# 4.0 WATERSHED PLANNING ELEMENTS

In order to achieve the strategic targets outlined in Chapter 1.0, both countywide and sub-watershed specific projects need to be identified and implemented. Several watershed planning elements are explored in this Chapter to identify countywide recommendations and implementation activities. The watershed planning elements are as follows:

1. Economics
2. Wastewater
3. Stormwater
4. Nonpoint Source Pollution
5. Water Supply
6. Instream Flows
7. Habitat
8. Utah Lake
9. Headwaters Protection

This Chapter is meant to provide the large view of water quality and watershed concerns countywide. Recommendations are made for each of these planning elements and possible funding mechanisms are detailed in Chapter 6.0 Implementation.

Barney's Creek, Barney's Creek Sub-Watershed

Corner Canyon Creek, Lower Corner Canyon Creek Sub-Watershed

## 4.1 ECONOMIC ELEMENT

An often forgotten component of watershed planning is the ramifications poor water quality and watershed functions may have on the local or regional economy. This section explores and evaluates the possible social and economic benefits that come from enhancing and preserving water quality and watershed functions. In addition, corridor preservation techniques and potential funding mechanisms for updating the WaQSP will be evaluated.

### 4.1.1 Economic and Social Benefits

The restoration, preservation and maintenance of the Salt Lake Countywide Watershed will likely have a positive effect on the County's social and economic spheres. Quality watersheds create a greater sense of place, better quality of life, increased recreational opportunities, and a better living environment. When natural resource areas are well maintained and preserved, community members feel pride in their neighborhood and have an enhanced sense of attachment to their local surroundings. By identifying appropriate locations for trails/trailheads and installing informational boards at these facilities the public may gain a greater sense of understanding and concern for the watershed. As a result, individuals and groups may engage more fully in stewardship activities. Recreational use of watersheds can also benefit private individuals and promote increased public health. Overall high water quality can increase the quality of life for all residents.

Example of recreation facility, Gray's Lake Park in Des Moines, IA

San Antonio River in San Antonio, TX

#### 4.1.1.1 Benefits

The economic benefits of good water quality and a healthy watershed are distributed throughout the community. High water quality not only affects the environment, it affects the public well being, private individuals, and businesses in the community, and the health of the County's economy. The result of these benefits is an overall positive economic impact on the County.

Existing research shows these benefits exist for both use and non-use activities. Use activities include swimming, boating, fishing and hiking along stream corridors. Non-use activities are based on the aesthetic value of knowing the land is there without ever stepping foot on it. A survey conducted along a 45 mile segment of the South Platte River in Colorado found that households were willing to pay $21 (in 1999 dollars) per month on their water bill for additional ecosystem services related to the river (Loomis, 1999). A similar survey conducted along the same river in 1976 found households were willing to pay $13 (in 1999 dollars) per month for similar environmental services (Loomis, 1999). A California survey conducted in 2000 found comparable results; households were willing to pay $23 (in 2000 dollars) per month for clean water (Larson and Lew, 2000). The survey also found that for every $10,000 of income, households were willing to pay an additional two dollars per month for better water quality.

Dry Creek Recreation Area, Lower Dry Creek Sub-Watershed

### 4.1.1.2 Beneficiaries

In addition to the effects felt across the community, certain individuals will receive additional benefits. Benefits take the form of increased property values along preserved and maintained corridors and increased sales for recreational supplies and services.

Existing research in California concluded that increased "water quality can result in increased property values of at least three percent for bank stabilization and up to 11 percent for improving fishing habitat," (Loomis, 1999). A different survey, also in California, found homes located on restored rivers had a three to 13 percent higher value than similar properties located along unrestored stream corridors (Center for Watershed Protection, 2000). In addition, a national survey of 39 communities found homes near natural buffers had either a positive or neutral effect on private property values in 82 percent of the communities (Center for Watershed Protection, 2000). Here in Utah, a study completed for West Jordan indicated that property owners near or adjacent to natural open space also see an increase in property values (Wikstrom Economic and Planning Consultants, 2002).

Businesses, especially outdoor retail establishments, benefit from increased watershed quality (National Parks Service, 1983). It is estimated that 5.9 percent of household income is spent on outdoor retail. Creating more recreational opportunities can create a larger market for outdoor retail sales. Additionally, preserving open space can increase tourism by increasing recreational opportunities. Nationally, nature-based tourism is increasing by 30 percent annually (EPA, 2007). Tourists add dollars and tax revenue directly to the economy. This money will help private enterprises as well as the local government through increased sales tax revenue.

### 4.1.1.3 Costs

Water quality and watershed health require ongoing funding and maintenance. Costs can be classified under four broad categories: land preservation, mitigation, enforcement, and treatment.

Preserving key areas of watershed is important to maintaining the health of the system. There are a variety of methods for preserving land (described in detail in the corridor preservation discussion below), ranging from regulatory approaches to paying full market value for the land.

Mitigation of existing pollution in the watershed will be required to increase watershed quality in Salt Lake County. The level of mitigation required will be based on the implementation strategy adopted by the County. As new development occurs, bringing with it increased stormwater runoff and associated pollution, additional steps may need to be taken to mitigate these effects in order to maintain water quality into the future.

Enforcement of watershed policies will be crucial to the success of the WaQSP after it has been adopted. A plan without enforcement lacks the


Informational Board, Upper Mill Creek Sub-Watershed power to make any real change. Strong enforcement of policies will often cost more than the revenue they generate.

Water treatment is the most expensive approach to maintaining or increasing water quality, but these costs can be reduced if a healthy watershed is fostered and maintained.

## 4.1.2 Funding

Salt Lake County budgeted $8.1 million dollars in 2007 for flood control activities. Of that, $5.3 million went towards engineering, operation and maintenance costs. $2.8 million went towards capital improvement projects for countywide facilities. These activities will continue under the WaQSP. In addition, the WaQSP will need to be updated every six (6) years at an estimated cost of $750,000.

Five (5) funding mechanisms have been identified for updating the WaQSP: taxes, fees/charges for services, charges for watershed degradation, fines, and voluntary contributions. The strengths and weaknesses of each method are discussed in detail below.

### 4.1.2.1 Taxes

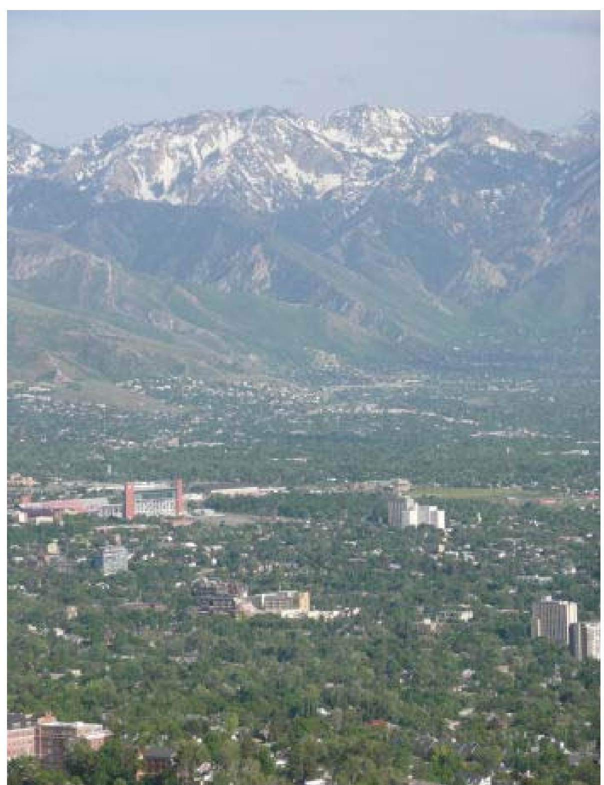
Taxes are the broadest means of collecting funds from the general population. Since taxes apply to businesses, households and tourists, they offer the largest available funding base. Taxes can be designed with great versatility by limiting collections to only smaller subsets of the population or taxing the entire population at once. In addition, taxes for watershed quality could be easily implemented through the existing tax collection system.

The largest drawback is the political fall-out that can surround a proposal for new or higher taxes. Politicians are often reluctant to enact such taxes. An additional drawback is tax exempt entities, such as schools, churches, and governmental agencies, which are exempt from paying taxes in spite of their contributions to stormwater runoff and other activities that have detrimental effects.

### 4.1.2.2 Fees/Charges for Services

Fees may be assessed in exchange for a particular service and access to this service must be seen as voluntary. Unlike taxes, each citizen has a choice whether or not they participate in the service. The fee must be designed to recuperate the costs of providing the service and cannot exceed the costs. Therefore, fees are appropriate for cost recovery, but are not generators of additional revenue.

In practical terms, mitigation activities for water, sewer and stormwater systems may be appropriately funded through fees and can draw on almost all members of the population. Other service fees would target more select populations that gain specific benefits from the protection and maintenance of the Countywide Watershed. Tax exempt entities are not exempt from fees if they utilize the service. Since fees are optional, there is less political resistance to the adoption of fees over taxes. Charges for services are more equitably distributed among users than a flat tax.



View of Wasatch Mountains from Ensign Peak in Salt Lake City

While fees need to be proportional and related to the service provided it is often difficult to adopt fees high enough to recuperate the full costs of the service. Setting fees too high can increase political resistance and create public opposition. Revenue collection from fees is also slightly less predictable than taxes since fees are voluntary by nature.

### 4.1.2.3 Charges for Watershed Degradation

Charges for watershed degradation are set up under a similar premise to fees. In this case the service is mitigating the impact of polluters on the watershed. One of the greatest strengths to this type of funding is its possible effect on the behavior of polluters. This funding mechanism also has the strongest correlation between the charge and treatment/mitigation costs associated with it that provides a very strong legal nexus.

These charges are typically set up as surcharges that offer a great amount of flexibility in directing how the funding is spent. When adopting new surcharges, the enacting legislation must specify how the revenue is to be spent. Through this mechanism, the governing body can allocate the revenue to planning, land acquisition and/or maintenance as a set percentage of the surcharge. Having this specification in enacting language will ensure how funding will be divided in the future.

In addition to general surcharges, the County has the ability to levy impact fees for environmental mitigation (Utah State Code 11-36-202-4) that is tied to federal environmental law. Since the WaQSP is an update of the federally mandated 208 plan as part of the Clean Water Act, enacting impact fees for watershed mitigation would be allowable under state statue.

This approach will produce fewer revenues than fees or taxes since it targets a much more select population. Charges for watershed degradation will require new collection methods and may have enforcement issues.

### 4.1.2.4 Fines

Fines can be used to change behavior and enforce watershed policies. Fines involve a regulatory agency such as forest rangers or police. While revenue from fines can be used in less restrictive manner by the County, the cost for enforcement can often outweigh the revenue received. This is especially true when, and if, behaviors change and fines are no longer collected. In this situation, enforcement patrols may need to continue without revenue from fines.

### 4.1.2.5 Voluntary Contributions

According to a poll taken as part of this study, voluntary contributions are the most widely favored method for raising revenue to fund future updates of the WaQSP (Appendix F). However, individual contributions may vary greatly from year to year.

In lieu of relying on individual contributions, voluntary interlocal agreements may be established, with water and wastewater districts, to provide reliable funding for ongoing watershed planning efforts. Water and wastewater districts both use surface waters of the County and benefit from long-term planning efforts. Therefore, it is appropriate that they should contribute to funding on-going planning activities. In discussions with water and wastewater districts, there is cautious support to voluntarily participate both financially and logistically in planning efforts.

Alternately, a non-profit organization could be created to solicit donations and host fund-raising events. Across the country, open space organizations have used walk-a-thons, races and one-day fundraisers to gain additional funding revenue from the community. When events such as these are held annually they can create a more consistent funding source.

### 4.1.2.6 Specific Funding Mechanisms

Tables 4.1.1 and 4.1.2 provide a matrix of funding options for Salt Lake County. For each funding mechanism there is a description, discussion of legal nexus, current legal status, steps required for implementation as well as the estimated level of funding that might be obtained.

### Table 4.1.1 Funding Mechanisms Nexus and Allocation

| Type | Funding Mechanism | Nexus | Funding Allocation |
|---|---|---|---|
| Charges for Watershed Degradation | Animal license surcharge | Pet waste increases pollution. | Enacting legislation could split funding between mitigation and planning. |
| | Septic tank surcharge | Septic tank leaks pollute water. Septic tanks are also more prevalent in the canyons. | Enacting legislation could split funding between mitigation and planning. |
| | Surcharge for development in the canyons | Development in the canyons has a larger impact on watershed quality. | Enacting legislation could split funding between mitigation and planning. |
| | Adding a special permit as part of the Foothills Canyons Overlay Zone development process | Development in the canyons has a larger impact on watershed quality. | To be used towards costs of staff reviewing the permit. A small portion could be adopted to go towards planning for the watershed. |
| | Surcharge for green field development | Green field development has a much higher impact on watershed quality than brown field development. | Enacting legislation could split funding between mitigation and planning. |
| | Percentage of construction permits | All construction impacts the watershed. A portion of the permit should go to the county to mitigate these impacts. | Enacting legislation could split funding between mitigation and planning. |
| | Surcharge tied to the issuance of the 404 federal permit for wetlands | Since actions triggering the issuance of a federal 404 permit also decrease the water quality in the area, local government could charge for mitigation. | Mitigation. |
| | Special building permits/ surcharge for building in a riparian area | Building in riparian areas has a larger impact on wetlands then building in non-riparian areas. | Enacting legislation should split funding between land acquisition, mitigation and planning. |
| | Creation of a fee in conjunction with the state fee on industries which are large polluters | Industries which pollute the most should be charged for their impact on the watershed quality. | Enacting legislation should split funding between land acquisition, mitigation and planning. |
| | A surcharge for private and domestic wells | Wells have an adverse impact on water quality by reducing the ability for the aquifer to recharge. | Enacting legislation should split funding between land acquisition, mitigation and planning. |

### Table 4.1.1 Funding Mechanisms Nexus and Allocation—*Continued*

| Type | Funding Mechanism | Nexus | Funding Allocation |
|---|---|---|---|
| **Fee** | Permit issuance fee for stream alterations | Issuing a stream alteration permit requires county staff time and has the potential to impact the county's watershed. | Must be used towards staff time of issuing the permit and providing the service. |
| | Stormwater connection fee | Connecting to the stormwater system impacts the capacity and flow of the system. | Must be used towards staff time of issuing the permit and providing the service. |
| | Creation of a trail head fee | Providing trails along watershed areas is a great benefit for recreational users. The cost of these services should be externalized to users. | Must be used towards staff time of issuing the permit and providing the service. |
| **Tax** | Property tax increase through flood control levy | The flood control levy is used to fund storm water and watershed quality. | Must be used towards flood control planning and projects. |
| | Sales tax on storm water fee | Storm water fees are based on impervious surface so there is a direct correlation between storm water fees and the impact on the watershed. | Unrestricted funds can be most easily targeted towards specific projects. |
| | Sales tax on sewer and/or water fee | Sewer and water use is closely related to water quality. | Unrestricted funds can be most easily targeted towards specific projects. |
| **Voluntary Contribution** | Voluntary contributions | Voluntary contributions can be made by individuals who want to support the watershed. | Any part of funding the watershed. |
| **Direct assessment to each of the cities** | Direct assessment to each of the cities | Since cities within Salt Lake County feed into the storm water system and share the county's watershed they should be responsible for their portion of the impacts. | Watershed quality planning and implementation. |

Residential neighborhood in eastern portion of Salt Lake County

### Table 4.1.2 Funding Mechanisms Implementation and Magnitude

| Type | Implementation | Potential Magnitude | Funds Generated Annually |
|---|---|---|---|
| **Charges for Watershed Degradation** | Create an ordinance or resolution adopting the surcharge. | During FY2007 $517,613 was collected throughout the county in animal charges. A surcharge would produce little revenue. A surcharge imposing a one percent increase would produce $5,176 annually. | <$10,000 |
| | Create and adopt a surcharge to be placed on annual property tax bill. | There are approximately 2,100 land records with septic tanks. Unless surcharge is substantial, revenue generated would be minimal. | <$10,000 |
| | Adopt surcharge to be collected at the planning counter. | During 2006 there were between 55 and 60 FCOZ permits approved. Unless surcharge is substantial, revenue generated would be minimal. | <$10,000 |
| | Adopt surcharge to be collected at the planning counter. | There were 42,121 single family building permits issued from 1997 through 2006 in Salt Lake County. While not all of these units would qualify as green field the vast majority would. At $100 per unit, this could raise an average of $421,210 annually. | >$100,000 |
| | Create an ordinance or resolution adopting the surcharge. | There were 12,512 building permits issued in Salt Lake County during 2006 accounting for a combined valuation of $2,075,491,700. A one percent surcharge of total valuation would result in $290,754,971 annually. | >$100,000 |
| | Adopt surcharge to be collected through the county engineering department. | Salt Lake County Engineering approves approximately 150 permits annually split between encroachments and connections. Unless surcharge is substantial, revenue generated would be minimal. | <$10,000 |
| | Adopt surcharge to be collected through the county engineering department. | Salt Lake County Engineering approves approximately 150 permits annually split between encroachments and connections. Unless surcharge is substantial, revenue generated would be minimal | <$10,000 |
| | Create an ordinance or resolution adopting the surcharge. | This will depend on the number of trails that are incorporated into the system and the number of annual visitors. | Varies |
| **Tax** | Truth in taxation requirements for property tax rate raise. | The taxable value of all of Salt Lake County is approximately $56 trillion dollars. A property tax increase of 0.000001 would result in $56,926 annually. | <$10,000-$100,000 |
| | Meet with the county attorney to determine if this is allowed under Utah Statute. | Only eight cities currently have a municipal stormwater utility. The average stormwater fee is $48 dollars annually. A quarter percent tax would produce an estimated $24,160 annually based on existing storm water utilities. If all cities adopted similar fees, revenue would increase to an estimated $37,959 annually. | <$10,000-$100,000 |
| | Meet with the county attorney to determine if this is allowed under Utah Statute. | The median annual sewer fee in Salt Lake County was $180 per household and the median annual water fee was $431 per household during 2007. A quarter percent tax would produce an estimated $483,182 annually. | >$100,000 |

### 4.1.3 Corridor Preservation Techniques

In addition to funding WaQSP updates, land preservation will be essential to the success of maintaining and protecting watershed quality. Land preservation can be achieved through a variety of techniques. Each of the techniques is analyzed according to effectiveness and cost.

#### 4.1.3.1 Appropriation of Funding for Buying Critical Lands

One of the most direct methods for obtaining critical lands needed for watershed preservation is through the governmental appropriation of funding and fee-simple acquisition. This is often an expensive option in terms of both political and monetary capital. Unless the land owner is willing to give a special discount to the County, lands will often have to be purchased at the market rate. In terms of political capital, the amount of funding appropriated through the County's budgeting process will often depend on other needs in the County and the administration. This structure may translate into an irregular revenue stream. Bonding for land acquisition is also a proven mechanism.

Direct acquisition creates a permanent land holding of critical lands for the County. Additionally, it is important to establish conservation measures over land holdings ensuring that critical watershed lands are protected in perpetuity. While costly, land acquisition will sometimes be the only means of acquiring a specific link needed in the watershed. This method of land acquisition should be reserved for the most critical lands, as well as a last resort when other methods have not come to fruition.

1,681 acres purchased through Salt Lake County Open Space Bond, Upper Rose Creek Sub-Watershed

Daybreak Development in South Jordan, Bingham Creek Sub-Watershed

#### 4.1.3.2 Development Exactions

Critical lands for watershed preservation can be acquired as part of the development process through development exactions. "A development exaction is a contribution requirement in the form of land or money which government imposes on new development as a condition of development approval" (Blaeser and Weinstein, 1989). The 2005 Utah legislature enacted language stating that an exaction can be imposed if: "1). an essential link exists between a legitimate government interest and each exaction; and 2). each exaction is roughly proportionate, in both nature and extent, to the impact of the proposed development" (Call, 2005). In addition, exactions must address some burden created by the new development and solve the problem in the least obtrusive manner. The County cannot simply mandate fee title to land surrounding a watershed without meeting these four requirements. If these conditions are not met, an exaction could be considered a taking.

Sometimes it will be in the County's best interest not to seek full fee title exactions for watershed lands. More often options such as flood control easements and set backs from stream corridors will promote better results. The benefits to these types of exactions include lower maintenance costs and ease of watershed access for maintenance staff.

### 4.1.3.3 Incentive Zoning

Incentive zoning is a method for the County to receive amenities from private developers through the development process. To receive this amenity the County must offer in return a bonus to the developer to incentivize the transaction. Bonuses often take the form of increased density on the site and a quicker development process (Juergenmeyer and Roberts, 2003). Incentive zoning may be adopted as part of the conditions for development. Most programs in the U.S. have a written set of specific incentives and bonus adopted into their zoning ordinance.

Using incentive zoning is often an effective way for critical lands to be preserved during the development process. A zoning incentive should be created for the preservation of stream corridors through private developments.

In the development agreement amenities can be maintained by the development or deeded to the County or city. The benefit to development maintained amenities is less maintenance costs to the County; however, in this arrangement the amenity may not be accessible to the general public. A drawback to this system of land preservation is lack of predictability as to whether or not the developer is interested in the incentive or not.

### 4.1.3.4 Transfer of Development Rights

Transfer of development rights is a type of growth management program devised to protect environmentally sensitive land without risking a taking (Juergenmeyer and Roberts, 2003). Nationally, 21 percent of counties are using this type of program (National Center for the Study of Counties and National Association of Counties, 2004). Transfer of development rights program involves the selling of development rights in a "sending" area and those rights being transferred for increased development in a "receiving" area. Transfer of development rights is voluntary on the parts of the buyer and the seller. The County could set up this program in the unincorporated County to focus development away from critical areas of the Watershed. Once a property in the sending area sells its development rights, the property is permanently preserved. Transfer of development rights is difficult to implement unless the County

Perkins Flat, Upper Emigration Creek Sub-Watershed

Planning Commission and County Council commit to maintain the adopted land use plan. Amendments to the land use element of the general plan undermine any value that could have been attributed to transfer of development rights.

### 4.1.3.5 Conservation Easements

As part of Utah's Land Conservation Easement Act, a conservation easement means, "an easement, covenant, restriction, or condition in a deed, will, or other instrument signed by or on behalf of the record owner of the underlying real property for the purpose of preserving and maintaining land or water areas predominantly in a natural, scenic, or open condition, or for recreational, agricultural, cultural, wildlife habitat or other use or condition consistent with the protection of open land," (Utah State Code 57-18-2). In addition, Utah state law only recognizes conservation easements held by the governmental or non-profit agencies (Utah State Code 57-18-3). Conservation easements for watershed preservation meet the statutory requirements. Conservation easements could be managed by the County or the County could set up an non-profit to manage them. Since the land owner retains all other rights associated with the land, the County incurs no maintenance costs. In addition, the donation of conservation easements results in sizable tax deductions for the donor (Land Trust Alliance, 2006). Conservation easements do not open the lands for public access.

Another form of conservation easements are ecosystem stewardship easements. In addition to conserving the land, stewardship easements may allow the property to be accessed by the County for flood control, water quality and stewardship issues.

### 4.1.3.6 Overlay Zones

Overlay zones can be created to promote sensitive development in critical watershed areas. Overlay zones act as a secondary set of regulations in addition to the underlying zoning regulations (University of Utah, 1994). By placing stricter development regulations along the watershed corridor impervious surfaces can be reduced, high polluting industries can be kept out and design guidelines can be created to minimize the development's impact.

While the overlay zone can help preserve the character of critical lands, overlay zones will not result in actual control of or access to critical lands.

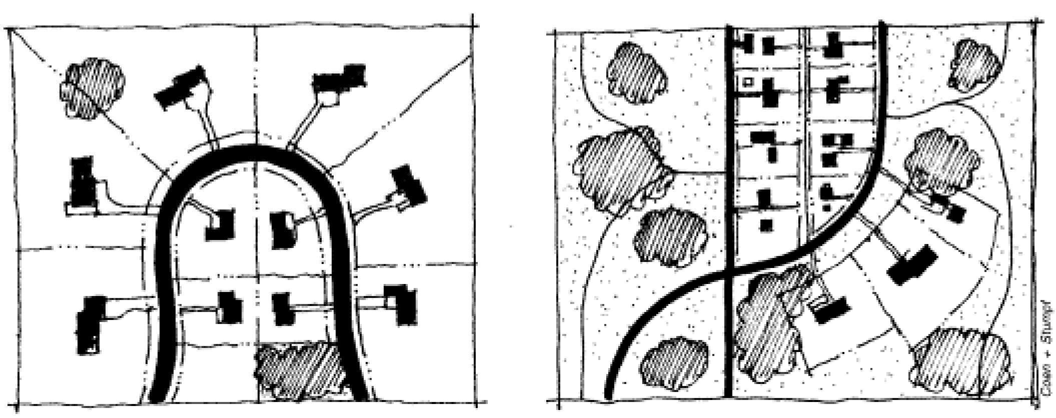
### 4.1.3.7 Cluster Development

Cluster development can be used to preserve portions of the Watershed that fall on parcels as they are converted to urban land uses, especially the conversion to residential housing. In a cluster development, individual housing lot sizes are reduced and placed near one another while more ecologically sensitive areas are preserved as commonly owned open space. Typically planning jurisdictions offer density bonuses to make these types of developments more appealing to developers. To make this method of land preservation most effective for watershed preservation, planners should try to make direct connections from the open space within the development to larger the watershed corridors. In order to create cluster development an ordinance will need to be adopted into the zoning code.

Cluster Development in Boston, MA

### 4.1.3.8 Land Trades

Land trades are a way to leverage lands currently owned fee title by the County but are not of great interest to the County. Land trades can be orchestrated so that lands valuable to developers can be traded with parcels of greater ecological interest. By exchanging lands, capital does not have to be spent upfront, yet the same outcome is achieved as purchasing the lands outright. In addition this practice will allow Salt Lake County to focus development in areas that are not as vital to the Countywide Watershed.




Schematic of Cluster Development

*Source: St. Croix Valley Community Foundation—2000 Report*

### 4.1.4 Preferred WaQSP Update Funding Mechanism

The future cost to update the WaQSP is estimated to be $750,000. However, this cost may vary depending on data availability and changes in the watershed. In order to fund the cost of WaQSP updates, it is recommended that each water category: stormwater, wastewater, and water supply, participate equally up to $250,000 every six years. These three categories benefit directly from and use surface waters in the watershed and should share in funding on-going planning activities.

The estimated $750,000 WaQSP update cost equates to approximately a penny, to a penny and a half, per month per connection. Connections in this case mean water, wastewater, and stormwater (i.e. Flood Control Levy). With contributions from all three sectors of water in the County, all property owners will contribute to watershed planning. For example, several properties, including schools, churches and other publicly held lands are tax exempt in Salt Lake County and therefore do not contribute to the Flood Control Levy. However, these facilities contribute to the overall stormwater runoff and pollutant loads in the watershed. With donations from wastewater and water districts, these properties would participate in the cost of watershed planning. Additionally, an individual who has a private septic system is by definition not connected to a wastewater utility; however, under the proposed structure, they would contribute to watershed planning through their water bill and property taxes. By using all three water sectors [stormwater (i.e. Flood Control Levy), wastewater, and water], every property owner in the County will participate in the cost of watershed planning.

It is anticipated that the County would contribute $250,000 every six years through the Flood Control Levy, which essentially represents stormwater. Additionally, it is proposed that water and wastewater districts contribute to WaQSP updates through the establishment of voluntary interlocal agreements.

Through discussions with these users service districts and other stakeholders, there is cautious support to voluntarily participate both financially and in planning efforts. Voluntary participation would be established in lieu of an additional fee or tax that would be passed through the districts. This voluntary funding mechanism may effectively support ongoing planning efforts, depending on the number of participating districts and the amount of funding required. However, if voluntary interlocal agreements are not successfully established, the County may need to consider increasing the Flood Control Levy to fund WaQSP updates.

Youth recreating in Sugar House Park, Lower Parley's Creek Sub-Watershed

## 4.2 WASTEWATER

This section is written to: 1) provide a description of existing wastewater treatment facilities, 2) review emerging trends in wastewater technology, 3) review current regulatory standards and trends, and 4) develop wastewater flow projections based on Wasatch Front Regional Council (WFRC) population projections. Additionally, this section is written to address the WaQSP strategic target, "Develop regional wastewater planning procedure requirements to enhance, improve and protect water quality functions." Finally, this planning element will allow Salt Lake County and affected stakeholders to make knowledgeable planning decisions that are critical to protecting water quality and public health and will allow the highest and best use of wastewater resources.

### 4.2.1 Background

In 1978, Salt Lake County completed its Area-Wide Water Quality Management Plan in accordance with section 208 of the Clean Water Act. This plan has served as a guiding document for nearly 30 years. In August of 2005, a request was made to amend the Area-Wide Water Quality Management Plan to allow a new wastewater treatment facility in the City of Riverton. In the process of re-visiting the 1978 plan, it became apparent that numerous factors such as land use, population projections, jurisdictional boundaries, water quality requirements/ impairments, water supply/use, and wastewater treatment processes have changed significantly since 1978. In addition, planned developments in the unserviced areas of Salt Lake County generate a significant quantity of wastewater flow as these areas are developed.

### 4.2.2 Description of Existing Facilities

The original Area-Wide Wastewater Management Plan recommended consolidation of nine (9) existing treatment plants into four (4), two (2) of which discharge into the Jordan River. During the 1978 planning process, Salt Lake County was geographically split into four specific planning areas for evaluating future wastewater treatment (2005) (Figure 4.2.1). The recommendations of the 208 Plan for each area are summarized below:

*Salt Lake City Planning Area*—Wastewater flows from the population of Salt Lake City are collected and treated at the Salt Lake City Water Reclamation Facility (SLCWRF). Effluent from the plant is discharged into the Salt Lake City Oil Drain which flows to the Salt Lake County Sewage Canal and ultimately to the Great Salt Lake. Future flows will be met by upgrade and expansion of the SLCWRF.

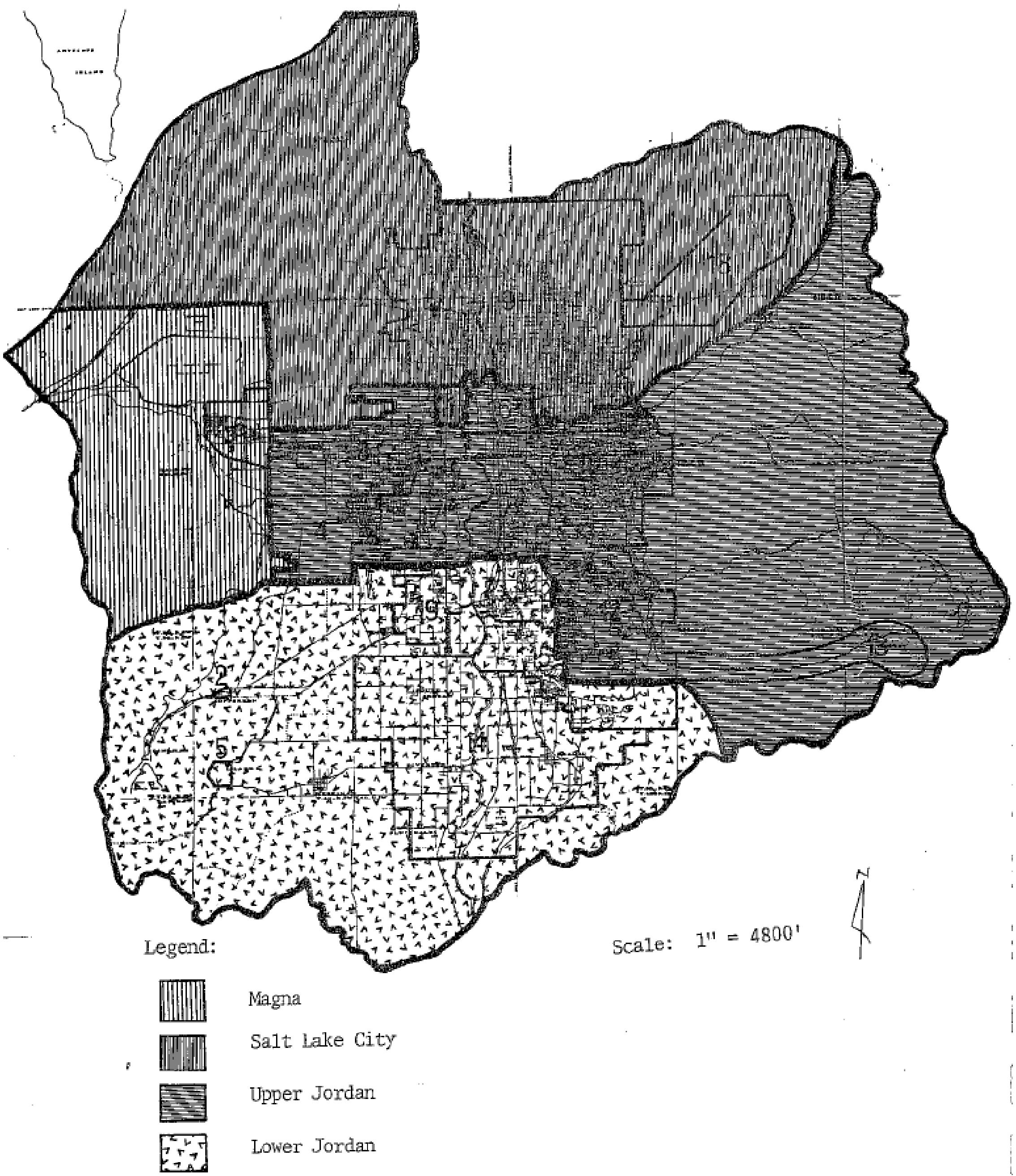
*Magna Planning Area*—Wastewater flows from the Magna Sewer District are collected and treated in the Magna Water Reclamation Facility (MagnaWRF). Effluent from the plant is discharged into Kersey Creek. Future flows will be met by upgrade and expansion of the plant.

*Upper Jordan Planning Area*—At the time of the Area-Wide Water Quality Management Plan, there were three treatment plants (Lark, Sandy and Midvale) in this planning area. The 208 Plan recommended that the Sandy and Midvale plants be regionalized to form the South Valley Water Reclamation Facility (SVWRF). Effluent from the SVWRF is discharged to the Jordan River. During the 1978 planning process, it was anticipated that future growth in this area would be accommodated at the SVWRF.

*Lower Jordan Planning Area*—At the time of the Area-Wide Water Quality Management Plan, there were five sewage treatment plants (Murray, Cottonwood, Salt Lake City Suburban Sanitary District No.1, South Salt Lake, and Granger-Hunter) in this planning area. Similar to the Upper Jordan area, these five treatment plants were regionalized to form the Central Valley Water Reclamation Facility (CVWRF). The CVWRF was expected to accommodate future growth in this area.

#### 4.2.2.1 Current Capacity and Treatment Technologies of Existing POTWS

Since the 208 Plan, the four wastewater treatment plants, SLCWRF, MagnaWRF, SVWRF, and CVWRF have undergone numerous expansions and process upgrades to keep pace with growing population, regulatory requirements, improved technology, and regular maintenance and repair. The purpose of this section is to describe the current capacity and main treatment process




*Source: Salt Lake County, 1978*

**Figure 4.2.1 Original 208 Area-Wide Water Quality Management Plan Facility Planning Areas**

utilized at each of the POTWs. Future expansion and upgrade plans are discussed in Section 4.2.3. Location of the existing POTWs and current district boundaries are presented in Figure 4.2.2.

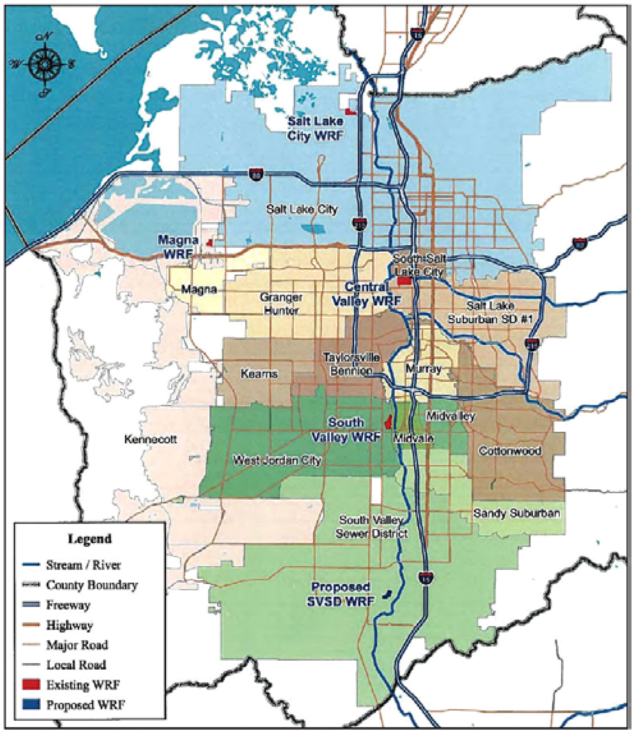



**Figure 4.2.2 POTW Service Areas and Locations**

*Salt Lake City Water Reclamation Facility* The original plant, located west of I-15 at 2300 North, was completed in 1965, with a capacity of approximately 45-million gallons per day (mgd). In 1981, Salt Lake City Public utilities conducted a study to expand its facility (SLCPU, 1981). The Salt Lake City Council adopted the plan in 1982 and expansion of the plant began in 1985. Plant improvements made during this time included the pretreatment plant rehabilitation, main plant rehabilitation, administration and laboratory building construction, short term aeration facilities, and sludge management and storage facilities. Improvements during this period increased treatment capacity to 56 mgd. Increases in biological treatment capacity made during 1993 through 1996 raised the plant's solids handling capacity from 60,000 lbs/day to 96,000 lbs/day. In 2002, a new 48-inch forcemain and replacement of two of the 250 hp with 350 hp influent pumps significantly increased the capacity of the Pretreatment Plant/Influent Pump Station. Currently, the plant is undergoing a major upgrade of its secondary treatment process including new aeration basins, secondary clarifiers, and return activated sludge (RAS) and waste activated sludge (WAS) pumping facilities in response to substantial increases in organic strength of their wastewater influent.

Process Description—The Salt Lake City Water Reclamation Facility (SLCWRF) uses a trickling filter/activated sludge process (TF/AS). The plant utilizes anaerobic digestion for solids treatment and cogenerates with digester gas. Liquid chlorine gas is used for disinfection prior to discharge into the Oil Drain. An overview of the plant and current facility index is presented in Figure 4.2.3. Main process components include the following:

- Pretreatment Plant/Influent Pump Station
- Grit Chambers
- Primary Clarifiers
- Trickling Filters
- Flocculation Basins
- Secondary Clarifiers
- Chlorine Contact Basin
- Anaerobic Digesters
- Sludge Drying Beds

Treatment Capacity—Treatment capacity of the SLCWRF is 56 mgd average daily flow (ADF). The plant is currently undergoing a secondary process upgrade to improve treatment capacity of the plant. These improvements are discussed further in Section 4.2.3. Currently, the plant receives approximately 33 mgd ADF.

A recent hydraulic capacity evaluation was completed by Salt Lake City in 2002 (Carollo Engineers, 2002). The conclusion of this evaluation was that the plant is hydraulically limited to passing approximately 96 mgd due to restrictions in the existing secondary treatment train. The current project addresses this issue by eliminating several bottlenecks identified in the plant and adding capacity through new process components including new aeration basins and secondary clarifiers. Based on these improvements and planned future additions of a fifth primary clarifier the plant is anticipated to pass peak flows of up to 140 mgd through the plant.

## FACILITY INDEX

**NEW / MODIFIED FACILITIES**

| | | | |
|---|---|---|---|
| A | AERATION BASINS | H | TRICKLING FILTER PUMP STATION |
| B | SECONDARY CLARIFIER NO. 8 | J | MANHOLE NO. 2 |
| C | SECONDARY CLARIFIER NO. 7 | K | BIOSOLIDS STORAGE PAD |
| D | NORTH RAS/WAS PUMP STATION | L | ELECTRICAL TRANSFORMER AND POWER FEED |
| E | SOUTH RAS/WAS PUMP STATION | M | SNAIL DEWATERING FACILITY |
| F | SECONDARY EFFLUENT CHANNEL | N | MCC 4A BUILDING |
| G | BLOWER BUILDING | P | MCC 8A BUILDING |

**EXISTING FACILITIES**

| | | | |
|---|---|---|---|
| 1 | BIOSOLIDS STORAGE PAD | 18 | SECONDARY CLARIFIER NO. 1 |
| 2 | SECONDARY CLARIFIER NO. 5 | 19 | SECONDARY CLARIFIER NO. 2 |
| 3 | SECONDARY CLARIFIER NO. 6 | 20 | SECONDARY CLARIFIER NO. 3 |
| 4 | TRICKLING FILTER NO. 1 | 21 | SECONDARY CLARIFIER NO. 4 |
| 5 | TRICKLING FILTER NO. 2 | 22 | FLOCCULATION BASINS |
| 6 | TRICKLING FILTER NO. 3 | 23 | SNAIL REMOVAL FACILITY |
| 7 | TRICKLING FILTER NO. 4 | 24 | EAST RAS PUMP STATION |
| 8 | TRICKLING FILTER NO. 5 | 25 | GRAVITY THICKENER |
| 9 | TRICKLING FILTER NO. 6 | 26 | PRIMARY CLARIFIER |
| 10 | TRICKLING FILTER NO. 7 | 27 | DIGESTER |
| 11 | TRICKLING FILTER NO. 8 | 28 | CONTROL BUILDING |
| 12 | WEST RAS PUMP STATION | 29 | MAINTENANCE BUILDING |
| 13 | REAERATION BASINS | 30 | SLUDGE DRYING BED |
| 14 | ADMINISTRATION BUILDING | 31 | ELECTRICAL TRANSFORMER AND POWER FEED |
| 15 | CHLORINE CONTACT BASIN | 32 | SWITCHGEAR BUILDING |
| 16 | CHLORINE BUILDING | 33 | TUNNEL G |
| 17 | COGENERATION BUILDING | 34 | POST AERATION |
| | | 35 | POST AERATION BLOWER ROOM & FAN HOUSE |


**Figure 4.2.3 SLCWRF Facility Map**

*Magna Water Reclamation Facility* Magna Water Company, an Improvement District, was formed by a resolution of the Board of Salt Lake County Commissioners and the Magna Water Board in 1949. Magna Water Company provides both potable water and sewer services to its customers. The Magna Water Reclamation Facility (MagnaWRF) is located north of 2100 South, between 7200 West and 8000 West. The original plant included primary treatment followed by trickling filters and disinfection. Major plant expansions included conversion of the plant to an oxidation ditch process by addition of two oxidation ditches, secondary clarifiers and RAS/WAS pumping facilities in 1988. This was followed by improvements to the headworks in 2000. Currently the plant is undergoing construction for major improvements including a fixed-bed bioreactor treatment process and new headworks discussed in Section 4.2.3.

Process Description The MagnaWRF is an oxidation ditch process. Solids are sent to sludge drying beds prior to land application and/or landfill. Liquid chlorine gas are used for disinfection prior to discharge to Kersey Creek which flows into the Great Salt Lake. An overview of the plant and process flow diagram is presented in Figures 4.2.4 and 4.2.5. respectively. Main process components include the following:

- Headworks Including Bar Screens and Grit Removal
- Influent Pump Station
- Oxidation Ditches
- Clarifiers
- Chlorination
- RAS/WAS Pump Station
- Sludge Drying Beds

Treatment Capacity Current treatment capacity of the MagnaWRF is 3.3 mgd ADF with a 6.6 mgd peak hour flow (PHF). The plant is currently in design for treatment of perchlorate laden residual streams from upstream, industrial and remedial action discharges. These improvements are anticipated to essentially double the existing plant capacity. In addition, the plant is considering reuse water opportunities to expand its current secondary water system. These improvements are discussed further in Section 4.2.3.

Capacity of the MagnaWRF is considered to be 3.3 mgd ADF. Currently the plant receives flows of approximately 2.6 mgd ADF and 3.9 mgd PHF.

*Source: Google*

**Figure 4.2.4 MagnaWRF Overview Map**

Kersey Creek, Great Salt Lake Sub-Watershed

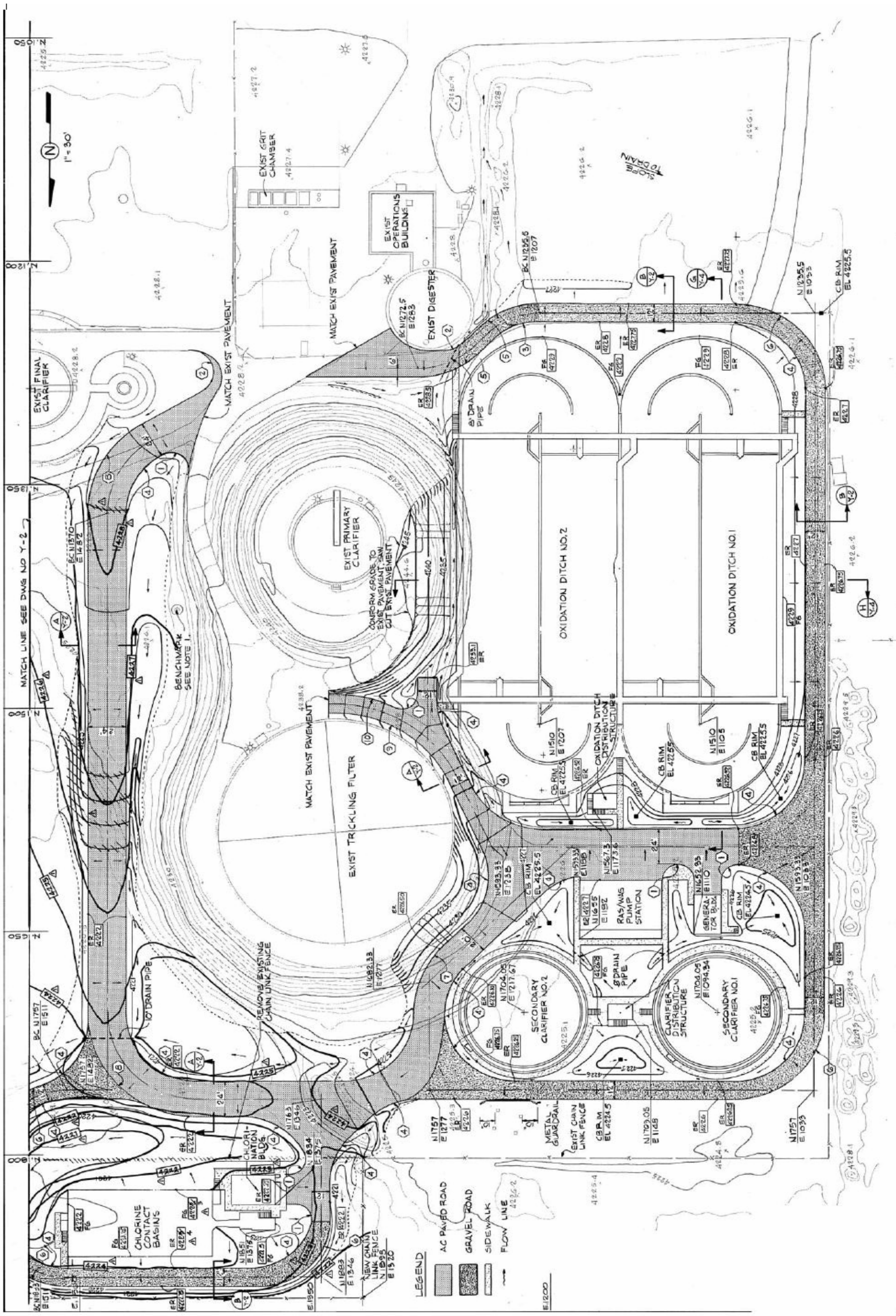



Figure 4.2.5 MagnaWRF Facility Map

*Central Valley Water Reclamation Facility* The Central Valley Water Reclamation Facility (CVWRF) was designed to replace five small antiquated wastewater treatment plants in the central part of the valley as part of the 1978 planning effort. Construction of the regional plant was completed in 1985. CVWRF serves populations within five sewage collection districts and two municipalities. Member entities include Granger-Hunter Improvement District (GHID), Kearns Improvement District (Kearns), Taylorsville-Bennion Improvement District (TBID), City of South Salt Lake (SSL), Murray City Corporation (Murray), Salt Lake City Suburban District No.1 (District 1) and Salt Lake County Cottonwood Sanitary District (Cottonwood). The CVWRF is located just North of 3200 South at 800 West Central Valley Road.

Process Description The CVWRF process includes primary treatment for initial removal of solids followed by a trickling filter/solids contact (TF/SC) secondary process. The plant utilizes anaerobic digestion for solids treatment and cogenerates with the digester gas. Class B biosolids are produced by the plant. Liquid chlorine gas disinfection followed by sulfur dioxide dechlorination is performed prior to discharge. The plant operates a small-scale filtration system that provides reuse water to an onsite golf course. An overview of the plant is presented in Figure 4.2.6. Main process components include the following:

Central Valley Water Reclamation Facility discharge to Mill Creek, Lower Mill Creek Sub-Watershed

- Pretreatment Including Screening and Grit Removal
- Primary Clarifiers
- Trickling Filters
- Solids Contact Tanks
- Final Sedimentation Clarifiers
- Chlorine Contact Basins
- Return Sludge and Waste Pumps
- Digester Feed Pumps
- Anaerobic Digesters – Conventional and Egg Shaped
- Screen Presses

Treatment Capacity The CVWRF has a capacity of 75 mgd ADF and receives approximately 50 mgd ADF of flow.

*South Valley Water Reclamation Facility* The South Valley Water Reclamation Facility (SVWRF) was designed to replace three small wastewater treatment plants in the upper Jordan planning area as part of the 1978 planning effort. The SVWRF is located approximately 15 miles south of Salt Lake City on the West Bank of the Jordan River in West Jordan, Utah (7495 South 1300 West, West Jordan). The facility provides wastewater treatment for the cities of Midvale, West Jordan, South Jordan, Riverton, Bluffdale, Draper, Copperton, most of Sandy (Sandy Suburban Improvement District), Herriman and unincorporated portions of South Salt Lake County. The SVWRF treatment plant was commissioned for service in 1985 with an initial capacity of 25.5 mgd ADF. In 1992, the plant was upgraded to its current capacity of 38 mgd ADF.

Process Description The SVWRF is an oxidation ditch process. The plant utilizes dissolved air flotation (DAF) thickening and belt press dewatering of undigested solids. Disinfection consists of ultra-violet disinfection (UV) with hypochlorite back-up. The plant discharges to the Jordan River. An overview of the plant is presented in Figure 4.2.7. Main process components include the following:

- Pretreatment Including Screening and Grit Removal
- Oxidation Ditches
- Final Clarifiers
- Ultra-Violet Disinfection

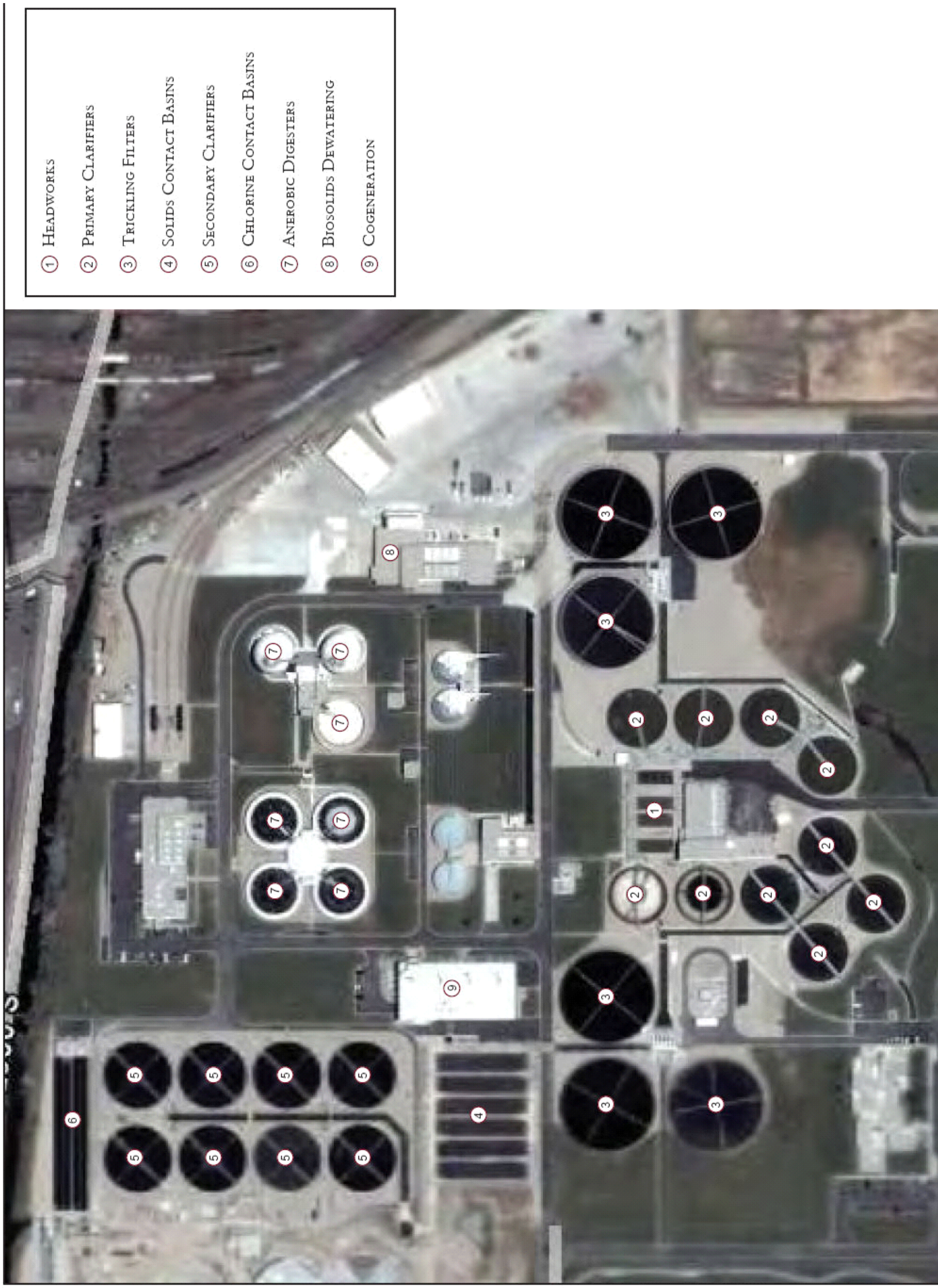



Figure 4.2.6 Central Valley WRF Facility Map


**Figure 4.2.7 South Valley WRF Facility Map**

- Final Sedimentation Clarifiers
- Return Sludge and Waste Pumps
- DAF-Thickening
- Belt Press Dewatering

Treatment Capacity The SVWRF has a treatment capacity of 38 mgd and is currently being expanded to 50 mgd. The plant is considered expandable to 80 using existing processes. The plant currently receives approximately 32 mgd ADF.

### 4.2.3 Expansion and Improvement Plans

The purpose of this section is to summarize known expansion and upgrade plans at each of the existing plants and the planned Riverton Facility. Future and current plans are discussed with regards to flow related expansion, process upgrades, biosolids and water quality.

Of the four existing wastewater treatment facilities, three plants SLCWRF, MagnaWRF and SVWRF, are currently in construction for major expansion and/or upgrade projects. CVWRF completed a secondary sedimentation system expansion that added two additional secondary clarifiers in 2005, return and waste pumps and related appurtenances. In addition, CVWRF is currently considering improvements to their disinfection system. Design concepts for the planned Riverton Facility as presented in the Wastewater Treatment Facility Plan Draft Report and 208 Addendum (Bowen Collins and Associates, 2005) are also summarized herein.

#### 4.2.3.1 Salt Lake City Water Reclamation Facility

In response to increases in organic strength of the influent wastewater, the SLCWRF began updating the facility to ensure compliance with permit water quality limitations. Construction of the Secondary Upgrades Project began in the first quarter of 2004. The project consists primarily of six new aeration basins with fine bubble diffusers, two new 159-ft diameter secondary clarifiers, two new 70-mgd RAS/WAS pumping stations, new electrical service, and ancillary facilities. Flow and organic loading criteria for the new process is listed in Table 4.2.1.

Figure 4.2.8 presents the secondary process upgrade. Based on flow projections developed in

**Table 4.2.1 SLCWRF Organic Loading Criteria**

| Design Parameter | Unit | Value |
|---|---|---|
| **Flow** | | |
| Annual Average Daily Flow | mgd | 56.0 |
| Maximum Month Daily Flow | mgd | 70.0 |
| Total Peak Hour Flow | mgd | 140.0 |
| Treated Peak Hour Flow | mgd | 96.0 |
| Bypassed Flow | mgd | 44.0 |
| **Organic Loading** | | |
| Average Annual $BOD_5$ | mg/L<br>lbs/day | 290<br>135,507 |
| Maximum Month Average Daily BOD | mg/L | 290 |
| Average Annual Total Suspended Solids (TSS) | mg/L<br>lbs/day | 190<br>88,780 |
| Average Annual Ammonia ($NH_3$-N) | mg/L<br>lbs/day | 18<br>8,410 |
| Average Annual TKN | mg/L<br>lbs/day | 28.8<br>13,457 |


FACILITY INDEX

NEW / MODIFIED FACILITIES

- (A) AERATION BASINS
- (B) SECONDARY CLARIFIER NO. 8
- (C) SECONDARY CLARIFIER NO. 7
- (D) NORTH RAS/WAS PUMP STATION
- (E) SOUTH RAS/WAS PUMP STATION
- (F) SECONDARY EFFLUENT CHANNEL
- (G) BLOWER BUILDING
- (H) TRICKLING FILTER PUMP STATION
- (J) MANHOLE NO. 2
- (K) BIOSOLIDS STORAGE PAD
- (L) ELECTRICAL TRANSFORMER AND POWER FEED
- (M) SNAIL DEWATERING FACILITY
- (N) MCC 4A BUILDING
- (P) MCC 8A BUILDING

EXISTING FACILITIES

- (1) BIOSOLIDS STORAGE PAD
- (2) SECONDARY CLARIFIER NO. 5
- (3) SECONDARY CLARIFIER NO. 6
- (4) TRICKLING FILTER NO. 1
- (5) TRICKLING FILTER NO. 2
- (6) TRICKLING FILTER NO. 3
- (7) TRICKLING FILTER NO. 4
- (8) TRICKLING FILTER NO. 5
- (9) TRICKLING FILTER NO. 6
- (10) TRICKLING FILTER NO. 7
- (11) TRICKLING FILTER NO. 8
- (12) WEST RAS PUMP STATION
- (13) REAERATION BASINS
- (14) ADMINISTRATION BUILDING
- (15) CHLORINE CONTACT BASIN
- (16) CHLORINE BUILDING
- (17) COGENERATION BUILDING
- (18) SECONDARY CLARIFIER NO. 1
- (19) SECONDARY CLARIFIER NO. 2
- (20) SECONDARY CLARIFIER NO. 3
- (21) SECONDARY CLARIFIER NO. 4
- (22) FLOCCULATION BASINS
- (23) SNAIL REMOVAL FACILITY
- (24) EAST RAS PUMP STATION
- (25) GRAVITY THICKENER
- (26) PRIMARY CLARIFIER
- (27) DIGESTER
- (28) CONTROL BUILDING
- (29) MAINTENANCE BUILDING
- (30) SLUDGE DRYING BED
- (31) ELECTRICAL TRANSFORMER AND POWER FEED
- (32) SWITCHGEAR BUILDING
- (33) TUNNEL G
- (34) POST AERATION
- (35) POST AERATION BLOWER ROOM & FAN HOUSE

**Figure 4.2.8 SLCWRF Secondary Process Upgrade Summary**

the 2002 Facility Design Report, the plant rated capacity of 56 mgd is expected to be reached in 2027 (Carollo Engineers, 2002).

Based on current improvements, and the planned future addition of a fifth primary clarifier, the plant is ultimately anticipated to pass peak flows of 140 mgd.

Currently, several process units are being brought online with anticipation that most major construction activities will end in the next six to eight months.

Other projects currently being considered by SLCWRF include reuse opportunities, odor control and biosolids. A new plant site was purchased in the 1990's to accommodate future growth of the City. Significant growth in the northwest quadrant of the City would likely be a catalyst for evaluating a new plant.

#### 4.2.3.2 Magna Water Reclamation Facility

Magna Water Company is currently in design and construction of a sidestream treatment process at the MangaWRF primarily for the removal of perchlorate (a byproduct of solid rocket fuel propellant) from upstream industrial discharges and planned groundwater remedial efforts at the Barton Well Field. The process treats perchlorate-laden waste streams by blending the concentrate waste streams with municipal wastewater in a fixed bed bioreactor. Perchlorate is biologically reduced to chloride oxygen by bacteria indigenous to the wastewater. Effluent is discharged back to the plant treatment process. The project consists of a new headworks including screens and grit removal, blending tank, influent pumps and perchlorate treatment facility (BIOBROx). A preliminary process flow diagram of the new facility is presented in Figure 4.2.9.

These improvements are anticipated to improve the existing plant capacity. Other projects currently being considered by MagnaWRF include reuse opportunities to expand the City's existing secondary system.

*Source: www.svwater.com*
South Valley Water Reclamation Facility Oxidation Ditch, Jordan River Corridor Sub-Watershed

#### 4.2.3.3 Central Valley Water Reclamation Facility

No current major flow or process related improvements to improve capacity are anticipated for the CVWRF. Future projects being considered by CVWRF include alternate means of disinfection (such as UV or onsite sodium hypochlorite generation) and improvements to their solids handling system to produce Class A biosolids.

#### 4.2.3.4 South Valley Water Reclamation Facility

The SVWRF is currently in construction of a major process upgrade to expand the plant from 38 mgd ADF to 50 mgd ADF (Project 4C). The project consists of a new staged aeration aerobic reactor, biosolids thermal dryer, blower building, electrical substation and final clarifier. Design criteria listed in the Executive Summary of the South Valley Water Reclamation Facility Plan for flow and loadings of the current plant expansion are listed in Table 4.2.2 (Montgomery Watson Harza, 2001).

An overview of the project facilities is presented in Figure 4.2.10.

Future planned projects will include modifying the existing oxidation ditches from surface aerators to diffused, staged aeration. These modifications will increase the plant to a capacity of 50 mgd. Additional expansion to 80 mgd is possible using existing processes.

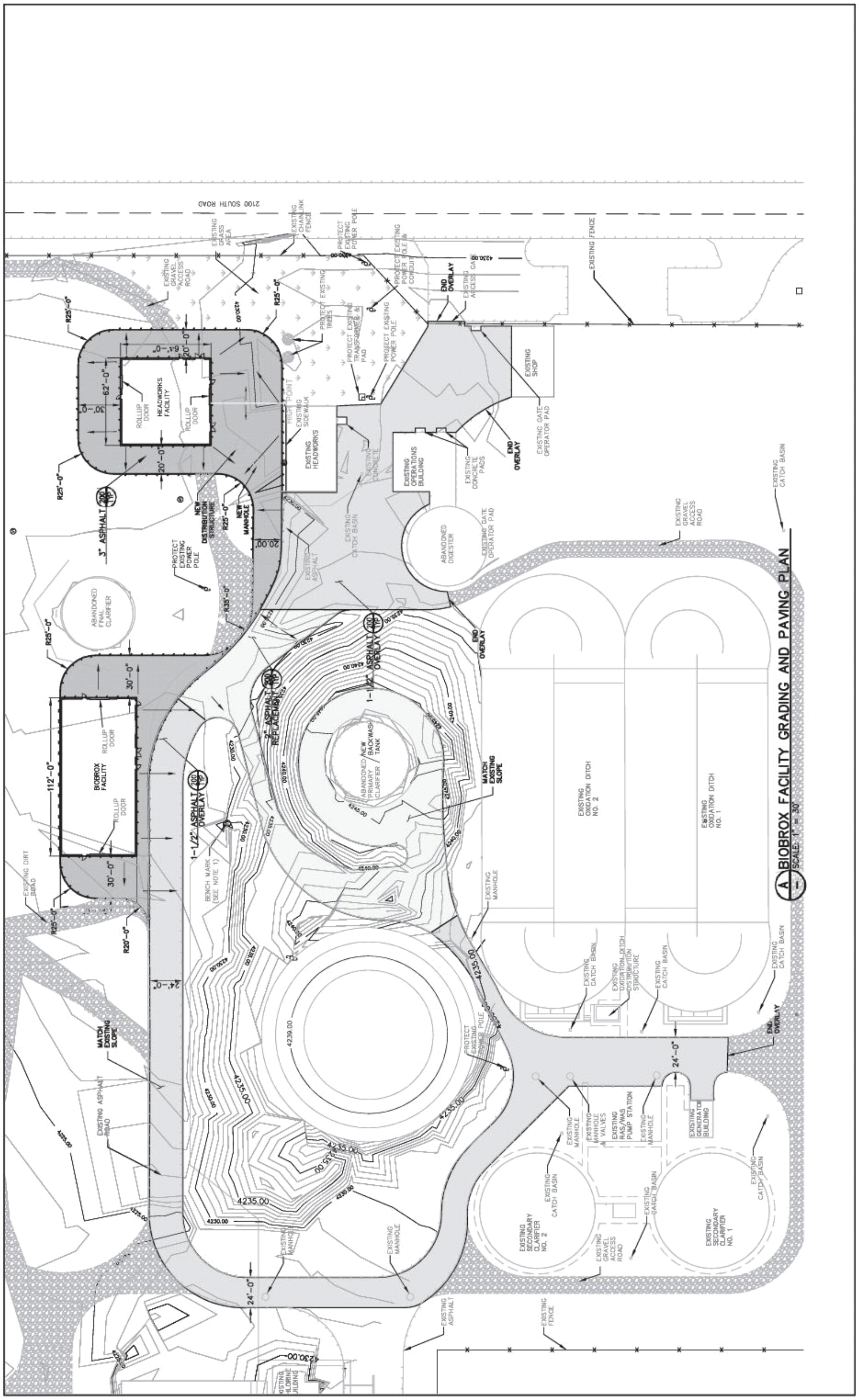



**Figure 4.2.9 MagnaWRF Preliminary Process Flow Diagram**

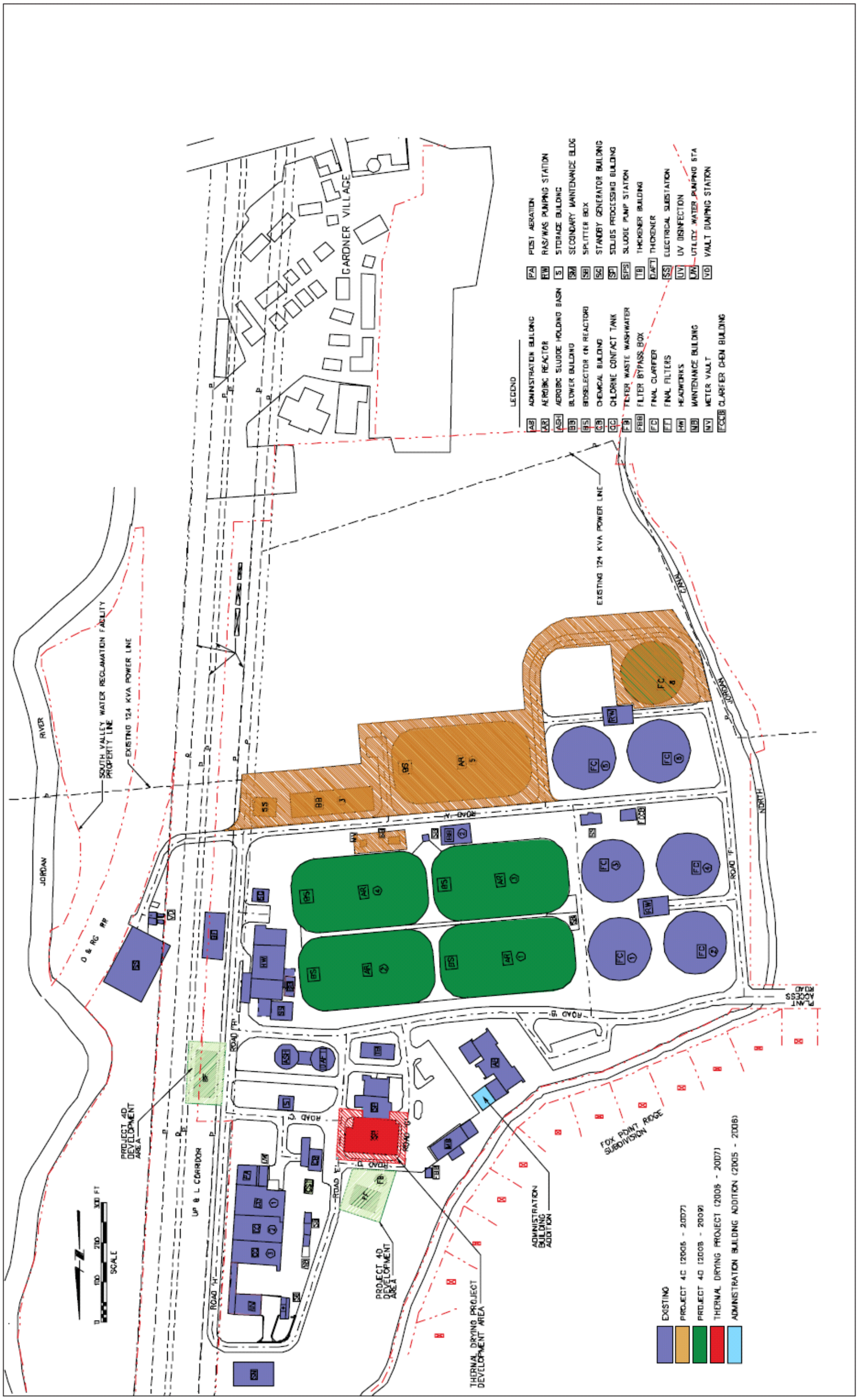



Figure 4.2.10 SVSD New Plant Location

**Table 4.2.2 SVWRF Design, Flow, and Loading Criteria**

| Design Parameter | Unit | Value |
|---|---|---|
| **Flow** | | |
| Peak to Average Daily Flow | ratio | 1.65 |
| Average Daily Flow | mgd | 50.0 |
| Peak Daily Flow | mgd | 82.5 |
| Flow Basis for Loads | mgd | 60.0 |
| **Influent Characteristics** | | |
| $BOD_5$ | mg/L | 200 |
| Ammonia-Nitrogen (NH3-N) | mg/L | 21 |
| TKN | mg/L | 31 |
| **Loadings** | | |
| Max. to Average Month Loadings | ratio | 1.1216 |
| Max month $BOD_5$ Loading | lbs/day | 112,250 |
| Max Month NH3-N Loading | lbs/day | 11,600 |
| Max. Month TKN Loading | lbs/day | 17,200 |

### 4.2.3.5 South Valley Sewer District POTW

The South Valley Sewer District (SVSD) provides wastewater collection services to rapidly growing communities located in south Salt Lake County and limited areas of north Utah County. Wastewater treatment in this area is currently provided by the SVWRF. Costs associated with providing additional conveyance and treatment capacity at SVWRF has prompted the District to explore alternatives for treatment at a new facility. The *Wastewater Treatment Facility Plan Draft Report* and 208 Addendum (Bowen Collins and Associates, 2005) was developed to evaluate potential sites for building a new facility, alternative treatment methods and preliminary costs. The report recommends building a new plant in Riverton with an initial capacity of 15.0 mgd expandable to 30.0 mgd.

The following process elements have been proposed for the new plant:

- Headworks and Influent Pump Station
- Aeration Basins
- Membrane Basins
- RAS/WAS Pump Station
- Ultraviolet Disinfection Facility
- Post Aeration Basin and Utility Water Pump Station
- River Discharge Structure
- Aerated Solids Holding Basin
- Solids Dewatering Facility and Transport Equipment
- Administration Building
- Maintenance Building
- Blower Building

Recently, the District has settled on a membrane bio-reactor process for the new plant. The proposed preliminary process flow diagram is shown in Figure 4.2.11.

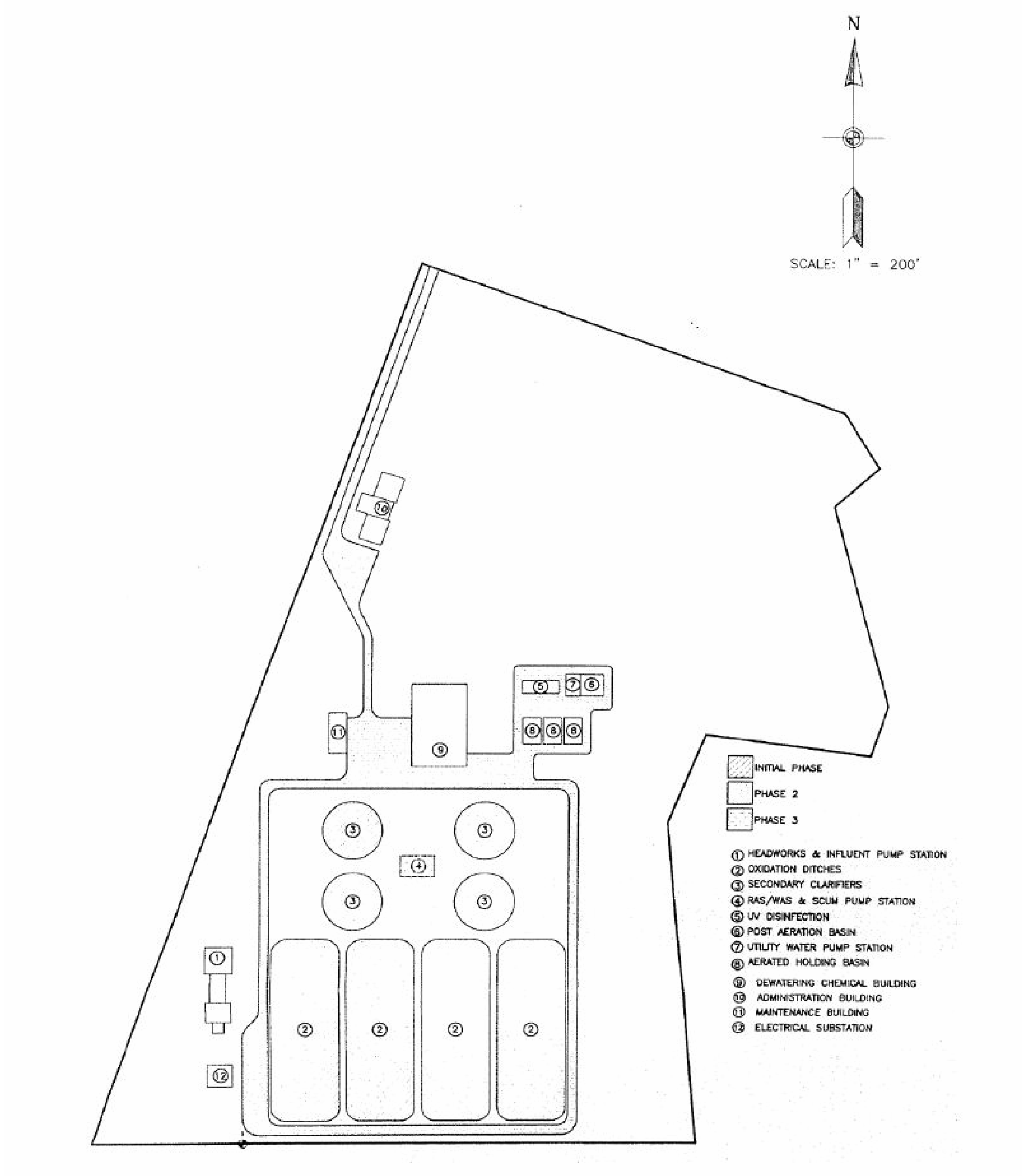



**Figure 4.2.11 SVSD Proposed Plant Layout**

## 4.2.4 Technology Review - Emerging Technologies, Trends, and Issues

### 4.2.4.1 Wastewater

The following sections provide a summary of emerging technologies, trends, and issues in the wastewater treatment field reviewed during this project. Write-ups of the technology, processes, trends and issues listed in the following sections can be found in Appendix C of this report. The review primarily focuses on secondary treatment, tertiary treatment, and disinfection processes since these are the process areas that have the most impact on improving water quality over current technology. Processes such as headworks (screens and grit removal), primary clarification and conventional secondary treatment processes such as trickling filters/biotowers and activated sludge are not covered, although there continues to be significant improvements in the design of these systems and the equipment associated with them.

