.* mg/l	*Ammonia N* mg/l	*T. Phos.* mg/l	*D-T Phos.* mg/l
Minimum	1.3	7.7	8.5	0	0	0	0
Maximum	15	8.3	11.8	39.2	0.06	0.064	0.031
Median	9.15	8.05	9.9	5.8	0	0.02815	0.0115
Mean	8.5	8.0	10.1	8.5	0.00	0.027	0.011
Number	14	14	14	14	14	14	14
Exceedences	0	0	0	1	1	3	0

The location was monitored 14 times during 1998. The tested samples had three instances in which phosphorus exceedences were detected. Also, there was an exceedence in ammonia. Normally this location has numerous phosphorus exceedences. There has been a great improvement at this location in comparison to previous years. Figures 5.2 and 5.3, as follows, compare the sample concentrations of TP and TSS at the two locations on the Provo River between Jordanelle and Deer Creek Reservoirs. And Figure 5.4 compares the 1998 average concentration of TSS and TP to historical data.



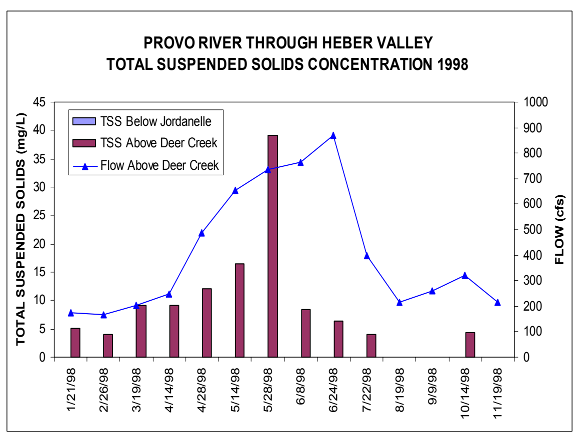


Figure 5. 2 Middle Provo River 1998 TP Concentrations
Figure 5. 3 Middle Provo River 1998 TSS Concentrations

Generally these graphs illustrate the accumulation of TP and TSS as the Provo River winds through the Heber Valley. In Figure 5.2, the TSS gain is very evident since none of the samples taken from below the Jordanelle had detectable levels of TSS. Also, these graphs illustrate the relationship between concentrations and flow. Generally, highest concentrations occur during highest level of flow. The next figure, Figure 5.4 shows the comparison of 1998 to historical data.

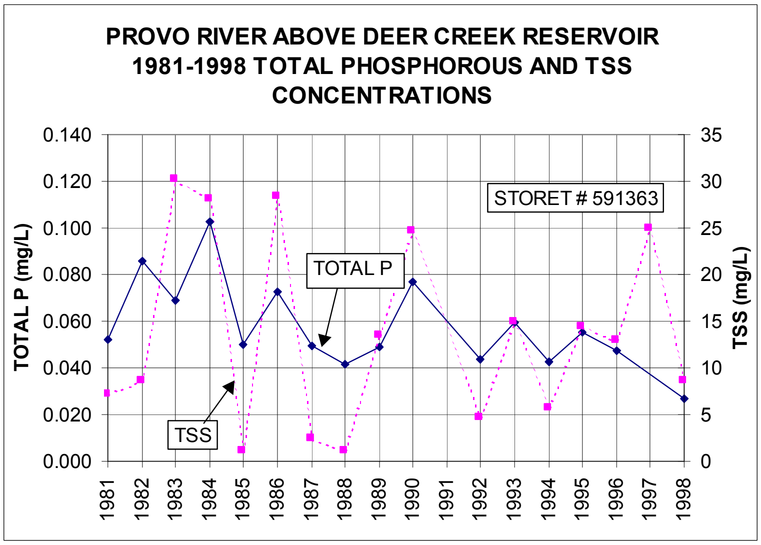


Figure 5. 4 Provo River above Deer Creek TP & TSS Average Conc. 1981-1998

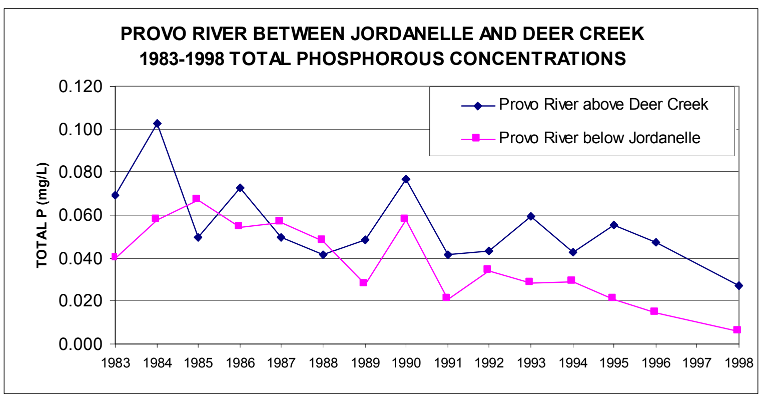


Figure 5. 5 Middle Provo River TP Average Concentrations 1983-1998

Figure 5.5 shows that this year's phosphorus concentrations are lower than ever. It appears again, that the Jordanelle Reservoir has had a great effect at reducing phosphorus concentrations after 1993. Hopefully, the trend that is shown will continue past 1998 to further improve the water quality.

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 by the hatchery in a monthly Discharge Monitoring Report (DMR) indicated that for 1997 the net increase of phosphorus measured was 190 kg. Also in the DMR, the TSS maximum daily loading was 555 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, 499713 – Water Quality Summary

Date	Temp Deg C	pH	D.O. mg/l	T.S.S. mg/l	Ammonia N mg/l	T. Phos. mg/l	D-T Phos. mg/l
Minimum	10.19	7	6.3	0	0	0	0
Maximum	17.37	7.8	10.5	9.6	0.164	0.388	0.022
Median	13.46	7.335	8	0	0.124	0.034	0.0105
Mean	13.1	7.4	8.2	0.5	0.111	0.055	0.011
Number	9	16	9	18	6	18	4
Exceedences	0	0	1	0	4	5	0

This location was sampled 18 times during 1997. TP concentration was measured in each sample but DTP concentration was only measured four times. TP concentrations exceeded the JTAC standard five of the eighteen samples. Also many of the ammonia concentrations exceeded state standards. This year is fairly consistent with historical conditions of the point source.

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

This monitoring site is located on Snake Creek slightly upstream from its confluence with Provo River above Deer Creek Reservoir. Snake Creek winds in a southerly direction through the west side of Heber. The Midway Fish Hatchery discharges into Snake Creek approximately one mile 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, 591016 – Water Quality Summary

Date	Temp Deg C	pH	D.O. mg/l	T.S.S. mg/l	Ammonia N mg/l	T. Phos. mg/l	D-T Phos. mg/l
Minimum	6.8	7.3	7.6	0	0	0	0
Maximum	15.5	8	11	21.2	0.23	0.044	0.031
Median	11.55	7.65	9.55	10	0.055	0.0225	0.005
Mean	11.4	7.6	9.5	9.9	0.05	0.019	0.009
Number	14	14	14	14	14	14	14
Exceedences	0	0	0	0	1	1	0

This location was monitored on 14 occasions during 1998. Only one phosphorus exceedence occurred as well as one ammonia exceedence. The phosphorus concentrations were significantly lower than historical data. Excellent improvements in the phosphorus levels occurred during 1998. Ask Brian for Graphic Here on Historical comparisons of this location.

STREAM LOADING IN THE HEBER VALLEY

The data from stream samples that were collected are used with flow data to calculate river loadings of three important constituents: TSS, TP, DTP. In the Upper Provo River area these loads are calculated in four stream locations: Provo River below Jordanelle, Spring Creek at Provo River, Provo River above Deer Creek, Snake Creek above Deer Creek; and one point source location being the Midway Fish Hatchery Effluent. The spreadsheets of these calculations can be found in Appendix C. Figure 5.6, as follows, graphically as well as geographically illustrates the results of stream loading calculations.

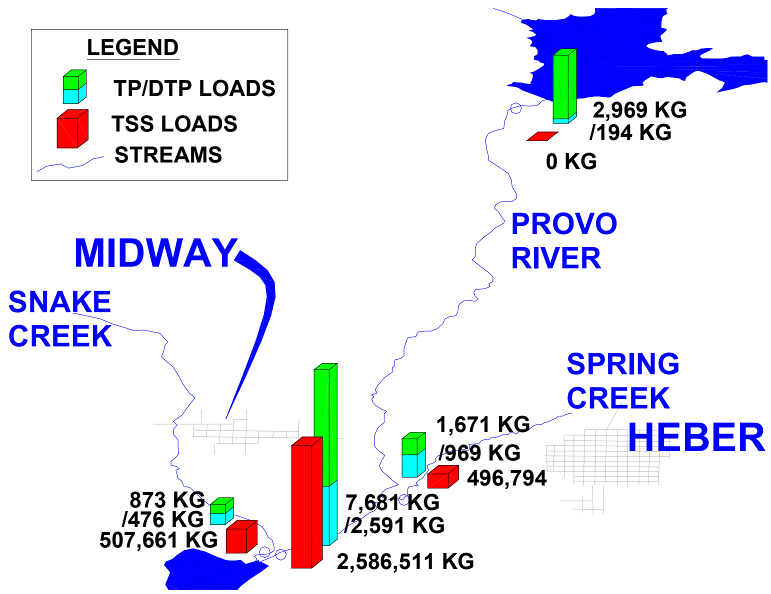


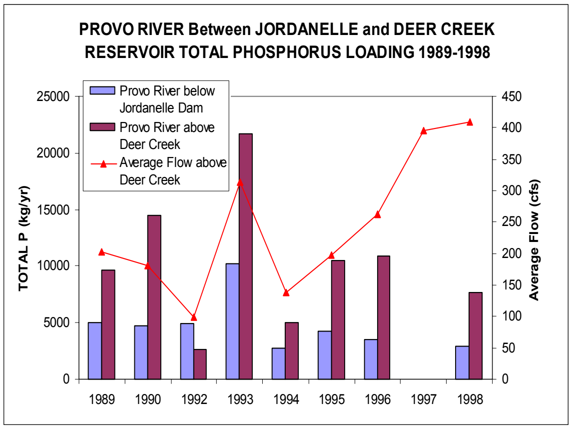
Figure 5. 6 Heber Valley TSS/TP/DTP Loading Overview

As shown in the map, there was some gain in phosphorus along the Provo River through the Heber Valley as TP loading increased by 4,712 kg from below the Jordanelle Reservoir to above the Deer Creek Reservoir. Approximately 35% of this increase can be attributed to Spring Creek, as its TP loading was 1,671 kg in 1998. At the Provo River below Jordanelle none of the samples had detectable levels of TSS hence the loading was calculated to be 0 kg. The comparison of loading to the previous five years is shown in Table 5.6.

