San Pitch River Watershed

Water Quality Management Plan

Developed under the leadership of the San Pitch River Watershed Stewardship Group

January 2006

Sanpete County Soil Conservation District

San Pitch River Watershed Stewardship Group

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1.0 EXECUTIVE SUMMARY

1.1 Purpose of the Plan

The purpose of this water quality management plan is to recommend a series of specific actions and management strategies to improve natural resource condition in the San Pitch River Watershed. If implemented, these recommendations are expected to reduce the introduction of salinity, sediment, and phosphorus into the San Pitch River each year. This would result in improved water quality, fisheries and aquatic wildlife, riparian and upland habitat, recreation, groundwater quality, storm water, weeds and pests, sensitive species, effects of urban development, source protection, and agricultural productivity.

This watershed plan will target site-specific needs of individual landowners, while adhering to the overall goals and objectives of the San Pitch River Watershed Stewardship Group. The building blocks of the Water Quality Management Plan are conservation plans. Conservation plans target the site-specific needs of individual landowners, while adhering to the goals and objectives of the Water Quality Management Plan. The conservation plans include projects, management strategies and implementation timetables with the intent of conserving natural resources and improving water quality and agriculture production.

Landowners and cooperators work voluntarily on their conservation plans. When outside funding is available, it can be used to assist in plan implementation.

1.2 Existing Situation

The San Pitch River has been identified by the State Division of Water Quality as a water body of concern based on water quality associated with excess salinity and nutrient runoff (DWQ 2002). The beneficial uses attributed to the San Pitch River and its tributaries are not limited to but including: recreation, cold water, warm water, species of fish, and agriculture.

The San Pitch River flows down through the Sanpete valley from North to South; it is diverted all along the river corridors in several locations for agricultural use. Other concerns for the San Pitch River include wetland loss, population growth, potential for agricultural runoff, storm water runoff, natural runoff, well head water protection, and sensitive species habitat.

1.3 Water Quality Issues

The San Pitch River has two main water quality issues that exist. High phosphorus levels and stream erosion occur in the upper river, and high salinity values and stream erosion occur within the middle section of the San Pitch River. Too much salinity in the San Pitch River is negatively affecting the beneficial uses in the Sanpete valley.

Unstable stream banks are the second largest source of sediment to the San Pitch River. During high water events unstable stream banks erode, sloughing soil back into the channel. It is estimated that 93 tons/year (*see table 4.4.12*) of sediment enters the San Pitch River annually from this source.

Stream reaches that have been straightened or otherwise altered by flooding tend to have unstable channels. In 1983 the entire San Pitch River flooded and massive erosion on stream banks occurred. Since then, further stream channel changes and erosion continue to occur. To reduce this sediment source it is important to restore the stream's natural function. Stable channels, or naturally functional streams, are able to consistently transport their sediment load, and will not erode their own banks.

Unstable stream banks are one of the largest sources of sediment in the river

1.4 Objectives/Action Items/Results:

The objectives of the San Pitch River Watershed Stewardship Group to improve the San Pitch River Watershed are:

OBJECTIVE 1:

Reduce Total Dissolved Solids (TDS) loading in the San Pitch River in order to meet endpoints identified in the Total Maximum Daily Load (TMDL).

Action Item 1: Focus on the Middle San Pitch River where the highest impairment occurs, work with landowners to improve their irrigation water management and efficiency of the irrigation systems.

Action Item 2: Reseed irrigated lands to reduce salt loading into the river.

Action Item 3: Purchase a pasture drill to reseed ~40,000 acres to reduce TDS loading from pasture runoff.

Action Item 4: Use Best Management Practices (BMP's) to re-seed rangeland to reduce sediment and nutrient loading into the river.

Results: The combination of the above practices is expected to reduce TDS loading to the San Pitch River by 11% (~4000 tons/year) and maintain water quality standards for its designated beneficial uses of agriculture in the Middle San Pitch River.

OBJECTIVE 2:
Reduce non-point source nutrient pollution to improve water quality through implementation of comprehensive nutrient management plans (CNMPs)

Action Item 1: Work with livestock and land owners to properly store and utilize manure. Develop a nutrient management plan for animal feeding operations (AFO's).

Action Item 2: Prevent runoff from corrals into surface waters and recharge areas.

Action Items 3: Help landowner purchase computer software programs to manage manure application.

Action Item 4: Provide financial assistance for manure testing, and help determine rates of manure in areas.

Action Item 5: Develop grazing management plans in combination with riparian restoration to reduce nutrient loading to the upper San Pitch River.

Results: Help improve water quality within the San Pitch River Watershed by managing nutrients and reducing erosion of excess nutrient to the San Pitch River.

OBJECTIVE 3:
Collect and map soil samples to determine baseline nutrient levels in the watershed.

Action Item 1: Take soil samples on fields throughout the watershed and create GIS map of soil sample results. Prioritize areas in need of nutrient management.

Action item 2: Use computer mapping software. Encourage taking soil samples, record keeping, utilizing soil test results, and determining manure applications.

Results: Baseline map to locate priority areas and guide implementation to control nutrient levels and to gage success of nutrient management activities.

OBJECTIVE 4:
Reseed pastures with large root mass species and control noxious weed population.

Action Item 1: Get involved with partnering agencies to map and control noxious weed populations.

Action Item 2: Coordinate with and involve the San Pitch CWMA to control noxious weed population throughout entire watershed.

Results: Increase control of noxious weed populations by about 70%.

OBJECTIVE 5:
Improve stability of the stream channel and tributaries to enhance the riparian corridor and buffer zones to proper functioning condition.

Action Item 1: Improve San Pitch River by stabilizing banks to reduce erosion and planting appropriate vegetations.

Results: Improve 7 miles of the San Pitch River by stabilizing banks to reduce erosion and planting appropriate vegetations. Decrease streambank erosion by 40 tons/year and reduce nutrient and TDS loading to the river.

OBJECTIVE 6:
Inform and educate landowners and citizens concerning non-point pollution sources and BMPs.

Action Item 1: Conduct tours of conservation projects, hold seminars to educate landowners, send out brochures and media information, and present Watershed Education Days for students and other interested parties.

Results: Increased knowledge of concerns, successes, and ongoing progress within the watershed. Annually educate 16 fourth grade classes in county, interested parties, etc., and supplied material for science curriculum.

OBJECTIVE 7:
Track individual progress, matching contributions, team efforts, and generate reports and data as needed.

Action Item 1: Employ a full time Watershed Coordinator through the Sanpete County Soil Conservation District (SSCD) to carry out work group meetings, track grants and project implementation, and develop conservation plans.

Results: Better coordination of all activities of watershed partners to achieve beset results of their efforts.

OBJECTIVE 8:
Obtain funding to implement BMPs for greatest improvement in the San Pitch River watershed.

Action Item 1: Research and apply for available funding and develop agency and stake holder partnerships.

Results: Maximize all available resources to ensure necessary projects can be implemented to restore the San Pitch River Watershed.

OBJECTIVE 9:
Assist communities in developing and implementing source water protection and storm water plans integrating aquifer classification.

Action Item 1: Classify Sanpete Valley Aquifer.

Action Item 2: Assist communities with implementing source water protection and storm water plans.

Action Item 3: Stay involved with local community and county leaders in land use planning for the watershed.

Results: Establish baseline conditions for the management of groundwater recharge areas and drinking water protection. Quality drinking water and less untreated storm water entering the San Pitch River.

OBJECTIVE 10:
Improve and conserve wildlife habitat in the watershed.

Action Item 1: Identify critical wildlife habitats within the watershed (ie: big game winter range, spotted frog, leatherside chub, etc.).

Action Item 2: Identify ownership boundaries where these critical habitats occur (private, SITLA, DWR, federal, municipalities, county, etc).

Action Item 3: Develop partnerships between landowners, state and federal land management agencies, and private organizations to improve communication and cooperation, leverage technical and financial resources, and develop innovative approaches to solving problems in critical riparian and shrub-steppe communities.

Action Item 4: Assist partners in implementing habitat projects within riparian and sagebrush-steppe communities, to improve overall rangeland conditions for wildlife and livestock production. This could include planning, funding, equipment, and technical assistance.

Results: Enhanced water quality through improved watershed conditions, improved habitat for big game and sensitive species, and improved rangeland conditions for livestock. Improve 128,290 acres Division of Wildlife Resources owned rangeland.

OBJECTIVE 11:
Expand cloud seeding area to benefit landowners within the watershed.

Action Item 1: Help centralize cloud seeding locations so that they will be more beneficial to landowners within the watershed. Also, make cloud seeding locations more uniform along the watershed.

Results: Increase water yield (~1.15 inches annually of 15% increase) uniformly along watershed boundary to benefit landowners in area.

OBJECTIVE 12:
Reduce sediment loading from Twelve Mile Canyon slides to down stream users.

Action Item 1: Obtain funding to research solutions to Twelve Mile Canyon slides sediment issue.

Action Item 2: Obtain funding to help mitigate Twelve Mile Canyon slides sediment loading issue.

Results: Reduce sediment loading to down stream users of Twelve Mile canyon slides area.

One objective is to increase riparian vegetation along the stream banks to reduce erosion.

2.0 PREFACE

Thanks to the many individuals representing private interests, and federal, state and local government agencies who have cooperated to bring this document to completion. Under the leadership of the Sanpete County Soil Conservation District (SSCD), the members of the San Pitch River Watershed Stewardship Group have provided technical assistance, editorial support, report preparation, data collection and analysis in this plan.

The intent of this Water Quality Management Plan is to provide a framework for watershed planning including the identification of resource problems, objectives and opportunities. The Water Quality Management Plan also provides direction and guidance for the development of individual cooperators' conservation plans. Conservation plans identify problems specific to the cooperator's land and prescribe appropriate best management practices (BMPs) to achieve improved water quality.

Treatment of this watershed will help the State of Utah to achieve its water quality improvement goals. Sponsors of this expect the San Pitch River Watershed to meet State Water Quality Standards and support its beneficial uses. They also expect:

- improved fish and wildlife habitat populations,
- improved riparian and wetlands habitat,
- stabilize or improve sensitive species populations,
- lower erosion rates,
- decreased sediment loads,
- healthier upland vegetation,
- more efficient use of irrigation water,
- increased forage availability for livestock and wildlife,
- enhanced recreation opportunities,
- improved aesthetic values, and
- viable agriculture enterprises.

State, federal agencies, local units of government, landowners, special interest groups, and donations will fund this work.

2.1 Authority

2.1.1 Watershed Planning

Utah State Law authorizes Soil Conservation Districts to provide leadership for the planning an implementation of measures to prevent soil erosion, flood or sediment damage, and non-point source pollution, with landowner consent. The law specifies this process may be achieved by developing cooperative agreements, providing conservation planning assistance, implementing projects, distributing educational materials, developing demonstration projects, and providing technical assistance.

2.1.2 TMDL's Water Quality Standards

The Utah Water Quality Standards (Utah WQS) establish a numeric criterion of 1,200 mg/L TDS for the protection of Class 4 waters (Utah Administrative Code R317-2, State of Utah, 2000). In addition, the Utah WQS provide numeric criteria for secondary standards (pH, boron, and metals) that may be applicable to the evaluation of dissolved solids impact on beneficial uses. Utah water quality criteria applicable to the 303(d) listed segments of the San Pitch River are listed in Table 2.2.1.

Table 2.2.1

Utah Water Quality Criteria for Class 4 Waters

Parameter	Criterion Maximum Concentration
Target Parameters*	
Total Dissolved Solids (TDS)	1,200 mg/L
Secondary Parameters**	
PH	6.5 – 9.0 pH units
Boron	0.75 mg/L
Arsenic	0.10 mg/L
Cadmium	0.01 mg/L
Chromium	0.10 mg/L
Copper	0.20 mg/L
Lead	0.10 mg/L
Selenium	0.05 mg/L

***Notes:* *** *Utah WQS clarify that TDS limits may be adjusted if such adjustment does not impair the designated beneficial use of the receiving water.*

*** Metals criteria as dissolved maximum concentration*.

TDS is listed as a criterion for protection of agricultural uses because of the negative effect of high salinity on crop production. The major components of salinity are the cations: calcium, magnesium, and sodium; and the anions: chlorine, sulfate, and bicarbonate. The potassium and nitrate ions are minor components of salinity. Salinity reduces crop growth by reducing the ability of plant roots to absorb water, and is evaluated by the relationship of salt tolerance to crops. Unlike salinity hazard, excessive sodium does not impair the uptake of water by plants, but does impair the infiltration of water into the soil. The growth of plants is, thus, affected by an unavailability of water. The reduction in infiltration of water can usually be attributed to surface crusting, the dispersion and migration of clay into the soil pores, and the swelling of expandable clays. The hazard from sodium is evaluated using the Sodium Absorption Ratio (SAR), a ratio of sodium to calcium and magnesium in the irrigation water; in relation to the irrigation water TDS (Tanji, 1990).

Boron is the primary toxic element of concern in irrigation waters. Boron is an essential trace element at low concentrations, but becomes toxic to crops at higher concentrations. Other trace elements, as listed in the table above, are potentially toxic to plants and animals. High pH (pH > 9.0) directly and adversely affects infiltration as well as limiting calcium concentrations and high SAR.

Therefore, in addition to evaluating TDS, the listed TMDL pollutant, a water quality assessment for protecting the agricultural beneficial use may also consider assessment of sodium, SAR, boron, pH, and other toxic metals. This additional assessment may be of particular interest if the source of TDS is primarily a natural source and does not impair agricultural uses. As identified in the Utah WQS, the 1,200 mg/L limit “may be adjusted if such adjustment does not impair the designated beneficial use of the receiving water”.

3.0 INTRODUCTION

3.1 Background on watershed planning process

This document is a Water Quality Management Plan for the San Pitch River Watershed located in the Central Utah region. In 1999 the Sanpete Soil Conservation District (SSCD) and the Natural Resources Conservation Service (NRCS) organized a local working group, the San Pitch River Watershed Stewardship Group, to help determine the most urgent natural resource concerns within Sanpete County and the San Pitch River corridor. The Watershed Stewardship Group identified the San Pitch River watershed as the primary concern based upon data collected in Utah's 303(d) list (DWQ 1998 through 2002) which stated the middle and lower segments of the river as being impaired due to an over abundance of total dissolved solids (TDS).

3.2 Critical issue – water quality

Of all the Earth's water, only a small percentage of the water is suitable for human, plant, and animal use. Too much sediment and nutrient runoff negatively affects water quality. In addition salinity sources exist in the watershed between Moroni and Gunnison Reservoir. High salinity can impair crop land and reduce crop production. A TMDL study submitted to the EPA has identified the primary sources of TDS as a combination of many factors such as: natural geology, soils, erosion, flood irrigation, and return flows. Major contributing factors of TDS include: eroding stream banks, erosion from uplands (rangelands, croplands, pastures), confined animal feeding operations, inadequate irrigation water management practices, runoff from irrigation systems carrying sediment with attached TDS and nutrients, erosion from ephemeral and perennial streams, landslides, and urban developments. The TMDL has developed a site specific standard of 2400 mg/L for the San Pitch River below the Gunnison Reservoir. Below the Gunnison Reservoir the primary source are natural springs high in salinity content.

3.3 Water Quality Issue Resolution – TMDL

The State of Utah requires TMDL's to be prepared for all water quality impaired water bodies. A TMDL is the acceptable limit of a pollutant in a water body that does not interfere with that water's beneficial uses.

In 2002, the San Pitch River was listed on Utah's 303(d) list (DWQ, 2002) and was considered for immediate TMDL development. On February 3, 2003, a TMDL was written by Millennium Science and Engineering Inc. to aid in the development of an improved watershed. The Water Quality Management Plan will assist in the aid of the TMDL to complete its objectives and goals.

In order to meet water quality standards the following improvements will be met:

1. Improvement of riparian areas and stabilization of stream banks throughout the watershed,
2. Inform and educate landowners about causes of TDS,
3. Improvement of irrigation systems for the reduction of sediment runoff,
4. Reduce the contribution of non-point source TDS and nutrients from runoff and groundwater recharge,
5. Improve meadows and uplands to reduce non-point source pollution,
6. Focusing resources in areas contributing to high TDS and nutrients,
7. Obtain funding to reduce TDS and nutrients with best available technology and BMPs,
8. Improve storm water systems,
9. Improvement of water quality from recreational use and public lands,
10. Implementing source water protection and storm water plans integrating aquifer classification,
11. Improvement in weeds and pests.

3.3.1 TMDL Process

Water quality standards are set by States, Territories, and Tribes. They identify the scientific criteria to support a waterbody's beneficial uses such as for drinking water supply, contact recreation (swimming), and agricultural uses (including irrigation of crops and stock watering). A TMDL or Total Maximum Daily Load is a calculation of the maximum amount of a pollutant that a waterbody can receive and still meet water quality standards (EPA, 1999). As part of the TMDL process, the maximum amount of the parameter of concern is allocated to its contributing sources. Therefore, a TMDL is the sum of the allowable loads of the parameter of concern from all contributing point and non-point sources. The calculation must include a margin of safety to account for future growth and changes in land use, uncertainties in data collection, analysis, and interpretation. The Clean Water Act, Section 303(d), establishes the TMDL program.

Section 303(d) and EPA's Water Quality Planning and Management Regulations (40 CFR Part 130), requires that States report waterbodies (i.e., lakes, reservoirs, rivers, and streams) that currently do not meet water quality standards for their designated beneficial use(s). EPA regulations require that each State submit a prioritized list of waterbodies to be targeted for improvement to EPA every two years. These regulations also require States to develop TMDLs for those targeted waterbodies. Thus, those waterbodies which are not currently achieving, or are not expected to achieve, applicable water quality standards are identified as water quality limited. Waterbodies can be water quality limited due to point sources of pollution, non-point sources of pollution, or both. Examples of pollutants that can cause use impairment include chemicals, pathogens, and other load parameters (e.g., TDS) for which there are numeric standards. In addition to pollutants, impairments may originate from sources such as habitat alteration or hydrologic modification that have associated narrative standards (DWQ, 2002). Section 303 (d)(1)(A) and the implementing regulations (40 CFR 130.7(b)) provide States with latitude to determine their own priorities for developing and implementing TMDLs.

Once a waterbody is identified as water quality limited, the State, Tribe, or EPA is required to determine the source(s) of the water quality problem and to allocate the responsibility for controlling the pollution. The goal of the TMDL is reduction in pollutant loading necessary for a waterbody to meet water quality standards and support its beneficial uses. This process determines: 1) the amount of a specific pollutant that a waterbody can receive without exceeding its water quality standard or impair a beneficial use; 2) the allocation of the load to point and non-point sources; and 3) a margin of safety. While the term TMDL implies that the target load (loading capacity) is determined on a daily time scale, TMDLs can range from meeting an instantaneous concentration (e.g., an acute standard) to computing an acceptable annual load to a waterbody (DWQ, 2002).

The middle and lower San Pitch River are listed on Utah's Year 2000 303(d) list as being impaired for TDS. The listing is based on an intensive water quality study that was completed in 1997-1998 by DWQ. This survey found numerical criteria exceedences for this water quality constituent (DWQ, 2000b). Therefore, DWQ prompted the TMDL to identify and quantify point source and non-point source pollution in the San Pitch River Watershed.

3.3.2 Utah's Watershed Approach

Utah's watershed approach is aimed at improving and protecting of the State's surface and groundwater resources. Characteristics of the approach include a high level of stakeholder involvement, water quality monitoring and information gathering, problem targeting and prioritization, and integrated solutions that make use of multiple agencies and groups. Federal and state regulations appoint DWQ with the task of preventing, controlling, and abating water pollution. Other state and local agencies have associated responsibilities. Utah's watershed approach is to form partnerships with accountable government agencies and interested groups to combine resources and increase the effectiveness of existing programs.

Throughout the State of Utah a series of ten management units provide spatial focus to watershed management activities, thereby improving coordination. Watershed management units in the State may contain more than one stream system, or watershed, defined as the entire area drained by a stream and its tributaries. Delineated watershed units are consistent with the hydrologic basins defined by the Utah Department of Natural Resources - Division of Water Resources for the State Water Plan project (Utah Division of Water Resources, 1990). The watershed management units provide boundaries for evaluating the impact of various stressors on commonly shared resources, provide boundaries for evaluating the impacts of management actions, and provide a better perspective for DWQ and stakeholders to determine environmental objectives and to develop management strategies that account for local and regional considerations.

Each watershed plan will establish management actions at several spatial scales ranging from the watershed scale to specific sites that are influenced by unique environmental conditions. Watershed plans consider a holistic approach to watershed management in which groundwater hydrologic basins and eco-regions encompassed within the units are considered. The goal of Utah's watershed approach is better coordination and integration of the State's existing resources and water quality management programs to improve protection for surface and groundwater resources. Better coordination and integration extends beyond the tiers of government agencies to include all stakeholders in the watershed.

Utah's watershed approach is based on hydrologically defined watershed boundaries and aims to de-emphasize jurisdictional delineations in watershed management efforts. This approach is expected to accelerate improvements in water quality as a result of increased coordination and sharing of resources. Statewide watershed management is not a new regulatory program, it is a means of operating within existing regulatory and non-regulatory programs to more efficiently and effectively protect, enhance, and restore aquatic resources. The Statewide watershed management approach has been introduced to establish a framework to integrate existing programs and coordinate management activities geographically (DWQ, 2000c).

In addition to the technical components, Utah's watershed approach is dependant on the critical role stakeholders play in watershed water quality management. The success of the implementation plan, and ultimately the restoration of water quality, depends on the voluntary participation of the stakeholders in Utah's watersheds. Therefore, to be successful, the TMDL development approach must ensure public participation and input at critical points throughout the process.

A successful water quality management plan and TMDL relies as much on voluntary stakeholder participation and buy-in as on the rigor of technical analysis. The advantages of involving stakeholders throughout the TMDL development and implementation process are numerous. Through their voluntary participation, the stakeholders can become more comfortable that the monitoring and modeling programs generate reliable data that are scientifically defensible. Further, effluent limits and Best Management Plans (BMPs) developed by the Stakeholders are less prone to credibility challenges and litigation. Stakeholders are more apt to agree to pollutant reduction or habitat improvement schemes that they helped to formulate.

The boundaries of watershed management units in Utah were drawn so that stakeholders would be aggregated or grouped into areas sharing common environmental characteristics. Defining watershed management units in this way is intended to encourage a sense of ownership in the resident stakeholders and to encourage involvement in stewardship activities. Based on a model successfully used by other states, the program draws on the expertise of those involved in or affected by water quality management decisions. These stakeholders help gather information and design BMPs, then become involved in stewardship activities.

3.4 Outreach

The San Pitch River Watershed Stewardship Group has adopted a holistic approach in improving the watershed. Each grant applied for plans to conserve all important areas to improve water quality. The Stewardship Group has created priority areas to focus on areas most in need within the watershed.

The San Pitch River Watershed Stewardship Group is currently involved in the state-wide Sage-Steppe initiative to help conserve Sage Grouse and other Sage-Steppe wildlife species within the watershed. The Watershed Group is also involved with the Comprehensive Weed

Management Group to help manage weeds within the watershed. These partnership groups help outreach local landowners to teach them the importance of conservation efforts within the watershed.