The four existing treatment plants in Salt Lake County use conventional secondary treatment that incorporate a form of the activated sludge process (Figure 4.2.12) which has been the predominant secondary treatment technology nationwide for the past 30 to 40 years. Since the existing treatment plants have been constructed, there have been a number of advances in the wastewater field that may be applicable for enhancing treatment or expanding the capacity of the existing systems or that could be incorporated into the design of new treatment and/or reuse systems constructed in the County.

In addition to treatment processes, the following section lists topics associated with wastewater treatment that are of emerging concern and will likely affect the design of treatment processes in the future. Examples of these issues include air and noise emissions and previously said compounds of emerging concern (CEC's) such as pharmaceuticals in wastewater effluents.

Examples of pharmaceuticals include: Endocrine Disrupting Compounds (EDCs), Pharmaceuticals and Personal Care Products (PPCPs), and Toxic Organic Compounds (TOCs).

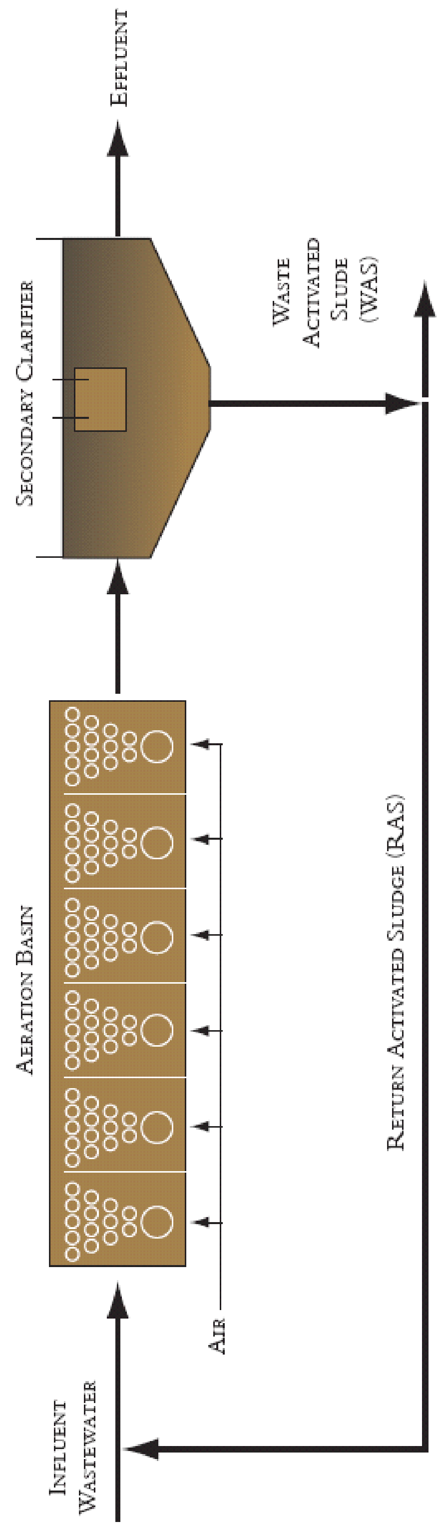



Figure 4.2.12 Typical Activated Sludge System Configuration for BOD Oxidation and Ammonia Nitrification

#### 4.2.4.2 Biosolids

Biosolids are the nutrient-rich solid organic material resulting from the treatment of domestic wastewater. Biosolids originate from the suspended solids entering the wastewater plant and from the solids produced by microorganism growth in the treatment process. These two types of solids are referred to as primary sludge and secondary or waste activated sludge, respectively. Biosolids differ from the "sludge" in that they are treated to standards required for recycling. Approximately 30 million pounds of dry solids from wastewater treatment are generated each day in the United States. Most of these solids are treated on-site and subsequently applied to agricultural lands in accordance with regulations developed by the U. S. Environmental Protection Agency (40 CFR, Part 503). The land application regulations for biosolids cover both chemical (metals and toxic organics) and biological contaminants. Depending on the concentration of pathogens, biosolids intended for land application are classified as either Class A or Class B. Unclassified biosolids are not allowed to be land applied and must be disposed of in a landfill or monofill.

The following section provides a list of the regulations, technologies, and issues concerning biosolids. Detailed writeups of each element can be found in Appendix C of this report. The review primarily focuses on the regulations and the processes necessary to produce Class A biosolids, the highest quality biosolids, since this is the area that has the most relevance for future management of biosolids from wastewater treatment processes. Processes such as conventional aerobic and anaerobic digestion that produce unclassified or Class B biosolids and solids thickening and dewatering processes are not covered, although there continue to be significant improvements in the design of these systems and the equipment associated with them.

*Class A Biosolids* The Class A biosolid criteria require that the concentrations of three classes of pathogens; bacteria, enteric viruses, and helminthes (intestinal worms), are below specified detection limits. The Class A requirements are:

- Fecal coliform less than 1,000 per gram dry solids:
- *Salmonella* less than 3 MPN per 4 grams dry solids
- Enteroviruses less than 1 PFU per 4 grams dry solids
- Helminth ova less than 1 viable ovum per 4 grams dry solids

All other biosolids are designated as Class B, with corresponding restrictions on distribution and the types of crops that can be grown on land to which Class B biosolids are applied, as well as restrictions on public access to the land. Since no such restrictions exist for the distribution and agricultural or landscaping use of Class A biosolids, there is an incentive for municipalities to produce Class A biosolids at wastewater treatment facilities.

The EPA regulations (40 CFR, Part 503) specify various methods by which Class A biosolids can be achieved. The six alternative methods in the regulations are:

- Alternative 1: Time and Temperature
- Alternative 2: Temperature and pH
- Alternatives 3 and 4: Documented Virus and Helminth Ova Destruction
- Alternative 5: PFRP Treatment Processes
- Alternative 6: Treatment with a Processes that Further Reduce Pathogens (PFRP)-Equivalent Process

In the list of alternatives above, there are several sludge treatment processes pre-approved as achieving Class A classification if certain operating conditions are met. In general, these processes rely on either chemical or thermal destruction of the pathogens in the sludge. Any process other than those pre-approved by EPA must be evaluated on a case-by-case basis to demonstrate that it can meet the Class A criteria. Processes proposed to achieve Class A status must be evaluated and approved by an EPA committee called the Pathogen Equivalency Committee (PEC). Class A equivalency can be sought and granted for either a specific treatment plant (site-specific equivalency) or for a generic process (national equivalency). The six alternatives for achieving Class A biosolids are outlined in more detail in the Appendix C.

*Class A Biosolids Processes* Although there are numerous processes with multiple variations that can be used to produce Class A biosolids, there are a few processes that are currently more common than others or are expected to be more applicable to Utah treatment facilities in the future. For example, composting (Alternative 5) is one of the more simple and straightforward processes and is commonly employed to achieve Class A biosolids. In some areas of the country, lime stabilization (Alternative 2) is relatively common since there is an agricultural need for material with a high pH to supplement low alkalinity soils. In Utah, most soils are already alkaline so lime stabilized biosolids are a less attractive product for land application. The three processes that are likely to have significant applicability for producing Class A biosolids at wastewater treatment facilities in Salt Lake County in the future are listed below. A complete writeup of these processes can be found in the Appendix C.

- Thermophilic-Mesophilic Anaerobic Digestion (Temperature Phased, or TPAD)
- Composting
- Thermal Sludge Drying

### 4.2.4.3 Water Reclamation and Reuse

There has been significant interest and activity in wastewater reclamation and reuse in states facing water shortages such as California over the past 10 to 15 years. With the recent drought and projected future population growth, reuse is gaining interest in Utah as well. Utah rules define two classifications of reuse water: Type I and Type II. Type I reuse water is the highest quality reuse water and is allowed to be used for the following applications:

- Residential irrigation, including landscape irrigation at individual houses.
- Urban uses, which includes non-residential landscape irrigation, golf course irrigation, toilet flushing, fire protection, and other uses with similar potential for human exposure. Internal building uses of reuse water are not allowed in individual residences; and are only permitted in situations where maintenance access to the building's utilities is strictly controlled and limited only to the services of a professional plumbing entity. Projects involving effluent reuse within a building must be approved by the local building code official.
- Irrigation of food crops where the applied reuse water is likely to have direct contact with the edible part, including spray irrigation of food crops.

Central Valley Water Reclamation Facility biosolids compost product

- Irrigation of pasture for milking animals.
- Reservoirs and impoundments of wastewater where direct human contact is likely to occur.

Type II reuse water is lower quality than Type I water and is permitted to be used for the following applications:

- Irrigation of sod farms, silviculture, limited access highway rights of way, and other areas where human access is restricted or unlikely to occur.
- Irrigation of food crops where the applied reuse water is not likely to have direct contact with the edible part, whether the food will be processed or not (spray irrigation not allowed).
- Irrigation of animal feed crops other than pasture used for milking animals.
- Impoundments of wastewater where direct human contact is not allowed or is unlikely to occur.
- Cooling water. Use for cooling towers which produce aerosols in populated areas may have special restrictions imposed.
- Soil compaction or dust control in construction areas.

Most reuse applications in an urban environment such as Salt Lake County would require the production of Type I reuse water. The production of Type I reuse water requires high quality secondary effluent with a BOD less than 10 mg/L. Filtration and disinfection processes are also required to produce a turbidity less than 2 NTU, a fecal coliform level of non-detect, and a residual chlorine concentration of greater than 1.0 mg/L after 30 minutes of contact time. For specific uses such as those impacted by salinity or dissolved solids additional treatment beyond that required for Type I reuse may be required. There are a number of treatment processes that are currently used to produce reuse water of Type I quality or greater. A complete writeup of these processes can be found in the Appendix C of this report.

#### 4.2.4.4 Decentralized Treatment Systems

Decentralized wastewater management refers to the collection, treatment and disposal of wastewater from individual residences and from small communities, isolated public facilities (e.g., state parks), industrial parks, and other isolated wastewater generators not connected to larger conventional sewer collection and treatment systems. In the United States, more than 60 million people live in homes served by decentralized wastewater collection and treatment systems (Crites and Tchobanoglous, 1998). Although in most instances it is preferable to have centralized facilities, complete centralization of sewerage in all areas will never be possible for geographical and economic reasons. Therefore, proper decentralized wastewater management is important for protection of the environment, health and water resources. Crites and Tchobanoglous (1998) outline a number of situations where decentralized wastewater management may be applicable including the following:

- Where a community or facility is remote from existing sewers.
- Where localized water reuse opportunities exist.
- Where the fresh water for domestic use is in short supply.
- Where existing wastewater system capacity is limited and not readily expandable or would require unnecessary disruption of the community.
- Where, for environmental reasons, the quantity of wastewater effluent discharged to the environment must be limited.
- Where residential density is sparse.
- Where regionalization would require political annexation that would be unacceptable.

There are a multitude of options for decentralized wastewater management. A few of the more common options that are currently used or may be applicable in the future in Salt Lake County are listed below. A complete writeup of these processes can be found in Appendix C of this report.

- Septic Systems (Conventional and Enhanced)
- Cluster Systems
- Package Membrane Bioreactor Systems
- Gray Water Systems

#### 4.2.4.5 Siting Trends

There are several trends emerging in the siting and integration of wastewater treatment facilities within the communities they serve. These siting and integration trends generally attempt to overcome past nuisance problems associated with wastewater treatment facilities and attempt to blend facilities into the surrounding community, make them better neighbors and provide additional community benefits such as environmental education centers and recreational facilities. Several issues relating to the siting and construction of wastewater facilities are listed below. A complete writeup of these issues and several relevant examples can be found in Appendix C of this report.

- Scalping vs. End of Pipe Treatment
- Architectural Treatments/Blending with Surroundings

Although siting of new, lower impact, aesthetically pleasing facilities may overcome past nuisance problems associated with existing facilities, it is important to note that in many instances, correction of nuisance issues can be accomplished at existing facilities at lower cost than new facilities.

Planned site for South Valley Sewer District facility in Riverton, UT

### 4.2.5 Current Regulatory Standards and Trends

Current environmental regulations at federal, state and local levels which have direct application to the wastewater element of the Water Quality Stewardship Plan (WaQSP), were researched and are presented in this section. Wastewater regulations are of primary importance for the development of the wastewater element of the stewardship plan. However, not every aspect of water/wastewater protection is translated into wastewater regulations and, therefore, some programs and guidelines such as the State's stormwater program and water reuse guidelines are also referenced. In addition to wastewater regulation, there are several other environmental regulations that directly and indirectly affect water and wastewater systems operation such as solid and hazard waste, air emission, safety, erosion and sediment control, environmental impact, and others. These regulations are also presented in this section.

#### 4.2.5.1 Federal Regulations

Federal laws designed to promote public health by protecting the nation's air, water, and soil are developed and enforced by the U. S. Environmental Protection Agency (EPA). The EPA is organized into ten different regions that are responsible for execution of the Agency's programs. Utah is located in EPA's Region 8 which also includes Colorado, Montana, North Dakota, South Dakota, Wyoming, and 27 sovereign tribal nations. EPA's Region 8 office is located in Denver, Colorado.

A list of federal regulations pertinent to wastewater planning are presented in the following sections.

*Water and Wastewater Regulations (including NPDES, stormwater, water reuse, wetlands and pretreatment)*

- The Clean Water Act (CWA)
- The Safe Drinking Water Act (SDWA)
- The NPDES system, Section 402 of the CWA
- Stormwater Regulations – Phases I and II of the NPDES Stormwater Program

- Wetlands – Section 404 of CWA
- Water Reuse: EPA Guidelines for Water Reuse
- Wastewater Pretreatment Program – 40 CFR Part 403

*Solid and Hazard Waste (including sludge management and reuse)*

- The Resource Conservation and Recovery Act (RCRA), also known as the Solid Waste Disposal Act
- Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA or Superfund)
- The Emergency Planning & Community Right-To-Know Act (EPCRA)
- EPA's Sewage Sludge Management Program

*Air Emissions*

- The Clean Air Act (CAA)

*Safety and Security*

- The Occupational Safety and Health Act
- Public Health Security and Bioterrorism Preparedness and Response Act (The Bioterrorism Bill)

*Additional Federal Regulations*

- National Environmental Policy Act of 1969 (NEPA)
- The Pollution Prevention Act (PPA)
- The Endangered Species Act (ESA)
- The Conservation Title of the Farm Security and Rural Investment Act (2002 Farm Bill)

### 4.2.5.2 Utah State Regulations

The Utah Administrative Code (UAC) is a compilation of the administrative law of Utah as published by the Division of Administrative Rules (DAR). The UAC is Utah's equivalent to the EPA's Code of Federal Regulations (CFRs). Revisions to the UAC are handled through the DAR on a monthly basis. Utah has primacy (i.e. the primary responsibility for administering and enforcing regulations) for all rules and while able to enforce more stringent requirements, must justify those through the EPA.

The UAC is generally organized alphabetically by department, board, or commission, then agency. Utah's environmental laws are located under the environmental section of the UAC and are as follows:

- Title R305. Administration.
- Title R307. Air Quality.
- Title R309. Drinking Water.
- Title R311. Environmental Response and Remediation.
- Title R313. Radiation Control.
- Title R315. Solid and Hazardous Waste.
- Title R317. Water Quality.

The Department of Environmental Quality, Division of Water Quality (DWQ) is the governing agency for regulations directly related to wastewater and wastewater treatment works in Utah.

### 4.2.5.3 Salt Lake Valley Health Department

Applicable Salt Lake Valley Health Department (SLVHD) regulations pertaining to wastewater management and planning in Salt Lake County include Health Regulation #13 Waste Water Disposal. The stated purpose of Regulation #13 is to "provide for the health, safety, and general welfare of the citizens of Salt Lake County and protect the environment through the regulation of illegal discharge of wastewater and pollutants to the maximum extent practicable as required by federal, state, and local law." The specific objectives of this regulation are to:

1. Mandate connections of buildings to a public sewer system when the sewer is available to property.
2. Permit and regulate the installation and use of onsite wastewater systems.
3. Require and regulate toilet facilities.
4. Prohibit the illegal discharge of wastewater.

#### 4.2.5.4 Anticipated Legislation

A review of proposed federal and state legislation pertinent to wastewater regulations can be found in Appendix C.

*State* Sections of State water quality rules (R317) which are currently under revision. The official publication for announcing such changes is the Utah State Bulletin, published on the 1st and 15th of each month by the Division of Administrative Rules (DAR) and available on their web site www.rules.utah.gov. Descriptions of each rule change can be found on the website.

In addition to the above, the State of Utah DWQ was contacted for further information on future wastewater rule updates. The following notes were developed based on this discussion:

- The DWQ is now authorized to issue permits for reuse facilities and they want to change the rules to allow them to issue operating permits for all types of facilities including non-discharging facilities such as containment lagoons (i.e., anyone currently without a UPDES permit)
- The DWQ will be revising R317 Part 3 which governs the design requirements for wastewater collection, treatment and disposal systems in the near future. The current rule is out-of-date and does not cover any of the newer processes such as Cannibal, MBR's, etc. This effort will begin in early 2007.
- The DWQ just finished rewriting R317 Part 4 which governs onsite wastewater systems.
- R317 Part 5 which governs large underground wastewater disposal systems needs to be rewritten soon.
- The DWQ is currently doing minor work on R317 Part 11 concerning the Certification Required to Design, Inspect and Maintain Underground Wastewater Disposal Systems, or Conduct Percolation and Soil Tests for Underground Wastewater Disposal Systems.

#### 4.2.5.5 Jordan River and Emigration Creek Water Quality Standards and TMDL Process

The following section includes summary information on the Jordan River and Emigration Total Maximum Daily Load (TMDL) process as well as an update on the current TMDL schedule.

A TMDL is a calculation of the maximum amount of a pollutant that a water body can receive on a daily basis and still meet water quality standards. The TMDL process consists of the following steps:

1. Review existing water quality data
2. Identify sources and causes of pollutants
3. Identify water quality goals
4. Establish the amount of pollutant that can be allowed in total
5. Allocate allowable pollutant loads
6. Identify and implement measures to achieve and maintain water quality standards
7. Monitor to assure that goals are met

The Division of Water Quality Board has grouped the waters of the State of Utah into classes so as to protect against controllable pollution. These classes are established to protect beneficial uses. Surface waters of the state of Utah are classified as follows (Utah Code R317-2-13):

Class 1 -- Protected for use as a raw water source for domestic water systems.

Class 1A -- Reserved.

Class 1B -- Reserved.

Class 1C -- Protected for domestic purposes with prior treatment by treatment processes as required by the Utah Division of Drinking Water

Class 2 -- Protected for recreational use and aesthetics.

Class 2A -- Protected for primary contact recreation such as swimming.

Class 2B -- Protected for secondary contact recreation such as boating, wading, or similar uses.

Class 3 -- Protected for use by aquatic wildlife.

Class 3A -- Protected for cold water species

Jordan River, Jordan River Corridor Sub-Watershed

of game fish and other cold water aquatic life, including the necessary aquatic organisms in their food chain.

Class 3B -- Protected for warm water species of game fish and other warm water aquatic life, including the necessary aquatic organisms in their food chain.

Class 3C -- Protected for nongame fish and other aquatic life, including the necessary aquatic organisms in their food chain.

Class 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.

Class 3E -- Severely habitat-limited waters. Narrative standards will be applied to protect these waters for aquatic wildlife.

Class 4 -- Protected for agricultural uses including irrigation of crops and stock watering.

Class 5 - The Great Salt Lake. Protected for primary and secondary contact recreation, waterfowl, shore birds and other water-oriented wildlife including their necessary aquatic organisms in their food chain, and mineral extraction.

*Jordan River TMDL* In 1998, the DWQ found that dissolved oxygen (DO) levels in the Jordan River were not meeting class 3B requirements. Subsequently, in the summer of 2004, the Salt Lake County Water Resources Planning and Restoration Program conducted a water quality assessment of the Jordan River to determine the sources and causes of the DO impairments. Data collected as part of this assessment indicate high levels of both pathogen indicator organisms and phosphorus in the Jordan River. This data, as well as conclusions drawn from this data, are found in the *Jordan River Water Quality Total maximum Daily Load Assessment* (Jensen and Rees, 2005).

The Jordan River has been listed as water quality impaired for: Dissolved Oxygen (DO), Total Dissolved Solids (TDS), E. coli, and Temperature.

The Jordan River TMDL timetable will extend past development of the WaQSP and includes study areas outside of Salt Lake County.

*Emigration Creek TMDL* Emigration Creek is a 3rd order tributary of the Jordan River supporting 2B-Non-contact recreation and 3A-Coldwater fishery beneficial uses. In 2002, Salt Lake County conducted a water quality assessment of Emigration Creek and found high fecal coliform levels. This data was published in 2003 in the *Emigration Watershed Non-Point Pollution Assessment: Coliform Bacteria Water Quality Analysis* (Jensen et al, 2003). Emigration Creek is currently listed as impaired for E. coli (DWQ, 2006). The County is in the initial water quality assessment phase of the TMDL process. In this phase, five major water quality datasets have been examined. After reviewing these major datasets, several gaps have been identified including:

Emigration Creek, Upper Emigration Creek Sub-Watershed

- Insufficient seasonal E. coli data
- Insufficient diurnal E. coli data
- Insufficient flow data/characterization

In order to fill these datasets, the DWQ is working in conjunction with Salt Lake County to install four stage discharge meters along Emigration Creek to augment existing flow data. Seasonal water quality grab samples will be taken at the four metered flow locations as well as Rotary Park and Burr Fork. The Emigration Creek TMDL timetable will extend past development of the WaQSP.

#### 4.2.5.6 Great Salt Lake Water Quality Standards Development

The following section includes summary information on the Great Salt Lake and Farmington Bay water quality standard development (as adapted in part from the State's DWQ website).

Currently the Great Salt Lake has no numeric water quality criteria. The Department of Environmental Quality (DEQ) has established the Great Salt Lake Water Quality Steering Committee ("GSL Water Quality Steering Committee") to guide the process of developing numeric standards for the lake. This group consists of federal and state regulatory agencies, other public entities, conservation organizations, recreation groups, and industrial users of the lake.

The overall objective of the study is to set site-specific numeric water quality standards for open waters of the Great Salt Lake. The initial focus is on selenium. Under the Steering Committee's oversight, a science panel will evaluate existing selenium studies on the Lake and conduct additional work, where necessary. The committee will consider the science panel's work, and then make a recommendation to the Water Quality Board. If the Board accepts the recommendation, the standard will be sent out for public comment before the action is final.

Mercury is also a concern and is currently being studied by the DWQ. DWQ has initiated a Mercury Work Group (MWG) to coordinate and collaborate mercury studies and investigations ongoing in the Great Salt Lake and Utah.

Great Salt Lake, Great Salt Lake Sub-Watershed

Farmington Bay was not initially listed on Utah's 303(d) list of impaired waters. In response to rising concerns that the nutrient load to Farmington Bay may be exceeding the assimilatory capacity of the wetlands the DWQ has applied for and received EPA grant money to begin developing assessment methods. Currently there are no EPA recommendations for water quality nutrient criteria for wetlands. The methods developed during this project will be used to set site specific water quality standards for nutrients as well as perform 303 (b)/303(d) assessments of the Farmington Bay wetlands. This process is ongoing and will extend past the development of the WaQSP.

#### 4.2.5.7 Reclaimed/Reuse Water Requirements

Regulations governing the recycling of wastewater in Utah emphasize the protection of public health. Reuse water regulations have been developed to greatly reduce or eliminate pathogens if human contact with the reclaimed water occurs. To reduce the risk of human uptake of pathogens, disinfection is required in most applications.

Regulations governing construction of wastewater treatment works in Utah are contained in the Utah Code Annotated under Utah R317-3, Design Requirements for Wastewater Collection, Treatment and Disposal Systems. Utah R317-1-4, Utilization and Isolation of Domestic Wastewater Treatment Works Effluent, contains requirements for reuse of treated domestic wastewater. In addition to specifying treatment requirements and reclaimed water quality for Type I and Type II effluent, there are regulations concerning record keeping, distribution system design, and signage.

If a new reuse project is proposed, a Reuse Project Plan must be submitted to the Division of Water Quality (DWQ) and to the local health department in accordance with R317-1-4.2. Details of the treatment requirements for Level I (where human exposure is likely) and Level II (where human exposure is unlikely) can be found in R317-1-4.3 (A) and (B) and R317-1-4.4 (A) and (B), respectively.

#### 4.2.5.8 Gray Water Requirements

Although seen as a viable reuse alternative in other States, gray water systems have yet to see widespread use in Utah. Gray water (i.e. wastewater generated from domestic processes such as washing dishes, laundry and bathing) systems are generally found in rural, single family residences where other wastewater disposal options are limited. However, due to increasing emphasis on water reuse and recycling efforts, gray water systems continue to gain attention locally and nationwide. State rules and regulations concerning the use of gray water can be obtained from the DEQ website and from the Salt Lake Valley Health Department (SLVHD). Utah rules pertaining to general definitions, administrative, and approval requirements for gray water systems can be found in Utah Code R317-401, Sections 1 through 4.

In comparison to other nearby States, Utah's rules appear to be more restrictive, not only from an administrative and approval standpoint, but also in adherence to a set of prescribed detailed design requirements and conditions. This is apparent by comparing the Utah administrative requirements in Table 4.2.3 to the requirements for surrounding states of Arizona and New Mexico.

#### 4.2.5.9 Biosolids Requirements

Disposal of biosolids (i.e. solids or semisolids obtained from treated wastewater) by land application is regulated under the U.S. EPA 40 CFR Part 503 biosolids rule and Utah's federal equivalent Title R315 Solid and Hazardous Waste. This regulation classifies biosolids as Class A or Class B based on pathogen levels remaining in the biosolids after stabilization. Aerobically digested biosolids are designated Class B and have site and time restrictions on land application and disposal whereas Class A biosolids have no disposal restrictions.

The U.S. EPA 40 CFR Part 503 regulations for biosolids contains five sub-parts including general provisions, requirements for land application, surface disposal, pathogen and vector attraction reduction, and incineration. For each of the disposal practices, the regulation outlines general requirements, pollutant limits, management practices, operational standards, monitoring, record keeping, and reporting.

Subpart B of the rule specifies requirements for land application of biosolids. There are several options for land disposal, all of which are equally protective of human health and the environment. In general, land application of biosolids must meet three conditions: 1) limitations of pollutants in the biosolids, 2) pathogen reduction requirements, and 3) vector attraction reduction requirements.

*Pollutant Limitations*

1) All biosolids must meet the ceiling concentrations for the 10 metal pollutants. If the limit for any one of the pollutants is exceeded, the sludge may not be land applied. Alternative disposal sites must be utilized or further processing must be performed.

### Table 4.2.3 Comparison of Utah Gray Water Provisions and Surrounding States

| Provision | Arizona | Colorado | Nevada | New Mexico | Utah |
|---|---|---|---|---|---|
| Permit Required | | X | X | | X |
| Allowed flow (gpd) | 400 | | SFD only | 250 | SFD only |
| Overflow to sewer | X | | X | X | X |
| Tank cover | X | | | X | X |
| ID as non potable | X | | | X | X |
| No runoff from lot | X | | X | X | X |
| No discharge to surface water | X | | X | X | X |
| No ponding | X | | X | X | X |
| Avoid people and pets | X | | | X | |
| No spraying | X | | X | X | X |
| No vegetable watering | | | | X | X |
| Setback distances | | | | X | X |
| No public nuisance | | | | X | |
| No hazmat | X | | | X | |

*Note: SFD = Single Family Dwelling*

2) Biosolids applied to the land must also meet either pollutant concentration limits or cumulative pollutant loading rate limits. The product of the pollutant concentration and annual sludge application rate shall not exceed the annual pollutant loading rate.
3) Either Class A or Class B pathogen reduction requirements and site restrictions must be met before biosolids can be land applied. Pathogen reduction requirements will be covered in detail in this Section. If biosolids are designated Class B, then site restrictions must be followed.

One out of the six options for vector attraction reduction must be met before biosolids can be land applied.

*Pathogen Reduction* Pathogen reduction alternatives ensure that pathogen levels in biosolids are reduced to levels considered safe for the biosolids to be land applied. Subpart D presents criteria for classifying biosolids as either Class A or Class B. If indicator pathogens such as *Salmonella* sp. bacteria, enteric viruses, E. coli, and viable helminth ova are reduced to nearly undetectable limits, the biosolids meet the Class A designation. Biosolids are designated as Class B if the indicator pathogens are detectable but are below levels that pose a threat to humans and the environment. Land application and usage restrictions for Class B biosolids are designed to prevent exposure to the pathogens while natural processes further reduce pathogens before the site is used for purposes which may affect humans.

Part 503 Subpart D lists six alternatives for treating biosolids to meet Class A pathogen reduction requirements. In general, the objective is to reduce pathogens below detectable limits defined as:

- The density of the *Salmonella* sp. bacteria in the biosolids must be less than 3 most probable number (MPN) per 4 grams of total solids (dry weight basis).
- Enteric Viruses must be less that 1 MPN per 4 grams of total solids.
- Viable helminth ova must be less that 1 MPN per 4 grams of total solids.

The six Class A stabilization alternatives are identified in 40 CFR Part 257 "Processes that Further Reduce Pathogens" (PFRPs) and equivalent technologies.

After municipal sludge has been treated using one of the six Class A alternatives for pathogen reduction, the potential for regrowth of pathogenic bacteria exists. To insure that significant regrowth has not occurred, Class A pathogen reduction alternatives also require the following at the time of disposal, use, or preparation for sale.

- *Either* the density of fecal coliform in the biosolids must be less than 1000 MPN per gram total solids (dry weight basis);
- *Or* the density of the *Salmonella* sp. bacteria in the biosolids must be less than 3 MPN per 4 grams of total solids (dry weight basis).

Class B pathogen requirements can be met using one of three alternatives, as defined in 40 CFR 257. Unlike Class A biosolids in which pathogens are below detectable limits, Class B biosolids contain limited amounts of pathogens. For this reason, the Class B requirements for land application of biosolids also include site restrictions for certain periods of time after application until environmental conditions have further reduced pathogens as listed below:

- Harvesting of food is restricted from 14 to 38 months depending on type of crop and its degree of contact with the soil/biosolids.
- Animal grazing is restricted for 30 days.
- Turf harvesting is restricted for 1 year.
- Public access is restricted from 30 days to 1 year depending on potential for public exposure.

*Vector Attraction Reduction* Vectors are any living organism capable of transmitting a pathogen from one organism to another. Vectors for sewage sludge pathogens are most likely to be insects, rodents, and birds. The 503 regulations contain 12 options to show that the biosolids have reduced attractiveness to vectors.

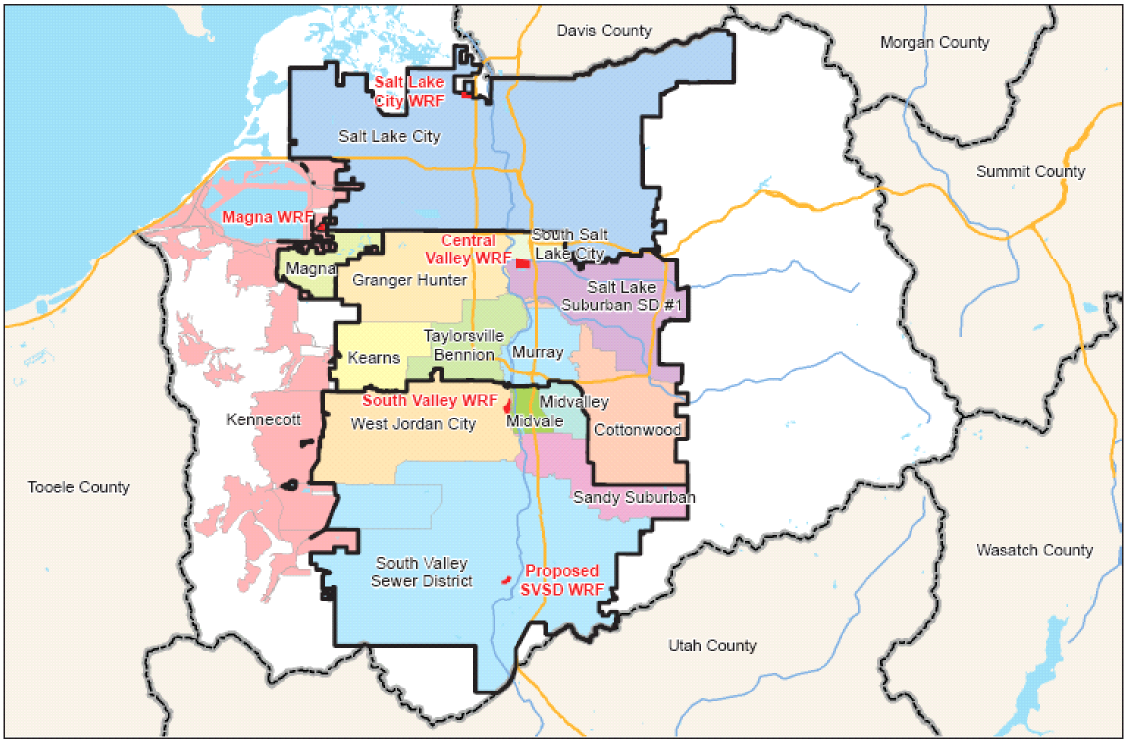
### 4.2.6 Wastewater Flow Projections

Wastewater flow projections were developed based on existing and projected population and employment information. Traffic Analysis Zone (TAZ) data was used to calculate the population and number of daily employees for areas in Salt Lake County. TAZ data is generated by the Wasatch Front Regional Council (WFRC). TAZ data is developed in the transportation planning process and consists mainly of aggregations of census blocks and subsets of census tracts. Boundaries are based mainly on streets and natural features and do not necessarily coincide with sewer district boundaries.

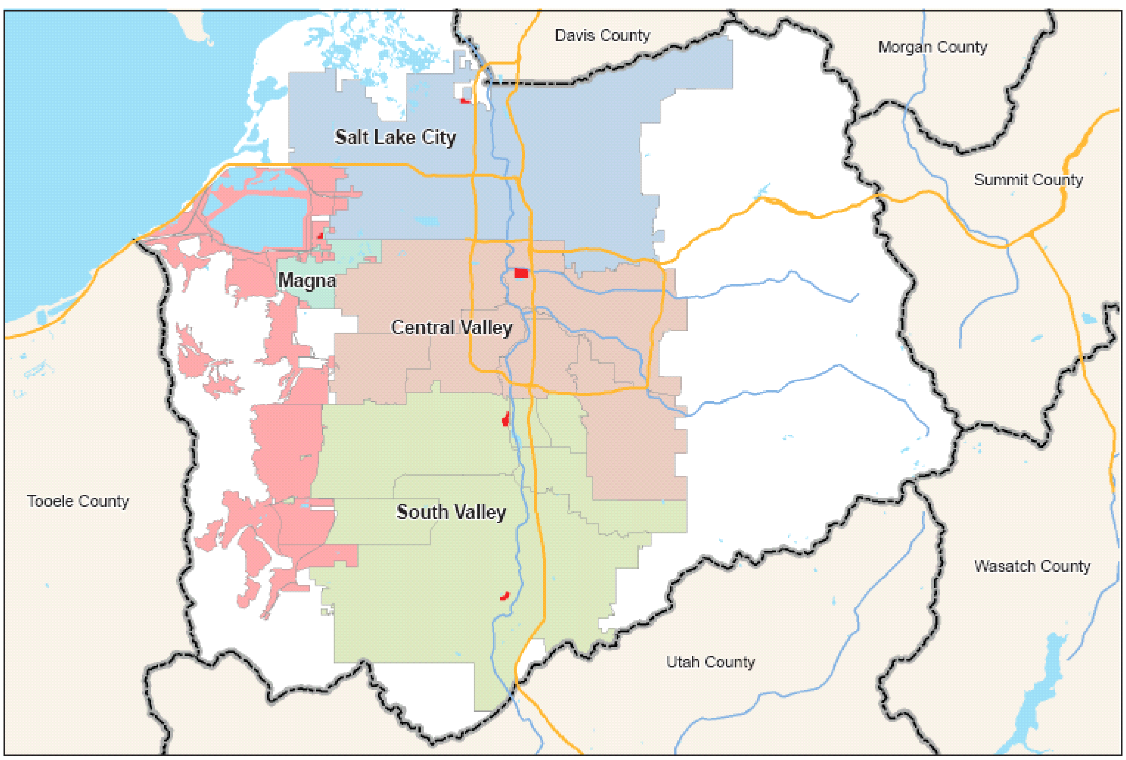
TAZ data consists of current and predicted future population and employment data. In Salt Lake County, the TAZ data is broken into 615 units, each covering an average of 450 acres. The TAZ data used for this study has 2005 and predicted 2030 population and employment numbers (including unserviced west-side areas) for each TAZ unit. 2050 population and/or build-out projections were not yet available at the time of this evaluation.

The 2005 and 2030 population and number of jobs were summed for all TAZ regions in the current and planned service areas for each existing POTW. Current sewer district boundaries and approximate POTW service areas are shown in Figure 4.2.13 and Figure 4.2.14 respectively.

Table 4.2.4 summarizes the population and employment projections for each WRF service area. Currently, the South Valley WRF service area includes only the first phase of Kennecott Land Development projects (Daybreak) along the west-side bench. The remaining land available along the west-side bench is not currently served by a WRF and is listed separately. Significantly, the majority of the Kennecott Land Development projects will occur after the study period (2030) and are not included in this report.




## Figure 4.2.13 Sewer Boundaries




## Figure 4.2.14 POTW Service Areas

Jordan River, Jordan River Corridor Sub-Watershed

Wastewater flows were calculated by multiplying the population and number of employees by flow per capita and employee per day respectively. The flow per capita or employee per day was determined by dividing the recorded 2005 flows (as reported to the State) at each WRF by the number of 2005 residents and employees in each service area. Table 4.2.5 presents the calculated residential and employee flow rates. Peak flow rates were calculated using average peaking factors (corresponding to average flow and population) listed in Metcalf and Eddy (Tchobaroghes, 1991). 2030 flow projections were calculated by multiplying projected 2030 population and employment numbers by the flow per capita/ employee per day.

Flows from the unserviced west-side area property owners total approximately 10 mgd average daily flow (ADF).

Load projections for biochemical oxygen demand (BOD) and total suspended solids (TSS) were calculated by multiplying average daily flows by concentrations of 260 mg/L BOD and 300 mg/L TSS respectively. BOD and TSS concentrations are based on design requirements listed in Utah Rule R317-3 Design Requirements for Wastewater Collection, Treatment and Disposal Systems (R317-3-4.3-C1a). 2030 load projections for BOD and TSS are presented in Table 4.2.6.

Loading from the unserviced west-side area property owners totals approximately 23,214 pounds per day (ppd) BOD and 26,786 ppd TSS.

#### 4.2.6.1 Area-Wide Water Quality Management Plan Comparison

As a supplement to projections developed in this analysis, recorded values for flows and loading (2005) were compared to original projections made in the 1978 Area-Wide Water Quality Management Plan. Flow projections in the 1978 Area-Wide Water Quality Management Plan were developed for the four planning areas consisting of Magna, Salt Lake City, Lower Jordan, and Upper Jordan.

Twenty year projections (1980 to 2000) excerpted from the 1978 Area-Wide Water Quality Management Plan are presented in Table 4.2.7.

The far right column lists 2005 recorded flows from each WRF. In comparison, flow projections made during the original Area-Wide Water Quality Management Plan were relatively close to present values. Flows are slightly higher for the Magna WRF and CVWRF and slightly below the SVWRF and SLCWRF. Loading projections however, have increased substantially over original projections. Higher loading can likely be contributed in part to the reduction of infiltration and inflow (I/I), conservation efforts, and other wastewater flow reduction improvements such as low-flow toilets, showerheads, etc.

#### 4.2.6.2 Alternative Analysis

Projected flows and loadings were used to establish the geographic proximity of future growth relative to existing and planned capacity of wastewater treatment facilities within Salt Lake County. In this analysis the capacity of existing treatment facilities are compared to projected wastewater flows to identify surplus capacity and potential shortfalls (expressed in ADF). At this time, the analysis does not consider flows or capacity required for build-out conditions (i.e. 2050 and beyond). 2050 data is not yet available from the WRFC.

Eight alternatives were developed based on potential flow and routing alternatives of west-side unserviced area property owners. Alternative 1 is the baseline condition and includes only those flows originating from existing WRF service areas. Alternative 2 through Alternative 6 compare projected flows (including west-side unserviced areas plus baseline conditions) to the original four

### Table 4.2.4 2030 Population Projections

| Item | Water Reclamation Facility | | | | Unserviced West-side Areas | Total |
|---|---|---|---|---|---|---|
| | Central Valley | Magna | Salt Lake City | South Valley | | |
| Total Area (acres) | 74,262 | 5,291 | 62,595 | 99,560 | 31,830 | 273,538 |
| 2005 Population | 470,811 | 23,610 | 183,301 | 286,513 | 5,004 | 969,239 |
| 2030 Population | 591,940 | 38,218 | 200,972 | 549,255 | 96,465 | 1,476,850 |
| 2005 Employees | 196,931 | 3,260 | 249,339 | 95,294 | 2,657 | 547,480 |
| 2030 Employees | 267,590 | 9,786 | 282,819 | 175,049 | 28,845 | 764,089 |

### Table 4.2.5 2030 Flow Projections

| Item | Water Reclamation Facility | | | | Total |
|---|---|---|---|---|---|
| | Central Valley | Magna | Salt Lake City | South Valley | |
| Average Plant Flow 2005 (mgd) | 53.2 | 2.4 | 33.9 | 28.9 | 118 |
| Residential Flow (gpcd) | 105 | 100 | 145 | 100 | -- |
| Employee Flow (gpcd) | 20 | 20 | 30 | 10 | -- |
| Average Plant Flow, ADF (mgd) | 67.5 | 4.0 | 37.6 | 56.7 | 166 |
| Peak Hour Factor | 2.0 | 3.3 | 2.5 | 2.1 | -- |
| Peak Hour Flow, PHF (mgd) | 135.6 | 13.1 | 94 | 116.2 | 359 |

### Table 4.2.6 2030 Loading Projections

| Item | Water Reclamation Facility | | | | Total |
|---|---|---|---|---|---|
| | Central Valley | Magna | Salt Lake City | South Valley (Including Daybreak) | |
| BOD (mg/L) | 260 | 260 | 260 | 260 | -- |
| TSS (mg/L) | 300 | 300 | 300 | 300 | -- |
| Average Daily BOD (ppd) | 146,379 | 8,712 | 81,587 | 122,896 | 359,574 |
| Average Daily TSS (ppd) | 168,899 | 10,052 | 94,139 | 141,803 | 414,893 |

### Table 4.2.7 Area-Wide Water Quality Management Plan Projected Average Daily Flows

| Planning Area | Flow | Year | | | |
|---|---|---|---|---|---|
| | | 1980 (projected) | 1990 (projected) | 2000 (projected) | 2005 (recorded) |
| Salt Lake City (SLCWRF) | Flow (mgd) | 36.0 | 36.6 | 37.1 | 34 |
| | BOD5 (lb/day) | 37,000 | 37,800 | 39,500 | 73,853 |
| Magna (Magna WRF) | Flow (mgd) | 1.2 | 1.5 | 1.7 | 2.4 |
| | BOD5 (lb/day) | 1,700 | 2,200 | 2,500 | 5,261 |
| Lower Jordan (CVWRF) | Flow (mgd) | 40.0 | 45.0 | 51.0 | 53.4 |
| | BOD5 (lb/day) | 55,700 | 63,000 | 71,300 | 115,736 |
| Upper Jordan (SVWRF) | Flow (mgd) | 16.0 | 24.0 | 32.0 | 29.5 |
| | BOD5 (lb/day) | 23,500 | 35,300 | 47,000 | 63,947 |

WRF service areas planned in the 1978 Area-Wide Water Quality Management Plan. Alternative 7 and Alternative 8 include the planned South Valley Sewer District (SVSD) WRF in Riverton. Flows between the SVWRF and SVSD WRF were split according to projections made in the Wastewater Treatment Facility Plan Draft Report and 208 Addendum (Bowen Collins and Associates, 2005) (approximately 22.5 mgd ADF to SVSD WRF in 2030). Alternatives evaluated are as follows:

Central Valley Water Reclamation Facility discharge to Mill Creek, Lower Mill Creek Sub-Watershed

**Alternative 1**: Baseline (includes flows only within the existing WRF service area boundaries, i.e. no flows from west-side unserviced areas)

**Alternative 2**: All west-side unserviced flow to Central Valley (plus baseline conditions)

**Alternative 3**: 1/3 west-side unserviced flow to Magna and 2/3 west-side unserviced flow to Central Valley (plus baseline conditions)

**Alternative 4**: 1/3 west-side unserviced flow to Magna, Central Valley, and South Valley (plus baseline conditions)

**Alternative 5**: All west-side unserviced flow to Magna (plus baseline conditions)

**Alternative 6**: All west-side unserviced flow to South Valley (plus baseline conditions)

**Alternative 7**: Includes the proposed SVSD WRF and all west-side unserviced flow to South Valley (plus baseline conditions)

**Alternative 8**: Includes the proposed SVSD WRF, and all west-side unserviced flow to Central Valley (plus baseline conditions)

#### 4.2.6.3 Results and Conclusions

Results of the alternative analysis, as presented in the POTW advisory group and stakeholder workshops, are included in Appendix C (Technical Memorandum No.3). The results of the alternative analysis support the following conclusions:

1. Treatment capacity exists or could be readily built at the five facilities identified in the Area-Wide Water Quality Plan and amendment to meet 2030 flow projections.
2. Conveyance and flow allocation is the biggest challenge in utilizing capacity at the five WRFs.
3. The requirements (flow and treatment) for 2050 and beyond (area build-out) have not been analyzed and are unknown. Future flow and loading projections could necessitate the need for increased expansion at the WRFs or the construction of additional facilities.
4. Based on the current planned capacity at each facility, there is no incentive for area-wide wastewater planning and coordination to meet 2030 flow projections. However, based on stakeholder and regulating agency input, there is a need for area-wide planning and coordination to ensure certainty in the planning and permitting process.
5. Enhanced water quality and regulatory limits, biosolids management, emergency planning, etc. could affect the ultimate planned capacity of the WRFs.

### 4.2.7 Permitting Process and Planning Framework

The purpose of this section is to document the preliminary planning and permitting process, as developed through stakeholder workshops as well as to identify those elements that are important to future wastewater planning. A review of the current process, as experienced through siting of the new Riverton Wastewater Treatment Facility, is summarized to gain an understanding of the issues surrounding wastewater management in Salt Lake County. Finally, attributes of the proposed planning process are reviewed as a means for further discussion and evaluation during subsequent stages of the planning study.

#### 4.2.7.1 Current Planning Process Description

The original Area-Wide Water Quality Management Plan was developed in accordance with section 208 of the Clean Water Act. During the course of planning, the 208 Project Steering Committee recognized the value of forming an on-going Area-Wide Water Quality Management Agency. This need was met in October of 1977 when the Salt Lake County Commission unanimously voted for an ordinance that created the Salt Lake County Department of Water Quality and Water Pollution Control. The County was subsequently designated as the designated planning agency. A copy of this ordinance is included in the Appendix C. The Area-Wide Water Quality Management Plan defines the role of the County planning agency as follows:

- Continuing planning, including annual update and recertification of the Areawide Water Quality Management Plan through required channels.
- Ongoing definition and clarification of roles and responsibilities, through regular meetings and continuing discussions with all agencies involved, to formulate, review, and adopt or modify goals or objectives.
- Administrative staff assistance and professional consultant studies where needed, to help attain water quality goals.
- Ongoing evaluation of the program, including review of monitoring and testing activities, and facilities planning and approval procedures.
- Public education process to obtain local understanding, support, and cooperation in efforts to improve water quality.
- Recommendations to regulatory agencies for appropriate changes in policies, standards, or legislation, to meet changing conditions or requirements with respect to water quality.
- Coordination of planning and implementation efforts with neighboring areawide planning organizations.
- Adequate financing for the activities listed.

The original planning and management organization chart and channels for public participation can be found in Section 7 Implementation of the Area-wide Water Quality

Management Plan. The initial 1978 Plan planning authority followed the general flow down chart as shown in Figure 4.2.15.

### 4.2.7.2 Current Permitting Process Description

The current permitting process for construction of new wastewater treatment facilities, expansions, and major process upgrades is defined through the State's UPDES standards and related regulations under Title R317 Water Quality. Plan approval through the County as well as local siting and land use regulations also apply. Figure 4.2.16 presents the current permitting process as it applies to new facilities, upgrades and expansions, industrial facilities and reuse/scalping facilities.

*Riverton Plant Siting Example* Since inception of the Area-Wide Water Quality Management Plan in 1978, and implementation of the plan's recommendations to consolidate existing facilities, there has been no official request to amend the plan until recently. In 2002, the South Valley Water Reclamation Facility (SVWRF) completed a study consisting of national experts and designated as the Blue Ribbon Panel to review plant improvements required to meet the projected growth needs of the service area.

Concern by the South Valley Sewer District (SVSD) over rising costs of providing additional plant capacity at the SVWRF as well as limited sewer conveyance capacity prompted the District to pursue masterplanning for a new treatment facility. SVSD completed a Draft Facility Plan in 2003 that evaluated flow and loading conditions, potential sites, alternative treatment processes and costs for the new facility. SVSD submitted the facility plan to the DWQ in support of their request to create a new discharge into the Jordan River. Concurrently, SVSD began the process for obtaining a conditional use permit for siting the facility in the City of Riverton (Bowen Collins and Associates, 2005).

In January 2005, the DWQ replied that the original Area-Wide Water Quality Management Plan would need to be amended by Salt Lake County before the State would act on issuing a new discharge permit. In December 2005 the Salt Lake County Council conditionally recommended approval of SVSD's request to amend the Area-Wide Water Quality Management Plan subject to seven environmental and facility siting conditions.

Subsequent to Salt Lake County's recommended approval of the amendment request, the conditional use permit was revoked by the Riverton Board of Adjustment requiring SVSD to seek resolution in District Court. When the court ruled in favor of the Board of Adjustment, SVSD initiated negotiations with the group opposed to siting of the facility in Riverton. Successful resolution of opposition issues has resulted in the lawsuit being vacated.

The SVSD facility plan was revised and submitted to the Salt Lake County Council in August, 2006 as an Area-Wide Water Quality Management Plan amendment. In March of 2007 (after the lawsuit was vacated), the Salt Lake County Council adopted the Area-Wide Water Quality Management Plan amendment (a copy of the Council approval is included in the Appendix C. Figure 4.2.17 summarizes the major events related to the SVSD Area-wide Water Quality Management Plan amendment process.

Several issues became evident during reactivation of the Area-Wide Water Quality Management Plan addendum process. The limitations of the original Area-Wide Water Quality Management Plan after thirty years were apparent. First, Salt Lake County and SVSD were unaware that Area-Wide Water Quality Management Plan concurrence was a requirement. It also was clear that the initial SVSD approach did not gain public acceptance, and perceived environmental and governance issues were not adequately addressed at the local level.

Establishing a modern and enforceable planning framework for future wastewater facilities in Salt Lake County has been exacerbated and convoluted by the absence of an active regional wastewater process for the last 30 years. Meeting the requirement for Area-Wide Water Quality Management Plan concurrence put the County in a reactive mode with respect to approval of the proposed SVSD facility because a fifth wastewater treatment facility in Salt Lake County was not envisioned in the original Area-Wide Water Quality Management Plan. Although the County has now approved the SVSD Area-Wide Water Quality Management Plan amendment request, the challenge of planning for significant growth in undeveloped parts of the County remains. It is clear that a comprehensive and enforceable wastewater planning process is in the best interest of all citizens in Salt Lake County.

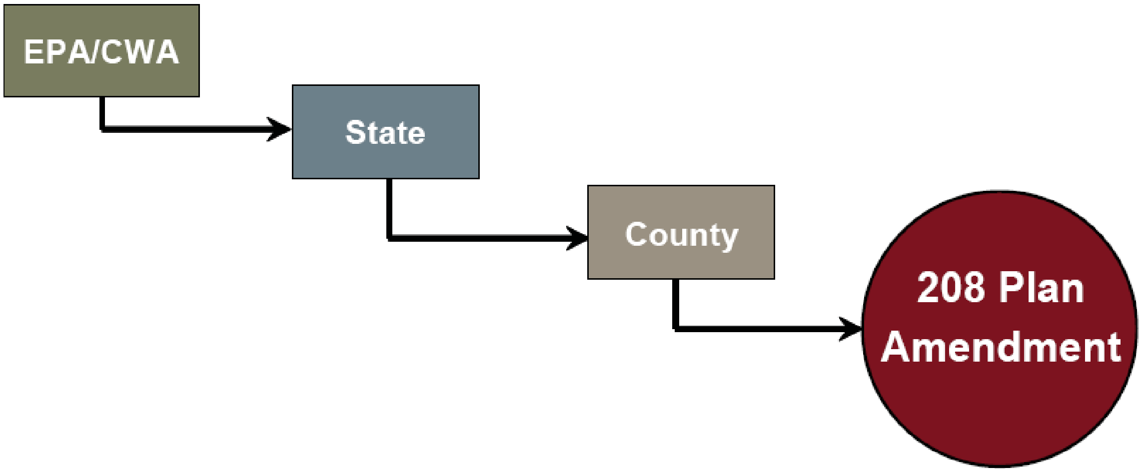



Figure 4.2.15 208 Planning Authority

| | County | State | Local | FACILITY |
|---|---|---|---|---|
| **New Facility** | Plan Approval | UPDES Permit/ Construction Permit | Siting/Land Use | |
| **Upgrade/ Expansion** | | Construction Permit | | |
| **Scalping** | Plan Approval | Construction/Reuse Permit<br>Groundwater Permit | Siting/Land Use | |
| **Industrial** | Plan Approval ? | UPDES Permit/ Construction Permit | Siting/Land Use | |

Figure 4.2.16 Current Permitting Process

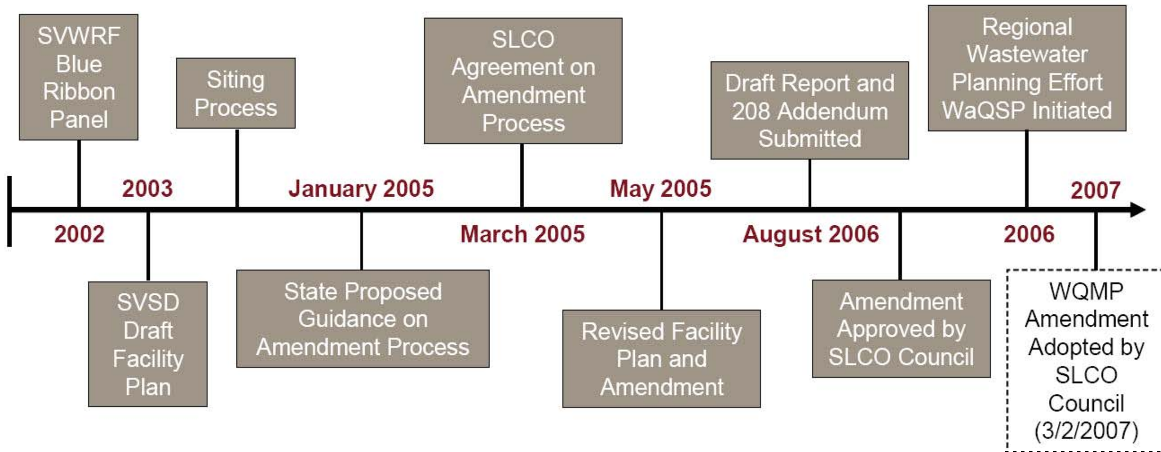



**Figure 4.2.17 SVSD 208 Amendment**

### 4.2.7.3 Proposed Planning Framework

A series of workshops were held to evaluate the future of wastewater planning within the region. Several innovative planning concepts were presented during the workshops as a primer for future discussions. They are as follows:

*Development of Community Values* The new planning process must achieve, to the highest degree possible, a community consensus on future wastewater management. Development of community values was recommended as a guide to help gain plan consensus. Community values can be developed through

- Focus groups
- Stakeholder interviews
- Public presentation and outreach programs

Community values can be used to guide solutions and future plan amendments and would ultimately reflect public and political support. In the Lacy, Olympia, Tumwater and Thruston County, Washington (LOTT) planning example presented in Workshop 2, community values were established through many mechanisms including:

- Elected Officials
- Phone Surveys (Over 1000 area residents participated)
- Newsletter Responses
- Multiple Community Workshops
- Stakeholder Interviews
- Active / Influential Individuals and Elected Officials
- Officially Recognized By Elected Officials

An example of the LOTT's community values are presented in Table 4.2.8. LOTT's community values have been utilized as a guiding tool for all future wastewater planning efforts with great success.

*Wastewater as a Resource* The traditional approach to wastewater facilities planning focuses on getting rid of a problem or treating wastewater to a point clean enough so that it can be acceptably disposed into the environment. Placed in the context of the following four types of capacity, the sequence of traditional wastewater planning first examines collecting, then carrying the wastewater to some location where it can be treated and disposed as indicated in the following sequence.

*Collection→Conveyance→Treatment→Disposal*
Under a proposed new process, planning will focus on treated water as a resource and how, as a valuable commodity, it might be used in environmentally beneficial ways. With use as a starting point, then planning moves to level of treatment required, to conveyance, and finally to collection of wastewater as shown below.

### Table 4.2.8 LOTT's Example of Community Values

| | |
|---|---|
| 1. Maximize Use of Existing Treatment Capacity | 6. Produce Multiple Community Benefits |
| 2. Prepare a Plan Meeting Current and Future Needs | 7. Conduct an Open Facilities Planning Process |
| 3. Maximize Benefits to the Environment | 8. Equitable Distribution of Costs |
| 4. Control Costs | 9. Equitable and Accountable Public Representation |
| 5. Value Treated Effluent as a Resource | 10. Integrate LOTT Plan with Other Infrastructure Requirements |

*Resource Use → Treatment →Conveyance → Collection* This paradigm reversal is possible because small treatment systems can be efficiently sited close to where the treated water is needed. Traditional thinking is based on where the treated water can be disposed with least impact. As with municipal solid waste, the emphasis is on gathering and disposing at an acceptable central location. By recognizing the value of highly treated water it is possible to serve water-dependent needs where and as they occur.

For example, if a use for reclaimed water can be served by a new satellite facility which can be located close to the use, such that it redirects flows from an interceptor reaching maximum capacity, several favorable things can happen:

1. Flows are removed from the receiving POTW, leaving capacity in reserve for future new connections.
2. Reclaimed water is used which reduces dependence on the regional system of aquifers and surface supplies, which may off-set a use of potable water.
3. Locating the treatment facility close to reclaimed water use saves infrastructure costs.
4. Redirecting flows away from a heavily utilized interceptor delays the need to upgrade or install parallel pipes to serve future flows.

*Attributes of a Future Permit Process* Attributes for a future permit process were developed as a starting point in evaluating improvements to the existing process. Attributes were developed based on insight gained from the current addendum process as well as discussions through workshops held with Salt Lake County staff and the stakeholder workshops. They are as follows:

- Protect public health and environment
- Clearly defined process
- Based on community values
- Meets current and future needs
- Mitigates public acceptance, environmental and governance issues beforehand
- Emphasis on sustainable resource

*Proposed Direction for the Future* Based on results of the stakeholder workshops, the proposed direction for future regional wastewater planning efforts will include:

1. A regional programmatic approach
2. A transparent environmental and public process that
   - Identifies community values
   - Includes stakeholder and public involvement
   - Develops public and political support and buy-in
   - Includes environmentally responsive facility planning with emphasis on sustainability

- Includes planning and permitting requirements for design and construction of all future wastewater treatment works

Based on input received from stakeholders and as discussed in the workshops, the preliminary process for the new planning and permitting process is presented in Figure 4.2.18.

### 4.2.8 Conclusions and Recommendations

Results of the stakeholder workshops support the following conclusions and recommended "next steps" for future planning of the wastewater element of the WaQSP:

1. Formalize the planning and permitting process.
2. Perform an evaluation of service area build-out conditions to 2050 and beyond.
3. Integrate the environmental and public process in the planning and permitting of future discharge facilities.
4. Evaluate Countywide sewer capacity and flow routing alternatives (model).
5. Evaluate ongoing Countywide wastewater planning process.

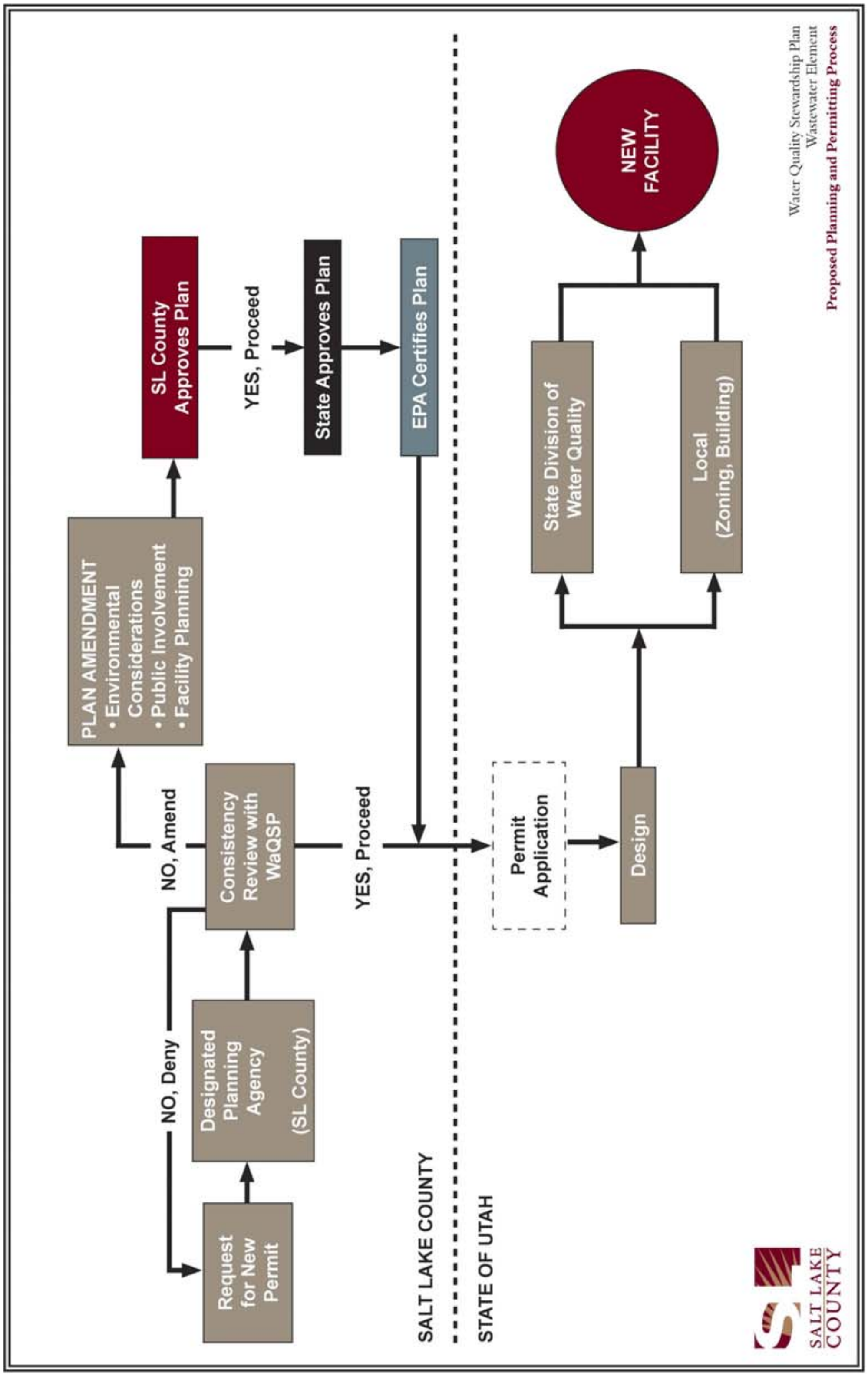



**Figure 4.2.18 WaQSP Involvement in Discharge Permit Process**

## 4.3 STORMWATER

As the Salt Lake Countywide Watershed becomes more developed and urbanized, the impact to receiving waters from the quantity and the quality of stormwater becomes more discernible. The land use analysis between existing and future projected conditions in Chapter 3 identified potential areas of concern for specific stormwater pollutants. This section focuses on the current regulatory programs, review of available local stormwater quality data and recommendations for future management of stormwater quality for the Salt Lake Countywide Watershed. Additionally, this section is written to address the WaQSP strategic target, "Reduce pollutant loads to improve water quality in the Salt Lake Countywide Watershed sufficient to support aquatic habitat, water supply and social functions" by examining this source of pollution.

### 4.3.1 Background

Stormwater runoff ("stormwater") results from precipitation on man-made and natural land surfaces in excess of surface infiltration rates and that lost to evaporation. Pervious surfaces (surfaces that allow water infiltration, i.e. grassed areas) allow infiltration of precipitation at a certain rate. Any precipitation above this rate contributes to stormwater runoff. In general, stormwater is not polluted but contributes to receiving water pollution by transporting pollutants generated by other sources. Examples of pollutant sources in urban areas are litter, spilled and/or illegal discharged substances, soil erosion from construction sites, pesticides, and excess herbicides and fertilizers from agricultural areas.

Garbage in Mill Creek, Lower Mill Creek Sub-Watershed

In general, any substance that gets onto the ground can be transported to a surface or subsurface (groundwater) body of water. Steeper, wetter and more impervious areas contribute to a shorter travel time for runoff. With the development of cities and drainage systems, stormwater runoff is conveyed directly to streams and rivers. The potential impact of spills or illegal discharges is greater because there is less time for response if a clean-up action needs to be taken.

Salt Lake County (SLCo), local municipalities, Utah Department of Environmental Quality (DEQ), and the Environmental Protection Agency (EPA) have extensive programs that address water pollution resulting from municipal and industrial stormwater. Even though the pollution resulting from stormwater runoff is generated as nonpoint source pollutants, Congress specifically included storm drainage as point source pollution and therefore stormwater discharges are subject to the National Pollutant Discharge Elimination System (NPDES program). The NPDES program requires permits for the discharge of stormwater to surface receiving waters. In Utah, the Utah Pollutant Elimination System (UPDES) program regulates permittees including Salt Lake County, municipalities, industries, construction sites, Utah Department of Transportation (UDOT), and other facilities. Salt Lake County and 14 municipalities are co-permittees for stormwater under the UPDES program.

Stormwater enforcement is an important component of a stormwater program. The Salt Lake Valley Health Department (SLVHD) is responsible for enforcement of stormwater regulations through the Wastewater Disposal Regulation #13. This regulation is based on the Clean Water Act and effectively prohibits polluting Waters of the State.

The EPA, the State, and the SLVHD oversee regulatory programs. The implementation of practices that protect and improve water quality is undertaken by the County, cities, developers and businesses/industries under regulatory requirement.

#### 4.3.1.1 Significance to WaQSP

Polluted stormwater runoff is a leading cause of impairment to the nearly 40 percent of surveyed U.S. water bodies which do not meet water quality standards (EPA, 2007). It is also one of the sources of pollution considered in a TMDL analysis when a water body is not attaining its beneficial use. Additionally, stormwater pollution can be difficult as well as costly to treat. However, the general public is not aware of the magnitude of the problem caused by stormwater pollution. As part of the SLCo UPDES stormwater management program, public surveys have been conducted to evaluate the public's perceptions of stormwater issues. These surveys revealed that the majority of the population believes industries and wastewater dischargers are the main cause of water pollution, and that stormwater is treated (SLCo, 1993; SLCo, 1998). Addressing the impact of stormwater pollution in the WaQSP is critical to the success of the plan.

### 4.3.2 Regulations

#### 4.3.2.1 Clean Water Act

Congress passed the Federal Water Pollution Control Act (PL 92-500) in 1972 (the "Act"). One of the provisions of the Act was the creation of a permit program to control point source discharges of wastewater. Section 402 created the NPDES program and was implemented by EPA Region 8 in Salt Lake County. The Act and subsequent amendments in 1987 allowed for the program to be operated under State authority. The authorities necessary were those such as the legal right to issue a permit, to require compliance with the permit, and the ability to issue fines and penalties for violations. The authorities also were required to be at least as stringent as the Federal requirements. Discussion of legal authorities appears in Section 6.1 and Appendix A of this Plan. The Utah State legislature has enacted these authorities and operates the permit program as the Utah Pollutant Discharge Elimination System (UPDES).

Another distinction made in the Act was the definition of stormwater as a point source pollutant (a pollutant discharged from a distinct source), rather than a nonpoint source pollutant (a pollutant that is diffuse in generation). Point sources are subject to permitting, whereas nonpoint sources are not, as a general rule. Stormwater pollution is generated as a nonpoint source pollutant and many control strategies are nonpoint source measures rather than point source measures (treatment). However, as most cities collect, convey and discharge stormwater runoff, EPA and state agencies are issuing discharge permits for stormwater runoff as discussed in the following sections.

#### 4.3.2.2 Utah Stormwater Discharge Permit Program

The Utah Division of Water Quality (DWQ) issues UPDES permits for the discharge of stormwater under Title R317-8 of the Utah Clean Water Act (Utah, 2007). The requirements for issuance of a UPDES permit are consistent with the requirements for issuance of an NPDES permit by EPA.

The stormwater permit program consists of two main program areas: municipal discharges and industrial discharges. In addition to requiring certain owner/operators of municipal drainage systems to obtain a discharge permit, eleven categories of industries/businesses are also required to become permitted. The municipal discharge program is called the Municipal Separate Storm Sewer System program (MS4); the business/industry program is called the industrial stormwater permit program.

These permits, both municipal and industrial are issued by the State and are exclusively written to meet the requirements of the Clean Water Act. All other permits and requirements, such as Flood Control, building permits and zoning controls, are separate and apart from the UPDES program and must be obtained through the appropriate agency.

*Municipal Separate Storm Sewer System Program*
Owner/operators of large, medium and regulated small MS4s require authorization to discharge stormwater under the UPDES permit program. Owner/operators of MS4s in Salt Lake County required to obtain a permit include the County, cities (with the exception of the Town of Alta), UDOT and the University of Utah. Medium and large MS4 operators were required to submit

comprehensive permit applications by 1992 and were issued permits at that time. These were classified as Phase I Cities. Small MS4 operators had the option of choosing to be covered by an individual permit, a general permit, or co-permitting with a large or medium MS4s existing permit by 2003; these were designated Phase II MS4s.

A large MS4 is a system that is located in an area with a 1990 census population of 250,000 or more. A medium MS4 is a system that is located in an area with a population between 100,000 and 249,999. A small MS4 is a system not already covered by a Phase I permit, and is located in an "urbanized area" as defined by the Bureau of the Census. Salt Lake County and UDOT were designated as large MS4s based on the 1990 census data used at the time of the 1992 application. Salt Lake City is classified as a medium MS4. All other Cities within the County are classified as small MS4s.

*Industrial Stormwater Permit Program* Activities that take place at industrial facilities, such as material handling and storage, are often exposed to the weather. As runoff from precipitation or snowmelt comes into contact with these activities and materials, it may convey pollutants to nearby storm drainage systems which discharge to the Jordan River, tributaries, Surplus and/or Sewage Canal or the Great Salt Lake. Stormwater pollution from industrial facilities is a significant source of water quality problems for the nation's waters. Of the 11 pollution source categories listed in a recent EPA document (EPA, 2000), urban runoff/storm sewers were ranked as the fourth leading source of impairment in rivers, third in lakes, and second in estuaries.

Operators of industrial facilities included in one of the 11 categories of stormwater discharges associated with industrial activity that discharge or have the potential to discharge stormwater to a MS4 or directly to receiving waters, require a UPDES industrial stormwater discharge permit. These general categories are shown in Table 4.3.1.

Industries that fall into these categories are required to obtain a UPDES permit from the State. Other industries that are not in these categories but have been determined by the State to be a significant or potentially significant contributor to stormwater pollution, are also required to be permitted. The State issues General Sector permits under which designated industries apply for coverage. An industry is required to develop a Stormwater Pollution Prevention Plan (SWPPP) and other documentation, and file a Notification of Intent (NOI) with the State to obtain coverage. The permit may or may not require water quality sampling. The permit may include sampling waivers if, for instance, all material storage is indoors.

**Table 4.3.1 General Industrial Categories Requiring UPDES Permits**

| Industry Category | General Description |
|---|---|
| Category One (i) | Facilities with effluent limitations |
| Category Two (ii) | Manufacturing |
| Category Three (iii) | Mineral, Metal, Oil and Gas |
| Category Four (iv) | Hazardous Waste, Treatment, or Disposal Facilities |
| Category Five (v) | Landfills |
| Category Six (vi) | Recycling Facilities |
| Category Seven (vii) | Steam Electric Plants |
| Category Eight (viii) | Transportation Facilities |
| Category Nine (ix) | Treatment Works |
| Category Ten (x) | Construction Activity |
| Category Eleven (xi) | Light Industrial Activity |

*Source: UCA R317-8*

The industrial permit program is managed by the State with the exception of permitting of Category Ten, Construction Activity. Local jurisdictions are required as part of the MS4 program to implement a portion of the construction activity program.

*Stormwater Management Plan* In contrast to UPDES permits for municipal wastewater treatment plant discharges, the requirements for stormwater discharge permits is based on the implementation of Best Management Practices (BMPs), rather than the achievement of numeric effluent requirements. BMPs are practices implemented to achieve the reduction of stormwater pollution to the Maximum Extent Practicable (MEP), the goal of the permit program. These practices can be programmatic, such as public education, zoning requirements, building set-backs, and wetland treatment, or they can be structural, such as construction and operation of treatment works, street sweeping, and detention basins for settling.