Table 5. 6 Heber Valley Stream Loading Summary

	1993	1994	1995	1996	1997	1998
Provo River below Jordanelle, STORET 499733						
Weighted Average Flow (cfs)	317	139	238	270	324	350
TP Weighted Average (mg/l)	0.036	0.022	0.020	0.015	-	0.010
TP Annual Load (kg/yr)	10,271	2,722	4,272	3,496	-	2,969
DTP Weighted Average (mg/l)	-	-	0.021	0.012	-	0.001
DTP Annual Load (kg/yr)	-	-	4,367	2,876	-	194
TSS Weighted Average (mg/l)	11.6	5.2	0.0	0.1	0.0	0.0
TSS Annual Load (kg/yr)	3,286,183	648,241	0	19,957	0	0
Spring Creek at Provo River, STORET 499725						
Weighted Average Flow (cfs)	-	-	-	-	25	35
TP Weighted Average (mg/l)	-	-	-	-	-	0.054
TP Annual Load (kg/yr)	-	-	-	-	-	1,671
DTP Weighted Average (mg/l)	-	-	-	-	-	0.031
DTP Annual Load (kg/yr)	-	-	-	-	-	969
TSS Weighted Average (mg/l)	-	-	-	-	28.3	15.9
TSS Annual Load (kg/yr)	-	-	-	-	634,393	496,794
Provo River above Deer Creek, STORET 591363						
Weighted Average Flow (cfs)	314	138	198	262	303	332
TP Weighted Average (mg/l)	0.077	0.040	0.060	0.047	-	0.026
TP Annual Load (kg/yr)	21,671	4,975	10,472	10,866	-	7,681
DTP Weighted Average (mg/l)	-	-	0.025	0.025	-	0.009
DTP Annual Load (kg/yr)	-	-	4,478	5,773	-	2,591
TSS Weighted Average (mg/l)	24.2	7.7	27.1	11.2	18.6	8.7
TSS Annual Load (kg/yr)	6,778,611	944,936	4,774,856	2,629,371	5,025,665	2,586,511
Midway Fish Hatchery, STORET 499713						
Weighted Average Flow (cfs)	23.5	21.0	18.8	18.3	16.3	18.8
TP Weighted Average (mg/l)	0.059	0.063	0.044	0.050	-	0.035
TP Annual Load (kg/yr)	1,349	1,176	740	820	-	591
DTP Weighted Average (mg/l)	-	-	0.046	0.031	-	0.013
DTP Annual Load (kg/yr)	-	-	769	515	-	213
TSS Weighted Average (mg/l)	0.8	2.5	0.5	1.9	1.1	0.7
TSS Annual Load (kg/yr)	17,615	47,099	8,472	31,398	15,305	11,455
Snake Creek above Deer Creek, STORET 591016						
Weighted Average Flow (cfs)	45	38	50	54	48	57
TP Weighted Average (mg/l)	0.057	0.058	0.061	0.038	-	0.017
TP Annual Load (kg/yr)	2,259	1,934	2,690	1,860	-	873
DTP Weighted Average (mg/l)	-	-	0.029	0.023	-	0.009
DTP Annual Load (kg/yr)	-	-	1,270	1,134	-	476
TSS Weighted Average (mg/l)	5.4	11.0	14.0	8.7	10.1	10.1
TSS Annual Load (kg/yr)	213,742	369,582	616,915	421,925	431,283	507,661
Provo River TP Increase Ratio	2.1	1.8	2.5	3.1	-	2.6

The table shows that the 1998 loadings are generally lower than were the five previous years. The following graphs also illustrate the improvements in loadings.



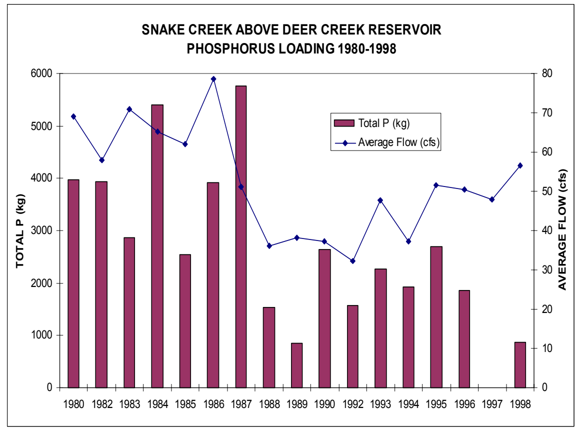


Figure 5. 7 Provo River TP Loadings in the Heber Valley 1989-1998
Figure 5. 8 Snake Creek TP Loading 1980-1998

In Figure 5.7 the 1998 TP loadings in the Provo River are compared to the previous years. A very noteworthy observance is that despite having high flows comparable to 1993, the loadings were substantially decreased. The loadings were not the lowest ever, but considering the relatively higher flow, the water quality improvements are very evident.

In Figure 5.8, Snake Creek historical TP loadings demonstrate that the 1998 loading very near to the lowest in the period of record that occurred in 1989. But 1998 is more noteworthy than 1989 because of the higher flows that occurred yet still maintained a relatively low load.

Comparisons to TMDLs

TMDLs were calculated in the Wasatch County Water Quality Management Plan 1999. In the Heber Valley they were calculated for the Provo River below Jordanelle, Provo River above Deer Creek, and Snake Creek above Deer Creek. Table 5.7 shows the comparisons of 1998 loadings to the annual TMDLs. As shown in the table, none of the 1998 loads exceed the annual TMDLs. Especially notable is Snake Creek, which typically has exceeded the TMDL from historical loading but did not during 1998.

Table 5. 7 Provo River through Heber Valley and Snake Creek TMDLs

Location	TMDL (kg/yr)	1998 Load (kg)
Provo River below Jordanelle	8,685	2,969
Provo River above Deer Creek	8,428	7,681
Snake Creek above Deer Creek	1,747	873

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 Fish Hatchery effluent, but the other locations were tested three to four times during 1998. In Table 5.8 below, a summary of the monitoring results is provided.

Table 5. 8 Heber Valley Dissolved Metals Summary

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													
21-Jan-98	<30.0	<5.0	43.0	<1.0	<5.0	<12.0	25.4	<3.0	<0.2	<5.0	<1.0	<2.0	<30.0
28-May-98	50.0	<5.0	45.0	<1.0	<5.0	<12.0	41.6	<3.0	<0.2	<5.0	<1.0	<2.0	<30.0
19-Aug-98	38.0	<5.0	43.0	<1.0	<5.0	<12.0	40.3	<3.0	<0.2	<5.0	<1.0	<2.0	<30.0
14-Oct-98	<30.0	<5.0	42.0	<1.0	<5.0	<12.0	31.4	<3.0	<0.2	<5.0	<1.0	<2.0	<30.0
Storet #499725, Spring Creek at entrance to Provo River east of WWTP													
21-Jan-98	<30.0	<5.0	170.0	<1.0	<5.0	<12.0	121.0	<3.0	<0.2	160.0	<1.0	<2.0	<30.0
14-Oct-98	<30.0	<5.0	120.0	<1.0	<5.0	<12.0	46.3	<3.0	<0.2	20.0	<1.0	<2.0	<30.0
Storet #591363, Provo River at McKeller Bridge above Deer Creek Reservoir													
21-Jan-98	<30.0	<5.0	65.0	<1.0	<5.0	<12.0	39.5	<3.0	<0.2	21.0	<1.0	<2.0	<30.0
19-Aug-98	<30.0	<5.0	63.0	<1.0	<5.0	<12.0	64.6	<3.0	<0.2	16.0	<1.0	<2.0	<30.0
14-Oct-98	<30.0	<5.0	57.0	<1.0	39.0	<12.0	35.7	<3.0	<0.2	11.0	<1.0	<2.0	<30.0
Storet #591016, Snake Creek above Deer Creek Reservoir at RR crossing													
21-Jan-98	<30.0	14.0	45.0	<1.0	<5.0	<12.0	<20.0	<3.0	<0.2	12.0	1.3	<2.0	<30.0
19-Aug-98	<30.0	21.0	42.0	<1.0	11.0	<12.0	<20.0	<3.0	<0.2	9.0	1.0	<2.0	<30.0
14-Oct-98	<30.0	17.0	40.0	<1.0	7.3	<12.0	31.0	<3.0	<0.2	7.4	1.2	<2.0	<30.0

The results of the testing the samples for dissolved metals show that there was one exceedence of Chromium in the Provo River above Deer Creek. The 39.0 µg/l recorded on October 14^{th} exceeded the state standard 1-hr allowable concentration of 16 µg/l for Class 3A waters. There were not any other exceedences. (Refer to Table 3.5 for values of allowable concentrations).

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. During 1998, JTACs monitoring schedule included cost-share funding for USGS to collect and analyze one sample from each of ten selected existing observation wells in the valley. Figure 5.9 shows the location of each well in the Heber Valley. Also, Table 5.9 shows an abbreviated table of the laboratory results, showing 3 of the 18 constituents measured: TDS, Dissolved Nitrates, and TDP. The entire table can be found in Appendix E.