3.5 Nine Elements of 319 funded projects

To ensure that Section Clean Water Act (319) projects funded with incremental dollars make progress restoring waters impaired by nonpoint source pollution, watershed-based plans that are developed or implemented with Section 319 funds to address 303(d)-listed waters must include at least the elements listed below. These elements will help provide reasonable assurance that the nonpoint source load allocations identified in the Nonpoint Source TMDL will be achieved. These nine elements come from the EPA Supplemental Guidelines for the Award of Section 319 Nonpoint Source Grants to States and Territories in FY 2003 (EPA 2002).

1. An identification of the causes and sources or groups of similar sources that will need to be controlled to achieve the load reductions estimated in this watershed-based plan (and to achieve any other watershed goals identified in the watershed-based plan), as discussed in item (2) immediately below. Sources that need to be controlled should be identified at the significant subcategory level with estimates of the extent to which they are present in the watershed (e.g., X numbers of dairy cattle feedlots needing upgrading, including rough estimate of the number of cattle per facility; Y acres of row crops needing improved nutrient management or sediment control; or Z linear miles of eroded streambank needing remediation).

2. An estimate of the load reductions expected for the management measures described under paragraph (3) below (recognizing the natural variability and difficulty in precisely predicting the performance of management measures over time). Estimates should be provided at the same level as in item (1) above (e.g., the total load reduction expected for dairy cattle feedlots; row crops; or eroded streambanks).

3. A description of the NPS management measures that will need to be implemented to achieve the load reductions estimated under paragraph (2) above (as well as to achieve other watershed goals identified in this watershed-based plan), and an identification (using a map or a description) of the critical areas in which those measures will be needed to implement this plan.

4. An estimate of the amounts of technical and financial assistance needed, associated costs, and/or the sources and authorities that will be relied upon, to implement this plan. As sources of funding, States should consider the use of their Section 319 programs, State Revolving Funds, USDA's Environmental Quality Incentives Program and Conservation Reserve Program, and other relevant Federal, State, local and private funds that may be available to assist in implementing this plan.

5. An information/ education component that will be used to enhance public understanding of the project and encourage their early and continued participation in selecting, designing, and implementing the NPS management measures that will be implemented.

6. A schedule for implementing the NPS management measures identified in this plan that is reasonably expeditious.

7. A description of interim, measurable milestones for determining whether NPS management measures or other control actions are being implemented.

8. A set of criteria that can be used to determine whether loading reductions are being achieved over time and substantial progress is being made towards attaining water quality standards and, if not, the criteria for determining whether this watershed based plan needs to be revised or, if a NPS TMDL has been established, whether the NPS TMDL needs to be revised.

9. A monitoring component to evaluate the effectiveness of the implementation efforts over time, measured against the criteria established under item (8) immediately above.

3.6 Watershed Boundary

United States Geological Survey (USGS) Team has created Hydrologic Accounting Unit (HUC) numbers to define watershed boundary areas. HUC numbers are based almost entirely on topographic ridgelines and geography. It has been noted that HUC numbers do not take into account actual hydrologic conditions and water usage. The

Sanpete County towns of Gunnison, Centerfield, and Axtell do not have natural drainage areas supplying irrigation water to nearby farms. To overcome this, irrigation companies in these areas have created irrigation ditches that supply irrigation water from Twelve Mile Canyon. According to the HUC number designation, Twelve Mile Canyon lies within the San Pitch River Watershed boundary, but Centerfield and Axtell areas are not included within this boundary. Since Twelve Mile Canyon water is used for Gunnison, Centerfield, and Axtell areas, the San Pitch River Watershed Stewardship Group has adopted HUC boundaries as well as looking at hydrologic conditions and water usage. This decision was based on water quality issues and drainage of irrigation water. Watershed boundaries have been changed to include areas of Gunnison, Centerfield and Axtell for this document.

4.0 DESCRIPTION OF WATERSHED

4.1 Location

The San Pitch River flows through the Sanpete Valley located in central Sanpete County, central Utah, about 90 miles south of Salt Lake City. The San Pitch River Watershed boundary is defined by the USGS HUC #16030004 (**see map 1**). The watershed boundary is almost entirely within Sanpete County. A few small areas of land on the west side of the watershed are within Juab County. The San Pitch River flows generally from north to south through the Sanpete Valley and at the south end of the watershed it curves west to its confluence with the Sevier River.

The first white settlers in Manti were Mormons

4.2 Historic Perspective

The first white settlers in Sanpete Valley were Mormons who arrived in the area in 1849. Sanpete County was created in 1850 with Manti as the county seat. In 1992 Manti had a population of approximately 2,000 people. Sanpete County had a 1990 Census population of 16,259 (Utah Division of Water Resources, 1999); its 1999 Census population was 21,408 (Utah League of Cities and Towns, 2000).

Since settlement, Sanpete County's economy has been based on agriculture. In its first few decades it served as Utah's granary. Principal crops are alfalfa, small grains, and corn for silage. Irrigation of all croplands is necessary because the climate at Manti is semi-arid. During the 1980s some irrigation practices converted from the ditch-and-furrow to the more sophisticated sprinkler types, both in town and farmlands.

The nearly 800 farms in the county comprise about 25% of the total land area (**see map 2**). Average farm size, including the privately owned range land, is about 480 acres, with about 560 of the farms under irrigation. Total agricultural income, which runs approximately $29.2 million annually, is sufficient to rank Sanpete fourth among the counties of the State of Utah based on this important economic resource (Census of Agriculture, 2002).

Sanpete County ranks in the top four for turkey production.

Livestock and poultry are the mainstays of Sanpete agriculture. Livestock is grazed on both private and public range land. The irrigated acreage is primarily devoted to raising feed for livestock. Vital to the economic well being of the Sanpete area is the production of turkeys for the national market. For many years Sanpete has ranked among the top 4 counties in the US based on total volume of turkey production. A typical year's output of Moroni Feed Company, an integrated farmer's cooperative which has been largely responsible for the rise of the turkey industry, is in excess of 80 million pounds of dressed turkey.

4.3 Physical Environment

4.3.1 Terrain

The San Pitch River Watershed consists of the following ecoregions: Mountain Valley

Zones, Wasatch Montane Zone, Semiarid Foothills, and Sagebrush Basins and Slopes.

Mountain Valley Zones: The un-forested ecoregion contains terraces, flood plains, alluvial fans, and hills. It is affected by cold temperatures and has a short growing season. Potential natural vegetation is mostly Great Basin sagebrush. It is distinct from the Juniper-Pinyon woodland and mountain mahogany-oak scrub of the semiarid foothills. Today, irrigated cropland, irrigated pastureland, and rangeland are common. Turkey farms, feedlots, and dairy operations occur locally. Land use contrasts with that of nearby high plateaus and mountains.

Wasatch Montane Zone: The partially and plateaus underlain by sedimentary and metamorphic rocks. It is litologically distinct from the igneous rocks of the High Plateaus ecoregion. Douglas-fir and aspen parkland are common and Engelman spruce and sub-alpine fir grows on steep, north facing slopes. Vegetation is unlike is unlike the lower juniper-pinyon woodland and mountain brush of semiarid ecoregion or the alpine meadows of the Alpine Zone ecoregion. Perennial streams provide water to lower, more arid regions.

Semi-Arid foothills: The ecoregions is found between 5000 and 8000 feet elevation. Widely spaced juniper and pinyon typically occur in a matrix of sagebrush, grama grass, mountain mahogany, and gamble oak. Maple-oak scrub is common in the north, but, southward, it is gradually replaced by pinyon-juniper woodland at lower elevations and ponderosa pine at upper elevations. Live stock grazing is common. Some rangeland has been cleared of trees and reseeded as grasses.

Sagebrush Basins and Slopes: The ecoregion is semiarid. The potential natural vegetation is Great Basin sagebrush but perennial bunchgrasses occur and become increasingly common northward as available moisture increases. However, cool season grasses are less abundant and have a potential natural vegetation of sagebrush steppe. The major land use is grazing, but feed lots, dairy operations, and irrigated cropland are found locally. This ecoregion includes valleys, alluvial fans, and mountain flanks that are not as saline nor as arid as other ecoregions. It is less rock, rugged and wooded.

The San Pitch River Watershed forms the northeast portion of the larger Sevier River basin. Sanpete Valley is a north-south-trending, Y-shaped valley bordered on the east by the Wasatch Plateau, which reaches elevations of 11,000 feet, and on the west by the San Pitch Mountains (also known as the Gunnison Plateau), which reach a maximum elevation of about 9,700 feet. The valley is divided in the north by Cedar Hill, which forms the center of the "Y" and reaches a maximum elevation of about 8,300 feet. Sanpete Valley is about 40 miles long and up to 13 miles wide. The west branch of Sanpete Valley runs from Moroni toward Fountain Green. The east branch heads up to Fairview. The San Pitch River begins on the Wasatch Plateau north of Fairview and flows through the east branch of Sanpete Valley. The Sanpete valley floor has an area of about 240 square miles; it ranges in elevation from 7,400 feet near the northern end of the eastern arm to about 5,040 feet where the San Pitch River meets the Sevier River. The Sanpete Valley fill thickness range from about 100-350 feet in the Mt. Pleasant-Fairview and Moroni-Fountain Green areas to 100-500 feet in the Ephraim-Manti areas (Robinson, 1971). Generally the valley fill is thicker on the west side. Groundwater wells on the west are under artesian and water table conditions. Wells on the east side are under water table conditions. Throughout the watershed there are areas of seepage and recharge.

4.3.2 Geology / Soils

The San Pitch River watershed is in the Basin and Range-Colorado Plateau transition zone (Stokes, 1988). Geologic units exposed in the Sanpete Valley area range from Jurassic to Quaternary in age (**see geology map 11**). The San Pitch Mountains and Wasatch Plateau both consist of Tertiary to Jurassic sedimentary rocks. Tertiary limestone and mudstone cap both ranges. Cretaceous sandstones and conglomerates underlie the Tertiary rocks and are folded as a monocline in the Wasatch Plateau on the eastern side of the valley and as a syncline in the San Pitch Mountains. Beneath the Cretaceous units is the Jurassic Arapien Shale, which contains evaporite deposits. The Cedar Hills consist of the Tertiary volcaniclastic and pyroclastic Moroni Formation, mostly tuff and andesite. Consolidated rocks have a maximum combined thickness of more than 29,000 feet. Unconsolidated valley-fill deposits are at least 500 feet thick in Sanpete Valley along the western margin (Robinson, 1971). Because of the many faults, there are numerous springs along the east edge of the valley. Geothermal warm springs occur near Manti.

Outcrops and road cuts near Gunnison Reservoir expose the Green River formation (Eocene), which varies from sand to silt and limestone. Ridges of the Green River formation, landslide blocks similar to those farther south, help contain the water in Gunnison Reservoir.

Near and north of the reservoir, ridges of the Green River formation are half-buried beneath the flat floor of the San Pitch Valley. One of them forms the hill on which Manti temple stands. Another, about two miles north of town, provided limestone for the temple from the Green River formation.

Southwest of Manti the Sanpete Valley narrows and is constrained by bedrock outcrops which impede most groundwater flow out of the valley, and is referred to as a "bottleneck" (Snyder and Lowe, 1998; Wilberg and Heilweil, 1995; Robinson, 1971).

In this area, confined groundwater is forced to the surface and forms a large marshy area extending as far north as Manti, about 2 miles north of the north end of Gunnison Reservoir (Snyder and Lowe, 1998; Wilberg and Heilweil, 1995; Robinson, 1971). Therefore, the only outlet for this groundwater is the San Pitch River. At Gunnison, an east-west fault crosses the valley. To the southeast Tertiary (Paleocene) lakebeds can be seen behind hogback slices, essentially landslide blocks of the slightly younger Green River formation. Beneath the Green River formation are Paleocene rocks. These Paleocene rocks appear in road cuts as highly fractured, along with the grayish and yellowish Arapien shale, a Jurassic Unit. Grey yellow and pink badlands of Arapien shale appear in the Arapien Valley to the southeast. The Arapien shale forms hills along the west side of Arapien Valley and in the vicinity of Sterling at the lower end of Sanpete valley. The Arapien shale is also exposed as a narrow discontinuous band along the base of the San Pitch Mountains in Sanpete Valley. Outcrops of evaporite deposits of the Arapien Shale are located on the west side of Sanpete Valley from Big Mountain south to the mouths of Axhandle and Rock canyons (Wilberg and Heilweil, 1995). This area was identified by Wilberg and Heilweil, (1995) as one of the two areas in the Sanpete Valley with higher TDS concentrations in groundwater and is near the San Pitch River west of Manti above Gunnison Reservoir at Creek crossing. The other area is on the east side of the valley near outcrops of the Green River and Crazy Hollow Formations from Chester to Pigeon Hollow. Robinson (1971) reported that the Arapien Shale underlies the narrow "bottleneck" in the vicinity of Gunnison Reservoir. Therefore, the Arapien shale is an important natural source of TDS loading to groundwater beneath the Sanpete Valley and the San Pitch River. The Arapien shale, which is mined west and south of Sanpete Valley for salt, can be seen between some of the ridges (Chronic, 1990). The Arapien Shale consists of lower limestone beds overlain by gray siltstone, shale, gypsiferous shale, and salt-bearing, red-weathering shale and siltstone (Lawton, 1985). The Arapien Shale was deposited in a marine environment. Complex deformation geometries are common in the Arapien Shale, likely due to the thin-bedded nature and incompetent lithologies, especially salt. Most of the Arapien Shale in Sanpete Valley is exposed as intrusive masses from salt and evaporite diapirism that has likely been moving upward since it was deposited during Middle Jurassic (Witkind, 1982). Many authors attribute the cause of increased groundwater salinity/TDS beneath the Sanpete Valley to the evaporites from the Arapien Shale, and the Green River and Crazy Hollow Formations (Utah Division of Water Resources, 1999; Snyder and Lowe, 1998; Wilberg and Heilweil, 1995; Robinson, 1971; and Richardson, 1907).

Soil data for the Sanpete Valley were collected from the USDA Soil Conservation Service (USDA SCS, 1981) and the State Soil Geographic Database (STATSGO) dataset.

The Soil Survey of Sanpete Valley (USDA SCS, 1981) provides a general soil map and detailed soil maps drawn on aerial photographs with detailed descriptions of each soil type. The dominant soil types adjacent to the San Pitch River are summarized below from the USDA Soil Conservation Service Soil Survey of Sanpete Valley, and a soil map generated from the STATSGO dataset. Detailed information about the soils in these associations, and the individual soil mapping units, are summarized below. The USDA SCS mapping symbol is provided in parenthesis for each soil unit. Soil units preceded by an asterisk are potential sources of salinity to the San Pitch River. The dominant soils adjacent to the San Pitch River are listed as follows, in order of abundance (**also, see map 3**):

Poganeab-Shumway-Chipman Association

Soils in this association are dominant on the east side of the San Pitch River from Chester to Gunnison Reservoir. North of Chester these soils continue up the valley toward Fountain Green. They discontinue in a small area near Moroni, and then follow the San Pitch River up toward Fairview. The dominant soils in this association include the following:

Poganeab silt loam (Pg)

This soil is found on flood plains and valley bottoms. The soil is used for pasture and for native wild hay. The available water capacity is high (8 to 12 inches, USDA SCS, 1981). This soil mapping unit is present west of Pigeon Hollow and west of Chester.

**Poganeab silt loam, strongly saline-alkali (Ph)*

This soil has a profile similar to the soil described above, but it is strongly saline-alkali affected. The available water capacity is low (2 to 3 inches) and the high salt content reduces the water available to plants (USDA SCS, 1981). This soil mapping unit is present east of the San Pitch River between Chester and Pigeon Hollow.

Shumway silty clay loam (Sm)

This soil is on valley bottoms in fairly large areas. This soil is used for native grass pasture and native grass hay. A dominant strip of this soil mapping unit can be found from Johnson Spring to STORET 494645 (San Pitch River northwest of Manti).

Xerofluvents and Fluvaquent - Mellor Association

This soil association is dominant on the west side of the San Pitch River from Gunnison Reservoir to north of Ephraim. The dominant soils in this association include:

**Xerofluvents and Fluvaquents (XE)*

These soils consist of recently deposited alluvium on the flood plains of the streams or rivers. Salinity is generally moderate, but it ranges from non-saline to strongly saline affected (USDA SCS, 1981). The dominant vegetation on the strongly saline affected areas is salt grass, alkali sacaton, and greasewood.
This soil is used for pasture or grazing and in places for native grass hay. The soil can be found west of Chester in the San Pitch River flood plain and north of Moroni in the San Pitch River flood plain. It is also present in the San Pitch River flood plain below water sampling site STORET 494645 to Gunnison Reservoir.

**Xerofluvents and Fluvaquents, saline (XF)*

This soil is strongly saline affected and there is typically a fluffy, granular salt crust on the surface (USDA SCS, 1981). Vegetation is usually sparse and is greasewood, pickleweed, kochia, bassia, and salt grass (USDA SCS, 1981). The soils are used as rangeland. These soils are abundant along Silver Creek and along the San Pitch River in the area west of Johnson Spring.

**Mellor silt loam (Md)*

This soil is on alluvial fans, flood plains, and lake terraces. Runoff is rapid and there is moderate sheet and rill erosion. The available water capacity is very low (1 to 2 inches). The high content of salt drastically reduces the amount of water available to plants (USDA SCS, 1981). This soil is used as spring and late fall range by sheep and cattle. This soil can be found near STORET 494654 on the San Pitch River.

Genola - Woodrow - Quaker Association

This soil association is present on both sides of the San Pitch River near Moroni and toward Chester. It is also present near the San Pitch River on the west side between Chester and Ephraim. Isolated areas of this soil are also located near the San Pitch River west of Manti. This is the dominant soil association of the lower San Pitch River.

**Quaker and Mellor soils (Qm)*

This mapping unit is on alluvial fans and alluvial plains. This soil is strongly saline-alkali, runoff is medium, and the available water capacity is low (2 inches). The high salt content reduces the amount of water available to plants. This soil is used as spring and late fall range by sheep and cattle. This soil unit is abundant west of

Johnson Springs, and on the west side of the San Pitch River near STORET 494654.

Other dominant types not shown on the USDA Soil Conservation Service Soil Survey "General Map" of Sanpete Valley

Abcal silty clay loam (Aa)
This soil is on flood plains and alluvial plains. It is slightly to moderately affected by salts and alkali. The available water capacity is high (8-12 inches). The soil is used for wet meadow pasture or hay. This soil can be found along the San Pitch River from Chester to Pigeon Hollow.

Fluvaquents (Fn)
These soils are recent alluvial deposits on stream flood plains and vegetation is wiregrass, tules, and cattails. These soils are used for pasture and native grass hay. These soils can be found northwest of Ephraim.

Kjar peaty silt loam (Kp)
This soil is found on valley bottoms and used for pasture and range. It can be found northwest of Manti.

Rock Land - Atepic - Amtoft Association
This soil association is present near and on the west side of the San Pitch River from Chester to Gunnison Reservoir.

4.3.3 Water

The San Pitch River has many drainage tributaries (**see map 4**). On the East side of the river, Dry Creek, Oak Creek, Birch Creek, Pleasant Creek, Cedar Creek, Canal Creek, Cottonwood Creek, Ephraim, Manti, Six Mile Canyon, and Twelve Mile Canyon are all tributaries to the river. The majority of the water in the San Pitch River originates from snowmelt from the Wasatch Plateau in the east. The tributaries draining the San Pitch Mountains to the west and north are not a significant source of spring snowmelt but do contribute flows during isolated storm events. The foothills of the Wasatch plateau are an important area for groundwater recharge in the basin and have been identified as sensitive areas for groundwater protection. The valley bottoms from Moroni south to Gunnison Reservoir are predominantly wet meadows in the region of groundwater discharge. Hydrologic modification of natural flows results in several dry dams along the middle San Pitch River and nearly all the flow of its tributaries are used for flood or sprinkler irrigation or stored in one of several reservoirs. All the snowmelt from the larger tributaries like Twelve Mile and Six Mile Creeks is stored in Nine Mile and Gunnison Reservoirs and diverted to sprinkler systems outside the basin to the south. As a result, the middle and lower San Pitch River collects a combination of irrigation return flow and groundwater recharge and as such is heavily impacted from salinity originating in soils and groundwater.

4.3.4 Climate

The climate of the San Pitch River Watershed is influenced by the large variations in topography. The elevation of the Sanpete valley floor ranges from 5,040 to 7,400 feet above sea level and the adjacent mountains rise to over 9,000 feet.

The Sanpete Valley climate is semi-arid despite its high elevation. The average annual precipitation ranges from approximately 8 inches in the lower valley to more than 30 inches in the higher mountains. Most of the precipitation in the San Pitch River watershed falls as snow in the mountains, particularly the Wasatch Plateau, from November to April (Robinson, 1971). Table 4.3.1 summarizes the annual temperature and precipitation for Manti, Utah.

Table 4.3.1 Climate and Precipitation for Manti, Utah

Temperature (˚F)		**Precipitation (inches)**	
Annual Mean Daily Maximum	Annual Mean Daily Minimum	Annual Mean Rainfall	Annual Mean Snowfall
62	32.5	13	55

(USDA Soil Conservation Service, 1981)

The climate of the San Pitch River Watershed can also be defined according to the Modified Koppen System, which delimits various climate types according to vegetation response and precipitation patterns. On a large scale the San Pitch River Watershed is located within the Middle-Latitude Desert region and can be described by two climate types: Steppe (Semiarid) and Desert (Arid). Steppelands occur between the desert margins and higher mountain regions. The average annual precipitation is slightly less than the potential evapotranspiration, creating a semi-arid climate sufficient for the growth of short and medium grasses, sagebrush, and other woody plants. Much of this grassland region forms the basis for Utah's livestock ranching industry (Pope et al., 1994). The remainder of the watershed is located on the Colorado Plateau desert. Table 4.3.2 summarizes the annual temperature and precipitation for climate and zones in the San Pitch River Watershed.

Table 4.3.2 Climatic Zones

Climatic Zone	**Precipitation (inches)**	**Temperature (˚F)**	**Frost Free Period (days)**	**Elevation (feet)**
High Mountain	22-40	34-45	40-90	8,000-10,000
Mountain	16-22	42-50	70-170	6,000-8,200
Upland	12-16	45-59	120-170	4,500-6,900
Semidesert	8-12	52-59	120-190	4,500-6,300
Desert	6-8	50-59	120-200	4,500-5,800

4.4 Water Quality Analysis

Utah's Year 2000 303(d) list identifies tributaries in two segments of the San Pitch River as being impaired due to water quality numeric exceedences of TDS (DWQ, 2002). These segments are described as:

San Pitch River - 1: San Pitch River and tributaries from confluence with Sevier River to tail-water of Gunnison Reservoir (excluding tributaries above USFS boundary). Hydrologic Unit Code (HUC) 16030004-001. Water body size: 15.82 miles.

