Water Quality Management Plan for 2005 Water Year

2006 Water Quality Implementation Report

Provo River, Deer Creek Reservoir and Jordanelle Reservoir

Prepared For:

The Wasatch County Council

and

The Provo River Watershed Council

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DRAFT FOR REVIEW

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CHAPTER 1 - INTRODUCTION

BACKGROUND

Water plays a vital role 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 Utah residences for drinking, agricultural, industrial, and recreational purposes. The Provo River supports a delicate ecosystem of invaluable living organisms.

Along the Provo River, Deer Creek and Jordanelle Reservoirs water management plans have helped make this water available for public and private use. These reservoirs are vital to the surrounding communities. One of the main challenges facing those in charge of managing the reservoirs is the control of eutrophication. Eutrophication is a natural process that occurs in lakes and reservoirs when there is an abundance of nutrients. It simply means that there are enough of the right nutrients present to incur algae growth. Excessive algae growth can seriously deteriorate water quality causing taste and odor problems, which in turn increase treatment costs.

FORMATION OF JTAC

Because of eutrophication evidences in the Deer Creek Reservoir, in 1981 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 the representation of over twenty federal, state, local agencies, and private companies.

The Water Quality Management Plan for Deer Creek and Jordanelle Reservoirs was implemented by JTAC in 1984. This plan directs JTAC to conduct a water sampling program that monitors the condition of water quality throughout the year. It also requires that an annual report be released that analyzes and presents the resulting data. This report was updated in 2004.

NEW PROVO RIVER WATERSHED COUNCIL

The Jordanelle Technical Advisory Committee's name has been changed to better suit the scope and direction of the Committee. The new name is Provo River Watershed Council (PRWC). A group was formed to develop a mission statement and goals for the PRWC. They are

Mission

Promote and support watershed best management practices to ensure high quality water for all users and to meet designated beneficial uses in the Provo River Watershed.

Goals

- Promote awareness and education about watershed issues
- Provide a forum for information exchange, analysis and debate of issues to promote collaborative, consensus-based decision making and planning
- Enhance stakeholder partnerships and respect local social and cultural values
- Monitor and document water quality trends
- Maximize communication, relationships and partnerships among members
- Encourage a sustainable, watershed level, ecosystem approach to planning and activities

PHOSPHORUS: LIMITING NUTRIENT

The JTAC water sampling program identifies many water quality parameters, some of these include physical and chemical properties, metals, and nutrients present in the water. The most critical water quality constituent for this analysis, however, is phosphorus. In general, phosphorus is the limiting nutrient that controls the growth of algae. By decreasing the phosphorus loads into the reservoirs algae growth will also decrease.

In the Provo River Watershed, a variety of natural sources contribute to the formation of phosphorus, but human factors also are a substantial contributor. The goal of JTAC is to reduce pollution from these sources by encouraging the implementation of projects, efficient management practices, and smart planning.

Another constituent often related to phosphorous concentrations is Total Suspended Solids (TSS). TSS is used to evaluate the amount of inorganic salts and other materials suspended in water. It is also used to determine the degree of treatment needed to ready the water for consumption. By removing TSS, many pollutants including phosphorus will also be removed.

PURPOSE AND SCOPE

The 2006 Water Quality Implementation Report is released to fulfill the requirement by the 1984 Water Quality Management Plan for the Deer Creek and Jordanelle Reservoirs. As directed by the plan, this report will:

- Present the results of water quality sampling,
- Identify exceedances of water quality 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

Desert Rose Environmental, LLC has been contracted by the Wasatch County Council to fulfill the requirements of the 1984 Water Quality Management Plan for the Deer Creek and Jordanelle Reservoirs by compiling information and preparing the 2004 Water Quality Implementation Report.

SOURCE OF DATA

The monitoring data has been gathered through the coordination of various agencies participating in JTAC. The Utah State Division of Water Quality has provided Desert Rose with the majority of 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 stream gage locations within the area of study. 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 Timpanogos Canal. Central Utah Water Conservancy District (CUWCD) has provided operational data for Deer Creek and Jordanelle Reservoirs, and the surrounding area. 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 ultimately affecting the water users. Several of these activities are extremely important to future water quality in the watershed. This chapter will briefly discuss the individual activities in this watershed that may have positive or negative affects upon the water quality.

CURRENT ACTIVITIES

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Jordanelle Basin Master Plan and Developments

Wasatch County has adopted the Jordanelle Basin Master Plan and the Jordanelle Basin Overlay Zone. These regulations are to guide development within the Basin and

provide the vision for what is to come. Wasatch County requires all new developments to follow A Guide for Erosion and Sediment Control. This calls for the containment of the entire runoff volume from a 2-year, 24-hour storm event. Following these measures will help limit the impact to the water quality in the Upper Provo River Basin.

Sewer and water lines are mostly in place in the Jordanelle Special Service District servicing developments in the Jordanelle Basin. Approximately 12,571 equivalent residential units (ERUs) have been approved in the master plans.

Deer Crest, located just west of the Mayflower Junction on U.S. 40 is in the process of building a large hotel near the Summit County / Wasatch County border. Single family commercial, and multi-family structures are in the planning and development stages.

Stillwater will consist of about 250 condo-hotels units, conference center facilities, and a restaurant. Construction of first phase on the condo-hotel is complete. Under way is the construction of the townhomes. Future phases are planned for a retail commercial village near the hotel.

Tuhaye, on the east side of Jordanelle Reservoir, will consist of a gated community with a golf course. The golf course is complete. The development of residential lots is currently underway with construction of residential units to begin soon.

Deer Canyon Preserve and Iroquois, adjacent to Highway 248 on the north arm of the Jordanelle Reservoir, has received final approval for most of their phases. This project included the relocation of Browns Canyon Road. The development includes commercial, single family residential and multifamily residential. There is a planned trail head with parking and restroom facilities planned within this development.

Hideout Canyon, located on the east side of the reservoir and adjacent to Highway 248 will include a golf course with a club house. Single and multifamily housing will also be included in Hideout Canyon.

Jordanelle Basin Oil Pipeline Spill

During the late summer 2004 Wasatch County reported to JTAC about a spill that dumped approximately 30,000 gallons of crude oil into the Jordanelle Resrvoir Watershed. This spill was the result of an accident involving earth moving equipment on the north end of the reservoir.

The clean-up plan originally approved by the State of Utah was for the spilled oil to be stabilized in-place. Wasatch County felt strongly that this approach was not an appropriate alternative in the watershed and requested that the contaminated soil material be moved to a suitable landfill facility. After a series of negotiations the plan was amended to move the soil material to an approved landfill. The Utah Division of Oil, Gas and Mining was providing oversight during the cleanup and disposal.

Cascade II Fire

On September 23, 2003, windy conditions blew a prescribed burn beyond the contingency area. The fire that ensued, called the Cascade II Fire, burned approximately 7,828 acres of Forest Service, State and private land west of Midway and Heber City, Utah. The Cascade II Fire affected watersheds that supply irrigation and culinary water to Utah and Salt Lake Counties. These counties are home to over 1 million people combined. Two major watersheds were affected by the recent fire incident. Streams on the western half of the fire drain to Provo Deer Creek while streams on the eastern half drain to Deer Creek Reservoir. Drinking water is supplied to Provo, Orem and Salt Lake City as well as a small subdivision (Canyon Meadows) whose source of drinking water is from Provo Deer Creek just below the Forest boundary. The Provo River main stem and Deer Creek Reservoir are major suppliers of culinary water for the Salt Lake/Utah County area.

The main threat to water quality is the delivery of ashy sediment and nutrients into drinking water sources, mainly Provo Deer Creek, Provo River, and Deer Creek Reservoir and the threat of sediment and nutrients flowing into Cascade Springs.

The US Forest Service has reported that approximately one-half of the burned area was on Forest Service land, and half on State lands. A BAER fire response team evaluated the burned land using a number of factors to assess its erosion potential. Fire burn intensity was a key factor. Approximately 18% to 20% of the area burned in the “hot” range. Areas that experienced intense burns were seeded and/or mulched. Between $600,000 and $700,000 was allocated to rehabilitation in the Little Provo/Deer Creek watershed.

In 2004 Central Utah Water Conservancy district installed equipment to collect water quality data on Little Deer Creek.

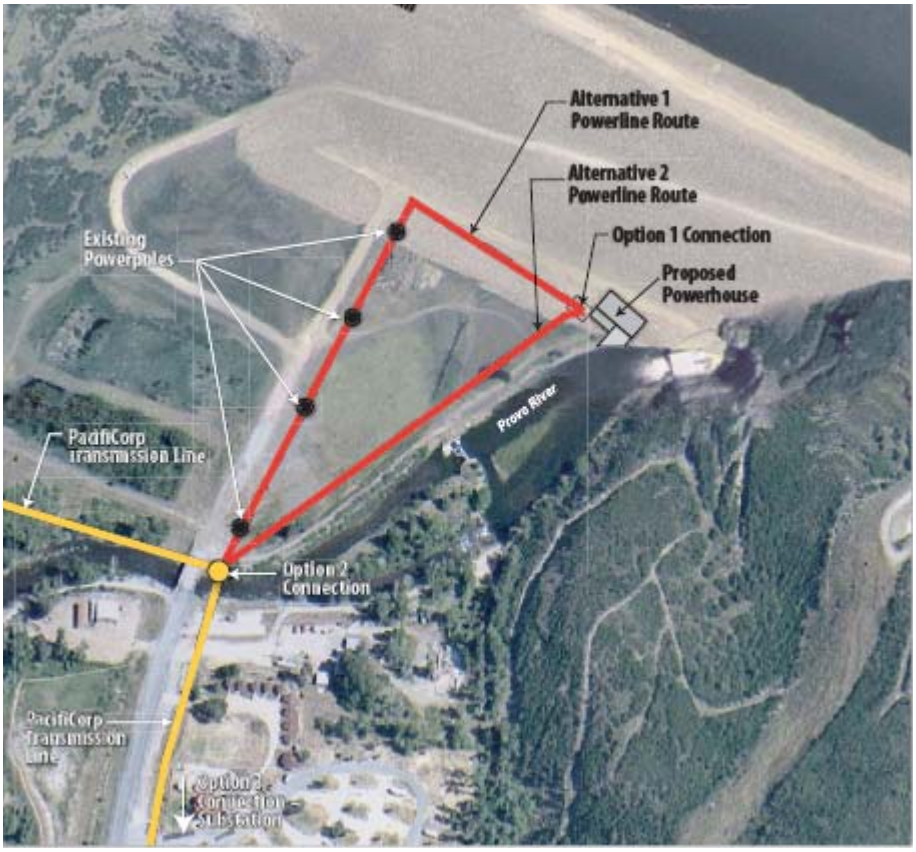
The US Forest Service also assessed impacts from Spring 2005 storm events. The majority of the sediment into the streams was being generated by the roads. Very little evidence was found of overland flow and erosion coming from the burned hillsides. BMPs such as dips and water bars were installed along the roads, however, the majority of them failed during a severe thunderstorm in July 2004. The major contributor of sediment appears to be the Midway-Cascade Springs Road. This road is poorly located, has very steep slopes and has been a source of problems for years. Effects to water from increased runoff and erosion are most likely to occur in the next one to two years during spring runoff and / or summer / early fall thunderstorms in fire affected areas without ground cover.

Cascade Springs Rehabilitation – NRCS

The NRCS initiated a watershed restoration project in the area burned by the Cascade II Fire. Triticales was planted as a nurse crop that will not reseed. Livestock will be restricted from the rehabilitated areas for two years. Contour fences were installed, as well as gully fences.

Initial reports from the NRCS in the Spring of 2005 were that three of the 17 gully check dams that were installed failed by filling up with ash and other materials. The ash sealed the filter fabric that was used in the construction of the check dams. Only three of the remaining check dams did not fill-up with soil. These are in need of repair and/or reinstallation of the gully check dams.

Jordanelle Dam Hydroelectric Project



In the Spring of 2004 the Department of the Interior initiated a NEPA process with public involvement for the execution of a Lease of Power Privilege contract and the construction, operation, and maintenance of a hydroelectric generation facility on Jordanelle Dam and associated power transmission lines and facilities. Through a competitive selection process the joint application of the Central Utah Water Conservancy District (District) and Heber Light and Power (HL&P) was chosen as the potential lessee to develop hydropower at Jordanelle Dam. Construction and generation of power will be accomplished by the partnership of the District and HL&P through a Lease of Power Privilege. A lease contract was executed among the District, HL&P, and the Department, which describes the development, operation, and maintenance of a hydroelectric generation facility at Jordanelle Dam, consistent with the purposes and operations of the Bonneville Unit. Development of a hydroelectric facility will not change the operation of Jordanelle Dam and Reservoir.

Jordanelle Special Service District

The Jordanelle Special Service District (JSSD) has been created to provide water and sewer services to the imminent developments around the Jordanelle Reservoir. The district has built the Keetley Water Treatment Plant at the mouth of the Ontario #2 Drain

Tunnel, as well as many waterlines, pump stations water storage tanks, sewer lines, and sewer lift stations.

The Deer Crest area is complete with infrastructure and new tanks were built to service other developments in Area A such as Stillwater and East Park. JSSD is also servicing developments in the Ross Creek area on the north arm of the Jordanelle Reservoir. During the summer of 2001, water transmission lines, main sewer lines, and pump stations were constructed to the Ross Creek Area. Water storage tanks have also been completed on the Butte Property and Deer Mountain.

The Keetley Water Treatment Plant is now operational and delivering water to developments in the Jordanelle Basin.

JSSD is currently in the design process for a new wastewater treatment facility to meet the needs of the JSSD district. The latest membrane technology will be incorporated in this plant design. The operational characteristics and design will make this a true water reclamation facility. The property for the facility has been purchased below Jordanelle Dam.

UPDES Permits

Two Fish Hatcheries in the watershed have surface water discharge permits that 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 and the Kamas Fish Hatchery

Midway Fish Hatchery

The UPDES permit was renewed on March 10, 2001 and expires February 28, 2005. 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 a net maximum of total phosphorus to 636 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 Midway Fish Hatchery has not been operational for 2001 and 2002 water years and anticipates construction completion by September 2003.

Kamas Fish Hatchery

The Kamas Fish Hatchery, although smaller than the Midway Fish Hatchery, has expanded its facilities and increased its fish production from 80,000 pounds per year to a projected 140,000 pounds per year in 2001. The new facilities 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, 2000 and expires February 28, 2005. The permit allows a maximum concentration of TSS at 25 mg/L.

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 expanded facilities that will contribute to reducing the amount of phosphorus loads that otherwise would have been discharged.

U.S. 189 Provo Canyon Highway Project

This is the next phase of the Provo Canyon Highway reconstruction project which will widen the road to a four-lane divided highway from the junction of state Route 92 (Sundance turn-off) to a half-mile east of Deer Creek Dam. The project will make the following improvements:

- Expand a two-lane section of U.S. 189 to a four-lane divided highway.
- Bridge the spillway at the base of Deer Creek Dam and create a new crossing which reduces the existing sharp turns at the dam.
- Build a new bridge crossing over the Historic Heber Valley Railroad.
- Realign sections of U.S. 189 and move the highway further away from the Provo River.
- Split the new road alignment from S.R. 92 to Horseshoe Bend - the westbound lanes will be raised 30 feet above the eastbound lanes.
- Utilize the abandoned highway section for local access and extend the Provo River trail system.
- Build a meandering stream for Little Deer Creek as part of a stream restoration project.

Once complete, this segment of U.S. 189 will accommodate projected traffic demands for 20 years into the future. Construction is anticipated to last 2 years.

In the area near Deer Creek Dam, work is underway at the new embankments leading up to the bridge. Two-thirds of the steel griders at the new bridge crossing at the Deer Creek Dam are in place. The remainder of the bridge section must wait until the embankment on the south side of the spillway is finished. Crews continue to excavate and stabilize the mountainside adjacent to the dam. In the Canyon Meadows area, crews are building the new highway alignment and stabilizing the hillsides.

Provo River Restoration

In 1999, the Utah Reclamation Mitigation and Conservation Commission began the Provo River Restoration Project (PRRP) between Jordanelle Dam and Deer Creek Reservoir to restore the middle Provo River's pattern and ecological function to a more natural condition. The project is expected to be complete in 2007.

PRRP consists of restoring the straightened river channel to a meandering channel mimicking historic conditions, reconnecting the river to existing remnants of historic secondary channels, and constructing small side channels to recreate aquatic features.

The project will provide a protected 800 to 2,200-foot-wide corridor along the entire reach of the restored middle Provo River for angler access and wildlife habitat. Existing levees are being set back to create a near natural flood plain and to allow the river to change course naturally. Planting and fostering streamside vegetation will provide necessary environment for healthy fisheries. Side channels and ponds will improve fish habitat and create habitat for wetland dependent wildlife. Baseline monitoring of riparian habitat, physical features, sensitive species, neotropical migratory birds and related studies are underway.

Utah Division of Wildlife Resources and U.S. Bureau of Reclamation construction crews helped initiate the project by carving new meanders, side channels and wetland ponds in a pilot project along approximately 1.5 miles of river corridor near the new Highway 40 river crossing. In 2000, about 1.3 miles of river reconstruction was completed starting beneath the bridge over Highway 40 and ending at River Road in Midway. Similar to the pilot project, main channel, secondary channel and wetlands features were created. In 2001, work began on a 2-mile reach of the Provo River that was completed the spring of 2002. In December 2002, crews completed reconstructing about 0.9 miles of river immediately upstream from the pilot project, above Cottonwood Canyon bridge to below Jordanelle Dam. Much farther downstream, below Midway Lane in Midway, reconstruction of two additional miles began in 2003, with work continuing in the area through 2004. In 2005, restoration began an approximately one and a half miles of river downstream from the bridge over River Road in Midway. Six angler access sites have also been completed along the restored river areas with parking lots, trash recepticles, educational displays and new restrooms.

Water Releases Increased from Deer Creek Reservoir

The ability of Utah's water storage facilities to recover at the end of a drought has been dramatically demonstrated at Deer Creek Dam and Reservoir on the Provo River. In 2004 water levels were extremely low as the five-year drought took its toll. However, in 2005 it is not only nearly full, but was only 1.8 feet from full at the end of Summer 2005. As a comparison, in 2004 after five years of drought, the reservoir level on the same day was 30.5 feet from full.

Because of this situation additional releases to accommodate dam safety/highway relocation construction efforts at the dam were undertaken by the US Bureau of Reclamation. The Reservoir level was drawn down over a couple of months, in advance of when this would normally occur, in order to allow for an additional margin of safety for construction work at the toe of the dam. This work will connect historic seepage areas into the filter and drain system of the dam. These releases will also provide storage space which is also needed in the reservoir to accommodate next year's spring runoff.

Flows in the Provo River will increase in some reaches. To the greatest extent possible, the water released will be utilized for beneficial purposes, with some water reaching Utah Lake.

Draft Ross Creek Concept Plan - Jordanelle State Park

In 1989, the U. S. Bureau of Reclamation (BOR) in conjunction with the Utah Division of Parks and Recreation (the division) and other state and local agencies drafted the Master Plan for Jordanelle State Park. The Master Plan outlined basic recreation opportunities and facilities that could be developed at Ross Creek. However, the site plans were not drafted and facilities were never built. State park management determined further planning for the Ross Creek area was essential given the recent increases in private development adjacent to the northern boundaries of Jordanelle State Park, the increased use of Ross Creek by hikers and fishermen displaced from Crandall Point, and the lack of a developed access point to accommodate area visitors. Therefore, in November 2004, representatives from the division and the BOR met to initiate a conceptual planning effort for the Ross Creek area of Jordanelle State Park.

The Ross Creek Conceptual Planning Team consisted of division staff, local users, adjacent landowners, and a representative from the BOR. The teams proposed solutions do not change any of the existing land management directives or cooperative agreements already in effect.

The plan provides recommended solutions founded upon four primary vision elements that will guide the future planning and management of the Ross Creek area of Jordanelle State Park. These elements focus on:

- Developing and enhancing recreation opportunities while maintaining the area's natural landscape and wildlife habitat.
- Providing controlled access to the water, shoreline, trails, and other recreation opportunities at Ross Creek.
- Planning and developing facilities and infrastructure that are well designed, well maintained, appropriately budgeted, feasibly staffed, and consistent with the area's natural aesthetics.
- Linking the Ross Creek area to the rest of Jordanelle State Park and the surrounding community through consistent management practices, interconnecting trails, interpretive programs, signage, and kiosks.

The planning team issued several specific recommendations in support of the plan's vision elements. Four issue areas form the basis of the team's solutions. Each issue area and solution is outlined as follows:

Staff funding and Operations

- Develop a feasibility/Business plan to study if, where, how much, and when development could occur at Ross Creek.
- Create a process for partnering private, state, and federal monies to develop the Ross Creek area.
- Obtain a commitment of the operational budget recommended by the business plan before development begins.

Recreation Opportunities (Day-use only)

- Fishing.
- Windsurfing.
- Lakeside boat access, docks (no formal launch facilities).
- Trails - hiking, biking, and equestrian.
- Picnicking - group and individual sites.
- Horseshoe pits.
- Wildlife viewing.
- Ice-fishing.
- Interpretive programs.
- Possible concession opportunities.

Facilities, Maintenance, & Development (day-use only)

- Group and individual picnic sites.
- Fishing facilities.
- Sanitation facilities.
- Trail related facilities.
- Water related facilities.
- Operational facilities.
- Improve access into and out of the Ross Creek area (roads and trails).
- Develop pedestrian access to the reservoir/shoreline.
- Limit trespass issues with proper signage.

Natural Resources

- Minimize impacts on the area's natural surroundings/resources.
- Place and design facilities to minimize impacts on the natural surrounding.
- Utilize and enhance native vegetation.
- Localize development and impacts when/where possible.
- Implement erosion control measures.
- Coordinate with Forestry Fire and State Lands and the BOR for wild fire control measures and planning.
- Consider lake fluctuations in facility placement.
- Develop interpretive plan for the Ross Creek area.
- Utilize water quality/runoff controls.
- Coordinate development with stakeholders to ensure consistency of design and protect of resources.

Implementing the solutions recommended by this plan will be contingent upon the acquisition of new funding sources. The competition for funding or other unforseen priorities may affect the implementation of this plan. The plan's success is dependant upon the continued support of park staff, community stakeholders, BOR staff, and resource professionals.

CHAPTER 3 – MONITORING PROGRAM

INTRODUCTION

This chapter describes the PRWC 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.

PRWC MONITORING PROGRAM

The PRWC monitoring program uses a method of systematically taking samples from streams and reservoirs in the watershed. In the 2005 water year, approximately 478 samples from 49 sample sites were collected for the purpose of water quality analysis. There are 21 stream, 7 reservoir, 3 point source, and 2 QA/QC sampling locations. At the seven reservoir sampling locations, samples were collected at multiple depths. The sampling locations were selected with the purpose of analyzing the progress towards the goals set in 1984.

A six-digit STORET number for the State's system of identification identifies each sampling location. **Error! Reference source not found.** on the following page lists the 29 sites, their corresponding STORET numbers, and descriptions. These locations are graphically shown on Maps 1-4 located at the end of this chapter.

Stream Monitoring

There are 19 locations along Provo River and the basin's tributary streams where stream samples were taken. Most stream locations were sampled on a monthly basis. Physical properties such as pH, temperature, and conductivity were analyzed in the field. Further analyses were then conducted at the State Laboratory for nutrients and dissolved metals, refer to **Error! Reference source not found.**.

Reservoir Monitoring

There are four locations on Deer Creek Reservoir and three on Jordanelle Reservoir where reservoir sampling occurred. Reservoir stations are generally sampled at various depths where possible. Considering each depth as a distinct sampling location yields a total of 24 reservoir sampling sites. Field data is gathered, along with turbidity measurements for the determination of water clarity of the reservoir. Further analyses are then conducted at the State Laboratory for nutrients and dissolved metals, refer to **Error! Reference source not found.**.

Table 3 - 1 PRWC Monitoring Plan Fiscal Year 2005-2006

Fiscal Year 2005 - 2006

21-Jul-05 **Water Quality Monitoring and Station Identification and Location**
Jordanelle/Deer Creek Water Quality Management For
Fiscal Year 2005 - 2006

METALS - AUG, OCT, JAN, MAY(2ND)
PERIPHYTON - JUL, AUG, SEP, OCT, NOV, JAN, APR, MAY
SLCPULab - JULY-NOVEMBER

Sampling Frequency

STORET Number	Station Location Description	J	A	S	O	N	D	J	F	M	A	M	J	TOTAL	FIELD	NUTRIENTS	CHEMISTRY			BACT.	MISC.				METALS			PROTOZOA	TASTE & ODOR	Total Lab Tests
															TEMPERATURE FLOW (STREAM) pH DIS. OXYGEN CONDUCTIVITY SECCHI (RES.) SURFACE	TYPE 9: NH3 TOT P DTOT P NO2-NO3	TYPE 1: TSS TDS T. ALK.	TYPE 2:	TYPE 1: Chloride	MF TOT. MF FEC.	T O C / U V 2 5 4	P H Y T. / P E R I.	C H L O R a	M T B E	TYPE 3: As Al Ag Ba Zn Cd Cu Cr Fe Hg Pb Se Mn	TYPE 1: D - Ca D - Mg T. HARD.	TYPE 4: D - Ca D - Mg D - K D - Na T. HARD.	GIARDIA / CRYPTO.	GEOSMIN / MIB	
					(b)				(a)						(e)						(f)	(d)			(c)			(g)		
	DEER CREEK RESERVOIR STATIONS																													
5913220	Deer Creek Res above dam 01-A	1	1	1	1			1		1		1	1	8	8	8	8				8	8/0	8			8				104
5913220	Deer Creek Res above dam 01-B	1	1	1	1			1		1		1	1	8	8	8	8									8				80
5913220	Deer Creek Res above dam 01-C	1	1	1	1			1		1		1	1	8	8	8	8									8				80
5913220	Deer Creek Res above dam 01-D	1	1	1	1			1		1		1	1	8	8	8	8								4	8				132
5913230	Deer Creek Res midlake 02-A	1	1	1	1			1		1		1	1	8	8	8	8				8	8/0	8			8				104
5913230	Deer Creek Res midlake 02-B	1	1	1	1			1		1		1	1	8	8	8	8									8				80
5913230	Deer Creek Res midlake 02-C	1	1	1	1			1		1		1	1	8	8	8	8									8				80
5913230	Deer Creek Res midlake 02-D	1	1	1	1			1		1		1	1	8	8	8	8								4	8				132
5913240	Deer Creek Res Upper end 03-A	1	1	1	1			1		1		1	1	8	8	8	8				8	8/0	8			8				104
5913240	Deer Creek Res Upper end 03-B	1	1	1	1			1		1		1	1	8	8	8	8									8				80
5913450	Deer Creek Res Wallsburg Bay 05	1	1	1	1			1		1		1	1	8	8	0	0					8/0								0
	JORDANELLE RESERVOIR STATIONS																													
5914010	Jordanelle Res ab Dam 01- Surface (21)	1	1	1	1			1		1		1	1	8	8	8	8				8	8/0	8			8				104
5914010	Jordanelle Res ab Dam 01- Gate 1 (22)	1	1	1	1			1		1		1	1	8	8	8	8									8				80
5914010	Jordanelle Res ab Dam 01- Gate 2 (23)	1	1	1	1			1		1		1	1	8	8	8	8									8				80
5914010	Jordanelle Res ab Dam 01- Gate 3 (24)	1	1	1	1			1		1		1	1	8	8	8	8									8				80
5914010	Jordanelle Res ab Dam 01- Gate 4 (26)	1	1	1	1			1		1		1	1	8	8	8	8									8				80
5914010	Jordanelle Res ab Dam 01- Gate 5 (27)	1	1	1	1			1		1		1	1	8	8	8	8									8				80
5914010	Jordanelle Res ab Dam 01- Gate 6 (28)	1	1	1	1			1		1		1	1	8	8	8	8									8				80
5914010	Jordanelle Res ab Dam 01- Bottom (29)	1	1	1	1			1		1		1	1	8	8	8	8								4	8				132
5914030	Jordanelle Res North Arm 03-A	1	1	1	1			1		1		1	1	8	8	8	8				8	8/0	8			8				104
5914030	Jordanelle Res North Arm 03-D	1	1	1	1			1		1		1	1	8	8	8	8								4	8				132
5914040	Jordanelle Res Provo Arm 04-A	1	1	1	1			1		1		1	1	8	8	8	8				8	8/0	8			8				104
5914040	Jordanelle Res Provo Arm 04-D	1	1	1	1			1		1		1	1	8	8	8	8								4	8				132
	DEER CK/JORDANELLE INFLOW / OUTFLOW																													
5913210	Provo River below Deer Creek Res.	1	1	1	1	1		1		2	2	2	2	14	14	14	14			14	14	8/8		4	4	14		12	12	290
5913460	Main Creek at bridge on US189 above Res.	1	1	1	1	1		1		2	2	2	2	14	14	14	14				4					14		12		160
5913520	Daniels Creek 100 feet below cnfl w/ LCC	1	1	1	1	1		1		2	2	2	2	14	14	14	14			14	4					14		12		174
5910020	Lower Charleston Canal ab Daniels Ck																													
5913630	Provo River above Deer Creek Res. at McKellar Br.	1	1	1	1	1		1		2	2	2	2	14	14	14		14	14		14	8/8			4		14	12		470
5910250	Provo River at Heber - Midway Bridge	1	1	1	1	1		1		2	2	2	2	14	14	14	14									14				140
4997300	Provo River at River Road Bridge	1	1	1	1	1		1		2	2	2	2	14	14	14	14				14					14				168
5910160	Snake Creek above Deer Creek Res.	1	1	1	1	1		1		2	2	2	2	14	14	14	14				4	0/8			4	14				200
4997330	Provo River bl Jordanelle Dam	1	1	1	1	1		1		2	2	2	2	14	14	14	14				14	8/0			4	14				220
4998130	Provo River ab Hailstone Junction	1	1	1	1	1		1		2	2	2	2	14	14	14	14				14	8/8				14				168
	MAIN PROVO RIVER STATIONS																													
4996780	Provo River at Murdock Diversion	1	1	1	1	1		1		1	1	1	1	10	10	10		10	10	10	10	0/8			4		10	12		374
4996810	Provo River at Olmsted Diversion	1	1	1	1	1		1		1	1	1	1	10	10	10	10			10	10	8/8			4	10		12		204
4996830	Lower South Fork Provo R at Vivian Park	1	1	1	1	1		1		1	1	1	1	10	10	10	10			10						10				120
4996850	Lower North Fork of Provo R at Wildwood	1	1	1	1	1		1		1	1	1	1	10	10	10	10		10	10						10				130
4996870	Little Deer Creek above cnfl with Provo River	1	1	1	1	1		1		1	1	1	1	10	10	10	10			10						10				120
4998140	Weber Provo Canal Diversion at US189	1	1	1	1	1		1		1	1	1	1	10	10	10	10									10				100
4998400	Provo River above Woodland at USGS gage	1	1	1	1	1		1		1	1	1	1	10	10	10		10			10				4		10			332
	HEBER VALLEY																													
5911120	Northwestward Flow to Provo R. (Flood Control)	1	1	1	1	1		1		2	2	2	2	14	14	14	14									14				140
4997250	Spring Creek at entrance to Provo River E of WWTP	1	1	1	1	1		1		1	1	1	1	10	10	10	10				10				4	10				172
5910273	Sagebrush-Spring ck cnl at 1200 North, Heber	1	1	1	1	1		1		1	1	1	1	10	10	10	10				10				4	10				172
5910293	Spring ck at 1200 North, Heber.	1	1	1	1	1		1		1	1	1	1	10	10	10	10				10				4	10				172
	POINT SOURCES																													
4929000	Kamas Fish Hatchery effluent	1		1		1		1		1		1		6	6	6	6									6				60
4997130	Midway Fish Hatchery comp below two outfalls	1		1		1		1		1		1		6	6	6	6									6				60
4998040	Ontario #2 Drain Tunnel (Park City Ventures)	1		1		1		1		1		1		6	6	6	6				6				6	6				150
	JORDANELLE / DEER CREEK BASIN STATIONS																													
4997670	McHenry Creek below Mayflower	1	1	1	1	1		1		2	2	2	2	14	14	14	14			14	14				4	14				234
	QA / QC PROGRAM																													
4896890	Quality Control samples on one selected stream site	1	1	1	1	1		1		2	2	2	2	14	14	14	14			14	14				4	14				262
5913490	Quality Control samples on Deer Creek Reservoir	1	1	1	1			1		1		1	1	8	8	8	8				8		8		4	8				156
	Total Sample Sites:								Total Samples:					478	478	470	436	34	90	78	232		56	4	78	436		72		7112

Reservoir Profiles

In addition to the reservoir sampling as described above, temperature, dissolved oxygen, specific conductance, redox potential, and pH data were gathered at seven 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 these conditions can be the cause of anaerobic activity, loss of aquatic wildlife, and undesired taste and odors. For lakes and reservoirs the 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 the DO, thus creating an anaerobic environment. The profiles provided in this report 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. PRWC has also funded a portion of groundwater monitoring 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

SURFACE WATER CLASSIFICATIONS

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 5,000 maximum total coliforms per 100 mL and 2000 total maximum fecal coliforms per 100 mL. The standards set for Class 2A recreational use water is 1000 maximum total coliforms per 100 mL and 200 maximum total fecal coliforms per 100 mL. The standards set for Class 2B recreational use water is 5,000 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 the Appendix.