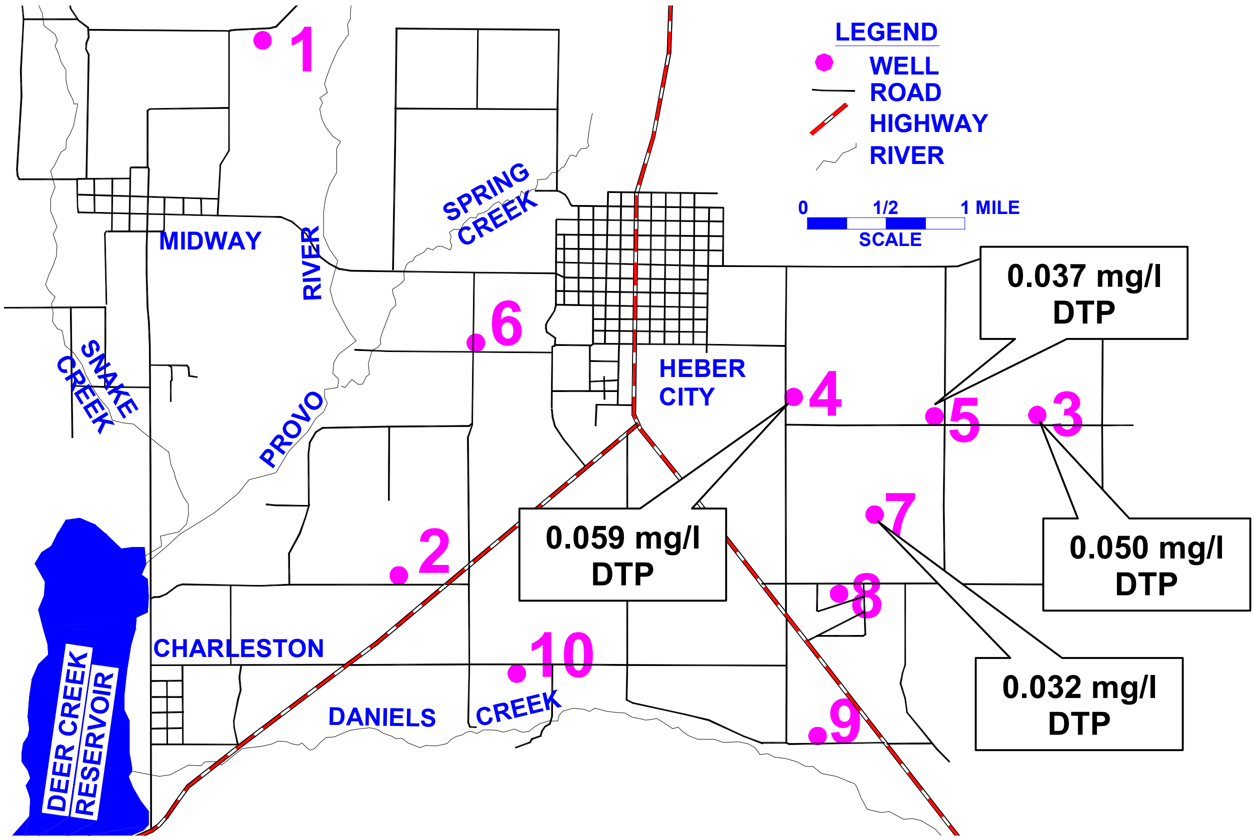


Figure 5. 9 Heber Valley Well Monitoring Program Map

Table 5. 9 1998 Heber Valley Well Monitoring Water Quality Summary

Well	USGS Station Number	Owner	TDS (mg/L)	D_Nitrates (mg/L)	DTP (mg/L)
1	403146111272701	L. Kohler	485	2.60	<0.010
2	402842111263101	HVSSD	233	1.51	<0.010
3	402937111214901	B. Baird	307	5.12	0.050
4	402946111233901	D. Giles	233	2.83	0.059
5	402842111223601	T. McDonald Mair	231	1.77	0.037
6	403003111255801	E. Moulton	237	1.64	<0.010
7	402904111225801	E. Blodgett	277	1.65	0.032
8	402840111232201	R. Wade	367	2.82	<0.010
9	402750111232701	B. Webster	248	0.63	<0.010
10	402813111253701	-	309	2.81	<0.010

The map in Figure 5.9 shows the locations of each well. As shown in Table 5.9, only four of the wells had detectable levels of phosphorus, two of which exceeded the JTAC indicator of 0.04 mg/l. These four wells are specifically indicated in Figure 5.9.

The results are surprising since higher levels of phosphorus were expected. On average, the concentration of phosphorus was 0.018 mg/l. This is much lower than the 0.05 mg/l that was assumed for groundwater phosphorus loading calculations into the Deer Creek

Reservoir, this was based on the 1991 USGS report "Hydrology of Heber and Round Valleys, Wasatch County, Utah with Emphasis on Groundwater".

Even more surprising is that the phosphorus was detected only in wells that are located in the northeastern side of the Heber Valley, more than four miles from the Deer Creek Reservoir. Wells 6, 2 and 10, which are significantly closer to Deer Creek and down gradient from the phosphorus polluted wells, did not detect any phosphorus. This may indicate that estimates of phosphorus loading into Deer Creek Reservoir are significantly overestimated.

Despite the results shown here, in the next chapter, the Deer Creek Reservoir phosphorus loading is calculated still using 0.05 mg/l as the estimated groundwater concentration. This equates to a 2,725 kg/year TP loading. It is necessary to stay consistent with calculations from previous years of phosphorus loading. With only one year of groundwater quality data additional information must be gathered before altering this method. If future groundwater quality monitoring shows that phosphorus loading has indeed been overestimated, then reevaluation of the loading calculation for the period of record may be necessary.

Deer Creek Reservoir Basin

CHAPTER 6

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.

STREAM MONITORING RESULTS

In the basin of the Deer Creek Reservoir, JTAC monitored five stream sampling locations and one point source discharge locations during the year of 1998. The stream monitoring locations are as follows:

	STORET No.	Location Description
•	591002	Lower Charleston Canal above Daniels Creek
•	591352	Daniels Creek below confluence w/ LCC
•	591346	Main Creek at Bridge above Deer Creek
•	591027	Sagebrush-Spring Creek Canal above Daniels Creek

Each stream monitoring location is discussed individually in the sections that follow. A summary table of the water quality monitoring results is presented, which lists maximums, minimums, averages, and number of exceedences for temperature, dissolved oxygen, pH, TSS, ammonia, dissolved phosphorus and total dissolved phosphorus. A more complete analysis of the data analyzing more constituents, however, is included in Appendix A.

Lower Charleston Canal above 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 passes on the west side of the city of Charleston and combines with Daniels Creek just south of Charleston. A significant portion of this water 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 above Daniels Crk, 591002 – Water Quality Summary

Date	Temp Deg C	pH	D.O. mg/l	T.S.S. mg/l	Ammonia N mg/l	T. Phos. mg/l	D-T Phos. mg/l
Minimum	0.2	7.8	11.3	0	0	0.056	0.052
Maximum	7.7	8.4	13.7	110.8	0.053	0.0825	0.064
Median	4.5	8.2	12.9	0	0	0.076	0.054
Mean	4.1	8.1	12.6	36.9	0.018	0.072	0.057
Number	3	3	3	3	3	3	3
Exceedences	0	0	0	1	0	3	3

This creek was sampled three times during 1998, once in January, once in February, and once in March. Each sample exceeded JTAC Phosphorus standards, which is typical because of the high percentage of flows through agricultural lands. Also the TSS concentration in January exceeded the state indicator level.

Daniels Creek 100feet below 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 snowmelt is completed, in Daniels Canyon, much of the water in Daniels Creek originates 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 feet below LCC, 591352 – Water Quality Summary

Date	Temp Deg C	pH	D.O. mg/l	T.S.S. mg/l	Ammonia N mg/l	T. Phos. mg/l	D-T Phos. mg/l
Minimum	3.6	7.7	7.8	0	0	0.029	0
Maximum	16.3	8.6	11.6	65.6	0.633	0.115	0.087
Median	10.2	8.1	9.6	13.6	0	0.066	0.033
Mean	10.2	8.1	9.6	27.7	0.064	0.069	0.037
Number	11	11	11	11	11	11	11
Exceedences	0	0	0	4	1	9	3

Daniels Creek was sampled eleven times in 1998. In eight of the samples, high levels of phosphorus concentrations were detected. In comparison to historical data, the TP concentrations were actually slightly lower than previous years indicating that some progress in water quality improvement has been made. These improvements, however, still do not meet the goals set by JTAC. Additionally, TSS standards were exceeded on four occasions.

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 at Bridge on US 189 above Deer Creek, 591346 – Water Quality Summary

Date	Temp Deg C	pH	D.O. mg/l	T.S.S. mg/l	Ammonia N mg/l	T. Phos. mg/l	D-T Phos. mg/l
Minimum	2	7.8	8.1	0	0	0	0
Maximum	18	8.2	14.9	96.9	0.08	0.149	0.104
Median	8.8	8	10.25	24	0	0.0565	0.027
Mean	9.5	8.0	10.3	32.8	0.011	0.061	0.034
Number	14	14	14	14	14	14	14
Exceedences	0	0	0	5	0	8	3

Main Creek was sampled fourteen times during 1998. Slightly more than half, eight of the fourteen samples, exceeded the JTAC phosphorus standards. Main Creek along with Daniels Creek, although slightly lower than previous years, continue to be unable to meet JTAC standards for phosphorus. Increased management efforts in these sub-watersheds may be necessary to control problems.

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 from of the headwaters of 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 above Daniels Creek, 591027 – Water Quality Summary

Date	Temp Deg C	pH	D.O. mg/l	T.S.S. mg/l	Ammonia N mg/l	T. Phos. mg/l	D-T Phos. mg/l
26-Feb-98	0.5	7.8	11.6	28.4	0.053	0.134	0.09
Exceedences	0	0	0	0	0	1	1

This canal was only sampled one time in February during 1998. As shown in the previous table, this sample was high in phosphorus concentrations, appearing to contribute to the high phosphorus concentrations in Daniels Creek.

STREAM LOADINGS INTO DEER CREEK RESERVOIR

The data from stream samples that were collected are used with flow data to calculate river loadings of three important constituents: TSS, TP, DTP. For the streams of focus in this chapter these loads are calculated for two stream locations: Daniels Creek above Deer Creek and Main Creek above Deer Creek. Two other important stream loadings, which were previously discussed in Chapter 5, are also included here so as to enable discussion of the entire 1998 loadings into the Deer Creek Reservoir. The spreadsheets of these calculations can be found in Appendix C. Figure 6.1, as follows, illustrates the calculation results.