San Pitch River - 3: San Pitch River and tributaries from Gunnison Reservoir to U132 crossing below USFS boundary. HUC 16030004-005. Water body size: 59.46 miles.

In this document, the San Pitch River - 1 segment is referred to as the lower San Pitch River, and the San Pitch River - 3 segment is referred to as the middle San Pitch River.

The above listing is based on an intensive water quality survey completed in 1996-1997 by DWQ. This survey found numerical criteria exceedences for TDS. The beneficial uses, as designated by the State of

Utah (Utah Division of Water Resources, 1999), for the San Pitch River are:

- 2B – Protected for secondary contact recreation such as boating, wading, or similar uses;
- 3C – Protected for non-game fish and other aquatic life, including the necessary aquatic organisms in their food chain;
- 3D – Protected for waterfowl, shore birds and other water-oriented wildlife not included in Classes 3A, 3B, or 3C, including the necessary aquatic organisms in their food chain
- 4 – Protected for agricultural uses including irrigation of crops and stock watering

Due to water quality impairments, the San Pitch River and some of its tributaries are not currently meeting beneficial use requirements for designated beneficial use 4 (agricultural uses including irrigation of crops and stock watering).

A third segment of the San Pitch River has been identified by the Division of Water Quality as requiring further study due to excess total phosphorus (TP). This river segment "San Pitch River and tributaries from U132 crossing to headwaters (UT16030004-009)" is classified as a 3A coldwater fishery and includes the same beneficial uses as the other segment listed above.

Applicable water quality standards are listed in Table 4.4.1. The State of Utah has adopted a numeric criterion for TDS and a narrative criterion for TP, which requires additional supporting information such as biological or physical data to determine the level of beneficial use support.

Table 4.4.1
Utah Water Quality Criteria

Parameter	Criterion Maximum Concentration
Class 4 – Agricultural Uses*	
Total Dissolved Solids	1,200 mg/L
Class 3A – Coldwater Fishery	
Total Phosphorus	0.05 mg/l

Notes: * Utah WQS clarify that TDS limits may be adjusted if such adjustment does not impair the designated beneficial use of the receiving water.

4.4.1 303(d) Listing Criteria

The 303(d) listing criteria provide guidance on evaluating beneficial use support status based on the number of violations of the water quality criterion as listed in Table 4.4.2.

Table 4.4.2
303 (d) Criteria for Assessing Agricultural Beneficial Use Support

Degree of Use Support	Conventional Parameter	Toxic Parameters
Full	Criterion exceeded in less than two samples and in less than 10% of the samples if there were two or more exceedences.	For any one pollutant, no more than one violation of criterion.
Partial	Criterion was exceeded two times, and criterion was exceeded in more than 10% but not more than 25% of the samples.	For any one pollutant, two or more violations of the criterion, but violations occurred in less than or equal to 10% of the samples.
Non-support	Criterion was exceeded two times, and criterion was exceeded in more than 25% of the samples.	For any one pollutant, two or more violations of the criterion, and violations occurred in more than 10% of the samples.

DWQ lists waterbodies assessed as 'partially supporting' or 'not supporting' on the 303(d) list with the exception of those waterbodies for which a TMDL study has already been completed and approved by the EPA.

Relation of Criteria to Beneficial Uses

Total phosphorus is a major nutrient affecting the productivity of surface water ecosystems. In excess, phosphorus can create conditions of high productivity detrimental to aquatic life. Cultural eutrophication can lead to excess aquatic plant and algae growth and diurnal depletion of dissolved oxygen in streams. Periods of low dissolved oxygen impairs fish survival and their ability to spawn. The criterion of 0.05 mg/l TP has been adopted as a narrative criteria and additional information such as dissolved oxygen data, periphyton biomass, and macroinvertebrate sampling may be necessary to determine an appropriate stream concentration necessary to maintain a healthy ecosystem and fishery.

TDS is listed as a criterion for protection of agricultural uses because of the negative effect of high salinity on crop production. The major components of salinity are the cations calcium, magnesium, sodium, and to a lesser extent potassium; and the anions, chlorine, sulfate, bicarbonate, nitrate, and at high pH, carbonate. Salinity reduces crop growth by reducing the ability of plant roots to absorb water and may cause deficiencies of nutrients such as potassium, calcium, nitrate and nitrite. Moderate concentrations of sodium, chloride, sulfate or other ions have been shown to reduce growth or cause specific plant injury. The hazard from sodium is evaluated by comparing the irrigation water Sodium Adsorption Ratio (SAR) with TDS, SAR being a ratio of sodium to calcium and magnesium in the irrigation water, while TDS alone is used to evaluate the hazard from general salinity effects. The concentrations of specific ions, such as boron, in irrigation water are also indications of crop damage potential. The effects from salinity are crop specific since some crops tolerate saline conditions better than others (Tanji, 1990).

Therefore, in addition to evaluating TDS, the listed TMDL pollutant, a water quality assessment for protecting the agricultural beneficial use may also consider assessment of sodium, SAR, boron, pH, and other toxic metals. This additional assessment may be of particular interest if the source of TDS is primarily a natural source and does not impair agricultural uses. As identified in the Utah WQS, the 1,200 mg/L limit "may be adjusted if such adjustment does not impair the designated beneficial use of the receiving water".

In April of 2003, a TMDL for the middle San Pitch River was submitted to the EPA and approved. In addition a recommendation for a site-specific criteria was also submitted and will be incorporated into the State of Utah Water Quality Standards during the next triennial review process. The following is a summary of the TMDL and the associated water quality analysis. The full TMDL analysis is contained in the appendix of the TMDL document.

4.4.2 TMDL Analysis for Total Dissolved Solids

Upper San Pitch River

STORET sampling locations on the upper San Pitch River, and its tributaries, are listed in Table 4.4.3. Note that TDS concentrations do not exceed water quality criteria at any of the sampling locations. The upper San Pitch River is not on the 303(d) list.

Table 4.4.3
Summary of TDS Data Available for the Upper San Pitch River (1995 - 2000)
(mg/L)

STORET #	Station Name	Begin Date	End Date	No. TDS Results	Mean TDS	Min TDS	Max TDS	%TDS Exceed
494675	San Pitch River 2.5 miles west of Mt. Pleasant at U-116 crossing	1/24/95	7/20/00	51	414	284	597	0%
494676	Pleasant Creek at Forest Service Boundary	1/24/95	6/24/97	17	240	202	280	0%
494677	Cottonwood Creek east of Fairview at Forest Service Boundary	1/24/95	6/24/97	17	254	160	328	0%
494678	Oak Creek north of Fairview at Creek 323 crossing	1/24/95	6/24/97	5	258	238	282	0%
494679	San Pitch River at US-89 crossing north of Fairview	1/24/95	6/24/97	18	354	272	470	0%
494689	Fountain Green Fish Hatchery East	1/24/95	7/20/00	36	289	174	341	0%
494690	Fountain Green Fish Hatchery West	1/24/95	7/20/00	25	291	234	330	0%

Middle San Pitch River

STORET sampling locations on the middle San Pitch River, and its tributaries, are listed in Table 4.4.4 from upstream to downstream (**also, see map 5**). STORET stations located on tributaries of the middle San Pitch River include:

494694 Moroni WWTP & Turkey Plant (Moroni Feed Co.) combined effluent

494656 Oak Creek at Spring City

494652 Johnson Spring North at Johnson Road crossing

494653 Johnson Spring South at Johnson Road crossing

494657 Ephraim Creek at Forest Service Boundary

494637 Manti Creek at Forest Service Boundary.

Note that TDS concentrations do not exceed water quality criteria in surface water tributaries to the San Pitch River. The geology of the tributary watersheds is not expected to significantly contribute to salinity. Also, note that surface water tributaries in this reach do not flow into the San Pitch River. Water from these tributaries is diverted into irrigation canals and reservoirs within the valley, and does not reach the San Pitch River under most circumstances.

In the middle San Pitch River, TDS concentrations exceed the criteria of 1,200 mg/L at four of the ten STORET stations (Table 4.4.4). The TDS data are displayed spatially on **Map 6,** along with average flow data for the irrigation and non-irrigation seasons.

Table 4.4.4
Summary of TDS Data Available for the Middle San Pitch River (1995 - 2000)
(mg/L)

STORET #	Station Name	Begin Date	End Date	No. TDS Results	Mean TDS	Min TDS	Max TDS	%TDS Exceed
494696	San Pitch River above Moroni WWTP	1/24/95	7/20/00	36	545	306	1160	0%
494694	Moroni WWTP & Turkey Plant (Moroni Feed Co.) combined effluent	1/24/95	7/20/00	29	683	75	913	0%
494665	San Pitch River 1 mile west of Chester on U-117	1/24/95	7/20/00	35	569	312	914	0%
494656	Oak Creek at Spring City	1/24/95	6/24/97	15	219	182	274	0%
494652	**Johnson Spring North at Johnson Road crossing**	**1/24/95**	**5/06/97**	**5**	**956**	**442**	**1750**	**20%**
494653	**Johnson Spring South at Johnson Road crossing**	**1/24/95**	**6/24/97**	**12**	**836**	**560**	**1984**	**8%**
494654	**San Pitch River northwest of Manti**	**1/24/95**	**6/24/97**	**15**	**862**	**468**	**1916**	**13%**
494657	Ephraim Creek at Forest Service Boundary	1/24/95	6/24/97	19	261	186	506	0%
494645	**San Pitch River west of Manti above Gunnison Reservoir at Creek crossing**	**1/24/95**	**7/20/00**	**53**	**1035**	**291**	**2353**	**26%**
494637	Manti Creek at Forest Service Boundary	1/24/95	6/24/97	19	345	246	464	0%

Bolded entries exceed TDS water quality criteria

None of the TDS data exceed criteria for STORET stations located on tributaries of the San Pitch River between the headwaters and Gunnison Reservoir (except at Johnson Spring); although these tributaries are included in the Section 303(d) List.

As indicated above and in Table 4.4.4 the exception to the tributary TDS concentrations is Johnson Springs (494652 and 494653). These springs rise within the valley floor (not a sub-watershed) and the elevated TDS could result from higher TDS groundwater or shallow subsurface irrigation return flows. However, it should be noted that at each STORET there was only one exceedence in the data set, and the mean flow from the springs is less than 0.8 cfs.

TDS exceeds criteria at two STORET sites located northwest and west of Manti on the San Pitch River (494654 and 494645). At these locations, the mechanism for salinity increase is irrigation on saline soils within the valley, potential contributions from naturally occurring groundwater, and the lack of dilution from surface water inflows.

Lower San Pitch River

As indicated in table 4.4.5, TDS exceeds criteria at one STORET location on the lower San Pitch River (494615 - San Pitch River east of Gunnison). Two major tributaries, Six Mile Creek and Twelve Mile, occur within this reach, but water from these tributaries does not flow into the San Pitch River, but are stored in Gunnison and Nine Mile Reservoirs. The remaining tributaries are diverted to sprinkler irrigation systems. It should also be noted that Six Mile Creek is specifically excluded from the current 303(d) list.

Table 4.4.5
Summary of TDS Data Available for the Lower San Pitch River (1995 - 2000)
(mg/L)

STORET #	Station Name	Begin Date	End Date	No. TDS Results	Mean TDS	Min TDS	Max TDS	%TDS Exceed
494636	Six Mile Creek above confluence/San Pitch River northwest of Sterling	1/24/95	6/24/97	18	304	218	706	0%
494632	Inlet Canal above Palisades Lake	1/24/95	6/14/00	4	258	236	302	0%
594326	Nine Mile Reservoir Inflow	1/24/95	6/14/00	4	668	586	718	0%
494616	Twelve Mile Creek at U-137 crossing in Mayfield	1/24/95	6/24/97	19	254	202	318	0%
494615	**San Pitch River 2 miles east of Gunnison at U-137 crossing**	**1/24/95**	**7/20/00**	**52**	**1414**	**214**	**2550**	**54%**

None of the TDS data exceed criteria for STORET stations located on tributaries of the lower San Pitch River; although these tributaries are included in the Section 303(d) List.

As with the middle San Pitch River, the mechanism for increased TDS in this reach is likely a combination of natural and human causes. STORET 494615 occurs within the groundwater zone influenced by Arapien Shale, which contributes to high salinity. Highly mineralized springs occur at the surface within this section of the river and contribute to natural TDS loads. Water from a spring, designated (D-18-2)23adb-S1 that discharges along a fault zone southwest of Manti had a TDS concentration of 1,780 mg/L (Willberg and Heilweil, 1995). In addition, the soils within the contributing area are alkaline as readily observed by the white residue (caliche) visible on the soil surface in this area.

4.4.3 Groundwater

Water quality of the Sanpete Valley groundwater has been studied extensively by Snyder and Lowe (1998); Wilberg and Heilweil (1995); and Robinson (1971). Additional groundwater quality data were collected by the Utah Geological Survey (UGS) from 107 wells during the summer and autumn of 1996 and spring of 1997 to evaluate TDS. The findings of these investigations, as they relate to groundwater TDS, are summarized below.

Agricultural irrigation, especially flood irrigation, can potentially degrade groundwater and surface water quality. A positive correlation between high TDS concentrations in shallow wells and flood irrigated lands has been noted by previous investigators mentioned above.

The concentration of TDS in groundwater varies throughout the valley. In many areas in the central part of the valley, TDS in groundwater is less than 500 mg/L. In the northwestern, central, and southern part of the valley there are TDS concentrations of over 500 mg/L. Water with higher TDS is generally concentrated in two areas of the valley (Wilberg and Heilweil, 1995). One area is down gradient from outcrops of the Green River and Crazy Horse Formations in the east-central part of the valley from Chester to Pigeon Hollow. In this area, groundwater is generally less than 200 feet below the surface. The other area is down gradient from outcrops of evaporite deposits of the Arapien shale on the west side of the valley from Big Mountain southward to the mouths of Axe handle and Rock canyons. Water quality STORET station 494654 is located 2 miles south of this area.

In another groundwater study conducted by the UGS (1988), groundwater samples from 107 wells showed TDS concentrations ranging from 234 to 2,752 mg/L; with an average TDS concentration of 531 mg/L. The groundwater TDS data are illustrated spatially in **Map 6**. In this study, groundwater with TDS concentrations greater than 1,000 mg/L were found in the Moroni area at the south end of the Cedar Hills, along the west side of the bedrock hills south and south-southeast of Chester, north of Sterling between Gunnison and Palisades Reservoirs, and along the east side of the West Hills south of Mayfield.

Lowe, et al. (2000) studied the distribution of TDS concentrations in groundwater with respect to perforated-interval-depth category and hydrogeologic setting (recharge/discharge area category). Of the 118 wells (the database provided by Millennial Science and Engineering (MSE) contained 107 wells) sampled and analyzed for general chemistry, 51 were shallow wells (less than 100 feet deep), 48 were medium-depth wells (100 to 200 feet deep), and 19 were deep wells (greater than 200 feet deep). TDS concentrations in shallow wells range from 234 to 2,490 mg/L and averaged 602 mg/L, in medium-depth wells range from 244 to 1,068 mg/L and averaged 468 mg/L, and in deep wells range from 260 to 2,752 mg/L and averaged 541 mg/L. No significant trends in the spatial distribution of TDS in groundwater could be identified. In general, wells with groundwater containing high TDS concentrations (>1000 mg//L) are located near Moroni and Chester, and near Sterling and Mayfield (lower San Pitch River). Groundwater with low TDS (<500 mg/L) is present in wells located in and north of Spring City, and mixed with moderate TDS concentrations (500 - 1000 mg/L) in groundwater in the middle San Pitch River valley.

Water from shallow wells in areas where flood irrigation is common typically has high TDS concentrations (Lowe et al. 2000). The source of the dissolved solids was reported to be from naturally occurring shallow groundwater and from irrigation. Richardson (1907) also states that water derived from shallow wells, especially in irrigated areas, typically contains abundant dissolved salts due to return irrigation flows leaching dissolved salts accumulated in soils from evaporation.

Excess irrigation and irrigation return water leach soil in valley lowlands where groundwater is within the zone of capillary action and the accompanying “alkali” salt-rich soil (Richardson, 1907). These dissolved salts in the soil are concentrated by flood irrigation processes as near surface water evaporates into dissolved salts (Pipkin, 1994). To leach out these unwanted salts and maintain soil salinity within crop tolerance, the amount of water applied must exceed plant requirements (Feth, 1966).

The type of water and quantity of dissolved solids is also influenced by local geology. Groundwater with high TDS concentrations and high sulfate and chloride concentrations along the west side of Sanpete Valley is likely due to soluble salts in the Jurassic Arapien Shale and gypsum in the Tertiary Green River and Crazy Hollow Formations (Snyder and Lowe, 1998; Wilberg and Heilweil, 1995; Robinson, 1971; and Richardson, 1907).

Groundwater quality is described as fair and of lower quality than in upstream subbasins. More specifically, the water is higher in salinity and is unsuitable for domestic uses. According to the Utah Division of Water Resources (1999) this is due to mineral constituents dissolved from the Arapien shale. One well near Axtell produces water with dissolved solids of 2,270 mg/L. The groundwater quality in the Gunnison area ranges from about 1,300 mg/L on the east side of the valley to 1,535 mg/L on the west side near the Sevier River (Utah Division of Water Resources, 1999). Numerous naturally occurring springs are also located below Gunnison Reservoir. These springs were considered a potential TDS source; however, limited water quality data are available to estimate their loading potential.

Therefore, multiple causes and sources of TDS loading are apparent in the Sanpete Valley that effect the water quality of the San Pitch River.

4.4.4 Surface Water and the San Pitch River

Flows in the San Pitch River are regulated for irrigation, storage, and release. Segments of the river are dewatered to various degrees. Consequently, the best available flow information is collected at the water diversion gages operated by Division of Water Rights. Where the river is totally diverted, these diversion gages provide the best estimate of the flow in the river prior to diversion.

Middle San Pitch River

Flow patterns in the middle San Pitch River near Chester (approximately RM 38) are characterized by flows measured at two diversions. The Bagnal Dam and West Point Canal divert water out of the river west of Chester; Bagnal Dam diverts water to the east and West Point Canal to the west. The combined flows, measured at these two stations, represent the flow pattern in the San Pitch River prior to diversion (Figure 1). Water flows in the San Pitch River primarily during the period from March through July, and again for a short period in October and November. No flows were measured at these diversions between December and February, or in July and August. There is no other reliable information on flows to indicate whether water is flowing in the San Pitch River and not being diverted during these dry months.

Flows are also measured at the head of the West Drainage Canal, RM 30. Although this canal is called a diversion, it is the San Pitch River at this location, and for approximately 9 miles downstream. As shown in Figure 2, flows occurred from October to June in water years 1996 and 1997. Figure 2 illustrates the variability in flows due to climatic differences between water years. Water year (WY) 1996 was apparently much drier with little runoff in May and June, in contrast to WY 1997 when high flows were measured in the river. This variability increases the uncertainty in estimating current TDS loads even when there are good flow data.

Flows measured at San Pitch River west of Manti, RM 20, (Figure 3) show the increased influence of both groundwater and surface water inflows. Flows during the base flow period between July and September are likely due to return irrigation and groundwater flows that are high in salinity. The increased flows in May and June are attributed to uncontrolled flood return flows that will be highly variable from year to year as indicated in the graph between WY 1996 and 1997.

Lower San Pitch River

Flow patterns for the lower San Pitch River are indicated by flow measured at the Old Field Canal, RM 3, considered a total diversion. Flows are less variable in the lower San Pitch, because flows are controlled by releases from Gunnison Reservoir. Between October and February the flows in the lower San Pitch River are zero to minimal, and then are regulated by releases from the reservoir from April through October for irrigation (see Figure 4).

Figure 1: Flows in the Middle San Pitch River - River Mile 38
"Bagnal Canal" & "West Point Canal" Combined

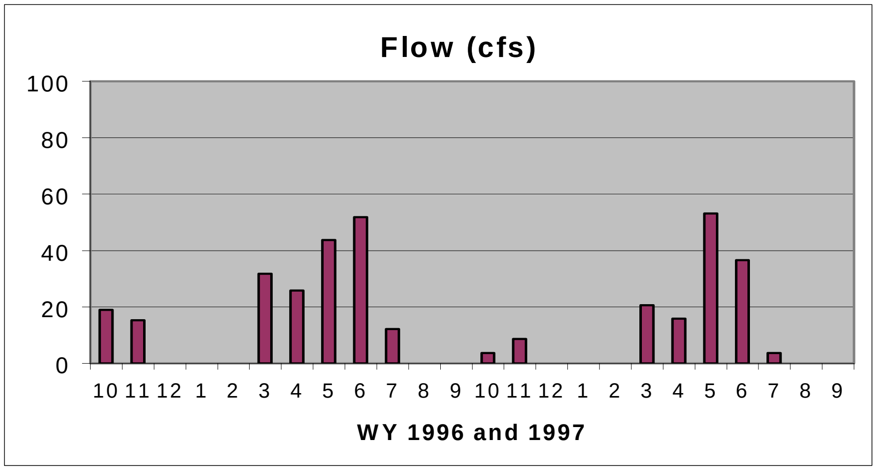


Figure 2: Flows in the Middle San Pitch River - River Mile 30
"West Drainage Canal" (The San Pitch River)

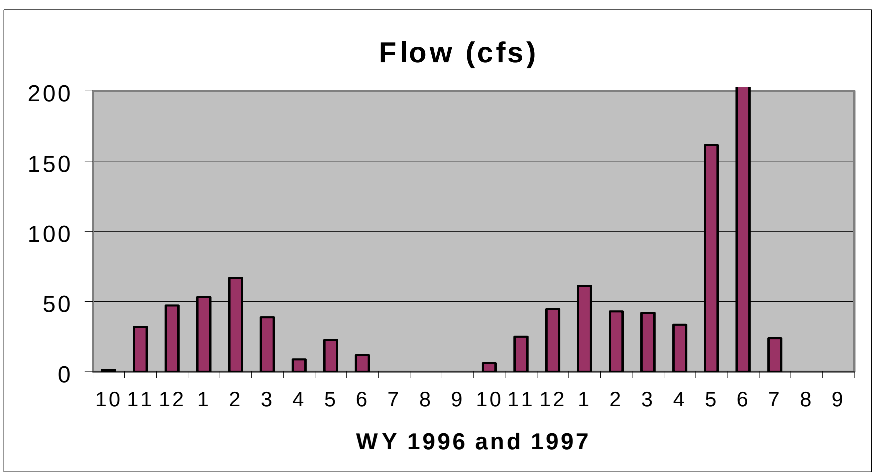


Figure 3: Flows in the Middle San Pitch River - River Mile 20
"San Pitch River West of Manti"

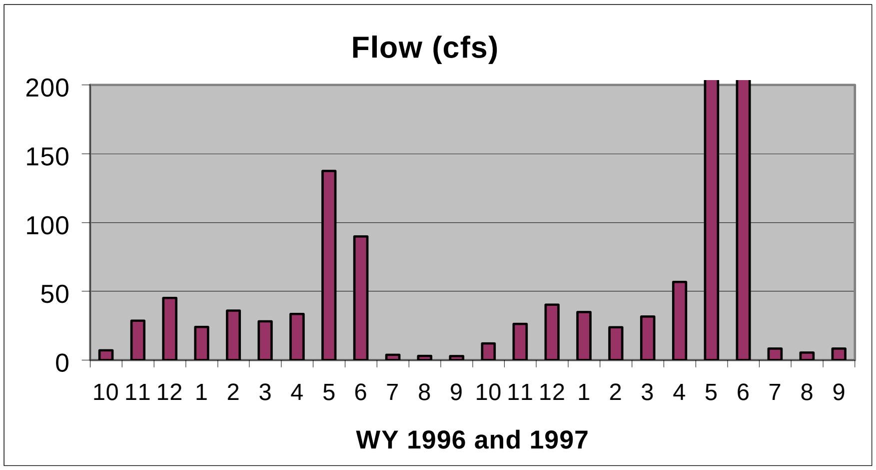
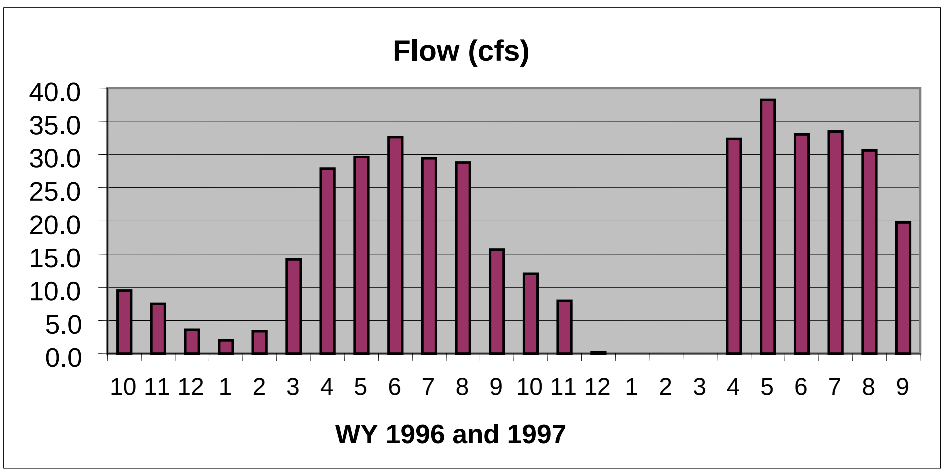


Figure 4: Flows in the Lower San Pitch River - River Mile 3
Old Field Canal: San Pitch near Gunnison



4.4.5 Point Sources

There are three active point source permits in the San Pitch River Watershed (State of Utah NPDES Permitting Section).