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. PRWC, 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 streams in the Provo River Watershed.

PRWC General Standards

Table 3 - 2 is a summary of the PRWC standards that were used to analyze the water quality data and identify potential problems.

Table 3 - 2 PRWC 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 Phosphorus as P (mg/L)	0.04/0.025*
Dissolved Phosphorus as P (mg/L)	0.04/0.025*

* The first value is used for streams and rivers; the 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. The newest water quality standards no longer include temperature as a criterion in determining maximum ammonia concentrations in Class 3A waterways. The State has established the following equation for the determination of maximum allowed ammonia concentrations:

$$\text{mg/L as N (Acute)} = (0.275/(1+10^{7.204-pH})) + (39.0/(1+10^{pH-7.204}))$$

Use of the equation will generate the chart used for this report, which is given below in Table 3 - 3.

Table 3 - 3 1-Hour Average Allowable Concentrations (mg/L) of Ammonia as N for Class 3A Waters

pH	Ammonia Limit (mg/l)
6.5	32.6
6.6	31.3
6.7	29.8
6.8	28.1
6.9	26.2
7.0	24.1
7.1	22.0
7.2	19.7
7.3	17.5
7.4	15.4
7.5	13.3
7.6	11.4
7.7	9.65
7.8	8.11
7.9	6.77
8.0	5.62
8.1	4.64
8.2	3.83
8.3	3.15
8.4	2.59
8.5	2.14
8.6	1.77
8.7	1.47
8.8	1.23
8.9	1.04
9.0	0.89

The state standard for ammonia has also been adopted by the PRWC to monitor water quality conditions. It should be noted that the new standard is significantly different from the previous standard for this parameter.

State Dissolved Metal Standards

Part of the PRWC 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 have few set standards on dissolved metal concentrations.

Table 3 - 4 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. Due to recent rule changes, beryllium and nickel have been added to the table and some of the limits have changed from previous years. The italicized entries are those that are different from previous years.

Table 3 - 4 Dissolved Metals Allowable Concentrations for 1-hr average measurements

Dissolved Metal	Allowable Concentration (µg/L)		
	Class 1C	Class 3A	Class 4
Aluminum		**750**	
Arsenic	***10***	*340*	100
Barium	**1000**		
Beryllium	***4***		
Cadmium	10	***2***	10
Chromium	50	**16**	100
Copper		***13***	200
Iron		**1000**	
Lead	***15***	*65*	100
Mercury	**2**	2.4	
Nickel		***468***	
Selenium	*50*	***18.4***	50
Silver	50	***1.6***	
Zinc		**120**	

Total Organic Carbon

Total organic carbon (TOC) provides a speedy and convenient way of determining the degree of organic contamination. By using TOC measurements, the number of carbon-containing compounds in a source can be determined. Organic contaminants (natural organic substances, insecticides, herbicides, and other agricultural chemicals) enter waterways in rainfall runoff. Domestic and industrial wastewaters also contribute organic contaminants in various amounts. As a result of accidental spills or leaks, industrial organic wastes may enter streams. The amount of carbon in a freshwater stream is an indicator of the organic character of the stream. The larger the carbon or organic content, the more oxygen is consumed. A high organic content means an increase in the growth of microorganisms that contribute to the depletion of oxygen supplies. The high TOC values are used as an indicator of high organic levels in the water and does not necessarily mean that there are problems with the natural balance of the reservoirs or Provo River.

Drinking water treatment processes may not completely remove all of the organic carbon. The organic carbon can become a problem for drinking water sources with the production of disinfection by-products during chlorination.

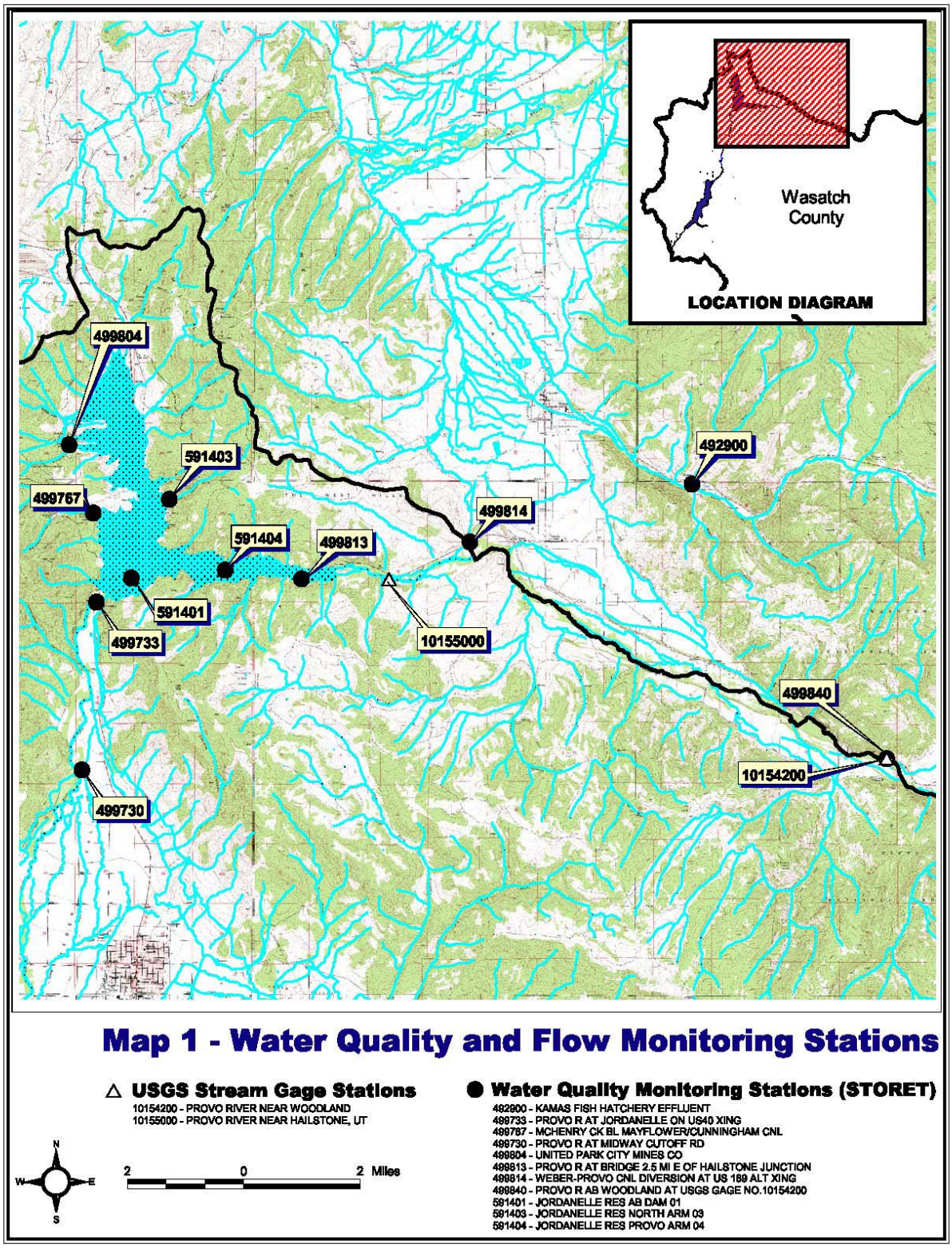
LOADING CALCULATIONS AND ASSUMPTIONS

Loading calculations are based on the water quality data gathered by PRWC and average daily flow measurements, typically taken from a USGS gage station. Loading is typically determined at each location for three 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. 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 October 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 October 1st and the first sampling date. Likewise, the loading for the period between the year's last sampling date and September 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.

Loading calculations for all stream sampling sites are included in Appendix A.



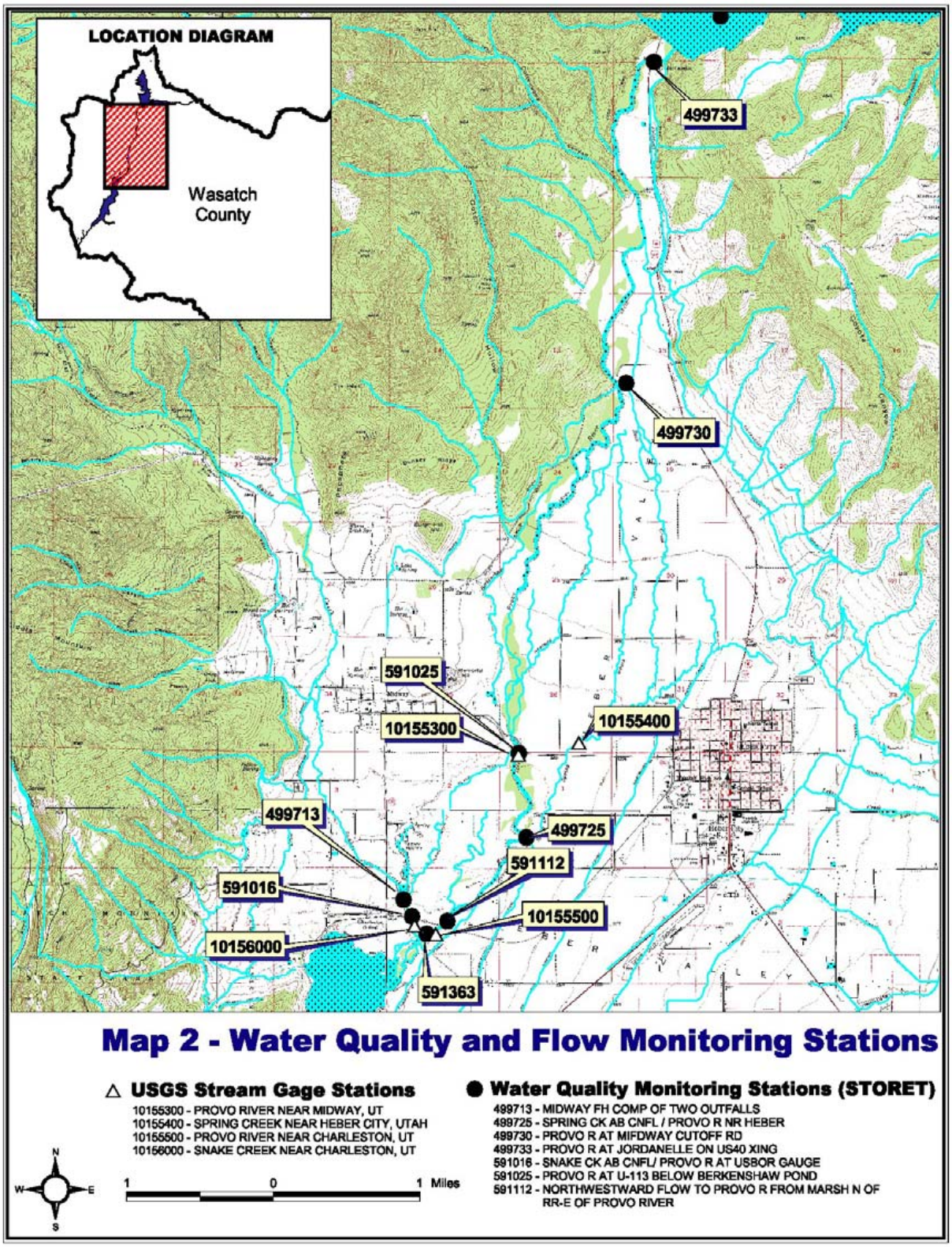
Map 1 - Water Quality and Flow Monitoring Stations

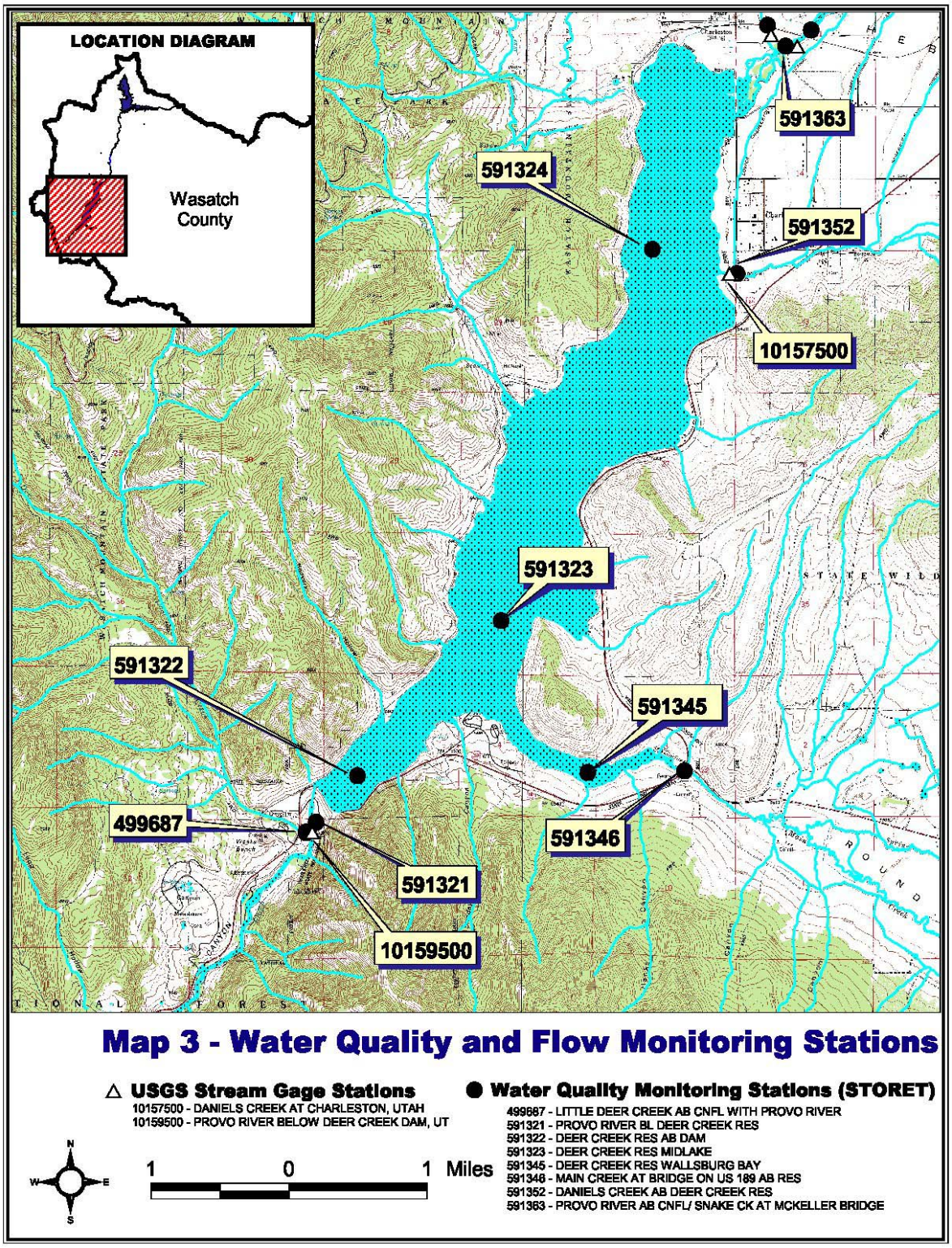
△ USGS Stream Gage Stations

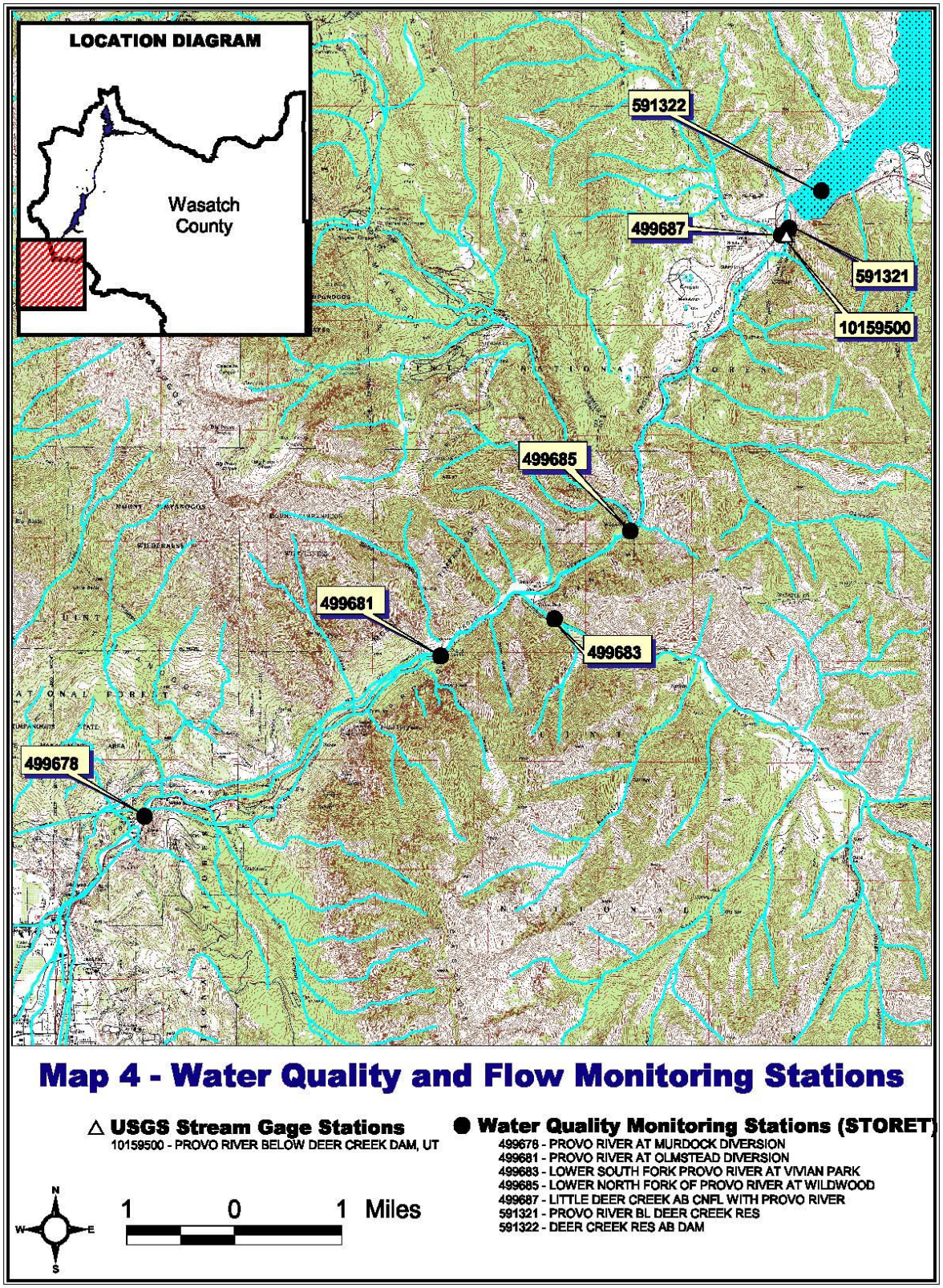
10154200 - PROVO RIVER NEAR WOODLAND
10155000 - PROVO RIVER NEAR HAILSTONE, UT

● Water Quality Monitoring Stations (STORET)

492900 - KAMAS FISH HATCHERY EFFLUENT
499733 - PROVO R AT JORDANELLE ON US40 XING
499787 - MCHENRY CK BL MAYFLOWER/CUNNINGHAM CNL
499730 - PROVO R AT MIDWAY CUTOFF RD
499804 - UNITED PARK CITY MINES CO
499813 - PROVO R AT BRIDGE 2.5 MI E OF HAILSTONE JUNCTION
499814 - WEBER-PROVO CNL DIVERSION AT US 189 ALT XING
499840 - PROVO R AB WOODLAND AT USGS GAGE NO.10154200
591401 - JORDANELLE RES AB DAM 01
591403 - JORDANELLE RES NORTH ARM 03
591404 - JORDANELLE RES PROVO ARM 04


LOCATION DIAGRAM
Wasatch County
499733
499730
591025
10155300
10155400
499713
499725
591112
591016
10155500
10156000
591363
Map 2 - Water Quality and Flow Monitoring Stations
△ USGS Stream Gage Stations
10155300 - PROVO RIVER NEAR MIDWAY, UT
10155400 - SPRING CREEK NEAR HEBER CITY, UTAH
10155500 - PROVO RIVER NEAR CHARLESTON, UT
10156000 - SNAKE CREEK NEAR CHARLESTON, UT
● Water Quality Monitoring Stations (STORET)
499713 - MIDWAY FH COMP OF TWO OUTFALLS
499725 - SPRING CK AB CNFL / PROVO R NR HEBER
499730 - PROVO R AT MIDWAY CUTOFF RD
499733 - PROVO R AT JORDANELLE ON US40 XING
591016 - SNAKE CK AB CNFL/ PROVO R AT USBOR GAUGE
591025 - PROVO R AT U-113 BELOW BERKENSHAW POND
591112 - NORTHWESTWARD FLOW TO PROVO R FROM MARSH N OF RR-E OF PROVO RIVER
N
W
E
S
1 0 1 Miles


LOCATION DIAGRAM
Wasatch County
591363
591324
591352
10157500
591323
591322
591345
499687
591346
591321
10159500
Map 3 - Water Quality and Flow Monitoring Stations
△ USGS Stream Gage Stations
10157500 - DANIELS CREEK AT CHARLESTON, UTAH
10159500 - PROVO RIVER BELOW DEER CREEK DAM, UT
● Water Quality Monitoring Stations (STORET)
499687 - LITTLE DEER CREEK AB CNFL WITH PROVO RIVER
591321 - PROVO RIVER BL DEER CREEK RES
591322 - DEER CREEK RES AB DAM
591323 - DEER CREEK RES MIDLAKE
591345 - DEER CREEK RES WALLSBURG BAY
591346 - MAIN CREEK AT BRIDGE ON US 189 AB RES
591352 - DANIELS CREEK AB DEER CREEK RES
591363 - PROVO RIVER AB CNFL/ SNAKE CK AT MCKELLER BRIDGE
N
W
E
S
1 0 1 Miles


LOCATION DIAGRAM
Wasatch County
591322
499687
591321
10159500
499685
499681
499683
499678
Map 4 - Water Quality and Flow Monitoring Stations
△ USGS Stream Gage Stations
10159500 - PROVO RIVER BELOW DEER CREEK DAM, UT
● Water Quality Monitoring Stations (STORET)
499676 - PROVO RIVER AT MURDOCK DIVERSION
499681 - PROVO RIVER AT OLMSTEAD DIVERSION
499683 - LOWER SOUTH FORK PROVO RIVER AT VIVIAN PARK
499685 - LOWER NORTH FORK OF PROVO RIVER AT WILDWOOD
499687 - LITTLE DEER CREEK AB CNFL WITH PROVO RIVER
591321 - PROVO RIVER BL DEER CREEK RES
591322 - DEER CREEK RES AB DAM
N
W
E
S
1 0 1 Miles

CHAPTER 4 – UPPER PROVO RIVER and JORDANELLE RESERVOIR

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, PRWC monitored three stream sampling locations and two point source discharge locations during the 2005 water year. 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
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 exceedances for temperature, dissolved oxygen, pH, total suspended solids, ammonia, dissolved phosphorus, and total dissolved phosphorus. A more complete analysis of the data is included in the Appendix

Provo River above Woodland, STORET # 4998400

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 in the table below. The location was sampled nine times during the 2005 water year. There were no exceedances of water quality parameters as is typical of this site.

Provo River above Woodland, 4998400 – Water Quality Summary

	Temperature (º C)	TP (mg/l)	DTP (mg/l)	TDS (mg/l)	TSS (mg/l)	Ammonia (mg/l)
Average	5.9	0.00	0.00	107.3	3.0	n/a
Maximum	11.9	0.01	0.00	166.0	10.4	n/a
Minimum	1.8	0.00	0.00	54.0	0.0	n/a

Kamas Fish Hatchery Effluent, STORET # 4929000

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.

Kamas Fish Hatchery Effluent, 4929000 – Water Quality Summary

	Temperature (º C)	TP (mg/l)	DTP (mg/l)	TDS (mg/l)	TSS (mg/l)	Ammonia (mg/l)
Average	10.7	0.06	0.05	254.3	0.4	0.48
Maximum	15.3	0.10	0.07	274.0	4.0	0.76
Minimum	7.6	0.00	0.03	228.0	0.0	0.30

The temperature was recorded 16 times during the 2005 water year. However, other water quality parameters were measured only six times. Total Phosphorus measurements exceeded the PRWC Standard three out of the six times and Dissolved Total Phosphorus measurements exceeded the standard five out of the six times.

Weber Provo Canal Diversion, STORET # 4998140

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. This site was monitored seven times during the 2005 water year and had no exceedances of water quality standards.

Weber Provo Canal Diversion at US 189, 4998140 – Water Quality Summary

	Temperature (º C)	TP (mg/l)	DTP (mg/l)	TDS (mg/l)	TSS (mg/l)	Ammonia (mg/l)
Average	5.9	0.01	0.00	126.0	8.2	0.02
Maximum	14.4	0.03	0.00	170.0	26.0	0.06
Minimum	0.7	0.00	0.00	84.0	0.0	0.00

Provo River above Hailstone, STORET # 4998130

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. This location was monitored nine times during the 2005 water year. Phosphorus results were consistent with historical results, typically present in low concentrations.

Provo River above Hailstone, 4998130 – Water Quality Summary

	Temperature (º C)	TP (mg/l)	DTP (mg/l)	TDS (mg/l)	TSS (mg/l)	Ammonia (mg/l)
Average	7.1	0.00	0.00	125.8	5.1	0.02
Maximum	14.8	0.02	0.00	176.0	25.6	0.10
Minimum	1.7	0.00	0.00	68.0	0.0	0.00

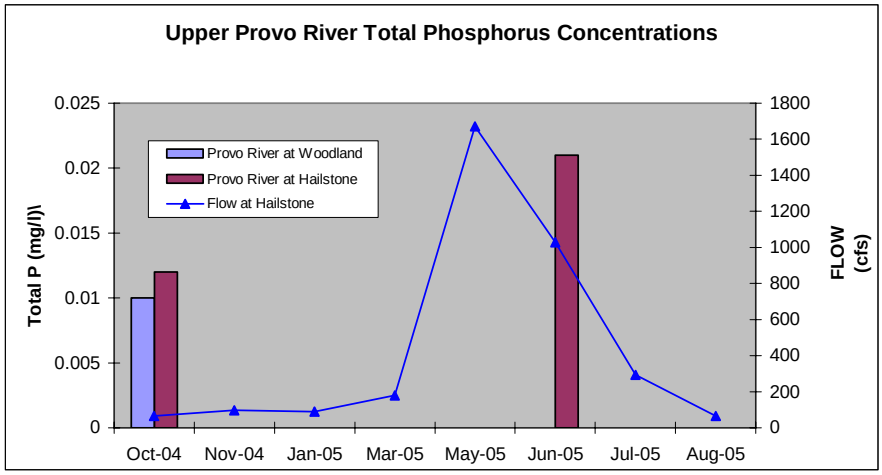


Figure 4 - 1 Upper Provo River Total Phosphorus Concentrations

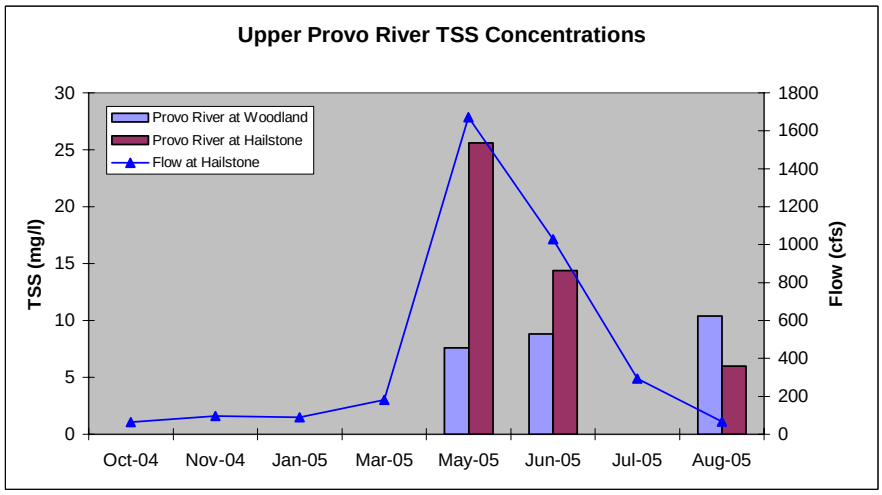


Figure 4 - 2 Upper Provo River TSS Concentrations

Figure 4 - 1 and Figure 4 - 2 compare the TP and TSS concentrations at Woodland to those 10-miles downstream at Hailstone. As in past years there was a peak in both TP and TSS during the summer. These trends generally correlate with the flow. However, there was also a spike during the fall of 2004 which is uncommon.