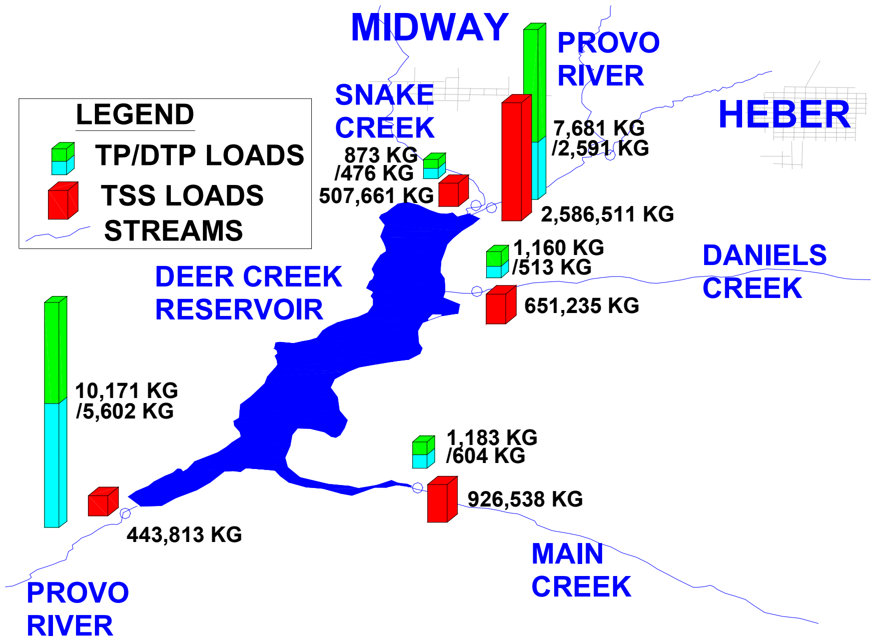
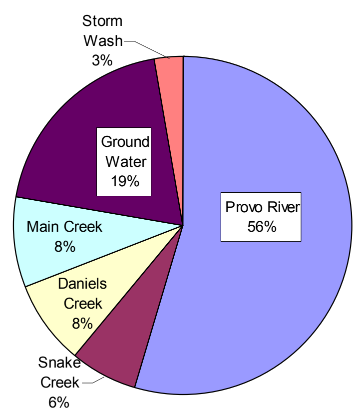


Figure 6. 1 Deer Creek Reservoir TSS/TP/DTP Loading Overview

Table 6. 5 Deer Creek Reservoir TP Loading Summary

Input Source	TMDL kg/yr TP	1998 Load kg/yr TP	% of total
Provo River	8,428	7,681	55%
Snake Creek	1,747	873	6%
Daniels Creek	488	1,160	8%
Main Creek	916	1,183	8%
Groundwater	n/a	2,725*	19%
Storm Flush	n/a	400**	3%
Total Input		**14,022**	



* Based on 61 cfs inflow of groundwater at 0.05mg/l-USGS report "Hydrology of Heber and Round Valleys, Wasatch County, Utah, with Emphasis on Groundwater"
** Based on an average calculated value of Storm Flush from previous implementation reports which ranged from 250 to 550 kg.yr

The loading that occurred in 1998 was lower than were those in previous years. Table 6.5 shows how these TP loads compare to TMDLs (Total Maximum Daily Loads) set by the 1999 Wasatch County Water Quality Management Plan. The TMDLs demonstrate the improvements that have been achieved in Provo River and Snake Creek, which had loadings significantly less than the TMDLs. Daniels Creek and Main Creek, however, did not meet their respective TMDL. Daniels Creek more than doubled its TMDL. And Main Creek exceeded its TMDL by 267 kg. The following figure shows the distribution of phosphorus loading per month.

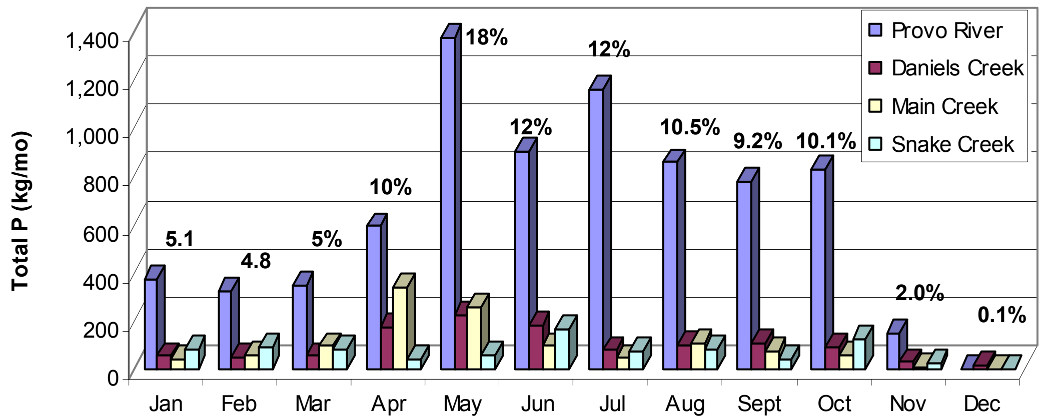


Figure 6. 2 Monthly Distribution of 1998 TP Loading

The majority of phosphorus loading occurred during the spring runoff months April, May, June which accounted for 40% of the total loading for the year. The Provo River above Deer Creek peak monthly load occurred in May with 1373 kg/mo. This load, however did not surpass the monthly TMDL of 2143 kg/mo, but the location did surpass monthly TMDLs during July, August, September and October for which the TMDLs were respectively 433, 334, 323, and 334 kg/mo. Snake Creek did not surpass the monthly TMDLs for any month, while in contrast, Daniels Creek exceeded the monthly TMDL in each month during 1998. Main Creek exceeded the monthly TMDL for seven of the twelve months, April through October.

Table 6.6 that follows compares the 1998 loading in Deer Creek to the previous five years. The table illustrates the loading improvements that occurred in 1998. Each of the four streams show TP loadings that are lower than the previous years.

Table 6. 6 Deer Creek Reservoir Stream Loadings 1993-1998

	1993	1994	1995	1996	1997	1998
Provo River above Deer Creek, STORET 591363						
Weighted Average Flow (cfs)	314	138	198	262	303	332
TP Weighted Average (mg/l)	0.077	0.040	0.060	0.047	-	0.026
TP Annual Load (kg/yr)	21,671	4,975	10,472	10,866	-	7,681
DTP Weighted Average (mg/l)	-	-	0.025	0.025	-	0.009
DTP Annual Load (kg/yr)	-	-	4,478	5,773	-	2,591
TSS Weighted Average (mg/l)	24.2	7.7	27.1	11.2	18.6	8.7
TSS Annual Load (kg/yr)	6,778,611	944,936	4,774,856	2,629,371	5,025,665	2,586,511
Snake Creek above Deer Creek, STORET 591016						
Weighted Average Flow (cfs)	45	38	50	54	48	57
TP Weighted Average (mg/l)	0.057	0.058	0.061	0.038	-	0.017
TP Annual Load (kg/yr)	2,259	1,934	2,690	1,860	-	873
DTP Weighted Average (mg/l)	-	-	0.029	0.023	-	0.009
DTP Annual Load (kg/yr)	-	-	1,270	1,134	-	476
TSS Weighted Average (mg/l)	5.4	11.0	14.0	8.7	10.1	10.1
TSS Annual Load (kg/yr)	213,742	369,582	616,915	421,925	431,283	507,661
Daniels Creek above Deer Creek, STORET 591352						
Weighted Average Flow (cfs)	24	8	18	14	22	19
TP Weighted Average (mg/l)	0.300	0.104	0.103	0.082	-	0.067
TP Annual Load (kg/yr)	6,517	702	1,645	1,047	-	1,160
DTP Weighted Average (mg/l)	-	-	0.046	0.049	-	0.030
DTP Annual Load (kg/yr)	-	-	732	625	-	513
TSS Weighted Average (mg/l)	241.7	36.4	86.7	62.9	90.3	37.8
TSS Annual Load (kg/yr)	5,257,412	247,102	1,390,923	801,933	1,801,933	651,235
Main Creek above Deer Creek, STORET 591346						
Weighted Average Flow (cfs)	23	11	28	65	30	23
TP Weighted Average (mg/l)	0.128	0.046	0.137	0.125	-	0.058
TP Annual Load (kg/yr)	2,570	437	3,452	7,154	-	1,183
DTP Weighted Average (mg/l)	-	-	0.038	0.099	-	0.030
DTP Annual Load (kg/yr)	-	-	964	5,669	-	605
TSS Weighted Average (mg/l)	106.1	25.7	108.7	19.9	139.5	45.4
TSS Annual Load (kg/yr)	2,136,137	243,025	2,750,898	1,146,639	3,727,492	926,538

DEER CREEK RESERVOIR MONITORING

On the Deer Creek Reservoir, JTAC monitored four locations during the year of 1998. Reservoir monitoring included samples taken at various depths in each location as well as profiles of physical characteristics at multiple depths to generate a profile of the water characteristics, the most important characteristic being dissolved oxygen (DO). The four monitoring locations listed are as follows:

STORET No.	Location Description
• 591324	Deer Creek Reservoir – Upper End
• 591323	Deer Creek Reservoir – Midlake
• 591345	Deer Creek Reservoir – Wallsburg Bay
• 591322	Deer Creek Reservoir – Above Dam

Each location is discussed individually in the sections that follow. A summary table of the water quality monitoring results is presented, which lists maximums, minimums, averages, and number of exceedences for temperature, dissolved oxygen, pH, TSS, ammonia, dissolved phosphorus and total dissolved phosphorus.

Upper End, STORET #591324

The north end of Deer Creek Reservoir near the inlet of the Provo River and Snake Creek is relatively shallow with an approximate depth of 8 meters. 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 6.7.

Table 6. 7 Deer Creek Reservoir Upper End, 591324 – Water Quality Summary

Date	Temp Deg C	pH	D.O. mg/l	T.S.S. mg/l	Ammonia N mg/l	T. Phos. mg/l	D-T Phos. mg/l
Minimum	7	7.4	5.9	0	0	0	0
Maximum	24.3	8.4	11.3	4.8	0.09	0.062	0.023
Median	13	7.95	8.1	0	0	0.0085	0.000
Mean	13.3	7.9	8.2	1.2	0.008	0.014	0.006
Number	18	18	18	18	18	18	16
Exceedences	3	0	0	0	1	2	0

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 6.8.