Active Permits:

- UT0020222 – Moroni Feed/Wastewater. This permit replaced the former Moroni City Corporation permit that was identified as UTD00085217.
- UTG130004 – Fountain Green Fish Hatchery. Under this current general permit, the Fountain Green Fish Hatchery may discharge to the irrigation canal system that flows to Silver Creek, a tributary of the San Pitch River. This permit replaced the former Utah Division of Wildlife individual permit UT0022144.
- UT0025216 – Spring City Corp Waste Water Treatment Plant

The Moroni Feed/Wastewater Treatment Plant is the only point source that occurs in a 303(d) designated stream segment. This treatment plant is evaluated as a point source in the middle San Pitch River segment. The treatment plant processes domestic wastewater for the City of Moroni and wastewater from the Moroni turkey processing plant. In the remainder of the document this point source is referred to as the "Moroni WWTP". Water samples tested for TDS from the Fountain Green Fish Hatchery outflow (226 TDS measurement since 1978) show a maximum TDS concentration of 564 mg/L with an average of 287 mg/L TDS. Therefore, this point source of TDS is not considered significant. The Spring City Corp Waste Water Treatment Plant does not discharge water.

4.4.6 Non-point Sources

Non-point sources of pollution include sources that reach a waterbody by way of surface runoff or subsurface flow to groundwater. Non-point sources in the San Pitch River Watershed are both natural and human-caused. Natural sources are often referred to as "background" sources and include naturally occurring salts in local soils, geology, and springs. Human-caused non-point sources of pollution in the San Pitch watershed include irrigated and non-irrigated lands used for grazing and crop production.

In a hydrology study of the Sanpete Valley, Wilberg and Heilweil (1995) state that the cause of the high concentrations of TDS in the San Pitch River near Manti could result from shallow groundwater that discharges into this reach of the river (see sections 4.8 and 4.3.2). Groundwater in this local flow system is recharged along outcrops of Arapien Shale in the nearby San Pitch Mountains, flows eastward, and discharges to the San Pitch River. This groundwater recharge is a natural source of TDS to the San Pitch River.

In the middle San Pitch River farmers must rely on a seasonal water supply from the San Pitch River, springs and wells, and flood irrigation practices are used. Flood irrigation is identified because this irrigation method contributes to salt loading by shallow and deep percolation to groundwater, and leaching of salts into the water that runs off. Therefore, the potential for TDS loading from these flood irrigated tracts was considered. Approximately 15,000 acres of land are flood irrigated along the middle San Pitch River. Flood irrigation along the middle San Pitch River is controlled and uncontrolled. **Irrigation Map 7** shows the areas irrigated by uncontrolled flood, controlled flood and sprinkler methods along the middle San Pitch River.

Controlled and uncontrolled flood irrigation in the middle San Pitch River watershed contributes to TDS loading to the river. Poor efficiency irrigation systems contribute to salt loading by shallow and deep percolation to groundwater, and leaching of salts into the water that runs off. This leaching of salts also contributes to soil health concerns, creating soils with high salt concentrations. Excess irrigation and irrigation return flows leach salt from soils in valley lowlands where groundwater is within the zone of capillary action and the accompanying "alkali" salt-rich soil (Richardson, 1907). These dissolved salts in the soil are concentrated by flood irrigation processes as near surface water evaporates into dissolved salts (Pipkin, 1994). This process is compounded with the presence of high saline soils in and adjacent to the middle San Pitch River.

Another potential source of TDS loading to the middle San Pitch River is the land application of animal manure. Turkey and cow manure is applied to lowlands of the middle San Pitch River watershed. Application rates for turkey manure and beef/dairy cow manure were provided by the Natural Resources Conservation Service (NRCS) in Manti, Utah (table 4.4.6). A total of 396,980 tons of manure (381 tons salt) are land-applied annually. Table 4.4.6 also shows the manure application rates on lands that are irrigated by uncontrolled flood and controlled flood/sprinkler methods.

Table 4.4.6
Animal Manure Land Application Rates

	Irrigation Type	Annual Application Rate (Tons)	Annual Salt Load (Lbs)	Annual Salt Load (Tons)
Turkey Manure[1]	Uncontrolled Flood	7,500	37,500	18.8
	Controlled Flood/Sprinkler	40,000	200,000	100.0
Beef / Dairy Cow Manure (all ages)[2]	Uncontrolled Flood	92,900	139,350	69.7
	Controlled Flood/Sprinkler	256,580	384,870	192.4
Total Manure Applied by Land Irrigation Type	Uncontrolled Flood	100,400	176,850	89
	Controlled Flood/Sprinkler	296,580	584,870	292
TOTAL		**396,980**	**761,720**	**381**

1. 5 Lbs salt per ton manure
2. 1.5 Lbs salt per ton manure

(Lbs Salt/Per Ton from Dr. Frame USU, Beef-Dairy estimated from manure test taken in Sanpete)

Salts from manure could be transported to the San Pitch River by several transport mechanisms: erosion, overland surface water flow, and percolation to groundwater.

Salt loading to the San Pitch River by erosion is not expected to be as significant because manure is applied on lowlands of the middle Sanpete Valley where slopes are gentle and soil loss is low. Overland surface water flow could be a significant transport mechanism for salt in manure in areas where uncontrolled flood irrigation is used. Percolation of surface water and leaching of manure salts to groundwater can transport salts to the San Pitch River via subsurface flow.

To evaluate the potential significance of this salt load to the San Pitch River, it can be assumed that 100% of the annual manure salt load is delivered to the river. Using this highly conservative assumption, and the existing TDS load in the San Pitch River (see table 4.4.7), the potential manure salt contribution is 1% of the total load. Similarly, the salt contribution from manure applied to uncontrolled flood areas (89 tons salt) is 0.3% of the total load.

Therefore, salt (TDS) loading to the San Pitch River from land application of animal manure is not considered a significant source. However, the potential nutrient loading to the San Pitch River from this source should be evaluated.

4.4.7 TMDL Load Calculations and Allocations

As described in the introduction, a TMDL is a calculation of the maximum amount of a pollutant that a water body can receive and still meet water quality standards. The calculation of a TMDL is described by the following relationships and associated terminology.

TMDL = WLA + LA + MOS = Target Load

TMDL - Total Maximum Daily Load.
WLA - Waste Load Allocation for point sources.
LA - Load Allocation for non-point sources (includes background/natural sources).
LA = Target Load - MOS (if no WLA).
MOS - Margin of Safety.
Target Load - The maximum pollutant load for the waterbody, set at the water quality criteria (Target Load is also referred to as load capacity).
Current Load - Pollutant load based on measured flows and TDS concentrations.
Load Reduction - Current Load minus Load Allocation.
Load Reduction = Current Load - LA (if no WLA).
Percent Reduction - Load Reduction divided by Current Load, expressed as percent.
Percent Reduction = Load Reduction / Current Load *100.
TMDL Measurement Point - A water quality monitoring station located at the bottom of the listed reach.

The Target Load is estimated by calculating the load based on the water quality criteria. The target TDS concentration of 1,200 mg/L is multiplied by representative flows at the measurement point for the critical period. The Margin of Safety (MOS) is calculated expressly as 5% of the Target Load. The Load Allocation (LA) is calculated by subtracting the MOS from the Target Load.

A full discussion of the assumptions and load calculations is included in the TMDL. The following is a brief summary of the recommended load reductions and the allocation among the various sources in the watershed.

TMDL and Allocations

For both the middle and lower San Pitch River TDS TMDL the first step of the analysis included identification of the critical season. The critical period for TDS contribution and effects on the beneficial use (agricultural use) is the irrigation season. Water for irrigation and stock water is the beneficial use of concern, which is potentially impacted by increased salinity. For the purposes of comparing year-to-year loads, the irrigation season is standardized to the time period March 01 to September 30.

Middle San Pitch River Watershed

On the middle San Pitch River, average TDS concentrations exceed criteria for six months during the irrigation season, March through May and July through September.

To calculate the target load, the 1,200 mg/L criterion was substituted in the spreadsheet of calculated current loads for these months. Although a load reduction is not recommended for the Moroni WWTP, a waste load allocation was calculated as 308 tons/year. The load capacity is estimated at 32,981 tons. Including a 5% margin of safety, the remaining load is 31,014 tons of TDS. The required load reduction is 3,997 tons of TDS during the critical season, or 11%. A load reduction will be realized through improved surface irrigation practices and irrigation water management. Using the information developed by the Price-San Rafael Salinity Control Project approximately 1,095 acre feet of return flows need to be reduced in order to meet the target loading (3,997 tons / 3.65 tons per acre foot).

The waste load allocations, load allocations, margins of safety, and load reductions are summarized for the middle San Pitch River in table 4.4.7.

Table 4.4.7
Loading Assessment

	Middle San Pitch River Watershed (Tons TDS for critical season, March - Sept.)
Current Load	35,329
Loading Capacity (Target Load)	32,981
Waste Load Allocation	318
Load Allocation	31,014
Margin of Safety (5%)	1,649
Load Reduction	3,997

Lower San Pitch River Watershed

On the lower San Pitch River, average TDS concentrations exceed criteria for six months during the irrigation season, April through September. As with the middle San Pitch River, target loads were calculated using the 1,200 mg/L criterion in the spreadsheet of calculated current loads for these months. The waste load allocation is set to zero because there are no current point sources, and the load capacity is estimated at 15,574 tons. Including a 5% margin of safety, the remaining load is 14,796 tons of TDS. The required load reduction is 4,401 tons of TDS during the critical season, or 23%. This load is assumed to be natural or background due to the hydrogeology of the lower watershed and the springs that supply some of the water to the lower San Pitch River (see Sections 4.8 and 4.3.2 of the Water Quality Management Plan for a discussion of geology and groundwater).

The waste load allocations, load allocations, margins of safety, and load reductions are summarized for the lower San Pitch River in table 4.4.8**.**

Table 4.4.8
Loading Assessment

	Lower San Pitch River Watershed (Tons TDS for critical season, March - Sept.)
Current Load	19,197
Loading Capacity (Target Load)	15,574
Waste Load Allocation	0
Load Allocation (attributed to natural sources)	14,796
Margin of Safety (5%)	779
Load Reduction	4,401

4.4.8 Source Allocation

Middle San Pitch River

The primary sources of TDS in the middle San Pitch River include flood irrigated tracts, groundwater input, saline sediments from upland and stream bank erosion, and springs. As discussed above, the total existing TDS load for the middle San Pitch River is 35,329 tons. This section discusses the TDS sources identified above and presents an allocation estimate of the TDS load from each source in 4.4.9 below.

The flood irrigated tracts are located on a variety of soil units. These soil units are comprised primarily of silt loams and silty clay loams with moderate to strong salinity. Flood irrigation increases the salinity of soil pore water by dissolving and transporting the salts in the underlying saline soils and geologic formations (USDI, 1997). According to findings of the Price/San Rafael Salinity Control Project (USDI – BOR, 1991), 3.65 tons of TDS loading is attributable to each acre-foot of irrigation return flow.

Approximately 15,000 acres are flood irrigated along the middle San Pitch River. Irrigation return flows have not been measured for the San Pitch River; however, assuming 30% efficiency for flood irrigation at a rate of 4 inches per acre (0.3 acre-feet), the return flows can be estimated at 3,465 acre feet. Using these average values, a rough estimate of 12,647 tons of TDS loading into the middle San Pitch River can be attributed to return irrigation flows during the entire irrigation season.

Groundwater inflows account for a significant source of TDS to the San Pitch River. Stream flow diversion records show an average gain of 30 cfs to the middle San Pitch River from groundwater during the irrigation season. This groundwater discharge rate is consistent with the findings of Wilberg and Heilweil (1995) who reported the groundwater discharge as seepage to the San Pitch River to range from 25 cfs to 110 cfs.

TDS concentrations in shallow wells range from 234 to 2,490 mg/L, with an average of 602 mg/L (Lowe et al., 2000). Using a groundwater inflow rate of 30 cfs and an average TDS concentration of 062 mg/L results in a TDS load of 10,228 tons to the San Pitch River from groundwater input.

Another potential source of TDS loading is from sediments eroded from uplands and stream banks. Saline soils are present on the western foothills and stream banks of the middle San Pitch River. The area usually receives less than 8 inches of precipitation a year; however storm events do occur. Thunderstorms can cause short term flooding on the western foothills potentially washing saline soils into the San Pitch River. However, the prospects of re-vegetating uplands to reduce erosion are very slight. There are more structural practices available to trap and retain floodwaters and sediment flows that arise from thunderstorms but their high cost may be prohibitive. However there are opportunities to reduce stream bank erosion. This potential TDS load is considered natural and not due to grazing or some other human-caused mechanism. The TDS load from eroded sediments has not been quantified, but rather assumed to account for the remainder of the quantifiable load.

Springs with high TDS waters discharge to the San Pitch River; however, the flow rate is generally less than 1 cfs. Johnson Spring discharges to the middle San pitch River with an average TDS concentration of 956 mg/L. Due to the low flow rate (0.8 cfs) this spring contributes approximately 450 tons TDS per irrigation season.

Table 4.4.9
Allocation of Current TDS Sources in the Middle San Pitch River.

Allocation	Source	TDS Load (tons)	TDS Load (% of total)
Background	Upstream load at Station 494675	6,898	20%
Natural Sources	Groundwater inflow	10,228	29%
	Johnson Springs	450	1%
	Eroded Sediments	4788	14%
Human-Caused Sources	Flood Irrigation Return Flows	12,647	36%
	Moroni WWTP	318	<1%
	Sprinkler Irrigation Return Flows	negligible	
Total		35,329	100%

Lower San Pitch River Watershed

Natural Sources of TDS

An evaluation of the geology, soils, hydrology, and irrigation system provides strong evidence that the high TDS concentrations are due to natural sources. Therefore, instead of calculating a load allocation for non-point sources, this study recommends adoption of a site-specific criterion for the lower San Pitch River. The evidence for natural sources of TDS will only be briefly summarized in this section since this information has been provided in detail in previous sections of this report.

Geology and Soils: The Sanpete Valley is comprised of complex geology with geologic units ranging from Jurassic to Quaternary in age. The Jurassic Arapien shale in Sanpete Valley consists of lower limestone beds overlain by gray siltstone, shale, gypsiferous shale, and salt bearing, red-weathering shale and siltstone. This geologic unit is mined for salt west and south of the Sanpete Valley. Many authors attribute the increased salinity in groundwater in Sanpete Valley to the evaporites from the Arapien shale and other geologic formations. Highly mineralized springs occur at the surface within this section of the river and contribute to natural TDS loads. In addition, the soils within the contributing area are alkaline as readily observed by the white residue (caliche) visible on the soil surface in this area. (See section 4.3.2)

Hydrology: During the irrigation season, all of the surface water released at the south end of Gunnison Reservoir is diverted into canals, which is eventually used for irrigation downstream of the watershed. Water from the major tributaries in this reach, Six Mile Creek, Nine Mile Creek and Twelve Mile Creek, are also diverted to canals and do not reach the San Pitch River. However, some snowmelt runoff may enter the river below this point between May 15th and mid-June.

Southwest of Manti, the Sanpete Valley narrows and is constrained by bedrock outcrops which impede most groundwater flow out of the valley. In this area, confined groundwater is forced to the surface and forms a large marshy area. The only outlet for this groundwater is the San Pitch River. The lower San Pitch River below Gunnison Reservoir is therefore characterized by the highly saline groundwater that discharges to it.

Groundwater Quality: Quality of the Sanpete Valley groundwater has been studied extensively by the Utah Division of Water Resources and Utah Geological Survey. Groundwater quality varies throughout the Sanpete Valley exhibiting high variability in TDS concentrations both spatially and by depth however, concentrations above 2,000 mg/L are regularly observed. The source of TDS in groundwater is influenced by irrigation practices, but the relative extent of this influence compared to natural sources can not be determined despite the extensive studies that have been undertaken.

Site-Specific Criteria

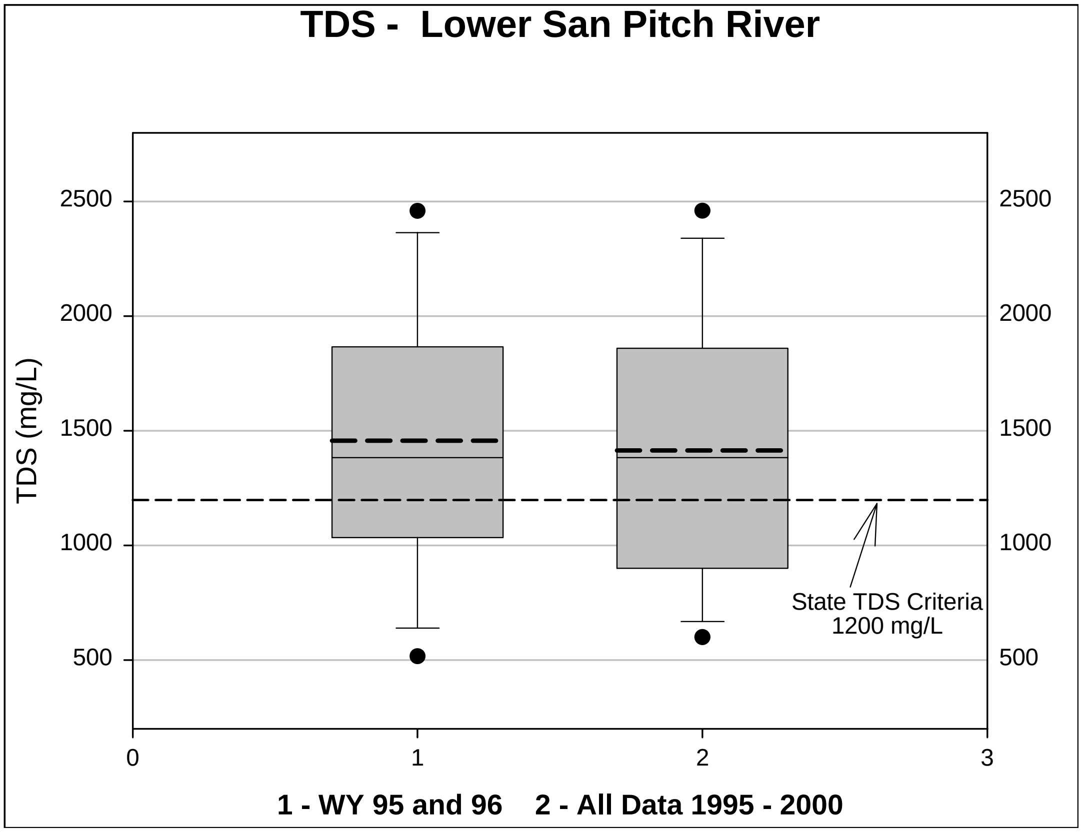
Guidance for developing site-specific criteria is summarized in two memorandums issued by EPA. A Region 8 Memorandum (Moon 1997) addressed procedures for *Use Attainability*

Analysis and Ambient Based Criteria, and a memorandum from EPA Office of Science and Technology (Davies 1997) addressed the subject, *Establishing Site-Specific Aquatic Life Criteria Equal to Natural Background*. These two memorandums were consulted for direction in developing site-specific criteria for the lower San Pitch River. The applicable points from these memoranda in developing site-specific criteria are:

1. Site-specific criteria are allowed by regulation subject to EPA review and approval.
2. Site-specific numeric aquatic life criteria may be set equal to natural background where Natural Background is defined *as background concentrations due only to non-anthropogenic sources*.
3. Previous guidance provided the direction to use the 85th percentile of the available representative data for natural ambient water quality conditions.

There is only one water quality station on the lower San Pitch River that provides sufficient data for estimating the natural background condition. This Station 494615, SPR 2 miles East of Gunnison at U-137 was used in calculating TDS loads. The data distribution for this station is illustrated in the box and whisker plots.

Figure 5: Background TDS concentration (mg/L) in the Lower San Pitch River.



Note: Shows 95th, 90th, 75th, 50th (median), 25th, 10th, and 5th percentile. Mean – dashed line.

Two time periods are compared in the box plot. WY 95 through WY 96 is the time period used consistently for estimating TDS loading. The second plot is for all data available for the project, January 1995 through July 2000. The plots illustrate similar data distribution for the two time periods; therefore the data set with the larger number of samples, the 1995-2000 data set, will be used for estimating a site-specific criterion.

Statistics for the data at Station 494615 are summarized in Table 4.4.10. Four potential percentiles are calculated for comparison to the existing criteria. Percent exceedence is calculated for the existing (1995 – 2000) data set to illustrate the potential effect on future water quality violations if this percentile were accepted as the site-specific criteria.