EPA set a goal of reducing stormwater pollution to the MEP rather than a specific numeric effluent concentration because of the disperse and intermittent nature of stormwater. To meet the goal of reducing stormwater pollution to the MEP, EPA requires that a Stormwater Management Plan (SWMP) be developed and implemented over the term of permit coverage (five years). The plan must address six minimum control measures. Utah DWQ requires an additional control measure be addressed by Phase I Cities. These control measures are listed in Table 4.3.2.

Implementation of each minimum control measure is accomplished through the establishment and implementation of a set of BMPs. Salt Lake County has developed a BMP Guidance Manual that is maintained on-line (SLCo, 1999).

Phase I permittees are also required to conduct representative storm event monitoring. SLCo and UDOT have monitored 31 storm events over the course of 15 years. The definition of a

**Table 4.3.2 Minimum Control Measures Required in Stormwater Management Plans**

| Minimum Control Measure | Example BMPs |
|---|---|
| Public Education and Outreach | General information for the public-at-large, reporting hot-lines, TV commercials, handouts, target school age children, businesses. |
| Public Involvement | Involve public in planning, reach all ethnic groups, provide opportunities for active participation such as signing, citizen volunteers |
| Illicit Discharge Detection and Elimination | Discharge sampling, ordinance development, promote reporting of dumping, participate in HHW and oil recycling programs |
| Construction Site Stormwater Runoff Control | Control erosion, control waste management and materials storage at construction sites, require State UPDES construction permit |
| Post-Construction Stormwater Management in New Development and Redevelopment | Require set-backs from streams, buffer strips, alternative parking lot strategies in new development, incorporate BMPs into master planning process |
| Pollution Prevention/Good Housekeeping for Municipal Operations | Keep municipal shops, warehouses, fleet facility areas clean, maximize efficiency of deicing chemicals, manage salt piles effectively |
| Industrial and High Risk Runoff (Phase I Only) | Develop a list of high risk industries, inspect and monitor runoff from such sites, develop plans to minimize impacts from runoff |
| *Source: UAC R317-8* | |

representative storm was determined through extensive research of storm events in the valley. It is labor intensive to monitor storm events due to the fact that storm events, either rain or snow, are extremely variable. The storms vary from day to day, from season to season, from area to area, in both intensity and duration. In addition, given the location in the arid west, representative storms are not frequent. However, the water quality data obtained from years of sampling provides important data for evaluating stormwater pollution, including a land use comparison, season variation, and a comparison with other cities.

There is co-management of construction site runoff in Utah. The DWQ requires all construction sites in the state that disturb over one acre in area to apply for and be covered by a UPDES construction site permit. The State, in the MS4 stormwater permit program, requires an MS4 to develop a program that is consistent with the state construction site requirements into a program for the MS4 to implement for construction sites within their jurisdiction. The concept behind the requirements is that the local MS4 should regulate a construction site between one and five acres in size and the State will regulate construction sites that disturb an area greater than five acres.

### 4.3.2.3 Salt Lake Valley Health Department

The Salt Lake Valley Health Department (SLVHD) regulates stormwater quality by enforcement of Health Regulation #13 Wastewater Disposal Regulation (SLVHD, 2006). This regulation prohibits "…any wastewater into any storm drain system, street, alley, sidewalk, gutter, watercourse, canal, river, stream or other waters…any landscaped area, vacant land, or other place not suited or designated for the disposal of sewage or wastewater." (SLVHD, 2006). Wastewater is defined as, "…sewage, industrial waste, or other liquid or waterborne substances causing or capable of causing pollution of waters…" (SLVHD, 2006).

Enforcement by the SLVHD is conducted Countywide and follows a tiered approach based on the severity of violation. The levels of enforcement are Administrative, Civil and Criminal. The administrative level consists of issuance of a Notice of Violation (NOV) and an Order of Compliance. A hearing is held and compliance and/or fines are determined and agreed to by all parties. The civil level consists of bringing civil action (suing) against a violator and presenting the case in court. The criminal level consists of charges being filed against the violator and the case going to court. Most violations in Salt Lake County are handled through the NOV process. The stormwater enforcement actions taken by the Health Department in 2006 are listed in Table 4.3.3 (SLCo, 2007).

### 4.3.2.4 Municipal Regulation

Another avenue of stormwater regulation is through municipal development regulations. Salt Lake County requires issuance of a Flood Control Permit before any new connection of a storm drainage system can be made to "major facilities" that the County operates as part of the Countywide Flood Control system. These facilities are listed in Title 17.8 of the Code of County Ordinances (SLCo, 2007) (Figure 4.3.1). The Flood Control Permit may include BMP's, such as sand filters, oil/gas separators, trash racks, constructed wetlands and other BMPs, for the maintenance and/or improvement of water quality. Of note, wasteload allocations and potential pollution reduction requirements may be identified in the Jordan River TMDL. Recommended BMPs will be used to address stormwater loading rather than traditional load reductions applied to point sources.

**Table 4.3.3 Salt Lake County Health Department Enforcement Actions 2006**

| Number | Action Taken |
|---|---|
| 8 | Settlement Conferences<br>$27,681.00 penalties issued<br>$10,003.00 suspended<br>$17,928.00 collected |
| 190 | Total complaints |
| 207 | Reinspections |
| 131 | Consultations |
| 51 | Warning letters |
| 7 | Education |

*Source: SLCo, 2007*

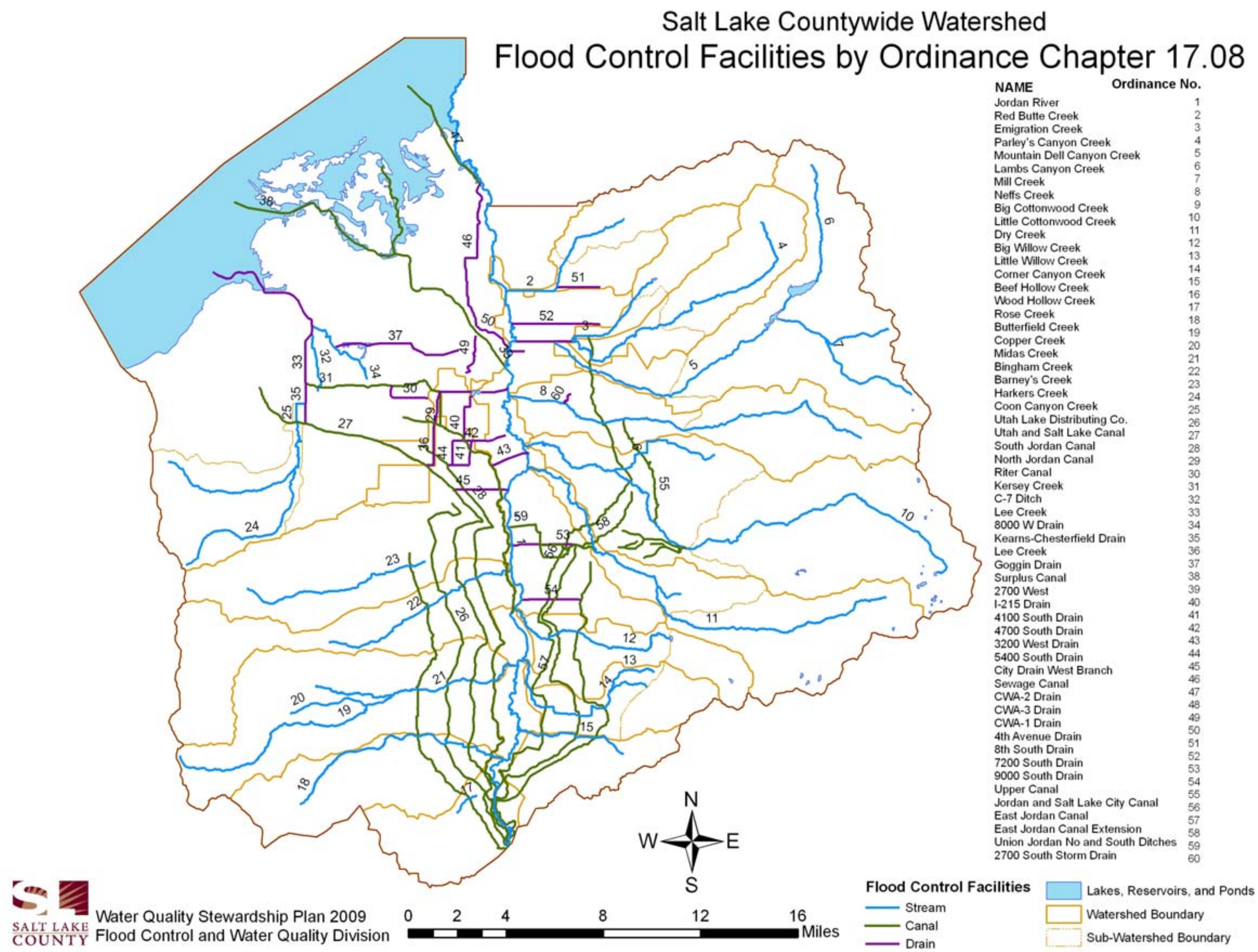



**Figure 4.3.1 Salt Lake County Flood Control Facilities**

### 4.3.3 Existing Conditions

This section presents a history of stormwater quality data compilation events in Salt Lake County. It is not meant to be a comprehensive examination or comparison of data that was collected. The data has been collected at different times using different protocols and was affected by the ambient environment at the time of collection, (e.g., population and land use, which greatly affect stormwater quality, have changed significantly in Salt Lake County from 1974 to 2007). To compare and contrast stormwater quality data from those two data sets would not result in usable conclusions.

Current stormwater quality data will be discussed at the end of this section.

#### 4.3.3.1 Hydrologic Basin Study (1974)

The first comprehensive study of stormwater pollution in Salt Lake County was contained in the Utah Lake-Jordan River Hydrologic Basins Water Quality Management Planning Study (Bureau of Environmental Health, 1974). That report concluded that stormwater contributed an average daily flow of 41.1 MGD (18% of total) and 23%, 14%, 7% and 3% of the BOD, TDS, Total Nitrogen (TN) and Total Phosphorus (TP) waste loads to surface waters, respectively. The results are summarized in Table 4.3.4.

The following seven measures (BMPs) were suggested to reduce urban runoff pollutant load:

- Diligent enforcement of anti-litter laws
- Increased street-cleaning efforts
- Improved maintenance of street surfaces
- Increased cleaning frequency of catch basins
- Training street maintenance personnel
- Prevention of excessive street salting during winter conditions
- Prohibit drainage channels as repository for snow removed from city streets.

#### 4.3.3.2 Area-Wide Quality Management Plan (1978)

Following the planning efforts of the Hydrologic Basin Management Study (1974), the Council of Governments (COG) undertook the Area-Wide Water Quality Management Planning effort (208 Plan) in compliance with Section 208 of the Clean Water Act. Two primary reports from that planning effort detailed urban runoff and/or stormwater pollution.

One of these reports analyzed existing point and nonpoint pollutant loads and developed uniform loadings for input to Jordan River Quantity and Quality models (Hydroscience, 1976). Due to the scarcity of data at that time, input values for the models were rudimentary and uniform for the River. However, input data did vary with season but urban runoff/stormwater were combined with irrigation return flow. Nevertheless, these surface water models were used in development of effluent limitations for municipal wastewater facilities beyond secondary treatment levels that were required at that time. Specific limits were set for un-ionized ammonia, chlorine and dissolved oxygen.

The other report following the area-wide water quality management planning effort was the

**Table 4.3.4 Waste Loads Imposed on Surface Waters, Salt Lake County (1974)**

| | Flow (mgd) | % of County Total | BOD (lb/day) | % of County Total | TDS (lb/day) | % of County Total | Total Nitrogen (lb/day) | % of County Total | Total Phosphorus (lb/day) | % of County Total |
|---|---|---|---|---|---|---|---|---|---|---|
| Municipal Wastewater | 70 | 31 | 17,000 | 59 | 474,000 | 24 | 16,100 | 80 | 14,780 | 67 |
| Industrial | 74 | 33 | 4,500 | 16 | 1,052,400 | 54 | 1,000 | 5 | 6,390 | 29 |
| Irrigation Return Flow | 41 | 18 | 700 | 2 | 153,700 | 8 | 1,600 | 8 | 170 | 1 |
| Urban Runoff | 41 | 18 | 6,800 | 23 | 263,900 | 14 | 1,400 | 7 | 580 | 3 |
| County Total | 226 | | 29,000 | | 1,944,000 | | 20,100 | | 21,920 | |

*Source: Bureau of Environmental Health, 1974*

Stormwater Assessment conducted in 1979 (SLCo, 1981). This assessment compiled data collected from stormwater runoff from ten (10) drainage basins throughout the County and calculates mean concentrations for various parameters collected from runoff from mostly residential land uses. Since flow data was not collected, event mean concentrations were not calculated; data was limited to mean concentrations only.

A summary of data from the report is shown in Table 4.3.5. Locations of the basins are shown in Figure 4.3.2.

#### 4.3.3.3 Nationwide Urban Runoff Program (1983)

In 1979, Salt Lake County took part in the National Urban Runoff Program (NURP). The program was funded in part by EPA and was conducted in 28 municipalities across the U.S. Data collected, both water quality and control strategy effectiveness data, were used to develop the criteria which led to the establishment of the NPDES stormwater permit program. Salt Lake County signed a cooperative agreement with the United States Geological Survey (USGS) and carried out a four-year sampling program which included collecting instream samples during storms and sampling to determine the effectiveness of six BMPs.

In the NURP study, stormwater quality data was collected from a number of drainage basins within Salt Lake County. A summary of possible stormwater impacts in 10 drainages sampled in the NURP is shown in Table 4.3.6.

Phase I permittees are required to estimate event mean concentrations (EMCs) through wet weather sampling. EMCs represent the concentration of a pollutant in a flow-weighted composite sample from the runoff event. To calculate EMCs, the calculated loading per event for each of the sampled storms is summed and divided by the total precipitation for the sampled events. The result is divided by the serviced basin area and runoff coefficient and converted to milligrams per liter. The following formula is used to calculate EMCs for Salt Lake County:

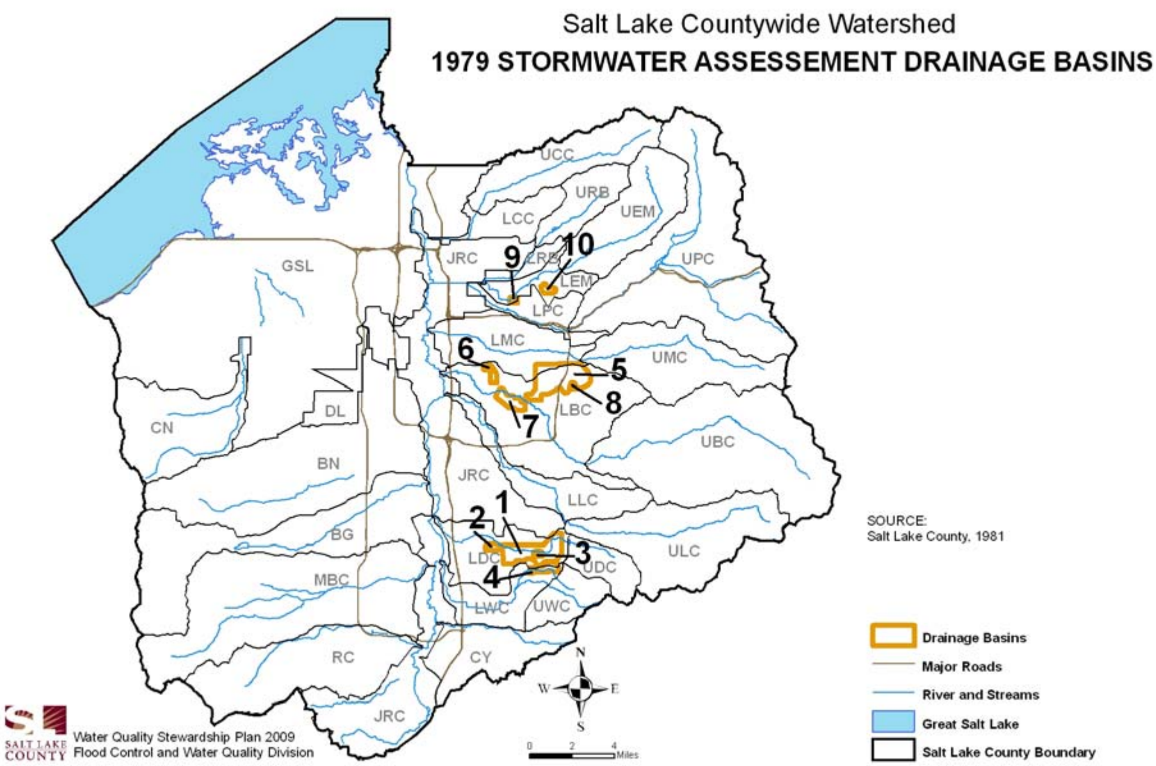



**Figure 4.3.2 1979 Stormwater Assessment Drainage Basins**

### Table 4.3.5 1979 Stormwater Assessment Summary

| Parameter | Dry Weather | Wet Weather | | |
|---|---|---|---|---|
| | Basins 1-5 | Basins 1-4 | Basins 5-8 | Basins 9-10 |
| $BOD_5$ [1] (mg/l) | 1.5 | 17.5 | 19.9 | 226.5 |
| TSS[2] (mg/l) | 13 | 722 | 313 | 1873 |
| Zn[3] (mg/l) | | 0.02 | 0.04 | 0.54 |
| Pb[4] (mg/l) | | 0.17 | 0.02 | 0.20 |
| COD[5] (mg/l) | | 240 | 128 | 1,285 |
| Land Use | | Predominantly vacant with residential | Residential/vacant mix with some commercial | Predominantly residential |

[1] 5-day Biological Oxygen Demand [2] Total Suspended Solids [3] Zinc [4] Lead [5] Chemical Oxygen Demand

*Source: SLCo, 1981*

### Table 4.3.6 Summary of NURP Study Possible Impact on Receiving Waters

| Receiving Water Basins | Stream Classification (UAC R317-2-13) | Number of Major Outfalls to Receiving Water[1] | Possible Stormwater Pollutants |
|---|---|---|---|
| Little Cottonwood Creek | 2B, 3A, 4 | 14 | Total Mercury, Total Chromium, Total and Suspended Copper, Total and Dissolved Iron, Total and Suspended Lead, Total and Suspended Zinc |
| Holladay Drain Basin | 2B, 3A, 4 (Big Cottonwood Creek) | NA (1)[2] | COD, $BOD_5$, Nitrogen, Phosphorus, Cadmium, Suspended Copper, Iron, Lead, and Zinc |
| Big Cottonwood Creek | 2B, 3A, 4 | 16 | Total and Dissolved Chromium, Copper, Iron, Lead, and Zinc |
| Mill Creek | 2B, 3A, 3C, 4 | 23 | Total Mercury, $BOD_5$ |
| Parley's Creek | 2B, 3A | 3 | Total Mercury |
| Emigration Creek | 2B,3A | 0 | Total Mercury |
| Red Butte Creek | 2B, 3A | 0 | Dissolved Copper |
| Eighth South Conduit | 2B, 3B,4 (Jordan River) | 1 | Ammonia, $BOD_5$, Dissolved Phosphorus, Total Mercury, Cadmium, Copper, Zinc |
| City Creek | 2B, 3A | 1 | Suspended Solids, Sediment |
| Canal Sites[3] | 4 | 20 | Total Mercury, $BOD_5$, Dissolved Copper, Dissolved Phosphorus |

[1] Number of major municipal storm sewer system outfalls which discharge to the receiving waters
[2] EPA reported "NA". "1" is shown here as the outfall to Big Cottonwood Creek
[3] Four canal sites are chosen for summary purposes

*Source: EPA, 1983*

$$EMC = \frac{\Sigma L_x \bullet 12}{\Sigma P \bullet R_a \bullet A_s \bullet 2.72}$$

where: $L_x$ = load for the storm event (pounds)

$P$ = precipitation for the storm event (inches)

$R_a$ = weighted average runoff coefficient based on land use of serviced area

$A_s$ = serviced area of basin (acres)

*(12 and 2.72 are conversion factors for pounds to mg/L)*

The EMCs for each constituent are calculated on an event basis and averaged to obtain the average EMC for Salt Lake County and Salt Lake City.

A summary of EMCs for typical pollutants found during sampling of runoff during the NURP study are shown in Table 4.3.7. Table 4.3.7 also presents the Utah Water Quality Standards for reference. These standards are for instream conditions based on Beneficial Use classification, and are not stormwater discharge limits.

### 4.3.3.4 Phase I UPDES Stormwater Permit Application

As discussed earlier, Salt Lake County and UDOT are classified as large MS4s. The permitting requirements for large MS4s called for a two-phase application process that extended over three years. Included in the required data submittal was current stormwater quality data gathered within the service area of the MS4. Salt Lake County and UDOT collected data from six stormwater monitoring sites at basin outflows to receiving waters. Instream water quality samples during storm events were not collected.

The six sites used in the UPDES permit application were selected based on their representation of land uses within the County. The land uses are residential, commercial, transportation, light industrial, and mixed use. Selected EMC data collected during the application process is shown in Table 4.3.7. Many more constituents sampled and analyzed over the years, but are not shown.

### 4.3.3.5 Phase I UPDES Stormwater Compliance Monitoring

The UPDES stormwater permits for Salt Lake County and UDOT require representative water quality sampling for the determination of pollutant loading to Waters of the State. The representative storm event sampling is undertaken for four purposes: 1) permit compliance (monitoring is required by permit conditions), 2) to develop data for pollutant load analyses, 3) to develop and track EMCs (used for establishment of water quality trends and for analysis of effectiveness of BMPs), and 4) to predict quality of runoff from outfalls to Waters of the State.

The most recent stormwater quality data (existing conditions) is documented in the *2005 Stormwater Quality Data Technical Report* published in 2006 (SLCo, 2005). Pertinent information from that report is summarized here.

*Sampling Procedures* Runoff is sampled from typical land uses throughout the County. For permit compliance, the County has established a network of five stormwater outfall sampling sites. An additional sampling site is operated under an Interlocal Agreement with Utah Department of Transportation. Salt Lake City operates three sampling stations; two outfall locations and one instream location. The representative land use for each sampling station is summarized in Table 4.3.8.

Base flow samples (constant flow in the drainage system from various sources – groundwater infiltration, excess home irrigation, basement sump pumps, etc.) and rise samples (flow during the rising limb of the storm hydrograph, sample collected during the first 30 minutes of runoff), are sampled and analyzed from grab samples. The base flow and rise samples are collected to determine background and initial flush conditions. Oil and Grease (O&G) and bacteria samples were collected by grab sampling as well due to compositing concerns. EMCs are not calculated for these parameters and situations.

**Table 4.3.7 Salt Lake County NURP Study and UPDES Permit Application EMCs for Selected Pollutants**

| Pollutant | Stormwater EMC | | Utah Water Quality Standards for Instream Conditions (R317-2-14) | | | |
|---|---|---|---|---|---|---|
| | NURP | UPDES | Domestic Water Supply (Class 1C) | Recreation (Class 2B) | Aquatic Wildlife (Class 3) | Agriculture (Class 4) |
| Biological Oxygen Demand ($BOD_5$) (mg/L) | 9 | 5 | 5 | 5 | 5 | 5 |
| Chemical Oxygen Demand (COD) (mg/L) | 81 | 62 | | | | |
| Total Suspended Solids (TSS) (mg/L) | 81 | 91 | | | | |
| Total Dissolved Solids (TDS) (mg/L) | 450 | 202 | | | | 1,200 Irrigation<br>2,000 Stock Watering |
| Oil and Grease (O&G) (mg/L) | | 5 | | | | |
| Total Phosphorus (TP)[1] (mg/L) | | 1.6 | 0.05 | 0.05 | 0.05 | |
| Dissolved Cadmium (µg/L) | 1.2 | 0.5 | 10 | | 0.25 | 10 |
| Total Cadmium (µg/L) | 1.2 | 1 | | | | |
| Dissolved Chromium (µg/L) | 2 | 6.2 | 50 | | 11 | 100 |
| Total Chromium (µg/L) | 3 | 8 | | | | |
| Dissolved Copper (µg/L) | 11 | 19 | | | 9 | 200 |
| Total Copper (µg/L) | 46 | 28 | | | | |
| Dissolved Lead (µg/L) | 14 | 26 | 15 | | 2.5 | 100 |
| Total Lead (µg/L) | 220 | 44 | | | | |
| Dissolved Mercury (µg/L) | 0.01 | 0.2 | 2 | | 0.012 | |
| Total Mercury (µg/L) | 0.2 | 0.7 | | | | |
| Dissolved Nickel (µg/L) | | 2.1 | | | | |
| Total Nickel (µg/L) | | 2.7 | | | | |
| Dissolved Selenium (µg/L) | | 3.3 | 50 | | 46 | 50 |
| Dissolved Silver (µg/L) | | 0.4 | 50 | | 16 | |
| Total Silver (µg/L) | | 1.2 | | | | |
| Dissolved Zinc (µg/L) | 35 | | | | 120 | |
| Total Zinc (µg/L) | 210 | | | | | |

*Sources: Christensen et al, 1984 and SLCo, 1993, 1994, 2001, and 2006*

### Table 4.3.8 Representative Land Use of Sampling Stations

| Sampling Location ID | Representative Landuse | Operator |
|---|---|---|
| DEL-02/01 | Commercial | Salt Lake County |
| DEL-05 | Light Industrial | Salt Lake County |
| JOR-01 | Representative Mix | Salt Lake County |
| JOR-04/03 | Transportation | UDOT |
| JOR-08 | Representative Mix | Salt Lake City |
| LED-02 | Light Industrial | Salt Lake City (instream sampling) |
| LIT-06 | Residential | Salt Lake County |
| MIL-03 | Residential | Salt Lake City |
| MIL-07 | Residential | Salt Lake County |

*Bacteria Sampling Results* Results from bacteria sampling are shown in Table 4.3.9. Due to inherent problems with sampling, especially short holding times required by standard methods of analysis, the sampling data is limited, making conclusions difficult. However, it is interesting to note that the highest reported values of fecal coliform bacteria were collected from primarily residential areas.

*Oil and Grease Sampling Results* Results from O&G base flow and rise sampling are shown in Table 4.3.10 (EPA Method 1664). The lack of data and the sampling protocol for collecting O&G samples make drawing conclusions from the results difficult. Oils and greases are only slightly emulsified in quiescent flow conditions and almost completely emulsified in extremely turbulent conditions, which is typical of stormwater runoff. Contingent upon flow conditions, different values may be reported.

A general conclusion drawn from the sampling results is that O&G in rise samples is not greatly elevated from base. Also, while there are a few instances of reported higher concentrations, above 50 mg/L, most of the data suggest that the concentrations range from detection limits to 10 mg/L. This would lend evidence to the conclusion that based on this data, no significant concentrations of oil and grease are in the baseflow and rising limb discharges. In fact, most structural treatment systems would not produce an effluent cleaner than 50 to 10 mg/L of O&G. Therefore, treatment systems to remove O&G concentrations from base flows and first flush would not be warranted.

*Storm Event Concentrations* EMCs are developed for six drainage basins in the County. Different EMC comparisons can serve to provide a better understanding of stormwater quality in the area. Land use EMCs, seasonal EMCs, municipal EMCs and EMC stability were evaluated in the *2005 Water Quality Technical Report* (SLCo, 2005). These results are provided in the tables below. A summary of EMCs calculated from combined land uses for years 2000 and 2005 for representative water quality constituents is shown in Table 4.3.11. It is interesting to note that even though methods for calculating EMCs were modified from 2000 to 2005, the values, except for total phosphorus, are not significantly different.

## Table 4.3.9 Base and Rise Bacteria Sampling Results

| STATION | Spring 1993 | Spring 1996 | Fall 1997 | Spring 1998 | Spring 1999 | Spring 2004 | Fall 1995 | Spring 1996 | Fall 1997 | Spring 1998 | Spring 1999 | Spring 2004 | Fall 2005 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | BASE | | | | | | RISE | | | | | | |
| DEL-02/01 | | | | | | | | | | | | | |
| Fecal Col. | | | TNTC* | | 100 | 3000 | TNTC | | TNTC | TNTC | 800 | 1200 | 2400 |
| Fecal Strep. | | | TNTC | | 72 | 1000 | TNTC | | TNTC | TNTC | 168 | 7800 | 1800 |
| DEL-05 | | | | | | | | | | | | | |
| Fecal Col. | | 240 | TNTC | | 300 | | TNTC | 160 | TNTC | TNTC | 800 | | 900 |
| Fecal Strep. | | 400 | TNTC | | 80 | | 2940 | 230 | TNTC | TNTC | 60 | | 410 |
| JOR-01 | | | | | | | | | | | | | |
| Fecal Col. | 24 | 80 | | 400 | | | TNTC | 1800 | | 2000 | | | >20000 |
| Fecal Strep. | 44 | 31 | | 752 | | | TNTC | 2000 | | TNTC | | | 880 |
| JOR-04/03 | | | | | | | | | | | | | |
| Fecal Col. | 16 | 70 | TNTC | 106 | | 100 | TNTC | 900 | TNTC | 800 | | 300 | |
| Fecal Strep. | 20 | 23 | TNTC | 628 | | 100 | 1070 | 2000 | TNTC | TNTC | | 100 | |
| LIT-06 | | | | | | | | | | | | | |
| Fecal Col. | | 90 | | | | | TNTC | 24000 | | | | 1000 | |
| Fecal Strep. | | 370 | | | | | 2890 | 2000 | | | | 3000 | |
| MIL-07 | | | | | | | | | | | | | |
| Fecal Col. | | 130 | | | | | 1000 | | | | | 28000 | 920 |
| Fecal Strep. | | 19 | | | | | 3000 | | | | | 1000 | 580 |

TNTC: Too numerous too count

*Source: SLCo, 2006*

## Table 4.3.10 Oil and Grease Sampling Results

| | STATION | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | DEL-02/01 | DEL-05 | JOR-01 | JOR-04/03 | LIT-06 | MIL-07 | JOR-08 | MIL-03 | LED-02 |
| **Base Flow Samples (mg/L)** | | | | | | | | | |
| Spring 93 | 1.1 | | 1.4 | <1 | | | | | |
| Spring 95 | | | | | | | | | <2 |
| Fall 95 | 7 | | | | | | <1 | <1 | |
| Spring 96 | | <5 | 68 | 52 | 44 | <5 | | | |
| Fall 96 | | | | | | | 3.3 | 3.5 | <2 |
| Fall 97 | | | <5 | 199 | | 7 | 2.8 | 2.8 | <2 |
| Spring 98 | | | 3 | 2 | | | | | |
| Fall 98 | | | <4 | <4 | <4 | | <1 | 7.6 | <1 |
| Spring 99 | <4 | <4 | <4 | <4 | <4 | | <1 | 11.9 | |
| Fall 99 | | | | | | | | | 5.1 |
| Spring 00 | | <1.9 | 3.02 | <2.6 | | 4.2 | | | |
| Fall 00 | | | | | | | <1.0 | 2.53 | <1 |
| Fall 01 | | | | | | | <1.3 | <1.3 | <1.3 |
| Fall 02 | | | | | | | <12.28 | | 116.1 |
| Spring 03 | | | | | | | <7.21 | | |
| Fall 03 | | | | | | | | <7.21 | <7.21 |
| Spring 04 | 3.9 | | | <3 | | | | | |
| Fall 04 | | | | | | | | 3.6 | |
| Fall 05 | | | | | | | | 6.5 | 5 |
| **Rise Samples (mg/L)** | | | | | | | | | |
| Fall 95 | 7 | 2 | 24 | <2 | 4 | 5 | 13 | 11 | 2 |
| Spring 96 | | 7 | 14 | 11 | 13 | 5 | <2 | <2 | <2 |
| Fall 96 | | | | | | | <2 | <2 | <2 |
| Spring 97 | | | | | | | 3.3 | <2 | <2 |
| Fall 97 | <5 | <4 | <5 | 8 | | <5 | <2 | 3.2 | <2 |
| Fall 97 | | | | | | | 2.7 | <1 | <2 |
| Spring 98 | 10 | 3 | 9 | 2 | | | <2 | <2 | |
| Fall 98 | | | 8.2 | <4 | 5.8 | <4 | 51.9 | <1 | 1.1 |
| Fall 98 | | | | | | | | | 1.4 |
| Spring 99 | <4 | <4 | <4 | <4 | <4 | <4 | 5.9 | 8.8 | 1.9 |
| Fall 99 | | | | | | 5.48 | 4.2 | <1 | 7.8 |
| Spring 00 | | <2.7 | <1.9 | <2.5 | 2.9 | 2.42 | 1.4 | 1.4 | 7.38 |
| Fall 00 | <1.9 | <1.9 | | | <1.9 | <2.1 | 2.6 | 1.28 | <1 |
| Spring 01 | <2.1 | 4.6 | | | 2 | 2.6 | 10.4 | 10.1 | 5.18 |
| Fall 01 | | 2.3 | | | | | 8825.1 | 321.6 | <1.3 |
| Spring 02 | | | | | | | <12.28 | <12.28 | <12.28 |
| Fall 02 | | | | | | | <12.28 | 105.4 | <12.28 |
| Spring 03 | | | | | | | | <7.21 | <7.21 |
| Fall 03 | | | | | | 9.3 | | | |
| Spring 04 | <3 | | | <3 | 69 | 14 | | | |
| Spring 05 | | | | | | | <5.9 | <5.9 | <5.9 |
| Fall 05 | <5 | 6 | 5 | <5 | <5 | <5 | | <5.9 | <5.9 |

*Source: SLCo, 2006*

**Table 4.3.11 Event Mean Concentration Summary**

| Constituent | 2000 EMC (mg/L) | 2005 EMC* (mg/L) |
|---|---|---|
| $BOD_5$ | 13.2 | 16.4 |
| TP | 0.39 | 0.68 |
| TSS | 116 | 154 |
| Total Cu | 0.039 | 0.047 |
| Total Pb | 0.031 | 0.046 |
| Total Zn | 0.181 | 0.207 |
| *Methods for EMC calculations were modified from 2000 | | |

*Source: SLCo, 2006*

*Land Use Runoff Comparisons* EMCs are calculated for outfalls and related to five general land use types. The land use types are commercial, industrial, representative mix (no one specific dominant land use), transportation and residential. These EMCs are shown in Figure 4.3.2. This data suggests that specific land uses contribute different pollutants to stormwater runoff. Further analysis would assist with the design of specific management practices targeted to pollutants.

*Seasonal Runoff Comparisons* An analysis was made of the potential effect that the season of the year has on EMCs. The results of that analysis are shown in Table 4.3.12. All EMCs evaluated increased in the fall with the exception of TSS. As the increases in EMCs for BOD, TP, and Total Copper, were large, a general conclusion can be made that fall rainfall events produce higher pollutant loading than spring. This may be due to high volumes of leaves in the Fall. It appears that the season does affect EMCs.

**Table 4.3.12 Seasonal EMCs**

| | Concentration (mg/L) | | |
|---|---|---|---|
| Constituent | Spring | Fall | Difference |
| $BOD_5$ | 7.9 | 10.3 | 24% |
| TP | 0.45 | 0.74 | 39% |
| TSS | 118 | 92 | -29% |
| Total Cu | 0.033 | 0.040 | 18% |
| Total Pb | 0.034 | 0.034 | 0% |
| Total Zn | 0.133 | 0.143 | 7% |

*Source: SLCo, 2006*

*Runoff Quality Stability/Trends* An analysis was conducted for stability or trend of EMC values over time. Calculated EMCs using all previous years data over time are shown in Table 4.3.13 and in Figure 4.3.3. It appears that EMCs have stabilized over time, most likely due to the collection and incorporation of more data into the calculations. It would be expected that without implementation of BMPs, EMCs would increase over time. As the population of the County increases, more land surface is covered with impervious areas, resulting in increased pollutant mass generation.

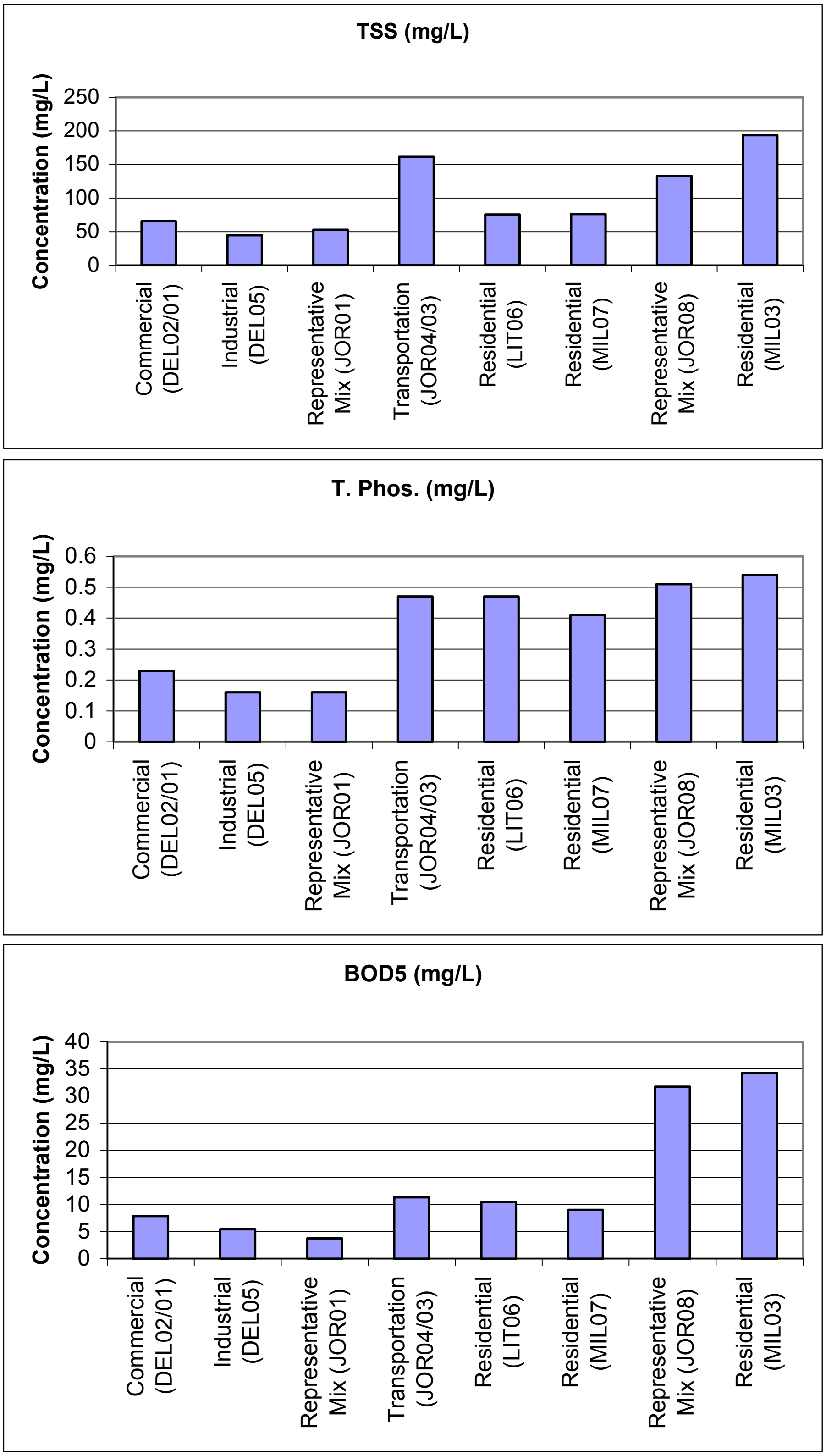
*Comparison with Regional Municipalities* A comparison of EMCs was conducted to determine how Salt Lake County EMCs correspond with regional municipalities with similar climates. The municipalities chosen for the comparison were Phoenix, Arizona; Boise, Idaho; Denver, Colorado; San Jose, California; Dallas, Texas; and Las Vegas, Nevada (Schueler et al., 2000).

The breakdown of the EMC comparisons is shown in Figure 4.3.4. The graphs indicate that Salt Lake County EMCs are within a similar range of the municipalities in the Intermountain West. The data indicates that stormwater pollution may not have the magnitude of impact on receiving waters in Salt Lake County as it does in other localities.

## 4.3.4 Extent of Impact

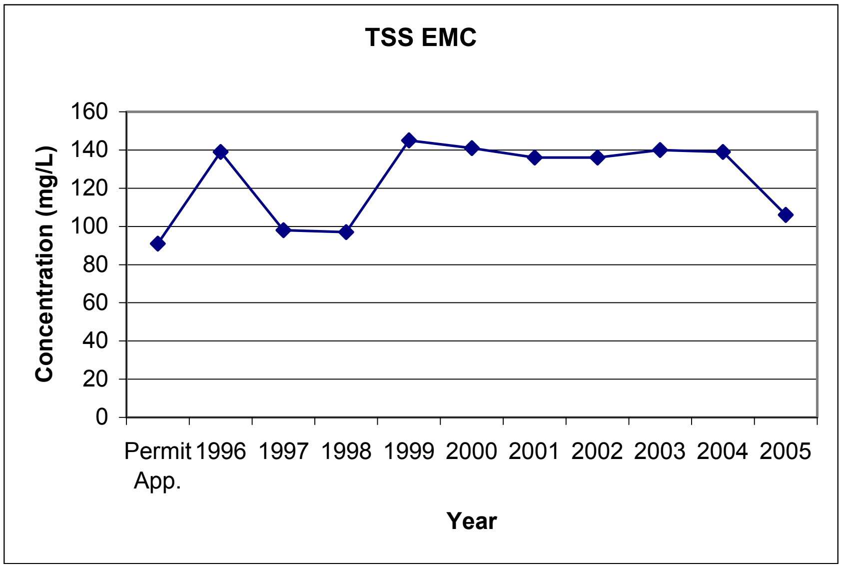
The variable nature and extent of stormwater discharges requires an integrated watershed management approach. The complexity of Salt Lake County's storm drainage system virtually ensures that every waterway in the County conveys stormwater runoff at some point in time. In addition, a spill or discharge of a pollutant in one sub-watershed could impact another sub-watershed where there is no natural physical connection, as stormwater runoff is currently collected and conveyed to irrigation canals where it may flow to an overflow diversion into a natural waterway or a piped system. Runoff will eventually discharge to the Jordan River or directly to the Great Salt Lake. With this conveyance system, stormwater pollutants are distributed throughout the County, making management universal and Countywide.

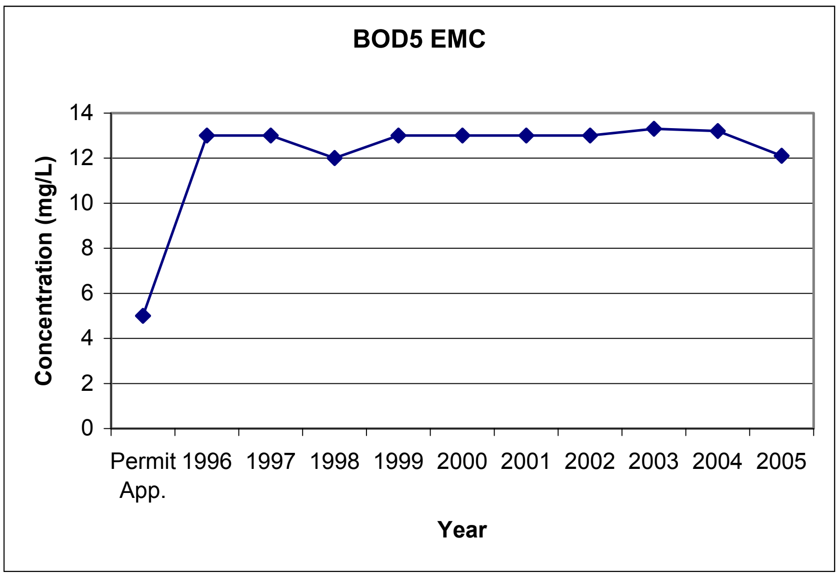
Data collected over the past 15 years has focused on general characterization of stormwater from




*Source: SLCo, 2006*

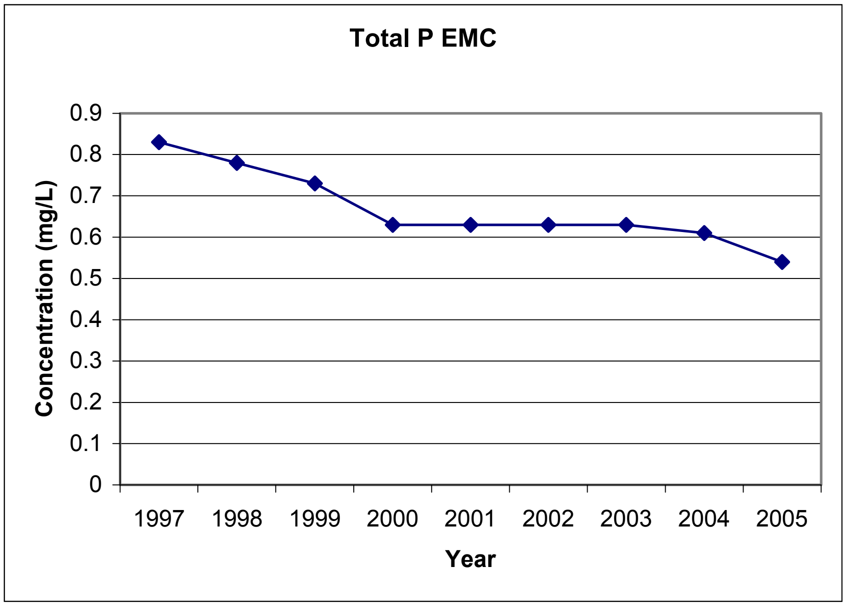
**Figure 4.3.3 Land Use EMCs**

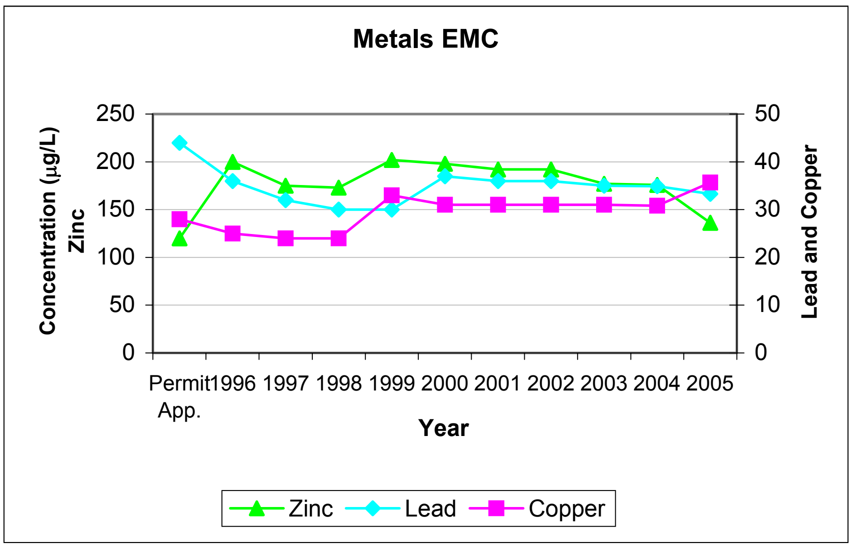



*Source: SLCo, 2006*

**Figure 4.3.4 EMC Stability/Trends**



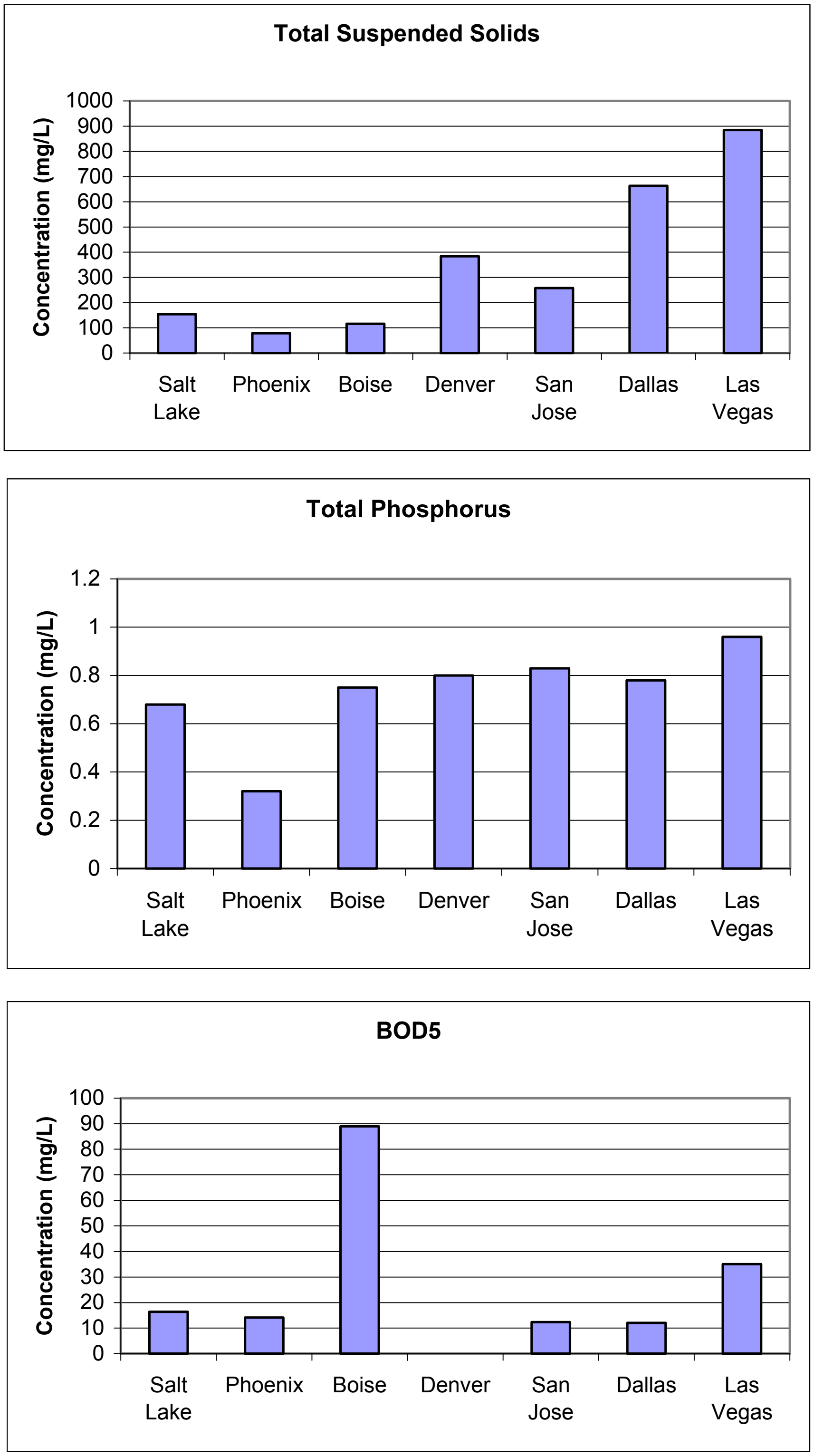

*Source: SLCo, 2006)*

**Figure 4.3.5 EMC Stability/Trends—*Continued***

**Table 4.3.13 EMC Stability/Trends**

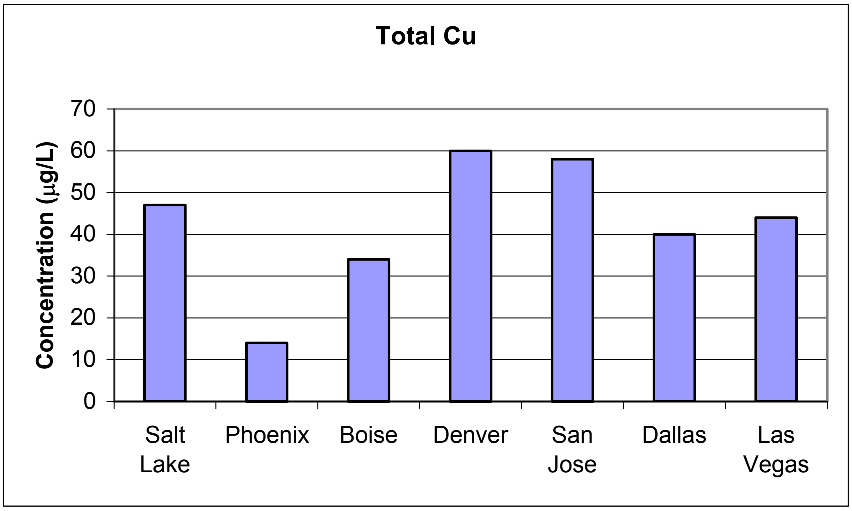
| | Permit App. | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| TSS (mg/L) | 91 | 139 | 98 | 97 | 145 | 141 | 136 | 136 | 140 | 139 | 106 |
| Total Phos (mg/L) | | | 0.83 | 0.78 | 0.73 | 0.63 | 0.63 | 0.63 | 0.63 | 0.61 | 0.54 |
| $BOD_5$ (mg/L) | 5 | 13 | 13 | 12 | 13 | 13 | 13 | 13 | 13.3 | 13.2 | 12.1 |
| Total Cu (µg/L) | 28 | 25 | 24 | 24 | 33 | 31 | 31 | 31 | 31 | 30.8 | 35.7 |
| Total Pb (µg/L) | 44 | 36 | 32 | 30 | 30 | 37 | 36 | 36 | 35 | 34.9 | 33.3 |
| Total Zn (µg/L) | 120 | 200 | 175 | 173 | 202 | 198 | 192 | 192 | 177 | 175.9 | 136.2 |
| Permit Application based on three storm events (9/4/92, 4/1/93, 6/17/93) | | | | | | | | | | | |

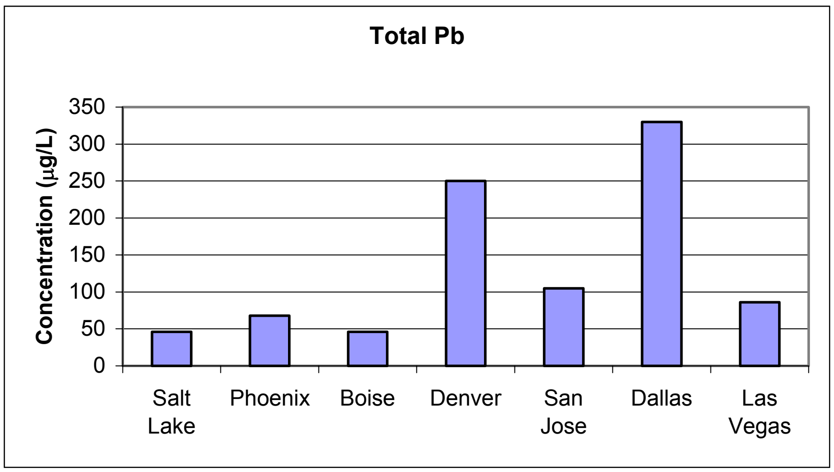
*Source: SLCO, 2006*

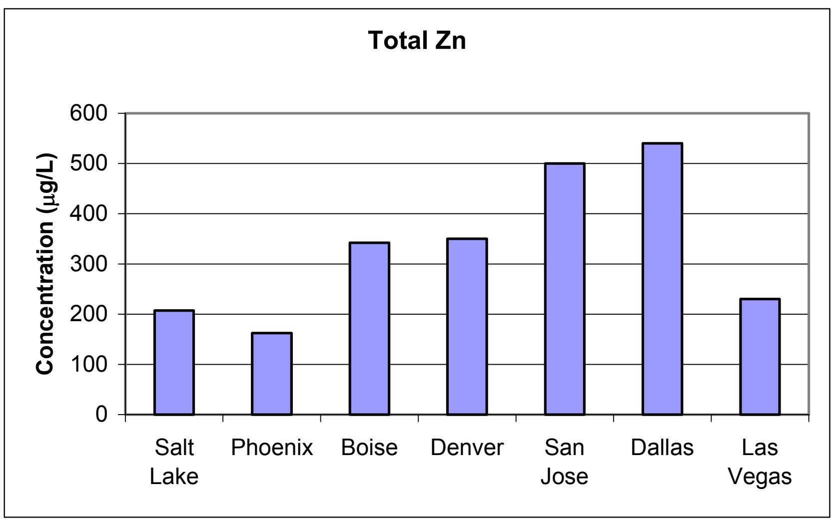



*Source: SLCo, 2006*

**Figure 4.3.6 Municipality EMC Comparison**




*Source: SLCo, 2006*

**Figure 4.3.7 Municipality EMC Comparison—*Continued***

different land uses in Salt Lake County. NURP data collected in the 1980's suggest the local streams and rivers that receive the stormwater discharges are impacted. The nature and extent of the instream response to stormwater discharges are not documented. Additional data collection of instream water quality during storm events would assist with identifying the degree of impact to streams and habitat.

### 4.3.5 Issues

Issues with stormwater management in Salt Lake County include: institutional management, TMDL implications, authorities and jurisdictions management of different discharge types, and methods for management. In looking at stormwater management on a watershed basis, reduction in pollutant loading is balanced with economic growth resource management and quality of life factors.

#### 4.3.5.1 Regulatory and Implementing Agency Coordination

Institutional management refers to stormwater management by the various regulatory and implementation agencies in the County. There are cities, the Health Department, and multiple State and Federal government agencies with jurisdiction relating to stormwater quality management within the County boundaries. The number of organizations involved, each with their own set of goals and objectives and methods, may lead to a duplication of efforts and/or missing data, if not for constant coordination..

#### 4.3.5.2 TMDL Regulatory Program

When a waterbody does not meet the designated beneficial use, a Total Maximum Daily Load (TMDL) study is initiated. This study develops an allowable pollutant mass per day discharge that will enable the water to meet the water quality numeric standard for that pollutant for the waterbody's designated beneficial use. The Waste Load Allocation (WLA) process allocates a portion of the allowable mass per day discharge to sources of discharge. A plan is then developed for each source to enable it to meet the allowable discharge amount.

Historically, stormwater discharge has not had the scrutiny of other point sources, such as municipal and industrial wastewater discharges, in TMDL allocations. This practice may likely not continue. Current and future TMDL allocations are and will take a detailed look at the contribution of stormwater runoff to overall pollutant loads.

#### 4.3.5.3 Stormwater Discharge Types

Stormwater is currently managed as three major discharge types. These types are municipal discharges, industrial discharges, and construction site discharges. While technically, runoff from construction sites is classified as industrial stormwater, DWQ effectively handles this runoff as a separate category. As discussed earlier, cities, the County and the State are all actively involved in the management of construction site runoff. Whereas cities and the County are responsible for MS4 discharges, the State is responsible for industrial discharges. However, some cities are actively engaged in management of industrial stormwater runoff.

Managing multiple stormwater discharge types by various agencies can also lead to a duplication of efforts and/or missing data if not for consistent coordination.

#### 4.3.5.4 Management Methods

There are basically three broad categories that BMPs fall into: hydrologic separation, source control, and treatment. Hydrologic separation implies that pollutants and runoff do not "mix". For example, routing roof drains onto permeable surfaces eliminates, or at least reduces, the amount of runoff that can entrain and transport pollutants to larger waterways and ultimately to Waters of the State. Source control is a BMP concept that embraces pollutant generation reduction. "Don't Litter" campaigns and street sweeping are examples of source control. Treatment is design, construction, maintenance and operation of a physical structure that treats stormwater runoff, often by mechanical means. Detention basins with sediment settling areas are examples of this category.

Issues with management methods involve the basic tenet of the stormwater permit regulations, particularly the reduction of pollutants to the MEP.

The method with the highest confidence for pollutant removal is treatment; however, treatment is considered to be one of the more costly BMPs. While a Public Information/Education Program is not as effective as treatment, it is a method that small communities can undertake and afford. Issues will arise with the selection of and enforcement of stormwater treatment, especially in the TMDL process. Factors other than effectiveness and cost also need to be considered when determining MEP. Wetlands treatment is an example of an effective treatment BMP without huge capital construction costs, but does need to be operated and maintained, which comes with associated costs.

#### 4.3.5.5 Trash and Debris

Trash and debris are often carried by storm runoff to receiving waters. There are no numeric criteria for trash and debris in the State water quality standards. There is, however, a prohibition in the narrative standards of the discharge or placement of "unnatural deposits, floating debris, oil, scum or other nuisances such as color, odor or taste…" into waters of the State (R317-2-7.2 UCA). BMPs to control trash and debris problems in County waterways include physical removal of debris by County maintenance crews from trash racks and booms, placement of trash receptacles, public education and volunteer clean-up efforts, among others.

### 4.3.6 Future Conditions

It is anticipated that the complexity and integrated stormwater runoff drainage system in Salt Lake County will remain largely unchanged during the planning horizon. Countywide Flood Control management will continue to be the responsibility of the County, while the cities will continue to manage municipal drainage.

Irrigation canals are anticipated to remain an integral part of the stormwater system. Capital costs will likely prohibit the construction of a separate system. The reduction of irrigated agricultural land in Salt Lake County is anticipated to result in irrigation canals primarily conveying stormwater and secondary home irrigation water, rather than agricultural irrigation water. When this happens, water quality improvement facilities can be installed and operated within the canals. These may consist of skimmers for floatables removal, linear detention improvements for solids removal, and the like.

The TMDL process is anticipated to evaluate stormwater pollution contributions and incorporate reductions in the waste load allocation. Greater emphasis likely will be put upon the stormwater contribution.

The population in Salt Lake County will continue to grow. Along with growth comes more cars, more roadways, more rooftops, and more impervious surface from which more runoff will be generated. As shown in the comparison of sampling data presented above, there is more pollutant mass being generated presently than in the past. A vigorous and directed public information and education program Countywide can serve well in informing the population at large of the problems created by stormwater runoff and can result in reductions of certain problems. However, the impacts will be minimized when rules and regulations are used in conjunction with such a program. The future Stormwater Management Program for Salt Lake County will most likely include a strong public information education program, implementation of stronger rules and regulations regarding development, setbacks, buffers, porous surface coverings and reliance on soft or passive treatment (wetland treatment) and less so on cost prohibitive mechanical treatment.

Land use will be affected by stormwater runoff control practices. Rules and regulations need to be instituted and implemented that require water quality considerations, such as streamside setbacks for development, less impervious area (smaller parking lots), alternative paving practices (porous pavement), and similar Leadership in Energy and Environmental Design criteria.

### 4.3.7 Recommendations

In reviewing: 1) existing Federal, state and local regulations relating to stormwater discharges, 2) existing stormwater quality conditions in Salt Lake County, 3) the extent of stormwater impact on surface water quality in Salt Lake County, 4) current stormwater issues, and 5) anticipated stormwater conditions, several issues were identified. In order to address these issues, the following recommendations are made:

#### 4.3.7.1 General Stormwater Quality Policy

1. Salt Lake County should continue to address the impacts of stormwater in the County as a matter of good public policy in addition to regional flood control authority.

2. Salt Lake County should incorporate water quality considerations into the evaluation of Flood Control Permits due to the County-wide drainage system influence on surface waters, irrigation waters and groundwater.

3. Salt Lake County should update the current stormwater quality management plan and the current GIS-based stormwater conveyance map. These efforts should be coordinated with all Cities in the County.

Daybreak development in South Jordan, UT

4. The County should sample instream water quality during storm events to assess impacts to surface water quality. The County should continue to sample stormwater discharges, as required by the State stormwater permit for large municipalities.

5. The County should participate in concurrent management programs relating to surface waters that convey stormwater within Salt Lake County, i.e. State led TMDL efforts, SLC Watershed Management Plan, Salt Lake County Foothill and Overlay Zone permitting.

#### 4.3.7.2 Stormwater Treatment Policy

1. The County should continue reliance on non-structural or programmatic BMPs. Public awareness, targeted education, ordinances, good housekeeping, trash management, etc., should be encouraged.

2. The County should evaluate retrofitting existing regional stormwater facilities to incorporate water quality treatment components and encourage the use of post-construction water quality practices (ie. constructed wetlands, bio-swales, wet ponds and other natural best management practices) during the permitting of new stormwater conveyance and discharge systems.

3. Salt Lake County should develop County-wide water quality design criteria targeting specific constituents for stormwater management facilities. These criteria should incorporate alternatives to meet the specific needs of the cities.

4. The County should conduct a feasibility study to identify specific irrigation canals that could be operated and maintained as water quality control facilities (i.e., linear detention basins) when not being used for transport of irrigation water.

5. The County should design, construct and monitor one treatment BMP per year. The County should incorporate open space and recreational opportunities into these

projects to meet requirements of the Clean Water Act (208(b)(2)(A)).

#### 4.3.7.3 Funding/Fiscal Policy

1. Salt Lake County should continue funding the overall stormwater coordinator Program and the municipal stormwater program in unincorporated County.

2. The County should use existing drainage funding sources to implement or expand existing post-construction BMP implementation.

3. The County should seek demonstration funds and/or grant monies to implement new stormwater quality improvement strategies.

4. Salt Lake County should continue to partner with other co-permittees for efficient programs.

## 4.4 NONPOINT SOURCE POLLUTION

The purpose of this planning element is to identify the sources of nonpoint pollution that occur in the Salt Lake Countywide Watershed and to review the applicable regulations and management plans, characterize the existing conditions and anticipated future conditions (up to year 2030), and develop source reduction strategies for each nonpoint source type. Additionally, this section is written to address the WaQSP strategic target, "Reduce pollutant loads to improve water quality in the Salt Lake Countywide Watershed sufficient to support aquatic habitat, water supply and social functions" by examining nonpoint source pollution in the County.

### 4.4.1 Background

Nonpoint source pollution (NPS) is pollution that is transported to receiving waters from diffuse sources rather than from pipes or other man-made conveyances. NPS pollution can include a variety of contaminates such as sediments, nutrients, pesticides, bacteria, organics and heavy metals that enter surface waters or leach into groundwater. Some common sources of NPS pollution include agricultural lands and operations, urban streets and parking lots, and construction sites.

#### 4.4.1.1 Nonpoint Sources

Nine (9) categories of nonpoint pollution sources were identified in the *Utah Nonpoint Source Pollution Management Plan* (Utah DEQ, 2000), each with several sub-categories (Table 4.4.1). Several nonpoint pollution sources are categorized as "other."

**Table 4.4.1 Categories of Nonpoint Source Pollution**

| Category | Pollution Source | Category | Pollution Source |
|---|---|---|---|
| 1. Agricultural Runoff | Non-irrigated crop production<br>Irrigated crop production<br>Pasture grazing - riparian and upland<br>Pasture grazing – riparian<br>Pasture grazing – upland<br>Rangeland - riparian and upland<br>Rangeland – riparian<br>Concentrated animal feeding operations<br>Animal feeding operations<br>Aquaculture | 6. Mining | Surface Mining<br>Subsurface mining<br>Petroleum activities<br>Abandoned mining (gravel pits) |
| 2. Urban Runoff | Nonindustrial (Municipal)<br>Industrial<br>Surface runoff<br>Other urban runoff<br>Highway/road/bridge runoff<br>Erosion and sediment | 7. Land Disposal | Sludge (Biosolids)<br>Wastewater<br>Landfills<br>Industrial land treatment<br>On-Site wastewater disposal |
| 3. Construction Runoff | Highway/road/bridge construction<br>Land development | 8. Silviculture | Harvesting, restoration, residue management<br>Forest management<br>Logging road construction/ maintenance |
| 4. Hydrologic Modification | Channelization<br>Dredging<br>Dam construction<br>Upstream impoundment<br>Flow regulation/modification | 9. Other | Atmospheric deposition<br>Golf courses<br>Spills<br>Internal nutrient cycling<br>Sediment resuspension<br>Natural sources<br>Sources outside jurisdiction or borders |
| 5. Habitat Modification | Removal of riparian vegetation<br>Bank or shoreline modification/ destabilization<br>Drainage/filling of wetlands | | |

*Source: Adapted from Table 3.1 of Utah Nonpoint Source Pollution Management Plan*

Of the primary sources, all are applicable to Salt Lake County except for silviculture. According to the *2003 Revised Forest Plan Wasatch-Cache National Forest*, no forest lands in Salt Lake County are capable or available for commercial timber harvest (USFS, 2003).

Each of the sources applicable to Salt Lake County is discussed in detail in the following sections.

#### 4.4.1.2 Regulations

The Department of Environmental Quality (DEQ) has been designated by the Environmental Protection Agency (EPA) as the lead agency to manage the water pollution control programs and to conduct provisions of the federal Clean Water Act (CWA) in Utah.

*Clean Water Act* The Clean Water Act (CWA), formerly known as the Federal Water Pollution Control Act Amendments of 1972, was intended to restore and maintain the chemical, physical, and biological integrity of the nation's waters. The CWA established the basic structure for regulating discharges of pollutants into the waters of the United States. It gave the EPA the authority to implement pollution control programs and to set water quality standards for all contaminants in surface waters.

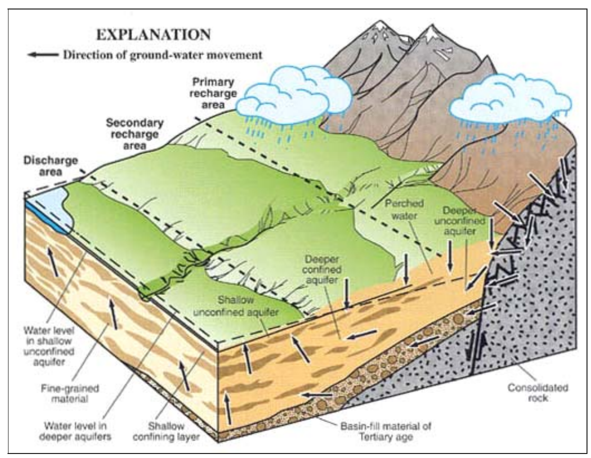
Following are brief descriptions of CWA provisions that relate to nonpoint source pollution.

CWA Section 402, the National Pollutant Discharge Elimination System (NPDES) Permit and Compliance Program, requires that all point source discharges of pollutants to the waters of the U.S. obtain a permit. The permit sets limits to the discharges and requires monitoring to ensure water quality standards are being met.

CWA Section 319, the Nonpoint Source Management Program, provides funding to states to reduce pollutant loading from nonpoint sources. Section 319 requires that the states follow an approved management plan when conducting NPS mitigation activities in order to qualify for funding.

*Utah Water Quality Act* The Water Quality Act is the enabling legislation for Utah's water quality protection program. The law established the Water Quality Board, the Division of Water Quality and Utah's Water Quality Rules (UAC R317).

The State of Utah's Water Quality Revolving Fund (SRF) was established through UAC R317-102. The SRF provides low interest rate loans to finance the construction of publicly owned water quality preservation and protection facilities. The DEQ administers the SRF through the Division of Water Quality (DWQ). The Utah Water Quality Board develops administrative rules for program implementation and authorizes loans under the SRF. Primary SRF activities of the DWQ include administering loans for water quality, assisting communities to properly treat and dispose of wastewater, and managing fund transactions. NPS control projects are eligible for funding under the SRF.




*Source: New York State University*
Groundwater flow in Salt Lake County

Utah's Groundwater Quality Protection Rules were established through UAC R317-6. Utah's groundwater protection regulations have an anti-degradation policy that provides for the maintenance and protection of current and probable future beneficial uses of groundwater and protection of higher quality waters at their existing water quality.

#### 4.4.1.3 Management Plans

The Utah Department of Environmental Quality prepared the *Utah Nonpoint Source Pollution Management Plan* in 2000. The plan describes the nonpoint source pollution control program in the state of Utah and integration of the program with the watershed approach to water resources management.

The Environmental Protection Agency (EPA) requested that states review and revise nonpoint source management programs to reflect the following nine (9) guidelines:

1. The state program contains explicit short- and long-term goals, objectives and strategies to protect surface and groundwater.
2. The state strengthens its working partnerships and linkages to appropriate state, interstate, Tribal, regional, and local entities (including conservation districts) private sector groups, citizen groups, and Federal agencies.
3. The state uses a balanced approach that emphasizes both state-wide nonpoint source programs and on-the ground management of individual watersheds where waters are impaired or threatened.
4. The state program (a) abates known water quality impairments from nonpoint source pollution and (b) prevents significant threats to water quality from present and future nonpoint source activities.
5. The state program identifies waters and their watersheds impaired by nonpoint source pollution and identifies important unimpaired waters that are threatened or otherwise at risk. Further, the State establishes a process to progressively address these identified waters by conducting more detailed watershed assessments and developing watershed implementation plans, and then by implementing the plans.
6. The state reviews, upgrades, and implements all program components required by section 319(b) of the Clean Water Act, and establishes flexible, targeted, and iterative approaches to achieve and maintain beneficial uses of water as expeditiously as practicable.
7. The state identifies Federal lands and activities which are not managed consistently with state nonpoint source program objectives. Where appropriate, the State seeks EPA assistance to help resolve issues.
8. The state manages and implements its nonpoint source program efficiently and effectively, including necessary financial management.
9. The state periodically reviews and evaluates its nonpoint source management program using environmental and functional measures of success, and revises its nonpoint source assessment and its management program at least every five (5) years.

The Utah NPS program established eight (8) goals and objectives, with forty (40) tasks to accomplish these goals and objectives:

1. Environmental protection
2. Improve program efficiency
3. Increase program effectiveness
4. Improve public participation
5. Integrate, review and focus statewide management programs
6. Improve data management
7. Improve working relationships at all levels of government and private sector
8. Increase accountability of agency staff

The Utah NPS program guidelines were integrated with the Utah Watershed Approach.

Additional management plans for subcategories of nonpoint pollution sources developed by DEQ are listed below and are summarized in the following applicable sections.

A. Agriculture
B. Silviculture
   *State of Utah Nonpoint Source Management Plan for Silvicultural Activities* (Summers et al., 1998)
C. Abandoned Mines
D. Hydrologic Modifications

Additionally, the Utah Department of Agriculture and Food is currently developing Pesticide State Management Plans (PMP). These plans contain the actions necessary to protect groundwater resources from specific pesticides being regulated by the EPA. The plans will be required by the EPA as a condition of future use of the pesticides.

Additional NPS management programs include the following:

A. Development and Implementation of TMDL's
B. Financial Assistance Programs
C. Information & Education Programs
D. Federal Consistency
E. High-Quality Waters and Priority Watersheds
F. Addressing All Significant Threats to Water Quality
G. Groundwater NPS Management Program
H. U.S. Department of Agriculture (USDA)/ Conservation Programs

## 4.4.2 Agricultural Runoff – Animal Feeding Operations

### 4.4.2.1 Background

An Animal Feeding Operation (AFO) is defined as a lot or facility where animals are stabled or confined and fed or maintained for a total of 45 days or more in any 12 month period and crops, vegetation forage growth, or post-harvest residues are not sustained in the normal growing season over any portion of the lot or facility.

A Concentrated Animal Feeding Operation (CAFO) is defined as an animal feeding operation where more than 1,000 animal units are confined at the facility or more than 300 animal units are confined at the facility and either one of the following conditions are met: pollutants are discharged into navigable waters through a man-made ditch, flushing system or other similar man-made device; or pollutants are discharged directly into waters of the United States which originate outside of and pass over, across, or through the facility or otherwise come into direct contact with the animals confined in the operation.