Table 6. 8 Deer Creek Reservoir Midlake, 591323 – Water Quality Summary

Date	Temp Deg C	pH	D.O. mg/l	T.S.S. mg/l	Ammonia N mg/l	T. Phos. mg/l	D-T Phos. mg/l
Minimum	5.4	7.1	1.1	0	0	0	0
Maximum	22.8	8.4	11.5	9.6	0.12	0.04	0.031
Median	13	7.9	7.55	0	0.000	0.000	0.000
Mean	13.1	7.8	7.1	0.5	0.011	0.012	0.006
Number	28	28	28	28	28	28	24
Exceedences	3	0	1	0	2	6	2

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 6.9.

Table 6. 9 Deer Creek Reservoir Wallsburg Bay, 591323 – Water Quality Summary

Date	Temp Deg C	pH	D.O. mg/l	T.S.S. mg/l	Ammonia N mg/l	T. Phos. mg/l	D-T Phos. mg/l
Minimum	7.4	7.9	7				
Maximum	23.3	8.4	10.3				
Median	14	8	8.5				
Mean	15.7	8.1	8.5				
Number	8	8	8				
Exceedences	2	0	0				

Above 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 6.10.

Table 6. 10 Deer Creek Reservoir above Dam, 591323 – Water Quality Summary

Date	Temp Deg C	pH	D.O. mg/l	T.S.S. mg/l	Ammonia N mg/l	T. Phos. mg/l	D-T Phos. mg/l
Minimum	4.1	6.9	0.1	0	0	0	0
Maximum	21.9	8.3	11.3	18.4	0.15	0.1	0.062
Median	12	7.9	7	0	0.00	0.019	0.000
Mean	12.3	7.8	6.6	1.7	0.02	0.020	0.009
Number	29	29	29	29	29	29	27
Exceedences	3	0	3	0	5	9	4

Deer Creek Reservoir DO Analysis

At the 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. Graphs of these profiles, located in Appendix F, 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 and the depth at which dissolved oxygen levels decrease. If anoxic conditions exist in the reservoir, it will be apparent in the generated profiles.

During 1998, Profile data was gathered 7-9 times at the four monitoring locations. They were gathered between months of March and December. Figure 6.3 below tracks the DO concentration throughout 1998 at the lowest depth of each profile.

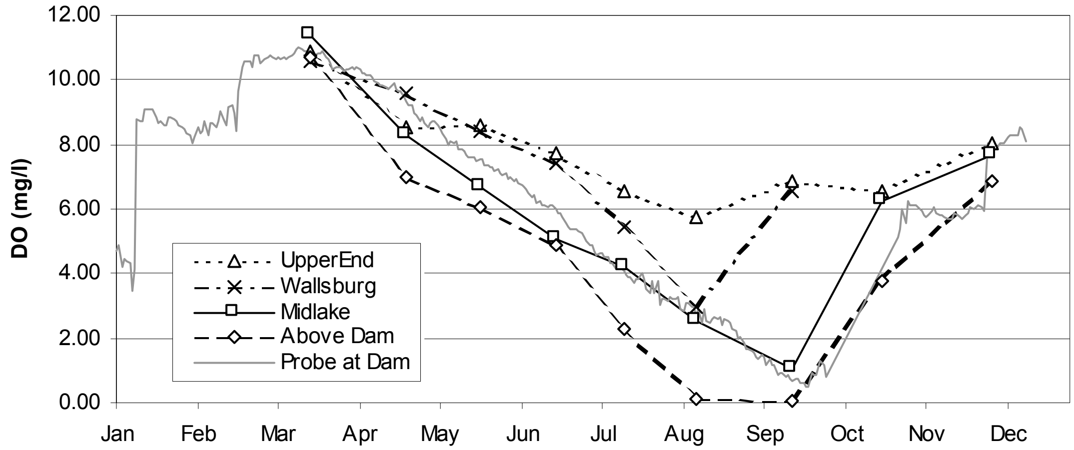


Figure 6. 3 Deer Creek Reservoir 1998 DO Concentrations at Bottom Depth

The figure shows how the reservoir goes through annual cycle of stratification. 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. Presentation of the profiles in a calander year shows the complete cycle of mixed to stratified back to mixed.

Heavy stratification occurred during August through September and DO levels dropped to nearly zero as anoxic conditions prevailed. Mostly, these problems occurred only in the deeper locations of the reservoir (Midlake and Above Dam) while the other locations showed only minor evidences of stratification. The relationship of the DO levels to TP concentration in the reservoir is shown in Figure 6.4.

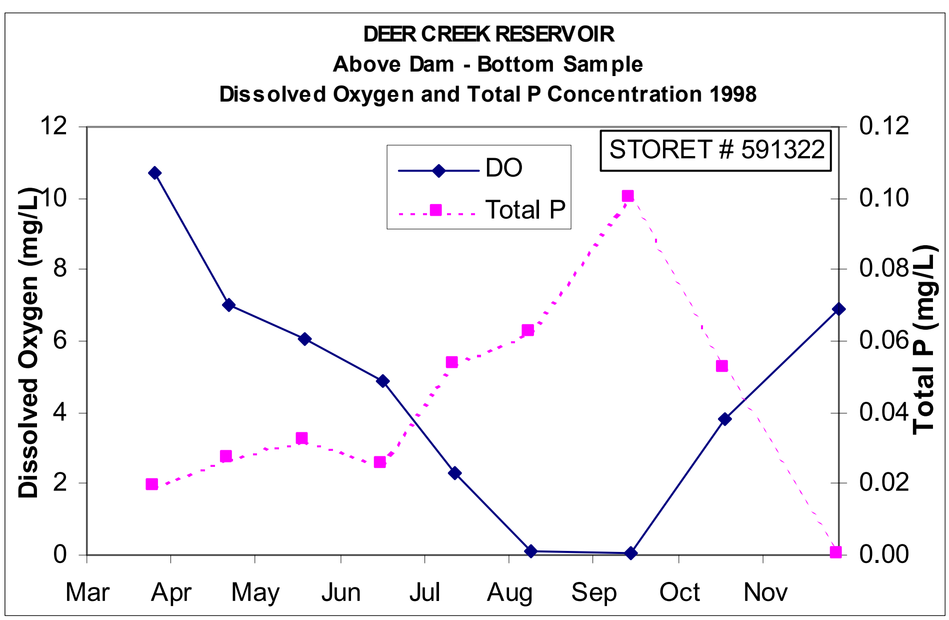


Figure 6. 4 Deer Creek Reservoir 1998 DO & TP Concentration above Dam

In Figure 6.5 the stagnation index shows the extent of anoxic conditions during the summer months from 1986 to present.

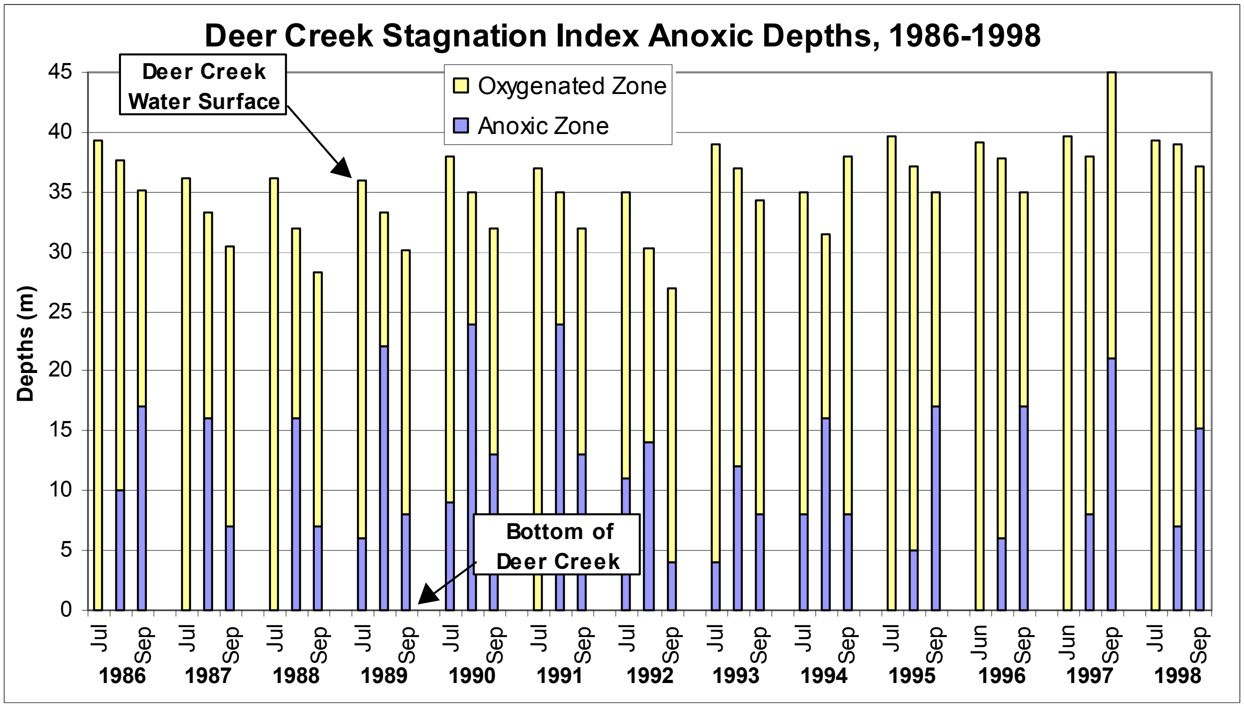


Figure 6. 5 Deer Creek Stagnation Index of Anoxic Depths, 1986-1998

Despite the encouraging results of decreasing phosphorus and algae levels in Deer Creek Reservoir, low DO concentrations are still an ongoing problem that has not yet been corrected. As shown in Figure 6.5 some improvements have been achieved in the last few years in comparison to stagnation levels from 1989-1991, especially for the earlier summer months July and August. September stagnation levels, however, have not improved.

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 6.5 below shows the data recorded from March of 1992 to December 1998. The graph shows the annual cycles in the reservoir with respect to temperature, dissolved oxygen and pH. 1998 shows no significant changes in these parameters as compared with previous years.