McHenry Creek below Mayflower, STORET # 4997670

This monitoring site is located on the west side of Jordanelle Reservoir where McHenry Creek flows into the reservoir. The site is also serves as a detention pond for Highway 40. McHenry Creek lays in the same drainage as the Mayflower mine and tailings ponds that pose a risk of surface water contamination. Development activities by Deer Valley Ski Resort further up in the drainage may also contribute to surface water contamination. A summary of the water quality data is provided below.

McHenry Creek below Mayflower, 9997670 – Water Quality Summary

	Temperature (º C)	**TP** (mg/l)	**DTP** (mg/l)	**TDS** (mg/l)	**TSS** (mg/l)	**Ammonia** (mg/l)
Average	13.9	0.02	0.01	720.3	3.8	0.04
Maximum	18.9	0.14	0.08	904.0	17.2	0.09
Minimum	9.2	0.00	0.00	450.0	0.0	0.00

This location was monitored eight times during the 2005 water year. In the fall of 2004 both the TP and DTP exceeded standards.

STREAM LOADINGS IN UPPER PROVO RIVER

The data from stream samples are used with flow data to calculate river loadings of four constituents: TSS, TDS, TP, and DTP. These calculations can be found in Appendix A.

Table 4 - 1 and Figure 4 - 3 illustrate the results of the loading calculations.

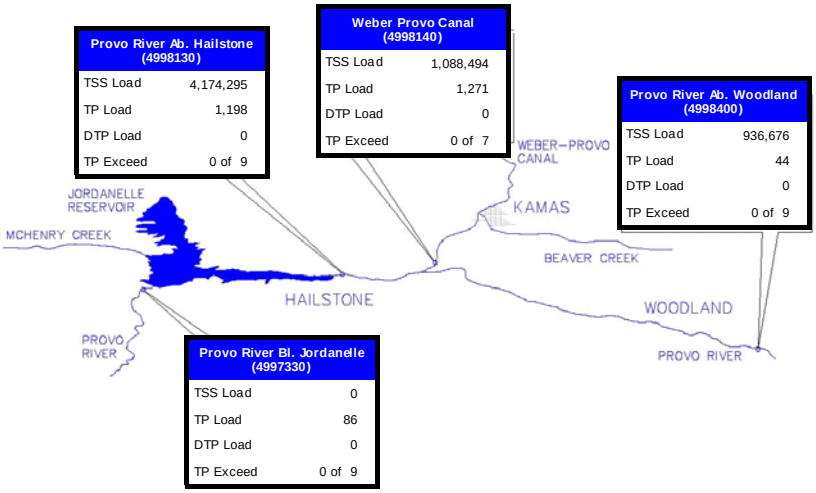


Figure 4 - 3 Upper Provo River Loading Overview

Table 4 - 1 Upper Provo River Loading Summary

	2000	2001	2002	2003	2004	2005
Provo River at Woodland STORET 4998400						
Weighted Average Flow (cfs)	138	342	132	112	123	226
TP Weighted Average (mg/l)	0	0.04	0	0	0	0
TP Annual Load (kg/yr)	106	13,385	223	228	0	44
DTP Weighted Average (mg/l)	0.01	0	0	0	0	0
DTP Annual Load (kg/yr)	786	0	0	106	0	0
TSS Weighted Average (mg/l)	4.6	68.1	0.3	n/a	0.99	3.0
TSS Annual Load (kg/yr)	559,772	20,735,744	35,304	n/a	108,736	936,676
Kamas Fish Hatchery STORET 4929000						
Weighted Average Flow (cfs)	4.1	4.3	3.7	7.58	3.98	4.6
TP Weighted Average (mg/l)	0.17	0.04	0.1	0.31	0.09	0.06
TP Annual Load (kg/yr)	610	156	341	2,075	319	224
DTP Weighted Average (mg/l)	0.07	0.03	0.11	0.16	0.06	0.05
DTP Annual Load (kg/yr)	256	97	374	1,103	204	185
TSS Weighted Average (mg/l)	0	0	0	n/a	0	0.4
TSS Annual Load (kg/yr)	0	0	0	n/a	0	1,190
Weber Provo Canal STORET 4998140						
Weighted Average Flow (cfs)	43	-	-	27	-	133
TP Weighted Average (mg/l)	0.01	-	-	0.00	-	0.01
TP Annual Load (kg/yr)	498	-	-	120	-	1,271
DTP Weighted Average (mg/l)	0	-	-	0.01	-	0
DTP Annual Load (kg/yr)	467	-	-	146	-	0
TSS Weighted Average (mg/l)	9.4	-	-	n/a	-	8.2
TSS Annual Load (kg/yr)	359,197	-	-	n/a	-	1,088,494
Provo River at Hailstone STORET 4998130						
Weighted Average Flow (cfs)	163	347	197	140	271	394
TP Weighted Average (mg/l)	0.01	0.07	0.02	0	0	0
TP Annual Load (kg/yr)	1,560	22,785	2,979	0	153	1,198
DTP Weighted Average (mg/l)	0.01	0	0	0	0	0
DTP Annual Load (kg/yr)	969	78	232	0	0	0
TSS Weighted Average (mg/l)	8.1	69	2.51	n/a	1.36	5.1
TSS Annual Load (kg/yr)	1,180,828	21,411,976	441,560	n/a	328,212	4,174,295
Provo River below Jordanelle STORET 4997330						
Weighted Average Flow (cfs)	243	205	205	196	278	285
TP Weighted Average (mg/l)	0.02	0	0	0	0	0
TP Annual Load (kg/yr)	4,781	0	862	0	0	86
DTP Weighted Average (mg/l)	0.01	0	0	0	0	0
DTP Annual Load (kg/yr)	1,413	0	483	326	0	0
TSS Weighted Average (mg/l)	0	0	1.62	n/a	18	0
TSS Annual Load (kg/yr)	0	0	295,871	n/a	45,705	0
Provo River TP Increase Ratio	**14.7**	**1.7**	**13.4**	**0.0**	**n/a**	**27.2**

As shown in Figure 4-3 a majority of the Total Phosphorus load comes from the Weber Provo Canal. As is historically typical, the loadings at Woodland are quite low (typically near or below the limit of detection). This stretch above Jordanelle Reservoir exhibits signs of a healthy, good quality river.

Comparisons to Target Loads

Target loads were calculated in the 1999 Wasatch County Water Quality Management Plan. In the Upper Provo River they were calculated for the Provo River at Woodland, Kamas Fish Hatchery, and Provo River at Hailstone. The following table shows the comparisons of 2005 loadings to the annual target loads. The 2003 TP Load exceeded the target load at Kamas Fish Hatchery.

Upper Provo River Target Loads for Total Phosphorous

STORET	Location	Target Load (kg/yr)	2005 TP Load (kg)
4998400	Provo River at Woodland	7,681	44
4929000	Kamas Fish Hatchery Provo	173	224
4998130	Provo River at Hailstone	9,837	1,198

JORDANELLE RESERVOIR MONITORING

On the Jordanelle Reservoir, PRWC monitored three locations during the 2005 water year. 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 with the most critical characteristic being dissolved oxygen (DO). The three monitoring locations are as follows:

STORET	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 exceedances for temperature, dissolved oxygen, pH, total suspended solids, ammonia, dissolved phosphorus, and total dissolved phosphorus.

Provo Arm, STORET #5914040

The Provo River Arm of Jordanelle Reservoir was sampled seven times during the water year. Samples were collected at the surface of the reservoir and at the reservoir bottom approximately 40 meters deep. A combined depth summary of the water quality data for the surface and bottom is shown below.

Jordanelle Reservoir Provo Arm, STORET 5914040 Water Quality Summary

	D.O	Temperature	TP	DTP	TDS	TSS	Ammonia

	(mg/l)	(º C)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)
Average	7.3	10.4	0.00	0.01	96	0.5	0.01
Maximum	10.1	21.5	0.00	0.04	156	6.4	0.07
Minimum	4.0	4.6	0.00	0.00	22	0	0.00

Two exceedances of the temperature standard were recorded at this location during July and August of 2005. Additionally, the phosphorus standard was exceeded once during the water year. Historically, there have been exceedances associated with high water temperatures on the reservoir surface and some exceedances in the phosphorus standards.

North Arm, STORET #5914030

The north arm of Jordanelle Reservoir was sampled seven times during the water year. Samples were collected at the surface of the reservoir and the reservoir bottom. A combined depth summary of the water quality data for the surface and bottom is shown below.

Jordanelle Reservoir North Arm, STORET 5914030 Water Quality Summary

	D.O (mg/l)	**Temperature** (º C)	**TP** (mg/l)	**DTP** (mg/l)	**TDS** (mg/l)	**TSS** (mg/l)	**Ammonia** (mg/l)
Average		10.5		0.00	109	0.4	0.01
Maximum		21.6		0.02	154	5.6	0.06
Minimum		5.4		0.00	62	0	0.00

There were two exceedance of the temperature standard during the 2005 water year, which occurred at the surface in July and August 2005. Historically, there have been exceedances associated with temperature, phosphorous, and low DO levels.

Above Dam, STORET #5914010

A combined depth summary of the water quality data for the Jordanelle Above Dam station is provided below.

Jordanelle Reservoir Above Dam, STORET 5914010 Water Quality Summary

	D.O (mg/l)	**Temperature** (º C)	**TP** (mg/l)	**DTP** (mg/l)	**TDS** (mg/l)	**TSS** (mg/l)	**Ammonia** (mg/l)
Average	7.3	9.7	0	0	109	0.2	0.02
Maximum	10.6	21.3	0	0	204	4.4	0.16
Minimum	4.0	4.6	0	0	0	0	0.00

The Above Dam station exhibited good water quality for most of the year. There were two exceedances of the temperature standard during the 2005 water year, which occurred at the surface in July and August 2005.

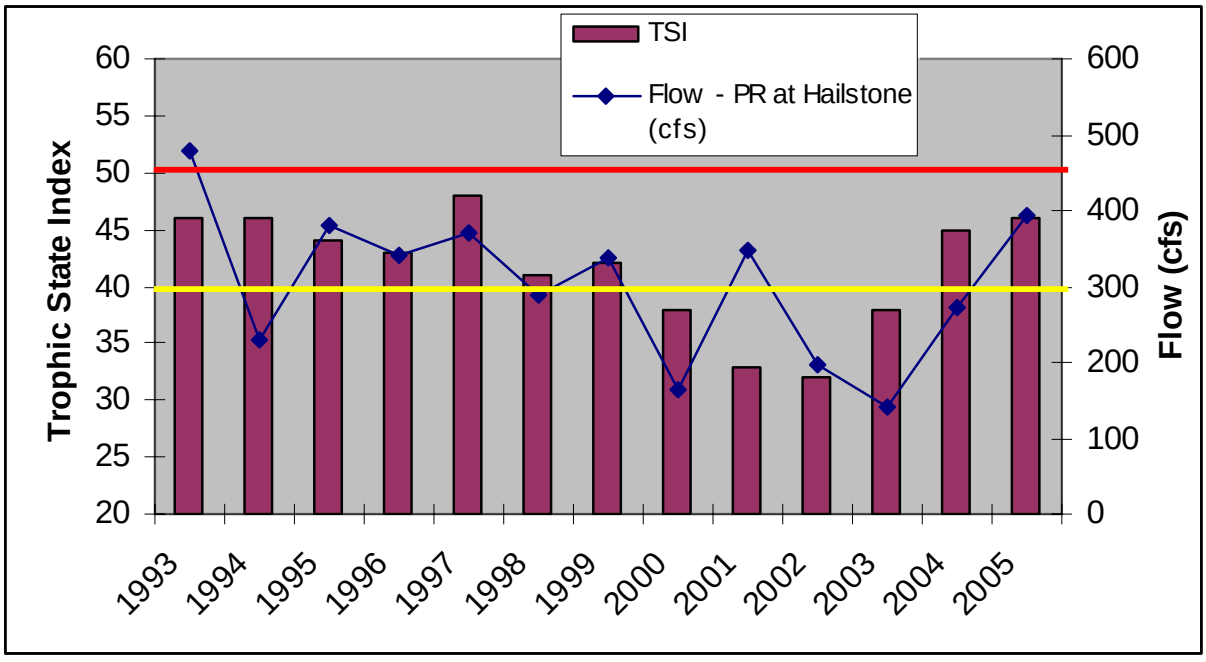
JORDANELLE TROPHIC STATE INDEX

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 Chlorophyll A or secchi depth data from May to September. Table 4 - 2 shows the TSI results for Jordanelle Reservoir for the 2005 water year. And Figure 4 - 4 compares the calculated TSI value to historical values that have been calculated since 1993 when the reservoir first began to fill.

Table 4 - 2 Carlson Trophic State Index (TSI) Calculations for Jordanelle Reservoir

Date	Jordanelle Res North Arm		Jordanelle Res Provo Arm		Jordanelle Res ab Dam	
	Chlorophyll a	Secchi Disk Depth	Chlorophyll a	Secchi Disk Depth	Chlorophyll a	Secchi Disk Depth
5/17/05	4.5	1.7	6.6	1.6	5.7	1.9
6/21/05	1.7	2.7	6.5	1.9	3.1	2.9
7/19/05	4.3	2.0	5.6	2.3	3.7	2.7
8/16/05	4.0	2.0	3.3	2.0	3.0	3.0
9/21/05	3.8	2.6	3.1	3.6	4.3	4.7
Average	3.7	2.2	5.0	2.3	4.0	3.0
TSI 46	43	49	46	48	44	44

Figure 4 - 4 Jordanelle Reservoir TSI and Provo River Average Flow 1993 - 2005



DISSOLVED METALS ANALYSIS

The dissolved metal concentrations were analyzed for samples from several sites on the Provo River, McHenry Creek and three sites in the Jordanelle Reservoir. Samples

were collected between one and three times during the 2005 water year. The specific stations sampled and the number of times sampled during the water year are shown in Table 4 - 3.

Table 4 - 3 Metal Sampling events in the Upper Provo River and Jordanelle Reservoir

Station Name	STORET No.	Number of Sampling Events
Provo River above Hailstone	4998130	3
Weber Provo Canal Diversion at US 189	4998140	2
Provo River above Woodland	4998400	3
McHenry Creek below Mayflower	4997670	2
Jordanelle Reservoir-Above Dam	5914010	1
Jordanelle Reservoir-North Arm	5914030	2
Jordanelle Reservoir-Provo River Arm	5914040	1

Few dissolved metals were detectable, and the ones that were detected occurred in concentrations well below the water quality standards outlined in Table 3.5, with one notable exception.

Samples taken from McHenry Creek below Mayflower (STORET No. 4997670) exceeded standards for cadmium, copper and zinc as shown in Table 4 - 4. This is an area of great concern. McHenry Creek drains developments in an abandoned mining area and is supposed to be monitored routinely by the property owners. There have been problems with this monitoring and data has not appropriately been provided to regulatory authorities.

When the excursions above standards were noted for this station from the 2005 sampling, a search was made for other data for this station from earlier time periods. Data from 2004 was found as well as one sample each from 1999 and 2003. Similar values exceeding standards were found in data from samples taken during the 2004 water year from this site. These are also shown in Table 4 - 4. The table lists all values reported for cadmium, copper, and zinc in the 2004 and 2005 water years with those that exceeded limits shown in a bold font. This is an area of concern and will be discussed in Chapter 8 of this report.

Table 4 - 4 Metal results from McHenry Creek below Mayflower (Station No. 4997670)

Date	Cd (µg/L)	Cu (µg/L)	Zn (µg/L)
27-Apr-04	ND	ND	76.8
25-May-04	**4.2**	ND	**476**
23-Jun-04	2.43	ND	**254**
24-Aug-04	1.26	ND	**211**
22-Sep-04	ND	ND	**181**
11-May-05	**7.85**	**19.9**	**1000**
23-Aug-05	1.99	ND	**250**

TOTAL ORGANIC CARBON

Figure 4 - 5 shows TOC concentrations in the Jordanelle Reservoir for the 2004 and 2005 water years. Concentrations are well within the typical range of TOC for surface water. Maximum concentrations are less than 5 mg/L at all stations. Figure 4 - 6 shows the TOC results from several points that feed into the reservoir. Again, values for the 2005 water year are all less than 5 mg/L. There is a general profile for both water years that shows an increase in TOC concentration during the high runoff periods, which is expected.

The only anomaly in the data at the McHenry Creek station (STORET No. 4997670) was that the highest point occurs in October of 2004. There is no indication in the data as the cause of this higher value, but it may be due to some point variance such as a rainstorm. Regardless of cause, the value is still less than 5 mg/L and is not a significant cause for concern. There are no other significant changes in TOC concentration in this part of the watershed.

See Chapter 3 of this report for a discussion of the overall significance of TOC concentrations

Figure 4 - 5 Jordanelle Reservoir TOC Concentrations

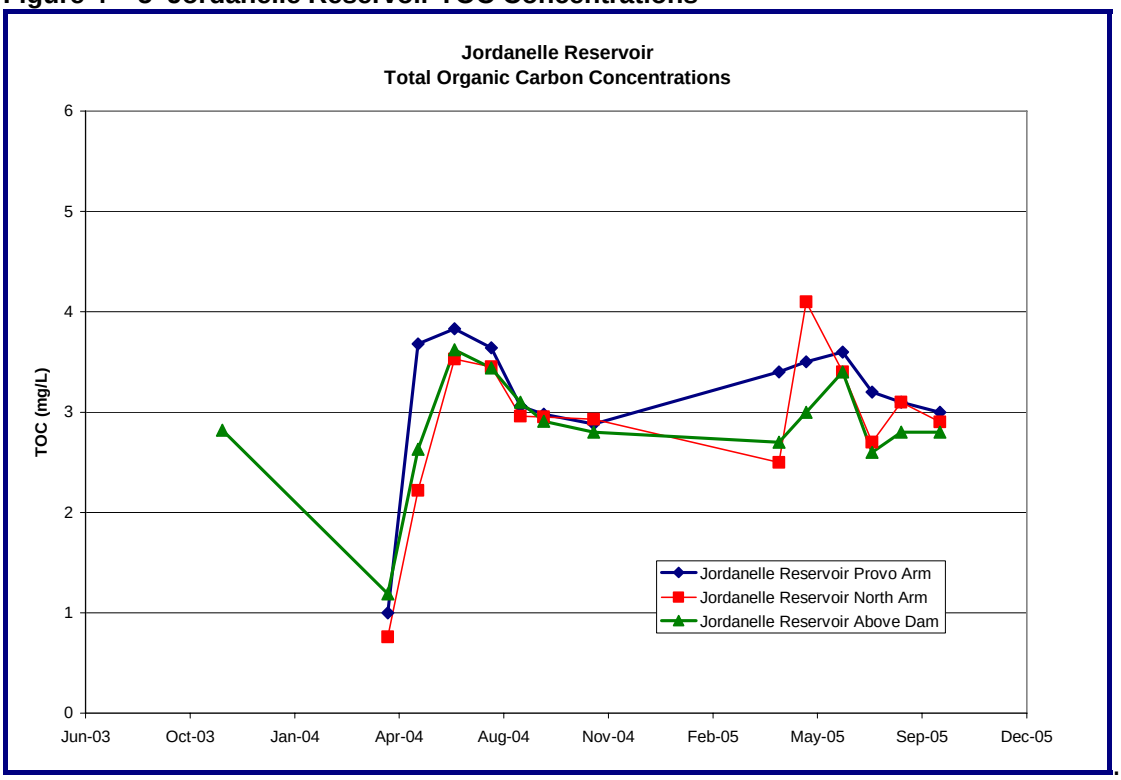
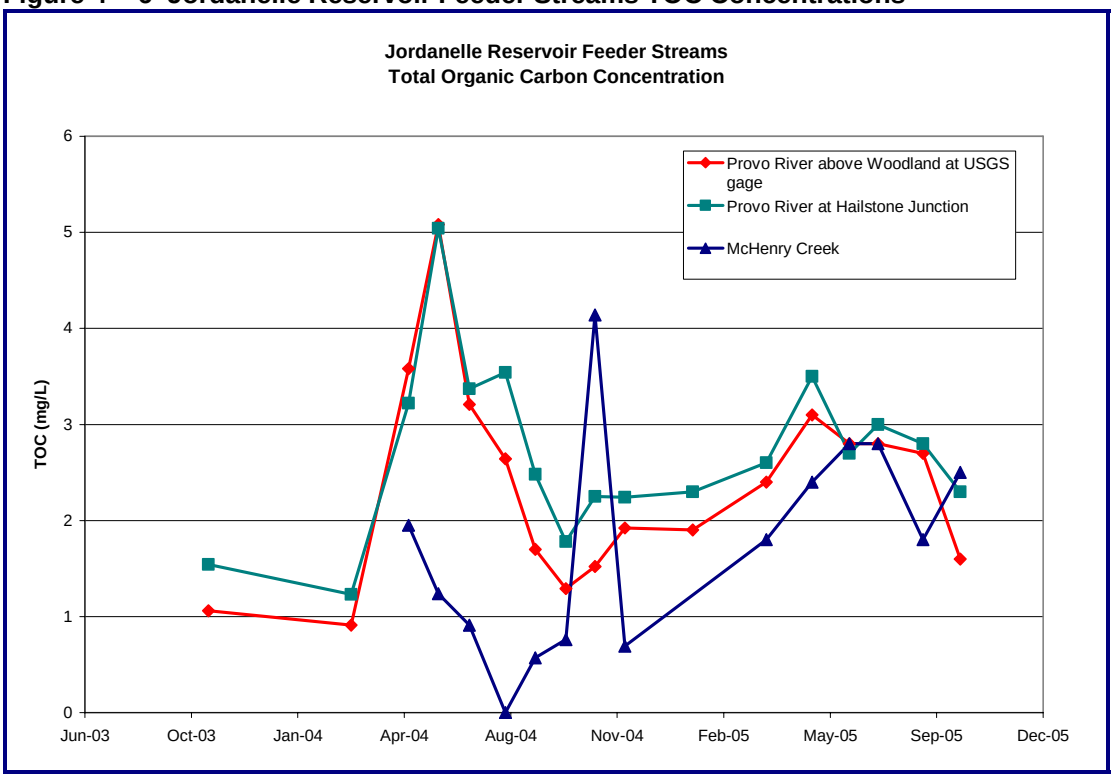


Figure 4 - 6 Jordanelle Reservoir Feeder Streams TOC Concentrations



CHAPTER 5 – MIDDLE PROVO RIVER THROUGH HEBER VALLEY

INTRODUCTION

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

STREAM MONITORING RESULTS

In the area of the Heber Valley Basin, PRWC monitored nine stream locations and one point source location during the 2005 water year as follows:

STORET No.	Location Description
4997330	Provo River below Jordanelle Dam
4997300	Provo River at River Road
5910250	Provo River at Heber-Midway Bridge below Berkenshaw Pond
4997250	Spring Creek entrance to Provo River
5911120	County Flood Control Channel at Provo River
5913630	Provo River at McKeller Bridge above Deer Creek
4997130	Midway Fish Hatchery Effluent
5910160	Snake Creek above Deer Creek at RR Crossing
5910273	Sagebrush-Spring Creek Canal at 1200 North
5910293	Spring ck at 1200 North, Heber

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 exceedances for temperature, dissolved oxygen, pH, total suspended solids, ammonia, dissolved phosphorus, and total dissolved phosphorus. A more complete analysis of the data is included in the Appendix.

Provo River below Jordanelle Dam, STORET #4997330

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 in the table below.

Provo River below Jordanelle Dam, STORET 4997330 Water Quality Summary

	Temperature (º C)	TP (mg/l)	DTP (mg/l)	TDS (mg/l)	TSS (mg/l)	Ammonia (mg/l)
Average	8.2	0.00	0.00	129.8	0.0	0.03

Maximum	12.4	0.01	0.00	166.0	0.0	0.10
Minimum	3.4	0.00	0.00	88.0	0.0	0.00

Nine samples were taken at this site during the 2005 water year. No exceedances were recorded. This site traditionally has low levels of phosphorus and solids. Figure 5- 1, below, illustrates the significant reduction in both Total Phosphorus and Total Dissolved Solids at this station since operation of the dam began in 1992.

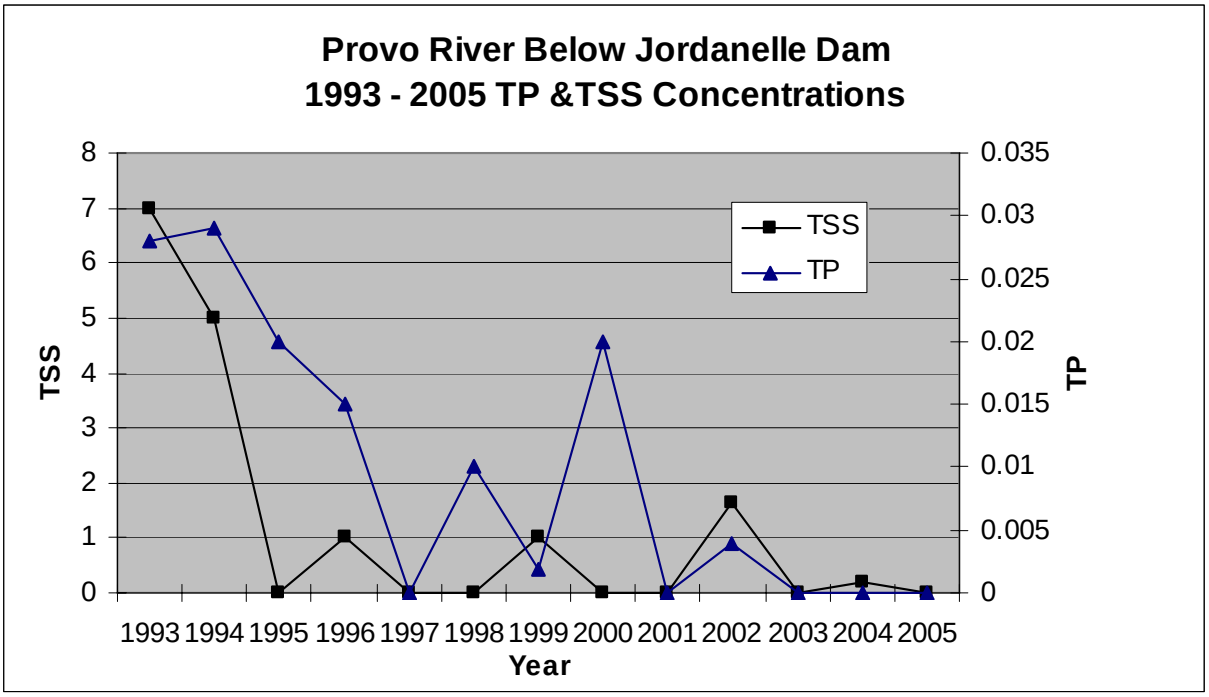


Figure 5- 1 Provo River Below Jordanelle Dam Historical TP & TSS Concentration

County Flood Control Channel at Provo River, STORET #5911120

This station is located to sample water flowing northwestwardly from the marsh north of the railroad east of Provo River. A summary of the water quality data for this location is shown in table below.

County Flood Control Channel at Provo River, STORET 5911120 Water Quality Summary

	Temperature (º C)	TP (mg/l)	DTP (mg/l)	TDS (mg/l)	TSS (mg/l)	Ammonia (mg/l)
Average	14.8	0.08	0.03	169.2	56.2	0.04
Maximum	24.2	0.16	0.06	200.0	134.0	0.08
Minimum	7.1	0.03	0.00	132.0	0.0	0.00

This site was monitored five times during the 2005 water year. Total Phosphorus and Dissolved total phosphorus exceeded the PRWC standards three times and two times respectively during the summer. Additionally, the temperature of the water exceeded state standards twice during the July and August. Since this is a channel that directs

flood waters from Heber City, which includes urban runoff, this site should be monitored closely in the future.

Provo River at River Road Crossing, STORET #4997300

This station is located midway between the Jordanelle Dam and Deer Creek Reservoir. A summary of the water quality data for this location is shown in Table below.
This monitoring site is located on Provo River below Berkenshaw Pond. A summary of the water quality data for this location is shown below in Table 5.4.

Provo River at River Road Crossing, STORET 4997300 Water Quality Summary

	Temperature (º C)	TP (mg/l)	DTP (mg/l)	TDS (mg/l)	TSS (mg/l)	Ammonia (mg/l)
Average	9.1	0.01	0.00	132.0	1.1	0.03
Maximum	13.9	0.05	0.00	168.0	4.8	0.11
Minimum	4.7	0.00	0.00	86.0	0.0	0.00

This site was monitored nine times during the water year. There was one time when total phosphorus exceeded the PRWC standard. This occurred in May during the early spring runoff. This station is relatively clean. Not many pollutants were added to the river between the Jordanelle dam and this site.

Provo River at Heber-Midway Bridge below Berkenshaw Pond, STORET #5910250

This monitoring site is located on the Provo River below Berkenshaw Pond. A summary of the water quality data for this location is shown in the table below.

Provo River at Heber-Midway Bridge, STORET 5910250 Water Quality Summary

	Temperature (º C)	TP (mg/l)	DTP (mg/l)	TDS (mg/l)	TSS (mg/l)	Ammonia (mg/l)
Average	9.2	0.06	0.00	161.1	0.9	0.03
Maximum	14.6	0.56	0.00	202.0	4.4	0.11
Minimum	4.7	0.00	0.00	112.0	0.0	0.00

This site was monitored nine times during the water year. There was one time when total phosphorus exceeded the PRWC standard. This occurred in May during the early spring runoff.

Spring Creek at Entrance to Provo River East of WWTP, STORET #4997250

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 in the table below.

Spring Creek at Entrance to Provo River, STORET 4997250 Water Quality Summary

	Temperature (º C)	TP (mg/l)	DTP (mg/l)	TDS (mg/l)	TSS (mg/l)	Ammonia (mg/l)
Average	10.4	0.13	0.07	258.7	46.2	0.17
Maximum	16.8	0.34	0.14	370.0	146.0	0.60
Minimum	6.4	0.06	0.04	206.0	8.8	0.00

This site was monitored nine times during the water year. Every time the PRWC standard for Total Phosphorus was exceeded. Additionally, all but one sample exceeded the standard for DTP. This is typical for this site. Because of the phosphorus problems that are exhibited at this site additional monitoring sites were added to the annual sampling program to try and determine where the problem was coming from.