An animal feeding operation of any size may be designated as a CAFO based on a finding that the facility is a significant contributor of pollution to waters of the United States. A facility with 300 animal units or less, however, may not be designated as a CAFO unless pollutants are discharged from a man-made conveyance or are discharged directly into waters passing over, across or through the facility or that otherwise come into direct contact with the confined animals. The regulations also provide that no animal feeding operation is a CAFO under the regulatory definition if it discharges only in the event of a 25-year, 24-hour or larger storm event.

*Regulations* The EPA adopted the CAFO Final Rule in 1993 (40 CFR Parts 9, 122, 123, and 412), which revised and clarified the regulatory requirements for CAFO's under the Clean Water Act. The rule provides the definition for AFO's and CAFO's, which operations need a permit, general permit requirements and conditions, and record keeping and reporting requirements. The rule requires all CAFO's to apply for an NPDES permit and to develop and implement a nutrient management plan. The required nutrient management plan identifies the site-specific actions to be taken by the CAFO to ensure proper and effective manure and wastewater management, including compliance with the Effluent Limitation Guidelines (40 CFR Part 412).

The compliance date was extended in response to changes required by the Second Circuit Court of Appeals decision in Waterkeeper Alliance et al. v. EPA. February 27, 2009 was established as the new date of compliance for newly defined CAFO's to seek NPDES permit coverage and for permitted CAFO's to implement nutrient management plans.

UAC R317-8-3.6 requires CAFO's to obtain a Utah Pollutant Discharge Elimination System (UPDES) permit from DEQ. The permit requires preparation of a comprehensive nutrient management plan (CNMP), manure testing, record keeping and elimination of polluted runoff. AFO's are encouraged to voluntarily participate in the program to reduce water quality impacts to receiving waters by preparing CNMP's.

*Management Plan* The USDA and EPA developed the *Unified National Strategy for Animal Feeding Operations* in 1999. The strategy addresses the water quality and public health impacts associated with animal feeding operations.

The Utah AFO/CAFO Advisory Committee prepared *A Utah Strategy to Address Water Pollution From*

*Animal Feeding Operations* in 2001. The primary objective of the strategy was to outline the approach to addressing water quality impacts associated with manure management practices at animal feeding operations.

The key elements to the strategy to address water pollution from animal feeding operations include the following:

- Information, education and training, research and demonstrations - An Education Committee was formed to prepare an education plan. The Education Committee includes the following agencies: USU Cooperative Extension, UDAF, UACD, NRCS and DEQ.
- Watershed prioritization—Prioritization is based on Utah's 303(d) list of impaired water bodies, the Unified Watershed Assessment and data from other agencies.
- Assessment of AFO/CAFO's—The assessment includes location, types of animals, number of animal units, proximity to nearest water body, potential pollution loading, receiving water, waste storage type and capacity, type of confinement and age of facility. An inventory of AFO/CAFO's was prepared from these assessments.
- Permitting goals and objectives—The objective of the permitting system is to specify the threshold for facilities required to have a permit, the permitting requirements, the enforcement response, and the maintenance of documentation.

Animal Feeding Operation, Rose Creek Sub-Watershed

- Compliance milestones—Immediate compliance action is necessary when severe pollution problems exist. Compliance milestones were developed for AFO/CAFO's.
- Permit development—CAFO's are required to obtain an Utah Pollutant Discharge Elimination System (UPDES) permit that requires a comprehensive nutrient management plan (CNMP), manure testing, record keeping and elimination of polluted runoff.
- Testing, record keeping and monitoring—The testing and monitoring schedule and protocols is specified in the CNMP for each facility. DEQ may monitor adjacent surface waters to verify and document any improvement in water quality resulting from implementation of the manure management practices.
- Implementation plan—An implementation schedule was developed.

### 4.4.2.2 Existing Conditions

There are no permitted CAFO's currently operating in Salt Lake County. Two AFO's were identified for this planning effort: Hogle Zoo, in the Lower Emigration Creek Sub-Watershed, and the Bureau of Land Management's Wild Horse and Burro Center in Butterfield Canyon in the Midas/ Butterfield Sub-Watershed. This may not be a comprehensive list of AFO's in Salt Lake County. Therefore, the exent of nonpoint source pollution from animal feeding operations may not be entirely described.

### 4.4.2.3 Future Conditions

With the exception of Hogle Zoo and the Wild Horse and Burro Center, the projected continued urbanization of the Salt Lake Valley will likely result in the reduction or complete elimination of animal feeding operations in Salt Lake County.

#### 4.4.2.4 Source Reduction Strategies

Implementation of the strategies in *A Utah Strategy to Address Water Pollution From Animal Feeding Operations* (Utah AFO/CAFO Committee, 2001) would result in reductions of the nonpoint source pollution from animal feeding operations.

### 4.4.3 Agricultural Runoff – Cropland/ Rangeland

#### 4.4.3.1 Background

This section considers nonpoint source pollution from agricultural runoff from cropland and rangeland, including irrigated and non-irrigated crop production, pasture grazing and rangeland.

*Regulations* The Utah Department of Agriculture and Food (UDAF), working through the Utah Conservation Commission, has a prominent role in managing agricultural NPS pollution through a memorandum of understanding with DEQ. The Utah Conservation Commission functions to coordinate the soil conservation program and the local Soil Conservation Districts. The Utah Conservation Districts devise and implement measures for the prevention of soil erosion, flood waters and sediment damage nonpoint water pollution, and for the conservation, development, utilization, and disposal of water on State and private lands with the consent of the land occupier (UAC 17A-3-805).

UDAF is also responsible for the regulation of pesticides, herbicides, and fertilizers through the Utah Pesticide Control Act and the Utah Fertilizer Act. UDAF certifies pesticide applicators and registers pesticides distributed in the State. Use may be restricted if they present an unreasonable risk to human health and the environment. Under the Utah Fertilizer Act, UDAF requires registration, labeling, and verification of performance claims for commercial fertilizers.

The EPA, under authority of the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), is working with States to establish State Management Plans (SMPs) and Pesticide Management Plans (PMPs) as a new regulatory mechanism for water quality.

*Management Plans* In 1997, the UDAF received approval from the EPA for its *Ground Water/ Pesticide State Management Plan*. The plan outlines UDAF's philosophy and plans towards protecting groundwater from pesticide contamination. The plan also details the State's response to a detection of pesticides in groundwater.

UDAF is currently developing Pesticide Management Plans (PMP). These plans contain the actions necessary to protect groundwater resources from specific pesticides being regulated by the EPA. The EPA has identified the first five (5) pesticides for restriction under the proposed PMP rule: alachlor, atrazine, cyanazine, metolachlor, and simazine. The pesticides are all broad-spectrum herbicides. These pesticides were chosen due to their high potential to leach into groundwater and to be a possible detriment to public health, safety, and the environment.

The Utah State University (USU) Cooperative Extension, Natural Resources Conservation Service and Soil Conservation Districts provide educational, technical and financial assistance for pest management, fertilizer management, irrigation management, erosion control and salinity control.

Integrated Pest Management (IPM) is the coordinated use of pest and environmental information with available pest control methods to prevent unacceptable levels of pest damage by the most economical means and with the least possible hazard to people, property, and the environment.

Fertilizer management involves the proper timing and application of fertilizers in order to reduce the transport of nutrients to receiving waters. Irrigation water management is the efficient use of water for crops to reduce the amount of irrigation return flows to ground and surface waters. Erosion control techniques help reduce the amount of sediment delivered to the receiving waters.

The Agricultural Resource Development Program provides loans for the installation of soil and water conservation practices on range and crop lands. The program is administered by the NRCS and the Utah Association of Conservation Districts.

#### 4.4.3.2 Existing Conditions

The Salt Lake valley portion of the watershed has historically been primarily agricultural and open space land; however, with urbanization, the agriculture and open space is diminishing rapidly. The remaining agricultural lands are predominantly located on the west side of the valley (Figure 4.4.1). As of 2002, there were 41,000 total acres of agricultural land in Salt Lake County, consisting of 12,400 acres of irrigated agricultural land and 28,600 acres of non-irrigated agricultural land (DWR GIS data from 2002).

The irrigated agricultural land is comprised of 5,600 acres of alfalfa, 4,300 acres of pasture, 1,200 acres of grain, 500 acres of corn and the remainder of grass/turf, hay, orchard and vegetables. Most of the irrigated agricultural land is located in the southern end of the valley in the vicinity of the irrigation canals. The source of virtually all of the irrigation water is the Jordan River.

The non-irrigated agricultural land is comprised of 15,600 acres of idle or fallow agricultural land, 8,600 acres of dry grain/seed, and 4,200 acres of dry pasture. Most of the non-irrigated agricultural land is located west of and above the canals in the western portion of the County.

#### 4.4.3.3 Future Conditions

The urbanization of the Salt Lake Valley is projected to continue in the future, resulting in an estimated loss of 36,000 acres with 4,600 acres remaining agricultural land by 2030 (Figure 4.4.2) (WFRC GIS data for 2030). Therefore, nonpoint source pollution associated with cropland and rangeland within Salt Lake County is anticipated to be considerably reduced in the future.

The non-irrigated agricultural land has the potential to be converted to irrigated lands as more water is made available due to conversion of irrigated land to residential and commercial development. The irrigation water would need to be pumped up from the canals and water shares would need to be transferred.

#### 4.4.3.4 Source Reduction Strategies

It has not been well documented what management practices have been implemented on the agricultural lands in Salt Lake County in order to reduce impacts on the water quality in the receiving waters. The *State of Utah Water Plan for the Jordan River Basin* (Utah Division of Water Resources, 1997) recommended the following measures to protect and enhance the watershed: improved vegetation; conservation tillage; grazing management; improved crop sequencing; irrigation system management; contour trenching; debris basins; gully control; livestock exclusion; and stream channel stabilization. In addition, the following water conservation measures were recommended: improved diversion structures; lining high seepage loss canals; irrigation system management; and conversion of flood irrigation to sprinkler or trickle applications.

### 4.4.4 Urban Runoff

Urban runoff, or stormwater, results from excess precipitation on pervious and impervious surfaces in developed communities that leads to surface flow to receiving waters. The urban runoff often conveys pollutants to the receiving waters that is detrimental to ecological and public health. The EPA, DEQ, Salt Lake County and local municipalities have extensive programs that address water pollution resulting from stormwater. The Utah NPS management program has devoted minimal resources to addressing this nonpoint source as stormwater is highly regulated by the pointsource program. Stormwater is addressed in detail in the Stormwater Planning Element (Section 4.3) of this plan.

### 4.4.5 Construction Runoff

Construction runoff, or stormwater during construction phase, is precipitation-driven surface flow from construction sites that results in erosion and sediment deposition in receiving waters. The EPA, DEQ, Salt Lake County and local municipalities have extensive programs that address water pollution resulting from construction runoff. Construction runoff is addressed in detail in the Stormwater Planning Element (Section 4.3) of this plan.

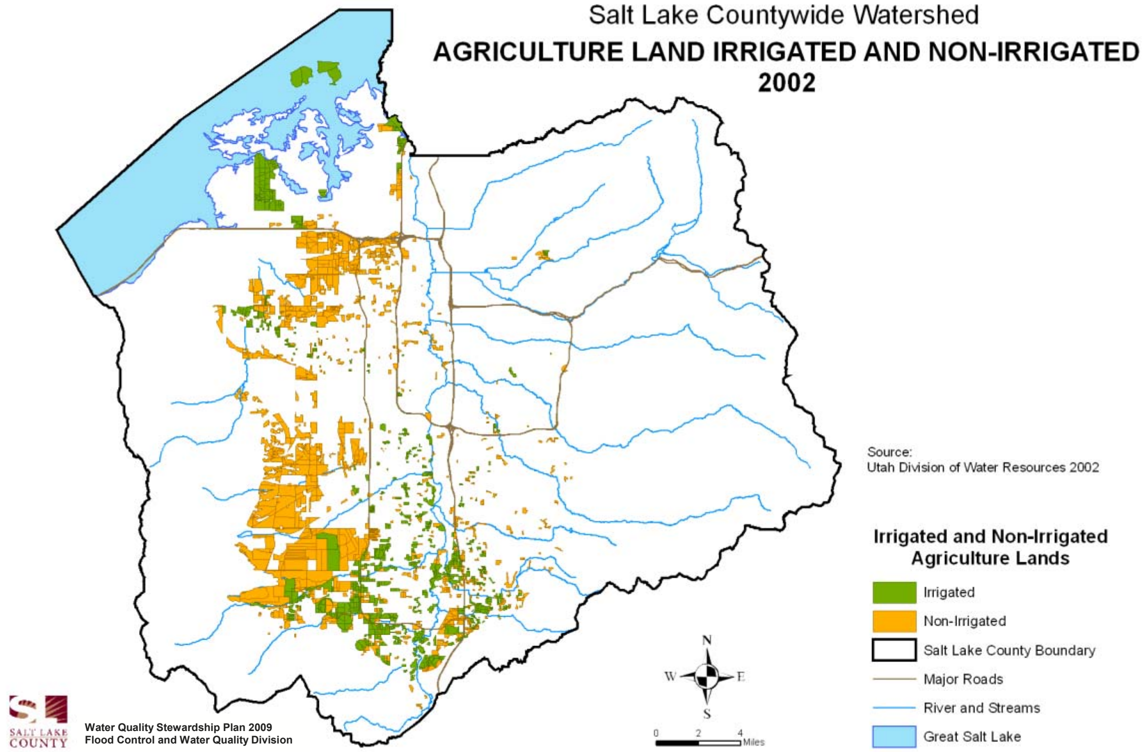



**Figure 4.4.1 Irrigated and Non-Irrigated Agricultural Land in 2002**

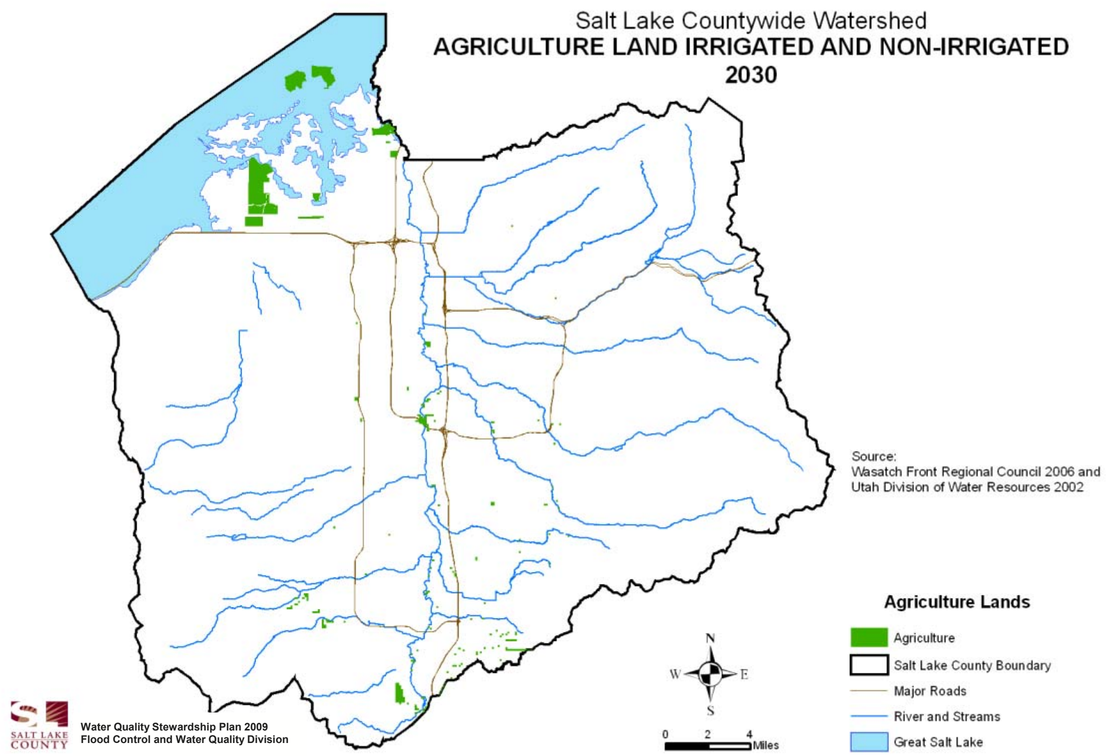



**Figure 4.4.2 Agricultural Land in 2030**

## 4.4.6 Golf Courses and Managed Parks

### 4.4.6.1 Background

The use and misuse of fertilizers and pesticides to maintain golf course greens and park lawns results in a nonpoint source of pollution. The fertilizer and pesticide residue enters adjacent streams and lakes either through surface runoff or groundwater leaching. The fertilizers result in nutrient loading to the receiving waters, which can lead to algae growth and oxygen depletion. The pesticides can result in unintended detrimental effects to organisms in the receiving waters.

*Regulations* There are no state or local water quality regulations specific to the management of golf courses and managed parks.

*Management Plans* DWQ has not developed a separate management plan for nonpoint source pollution from golf courses and managed parks. BMP's for managing riparian areas, irrigation water, and water quality in protection in urban areas are included in the *Utah Nonpoint Source Pollution Management Plan* (DEQ, 2000).

### 4.4.6.2 Existing Conditions

There are currently 30 golf courses in Salt Lake County. They are primarily located in the valley portion of the watershed, with the exception of the Mountain Dell Canyon Golf Course, which is located in upper Parley's Creek Sub-Watershed (Figure 4.4.3). A majority of the golf courses are adjacent to a stream or have a stream running through them. Seven golf courses are adjacent to the Jordan River within Salt Lake County.

There are numerous managed parks within Salt Lake County. Figure 4.4.3 shows all of the parks regardless of the level of management. With regards to nonpoint sources of pollution, the parks that utilize fertilizers, herbicides and pesticides for management of grass and vegetation are of primary concern. The parks that have extensive vegetation management have not been compiled; however, this applies to many of the parks in the valley. In addition, many managed parks are adjacent to a stream or have a stream running through them.

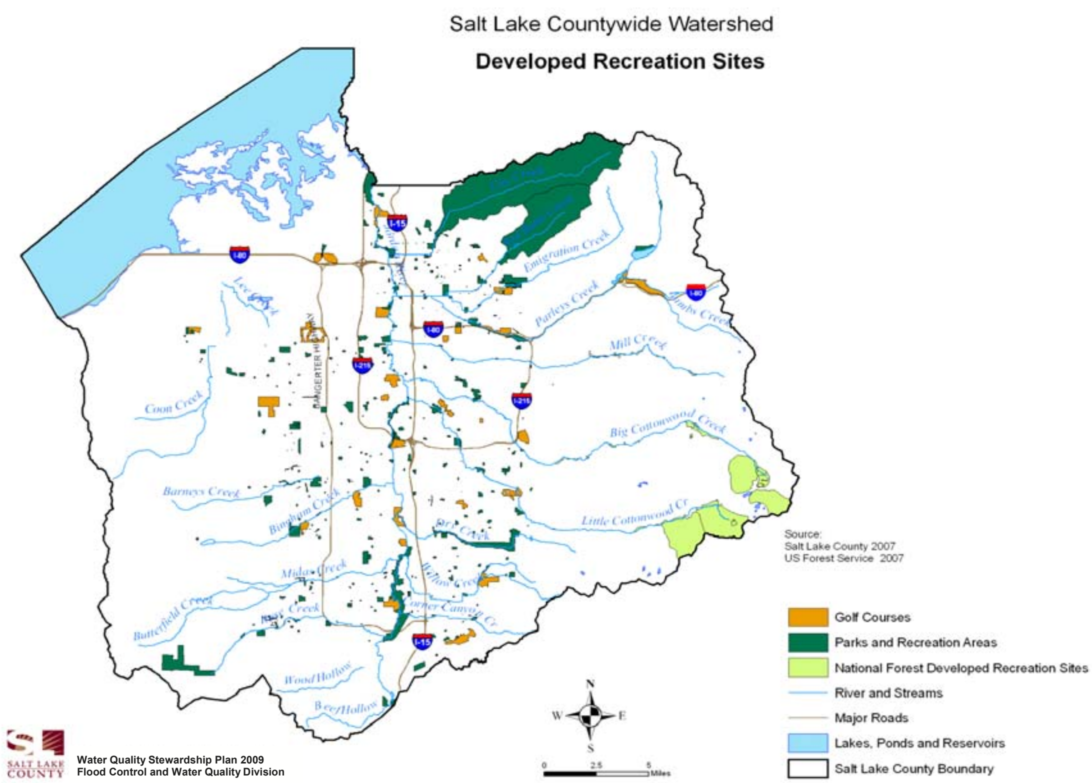



**Figure 4.4.3 Golf Courses and Parks**

#### 4.4.6.3 Future Conditions

Demand for golf courses and managed parks is anticipated to increase and will be part of new communities as they develop in the valley. Some additional parks will be created in existing developed areas.

#### 4.4.6.4 Source Reduction Strategies

The current management practices of the golf courses and parks in Salt Lake County were not compiled for this planning effort. Recommended management practices for golf courses and parks include:

- Preparation and implementation of an integrated pest management plan
- Use of biological treatments for pest management such as selection of tolerant species and introduction of predators
- Irrigation management for efficient use of water
- Turf management to reduce the amount of nutrients and herbicides in return flows
- Testing of soil to determine the suitable amount of nitrogen and phosphorus fertilizer required for plant growth
- Landscape and vegetation management to reduce sediment load in stormwater runoff
- Maintenance of adequate stream buffers and riparian vegetation management

The Audubon Society developed a certification program for golf courses called the Audubon Cooperative Sanctuary Program (ACSP). The

Rose Park Golf Course, Jordan River Corridor Sub-Watershed

certification program integrates environmental management and natural areas preservation with golf course operation. The program enhances valuable natural areas and wildlife habitats that golf courses provide, improves maintenance efficiency, and minimizes potentially harmful impacts of golf operations. Audubon International conducts a site assessment and provides guidance to help the golf course with environmental planning, wildlife and habitat management, chemical use reduction and safety, water conservation, water quality management, and outreach and education.

Wolf Creek Golf Resort in Eden, UT: an ACSP course

### 4.4.7 Hydrologic Modification and Habitat Alteration

#### 4.4.7.1 Background

Hydrologic modification is defined to occur whenever human activities significantly change the hydrologic function (dynamics) or the attendant pollutant release regime of rivers and riverine systems, lakes and impoundments, and groundwater systems.

Activities falling under hydrologic modification fall under three types:

1. Those activities that alter the flow regime of a body of water:

   *streams*: diversions from the stream, diversions to the stream, impoundments

   *watersheds*: vegetation removal or change in type, construction that leaves soil bare, or covers the soil (i.e., hardtop) *lakes and reservoirs*: activities that change capacity, circulation patterns, or that release stored pollutants (i.e., sluicing)

*groundwater*: change recharge pattern, direct recharge, pumping from groundwater.

2. Those near-stream or in stream activities that alter the function or stability of a stream channel or its flood plain: channel realignment, grade control, in-stream structures, stream crossings, bank stabilization, material extraction.
3. Activities in the floodplain area: flood control practices, riparian/floodplain modification, structures, wetland modification.

Habitat alteration includes removal of riparian vegetation, bank or shoreline modification, and draining or filling wetlands. For a detailed consideration of habitat alteration in Salt Lake County, refer to section 4.7 Habitat Planning Element.

*Regulations* This section provides a brief overview of regulations pertaining to hydrologic modification. For a detailed discussion of regulations pertaining to instream flows, refer to Section 4.6.1 of the Instream Flows Planning Element.

The U.S. Army Corps of Engineers (USACE) regulates activities in the nation's waterways for both the protection and utilization of water resources. Section 404 of the Clean Water Act prohibits discharge of dredged or fill material or excavation in waters of the United States without a permit from USACE. Under the Section 404(b)(1) Guidelines, USACE can only permit the least damaging practical alternative after consideration of impact avoidance, minimization, mitigation and compensation. The guidelines also require no significant degradation.

In Utah, the State Engineer is responsible for the general administrative supervision of the waters of the state and the measurement, appropriation, apportionment, and distribution of those waters (UCA). The State Engineer is in the Division of Water Rights within the Department of Natural Resources.

The Division of Water Rights administers all water rights appropriations and certifications, including new appropriations, changes to beneficial use or point of diversion, exchanges, segregations, extensions of time to resume use, and diligence claims.

The Dam Safety program within the Division of Water Rights is responsible for overseeing dam construction and repair. The program reviews plans and specifications, as well as performs periodic inspections on the dams throughout the state.

The Utah Stream Alteration Act of 1971, with subsequent amendments and modifications, regulates activities within the stream channel (UCA 73-3-29). The Stream Alteration Act requires that a permit be obtained from the State Engineer for any project that will alter the bed and bank of any natural stream. The decision to approve applications is based on a public interest review to determine if the proposed alteration would unreasonably or unnecessarily interfere with the natural resources, including an evalution of the natural stream environment, fish and wildlife, channel capacity, water rights and recreational uses.

As a result of the Stream Alteration Act, USACE issued General Permit 040 in 1987 that authorizes the State Stream Alteration Permit to fulfill the requirements of Section 404 of the CWA for certain activities. The Stream Alteration program within the Division of Water Rights assumed the responsibility from the USACE for the regulation of fill and dredge operations within stream channels, except for those projects that involve listed threatened or endangered species, properties on the National Historic Register, navigable waters, channel relocations, or pushing streambed material against a streambank using heavy equipment. The permit authority does not apply to wetlands.

The Division of Water Quality provides water quality certification under Section 401 of the CWA. A State 401 Water Quality Certification must be obtained for activities that may impact the water quality of the waters in the state.

Salt Lake County has regulatory authority and responsibility for flood control activities within both incorporated and unincorporated areas of the county (UCA 17-8-5). Salt Lake County has the authority to regulate development within stream or river flood channel meander boundaries.

Salt Lake County and the municipalities have regulatory authority to control land use within their respective boundaries (UCA 17-27-101). Zoning ordinances designate appropriate uses of properties for public health, safety and welfare. Sensitive areas ordinances regulate development within or adjacent to streams and wetlands, and specify set backs and buffers.

*Management Plans* The Utah NPS Task Force adopted the *Nonpoint Source Management Plan for Hydrologic Modifications* in 1995 (Robinson, 1995). The intent of the plan was to identify methods to improve water quality protection during hydrologic modifications and achieve water quality improvements from previous modification through an incentive-based or voluntary approach.

The hydrologic modification NPS control program includes the following strategies: information and education, regulation, zoning, planning, incentives, research, agency coordination and technical assistance. The plan defines the Hydromod Planning Process, which outlines a standard process for hydrologic modification BMP development, implementation, and documentation.

The plan provides a description of Utah's Hydromod BMP's, which identify application standards for each hydrologic modification activity. The activities with BMP's include measures to control construction activities, emergency measures, trans-basin diversions, diversions, impoundments, groundwater withdrawal/recharge, channel realignment, grade control, in-stream structures, stream crossings, bank stabilization, channel/floodplain extraction or re-working, fish habitat enhancement, flood control practices, riparian/floodplain modification and wetland enhancement.

The EPA issued the *National Management Measures to Control Nonpoint Source Pollution from Hydromodification* in 2007. The primary goal of the guidance document is to provide technical assistance to states, territories, tribes, local governments, and the public for managing hydromodification and reducing associated NPS pollution. The document recommends measures to address channelization and channel modification, dam construction, operation and removal, and streambank and shoreline erosion.

#### 4.4.7.2 Existing Conditions

For a detailed discussion of existing modifications to flow regime, refer to Section 4.6.2 of the Instream Flows Planning Element. For a detailed discussion of existing conditions of habitat, refer to Section 4.7.2 of the Habitat Planning Element.

The extent of nonpoint source pollution from hydrologic and habitat modification associated with stream channel, streambank, floodplain and riparian alteration has not been well documented. It is safe to say, however, that significant alteration of stream corridors has occurred historically in Salt Lake County. Typical practices included putting streams in pipes, channel straightening, channel realignment around agricultural fields and developments, channel dredging, instream flow control structures and facilities, streambank hardening and armoring, floodplain disconnection and development, and riparian vegetation removal.

#### 4.4.7.3 Future Conditions

For a detailed discussion of future modifications to flow regime, refer to Section 4.6.3 of the Instream Flows Planning Element. For a detailed discussion of future conditions of habitat, refer to Section 4.7.3 of the Habitat Planning Element.

Pressures on stream corridors from development are expected to continue in the future, particularly on the west side of the valley. However, stream alteration activities are much more regulated than in the past, which should offer some measure of protection from deleterious effects.

#### 4.4.7.4 Source Reduction Strategies

The primary source reduction strategy is avoidance of activities within the stream corridor and maintenance of suitable stream buffers. If stream alteration is unavoidable, minimization of impacts and mitigation for activities will reduce the overall effect on the stream. Flood control activities should be conducted in a sustainable way to promote stable channel conditions.

## 4.4.8 Mining

### 4.4.8.1 Background

This section considers nonpoint source pollution from mining activities, including surface mining, subsurface mining, petroleum activities and abandoned mines. At abandoned mines, only discharges from a draining adit, or horizontal mine entry, are considered to be point sources.

*Regulations* The Comprehensive Environmental Response Compensation and Liability Act (CERCLA), commonly known as Superfund, was enacted by Congress in 1980 and is administered by the Environmental Protection Agency. The federal law provides the framework for environmental clean-up of hazardous waste sites, including abandoned mines. CERCLA established prohibitions and requirements concerning closed and abandoned hazardous waste sites, provided for liability of persons responsible for releases of hazardous waste at these sites, and established a trust fund to provide for cleanup when no responsible party could be identified.

CERCLA actions are taken principally at sites on the National Priorities List (NPL). The NPL is the list of national priorities among the known releases or threatened releases of hazardous substances, pollutants, or contaminants throughout the United States and its territories. The NPL is intended primarily to guide the EPA in determining which sites warrant further investigation. There are no abandoned mines in Salt Lake County currently listed or proposed for listing on the NPL.

In June 2007, the EPA issued the Good Samaritan administrative CERCLA tools. The Good Samaritan Initiative accelerates restoration of watersheds and fisheries threatened by abandoned hard rock mine runoff by encouraging voluntary cleanups by parties that do not own the property and are not responsible for the property's environmental conditions. The tools are a model comfort letter and a model settlement agreement (an administrative order on consent or "AOC").

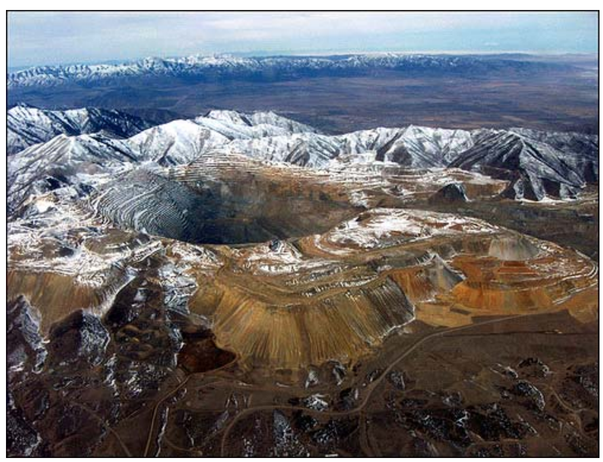
The Utah State Legislature passed the Voluntary Release Cleanup Program statute in 1997. Under the legislation, the Voluntary Cleanup Program (VCP) was created, which is administered by the DEQ. The program encourages the voluntary cleanup of sites (Brownfields) where there has been a contaminant release threatening public health and the environment by providing incentives.

Discharges of process water, stormwater and mine dewatering water to surface waters, including storm drains, requires a UPDES Permit prior to beginning operations. UPDES permits are typically required for mining operations, as well as sand and gravel operations.

*Management Plans* Utah DEQ prepared the *Nonpoint Source Management Plan for Abandoned Mines in Utah* in 2005. The primary objective of the plan was to outline a systematic approach for the identification and remediation of abandoned metal mine sites in the state of Utah that adversely affect surface and groundwater quality.

The potential effects associated with abandoned mines include:

- Reduction in soil productivity or soil sterilization due to heavy metal contamination.
- Acid drainage containing iron, manganese, aluminum, and iron hydroxide and sulfuric acid enters waterways and water supplies.
- Alkaline runoff high in salts and sediments.
- Air pollution resulting from blown dust and mine wastes.
- Flooding and pollutant discharge resulting from ruptures of dams, ponds and impoundments.



***Source: www.flickr.com/photos/new2thelou/350638239/***
Kennecott Utah Copper Bingham Canyon Mine


Source: www.geo-outdoors.info

Abandoned mine near Park City, UT

The plan established four (4) priorities for Utah's abandoned mine nonpoint source program as follows:

1. To abate known water quality impairments resulting from nonpoint source pollution.
2. To prevent significant future threats to water quality from abandoned mine sites.
3. To develop and implement new and existing technologies for water quality restoration.
4. To provide information and education to key decision-makers and landowners about the importance of nonpoint source initiatives.

The plan established four (4) goals for Utah's abandoned mine nonpoint source program as follows:

1. In association with TMDL development, conduct watershed reconnaissance studies for impacted watersheds to assess and characterize mining-related NPS problems and to identify threats to water quality.
2. Protect surface and groundwater by developing and implementing water quality restoration and preservation projects using BMP's to: a) restore streams impacted by mining to designated uses and b) prevent significant threats to water quality.
3. Build long-term partnerships to enhance cooperation between industry, environmental groups, and government in restoration of abandoned mine lands.
4. Educate and inform target audiences regarding all aspects of NPS mining projects.

The plan lists eleven (11) objectives and thirty (30) tasks intended to meet the goals.

The approach to nonpoint source control for abandoned mines is described in the plan. The first step is to identify stream segments with water quality impairment resulting from abandoned mines. Then a comprehensive data collection program and source characterization effort is undertaken. Next, the goals for the cleanup of the impacted stream segments are established based on water quality standards and the potential productivity of the stream system and its aquatic ecology. A Use Attainability Analysis (UAA) may need to be prepared to determine the appropriate beneficial uses, the levels of protection for sensitive aquatic species and the ability of the stream segment to sustain the desired uses. After the goals are established, the strategies for attaining the desired water quality improvement are developed. The nonpoint source control approach is often undertaken under watershed planning and/or TMDL efforts.

The plan describes Best Management Practices (BMP's) for the control of acid rock drainage, radiological problems, and erosion and sedimentation problems. The BMP's for acid rock drainage include diversion, removal, isolation, water chemistry manipulation and treatment.

The Utah Division of Oil, Gas and Mining (DOGM) administers the Abandoned Mine Reclamation Program. The program undertakes mine reclamation projects throughout the state.

The Bureau of Land Management and Forest Service administer the Abandoned Mine Lands program. The program maintains an inventory of known abandoned mine lands on public lands and undertakes remediation and reclamation projects.

### 4.4.8.2 Existing Conditions

Figure 4.4.4 shows abandoned mine reclamation projects within Salt Lake County according to the Utah Division of Oil, Gas and Mining. Information regarding the status of these projects was not provided. Therefore, it is not known how many reclamation projects have been completed and how many remain abandoned. The highest concentration of abandoned mine reclamation projects are in Upper Big Cottonwood and Upper Little Cottonwood Sub-Watersheds. Midas/Butterfield Sub-Watershed also has numerous abandoned mine reclamation projects.

Several mine reclamations have been completed by the United States Forest Service. The Malmborg Mine, located in Big Cottonwood Canyon, consisted of an adit and buildings which were unsafe and accessible to an area heavily used by recreationists. The remnants of Jones Mine, located in the Mill Creek Canyon in the Mt. Olympus Wilderness, consisted of a spill pile, old generator, building foundation and scattered debris, as well as unsafe underground workings. The trash and other debris were removed, piece by piece to the trail head via mules and then trucked for disposal. The chief benefit of the projects was to secure hazardous abandoned mines that were in easy reach of hikers and skiers.

Kennecott Utah Copper operates the Bingham Canyon Mine, the largest man-made excavation on earth that was started in 1908.

There are seven (7) active sand and gravel operations within Salt Lake County according to the Utah Division of Oil, Gas and Mining's Mineral Regulatory Program (Figure 4.4.5). Five (5) of the sand and gravel operations are located within the Jordan River Corridor Sub-Watershed in the northern part of the County. The other two (2) sand and gravel operations are within the Upper Parley's Creek and Lower Little Cottonwood Creek Sub-Watersheds.

A TMDL for high zinc levels was completed and approved for Little Cottonwood Creek in 2002 (DWQ, 2002). Dissolved zinc concentrations in the upper reaches exceeded water quality standards for the designated beneficial use (cold water fishery). The TMDL proposed an implementation plan directed towards the reduction of zinc loads. Recommendations in the TMDL study included: 1) "Expand the Alta Fen wasteload allocation for the Howland Tunnel to take additional flow, if not all of the flow, from the Howland Tunnel", 2) "Develop a flow delivery system that will allow the Fen to operate the entire year, not just during the summer months", and 3) "Establish a program to monitor flows and chemistry from the Howland Tunnel and from the Fen over an entire year" (DWQ, 2002). Salt Lake County is currently working with the Little Cottonwood Abandoned Mine Coalition to accomplish these recommendations; however, siting of the Fen and liability issues are currently unresolved. Additionally, two (2) monitoring programs were recommended in this TMDL study that included: 1) a water monitoring program to further validate or define loading sources, and to monitor responses to implementation actions, and 2) a macroinvertebrate study to gauge stream response to implementation actions. Neither of these have been completed.

### 4.4.8.3 Future Conditions

Kennecott Utah Copper, a wholly-owned subsidiary of Rio Tinto, owns most of the land in the Oquirrh Mountains, including the mineral rights. Kennecott Utah Copper has not divulged plans to develop any new mines, but has kept that as an option. No future mining activities are allowed in the Central Wasatch Management Area of the Wasatch-Cache National Forest.

### 4.4.8.4 Source Reduction Strategies

Implementation of the strategies in *Nonpoint Source Management Plan for Abandoned Mines in Utah* (Utah DEQ, 2005) would result in reductions of the nonpoint source pollution from abandoned mines.

Management of nonpoint source pollution from mining operations is addressed through the UPDES permitting process.

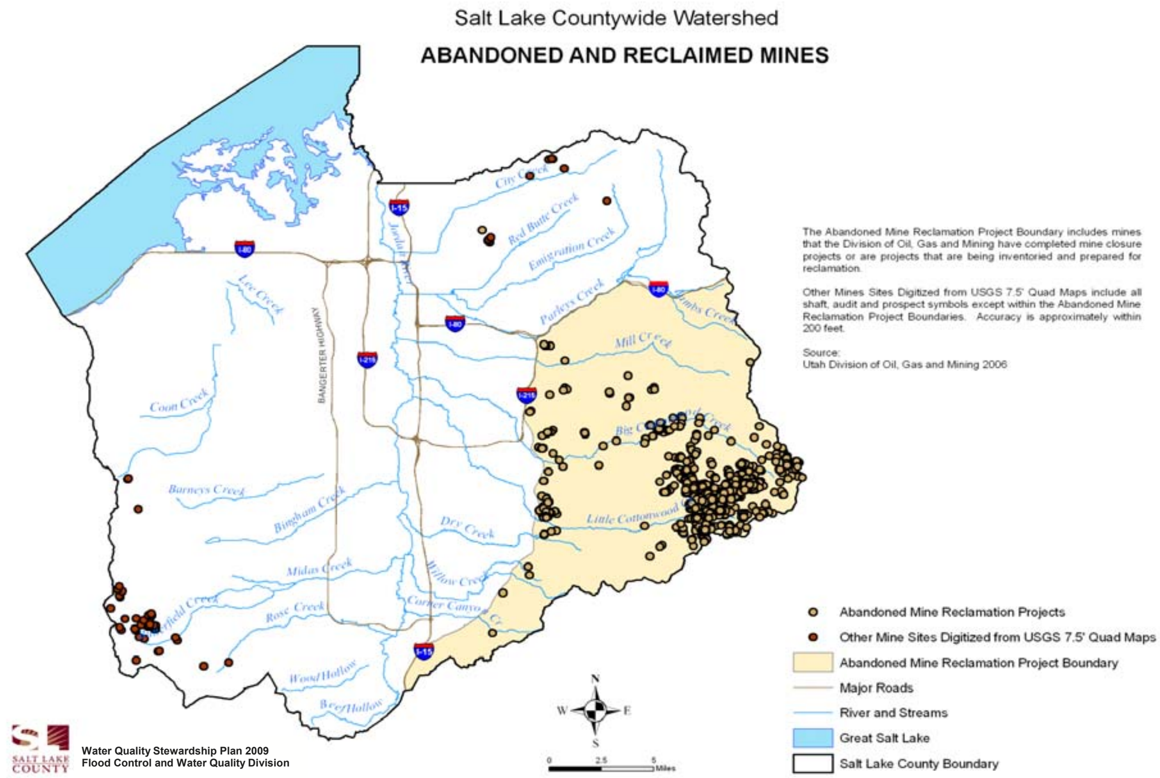



**Figure 4.4.4 Abandoned Mine Reclamation Projects**

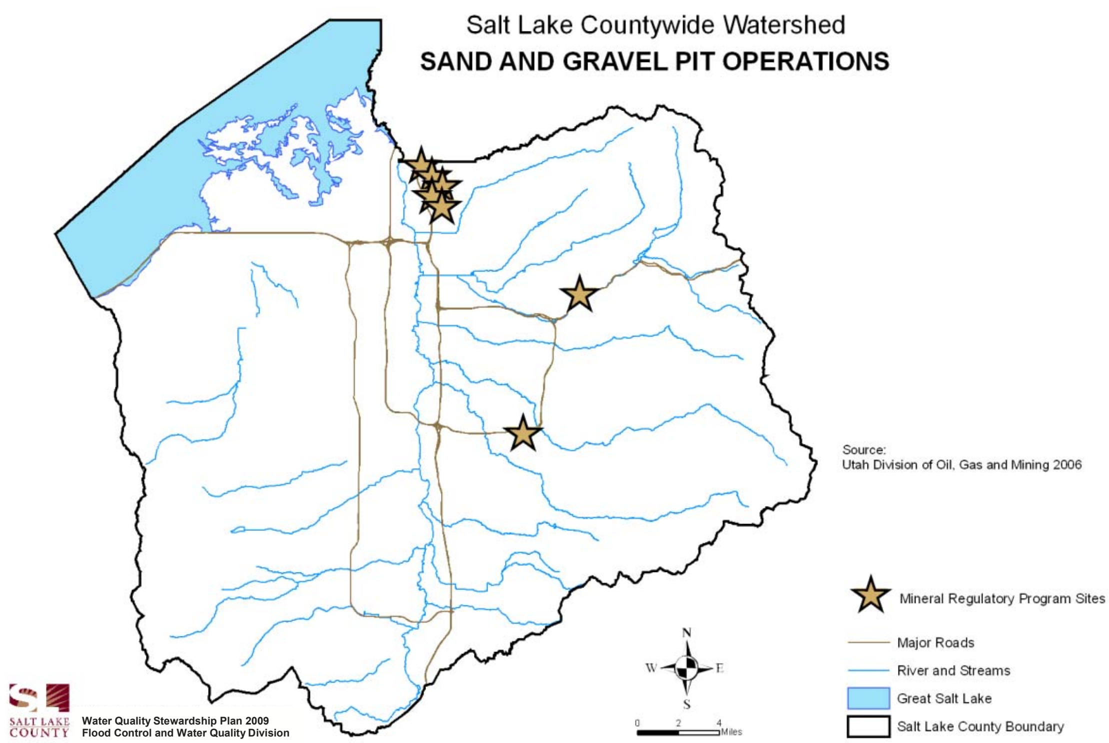


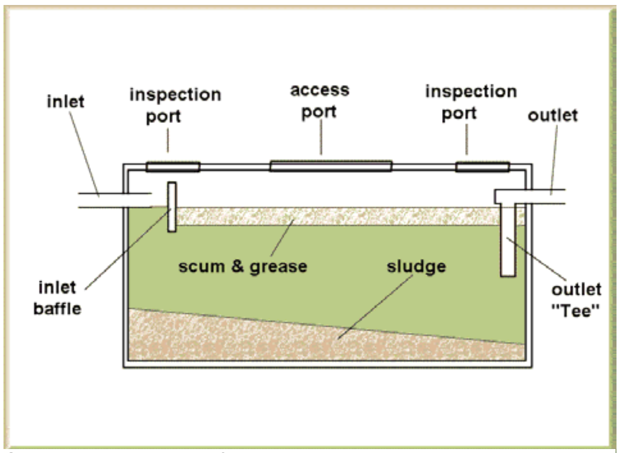

**Figure 4.4.5 Sand and Gravel Operations**

### 4.4.9 On-Site Wastewater Disposal

#### 4.4.9.1 Background

On-site wastewater disposal system is defined as an underground wastewater disposal system for domestic wastewater which is designed for a capacity of 5,000 gallons per day (gpd) or less, and is not designed to serve multiple dwelling units which are owned by separate owners except condominiums. It usually consists of a building sewer, a septic tank and an absorption system.

When properly installed and maintained, onsite wastewater disposal systems pose only a minor threat to environmental health. However, septic systems can be a source of pathogenic contamination and nutrient enrichment to surface and groundwater if the wastewater is inadequately treated. Causes of failure include improper design or installation, high density, proximity to sensitive aquifers and certain soil properties of the drain field.




*Source: www.septictankinfo.com*
Septic System Basics

*Regulations* The Division of Water Quality regulates on-site wastewater disposal systems through Utah Administrative Code R317-4 Onsite Wastewater Systems, R317-5 Large Underground Wastewater Disposal Systems and R317-11 Certification Required to Design, Inspect and Maintain Underground Wastewater Disposal Systems, or Conduct Percolation and Soil Tests for Underground Wastewater Disposal Systems. The rules require construction plan review and permitting for on-site septic systems. The rules also require certification of Onsite System Professionals to design, inspect and maintain underground wastewater disposal systems.

Utah Code Annotated Section 26A-1-121(1) authorizes local county health departments to regulate on-site wastewater disposal systems. The Salt Lake Valley Health Department regulates on-site wastewater disposal systems in incorporated and unincorporated areas of Salt Lake County through Health Regulation #13 Wastewater Disposal Regulation adopted in 1986 and amended in 2006. The regulation requires that each building be connected to the public sewer system where available and practicable or have an on-site wastewater disposal system. The regulation requires that a permit and inspection be obtained from the Health Department for the installation or replacement of an on-site wastewater disposal system or construction of additional bedrooms.

DWQ reviews and approves systems greater than 5,000 gpd, and Salt Lake Valley Health Department reviews and approves systems less than 5,000 gpd.

*Management Plans* The NPS task force has not prepared a separate management plan for nonpoint pollution from on-site wastewater disposal systems; however, DWQ's Onsite Program conducts activities to address water quality issues related to on-site wastewater disposal systems, including review of plans for on-site septic systems, certification of Onsite System Professionals, technical assistance to local health departments and financial assistance through the State Revolving Fund (SRF). The program also conducts groundwater studies to determine local septic tank density recommendations and support local aquifer classification studies. DWQ works cooperatively with the Salt Lake Valley Health Department to implement the Onsite Program.

#### 4.4.9.2 Existing Conditions

The septic systems in Salt Lake County are primarily located in Upper Emigration Creek, Upper Parley's Creek (Lambs Canyon) and Rose Creek Sub-Watersheds, with limited individual systems scattered throughout the County (Figure 4.4.6). Mill Creek Canyon is suspected to have a number of septic systems, though that did not show up in County Assessor's Office records.

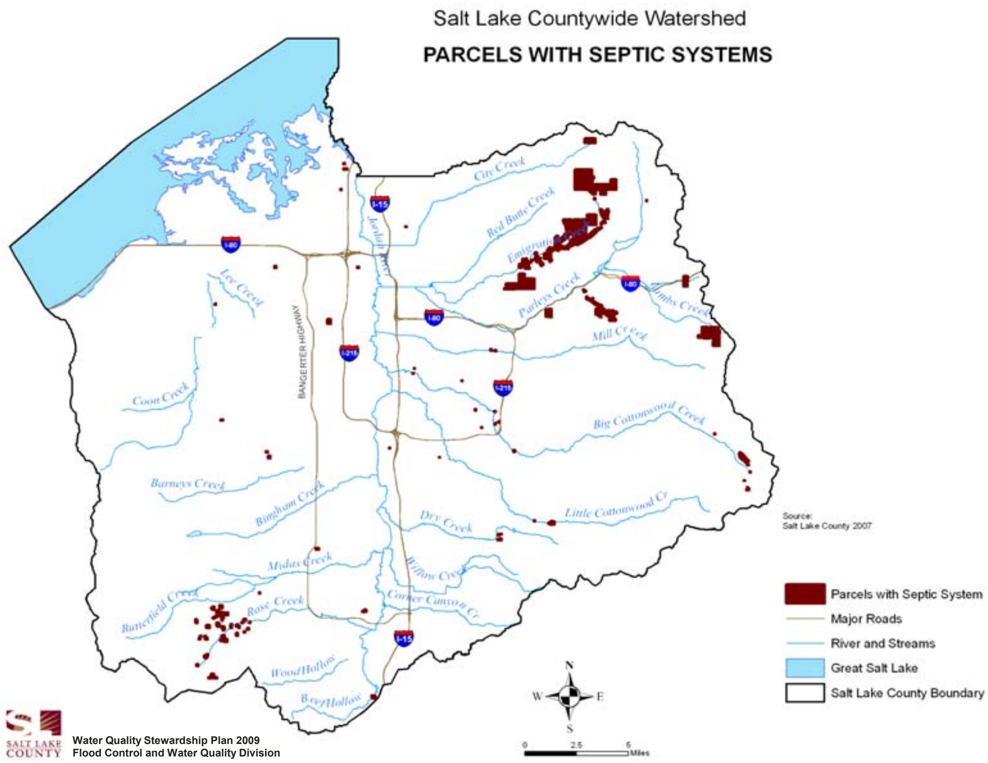



**Figure 4.4.6 Onsite Wastewater Disposal Systems**

### 4.4.9.3 Future Conditions

A sanitary sewer system has been considered in the past for Emigration Canyon, but there are no definitive plans for implementation. The Emigration Improvement District (EID) was formed in 1968 for the purpose of providing water and sewer services to the canyon; however, the EID decided against installing a canyon-wide sanitary sewer system. Salt Lake City Public Utilities has been unwilling to provide sewer services in the canyon, since the area is outside of the city's boundaries. Efforts to get a variance in Salt Lake City's policy or to annex Emigration Canyon into the city have not been successful.

There are no plans to extend sanitary sewer services to Lambs Canyon.

The septic systems in the southwestern portion of the county will likely get connected to a sanitary sewer system in the future as that area continues to urbanize.

### 4.4.9.4 Source Reduction Strategies

Renewed efforts to extend sanitary sewer services to Emigration Canyon would help to reduce the largest nonpoint pollution source from septic systems in the County. Emigration Creek is listed as impaired for E. Coli and a TMDL Study is currently being undertaken by DWQ and Salt Lake County. The primary source reduction strategy for other areas with on-site wastewater systems is continued adherence to the Utah DWQ guidelines and Salt Lake Valley Health Department regulations.

## 4.4.10 Landfills and Industrial Land Treatment

### 4.4.10.1 Background

Surface runoff and groundwater leachate from solid waste landfills can be a nonpoint source of pollution that is detrimental to water quality. Individuals and businesses must dispose of solid waste at facilities complying with Utah's solid and hazardous waste rules. Solid Waste disposal sites must obtain permits and are subject to inspection by the Utah

Division of Solid and Hazardous Waste and Salt Lake Valley Health Department. Landfills and some other solid waste facilities are subject to location restrictions, design and operating criteria, groundwater monitoring and corrective action requirements, closure and post-closure care requirements and financial assurance requirements.

*Regulations* The Utah Solid and Hazardous Waste Act (Title 19-6) governs solid waste management activities and facilities in the State of Utah. The Division of Solid and Hazardous Waste regulates landfills through Utah Administrative Code R315-301 through R315-320.

Management Plans The Utah NPS task force has not prepared a separate management plan for nonpoint pollution from landfills.

### 4.4.10.2 Existing Conditions

There are seven (7) solid waste and construction debris landfills in Salt Lake County, including the Salt Lake Valley Solid Waste Management Facility, the Mountain View Landfill and the Trans-Jordan Landfill (Figure 4.4.7). Three of the landfills are owned and operated by Kennecott Utah Copper. All of the facilities are located on the west side of the county. Five (5) of the landfills are within the Great Salt Lake Sub-Watershed.

### 4.4.10.3 Future Conditions

The Salt Lake Valley Solid Waste Management Facility, jointly operated by Salt Lake County and Salt Lake City, is not planned for expansion by 2030 and no new landfill is planned (personal communication with John Ioannou, Salt Lake County Solid Waste Management Division Director, 2007). There are no current plans to expand the Trans-Jordan Landfill (personal Communication with Dwayne Woolley, Trans-Jordan Landfill General Manager).

### 4.4.10.4 Source Reduction Strategies

The primary source reduction strategy for landfills is continued compliance with the Utah Solid and Hazardous Waste Act.

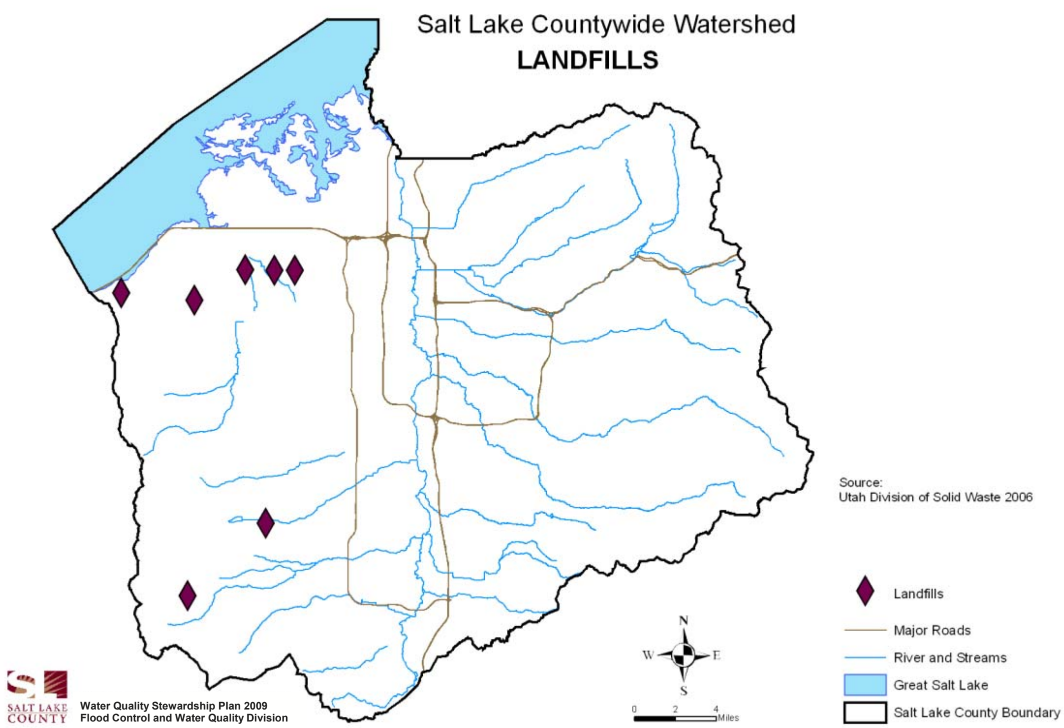



**Figure 4.4.7 Landfills**

Water Quality Stewardship Plan

## 4.4.11 Atmospheric Deposition

### 4.4.11.1 Background

Airborne pollutants that are deposited on the watershed through precipitation can have adverse impacts on water quality and wildlife resources. The source of the airborne pollutants can be from within and from outside of the watershed. The two (2) primary airborne pollutants of concern in the Salt Lake County watershed are acidic compounds and mercury.

*Acidic Compounds* Atmospheric deposition of sulfates, nitrates, and ammonia affect natural ecosystems by acidifying surface waters and lakes. Deposition of nitrates and ammonia also results in nutrient enrichment that disrupts natural systems. In the mid-1980's, the Environmental Protection Agency conducted the Western Lakes Survey to quantify the lake chemistry in areas where lakes were expected to exhibit low alkalinity. In 1986, the State of Utah initiated the Utah Acid Deposition Technical Advisory Committee (ADTAC) to report on acid deposition in Utah.

Activities within Utah that are sources of acid pollution include automobiles, urban combustion sites, coal-fired power generation, copper smelting, mineral recovery, and oil and gas development.

*Mercury* Mercury is among a group of pollutants called persistent bioaccumulative toxins (PBT). Mercury does not degrade in the environment and cannot be destroyed or combusted. Mercury also bioacccumulates in the environment, meaning it builds up in the food chain over time.

Mercury is released in the environment from natural sources, such as volcanic and geothermal activity, marine environments or forest fires, as well as from anthropogenic sources, including power plants, mining activities, incinerators and other industrial sources (Table 4.4.2). Recent studies suggest that human activity contributes 50-70% of the mercury in the environment globally (EPA, 1997). Mercury emissions in the states of Utah, Arizona, Colorado, New Mexico and Nevada totaled 4.6 metric tons in 2003 (DEQ, 2007). Approximately 92% of mercury deposition nationally in 2003 originated from sources outside of the United States.

*Regulations* The Clean Air Act, which was last amended in 1990, requires EPA to set National Ambient Air Quality Standards (40 CFR part 50) for pollutants considered harmful to public health and the environment. The Clean Air Act established two types of national air quality standards. Primary standards set limits to protect public health, including the health of "sensitive" populations such as asthmatics, children, and the elderly. Secondary

**Table 4.4.2 Common Sources of Mercury**

| Point Sources | Nonpoint Sources | Current Products | Historical Products & Uses |
|---|---|---|---|
| • Crematories (from dental fillings)<br>• Wastewater treatment facilities (from sewage & some industrial effluents)<br>• Mining<br>• Burning of fossil fuels, including coal-fired power plants, cement kilns & other industrial operations<br>• Incineration of waste: medical and municipal<br>• Steel mills (from mercury switch residuals in auto & appliance shred | Runoff from:<br>• Mines & mine waste piles<br>• Fertilizers that contain toxic waste<br>• Manure<br>• Land-applied biosolids<br>• Vehicle emissions (mobile sources)<br>• Naturally-occurring from volcanoes & rock/soil erosion<br>• Landfill gas & potentially landfill leachate | • Switches and relays<br>• Dental amalgam<br>• Sensors (e.g. flame sensors, antilock brake sensors)<br>• Vaccine preservatives<br>• Light bulbs (fluorescents, high intensity discharge (HID), some neon)<br>• Pressure management devices<br>• Button batteries<br>• Thermometers<br>• Thermostats<br>• Mercury compounds & alloys for various industrial & lab uses<br>• Certain chemicals produced by the mercury cell process, which are then used in cleaners, pharmaceuticals & other industrial chemicals | • Kids' chemistry sets<br>• Alkaline batteries (pre-1990)<br>• Pesticides, slimicides/ fungicides, antifouling agents<br>• Old paint<br>• Medicinals such as laxatives, teething powders, diuretics, calomine lotion, topical antiseptics, boil treatments<br>• L.A. Gear lighted shoes (pre-1997)<br>• Legacy wastes remaining in plumbing systems<br>• Counterweight (grandfather clocks)<br>• Colorant for paint, ink & paper) |

standards set limits to protect public welfare, including protection against decreased visibility, damage to animals, crops, vegetation, and buildings.

Utah DEQ Division of Air Quality (DAQ) implements and enforces the air quality standards through the *Utah State Implementation Plan* (SIP). The State Implementation Plan describes the strategy and framework for how the air quality standards will be achieved, maintained and enforced. The SIP has a section for Salt Lake County. Each project in Salt Lake County must conform to the SIP and is allocated a budget for discharge. A project is in general conformity if the discharge does not exceed 100 times the air quality criteria. Some pollution trading occurs in Salt Lake County (Heying, 2006).

*Management Plans* Utah DEQ Division of Air Quality (DAQ) manages air quality through the *Utah State Implementation Plan* (SIP). The SIP includes provisions for sulfur dioxide and nitrogen oxides.

Utah DEQ issued the *DEQ Mercury Strategic Plan* in 2007. The intent of the plan was to summarize DEQ's strategic goals and efforts to reduce mercury in the environment. The goal for air quality is to ensure that mercury emissions continue to decrease in Utah by conducting a periodic review every five (5) years to measure progress and refine emission reduction goals.

Utah DEQ is facilitating a Mercury Work Group (MWG) to coordinate and collaborate mercury studies and investigations ongoing in Utah. Stakeholders from state, federal, and non-profit agencies, industry, and the public participate in the work group. The initial objectives of the group are as follows:

- To provide the citizens of Utah with current, accurate and understandable information on the human and ecological concerns posed by mercury.
- To develop an ongoing, systematic, logical, and defensible mercury monitoring program to assess mercury levels in fish and waterfowl tissue.
- To share technical information, data, and results of any investigations on mercury.
- To coordinate efforts by private and public entities in researching mercury issues in Utah.
- To provide the citizens of Utah with access to mercury data, advisories, and information via websites, printed materials, and contact information for public health officials.

The EPA issued the *Roadmap for Mercury* in 2006. The primary goal of the document is to provide a national action plan for reducing health risks associated with mercury exposure. The document addresses: mercury releases to the environment; mercury uses in products and processes, including international sources; managing commodity-grade mercury supplies; communicating risks to the public; and conducting mercury research and monitoring.

### 4.4.11.2 Existing Conditions

*Acidic Compounds* The ADTAC reported on the acid neutralization capacity of the bedrock geology and high elevation streams and lakes in Utah (Revelt, 1990). Acid neutralization capacity (ANC) is a measure of the capacity of the soil, rock or water to react with and neutralize acids.

The ANC of the bedrock geology of the mountains within Salt Lake County ranges from low to moderate buffering capacity to high buffering capacity. The Salt Lake Valley has an unknown buffering capacity due to the presence of a thick upper layer of unconsolidated alluvial deposits.

No lakes or streams within Salt Lake County were sampled in order to evaluate their buffering capacity. However, Pittsburgh and Hardy Lakes in American Fork Canyon were determined to be sensitive to acid deposition due to low buffering capacity, and may be representative of upper elevation Wasatch Mountain lakes.

The atmospheric deposition of sulfates, nitrates and ammonia is monitored by the National Atmospheric Deposition Program. For 2005, the wet deposition of sulfate in Salt Lake County was less than 3 kg/ha, of nitrate was less than 4 kg/ha and of ammonia was less than 2 kg/ha (NADP, 2007).

*Mercury* The Utah DEQ samples fish tissue for mercury content. In 2001, the mercury content of brown trout from City Creek ranged from 0.033 to 0.049 micrograms/gram (3 samples). In 2004, the mercury content of brown trout from Big

Cottonwood Creek above Mill A ranged from 0.040 to 0.071 micrograms/gram (3 samples). The EPA significant value for fish advisories is 0.3 micrograms/grams.

Utah DEQ has established the Utah Mercury Work Group to monitor bioaccumulation of mercury in the environment and to advise of specific actions. As part of this effort, the Utah DEQ samples duck tissue for mercury content. However, to date, no ducks have been sampled in Salt Lake County.

#### 4.4.11.3 Future Conditions

*Acidic Compounds* Release and deposition of acidifying compounds is a regional and global phenomenon and it is therefore difficult to project future conditions in Salt Lake County.

*Mercury* Mercury release and deposition is a regional and global phenomenon and it is therefore difficult to project future conditions in Salt Lake County.

#### 4.4.11.4 Source Reduction Strategies

*Acidic Compounds* Due to the low potential for effect on surface waters in Utah, the deposition of acidifying compounds has become a lower priority concern. Since the source of the majority of the acidic compounds is from outside Salt Lake County, the scope of the issue is beyond the watershed scale.

*Mercury* Utah DEQ has established the Utah Mercury Work Group to monitor on bioaccumulation of mercury in the environment and advise specific actions. Since the source of the majority of the mercury is from outside Salt Lake County, the scope of the issue is beyond the watershed scale.

### 4.4.12 Sub-Watershed Summary

Table 4.4.3 summarizes the sources of nonpoint pollution for each sub-watershed. With the exception of Upper Red Butte Creek Sub-Watershed, all of the sub-watersheds are currently being impacted by one or more nonpoint sources of pollution. Of the nine categories, Midas/Butterfield Sub-Watershed has eight categories present, with one-third of the sub-watersheds having five categories.

No data was made available for animal feeding operations, though their occurrence is likely minimal in Salt Lake County. All the sub-watersheds are impacted to some extent by atmospheric deposition, though the source of the pollution is primarily from outside the watershed.

The streams on the west side of the county have the most categories of nonpoint pollution sources, partially due to the fact that these sub-watersheds include a mountain and a valley portion. The west side watersheds are currently undergoing the most urbanization, as well.

The sources of nonpoint pollution with the greatest frequency and intensity of occurrence include urban runoff, hydrologic modification/habitat alteration, and golf courses/managed parks.

## Table 4.4.3 Nonpoint Pollution Sources by Sub-Watershed

| Sub-watershed | Agriculture-Animal Feeding Operations | Agriculture-Cropland And Rangeland | Urban Runoff | Construction Runoff | Golf Courses And Managed Parks | Hydrologic And Habitat Modifications | Mining - Abandoned | Mining - Active | On-Site Wastewater Disposal | Landfills And Industrial Land Treatment | Atmospheric Deposition |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Barney's Creek | ND | H | H | H | M | L | | M | | | L |
| Big Cottonwood Creek—Upper | ND | | L | L | | L | H | | L | | L |
| Big Cottonwood Creek—Lower | ND | L | H | L | H | H | | M | L | | L |
| Bingham Creek | ND | H | H | H | H | H | | H | | H | L |
| City Creek—Upper | ND | | L | | | L | | | | | L |
| City Creek—Lower | ND | | H | L | M | H | L | | | | L |
| Coon Creek | ND | M | H | H | L | L | | | | | L |
| Corner Canyon Creek | ND | H | H | H | H | H | L | | | | L |
| Decker Lake | ND | M | H | L | H | L | | | | | L |
| Dry Creek—Upper | ND | | | | | | L | | | | L |
| Dry Creek—Lower | ND | L | H | M | M | H | | | L | | L |
| Emigration Creek-Upper | ND | | M | L | | L | | | H | | L |
| Emigration Creek-Lower | ND | | H | L | H | H | | | | | L |
| Great Salt Lake | ND | H | H | H | H | | | | | H | L |
| Jordan River | ND | M | H | H | H | H | | H | | | L |
| Little Cottonwood Creek—Upper | ND | | L | L | | L | H | | L | | L |
| Little Cottonwood Creek—Lower | ND | L | H | L | H | H | | | | | L |
| Level of Occurrence: H—high, M-medium, L—low, Blank—negligible or none, ND—no data | | | | | | | | | | | |

**Table 4.4.3 Nonpoint Pollution Sources by Sub-Watershed—*Continued***

| Sub-watershed | Agriculture-Animal Feeding Operations | Agriculture-Cropland And Range-land | Urban Runoff | Construction Runoff | Golf Courses And Managed Parks | Hydrologic And Habitat Modifications | Mining - Abandoned | Mining - Active | On-Site Wastewater Disposal | Landfills And Industrial Land Treatment | Atmospheric Disposal |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Midas/Butterfield Creek | ND | H | H | H | M | M | | H | H | H | L |
| Mill Creek—Upper | ND | | L | | | | M | | L | | L |
| Mill Creek—Lower | ND | | H | L | H | H | | | | | L |
| Parley's Creek-Upper | ND | | L | L | H | H | | L | H | | L |
| Parley's Creek-Lower | ND | | H | L | H | H | L | | | | L |
| Red Butte Creek-Upper | ND | | | | | | | | | | L |
| Red Butte Creek-Lower | ND | | H | L | M | H | | | | | L |
| Rose Creek | ND | H | H | H | H | M | | | H | | L |
| Willow Creek-Upper | ND | | | | | | L | | | | L |
| Willow Creek-Lower | ND | H | H | M | H | H | | | | | L |

Level of Occurrence: H—high, M-medium, L—low, Blank—negligible or none, ND—no data

### 4.4.13 Recommendations

Nonpoint sources of pollution are defined and regulated by Federal, State, and local agencies. These agencies in cooperation with elected officials, landowners and developers can implement management measures to reduce nonpoint source pollution. Management measures are targeted for each category of nonpoint source pollution and specific to pollutants. Most management measures are identified in management plans based on a watershed approach.

It is recommended that regulating agencies and the regulated community continue to work together on a watershed and sub-watershed level to implement specific practices to benefit surface and ground waters within the Salt Lake County Watershed. Priority may be given to sub-watersheds with the most categories of sources.

Following are the specific recommendations for managing each of the nonpoint pollution sources:

- Implement strategies in *A Utah Strategy to Address Water Pollution From Animal Feeding Operations* (AFO/CAFO Committee, 2001).
- Implement strategies in the *State of Utah Water Plan for the Jordan River Basin* (Utah Division of Water Resources, 1997).
- Implement best management practices for golf courses and parks.
- Avoid activities within the stream corridor and maintain suitable stream buffers.
- Flood control activities should be conducted in a sustainable way to promote stable channel conditions.
- Implement strategies in *Nonpoint Source Management Plan for Abandoned Mines in Utah* (Utah DEQ, 2005).
- Continue adherence to the Utah DWQ guidelines and Salt Lake Valley Health Department regulations pertaining to on-site waste disposal systems.
- Continue adherence to the Utah Solid and Hazardous Waste Act (landfills).

## 4.5 WATER SUPPLY

The purpose of this planning element is to: 1) review existing water supply systems and sources, 2) review groundwater and drinking water quality standards, 3) review plans of principal water providers, 4) describe existing water treatment facilities, and 5) identify effects of water supply strategies on water quality in Salt Lake County.

Little Cottonwood Creek, Upper Little Cottonwood Creek Sub-Watershed

### 4.5.1 Water Systems

In Salt Lake County, potable water is provided by municipal water systems, private water companies, and two (2) large water districts. In this section, water supply is described generally for municipal and private water suppliers.

There are 33 community water systems in Salt Lake County that serve homes and businesses year round. An additional 40 non-community water systems serve locations such as schools, campgrounds, rest stops, and gas stations throughout Salt Lake County (EPA website). Table 4.5.1 lists the community water systems in Salt Lake County with the population served, the primary source of water, and the total number of connections reported in 2005.

Based on information from the Utah Division of Water Rights (DWRi), the water suppliers with the greatest number of connections in Salt Lake County include: Salt Lake City Corporation (84,710), Granger-Hunter Improvement District (27,509), and Sandy City (26,968). The suppliers that service the most individuals were similar: Salt Lake City Corporation (312,000 people), Granger-Hunter Improvement District (106,000 people), and Sandy City (88,000 people). However, the service populations reported in Table 4.5.1 should be considered an estimate. These numbers may be inconsistent with other census data due, in part, to the way individual water suppliers account for the residents they serve. For example, two (2) entities may report service to overlapping populations. Additionally, various lists of water systems are available; however, these lists can be quite different based on reporting methods.

Although detailed information is not available for many of the small water systems, the three (3) principal water providers have developed plans for future growth and development. The three (3) principal water providers are: Salt Lake City Department of Public Utilities (SLCPU), Metropolitan Water District of Salt Lake and Sandy (MWDSLS), and Jordan Valley Water Conservancy District (JVWCD). The JVWCD boundaries encompass the central and western portions of Salt Lake Valley; whereas, the MWDSLS services the northern and eastern portion of the Valley (Figure 4.5.1).

Notably, MWDSLS only wholesales water and only to SLCPU and Sandy City. JVWCD wholesales water to 18 member agencies that are mostly cities, but includes other entities, and retails water to individual connections in a relatively small service area in and around the Holladay City area. SLCPU is a major water provider and also receives water from MWDSLS.

### 4.5.2 Water Supply Sources

Sources for drinking water in Salt Lake County include: 1) Groundwater and springs; 2) Wasatch Mountain streams (City Creek, Parley’s Creek, Big Cottonwood Creek, Little Cottonwood Creek, Bells Canyon and several small streams); and 3) Import Water from outside the Salt Lake County. For this document, the term “imports” includes water that would naturally flow into Salt Lake County but is diverted outside the County and brought into Salt Lake County by man-made conveyance. For example, Provo River water could reach Salt Lake County through Utah Lake and the Jordan River but can be diverted and conveyed by pipeline into the County.