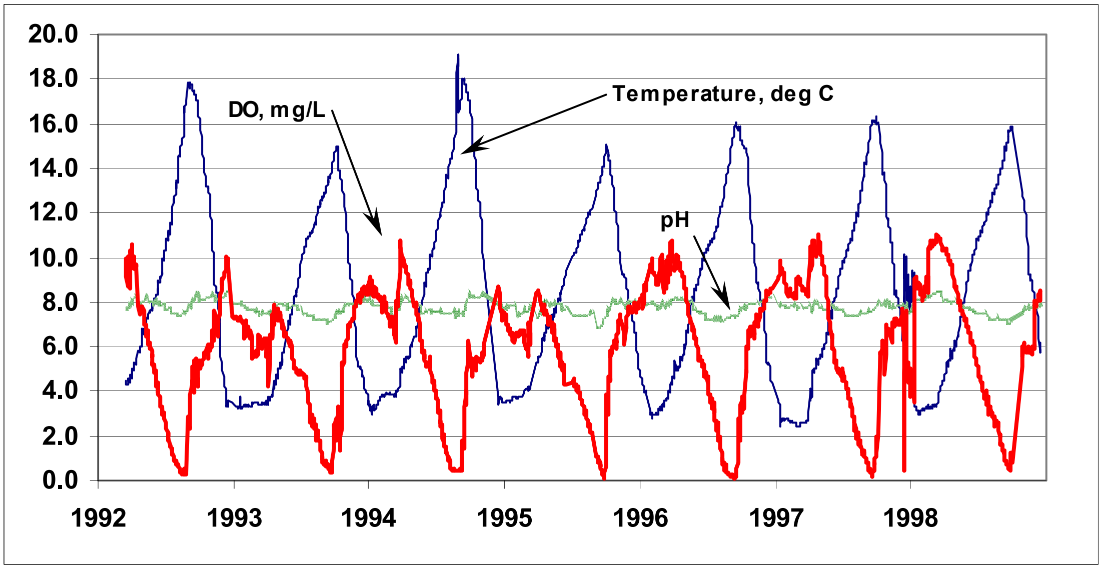


Figure 6. 6 Deer Creek Dam Monitoring Probe Measurements 1992 - 1998

PHYTOPLANKTON FLORAS FROM DEER CREEK

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):

> The algal plankton flora of Deer Creek Reservoir, Wasatch County, Utah was studied through the 1998 calendar year. Quantitative net plankton and total plankton samples were examined. A total of 51 taxa was identified in the plankton flora. In addition, the two common categories, centric diatoms and pennate diatoms, each contained many additional taxa.
>
> Diatoms continued to dominate the algal flora of the Deer Creek Reservoir during 1998. The most important plankters as determined by calculating Important Species Indices (ISIs) from all Deer creek Reservoir combined net and total plankton samples collected during 1998 in descending order were **Fragilaria crotonensis** (ISI = 16.11), **Stephanodiscus niagarae** (ISI = 10.16), the category pennate diatoms (ISI = 5.83); the green algae **Sphaerocystis schroeteri** (ISI2.88) and **Cosmarium** species (ISI = 1.22); and the cyanophyte **Aphanizomenon flos-aquae** (ISI = 4.06) (Table 2). These taxa (and the category pennate diatoms) all had ISIs greater than or equal to 1.0. These five taxa and one category comprised about 91% of the phytoplankton flors (as determined by summing importance values) of Deer Creek Reservoir for the 1998 year. This measurement is an assessment of algal standing crop and distribution through the year as reflected in our samples.
>
> The three top three plankters in the reservoir were diatoms and comprised fully 70% of sum ISIs of all plankton in the reservoir for 1998. When ISIs for all

diatoms in Deer Creek for 1998 are summed, they comprise about 75% of the flora.

During 1998, green algae comprised about 13% of the Deer Creek flora. This is a substantial drop from the previous year when more that 30% of the flora was comprised of chlorophyta.

DEER CREEK 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. A TSI value can be calculated individually from each of these parameters. In this report, we have taken an average of the TSIs calculated from each. Table 6.11 shows the calculation results for Deer Creek Reservoir. And Figure 6.6 compares the calculated TSI value to historical values that have been calculated since 1981.

Table 6. 11 Carlson Trophic State Index (TSI) calculation for Deer Creek Reservoir

Sample Date	Upper End Transp. m	Upper End Chlor-A µg/l	Upper End TP mg/l	Midlake Transp. m	Midlake Chlor-A µg/l	Midlake TP mg/l	Above Dam Transp. m	Above Dam Chlor-A µg/l	Above Dam TP mg/l
20-May-98	3.4	2.9	0	4	3.8	0	3.7	3.8	0
18-Jun-98	2.7	5.1	0.032	4.3	3.3	0	4.2	5.2	0
14-Jul-98	2.9	6.3	0	3.4	4	0	3.6	4.7	0.02
11-Aug-98	2.8	7.5	0	3.8	4.3	0	3.7	3.8	0
17-Sep-98	3	9.4	0.021	4	4.1	0	3.9	3.6	0
Average	3.0	6.2	0.011	3.9	3.9	0.000	3.8	4.2	0.004
TSI	**44.4**	**48.6**	**38.2**	**40.4**	**44.0**	**N/A**	**40.7**	**44.7**	**24.1**
TSI Average		**43.7**			**42.2**			**36.5**	

Average TSI for Reservoir → 40.8

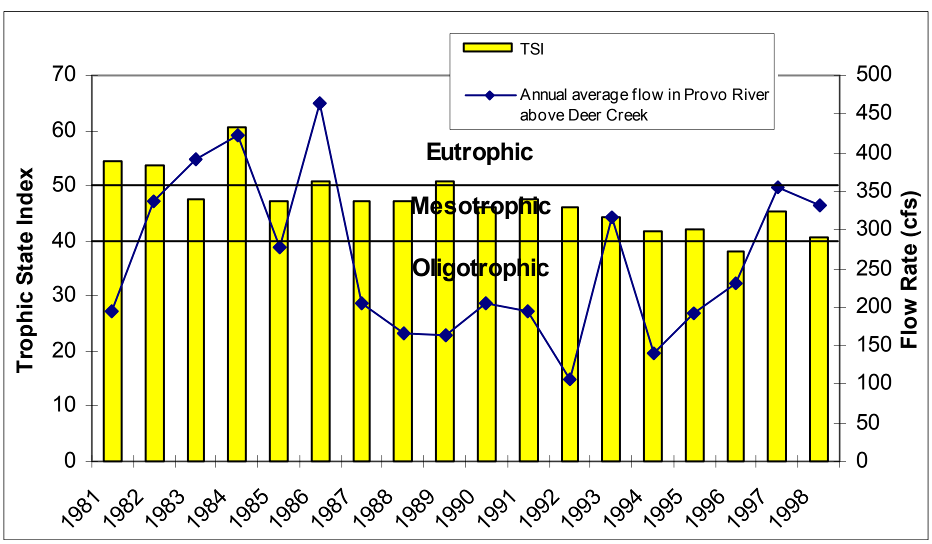


Figure 6. 7 Deer Creek Reservoir TSI and Provo River Average Flow 1981-1998

The TSI was calculated to 40.8, which classifies the reservoir as mesotrophic indicating a healthy balance of nutrients. The TSI is almost the lowest calculated TSI for the period of record and is very close to an oligotrophic state (lack of nutrients). This figure is excellent evidence of improvements made to water quality in Deer Creek Reservoir, but as evidenced by DO data, there is still a need for additional improvements.

DISSOLVED METAL 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 1998. Very few dissolved metals were detectable and the ones that were detected occurred in very small concentrations. There were no exceedences of the standards outlined in Table 3.5. The following table, Table 6.12, summarizers the results of the monitoring.

Table 6. 12 Deer Creek Reservoir Dissolved Metals Summary

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													
20-May-98	<30.0	<5.0	63.0	<1.0	<5.0	<12.0	31.5	<3.0	<0.2	8.3	<1.0	<2.0	<30.0
11-Aug-98	<30.0	<5.0	75.0	<1.0	<5.0	<12.0	28.6	<3.0	<0.2	<5.0	<1.0	<2.0	<30.0
21-Oct-98	<30.0	<5.0	71.0	<1.0	<5.0	<12.0	<20.0	<3.0	<0.2	5.8	<1.0	<2.0	<30.0
Storet #591323, Deer Creek Reservoir at Midlake													
20-May-98	<30.0	<5.0	66.0	<1.0	<5.0	<12.0	23.6	<3.0	<0.2	5.3	<1.0	<2.0	<30.0
21-Oct-98	<30.0	<5.0	71.0	<1.0	<5.0	<12.0	<20.0	<3.0	<0.2	<5.0	<1.0	<2.0	<30.0
Storet #591322, Deer Creek Reservoir above the dam													
20-May-98	<30.0	<5.0	72.0	<1.0	<5.0	<12.0	28.1	<3.0	<0.2	20.0	<1.0	<2.0	<30.0
11-Aug-98	<30.0	<5.0	60.0	<1.0	<5.0	<12.0	<20.0	<3.0	<0.2	39.0	<1.0	<2.0	<30.0
21-Oct-98	<30.0	<5.0	74.0	<1.0	<5.0	<12.0	<20.0	<3.0	<0.2	54.0	<1.0	<2.0	<30.0
Storet #591002, Lower Charleston Canal above confluence with Daniels Creek													
21-Jan-98	<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													
19-Aug-98	<30.0	<5.0	140.0	<1.0	5.4	<12.0	57.1	<3.0	<0.2	11.0	<1.0	<2.0	<30.0
14-Oct-98	<30.0	<5.0	110.0	<1.0	<5.0	<12.0	25.1	<3.0	<0.2	<5.0	<1.0	<2.0	<30.0
Storet #591346, Main Creek at bridge on US 189 above reservoir													
21-Jan-98	<30.0	<5.0	100.0	<1.0	<5.0	<12.0	22.5	<3.0	<0.2	50.0	<1.0	<2.0	<30.0
19-Aug-98	<30.0	<5.0	130.0	<1.0	11.0	<12.0	53.6	<3.0	<0.2	42.0	<1.0	<2.0	<30.0
14-Oct-98	<30.0	<5.0	110.0	<1.0	6.5	<12.0	22.3	<3.0	<0.2	34.0	<1.0	<2.0	<30.0

Lower Provo River below Deer Creek Reservoir

CHAPTER 7

INTRODUCTION

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

STREAM MONITORING RESULTS

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
• 499678	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.S.S.* mg/l	*Ammonia N* mg/l	*T. Phos.* mg/l	*D-T Phos.* mg/l
Minimum	2.6	7.4	4.9	0	0	0	0
Maximum	14.6	8.3	11.7	9.2	0.08	0.056	0.038
Median	8.9	8	9	0	0	0.0221	0.013
Mean	9.3	8.0	8.7	1.0	0.03	0.023	0.014
Number	17	17	17	14	14	14	14
Exceedences	0	0	2	0	0	2	0

The location was sampled on seventeen occasions during 1998. The location showed only two exceedences in total phosphorus. Historically this location has had three or four exceedences of phosphorus each year. The TSS concentrations are comparable to past years. Also, there were two exceedences in DO concentration, which is one more exceedences for this location than last year. Figure 7.1 compares the total phosphorus and total suspended solids concentrations to previous years.