Table 4.4.10

Summary Statistics for Developing Site-Specific Criteria - Station 494615

Statistic	Value	% Exceedence
Number	52	
Mean	1,414	
Median	1,383	
Minimum	214	
Maximum	2,550	
95th Percentile	2,456	3.8%
90th Percentile	2,332	9.6%
85th Percentile	2,168	13.5%
75th Percentile	1,857	17.3%
Existing Criteria	*1,200*	*36.5%*

The 90th percentile, a value of 2,332 mg/L, results in less than 10% exceedences. A 90th percentile also provides some allowance for the unknown but minor anthropogenic contribution of TDS. For practical purposes the numeric value is rounded up to 2,400 mg/L. A TDS concentration of 2,400 mg/L is therefore suggested as the site-specific criteria applicable to the lower San Pitch River. (*Note: These criteria should only apply to the main stem of the river, not to the adjacent tributaries. The surface tributaries are derived from a different geologic strata and do not exhibit a high natural TDS concentration.)*

Upper San Pitch River – Total Phosphorus

As mentioned above, the primary water quality concern in the upper San Pitch River is total phosphorus and its effect on the potential for a viable coldwater fishery. Compared to the Middle and Lower River there is limited data available for water quality and load analysis. None of the tributaries in the upper watershed have year-round phosphorus samples or flow observations in the DWQ database so load contributions are not possible to calculate. Two stations have adequate water quality data associated with them to calculate loads: 495679 (San Pitch River North of Fairview at U89 Crossing) and 494675 (San Pitch River West of Mt. Pleasant at U116 Crossing).

495679- San Pitch River North of Fairview at U89 Crossing

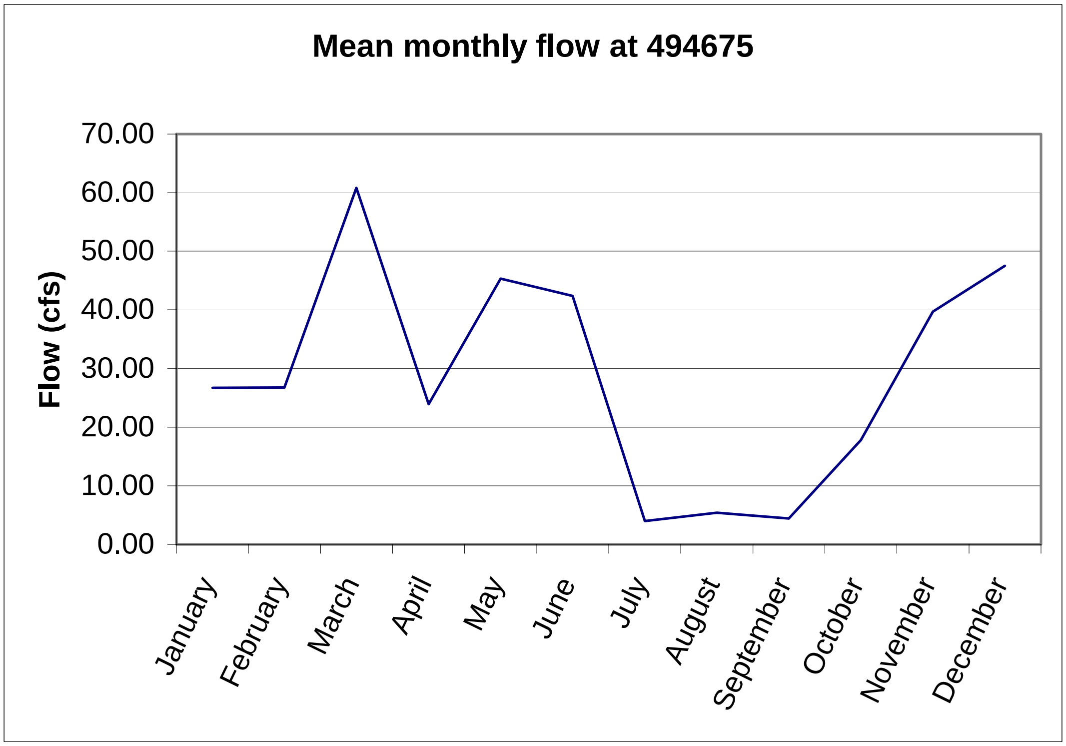
	Flow (cfs)	Dissolved P (mg/l)	Total P (mg/l)	TP Load (kg/day)
January	4.15	0.01	0.01	0.09
February	3.75	0.01	0.01	0.06
March	4.00	0.01	0.02	0.16
April	8.12	0.01	0.01	0.38
May	41.33	0.01	0.03	1.82
June	9.00	0.01	0.01	0.45
July	4.00	0.01	0.01	0.10
August	0.50	0.01	0.01	0.01
September	0	-	-	0
October	3.80	0.01	0.01	0.14
November	1.50	0.01	0.01	0.04
December	2.75	0.01	0.01	0.07
Average	**6.91**	**0.01**	**0.01**	**0.28**

494675 – San Pitch River West of Mt. Pleasant at U116 Crossing

	Flow (cfs)	Dissolved P (mg/l)	Total P (mg/l)	TP Load (kg/day)
January	26.68	0.01	0.04	1.49
February	26.73	0.01	0.03	2.25
March	60.83	0.03	0.07	10.88
April	23.89	0.04	0.03	1.69
May	45.34	0.02	0.10	6.58
June	42.37	0.02	0.06	6.59
July	4.00	0.05	0.03	0.27
August	5.43	0.01	0.02	0.29
September	4.42	0.03	0.04	0.13
October	17.80	0.01	0.02	0.06
November	39.70	0.01	0.01	0.71
December	47.50	0.08	0.02	4.16
Average	**28.73**	**0.03**	**0.04**	**2.92**

While station 495679 often exhibits periods of low or no flow due to irrigation withdrawals, the lower station 494675 is located on a perennial reach of stream which is fed by a combination of tributary flow and spring water to adjacent springs and the stream channel. Annual average stream flows are presented in Figure 6.

Figure 6. Annual discharge for station 494675 – SPR at U116 Crossing

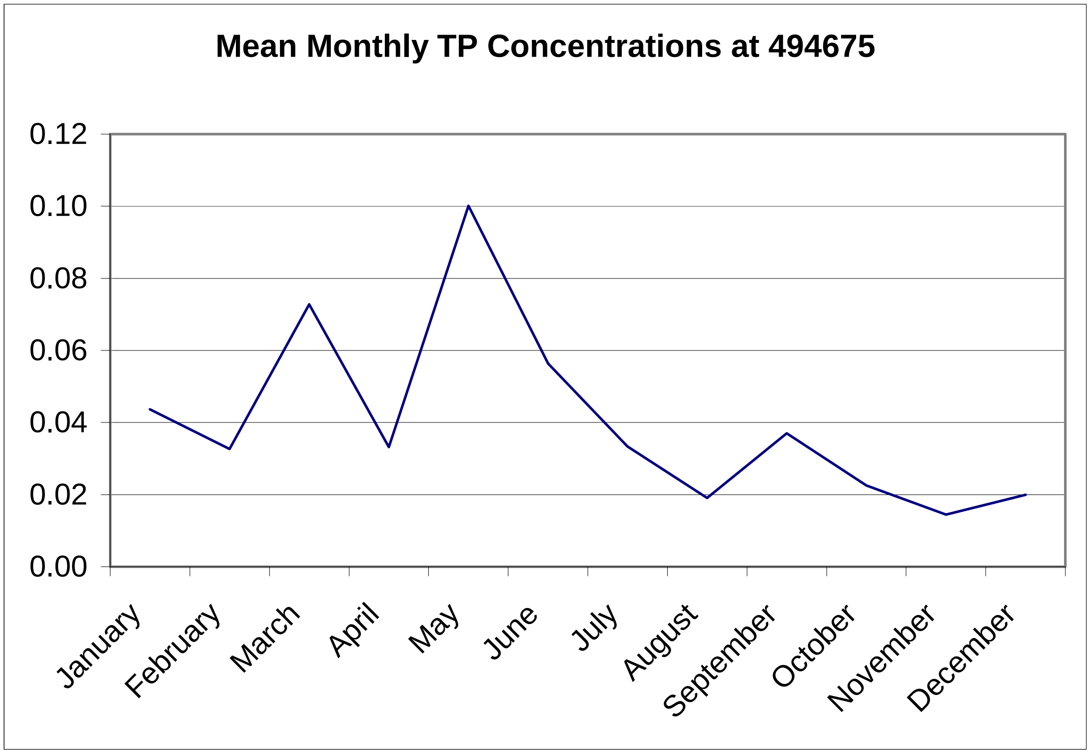


The hydrograph at station 494675 is typical of streams in this eco-region, exhibiting an early low elevation spring snowmelt followed by a later peak runoff from high elevation snowmelt. This later runoff period is somewhat depressed due in part to irrigation withdrawals for agricultural production.

Total phosphorus concentrations closely resemble the flow curve when monthly values are plotted (see Figure 7) suggesting that total phosphorus concentrations closely related to high flow events. Low elevation snowmelt may be contributing phosphorus through runoff from fields and stream channels where animals, development and/or erodible soils are present. Concentrations are highest during the later runoff period and may be a product of irrigation returns in combination with eroding stream banks and grazing. Additional sources include the town of Fairview and surrounding development, which are currently all utilizing on-site systems for sewage treatment.

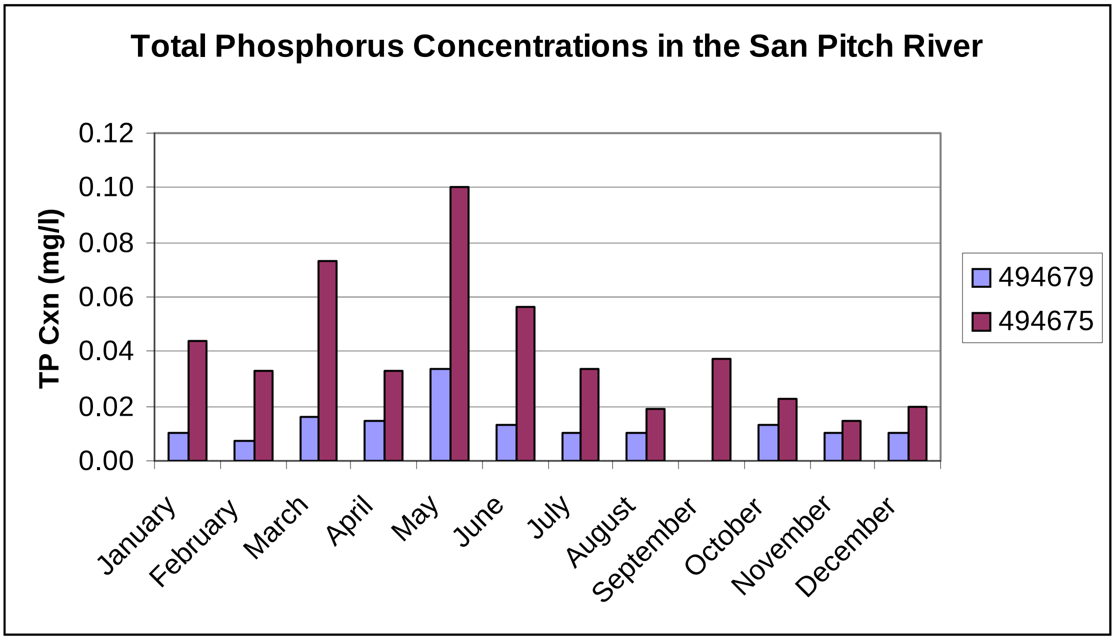
4.4.8 Total Phosphorus Sources

Figure 7. Mean monthly total phosphorus concentration in the San Pitch River.



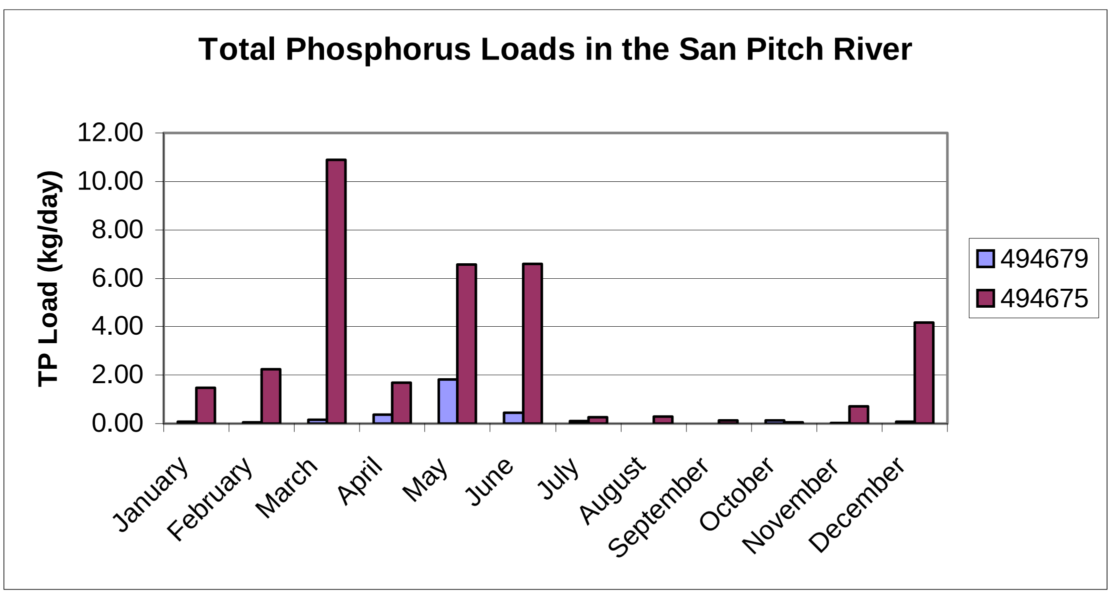
Total phosphorus concentrations between the two sites (494679 and 494675) vary greatly, particularly during the spring and summer months (see Figure 8). On average, there is a fourfold increase in TP concentrations, increasing from an annual average of 0.01 mg/l at 494679 to 0.04 mg/l at 494675.

Figure 8. Mean monthly TP concentrations at selected sites on the San Pitch



Similarly TP loads increase significantly between the two sites as a function of increased flow and concentrations (see Figure 9). As a result, the downstream site (494675) exhibits a tenfold increase in TP load (2.92 kg/year) over the upstream site at 494679 (0.28 kg/yr).

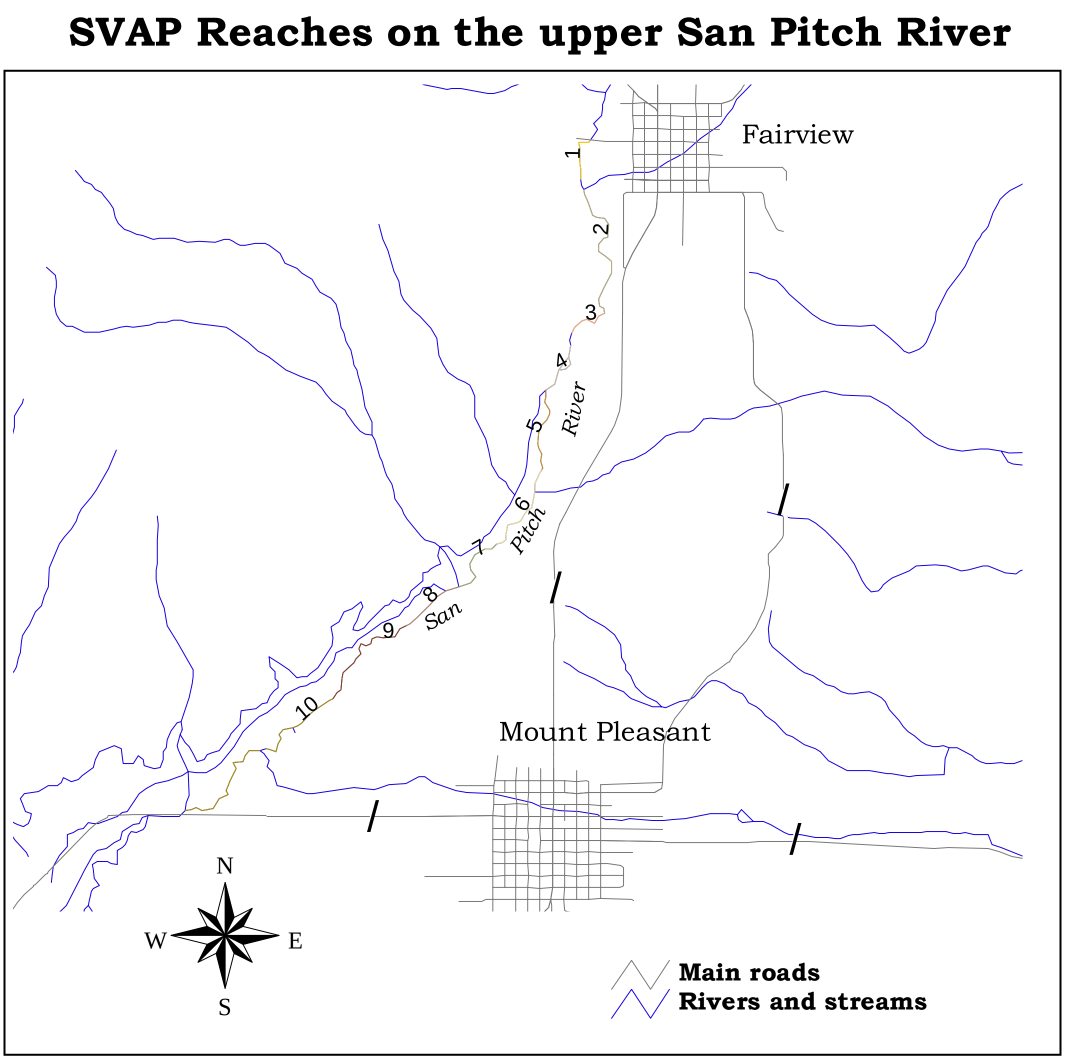
Figure 9. Total Phosphorus Loads in the San Pitch River



In general, total phosphorus concentrations and loads at 494679 (North of Fairview) are low, with average annual concentrations of 0.01 mg/l and average daily loads of 0.28 kg/day. This suggests that the major source areas reside within a narrow segment of the watershed between Fairview and Mt. Pleasant.

4.4.9 Stream Habitat – SVAP

Figure 10: SVAP Reaches on the Upper San Pitch River



4.4.10 Stream Visual Assessment Protocol (SVAP) Methods

The river was divided into sections which had similar stream characteristics, vegetation, flow regime and/or management practices. These decisions were primarily made in the field. Stream measurements and scoring for a number of categories were completed before proceeding with the next reach. SVAP scores are summarized for each reach in Table 4.4.11. While not a monitoring tool, SVAP is particularly useful in highlighting problem areas, demonstrating changes between management areas, and determining priority areas within a watershed.

Table 4.4.11. SVAP scores by reach. (Please refer to map 4.4.9)

Category	1	2	3	4	5	6	7	8	9	10
Channel Condition	3	1	3	2	3	1	5.5	9	7	3
Hydrologic Alteration	8	3	5	3	3	3	5	5	5	5
Riparian Zone	3	1	3	3	3	2	4	8	8	4
Bank Stability	3	2	3	2	1	1	6	9	4	3
Water Appearance	7	7	7	5	5	5	5	5	5	5
Nutrient Enrichment	3	1	2	4	4	3	3	4	3	3
Fish Barriers	3	3	1	1	3	3	10	1	3	5
Fish Cover	6	3	3	8	5	3	3	8	5	5
Pools	3	3	5	4	4	6	5	7	4	5
Invertebrate Habitat	5	3	3	7	3	2	1	10	3	4
Canopy Cover	1	1	1	1	2	1	1	7	1	1
Manure Presence	2	2	3	5	3	1	5	4	3	3
Salinity	NA	NA	NA	NA	NA	NA	NA	NA	5	NA
Riffle Embeddedness	8	7	6	8	5	4	3	9	7	7
Macroinvertebrates Observed	3	2	0	10	7	7	6	8	7	6
Score	**4.1**	**2.8**	**3.2**	**4.5**	**3.6**	**3**	**4.5**	**6.7**	**4.7**	**4.2**
Rating	**Poor**	**Poor**	**Poor**	**Poor**	**Poor**	**Poor**	**Poor**	**Fair**	**Poor**	**Poor**

For explanation of table, please read below

In general, nearly all reaches surveyed scored in the lowest scoring category and were considered in *poor* condition. Since the SVAP contains scoring elements for a broad range of attributes associated with a stream's physical, biological, and chemical habitat it is a good screening tool in areas where there is an absence of monitoring data. For purposes of discussion several scoring categories have been singled out as important indicators of stream habitat conditions and the systems ability to support a viable fishery.

In the SVAP, "channel condition" is categorized by human altered streams (berms, dikes, riprap, channelization, etc.) and streams exhibiting excessive lateral cutting, incisement, or aggradation. Regardless of the particular activity or hydrologic effects to the channel, this rating addresses the level of channel alteration from a natural channel. The average score for channel condition for reaches on the San Pitch River was 3.7 (Poor). Nearly all the reaches had channels which were deeply incised, bermed, or rip rapped. As a result most reaches had a limited floodplain and steep eroding banks. The exception to this was Reach 8 which, despite being below a large diversion structure had a well developed floodplain and a natural channel that was well vegetated and protected from incisement by a stable channel bottom of cobble and boulder.

The scores for "riparian zone" reflect the extent to which the floodplain is vegetated (10 = at least 2 active channel widths on each side of stream) or denuded of natural vegetation (1= less than 1/3 channel width and/or not regenerating). For this element, the word *natural* means plant communities with (1) all appropriate structural components and (2) species native to the site or introduced species that function similar to native species at reference sites. The average score for the riparian zone for reaches on the San Pitch River was 3.9 (Poor). In all but a few cases, the majority of the river has very little natural vegetation on its floodplain, particularly areas where there is an absence of regeneration, heavy grazing pressure, and an incised channel, which has isolated the stream from its historic floodplain. Again, exceptions occur in the vicinity of reach 8 and 9 where there is a greater abundance of woody riparian vegetation.

“Bank stability” is the existence of or the potential for detachment of soil from the upper and lower stream banks and its movement into the stream. This element primarily incorporates bank height and deep-rooted vegetation for determination of scoring. The average score for bank stability for reaches on the San Pitch River was 3.2 (Poor). Since this element depends on the presence of deep-rooted plants, the lack of bank stability can be directly related to the absence of a natural or functioning riparian zone.

“Fish Cover” measures availability of physical habitat for fish. The potential for the maintenance of a healthy fish community and its ability to recover from disturbance is dependent on the variety and abundance of suitable habitat and cover available. The average score for fish cover for reaches on the San Pitch River was 5 (Poor to Fair). This average reflects a typical stream reach which would have approximately five types of fish cover, and for reaches on the San Pitch River these would typically include macrophyte beds, riffles, undercut banks, boulder/ cobbles, occasional deep pools and large woody debris.