### Table 4.5.1 Community Water Systems in Salt Lake County

| Water System[1] | Population Served[1] | Number of Connections [2] | Primary Water Source[1] |
|---|---|---|---|
| Alta Town Water System | 400 | 83 | Groundwater |
| Bluffdale Water System | 14,100 | 1,336 | JVWCD |
| Boundary Spring Water Co. | 110 | 49 | Groundwater |
| Copperton Improvement District | 990 | 305 | Groundwater |
| Dansie Water Company | 50 | 28 | Groundwater |
| Draper City Water System | 13,200 | 2,930 | JVWCD |
| Draper Irrigation Co. (WaterPro) | 23,000 | 5,890 | Surface Water |
| Emigration Improvement District | 340 | -- | Groundwater |
| Granger-Hunter Improvement District | 106,000 | 27,509 | JVWCD |
| Herriman City | 15,000 | 0 | Groundwater |
| Hi-Country Estates #2 | 325 | 166 | Groundwater |
| Hi-Country Estates #1 | 300 | 103 | Groundwater |
| Holliday Water Company | 15,000 | 3,917 | Groundwater /Surface Water |
| Jordan Valley W.C.D. | 82,500 | 8,627 | Surface Water |
| Kearns Improvement District | 46,000 | 12,734 | JVWCD |
| Kennecott – Zone A RO | 0 | -- | Groundwater |
| Magna Water Improvement District | 31,000 | 8,711 | Groundwater |
| Metro-Water District of Salt Lake & Sandy | See Note[3] | 42 | Surface Water |
| Midvale City Water Department | 11,900 | 3,307 | Groundwater |
| Murray City Water | 36,000 | 9,499 | Groundwater |
| Riverton City Water | 30,000 | 12,207 | Groundwater |
| Salt Lake City Corp. Culinary Water | 312,000 | 84,710 | Surface Water |
| Sandy City Water System | 88,000 | 26,968 | Groundwater |
| Silver Fork Pipeline Corporation | 300 | 260 | Groundwater |
| Silver Lake Company | 320 | 108 | Groundwater |
| SL CO SRVC Area 3 Snowbird | 3,200 | -- | Groundwater |
| South Jordan Municipal Water | 40,000 | 10,877 | Groundwater |
| South Salt Lake Culinary Water | 18,000 | 3,227 | Groundwater |
| Spring Glen Water Company | 50 | -- | Groundwater |
| Taylorsville-Bennion Improvement District | 67,000 | 16,691 | Groundwater |
| Webb Well Water | 90 | 52 | Groundwater |
| West Jordan City Utilities | 82,000 | 20,089 | JVWCD |
| White City Water Improvement District | 15,800 | 4,142 | Groundwater |

*Sources:*
*[1] US EPA Safe Drinking Water Information System (SDWIS) with information maintained by the Utah Division of Drinking Water. Queried April 2007. Includes all connections.*
*[2] Utah Division of Water Rights. "Public Water Suppliers Flow Data."*
*[3] Metropolitan Water District of Salt Lake and Sandy is strictly a wholesale provider. While they do provide potable water to a significant population (410,000), these residents are accounted for in the SLCPU and Sandy City water systems.*

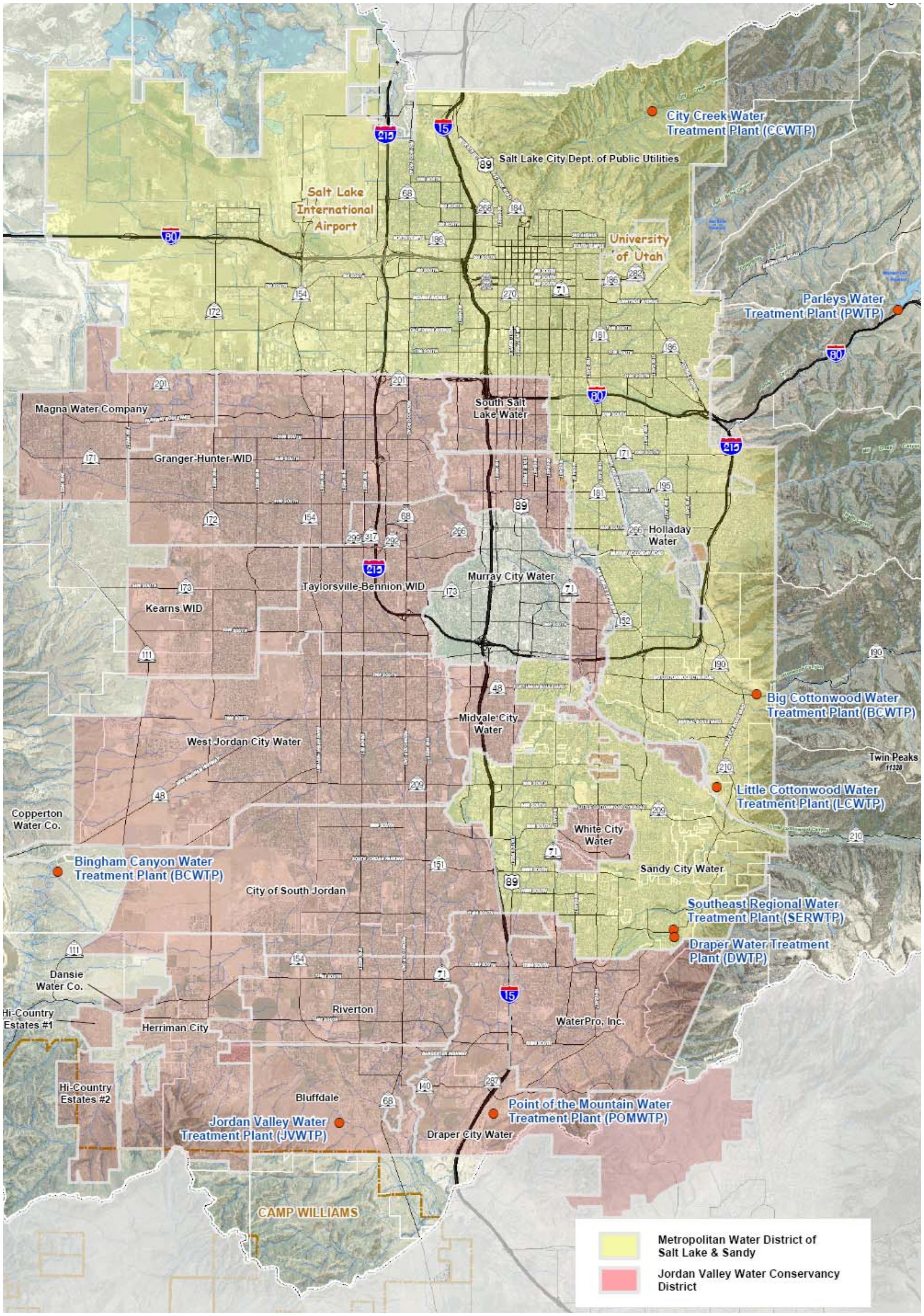



**Figure 4.5.1 Large Water District Boundaries**

As can be seen in Figure 4.5.2, the majority of water treated by the three (3) major providers comes from import waters, 100,277 af per year (USGS, 2006). Similar amounts of groundwater, 65,400 af, and Wasatch Mountain stream waters, 57,112 af, are used as potable sources in the County.

In addition to water sources for the major suppliers, some source information is also available for community water providers (Table 4.5.2) (Packard, 2007)). The sources for these community water providers have been broken down into five (5) categories that include: JVWCD, Groundwater, Secondary Water (raw water, typically from irrigation canal companies), Springs, and Other Culinary Water. "Other Culinary Water" is defined as waters purchased from other water providers. These "other culinary waters" may come from several sources. As can be seen in Table 4.5.2, several cities function as water suppliers and may have their own well systems to obtain groundwater.

The significance of Table 4.5.2 is that potable water in Salt Lake County is obtained from several sources and is developed by municipal entities and by major water wholesalers.

## 4.5.3 Water Quality of Water Sources

This section describes water quality standards for surface water, groundwater, and drinking water. As discussed earlier, potable water sources in Salt Lake County include: groundwater, Wasatch Mountain streams, and imported water. The water quality of these sources can vary and may dictate the treatment process that is required to attain drinking water quality standards. State Law regulates the water quality of both treated and raw water sources.

### 4.5.3.1 Surface Water Quality Protection Standards

Many of the Wasatch Mountain streams are designated Class 1C "High Quality Waters" that are protected for use as a drinking water source (UAC R317-2). Class 1C streams in Salt Lake County include the following:

- Jordan River, from Narrows Diversion to Utah Lake. This area is outside Salt Lake County but the water would be used in Salt Lake County.

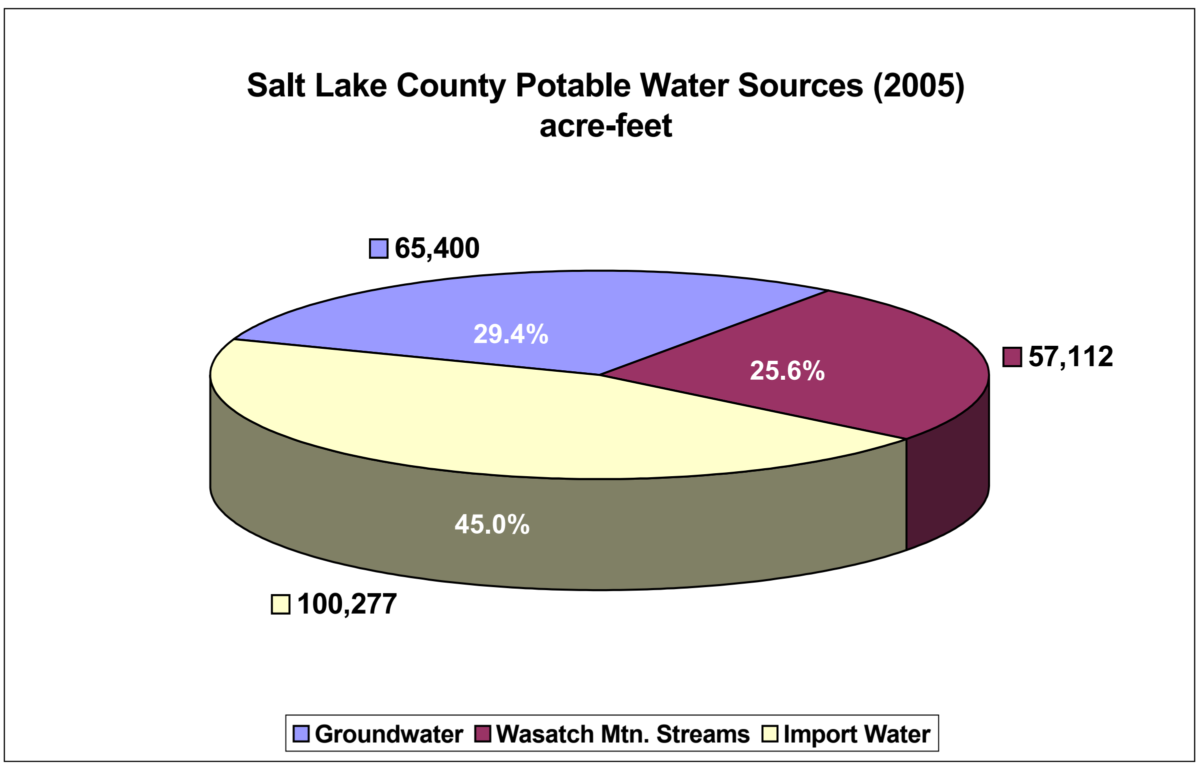



**Figure 4.5.2 Salt Lake County Potable Water Sources (2005)**

## Table 4.5.2 Municipal Water Sources (2004)

| Agency | Water Source | Volume (af) |
|---|---|---|
| Bluffdale | JVWCD | 1,245 |
| Draper City | JVWCD | 2,372 |
| Draper Irrigation | JVWCD | 2,581 |
| | Groundwater | 236 |
| | Other Culinary Water | 2,370 |
| | Secondary Water | 4,459 |
| Granger-Hunter | JVWCD | 19,284 |
| | Groundwater | 3,108 |
| Herriman | JVWCD | 1,096 |
| | Groundwater | 577 |
| | Springs | 95 |
| Hexcel Corporation | JVWCD | 720 |
| Holliday Water | Groundwater | 1,670 |
| | Other Culinary Water | 711 |
| | Springs | 1,571 |
| JVWCD Retail | JVWCD | 9,302 |
| Kearns | JVWCD | 7,284 |
| | Groundwater | 675 |
| Magna | JVWCD | 894 |
| | Groundwater | 4,465 |
| Midvale | JVWCD | 150 |
| | Groundwater | 2,558 |
| | Other Culinary Water | 79 |
| Murray | Groundwater | 8,585 |
| Riverton | JVWCD | 620 |
| | Groundwater | 3,350 |
| | Secondary Water | 4,222 |
| Salt Lake City | MWDSLS | 33,747 |
| | Groundwater | 10,179 |
| | SLC Treatment Plants | 37,987 |
| Sandy | JVWCD | 317 |
| | Groundwater | 10,595 |
| | Other Culinary Water | 15,861 |
| South Jordan | JVWCD | 9,169 |
| South Salt Lake | JVWCD | 1,524 |
| | Groundwater | 1,546 |
| Taylorsville-Bennion | JVWCD | 4,865 |
| | Groundwater | 7,751 |
| | Secondary Water | 93 |
| Utah Dept. of Corrections | JVWCD | 549 |
| | Groundwater | 145 |
| | Secondary Water | 104 |
| West Jordan | JVWCD | 14,075 |
| | Groundwater | 2,712 |
| | Secondary Water | 36 |
| White City | JVWCD | 98 |
| | Groundwater | 3,006 |
| | Other Culinary Water | 50 |
| **Total Provided** | | |
| **JVWCD** | | **76,145** |
| **Groundwater** | | **61,158** |
| **Other Culinary Water** | | **57,154** |
| **Secondary Water** | | **8,915** |

*Source: Jordan Valley Water Conservancy District, Personal Communication, Alan Packard, March 28, 2007*

- City Creek, from City Creek Water Treatment Plant (CCWTP) to headwaters
- Red Butte Creek and tributaries, from Red Butte Reservoir to headwaters
- Parley's Creek and tributaries, from 1300 East in Salt Lake City to headwaters
- Big Cottonwood Creek and tributaries, from Big Cottonwood Water Treatment Plant (BCWTP) to headwaters
- Deaf Smith Canyon Creek and tributaries
- Little Cottonwood Creek and tributaries, from Little Cottonwood Water Treatment Plant (LCWTP) to Headwaters
- Bell Canyon Creek and tributaries, from lower Bell's Canyon reservoir to headwaters
- Little Willow Creek and tributaries, from Draper Irrigation Company diversion to headwaters
- Big Willow Creek and tributaries, from Draper Irrigation Company diversion to headwaters
- South Fork of Dry Creek and tributaries, from Draper Irrigation Company diversion to headwaters

Figure 4.5.3 shows the Class 1C waters within Salt Lake County

Emigration, Mill, Coon, Barney's, Bingham, Butterfield, and Rose Creeks in Salt Lake County are designated Class 2B and are protected for secondary contact recreation such as boating, wading, or similar uses. These streams are not protected as drinking water sources at this time (UAC R317-2).

The Provo River and tributaries in Utah County are also designated as Class 1C from the Murdock Diversion near the mouth of Provo Canyon to the headwaters of the Provo River. The Provo River is designated Class 2B below the Murdock Diversion extending to Utah Lake.

Water quality protection standards for Class 1C water are established for nitrates and Total

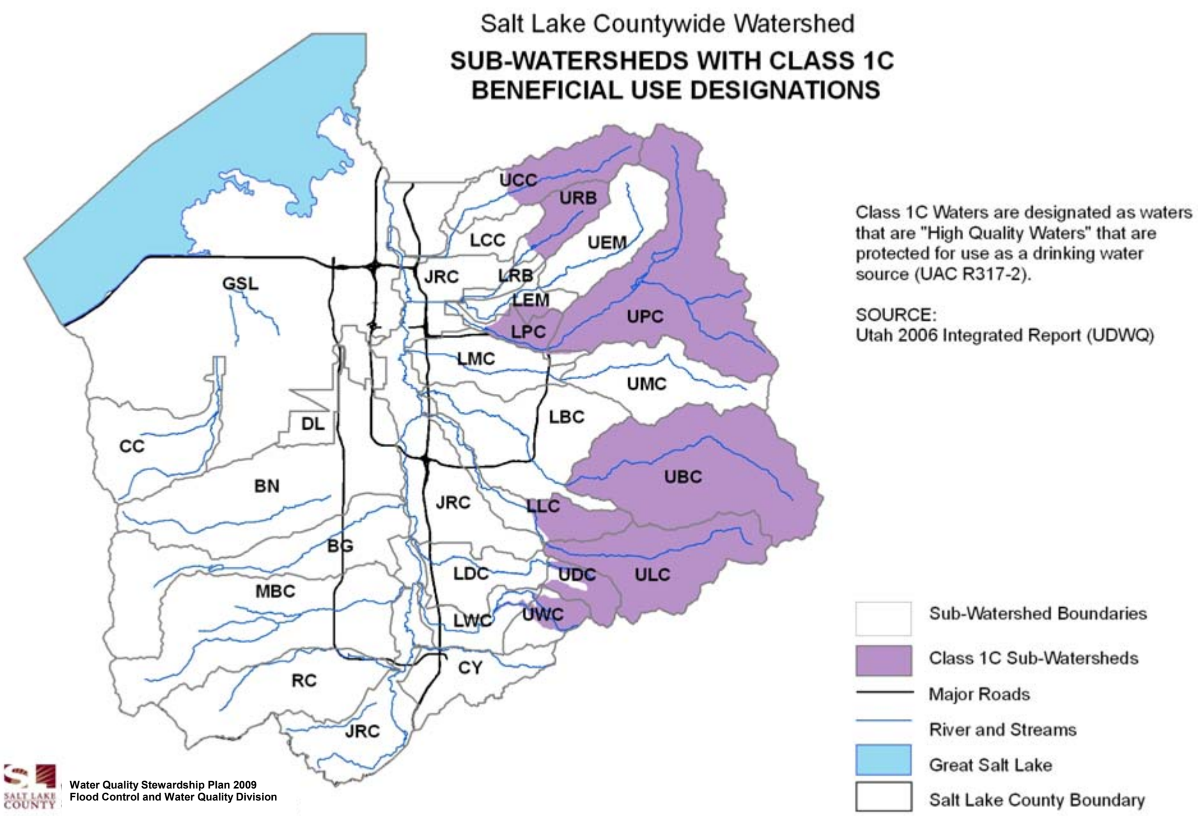



**Figure 4.5.3 Class 1C Waters in Salt Lake County**

Dissolved Solids (TDS), but not for Total Phosphorus (TP). The protection standard for nitrates is 10 mg/L. The protection standard for TDS is background and is determined on a stream-by-stream basis. Phosphorus is considered a pollution indicator and a protection standard of 0.05 mg/L has been established for Class 2B waters in streams and 0.025 mg/L in lakes and reservoirs.

#### 4.5.3.2 Groundwater Quality Protection Standards

The Utah Groundwater Quality Protection Standards and classification are determined by TDS and/or other potentially harmful contaminants when present. The groundwater aquifer below Salt Lake County is subdivided into classes of groundwater based, in part, on the concentration of TDS. Groundwater containing less than 500 mg/L TDS is considered Class I "pristine groundwater". Class 1 waters can be used as a source of drinking water. Figure 4.5.3 shows that Class 1 waters are located primarily in the eastern area of Salt Lake Valley near Big and Little Cottonwood Creeks. Additionally, some Class 1 waters are located near Coon Creek and Butterfield Creeks in the western portion of the Valley.

Groundwater containing between 500 mg/L and 3,000 mg/L TDS is considered Class II "drinking water quality groundwater". The majority of groundwater in the principle aquifer of the Salt Lake Valley contains TDS levels between 500 and 2,000 mg/L. A few areas near the Great Salt Lake and Bingham Creek contain levels between 2,000 and 5,000 mg/L. Subsequent classes of groundwater contain greater concentrations of TDS and/or other potentially harmful contaminants. The groundwater protection standard for nitrate (as N) is 10 mg/L. A groundwater quality protection standard has not been established for Total Phosphorus (TP) (UAC R317-6). For a comprehensive description of groundwater quality in the Salt Lake Valley refer to Thiros and Manning's groundwater quality study *Quality and Sources of Ground Water Used for Public Supply in Salt Lake Valley,* prepared by the U.S. Geological Survey (Thiros, 2004).

Of note, House Bill (H.B.) 40 passed on February 29, 2008. This bill requires that Counties adopt an ordinance to protect sources of drinking water, namely wells, through regulation of land use. It will require Salt Lake County to adopt such an ordinance by May 3, 2010. It also allows a county or municipality to change the zoning designation in an industrial protection area and designate drinking water source protection zones, management areas, or groundwater recharge areas. Several cities in Salt Lake County have already adopted source water protection ordinances. The Salt Lake County Council took a position to officially support this bill and supports efforts to minimize risk to source protection zones through coordination of planning and permitting activities. As such, the County is currently working to develop a source water protection ordinance for adoption.

#### 4.5.3.3 Drinking Water Quality Standards

Water providers are required to treat the water they supply to drinking water quality standards, which are listed as Maximum Contaminant Levels (MCLs). These MCLs are separated into Primary and Secondary standards. Primary standards are legally enforceable standards that apply to public water systems, while secondary standards are non-enforceable guidelines regulating contaminants that may cause cosmetic effects (such as skin or tooth discoloration) or aesthetic effects (such as taste, odor, or color) in drinking water. Primary drinking water standards are established for nitrate and nitrite. Secondary drinking water standards are established for TDS. A drinking water quality standard has not been developed for phosphorus.

There are hundreds of Primary and Secondary MCLs, but for the WaQSP, only TDS, nitrate, and phosphorus are discussed as indicators of relative water quality.

The Utah Division of Drinking Water (DDW) will allow up to 500 mg/L TDS without obtaining permission to exceed the secondary standard. The DDW requires demonstration that there are no other better water sources to grant an exception to allow TDS greater than 1,000 mg/L. Table 4.5.3 summarizes the 2005 water quality of water sources compared with the respective water quality standards. 2005 is the most current published data for the providers. As can be seen in Table 4.5.3, many of the potable water sources have TDS levels below 500 mg/L.

## Table 4.5.3 Summary of 2005 Water Quality of Existing Sources Delivered by Provider

| | Source Water Quality | | | |
|---|---|---|---|---|
| **Provider** | TDS (mg/L) | Nitrate (mg/L) | Nitrite (mg/L) | Phosphorus (mg/L) |
| Surface Water Quality Protection Standard – Class 1C | Background | 10 | -- | 0.025[4] |
| Groundwater Quality Protection Standard | -- | 10 | 1 | -- |
| Primary Drinking Water Quality Standard (MCL) | 500[5] | 1 | 1 | -- |
| Salt Lake City[1] | | | | |
| Parleys | 510 | ND | ND | ND |
| Big Cottonwood | 254 | 0.14 | ND | ND |
| City Creek Canyon | 230 | 0.1 | ND | ND |
| Jordan Valley | 215 | 0.8 | 0.1 | ND |
| Wells (range) | 186-698 | 0.27-4.52 | ND | ND |
| MWD for SL & Sandy[2] | | | | |
| Little Cottonwood (Range) | 138-288 | 0.23-0.46 | <0.03 | <0.10 |
| Deer Creek (Range) | 184-296 | 0.22-0.48 | <0.03 | <0.10-0.108 |
| JVWCD[3] | | | | |
| Deer Creek/Provo River | 184-296 | 0.22-0.48 | <0.03 | <0.10-0.108 |
| Wells and Wasatch Mountain Stream | 120-512 | 0.1 | 3.5 | ND |

Notes:
mg/L – milligrams-per-liter
ND – Non-detect
MCL – Maximum Contaminant Level

*Sources:*
*[1] 2006 Consumer Confidence Report, Salt Lake City Department of Public Utilities*
*[2] 2006 CRR data provided by Claudia Wheeler, Environmental Services Manager, MWDSLS*
*[3] JVWCD source quality for Provo River are the same as for MWDSLS*
*[4] This value is a Class 2B surface water protection standard. There is no Class 1C surface water protection standard*
*[5] This value is a secondary drinking water quality protection stan-*

By comparing the surface water and groundwater quality protection standards with drinking water quality standards, it becomes clear that the highest concentration, or upper limit of potentially harmful contaminants like TDS, nitrate and TP to be expected in the Salt Lake County water systems, is the drinking water quality protection standard. In many cases, water quality of water sources (surface water and groundwater) is protected to maintain concentrations well below this drinking water upper limit. Stated another way, the most restrictive standard for water quality could be either the surface water standard or the drinking water standard, depending on the source water.


Big Cottonwood Creek, Upper Big Cottonwood Creek Sub-Watershed

### 4.5.4 Principal Water Providers

The following section summarizes the three (3) major water suppliers' plans for future water development. These plans are contained in:

1. Salt Lake City Department of Public Utilities' *Major Conveyance Study*, 2007
2. MWDSLS *Master Plan Update*, 2003
3. Jordan Valley Water Conservancy District's *Annual Budget Report*. For this study, the 2006 report was used.

Information for this section was obtained from personal communications with staff and from the above referenced documents.

Although the majority of potable waters in Salt Lake County come from import sources, the three (3) principal providers use these sources to varying degrees. As can be seen in Table 4.5.4, Salt Lake City Public Utilities gets the majority of their water from Wasatch Mountain streams. Metropolitan Water District of Salt Lake & Sandy gets the majority of their waters from import sources such as the Provo River (53.3%; 36,351 af), and Jordan Valley Water Conservancy District also relies primarily on import waters as their source (85.6%; 63,926 af).

Significantly, the three (3) principal suppliers all treat Wasatch Mountain stream waters for potable use (Table 4.5.5). The majority of these streams are protected as anti-degradation segments; however, water diversions for potable water purposes often completely de-waters several of these streams. Of note, new point source discharges are prohibited in anti-degradation segments. Additionally, diffuse sources are controlled to the extent feasible through implementation of best management practices or regulatory programs.

#### 4.5.4.1 Salt Lake City Department of Public Utilities

Salt Lake City Department of Public Utilities (SLCPU) relies on three (3) water treatment plants, numerous wells/springs, and water delivery from Metropolitan Water District of Salt Lake & Sandy to supply potable water to users in Salt Lake City, as well as a significant portion of the east side of unincorporated Salt Lake County. Figure 4.5.1 shows SLCPU's potable water distribution boundary and water treatment plants. In 2005, the SLCPU served a population of 317,981 (UDWRi website).

SLCPU water treatment plants include the Big Cottonwood Water Treatment Plant (BCWTP), Parleys Water Treatment Plant (PWTP) and the City Creek Water Treatment Plant (CCWTP), which are designed to collect and treat water from Wasatch Mountain streams. Table 4.5.6 shows the capacity of these treatment plants.

**Table 4.5.4 2005 Water Sources for Major Salt Lake County Potable Water Providers**

| | Sources of Water (af) | | |
|---|---|---|---|
| **Provider** | Groundwater | Wasatch Streams | Imports [4] |
| SLCPU[1] | 1,288 | 38,255 | 0 –(from MWD only) |
| MWDSLS[2] | NA | 16,966 | 36,351 |
| JVWCD[3] | 8,859 | 1,891 | 63,926 |
| **Total** | **10,147** | **57,112** | **100,277** |
| NOTE: These numbers may change significantly every year based on snow pack. | | | |

*Sources:*
*[1] Utah Division of Water rights. "Public Water Suppliers Flow Data."*
*[2]Communication with Claudia Wheeler, Environmental Services Manager, MWDSLS*
*[3]JVWCD Annual Report 2005 – JVWCD also delivers 27,929 acre-feet of raw water (9,866 af from Utah Lake and 18,063 af from the Provo River)*
*[4]Currently, all imported water is from the Provo River*

### Table 4.5.5 Wasatch Mountain Streams Used by Major Water Suppliers

| Provider | Wasatch Mountain Streams |
|---|---|
| Salt Lake City Public Utilities (SLCPU) | City Creek<br>Parley's Creek<br>Big Cottonwood Creek |
| Jordan Valley Water Conservancy District (JVWCD) | Middle Fork of Dry Creek<br>South Fork of Dry Creek<br>Rocky Mouth<br>Big Willow |
| Metropolitan Water District of Salt Lake & Sandy (MWDSLS) | Little Cottonwood Creek<br>Bells Canyon |

SLCPU also receives water transfers from the Little Cottonwood Water Treatment Plant (LCWTP), which is owned and operated by MWDSLS. Wasatch Mountain streams account for 60 percent of the potable water used in Salt Lake City.

SLCPU anticipates that the demand for water will outpace supply by the year 2030. A number of approaches have been identified to augment SLCPU's water supply and match projected future demands. Wastewater reuse is being considered to supply two (2) large golf courses in Salt Lake City. Reuse could produce 5,000 af annually and water deliveries of wastewater reuse water for outdoor uses are planned for 2015. SLCPU estimates that development of new wells could yield up to 12,000 af of additional groundwater annually.

In addition to wastewater reuse and new well systems, SLCPU is considering treating surface water from Mill Creek, which would contribute an additional 3,967 af during average water years. Although, Mill Creek is currently not fully utilized as a source of potable water, it is one of the major sources of high quality surface water among the Wasatch Mountain streams. Annually, Mill Creek contributes 10,762 af of water to the Salt Lake Valley (Bear West, 1999). Figure 4.5.4 illustrates Salt Lake City's projected demands, and existing and future supplies.

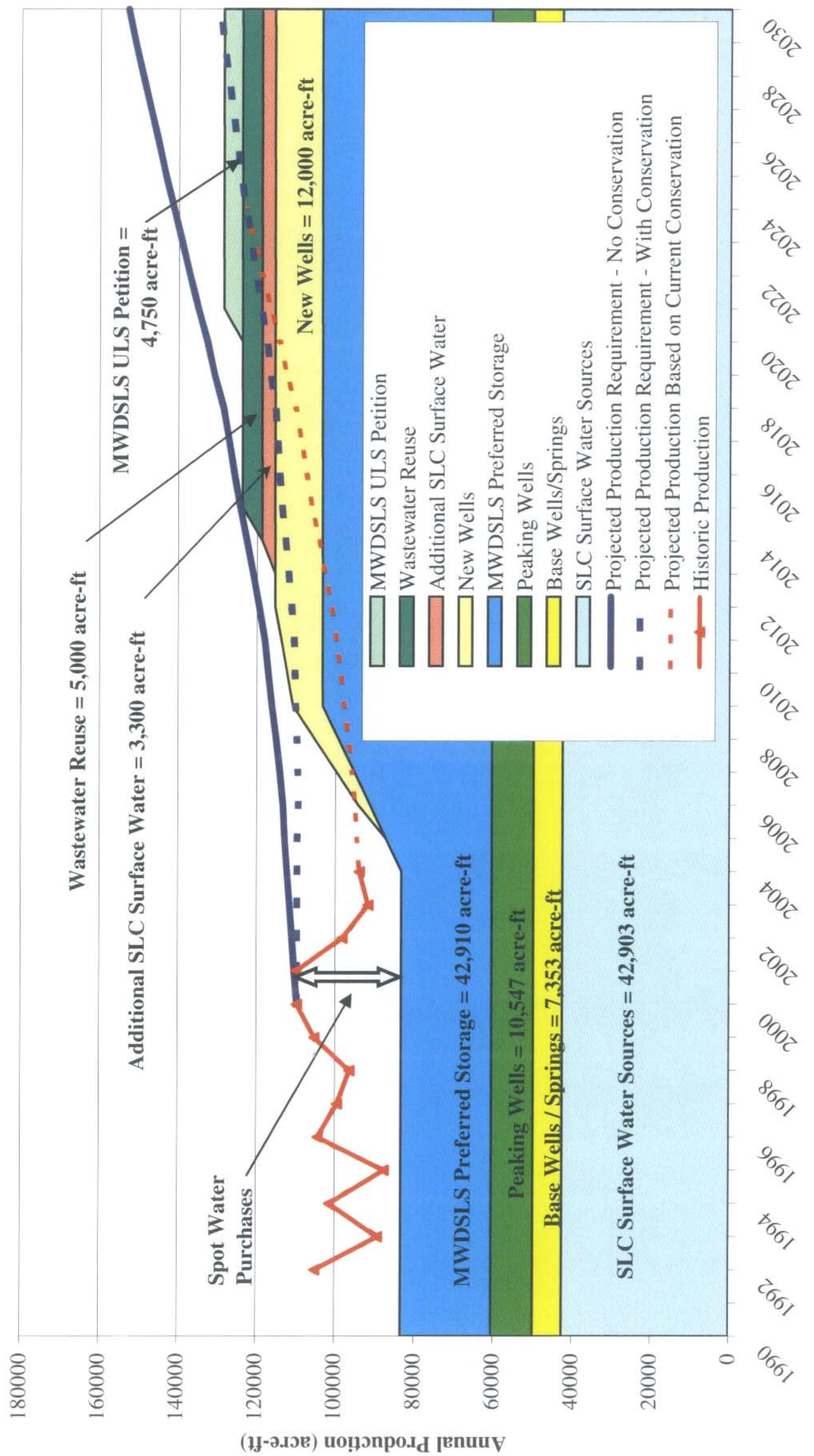
#### 4.5.4.2 Metropolitan Water District of Salt Lake and Sandy

Metropolitan Water District of Salt Lake and Sandy (MWDSLS) supplies water to Salt Lake City and Sandy City as a wholesale provider and periodically transfers water to JVWCD through an exchange agreement. The district owns and operates the Little Cottonwood Water Treatment Plant (LCWTP) located just northwest of the mouth of Little Cottonwood Canyon. It treats water from Little Cottonwood Creek and Deer Creek Reservoir water imported to the Salt Lake valley from the Provo River through the Salt Lake Aqueduct. In early 2007, the district began treating water from Bells Canyon, a Wasatch Mountain stream in the southeastern portion of the County.

### Table 4.5.6 Capacity of SLCPU Water Treatment Plants

| | Capacity (mgd) | |
|---|---|---|
| Water Treatment Plant | Peak | Peak Day/Dry Year |
| Big Cottonwood WTP | 38 | 14 |
| Parleys WTP | 35 | 35 |
| City Creek WTP | 13 | 4 |
| **Total** | **86** | **53** |

*Source: Salt Lake City Department of Public Utilities, Major Conveyance Study, January 2007*




*Volumes given are for 2030 projected supply.

**Figure 4.5.4 Projected Salt Lake City Production Demand vs. Supply (Dry Year)**

**Jordan Valley Water Treatment Plant**
Rated capacity = 180 MGD
Constructed in 1972, with expansions in 1979 and 1986

**Southeast Regional Water Treatment Plant**
Rated capacity—20 MGD
Constructed in 1985 with a major process enhancement in 2000.

Construction of the new Point of the Mountain Water Treatment Plant (POMWTP) began in 2005 and started operating in 2007. The new POMWTP is located in Draper near I-15 and will treat 43.75 mgd (70 mgd capacity) of raw water from the Provo Reservoir Canal (Provo River water). Additionally, the POMWTP will pump treated water into the MWDSLS distribution system and to the LCWTP. MWDSLS does not withdraw groundwater and does not anticipate developing groundwater as a source; however, it is studying an aquifer storage and recovery project to use treated surface water from the LCWTP for recharge of the aquifer.

The only future water source for MWDSLS is 8,600 af from the Utah Lake System (ULS) project (Central Utah Water Conservancy District delivery of Strawberry Reservoir water).

#### 4.5.4.3 Jordan Valley Water Conservancy District

The Jordan Valley Water Conservancy District (JVWCD) provides wholesale waters to much of the Salt Lake Valley and to a lesser extent to retail water users. JVWCD imports more water to the valley than any other water provider. Its two (2) primary import sources are:

1. 50,000 af from the Central Utah Project (Jordanelle Reservoir).
2. Approximately 20,000 af from the Provo River from acquisition of irrigation water and exchange for Provo River Water (Welby-Jacob Exchange).

JVWCD's current supply is comprised of 70,000 af of imported water and approximately 20,000 af of developed groundwater (Packard, 2007). However, in planning in 2005 for future demand, JVWCD identified five (5) additional sources of water for future use. These sources include: 1) Southwest Groundwater Project, 2) Water Reuse, 3) Utah Lake Systems waters, 4) Shallow Groundwater Wells, and 5) Bear River water.

Table 4.5.7 summarizes JVWCD's anticipated future sources of water.

Figure 4.5.5 was provided by JVWCD and illustrates the projected demands and future water sources needed to meet those demands, as determined in 2005. Two (2) demand projection lines are shown. The higher demand line shows future demands without conservation and the lower shows future demands with a 25 percent conservation reduction below 2000 per capita demands. This demonstrates that conservation is a vital component to meeting future demands. Even with all the proposed water development projects, demands will not be met without significant conservation.

### 4.5.5 Potable Water Treatment Plants

In Salt Lake County, there are nine (9) principal water treatment plants for treatment of drinking water. Eight (8) of the plants treat surface water and one treats groundwater. The locations of these facilities are shown on Figure 4.5.1. Table 4.5.8 summarizes the capacity, ownership and water sources for the treatment plants.

### Table 4.5.7 Future JVWCD Sources Identified in 2005

| Source | Volume (af) | First Year Delivered |
|---|---|---|
| Southwest Groundwater Project | 8,200 | 2009 |
| Wastewater Reuse Phase 1 | 5,000 | 2013 |
| Utah Lake System (CUWCD) | 21,400 | 2015 |
| Jordan River, shallow groundwater | 8,000 | 2028 |
| Wastewater Reuse Phase 2 | 10,000 | 2032 |
| Bear River Phase 1 | 25,000 | 2036 |
| Bear River Phase 2 | 25,000 | 2047 |
| **Total New Water Sources** | **102,600** | |

The Point of the Mountain Water Treatment Plant became operational in 2007. A new water treatment plant is being contemplated by Salt Lake City to treat approximately 4,000 af of water from Mill Creek; however, the capacity has not been determined. JVWCD has plans for a second plant to treat groundwater. It is called the Southwest Groundwater Treatment Plant and will be located northeast of the Bingham Canyon Water Treatment Plant.

## 4.5.6 Import Water

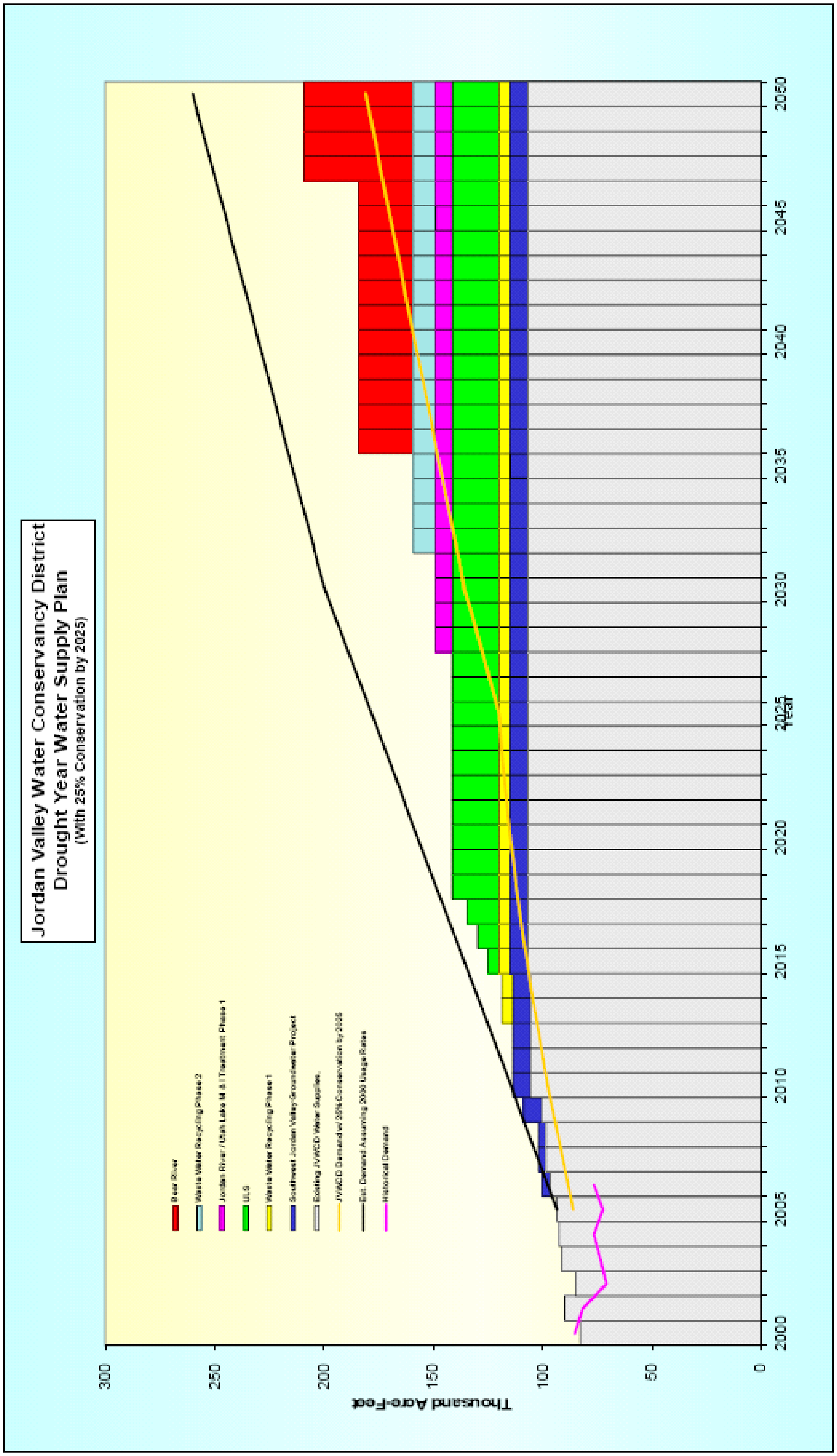
Import water is water that is brought into Salt Lake County outside the County.

Tables 4.5.9 and 4.5.10 summarize projected future importations of water to Salt Lake County beyond what is currently imported. Current imports are all from the Provo River drainage and include Deer Creek Reservoir storage, Jordanelle Reservoir storage and irrigation water conveyed

### Table 4.5.8 Summary of Potable Water Treatment Plants in Salt Lake County

| Water Treatment Plant | Agency | Capacity (mgd) | Water Source(s) |
|---|---|---|---|
| Jordan Valley[1] | JVWCD/MWDSLS | 180 | Provo River |
| Southeast Regional[1] | JVWCD | 20 | Bells Canyon, Middle Fk, South Fk, Rocky Mouth, Big Willow, and Provo River |
| Bingham Canyon[1] | JVWCD | 3 | Groundwater |
| Draper [2] | Draper Irrigation Co. | 6.6 | Bells Canyon |
| Little Cottonwood[3] | MWDSLS | 150 | Provo River, Little Cottonwood and Bells Canyon |
| Point of the Mountain[3] | MWDSLS | 70 | Provo River |
| Big Cottonwood[4] | Salt Lake City | 38 | Big Cottonwood |
| Parleys[4] | Salt Lake City | 35 | Parleys Creek |
| City Creek[4] | Salt Lake City | 13 | City Creek |

*Sources:*
*[1]Personal communications: Jeff Bryant, Water Supply Dept. Manager, JVWCD, March 29, 2007*
*[2]Personal communications: Jerry Nielson, Plant Operator, Draper Irrigation Company, March 29, 2007*
*[3]Personal communications: Brad Bender, MWDSLS, March 29, 2007*
*[4]Bowen Collins and Associates, 2007, Salt Lake City, Major Conveyance Study, January 2007*




*Source: Jordan Valley Water Conservancy District Annual Budget Report 2006*

**Figure 4.5.5 Jordan Water Conservancy District Drought Year Water Supply Plan**

**Table 4.5.9 Description of Projected Future Import Water Sources for Major Salt Lake**

| Source | Description |
|---|---|
| **Geneva Steel Waters** | Since its 2005 planning effort, JVWCD has developed plans to subscribe to an additional 9,000 af of water from Central Utah Water Conservancy District (CUWCD) from its Geneva Steel groundwater supplies. CUWCD acquired this water by purchase. Geneva Steel was a steel mill on the east shore of Utah Lake that has been decommissioned. This project was recently conceived to develop and convey water previously used at Geneva Steel to northern Utah County and to JVWCD. As a result, these waters were not included in JVWCD |
| **Southwest Groundwater Project** | JVWCD has developed the Southwest Groundwater Project that will pump and treat contaminated groundwater to potable water standards. This will both clean up the contamination and provide high quality drinking water using reverse osmosis technology.<br><br>Kennecott Utah Copper is the primary "developer" of this project as a result of Federal and State legal action. JVWCD joined as a partner to participate in developing increased capacity for a Reverse Osmosis (RO) plant that Kennecott was required to construct. |
| **Water Reuse** | JVWCD intends to meet some of its future demands by treating wastewater to a quality sufficient for human contact but not for potable use. The water will be used for irrigation of landscape. JVWCD's contract for ULS System deliveries is subject to CUWCD's commitment to recycle 18,000 acre-feet of return flows from the Bonneville Unit segment of the Central Utah Project by 2030. JVWCD's contract for ULS System deliveries is subject to CUWCD's commitment to recycle 18,000 acre-feet of return flows from the Bonneville Unit segment of the Central utah Project by 2030. JVWCD will therefore be supportive of wastewater reuse projects which will fulfill the commitment.. |
| **Utah Lake System (ULS)** | The Utah Lake System (ULS) is the last element of the Central Utah Project. ULS will convey water from Diamond Fork (Spanish Fork Canyon) and deliver a portion of this water to the mouth of Provo Canyon. From this point, the water will be conveyed in an enclosed Provo Reservoir Canal to the Point of the Mountain Treatment Plant and the Jordan Valley Water Treatment Plant. |
| **Shallow Groundwater Wells** | JVWCD has plans to construct shallow groundwater wells to intercept groundwater that would naturally discharge to the Jordan River. The water would require advanced treatment for potable water use, possibly reverse osmosis. Brine from the treatment process could be conveyed to the Great Salt Lake. |
| **Bear River Water** | The Bear River Project is a plan to collect and convey Bear River water to Weber, Davis and Salt Lake Counties. JVWCD is the only agency in Salt Lake County participating in planning for this project. They are working in a cooperative effort with Weber Basin Water Conservancy District and the Utah State Division of Water Resources. |

*Source: JVWCD, 2007*

**Table 4.5.10 Summary of Projected Future Imported Water Sources for Major Salt Lake County Potable Water Providers**

| Provider | Projected Future Sources of Water (af) | | |
|---|---|---|---|
| | Geneva Groundwater | Utah Lake System | Bear River |
| Salt Lake City | 0 | From MWDSLS | 0 |
| MWDSLS[1] | 0 | 8,600 | 0 |
| JVWCD[2] | 9,000 | 21,400 | 50,000 |
| Total | 9,000 | 30,000 | 50,000 |

*Sources:*
*[1] Personal communication Claudia Wheeler and Brad Bender, MWDSLS, 2007.*
*[2] Personal communications Alan Packard, JVWCD, March 28, 2007*

through the Provo Reservoir Canal and the Jordan Aqueduct. Importation of water into Salt Lake County may impact water quality because this represents a change from natural water conditions. Water imported to Salt Lake County is generally of very high quality, having Total Dissolved Solids (TDS), Total Nitrogen (TN) and Total Phosphorus (TP) levels that are typically much lower in concentration than water sources within Salt Lake County (Table 4.5.11).

A common method of indicating the magnitude of water quality impacts associated with importation of water from one drainage to another is to quantify the volume of salt, in tons, imported with the water. Salt is defined in this context as all solids in solution (Total Dissolved Solids) in the water, not just sodium chloride. Salt annually imported with the existing 100,277 a.f. of Provo River water is approximately 40,300 tons. Table 4.5.12 summarizes the tonnage of salt imported to Salt Lake County from both current and future sources.

Although this volume of salt appears large, its significance to water quality in Salt Lake County may be minimal. Imported water that is used for irrigation can cause environmental damage as it evaporates and leaves behind salt. However, since salt concentrations in the imported water, as reported as Total Dissolved Solids (TDS), are so low (150 to 296 ppm), this water will likely move salts through the soil profile and will generally not accumulate in the root zones where it could harm plants.

The portion that is for indoor use and eventually treated by wastewater treatment plants will typically pick up 200 to 300 ppm additional TDS. The resulting discharge from wastewater treatment plants to the Jordan River will consequently be less than 600 ppm TDS. This is lower than the Jordan River receiving waters which typically have 800 to 1200 ppm TDS (Cirrus, 2007).

In summary, the high quality imported potable water will likely not have detrimental effects on the water quality of surface streams or groundwater within Salt Lake County.

### 4.5.7 Summary of Future Potable Water Sources for Salt Lake County

Future sources of potable water will include development of groundwater, Wasatch Mountain streams, and importation of water. Development of groundwater will be accomplished by large providers like SLCPU and JVWCD and by numerous municipal and private water companies. Mill Creek may also be developed by SLCPU.

Projected increases of imported water to Salt Lake County total 89,000 af. This includes 9,000 ac-ft from Utah Valley groundwater (Geneva), 30,000 ac-ft of ULS water (Strawberry Reservoir), and 50,000 af of Bear River water.

Another source of water to meet future non-potable water demands is reuse of wastewater. Both JVWCD and SLCPU have plans to use wastewater reuse to meet future demands.

### 4.5.8 Summary of Future Potable Water Sources Demand

In 2005 and 2006, Bowen, Collins & Associates (BC&A) completed studies of water supply and demand for the MWDSLS and JVWCD. Similar studies were also conducted for Holliday Water Company and Murray City Water, the two major water providers in the County that are not members of either MWDSLS or JVWCD. To gain additional insight into the overall water availability and needs throughout Salt Lake County, MWDSLS, JVWCD, Holliday Water, and Murray City Water combined to commission BC&A to develop a study that considers all of the water supply agencies jointly. This study was published in 2007 (BC&A, 2007).

The purpose of the BC&A study was to evaluate the water needs and supplies of all four agencies. In order to accomplish this, the BC&A study:

- Updated County demand projections through full development
- Evaluated the ability of supply agencies to meet projected demands

Based on population projections, total demands will increase between 2000 and 2100 by 67 percent (including projected conservation measures). Without conservation, total demands in the County are projected to reach almost 640,000 a.f. Conservation measures will reduce this demand by 160,000 a.f.

### 4.5.8 Effects of Water Supply Strategies

As population continues to increase in Salt Lake County, water distributors and suppliers anticipate developing numerous strategies to meet future water supply demand. Some of these strategies include:

1. Development of local groundwater
2. Collection and treatment of additional Wasatch Mountain stream water
3. Importing water from outside Salt Lake County
4. Reuse of wastewater for landscape irrigation
5. Conservation

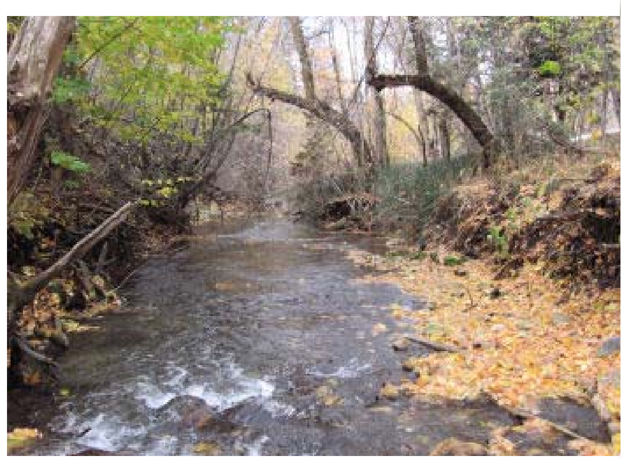
As discussed earlier, waters outside of Salt Lake County that are currently planned for future development are generally of high quality. In addition, local waters that are anticipated to be developed for future needs are also of high quality. Therefore, the currently planned water development projects are not anticipated to have a negative effect on water quality in Salt Lake County.

However, water supply strategies may affect the hydrology of waters in Salt Lake County. For example, importing water from outside of Salt Lake County may increase discharge to the Jordan River, which is a primary receiving water of wastewater treatment facilities in the County. Also, water development projects will likely change the quantity and location of return flows to natural drainages. Reuse of wastewater, and new surface water diversions, may reduce instream flows. Consequently, coordination between water providers, wastewater treatment facilities, and watershed managers will become more important as these changes occur.

### 4.5.9 Recommendations

As Salt Lake County's population continues to grow, it is recommended that the County participate in water supply in the following ways:

1. Facilitate discussions between water supply, wastewater, and stormwater professionals to assure that water resources are viewed collectively in Salt Lake County.
2. Support water reuse efforts.
3. Support water conservation efforts.



City Creek, Upper Creek Sub-Watershed

### Table 4.5.11 Water Quality of Future Salt Lake County Potable Water Sources

| | Source Water Quality | | |
|---|---|---|---|
| **Source** | **TDS (ppm)** | **Nitrate + Nitrite (ppm)** | **Phosphate (ppm)** |
| Utah Lake System[1] | 150 | | -0.066 |
| Bear River[2] | 600 | 0.02 | |
| Geneva Steel Groundwater[3] | 141 | ND | |

*Sources:*
*[1] Utah Department of Environmental Quality, Straw berry Reservoir TMDL Study, March 2005.*
*[2] Personal communications: Alan Packard, JVWCD, March 28, 2007 (Bear River water will be treated to reduce TDS to 250 ppm).*
*[3] USGS, Records of Wells and Springs Selected Driller's Logs of Wells and Chemical Analyses of Ground and Surface Waters, Northern Utah Valley, 1962*

### Table 4.5.12 Summary of Annual Salt Imported by Current and Future Sources of Water

| Source | TDS (ppm) | Annual Tons Salt |
|---|---|---|
| Provo River (current) | 296 | 40,300 |
| Bear River (post treatment) | 250 | 16,978 |
| *Utah Lake System | 159 | 6,112 |
| Geneva Groundwater | 141 | 1,724 |
| **Total** | | **65,128** |

**Source water for Utah Lake System is Strawberry Reservoir*

## 4.6 INSTREAM FLOWS

This section is written to: 1) review existing stream flow conditions of all major streams and river in Salt Lake County, 2) review anticipated changes to flow conditions of all major streams and river in Salt Lake County, and 3) delineate methods to preserve and augment stream flow. Additionally, this section is written to address the WaQSP strategic target, "Increase instream flows under normal and drought conditions to support aquatic habitat and recreational functions."

### 4.6.1 Background and Methodology

Instream flow is defined as water in the stream channel that is generated by surface runoff (overland flow, storm flow and return flow), shallow subsurface flow, and/or groundwater from the watershed. Instream flows help to maintain the existing aquatic resources and associated wildlife and riparian habitat.

The objective of this planning element is to address the strategic target of this plan to: "Increase instream flows under normal and drought conditions to support aquatic habitat and recreational functions."

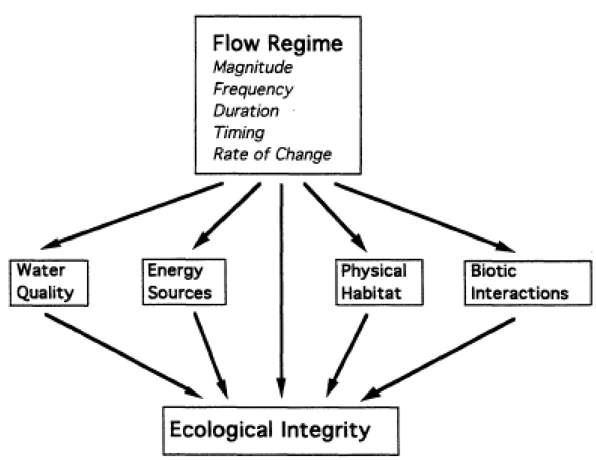
#### 4.6.1.1 Natural Flow Regime

The natural flow regime of streams and rivers is of critical importance in sustaining native biodiversity and ecological integrity of a stream system (Poff et al., 1997). The natural flow regime of a stream or river refers to the characteristic pattern of flow quantity, variability and timing. Five (5) components, critical for hydro-ecological processes, define the natural flow regime: magnitude, frequency, duration, timing and rate of change (Richter et al., 1996).

- magnitude: The flow rate, expressed as volume per unit time interval, at a fixed location in the stream. Generally, the minimum, mean and maximum flow magnitudes are quantified.
- frequency: The probability of a flow rate above a given magnitude recurring over some specified time interval, i.e. the 100-year flood is equaled or exceeded once every 100 years on average.
- duration: The period of time associated with a specific flow condition.
- timing: The seasonal regularity of when flows of a specified magnitude occur.
- rate of change: The flashiness of flow, or how quickly the flow magnitude changes.

In combination with water quality, physical habitat, energy sources and biotic interactions, the flow regime of a stream is considered the primary variable in determining ecological integrity (Figure 4.6.1). Water quality and physical habitat characteristics have been correlated with streamflow quantity and variability. Many physical habitat features, such as stream bars and riffle-pool sequences, are formed and maintained by the dominant discharge. The dominant discharge, or channel forming flow, is the streamflow that transports the majority of the sediment and creates or maintains the characteristic size and shape of the channel. (Wolman and Miller, 1960; Leopold et al., 1964; Knighton, 1984). The maximum sediment transport usually occurs at moderate flows that have a higher frequency of occurrence than larger flood events. Many water quality parameters of streams, such as temperature, dissolved oxygen and nutrients, are greatly affected by streamflow quantity and variability. Temperature in streams is increased and dissolved oxygen concentration can be reduced during periods of low flow in the summer.

A free-flowing stream with an active floodplain provides a range of ephemeral, seasonal and perennial types of habitat. Over long periods of time, species adapt and evolve based on the




*Source: Poff et al., 1997 after Karr 1991*

**Figure 4.6.1 Flow Regime and Ecological Integrity Schematic**

availability and dynamics of the habitat types made possible by the variation in flows. In this way, species distribution and abundance is dependent on the hydrologic variation of the stream (Poff and Allan, 1995). Numerous studies have been conducted that have established the connection between flow regime and ecological response in stream and river systems (refer to Table 2 in Poff, 1997).

#### 4.6.1.2 Hydrologic Modification

Hydrologic modification of instream flows through diversions can have a significant adverse impact on water quality, stream channel stability, as well as aquatic and riparian habitat. Flow alterations are defined as changes over substantial periods of time (i.e. weeks or longer). Flow alterations change the amount and type of habitat, which results in changes to production and species composition. Instream flow and flow alteration considerations include flow diversions from streams, groundwater withdrawals, trans-basin import water, wastewater treatment plant discharge, and water reuse.

The historical development of water sources for Salt Lake City and the Salt Lake valley provides context for the current conditions observed in the streams and the constraints to augmenting flows of modified streams. Stream diversions began in the late 1840's for irrigation and culinary water necessary to sustain the settlers in the valley. Without the stream diversions, the settlers would not have been able to grow crops and survive in the inhospitable arid environment of the valley. Ever since the 1840's, new sources of water have been continuously developed to meet the demands of the growing population. Starting with City Creek, sources of water which were developed within Salt Lake County included the Wasatch Mountain streams, the Oquirrh Mountain streams, Jordan River, as well as springs, tunnels and groundwater. Trans-basin and import water sources were eventually developed due to the growth in population in Salt Lake County.

The water development occurred under the framework of Utah's water rights laws and the principles of beneficial use and prior appropriation. The water purveyors in Salt Lake County were appropriated water, purchased water rights and exchanged water rights in order to meet the growing demand for water. The State Division of Water Rights fully allocated the streams to water users based on appropriation. However, flows were not reserved for instream flows, even under surplus conditions. When all water rights holders exercise their rights to use the water within a given watershed, segments of the stream have the potential to become dewatered. See Section 4.6.1.6 Water Rights below, for further discussion of water rights as they pertain to instream flows.

*Hydrologic Modification Categories* Salt Lake County categorized the main stems of the streams within County boundaries to indicate the impact of flow modification based on the best available data.

The United States Geological Survey (USGS) designates stream channels as either intermittent or perennial. Intermittent streams flow for a portion of the year or seasonally. Perennial streams flow continuously throughout the year.

Three (3) flow modification categories were defined for streams with altered flow: reduced, reduced with exchange, and interrupted. Following are the definitions for the established flow modification categories:

- Reduced: Stream reaches where instream flows are decreased due to diversions for water supply, irrigation or power generation. Diversions to canals or community irrigation systems were included. Minor diversions to individual properties were not considered.

- Reduced with Exchange: Stream reaches where instream flows have been removed and are replaced by water from another source through water rights exchange agreements. This category only applies to Little Cottonwood Creek, Big Cottonwood Creek, and Mill Creek.

- Interrupted: Stream reaches which are completely dewatered for any duration during the year as a result of diversions.

The USGS stream designations combined with the hydrologic modification definitions result in seven (7) instream flow categories:

1. Intermittent
2. Intermittent Reduced
3. Intermittent Interrupted
4. Perennial
5. Perennial Reduced
6. Perennial Reduced with Exchange
7. Perennial Interrupted

Each reach of the main stem tributaries was assigned to an instream flow category by Salt Lake County staff based on institutional knowledge of the stream systems, review of previous studies (Coon King & Knowlton Engineers et al., 1982; Utah Division of Water Resources, 1997), flow gauge data and water rights records. The length of stream in each sub-watershed that was categorized as reduced or interrupted was then calculated.

*Hydrologic Modification Characterization* Hydrologic indices and metrics have been developed to more fully characterize the hydrologic regime of streams and to quantify the effect of flow alterations on the natural flow regime. Recent research has focused on selecting the smallest number of ecologically relevant hydrologic indices to adequately describe stream flow variability while reducing computational redundancy (Olden and Poff, 2003). The National Hydrologic Assessment Tool (NATHAT), developed by the USGS, calculates the ten (10) statistically significant hydrologic indices for six (6) different stream types using mean daily flow data and peak annual flow data (Henriksen et al., 2006). These ten (10) selected hydrologic indices quantify the variability of the five (5) components of the natural flow regime: low, average and high magnitude; low and high frequency; low and high duration; low and high timing; and average rate of change. The hydrologic indices for perennial snowmelt type streams are summarized in Table 4.6.1.

NATHAT calculates the hydrologic indices for selected periods of the flow record (ie. prior to flow alteration and after flow alteration) in order to evaluate the effect of hydrologic modification. The program can also perform a trend analysis to discern effects of hydrologic modification that are more gradual, such as urbanization. Hydrologic modification in Salt Lake County started in the late 1840's with the settlement of the Salt Lake Valley by the Mormon Pioneers. As a result, there are little or no flow records in the Salt Lake valley for the period prior to flow alteration that would characterize natural stream flows. However, flow gauges have been maintained at the mouth of several canyons that characterize the natural flow regime in those canyons in which limited hydrologic alteration has occurred. Comparisons between the hydrologic indices calculated from the natural stream flow record and the altered stream flow record were not made for this planning effort; however, it could be calculated in future planning efforts in order to more fully characterize the effect of hydrologic modification on the flow regime.

### 4.6.1.3 Existing Conditions

*Hydrology* Existing instream flow conditions were characterized for this planning element in order to: 1) identify streams that would benefit from flow augmentation, and 2) assess the level of hydrologic modification of the streams in Salt Lake County. Previously published reports, available flow records and communication with agency staff were used for the evaluation.

For streams with long term flow records, existing flow conditions were characterized by performing a flow duration analysis. A flow duration curve shows the amount of time that a flow was equal to or less then a range of rates. Mean daily flows were used for the flow duration analysis.

One limitation of the Salt Lake County flow gauge data is that it was primarily collected for flood control purposes, and as such, low flows were not critical observations. It is difficult to accurately measure low flows in natural stream reaches, and even through hydraulic flow measurement structures. Therefore, flow records below 1 to 3 cfs were not available for some gauges and the reliability of the low flow measurements can be variable. Also, the presence or absence of flow is not discernible from the flow records at some of the flow gauges.

Flow and water consumption data was also obtained from Salt Lake City Department of Public Utilities for flows from the Wasatch canyons. The flow data was collected for water supply purposes.

**Table 4.6.1 Summary of Hydrologic Indices for Perennial Snowmelt Type Streams**

| Index | Component | Level | Description |
|---|---|---|---|
| MA29 | Magnitude | Average | Variability (coefficient of variation) of monthly flow values. Compute the standard deviation for each month in each year over the entire flow record. Divide the standard deviation by the mean for each month. Average (or median - Use Preference option) these values for each month across all years (percent – temporal). |
| ML13 | Magnitude | Low | Variability (coefficient of variation) across minimum monthly flow values. Compute the mean and standard deviation for the minimum monthly flows over the entire flow record. ML13 is the standard |
| MH1 | Magnitude | High | Mean (or median - Use Preference option) maximum flows for each month across all years. Compute the maximums for each month over the entire flow record. For example, MH1 is the mean of the maximums |
| FL3 | Frequency | Low | Frequency of low pulse spells. Compute the average number of flow events with flows below a threshold equal to 5 percent of the mean flow value for the entire flow record. FL3 is the average (or median - Use |
| FH8 | Frequency | High | Flood frequency. Compute the average number of flow events with flows above a threshold equal to 25 percent exceedence value for the entire flow record. FH8 is the average (or median - Use Preference |
| DL5 | Duration | Low | Annual minimum of 90-day moving average flow. Compute the minimum of a 90day moving average flow for each year. DL5 is the mean (or median - Use Preference option) of these values (cubic feet per |
| DH19 | Duration | High | High flow duration. Compute the average duration of flow events with flows above a threshold equal to seven times the median flow value for the entire flow record. DH19 is the average (or median - Use |
| TL1 | Timing | Low | Julian date of annual minimum. Determine the Julian date that the minimum flow occurs for each water year. Transform the dates to relative values on a circular scale (radians or degrees). Compute the x and y components for each year and average them across all years. Compute the mean angle as the arc tangent of y-mean divided by x-mean. Transform the resultant angle back to Julian date (Julian day – |
| TH1 | Timing | High | Julian date of annual maximum. Determine the Julian date that the maximum flow occurs for each year. Transform the dates to relative values on a circular scale (radians or degrees). Compute the x and y components for each year and average them across all years. Compute the mean angle as the arc tangent of y-mean divided by x-mean. Transform the resultant angle back to Julian date (Julian day – |
| RA1 | Rate of change | Average | Rise rate. Compute the change in flow for days in which the change is positive for the entire flow record. RA1 is the mean (or median - Use Preference option) of these values (cubic feet per second/day – |

Many streams, particularly in the southeast and southwest areas of the County, had extremely limited or no continuous flow rate measurements. Evaluation of existing conditions for ungauged streams relied on previous studies and Salt Lake County staff knowledge.

*Ecology and Recreation* The focus of the existing conditions assessment was on characterizing the hydrology and level of modification of flows in each stream; however, the sport fish resources, as determined by the Utah Division of Wildlife Resources (DWR), as well as the aquatic life and recreational beneficial use classification, as designated by the Utah Division of Water Quality (DWQ), are presented to provide ecological and recreational context for each sub-watershed. Significant stream habitat alteration has occurred to the streams within the urbanized area of Salt Lake County. Refer to the Habitat Planning Element for a more detailed assessment of physical habitat and aquatic resources of each stream.

DWR uses the Statewide Aquatic Habitat Classification System (SAHCS) method to classify sport fisheries. The SAHCS method is based on the importance of the water body to sport fisheries and consists of numerical ratings using three categories: aesthetics, availability, and productivity. Each of these categories is given a weighted numeric rating. The aesthetics rating is multiplied by 1, availability by 2, and productivity by 4. The score is weighted, totaled and given a numerical rating of 1 to 6 with 1 being the highest rating possible (blue ribbon trout stream). A description of the ratings are as follows:

Class 1: Blue ribbon trout waters, so rated because of their productivity, aesthetics and accessibility.

Class 2: Excellent trout waters. They lack only one element which makes them less than Class 1.

Class 3: Important because they support the bulk of stream fishing pressure in Utah. Generally, they have less aesthetic quality and lower productivity compared to Class 1 or 2 waters.

Class 4: Typically poor in quality with limited sport fish value; however, they may support native non-sport fish populations.

Class 5: Little value to the sport fishery. May support limited native fish populations.

Class 6: Streams that are de-watered for a significant period each year.

The sportfish introduced in the Jordan River Hydrologic Unit (16020204) include rainbow trout, brown trout, brook trout, walleye, green sunfish, white bass, black bullhead, and channel catfish.

DWR uses the Habitat Quality Index (HQI) method to assess stream productivity (Binns, 1982). The HQI method provides an index for trout streams and measures the following attributes: late summer stream flow, annual stream flow variation, maximum summer stream temperature, nitrate/nitrogen, fish food abundance, cover, water velocity, stream width, substrate, and bank erosion. Each of these attributes is given a number rating of 1 through 4 with 4 being the highest. The HQI rating is indicated in kg/hectare or lb/acre of trout biomass units.

The DWR sport fishery classification and HQI productivity are presented as published in the *Jordan River Drainage Management Plan Hydrologic Unit 16020204* (Thompson et al., 2003).

The DWQ aquatic life and recreational beneficial use designation are presented as published in the *Utah Lake-Jordan River Watershed Management Unit Stream Assessment* (Toole, 2002).

### 4.6.1.4 Flow Preservation and Augmentation

Preserving and increasing instream flows to improve ecological integrity has primarily been approached either by establishing the minimum instream flows required to sustain a targeted species or by mimicking a more natural flow regime to sustain a diverse array of native species.

*Minimum Instream Flows* Minimum instream flows are required to sustain fish habitat and production, as well as riparian vegetation and wildlife habitat. No minimum instream flow requirements have been established for the Jordan River or the tributary streams by the state of Utah (Utah Division of Water Resources, 1997). In addition, natural streamflow quantity and variability required for healthy ecosystem function have not historically been considered in water resources management in Salt Lake County.

The Instream Flow Incremental Methodology (IFIM) was developed as a decision support tool for establishing minimum instream flow requirements needed to maintain the fish production potential of a river (Bovee and Milhous, 1978; Bovee et al. 1998). IFIM has been widely implemented in the United States, particularly for the licensing of hydroelectric projects through the Federal Energy Regulatory Commission (FERC). IFIM combines hydrologic and hydraulic data, physical habitat measurements and habitat preferences for targeted species to determine the relationship between quantity of flow and amount of habitat for a stream or river. An IFIM study is a fairly intensive effort that requires field data collection, as well as hydrologic and habitat simulation. IFIM focuses on quantifying the habitat at each flow rate and does not directly address benefits of natural stream flow variability.

*Normative Flows* In a highly urbanized stream corridor with a channel that has been physically altered and/or that has adjusted to the altered hydrology, the natural flow regime may no longer be realistic or appropriate. In this case, mimicking a more natural flow regime to improve the ecological integrity of the stream corridor would be the objective, rather than a full restoration of the natural flow regime. The concept of a normative flow refers to a flow regime that resembles the natural flow regime sufficiently to sustain all life stages of a diverse suite of native species.

Implementation of normative flows requires an assessment of stream resources and the relative cost/benefit of proposed flow regimes in meeting stream ecosystem objectives in order to formulate optimized flow management recommendations.

#### 4.6.1.5 Regulatory

The Utah Division of Water Quality (DWQ) has the authority to regulate discharges to and protect designated uses of waters of the state. Waters of the state are defined as all streams, lakes, ponds, marshes, watercourses, waterways, wells, springs, irrigation systems, drainage systems, and all other bodies or accumulations of water, surface and underground, natural or artificial, public or private, which are contained within, flow through, or border upon this state or any portion of the state (Utah Water Quality Act, Utah Code Title 19 Chapter 5). DWQ has not established narrative or numeric streamflow criteria to protect flows necessary to support designated uses assigned to the waters of the state.

The Utah Department of Environmental Quality (DEQ) and Utah Nonpoint Source (NPS) Task Force consider hydrologic modification as a nonpoint source of water pollution that impacts aquatic wildlife habitat. According to the state, “Hydrologic modification occurs whenever human activities significantly change the hydrologic function (dynamics) or the attendant pollutant release regime of rivers and riverine systems, lakes and impoundments, and groundwater systems” (DEQ, 2000). Activities that alter instream flows include trans-basin diversions (such as sustained high flows or flows that greatly exceed the geomorphic capacity of a stream or its valley), reservoir release regime, and diversions (including dewatering). In addition, watershed activities that result in flow alterations, including forest harvest, fire, brush removal, land disturbance, urbanization, mining, and other land use activities are considered hydrologic modifications (Robinson, 1995).

The *Utah Nonpoint Source Pollution Management Plan* (DEQ, 2000) provides management strategies to address nonpoint source water pollution, including hydrologic modification. The *State of Utah Nonpoint Source Management Plan for Hydrologic Modifications* (Robinson, 1995) specifically addresses hydrologic modification.

Flow alteration resulting from hydrologic modification was not listed as a contributor to the impairment of any of the streams or rivers listed by the Utah DWQ in the Jordan River management unit (Toole, 2002).

The Federal Power Act (FPA) requires all nonfederal hydropower projects located on navigable waters to be licensed. The FPA (16 U.S.C. 791-828c) was originally enacted as the Federal Water Power Act in 1920 and was made part of the FPA in 1935. The Federal Energy Regulatory Commission (FERC) is the independent regulatory agency within the Department of Energy that has exclusive authority, under the FPA, to license such projects. The hydropower dam relicensing process assesses the balance between natural resources and the generation of electricity, while protecting and maintaining the designated uses of the water body as required by the Clean Water Act (CWA).

### 4.6.1.6 Water Rights

The State Engineer has the legal authority to preserve water for natural flows. The State Engineer can withhold approval or reject applications that would unreasonably affect public recreation or the natural stream environment. All of the surface water in Salt Lake County has been 100% appropriated and no flows were reserved for the natural stream environment. For new appropriations and change applications, the State Engineer does make consideration for impacts on the natural system and potential impacts to recreation (Olds, 2007).

Water rights in the state of Utah are granted only for beneficial uses of the water. In 1986, Utah enacted an amendment to its water code recognizing instream flows as a beneficial use not subject to diversion requirements (Utah Code 73-3-3-11 and UC 73-3-3-12). The purpose of the instream flow must be for the propagation of fish, public recreation, or the reasonable preservation or enhancement of the natural stream environment. Instream flow rights can be applied to natural stream channels and altered natural stream channels.

The Utah Division of Wildlife Resources and the Utah Division of Parks and Recreation are the only entities that currently may hold temporary or permanent instream flow rights. A change application can be filed on rights presently owned by either division; on perfected water rights purchased by either division through funding provided for that purpose, or acquired by lease, agreement, gift, exchange, or contribution; or on water rights acquired by either division with the acquisition of real property. The divisions can only purchase water rights for instream flow purposes with legislative approval. Unappropriated water cannot be appropriated for instream purposes and instream flows cannot be acquired through eminent domain. Instream flow rights retain the priority date of the original right.

The change application must identify the points on the stream between which the instream flow will be provided and must document the public benefits derived from the flow. Individuals may acquire an existing water right and transfer it to one of the agencies to hold as an instream flow right.

*Legislative Proposals* Two bills were proposed during the 2008 Utah legislative session that dealt with instream flows. House Bill (H.B.) 117 passed on February 21, 2008 and was sent to the Legislative Research and General Council for enrolling on February 22, 2008. This Bill authorizes nonprofit organizations to temporarily change a water right for instream flow to protect or restore native trout habitat. Prior to this new legislation, the Division of Wildlife Resources (DWR) and Division of Parks and Recreation (DPR) were the only entities that could hold water rights for instream flow. Outside of DWR and DPR, water rights in Utah were granted only for consumptive uses such as irrigation and drinking water. This bill will allow the preservation of instream flows by granting a water right for a non-consumptive use. Another bill was proposed that would have allowed wastewater treatment plants to temporarily lease water rights for instream flows. The additional stream flows would have been used to dilute the treatment plant effluent in order to meet state water quality standards. After initially gaining support, the wastewater bill failed to pass the legislature.

### 4.6.1.7 Previous Studies

Several previous studies have addressed hydrology and instream flows in the Salt Lake Countywide Watershed. Most of these have been prepared from a water supply and/or flood control perspective. The most relevant studies are listed below and additional studies are referenced in the Existing Conditions section.

- *Water Resources of Salt Lake County (*Hely et al., 1971): Study characterized and inventoried the water resources within Salt Lake County for water supply planning.

- *Salt Lake County Area-Wide Water Study* (Coon, King & Knowlton Engineers et al., 1982): The study identified, described and determined the cost to develop all surface water in Salt Lake County for potable purposes.
- *Salt Lake City Watershed Management Plan 1988* (Bear West Consulting Team, 1988): Management plan for the Wasatch canyon watersheds for which Salt Lake City owns the vast majority of water rights, including City Creek, Red Butte Creek, Emigration Creek, Parley's Creek, Mill Creek, Big Cottonwood Creek and Little Cottonwood Creek. The plan has the following recommendation regarding instream flows:

  *"The full appropriation of water rights in the Wasatch canyon streams and their ongoing committed purpose of providing water supply for the Salt Lake Valley prevents Salt Lake City from committing waters currently used by the city to instream flows. However, Salt Lake City recognizes the value of retention of minimum stream flows in the Wasatch canyons for aesthetic and ecological objectives. Salt Lake City should review the potential for committing water rights to instream flows on a canyon-by-canyon and case-by-case basis.*

  *In water development projects relating to canyon streams, Salt Lake City should consider retention of minimum flows in the streams to maintain aquatic and riparian habitat."*
- *Jordan River Basin Plan* (Utah DWRe, 1997): Water supply plan for the Jordan River Basin.
- *Salt Lake City Watershed Management Plan 1999* (Bear West Consulting Team, 1999): Update to the management plan for the Wasatch canyon watersheds for which Salt Lake City owns the vast majority of water rights, including City Creek, Red Butte Creek, Emigration Creek, Parley's Creek, Mill Creek, Big Cottonwood Creek and Little Cottonwood Creek. The plan only refers to instream flows as a response to a comment regarding instream flows:

  *"Salt Lake City has no intention of establishing instream flows. The State Department of Natural Resources requires and provides for instream flow regulations."*
- *Jordan River Flow Analysis* (Borup and Haws, 1999): Hydrologic study of flows in the Jordan River for the Utah Pollution Discharge Elimination System (UPDES).
- *2002 Southwest Canal and Creek Study* (Bowen Collins and Associates, 2003): The study identified institutional and structural improvements needed to manage stormwater runoff conveyed in the streams and canals located in the southwest quadrant of Salt Lake County.
- *Jordan River Return Flow Study* (CH2M Hill, 2005): Study evaluated the effect of future water reuse projects on the flows in the Jordan River downstream of Turner Dam.
- *Jordan River TMDL: Work Element 1 – Evaluation of Existing Information* (Cirrus Ecological Solutions, 2007): The report compiled and summarized the existing flow, water quality and biological information for the Jordan River in support of the Total Maximum Daily Load (TMDL) study.