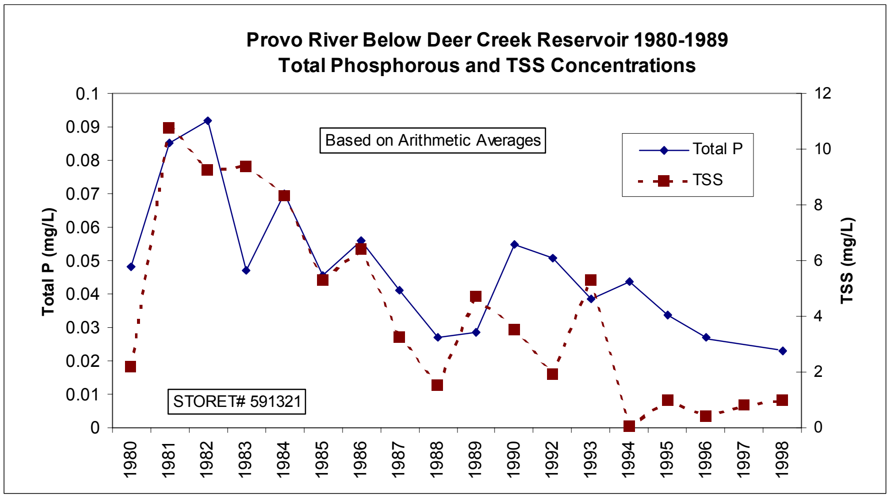


Figure 7. 1 Provo River Below Deer Creek Reservoir, TP & TSS Concentrations 1980-1998

The graph illustrates the significant reduction in total phosphorus below the Deer Creek Reservoir. The TSS has increased in concentration compared to the previous four years but is still a great improvement compared to the 1980's.

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.S.S.* mg/l	*Ammonia N* mg/l	*T. Phos.* mg/l	*D-T Phos.* mg/l
Minimum	2.4	8.3	8.4	0	0	0	0
Maximum	13	8.5	11.2	65.2	0	0.092	0.058
Median	8.9	8.4	8.9	9.6	0	0.021	0.015
Mean	8.6	8.4	9.5	16.2	0.00	0.027	0.014
Number	11	11	11	11	11	11	11
Exceedences	0	0	0	1	0	4	1

This location was monitored on eleven occasions during 1998. Four out of the eleven samples taken at this location had levels of total phosphorous 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 and had only one exceedence. 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 area 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.S.S.* mg/l	*Ammonia N* mg/l	*T. Phos.* mg/l	*D-T Phos.* mg/l
Minimum	1.5	8.2	8.9	0	0	0	0
Maximum	11	8.5	12	14.8	0	0.028	0.015
Median	8.3	8.3	9.8	0	0	0	0
Mean	7.1	8.3	10.1	4.9	0.00	0.004	0.001
Number	11	11	11	11	11	11	11
Exceedences	0	0	0	0	0	0	0

This location was monitored eleven times during 1998. This location indicated no exceedences of phosphorus. Historically, this area has rarely had occasions of phosphorus exceedences. The TSS concentrations improved drastically this year compared to last year's monitoring.

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.S.S.* mg/l	*Ammonia N* mg/l	*T. Phos.* mg/l	*D-T Phos.* mg/l
Minimum	2.9	8.1	8.4	0	0	0	0
Maximum	11.7	8.3	11.3	24	0	0.043	0.032
Median	8.8	8.2	9.5	9.2	0	0	0
Mean	8.4	8.2	9.7	10.1	0.00	0.013	0.010
Number	11	11	11	11	11	11	11
Exceedences	0	0	0	0	0	1	0

This location was monitored eleven times during 1998. This location's water monitoring was of high quality with only total phosphorous registering one exceedence. 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 1998.

Provo River at Olmsted Diversion, STORET #499681

The 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.S.S. mg/l	Ammonia N mg/l	T. Phos. mg/l	D-T Phos. mg/l
Minimum	2.2	7.8	7.5	0	0	0	0
Maximum	14.6	8.4	11.8	10.4	0.05	0.051	0.03
Median	11.7	8.2	9.6	0	0	0.025	0.022
Mean	9.8	8.1	9.8	2.7	0.00	0.026	0.019
Number	13	13	13	11	11	11	11
Exceedences	0	0	0	0	0	3	1

This site was monitored eleven times for TSS, ammonia N, total phosphorous and dissolved total phosphorous. Three exceedences of total phosphorous were registered in 1998. Historically, this location on the Provo River has shown to have approximately half of its phosphorous measurements in exceedence. The TSS concentrations for this site are consistent with past years. There were no other exceedences at this location.

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.S.S. mg/l	Ammonia N mg/l	T. Phos. mg/l	D-T Phos. mg/l
Minimum	2.1	8.1	8.4	0	0	0	0
Maximum	14.6	8.5	10.7	30.4	0.07	0.043	0.032
Median	11.8	8.3	9.1	4.8	0	0.027	0
Mean	9.8	8.3	9.2	7.3	0.01	0.027	0.011
Number	11	7	7	7	7	7	7
Exceedences	0	0	0	0	0	1	0

This location was monitored seven occasions during 1998. Total phosphorous was in exceedence of JTAC standards one time. Historically this site has one or two exceedences each year. TSS concentrations were at levels comparable to past years. There were no other exceedences in the year.

Figures 7.2 & 7.3 compares the total phosphorus concentration and the TSS concentration at below Deer Creek, Olmstead, and Murdock. Great improvement in both the phosphorus and TSS are indicated in the three locations. Figure 7.2 indicates that the three locations maintained phosphorus concentrations below JTAC standard for most of the time, except for three months.

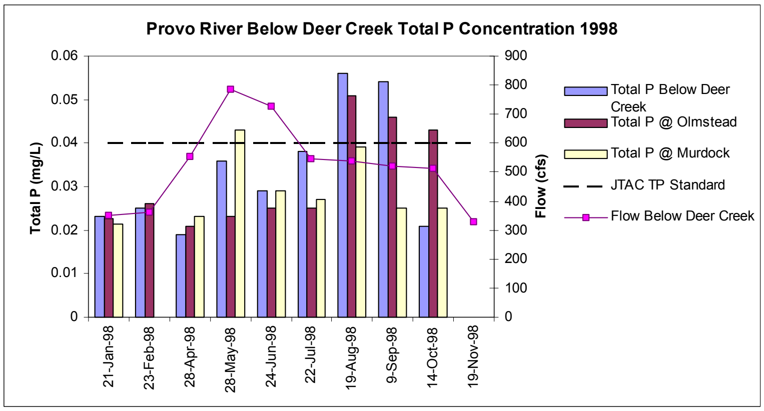


Figure 7. 2 Below Deer Creek, 1998 Total Phosphorus Concentrations

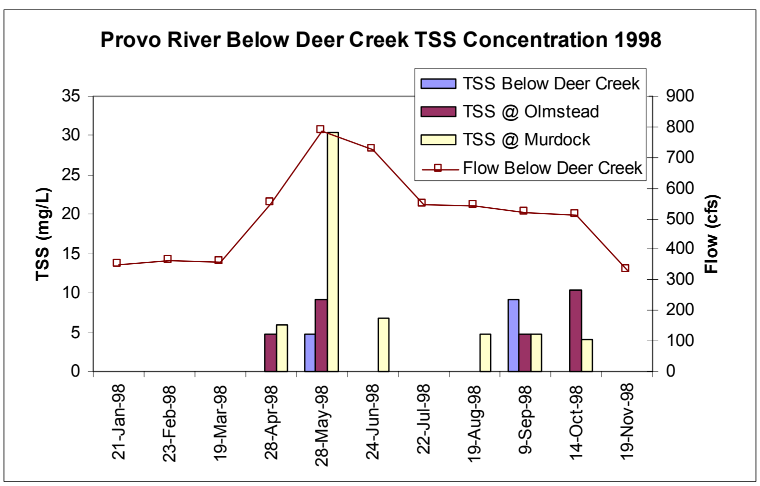


Figure 7. 3 Below Deer Creek TSS Concentration 1998

LOADINGS IN THE LOWER PROVO RIVER

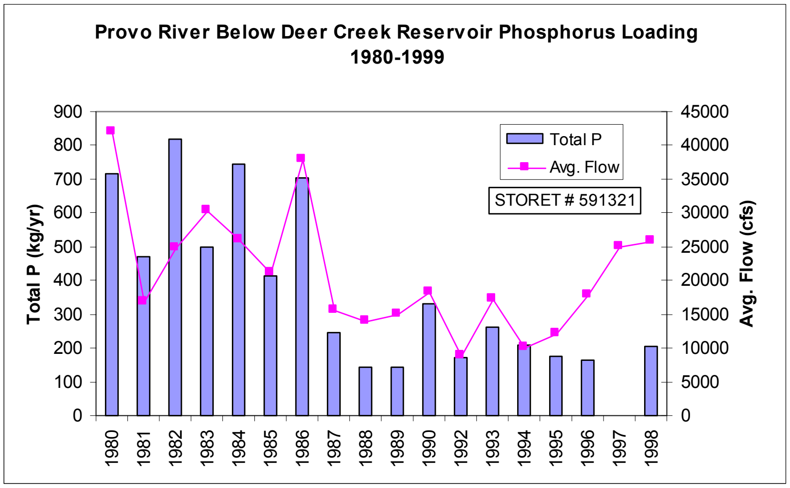


Figure 7. 4 Historical Phosphorus Loading Below Deer Creek Reservoir

The phosphorous loads were calculated at only one JTAC monitoring location in this area of the watershed. The location is directly below the Deer Creek dam on the Provo River. Figure 7.4 indicates the historical phosphorous loading and the phosphorous loading for 1998 (see Appendix C for complete calculations for phosphorous loading). The phosphorus data for 1997 was corrupt and therefore was disregarded. Table 7.7 indicates the loads for total phosphorus, dissolved total phosphorus, TSS, and the average flow. The 1998 loads of TSS and total phosphorus have dropped excessively from previous years as shown in Table 7.7.