The two additional sites monitored were Spring Creek Canal at 1200 North in Heber and the Sagebrush-Spring Creek Canal at 1200 North in Heber. The flows are difficult to monitor at this point so loading is difficult to predict accurately. But by comparing the concentrations it can be seen, as shown in Table 5- 1, that the Sagebrush-Spring Creek Canal is the major contributor.

Table 5- 1 Phosphorus Concentrations for Two Sites along Spring Creek in Heber City

Date	Sagebrush-Spring Creek Canal at 1200 North, Heber STORET 5910273		Spring ck at 1200 North, Heber STORET 5910293	
	Dissolved Phosphorus	Total	Dissolved	Total
07/12/05	0.089	0.117	0.036	0.044
08/23/05	0.081	0.103		
09/27/05	0.082	0.135		

Provo River at McKeller Bridge above Deer Creek, STORET #5913630

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 loading into Deer Creek Reservoir from the Provo River. A summary of the water quality data for this location is shown in the table below.

Provo River at McKeller Bridge above Deer Creek, STORET 5913630 Water Quality Summary

	Temperature (º C)	TP (mg/l)	DTP (mg/l)	TDS (mg/l)	TSS (mg/l)	Ammonia (mg/l)
Average	10.4	0.035	0.006	187.1	33.8	0.05
Maximum	16.2	0.117	0.032	246.0	143.2	0.14
Minimum	5.1	0.000	0.000	128.0	6.4	0.00

This site was monitored nine times during the water year. The TP concentrations exceeded the PRWC standard three times in October and November, 2004 and then again in January 2005. This site historically has phosphorus exceedances.

Figure 5- 2 and Figure 5- 3 compare the concentrations of Total Phosphorus and Total Suspended Solids at various locations on the Provo River through the Heber Valley. Generally, only the station above Deer Creek Reservoir exhibits much Total Phosphorus. However, there was a large spike of Total Phosphorus at the Midway Bridge during May of 2005. The most likely culprit for this spike is sampling error, since we did not see a corresponding spike downstream from this location.

As with the phosphorus, total suspended solids were quite low in the Provo River throughout the Heber Valley except for the station above Deer Creek Reservoir. This has been one of the first years where TP or TSS has not correlated to flow in the Provo River. This would lead us to believe that the Provo River is being heavily influenced by Spring Creek.

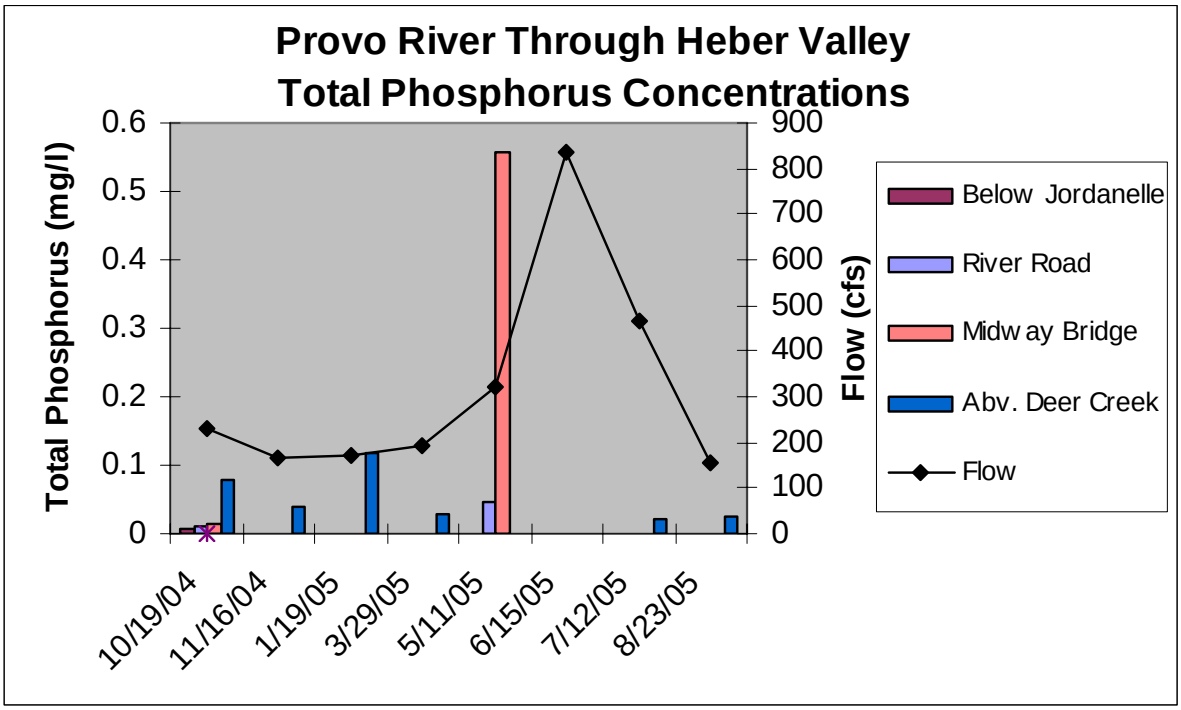


Figure 5- 2 Provo River Through Heber Valley Total Phosphorus Concentrations

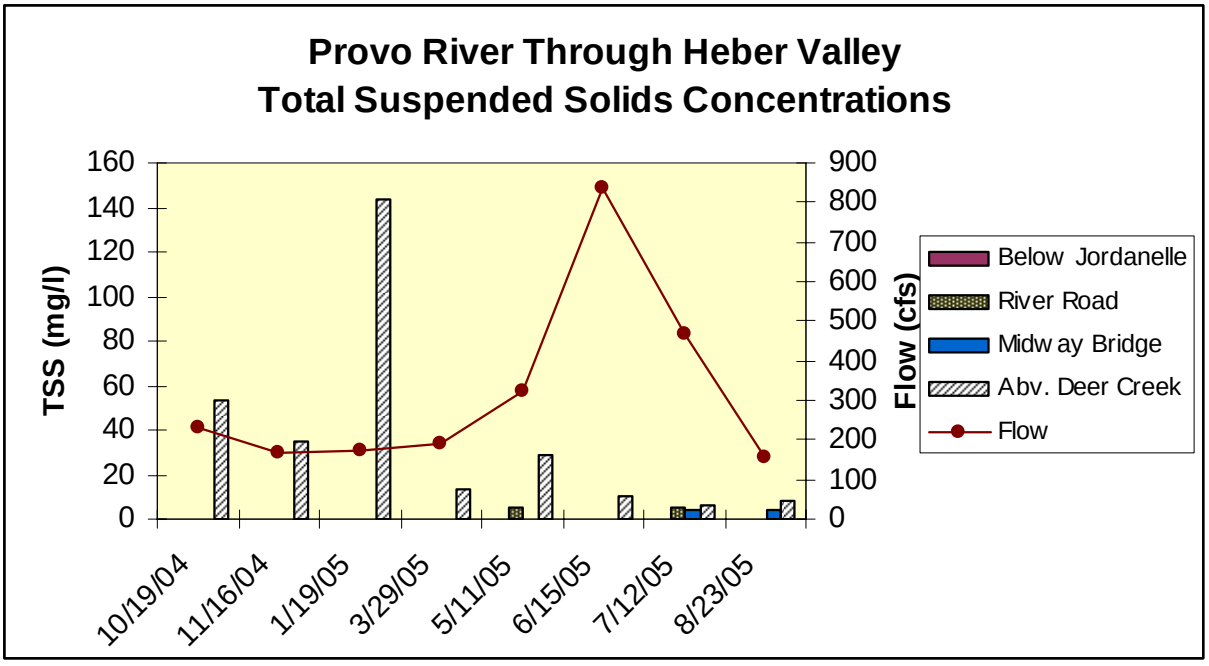


Figure 5- 3 Provo River Through Heber Valley Total Suspended Solids Concentrations

Historical trends of average annual TP and TSS for the Provo River above Deer Creek Reservoir are shown in Figure 5- 4. Prior to 1997 there was strong correlation between TP and TSS. However, since that time there has not been a direct relationship between these two constituents.

Figure 5- 5 shows the historical TP concentrations in the Provo River below Jordanelle Reservoir and above Deer Creek. Jordanelle Reservoir has effectively reduced phosphorus concentrations in the Provo River below the dam since 1993. The reduction in TP is not as apparent in the Provo River as it enters Deer Creek Reservoir since the concentrations of TP at this point are influenced by a number of sources including Spring Creek, the County Flood Control Channel, Snake Creek, and Midway Fish Hatchery.

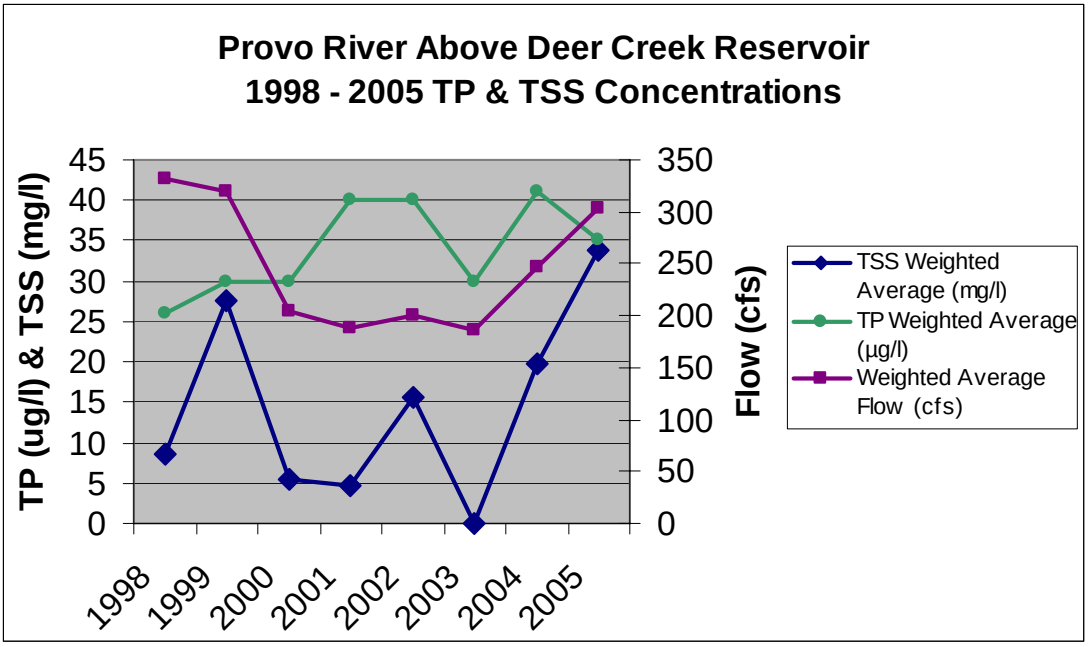


Figure 5- 4 Provo River above Deer Creek TP & TSS Average Concentration 1998 to 2005

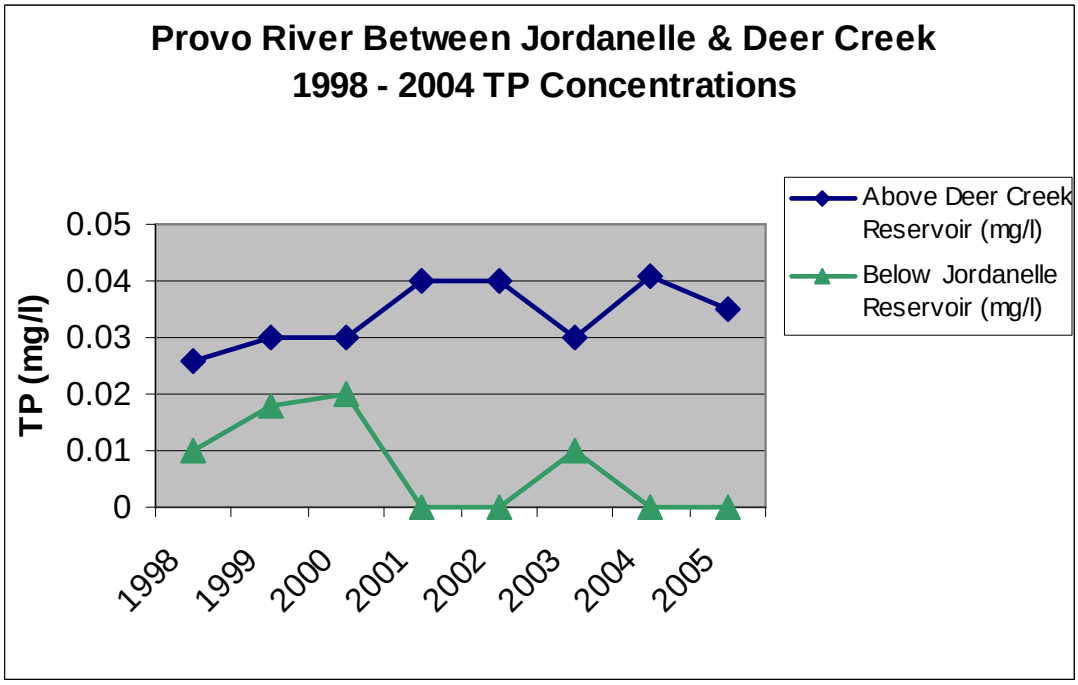


Figure 5- 5 Middle Provo River TP Average Concentrations 1998 to 2005

Midway Fish Hatchery Effluent, STORET #4997130

For many years, the Midway State Fish Hatchery was the biggest fish producer in the state's hatchery system. Up to 200,000 pounds of fish were raised at the hatchery for anglers across the northern half of Utah. Then in 2000, whirling disease was found in the hatchery and it was closed.

After years of dye and tracer tests, evaluation, well drilling, and design and construction of a partial fish production facility, the Division of Wildlife Resources' hatchery in northern Utah is raising fish again. After evaluations were completed, DWR officials decided the best way to keep whirling disease out of the hatchery was to use deep well water that will provide the hatchery with a clean water source.

It will take about $7 million to construct the hatchery facilities needed to bring production back to where it once was. Securing the funding could be a long process, and DWR officials are working hard to make it happen.

The effluent water from the Midway Fish Hatchery discharges from two 24-inch pipes into Snake Creek approximately 1 mile from the mouth of the creek at Deer Creek Reservoir. Prior to discharge the effluent water first passes through a series of settling ponds.

The Hatchery has a UPDES permit that requires the hatchery to monitor the influent and the effluent to determine that the net increase of total phosphorus does not exceed 626 kg/yr. There was no water quality sampling completed for the hatchery during the water year.

Snake Creek above Deer Creek at RR Crossing, STORET #5910160

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.

Snake Creek above Deer Creek, STORET 5910160 Water Quality Summary

	Temperature (º C)	**TP** (mg/l)	**DTP** (mg/l)	**TDS** (mg/l)	**TSS** (mg/l)	**Ammonia** (mg/l)
Average	13.0	0.021	0.003	599	13.2	0.04
Maximum	17.1	0.061	0.030	756	18	0.08
Minimum	10.4	0.000	0.000	416	5	0.00

This location was monitored on nine occasions during the water year. TP exceedances occurred only once in October 2004. The phosphorus concentrations have remained at this level for quite a few years.

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 constituents: TSS, TP, DTP. In the Heber Valley area these loads are calculated in five stream locations: Provo River below Jordanelle, Spring

Creek at Provo River, Provo River above Deer Creek, Snake Creek above Deer Creek, and Daniels Creek. Loads are also calculated at one point source location, the Midway Fish Hatchery Effluent. These calculations can be found in the Appendix. Figure 5- 6 illustrates the results of stream loading calculations for the 2005 water year.

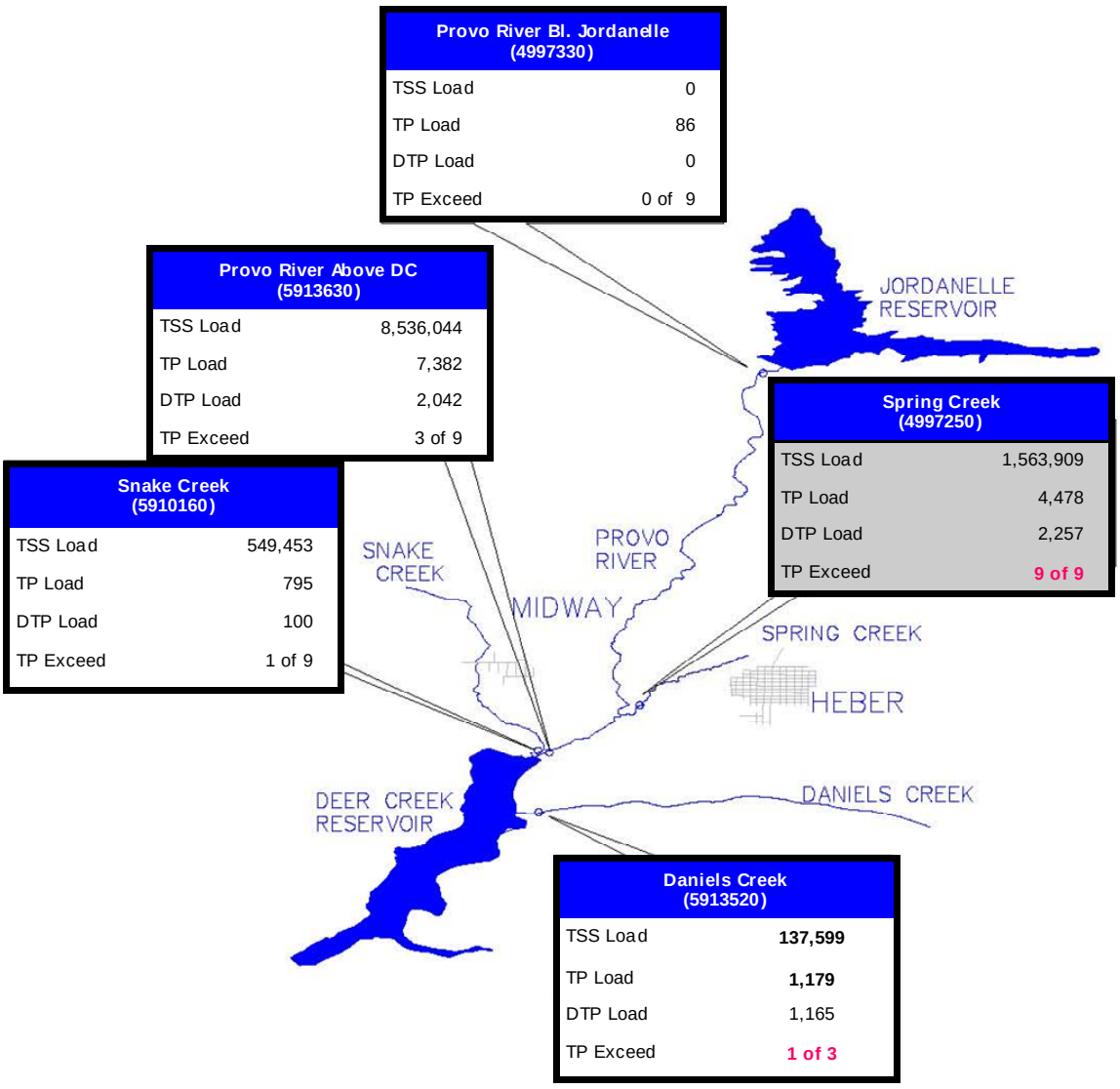


Figure 5- 6 Heber Valley TSS, TP and DTP Loading Overview

As can be seen in Figure 5- 6, the Provo River picks up a significant amount of phosphorus as it winds its way through the Heber Valley. The primary contributor is Spring Creek, which is contributing 60% of the total phosphorus and nearly all of the dissolved total phosphorus to the river system. Table 5- 2 shows the historical loading summary for the various points throughout the Heber Valley.

The annual load of total phosphorus in the Provo River below Jordanelle Reservoir was virtually nonexistent for 2005. A trend is being established at this point in-that the phosphorus is being retained in Jordanelle and the load below the dam is negligible. The selective level outlet works at the dam is being operated well to minimize impacts to the Provo River water quality downstream.

The total phosphorus load at the Heber-Midway Road station was quite high. However, this is due to one sample taken during high runoff. Most likely there was error in the sample. This load should be disregarded.

The loading at the various stations along the Provo River is shown in Figure 5- 7. As can be seen from the graph, the load increases as it progresses downstream.

Table 5- 2 Heber Valley Stream Loading Summary

	1999	2000	2001	2002	2003	2004	2005
Provo River Below Jordanelle Reservoir STORET 4997330							
Weighted Average Flow (cfs)	348	228	204	205	196	278	285
TP Weighted Average (mg/l)	0.018	0.02	0	0	0.01	0	0.00
TP Annual Load (kg/yr)	5,454	4,781	0	862	0	0	86
DTP Weighted Average (mg/l)	0.002	0.01	0	0	0	0	0.00
DTP Annual Load (kg/yr)	697	1,413	0	483	326	0	0
TSS Weighted Average (mg/l)	1	0	0	1.62	0	0.18	0.0
TSS Annual Load (kg/yr)	322,466	0	0	295,871	0	45,705	0
Provo River at River Road Crossing STORET 4997300							
Weighted Average Flow (cfs)	-	-	146	143	180	138	237.5
TP Weighted Average (mg/l)	-	-	0.01	0.01	0	0	0.01
TP Annual Load (kg/yr)	-	-	939	791	0	0	1,922
DTP Weighted Average (mg/l)	-	-	0	0	0	0	0.00
DTP Annual Load (kg/yr)	-	-	0	468	444	0	0
TSS Weighted Average (mg/l)	-	-	3.8	1.67	0	0.53	1.2
TSS Annual Load (kg/yr)	-	-	4,487,064	211,692	0	65,813	288,228
Provo River at Heber - Midway Road Crossing blw Berkenshaw Pond STORET 5910250							
Weighted Average Flow (cfs)	-	-	146	153	176	136	249
TP Weighted Average (mg/l)	-	-	0.01	0.02	0.02	0	0.06
TP Annual Load (kg/yr)	-	-	867	2,766	0	430	23771
DTP Weighted Average (mg/l)	-	-	0	0	0	0	0.00
DTP Annual Load (kg/yr)	-	-	178	610	382	0	0
TSS Weighted Average (mg/l)	-	-	2.5	6.48	0	2.73	0.9
TSS Annual Load (kg/yr)	-	-	321,047	881,414	0	332,750	158,563
Spring Creek at Provo River							

STORET 4997250							
Weighted Average Flow (cfs)	13	18	32	21	22	25	38
TP Weighted Average (mg/l)	0.113	0.06	0.12	0.1	0.09	0.11	0.13
TP Annual Load (kg/yr)	1,282	1,047	3,409	1,904	1,672	2,390	4478
DTP Weighted Average (mg/l)	0.055	0.02	0.06	0.06	0.05	0.05	0.07
DTP Annual Load (kg/yr)	630	306	1,624	1,099	895	1060	2257
TSS Weighted Average (mg/l)	62.5	19.6	21.7	10.3	0	42.03	46.2
TSS Annual Load (kg/yr)	712,786	317,357	620,085	193,218	0	938,354	1,563,909
Snake Creek above Deer Creek STORET 5910160							
Weighted Average Flow (cfs)	43	44	41	33	34	34	52
TP Weighted Average (mg/l)	0.024	0.02	0.02	0.02	0.02	0.01	0.021
TP Annual Load (kg/yr)	1,416	933	809	718	743	155	795
DTP Weighted Average (mg/l)	0.011	0.01	0	0	0.01	0	0.00
DTP Annual Load (kg/yr)	502	268	81	85	422	0	100
TSS Weighted Average (mg/l)	13.1	5.4	6.5	9.28	0	6.46	13.2
TSS Annual Load (kg/yr)	423,365	213,919	236,542	274,567	0	198,515	549,453
Provo River abv Deer Creek STORET 5913630							
Weighted Average Flow (cfs)	319	205	188	200	186	247	304
TP Weighted Average (mg/l)	0.03	0.03	0.04	0.04	0.03	0.041	0.035
TP Annual Load (kg/yr)	18,551	5,849	6,160	7,135	5,066	7,767	7382
DTP Weighted Average (mg/l)	0.009	0.02	0.04	0.01	0	0	0.006
DTP Annual Load (kg/yr)	5,253	4,475	4,328	2,114	293	0	2,042
TSS Weighted Average (mg/l)	27.6	5.5	4.6	15.63	0	19.85	33.8
TSS Annual Load (kg/yr)	7,856,242	1,010,736	772,618	2,779,700	0	4,373,323	8,536,044
Provo River TP Increase Ratio	**3.4**	**1.2**	**1.2**	**8.3**	**-**	**-**	**86.3**

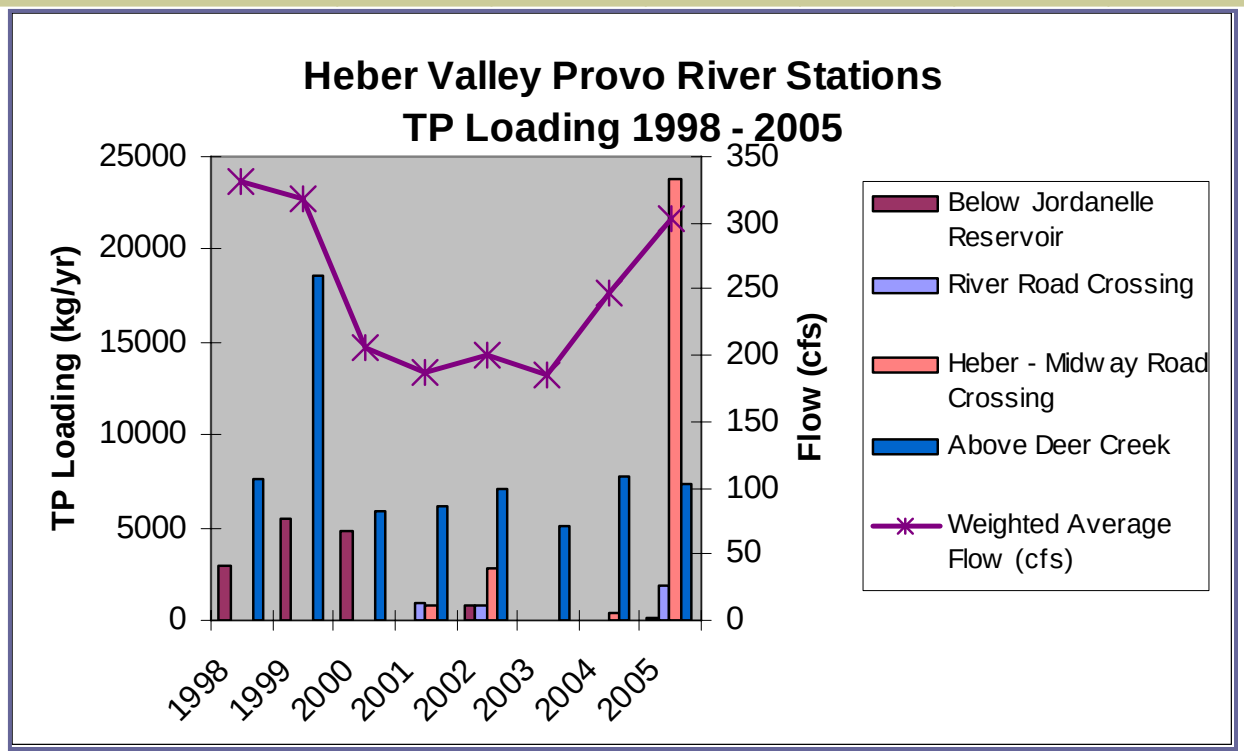


Figure 5- 7 Provo River Stations in Heber Valley TP Loadings 1998 - 2005

Many years ago Snake Creek was a significant contributor of phosphorus to the Provo River. However, over the years the water quality in Snake Creek has improved. However, the improvements made in Snake Creek have been offset by the poor water quality seen in Spring Creek. This is illustrated in Figure 5- 8 which compares the loads and flows in Spring Creek and Snake Creek.

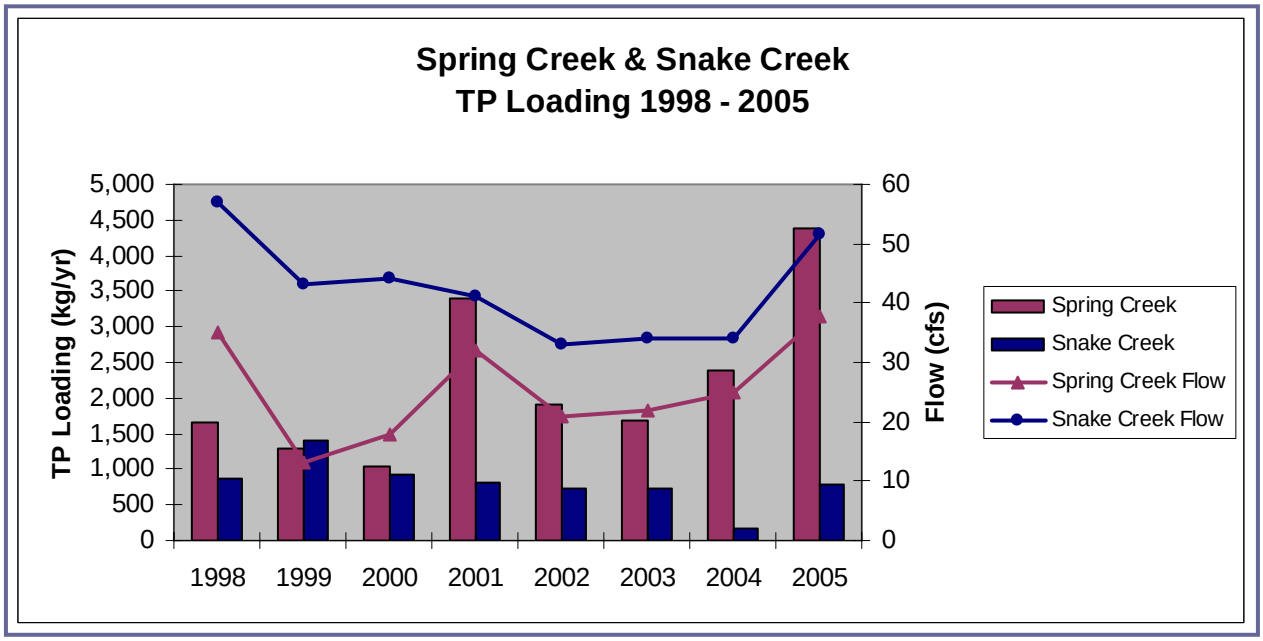


Figure 5- 8 Spring Creek and Snake Creek TP Loading 1998 - 2005

Comparisons to Target Loads

Target loads were calculated in the 1999 Wasatch County Water Quality Management Plan. 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- 3 shows the comparisons of 2005 water year loadings to the annual target loads. As shown in the table, the annual target loads were not exceeded.