## 4.6.2 Existing Conditions

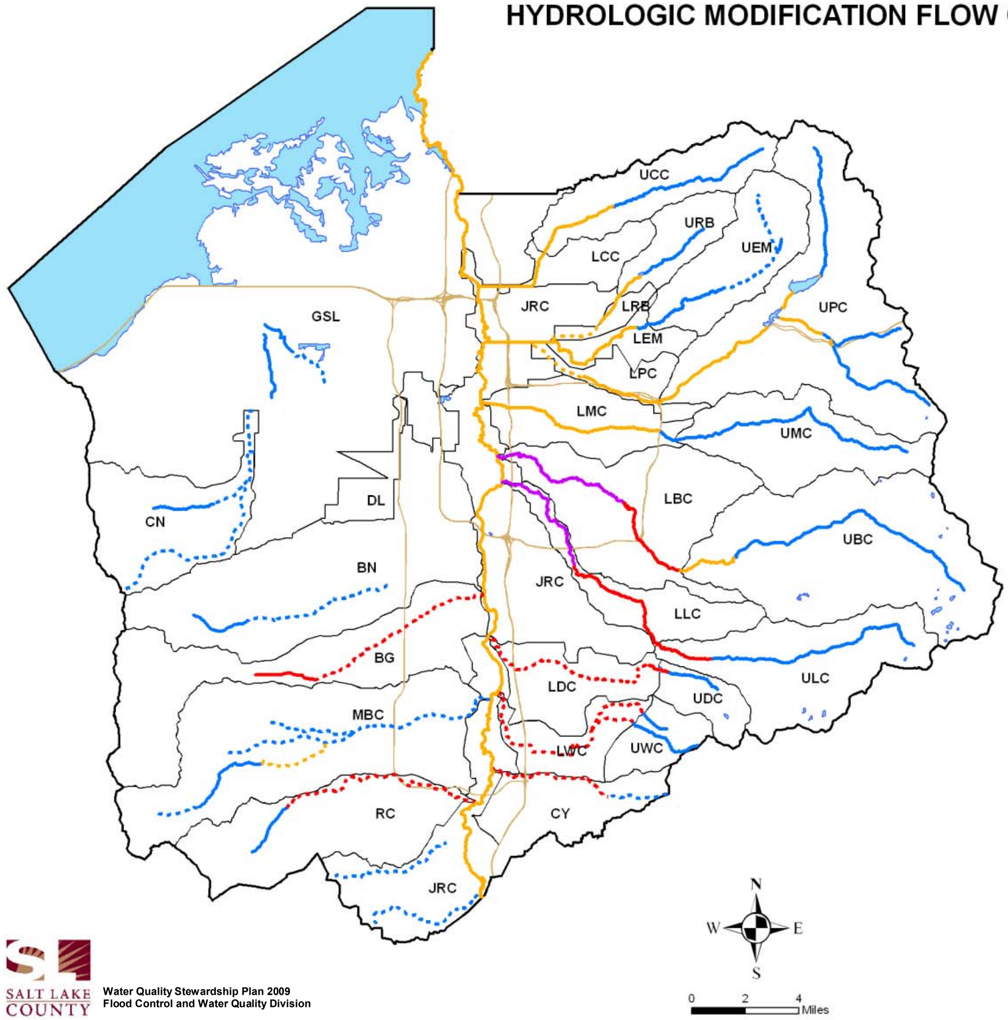
This section provides an evaluation of existing instream flow conditions for each of the sub-watersheds in Salt Lake County.

### 4.6.2.1 Stream Hydrologic Modification Category

Figure 4.6.2. presents the instream flow category of each stream reach. Further discussion for each sub-watershed is presented below.

Salt Lake Countywide Watershed

## HYDROLOGIC MODIFICATION FLOW CONDITIONS




NOTE: Only major surface water diversions are shown. Wells, springs and other groundwater withdrawals are not included on this map. However, all water withdrawal and imported water ultimately have an affect on surface water levels.

USGS designation of the streams in Salt Lake County were used and are defined as follows:
Perennial - Flows continuously throughout the year.
Intermittent - One which flows only at certain times of the year when it receives water from springs or from some surface source such as melting snow from mountainous areas.

Salt Lake County flow modification categories were assigned and are defined as follows:
Reduced - Stream reaches where instream flows are decreased due to diversions for irrigation or water supply. Minor diversions were not considered.
Reduced with Exchange - Stream reaches where instream flows have been removed and are replaced by water from another source through water rights exchange agreements. This category only applies to Little Cottonwood Creek and Big Cottonwood Creek.
Interrupted - Stream reaches which are completely dewatered for any duration during the year as a result of diversions.

SOURCE:
United States Geological Survey and Salt Lake County Engineering Division

**Flow Condition**

- Reservoirs, Culverts, and Ponds
- Perennial
- Perennial, Interrupted
- Perennial, Reduced
- Perennial, Reduced/Exchange
- Intermittent
- Intermittant, Interrupted
- Intermittant, Reduced
- Sub-Watersheds
- Major Roads
- Lakes, Ponds and Reservoirs
- Salt Lake County Boundary

**Figure 4.6.2 Hydrologic Modification Category of Salt Lake County Streams**

#### 4.6.2.2 Wasatch Mountain Streams

The average annual precipitation in the Wasatch Mountains varies from 22 to 61 inches. Most of the precipitation is in the form of snow during the winter. The snowfall accumulation and snowmelt pattern in the Wasatch Mountains varies for each watershed. The lower elevation watersheds in the northeast (City Creek, Red Butte Creek and Emigration Creek) receive less snowfall and have an earlier peak snowmelt runoff than the higher elevation watersheds in the central east (Parley's Creek, Mill Creek, Big Cottonwood Creek and Little Cottonwood Creek). The southeastern watersheds (Dry Creek, Willow Creek and Corner Canyon Creek) are generally higher in elevation with a smaller aerial extent than the northeastern watersheds.

The Wasatch Mountain watersheds receive greater amounts of snow due to the "lake effect". The lake effect results from arctic winter winds over warmer Great Salt Lake. Water is evaporated and then subsequently precipitated over the Wasatch Mountains due to orographic lift. The lake effect phenomenon also happens during summer thunderstorms.

Once the Wasatch Mountain streams leave the canyons, the channels traverse through alluvial fill material and the streambeds are high above the groundwater level. These streams lose flow to seepage through the reaches in the upper benches. Hely et al. (1971) estimated that groundwater seepage losses in Red Butte Creek, Emigration Creek, Parley's Creek, Mill Creek, Big Cottonwood Creek and Little Cottonwood Creek averaged 11.4 percent of the runoff during 1964 to 1968. Further downstream in the lower benches, the streams gain flow from groundwater, irrigation return flows and stormwater.

The perennial Wasatch mountain streams may naturally dewater during severe drought conditions, such as the drought that occurred in the 1930's; however, it is difficult to establish if the dewatered state occurred naturally due to drought or was a result of upstream diversions.

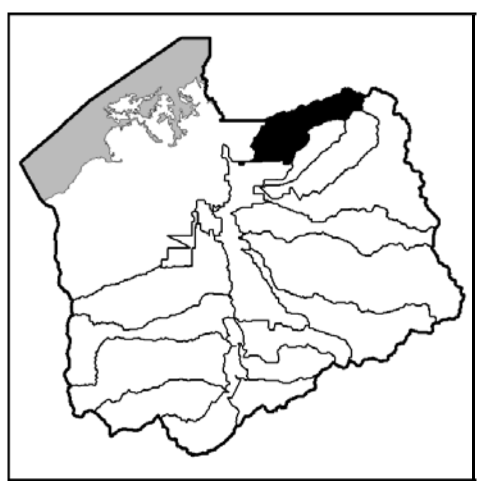
The Wasatch Mountain streams are a primary source of water for the Salt Lake Valley.

City Creek, Lower City Creek Sub-Watershed

*City Creek*

General Watershed Description The Upper City Creek sub-watershed has a drainage area of 11,189 acres comprised of low-lying mountain slopes with an elevation range from 4,300 to 9,400 feet. The portion of the sub-watershed above the water treatment plant is protected as a primary water supply source and designated as the City Creek Nature Preserve. Use is limited to recreational activities including hiking, biking, picnicking, hunting and fishing. Below the water treatment plant, the land use is also limited to recreational activities.

The Lower City Creek Sub-Watershed has a drainage area of 4,621 acres comprised of several undeveloped gulches and an urbanized residential neighborhood on the lower mountain/valley interface.



City Creek Watershed

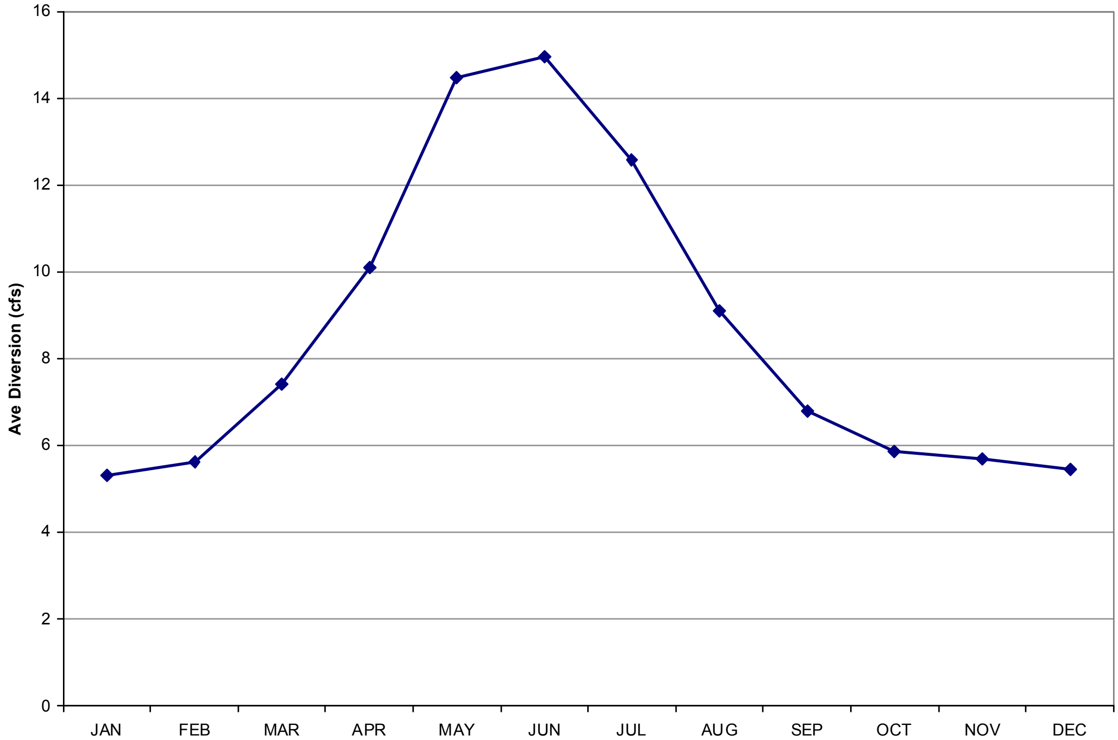
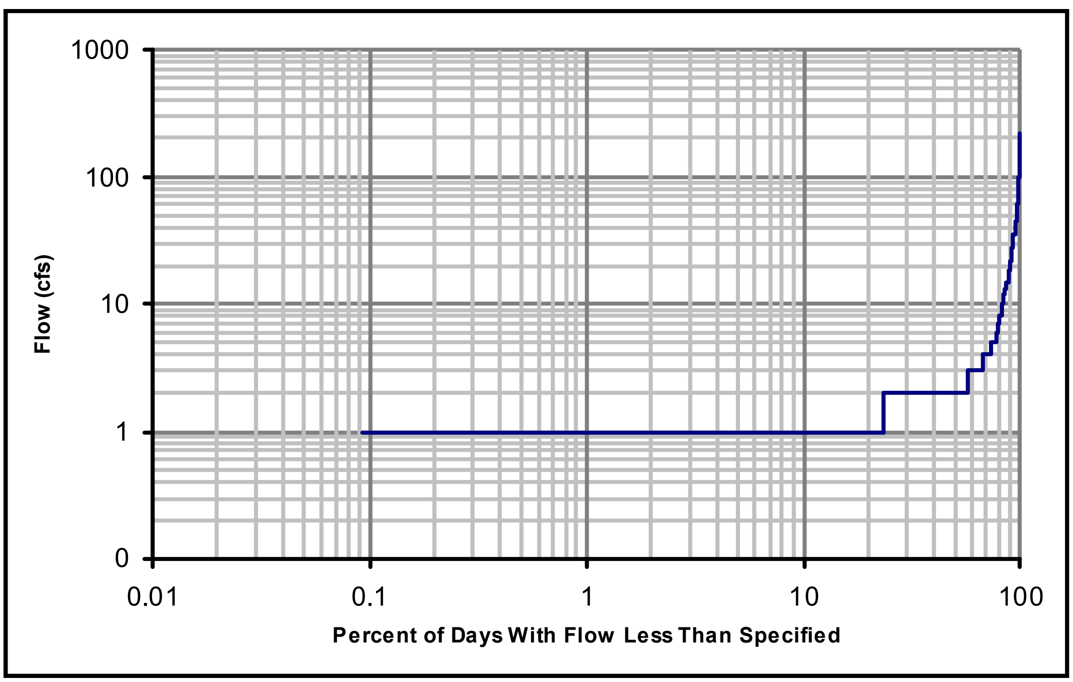



**Figure 4.6.3 Mean Monthly Flow diversion from City Creek to the City Creek Water Treatment Plant (1986-2005)**




*Stream gauge located at Memory Grove Park (SLCo 820/USGS 10172499) for the period 1/1/1980 – 9/30/2005*

**Figure 4.6.4 Mean Daily Flow Duration Curve for City Creek**

City Creek, Upper City Creek Sub-Watershed

Ecology The DWQ designated beneficial use for City Creek for aquatic life is Class 3A, which is protected for cold-water species of game fish and other cold water aquatic life (Toole, 2002).

The DWR sport fish management class for City Creek is 3, which is considered a good trout fishery. The Habitat Quality Index (HQI) productivity for the stream above the water treatment plant is 65 lb/acre (Thompson et al., 2003).

The native fish species in City Creek is Bonneville cutthroat trout. Introduced fish species include brown trout and rainbow trout (Thomson et al., 2003).

Recreation The City Creek DWQ designated beneficial use for recreation and aesthetics is Class 2B, which is protected for secondary contact recreation such as boating or wading (Toole, 2002). Although the designated beneficial use is Class 2B, watershed specific ordinances restrict many recreational activities in the stream channel within the protected watershed boundary.

City Creek, Lower City Creek Sub-Watershed

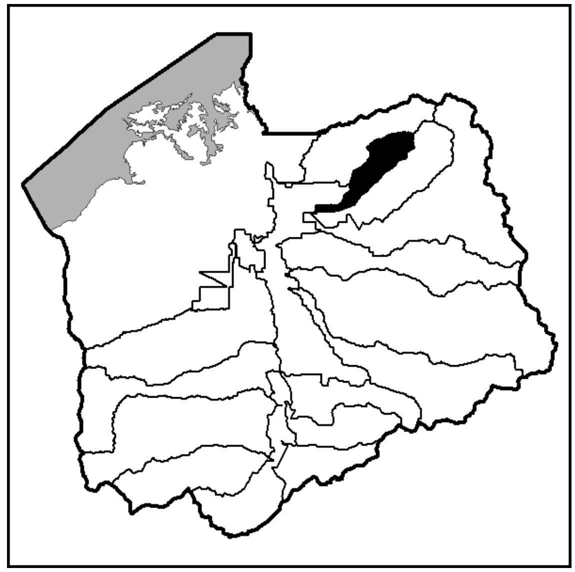
Hydrology City Creek is classified as a perennial stream. Below the City Creek Water Treatment Plant, the flow is reduced due to the diversion for water supply consumption. City Creek enters a pipe below Memory Grove Park that has open channel sections in the median between Canyon Road and Canyon Side Road, as well as through City Creek Park. City Creek then enters the North Temple Conduit to the Jordan River.

Salt Lake City Department of Public Utilities maintains and operates the City Creek Water Treatment Plant, with a design capacity of 15 million gallons per day (mgd), or 23 cfs. This is the only diversion on City Creek, as Salt Lake City asserts water rights to 100% of the flow. Salt Lake City's mean monthly diversion rate from City Creek to the water treatment plant is shown in Figure 4.6.3.

The flow in City Creek rises gradually during April and May to the peak and then gradually recedes in June and July to base flow conditions. A flow duration analysis was conducted on the mean daily flow records from 1980 through 2005 for the gage located at Memory Grove Park (Figure 4.6.4). For 56.6% of the time, the flow was at or below 2.0 cfs, which is the detection limit for the City Creek gage.

City Creek, Upper City Creek Sub-watershed

### *Red Butte Creek*


Red Butte Creek Watershed

General Watershed Description The Upper Red Butte Creek Sub-Watershed has a drainage area of 5,403 acres comprised of moderately steep mountain slopes with an elevation range from 5,000 to 8,200 feet.

The United States Forest Service (USFS) owns 83 percent of the sub-watershed, with the remainder owned by Salt Lake City and private individuals (Bear West Consulting Team, 1999). The USFS has designated much of the sub-watershed as the Red Butte Research Natural Area (RNA). The Red Butte RNA is managed for non-manipulative research, observation, and study, with public access limited to these purposes (USFS, 2003).

The Lower Red Butte Creek sub-watershed has a drainage area of 1,652 acres comprised of the mountain/valley interface area below the canyon outlet. The land use within the sub-watershed is comprised primarily of the University of Utah campus and Research Park, and single-family residential neighborhoods.

Ecology The DWQ designated beneficial use for aquatic life for Red Butte Creek above the reservoir is Class 3A, which is protected for cold-water species of game fish and other cold water aquatic life (Tooele, 2002). DWQ has not designated a beneficial use to Red Butte Creek downstream of the reservoir.

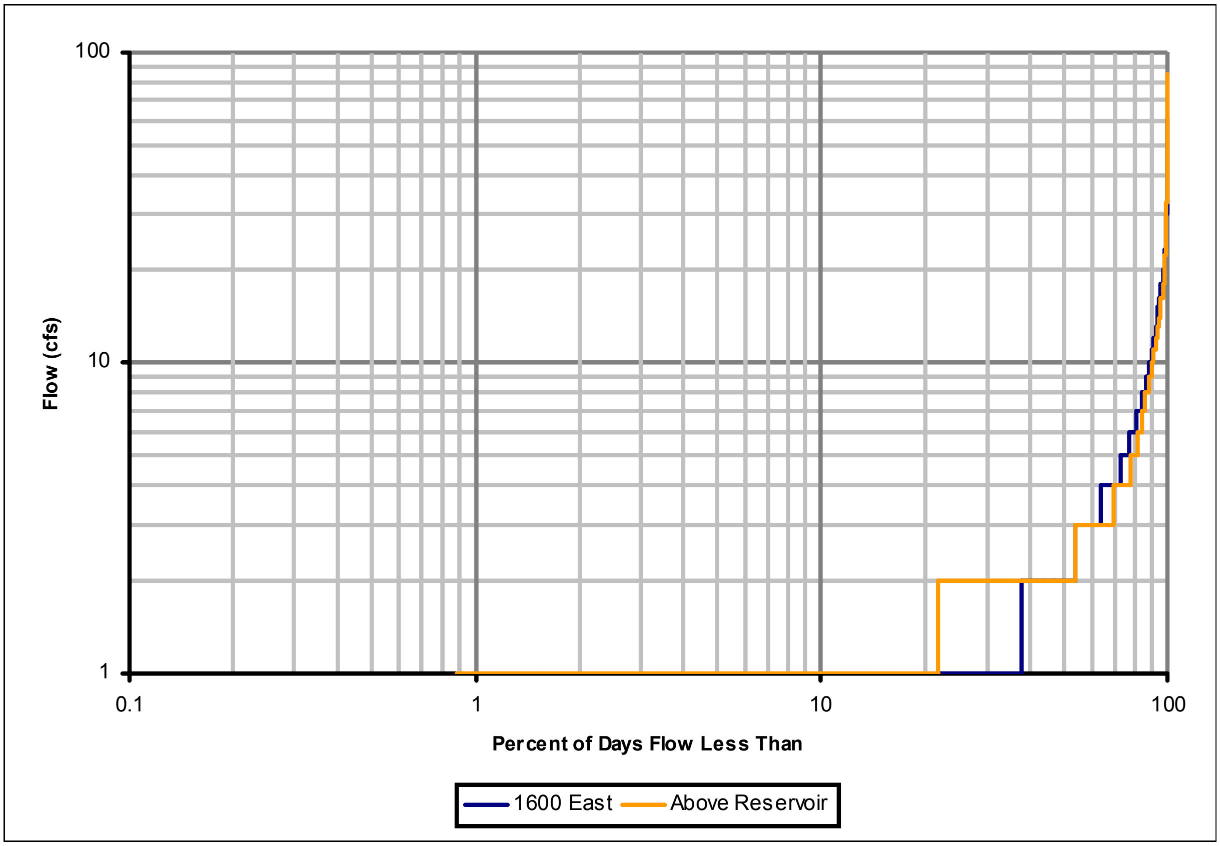
The DWR sport fish management class for Red Butte Creek above the reservoir is 3, which is considered a good trout fishery. The HQI productivity for the stream above the reservoir is 75 lb/acre (Thompson et al., 2003). The DWR sport fish management class for Red Butte Creek below the reservoir is 5, which is considered of little value as a fishery. Currently, the reservoir in Upper Red Butte Sub-Watershed is being used as a nursery for the June Sucker. Therefore, some fish may spawn upstream.


Red Butte Creek, Lower Red Butte Creek Sub-Watershed

The native fish species in Red Butte Creek above the reservoir is Bonneville cutthroat trout and no introduced fish species are present. Red Butte Creek below the reservoir does not have any native or non-native fish species (Thompson et al., 2003).

Recreation The DWQ designated beneficial use for recreation and aesthetics for Red Butte Creek above the reservoir is Class 2B, which is protected for secondary contact recreation such as boating or wading (Toole, 2002). DWQ has not designated a beneficial use to Red Butte Creek downstream of the reservoir.

Hydrology Red Butte Creek is classified as a perennial stream. Below the Red Butte Reservoir, the flow is reduced due to the management of releases from the reservoir and downstream diversions for irrigation purposes. Red Butte Creek enters a piped system near 1100 East that combines with the 1300 South conduit downstream and conveys flow to the Jordan River.




*Flow gauges located above the reservoir USGS 10172200 for the period 10/1/1963 – 9/30/2003) and at 1600 East (SLCo 740/USGS 10172300 for the period 3/10/1984 – 9/30/2005*

**Figure 4.6.5 Flow Duration Curves for Red Butte Creek**

The Red Butte Reservoir, which covers about 10 acres, is fed by Red Butte Creek. Red Butte Reservoir was built in 1930 at the base of Red Butte Canyon approximately 1.5 miles east of the University of Utah. Originally constructed as a water supply reservoir for Fort Douglas, in 1991 the fort switched to the municipal water supply from Salt Lake City (CUWCD, 2005). Until recently, the reservoir was in federal ownership and was managed by the United States Forest Service as part of the protected RNA.

In 2004, the ownership and management responsibility for the reservoir was transferred to the Central Utah Water Conservancy District (CUWCD). Currently, operation and management of the reservoir focuses on providing a long-term refuge for the endangered June sucker. There is no written protocol for management of the water level and outflows from the reservoir; however, the general policy is to maintain the reservoir between 5,360 feet and 5,365 feet elevation and match outflows to inflows (Crofts, 2007). CUWCD uses the USGS gauge above the reservoir to determine inflows and has a flow meter in their discharge line.

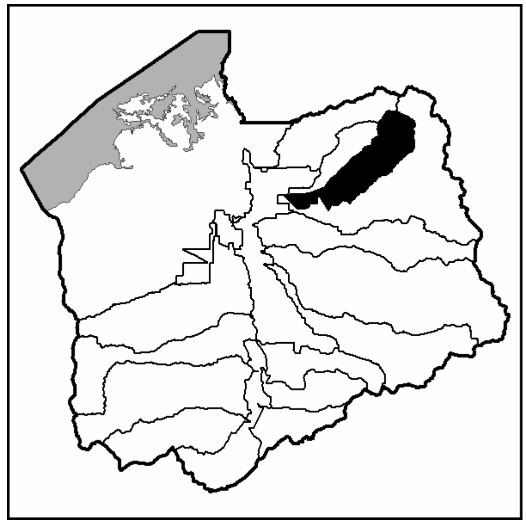
Historically, Red Butte Creek was diverted below the reservoir for potable and irrigation water supply to Fort Douglas. This diversion was discontinued in 1991 when Fort Douglas was connected to the Salt Lake City water supply system.

Red Butte Creek naturally loses flow to groundwater between the canyon mouth and approximately 1600 East. The average monthly channel losses in this reach for the water years 1964 - 1968 varied from 0.2 cfs from August through November to 2.3 cfs in May (Hely et al., 1971). The stream losses vary with flow magnitude, flow duration and stream substrate composition. Below 1600 East, Red Butte Creek gains flow from groundwater.

Red Butte Creek flows into Liberty Park Pond, an inline flood detention basin with a 19.7 af capacity that regulates outflows to the 1300 South conduit. Of note, flow can be re-directed around Liberty Park, thus by-passing the detention pond in the Park.

Red Butte Creek stream flows primarily result from snowmelt. The flow in Red Butte Creek attains its seasonal peak on average on April 30, the earliest peak of any of the Wasatch sub-watersheds (Coon King and Knowlton et al., 1982). A flow duration analysis was conducted on the mean daily flow records from 1963 through 2005 for the gage located immediately above the reservoir and below the reservoir at 1600 East (Figure 4.6.5). The flow was at or below 1.0 cfs for 21.5% of the time above the reservoir and 37.5% of the time at 1600 East; however, these values vary greatly between reports.

*Emigration Creek*

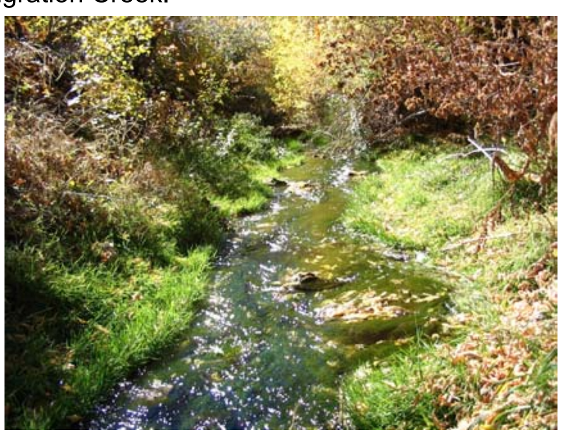


Emigration Creek Watershed

General Watershed Description The Upper Emigration Creek Sub-Watershed has a drainage area of 11,635 acres comprised of moderately steep mountain slopes with an elevation range from 5,000 to 8,900 feet. The land use in the sub-watershed is primarily comprised of full-time residential with limited commercial.

The Lower Emigration Creek sub-watershed has a drainage area of 3,742 acres comprised of the bench area below the canyon outlet. The land use within the sub-watershed is comprised primarily of a heritage park and zoo, commercial development and single-family residential neighborhoods.

Ecology The DWQ designated beneficial use for aquatic life for Upper Emigration Creek is Class 3A, which is protected for cold-water species of game fish and other cold water aquatic life (Tooele, 2002). DWQ has not designated a beneficial use to Lower Emigration Creek.



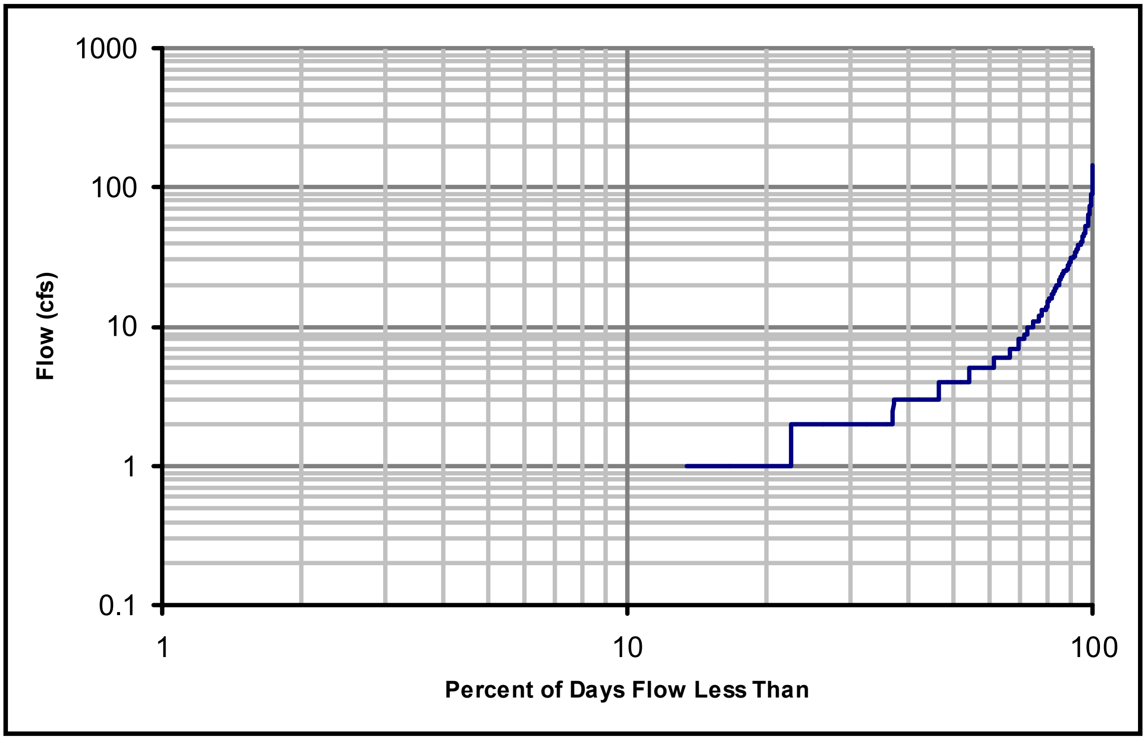
Emigration Creek, Upper Emigration Creek Sub-Watershed

The DWR sport fish management class for Upper Emigration Creek is 3, which is considered a good trout fishery. The HQI productivity for the stream above the reservoir is 112 to 320 lb/acre (Thompson et al., 2003). The DWR sport fish management class for Lower Emigration Creek is 4, which is considered of limited value as a fishery.

The native fish species in Upper Emigration Creek is Bonneville cutthroat trout and introduced fish species are rainbow trout and rainbow trout–cutthroat trout hybridization. Lower Emigration Creek has native Bonneville cutthroat trout and does not have non-native fish species (Thompson et al., 2003).

Recreation The DWQ designated beneficial use for recreation and aesthetics for Upper Emigration Creek is Class 2B, which is protected for secondary contact recreation such as boating or wading (Toole, 2002). DWQ has not designated a beneficial use to Lower Emigration Creek. Although the designated beneficial use is Class 2B, watershed specific ordinances restrict many recreational activities in the stream channel within the protected watershed boundary.

Hydrology Emigration Creek is classified as intermittent in the upper portion of the canyon and as a perennial stream in the lower portion of the canyon. Through the valley, the flow is reduced due to diversions for irrigation and water supply purposes. Emigration Creek enters a piped system near 1100 East that combines with the 1300 South conduit downstream and conveys flow to the




*Stream gauge located at the canyon mouth (SLCo 620/USGS 10172000) for the period 10/1/1980 – 2/31/2005*

**Figure 4.6.6 Mean Daily Flow Duration Curve for Emigration Creek**

Jordan River. Burr Fork, a tributary in the upper portion of the canyon, is classified as intermittent.

The water rights holders in Emigration Canyon include Salt Lake City Public Utilities, private water companies and numerous individual property owners. The water sources are from springs, tunnels and wells. There are a limited number of diversions directly from the creek in the canyon.

The houses and businesses in Emigration Canyon are typically on septic systems that provide some return flows to the creek.

Emigration Creek naturally loses flow to groundwater between the canyon mouth and approximately 1300 East. The average monthly channel losses in this reach for the water years 1964 - 1968 varied from 0.7 cfs from November through January to 3.3 cfs in May (Hely et al., 1971). The stream losses vary with flow magnitude, flow duration and stream substrate composition. Below 1300 East, Emigration Creek gains flow from groundwater.

Emigration Creek, Upper Emigration Creek Sub-Watershed

Several individuals have water rights to surface water from the creek below the canyon mouth. The

Mount Olivet Cemetery diverts water from Emigration Creek near Hogle Zoo for irrigation purposes.

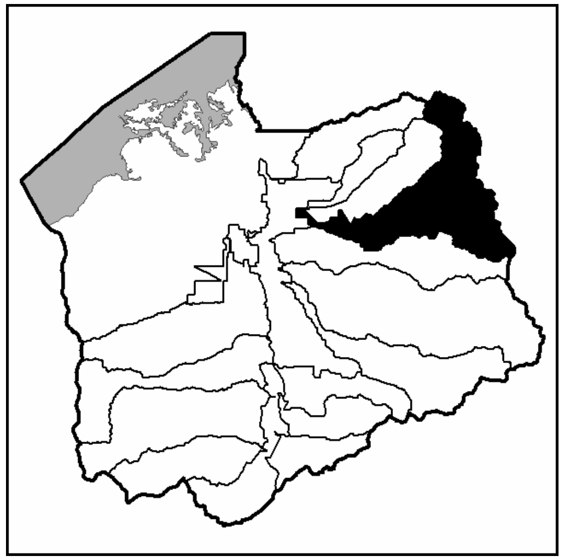
Emigration Creek typically flows into Liberty Park Pond, an inline flood detention basin with a 19.7 af capacity that regulates outflows to the 1300 South conduit. However, the detention basin can be by-passed.

Snowmelt is the primary component of stream flow in Emigration Creek. The flow in Emigration Creek typically attains its seasonal peak on average on May 1 (Coon King and Knowlton Engineers et al., 1982); however, this can vary. A flow duration analysis was conducted on the mean daily flow records from 1980 through 2005 for the gauge located at the canyon mouth (Figure 4.6.6). The flow was at or below 3.0 cfs for 4.1% of the time.

*Parley's Creek*

General Watershed Description The Upper Parley's Creek sub-watershed has a drainage area of 33,271 acres comprised of moderate to steep mountain slopes with an elevation range from 4,700 to 9,400 feet. The headwaters of the sub-watershed are subdivided into two canyons, Mountain Dell Canyon and Lambs Canyon.

Mountain Dell Canyon drains into the Little Dell Reservoir, which outfalls to the Mountain Dell Reservoir. Lambs Canyon drains into Parley's Creek above the Mountain Dell Reservoir. There is a flow diversion from Parley's Creek just downstream of the confluence with Lambs Canyon that conveys water to Little Dell Reservoir. Immediately downstream of the Mountain Dell Reservoir is the Parley's Water Treatment Plant, which is owned and operated by Salt Lake City Public Utilities.


Parley's Creek Watershed


Parley's Creek, Upper Parley's Creek Sub-Watershed

The land use in the sub-watershed is primarily as a transportation corridor for I-80, with summer homes in Mount Aire and Lambs Canyon and developed recreational facilities including golf and picnicking. The vegetation in the higher elevations is mostly conifer and aspen, with scrub oak and grasses in the lower elevations.

The Lower Parley's Creek sub-watershed has a drainage area of 4,112 acres comprised of the valley below the canyon outlet. The land use within the sub-watershed is comprised primarily of commercial development and single-family residential neighborhoods.

Ecology The DWQ designated beneficial use for aquatic life for Parley's Creek is Class 3A, which is protected for cold-water species of game fish and other cold water aquatic life (Toole, 2002).

The DWR sport fish management class for Lambs Creek, Mountain Dell Creek and Parley's Creek is 3, which is considered a good trout fishery. The HQI productivity is 56 lb/acre for Lambs Creek above the confluence with the Right Fork, 51 to 124 lb/acre for Mountain Dell Creek and 110 lb/acre for Parley's Creek (Thompson et al., 2003).

The native fish species in Lambs Creek, Mountain Dell Creek and Parley's Creek is Bonneville cutthroat trout. Introduced fish species in Mountain Dell Creek are brook trout (Thompson et al., 2003).

Recreation The DWQ designated beneficial use for recreation and aesthetics for Parley's Creek is Class 2B, which is protected for secondary contact recreation such as boating or wading (Toole, 2002). Although the designated beneficial use is Class 2B, watershed specific ordinances restrict many recreational activities in the stream channel within the protected watershed boundary.

Hydrology Parley's Creek, Mountain Dell Creek and Lambs Creek are classified as perennial. Below the water supply diversion located approximately 1.5 miles upstream of Mountain Dell Reservoir, the flow in Parley's Creek is reduced. Below Mountain Dell Reservoir, Parley's Creek is categorized as reduced. Parley's Creek is conveyed in sections of open channel and underground conduit below Mountain Dell Reservoir to the mouth of the canyon. The stream flows through an open channel through the valley before entering a piped system near 1300 East that combines with the 1300 South Conduit downstream and conveys flow to the Jordan River.

Construction on Mountain Dell Reservoir was originally completed in 1917 and the dam was raised in 1924. The reservoir has a storage capacity of 2,500 af that is used for potable water supply, with an additional 1,000 af reserved for flood storage. The Salt Lake City Department of Public Utilities operates and maintains the reservoir for potable water supply and flood control purposes.

In 1993, the Army Corps of Engineers completed construction on the Little Dell Reservoir, located approximately 1.5 miles upstream of Mountain Dell Reservoir on Mountain Dell Creek. The reservoir has a storage capacity of 20,500 af that is allocated to flood control, water supply and recreational benefits. The Salt Lake City Department of Public Utilities operates and maintains the reservoir for potable water supply and flood control purposes.

A permanent storage of 1,000 af and 3,000 af is reserved for flood control in Mountain Dell Reservoir and Little Dell Reservoir, respectively. A variable flood control storage up to 18,500 af is maintained between February 15 and June 30 based on snowmelt runoff predictions (Army Corps of Engineers, 1993).

The maximum release rate, except during emergencies, below Little Dell Reservoir and Mountain Dell Reservoir is 300 cfs. In addition, flows should not exceed 400 cfs at the 1300 South Street conduit. These maximum release rates are intended to be at or below the channel capacity and thereby prevent overbank flooding. The maximum rate of change of release for flood control is 50 cfs per hour in order to prevent floodplain damage, bank erosion and sloughing (Army Corps of Engineers, 1993).

The US Fish and Wildlife Service requires that a minimum flow of 5.0 cfs be maintained below the Parley's Creek diversion structure, located approximately 1.5 miles upstream of Mountain Dell Reservoir on Parley's Creek, in order to prevent any loss of fisheries resources. The diverted water is conveyed by pipeline to Little Dell Reservoir.

Salt Lake City Public Utilities maintains and operates the Parley's Water Treatment Plant, with a design capacity of 38 mgd (59 cfs). This is the primary diversion on Parley's Creek, as Salt Lake City holds water rights to 100% of the flow. Salt Lake City's mean monthly diversion rate from Parley's Creek to the water treatment plant is shown in Figure 4.6.7.

Parley's Creek naturally loses flow to groundwater between the canyon mouth and approximately 1300 East. The average monthly channel losses in this reach for the water years 1964 - 1968 varied from 1.4 cfs in February to 7 cfs in July (Hely et. al., 1971). The stream losses vary with flow magnitude, flow duration and stream substrate composition. Below 1300 East, Parley's Creek gains flow from groundwater.

There are water users below the mouth of the canyon. They receive water from Salt Lake City through exchange agreements. The exchange agreements allow water from the canyon to be diverted for municipal supply and be replaced with water from Utah Lake or other sources. Exchanges of water typically occur from April through October.

Sugar House Park Pond is an inline flood detention basin with a 140 af capacity that regulates flows in Parley's Creek downstream from Sugar House Park to the 1300 South conduit.

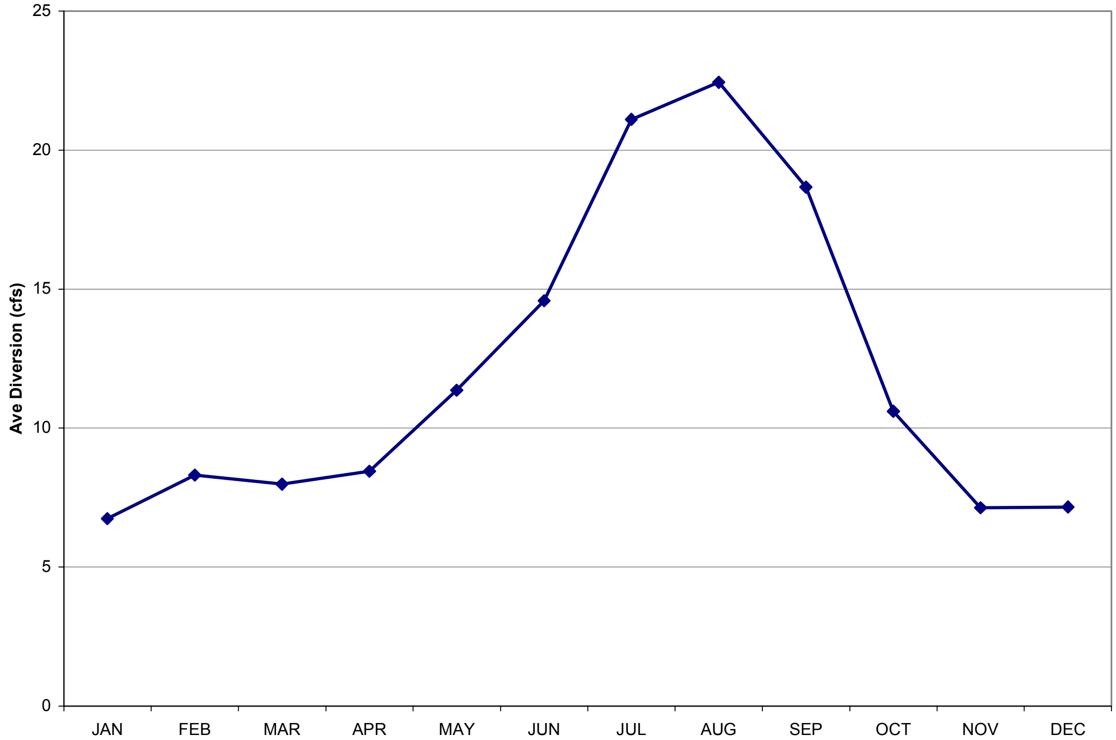
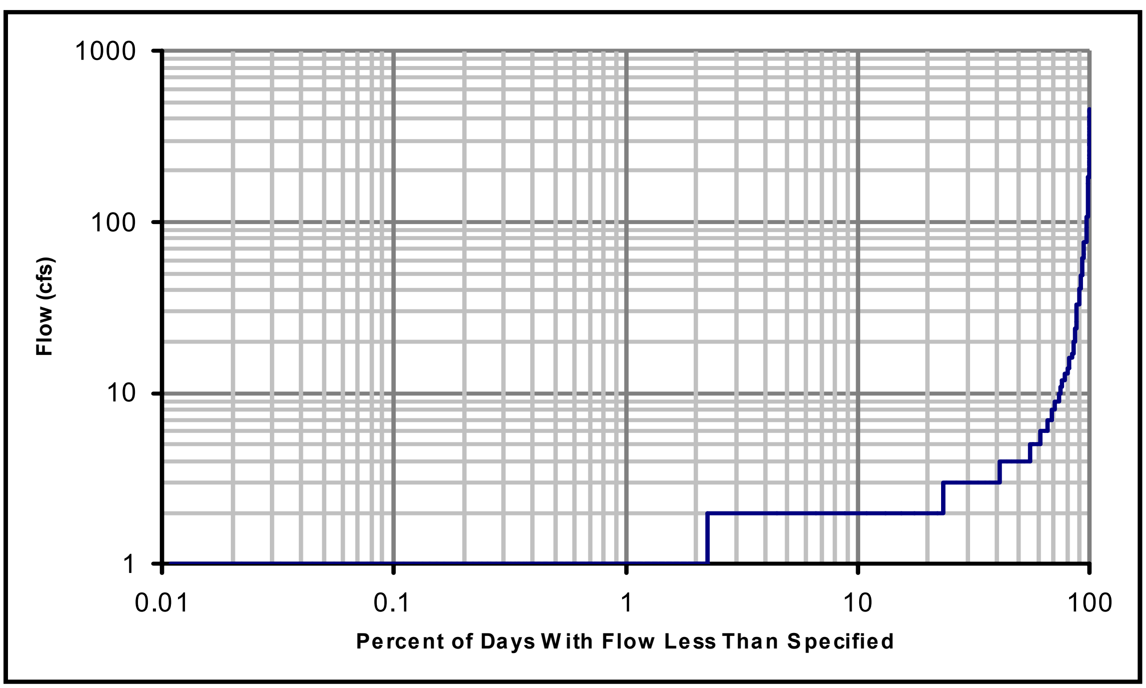


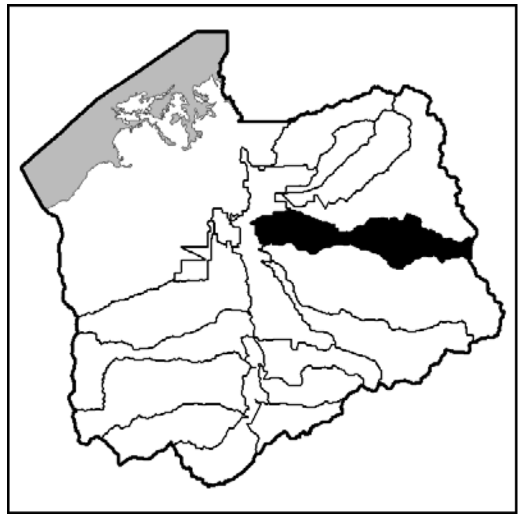

**Figure 4.6.7 Mean Monthly Flow Diversion from Parley's Creek to the Parley's Water Treatment Plant (1986-2005)**




*Stream gauge located at Suicide Rock (SLCo 520/USGS 10171600) for the period 10/1/1980 – 12/31/2005*

**Figure 4.6.8 Mean Daily Flow Duration Curve for Parley's Creek**

Snowmelt is the primary component of stream flow in Parley's Creek. The flow in Parley's Creek attains its seasonal peak on average on May 12 (Coon, King & Knowlton Engineers et al., 1982). A flow duration analysis was conducted on the mean daily flow records from 1980 through 2005 for the gauge located at the Suicide Rock (Figure 4.6.8). The flow was at or below 1.0 cfs for 2.2% of the time.



Mill Creek Watershed

*Mill Creek*

General Watershed Description The Upper Mill Creek sub-watershed has a drainage area of 13,915 acres comprised of steep mountain slopes with an elevation range from 5,100 to 10,200 feet. The primary land use in Upper Mill Creek Sub-Watershed is managed forest land for recreational use, including hiking, biking, picnicking, fishing and cross-country-skiing. There are a limited number of summer residences in the canyon, two year-round restaurants and an extensive area used by the Boy Scouts of America.

The Lower Mill Creek Sub-Watershed has a drainage area of 15.2 square miles (23,644 acres) through the Salt Lake valley. The Lower Mill Creek Sub-Watershed has a drainage area of 9,729 acres. Lower Mill Creek is highly urbanized, with primarily residential land use. Increased commercial and industrial uses occur on the east bench and closer to the Jordan River.

Total Mill Creek watershed drainage area is 9,729 acres.

Ecology The DWQ designated beneficial use for aquatic life for Mill Creek is Class 3A, which is protected for cold-water species of game fish and other cold water aquatic life (Tooele, 2002). The reach of Mill Creek downstream of I-15 is designated as Class 3B, which is protected for warm water species of game fish and other warm water aquatic life.

Mill Creek, Upper Mill Creek Sub-Watershed

DWR divides Mill Creek into four reaches. A summary of the fisheries classification is presented in Table 4.6.2 (Thompson et al., 2003). There are no fish in DWR Reach 2, from the canyon mouth to Highland Drive (Thompson et al., 2003).

Recreation The DWQ designated beneficial use for recreation and aesthetics for Mill Creek is Class 2B, which is protected for secondary contact recreation such as boating or wading (Toole, 2002). Although the designated beneficial use is Class 2B, watershed specific ordinances restrict many recreational activities in the stream channel within the protected watershed boundary.

Hydrology Mill Creek is classified as a perennial stream. The stream flow is reduced for part of the year through the valley due to irrigation diversions. Mill Creek enters the Jordan River in the vicinity of 2900 South.

Salt Lake City owns the vast majority of water rights in Mill Creek Canyon. In addition, several water companies and individuals own water rights in the canyon. The source of water for the users in the canyon is from springs and wells. There are no significant flow diversions directly from the creek upstream of the canyon mouth.

### Table 4.6.2 DWR Fisheries Summary for Mill Creek

| Reach | Downstream Boundary | Length (miles) | Management Class | Productivity (lb/ac) | Native Fish | Introduced Fish |
|---|---|---|---|---|---|---|
| 4 | DS Elbow Fork Road | 3.6 | 3 | 53 | | RT, CT |
| 3 | Canyon Mouth | 8.8 | 3 | 34 | | BN, CT, RT |
| 2 | Highland Drive | 2.6 | 6 | | | |
| 1 | Jordan River | 3.4 | 4 | | CBUT, DCLN, SKMT, SKUT | BN, CPCO, RT |

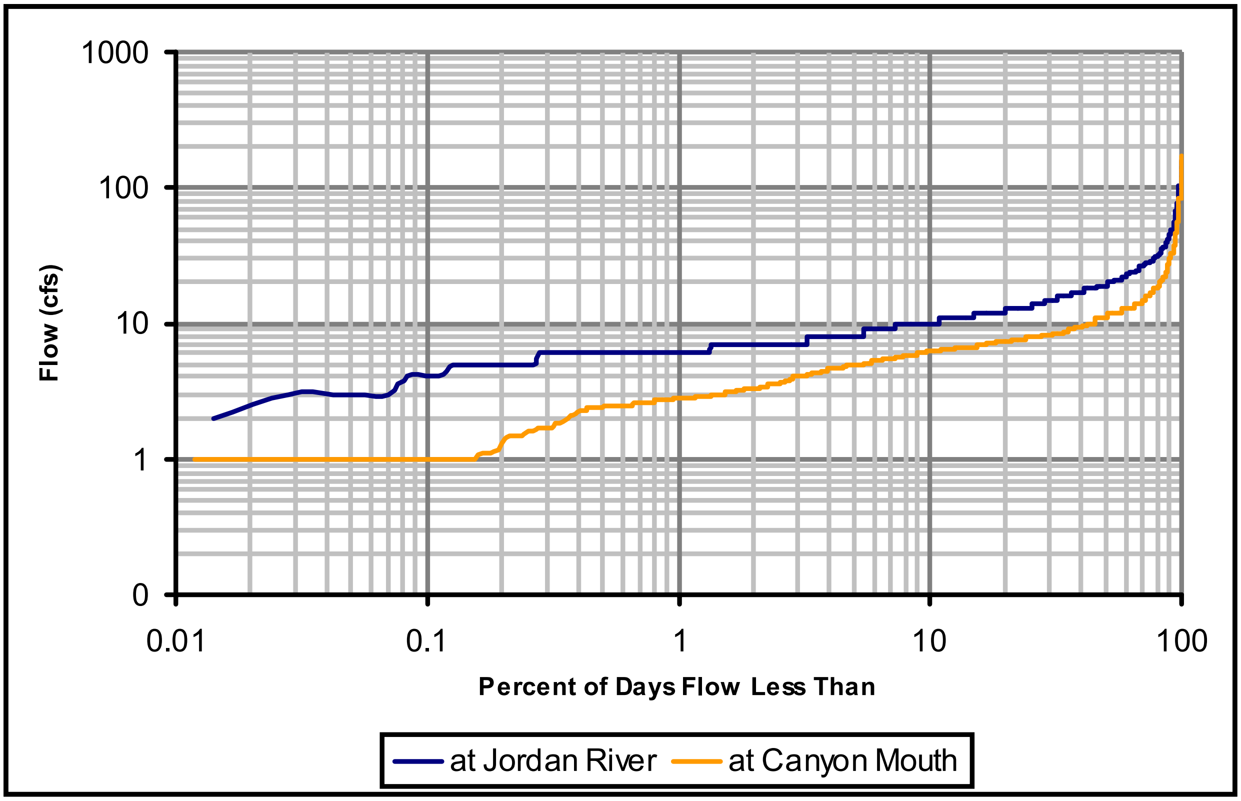
BK: Brook trout; BN: Brown trout; CPCO: Common carp; DCLN: Longnose dace; DCSP: Speckled Dace; RT: Rainbow trout; SKMT: Mountain sucker; SKUT: Utah sucker

### Table 4.6.3 Mill Creek Water Rights per the Morse Decree #4449, 8/1/1913

| Stream Flow Range[1] | Primary | Secondary | Surplus |
|---|---|---|---|
| | 2.3875 - 29.03 cfs | 29.03 - 41.93 cfs | >41.93 cfs |
| **User** | **Proportion of Available Streamflow (%)** | | |
| First Ditch | 9.83 | 13.05 | 29.46 |
| Osguthorpe & Skidmore Ditch | | | |
| Chamberlain Ditch | | | |
| Stillman and Russell Ditch | | | |
| Stillman and Hussy Ditch | | | |
| Tripp Ditch | | | |
| East Mill Creek Water Company | 33.12 | 36.32 | 29.86 |
| Franklin and John Neff Ditch | | | |
| Amos H. Neff Ditch | | | |
| Brigham Young Ditch | | | |
| Lower Mill Creek Irrigation Co. | 36.8215 | 31.13 | 25.02 |
| Hoagland and Murphy Ditch | | | |
| White Ditch | 8.3333 | 8.81 | 7.08 |
| Wasatch Lawn Cemetery | 4.8542 | 4.11 | 3.3 |
| Kellar Ditch | 7.05 | 6.58 | 5.28 |
| **Total** | **100** | **100** | **100** |

*1:* First 2.3875 cfs of stream flow dedicated to "House Use Rights".

*Source: Adapted from Eckhoff Watson and Preator, 1990*




*Stream gauges located at Canyon Mouth (SLCo 420/USGS 10169999) for the period 10/1/1980 – 9/30/2004 and Mill Creek at Jordan River (SLCo 490/USGS 10170250) for the period 1/1/1980 – 9/30/2005*

**Figure 4.6.9 Mean Daily Flow Duration Curves for Mill Creek**

Mill Creek naturally loses flow to groundwater between the canyon mouth and approximately 2200 East. The average monthly channel losses in this reach for the water years 1964 - 1968 varied from 1.8 cfs in September to 2.9 cfs in June (Hely et al., 1971). The stream losses vary with flow magnitude, flow duration and stream substrate composition. Below 2200 East, Mill Creek gains flow from groundwater.

Salt Lake City has obtained rights to most of the flow in Mill Creek through exchange agreements with irrigation companies and individuals. The exchange agreements allow water from the canyon to be diverted for municipal supply and be replaced with water from Utah Lake or other sources. Exchanges of water typically occur from April through October. Salt Lake City has not fully developed all of the water rights it owns in the Mill Creek watershed.

The Mill Creek stream flow is diverted for irrigation purposes at several locations through the valley reach (Figure 4.6.9). The Morse Decree (File #4449, 8/1/1913) confirmed the rights to water in Mill Creek. The proportion of stream flow granted to each water right holder is summarized in Table 4.6.3.

Below the Chamberlain Ditch irrigation diversion, the stream flow is reduced for part of the year. The stream flow is 100% allocated and therefore could be completely dewatered by the White Ditch point of diversion; however, no flow gauge data was available to verify flow rates immediately below the irrigation diversions.

Salt Lake City Public Utilities discharges water from the Upper Canal and the Jordan and Salt Lake Canal to Mill Creek to fulfill the obligations of the exchange agreements. Surplus water, irrigation return flows and stormwater from these canals are also discharged to Mill Creek.

The Central Valley Water Reclamation Facility (CVWRF) discharges to Mill Creek approximately 3,000 feet upstream of the confluence with the Jordan River. The CVWRF has a design capacity of

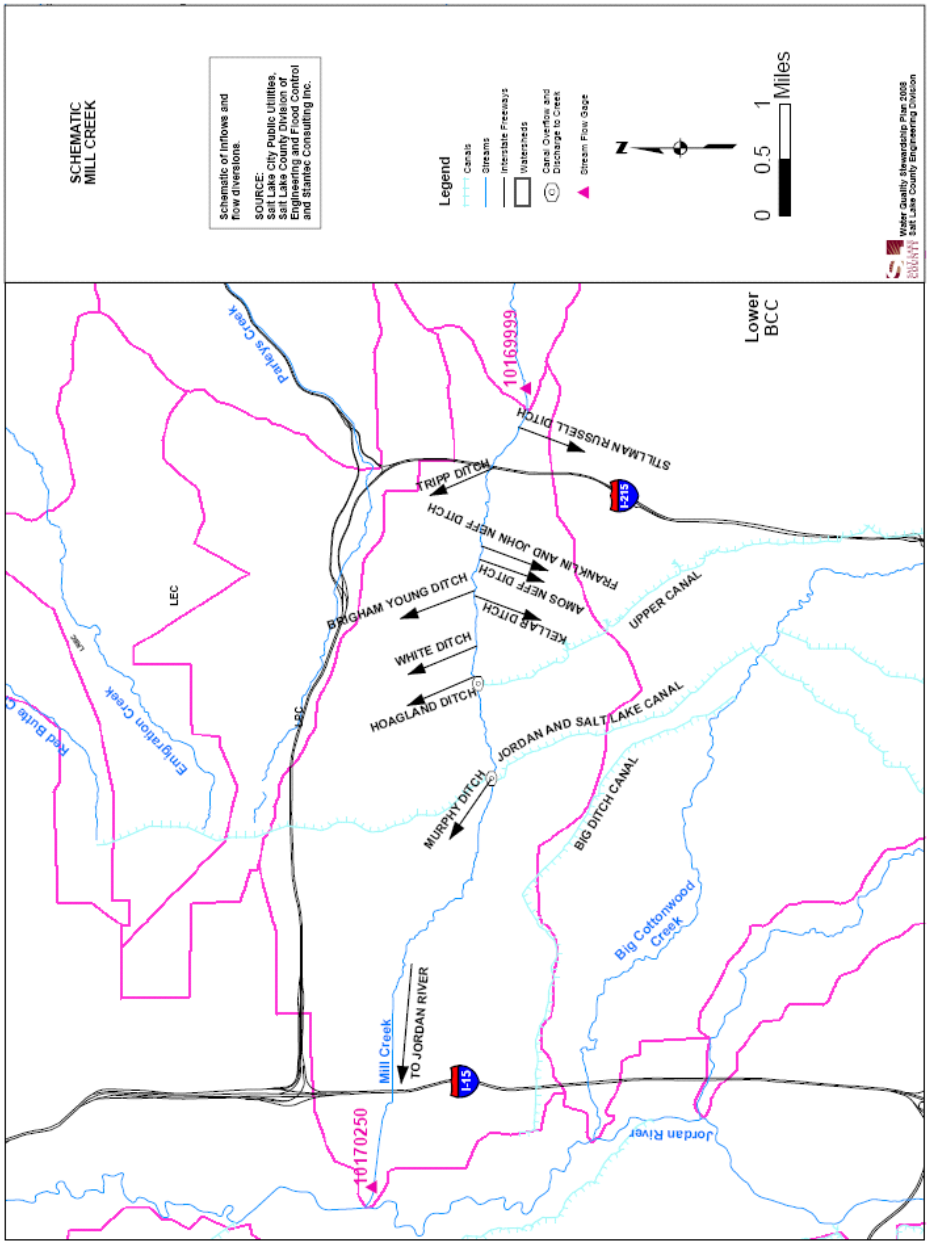



Figure 4.6.10 Schematic of Mill Creek Diversions

75 mgd (116 cfs) and currently receives an average daily flow of 50 mgd (77 cfs). The Mill Creek gauge (SLCo 490/USGS 10170250) measures flow above the CVWRF discharge.

The hydrology of Mill Creek is snowmelt dominated from April through July with base flow the remainder of the year. A flow duration analysis was conducted on the flow records from 1980 through 2005 for the gauges located at the Canyon Mouth and near the confluence with the Jordan River (Figure 4.6.10). The flow was at or below 1.0 cfs at the canyon mouth for 0.1% of the time and never below 1.0 cfs at the Jordan River above the Central Valley Water Reclamation Facility. It is unknown what portion of the flow at the lower gage is constituted by exchanged sources during the irrigation season.

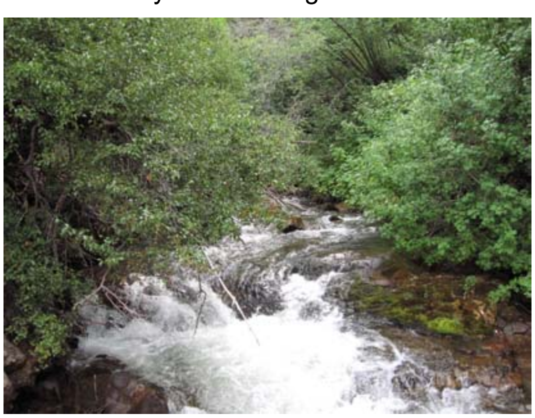
*Big Cottonwood Creek*

General Watershed Description The total Big Cottonwood Creek watershed drainage area is 52,203 acres. The Upper Big Cottonwood Creek Sub-Watershed has a drainage area of 31,955 acres comprised of steep mountain slopes with an elevation range from 5,000 to 10,500 feet. The primary land use in Upper Big Cottonwood Creek Sub-Watershed is managed forest land for recreational use, including hiking, biking, camping, picnicking, fishing, and downhill and cross-country skiing. There are part-time and year-round residences, two ski resorts and lodging in the canyon.

The Lower Big Cottonwood Creek sub-watershed has a drainage area of 20,248 acres through the Salt Lake Valley. Lower Big Cottonwood Creek

Big Cottonwood Creek Watershed

sub-watershed drainage area includes Neffs Canyon (2,240 acres), Tolcats Canyon (512 acres), Heughes Canyon (1,216 acres) and Ferguson Canyon (832 acres). Lower Big Cottonwood Creek is highly urbanized, with primarily residential land use. Increased commercial and industrial uses occur near I-15 and I-215.



Big Cottonwood Creek, Upper Big Cottonwood Creek Sub-Watershed

Ecology The DWQ designated beneficial use for aquatic life for Big Cottonwood Creek is Class 3A, which is protected for cold-water species of game fish and other cold water aquatic life (Toole, 2002).

DWR divides Big Cottonwood Creek into seven reaches. A summary of the fisheries classification is presented in Table 4.6.4 (Thompson et al., 2003).

Recreation The DWQ designated beneficial use for recreation and aesthetics for Big Cottonwood Creek is Class 2B, which is protected for secondary contact recreation such as boating or wading (Toole, 2002). Although the designated beneficial use is Class 2B, watershed specific ordinances restrict many recreational activities in the stream channel within the protected watershed boundary.

*Hydrology* Big Cottonwood Creek is classified as a perennial stream. From the intake to the Stairs Power Plant at Storm Mountain in the canyon, to the intake to the Water Treatment Plant, the flow is reduced due to the diversion for hydroelectric power generation. From the Water Treatment Plant intake to the East Jordan Canal Extension, the flow is interrupted for part of the year. Below the East Jordan Canal Extension, the flow is reduced with the

**Table 4.6.4 DWR Fisheries Summary for Big Cottonwood Creek**

| Reach | Downstream Boundary | Length (miles) | Management Class | Productivity (lb/ac) | Native Fish | Introduced Fish |
|---|---|---|---|---|---|---|
| 7 | Camp Tuttle Road | 1.4 | 3 | 5 | | BK |
| 6 | Solitude Entrance 1 | 6.8 | 2 | 155 | | BK, BN |
| 5 | DS Blind Miners Mine | 6.0 | 3 | 126 | | BK, BN, RT |
| 4 | US Elbow Fork Creek | 0.8 | 5 | 3 | | BN, RT |
| 3 | Stairs Power Plant | 2.0 | 3 | 69 | | BN, RT |
| 2 | Canyon Mouth | 2.0 | 6 | | | |
| 1 | Jordan River | 7.0 | 4 | | DCLN, DCSP, SKMT, SKUT | BN, CPCO |

BK: Brook trout; BN: Brown trout; CPCO: Common carp; DCLN: Longnose dace; DCSP: Speckled Dace; RT: Rainbow trout; SKMT: Mountain sucker; SKUT: Utah sucker

addition of exchange waters. Big Cottonwood Creek enters the Jordan River in the vicinity of 4170 South.

Salt Lake City owns and operates two reservoirs that impound water in the headwaters portion of Big Cottonwood Creek (DWR, 1997). Twin Lakes Reservoir was constructed in 1914 and has a capacity of 486 af. Lake Mary Reservoir was constructed in 1915 and has a capacity of 85 af.

Salt Lake City owns the vast majority of water rights in Big Cottonwood Canyon. The water users in the canyon include the Brighton and Solitude ski areas, Solitude Village, private water companies and numerous individual property owners. Salt Lake City provides water to the users in the canyon under surplus water agreements. The surplus water agreements obligate Salt Lake City to provide water only after the demands of the water users in the valley are met. Salt Lake City has historically always been able to provide water to the users in the canyon.

The water sources in the canyon are from springs, tunnels and wells. There are a limited number of diversions directly from the creek in the canyon. Solitude Ski Resort withdraws water from Big Cottonwood Creek for snowmaking purposes during the ski season. Per the Environmental Impact Statement for the Solitude Ski Resort Master Plan Update, the ski resort is required to maintain a minimum instream flow of 2.1 to 2.8 cfs in Big Cottonwood Creek below the Lower Parking Lot during snowmaking activities.

Wastewater is conveyed down the canyon in a sewer main.

Water was originally diverted by Salt Lake City for municipal water supply with the construction of the Big Cottonwood Creek diversion works and conduit in 1907. The conduit conveyed water from Big Cottonwood Creek to the mouth of Parley's Canyon. The Big Cottonwood Creek Water Treatment Plant was subsequently put into service in 1957 and is owned and operated by Salt Lake City Department of Public Utilities. The current design capacity is 45 mgd (70 cfs).

Two power plants owned and operated by Rocky Mountain Power are located within the Upper Big Cottonwood Creek sub-watershed: Stairs Power Plant (1,200 KW capacity) and Granite Power Plant. Water is diverted at the Storm Mountain diversion dam and intake structure and conveyed through a 2,850 foot penstock to the Stairs Power Plant. Water from the Stairs Power Plant is conveyed to the Granite Power Plant via the Granite Flume.

The Stairs and Granite Power Plants are operated as run-of-river, defined when the inflow into the plant penstock is about equal to the outflow from the plant powerhouse. Excess water at the Storm Mountain diversion dam flows over the concrete spillway and into Big Cottonwood Creek.

Per Article 401 of the Federal Energy Regulatory Commission (FERC) license for the Stairs Hydroelectric Project (Project No. 597-003), a minimum of 4.0 cfs must be maintained in the bypassed reach of Big Cottonwood Creek (FERC 1999).

Water from the Granite Power Plant is conveyed to the adjacent Big Cottonwood Water Treatment Plant. In addition to the water from the power plant, the water treatment plant diverts water directly from Big Cottonwood Creek. Big Cottonwood Creek constitutes approximately 25% of Salt Lake City's municipal water supply. Salt Lake City's mean monthly diversion rate from Big Cottonwood Creek to the water treatment plant is shown in Figure 4.6.11.

Big Cottonwood Creek naturally loses flow to groundwater between the canyon mouth and approximately Cottonwood Lane. The average monthly channel losses in this reach for the water years 1964 - 1968 varied from 0.2 cfs in January to 23 cfs in June (Hely et al., 1971). The stream losses vary with flow magnitude, flow duration and stream substrate composition. Below Cottonwood Lane, Big Cottonwood Creek gains flow from groundwater.

Salt Lake City has obtained rights to most of the flow in Big Cottonwood Creek through exchange agreements with the irrigation companies. The exchange agreements allow water from the canyon to be diverted for municipal supply and be replaced with water from Utah Lake and other sources. Exchanges of water typically occur from April through October.

Neffs Creek, Tolcats Creek, Heughs Creek and Ferguson Creek enter the storm drain system before discharging to Big Cottonwood Creek. Some of the water from these tributaries is diverted for water supply purposes.

The stream flow from Big Cottonwood Creek is diverted for irrigation purposes at several locations

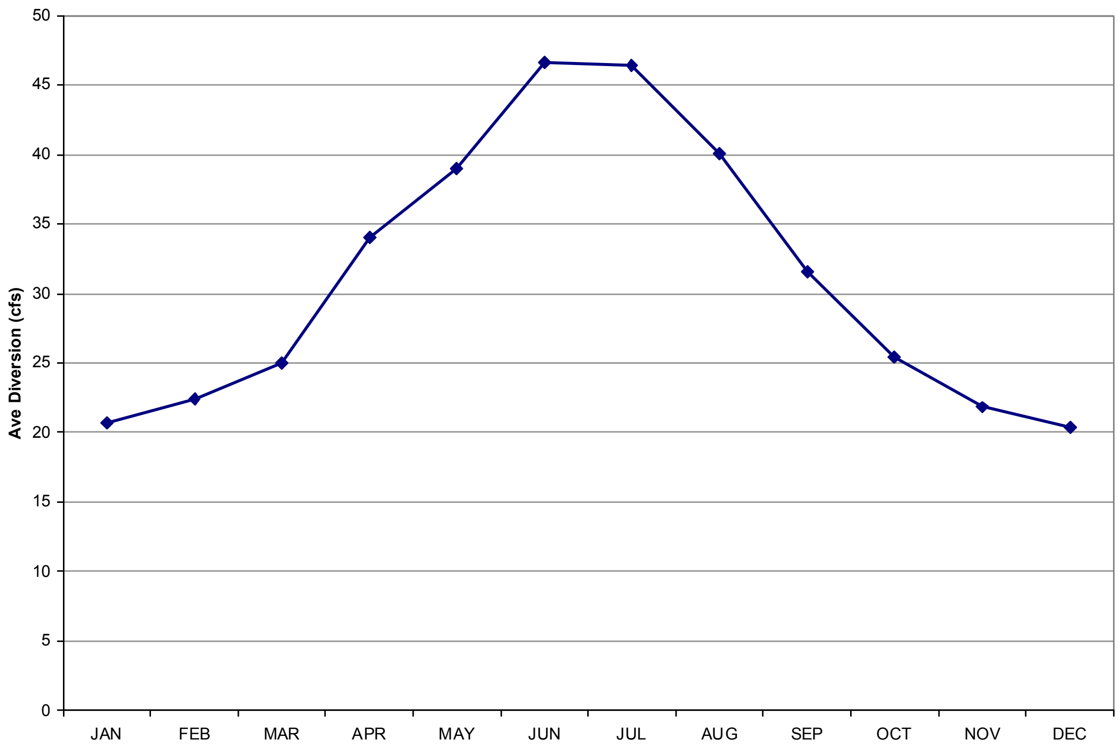


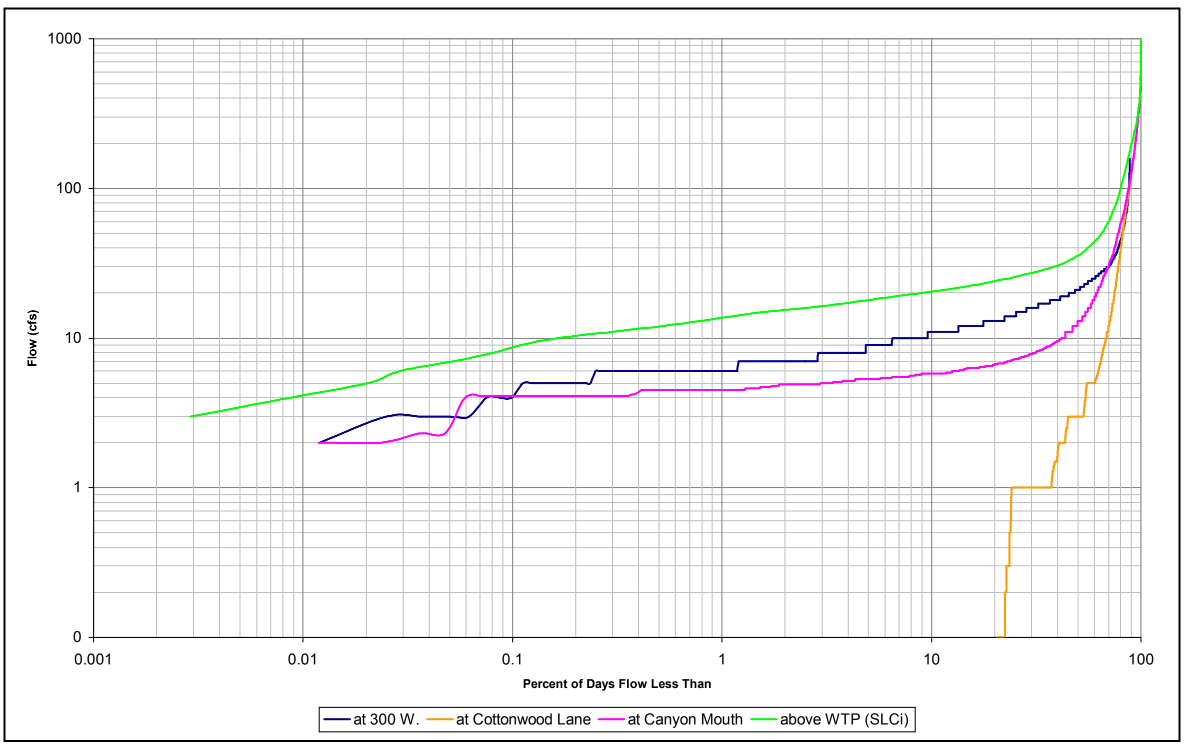

**Figure 4.6.11 Mean Monthly Flow Diversion from Big Cottonwood Creek (1986-2005)**

along the valley reach (Figure 4.6.12). A 30-inch diameter pressure line conveys exchange water from the East Jordan Canal Extension to the Upper Canal. The Tanner and Knudsen-Bagley Ditches also receive exchange water from the 30-inch pressure line. The Green and Walker Ditches receive exchange water from a groundwater well and the Farr-Harper Ditch relies upon groundwater accretion to Big Cottonwood Creek (O'Hara, 2007).