Table 7. 7 Historic Water Quality Data (1993-1998)

	1993	1994	1995	1996	1997	1998
Provo River below Deer Creek, STORET 499733						
Weighted Average Flow (cfs)	343	201	240	358	406	462
TP Weighted Average (mg/l)	0.043	0.058	0.042	0.025	-	0.025
TP Annual Load (kg/yr)	12,999	10,331	8,887	8,099	-	10,171
DTP Weighted Average (mg/l)	-	-	0.035	0.021	-	0.014
DTP Annual Load (kg/yr)	-	-	7,432	6,711	-	5,603
TSS Weighted Average (mg/l)	5.4	2.9	1.7	0.5	0.9	1.1
TSS Annual Load (kg/yr)	1,640,831	515,278	365,927	164,330	324,265	443,813

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 1998. 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 7.8, 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													
21-Jan-98	<30.0	<5.0	74.0	<1.0	<5.0	<12.0	<20.0	<3.0	<0.2	7.3	<1.0	<2.0	<30.0
28-May-98	<30.0	<5.0	61.0	<1.0	<5.0	<12.0	<20.0	<3.0	<0.2	5.6	<1.0	<2.0	<30.0
19-Aug-98	<30.0	<5.0	60.0	<1.0	<5.0	<12.0	<20.0	<3.0	<0.2	8.9	<1.0	<2.0	<30.0
14-Oct-98	<30.0	<5.0	74.0	<1.0	32.0	<12.0	<20.0	<3.0	<0.2	22.0	<1.0	<2.0	<30.0
Storet #499687, Little Deer Creek above confluence with the Provo River													
21-Jan-98	<30.0	<5.0	65.0	<1.0	<5.0	<12.0	<20.0	<3.0	<0.2	<5.0	1.1	<2.0	<30.0
19-Aug-98	<30.0	<5.0	73.0	<1.0	8.0	<12.0	<20.0	<3.0	<0.2	<5.0	1.1	<2.0	<30.0
14-Oct-98	<30.0	<5.0	65.0	<1.0	10.0	<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													
21-Jan-98	<30.0	<5.0	40.0	<1.0	<5.0	<12.0	<20.0	<3.0	<0.2	<5.0	1.3	<2.0	<30.0
19-Aug-98	<30.0	<5.0	30.0	<1.0	5.5	<12.0	<20.0	<3.0	<0.2	<5.0	<1.0	<2.0	<30.0
14-Oct-98	<30.0	<5.0	32.0	<1.0	8.0	<12.0	<20.0	<3.0	<0.2	<5.0	1.2	<2.0	<30.0
Storet #499683, Lower South Fork Provo River at Vivian Park													
21-Jan-98	<30.0	<5.0	61.0	<1.0	<5.0	<12.0	<20.0	<3.0	<0.2	<5.0	1.1	<2.0	<30.0
19-Aug-98	<30.0	<5.0	58.0	<1.0	6.7	<12.0	<20.0	<3.0	<0.2	<5.0	<1.0	<2.0	<30.0
14-Oct-98	<30.0	<5.0	53.0	<1.0	7.2	<12.0	20.1	<3.0	<0.2	<5.0	<1.0	<2.0	<30.0
Storet #499681, Provo River at Olmstead Diversion													
21-Jan-98	<30.0	<5.0	70.0	<1.0	<5.0	<12.0	<20.0	<3.0	<0.2	9.2	<1.0	<2.0	<30.0
19-Aug-98	<30.0	<5.0	60.0	<1.0	5.5	<12.0	<20.0	<3.0	<0.2	8.0	<1.0	<2.0	<30.0
14-Oct-98	<30.0	<5.0	63.0	<1.0	5.3	<12.0	<20.0	<3.0	<0.2	16.0	<1.0	<2.0	<30.0
Storet #499678, Provo River at Murdock Diversion													
21-Jan-98	<30.0	<5.0	62.0	<1.0	<5.0	<12.0	<20.0	<3.0	<0.2	<5.0	1.1	<2.0	<30.0
19-Aug-98	<30.0	<5.0	56.0	<1.0	5.2	<12.0	<20.0	<3.0	<0.2	<5.0	<1.0	<2.0	<30.0
14-Oct-98	<30.0	<5.0	57.0	<1.0	22.0	<12.0	<20.0	<3.0	<0.2	<5.0	<1.0	<2.0	<30.0

Conclusions and Recommendations

CHAPTER 8

INTRODUCTION

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. This final chapter summarizes the water quality problems that were detected in the basin and gives recommendations to help towards improving water quality for the problem areas as well as the watershed as a whole.

PROBLEM AREAS

Despite great improvements in many areas, the 1998 monitoring program detected several water quality problems in the watershed. As a summary, the problems detected are as follows:

Table 8. 1 1998 Water Quality Problem Areas

Location	Problem	Exceedence Rate
Ontario Drain Tunnel #2 (UPCM)	High Zinc Concentrations	33%
	High pH	40%
Kamas Fish Hatchery	High Ammonia Concentration	90%
	High Phosphorus Concentration	90%
Midway Fish Hatchery	High Ammonia Concentration	67%
Deer Valley Mayflower Basin	High Phosphorus Concentration	N/A
Spring Creek	High Phosphorus Concentration	100%
Lower Charleston Canal	High Phosphorus Concentration	100%
Daniels Creek	High Phosphorus Concentration	82%
Main Creek	High Phosphorus Concentration	57%
Deer Creek Reservoir	Low Dissolved Oxygen	N/A
Little Deer Creek	High Phosphorus Concentration	36%

RECOMMENDATIONS

This report recommends the following eight items as suggestions for JTAC to continue to improve on water quality management and reduce the problems shown in Table 8.1.

1. Heber Valley Storm Water Controls

In response to recommendations from previous years' implementation reports Wasatch County, through a contract with Psomas, has completed the third year of a three year Storm Water Study in Heber Valley. Wasatch County continues to experience increased urbanization which tends to increase natural storm runoff conditions. The study has identified potential sites for construction of new sedimentation basins intended to reduce eroded sediments in surface waters prior to entering Deer Creek Reservoir. By removing sediments, many pollutants including phosphorus will also be removed. The implementation of these basins will help reduce phosphorus from Spring Creek, Daniels Creek, the Lower Charleston Canal, and Snake Creek. As shown previously in Table 8.1, all of these creeks except Snake Creek had phosphorus problems in 1998.

JTAC should support and encourage Wasatch County in its implementation of the recommended stormwater controls.

Implementation of this recommendation may mitigate the water quality problems listed in Table 8.1 for the following locations:
- Spring Creek
- Daniels Creek
- Lower Charleston Canal
- Snake Creek

2. 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 and TP 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. And JTAC should continue to work with the DWQ to encourage phosphorus limits in the hatchery’s UPDES permit. In addition, high ammonia concentrations are occurring at both the Kamas Fish Hatchery and the Midway Fish Hatchery; JTAC should encourage ammonia limits as well.

Implementation of this recommendation may mitigate the water quality problems listed in Table 8.1 for the following locations:
- Kamas Fish Hatchery
- Midway Fish Hatchery

3. EPA Cleanup of Mine Sites

The mining industry once thrived in the Park City area of Summit County. Some of the mining activities spilled into Wasatch County, especially on the west side of Jordanelle Reservoir. The mine waste that remains contains hazardous levels of certain metals particularly arsenic and lead. Due to the potential hazards of these materials and plans for residential developments, the Utah Division of Environmental Response and Remediation requested that EPA, Region VIII, reevaluate the Mayflower Mountain Tailings Pond and evaluate other nearby mining-related sites which may pose risks to human health and the environment. EPA's reevaluation of these sites is expected to commence in the near future.

JTAC should support mitigation of these potential water quality hazards. JTAC should also closely monitor these sites for discharges of contaminated water that may pose a risk to drinking water sources such as the Jordanelle Reservoir.

Implementation of this recommendation may mitigate the water quality problems listed in Table 8.1 for the following locations:

- Ontario Drain Tunnel #2

4. 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 has 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.

5. 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.

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.

6. Agricultural – Non-Point Source Erosion

Agriculture appears to continue to have an impact on water quality. There are many ongoing programs that will help to reduce these impacts such as the Tri-Valley Watershed Project, Wasatch County Water Efficiency Project, and the Deer Creek Reservoir Resource Management Plan. In addition the NRCS is working with farmers on an individual basis to help them manage lands with Best Management Practices (BMPs) which will also favorably impact water quality. Better management practices in the Heber Valley will reduce non-point source phosphorus loading resulting in improved water quality.

JTAC should continue to support projects that will reduce pollutant contributions from non-point sources and support the education of local farmers and ranchers in BMPs.

Implementation of this recommendation may mitigate the water quality problems listed in Table 8.1 for the following locations:

- Spring Creek
- Daniels Creek
- Lower Charleston Canal
- Snake Creek
- Deer Creek Reservoir

7. Additional Monitoring of Provo Canyon

Many of the Provo River culinary water diversions are in the Provo Canyon. Increased monitoring in this area for drinking water specific constituents would help identify some of the problems more specific to drinking water. Drinking water treatment plants generally are concerned with phosphorus, algae, dissolved oxygen, total organic carbon, Cryptosporidium, Giardia, and metals.

JTAC should consider increased efforts to monitor many of these constituents within the Provo Canyon.

8. 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 water quality concerns such as proper storm water management, sediment controls, erosion controls, revegetations, restoration and drainage.

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

Implementation of this recommendation may mitigate the water quality problems listed in Table 8.1 for the following locations:

- Deer Valley Mayflower Basin

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