Table 5- 3 Provo River and Snake Creek Target Loadings (based on TMDL)

STORET	Location	Target Load (kg/yr)	2005 Load (kg/yr)
4997330	Provo River below Jordanelle	8,685	86
5913630	Provo River above Deer Creek	8,428	7,382
5910160	Snake Creek above Deer Creek	1,747	795

DISSOLVED METALS ANALYSIS

The dissolved metal concentrations were analyzed for samples from several sites on the middle Provo River as well as several tributaries. Samples were collected between one and three times during the 2005 water year. The specific stations sampled and the number of times sampled during the water year are shown in Table 5- 4 below.

Table 5- 4 Metals Sampling Events in the Middle Provo River through Heber Valley

Station Name	STORET No.	Number of Sampling Events
Provo River at Midway Cutoff Rd North of Heber	4997300	2
Provo River below Jordanelle Dam	4997330	3
Provo River at Heber-Midway road below Berkenshaw Pond	5910250	2
Provo River at McKeller Bridge above Deer Creek Reservoir	5913630	3
Spring Creek entrance to Provo River	4997250	3
County Flood Control Channel at Provo River	591120	1
Snake Creek above Deer Creek at RR Crossing	5910160	3

Few dissolved metals were detectable, and the ones that were detected occurred in concentrations well below the water quality standards. There are no areas of concern with this data from the Heber Valley.

GROUNDWATER STUDY

In 1995, the State Water Quality Board classified the aquifer in the Heber Valley as Class 1A pristine. From recommendations made in previous implementation reports, the Provo River Watershed Council has been working with Wasatch County, Central Utah Water Conservancy District and the USGS to develop a groundwater monitoring plan.

Figure 5- 9 shows the location of the monitoring wells in the Heber Valley along with the Dissolved Total Phosphorus concentrations. Higher concentrations of phosphorus are found in the eastern side of the valley. These concentrations have remained consistent since 2001 as shown in Table 5- 5.

Figure 5- 10 shows the 2005 concentrations for dissolved nitrates in the same monitoring wells. Three wells have exhibited increasing nitrate concentrations. Two of these wells are located in the eastern portion of the valley. The sample taken for one of these wells measured 7.8 mg/l of dissolved nitrates. This is well above the numeric criteria for cold water game fish.

The average concentration of DTP for the 10 monitoring wells was 0.048 mg/l for all of the sites. The average concentration of dissolved nitrates was 2.6 mg/l.

Figure 5- 9 Heber Valley Groundwater Monitoring Program – DTP Results

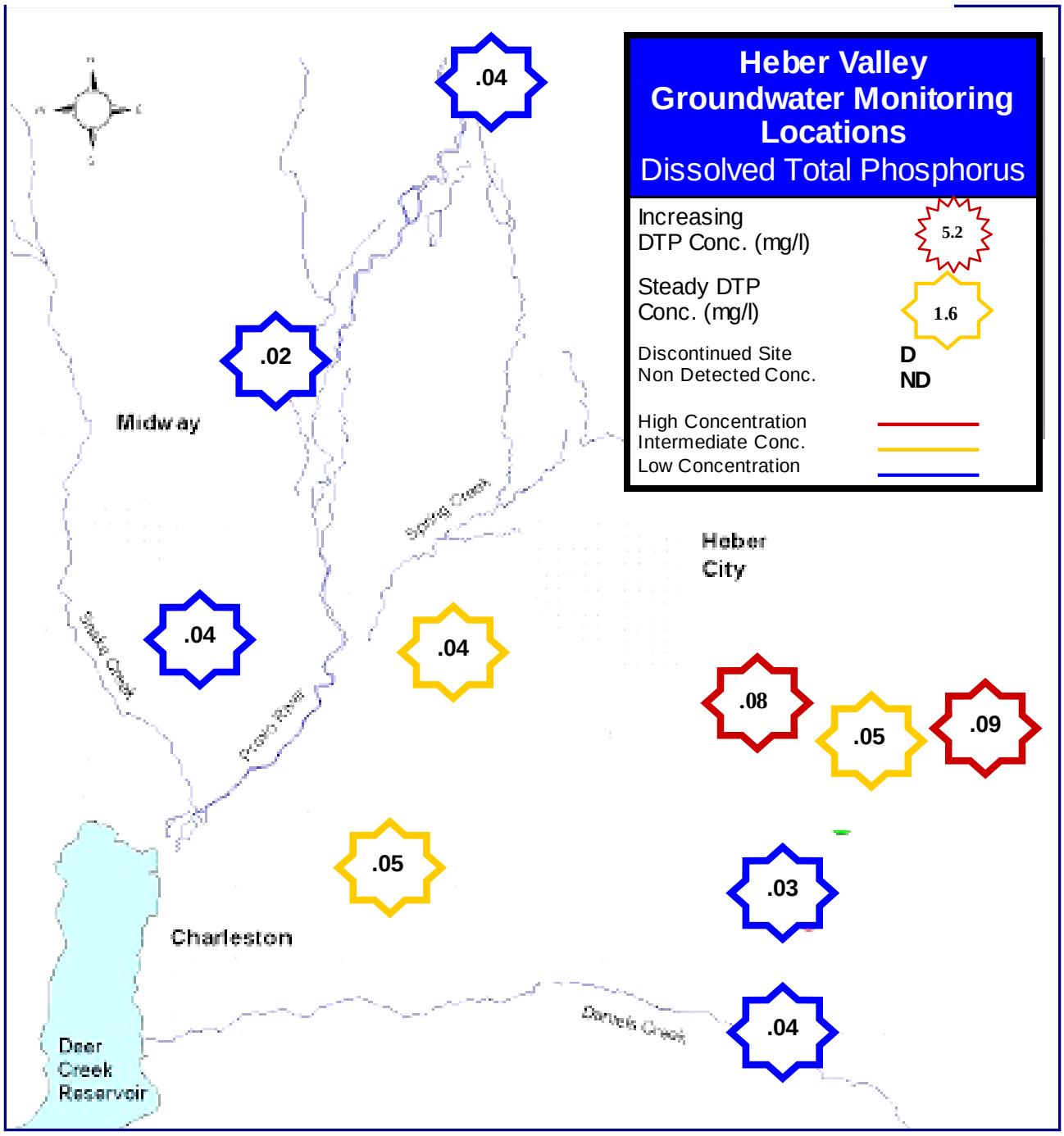
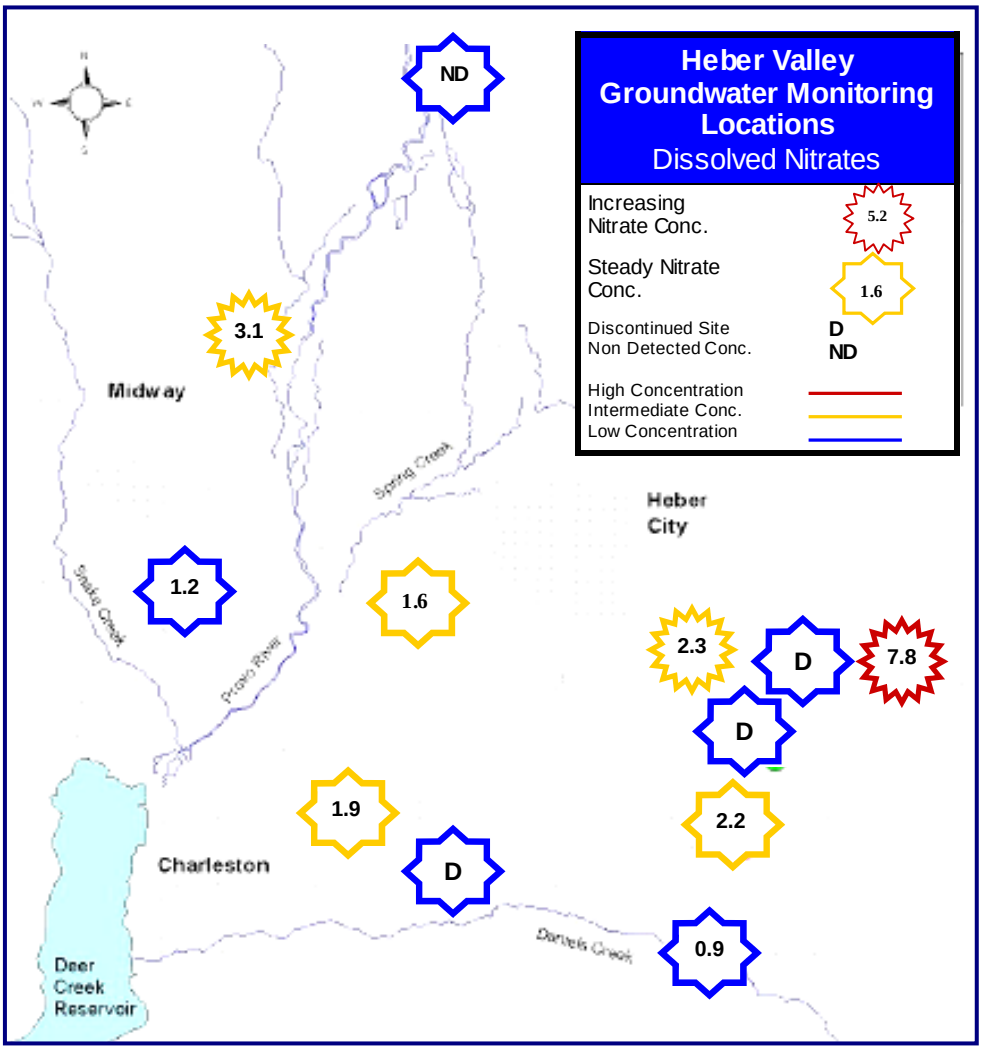


Table 5- 5 Heber Valley Groundwater Monitoring Water Quality Summary (2001 – 2005)

USGS Station Number	Dissolved Nitrates (mg/l)						DTP (mg/l)					
	2001	2002	2003	2004	2005	Avg.	2001	2002	2003	2004	2005	Avg.
403146111272701	1.16	1.31	1.48	-	2.32	1.57	<0.06	<0.06	0.02	-	0.02	0.02
402842111263101	1.92	1.74	1.81	1.83	1.85	1.83	<0.06	0.06	0.05	0.04	0.04	0.05
402937111214901	4.33	4.7	5.58	5.49	7.78	5.58	0.076	0.08	0.1	0.08	0.1	0.09
402946111233901	1.97	2.15	2.52	2.76	3.17	2.51	0.082	0.08	0.09	0.08	0.08	0.08
402842111223601	-	-	0.18	Discontinued		0.18	-	-	0.05	-	-	0.05
403003111255801	2.1	2.33	2.07	2.12	1.62	2.05	0.03	0.04***	0.05	0.03	0.04	0.04
402904111225801	1.38	1.71	Discontinued			1.55	0.033	0.07	-	-	-	0.05
403325111254601	-	-	<0.06	<0.06	<0.06	<0.06	-	-	<0.04	<0.04	0.04	0.04
402840111232201	2.19	2.34	-	2.12	2.19	2.21	<0.06	0.04	-	0.03	0.03	0.03
402750111232701	0.618	0.64	0.67	0.65	0.84	0.68	<0.06	<0.06	<0.04	<0.04	0.04	0.04
402813111253701	1.46	1.34	Discontinued			1.40	<0.06	<0.06	-		-	<0.06
403004111280301	-	-	0.45	0.41	1.2	0.69	-	-	<0.04	<0.04	0.04	0.04

Figure 5- 10 Heber Valley Groundwater Monitoring Program – Dissolved Nitrates

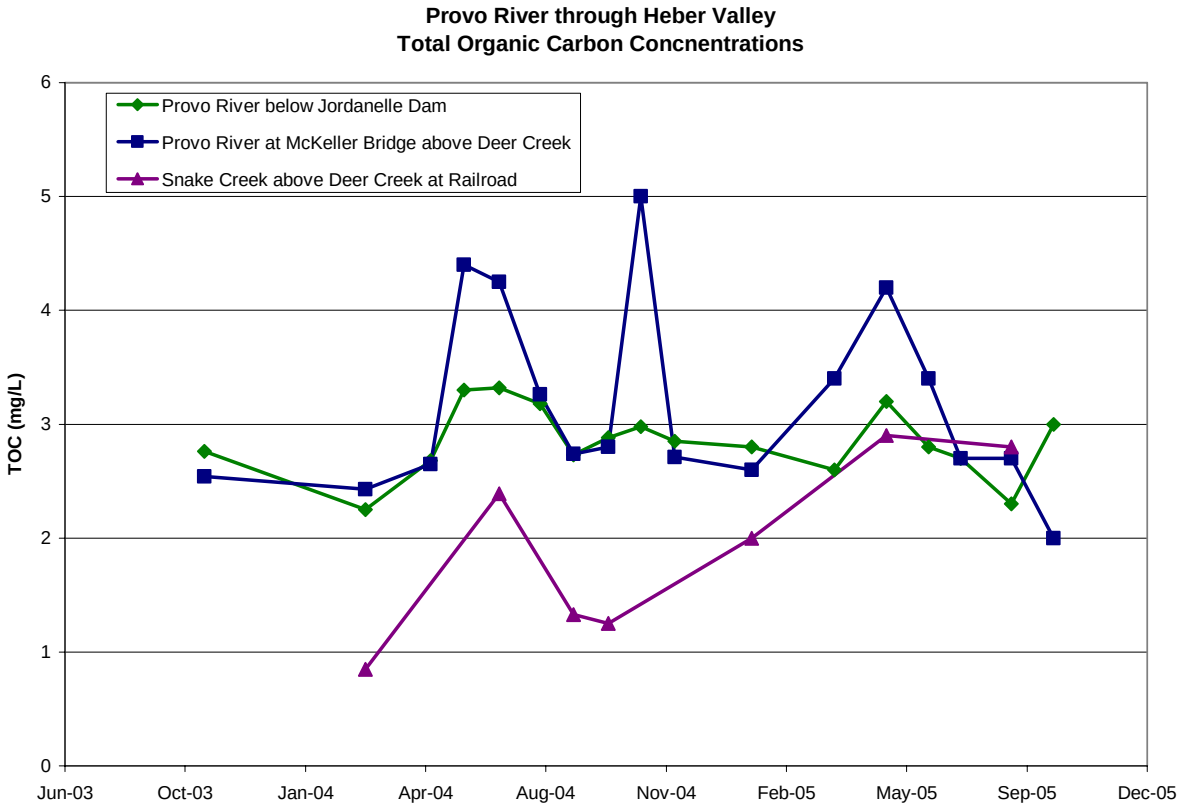


TOTAL ORGANIC CARBON

Figure 5- 11 shows TOC concentrations in the Middle Provo River for the 2004 and 2005 water years. Concentrations are well within the typical range of TOC for surface water. Maximum concentrations are 5 mg/L at one station for one sampling event and less than 5 mg/L for all other stations. There is a general profile for both water years that shows an increase in TOC concentration during the high runoff periods, which is expected. The values at Snake Creek above Deer Creek at the Railroad Crossing (STORET No. 5910160) are significantly higher in 2005 than in 2004, but are still slightly lower than the other stations reported in this area. It is probable that this change is not indicative of an impending problem. There are no other significant changes in TOC concentration in this part of the watershed.

See Chapter 3 of this report for a discussion of the overall significance of TOC concentrations.

Figure 5- 11 Provo River through Heber Valley TOC Concentrations



CHAPTER 6 – DEER CREEK RESERVOIR BASIN

INTRODUCTION

This chapter will present and analyze the water quality monitoring for Deer Creek Reservoir and the major tributaries not analyzed in previous chapters including 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 2003 water year. The stream monitoring locations are as follows:

STORET No.	Location Description
5913520	Daniels Creek below Confluence w/ LCC
5913460	Main Creek at Bridge above Deer 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 exceedances for temperature, DO, pH, TSS, ammonia, TP and TDP. A more complete analysis of the data analyzing more constituents, however, is included in Appendix A.

Daniels Creek 100 feet below LCC, STORET #5913520

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 shown below.

Daniels Creek 100 feet below LCC, STORET 5913520 Water Quality Summary

	Temperature (º C)	TP (mg/l)	DTP (mg/l)	TDS (mg/l)	TSS (mg/l)	Ammonia (mg/l)
Average	10.8	0.025	0.016	204	34	0.06
Maximum	17.9	0.074	0.048	252	82	0.08
Minimum	6.6	0.000	0.000	170	10	0.07

This station was sampled three times during the 2005 water year. The sample taken during March of 2004 exceeded the standard for both TP and DTP. However, this was not a peak flow time period and so the overall loading was relatively low.

Main Creek at Bridge above Reservoir, STORET #5913460

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 in the Table below.

Main Creek at Bridge above Reservoir, STORET 5913460

	Temperature (º C)	**TP** (mg/l)	**DTP** (mg/l)	**TDS** (mg/l)	**TSS** (mg/l)	**Ammonia** (mg/l)
Average	12.2	0.054	0.022	306	27	0.05
Maximum	23.2	0.10	0.05	462	64	0.09
Minimum	0.6	0.00	0.00	150	0	0.07

Main Creek was sampled nine times during the water year. There were five exceedences of standards for TP and two for DTP. Additionally, the water temperature exceeded standards twice during the summer of 2005.

STREAM LOADINGS INTO DEER CREEK RESERVOIR

The data from stream samples that were collected in Main Creek were used in conjunction with flow data to calculate river loadings for two constituents: TP, and DTP. Two other stream loadings, which were previously discussed in Chapter 5, are also included here to enable discussion of the entire loadings into the Deer Creek Reservoir. These calculations can be found in the Appendix. Figure 6 - 1 illustrates the loadings results for the 2005 water year.

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

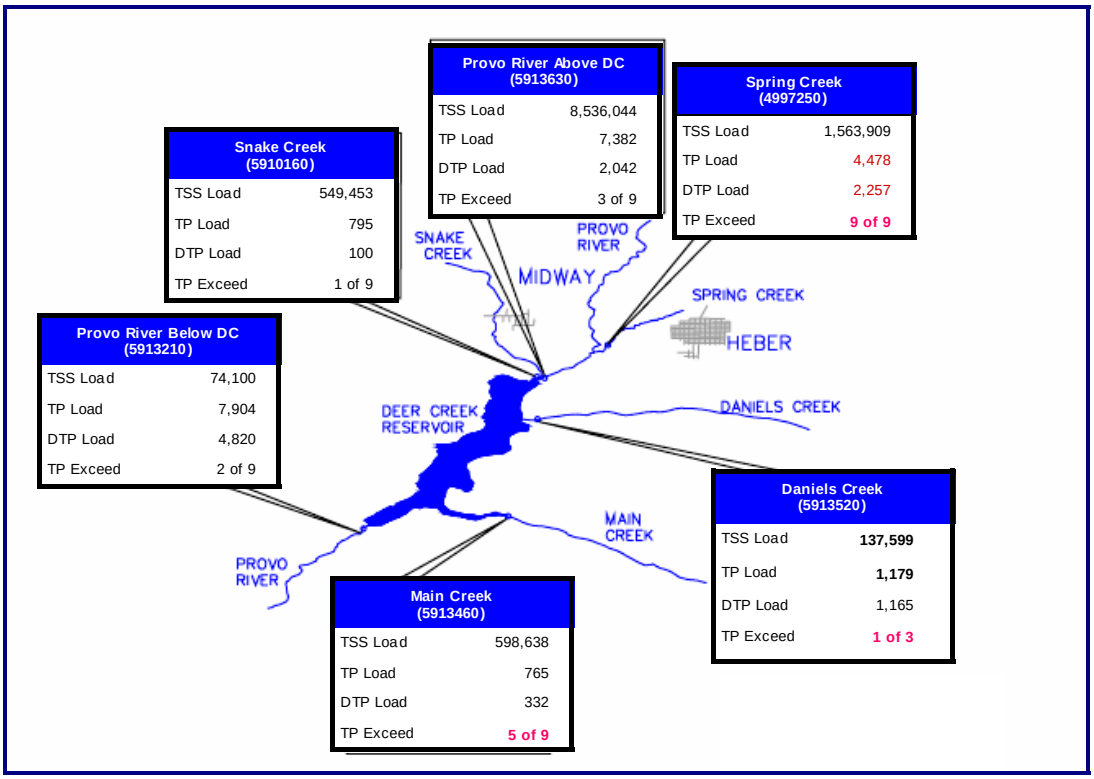


Table 6 - 1 Deer Creek Reservoir TP Loading Summary

STORET #	Location	Target Load (kg/yr)	2005 Load (kg/yr)	Percent of Total
5913630	Provo River	11,136	7,382	56%
5910160	Snake Creek	2,308	795	6%
5913520	Daniels Creek	645	1,179	9%
5913460	Main Creek	1,210	765	6%
	Ground Water*	n/a	2,725	21%
	Storm Wash†	n/a	400	3%
	Total Input	**15,300**	**13,246**	**100%**

The total annual loading into Deer Creek reservoir has been consistently low for the past three years.

Table 6 - 1 shows how these TP loads compare to TMDL target loads which were identified in the 2002 Deer Creek Reservoir Drainage TMDL Study. All inputs to Deer Creek Reservoir were below target loads except for Daniels Creek. Additionally, nearly all of the load from Daniels Creek occurred in the form of Dissolved Phosphorus as can be seen in Table 6 - 2.

* Based on 61 cfs inflow of groundwater at 0.05 mg/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.

Table 6 - 2 Deer Creek Reservoir DTP Loading Summary

STORET #	Location	2005 Load (kg/yr)	DTP / TP In-Stream	Percent of Total Load to Reservoir
5913630	Provo River	2042	28%	30%
5910160	Snake Creek	100	13%	1%
5913520	Daniels Creek	1165	99%	17%
5913460	Main Creek	332	43%	5%
	Ground Water	2725	100%	40%
	Storm Wash	400	100%	6%
	Total Input	**6764**	**51%**	**100%**

Monthly Distribution of Loading in the Provo River are shown in **Error! Reference source not found.**. Unusually high loadings occurred in the winter. These loadings are not related to high flows.

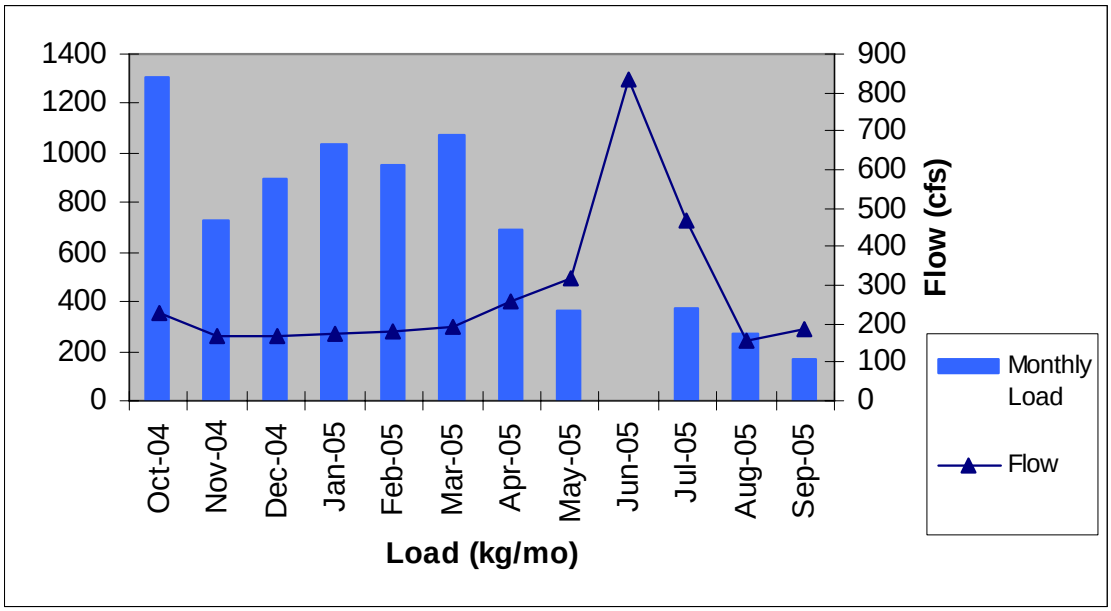


Figure 6 - 2 Monthly Distribution of 2005 TP Loadings in Provo River (above Deer Creek)

Figure 6 - 3 shows the monthly loadings for Snake Creek and Main Creek. Snake Creek's average load per ac-ft of water is half as much as Main Creek's load per ac-ft. Additionally, whereas Snake Creek's phosphorus can be attributed to phosphorus bound-up in sediments, half of Main Creek's phosphorus load is dissolved phosphorus. Dissolved phosphorus is readily available for algae growth and has a more extreme effect to eutrophication in the reservoir.

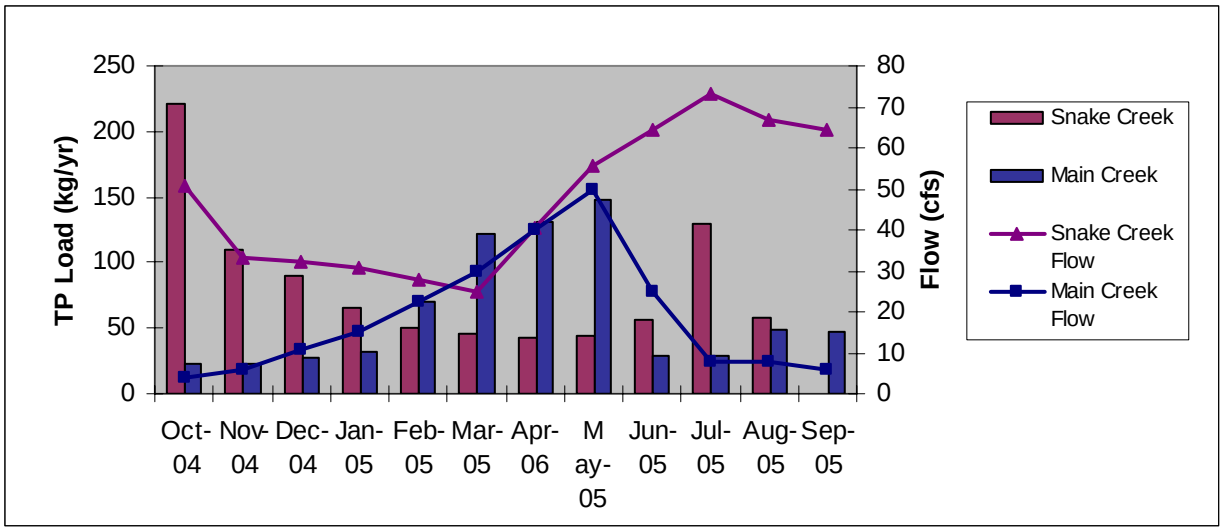


Figure 6 - 3 Snake Creek & Main Creek Monthly TP Loadings

Table 6 - 3 compares the loadings to Deer Creek for 1999 to 2005. The 2005 water year brought higher flows then we have seen since 1999. Comparing 1999 to 2005 there has been a significant reduction in both TP and DTP loads in all three streams. However, TSS loads have stayed the same for Snake Creek and Provo River.

Table 6 - 3 Deer Creek Reservoir Stream Loadings 1999 - 2005

	1999	2000	2001	2002	2003	2004	2005
Main Creek abv Deer Creek STORET 5913460							
Weighted Average Flow (cfs)	16	13	14	8	8	8	17
TP Weighted Average (mg/l)	0.07	0.05	0.05	0.03	0.05	0.04	0.054
TP Annual Load (kg/yr)	977	523	587	251	324	194	765
DTP Weighted Average (mg/l)	0.04	0.03	0.03	0.01	0.01	0.03	0.022
DTP Annual Load (kg/yr)	511	324	349	100	56	141	332
TSS Weighted Average (mg/l)	68.8	19	15.8	9.6	N/A	21.4	27
TSS Annual Load (kg/yr)	1,005,716	218,565	198,017	71,441	N/A	111,289	598,638
Snake Creek above Deer Creek STORET 5910160							
Weighted Average Flow (cfs)	43	44	41	33	34	34	52
TP Weighted Average (mg/l)	0.024	0.02	0.02	0.02	0.02	0.01	0.021
TP Annual Load (kg/yr)	1,416	933	809	718	743	155	795
DTP Weighted Average (mg/l)	0.011	0.01	0	0	0.01	0	0.00
DTP Annual Load (kg/yr)	502	268	81	85	422	0	100
TSS Weighted Average (mg/l)	13.1	5.4	6.5	9.28	0	6.46	13.2
TSS Annual Load (kg/yr)	423,365	213,919	236,542	274,567	0	198,515	549,453
Provo River abv Deer Creek STORET 5913630							
Weighted Average Flow (cfs)	319	205	188	200	186	247	304
TP Weighted Average (mg/l)	0.03	0.03	0.04	0.04	0.03	0.041	0.035
TP Annual Load (kg/yr)	18,551	5,849	6,160	7,135	5,066	7,767	7382
DTP Weighted Average (mg/l)	0.009	0.02	0.04	0.01	0	0	0.006
DTP Annual Load (kg/yr)	5,253	4,475	4,328	2,114	293	0	2,042

TSS Weighted Average (mg/l)	27.6	5.5	4.6	15.63	0	19.85	33.8
TSS Annual Load (kg/yr)	7,856,242	1,010,736	772,618	2,779,700	0	4,373,323	8,536,044

DEER CREEK RESERVOIR MONITORING

On the Deer Creek Reservoir, four locations were monitored during the 2003 water year. 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 critical characteristic being oxygen (DO). The four monitoring locations listed are as follows:

STORET No.	Location Description
5913240	Deer Creek Reservoir – Upper End
5913230	Deer Creek Reservoir – Midlake
5913450	Deer Creek Reservoir – Wallsburg Bay
5913220	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 exceedances for temperature, dissolved oxygen, pH, ammonia, TSS, dissolved phosphorus and total phosphorus.

Upper End, STORET #5913240

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. This location was monitored six times during the 2005 water year. 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.

Deer Creek Reservoir Upper End, STORET 5913240 Water Quality Summary

	D.O. (mg/l)	Temperature (º C)	TP (mg/l)	DTP (mg/l)	TDS (mg/l)	TSS (mg/l)	Ammonia (mg/l)
Average	7.6	15.0	0.01	0.00	225	1.8	0.07
Maximum	9.5	24.5	0.05	0.03	290	8.4	0.13
Minimum	3.2	8.8	0.00	0.00	178	0.0	0.00

The TP and DTP standard was exceeded once in July of 2005. The temperature standard was exceeded twice (July and August 2005). Historically, there have been exceedances associated with high water temperatures on the reservoir surface and some exceedances in the phosphorous standards.

Midlake, STORET #5913230

Samples at this site 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 six times during the 2005 water year. A combined summary of the water quality data is provided below.