Similar to fish cover, “invertebrate habitat” measures the number of substrates available for insects and invertebrates to occupy. Substrate refers to the stream bottom, woody debris, or other surfaces on which invertebrates can live. Optimal conditions include a variety of substrate types within a relatively small area of the stream. The average score for insect habitat for reaches on the San Pitch River was 4 (Poor), which would translate to approximately 3 types of substrate, comprised primarily of coarse gravel, cobble, and undercut banks.

“Riffle Embeddedness” measures the degree to which gravel and cobble substrate are surrounded by fine sediment. It relates directly to the suitability of the stream substrate as habitat for macroinvertebrates, fish spawning, and egg incubation. The average score for riffle embeddedness for reaches on the San Pitch River was 7 (Fair). This score is indicative of a system in which sedimentation from tributaries and bank erosion and hydro-modification (irrigation withdrawals) have resulted in high bed load of sediment and fines. Some areas exhibited higher levels of embeddedness than others, perhaps due to localized sources of sedimentation from streambank erosion. The overall system demonstrated the ability of moving bed load of sediment through the system.

Streambank Erosion

Streambank erosion was estimated while performing the SVAP survey applying the Stream Erosion Condition Index (SECI) to the streambank length and average bank height for each reach to determine the volume and mass of bank material lost each year. Results of this estimation are presented in Table 4.4.12. These estimates are based on an erosion hazard which is estimated from observed characteristics of the stream channel and streambanks. Although a method of estimation, it is a rapidly performed method of assessing the contribution of bank materials within a reach, and like the SVAP is a good tool for prioritizing areas of concern.

Table 4.4.12
San Pitch River Streambank Erosion Condition Inventory (June 2004)

Reach	Stream bank Length	Bank Height (ft)	Erosion Severity	LRR Index Value	Lateral Recession Rate (ft/yr)	Erosion Rate kg/year	Erosion Rate (tons/yr)
1	4794	3.5	**Moderate**	7.5	0.2	2071.9	**2.3**
2	8960	5	**Severe**	10.5	0.4	10189.6	**11.2**
3	8960	4	**Moderate**	7.5	0.2	4425.5	**4.9**
4	8279	5	**Moderate**	8.5	0.3	6415.3	**7.1**
5	5856	6	**Severe**	11	0.4	8694.9	**9.6**
6	12334	7	**Severe**	11.5	0.5	23163.2	**25.5**
7	6479	3	**Slight**	4.5	0.1	949.4	**1.0**
8	11104	3	**Slight**	1	0.0	106.1	**0.1**
9	10502	4.5	**Moderate**	8.5	0.3	7324.0	**8.1**
10	18364	5	**Severe**	13	0.6	30774.4	**33.9**
						Total	**103.7**

Erosion severity ranged from slight to severe, with approximately 40% of the reaches in the severe category contributing over 75% of the total stream bank erosion. Areas contributing the least erosion coincide with the reaches having the greatest abundance of woody vegetation and developed floodplain. Although it is difficult to assess the contribution of stream bank material to the total phosphorus load at the Crossing West of Mt. Pleasant, it is evident that stream bank erosion is a serious impact to water quality in the upper river, both to water quality and the instream habitat.

4.4.11 Total Phosphorus Sources

Currently, phosphorus loads in the upper watershed originate primarily from non-point sources, which include streambank erosion, animals waste, septic systems, and natural background. The homes in the city of Fairview and surrounding have historically been utilizing on-site systems for the disposal of wastewater. A new micro-filtration plant is under construction and will be on line by 2005. It is intended to serve approximately 560 Equivalent Residential Units (or ERUs) with a design flow (capacity of 375,000 gallons per day (gpd). This plant will likely result in a net decrease in phosphorous loads as older on-site systems are connected to sewers and their potential contributions of phosphorous minimized. Currently the Division of Water Quality is sampling a site located just upstream and downstream of the proposed Waste Water Treatment Plant (WWTP) discharge to determine the background concentrations and the potential impact of the plant. Data for those sites will become available in the near future.

Animal waste is another potential source of phosphorus to surface water in the San Pitch River. Information from the AFO/CAFO surveys performed by the NRCS and UACD in combination were obtained and a review of the locations of the animal feeding operations to the surface water and their relatively small size indicates that AFO's are not a significant source of the total phosphorus load in the river. Approximately 100 animals (horses, cattle, and sheep combined) were found to occupy corrals for 45 days or more in the upper watershed. Only 15 cattle were found to occupy an AFO adjacent to flowing surface water. The remaining animals in the upper watershed are primarily located in pastures adjacent to the river and its tributaries. Surveys of livestock adjacent to the upper San Pitch were provided by the local Watershed Coordinator and summarized for two reaches of the San Pitch River (*table 4.4.13*). The reach break at the U89 near

Fairview was chosen since this is a DWQ monitoring station and due to the water withdrawals which essentially separate the upper reach from the lower reach which extends down to the U116 crossing west of Mt. Pleasant. Literature values for phosphorus content of manure were used to calculate the gross production of TP from cattle (NRCS 1999), to which an assumed delivery ration of 10% was applied to estimate the contribution of the total load to the river (Koelsch and Shapiro 1997).

Livestock are listed in table 4.4.13 as the total number of animals in each reach (cows, horses, sheep, etc.) and phosphorus loading for each type of livestock was adjusted based on animal production of phosphorus and animal weight. Overall, phosphorus loading to the stream from livestock in Reach 2 was approximately 25% of the total yearly load measured at station 494975 (1066 kg/year). Loads in Reach 1 upstream of station 494679, although higher due to greater animal numbers, are not reflected in the stream loads since the stream is diverted much of the year. In addition to grazing in or near stream channels are contributions of phosphorus from streambank erosion, which occurs as a result of bank instability, the lack of deep-rooted vegetation, and flow events. In October of 2003 and June 2004, stream surveys utilizing the Stream Visual Assessment Protocol (SVAP) were completed on reaches of the upper watershed between Fairview and the U116 crossing west of Mt. Pleasant (see figure 10). Results of the contribution of sediment from streambank erosion are discussed above.

Table 4.4.13 Phosphorous Numbers

Reach	**Livestock #s**	**TP Load(Kg/year)**
1 (upstream of 494679)	1964	307
2 (upstream of 494975)	1793	264
Total	3757	571

4.5 Biological Environment

4.5.1 Wildlife

San Pitch River Watershed supports a diverse wildlife community. Year around habitat exists throughout all or part of the watershed for elk, mule deer, etc. The watershed's riparian corridor provides habitat for many migratory birds. Sanpete County's wildlife according to DWR includes, but is not limited to:

1	Band-tailed Pigeon
2	Blue Grouse
3	Elk
4	Moose
5	Mule Deer
6	Ruffed Grouse
7	Black Bear
8	Cougar
9	Bobcat
10	Black-tailed Jackrabbit
11	Cottontail Rabbit

There are also historic documents that Sage Grouse inhabited Sanpete County.

4.5.2 Aquatic Life

DWR has classified most of the San Pitch River Watershed and its tributaries according to their ability to produce sport fish and other aquatic life (DWR, ~1980). Fish species present in the San Pitch River include: Rainbow Trout (RT), Bonneville Cutthroat Trout (CTBV), Brown Trout (BN), Brook Trout (BK), Carp (CC), Leatherside Chub (CBLS), Red Side Shiner (SKMT), Speckled Dace (DCSP), Mountain Sucker (SKMT), Mottled Sculpin (SCMT), which are all mentioned in Table 4.5.1 and their locations. This table also summarizes the San Pitch River and it's tributaries for species, stream classification, and fishery type as the following:

Stream Classification:

1 Blue ribbon trout stream, high productivity, aesthetics, and accessibility.

2 Excellent trout streams, they lack only one element compared to class 1

3 Support the bulk of stream fishing pressure in Utah
3B Spawning and nursery habitat
4 Typically poor in quality with limited sport fish
5 Of little value to sport fishery
6 Dewatered for significant amount of time.

Table 4.5.1: San Pitch River Watershed Stream and Species Classification (See map 4 for watershed tributaries)

Stream	Stream Reach	Miles	Class	Species
San Pitch River	Sevier River-Div. E. Gunnison	5.7	6	
San Pitch River	Div. E Gunnison-Gunnison Res.	7.5	4	CC,CBLS,DCSP,SRRS,SCMT
San Pitch River	Gunnison Res.- Br. W Manti	2	4	CC
San Pitch River	Br. W Manti-Div. 1mile E U132	22.5	6	
San Pitch River	Div. 1mile E U132-s Spring Cr.	9.8	3	RT,BN,BK,SCMT,CBLS
San Pitch River	S. Spring Creek-Milburn	5.8	3B	RT,BN,BK
San Pitch River	Milburn- Div. 1mile N	1	6	
San Pitch River	Div.- N Fk. San Pitch River	3	3	CTBV,SCMT
Twelve Mile Creek	San Pitch - Gunnison Canal Div.	0.9	6	
Twelve Mile Creek	Gunnison Canal Div.-N, S Fk.	7.8	4	RT,BK,SCMT
N Fk. Twelve Mile Creek	Twelve Mile Creek- HW	5.8	4	RT
S Fk. Twelve Mile Creek	Twelve Mile Creek- HW	5.8	4	RT,CTBV
Six Mile Creek	San Pitch- Beaver Creek	8.8	4	RT,CTBV
Six Mile Creek	Beaver Creek- HW	5.5	4	RT,CTBV,BK
S Fk. Six Mile Creek	Six mile Creek- HW	4	4	
Manti Creek	San Pitch- Div. 250 E 1st S. Manti	4.4	6	
S. Fk. Manti Creek	Manti Creek- HW	3.5	3	CTBV
N Fk. Manti Creek	Manti Creek- HW	3.9	4	CTBV
Willow Creek	San Pitch- Div. Canyon Mouth	5	5	
Willow Creek	Div. Canyon Mouth-HW	5.6	5	
Ephraim Creek	San Pitch- 2nd W. 1st N Ephraim	5.3	6	
Ephraim Creek	2nd W 1st N Ephraim- HW	8.6	4	CTBV,RT,BK
New Canyon Creek	Ephraim Creek- HW	4	4	
Oak Creek	San Pitch-U30 Spring City	7	6	
Oak Creek	U30-Power Plant	3.9	4	RT,CTBV,BN,BK
Oak Creek	Power Plant Div- HW	4.1	4	
Canal Creek	Oak Creek- Div. Canyon Mouth	6.5	6	
Canal Creek	Div. Canyon Mouth-HW	7.2	4	
Cedar Creek	San Pitch- HW	1	3	RT,BN,BK
Pleasant Creek	San Pitch-Power Plant	7	4	RT,BK
Pleasant Creek	Power Plant- HW	4.8	4	RT
Coal Fork Creek	Pleasant Creek- HW	2.1	4	BK
Cove Creek	San Pitch River- HW			
Birch Creek	San Pitch- Div. Shares Dev.	4.2	6	
Birch Creek	Div. Shares Development- HW	5.3	3	RT,CTBV,BN
S. Fk. Birch Creek	Birch Creek- HW	3.6	3	RT,CTBV,BN,BK

S. Spring Creek	San Pitch- HW	1.3	3	RT,CTBV,BN,BK,SCMT
Cottonwood Creek	San Pitch- Div. 4th S. Fairview	1.2	6	
Cottonwood Creek	Div. 4th S Fairview-HW	5	3	RT,CTBV,BN,BK
L Fk. Cottonwood Creek	Cottonwood Creek- HW	1.8	4	RT,CTBV,SCMT
Oak Creek	SR-Div. Canyon Mouth	2	6	
Oak Creek	Div. Canyon Mouth- HW	7	3B	RT,CTBV
Dry Creek	Div. Canyon Mouth- HW	1.5	6	
Silver Creek	Wales Res.- HW	1.5	4	CC,SKMT
Fountain Green Creek	Div.- HW	1.1	4	RT,CTBV

Species found in impounded (lakes and reservoirs) waters in the San Pitch River Watershed include: Rainbow Trout (RT), Bonneville Cutthroat Trout (CTBV), Brown Trout (BN), Brook Trout (BK), Channel Catfish (CF), Black Bullhead (BB), Carp (CC), Utah Chub (CBUT), Largemouth Bass (BSLM), Bluegill (SFBG), and Yellow Perch (PYCL). The following table (4.5.2) summarizes all the impounded water bodies, with their species identification, and water quality classification:

Table 4.5.2 San Pitch River Watershed Impounded Waters and Species Classification

Impounded Waters Section	Fishery Type	Species
Beaver Dam Reservoir	Cold Water	RT,CTBV,BK
Blue in the Corner	Cold Water	RT,CTBV,BK
Community Lake	Cold Water	RT
Deep Lake	Cold Water	RT
Fairview Reservoir	Cold Water	RT,BK
Gunnison Reservoir	Warm Water	CF,CC,CBUT,BSLM,SFBG,PYCL
Island Lake	Cold Water	CTBV
Logger Lake	Cold Water	RT,BK
Loveridge Flat Pond	Cold Water	RT,CTBV,BK
New Canyon Reservoir	Cold Water	RT
Nine Mile Reservoir	Cold Water	RT,CTBV,BN
Palisade Reservoir	Cold Water	RT
Lower Pete's Reservoir	Cold Water	RT,CTBV,BK
Shingle Mill Reservoir	Cold Water	RT,CTBV,BK
Strate Pond	Cold Water	RT,BK,BB
Towne Reservoir	Cold Water	RT,BK,CBUT
Twin Lake	Cold Water	RT,BN,BK
Yearns Reservoir	Cold Water	RT

4.5.3 Vegetation

There are five general vegetation types that occur within the San Pitch River Watershed from the mountain plateaus that are located above 8,000 feet and receive 20-35 inches of precipitation annually; to the valley floors that receive less than 8 inches of precipitation annually.

Conifer-Aspen forests are found on mountain slopes with elevations over 8,000 feet that receive 20-35 inches of precipitation annually. These forests contain mostly white fir, douglas fir, ponderosa pine, spruce, and quaking aspen; these are primarily snags. On steep slopes with elevations ranging from 7,500 to 8,500 feet and 18-25 inches precipitation annually, the prominent vegetation consists of mountain brush including gamble oak, serviceberry, and curlleaf mountain mahogany. In the foothills that occur at elevations ranging from 5,000 to 7,500 feet and receive 10-20 inches of precipitation annually pinyon pine and juniper trees lend a forest aspect. Here the prominent vegetation types include pinyon pine and Utah juniper with scattered areas of brush, grasses, and forbes. Throughout the watershed, sagebrush is found at nearly every elevation and range of precipitation on deep, well drained soils. A wide variety of grasses, browse, and forbes are found within the predominant big sagebrush. At elevations from 4,500 to about 5,000 feet, where precipitation ranges from 8-10 inches, grass and the northern desert shrub are found.

Other types of important vegetation include Indian ricegrass, needle and thread grass, winterfat, black greasewood, and shadscale. Most of these are found in the low lands where soils are affected by salts. In addition, barren areas include desert playas, recent extrusions of volcanic basalt, and areas covered predominantly with annual weeds such as pickleweed and gray Molly (Utah Division of Water Resources, 1999).

Robinson (1971) estimated the phreatophytes in Sanpete Valley, principally saltgrass, wiregrass, greasewood, and rabbitbrush, in the mid-1960s to cover about 45,200 acres in an area southwest of Manti. In this area the Sanpete Valley narrows and is constrained by bedrock outcrops which impede most groundwater flow out of the valley (Snyder and Lowe, 1998; Wilberg and Heilweil, 1995; Robinson, 1971). In this area, confined groundwater is forced to the surface and forms a large marshy area extending as far north as Manti, about 2 miles north of the north end of Gunnison Reservoir (Snyder and Lowe, 1998; Wilberg and Heilweil, 1995; Robinson, 1971).

A 1997 census of agriculture by the US Department of Agriculture (USDA, 1997) indicates that the top 5 crop commodities in Sanpete County are: hay crops (51,313 acres), barley (7,304 acres), corn for silage (1,855 acres), wheat (1,097 acres), and oats (523 acres).

4.6 Human Environment

4.6.1 Population / Land Ownership

Nearly all of the land within the San Pitch River Watershed is presently used for some designed activity and most areas have several concurrent uses. The primary land uses in Sanpete County are grazing and agriculture. Sanpete County has 1,022,609 total acres. According to 1999 survey by the Utah Department of Community and Economic Development, Sanpete County contains approximately 528,591 acres of federal land (52%), 434,105 acres of private land (42%), and 59,914 acres of state land (6%). There are 94,000 acres of irrigated cropland in Sanpete County (Utah Division of Water Resources, 2002); most irrigated cropland is in the central portions of the Sanpete and Arapien Valleys. Most of the cropland is irrigated by flood methods (55%), with the remaining irrigated with sprinklers (Utah Division of Water Resources, 2002). The county is rural with the population estimated at 22,763 in 2000 (GOPB, 2000). It is interesting to note that the population has essentially remained the same since the turn of the century when the population was estimated at 16,313. However, it has been growing since 1990 and is expected to continue growing throughout the next few decades. The annual rate of population growth is expected to be about 1.8 percent. Ephraim is the major population center in Sanpete valley with 4,505 people (GOPB, 2001).

According to the General Plan of 1997, 25% of public lands are used for grazing cattle, 15% used for sheep, and 8% are used for both sheep and cattle grazing.

4.6.2 Land Use / Water-Related Land Use

The primary land use along the Upper San Pitch River is agriculture, including grazing pasture, animal feeding operation, hay land, and turkey production.

Early in its history, sheep ranching produced some of the County's most prominent economic gains. Cattle, feed grains, dry land farming, and dairying have contributed to Sanpete agricultural production. During the past fifty years, turkey ranching has grown each year and Sanpete is now one of the top three turkey producing areas in North America.

Water is vital to the residents and semi-arid farmlands of central Utah. With the exception a few prolific springs located in the foothill areas and selectively developed well waters, most the water in Sanpete County flows from numerous natural springs and catchment basins located in the mountains which border the principal valley areas of the County. Current uses of the river and its tributaries include irrigation diversion, with much of the water in the San Pitch and its tributaries diverted through irrigation canals. Fishing and recreation are important in the upper reaches. The river floodplain is used intensively for agricultural purposes; for animal watering and pasture and as irrigated and non-irrigated cropland.

Grazing is primarily unrestricted in the stream channel and has resulted in stream bank erosion and habitat degradation. Although much of the area is under sprinkler irrigation, flood irrigation is common and can contribute sediment and animal waste when fields are flooded. In addition to turkey waste, corrals located on or near live water is also a source of phosphorus in the upper watershed.

4.7 Surface Water Hydrology

Approximately 11,000 acre feet per year (acre-ft/yr) of water from the Colorado River Basin are brought into the San Pitch River drainage basin via 13 tunnels and ditches (Wilberg and Heilweil, 1995). The amount of transbasin diversions represents less than 10 percent of the cumulative average annual streamflow (Wilberg and Heilweil, 1995). Major transbasin diversions include the Ephraim, Fairview, Manti, and Spring City tunnels; some of this water is from Fairview Lakes and Lower Gooseberry Reservoir (Wilberg and Heilweil, 1995). An additional transbasin diversion, the Narrows project, is planned to bring supplemental water supply to water users in north Sanpete County, Utah.

Most surface water inflow in Sanpete Valley is diverted for irrigation purposes. The flow of the San Pitch River is managed according to the 1936 Cox Decree, which sets forth all the water rights for the Sevier River system. There is a general difference in irrigation practices in the middle and lower San Pitch River. The majority of irrigation water that is diverted from the middle San Pitch River is distributed to pastures and fields by means of flood irrigation methods. Irrigation water that is diverted from the lower San Pitch River is distributed to fields via sprinklers. The diversion locations are listed in (Table 4.7.1).

Table 4.7.1 Division of Water Rights Gauging Stations

SEGMENT	DIVERSION
Middle San Pitch River	Upper Rock Dam
	Lower Rock Dam
	Bagnal Canal
	West Point Canal
	East Drainage Canal
	West Drainage Canal
	San Pitch River West of Manti
Lower San Pitch River	San Pitch River Below Old Field Canal
	Old Field Canal

4.7.1 Middle San Pitch River- Water Budget for Typical Year

Water diverted from the middle San Pitch River is used to flood irrigate croplands and pastures, and for stock watering. There are some sprinkler irrigation systems in this area; however, the water that supplies these systems comes almost entirely from wells, not from the San Pitch River. The irrigation season in the watershed is usually from March 1st to September 30th. The first flush from low elevation snowmelt in Sanpete Valley occurs in February, a second flush, from higher elevation snowmelt, occurs in May. The northernmost diversion on the middle San Pitch River is Upper Rock Dam. At this location the Moroni Wastewater Treatment Plant (WWTP), a combined plant serving the City of Moroni and the Moroni Feed Co., discharges effluent into the San Pitch River. This discharge mixes with the San Pitch River water below Upper Rock Dam and most of this water is taken out of the river at Lower Rock Dam. To measure flow, flow gages are present at the Upper and Lower Rock Dam diversions.

Silver Creek and the San Pitch River mingle below the Rock Dam diversions. There is no flow gage on Silver Creek and, therefore, no flow record. The Water Commissioners commented that Silver Creek generally flows between the months February and June. Below the confluence with Silver Creek are the Bagnal and West Point Canal diversions. These are total diversions and the water diverted at the Bagnal diversion is used to flood pastures, and the water diverted at the West point diversion is used to flood croplands. Flow gages are present at the Bagnal and West Point Canal diversions. Flood irrigation return flows are collected back in the San Pitch River following flooding from the Bagnal and West point diversions. Further down river, water in the San Pitch River is totally diverted at the Ephraim Olsen and Price diversions; unfortunately, there are no gages on the Ephraim Olsen and Price diversions.

At river mile 32, spring water from Johnson Spring flows into the San Pitch River with an average seasonal flow of 0.7 cubic feet per second (cfs). Farther south, water is diverted from the San Pitch River at the East Drainage Canal diversion. Adjacent to the East Drainage Canal is the West Drainage Canal, which was created along the original route of the San Pitch River. Along this reach, the San Pitch River was originally quite shallow and braided, and the West Drainage Canal was excavated deeper than the river bottom to more efficiently direct flows through this section. The East and West Drainage Canals are the last diversions on the middle San Pitch River.

Although there is no surface water tributaries that contribute flows to the middle San Pitch River between monitoring station STORET 494654 "San Pitch River-NW Manti" and STORET 494645 "San Pitch River-W Manti", flow data in the STORET database indicate that the river is generally gaining flows through this segment. The Water Commissioners indicated that flow contributions could be attributed to return flows from upstream irrigation. Robinson (1971) conducted seepage runs on the San Pitch River in 1966 and determined that two of the major areas of surface water gain from groundwater were located above the bridge west of Ephraim (near the West Drainage Canal diversion), and within a phreatophyte patch north of Gunnison Reservoir (near STORET 494645). Seepage runs conducted by Sandberg and Smith (1995) between Moroni and Gunnison Reservoir showed two gaining sections and one losing section of the San Pitch River. The two groundwater discharge areas (gaining sections) on the San Pitch River are from Moroni to Wales (gain of about 1.8 cubic feet per second) and from west of Ephraim (near the West Drainage Canal, about 2 miles north of STORET 494654) to Gunnison Reservoir (gain of about 0.9 cubic feet per second). Between these gaining sections, the water loss to groundwater is from 0.2 to 0.4 cubic feet per second (Sandberg and Smith, 1995).