Salt Lake City Public Utilities discharges water from the East Jordan Canal Extension and the Jordan and Salt Lake Canal to Big Cottonwood Creek to fulfill the obligations of the exchange agreement for Big Ditch and Hill Ditch. Surplus water, irrigation return flows and stormwater from these canals are also discharged to Big Cottonwood Creek.

The hydrology of Big Cottonwood Creek is snowmelt dominated from April through July with base flow the remainder of the year. A flow duration analysis was conducted on the flow records from the gages located at the canyon mouth (located below the diversions for the power plant and water treatment plant), at Cottonwood Lane and near the confluence with the Jordan River (Figure 4.6.13). In addition, Salt Lake City provided a long term time series of stream flows above the water treatment plant. The mean daily flow duration curve shows that Big Cottonwood Creek at Cottonwood Lane was dewatered for 20.6% of the time and was at or below 1.0 cfs for 37.3% of the time. The flow duration curves at the canyon mouth and at the confluence with the Jordan River were similar. The effect of the diversion for the hydroelectric plants and water treatment plant is to reduce flow rates at all probability levels.

The Big Cottonwood Creek at Cottonwood Lane flow gauge (SLCo 340) is located upstream of the East Jordan Canal Extension and the Jordan and Salt Lake City Canal. Salt Lake City Public Utilities discharges water from these canals to Big Cottonwood Creek to fulfill the obligations of the exchange agreements and when there is excess water. Therefore, the flow gauge is located in a section of creek that is dewatered for part of the year. The dewatered section goes from Walker




*Stream gauges located at Canyon Mouth (SLCo 320/USGS 10168499 for the period 10/1/1980 – 9/30/2004), at Cottonwood Lane (SLCo 340/USGS 10168800 for the period 10/1/1979 – 9/30/2004), at 300 West SLCo 390/USGS 10169500 for the period 10/1/1980 – 9/30/2004) and above the Water Treatment Plant (SLCi for the period 1/1/1901 – 12/31/2005)*

**Figure 4.6.12 Mean Daily Flow Duration Curves for Big Cottonwood Creek**

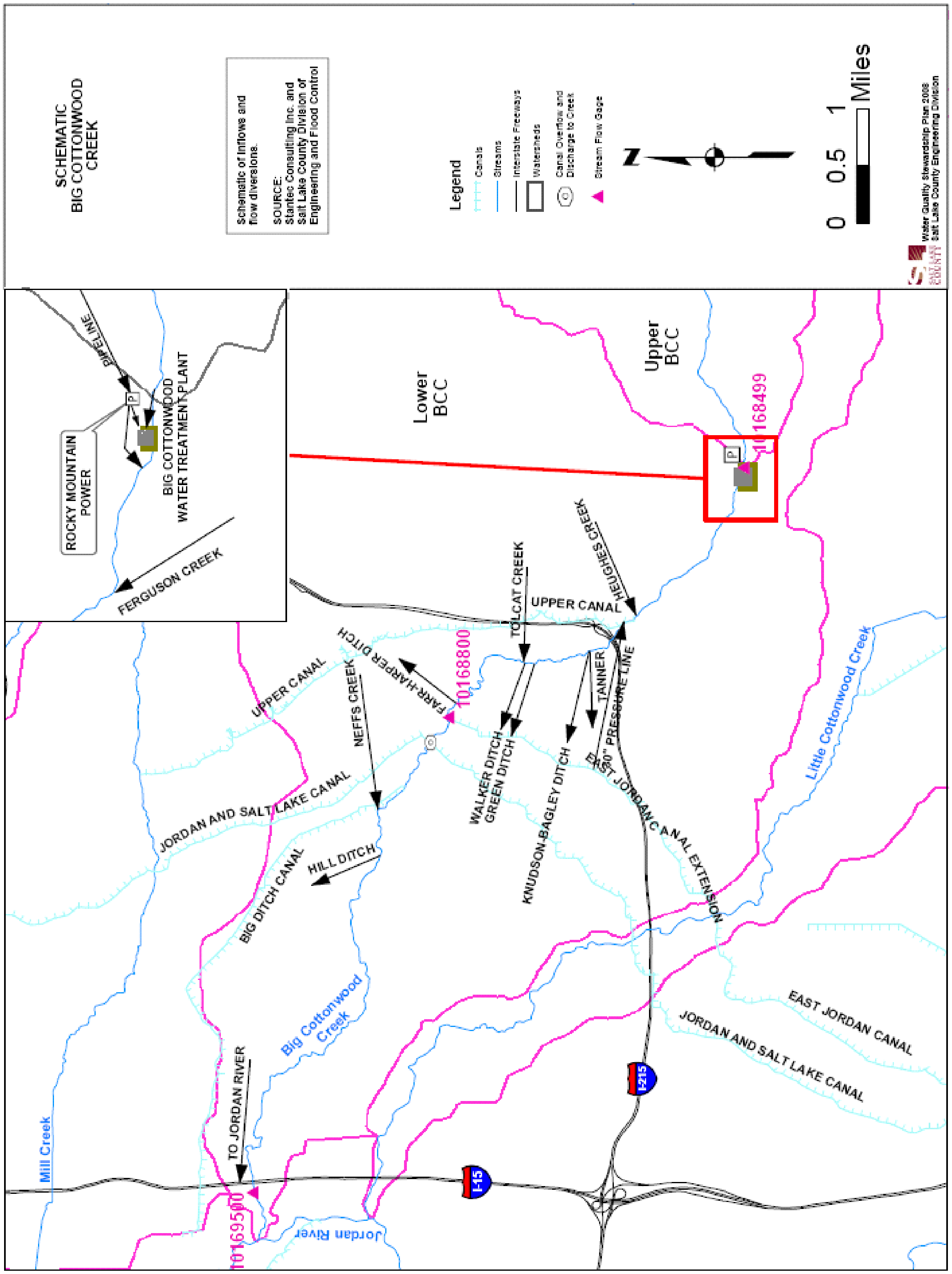



Figure 4.6.13 Schematic of Big Cottonwood Creek Diversions, Exchanges and Tributary Inflows

Ditch to either East Jordan Canal or Jordan and Salt Lake City Canal. Downstream of the Jordan and Salt Lake City Canal the flow is perennial in Big Cottonwood Creek, as evidenced by the flow record at the gauge located near the confluence with the Jordan River (SLCo 390).

Another section of Big Cottonwood Creek that is dewatered for part of the year is below the Water Treatment Plant. The flow picks up from tributaries and groundwater accretion.

### *Little Cottonwood Creek*

General Watershed Description The Upper Little Cottonwood Creek Sub-Watershed has a drainage area of 17,366 acres comprised of steep mountain slopes with an elevation range from 5,200 to 11,200 feet. The primary land use in Upper Little Cottonwood Creek is managed forest land for recreational use, including hiking, biking, camping, picnicking, fishing, and downhill and cross-country skiing. There are part-time and year-round residences, two ski resorts and lodging in the canyon.

The Lower Little Cottonwood Creek Sub-Watershed has a drainage area of 8,141 acres through the Salt Lake valley. Lower Little Cottonwood Creek Sub-Watershed drainage area includes Deaf Smith Canyon (3.6 square miles). Lower Little Cottonwood Creek is highly urbanized, with primarily residential land use. Increased commercial and industrial uses occur near I-15 and I-215.

Little Cottonwood Creek, Upper Little Cottonwood Creek Sub-Watershed

Little Cottonwood Creek Watershed

Total Little Cottonwood Creek watershed drainage area is 25,507 acres.

Ecology The DWQ designated beneficial use for aquatic life for Little Cottonwood Creek is Class 3A, which is protected for cold-water species of game fish and other cold water aquatic life (Toole, 2002).

DWR divides Little Cottonwood Creek into five reaches. A summary of the fisheries classification is presented in Table 4.6.5 (Thompson et al., 2003).

Recreation The DWQ designated beneficial use for recreation and aesthetics for Little Cottonwood Creek is Class 2B, which is protected for secondary contact recreation such as boating or wading (Toole, 2002). Although the designated beneficial use is Class 2B, watershed specific ordinances restrict many recreational activities in the stream channel within the protected watershed boundary.

Hydrology Little Cottonwood Creek is classified as a perennial stream. From the intake to the Murray Power Plant, near the Wasatch Resort in the canyon, to the East Jordan Canal, the flow is interrupted for part of the year. Below the East Jordan Canal, the flow is reduced with the addition of exchange waters. Little Cottonwood Creek enters the Jordan River in the vicinity of 4800 South.

**Table 4.6.5 DWR Fisheries Summary for Little Cottonwood Creek**

| Reach | Downstream Boundary | Length (miles) | Management Class | Productivity (lb/ac) | Native Fish | Introduced Fish |
|---|---|---|---|---|---|---|
| 5 | Bypass Road | 7.5 | 3 | 161 | | |
| 4 | Tanner Flat Campground | 2.0 | 6 | | | |
| 3 | Little Cottonwood Road | 0.9 | 3 | 24 | CTBV | CT |
| 2 | East Jordan Canal | 2.0 | 6 | | | |
| 1 | State Street | 3.0 | 5 | | DCLN, SKUT | BHBK, BHCH, BN, CPCO, RT |

BHBK: Black bullhead; BHCH: Channel catfish; BN: Brown trout; CPCO: Common carp;
CTBV: Bonneville cutthroat trout; DCLN: Longnose dace; RT: Rainbow trout; SKUT: Utah sucker

The hydrology of Little Cottonwood Creek is characterized as flashy, with high magnitude peak flows resulting from spring snowmelt runoff. The flashiness of the watershed results from the large percentage of impervious rock area and steep side slopes. The peak flow day on average is June 4.

Three privately owned and operated reservoirs impound water in the headwaters portion of Little Cottonwood Creek (DWR, 1997). Little Cottonwood Water Association manages Secret Lake (60 af capacity) and Red Pine Lake (202 af capacity). South Despain Ditch Company manages White Pine Lake (315 af capacity).

Salt Lake City owns the vast majority of water rights in Little Cottonwood Canyon. The water users in the canyon include the Town of Alta, Alta and Snowbird ski areas, Snowbird Resort, special service districts and numerous individual property owners. Salt Lake City provides water to the users in the canyon under surplus water agreements. The surplus water agreements obligate Salt Lake City to provide water only after the demands of the water users in the valley are met. Salt Lake City has historically always been able to provide water to the users in the canyon.

The water sources in the canyon are from springs, tunnels and wells. There are a limited number of diversions directly from the creek in the canyon. Alta Ski Lifts withdraws water from Little Cottonwood Creek for snowmaking purposes between November and April. Per the Environmental Impact Statement for the Alta Ski Lifts Master Plan Update, the ski resort is required to maintain a minimum instream flow of 1.3 cfs in Little Cottonwood Creek below the Jump Hill diversion during snowmaking activities.

Wastewater is conveyed down the canyon in a sewer main.

Murray City Power owns and operates a power plant located below the mouth of the canyon: The Murray Power Plant currently has a power generation capacity of 4,800 kw and a hydraulic design capacity of 160 cfs. The dam and diversion structure is located approximately one mile from the canyon mouth. The Murray Power Plant is operated as run-of-river, defined when inflow into the plant penstock is about equal to the outflow from the plant powerhouse. The power plant is exempt from the FERC permit process due to the size of the plant and therefore does not have any requirement to maintain minimum flows in the bypassed reach of the stream. Generally, the power plant diverts all water from the creek during summer, fall and winter base flow periods (approximately mid-July through April). Murray City has non-consumptive use rights for the power plant.

The Little Cottonwood Water Treatment Plant was originally put into service in 1960 and is owned and operated by Metropolitan Water District of Salt Lake & Sandy (MWDSLS). The current approved treatment capacity is 113 mgd and the hydraulic capacity is 150 mgd. The treatment plant receives water from the Salt Lake Aqueduct as well as diverted water from Little Cottonwood Creek. The MWDSLS treats the water and distributes it as a wholesaler to water suppliers.

Water from the Murray Power Plant tailrace is conveyed directly to the Little Cottonwood Water Treatment Plant. In addition to the water from the power plant, the water treatment plant diverts water directly from Little Cottonwood Creek and receives water from the Salt Lake Aqueduct.

The MWDSLS may divert the entire stream flow during the non-irrigation months, resulting in a dewatered creek condition below the treatment plant. MWDSLS's mean monthly diversion rate from Little Cottonwood Creek to the water treatment plant is shown in Figure 4.6.14.

Little Cottonwood Creek naturally loses flow to groundwater between the canyon mouth and approximately 2050 East. The average monthly channel losses in this reach for the water years 1964 - 1968 varied from 1.3 cfs in February to 17 cfs in May (Hely et al., 1971). The stream losses vary with flow magnitude, flow duration and stream substrate composition. Below 2050 East, Little Cottonwood Creek gains flow from groundwater. The Cutoff Savings Ditch along Little Cottonwood Creek was constructed due to the natural channel losing water through the bypassed reach.

Salt Lake City has obtained some of the water rights in Little Cottonwood Creek through exchange agreements with irrigation companies. The exchange agreements allow water from the canyon to be diverted for municipal supply and be replaced with water from Utah Lake or groundwater withdrawals.

Deaf Smith Fork (Little Willow Creek) enters Little Cottonwood Creek near Willow Creek Drive. The stream flow is diverted for irrigation purposes at several locations along the valley reach (Figure 4.6.15). The Cutoff Savings Ditch was constructed in the early 1900's to prevent stream flow losses to groundwater. The Nichol and Last Chance Ditch and Richard's Ditch divert water from the Cutoff Savings Ditch. Water is diverted at Farmers Gate to provide enough flow for the downstream irrigation

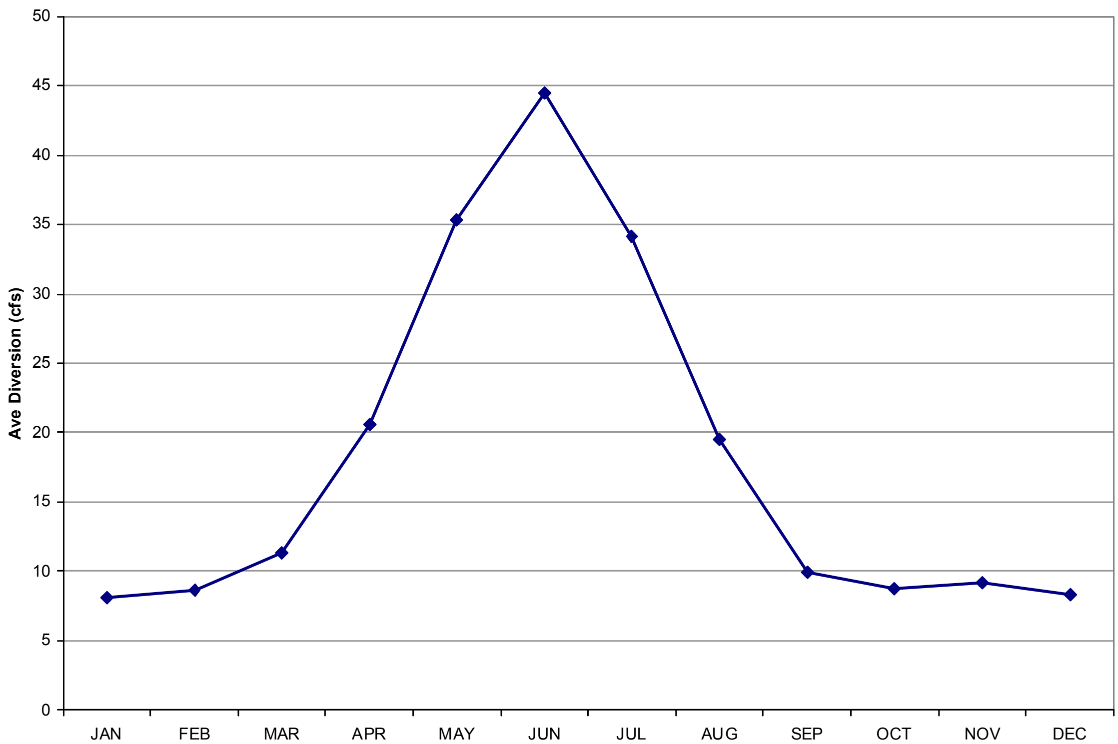



**Figure 4.6.14 Mean Monthly Flow Diversion from Little Cottonwood Creek Plant (1986-2005)**

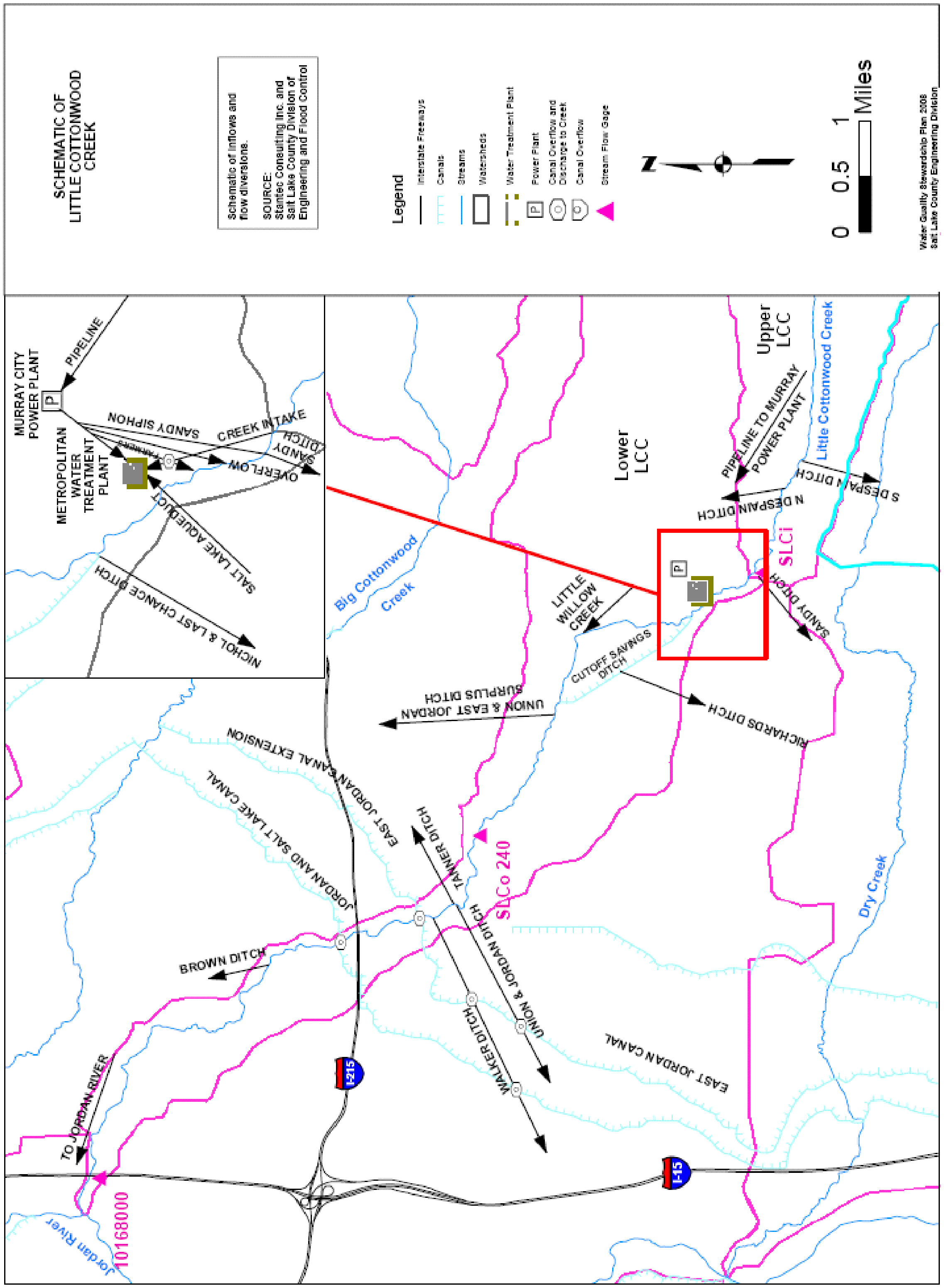
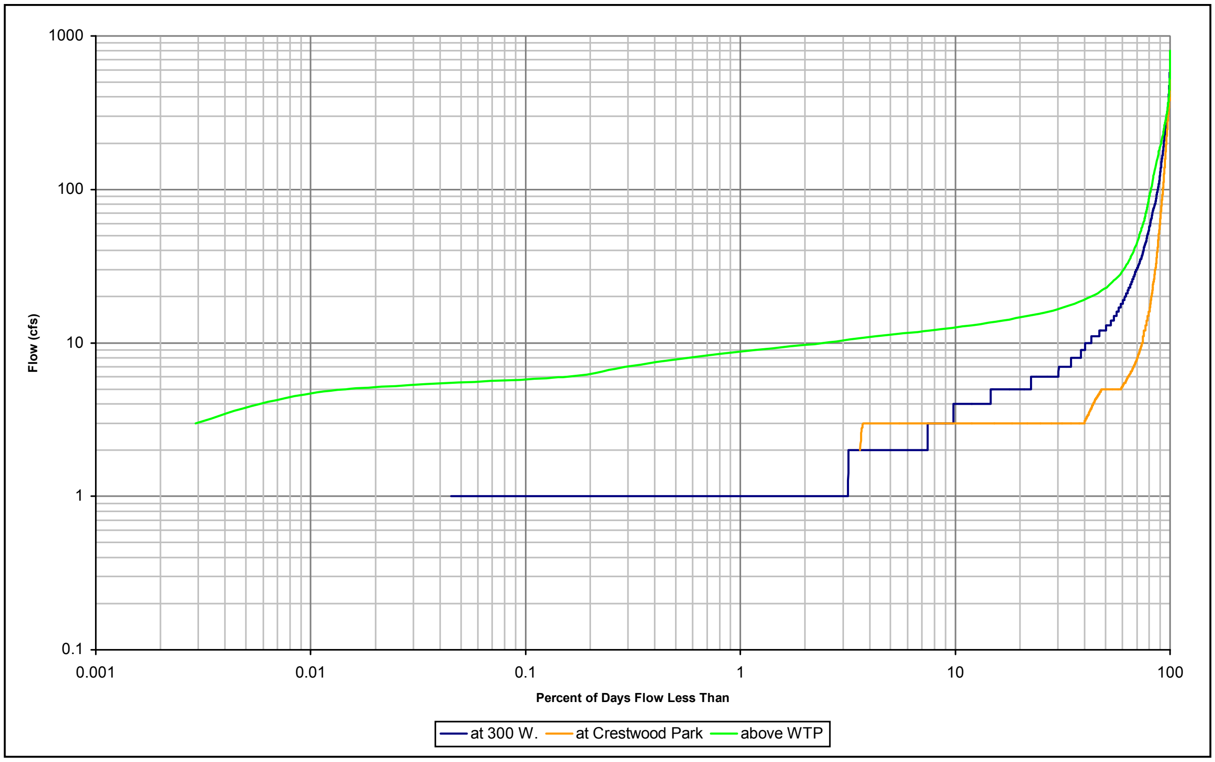



**Figure 4.6.15 Schematic of Little Cottonwood Creek Diversions, Exchanges and Tributary Inflows**




*Stream gages located at Crestwood Park (SLCo 240 for the period 10/1/1987 – 9/30/2004), at 300 W. (SLCo 290/ USGS 10168000 for the period 2/20/1987 – 9/18/2005) and above the Water Treatment Plant (SLCi for the period 1/1/1910 – 12/31/2004)*

**Figure 4.6.16 Mean Daily Flow Duration Curves for Little Cottonwood Creek**

water users above the East Jordan Canal. The water at Farmer's Gate either originates from the outflow from the Murray Power Plant or from the creek intake to the Little Cottonwood Water Treatment Plant.

Salt Lake City Public Utilities discharges water from the East Jordan Canal and the Jordan and Salt Lake Canal to Little Cottonwood Creek to fulfill the obligations of the exchange agreement for Brown Ditch. Excess water from these canals is also discharged to Little Cottonwood Creek.

Sandy City owns all of the shares in the Union Jordan Irrigation Company, Thompson Ditch Company, Lym Ditch Company, Last Chance Ditch Company and the Nickle Irrigation Company.

A flow duration analysis was conducted on the mean daily flow records from gages located at Crestwood Park and near the confluence with the Jordan River (Figure 4.6.16). In addition, Salt Lake City provided a long term time series of stream flows above the water treatment plant, The flow duration curve shows that Little Cottonwood Creek at Crestwood Park was at or below 3.0 cfs for 39.5% of the time and at the confluence with the Jordan River for 9.8% of the time, while only one (1) day had flows at or below 3.0 cfs above the water treatment plant. The effect of the diversion for the hydroelectric plant and water treatment plant is to reduce flow rates at all probability levels.

Little Cottonwood Creek, Upper Little Cottonwood Creek Sub-Watershed

*Dry Creek*

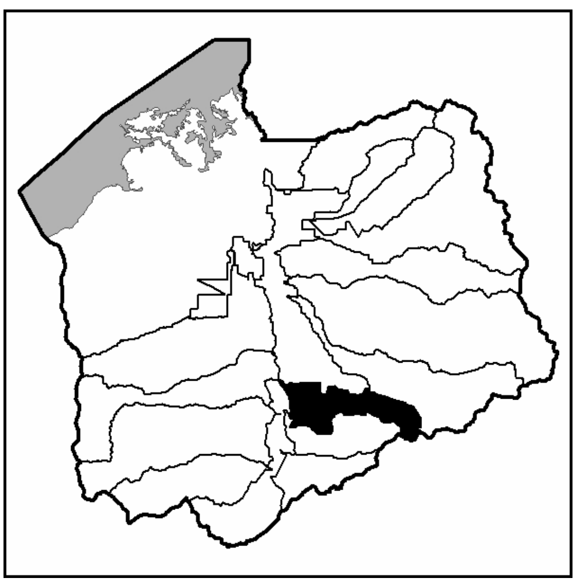
General Watershed Description The Upper Dry Creek Sub-Watershed has a drainage area of 3,878 acres comprised of three canyon drainages: Bells Canyon, Middle Fork Dry Creek, and South Fork Dry Creek. The primary land use in Upper Dry Creek Sub-Watershed is managed forest land with limited recreational use, including hiking, biking, camping and fishing. Bells Canyon has very steep mountains, with an elevation range from 5,000 to 10,000 feet.

The Lower Dry Creek Sub-Watershed has a drainage area of 8,557 acres through the Salt Lake valley. Lower Dry Creek Sub-Watershed is highly urbanized, with primarily residential and commercial land use.

Total Dry Creek watershed drainage area is 12,435 acres.

Ecology The DWQ designated beneficial use for aquatic life for Bells Canyon Creek and South Fork Dry Creek is Class 3A, which is protected for cold-water species of game fish and other cold water aquatic life (Toole, 2002). Middle Fork Dry Creek and Dry Creek are not classified.

The DWR sport fish management class for Bells Canyon Creek is 3, which is considered a good trout fishery. The native fish species in Bells Canyon Creek is Cutthroat Bonneville trout (Thompson et al., 2003).



Dry Creek Watershed

Dry Creek, Lower Dry Creek Sub-Watershed

Recreation The DWQ designated beneficial use for recreation and aesthetics for Bells Canyon Creek and South Fork Dry Creek is Class 2B, which is protected for secondary contact recreation such as boating or wading (Toole, 2002). Middle Fork Dry Creek and Dry Creek are not classified.

Hydrology Dry Creek in Bells Canyon is classified as perennial. Between the flow diversion and Lower Bells Canyon Reservoir, the stream flow is interrupted for part of the year. Below Lower Bells Canyon Reservoir, Dry Creek is classified as intermittent, with interrupted flow during part of the year. Dry Creek enters the Jordan River approximately 0.5 miles upstream from 9000 South.

One reservoir impounds water in Upper Dry Creek: Lower Bells Canyon Reservoir is located at the mouth of the canyon and has 25 af storage capacity. The Upper Bells Canyon Reservoir located above the lower reservoir originally stored water; however, it was subsequently breached. There are no reservoirs on Middle Fork Dry Creek and South Fork Dry Creek. Middle Fork Dry Creek discharges to the Draper Irrigation Ditch.

The Draper Irrigation Company (WaterPro), Sandy City and Jordan Valley Water Conservancy District all divert water from Bells Canyon.

The Draper Irrigation Company diverts water from Bells Canyon Creek above the Lower Bells Canyon Reservoir and from South Fork Dry Creek at the canyon mouth to the WaterPro Water Treatment Plant.

The Jordan Valley Water Conservancy District (JVWCD) diverts stream flow from Bells Canyon


Dry Creek, Lower Dry Creek Sub-Watershed

above the lower reservoir, as well as the Middle and South Fork of Dry Creek. The diverted water is conveyed to the South-East Regional Water Treatment Plant.

Sandy City diverts an estimated average annual volume of 880 af (1.2 cfs) from Bells Canyon to Little Cottonwood Creek.

The hydrology of Upper Dry Creek Sub-Watershed is dominated by snowmelt, with high magnitude peak flows in the spring and base flows the rest of the year.

JVWCD collected stream flow and diversion records for Bells Canyon above the Lower Bells Canyon Reservoir from 1995 to 2006. The average annual diversion of water from Bells Canyon is 100%.

### *Willow Creek*

General Watershed Description The Upper Willow Creek Sub-Watershed has a drainage area of 4,450 acres comprised of five canyon drainages: Rocky Mouth Canyon; Big Willow Canyon; Little Willow Canyon; Bear Canyon and Cherry Canyon. The primary land use in Upper Willow Creek Sub-Watershed is managed forest land for water supply, with an elevation range from 5,400 to 10,000 feet.

Lower Willow Creek Sub-Watershed is highly urbanized, with primarily residential and commercial land use. The Lower Willow Creek Sub-Watershed has a drainage area of 6,001 acres through the Salt Lake valley.

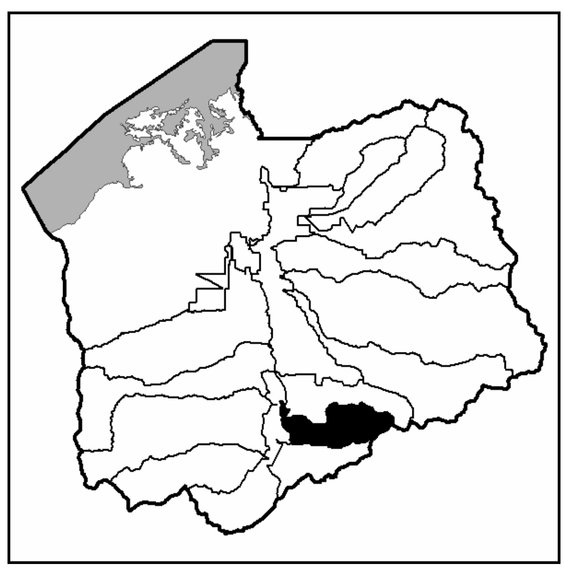
Total Willow Creek watershed drainage area is 10,451 acres.

Ecology The DWQ designated beneficial use for aquatic life for Rocky Mouth Canyon, Big Willow Creek and Little Willow Creek is Class 3A, which is protected for cold-water species of game fish and other cold water aquatic life (Toole, 2002). Willow Creek, Bear Canyon and Cherry Canyon are not classified.

The DWR sport fish management class for Little Willow Creek is 3, which is considered a good trout fishery, with an HQI productivity of 103 to 146 lb/acre (Thompson et al., 2003). The native fish species in Little Willow Creek is Cutthroat Bonneville trout.

Recreation The DWQ designated beneficial use for recreation and aesthetics for Rocky Mouth Canyon, Big Willow Creek and Little Willow Creek is Class 2B, which is protected for secondary contact recreation such as boating or wading (Toole, 2002). Willow Creek, Bear Canyon and Cherry Canyon are not classified.

Hydrology Big and Little Willow Creek in the canyons are classified as perennial. Below the canyon mouth, Willow Creek is classified as intermittent, with interrupted flow during part of the year. Lower Willow Creek is dewatered for part of the year as a result of diversions; however, the downstream reach receives water from groundwater accretion and canal inflow. Willow


Willow Creek Watershed


Big Willow Creek, Lower Willow Creek Sub-Watershed

Creek enters the Jordan River in the vicinity of 11000 South.

None of the canyons have reservoirs for the storage of water.

The Draper Irrigation Company diverts water from Rocky Mouth Canyon and Big Willow Creek at the canyon mouths. WaterPro diverts water from Big Willow Creek and Little Willow Creek at the canyon mouth.

The Jordan Valley Water Conservancy District diverts stream flow from Rocky Mouth Canyon and Big Willow Creek at the canyon mouths. The diverted water is conveyed to the South-East Regional Water Treatment Plant. The City of Sandy also diverts water from Willow Creek.

Bear Canyon flow gets diverted by the City of Riverton. Cherry Canyon Creek discharges to the Draper Irrigation Canal.


Little Willow Creek, Lower Willow Creek Sub-Watershed

The flows in the Upper Willow Creek Sub-Watershed are dominated by snowmelt. There are no historic or active flow gauges on Willow Creek or any of its tributaries below the diversions. The flow volume from the canyons was estimated in the Salt Lake County Area-Wide Water Study (Coon, King & Knowlton Engineers et al., 1982); however, it was not determined how much of the flow remains in the creek after the diversions.

### *Corner Canyon Creek*

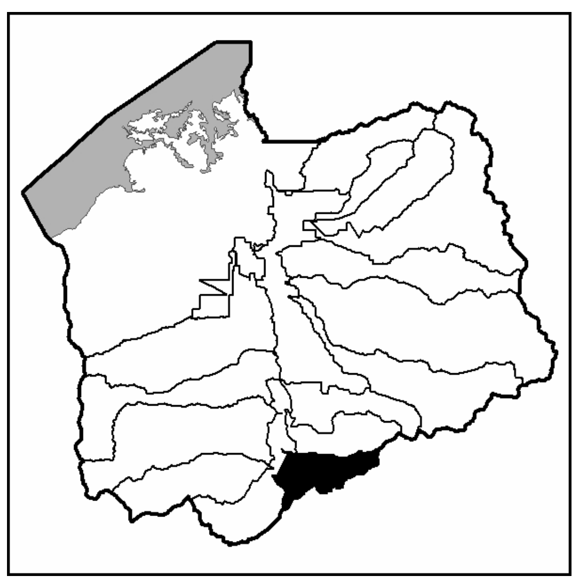
General Watershed Description Corner Canyon Creek watershed has a drainage area of 9,344 acres comprised of four canyon drainages: Corner Canyon; Maple Hollow Canyon; Oak Hollow Canyon and an unnamed Canyon.

The primary land use in the upper sub-watershed is managed forest land for water supply, with an elevation range from 4,800 to 9,000 feet. The valley portion of the watershed is primarily residential and commercial land use.

Ecology Corner Canyon Creek does not have a DWQ designated beneficial use for aquatic life.

The DWR does not classify Corner Canyon Creek for recreational sport fish resources.

Recreation Corner Canyon Creek does not have a DWQ designated beneficial use for recreation and aesthetics.


Corner Canyon Watershed

Corner Canyon Creek, Upper Corner Canyon Creek Sub-Watershed

Hydrology Corner Canyon Creek is an intermittent stream. Below the canyon mouth, Corner Canyon Creek has interrupted flow during part of the year. The downstream reach receives water from groundwater accretion and canal inflow. Corner Canyon Creek enters the Jordan River approximately 1.1 miles downstream of Bangeterr Highway.

The flows in Corner Canyon Creek are dominated by snowmelt and summer thunderstorms. Corner Canyon Creek does not have a reservoir for the storage of water in the canyon.

Salt Lake County and Draper City recently constructed a detention and debris basin located at the mouth of the canyon with 4.3 af of sediment storage and 2.0 acre feet of detention storage. (Hansen, Allen and Luce, Inc., 1993).

The Corner Canyon Water Company and WaterPro divert water from Corner Canyon Creek at the canyon mouth. There are approximately eight diversion structures located along Corner Canyon Creek between Fort Street and South Field Ditch (1150 East) (Hansen, Allen and Luce, Inc., 1993).

There are no historic or active flow gages on Corner Canyon Creek or any of its tributaries below the diversions. The flow volume from the canyons was estimated in the Salt Lake County Area-Wide Water Study (Coon, King & Knowlton Engineers et al., 1982); however, it was not determined how much of the flow remains in the creek after the diversions.

### 4.6.2.3 Oquirrh Mountain Streams

The average annual precipitation in the Oquirrh Mountains varies from 18 to 28 inches, much of this coming from “lake effect snows”. The snowfall accumulation in the Oquirrh Mountains is generally less than in the Wasatch Mountains for several reasons. The Oquirrh Mountains, which top out at around 9,000 feet, are lower in elevation than the Wasatch Mountains. The Oquirrh Mountains in Salt Lake County have an eastward aspect, which means that most of the moisture from Pacific frontal systems is removed on the Tooele County side as the storms move east. However, some lake event precipitation events may favor the Oquirrh Mountains.

As a result of the lower snowfall accumulation and snowmelt, the spring peak flows and base flows in the Oquirrh Mountain streams are significantly lower. The streams are also more prone to flash floods resulting from summer thunderstorms.

*Rose Creek*

General Watershed Description Rose Creek watershed has a drainage area of 17,654 acres. The primary land use in the canyon portion of the watershed is managed for water supply, wildlife and military reservation. The valley portion of the watershed is rapidly urbanizing, transitioning from primarily agricultural land use to residential and commercial land use.

Ecology The DWQ designated beneficial use for aquatic life for Rose Creek is Class 3D, which is protected for waterfowl and other water-oriented wildlife (Toole, 2002).

The DWR does not classify Rose Creek for recreational sport fish resources.

Recreation The DWQ designated beneficial use for recreation and aesthetics for Rose Creek is Class 2B, which is protected for secondary contact recreation such as boating or wading (Toole, 2002).

Hydrology The reduced snow accumulation and snowmelt in the Rose Creek watershed results in reduced spring peak flows and base flows. Rose

Rose Creek Watershed

Rose Creek, Lower Rose Creek Sub-Watershed

Rose Creek, Lower Rose Creek Sub-Watershed

Creek through the valley is classified as an intermittent stream. Below the diversion to the Rose Creek Irrigation Company, the flow is interrupted for part of the year. The lower reach of Rose Creek near the Jordan River has perennial flows as a result of stormwater, irrigation return flows and groundwater accretion.

Rose Creek crosses under the Welby-Jacobs Canal, Utah Lake Distributing Canal, Utah and Salt Lake Canal, and South Jordan Canal. With the exception of Welby-Jacobs, these canals have overflow structures to the creek that flow during storm events. Additionally, there is a detention basin located at approximately 5600 West. Rose Creek enters the Jordan River approximately 0.6 miles upstream of Bangerter Highway.

Several of the smaller drainages within the Rose Creek watershed terminate at the Welby-Jacobs Canal.

Rose Creek does not have an in-line reservoir for the storage of water. The Herriman City Municipal Water Department diverts water from springs in Rose Canyon. The Rose Creek Irrigation Company diverts water directly from the creek.

There are no historic or active flow gages on Rose Creek or any of its tributaries below the diversions. The flow volume from the canyons was estimated in the Salt Lake County Area-Wide Water Study (Coon, King & Knowlton Engineers et al., 1982); however, it was not determined how much of the flow remains in the creek after the diversions.

*Midas/Butterfield Creek*

General Watershed Description Midas/Butterfield Creek Watershed has a drainage area of 32,173 acres. The watershed is comprised of several gulches that are tributary to Butterfield Creek and Midas Creek.

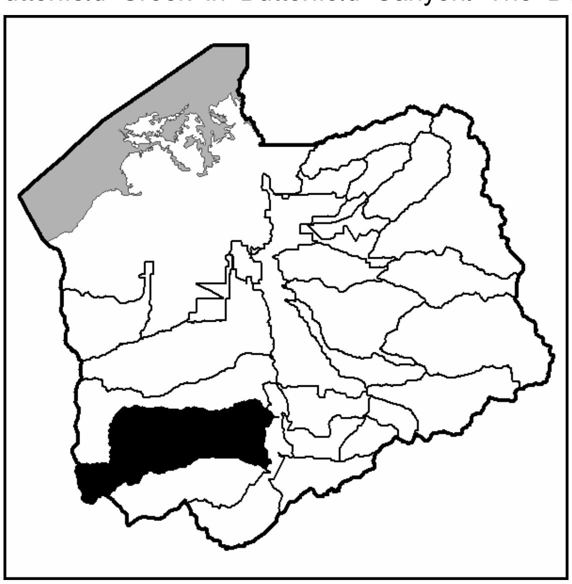
Butterfield Creek originates in the Oquirrh Mountains and is conveyed to Copper and then Midas Creek along 6000 West. The channel continues downstream and terminates between the Utah Lake Distributing Canal and the Utah and Salt Lake Canal.

The headwaters of Midas Creek are formed by several gulches. The drainage pattern in the headwaters were modified by the Kennecott Copper Pit Mine, which resulted in tributary area being routed to Bingham Creek.

The primary land use in the canyon portion of the watershed is managed for water supply. The valley portion of the watershed is urbanized, with primarily residential and commercial land use. The Creek ultimately discharges to the Jordan River.

Ecology The DWQ designated beneficial use for aquatic life for Midas/Butterfield Creek is Class 3D, which is protected for waterfowl and other water-oriented wildlife (Toole, 2002).

The DWR only classified a 1.6 mile long reach of Butterfield Creek in Butterfield Canyon. The DWR



Midas/Butterfield Creek Watershed

Butterfield Creek, Midas/Butterfield Creek Sub-Watershed

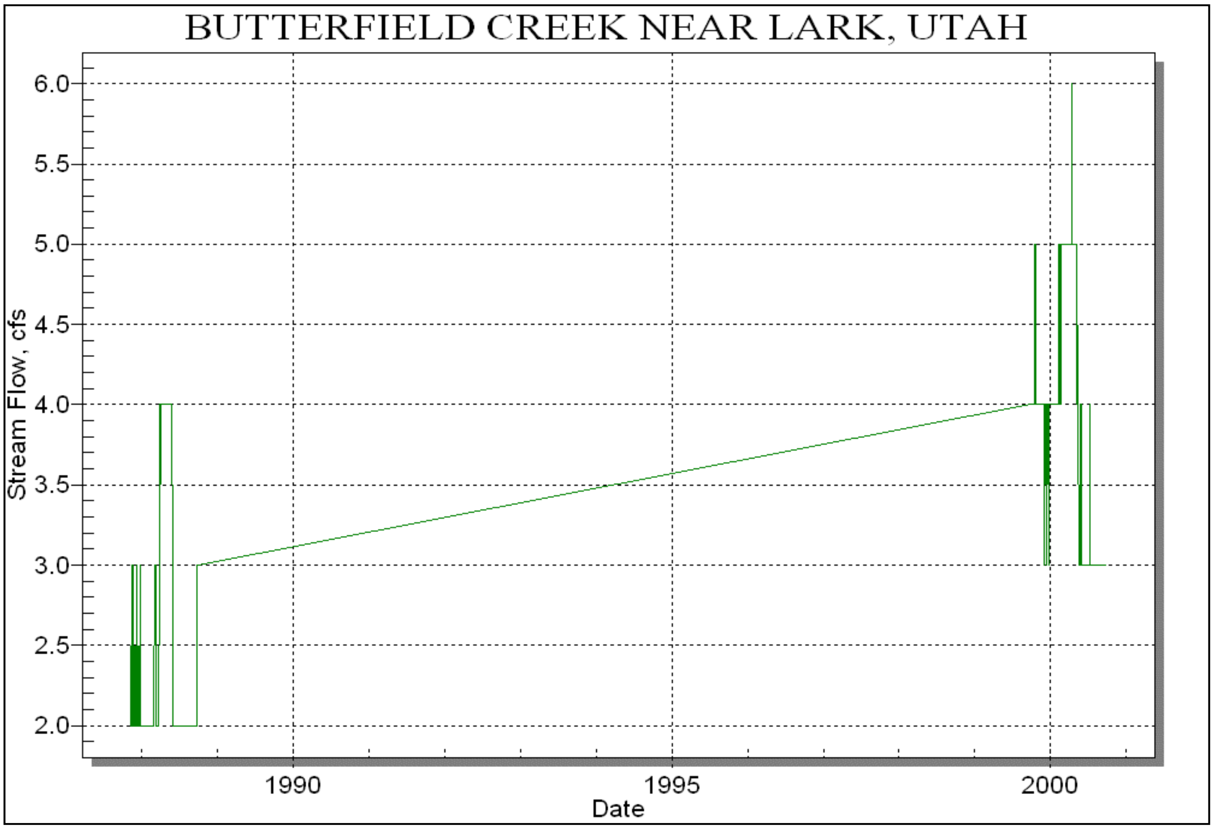
sport fish management class for Butterfield Creek is 4, which is considered a poor trout fishery of limited value, with a predicted HQI productivity of 2 lb/acre (Thompson et al., 2003). The native and introduced fish species in Butterfield Creek are not known. The DWR does not classify Midas Creek for recreational sport fish resources.

Recreation The DWQ designated beneficial use for recreation and aesthetics for Midas/Butterfield Creek is Class 2B, which is protected for secondary contact recreation such as boating or wading (Toole, 2002).

Hydrology The reduced snow accumulation and snowmelt in the Midas/Butterfield Creek watershed results in reduced spring peak flows and base flows. Butterfield Creek in the canyon has perennial flows. Butterfield, Midas and Cooper Creeks through the valley have intermittent flows. Butterfield Creek has reduced flows before the confluence with Copper Creek. The lower reach of Midas Creek near the Jordan River has perennial flows as a result of stormwater, irrigation return flows and groundwater accretion.

Midas Creek crosses under the Welby-Jacobs Canal, Utah Lake Distributing Canal, Utah and Salt Lake Canal, and South Jordan Canal. The canals have overflow structures to the creek that flow during storm events. Midas Creek enters the Jordan River approximately 1.0 miles upstream of South Jordan Parkway.

The Herriman Irrigation Company diverts water from Butterfield Tunnel, which is tributary to Butterfield Creek.




*Source: USGS 403403011112062801*

**Figure 4.6.17 Flow Time Series for Butterfield Creek Near Lark**

There are no historic or active flow gages on Midas Creek or any of its tributaries below the diversions.

Salt Lake County maintains a flow gage on Butterfield Creek; however, the reliability and accuracy of the flow records are considered poor, so the County does not publish the data. The USGS published flow records for gage number 403011112062801 from 11/11/1987 to 9/29/1988 and 10/1/1999 to 9/30/2000 are represented in Figure 4.6.17. The maximum flow during this time period was 6.0 cfs.

Midas Creek, Midas/Butterfield Creek Sub-Watershed

*Bingham Creek*

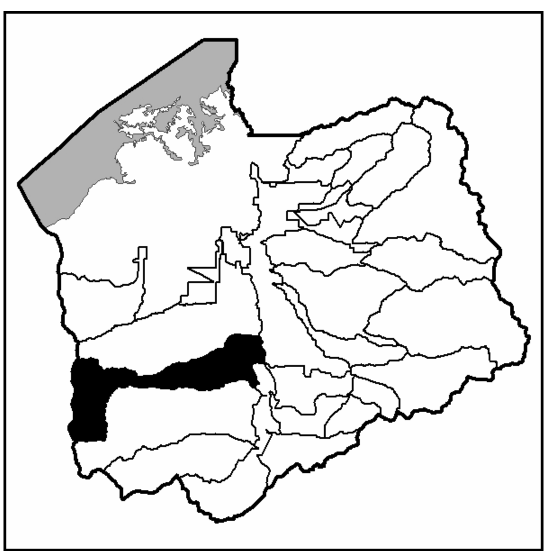
General Watershed Description Bingham Creek Watershed has a drainage area of 23,172 acres.

The headwaters of Bingham Creek are primarily comprised of the Kennecott Bingham Canyon Mine, an open-pit copper mine owned and operated by Kennecott Utah Copper Corporation (KUCC). The copper mine and other mine shafts have resulted in the modification of natural drainage patterns in the watershed. The eastern portion of the copper mine originally had slopes that drained to Midas Creek prior to excavation.

The primary land use in the canyon portion of the watershed is mining activities. The valley portion of the watershed is urbanized, primarily residential and commercial land use.

Ecology The DWQ designated beneficial use for aquatic life for Bingham Creek is Class 3D, which is protected for waterfowl and other water-oriented wildlife (Toole, 2002).

The DWR only classified a 1.7 mile long reach of Bingham Creek in Bingham Canyon above Copperton. The DWR sport fish management class for Bingham Creek is 4, which is considered a poor trout fishery of limited value, with a predicted HQI productivity of 1 lb/acre (Thompson et al., 2003). The native and introduced fish species in Bingham Creek are not known.



Bingham Creek Watershed

Bingham Creek, Lower Bingham Creek Sub-Watershed

Recreation The DWQ designated beneficial use for recreation and aesthetics for Bingham Creek is Class 2B, which is protected for secondary contact recreation such as boating or wading (Toole, 2002).

Hydrology The upper portion of Bingham Creek in the canyon has been substantially impacted by KUCC mining operations. These activities include dumping of waste rock in the upper canyon areas, resulting in loss of channel segments. Surface and shallow groundwater flows at the canyon mouth are collected by a cutoff wall and entirely diverted to the KUCC process system, resulting in dewatered flow conditions downstream of the diversion. Bingham Creek no longer has a flow classification above the process reservoirs near Copperton.

Bingham Creek through the valley is classified as intermittent, with interrupted flows during part of the year. The lower reach of Bingham Creek near the Jordan River has perennial flows as a result of stormwater, irrigation return flows and groundwater accretion.

Bingham Creek crosses under the Welby-Jacobs Canal, Utah Lake Distributing Canal, Utah and Salt Lake Canal, South Jordan Canal and North Jordan Canal. The canals have overflow structures to the creek that flow during storm events. Bingham Creek enters the Jordan River approximately 0.3 miles upstream of 7800 South.

Surface drainage and groundwater that seeps into Kennecott's Bingham Canyon Mine is collected and used for dust suppression on haul routes and other mining operations. Waste rock from the Bingham Canyon Mine is placed into Bingham Canyon and is slowly filling the canyon (Kennecott Utah Copper, 2007).

Surface and shallow sub-surface water that would drain to Butterfield Creek is collected by a cutoff wall system that surrounds the exterior base of the mine. The water is conveyed into Kennecott's operations water system, where it is used for mine tailings conveyance and other processes. Kennecott is required to maintain zero discharge from its mining operations.

Kennecott Copper owns and operates a water treatment plant in Bingham Canyon that delivers treated water to the Jordan Valley Water Conservancy District (JVWCD). The capacity of the plant is 3 mgd and the source of the water is from groundwater wells.

There are no historic or active flow gages on Bingham Creek or any of its tributaries.

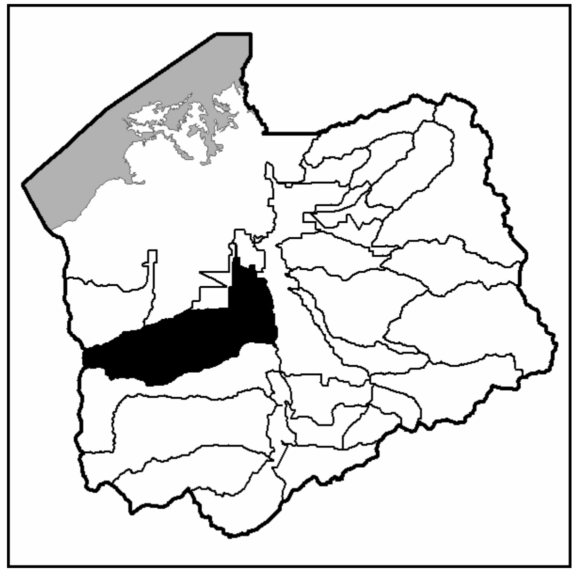
The flow volume for Bingham Creek at the Jordan River was estimated in the Salt Lake County Area-Wide Water Study (Coon, King & Knowlton Engineers et al., 1982). Flow diversions and mining operations were not considered in the estimate.

*Barney's Creek*

General Watershed Description Barney's Creek Watershed has a drainage area of 31,873 acres. The headwaters of Barneys Creek are comprised of moderately steep mountains that range in elevation from 5,300 to 8,000 feet.

Barneys Canyon Mine is an open-pit gold mine located in the canyon. Kennecott operated the mine from 1989 to 2001 (Kennecott Utah Copper, 2007). The mine affects natural drainage patterns in the watershed.

Barney's Creek, Barney's Creek Sub-Watershed



Barney's Creek Watershed

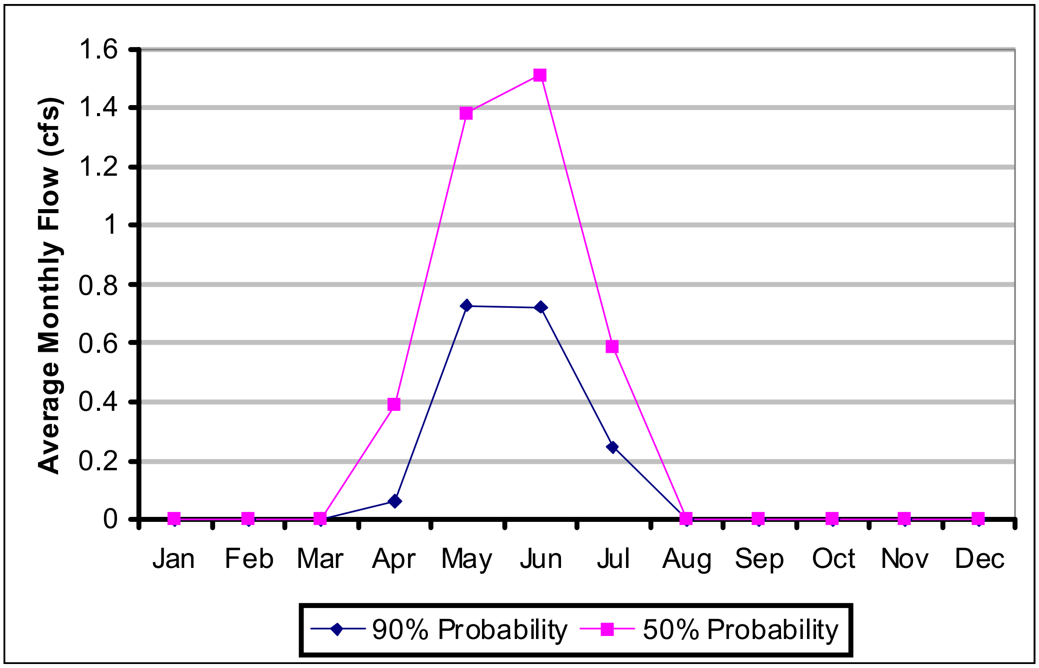
The primary land use in the canyon portion of the watershed is mining activities. The waste dumps and hauling routes are being reclaimed and revegetated. The valley portion of the watershed is urbanized, primarily residential and commercial land use.

*Ecology* The DWQ designated beneficial use for aquatic life for Barney's Creek is Class 3D, which is protected for waterfowl and other water-oriented wildlife (Toole, 2002).

The DWR has not completed a fish survey of Barney's Creek, though 6.2 miles of the stream are listed on the stream inventory for the Jordan River Drainage (Thompson et al., 2003).

Recreation The DWQ designated beneficial use for recreation and aesthetics for Barney's Creek is Class 2B, which is protected for secondary contact recreation such as boating or wading (Toole, 2002).

Hydrology The upper portion of Barney's Creek in the canyon has perennial flows resulting from snowmelt. Barney's Creek through the valley is intermittent and only has flows during spring snowmelt and large storm events. Barney's Creek channel ends just downstream of Airport Road after crossing the Welby-Jacob Canal and does not reach the Jordan River as an open channel. A large tributary enters Barneys Creek from the north near 4800 West. Another drainage, Barney's Wash, ends near Grizzly Way off of New Bingham Highway.




*Source: Coon, King & Knowlton Engineers et. al., 1982*

**Figure 4.6.18 Average Monthly Flow Rate for Barneys Creek at the Canyon Mouth**

There are no historic or active flow gages on Barneys Creek or any of its tributaries. The flow volume for Barney's Creek at the canyon mouth was estimated in the *Salt Lake County Area-Wide Water Study* (Coon, King & Knowlton Engineers et al., 1982). Flow diversions were not considered in this estimate. The average monthly flowrate for the 50% probability and 90% probability of occurrence is presented in Figure 4.6.18. Note that Barney's Creek Watershed at the canyon mouth was assumed to have 4.0 square miles drainage area for the study.

Barneys Creek, Barney's Creek Sub-Watershed

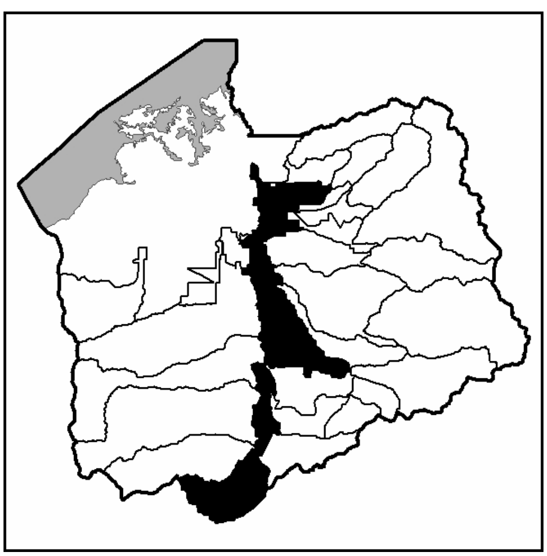
### 4.6.2.4 Jordan River

General Watershed Description The Jordan River is the natural outlet to Utah Lake. The river meanders from Utah Lake through the Utah Lake valley, Jordan Narrows and Salt Lake valley, before draining into the Great Salt Lake. The Jordan River is approximately 44 miles in length through Salt Lake County.

Utah Lake is a freshwater lake that was converted into a storage reservoir in 1872 by the construction of a low dam across the outlet. Gates in the dam control the outflow from the lake and keep pumped water from flowing back to the lake. Pumps were installed at the outlet in 1902 so that the lake could be lowered below the elevation of the river.

The release of water from Utah Lake to the Jordan River is managed for water supply (irrigation water rights), industrial use, and flood control purposes. The Utah Lake and Jordan River Commissioner, who is appointed by the State Engineer in the Division of Water Rights, manages the releases from Utah Lake.

Ecology The DWQ designated beneficial use for aquatic life for the Jordan River above 6400 South is Class 3A, which is protected for cold-water species of game fish and other cold water aquatic life (Toole, 2002). The DWQ designated beneficial use for aquatic life for the Jordan River below 6400 South is Class 3B, which is protected for warm-water species of game fish and other warm water aquatic life.



Jordan River Corridor Watershed

Jordan River, Jordan River Corridor Sub-Watershed

DWR divides the Jordan River into four reaches. A summary of the fisheries classification is presented in Table 4.6.6 (Thompson et al., 2003).

Recreation The DWQ designated beneficial use for recreation and aesthetics for the Jordan River is Class 2B, which is protected for secondary contact recreation such as boating or wading (Toole, 2002).

Hydrology The hydrology of the Jordan River is regulated by the management of the Utah Lake outlet, diversions, tributaries, point discharges and groundwater.

The management of the outlet from Utah Lake for flood control purposes is specified in the "Compromise Agreement (Civil No. 64770) of 1985." According to the agreement, water must be released from Utah Lake once the level of water in the lake exceeds the "compromise elevation," or the maximum legal storage elevation in Utah Lake, which was established in 1985 at 4489.045 feet above sea level (USGS datum). The control gates at the outlet to Utah Lake are fully opened at compromise level, with the restriction that the flow in the Jordan River measured at 2100 South is not to exceed 3,400 cfs.

The Surplus Canal diversion structure is located on the Jordan River at approximately 2100 South Street. The Surplus Canal was constructed in 1910 to route floodwaters from the Jordan River and it's tributaries away from the densely populated downtown, Glendale and Rose Park areas of Salt Lake City. To accommodate increased flows, the Surplus Canal was enlarged by the Army Corps of Engineers in 1960. The physical configuration of the diversion actually diverts the Jordan River off the Surplus Canal through three head gates and two

### Table 4.6.6 DWR Fisheries Summary for Jordan River

| Reach | Downstream Boundary | Length (miles) | Management Class | Productivity (lb/ac) | Native Fish | Introduced Fish |
|---|---|---|---|---|---|---|
| 4 | 14600 South | 3.9 | 3 | | SKUT | BHCH, BSWH, CPCO, RT, WE |
| 3 | 9000 South | 3.9 | 3 | | MNFH, SCMT, SKUT | BKBL, BN, CPCO, RT, SFBG |
| 2 | 2100 South | 8.7 | 3 | | SKUT | CPCO, RT |
| 1 | Burton Dam | 13.5 | 3 | | SKUT, CBUT | CPCO |

DWR Fisheries Abbreviation Key

| | |
|---|---|
| BHCH | Channel catfish (Ictalurus punctatus) |
| BN | Brown Trout (Salmo trutta) |
| BSWH | White Bass (Morone chrysops) |
| CBUT | Utah Chub (Gila atraria) |
| CPCO | Common Carp (Cyprinus carpio) |
| MNFH | Flathead Minnow (Pimephales promelus) |
| RT | Rainbow Trout (Onchoryncus mykiss) |
| SCMT | Mountain Sucker (Catostomus Platyrhynchus) |
| SFBG | Bluegill Sunfish (Lepomis Macrochirus) |
| SKUT | Utah Sucker (Catostomus ardens) |

radial gate. A check structure in the river raises the water surface and forces water to the east and into the Jordan River.

The operation of the diversion structure is mandated by the Operation and Maintenance criteria established by the Corps of Engineers for the Jordan River Project when the current Surplus Canal was constructed (USACE, 1985) and by the Jordan River Flow Management Agreement as an outcome of the mitigation negotiations for the construction of Little Dell Dam and Reservoir (Salt Lake County, 1989).

Jordan River, Jordan River Corridor Sub-Watershed

The diversion structure is to be operated as follows:

- All excess flows will be diverted to the Jordan River unless:
  - The diversion interferes with satisfying any existing water rights,
  - The diversion is in excess of 300 cfs, and
  - The diversion would be in a period of threatening or actual rainstorms or that the diversion results in flooding during dry weather.
- The County will operate the structure when flows are greater than 600 cfs.
- The Lower Jordan River Commissioner will operate the structure when flows are less than 600 cfs.
- Mitigation flows will be reduced immediately if the River Commissioner determines excess flows are not present.

The "1992 Utah Lake Water Distribution Management Plan" specifies the protocols for storage of water in the Provo River/Utah Lake reservoirs and the distribution of water for downstream water rights holders in the Jordan River (Utah Division of Water Rights, 1992).

Water released from Utah Lake for downstream water users is diverted from the Jordan River into several canals (Table 4.6.7). The first diversion (Jordan Valley Water Conservancy District Pump Station) for water users is just above Turner Dam approximately 9.6 miles downstream from the Utah Lake outlet. The Utah Lake releases get mixed with groundwater, springs, tributaries and stormwater in the Jordan River before being diverted. The releases and diversions occur primarily during the irrigation season between April 15 and October 15.

### Table 4.6.7 Flow Diversions From the Jordan River Within Salt Lake County

| Diversion | River Mile | Purpose |
|---|---|---|
| Jordan Valley Pump Station[1] | 41.9 | Irrigation |
| Utah Lake Distributing Canal | 41.9 | Irrigation |
| Utah and Salt Lake Canal | 41.8 | Irrigation |
| East Jordan & Draper Canal | 41.8 | Irrigation |
| South Jordan Canal | 40.0 | Irrigation |
| Jordan & Salt Lake Canal | 39.9 | Irrigation |
| North Jordan Canal | 28.8 | Irrigation |
| Brighton Canal | 26.4 | Irrigation |
| Surplus Canal | 16.0 | Flood Control |
| UP&L Diversion | 12.2 | Process |
| State Canal | 1.7 | Irrigation |

[1] Pumped to Jordan Aqueduct and Welby-Jacob Canal

The primary inflows from tributary streams and point discharges are summarized in Table 4.6.8. There are two wastewater treatment plants that discharge treated effluent to the Jordan River within Salt Lake County (Table 4.6.9). South Valley Water Reclamation Facility (SVWRF) discharges to the River at approximately 7400 South. Central Valley Water Reclamation Facility (CVWRF) discharges to Mill Creek at approximately 3100 South near the confluence with the Jordan River. The South Davis South Water Reclamation Facility discharges to the Jordan River; however, the plant is located within Davis County and is outside the consideration of this planning document.

The Jordan River gains flows from groundwater throughout the entire length. Previous studies have attempted to quantify the amount of groundwater contribution to the Jordan River. Table 4.6.10 summarizes the groundwater contribution for each reach of the Jordan River (CH2M Hill, 2005). The groundwater amounts shown include natural groundwater, as well as return flows from agricultural and residential irrigation practices.

Jordan River at 9000 South, Jordan River Corridor Sub-Watershed

A seasonal flow duration analysis was conducted on the mean daily flow records from the gages located at the Narrows (located below Turner Dam), at 9000 South, at Surplus Canal (above diversion), at 1700 South and at 500 North (Figure 4.6.19). The analysis was performed for both the irrigation season (May through October) and non-irrigation season (November through April).

Figure 4.6.19 clearly shows that there are two distinct flow regimes on the Jordan River: one upstream of the Surplus Canal and one downstream of the Surplus Canal. Downstream of the Surplus Canal the flows are reduced, with significantly less variation, than upstream of the diversion.

### Table 4.6.8 Primary Tributaries to the Jordan River

| Inflows | River Mile | Type |
|---|---|---|
| Rose Creek | 37.1 | Intermittent |
| Corner Canyon Creek | 35.3 | Perennial |
| Midas Creek | 31.5 | Intermittent |
| Willow Creek | 30.8 | Intermittent |
| Dry Creek | 28.6 | Perennial |
| Bingham Creek | 26.4 | Intermittent |
| South Valley WRF | 26.3 | Effluent |
| 7800 S Conduit/ Barney's Creek | 26.2 | Intermittent |
| Little Cottonwood Creek | 21.6 | Perennial |
| Big Cottonwood Creek | 20.1 | Perennial |
| Mill Creek/Central Valley WRF | 17.2 | Perennial/ Effluent |
| Kearns-Chesterfield Drain | 16.9 | Return Flow |
| 1300 South Conduit | 14.2 | |
| Parley's Creek | | Perennial |
| Emigration Creek | | Perennial |
| Red Butte Creek | | Perennial |
| North Temple Conduit | 11.4 | Perennial |

### Table 4.6.9 Point discharges to the Jordan River within Salt Lake County

| Wastewater Treatment Facility Tributary to the Jordan River within Salt Lake County | River Mile | Existing Design Capacity (cfs)[1] | Mean Daily Discharge (cfs)[2] |
|---|---|---|---|
| South Valley WWTP | 26.3 | 77 | 27 |
| Central Valley WWTP via Mill Creek | 17.2 | 116 | 53 |

### Table 4.6.10 Groundwater inflow to the Jordan River

| Reach | Average Flow (cfs)[1] | Flow per River Mile (cfs/mi) |
|---|---|---|
| 13200 South to Joint Diversion | 22.8 | 3.5 |
| 9400 South to 13200 South | 45.3 | 7.1 |
| 7000 South to 9400 South | 19.2 | 5.3 |
| 4500 South to 7000 South | 7.4 | 1.8 |
| 2800 South to 4500 South | 4.5 | 1.3 |
| 2100 South to 2800 South | 2.6 | 1.6 |
| 500 North to 2100 South | 18.9 | 3.4 |
| 1700 North to 500 North | 5.9 | 3.4 |
| Cudahy Lane to 1700 North | 4.5 | 1.4 |
| Great Salt Lake to Cudahy Lane | 3.1 | 0.6 |
| Total | 134.2 | |

*Source: Jordan River Return Flow Study (CH2M Hill, 2005)*

Jordan River Restoration Site (Approximately 11400 South), Jordan River Corridor Sub-Watershed

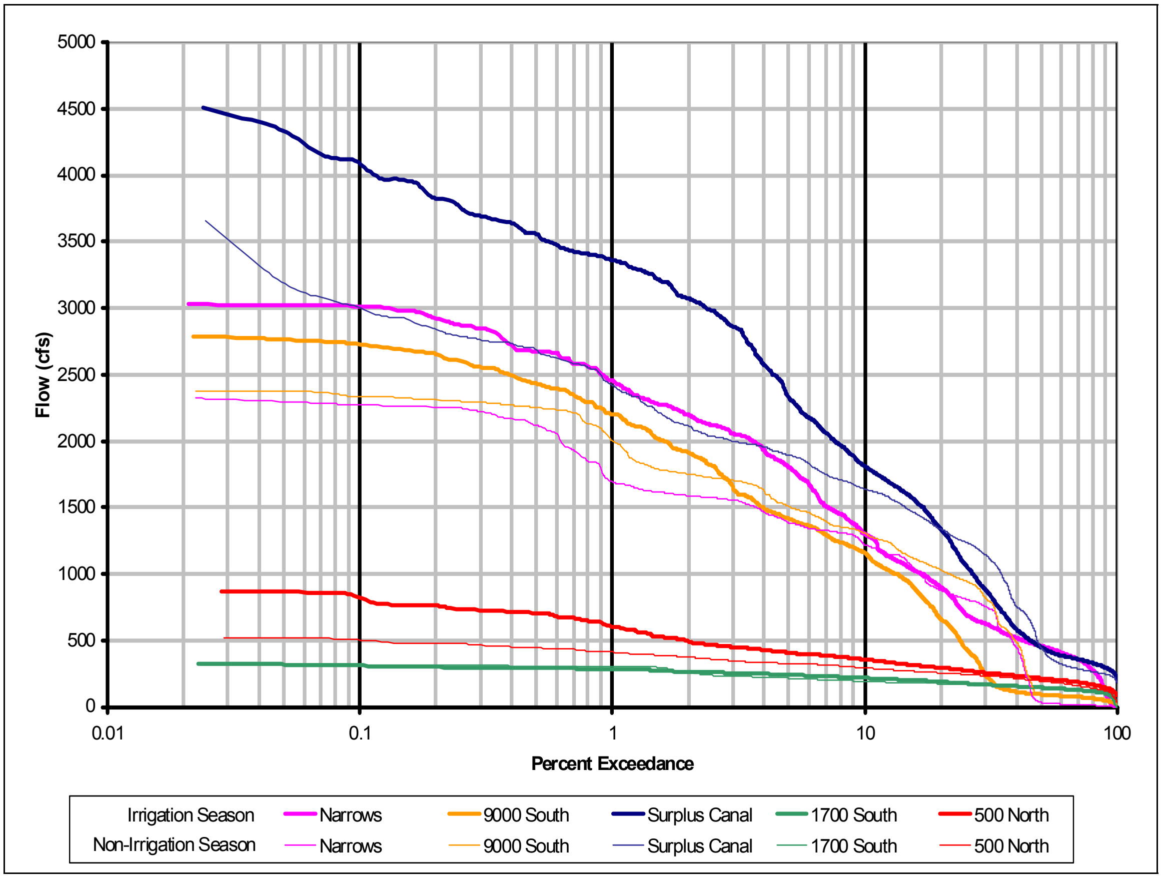



**Figure 4.6.19 Flow Duration Curves for Jordan River at Five Gage Locations for Irrigation Season and Non-irrigation Season**

There is also evidence of seasonal flow differences. The peak flows are generally greater and the low flows lower during the irrigation season. The flows at the Narrows are greater than at 9000 South during the irrigation season. The flow durations at 1700 South are similar for the irrigation and non-irrigation seasons.

The flows at the Narrows were less than 5 cfs for 8.8% of the time during the non-irrigation season and 1.8% of the time during the irrigation season. The flows at 1700 South were less than 5 cfs for 1 day during the non-irrigation season and for 6 during the irrigation season. The flows were not below 5 cfs at any of the other gauges.

The segments of the Jordan River with the greatest potential for lack of minimum flows are between Utah Lake and Turner Dam, immediately downstream of the Joint Dam (South Jordan Canal, and Jordan and Salt Lake City Canal diversions), and immediately downstream of the North Jordan Canal diversion. Dry Creek enters the Jordan River approximately 0.2 miles downstream of the North Jordan Canal; however, Dry Creek has intermittent flows. Groundwater and springs add flows to the Jordan River throughout these segments, so the extent of the lack of flows both spatially and temporally is not well known.

The management of Utah Lake releases through the "Compromise Agreement" has resulted in little variation in annual peak flow rates at the Narrows (CH2M Hill, 1993). The flood control management results in reduced "flashiness" of the river, which is characteristic of snowmelt dominated systems. The peak flood flows are reduced on the Jordan River; however, the flood flows last for extended periods of time.

Utah Lake has historically experienced cyclic fluctuations in annual peak lake water surface elevation that occurs on a 30-year cycle as a result of climatic trends. These cyclic periods result in extended periods of flood flows over several years. The most recent occurrence was between 1983 and 1987 (CH2M Hill, 1993).

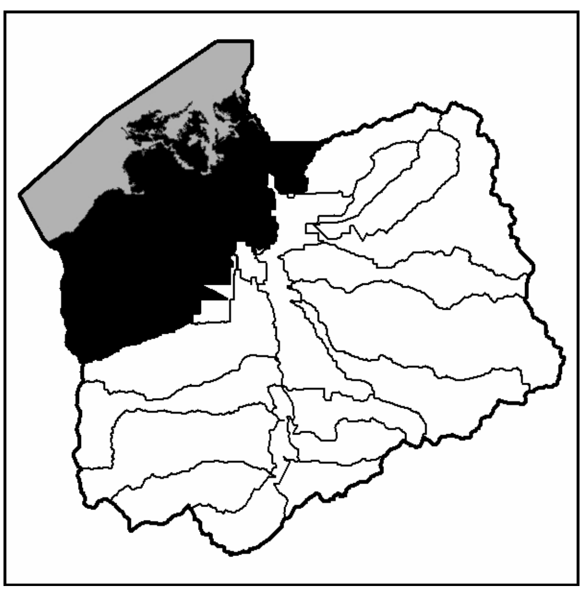
The natural flow regime of the Jordan River is not well understood, as no flow records precede the construction of the outlet structure at Utah Lake.

### 4.6.2.5 Great Salt Lake

The Great Salt Lake sub-watershed in Salt Lake County has two streams: Kersey Creek and Lee Creek.

Kersey Creek starts south of I-80 and ends at the C-7 Ditch, which drains to the Great Salt Lake. Kersey Creek is categorized as a perennial stream (2.6 miles). The Magna Water Reclamation Facility discharges to Kersey Creek and has a design capacity of 4.0 mgd and a current average treatment rate of 2.6 mgd.

Lee Creek flow was diverted to the original stream in 1998. Kersey Creek flows into Lee Creek prior to entering the Inland Sea Shorebird Reserve near the Great Salt Lake. USGS has installed a flow meter on the outflow of the Inland Sea Shorebird Reserve and has been collecting measurements since 2006. The upstream reach of Lee Creek is categorized as intermittent (2.1 miles) and the downstream reach is categorized as perennial (1.8 miles).