Deer Creek Reservoir Midlake, STORET 5913230 Water Quality Summary

	D.O. (mg/l)	Temperature (º C)	TP (mg/l)	DTP (mg/l)	TDS (mg/l)	TSS (mg/l)	Ammonia (mg/l)
Average	6.9	12.8	0.00	0.00	208	0.2	0.07
Maximum	10.6	23.5	0.03	0.02	272	4	0.19
Minimum	1.4	6.4	0.00	0.00	0	0	0.00

The water quality at this station was quite good for the 2005 water year. There was only one time during August 2005 that the D.O. and the TP standard was exceeded. Temperature was exceeded in twice in July and August at the surface. Historically, there have been exceedances associated with high water temperatures on the reservoir surface and some exceedances in the phosphorous standards.

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 on average 9 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.

Deer Creek Reservoir Wallsburg Bay, STORET 591345 Water Quality Summary

	D.O. (mg/l)	Temperature (º C)	TP (mg/l)	DTP (mg/l)	TDS (mg/l)	TSS (mg/l)	Ammonia (mg/l)
Average	6.9	13.2	N/A	N/A	N/A	N/A	N/A
Maximum	10.6	23.6	N/A	N/A	N/A	N/A	N/A
Minimum	0.8	6.7	N/A	N/A	N/A	N/A	N/A

D.O. was below 2.0 mg/l once and Temperature was above the standard twice during the water year. These occurred during the late summer months.

Above Dam, STORET #5913220

Samples were collected at five separate depths (“surface”, “above thermocline”, “mid-depth”, “below thermocline” and “bottom”) at this site on seven separate occasions. A summary of the water quality is given below.

Deer Creek Reservoir Above Dam, STORET 5913220 Water Quality Summary

	D.O. (mg/l)	Temperature (º C)	TP (mg/l)	DTP (mg/l)	TDS (mg/l)	TSS (mg/l)	Ammonia (mg/l)
Average	6.4	12.1	0.01	0.01	214	0.9	0.06
Maximum	11.0	22.3	0.10	0.11	270	6.4	0.16
Minimum	0.1	6.0	0.00	0.00	114	0	0.00

As is typical with this site, D.O. was below the 2.0 mg/l standard during July, August and September. Similarly, the TP and DTP also exceeded standards during the same months. These exceedances occurred at the bottom sampling location in the water column.

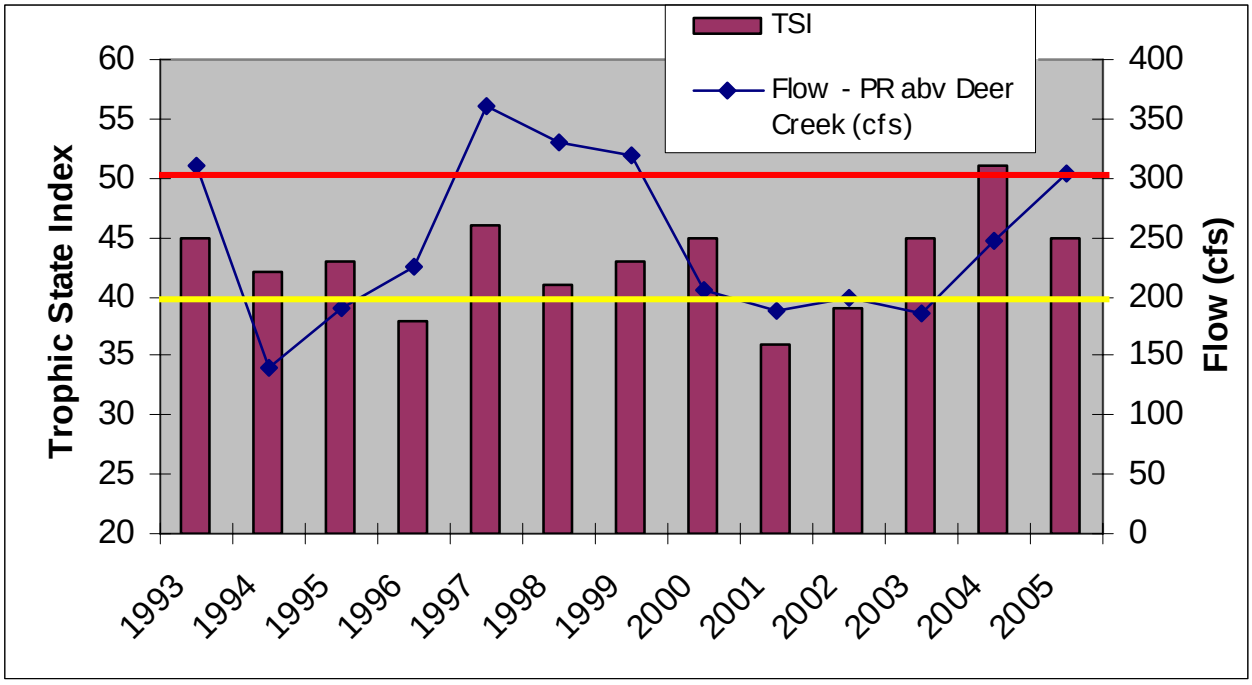
DEER CREEK TROPHIC STATE INDEX

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 Chlorophyll A or secchi depth data from May to September. Table 6 - 4 shows the calculation of results for Deer Creek Reservoir. Figure 6 - 4 compares the calculated TSI value to historical values that have been calculated since 1993.

Table 6 - 4 Carlson Trophic State Index (TSI) Calculations for Deer Creek Reservoir

Date	Jordanelle Res North Arm		Jordanelle Res Provo Arm		Jordanelle Res ab Dam	
	Chlorophyll a	Secchi Disk Depth	Chlorophyll a	Secchi Disk Depth	Chlorophyll a	Secchi Disk Depth
5/18/2005	4.6	3.3	2	4.7	4.2	5.3
6/22/2005	6	2.8	5.1	2.8	6.05	2.9
7/20/2005	7	2	3.6	2.2	5.2	2.4
8/17/2005	14.5	2	3.6	4.5	4.7	3.4
9/21/2005					5.35	2.9
Average	8.0	2.5	3.6	3.6	5.1	3.4
TSI 45	51	47	43	42	47	42

Figure 6 - 4 Historical Deer Creek Reservoir TSI and Provo River Average Flow



COMPARISON OF STREAM LOADINGS INTO DEER CREEK RESERVOIR TO TMDLS

Table 6 - 5 compares the water quality results with the TMDLs calculated in the 2003 Deer Creek Reservoir Drainage TMDL Study. The criterion for in-stream total phosphorus was exceeded in Main Creek and the Provo River. Additionally, during August and September more than 50% of the water column had D.O. less than 4.0 mg/l. The Total Phosphorus loads to the reservoir during the summer months also exceeded the limits set in the TMDL. The chlorophyll a biomass also exceeded the target of 5.1 µg/l. The other parameters met there respective target/endpoints as defined in the Deer Creek Reservoir TMDL. There were no fish kills in the reservoir and the average TSI for the 2005 water year was within the limits established by the TMDL.

Table 6 - 5 TMDL Targets/Endpoints – 2005 Results

Parameter	TMDL	2005	Meeting Criteria
Dissolved Oxygen Water Column % Impaired	>50% of column with DO <4.0 mg/l	Above Dam Aug. Above Dam Sept. Midlake Aug.	**No**
Fish Habitat Indicator	No Fish Kills	No Fish Kills	Yes
In-lake Phosphorus Concentration	0.025 mg/l TP (Avg. all depths)	0.01 mg/l TP	Yes
In-stream Phosphorus Concentration:			
Provo River	0.030 mg/l TP	**0.035**	**NO**
	0.025 mg/l DTP	0.006	Yes
Snake Creek	0.030 mg/l TP	0.021	Yes
	0.025 mg/l DTP	0.003	Yes
Daniels Creek	0.030 mg/l TP	0.025	Yes
	0.025 mg/l DTP	0.016	Yes
Main Creek	0.030 mg/l TP	**0.054**	**No**
	0.025 mg/l DTP	0.022	Yes
Phosphorus Loads to Lake	15,300 kg/yr TP	13,221 kg/yr TP	Yes
	9,700 kg/yr DTP	6,764 kg/yr DTP	Yes
	560 kg/mo TP for Aug-Oct	730 kg/mo TP (avg.)	**No**
	350 kg/mo DTP for Aug-Oct	117 kg/mo DTP (avg)	Yes
Average TSI	40-45	45	Yes
Algae Biomass	5.1 µg/l Chlorophylla	5.7 µg/l	**No**
	6.5x107 µm 3/ml Biomass	NA	NA
	3.3x107 µm 3/ml Cyanophyta	NA	NA

DISSOLVED METALS ANALYSIS

The dissolved metal concentrations were analyzed for samples from several sites on the Deer Creek Reservoir as well as two non-Provo River tributaries. Samples were collected between one and three times during the 2005 water year. The specific stations sampled and the number of times sampled during the water year are shown in Table 6 - 6 below.

Table 6 - 6 Metals Sampling Events in Deer Creek Reservoir

Station Name	STORET No.	Number of Sampling Events
Deer Creek Reservoir-Above Dam	5913220	1
Deer Creek Reservoir-Midlake	5913230	1
Deer Creek Reservoir-Upper End	5913240	1
Daniels Creek below Confluence w/LCC	5913520	1
Main Creek at Bridge above Deer Creek	5913460	2

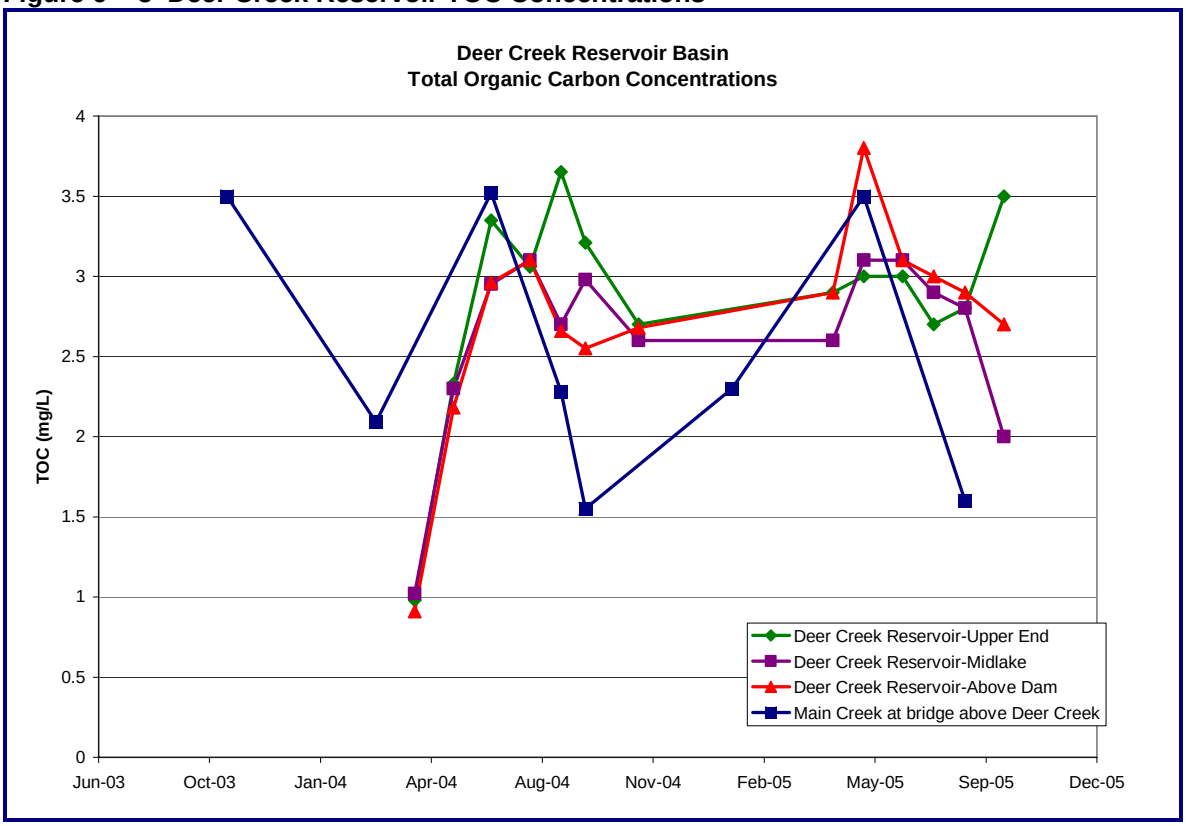
Few dissolved metals were detectable, and the ones that were detected occurred in concentrations well below the water quality standards. There are no areas of concern with this data.

TOTAL ORGANIC CARBON

Figure 6 - 5 shows TOC concentrations in the Deer Creek Reservoir for the 2004 and 2005 water years. Concentrations are well within the typical range of TOC for surface water. Maximum concentrations are less than 4 mg/L for all stations. There is a general profile for both water years that shows an increase in TOC concentration during the high runoff periods, which is expected, though it is not as pronounced as higher in the watershed. There are no significant changes in TOC concentration from year to year in this part of the watershed.

See Chapter 3 of this report for a discussion of the overall significance of TOC concentrations.

Figure 6 - 5 Deer Creek Reservoir TOC Concentrations



CHAPTER 7 – LOWER PROVO RIVER BELOW DEER CREEK RESERVOIR

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	Deer Creek Dam
499687	Little Deer Creek above confluence with Provo River
499685	Lower North Fork of Provo River at Wildwood
499683	Lower South Fork Provo River at Vivian Park
499681	Provo River at Olmsted Diversion
499678	Provo River at Murdock Diversion

Each site is described in the following sections with a summary table of the water quality monitoring. For more complete tables showing water quality monitoring data from the 2005 water year refer to the Appendix.

Provo River below Deer Creek Dam, STORET #5913210

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

Provo River below Deer Creek Dam, STORET 5913210 Water Quality Summary

	Temperature (º C)	TP (mg/l)	DTP (mg/l)	TDS (mg/l)	TSS (mg/l)	Ammonia (mg/l)
Average	9.8	0.03	0.02	262	0	0.08
Maximum	14.5	0.09	0.06	296	4	0.16
Minimum	2.4	0.00	0.00	216	0	0.00

This location was sampled on nine occasions during the 2005 water year. Two exceedances of TP and DTP were recorded in the fall of 2005. Historically this location has had three or four exceedances of phosphorus each year.

Little Deer Creek above Confluence with Provo River, STORET #4996870

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.

Little Deer Creek above Confluence with Provo River, STORET 4996870 Water Quality Summary

	Temperature (º C)	TP (mg/l)	DTP (mg/l)	TDS (mg/l)	TSS (mg/l)	Ammonia (mg/l)
Average	10.0	0.02	0.01	282	14	0.02
Maximum	17.3	0.04	0.04	340	64	0.07
Minimum	2.2	0.00	0.00	208	0	0.00

This location was monitored ten times during the 2005 water year. No exceedances were recorded. Historically, this location is known to have few water qualtiy problems.

Lower North Fork of Provo River at Wildwood, STORET #4996850

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 the Table.

Lower North Fork of Provo River at Wildwood, STORET 4996850

	Temperature (º C)	TP (mg/l)	DTP (mg/l)	TDS (mg/l)	TSS (mg/l)	Ammonia (mg/l)
Average	7.6	0.01	0.00	225	17	0.01
Maximum	11.1	0.06	0.00	348	92	0.08
Minimum	2.6	0.00	0.00	140	0	0.00

This location was monitored nine times during the 2005 water year. One exceedance of Total Phosphorus was reported in October 2004. Historically, this area has rarely had occasions of high phosphorus.

Lower South Fork Provo River at Vivian Park, STORET #4996830

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.

Lower South Fork Provo River at Vivian Park, STORET 4996830 Water Quality Summary

	Temperature (º C)	TP (mg/l)	DTP (mg/l)	TDS (mg/l)	TSS (mg/l)	Ammonia (mg/l)
Average	9.0	0.11	0.00	184	5	0.02
Maximum	13.7	**0.86**	0.00	246	28	0.07
Minimum	3.0	0.00	0.00	152	0	0.00

This location was monitored eight times during the 2002 water year. One exceedance of TP was recorded at this location in May of 2005. This sample measured 0.86 mg/l of TP and brought the average for the site to 0.11 mg/l for the water year. However, all but two samples showed nondetect level. Historically, it has not been common to have more than one exceedance per year recorded at this location.

Provo River at Olmsted Diversion, STORET #4996810

This monitoring site is located on the Provo River at the Olmsted Diversion about one mile downstream from the South Fork at Vivian Park. This water quality data represents the combined flow of the Lower Provo River with its major tributaries. A summary of the monitoring data is shown below.

Provo River at Olmsted Diversion, STORET 4996810 Water Quality Summary

	Temperature (º C)	TP (mg/l)	DTP (mg/l)	TDS (mg/l)	TSS (mg/l)	Ammonia (mg/l)
Average	9.7	0.12	0.00	268	1	0.05
Maximum	14.6	0.85	0.04	328	5	0.11
Minimum	1.6	0.00	0.00	214	0	0.00

This site was monitored nine times during the 2005 water year. Only one exceedance of the TP standard was measured in May of 2005 This sample measured 0.85 mg/l of TP and brought the average for the site to 0.12 mg/l for this site for the water year . This is similar to the results for the Lower South Fork which indicates that the problem originated in the Lower South Fork. However, overall this location has shown improvement in water quality. Historically, this location on the Provo River has been known to have approximately half of its phosphorous measurements exceed standards for TP.

Provo River at Murdock Diversion, STORET #4996780

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.

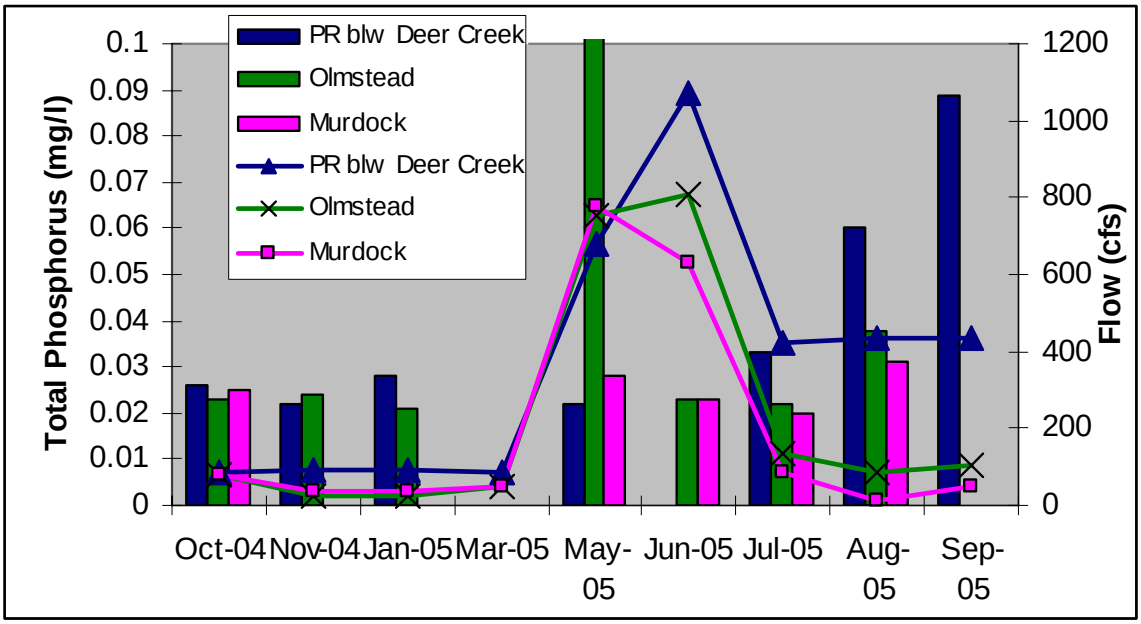
Provo River at Murdock Diversion, STORET 4996780 Water Quality Summary

	Temperature (° C)	TP (mg/l)	DTP (mg/l)	TDS (mg/l)	TSS (mg/l)	Ammonia (mg/l)
Average	10.0	0.02	0.00	247	4	0.04
Maximum	16.1	0.03	0.02	280	14	0.12
Minimum	3.0	0.00	0.00	210	0	0.00

This location was monitored eight times during the 2005 water year. TP and DTP did not exceed standards. Historically this site has had one to two exceedances each year.

Figure 7 - 1 compares the TP concentrations on the Provo River below Deer Creek, Olmsted, and Murdock. This shows that phosphorus concentrations at the three locations were below the PRWC standard for much of the time except for one spike at the Olmstead Diversion (due to South Fork) and the late summer and early fall months below Deer Creek during the reservoir turnover period.

Figure 7 - 1 Provo River Below Deer Creek TP Concentration



STREAM LOADINGS IN THE LOWER PROVO RIVER

The data from stream samples that were collected are used with flow data to calculate river loadings of three constituents: TSS, TP, and DTP. These loads were calculated at six monitoring locations in this area of the watershed. Figure 7 - 2 indicates the historical phosphorous loading and the phosphorous loading for the 2005 water year. The phosphorus data for 1997 was disregarded. Table 7 - 1 indicates the loads for TP, DTP, TSS, and the average flow in comparison to the previous six years.

Figure 7 - 2 Historical Phosphorus Loading below Deer Creek Reservoir

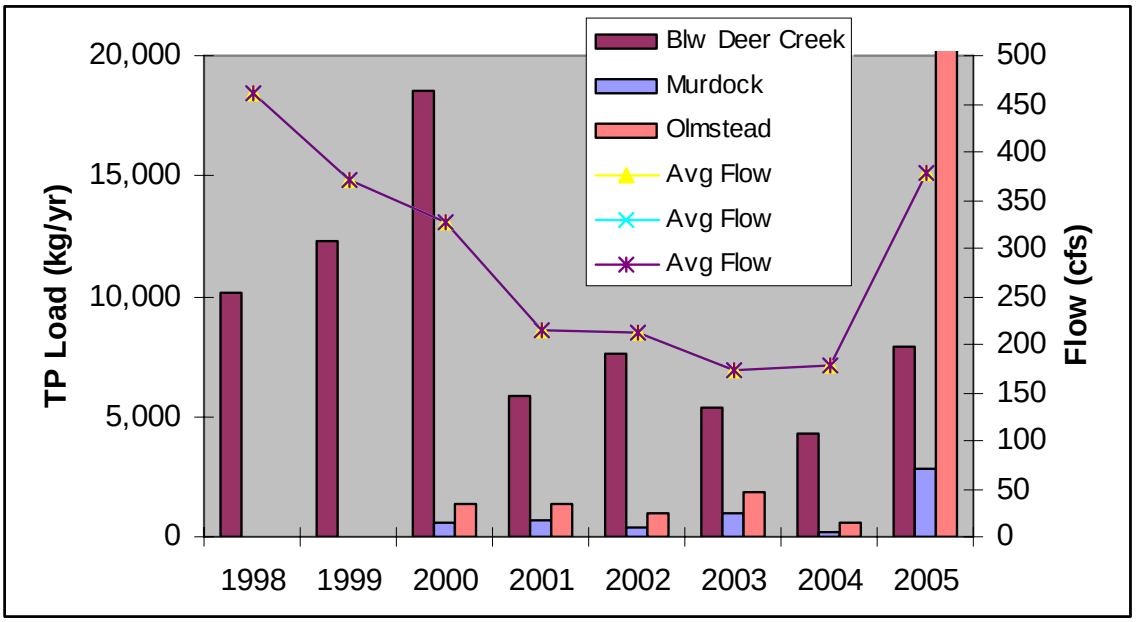


Table 7 - 1 Lower Provo River & Tributaries TSS/TP/DTP Loading Overview

	1999	2000	2001	2002	2003	2004	2005
Provo River below Deer Creek, STORET 5913210							
Weighted Average Flow (cfs)	371	327	215	211	172	177	378
TP Weighted Average (mg/l)	0.037	0.06	0.03	0.04	0.04	0.03	0.03
TP Annual Load (kg/yr)	12,299	18,584	5,854	7,614	5,399	4,274	7,904
DTP Weighted Average (mg/l)	0.022	0.03	0.02	0.02	0.02	0.01	0.02
DTP Annual Load (kg/yr)	7,219	8,839	4,253	4,404	3,360	2,369	4820
TSS Weighted Average (mg/l)	1.5	1.2	0.59	1.06	N/A	0.99	0
TSS Annual Load (kg/yr)	495,506	360,223	114,069	198,877	N/A	157,184	74,100
Provo River at Murdock Diversion STORET 4996780							
Weighted Average Flow (cfs)	-	43	34	34	59	64	195
TP Weighted Average (mg/l)	-	0.02	0.02	0.01	0.02	0	0.02
TP Annual Load (kg/yr)	-	608	703	352	957	176	2,844
DTP Weighted Average (mg/l)	-	0.02	0	0.01	0	0	0.00
DTP Annual Load (kg/yr)	-	611	68	174	249	27	58
TSS Weighted Average (mg/l)	-	8	0	3	N/A	2.4	4
TSS Annual Load (kg/yr)	-	306,864	0	84,628	N/A	136,360	836,393
Provo River at Olmsted Diversion STORET 4996810							
Weighted Average Flow (cfs)	-	63	55	46	93	75	230
TP Weighted Average (mg/l)	-	0.02	0.03	0.02	0.02	0.01	0.12
TP Annual Load (kg/yr)	-	1,381	1,372	927	1,805	624	64,246
DTP Weighted Average (mg/l)	-	0.02	0.02	0.01	0.01	0	0.00
DTP Annual Load (kg/yr)	-	1,119	881	544	803	313	327
TSS Weighted Average (mg/l)	-	0.27	0	1	N/A	0.56	1
TSS Annual Load (kg/yr)	-	15,189	0	50,443	N/A	37,893	394,019
Lower South Fork Provo River at Vivian Park							

STORET 4996830							
Weighted Average Flow (cfs)	-	15	16	11	11	10	20
TP Weighted Average (mg/l)	-	0.01	0.01	0.01	0.01	0	0.11
TP Annual Load (kg/yr)	-	125	195	51	82	0	1,821
DTP Weighted Average (mg/l)	-	0.01	0	0	0.01	0	0.00
DTP Annual Load (kg/yr)	-	42	0	30	79	0	0
TSS Weighted Average (mg/l)	-	3.8	2.1	3.4	N/A	2.03	5
TSS Annual Load (kg/yr)	-	51,386	29,984	33,389	N/A	18,863	93,578
Lower North Fork of Provo River at Wildwood STORET 4996850							
Weighted Average Flow (cfs)	-	14	17	13	14	14	23
TP Weighted Average (mg/l)	-	0.01	0.01	0.01	0	0	0.01
TP Annual Load (kg/yr)	-	159	102	84	58	0	106
DTP Weighted Average (mg/l)	-	0.01	0	0	0	0	0.00
DTP Annual Load (kg/yr)	-	99	0	36	30	0	0
TSS Weighted Average (mg/l)	-	2.1	4.1	1.2	N/A	0.65	17
TSS Annual Load (kg/yr)	-	26,263	61,160	12,982	N/A	7,945	386,249
Little Deer Creek Above Provo River STORET 4996870							
Weighted Average Flow (cfs)	-	13	18	15	14	14	27
TP Weighted Average (mg/l)	-	0	0	0.01	0.01	0.01	0.02
TP Annual Load (kg/yr)	-	39	42	76	90	71	469
DTP Weighted Average (mg/l)	-	0.01	0	0	0.01	0	0.01
DTP Annual Load (kg/yr)	-	131	0	0	103	25	206
TSS Weighted Average (mg/l)	-	5.6	4.4	1.9	N/A	4.6	14
TSS Annual Load (kg/yr)	-	64,918	71,131	26,263	N/A	58,044	482,686

DISSOLVED METALS ANALYSIS

The dissolved metal concentrations were analyzed for samples from several sites on the Provo River as well an additional tributary. Samples were collected two or three times during the 2005 water year. The specific stations sampled and the number of times sampled during the water year are shown in Table 7 - 2 below.

Table 7 - 2 Metals Sampling Events in Deer Creek Reservoir

Station Name	STORET No.	Number of Sampling Events
Provo River at Murdock Diversion	4996780	3
Provo River at Olmsted Diversion	4996810	3
Provo River below Deer Creek Reservoir	5913210	3
Little Deer Creek above confluence with Provo River	4996870	3
Lower North Fork of Provo River at Wildwood	4996850	2
Lower South Fork of Provo River at Vivian Park	4996830	2

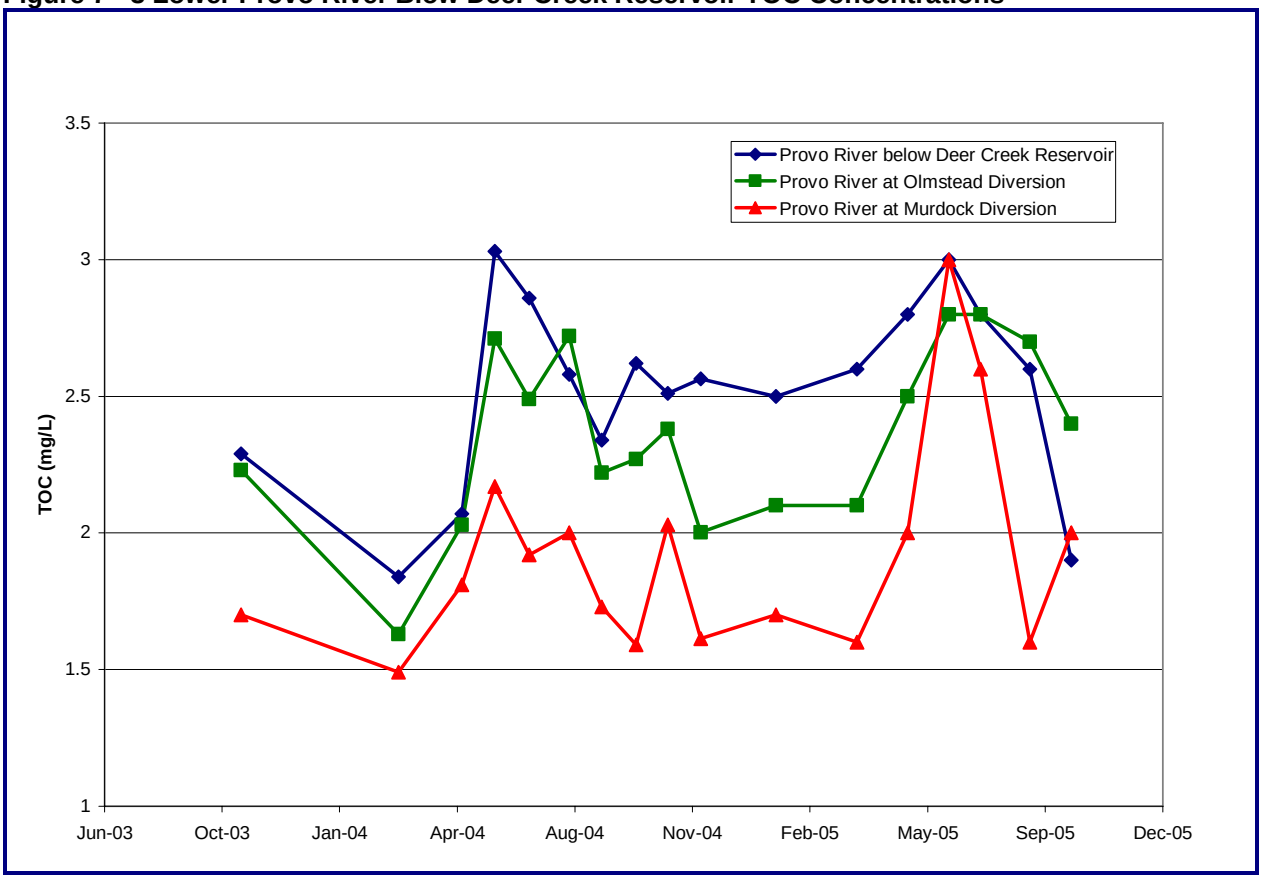
Few dissolved metals were detectable, and the ones that were detected occurred in concentrations well below the water quality standards outlined in Chapter 3. There are no areas of concern with this data.