Currently, flow data for the middle San Pitch River are available from only two flow gauging stations. Both gauges are continuous recorders and are located at the West Drainage Canal diversion and the San Pitch River West of Manti diversion. Although these locations are referred to as diversions, water is not diverted from the San Pitch River at these locations.

4.7.2 Lower San Pitch River-Water Budget for Typical Year

The lower San Pitch River Watershed section begins at the south end of the Gunnison Reservoir impoundment. During the irrigation season, all of the surface water released at the south end of Gunnison Reservoir is diverted to Highland Canal by way of Six Mile Creek. Sources of water to Highland Canal include Gunnison Reservoir, Six Mile Creek, and Twelve Mile Creek. On Six Mile Creek there is a flume that crosses Highland Canal before the confluence with the San Pitch River. This flume only transports water to the San Pitch River via Six Mile Creek when there is overflow. Otherwise, the water in Six Mile Creek is diverted to Highland Canal. Nine Mile Reservoir is located east of Highland Canal. Water stored in Nine Mile Reservoir is released for irrigation purposes between June 15th and September 1st. At the south end of Highland Canal, there is a flume that transports water in Highland Canal over Twelve Mile Creek. The water in Twelve Mile Creek is completely shut off at this point during most of the year, except for when there is overflow. This type of overflow generally occurs for about six weeks each year.

Flows that emerge in the San Pitch River below the Six Mile Creek/Highland Canal diversion are essentially from spring sources. However, some snowmelt runoff enters the river below this point between May 15th and mid-June.

Southwest and down river of Highland Canal is Old Field Canal. Old Field Canal was constructed in the 1800's and is possibly the oldest diversion in the watershed. Old Field Canal is a total diversion of water from the San Pitch River. A gauging station is located at the beginning of the Old Field Canal diversion. The Water Commissioners commented that the flows in Old Field Canal are representative of the flows in the San Pitch River above the diversion for Old Field Canal. Therefore, the flows recorded in Old Field Canal were used to reasonably estimate the flows in the San Pitch River above the Old Field Canal diversion.

One gauging station existed on the lower San Pitch River "San Pitch River at Old Field Canal" (also referred to as "San Pitch River below Old Field Canal"). However, the gage was moved from the river in 1994 (DWRt diversion flow records, 2001) and flows are estimated. Estimated and measured flow data for the lower San Pitch River are also available from STORET station 494615 "San Pitch River 2 miles east of Gunnison at U137 crossing".

4.8 Groundwater Hydrology

Groundwater in the Sanpete Valley area occurs in two types of aquifers: fractured bedrock and unconsolidated deposits. Groundwater in the Sanpete Valley area is obtained principally from unconsolidated deposits of the valley-fill aquifer (Wilberg and Heilweil, 1995). However, fractured-rock aquifers are important sources of water in Sanpete Valley; they yield water to springs and some wells in Sanpete Valley (Wilberg and Heilweil, 1995).

Groundwater in the valley-fill aquifer of Sanpete Valley occurs under confined and unconfined conditions in unconsolidated deposits (Robinson, 1971). Based on water-well data, the thickness of unconsolidated fill is estimated to be at least 500 feet in the widest part of Sanpete Valley, between Ephraim and Moroni (Robinson, 1971). According to the Sanpete Valley Utah Geological Groundwater Survey, TDS concentrations for wells tested for general chemistry range from 234 to 2,752 mg/L. By area, 66.5 percent of the aquifer is classified as class 1A (Pristine), 32 percent is classified as class 2 (Drinking Water Quality), and about 1.5 percent is classified as class 3 (Limited Use). Elevated levels of TDS concentrations in groundwater are largely attributed to proximity to outcrops of the Arapien Shale and the Green River Formation. The average nitrate concentration for groundwater in the valley-fill aquifer is 3.3 mg/L. Of the water wells analyzed for nitrate, 86.5 percent yielded values less than 5 mg/L, and only 3.5 percent exceeded Utah drinking-water standards for nitrate and are considered high nitrate wells. Many residents use septic tank soil absorption systems for wastewater treatment. Septic-tank effluent, agricultural fertilizers, and animal wastes from feed lots and turkey farms are potential sources of nitrate, the principal groundwater contaminant identified.

Two groundwater reservoirs including the Sanpete Valley Reservoir and the Redmond – Gunnison Reservoir affect the San Pitch watershed (Robinson, 1971). The Sanpete Valley Groundwater Reservoir underlies almost the entire extent of the watershed from headwaters to the southern end of Gunnison Reservoir. Storage in the upper 200 feet of valley fill in Sanpete Valley is estimated at 3,000,000 acre-ft, and withdrawals from the Sanpete Valley Groundwater Reservoir are estimated at 6,300 acre-ft/yr (Wilberg and Heilweil, 1995). The Redmond – Gunnison Groundwater Reservoir underlies the southern extreme of the watershed including Nine Mile Reservoir. Storage in the upper 200 feet of alluvial fill is estimated to be 150,000 acre-ft. Withdrawals are estimated at 4,500 acre-ft/yr (4,200 for irrigation and the balance for industrial and municipal purposes).

Four sources of recharge to the groundwater reservoir have been estimated by Wilberg and Heilweil (1995) including: 1) tributaries, 2) seepage from the San Pitch River, 3) deep percolation of unconsumed irrigation water, and 4) precipitation. Recharge from tributaries occurs where the streams flow across alluvial fans. The estimated loss is between 9 and 39 percent. Seepage from the San Pitch River varies through its length.

About 116,900 acre-ft/yr of water is used for irrigation in Sanpete Valley above Gunnison Reservoir (Wilberg and Heilweil, 1995). Groundwater recharge from percolation of unconsumed irrigation water was estimated to average 29,000 acre-ft, which is 25% of the applied irrigation water (range and average values were not estimated).

Precipitation is also a significant part of the recharge to the groundwater reservoir. Based on other studies in Utah, Wilberg and Heilweil estimated recharge due to precipitation at 10 percent of the annual precipitation. Groundwater recharge is variable through the year and between years, but is estimated to average from 74,000 to 103,000 acre-ft/yr (Table 4.8.1).

Table 4.8.1 Sources of Groundwater Recharge

Recharge Source	Estimated Averages (acre-feet per year)
Tributaries	28,500 - 57,000
Seepage from the San Pitch River	1,500 - 1,800
Percolation of Unconsumed Irrigation Water	29,000
Precipitation	15,000
Total	74,000 - 102,800

Groundwater is discharged from the valley-fill aquifer by 1) evapotranspiration, 2) seepage into the San Pitch River, 3) withdrawals from wells, and 4) spring discharge (Wilberg and Heilweil, 1995). Groundwater discharge also varies seasonally and yearly and is estimated to average from 76,000 to 224,000 acre-ft/yr (Table 4.8.2)

Table 4.8.2 Sources of Groundwater Discharge

Discharge Source	Estimated Averages (acre-feet per year)
Evapotranspiration	41,000 - 116,000
Seepage into the San Pitch River	18,500 - 80,300
Withdrawals from Wells	5,500 - 16,800
Springs	11,000
Total	76,000 - 224,100

The primary source of water for irrigation is surface water; however, groundwater is pumped when surface water supplies are inadequate. Groundwater withdrawals from wells are from pumped and flowing wells. Nearly all of the groundwater from well withdrawals is applied as irrigation water in Sanpete Valley (Wilberg and Heilweil, 1995). The average amount of well withdrawals was estimated at 10,300 acre-ft/yr and includes 6,300 acre-ft/yr of water from pumped wells, and 4,000 acre-ft/yr of water from flowing wells (Utah Division of Water Resources, 1999). Artesian wells drilled through valley sediments into limestone and sandstone of the Green River Formation are an important source of irrigation water near Manti (Snyder and Lowe, 1988). Groundwater from wells in the Green River formation has yielded water that is saline and not suitable for culinary use (Robinson, 1971). Southwest of Manti (near STORET 494645) the Sanpete Valley narrows and is constrained by bedrock outcrops which impede most groundwater flow out of the valley (Snyder and Lowe, 1998; Wilberg and Heilweil, 1995; Robinson, 1971). In this area, confined groundwater is forced to the surface and forms a large marshy area extending as far north as Manti, about 2 miles north of the north end of Gunnison Reservoir (Snyder and Lowe, 1998; Wilberg and Heilweil, 1995; Robinson, 1971). Therefore, the only outlet for this groundwater is the San Pitch River.

The valley-fill aquifer is the principal source of drinking water for residents of Sanpete Valley, although springs along the valley margins are also used as a drinking water source. Preservation of good ground water quality is a critical issue for land-use planning and resource management in Sanpete County. Numerous naturally occurring springs are located below Gunnison Reservoir. These springs were considered as a potential TDS source to the lower San Pitch River. Within the Sanpete Valley, groundwater TDS range from about 500-600 mg/L in the Fairview- Mt. Pleasant area and to about 1,000 mg/L below Chester and Gunnison Reservoir. Nitrate concentrations are also a problem in some areas.

5.0 MAJOR PROBLEMS/ ISSUES/ OPPORTUNITIES

5.1 Pasture Reseeding and Grazing

Pastures in the San Pitch River Watershed fall into two basic categories. The first category is low elevation pastures that are a mixture of native and introduced grasses that have a high water table and are flooded by spring runoff. The second category is pasture ground that consists of irrigated ground that is improved varieties. The pastures act as a buffer to the river, by filtering runoff before it reaches the river. The pastures also increase the water holding capacity of the flood plain. This is important for maintaining the water tables and supporting season long growth of vegetation. Invasive weeds and annuals have decreased production and cover on these areas. Livestock in some instances have been allowed to over graze. Some irrigation practices also cause soil erosion on fields. Many of the soils have a high Total Dissolved Solids (TDS), and can contribute sediment and nutrients to the stream where pastures are in poor condition. The opportunity exists to improve the vegetative cover and management of these pastures through seeding and pasture management practices.

5.2 Rangeland Seeding and Grazing

There is about 468,987 acres of rangeland within the San Pitch Watershed and its Sub-watersheds. Improper livestock grazing, drought, and other practices have caused a decline in rangeland vegetation condition and cover. This vegetation decline means diminished soil protection allowing more soil erosion from these sites.

Invasive woody species such as Juniper, sagebrush, rabbit brush, and greasewood are suppressing areas better suited for grass, forbs, and shrub mixes. Areas invaded by woody species are yielding excessive erosion of top soil and decreasing the soils water holding capacity. Vegetative cover has declined or changed in species composition in areas overgrazed by wildlife or livestock. Many of these areas have degraded because of drought conditions and insect infestations. Approximately 12,461 acres have soils with high Electro Conductivity values (**see map 8**) (salt), and include soils that are naturally high erodible (Soil tolerance of 1) (**see map 9**). The opportunity exists to improve these areas through Best Management Practices that will improve vegetative cover and composition, and the management of these lands through proper grazing use and wildlife management.

Allowing landowners to drill wells for stock water on dry rangeland will increase grazing management practices. When water is present, landowners can fence smaller grazing areas and rotate cattle and sheep to prevent over grazing. Rotating animals and not over grazing will help increase water quality and also improve rangeland vegetative health.

Stream bank instability can be an indicator of poor channel and riparian vegetation.

5.3 Riparian/ Stream Restoration

For streams to function properly, their individual components must be present and working. The channel must be properly configured for the stream to adequately transport its sediment load without too much deposition or erosion occurring. Riparian vegetation must be present and of substantial quantity and quality to anchor stream banks and filter incoming runoff.

Stream bank instability can be an indicator of poor channel and riparian condition. Unstable stream banks are prone to erosion and contribute a disproportionately high amount of sediment to the stream system.

Woody plant species and late seral herbaceous species are lacking along many of the San Pitch River corridors. Where woody plant species are present, willows and cottonwoods, young plant growth are not rapid enough to continue the spread for stream bank stability. Bank erosion along the river has resulted in higher width/depth ratios along many stream corridors and increased head cuts on the upstream ends.

In areas where the stream channel has been straightened or in some other way altered, water velocity increases and vegetation is disturbed, resulting in higher erosion rates. Channel alteration also reduces the amount and quality of fish habitat within the channel. By improving altered reaches to increased sinuosity and applying BMPs, water quality, stream corridor condition, riparian condition, and habitat condition will improve.

Irrigation distribution systems and return flows can also contribute to channel instability and stream bank erosion. Changes in irrigation management and systems can reduce these impacts. With irrigation technology and improvement, it will help with management of soil moisture to promote desired crop response, optimization use of available water supplies, minimize irrigation induced soil erosion to decrease non-point source pollution of surface and groundwater resources, manage salts in the crop root zone, and manage air, soil, or plant microclimate.

The Division of Wildlife Resources has designated the upper portion of the San Pitch River a priority for stream bank restoration projects. The upper portion of the river includes everything north of road crossing U-116 in Moroni. This section is perennial and is ideal for cold water fish species, wildlife, and is most feasible to improve proper stream function.

The lower portion of the San Pitch River, section south of U-116 road crossing, is not economically feasible to improve proper stream function. This section of the stream is intermittent, is lacking in riparian vegetation, and wildlife habitat. All the water is diverted during the irrigation season. Because of the dry stream beds, riparian vegetation is hard to establish. Most areas have greatly incised stream banks and no existing flood plain for the water to dissipate its energy. In order for the stream to reach a flood plain the entire lower section of the San Pitch River's stream bed needs to be raised significantly. The stream is constantly changing and restoration efforts are not cost effective.

5.4 CNMP/ AFO-CAFOs

Animal feeding operations in the watershed have the potential to contribute excess nutrients to surface and groundwater. Excess nutrients can be delivered directly or indirectly to the stream by runoff.

Currently, there is a non-partisan partnership between: Utah Farm Bureau, Utah Association of Conservation Districts, Utah Ag. Commodity Groups, Utah Department of Ag. and Food, Utah Dept. of Environmental Quality, Utah Division of Water Quality, and the US EPA. The Utah Clean Water Initiative is a statewide effort to identify and help mitigate animal feeding operations that are affecting water quality. The goals of the Utah Clean Water Initiative are to: restore and protect the quality of waters for its beneficial uses, maintain a viable and sustainable agricultural industry, and keep the decision making process on these issues at the state and local level. This is a voluntary incentive-based approach, so that other regulatory methods are used only for the largest facilities or where voluntary methods over time fail to solve pollution problems. By reducing the runoff from animal feeding operations, water quality will be improved and state and federal mandates will be met. Some options to help mitigate pollution include runoff containment facilities, land spreading of manure, anaerobic and aerobic treatment of collected wastes in lagoons or oxidation ponds, composting, retail marketing, gas extraction, and or combining these methods, etc.

Sanpete County has 8 dairy, 41 feedlot, 47 poultry and 27 other Animal Feeding Operations (AFO's); 6 dairy, 6 feedlot, 2 poultry, and 2 other Potential Confined Animal Operations (pCAFO's); 1 dairy, 1 feedlot, 5 poultry, and 1 other permitted Confined Animal Feeding Operations.

Corral on the San Pitch River

5.5 Groundwater – Aquifer Classification

Sanpete County Commissioners have petitioned to the water quality board to prepare aquifer classification within the county. To implement best management practices (BMP's) in the San Pitch River watershed, the Utah Geological Survey prepared groundwater quality classification maps based on the data collected.

Aquifer classification is a planning tool for local governments to use in making land-use management decisions. It establishes a bench march of groundwater quality and classes of water use for protection against degradation. It allows local governments to use potential impacts on groundwater quality as a reason for permitting or not permitting a proposed activity or land use based on the differential protection policy.

Since Aquifer classification and Source Protection plans are similar in design, both plans within Sanpete County will be considered before any land management decisions will begin.

5.6 Source Water Protection

Source water is untreated water from streams, rivers, lakes, or underground aquifers which is used to supply private wells and public drinking water. The Source Protection Plan is intended to alert water systems to sources of potential contamination near their drinking water sources. The source water protection plans have already been compiled for the Sanpete County areas of Camperworld, Ephraim, Fairview, Fountain Green, Gunnison, Heartland, Manti, Mayfield, Moroni, Mt. Pleasant, Palisade Lodge, Palisade State Park, Pine Creek, Skyline, Spring City, Sterling, and Wales. The plans include a delineation section, an inventory of potential contamination sources, an assessment of potential contamination source hazards, a management program for existing potential contamination sources, a management program for future potential contamination sources, an implementation schedule, a resource evaluation, a recordkeeping section, and a section regarding pesticide and volatile organic chemical monitoring values. A contingency plan for the water system is also included in the report. A management program to control or prohibit any future pollution sources to be located within the management area of the water sources has also been prepared.

The source water protection plan is to alert water systems to sources of potential contamination near their drinking water sources. Recommendations are provided to assist the systems in minimizing the risks of contamination. The delineation of the protection zones assumes average aquifer characteristics, and uses the local topography to estimate the groundwater flow direction. The delineation will include local aquifer conditions and geology, since the data is being gathered in 2005. The EPA groundwater modeling program was used to model the groundwater protection areas (EPA 2004).

ATV's are very popular in Sanpete County for recreational purposes

5.7 Recreation / Public and Private Lands

The Sanpete County area attracts recreation users for a variety of purposes including ATV or mountain bike riding, hiking, camping, fishing, hunting, golfing, boating, and site seeing. People are drawn to the open land from nearby urban areas. Sanpete County is beautiful, and is home to diverse wildlife.

As the population of nearby urban areas grows, demand for recreation in Sanpete County grows as well. With the increase for recreation, private landowners deal with recreating public who do not respect the rights of privately owned land. There is an increasing need to educate the local and urban public about property rights and responsibilities for use. There is also a need to preserve existing private access and to work cooperatively with private landowners in obtaining or allowing access to and across private land for recreation activities.

The majority of land mass is owned by government entities and provides substantial recreation opportunities.

5.8 Narrows Project

The Sanpete Conservancy District currently has a plan to bring additional water into the basin through the Narrows (Gooseberry) Project in Sanpete County. A Draft Environmental Impact Statement was issued in March 1998 with public hearings in April 1998. The primary purpose of the Narrows Project is to supplement irrigation and municipal & Industrial (M&I) supply source for users in north Sanpete County via pipelines that will be constructed to deliver water to existing water distribution systems (USDI - BOR, 2001). This additional water is not expected to add surface flow to the San Pitch River below Moroni. The project includes a dam and reservoir on Gooseberry Creek with a capacity of 17,000 acre-feet of which 14,500 acre-feet would be active storage. Pipelines would deliver 5,400 acre-feet annually, of which 4,900 acre-feet is for supplemental irrigation of 15,400 acres of irrigated land in Fairview, Mt. Pleasant, Spring City and Moroni and 500 acre-feet is for municipal and industrial use.

The project would include realigning about one mile of State Road 264. Recreation facilities would be built around and in connection with the proposed reservoir. There will also be measures mitigating the fishery, wetlands and wildlife values that might be adversely impacted by the project.

Battles on whether to build the reservoir have been going on for decades. Recently the U.S. Forest Service proposed to designate Gooseberry Creek as a “wild and scenic river” which would have negatively impacted the project. In October of 2004, the U.S. Forest Service decided Gooseberry Creek was ineligible for “wild and scenic river” designation allowing for the project to move ahead.

5.9 Twelve Mile Canyon Slides

Twelve Mile Canyon mud slides continually impact this entire sub-watershed. Twelve Mile Creek is notorious for high levels of sediment loads from the numerous canyon slides in the canyon.

Downstream water users are adversely affected by the amount of sediment that is contained in the water after a mud slide. Irrigation systems wear quickly, plant growth decreases, municipals, fisheries, riparian vegetation and areas, wildlife, and cattle are all affected by the amount of sediment in the water.

Twelve Mile Canyon is composed of two geologic rock formations. Flagstaff Limestone is the upper rock unit and North Horn Shale is the lower rock unit. The overlaying Flagstaff Limestone is jointed and fractured and has karst sinkhole ponds at the top of the mountain. There is an extensive, well supplied groundwater system in the upper area. This is held in the limestone by the underlying North Horn Shale. The North Horn Shale is one of the most landslide prone rock units in Utah. This combination of limestone over shale was also a contributing factor for the enormous 1983 Thistle Landslide. Many of the sub-watersheds located between Thistle and Twelve Mile canyons have similar rock formations that are prone to sliding.

The landslide problem will continue to create sediment problems for local water users below the slide, but over centuries the rock formations will cease to slide and not be a major impact to the irrigation systems below. To improve the sediment problem, mitigation planning can be accomplished by an interdisciplinary team working with the water users. Planning must concentrate on handling the annual sediment load and protecting irrigation systems and public water supplies.

5.10 Urban Storm Water

Storm water discharges are generated by runoff from land areas such as paved streets, parking lots, and building roof tops during storm events. These urban areas contain pollutants in quantities that could adversely affect water quality. Within the Sanpete area, storm water discharge pollutes irrigation ditches in nearby fields. The EPA has done studies of waterways and receiving waters near urban and suburban areas affected by storm water runoff. The following resulted impacts include (EPA 2004):

1. Alterations in hydraulic characteristics of streams receiving runoff such as higher peak flow rates, increased frequency and duration of bankfull and sub-bankfull flows, increased occurrences of downstream flooding and reduced base flow levels.
2. Changes in receiving stream morphology such as increased rates of sediment transport and deposition, increased shoreline erosion, stream channel widening, and increased stream bed scouring.
3. Aquatic habitat impacts leading to changes in fish and macroinvertebrate populations and loss of sensitive species.
4. Public health and recreation impacts such as increased risk of illness due to contact with contaminated water bodies, contamination of drinking water supplies, and restrictions on fishing.

To reduce storm water discharges, the method of primary control would be through BMP's. Sanpete County does not currently have a storm water plan since the land is not urbanized enough.

5.11 Air Quality

In the past, residents of Sanpete County have complained about various air quality issues such as dirt roads, agricultural pollution, and wind erosion. Currently the Division of Air Quality does not monitor Sanpete County, and will not until the resident population increases by a substantial amount. The Division of Air Quality believes that Sanpete County is meeting all quality criteria and is not concerned about health impacts.

5.12 Sensitive Species (Animals)

There are several sensitive species with potential habitat within the San Pitch River Watershed. These include:

1	Bald Eagle
2	Bonneville Cutthroat Trout
3	Brown (Grizzly Bear)
4	Burrowing Owl
5	Canada Lynx
6	Colombia Spotted Frog
7	Ferruginous Hawk
8	Grasshopper Sparrow
9	Greater Sage-Grouse
10	Kit Fox
11	Leatherside Chub
12	Lewis's Woodpecker
13	Nine Mile Pryg (mollusk)
14	Northern Goshawk
15	Southern Bonneville Springsnail
16	Three-toed Woodpecker
17	Utah Prairie-dog
18	Western Toad

Of the sensitive species, spotted frog and leatherside chub are most affected by water use within the Sanpete County. UDWR has formed teams to monitor spotted frog and leatherside chub species which reside near the San Pitch River waterways.

Colombia Spotted Frog. Picture taken by DWR, Krissy Wilson

Spotted frogs are purely aquatic species, needing perennial water sources beyond the breeding season. They inhabit cold water ponds, streams, lakes and springs. The San Pitch River contains eleven breeding sites that have been monitored since 1992. Surveys conducted annually in the San Pitch River Watershed, have shown that populations have decreased over the past couple of years. Some of the many different reasons for the decline and slow population recovery in spotted frog populations include: Water levels decrease, drought conditions over the past several years, changes in water quality, trampling near waterways from wildlife or agricultural animals, predatory species such as the leopard frog, and lack of riparian vegetation. Surveys taken in 2002 show that there were approximately 172 adult frogs present within the San Pitch River Watershed (Wilson and Olsen 2002). Efforts are underway to develop conservation easements within several property owners in the San Pitch valley. These efforts may result in habitat improvements and protection, as well as encouraging other property owners to cooperate with management activities for the spotted frog within the San Pitch valley (Wilson and Olsen 2002).

With successful implementation of the habitat management plan, it is expected that the San Pitch River watershed population could meet the Conservation Agreement goal of 1000 adult individuals. Goals to protect the spotted frog species would be to restore, maintain, and protect the frog habitat within the San Pitch River Watershed (Wilson and Olsen, 2001, 2002; Wilson and Balcombe 2001).

Leatherside Chub. Picture taken by DWR, Krissy Wilson

The Leatherside chub are small fish native to Utah and parts of Idaho. Due to population decreases, it is listed as a species of special concern. In 2001 and 2002 seventy-one survey sites were monitored along the San Pitch River and its tributaries. Fish were electro-shocked for identification and counted to determine current distribution and population abundance. It was recorded that Leatherside chub were observed at six of the sites surveyed along the River, and its tributaries.

Leatherside chub currently occupy the lower portion of the San Pitch River near Gunnison. They also occupy a six mile stretch of the river east of Moroni, one mile south of Fairview, and a small portion of Manti Creek.

Some likely explanations for decreases in Leatherside chub populations are due to habitat degradation, mud slides, sediment, the lack of riparian vegetation, predatory fish, and irrigation practices. Other reasons for Leatherside chub populations can be contributed to grazing practices along streams where Leatherside chub populations are found (Wilson, 2004).

The knowledge of both spotted frog and Leatherside Chub populations and distributions can help aid in conservation efforts within the watershed.

5.13 Pests and Weeds

Noxious weeds are undesirable, invasive, and are very difficult to control. These plants tend to reduce vegetation productivity, promoting upland soil erosion. Noxious weed populations change drastically over growing seasons, and are very difficult to control.

Noxious Weeds are a big problem within the San Pitch River Watershed

Brother Alfred Brousseau. Courtesy of St. Mary's College of California. ©St. Mary's College of California

Currently there are thousands of acres of weeds in the watershed that are treated annually with herbicides. Manual treatment is used when site conditions warrant it. Currently, a Weed Management Group within the county is conducting study's using goats to control Russian Knapweed. Some noxious weeds have very shallow root systems which may lead to excess soil erosion, nutrients, and TDS to the San Pitch River and its tributaries.

Currently local working groups within Sanpete County, San Pitch Coordinated Weed Management Area, have formed to help map out the noxious weed populations in the area. Noxious weeds of concern in the area are listed in Table 5.13.1. Because pest control methods change so rapidly; for up to date information check the weed management handbook. Also, licensed pest control personnel can recommend the best control methods to use.

Mormon crickets are also a large nuisance within the San Pitch River Watershed. Crickets mate and lay their eggs in the soil in late summer before succumbing to old age or freezing to death. The eggs hatch in late spring or early summer. The combinations of mild winters and warm temperatures in Utah have contributed to early cricket hatchings. Utah's cricket population has grown tremendously since 1997.

Another pest in the San Pitch River Watershed are field crickets. Field Crickets hatch in the Spring, usually in May. Field crickets eat plant materials, especially seeds, small fruits, and living and dead insects. If they are really hungry they will eat each other. After mating, female field crickets look for damp soil to lay eggs. They inject their ovipositors, like a needle, deep into the soil. Female crickets will lay about 50 eggs at one time through her ovipositor. One female can lay 400 eggs in her short life. Field crickets do not survive over winter. Any adult cricket or nymph will die when cold water arrives. Cricket eggs, however over winter. They will survive and hatch in the following spring.

Crickets infest agricultural crops and fields eating large portions in their path. Pest control sprays have known to help, but have to be applied at specific time periods in order to control the cricket populations.

Table 5.13.1 Noxious Weeds in Sanpete County

Noxious Weeds
Black Henbane
Canada thistle
Dalmation toad flax
Dyer's woad
Houndstongue
Leafy Spurge
Morning Glory
Musk thistle
Quackgrass
Russian knapweed
Scotch thistle
Small Whitetop
Spotted knapweed
Tall Whitetop
Velvet leaf

5.14 Irrigated Cropland

Based on the Sevier Basin Land Use Survey conducted by the Division of Water Resources in 2004, there are approximately 138,200 acres of cropland, pasture and hay land in the San Pitch River Watershed (**see Map 10**). Of this total, about 72,900 acres are irrigated, 15,600 acres are sub-irrigated, and about 49,700 acres are non-irrigated (**see Map 7**). About 74% of the irrigated cropland is irrigated by sprinkle irrigation. Much of the flood irrigating has been replaced by sprinkler irrigation systems in the past several years.

The replacement of flood irrigation methods with sprinkler irrigation systems has been spurred by the idea that productivity of the farms will be increased. In addition, this change also improves water quality. Sprinkler irrigation is more efficient than flood irrigation. Due to the increased efficiency, there is lower return flow. Lower return flows result in less soil erosion and fewer adsorbed pollutants (i.e. salt, fertilizer) to downstream water bodies (*Utah State Water Plan*, Division of Water Resoures, 2001).

By improving irrigation systems and management, there is the opportunity to improve irrigation practices both on flood and sprinkle irrigated ground. Improved practices will result in better water quality. Irrigation companies can assist with improved water quality by lining or piping canals. This reduces the sediment loading during the transport of the water from the supply source to the croplands.

Several major irrigation companies that provide water for irrigation within the San Pitch River Watershed include the following:

Birch Creek Irrigation Co.
Cedar and Twin Creek Sloughs
Chester Irrigation Co.
Ephraim Irrigation Co.
Ephraim-Willow Creek Irrigation Co.
Fountain Green Irrigation Co.
Gooseberry-Cottonwood Irrigation Co.
Gunnison Irrigation Co.
Gunnison Irrigation Co.
Horseshoe Irrigation Co.
Island Irrigation Co.
Island Irrigation Co.
Manti Irrigation Co.
Mayfield Irrigation Co.
Mayfield Irrigation Co.
Moroni Irrigation Co.
Moroni- Mt. Pleasant (M&M) Irrigation Co.
Moroni-Mt. Pleasant (M&M) Irrigation Co.
North Creek Irrigation Co.
North Six Mile Irrigation Co.
Pleasant Creek Highland Irrigation Co.
Pleasant Creek Irrigation Co.
Rock Dam Irrigation Co.
San Pitch River Drainage District
Silver Creek Irrigation Co.
Sterling Irrigation Co.
Twin Creek Irrigation Co.
West Point Irrigation Co.

5.15 Forest / Upland

Uplands comprise the largest segment of agricultural land. Some of this land is forested, and is grazed by livestock and/or wildlife. Large areas of grazing land are located within the western portion of the basin. These areas are mostly used for spring or fall grazing.

Permitted grazing on public lands declined after the 1940's, but since then has remained fairly stable. Many grazing permits have changed from sheep to cattle. As rangeland conditions improve, grazing permits should be restored where vegetation have been stabilized.

There has been considerable work done in localized areas to increase livestock and wildlife forage on uplands with practices such as chaining pinyon-juniper (PJ) and brush, and reseeding with grass and forbs. The Sage-steppe localized partnership group has been formed to improve wildlife habitat in many of the upland areas focusing on upland management and preventing water erosion. The focus is on Sage brush management to ultimately improve the Sage-grouse population within the area.

The Forest Service management plan is under review and being updated.

5.16 Scenic Rivers

The Wild and Scenic Rivers Act of 1968 was developed for the planning and use of water and related land resources. When a water body is deemed a 'Wild' or 'Scenic' river, the river must be free flowing and possess "outstandingly remarkable scenic, recreational, geologic, fish and wildlife, historic, cultural, or other similar values" (USDA 2004).

Manti-La Sal National Forest began their initial inventory for wild and scenic river segments in 2001 that might qualify. Once a river has been selected, the Forest Service is required to have public input to determine if the wild and scenic river recommendations make sense. Currently within the Sanpete County there are no wild and scenic rivers within the watershed. Fish Creek/ Gooseberry Creek River segments were previously under review but did not meet the wild and scenic criteria designation.

If wild and scenic classification is given to any stretch of river, it determines the management allowable along the river segment. Management direction in the Forest Plan would reflect this classification if a river segment is found suitable for recommendations to Congress. Any limits on the ability to access, exchange or store water could impact the availability of irrigation, municipal, and culinary water supply existing to users. Scenic rivers management could conflict with existing water rights (USDA 2004).

5.17 Cloud Seeding/Weather Modification

The Division of Water Resources (DWRe) regulates cloud seeding processes in Utah (*see table 5.17.1 for data collected*). DWRe also provides funding. The Utah Water Development Corporation (UWCD) is an organization that sponsors the Central/Southern Utah Project that provides cloud seeding across much of southern and central Utah. Both UWDC and DWRe fund this project. Money is collected by UWCD from the counties and water conservancy districts in the area that it serves. The San Pitch River Watershed is included in this area.

The object of the Central/Southern Utah Project is to increase wintertime precipitation and the resulting snow pack. This increase results in increased stream discharge and groundwater recharge. This project is a wintertime seeding program that targets orographic clouds using propane-fired silver iodide ground generators. Orographic clouds are formed as moist air is cooled while crossing mountain ranges. Orographic clouds tend to form from super-cooled liquid droplets.

Generators are located in the valley and foothills upwind of the targeted mountain or plateau. A solution containing the silver iodide is burned in a propane flame that produces small particles that enhance the formation of ice crystals in these clouds. These crystals then attract moisture from the surrounding air forming droplets that grow large enough to fall to the ground as snow. If not seeded, orographic clouds tend to be poor precipitators, retaining most of the moisture until the droplets evaporate.

Cloud seeding is most effective when it is continued over several years providing increased soil moisture and groundwater recharge that helps to maintain the base flows of the streams. Cloud seeding has been conducted over southern and central Utah for 27 seasons. Currently, 62 generators are being operated in this area.

To evaluate the affect of cloud seeding in the area, a target and control evaluation method was used. Using precipitation data prior to any seeding, a regression equation was developed to indicate the relationship between the target and control precipitation gages. This equation is used to estimate the amount of precipitation that would have occurred without seeding in the target area during the seeding periods. The estimated amount is then compared to the amount of precipitation that actually fell in the target area during seeding periods. The results of this method indicate an average increase in precipitation of 15% for the

Central/Southern Utah Project (*see table 15.17.1*).

Table 15.17.1 CENTRAL/SOUTHERN UTAH PROJECT SUMMARY OF DECEMBER – MARCH PRECIPITATION EVALUATIONS

Summary and Evaluation of 2003 – 2004 winter cloud seeding operations in Central and Southern Utah, Northern American Weather Consultants, Inc. Sept. 2004.

Water Year	Predicted (inches)	Observed (inches)	Ratio Observed/Predicted*	Excess Water (inches)*
2004	8.35	10.23	1.23	1.88
2003	6.62	9.11	1.38	2.49
2002	6.12	5.88	0.96	(0.24)
2001	6.47	9.11	1.41	2.64
2000	10.22	11.97	1.17	1.75
1999	5.91	6.62	1.12	0.71
1998	12.04	13.73	1.14	1.69
1997	10.97	11.65	1.06	0.68
1996	11.98	12.42	1.04	0.44
1995	12.01	13.48	1.12	1.47
1994	5.90	8.34	1.41	2.44
1993	16.70	19.13	1.15	2.43
1992	7.35	9.73	1.32	2.38
1991	7.55	10.28	1.36	2.73
1990	6.81	8.78	1.29	1.97
1989	9.52	9.75	1.02	0.23
1988	6.68	9.45	1.41	2.77
1983	14.47	16.76	1.16	2.29
1982	14.83	16.18	1.09	1.35
1981	7.10	8.78	1.24	1.68
1980	16.30	19.66	1.21	3.36
1979	15.31	15.62	1.02	0.31
1978	18.08	19.33	1.07	1.25
1977	4.06	6.10	1.50	2.04
1976	8.78	9.56	1.09	0.78
1975	12.01	12.27	1.02	0.26
1974	10.39	10.74	1.03	0.35
* Numbers vary slightly (i.e. 1.23 vs 1.22) from reference report due to rounding				
A weighted average was used to get overall ratio of 1.15 - or 15% increase				

6.0 OBJECTIVES, ACTION PLAN AND RESULTS:

Actions items to achieve each planning objective will be implemented through voluntary participation by developing conservation plans with individual or groups of landowners. These plans will be tailored to address the specific resource problems and opportunities that pertain to each particular property. Implementation of the conservation plan will result in improved water quality, increased agricultural production and other resource benefits. When outside funding is available, it can be used to assist private landowners and agency personnel to implement the conservation plan.

OBJECTIVE 1:
Reduce Total Dissolved Solids (TDS) loading in the San Pitch River in order to meet endpoints identified in the TMDL.

Action Item 1: Focusing on the Middle San Pitch River where the highest impairment occurs, work with landowners to improve their irrigation water management and efficiency of the irrigation systems.

Action Item 2: Reseed irrigated lands to reduce salt loading into the river.

Action Item 3: Purchase a pasture drill to reseed ~40,000 acres to reduce TDS loading from pasture runoff.

Action Item 4: use Best Management Practices (BMP's) to re-seed rangeland to reduce sediment and nutrient loading into the river.

Results: The combination of the above practices is expected to reduce TDS loading to the San Pitch River by 11% (~4000 tons/year) and maintain water quality standards for its designated beneficial uses of agriculture in the Middle San Pitch River.

OBJECTIVE 2:
Reduce non-point source nutrient pollution to improve water quality through implementation of comprehensive nutrient management plans (CNMPs)

Action Item 1: Work with livestock and land owners to properly store and utilize manure. Develop a nutrient management plan for animal feeding operations (AFO's).

Action Item 2: Prevent runoff from corrals into surface waters and recharge areas.

Action Items 3: Help landowners' purchase computer software programs to manage manure application.

Action Item 4: Provide financial assistance for manure testing, and help determine rates of manure in areas.

Action Item 5: Develop grazing management plans in combination with riparian restoration to reduce nutrient loading to the upper San Pitch River.

Results: Help improve water quality within the San Pitch River Watershed by managing nutrients and reducing erosion of excess nutrient to the San Pitch River.

OBJECTIVE 3:
Collect and map soil samples to determine baseline nutrient levels in the watershed.

Action Item 1: Take soil samples on fields throughout the watershed and create GIS map of soil sample results. Prioritize areas in need of nutrient management.

Action item 2: Computer mapping software. Encourage taking soil samples, record keeping, utilizing soil test results, and determining manure applications.

Results: Baseline map to locate priority areas and guide implementation to control nutrient levels and to gage success of nutrient management activities.

OBJECTIVE 4:
Reseed pastures with large root mass species and control noxious weed population.

Action Item 1: Get involved with partnering agencies to map and control noxious weed populations.

Action Item 2: Coordination and involvement with the San Pitch CWMA to control noxious weed population's throughout entire watershed.

Results: Better control of noxious weed populations by about 70%.

OBJECTIVE 5:
Improve stability of the stream channel and tributaries to enhance the riparian corridor and buffer zones to proper functioning condition.

Action Item 1: Improve San Pitch River by stabilizing banks to reduce erosion and planting appropriate vegetations.

Results: Improve 7 miles of the San Pitch River by stabilizing banks to reduce erosion and planting appropriate vegetations. Decrease streambank erosion by 40 tons and reduce nutrient and TDS loading to the river.

OBJECTIVE 6:
Inform and educate landowners and citizens concerning non-point pollution sources and BMPs.

Action Item 1: Conduct tours of conservation projects, hold seminars to educate landowners, send out brochures, media information, and present Watershed Education Days for students and other interested parties.

Results: Increased knowledge of concerns, successes, and ongoing progress within the watershed. Annually educate 16 fourth grade classes in county, interested parties, etc., and supplied material for science curriculum.

OBJECTIVE 7:
Track individual progress, matching contributions, team efforts, and generate reports and data as needed.

Action Item 1: Sanpete County Soil Conservation District (SSCD) will employ a full time Watershed Coordinator to carry out work group meetings, track grants and project implementation, and develop conservation plans.

Results: Better coordination of all activities of watershed partners to achieve beset results of their efforts.

OBJECTIVE 8:
Obtain funding to implement BMPs for greatest improvement in the San Pitch River watershed.

Action Item 1: Research and apply for available funding and develop agency and stake holder partnerships.

Results: Maximize all available resources to ensure necessary projects can be implemented to restore the San Pitch River Watershed.

OBJECTIVE 9:
Assist communities in developing and implementing source water protection and storm water plans integrating aquifer classification.

Action Item 1: Classify Sanpete Valley Aquifer.

Action Item 2: Assist communities with implementing source water protection and storm water plans.

Action Item 3: Stay involved with local community and county leaders in land use planning for the watershed.

Results: Establish baseline conditions for the management of groundwater recharge areas and drinking water protection. Quality drinking water and less untreated storm water entering the San Pitch River.

OBJECTIVE 10:
Improve and conserve wildlife habitat in the watershed.

Action Item 1: Identify critical wildlife habitats within the watershed (ie: big game winter range, spotted frog, leatherside chub, etc.).

Action Item 2: Identify ownership boundaries where these critical habitats occur (private, SITLA, DWR, federal, municipalities, county, etc).

Action Item 3: Develop partnerships between landowners, state and federal land management agencies, and private organizations to improve communication and cooperation, leverage technical and financial resources, and develop innovative approaches to solving problems in critical riparian and shrub-steppe communities.

Action Item 4: Assist partners in implementing habitat projects within riparian and sagebrush-steppe communities, to improve overall rangeland conditions for wildlife and livestock production. This could include planning, funding, equipment, and technical assistance.

Results: Enhanced water quality through improved watershed conditions, improved habitat for big game and sensitive species, and improved rangeland conditions for livestock. Improve 128,290 acres Division of Wildlife Resources owned rangeland.

OBJECTIVE 11:
Expand cloud seeding area to a cloud seeding project area to benefit landowners within the watershed.

Action Item 1: Help centralize cloud seeding locations so that they will be more beneficial to landowners within the watershed. Also, make cloud seeding locations more uniform along the watershed.

Results: Increase water yield (~1.15 inches annually of 15% increase) uniformly along watershed boundary to benefit landowners in area.

OBJECTIVE 12:
Reduce sediment loading from Twelve Mile Canyon slides to down stream users.

Action Item 1: Obtain funding to research solutions to Twelve Mile Canyon slides sediment issue.

Action Item 2: Obtain funding to help mitigate Twelve Mile Canyon slides sediment loading issue.

Results: Reduce sediment loading to down stream users of Twelve Mile canyon slides area.

6.1 Accomplishments

The San Pitch River Watershed Stewardship Group and Sanpete County Soil Conservation District have accomplished the following:

319 contract 03-0157 Soils grant:
Total funds- $15,000.00.
Spent- $8,500.00
Grant money spent on soil tests within watershed, newspaper articles to announce funding, soils education class to teach landowners about importance of soil testing, create a soils map of county with current phosphorous and potassium levels, and administration costs to manage grant.

319 contract 04-1264 implementation grant:
Total funds- $113,300.00
Spent- $76,916.76
Grant money is used for projects that will help improve water quality within the San Pitch River Watershed. Projects include: Corral relocation, irrigation improvement, stream restoration, pasture management, range management, CNMP's, media campaign, and landowner education.

To date the following projects have been completed: Two mile stream restoration project south of Fairview, corral relocation project to move corral off of stream, and irrigation up grade from wild flood to sprinkler on 57 acres near San Pitch River.

The following projects will be accomplished with in the next couple of months: 1,040.3 acres of pasture seeding in wet bottom meadows of Ephraim, Brush management on 150 acres near San Pitch River.

319 contract 05-1645 implementation grant:
Total- $200,000
Spent- $27,000
Grant money is used for projects that will help improve water quality within the San Pitch River Watershed. Projects include: irrigation improvement, stream restoration, range management, media campaign, and landowner education. This grant was recently set up. The following are projected goals to have accomplished within the next year:

Four irrigation improvement projects to help improve water quality covering 141 acres, and three rangeland projects to help improve water quality covering 480 acres.

A rangeland drill was purchased with this grant to help provide landowner assistance with pasture and rangeland seeding projects. Seeding projects within the San Pitch River priority area help improve water quality with the watershed.

EQIP Soils and Manure Testing Grant
Total- $24,000
Spent- $10,849
Grant money has been used for soil testing fields, Watershed Education Day for fourth grade students, manure tests, and soil testing course. Soil testing improves the water quality within the watershed.

Agriculture is a big part of Sanpete County

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APPENDICIES

Abbreviated Words

Ac- acre
AFO- Animal Feeding Operation
ATV- All Terrain Vehicle
BMP- Best Management Practices
BOR- Bureau of Reclamation
CAFO- Confined Animal Feeding Operation
Cfs- Cubic feet per second
CWA- Clean Water Act
DWSP- Drinking Water Source Protection
DWQ- Division of Water Quality
EPA- Environmental Protection Agency
M&I- Municipal and Industrial
MSE- Millennium Science and Engineering
NEPA- National Environmental Protection Agency
NRCS- Natural Resource Conservation Service
OHV- Off Highway Vehicle
PJ- Pinyon/ Juniper
SAR- Sodium Absorption Ration
SCD- Soil Conservation Service
SECI- Stream Erosion Condition Index
SSCD- Sanpete County Soil Conservation District
STATSGO- State Soil Geographical Database
STORET- Storage and Retrieval
SVAP- Stream Visualization Assessment Protocol
TDS- Total Dissolved Solids
TMDL- Total Maximum Daily Load
TP- Total Phosphorus
UACD- Utah Association of Conservation Districts
UDWRe- Utah Division of Water Resources
UDWR- Utah Division of Wildlife Resources
UDWRt- Utah Division of Water Rights
USDA- United States Department of Agriculture
USDI- United States Department of Interior
USFS- United States Forest Service
USGS- Utah State Geological Survey
WQMP- Water Quality Management Plan
WQS- Water Quality Standards
WWTP- Waste Water Treatment Plant

Appendix 1
List of Contributors

Governmental and non-governmental entities, the San Pitch River Watershed Stewardship Committee, and Soil Conservation District Board assisted in contributing essential watershed information and data, and helped with the preparation of the San Pitch River Watershed Water Quality Management Plan. These groups consisted of the following individuals:

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