TOTAL ORGANIC CARBON

Figure 7 - 3 shows TOC concentrations in the Lower Provo River for the 2004 and 2005 water years. Concentrations are well within the typical range of TOC for surface water. Maximum concentrations are less than 3 mg/L for all stations. There is a general profile for both water years that shows an increase in TOC concentration during the high runoff periods, which is expected. As with the Deer Creek Reservoir profile, the variance is not as pronounced as higher in the watershed. It is also notable that the concentrations are dropping as we move lower in the watershed. There are no significant changes in TOC concentration from year to year in this part of the watershed.

See Chapter 3 of this report for a discussion of the overall significance of TOC concentrations.

Figure 7 - 3 Lower Provo River Blow Deer Creek Reservoir TOC Concentrations



CHAPTER 8 – CONCLUSIONS and RECOMMENDATIONS

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 high 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 monitoring program for the 2003 water year detected several water quality problems in the watershed. As a summary, the problems detected are as follows in Table 8.1. This year's monitoring plan included six sites in this area. Below is listed the description of each site with its STORET number.

Table 8 - 1 2005 Water Quality Problem Areas

STORET Number	Location	Problem	Exceedence Rate	Comments
Upper Provo River and Jordanelle Reservoir*				
4998140	Weber Provo Canal	Majority of Load to Jordanelle from Weber Drainage		As shown in Figure 4-3 a majority of the Total Phosphorus load comes from the Weber Provo Canal.
4997670	McHenry Creek below Mayflower	High Heavy Metals Concentrations	Cadmium – Copper – Zinc -	Standards for cadmium, copper and zinc were exceeded as shown in Table 4 – 4.
Middle Provo River through Heber Valley†				
5911120	County Flood Control Channel at Provo River	High Phosphorus Concentrations	TP – 60% DTP – 40%	Total Phosphorus and Dissolved total phosphorus exceeded the PRWC standards three times and two times respectively during the summer.

* See Chapter 4 for specific details
† See Chapter 5 for specific details

5911120	County Flood Control Channel at Provo River	High Temperatures	Temp. - 40%	Temperature of the water exceeded state standards twice during the July and August. Max temperature 24° C
4997250	Spring Creek at Entrance to Provo River	High Phosphorus Concentrations	TP – 100% DTP – 87%	Average TP equals 0.34 mg/l. Average DTP equals 0.14 Spring Creek is contributing 60% of the total phosphorus and nearly all of the dissolved total phosphorus load to the Provo River system.
5910273	Sagebrush-Spring Creek Canal at 1200 North, Heber	High Phosphorus Concentrations	TP – 100% DTP – 100%	Average TP equals 0.12 mg/l Average DTP equals 0.08 mg/l
4997250	Spring Creek at Entrance to Provo River	Increasing TP and DTP Loads from 1999 to Present	N/A	Refer to Figure 5-8
402937111214901 403146111272701 402946111233901	Groundwater monitoring wells	Increasing concentrations of dissolved nitrates	N/A	Three wells have exhibited increasing nitrate concentrations. Two of these wells are located in the eastern portion of the valley. The sample taken for one of these wells measured 7.8 mg/l of dissolved nitrates.
402937111214901 402946111233901	Groundwater monitoring wells	High Phosphorus Concentrations	N/A	DTP concentrations averaged 0.9 and 0.8 between 2001 and 2005
Deer Creek Reservoir Basin[‡]				
5913460	Main Creek	High Phosphorus Concentrations	TP – 55% DTP – 22%	Average TP equals 0.54 mg/l. Max TP equal 0.1 mg/l.
5913460	Main Creek	High Temperatures	Temp - 22%	Max Temperature equals 23.2°
5913520	Daniels Creek	High Phosphorus Loads	Load – 180% of TMDL	Nearly all of the load occurred in the form of Dissolved Phosphorus
5913630	Provo River abv Deer Creek	High Phosphorus Loads in Winter	N/A	Loads not related to flow.
	Deer Creek Reservoir	High Phosphorus Loads Aug – Oct	130% of Target	Summer loadings from all inputs to Deer Creek exceed TMDL
	Deer Creek Reservoir	High Algae Biomass	111% of Target	Chlorophyll a average equals 5.7 μg/l
5913220 5913230	Deer Creek Reservoir Above Dam & Midlake	Low DO in water column	N/A	Above dam August & Sept., 2005 Midlake August, 2005

[‡] See Chapter 6 for specific details

Lower Provo River below Deer Creek Reservoir[§]				
4996830	Lower South Fork Provo River at Vivian Park	High Phosphorus Concentration – Single Event	TP - 11%	May 2005 TP concentration was 0.86 mg/l. Saw similar concentration at Olmstead
4996810	Provo River at Olmstead Div.	High Phosphorus Concentration – Single Event	TP - 11%	May 2005 TP concentration was 0.85 mg/l. Saw similar concentration at South Fork.

RECOMMENDATIONS

This report recommends the following items as suggestions for PRWC to continue to improve on water quality management and reduce the problems shown in Table 8 - 2. These recommendations are listed in Table 8 - 2. Focus was directed to the most extreme and critical problems within the watershed.

1. EPA Assessment of Jordanelle Basin 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 Mayflower tailings pile was capped in 2001, and an energy dissipation basin and sediment trap were also constructed.

PRWC should support mitigation of these potential water quality hazards. PRWC 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. Wasatch County should likewise support mitigation and review property owner monitoring.

Specific areas recommended for continued monitoring and support of mitigation activities include:

- McHenry Creek below Mayflower (STORET 499767)

2. Evaluation of Flows Into Spring Creek and Additional Water Quality Monitoring

Over the past seven years water quality within the Provo River through Heber Valley has greatly improved; however, improvements have not been observed in Spring Creek. These TP loadings from Spring Creek are a considerable portion of the total load to Deer Creek Reservoir. There have been some changes to the flow regime in this area; an additional 5 cfs of water is now being allowed to flow down Spring Creek from the location where the dam at Spring Creek Sagebrush Ditch diverted water. Flood irrigation practices on pasturelands are still being conducted in the north fields.

[§] See Chapter 7 for specific details

Irrigation water flows into secondary streams to Spring Creek including Middle Ditch and Rock Creek.

A site visit was conducted in the spring of 2004 in with the purpose of determining the cause of high phosphorus concentrations in Spring Creek. A previous report (MAG, 1987) documented the location of one groundwater drain discharge into Spring Creek Canal. The discharge point was found, however no flow was present on the day of the site visit.

Because of the phosphorus problems that are exhibited in Spring Creek, additional monitoring sites were added to the annual sampling program for the 2005 Water Year to try and determine where the problem was coming from. The two additional sites monitored were Spring Creek Canal at 1200 North in Heber and the Sagebrush-Spring Creek Canal at 1200 North in Heber. The flows are difficult to monitor at this point so loading is difficult to predict accurately. But by comparing the concentrations it can be seen that the Sagebrush-Spring Creek Canal is the major contributor.

It is suggested that additional research be conducted to identify any drains that may exist that discharge into Spring Creek. Additional observation and water quality monitoring of these sites should be integrated into the PRWC annual monitoring plan.

Of the problem areas identified in Table 8 - 2, the following will be addressed by implementation of this recommendation:

- Spring Creek, High TP Loads

3. Continue Groundwater Monitoring

Since the late 1990's groundwater monitoring has been conducted on 10 wells in the Heber Valley by the USGS and Central Utah Water Conservancy District. This has been done as part of the Wasatch County Water Efficiency Project. Higher concentrations of phosphorus are found in the eastern side of the valley. These concentrations have remained consistent since 2001, however some wells have DTP concentrations in the 0.08 to 0.09 mg/l range.

Additionally, three wells have exhibited increasing nitrate concentrations. Two of these wells are located in the eastern portion of the valley. The sample taken for one of these wells measured 7.8 mg/l of dissolved nitrates. This is well above the numeric criteria for cold water game fish.

The USGS and Central Utah Water Conservancy District have proposed discontinuing monitoring of the wells due to the completion of the Wasatch County Water Efficiency Project. However, it is suggested that monitoring be continued, specifically on the wells in the eastern side of the valley, to determine if the trends in this area will continue.

Of the problem areas identified in Table 8 - 2, the following will be addressed by implementation of this recommendation:

- Groundwater Monitoring Wells

4. Detailed Assessment of Main Creek and Water Quality Monitoring in Wallsburg Bay

Main Creek was sampled nine times during the water year. There were five exceedences of standards for TP and two for DTP. Additionally, the water temperature exceeded standards twice during the summer of 2005.

Main Creek's average load per ac-ft of water is twice as much as Snake Creek's load per ac-ft. Additionally, whereas Snake Creek's phosphorus can be attributed to phosphorus bound-up in sediments, half of Main Creek's phosphorus load is dissolved phosphorus. Dissolved phosphorus is readily available for algae growth and has a more extreme effect to eutrophication in the reservoir.

Main Creek's concentrations can be directly correlated to flow, indicating that much of the phosphorus input is related to runoff from the watershed.

It is suggested that a detailed study of the land management practices along Main Creek be conducted. Following the study a mitigation plan should be prepared that details practices to control runoff and improve land management practices in the area.

Additionally, water quality monitoring should be implemented in Deer Creek Reservoir in Wallsburg Bay during the spring and summer to observe water quality trends from the Main Creek Drainage.

Of the problem areas identified in Table 8 - 2, the following will be addressed by implementation of this recommendation:

- Main Creek (STORET 5913460)

Table 8 - 2 Summary of Recommendations

	Recommendations	Responsible Organization	Problem Area Addressed
1	**EPA Assessment of Jordanelle Basin Mine Sites**	PRWC[**] & Wasatch County	McHenry Creek below Mayflower (STORET 499767)
2	**Evaluation of Flows Into Spring Creek and Additional Water Quality Monitoring**	PRWC, Wasatch County, State of Utah DWQ[††], CUWCD[‡‡], & MAG[§§]	Spring Creek, High TP Loads

[**] Provo River Watershed Council
[††] Utah Division of Water Quality
[‡‡] Central Utah Water Conservancy District

3	**Continue Groundwater Monitoring**	CUWCD & USGS***	High DTP and increasing Nitrates in Groundwater Monitoring Wells in Heber Valley
4	**Detailed Assessment of Main Creek and Water Quality Monitoring in Wallsburg Bay**	NRCS††† & MAG	High Phosphorus Concentrations in Main Creek

§§ Mountainland Association of Governments
*** US Geological Survey
††† Natural Resource Conservation Service

Appendix A – Loading Calculations

Water Quality Data Analysis
2005 Water Year

Station ID	4929000	Kamas Fish Hatchery effluent
Time Period	10/1/2004	

	Flow	Phosphorus as P		Solids		Temperature	Volume (ac-ft)	DTP Mass Loading	TP Mass Loading	Total TDS Loading	Total TSS Loading
		Dissolved	Total	Dissolved	Total Suspended	water					
10/05/04					0		0	0.000000	0	0	0
11/02/04	1734				0	10.1					
11/03/04	1703	0.036	0	260	0	11.75	248	10.994539	0	79405	0
12/07/04	1703				0	10.1					
12/15/04	1753	**0.052**	**0.069**	274	0	7.6	325	20.805612	28	109630	0
01/05/05	1724				0	10.5					
02/16/05	1615				0	10.1					
03/22/05	2017	**0.061**	**0.063**	260	0	9.2	864	64.856486	67	276437	0
03/24/05	1946				0	10.2					
04/05/05	2213				4	9.8	117				577
04/21/05	2080	0.033	**0.045**	244	0	9.24	276	11.190371	15	82741	
05/03/05	3090				0	9.3					
06/15/05	2788				0	10.5					
06/29/05	2309	**0.072**	**0.1**	260	0	13.43	704	62.337800	87	225109	
07/12/05	2170				4	11.2	125				613
08/02/05	2000				0	12.2					
08/10/05	1923	0.033	**0.063**	228	0	15.25	357	14.483998	28	100071	0
09/08/05					0						
Grand Total							**3,016**	**184.67**	**224**	**873,393**	**1,190**

Average Flow	4.6

Average TP	0.06
Max TP	0.10
Min TP	0.00

Average DTP	0.05
Max DTP	0.07
Min DTP	0.03

Average TDS	254.3
Max TDS	274.0
Min TDS	228.0

Average TSS	0.4
Max TSS	4.0
Min TSS	0.0

Average Temp	10.7
Max Temp	15.3
Min Temp	7.6

Water Quality Data Analysis
2005 Water Year

Station ID	4996780	Provo River at Murdock Diversion

Time Period 10/1/2004 9/30/2005

	Flow	Phosphorus as P		Solids		Temperature	Volume (ac-ft)	DTP Mass Loading	TP Mass Loading	Total TDS Loading	Total TSS Loading
		Dissolved	Total	Dissolved	Total Suspended	water					
10/19/04	79.7	0	0.025	250	8.4	10.36	2845	0	87	874780	29393
11/16/04	36.4	0	0	254	0	8.02	2021	0	31	626452	10441
1/20/05	35.3	0	0	258	0	2.98	4550	0	0	1432702	0
3/29/05	52	0	0	260	0	5.8	7012	0	0	2233777	0
5/11/05	780	0	0.028	280	11.2	7.45	66510	0	1145	22087911	458120
6/15/05	629	0	0.023	252	0	13.05	43656	0	1369	14283287	300701
7/12/05	83.2	0	0.02	214	0	16.07	4455	0	118	1276647	0
8/23/05	12	0.022	0.031	210	14.4	13.48	999	14	31	260612	8851
9/27/05	47					13.23	3262	44	62	421292	28889
Grand Total			0.127			90.4	**135,309**	**58**	**2844**	**43,497,459**	**836,393**

Average Flow	195

Average TP	0.02
Max TP	0.03
Min TP	0.00

Average DTP	0.00
Max DTP	0.02
Min DTP	0.00

Average TDS	247
Max TDS	280
Min TDS	210

Average TSS	4
Max TSS	14
Min TSS	0

Average Temp	10.0
Max Temp	16.1
Min Temp	3.0

Water Quality Data Analysis
2005 Water Year

Station ID	4996810	Provo River at Olmsted Diversion
Time Period	10/1/2004	9/30/2005

	Flow	Phosphorus as P		Solids		Temperature	Volume (ac-ft)	DTP Mass Loading	TP Mass Loading	Total TDS Loading	Total TSS Loading
		Dissolved	Total	Dissolved	Total Suspended	water					
10/19/04	79.7	0	0.023	252	0	10.98	2845	0	80	881778	0
11/16/04	24.5	0	0.024	320	0	7.63	1360	0	39	478540	0
1/20/05	23.8	0	0.021	294	0	1.56	3068	0	85	1158395	0
3/29/05	52	0	0	328	0	6.67	7012	0	91	2682258	0
5/11/05	755	0	**0.845**	270	4.8	5.65	64378	0	33456	23676332	190044
6/15/05	806	0	0.023	242	0	12.05	55940	0	29862	17614523	165136
7/12/05	136.7	0	0.022	224	0	14.63	7319	0	203	2097568	0
8/23/05	84	0.037	0.038	214	4.4	14.05	6996	159	258	1884519	18931
9/27/05	106					13.95	7357	167	172	968246	19908
Grand Total			0.996			87.2	**156,275**	**327**	**64246**	**51,442,157**	**394,019**

Average Flow	230

Average TP	0.12
Max TP	0.85
Min TP	0.00

Average DTP	0.00
Max DTP	0.04
Min DTP	0.00

Average TDS	268
Max TDS	328
Min TDS	214

Average TSS	1
Max TSS	5
Min TSS	0

Average Temp	9.7
Max Temp	14.6
Min Temp	1.6

Water Quality Data Analysis
2005 Water Year

Station ID **4996830** **Lower South Fork Provo R at Vivian Park**
Time Period 10/1/2004 9/30/2005

	Flow	Phosphorus as P		Solids		Temperature	Volume (ac-ft)	DTP Mass Loading	TP Mass Loading	Total TDS Loading	Total TSS Loading
		Dissolved	Total	Dissolved	Total Suspended (TSS)	water					
10/19/04	12	0	0.018	192	0	8.78	428	0	9	101154	0
11/16/04	13	0	0	246	4	7.04	722	0	8	194434	1776
1/20/05	12	0	0	186	0	2.98	1547	0	0	410938	3805
3/29/05	12	0	0	178	5.3	6.78	1618	0	0	362234	5274
5/11/05	22	0	**0.862**	152	27.6	7.28	1876	0	994	380718	37956
6/15/05	22	0	0	166	0	13.74	1527	0	809	298618	25918
7/12/05	20	0	0	182	0	13.62	1071	0	0	229177	0
8/23/05	20	0	0	172	6.4	11.69	1666	0	0	362644	6556
9/27/05	45					9.23	3123	0	0	330375	12293
Grand Total	**178.0**		0.880			31.1	**13,578**	**0**	**1821**	**2,670,291**	**93,578**

Average Flow 20

Average TP	0.11
Max TP	0.86
Min TP	0.00

Average DTP	0.00
Max DTP	0.00
Min DTP	0.00

Average TDS	184
Max TDS	246
Min TDS	152

Average TSS	5
Max TSS	28
Min TSS	0

Average Temp	9.0
Max Temp	13.7
Min Temp	3.0

Water Quality Data Analysis
2005 Water Year

Station ID 4997130 **Midway Fish Hatchery comp below two outfalls**

Time Period 10/1/2004 9/30/2005

	Flow
4/5/2005	0
6/1/2005	0
6/29/2005	0
8/10/2005	0
Grand Total	

Volume (ac-ft)	DTP Mass Loading	TP Mass Loading	Total TDS Loading	Total TSS Loading
0	0	0	0	0
0	0	0	0	0
0	0	0	0	0
0	0	0	0	0
0	0	0	0	0
0	0	0	0	0
0	0	0	0	0
0	0	0	0	0
0	0	0	0	0
0	**0**	**0**	**0**	**0**

Average Flow 0.0

Average TP	#REF!
Max TP	#REF!
Min TP	#REF!

Average DTP	#REF!
Max DTP	#REF!
Min DTP	#REF!

Average TDS	#REF!
Max TDS	#REF!
Min TDS	#REF!

Average TSS	#REF!
Max TSS	#REF!
Min TSS	#REF!

Average Temp	#REF!
Max Temp	#REF!
Min Temp	#REF!

Water Quality Data Analysis
2005 Water Year

Station ID **4996870** **Little Deer Creek above cnfl with Provo River**

Time Period 10/1/2004 9/30/2005

	Flow	Phosphorus as P		Solids		Temperature	Volume (ac-ft)	DTP Mass Loading	TP Mass Loading	Total TDS Loading	Total TSS Loading
		Dissolved	Total	Dissolved	Total Suspended (TSS)	water					
10/19/04	18.5	0.022	0.035	320	11.2	7.82	660	18	28	259909	9097
11/16/04	12.8	0	0	340	7.6	7.53	711	10	15	288476	8217
1/20/05	12.8	0	0	304	5.2	2.22	1650	0	0	653442	12988
3/29/05	13.7	0	0.037	272	15.6	7.34	1847	0	42	654410	23631
5/11/05	67.7	0.038	0.023	208	63.6	6.85	5773	135	213	1704104	281177
6/15/05	27	0	0.034	256	16.8	16.12	1874	44	66	534746	92659
7/12/05	44.5	0	0.021	288	6.4	17.27	2383	0	81	797114	33995
8/23/05	22.2	0	0	278	12	14.55	1849	0	24	643601	20923
9/7/05		0	0	274	6		0	0	0	0	0
9/27/05	20	0	0	280	0	10.63	0	0	0	0	0
Grand Total		0.0600	0.150			90.3	**16,746**	**206**	**469**	**5,535,803**	**482,686**

Average Flow 27

Average TP	0.02
Max TP	0.04
Min TP	0.00

Average DTP	0.01
Max DTP	0.04
Min DTP	0.00

Average TDS	282
Max TDS	340
Min TDS	208

Average TSS	14
Max TSS	64
Min TSS	0

Average Temp	10.0
Max Temp	17.3
Min Temp	2.2

Water Quality Data Analysis
2005 Water Year

Station ID **4996850** **Lower North Fork of Provo R at Wildwood**

Time Period 10/1/2004 9/30/2005

	Flow	Phosphorus as P		Solids		Temperature	Volume (ac-ft)	DTP Mass Loading	TP Mass Loading	Total TDS Loading	Total TSS Loading
		Dissolved	Total	Dissolved	Total Suspended (TSS)	water					
10/19/04	12	0	**0.058**	200	42	7.39	428	0	31	105369	22127
11/16/04	9	0	0	268	0	6.1	500	0	18	143828	12908
1/20/05	12	0	0	322	0	2.61	1547	0	0	561235	0
3/29/05	13	0	0	348	4	4.9	1753	0	0	722312	4312
5/11/05	35	0	0	232	91.6	5.72	2984	0	0	1064541	175466
6/15/05	30	0	0	176	6.8	10.57	2082	0	0	522453	126003
7/12/05	45	0	0.021	142	12.8	11.07	2409	0	31	471196	29042
8/23/05	25	0	0	140	0	10.8	2082	0	27	361107	16391
9/27/05	28	0	0	194	0	8.82	1943	0	0	399181	0
Grand Total			0.079			68.0	**15,729**	**0**	**106**	**4,351,222**	**386,249**

Average Flow 23

Average TP	0.01
Max TP	0.06
Min TP	0.00

Average DTP	0.00
Max DTP	0.00
Min DTP	0.00

Average TDS	225
Max TDS	348
Min TDS	140

Average TSS	17
Max TSS	92
Min TSS	0

Average Temp	7.6
Max Temp	11.1
Min Temp	2.6

Water Quality Data Analysis
2005 Water Year

Station ID **4997250** **Spring Creek at entrance to Provo River E of WWTP**
Time Period 10/1/2004 9/30/2005

	Flow	Phosphorus as P		Solids		Temperatu	Volume (ac-ft)	DTP Mass Loading	TP Mass Loading	Total TDS Loading	Total TSS Loading
		Dissolved	Total	Dissolved	Total Suspended (TSS)	water					
10/19/04	57	**0.136**	**0.342**	370	146	7.76	2035	340	856	925927	365366
11/16/04	20	**0.056**	**0.145**	278	59.2	7.33	1110	131	333	442548	140140
1/19/2005	19.2	**0.044**	**0.085**	286	14.8	6.45	2437	150	345	845197	110895
3/29/05	27.8	**0.049**	**0.122**	256	47.6	6.4	3804	218	484	1267918	145974
5/11/05	62.3	**0.134**	**0.236**	250	77.2	7.94	5312	598	1170	1653122	407726
6/15/05	53.9	**0.044**	**0.074**	206	34.8	14.93	3741	410	713	1049106	257675
7/12/05	42.5	**0.05**	**0.063**	224	14.8	16.81	2275	132	192	601754	69412
8/23/05	26	**0.06**	**0.075**	220	12.8	15.57	2165	146	184	591294	36756
9/27/05	32.5	0.036	**0.071**	238	8.8	10.4	2256	133	203	635352	29964
Grand Total		**0.6090**	**1.213**			**93.6**	**25,135**	**2257**	**4478**	**8,012,219**	**1,563,909**

Average Flow	38

Average TP	0.13
Max TP	0.34
Min TP	0.06

Average DTP	0.07
Max DTP	0.14
Min DTP	0.04

Average TDS	258.7
Max TDS	370.0
Min TDS	206.0

Average TSS	46.2
Max TSS	146.0
Min TSS	8.8

Average Temp	10.4
Max Temp	16.8
Min Temp	6.4

Water Quality Data Analysis
2005 Water Year

Station ID **4997300** **Provo River at River Road Bridge**
Time Period 10/1/2004 9/30/2005

	Flow	Phosphorus as P		Solids		Temperature	Volume (ac-ft)	DTP Mass Loading	TP Mass Loading	Total TDS Loading	Total TSS Loading
		Dissolved	Total	Dissolved	Total Suspended (TSS)	water					
10/19/04	146.8	0	0.01	134	0	9.32	5240	0	64	863637	0
11/16/04	130.6	0	0	168	0	8.01	7251	0	45	1346809	0
1/19/05	127.4	0	0	152	0	4.72	16169	0	0	3181978	0
3/29/05	139.7	0	0	146	0	5.1	19115	0	0	3503157	0
5/11/05	207.3	0	**0.046**	148	4.8	6.59	17676	0	500	3196045	52180
6/15/05	668.9	0	0	128	0	9.12	46425	0	1313	7880180	137047
7/12/05	407.2	0	0	86	4.8	13.94	21802	0	0	2869347	64359
8/23/05	140.9	0	0	102	0	13.33	11735	0	0	1356800	34642
9/27/05	169	0	0	124	0	12.14	11729	0	0	1630276	0
Grand Total			0.056			82.3	**157,142**	**0**	**1922**	**25,828,230**	**288,228**

Average Flow 237.5

Average TP	0.01
Max TP	0.05
Min TP	0.00

Average DTP	0.00
Max DTP	0.00
Min DTP	0.00

Average TDS	132.0
Max TDS	168.0
Min TDS	86.0

Average TSS	1.1
Max TSS	4.8
Min TSS	0.0

Average Temp	9.1
Max Temp	13.9
Min Temp	4.7

Water Quality Data Analysis
2005 Water Year

Station ID **4997330** **Provo River bl Jordanelle Dam**
Time Period 10/1/2004 9/30/2005

	Flow	Phosphorus as P		Solids		Temperature	Volume (ac-ft)	DTP Mass Loading	TP Mass Loading	Total TDS Loading	Total TSS Loading
		Dissolved	Total	Dissolved	Total Suspended (TSS)	water					
10/19/04	140.8	0	0.008	140	0	10.16	5026	0	49	865428	0
11/16/04	132.1	0	0	166	0	8.02	7335	0	36	1380321	0
1/19/05	147.3	0	0	142	0	3.38	18694	0	0	3541044	0
3/29/05	147.5	0	0	140	0	3.97	20182	0	0	3500161	0
5/11/05	244.6	0	0	146	0	5.9	20857	0	0	3668502	0
6/15/05	780.1	0	0	116	0	7.06	54143	0	0	8724036	0
7/12/05	511.8	0	0	88	0	11.22	27402	0	0	3437891	0
8/23/05	232.8	0	0	98	0	11.48	19389	0	0	2217906	0
9/27/05	228	0	0	132	0	12.41	15824	0	0	2238353	0
Grand Total						73.6	**188,852**	**0**	**86**	**29,573,641**	**0**

Average Flow	285
Average TP	0.00
Max TP	0.01
Min TP	0.00
Average DTP	0.00
Max DTP	0.00
Min DTP	0.00
Average TDS	129.8
Max TDS	166.0
Min TDS	88.0
Average TSS	0.0
Max TSS	0.0
Min TSS	0.0
Average Temp	8.2
Max Temp	12.4
Min Temp	3.4

Water Quality Data Analysis
2005 Water Year

Station ID **4997670** **McHenry Creek below Mayflower**
Time Period 10/1/2004 9/30/2005

	Flow	Phosphorus as P		Solids		Temperature	Volume (ac-ft)	DTP Mass Loading	TP Mass Loading	Total TDS Loading	Total TSS Loading
		Dissolved	Total	Dissolved	Total Suspended (TSS)	water					
10/19/04	5	**0.078**	**0.144**	622	0	10.05	178	17	32	136540	0
11/16/04	2.5	0	0.027	904	7.2	10.7	139	7	15	130272	615
3/29/05	4	0	0	618	5.6	9.53	1055	0	18	987470	8305
5/11/05	8	0	0	450	17.2	9.2	682	0	0	448051	9565
6/15/05	4	0	0	790	0	18.72	278	0	0	211713	2937
7/12/05	3	0	0	810	0	18.86	161	0	0	158053	0
8/23/05	3	0	0	780	0	18.08	250	0	0	244324	0
9/27/05	4	0	0	788	0	15.66	278	0	0	267715	0
Grand Total		**0.0780**	**0.171**			**110.8**	**3,020**	**24**	**64**	**2,584,138**	**21,421**

Average Flow	4.2

Average TP	0.02
Max TP	0.14
Min TP	0.00

Average DTP	0.01
Max DTP	0.08
Min DTP	0.00

Average TDS	720.3
Max TDS	904.0
Min TDS	450.0

Average TSS	3.8
Max TSS	17.2
Min TSS	0.0

Average Temp	13.9
Max Temp	18.9
Min Temp	9.2

Water Quality Data Analysis
2005 Water Year

Station ID **4998130** **Provo River ab Hailstone Junction**
Time Period 10/1/2004 9/30/2005

	Flow	Phosphorus as P		Solids		Temperature	Volume (ac-ft)	DTP Mass Loading	TP Mass Loading	Total TDS Loading	Total TSS Loading
		Dissolved	Total	Dissolved	Total Suspended (TSS)	water					
10/19/04	65	0	0.012	176	0	6.28	2320	0	34	502257	0
11/16/04	96.6	0	0	164	0	2.76	5364	0	40	1121533	0
1/19/05	88.6	0	0	140	0	1.7	11244	0	0	2102254	0
3/29/05	180	0	0	136	0	2.4	24629	0	0	4180503	0
5/11/05	1672	0	0	104	25.6	3.04	142570	0	0	21043298	2244618
6/15/05	1028.2	0	0.021	68	14.4	9.71	71362	0	922	7548696	1755511
7/12/05	292.8	0	0	84	0	14.8	15677	0	202	1465468	138834
8/23/05	65.8	0	0	112	6	13.98	5480	0	0	660586	20222
9/27/05	59	0	0	148	0	9.38	4095	0	0	654774	15110
Grand Total						64.1	**282,741**	**0**	**1198**	**39,279,367**	**4,174,295**

Average Flow 394.2

Average TP	0.00
Max TP	0.02
Min TP	0.00

Average DTP	0.00
Max DTP	0.00
Min DTP	0.00

Average TDS	125.8
Max TDS	176.0
Min TDS	68.0

Average TSS	5.1
Max TSS	25.6
Min TSS	0.0

Average Temp	7.1
Max Temp	14.8
Min Temp	1.7

Water Quality Data Analysis
2005 Water Year

Station ID **4998140** **Weber Provo Canal Diversion at US189**
Time Period 10/1/2004 9/30/2005

	Flow	Phosphorus as P		Solids		Temperature	Volume (ac-ft)	DTP Mass Loading	TP Mass Loading	Total TDS Loading	Total TSS Loading
		Dissolved	Total	Dissolved	Total Suspended (TSS)	water					
10/19/04	0						0	0	0	0	0
11/16/04	0						0	0	0	0	0
1/19/05	22.3	0	0	158	0	0.72	4864	0	0	472664	0
3/29/05	58	0	0	170	0	1.8	7936	0	0	1600843	0
5/11/05	454.7	0	0.025	132	26	2.91	38772	0	596	7201089	619961
6/15/05	219.2	0	0.029	84	14.8	9.47	15214	0	505	2020971	381739
7/12/05	178.1	0	0	86	0	14.39	9536	0	170	996952	86794
Grand Total			0.054			29.3	**76,321**	**0**	**1271**	**12,292,520**	**1,088,494**

Average Flow	133.2
Average TP	0.01
Max TP	0.03
Min TP	0.00
Average DTP	0.00
Max DTP	0.00
Min DTP	0.00
Average TDS	126.0
Max TDS	170.0
Min TDS	84.0
Average TSS	8.2
Max TSS	26.0
Min TSS	0.0
Average Temp	5.9
Max Temp	14.4
Min Temp	0.7

Water Quality Data Analysis
2005 Water Year

Station ID **4998400** **Provo River above Woodland at USGS gage**
Time Period 10/1/2004 9/30/2005

	Flow	Phosphorus as P		Solids		Temperature	Volume (ac-ft)	DTP Mass Loading	TP Mass Loading	Total TDS Loading	Total TSS Loading
		Dissolved	Total	Dissolved	Total Suspended (TSS)	water					
10/19/04	47	0	0.01	166	0	6.03	1678	0	21	342536	0
11/16/04	67	0	0	136	0	2.23	3720	0	23	690936	0
1/19/05	61	0	0	114	0	2.48	7742	0	0	1190276	0
3/29/05	82	0	0	90	0	1.85	11220	0	0	1407638	0
5/11/05	534	0	0	88	7.6	1.78	45534	0	0	4984568	212824
6/15/05	801	0	0	54	8.8	6.72	55593	0	0	4854972	560715
7/12/05	290	0	0	58	0	11.85	15527	0	0	1069492	84032
8/23/05	101	0	0	110	10.4	11.57	8412	0	0	869116	53802
9/27/05	57	0	0	150	0	8.53	3956	0	0	632578	25303
Grand Total						53.0	**153,381**	**0**	**44**	**16,042,112**	**936,676**

Average Flow 226.7

Average TP	0.00
Max TP	0.01
Min TP	0.00

Average DTP	0.00
Max DTP	0.00
Min DTP	0.00

Average TDS	107.3
Max TDS	166.0
Min TDS	54.0

Average TSS	3.0
Max TSS	10.4
Min TSS	0.0

Average Temp	5.9
Max Temp	11.9
Min Temp	1.8

Water Quality Data Analysis
2005 Water Year

Station ID **5910020** **Lower Charleston Canal ab Daniels Ck**
Time Period 10/1/2004 9/30/2005

	Flow	Phosphorus as P		Solids		Temperature	Volume (ac-ft)	DTP Mass Loading	TP Mass Loading	Total TDS Loading	Total TSS Loading
		Dissolved	Total	Dissolved	Total Suspended (TSS)	water					
10/19/04	0						0	0	0	0	0
11/16/04	0						0	0	0	0	0
1/19/05	1.9	0.049	0.064	316	0	7.3	144570	4357	5690	28095815	0
7/12/05	5.8	0	0.033	274	0	19.08	2001	60	119	726151	0
8/23/05	2.7	0	0	258	0	16.44	225	0	5	73574	0
9/27/05	4.1	0	0.022	284	0	10.69	285	0	4	94853	0
Grand Total	**14.5**	0.0490	0.0319			63.5	**147,081**	**4417**	**5818**	**28,990,392**	**0**

Average Flow 2.4

Average TP	0.030
Max TP	0.064
Min TP	0.000

Average DTP	0.012
Max DTP	0.049
Min DTP	0.000

Average TDS	283.000
Max TDS	316.000
Min TDS	258.000

Average TSS	0.000
Max TSS	0.000
Min TSS	0.000

Average Temp	13.378
Max Temp	19.080
Min Temp	7.300

Water Quality Data Analysis
2005 Water Year

Station ID **5910160** **Snake Creek above Deer Creek Res.**
Time Period 10/1/2004 9/30/2005

	Flow	Phosphorus as P		Solids		Temperature	Volume (ac-ft)	DTP Mass Loading	TP Mass Loading	Total TDS Loading	Total TSS Loading
		Dissolved	Total	Dissolved	Total Suspended (TSS)	water					
10/19/04	50.6	0.03	**0.061**	756	14.8	10.38	1806	67	136	1679472	32879
11/16/04	33	0	0.03	680	17.6	11.66	1832	34	103	1618170	36510
1/19/05	30.6	0	0.027	686	14	10.6	3884	0	136	3262496	75472
3/29/05	25.1	0	0.021	682	4.8	11.29	3434	0	101	2889394	39708
5/11/05	55.7	0	0	506	12.4	10.99	4749	0	61	3470067	50240
6/15/05	64.6	0	0.024	416	14.4	15.44	4484	0	66	2542315	73898
7/12/05	73.1	0	0.023	484	13.6	17.06	3914	0	113	2166314	67396
8/23/05	66.8	0	0	582	15.6	16.45	5564	0	79	3647378	99909
9/27/05	64.2	0	0	598	11.2	12.87	4456	0	0	3233575	73441
Grand Total	**463.7**		0.186			416.7	**34,122**	**100**	**795**	**24,509,181**	**549,453**

Average Flow 52

kg/ac-ft 0.0233

Average TP	0.021
Max TP	0.061
Min TP	0.000

Average DTP	0.003
Max DTP	0.030
Min DTP	0.000

Average TDS	599
Max TDS	756
Min TDS	416

Average TSS	13.2
Max TSS	18
Min TSS	5

Average Temp	13.0
Max Temp	17.1
Min Temp	10.4

Water Quality Data Analysis
2005 Water Year

Station ID **5910250** **Provo River at Heber - Midway Bridge**
Time Period 10/1/2004 9/30/2005

	Flow	Phosphorus as P		Solids		Temperature	Volume (ac-ft)	DTP Mass Loading	TP Mass Loading	Total TDS Loading	Total TSS Loading
		Dissolved	Total	Dissolved	Total Suspended (TSS)	water					
10/19/04	147.5	0	0.014	170	0	8.62	5265	0	91	1100883	0
11/16/04	122.6	0	0	196	0	7.14	6807	0	59	1532242	0
1/19/05	134.8	0	0	202	0	4.71	17108	0	0	4187461	0
3/29/05	150.4	0	0	170	0	5.42	20579	0	0	4708013	0
5/11/05	236.6	0	**0.558**	178	0	7.03	20175	0	6923	4317778	0
6/15/05	701.1	0	0	132	0	10.14	48660	0	16699	9277000	0
7/12/05	416.5	0	0	112	4	13.78	22300	0	0	3346312	54858
8/23/05	167.7	0	0	132	4.4	14.63	13967	0	0	2095897	72154
9/27/05	168	0	0	158	0	11.52	11660	0	0	2079568	31552
Grand Total	**2245.2**		**0.572**			**83.0**	**166,520**	**0**	**23771**	**32,645,154**	**158,563**

Average Flow 249.5

Average TP	0.06
Max TP	0.56
Min TP	0.00

Average DTP	0.00
Max DTP	0.00
Min DTP	0.00

Average TDS	161.1
Max TDS	202.0
Min TDS	112.0

Average TSS	0.9
Max TSS	4.4
Min TSS	0.0

Average Temp	9.2
Max Temp	14.6
Min Temp	4.7

Water Quality Data Analysis
2005 Water Year

Station ID **5910273** **Sagebrush-Spring ck cnl at 1200 North, Heber**
Time Period 10/1/2004 9/30/2005

	Flow	Phosphorus as P		Solids		Temperature	Volume (ac-ft)	DTP Mass Loading	TP Mass Loading	Total TDS Loading	Total TSS Loading
		Dissolved	Total	Dissolved	Total Suspended (TSS)	water					
7/12/05	8	**0.089**	**0.117**	256	0	15.68	286	31	41	89915	0
8/23/05	8	**0.081**	**0.103**	248	20	13.73	666	70	90	206523	8195
9/27/05	12	**0.082**	**0.135**	284	0	9.78	833	83	122	272495	10244
						39.2	**1,785**	**184**	**253**	**568,932**	**18,440**

Average Flow 9.3

Average TP	0.12
Max TP	0.14
Min TP	0.10

Average DTP	0.08
Max DTP	0.09
Min DTP	0.08

Average TDS	263
Max TDS	284
Min TDS	248

Average TSS	7
Max TSS	20
Min TSS	0

Average Temp	13.1
Max Temp	15.7
Min Temp	9.8

Water Quality Data Analysis
2005 Water Year

Station ID **5910293** **Spring ck at 1200 North, Heber.**
Time Period 10/1/2004 9/30/2005

	Flow	Phosphorus as P		Solids		Temperatur	Volume (ac-ft)	DTP Mass Loading	TP Mass Loading	Total TDS Loading	Total TSS Loading
		Dissolved	Total	Dissolved	Total Suspended (TSS)	water					
7/12/05	1	0.036	**0.044**	162	0	15.05	36	2	2	7112	0
Grand Total	**1.0**		**0.044**				**36**	**2**	**2**	**7,112**	**0**

Average Flow	1.0

Average TP	0.04
Max TP	0.04
Min TP	0.04

Average DTP	0.04
Max DTP	0.04
Min DTP	0.04

Average TDS	162
Max TDS	162
Min TDS	162

Average TSS	0
Max TSS	0
Min TSS	0

Average Temp	15.1
Max Temp	15.1
Min Temp	15.1

Water Quality Data Analysis
2005 Water Year

Station ID 5911120 **Northwestward Flow to Provo R. (Flood Control)**
Time Period 10/1/2004 9/30/2005

	Flow	Phosphorus as P		Solids		Temperature	Volume (ac-ft)	DTP Mass Loading	TP Mass Loading	Total TDS Loading	Total TSS Loading
		Dissolved	Total	Dissolved	Total Suspended (TSS)	water					
10/19/04	0						0	0	0	0	0
11/16/04	0						0	0	0	0	0
1/19/05	0						0	0	0	0	0
3/29/05	12	0.058	0.12	200	80	7.08	1642	59	121	201957	80783
5/11/05	20	0.058	0.16	180	134	8.17	1705	122	294	398547	224445
6/15/05	30	0.025	0.069	148	58	16.2	2082	106	293	420011	245860
7/12/05	3	0	0.032	186	0	24.24	161	2	10	32994	5729
8/23/05	6	0	0.028	132	8.8	20.58	500	0	18	97729	2704
9/27/05	12					12.71	833	0	14	67612	4507
Grand Total	83.0	0.179	0.429			7.1	6,923	289	751	1,218,850	564,029

Average Flow	9.2
Average TP	0.08
Max TP	0.16
Min TP	0.03
Average DTP	0.03
Max DTP	0.06
Min DTP	0.00
Average TDS	169.2
Max TDS	200.0
Min TDS	132.0
Average TSS	56.2
Max TSS	134.0
Min TSS	0.0
Average Temp	14.8
Max Temp	24.2
Min Temp	7.1

Water Quality Data Analysis
2005 Water Year

Station ID **5913210** **Provo River below Deer Creek Res.**
Time Period 10/1/2004 9/30/2005

	Flow	Phosphorus as P		Solids		Temperature	Volume (ac-ft)	DTP Mass Loading	TP Mass Loading	Total TDS Loading	Total TSS Loading
		Dissolved	Total	Dissolved	Total Suspended (TSS)	water					
10/19/04	87.5	0.02	0.026	272	0	13.59	3123	77	100	1044906	0
11/16/04	92	0.024	0.022	296	0	9.44	5108	138	151	1784399	0
1/20/05	91	0.021	0.028	292	0	2.35	11729	325	361	4241602	0
3/29/05	88.5	0	0	276	0	5.04	11934	154	205	4168678	0
5/11/05	680.3	0	0.022	280	0	6.76	58009	0	785	19835427	0
6/15/05	1070	0	0	238	0	10.8	74263	0	1005	23658075	0
7/12/05	420.2	0.024	0.033	244	0	12.46	22498	332	457	6669061	0
8/23/05	436.8	**0.052**	**0.06**	216	0	13.19	36379	1700	2081	10291711	0
9/27/05	434	**0.061**	**0.089**	240	4	14.51	30122	2093	2760	8447349	74100
Grand Total	**3400.3**	0.2020	0.280			88.1	**253,165**	**4820**	**7904**	**80,141,208**	**74,100**

Average Flow 378

Average TP	0.03
Max TP	0.09
Min TP	0.00

Average DTP	0.02
Max DTP	0.06
Min DTP	0.00

Average TDS	262
Max TDS	296
Min TDS	216

Average TSS	0
Max TSS	4
Min TSS	0

Average Temp	9.8
Max Temp	14.5
Min Temp	2.4

Water Quality Data Analysis
2005 Water Year

Station ID **5913460** **Main Creek at bridge on US189 above Res.**
Time Period 10/1/2004 9/30/2005

	Flow	Phosphorus as P		Solids		Temperature	Volume (ac-ft)	DTP Mass Loading	TP Mass Loading	Total TDS Loading	Total TSS Loading
		Dissolved	Total	Dissolved	Total Suspended (TSS)	water					
10/19/04	4	**0.047**	**0.079**	462	27	8.78	143	8	14	81134	4742
11/16/04	6	0	0.027	362	16	9.64	333	10	22	168824	8810
1/19/05	15	0	0.03	338	10	0.55	1904	0	67	819534	30440
3/29/05	30	0.021	**0.078**	260	47.6	10.16	4105	53	273	1509626	145409
5/11/05	50	0.033	0	150	64.4	7.8	4263	142	205	1075029	293666
6/15/05	25	0.022	0.032	166	0	17.15	1735	59	34	337204	68721
7/12/05	8	**0.042**	**0.063**	332	8.4	**23.21**	428	17	25	131184	2213
8/23/05	8	0.036	**0.1**	328	43.2	**20.42**	666	32	67	270446	21144
9/27/05	8	0	**0.073**	352	25.6	12.44	555	12	59	232201	23493
Grand Total	**154.0**	**1.2010**	**0.482**			**110.2**	**14,133**	**332**	**765**	**4,625,183**	**598,638**

Average Flow 17

kg/ac-ft 0.0541

Average TP	0.054
Max TP	0.10
Min TP	0.00

Average DTP	0.022
Max DTP	0.05
Min DTP	0.00

Average TDS	306
Max TDS	462
Min TDS	150

Average TSS	27
Max TSS	64
Min TSS	0

Average Temp	12.2
Max Temp	23.2
Min Temp	0.6

Water Quality Data Analysis
2005 Water Year

Station ID **5913520** **Daniels Creek 100 feet below cnfl w/ LCC**
Time Period 10/1/2004 9/30/2005

	Flow	Phosphorus as P		Solids		Temperature	Volume (ac-ft)	DTP Mass Loading	TP Mass Loading	Total TDS Loading	Total TSS Loading
		Dissolved	Total	Dissolved	Total Suspended (TSS)	water					
3/29/05	13	**0.048**	**0.074**	252	9.6	7.78	464	27	42	143828	5479
5/11/05	76	0	0	170	82.4	6.62	1137	1137	1137	1137	115251
6/15/05	19	0	0	190	10.4	17.88	1319	0	0	308179	16869
Grand Total	**108.0**	**0.0480**	**0.074**			**32.3**	**2,920**	**1165**	**1179**	**453,144**	**137,599**

Average Flow 36.0

Average TP	0.025	0.02	**204**	34
Max TP	0.074	**0.05**	**252**	82
Min TP	0.000	0.00	**170**	10

Average DTP	0.016
Max DTP	0.048
Min DTP	0.000

Average TDS	204
Max TDS	252
Min TDS	170

Average TSS	34
Max TSS	82
Min TSS	10

Average Temp	10.8
Max Temp	17.9
Min Temp	6.6

Water Quality Data Analysis
2005 Water Year

Station ID **5913630** **Provo River above Deer Creek Res. at McKellar Br.**
Time Period 10/1/2004 9/30/2005

	Flow	Phosphorus as P		Solids		Volume (ac-ft)	DTP Mass Loading	TP Mass Loading	Total TDS Loading	Total TSS Loading
		Dissolved	Total	Dissolved	Total Suspended (TSS)					
10/19/04	231	0.023	**0.079**	226	53.6	8245	233	801	2292032	543597
11/16/04	165.4	0	**0.041**	202	34.4	9184	130	678	2417326	497020
1/19/05	173.1	0	**0.117**	218	143.2	21968	0	2135	5674455	2399484
3/29/05	192.7	0	0.03	246	13.2	26367	0	2384	7523962	2536094
5/11/05	321	0.032	0	188	28.4	27371	539	505	7305687	700269
6/15/05	834.9	0	0	150	10	57946	1140	0	12045284	1368458
7/12/05	468.4	0	0.021	128	6.4	25079	0	324	4287689	252943
8/23/05	157.9	0	0.024	156	8	13151	0	364	2296929	116464
9/27/05	187.6	0	0	170	7.2	13020	0	192	2610456	121714
Grand Total	**2732.0**	**0.0550**	**0.312**			**202,331**	**2042**	**7382**	**46,453,820**	**8,536,044**

Average Flow	304
Average TP	0.035
Max TP	0.117
Min TP	0.000
Average DTP	0.006
Max DTP	0.032
Min DTP	0.000
Average TDS	187.1
Max TDS	246.0
Min TDS	128.0
Average TSS	33.8
Max TSS	143.2
Min TSS	6.4
Average Temp	10.4
Max Temp	16.2
Min Temp	5.1

2006 Water Quality Implementation Report

Data Loading Calculations

Station ID **5913630** **Provo River above Deer Creek Res. at McKellar Br.**

Time Period 10/1/2004 9/30/2005

	Flow	Phosphorus as P		Solids		Temperature	Volume (ac-ft)	DTP Mass Loading	TP Mass Loading	Total TDS Loading	Total TSS Loading
		Dissolved	Total	Dissolved	Total Suspended (TSS)	water					
10/19/04	231	0.023	0.079	226	53.6	8.61	8245	233	801	2292032	543597
11/16/04	165.4	0	0.041	202	34.4	8	9184	0	463	2281775	388579
1/19/05	173.1	0	0.117	218	143.2	5.09	21968	0	3161	5890625	3869438
3/29/05	192.7	0	0.03	246	13.2	6.31	26367	0	973	7977995	428088
5/11/05	321	0.032	0	188	28.4	8.67	27371	1077	0	6329351	956136
6/15/05	834.9	0	0	150	10	13.21	57946	0	0	10691080	712739
7/12/05	468.4	0	0.021	128	6.4	16.11	25079	0	648	3948375	197419
8/23/05	157.9	0	0.024	156	8	16.2	13151	0	388	2523387	129404
9/27/05	187.6	0	0	170	7.2	11.41	13020	0	0	2722561	115308
Grand Total	**2732.0**						**202,331**	**1311**	**6435**	**44,657,181**	**7,340,708**

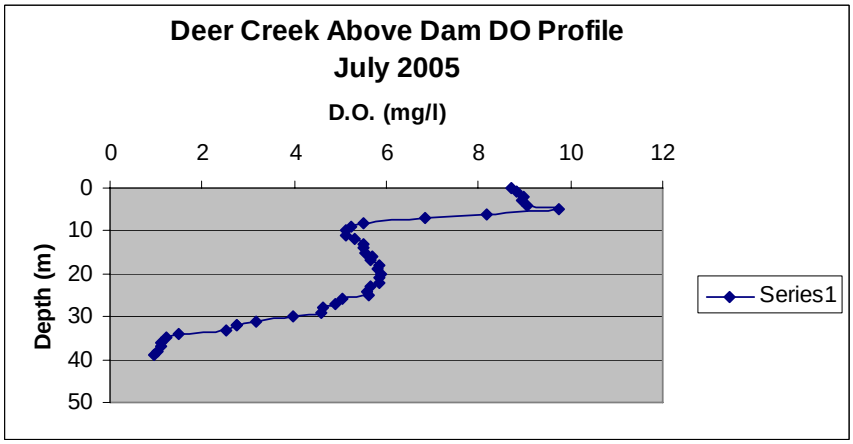
Average TP	0.035
Max TP	0.117
Min TP	0.000

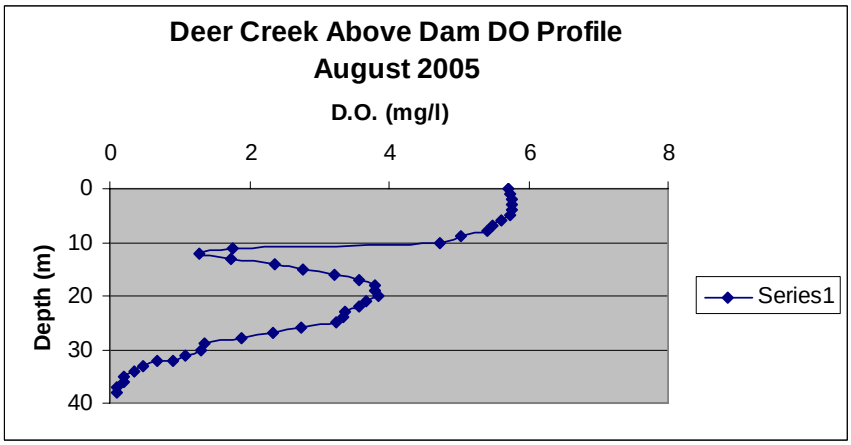
Average DTP	0.006
Max DTP	0.032
Min DTP	0.000

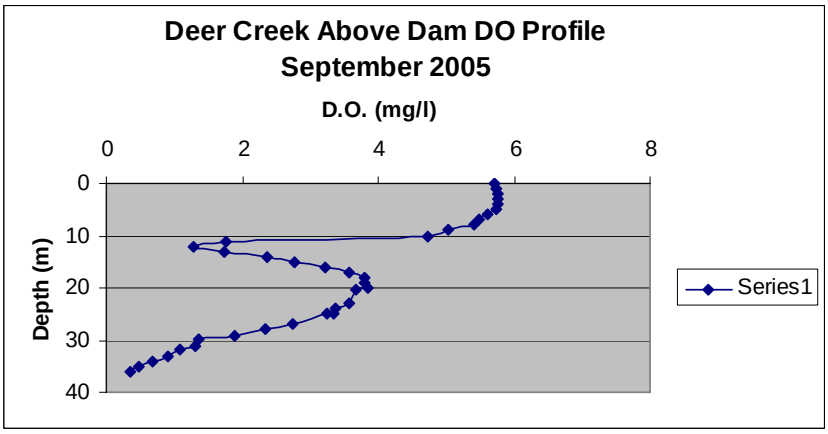
Average TDS	187.111
Max TDS	246.000
Min TDS	128.000

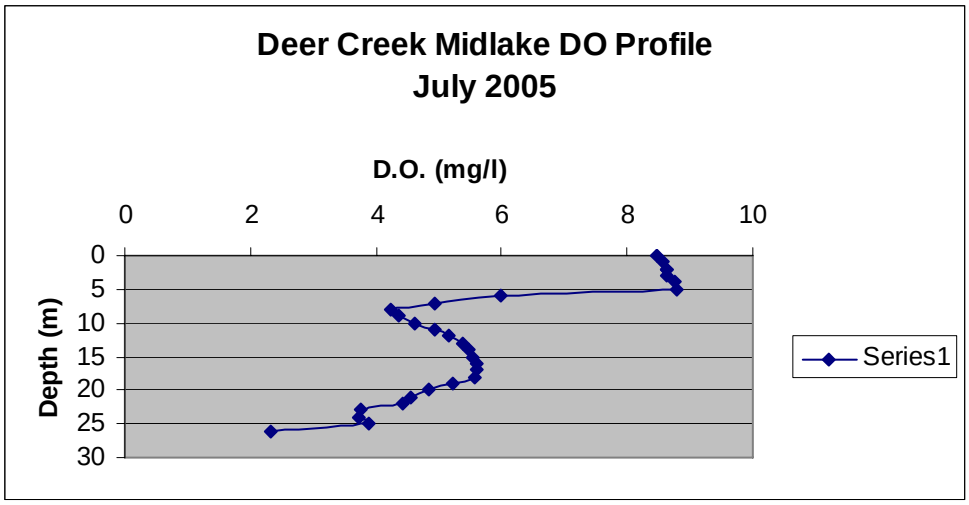
Average TSS	33.822
Max TSS	143.200
Min TSS	6.400

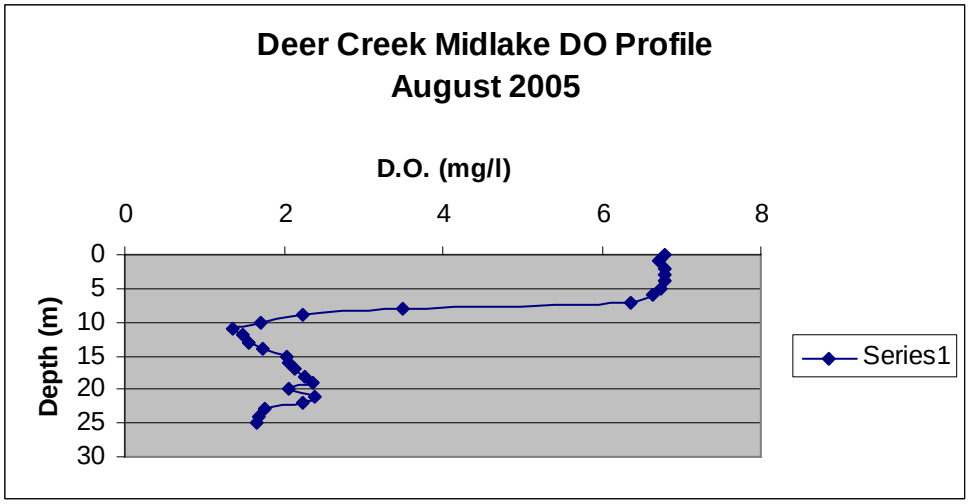
Appendix B – Deer Creek Reservoir D.O. Profiles

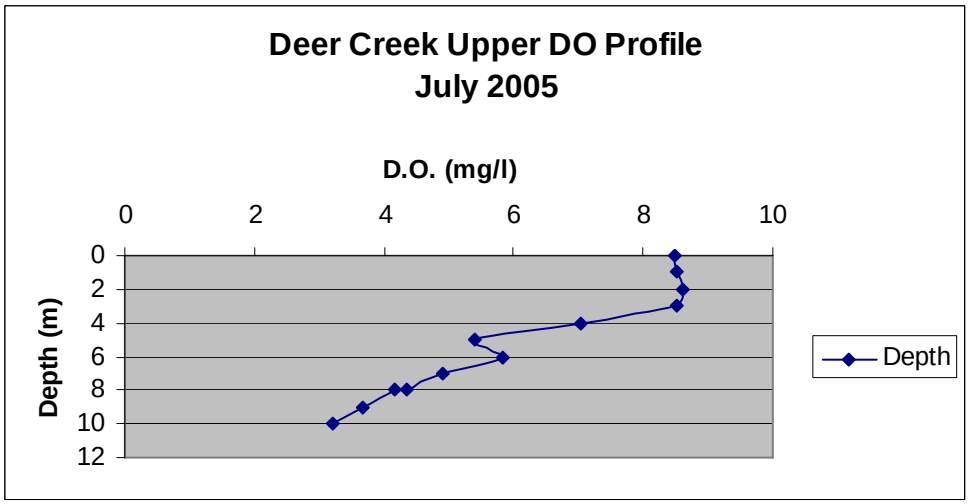


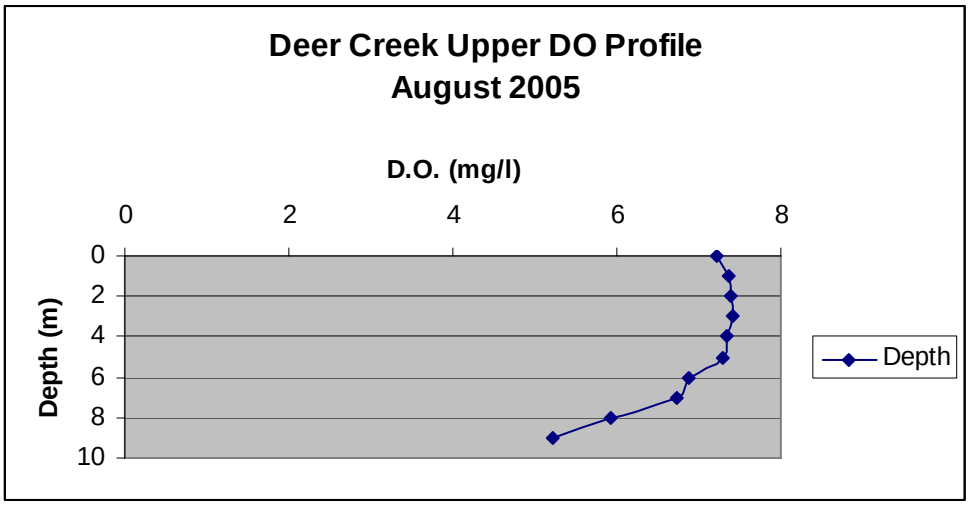





Deer Creek Midlake DO Profile
July 2005
D.O. (mg/l)
0
2
4
6
8
10
Depth (m)
0
5
10
15
20
25
30
Series1


Deer Creek Midlake DO Profile
August 2005
D.O. (mg/l)
0
2
4
6
8
Depth (m)
0
5
10
15
20
25
30
Series1


Deer Creek Upper DO Profile
July 2005
D.O. (mg/l)
0
2
4
6
8
10
Depth (m)
0
2
4
6
8
10
12
Depth


Deer Creek Upper DO Profile
August 2005
D.O. (mg/l)
0
2
4
6
8
Depth (m)
0
2
4
6
8
10
Depth