Great Salt Lake Watershed

Great Salt Lake Shorelands

DWQ does not classify Kersey Creek or Lee Creek for aquatic life use or recreational use. DWR does not classify the creeks for recreational sport fish resources.

The USGS maintained a flow gauge on Lee Creek from 10/1/1971 to 9/30/1982 (10172640); however, the main portion of flow from Lee Creek was diverted through the C-7 Ditch into the Great Salt Lake. Subsequently, Lee Creek was reconnected to its original outlet channel, which is the current configuration. Therefore, no flow information was available for Kersey Creek or Lee Creek.

*Coon Creek*

General Watershed Description Coon Creek Watershed has a drainage area of 14,409 acres. Coon Creek watershed includes Harkers Canyon and Coon Canyon. Coon Creek is tributary to the Great Salt Lake.

The headwaters of Harkers Creek and Coon Creek are comprised of moderately steep mountains that range in elevation from 5,000 to 9,300 feet. The primary land use in the canyon portion of the watershed is managed for water supply and wildlife. The valley portion of the watershed is urbanized, primarily residential, industrial and commercial land use.

Ecology The DWQ designated beneficial use for aquatic life for Coon Creek is Class 3D, which is protected for waterfowl and other water-oriented wildlife (Toole, 2002).

The DWR has not completed a fish survey of Coon Creek, though 4.2 miles of the stream are listed on the stream inventory for the Jordan River Drainage (Thompson et al., 2003).

Coon Creek Sub-Watershed

Recreation The DWQ designated beneficial use for recreation and aesthetics for Coon Creek is Class 2B, which is protected for secondary contact recreation such as boating or wading (Toole, 2002).

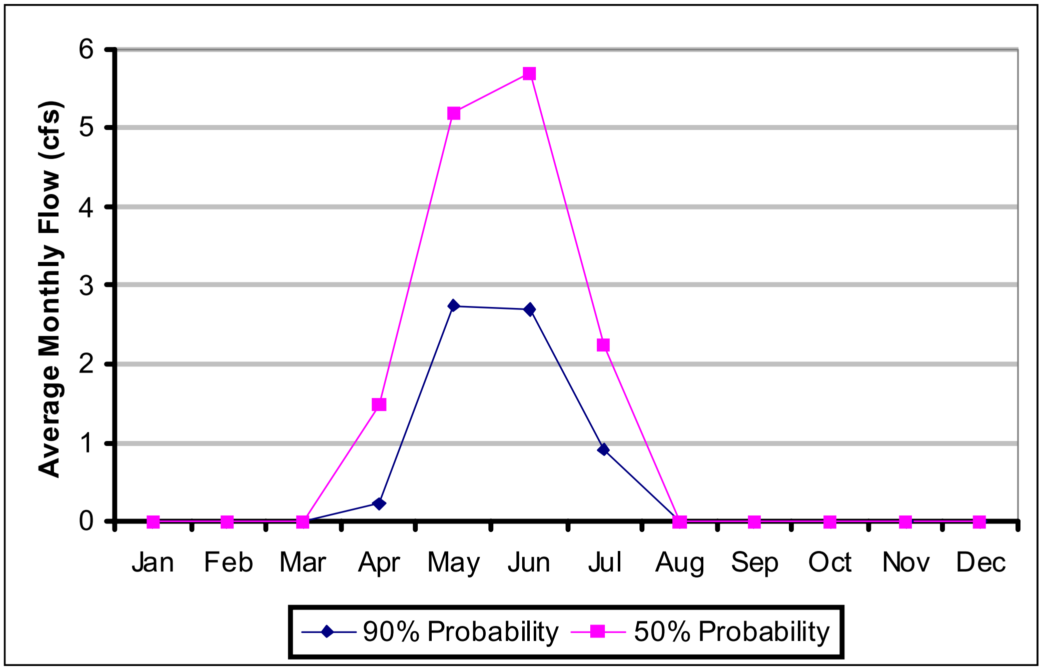
Hydrology The upper portion of Coon Creek in the canyon has perennial flows resulting from snowmelt. Lower snow accumulation and snowmelt in Coon Canyon results in reduced spring peak flows and base flows. The upper portion of Harkers Creek in the canyon and Coon Creek below the canyon have intermittent flows that only occur during spring snowmelt and large storm events. Harkers Creek enters Coon Creek just below the canyon mouth. Coon Creek crosses the Utah and Salt Lake Canal, enters a piped system that drains to the C-7 ditch and then to the Great Salt Lake. A detention basin is located at 4100 South. The C-7 ditch is not regulated as an ecological resource.

Coon Creek, Coon Creek Sub-Watershed

Coon Creek, Coon Creek Sub-Watershed

There are no historic or active flow gauges on Coon Creek or Harkers Creek below the diversions. The flow volume for Coon Creek at the canyon mouth was estimated in the *Salt Lake County Area-Wide Water Study* (Coon, King & Knowlton Engineers et al., 1982). Flow diversions were not considered in this estimate. The average monthly flowrate for the 50% probability and 90% probability of occurrence is presented in Figure 4.6.20. Note that Coon Creek, combined with Harkers Creek, watershed at the canyon mouth was assumed to have 15.1 square miles drainage area for the study.

Coon Creek, Coon Creek Sub-Watershed




*Source: Coon, King & Knowlton Engineers et. al., 1982*

**Figure 4.6.20 Average Monthly Flow Rate for Coon Creek With Harkers Creek at the Canyon**

## 4.6.3 Future Conditions

This section provides a brief summary of current water development plans relevant to instream flows in Salt Lake County for the planning period 2005 to 2030. The proposed flow modifications considered include development of water resources within Salt Lake County, trans-basin import water, Utah Lake water, wastewater discharge and water reuse. The effect of urbanization and land use conversion is discussed in more detail in the Habitat Planning Element and below under Flow Augmentation.

### 4.6.3.1 Salt Lake County Area-Wide

*Import Water* Jordan Valley Water Conservancy District has plans to import 25,000 af per year of water from the Bear River by the year 2036, 21,400 af per year from the Utah Lake System by the year 2015 and 9,000 af per year of groundwater from the former Geneva Steel site in Utah County (refer to Water Supply Planning Element). Metropolitan Water District of Salt Lake & Sandy has plans to import an additional 8,600 af of water from the Utah Lake System. It has not been fully determined where this water will be used, how much consumptive use will occur and where the resultant irrigation return flow and treated wastewater will be discharged; however, much of it is intended to meet demand for the expected growth in the western portion of the County.

*Water Reuse* The water providers and wastewater treatment plants in Salt Lake County are planning for additional future water reuse. The Central Utah Water Conservancy District mandates that a certain amount of future water deliveries be reused. The details of the proposed water reuse projects and their effect on instream flows is not known at this time; however, the primary effect will likely be on the Jordan River (see below).

### 4.6.3.2 Wasatch Mountain Streams

Salt Lake City Department of Public Utilities has plans to develop an additional 3,967 af (average year) from surface water supplies from Wasatch Mountain Streams (Bowen Collins and Associates, 2007). The additional water would come primarily from Upper Mill Creek and Upper Emigration Creek, both of which are sources of high quality water that have not been fully developed. A feasibility study completed in 1990 for the proposed Mill Creek Water Treatment Plant (Eckhoff Watson and Preator Engineering et al., 1990) assumed a minimum instream flow of 1 cfs, as stipulated by


View of Oquirrh Mountains

Salt Lake City. No basis was presented for how the minimum instream flow was determined.

Metropolitan Water District of Salt Lake & Sandy has made improvements to expand the Little Cottonwood Water Treatment Plant to a treatment capacity of 143 mgd (from 113 mgd) and divert more water from Little Cottonwood Creek.

#### 4.6.3.3 Oquirrh Mountain Streams

The western portion of Salt Lake County at the base of the Oquirrh Mountains is projected to experience a high level of growth and development. Kennecott Land Corporation (Kennecott) is the primary land owner and developer in this area. Kennecott along with governmental agencies are currently undertaking extensive planning efforts to accommodate this growth. Kennecott owns a majority of the water rights in Bingham Creek, Barney's Creek and Coon Creek Sub-Watersheds, as well as minor water rights in Midas/Butterfield Creek Sub-Watershed. The volume of water available from these sub-watersheds is small compared to the projected water demands. However, there is the potential that the water resources will be further developed, resulting in reduced instream flows in these sub-watersheds.

#### 4.6.3.4 Jordan River

The import water, water reuse and additional water development in the Wasatch Mountain and Oquirrh Mountain streams described above all affect the hydrology of the Jordan River. Most, if not all, of the import water that is not consumed will be discharged to the Jordan River either through wastewater treatment effluent or irrigation return flow. Land use changes and population growth within the County will have significant impacts on the hydrology of the Jordan River, as well.

Additional water development and wastewater treatment projects that directly affect the flows in the Jordan River are described below.

By the year 2009, JVWCD plans to pump and treat 8,200 af per year (11.3 cfs) of contaminated groundwater from the southwestern part of the County as part of the Southwest Groundwater Project. By the year 2028, JVWCD plans to develop an additional 8,000 ac-ft per year (11.1 cfs) of water from shallow groundwater wells that would naturally discharge to the Jordan River. Refer to the Water Supply Planning Element for further description of these projects.

The South Valley Sewer District plans to construct a new wastewater treatment plant with 15 mgd capacity (23.2 cfs). The effluent from this plant will discharge to the Jordan River near the mouth of Corner Canyon Creek at approximately river mile 35.3.

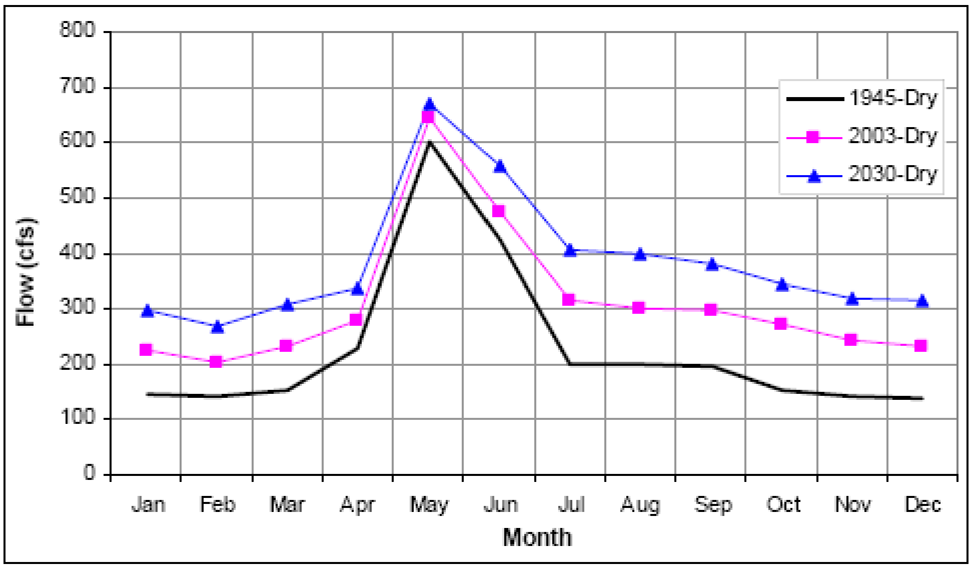
The *Jordan River Return Flow Study* projected flow conditions in the Jordan River in 2030 considering


Waterfowl reliant on the Jordan River, Jordan River Corridor Sub-Watershed

**Table 4.6.11 Jordan River Flow Volume Balance Summary Under Dry Hydrologic Conditions**

| Reach | 2003 (af) | 2030 (af) |
|---|---|---|
| Return flows (wastewater and irrigation) | 165,200 | 211,300 |
| Groundwater | 44,700 | 44,700 |
| Utah Lake releases | 115,300 | 114,300 |
| Tributaries including stormwater | 81,000 | 78,300 |
| Canal diversions | (147,400) | (138,800) |
| Outflow (Surplus Canal & Jordan @ Cudahy Lane) | 258,800 | 309,800 |

*Source: Jordan River Return Flow Study (CH2M Hill, 2005)*




*Source: Jordan River Return Flow Study (CH2M Hill, 2005)*

**Figure 4.6.21 Simulated Mean Monthly Flow in the Jordan River at 2100 South Under Dry Hydrologic Conditions**

the proposed water development projects and including 18,000 af per year of water reuse (CH2M Hill, 2005). The study estimated the water budget for dry, average and wet hydrologic conditions. The report concluded that annual flow volumes in the Jordan River are projected to increase in the future primarily due to an increase in import water which will more than compensate for the proposed water reuse and water development projects (Table 4.6.11). The mean monthly flow rates were also projected to increase for 2030 (Figure 4.6.21).

#### 4.6.3.5 Great Salt Lake

No water development plans affecting flows in Kersey Creek and Lee Creek were identified.

### 4.6.4 Flow Preservation and Augmentation

#### 4.6.4.1 Flow Preservation and Augmentation Strategies

This section presents strategies to preserve and protect the existing instream flows and to provide flow augmentation to hydrologically modified streams in Salt Lake County. In addition to flow regime, the four other factors that are required for ecological integrity of the stream corridor include water quality, physical habitat, energy sources and biotic interactions. Some stream segments may be permanently or severely impaired in one or more of these areas and therefore may not be good candidates for flow augmentation. Additional field work is required to inventory and characterize the potential function of each of the stream corridors in Salt Lake County.

The general approach to providing flow augmentation is through cooperation and opportunities rather than through regulation. All of the stream segments considered in this planning element have been 100% appropriated and many have waiting lists should water rights be forfeited. The Division of Water Rights does not have the legal authority to condemn water rights for the purposes of providing instream flows.

Many of the strategies for flow preservation are similar to the strategies for flow augmentation; however, regulatory compliance plays a more prominent role in flow preservation. Stormwater management practices mandated by development standards have a major impact on instream flows. In addition, water rights change applications for proposed developments need to consider the effect on the stream resources.

*Water Rights and Water Shares Acquisition* One strategy for providing flow augmentation is to work collaboratively with water right holders to identify opportunities for water rights/shares acquisition. Water rights are classified as "real property" in the state of Utah and are bought and sold much like real estate. Many real estate agencies will have listings for water rights much as they do for properties.

Water shares entitle the stockholder to receive a portion of the water owned by the irrigation company or water company. The amount of water received is proportional to the shares owned. The water rights are held by the irrigation company or water company. Sale or transfer of water shares is similar to other stock transactions; however, they are subject to and may be restricted by the bylaws and covenants of each company. Salt Lake County commits to working collaboratively with water right/share owners in identifying flow augmentation and preservation opportunities.

The beneficial use of any acquired water rights would need to be designated for instream flow purposes, which would be accomplished through a change application filed with the Division of Water Rights. Currently, only the Utah Division of Parks and Recreation, the Division of Wildlife Resources, and non-profit organizations may hold instream flow rights. Any acquired water rights would need to be transferred to one of these entities.

In lieu of outright purchase of water rights, which would be expensive and may not be appealing to the water rights holders, water rights could be leased on a short-term or long-term temporary basis. The leased water rights would not be diverted and the flow would remain in the stream. The lease would be retained by the Division of Wildlife Resources. The County commits to working collaboratively with water right and share owners to identify flow augmentation strategies.

Funding mechanisms and tracking procedures would need to be developed for the acquisition of water rights and water shares. The water rights acquisition program could be modeled after other similar programs such as open space acquisition.

Public support for a water rights acquisition program has been demonstrated in the past. In a public survey conducted for the Division of Wildlife Resources in 1998, acquiring water rights during dry periods to protect fish populations was rated as a "very high priority" by 66% of the general public and 77% of fishing and hunting license holders (Krannich and Teel, 1999).

One limitation to this strategy is the potential that very few water rights or water shares in Salt Lake County are available for purchase. A market analysis would need to be conducted to evaluate the feasibility of purchasing water rights and water shares.

*Water Bank* If it is determined that water rights or water shares acquisition is feasible, establishment of a water bank for the Utah Lake and Jordan River water distribution system would help facilitate the transfer of water rights. Establishment of such a bank would be done in collaboration with water right and share owners.

A water bank is an institutional mechanism that facilitates the legal transfer and market exchange of various types of surface, groundwater, and storage entitlements. Essentially, the water bank acts as a broker, clearinghouse or market maker and administrator to facilitate transactions. Water banks are often established to maintain instream flows and ensure that water goes to the highest use during drought conditions. For instance, along the Yakima River in Washington State, there are permanent, high-end croplands (orchards, hops) that pay other agricultural users to have their land remain fallow during drought conditions (Clifford et al., 2004).

A water bank has not previously been established in Utah; however, the water rights laws make it possible, since water rights can be legally transferred or exchanged. The forfeiture requirements stipulate that water rights be used within five years and do not apply to water stored in reservoirs (Clifford et al., 2004).

A Utah Lake and Jordan River water bank could be a mechanism for restoring the Jordan River to a more natural flow regime and maintaining minimum instream flows in the tributaries.

*Water Rights Inventory and Reallocation* Another strategy for providing flow augmentation is to change the beneficial use designation of existing water rights that are not being fully utilized. Salt Lake County currently holds numerous water rights and water shares in irrigation canals for various purposes. An evaluation may be conducted to determine if any of these water rights or water shares could be used for instream flow purposes rather than their current use. Arrangements can be made that temporarily transfers the use of the water right to the Division of Wildlife Resources for instream flows, while retaining ownership of the water right (Olds, 2007). Other municipalities and agencies could also undertake such an evaluation of their water rights. Ideally, all of the jurisdictions within a sub-watershed would work together cooperatively to best manage and allocate the water rights.

*Canal Water Diversion* An engineered method to provide additional instream flows is to divert flow to the streams from the irrigation canals on either side of the Jordan River. The source of the water in the canals is the Jordan River, irrigation return flows and stormwater. The quality of the water in the irrigation canals is lower than the naturally occurring flows from the canyons; however, it would provide flow augmentation to the streams.

Another possible source of water is treated effluent from a water reclamation facility. For example, the South Valley Sewer District's proposed water reclamation facility in Riverton could discharge treated effluent to the irrigation canal(s). The reuse water would then be conveyed for diversion to tributaries that would benefit from flow augmentation.

Ideally, the flows would be diverted higher in the stream system where they are most needed. In order to get the flows to the mouth of the canyon, the water would need to be pumped from the canals. Additional infrastructure would be required, including conveyance pipe and pumps.

Complicating considerations that might limit the feasibility of this engineered solution include flow conveyance and water rights. Conveyance of the water in the canals could be an issue. Irrigation water is typically conveyed in canals that narrow or constrict in the downstream direction as the number of water users decreases. The capacity of the canals could limit the conveyance of water for instream flows. In addition, water rights would be required to implement the diversions to the streams.

*Import Water* Another proposed option would be to divert water above Utah Lake and convey it to Salt Lake County for use for instream flow augmentation. Diverting the water higher in the system would help alleviate any potential deleterious water quality effects of Utah Lake. This option requires additional investigation to determine feasibility, as there are many water rights and engineering issues that would need to be addressed. Existing storage and conveyance infrastructure above Utah Lake are owned by various entities and subject to existing contractual agreements.

Trans-basin water from the Colorado River watershed is another potential source of water for flow augmentation. This source of water has the same issues with storage and conveyance as the Utah Lake System water.

Transferring water within the basin or from another watershed for environmental and recreational flow augmentation purposes is potentially problematic due to the adverse effects on the source waterbodies. Therefore, this strategy is given lower priority.

*Legislation* Currently, only the Utah Division of Water Rights, Division of Wildlife Resources and Division of Parks and Recreation are allowed to hold water rights for instream flows. Another strategy for providing flow augmentation is to expand the list of entities allowed to hold instream flow rights. Recent legislative attempts have been made to expand the list; however, each of the bills has failed thus far. Expansion of the list of entities would encourage and assist the transfer of water rights for instream flow purposes.

Several Western states, including Colorado, only allow one entity to hold water rights for instream flow use. This may be a more efficient way to manage resources and instream flows; however, it may not be the most effective way to expand acquisition of instream flows.

*Stormwater Management Practices* Through development requirements and incentive programs, encourage the use of low impact design techniques to manage stormwater from existing and new developments. Stormwater that is infiltrated reduces stream flooding and adds to baseflow in the streams. Many structural techniques have been developed to promote infiltration of stormwater collected from impervious surfaces, including infiltration ponds, vaults and trenches (dry wells), and bioretention cells (rain gardens). Clustered development and the reduction of impervious surface also results in additional stormwater infiltration.

*Instream Flow Studies* A detailed study of instream flow conditions for each stream should be prepared in order to establish minimum instream flow required, as well as the benefits of providing a more natural flow regime, for aquatic and riparian species use and production. The purpose of conducting an instream flow study is to estimate the amount of habitat available at different flow rates. The results of the instream flow study would be used by program managers to make decisions on water rights acquisition based on the relative benefits of flow augmentation. The results of the instream flow study could also be used by water resource managers to make decisions on water use based on the evaluation of the impacts of altered flow on instream resources.

A typical detailed instream flow study includes: 1) a characterization of existing stream flow and hydrologic modification; 2) a characterization of existing physical habitat in the stream corridor; 3) an evaluation of current and potential aquatic and riparian species use and production; 4) a determination of the targeted species for the stream corridor 5) an evaluation of the potential benefits of flow augmentation based on the habitat preferences of the targeted species.

In order to determine the potential benefits of providing additional instream flows, the habitat preferences of the native and sport fish species at selected life stages must be determined. The habitat characteristics include stream cover, channel substrate, flow depth and flow velocity. Habitat preferences should be based on literature review and consultation with local experts. Further discussion of habitat preferences is included in the Habitat Planning Element section.

*Cloud Seeding* The Division of Water Resources currently has a cloud seeding program. This is a fairly high benefit to cost solution. The water produced by this effort could be used in flow augmentation efforts.

### 4.6.4.2 Flow Augmentation Screening

Streams in which flows have not been sufficiently altered to impair the presence and production of aquatic and riparian species do not require flow augmentation. Additionally, streams with reduced stream flows but without suitable physical habitat, i.e. a concrete channel with a disconnected floodplain, would not appreciably benefit from increased flows (at least until the physical habitat was restored). Ideally, the best candidates for flow augmentation would be those streams with good physical habitat where species use and production is limited by the alteration of hydrology. This section screens out those stream segments that would not benefit significantly from additional flow and removes them from further consideration for flow augmentation.

The mountain reaches of the east and west side streams have not experienced impairment to species use and production resulting from limited hydrologic modification. However, each stream in the Salt Lake valley has been hydrologically modified to some extent based on the characterization of existing flow conditions presented above. Due to the limited availability of physical habitat data, as well as aquatic and riparian species use and production, it was not possible to determine if the flow condition is the limiting factor to aquatic and riparian resource development. Therefore, only streams considered to have minor flow modification were removed from consideration for flow augmentation. Additional physical habitat data will be collected during 2007 and 2008, but were not available for the preparation of this planning element.

A summary of the stream segments removed from consideration for flow augmentation is presented in Table 4.6.12. No evidence was found to suggest that Kersey Creek and Lee Creek in the Great Salt Lake Sub-Watershed are flow limited and in fact, additional flow could be detrimental.

#### 4.6.4.3 Flow Augmentation Prioritization

In order to guide the acquisition of water rights and preparation of instream flow studies in a strategic and equitable manner, a framework was developed for the screening and prioritization of instream flow augmentation for the streams and rivers in Salt Lake County.

*Framework* The factors that should be considered in the prioritization of flow augmentation are presented below. The prioritization framework is conceptual and qualitative at this point and the factors have not been given numeric criteria for aggregation and comparison. The prioritization criteria and procedures need to be more fully defined and quantified during the implementation phase.

Water quantity Highest priority should be assigned to perennial streams that are interrupted, or dewatered, for some duration during the year as a result of flow diversions. Lower priority should be those streams that have reduced streamflows and/or are intermittent streams.

Flow hydrograph Highest priority should be given to those streams with the most alteration to their natural stream hydrograph due to water withdrawals, flow management and urbanization.

Physical habitat Highest priority should be assigned to those streams with the largest quantity of best quality physical habitat. Lower priority should be those streams with less quantity or poorer quality physical habitat.

Species diversity Highest priority should be assigned to those streams with the highest number of species present or possible. A lower weighting could be given to those with potential species use rather than existing use.

Targeted species Highest priority should be assigned to those streams with targeted species with the poorest population health.

**Table 4.6.12 List of Stream Segments Removed From Consideration for Flow Augmentation**

| Stream Segment | Basis |
|---|---|
| Upper City Creek above the water treatment plant | Limited or no impairment to aquatic and riparian resources due to alteration of natural flow regime |
| Upper Red Butte Creek above the Red Butte Reservoir | |
| Upper Emigration Creek | |
| Upper Parley's Creek | |
| Mountain Dell Creek above Mountain Dell Reservoir | |
| Lambs Creek above the diversion to Little Dell Reservoir | |
| Upper Mill Creek | |
| Upper Big Cottonwood Creek above the hydroelectric diversion | |
| Upper Little Cottonwood Creek above the hydroelectric diversion | |
| Upper Dry Creek above Bells Canyon Reservoir | |
| Upper Willow Creek | |
| Barney's Creek | |
| Coon Creek/Harkers Creek | |
| GSL: Kersey Creek/Lee Creek | Not flow limited |

Water rights availability Highest priority should be assigned to those streams with the most water users potentially interested in selling or leasing their water rights.

Community support Highest priority should be assigned to those streams with local and community support and involvement. It is anticipated that those streams with community support will have a higher likelihood to have cooperative water rights holders and implement low impact development standards.

*Preliminary Qualitative Ranking* Based on the considerations outlined in the previous section, a preliminary qualitative ranking of streams in Salt Lake County for flow augmentation was developed. Limited information was available for some of the considerations. The ranking and basis is summarized in Table 4.6.13.

The Jordan River was not considered in the ranking due to its size and importance. The Jordan River does not have a natural flow regime, due to the management of the outlet at Utah Lake, the management of the diversion at the Surplus Canal, irrigation diversions and wastewater treatment plant effluent. The Jordan River is discussed further below in the Recommendations section, as well as in the Utah Lake planning element.

**Table 4.6.13 Rank of Stream Segments for Flow Augmentation**

| Rank | Stream | Basis |
|---|---|---|
| 1 | Lower Big Cottonwood<br>Lower Little Cottonwood | Perennial stream with dewatered sections for some of the year, large quantity of suitable physical habitat, fish use, community support. |
| 2 | Lower Mill Creek | Perennial stream with potential current and future dewatered sections for some of the year and current reduced flows, large quantity of suitable physical habitat, fish use, community support. |
| 3 | Lower City Creek<br>Upper Parley's Creek<br>Lower Parley's Creek | Perennial stream with reduced stream flows and altered hydrographs for most of the year, limited quantity of suitable physical habitat, fish use. |
| 4 | Lower Emigration Creek<br>Lower Red Butte Creek | Perennial stream with reduced stream flows and altered hydrographs for some of the year, limited quantity of suitable physical habitat, fish use. |
| 5 | Lower Dry Creek<br>Lower Willow Creek<br>Lower Corner Canyon | Intermittent stream with dewatered sections for some of the year, limited quantity of suitable physical habitat, no fish use. |
| 6 | Bingham Creek | Perennial and intermittent stream segments with dewatered sections for some of the year, limited quantity of suitable physical habitat, no fish use. |
| 7 | Rose Creek<br>Midas/Butterfield Creek | Intermittent stream with reduced flows, limited quantity of suitable physical habitat, no fish use. |

### 4.6.5 Recommendations

In order to address the WaQSP strategic target, "Increase instream flows under normal and drought conditions to support aquatic habitat and recreational functions", the following recommendations are made:

#### 4.6.5.1 Programmatic

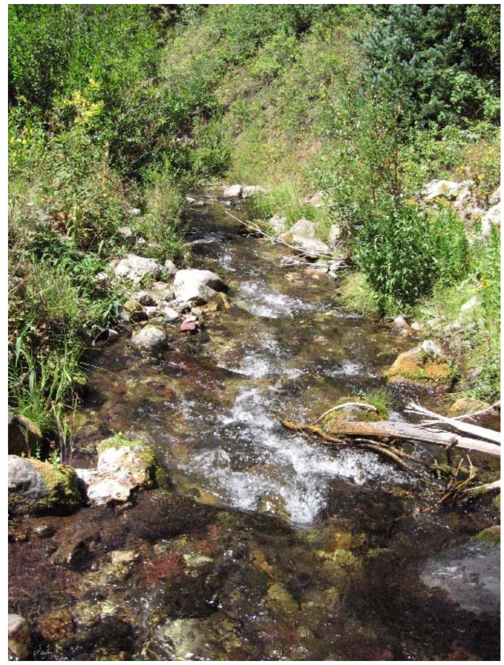
*Stream Gauging* Following are the recommendations for the Salt Lake County stream gauging program:

1. Improve the accuracy of measuring low flows at existing stream gauging stations to assist with the evaluation of critical low flow periods.
2. Publish sub-daily flow records for active stream gauges to assist in the determination of critical low flow periods.
3. Install additional flow gauges in currently ungaged streams, including Dry Creek, Willow Creek and Corner Canyon Creek.

*Water Rights Acquisition* Under the auspices of the Jordan River Watershed Coordinator, develop a program to identify water rights acquisition and flow augmentation opportunities. The following elements are recommended to be part of the program:

1. Develop funding mechanism for the acquisition of water rights for flow augmentation.


Bingham Creek, Lower Bingham Creek Sub-Watershed


Mill Creek, Upper Mill Creek Sub-Watershed

2. Review water rights and water shares currently owned by Salt Lake County for possible use for instream flows.
3. Develop protocols and numeric criteria for prioritizing flow augmentation opportunities.
4. Work collaboratively with water right/share owners to conduct an outreach effort to identify water users potentially interested in selling or leasing their water rights.

#### 4.6.5.2 Sub-Watershed Specific

*Wasatch Mountains* Initiate detailed instream flow studies on high priority stream segments or sub-watersheds to quantify the cost and benefits of flow augmentation. These studies will provide the basis for future management decisions regarding instream flows and flow augmentation opportunities.

*Oquirrh Mountains* With the highest projected growth and development, the focus of the Oquirrh Mountain sub-watersheds should be on the preservation of instream flows.

1. A rigorous review process is conducted for any proposed changes to water rights and

water use that could potentially reduce instream flows to the detriment of aquatic and riparian habitat. The review should include an instream flow study that determines the hydrology required to maintain the natural stream and riparian community.

2. Through the planning and permitting process, encourage the adoption of Leadership in Energy and Environmental Design criteria intended to reduce impervious area and promote stormwater infiltration in neighborhood and site developments. Recharge of the shallow aquifer is a critical component of the hydrology of the western streams.

*Jordan River* Conduct a detailed instream flow study that considers the hydrology and physical habitat of the Jordan River. The objective of the study would be to develop a management strategy for the releases from Utah Lake such that the flows in the Jordan River more closely resemble a natural flow regime that would benefit recreational and aquatic resources. The current management protocol only considers water users and flood control concerns. Development of the Utah Lake management strategy should be a cooperative effort between the Division of Water Rights (representing water distribution), Division of Water Quality, Salt Lake County and Utah County (representing flood control), and should integrate recommendations from future studies and/or TMDL recommendations to improve water quality. For further discussion on this recommendation, refer to the recommendation section in the "Affect of Utah Lake on Water Quality in Salt Lake County" Planning Element.

## 4.7 HABITAT

### 4.7.1 Introduction

This element of the plan responds to two stated objectives of this Water Quality Stewardship Plan (WaQSP), addressing 1) degraded physical habitat conditions in the watershed, and 2) the need for increased stream corridor and wetland preservation. These objectives reflect the importance of aquatic, riparian, and wetland habitats, both in their own right and as indicators of overall watershed health. This element is organized as follows:

- The Methods section describes the information sources and analytical techniques used to complete this element of the plan.
- The Existing Conditions section characterizes the current status of aquatic, riparian, and wetland habitats in each of the watersheds and sub-watersheds in the planning area. These assessments conclude by identifying, if possible, areas of degraded physical habitat in Wasatch Mountain streams, Oquirrh Mountain streams, the Jordan River Corridor, and shorelands of the Great Salt Lake.
- The Future Conditions section outlines trends in population, development, water availability and other factors that may influence aquatic, riparian, and wetland habitat in the planning area.
- The Habitat Deficiencies section categorizes and describes the broad types of habitat deficiencies found in the planning area and identifies where each type occurs.
- The Preservation, Conservation, and Restoration Opportunities and Techniques section identifies and addresses a suite of preservation, conservation, and restoration opportunities and techniques to address each type of habitat deficiency. These opportunities and techniques were assessed and prioritized in preparation of the Atlas of Opportunities chapter of this plan.
- The Information Needs section identifies critical gaps in the knowledge base available to support planning and management of the Salt Lake County's aquatic, riparian, and wetland habitats.

This element of the plan was prepared using existing information rather than data collected for this planning process. Published reports were the main source, augmented with "gray literature," digital data from various public, watershed-scale GIS databases, and some discussions with relevant agency personnel and researchers. Fieldwork was limited to spot checks of specific sites of concern. The coverage provided by existing information varies considerably within the planning area and, as a result, it was possible to address some watersheds and sub-watersheds in a much more detailed manner than others. Information on the southeast (i.e., streams from the southern portion of the Wasatch Mountains) and western (i.e., streams from the Oquirrh Mountains) portions of the planning area in particular is lacking.

In addition to limiting the scope of the analysis documented in this section, this situation also highlights the need for additional data collection – and specifically more uniform coverage of the planning area – to set the stage for effective analysis and planning.

This assessment of aquatic and riparian habitat focuses on a corridor encompassing each stream channel and adjacent riparian corridor; however, wetland habitat is not always confined to this area. Therefore, wetland habitat was examined as it occurs throughout the watershed.

As in much of the arid West, the extent and duration of flows in the waterways of Salt Lake County are a significant influence on aquatic, riparian, and wetland habitat conditions. This section does not include an assessment of biological interactions between stream hydrology and habitat conditions. Detailed information characterizing flows and the hydrology of streams is presented in the Instream Flows Planning Element, Section 4.6.

## 4.7.2 Methodology

### 4.7.2.1 Existing Conditions

As noted above, the methods used to characterize the existing condition of aquatic, riparian, and wetland habitat relied primarily on previous studies and thus on the technical methods used in each of those studies. Appendix D lists the documents reviewed and notes the geographic focus of each (i.e., Wasatch Mountains, Oquirrh Mountains, Jordan River, or Great Salt Lake shorelands) and the habitat types addressed. Appendix D also includes tables summarizing the information drawn from these documents for each planning area stream. The specific variables of interest for each of the three habitat types are discussed below in this methods section, and these variables are the basis of the stream-specific discussions under Existing Conditions (Section 4.7.3).

The amount of available information varied substantially among these areas of geographic focus and among the three habitat types considered. Because of this variation, the descriptions of existing conditions differ considerably in level of detail. In general, the most information was available on the Jordan River, followed by the Wasatch Mountains, then the Great Salt Lake shorelands, then the Oquirrh Mountains. In terms of habitat types, aquatic habitats have been studied more than riparian types, and wetlands are the least studied type.

Based on the general lack of riparian and wetland studies, supplemental information was drawn from existing GIS databases, particularly the U.S. Geological Survey's Southwest Regional Gap Analysis Program (GAP) and the U.S. Fish and Wildlife Service's National Wetland Inventory (NWI).

Gap analysis maps the distribution of plant communities and select animal species and compares these distributions with land stewardship to identify biotic elements at potential risk. The initial analysis for Utah was completed in 1995, and Utah has since participated in a coordinated regional effort, yielding the Provisional Southwest Regional Landcover Data (Lowry et al., 2005) consulted for this analysis.

Undercut bank habitat for fish and other organisms

The NWI was originally established in 1974 and later modified in 1986 by the Emergency Wetlands Resources Act. Ongoing improvements are intended to provide digital, geographic information on wetland and deepwater habitats for natural resource management and planning in support of the Fish and Wildlife Service's conservation goals. Improved coverage of Salt Lake County was completed in 2001.

Both of these databases reflect broad-based, remote sensing efforts and provide Countywide coverage, but both are subject to the inherent limitations of such large-scale undertakings (e.g., relatively coarse resolution/scale and limited site-specific detail). Specific applications of the GAP and NWI databases are discussed in more detail below under Riparian Habitat and Wetland Habitat.

Some of the key technical approaches employed in the reviewed studies or to supplement those studies for this analysis are described in the following discussions of habitat-specific methods.

*Aquatic Habitat* Aquatic habitat occurs in the stream channel itself and is spatially delimited by the width between channel banks and the length of the mainstem channel. Measures of aquatic habitat considered in this assessment include both physical and biological features of streams in the planning area. Some of the physical features reviewed and reported below under Existing Conditions include channel type, slope, dominant substrate, bank stability, ratio of pools to riffles, and channel entrenchment. Biological features of aquatic habitat include measurements of macroinvertebrate populations, habitat suitability and productivity projections, and fish species observed. The main methods employed to gauge these features are outlined below.

Many of the documents characterizing aquatic habitat in the planning area utilize the Rosgen (1996) method to classify stream channels. Many parameters included in the Rosgen method characterize stream channel morphology and bank stability. However, several parameters used in the Rosgen method can directly or indirectly indicate the condition of aquatic habitat features. For instance, channel substrate provides support for many life stages of fish and macroinvertebrates. Channel sinuosity, width:depth ratio, and pool:riffle ratio all indicate occurrence of habitat features needed to sustain viable aquatic populations. If a Rosgen assessment identifies a channel type that is not typical for a given watershed location, some problems are likely to exist that directly influence aquatic habitat.

A Rosgen stream channel assessment can be completed at different levels of detail ranging from a watershed scale Level I assessment involving little or no field work to a Level IV assessment that requires reach-specific observations and analyses. Published documentation of Level II and Level III Rosgen assessments were identified for many mountain and valley portions of Wasatch Mountain streams in the planning area. Figure 4.7.1 provides a summary of the Rosgen method and indicates several of the physical measures used to characterize stream channels. Particle size and distribution of stream substrate is a measure used by Rosgen and many others to assess aquatic habitat. Table 4.7.1 includes dimensions of typical particle size classes used in assessing substrate.

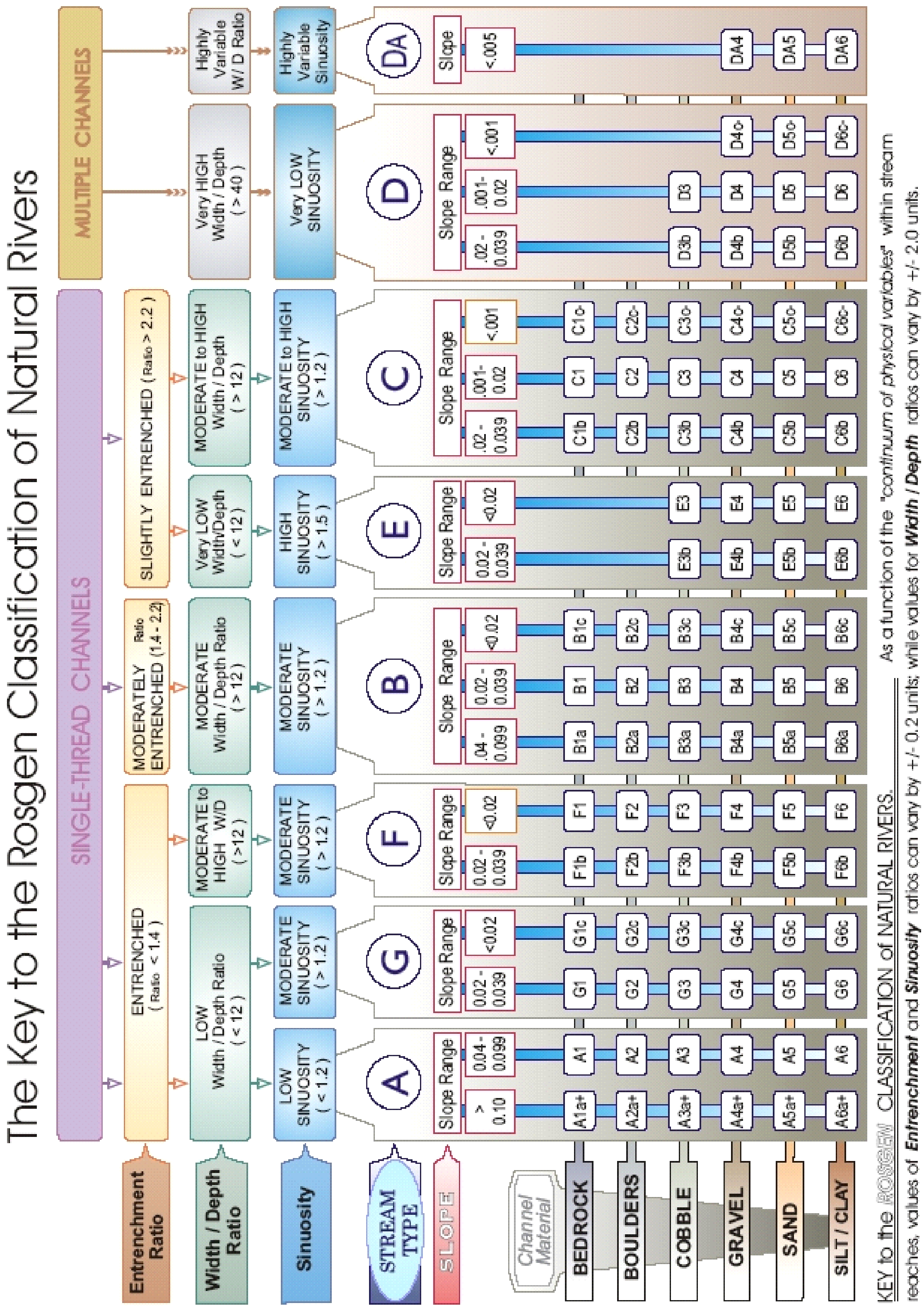
Stability of channel banks in the planning area was assessed in a number of reviewed studies using methodologies developed by Pfankuch (1975), USDA (1992), and Overton et al. (1997). The Pfankuch method was developed to systematically assess resistance of stream channels to bed and bank erosion as well as determine their ability to recover from changes in flow and sediment production. Table 4.7.2 indicates measures of bank and channel features used to determine levels of stability. The USDA and Overton et al. methodologies include a measure of bank stability as one part of an aquatic community habitat assessment. Channel banks considered as stable show no evidence of active erosion, breakdown, tension cracks, shearing, or slumping. Channel banks considered to be unstable show evidence of active erosion or bank sloughing. Undercut channel banks are considered stable in the absence of surface tension fractures. Overall, information on all or some combination of these physical parameters was located for most planning area streams.

A number of reviewed studies included surveys of aquatic macroinvertebrates to provide insights into habitat condition and water quality. As many types of macroinvertebrates are quite specific in their habitat preferences, particularly tolerance of pollutants, they are a useful barometer of aquatic habitat health. The studies reviewed reported a number of species lists, species associations, and indices based on the types and number of organisms found. Pertinent results are

**Table 4.7.1 Stream Channel Substrate Size Categories**

| Class | Dimension (mm) | Description |
|---|---|---|
| Sand | < 2 | Smaller than a lady bug. |
| Very Fine Gravel | 2-4 | Lady bug to marble size. |
| Fine Gravel | 4-8 | |
| Medium Gravel | 8-16 | |
| Coarse Gravel | 16-32 | Marble to tennis ball size. |
| Very Coarse Gravel | 32-64 | |
| Small Cobble | 64-90 | Tennis ball to basketball size. |
| Medium Cobble | 90-128 | |
| Large Cobble | 128-180 | |
| Very Large Cobble | 180-256 | |
| Small Boulder | 256-512 | Basketball to car size. |
| Medium boulder | 512-1024 | |
| Large Boulder | 1024-2048 | |
| Very Large Boulder | 2048-4096 | |
| Bedrock | >4096 | Bigger than a car. |

*Source: Particle size classes from Wolman, 1954.*




*Source: Applied River Morphology, Rosgen, 1996*

**Figure 4.7.1 Rosgen Stream Classification Key**

### Table 4.7.2 Pfankuch Bank Stability Assessment Methodology

| | Bank Feature | Excellent | Good | Fair | Poor |
|---|---|---|---|---|---|
| 1 | Landform Slope | Bank slope gradient <30% | Bank slope gradient 30—40% | Bank slope gradient 40—60% | Bank slope gradient >60% |
| 2 | Mass Wasting or Failure | No evidence of past or potential for future mass wasting. | Infrequent and/or very small Low future potential. | Moderate frequency and size with some raw spots. | Frequent or large, causing sediment nearly yearlong. |
| 3 | Debris Jam Potential | Essentially absent from immediate channel area. | Present but mostly small limbs and twigs. | Present, volume and size are both increasing. | Moderate to heavy amounts, predominantly larger sizes. |
| 4 | Vegetative Bank Protection | 90% plant density. | 70-90% plant density. | 50-70% plant density. | < 50% plant density. |
| 5 | Channel Capacity | Ample for present flows, Peak flows contained. W:D ratio < 7 | Adequate. Overbank flows rare. W:D ratio 8-15. | Occasional overbank flows. W:D ratio 15-25. | Inadequate. Overbank flows common. W:D ratio > 25. |
| 6 | Bank rock content | 65% with large, angular boulders 30cm numerous. | 40-65%, mostly small boulders to cobbles 15-30cm. | 20-401, with most in the 7.5-15cm diameter class. | <20% rock fragments of gravel sizes, 2.5-7.5 cm or less. |
| 7 | Obstructions (flow deflectors Sediment traps) | Rocks and old logs firmly embedded. Flow pattern without cutting or deposition. Pools and riffles stable. | Some present, causing erosive cross currents and minor pool filling. Obstructions and deflectors newer and less firm. | Moderately frequent, unstable obstructions and deflectors move with high water causing bank cutting and filling of pools. | Frequent obstructions and deflectors cause bank erosion. Sediment traps' full channel migration occurring. |
| 8 | Undercutting | Little or none evident. Infrequent raw banks <150cm high. | Some, intermittently at outcurves and constrictions. Raw banks <30cm. | Significant. Cuts 15-30cm high. Root mat overhangs and sloughing evident. | Almost continuous cuts, some >30cm high. Failure of overhangs frequent. |
| 9 | Deposition | Little or no enlargement of channel or point bars. | Some new increase in bar formation, mostly from course gravels. | Moderate deposition of new gravel and course sand on old and some new bars. | Extensive deposits of predominantly fine particles. Accelerate bar development. |
| 10 | Rock Angularity | Sharp edges and corners, plane surface roughened. | Rounded corners and edges, surfaces smooth and flat. | Corners, edges well rounded in 2 dimensions. | Well rounded in all dimensions, surfaces smooth. |
| 11 | Brightness | Surfaces dull, darkened, or stained. Generally not "bright". | Mostly dull, but may have up to 35% bright surfaces. | Mixture, 50-50% dull and bright, +/- 15%. | Predominately bright, 65%, exposed or scoured surfaces. |
| 12 | Consolidation or Particle Packing | Assorted sizes tightly packed and/or overlapping. | Moderately packed with some overlapping. | Mostly a loose assortment with no apparent overlap. | No packing evident. Loose assortment, easily moved. |
| 13 | Bottom Size Distribution and % Stable Materials | No change in sizes evident. Stable materials 80-100%. | Distribution shift slight. Stable materials 50-80%. | Moderate change in sizes. Stable materials 20-50%. | Marked distribution change. Stable materials 0-20%. |
| 14 | Scouring and Deposition | Less than 5% of the bottom affected by scouring and deposition. | 5-30% affected. Scour at constrictions and gradient changes. Some deposition in pools. | 30-50% affected. Deposits & scour at obstructions, constrictions, and bend. Some filling of pools. | More than 50% of the bottom in a state of flux or change nearly yearlong. |
| 15 | Clinging Aquatic Vegetation | Abundant. Growth largely moss-like, dark green, perennial. | Common. Algal forms in low velocity and pool areas. | Present but spotty, mostly in back water areas. | Perennial types scarce or absent. Yellow-green, short term blooms present. |

*Source: Pfankuch, 1975*

Native sedges and willows along Jordan River, Jordan River Corridor Sub-Watershed

summarized for each planning area stream for which they are available. Additional macroinvertebrate and habitat data will be available from DWQ's Environmental Monitoring and Assessment Program (EMAP) and Utah's Comprehensive Assessment of Stream Ecosystem (UCASE) Program. This data should be incorporated into future updates of the WaQSP as it becomes available.

Habitat preferences for each fish species identified in the planning area are provided in Table 4.7.3, including preferences for general habitat, cover, substrate, water depth, and velocity. A detailed characterization of flows is provided in Section 4.6 on instream flows. These characteristics were used in this analysis to determine the types of fish potentially occurring in all planning area streams.

Detailed field surveys of aquatic habitat in the mountain reaches of Big Cottonwood Creek, Little Cottonwood Creek, and Mill Creek were completed by the Wasatch-Cache National Forest. Measures of stream habitat and fish populations were collected from representative segments of each stream from the headwaters downstream to the valley margin. The type of habitat measurements collected varied based on the reach type, channel unit, and the habitat type. Fish populations were measured by snorkel survey and included every tenth slow water habitat as well as several non-turbulent fast water habitats.

Further stream-specific information on aquatic habitat condition was obtained from the Utah Division of Wildlife Resources (DWR) Jordan River Drainage Management Plan, Hydrologic Unit 16020204 (Thompson et al., 2005). This plan includes the results of an assessment using the Habitat Quality Index (HQI) method (Binns, 1982). The HQI method provides an index of trout stream health and productivity based on the following attributes: late summer stream flow, annual stream flow variation, maximum summer stream temperature, nitrate/nitrogen, fish food abundance, cover, water velocity, stream width, substrate, and bank erosion. Each of these attributes is given a number rating of 1 through 4 with 4 being the highest. The HQI rating is indicated in units of trout biomass per unit area. HQI rating for the hydrologic unit that includes the planning area ranged from 1 to 146 pounds/acre. Indices for most planning area streams are provided in this report and noted below.

DWR manages fishery resources in Salt Lake County. DWR management classifications associated with fishery resources are discussed in the section of this plan addressing instream flows (Section 4.6). One management class used by DWR to support native fish species is the Special Fish Species (SFS) category. The focus of this management class is on conserving and enhancing genetically unique special fish species within their historic habitats. Where possible, species associated with the SFS management class are incorporated into the DWR sport fish program (Thompson et al., 2003). Such designations are noted as appropriate below.

Documented population surveys were used to define documented use of planning area streams by fish species. The actual occurrence of fish species served in this analysis as a keystone indicator of aquatic habitat health; if the anticipated types and numbers of fish are not present, there is evidently some sort of habitat impairment. The impairment may be identified in existing studies or it may remain unknown, as discussed in the conclusion of each stream-specific write-up.

*Riparian Habitat* Riparian habitat generally incorporates all physical and biological resources found within the vegetated corridor adjacent to and supported by the stream channel. Vegetation types found in this corridor are generally comprised of a mixture of mesic grass, forb, shrub, and tree species. The main measures of

## Table 4.7.3 Habitat Suitability for Aquatic Species Located in Salt Lake County Streams

| Fish Species | General Habitat Type | Cover[1] | Substrate[2] | Water Depth | Water Velocity |
|---|---|---|---|---|---|
| Black Bullhead *Ameirus melas*[a,j] | 50-80% total stream area with low velocity pools/ backwaters and riffle-run areas | IS: ≥20% vegetation, brush, and debris | S: >50% fines<br>G: Silt | S: 0.5-1.5 m<br>G: Pools | S: Slow<br>G:Weak or absent; ≤4cm/sec |
| Brook Trout *Salvelinus fontinalis*[b,j] | Clear, cold water with riffle-run habitat, areas with slow, deep water and a 1:1 pool: riffle ratio | C: 50-75% mid-day shade.<br>IS: ≥10-25% vegetation, debris/logs, undercut banks, small boulders, deep water, and turbulence | S: 3-8 cm diameter gravel, ≤5% fines<br>G: Silt-free, rocky | G: >15 cm | S: 1-92 cm/sec<br>G: ≤15 cm/sec |
| Brown Trout *Salmo trutta*[c,j] | Clear, cool /cold water with 50-70% pools and 30-50% riffle-run habitat and areas with slow deep water | C: 50-75% mid-day shade.<br>IS: ≥10-35% vegetation, debris/logs, undercut banks, small boulders, deep water, and turbulence | S: 1-7cm diameter gravel, ≤5% fines<br>G: Silt-free, rocky | S: 24-46 cm<br>G: ≥15 cm | S: 40-70 cm/sec<br>G: ≤15 cm/sec |
| Channel Catfish *Ictalurus punctatus*[d,j] | Warm waters of deep pools and backwaters of rivers and lakes | IS: > 40% area with debris, logs, cavities, boulders, and undercut banks | S, G: Boulders, gravel, sand | S,G: Deep pools and littoral areas <5m. | S: Weak or absent<br>G: <15 cm/sec |
| Cutthroat Trout *Oncorhynchys clarkie*[e,j] | Clear, cold headwater streams and lakes with 1:1 pool to riffle ratio and areas of low velocity flow for feeding | C: 50-75% mid-day shade.<br>IS: ≥10-25% vegetation, debris/logs, undercut banks, small boulders, deep water, and turbulence | S: 1.5-6cm diameter gravel with ≤5% fines<br>G: Low-no silt, rocky | S: 18-61cm<br>G: 15-75cm | S: 30-60 cm/sec<br>G: Mix of riffle, run, and pool habitats with slow, deep areas. |
| Longnose Dace *Rhinichthys cataractae*[f,j] | Swift flowing, steep gradient, headwater streams with a mix of riffles and calm shallow areas | IS: Crannies between large rocks, gravel, and overhanging vegetation | S: 5-20cm diameter gravel/rock<br>G: Boulder-strewn with gravel and rock beds | S: Shallow areas<br>G: <0.3m and rarely >1.0m | S: Swift; 45-60 cm/sec<br>G: Swift; >45cm/sec |
| Mountain Sucker *Catastomus platyrhynchus*[j] | Cold, clear riffles of streams and rivers | | S: Gravel<br>G: Gravel, rubble, sand, or boulders | G: Shallow areas; 0.3-0.9m | G: Calm to swift |
| Rainbow Trout *Oncorhynchus mykiss*[g,j] | Clear, cold lakes and streams with 1:1 pool to riffle ratio. | C: 50-75% mid-day shade.<br>IS: ≥10-25% vegetation, debris/logs, undercut banks, small boulders, deep water, and turbulence | S: 1.5-10 cm diameter gravel, ≤5% fines<br>G: Silt-free, rocky | S: Shallow riffle areas<br>G: Deeper; ≥15cm | S: 30-70 cm/sec<br>G: ≤15 cm/sec |
| Utah Chub *Gila atraria*[j] | Diverse habitats including irrigation ditches, reservoirs, ponds, sloughs, creeks, large rivers, and large lakes | IS: Dense vegetation | G: Clay, mud, sand, gravel, peat, rubble, or marl | S: <0.61 m<br>G: 0.5-1.2 m | G: Calm or swift |

**Table 4.7.3 Habitat Suitability for Aquatic Species Located in Salt Lake County Streams—*Continued***

| Fish Species | General Habitat Type | Cover[1] | Substrate[2] | Water Depth | Water Velocity |
|---|---|---|---|---|---|
| Utah Sucker<br>*Catostomus ardens*[j] | Warm to cold waters of lakes, rivers, and creeks | | S: Gravel and sand<br>G: Mud, clay, sand, and gravel | | G: Absent or swift |
| Walleye<br>*Sander vitreus*[h,j] | Cool waters of rivers and lakes | IS: Deep or turbid waters, boulders, log piles, brush, dense underwater vegetation, and sometimes non-turbulent areas | S: 2.5-15 cm diameter gravel or dense vegetation free of sand & detritus<br>G: Clean, rocky, vegetated | S: 0.6-1.2 m<br>G: Shallow-moderate | S: Sufficient for oxygen circulation<br>G: Slow |
| White Bass<br>*Morone chrysops*[i,j] | Warm waters of larger rivers, lakes, and reservoirs | IS: Deep water | S: Gravel rocks, and vegetation<br>G: Sand, gravel, and rubble lacking high silt, high vegetation, and organic bottoms | S: 0.5-6 m<br>G: 0.5-3 m; dependent upon prey abundance | G: Slow |

[1] IS: In-stream C: Canopy [2] S: Spawing Grounds G: General Habitat

Sources:
[a] *Stuber, R.J. 1982. Habitat Suitability Index Models: Black Bullhead*
[b] *Raleigh, R.F. 1982. Habitat Suitability Index Models: Brook Trout*
[c] *Raleigh, R.F., Zuckerman, L.D., & Nelson, P.C. 1986. Habitat Suitability Index Models: Brown Trout*
[d] *McMahon, T.E. and Terrell, J.W. 1982. Habitat Suitability Index Models: Channel Catfish*
[e] *Hickman, T. and Raleigh, R.F. 1982. Habitat Suitability Index Models: Cutthroat Trout*
[f] *Edwards, E.A., Li, H., & Schreck, C.B. 1983. Habitat Suitability Index Models: Longnose Dace*
[g] *Raleigh, R.F, Hickman, T., Solomon, R.C., & Nelson, P.C. 1984. Habitat Suitability Index Models: Rainbow Trout*
[h] *McMahon, T.E., Terrell, J.W., & Nelson, P.C. 1984. Habitat Suitability Index Models: Walleye*
[i] *Hamilton, K. and Nelson, P.C. 1984. Habitat Suitability Index Models and Instream Flow Suitability Index Curves: White Bass*
[j] *Sigler, W.F. and Sigler, J.W. 1996. Fishes of Utah: a natural history*

riparian habitat considered in this assessment include area, vegetation community, and percent canopy cover.

At present, mapping has not been completed to define the functional boundaries of riparian corridors in the planning area. For this assessment, we used an estimate of riparian corridor width completed by Salt Lake County for valley portions of each watershed based on air photo interpretation of stream corridor vegetation. These figures are reported for the lower (valley) portions of the Wasatch and Oquirrh Mountain streams and the Jordan River. Recent data collection efforts associated with the Salt Lake County Stream Function Index could help further define riparian corridors in mountain and valley watersheds in the near future. Valuable information on conditions within these corridors will also be generated.

Riparian habitat has been recently assessed in the mountain portion of Big Cottonwood Creek, Little Cottonwood Creek, and Red Butte Creek by the Wasatch-Cache National Forest according to the protocol outlined in the *R1/R4 Northern/ Intermountain Regions Fish and Fish Habitat Standard Inventory Procedures* (Overton et al., 1997). Measures of riparian habitat included in these surveys, particularly the general vegetation types found within the riparian corridor, are summarized for upper sub-watersheds.

One important function of riparian areas is their hydrologic interaction with stream channels. Stream channels and riparian corridors have been drastically modified throughout most urban areas of Salt Lake County to meet development and flood control needs. Channelization has improved the ability of stream channels to convey flood waters but has often resulted in downcutting due to increased stream velocity. Much of the upstream load of sediment and bedload material has been diverted into irrigation diversions and is not available to replace material lost through downcutting. Removal of floodplains has also occurred due to encroachment by residential and commercial development.

These activities have served to disconnect stream channels from adjacent floodplains. This process has mostly occurred near perennial streams located on the east side of the planning area as well as the Jordan River. Similar development trends are taking place near intermittent and perennial streams located on the west side of the County. Municipal governments continue to receive steady pressure to develop the remaining open space in the Jordan River Corridor, which would exacerbate this problem. While some of the studies reviewed provide site-specific assessments of this problem (noted in the stream-specific sections below), it is more generalized through the valley portion of the planning area than these studies indicate.

GIS information was used where appropriate to supplement the assessment of existing riparian habitat conditions, particularly when little or no information was available in the form of documented surveys. The primary GIS database used in this effort was the Southwest Regional GAP land cover data (Lowry et al., 2005). This data has a 30-meter spatial resolution that could potentially exceed the width of riparian corridors in some locations. GAP data was used to identify the riparian vegetation types that are intersected by each stream channel. Specifically, this analysis included calculation of the linear intercept of planning area streams with GAP riparian land cover types. The GAP uses land cover classes drawn from EcoServe's Ecological System concept to map most of the 125 cover types. The remaining types are generally not characterized by natural vegetation (e.g., dunes, scars, agricultural, and various types of development).

The GAP riparian land cover types intersecting planning area stream corridors include the following, which are described in detail in Appendix E:

- Rocky Mountain Alpine-Montane Wet Meadow.
- Rocky Mountain Subalpine-Montane Riparian Shrubland.
- Rocky Mountain Lower Montane Riparian.
- Great Basin Foothill and Lower Montane Riparian Woodland and Shrubland.

It is important to emphasize that these GAP results do not provide a comprehensive catalog of planning area riparian vegetation. As noted


Wetland Habitat, Upper Mill Creek Sub-Watershed

above, the 30-meter resolution misses narrow riparian corridors, and riparian vegetation certainly occurs in other land cover types, whether characterized by natural vegetation communities, agriculture, or development. As a result, the GAP data should be interpreted as describing only the major, extensive riparian habitat types in the planning area.

*Wetland Habitat* Wetland habitat typically occurs as a transition between surface water and drier, upslope areas. Such habitat can become dry during certain times of the year but still perform important wetland functions. Wetlands in the planning area can be found within riparian corridors adjacent to streams and lakes as well as at locations of shallow groundwater or springs that support marshes or wet meadows.

This assessment of wetland habitat considered all available wetland data that could be located in the planning area. The main measures of wetland habitat considered in this assessment include wetland size and type. These measures are addressed for just a few planning area streams in the reviewed studies, as noted in the stream-specific sections below.

Salt Lake County's Wetland Advanced Identification Study (WAIDS) documents surveys of wetland habitat on the mainstem Jordan River and select headwater locations of Wasatch Mountain tributary streams. WAIDS surveys were initially completed on the Jordan River in 1987 to identify wetland areas damaged by dredge-and-fill activities and provide information for future preservation of wetlands (Jensen, 1987). Additional surveys were completed in Little Cottonwood Canyon and Big Cottonwood Canyon during 1993 and 2000, respectively, to better understand and preserve wetland function in areas serving as municipal watersheds. Pertinent information from these studies is noted in the description of existing conditions for these watersheds presented below.

GIS information was used to supplement the assessment of existing wetland habitat conditions when little or no information was available in the form of documented surveys. The primary GIS database used in this effort was the NWI completed by the U.S. Fish and Wildlife Service. The NWI classifications are described in the Service's *Classification of Wetlands and Deepwater Habitats of the United States* (Cowardin et al., 1979). In this analysis, classifications were limited to the system and class level, and the following types, which are described in detail in Appendix E occur in the planning area:

- Palustrine System: Forested, Scrub-Shrub, Emergent, Aquatic Bed, Unconsolidated Bottom, and Unconsolidated Shore Classes.
- Lacustrine System: Littoral and Limnetic Subsystems.
- Riverine System: Lower Perennial, Intermittent, and Unconsolidated Shore Subsystems or Classes.

*Wildlife* The health of aquatic, riparian and wetland habitat in Salt Lake County is essential to a diversity of animal species, including birds, fish, reptiles, invertebrates, and mammals for feeding, nesting, cover, and breeding. These areas provide hiding and thermal cover and favorable microclimates for many terrestrial vertebrate species because of increased humidity, a higher transpiration rate, shade, and increased air movement helping in homeostasis (a condition where energy expenditure is minimized), especially when surrounded by non-forested ecosystems. Wildlife use aquatic, riparian, and wetland zones significantly more than other habitats. In fact, these zones are the sole habitat for many species, and are often of prime importance to federally-listed and Utah threatened, endangered, and sensitive species.

While some of the reviewed studies did provide stream-specific wildlife information, the mobility of wildlife species coupled with broad extent and shared characteristics of wildlife issues suggests that these issues are best discussed at a Countywide rather than stream-specific level. As a result, a single discussion of wildlife issues is presented following the stream-specific write-ups below under Existing Conditions (Section 4.7.3).

The Common Moorhen: an uncommon wetlands visitor in Salt Lake County (Photo: Utah DNR)

For this analysis, a number of species lists including the Utah Sensitive Species List, the Utah Partners in Flight Priority List, the Utah Division of Wildlife Action Plan, and the Wasatch-Cache National Forest Management Indicator Species List were reviewed to identify those special-status species or species of particular conservation concern that are dependent on planning area aquatic, riparian, or wetland habitats during their life cycle.

#### 4.7.2.2 Future Conditions

The purpose of this aspect of the analysis is to determine how factors such as population growth and development, land use, and water availability and use might change in the future in ways that would affect aquatic, riparian, and wetland habitat conditions. Emphasis is placed on habitat deficiencies and how such changes might exacerbate or alleviate them. The primary information source was published projections regarding the identified factors, primarily from County and local governments (Section 4.7.4).

#### 4.7.2.3 Habitat Deficiencies

The methodology for locating and identifying habitat deficiencies also centered on review of published studies, supplemented with discussions with knowledgeable agency personnel and researches and limited site visits. Once deficiencies had been recorded for each watershed/sub-watershed, they were subjected to a basic cluster analysis to arrive at a classification based on key physical and functional similarities. This classification is detailed below under Habitat Deficiencies (Section 4.7.5).

#### 4.7.2.4 Preservation, Conservation, and Restoration Opportunities and Techniques

The methodology for identifying, describing, and assessing a suite of preservation, conservation, and restoration opportunities and techniques applicable to each of the habitat deficiency classes discussed above was based on technical expertise in the area of habitat management, coupled with review of documented preservation, conservation, and restoration efforts in the planning area. The focus was technical; it did not consider feasibility in terms of land ownership, administrative authority, access, etc. at this point, and did not attempt to identify or prioritize specific habitat projects. The results of this effort are reported below under Preservation, Conservation, and Restoration Opportunities and Techniques (Section 4.7.6).

A Deficient Reach along Little Willow Creek, Lower Willow Creek Sub-Watershed

### 4.7.3 Existing Conditions

The following discussion is broken down by region within Salt Lake County, first Wasatch Mountain streams, then Oquirrh Mountain streams, followed by the Jordan River, and finally the Great Salt Lake shorelands.

#### 4.7.3.1 Wasatch Mountain Streams

As noted above in the Methods section, these streams have been relatively well studied, particularly the upper sub-watersheds of the northern streams. This reflects their importance to the Wasatch Mountains in terms of potable water supply, flood conveyance, recreation, and other functions and values.

City Creek Watershed

#### City Creek

The City Creek Watershed is located in the northeast corner of Salt Lake County in the Wasatch Mountains. The watershed comprises 15,810 acres that range in elevation from approximately 4,300 feet to 9,400 feet.

City Creek is 11.8 miles long. Stream headwaters commence in a small basin high up in the canyon between approximately 8,000 and 9,000 feet and continue for 8 miles before arriving at the City Creek Water Treatment Plant about 3 miles above the mouth of the canyon. City Creek is a source of potable water for residents of Salt Lake City. The canyon is a protected watershed and is managed according to guidelines designed to protect and sustain water quality. No dwellings or overnight camping are allowed in City Creek Canyon.

City Creek, Upper City Creek Sub-Watershed

After portions of flow are taken for Salt Lake potable water at the treatment plant, the remaining city flow travels downstream past the canyon mouth and into the valley at an elevation of approximately 5,000 feet. The stream is routed entirely into the North Temple conduit downstream of Memory Grove Park and finally terminates at the confluence with the Jordan River.

Two sub-watersheds comprise the City Creek Watershed. Upper City Creek Sub-Watershed is 11,189 acres and contains the length of City Creek down to the water treatment plant as well as a small segment below the plant. The hydrologic classification of Upper City Creek is a mix of Perennial and Perennial-Reduced flows as a result of diversions for municipal water use. The Lower City Creek Sub-Watershed is 4,621 acres and contains 1.5 miles of Perennial stream channel (Figure 3.10.1).

The average annual precipitation ranges from 42 inches at the upper elevations to 11 inches in the valley (Figure 3.9.1).

A total of three studies were identified that describe habitat conditions in the City Creek Watershed, each of which provided information on aquatic and riparian habitat (Coon et al., 1982; Salt Lake County, 1978; Salt Lake County, 2007; Thompson et al., 2003; see Appendix D). No studies were located that describe wetland habitat in the watershed. The watershed falls within the coverage area of the GIS resources described above under Methodology.

*Aquatic Habitat - Upper City Creek* There is limited information documenting existing aquatic conditions in this sub-watershed. In general, the channel gradient in the canyon is moderately steep at upper elevations and becomes gentler as it approaches the canyon mouth. Above the water treatment plant, stream substrate includes limestone bedrock in some areas. Channelization and dewatering have degraded the upper reaches of City Creek in the past (Salt Lake County, 1978, Coon et al., 1982). The macroinvertebrate community is sparse, generally believed to reflect a lack of suitable habitat (Salt Lake County, 1978), suggesting that substrate and/or flows are lacking. No information on the other physical aquatic habitat parameters was found.

An HQI of 65 pounds per acre was calculated for City Creek by the Utah DWR. This value is in the mid- to lower-range of values observed for Wasatch Mountain streams.

While specific information on the physical characteristics of this aquatic habitat is limited, some inferences can be drawn based on the information outlined above and similarities with other Wasatch Mountain watersheds. Given the general characteristics of aquatic habitat and the habitat preferences shown in Table 4.7.3, aquatic habitat in this sub-watershed is considered suitable for cold water aquatic species.

The upper reaches of the sub-watershed support rainbow trout, cutthroat trout, and rainbow-cutthroat trout crosses. Lower reaches support brown trout and Bonneville cutthroat trout. Information on the size and health of fish populations is not available, but this species mix indicates that there are not major, sub-watershed wide habitat deficiencies. Dewatering of some reaches undoubtedly diminishes habitat values at these locations.

*Aquatic Habitat - Lower City Creek* No studies were located defining aquatic conditions in the Lower City Creek Sub-Watershed's 1.5 miles of stream habitat. The remainder of the stream is in the North Temple conduit. Insufficient information is available to identify or characterize aquatic habitat deficiencies in this sub-watershed.

*Riparian Habitat - Upper City Creek* In general, riparian vegetation in the upper elevations consists of fir, maple, birch, dogwood, chokecherry, and currant. GAP data defines approximately 3.6 miles of riparian habitat along the upper reaches of City Creek including 3.5 miles of Rocky Mountain Lower Montane Riparian Woodland and Shrubland and 0.1 miles of Rocky Mountain Subalpine-Montane Riparian Shrubland. No studies were located defining riparian canopy cover. Deficiencies in riparian habitat could not be identified due to data limitations.

*Riparian Habitat - Lower City Creek* The extent of the Lower City Creek riparian corridor has been estimated at approximately 40 acres. General vegetation descriptions for lower canyon elevations include cottonwood, maple, birch, box elder, and grasses. Streamside vegetation includes cottonwood, elm, maple, birch, box elder, and grasses.

GAP data indicates that approximately 0.8 miles of Rocky Mountain Lower Montane Riparian Woodland and Shrubland occurs along Lower City Creek. Based on limited data available, riparian habitat deficiencies could not be characterized.

*Wetland Habitat - Upper City Creek* No site-specific studies on wetlands in this sub-watershed were located. The National Wetlands Inventory classifies approximately 23 acres of wetlands in the sub-watershed. The most common wetland types are Palustrine Emergent wetlands comprising 10 acres followed by Palustrine Forested wetland types with 7 acres. Most wetlands are located adjacent to upper stream segments in the sub-watershed. Wetland habitat deficiencies could not be defined due to the limited data available.

City Creek, Lower City Creek Sub-Watershed

*Wetland Habitat - Lower City Creek* No wetlands information was located for this sub-watershed, including a thorough review of the NWI. Insufficient information is available to identify or characterize wetland habitat deficiencies in this sub-watershed.

### Red Butte Creek

Red Butte Creek Watershed is located in the northeast corner of the County in the Wasatch Mountains. A total of 7,055 acres are found in the watershed ranging from 4,300 feet to 8,200 feet. Use of the Red Butte Canyon area is limited to research purposes and watershed functions.

Red Butte Creek is 6.8 miles long. Stream headwaters commence at an elevation of approximately 8,200 feet. The creek flows downstream into Red Butte Reservoir at 5,380 feet. Below this point, the creek flows through a series of landscaped ponds near Fort Douglas and is eventually transferred into a culvert at 1100 East. It then flows through a small pond and on to the 1300 South Conduit near 1100 East, which eventually discharges into the Jordan River at approximately 4,300 feet elevation.

The Red Butte Creek Watershed is comprised of two sub-watersheds. Upper Red Butte Creek Sub-Watershed is 5,403 acres. The upper flows are predominately Perennial with a small amount of Perennial-Reduced conditions (Figure 3.7.1).

Lower Red Butte Creek sub-watershed is 1,652 acres and contains approximately 4.7 miles of the creek. Lower Red Butte Creek flows are Perennial-Reduced with a limited amount of Intermittent-Reduced flows (Figure 3.10.1).

The average annual precipitation ranges from 32 inches at the headwaters to 11 inches in the Salt Lake Valley (Figure 3.9.1).

Six documented studies were identified for the Red Butte Creek Watershed that provide general descriptions of aquatic and riparian habitat (see Appendix D). No studies were located that describe wetland habitat in the watershed. The watershed falls within the coverage area of the GIS resources described above under Methodology.

*Aquatic Habitat - Upper Red Butte Creek* Red Butte Creek begins as a silt-dominated, entrenched channel that is confined throughout much of its length by steep canyon walls. The lower canyon elevations include rubble/gravel substrate as well as cobble, boulder, and silt. Near the canyon mouth, channel substrate transitions to an unconsolidated mixture of cobble, gravel, and sand. The stream channel is considered largely unstable due to a very high sediment supply from both upslope and channel- derived sources (Wasatch Cache National Forest, 2006).

The overall channel gradient in the canyon ranges from 3 to 13 percent, with an overall average slope of 6 percent. Rosgen channel types range from A5 to G4 with more stable A streams in the upper elevations and unstable G streams found at lower elevations. Mass-wasting processes are characteristic of G channel types with fine alluvial silts and/or clays contributing to debris avalanche and debris torrents (Rosgen, 1996).

Bank stability in the sub-watershed appears poor on average and ranges from 10 to 80 percent stable, with an average of 39 percent stable (Wasatch Cache National Forest, 2006) per Overton et al. (1997). Large numbers of beaver dams may be responsible for high amounts of silt deposition found in stream channel segments (Jensen, 1996).

Red Butte Creek Watershed

Macroinvertebrates are assumed to be common and dominated by mayflies. An HQI of 75 pounds per acre was calculated for the upper half of Red Butte Creek. Similar to City Creek, this value is in the mid- to lower-range of values observed for Wasatch Mountain streams.

Although information describing the physical characteristics of aquatic habitat in the sub-watershed is limited, similarities between this and other Wasatch Mountain watersheds provide a basis for comparison. Given the general characteristics of aquatic habitat and the habitat preferences shown in Table 4.7.3, aquatic habitat in this sub-watershed is considered suitable for cold water aquatic species.

Upper Red Butte Creek currently supports Bonneville cutthroat trout. Brook trout previously occurred in the creek but appear to be no longer present. No fish occur below the reservoir (Salt Lake County, 1978; Thompson et al., 2003; Coon et al., 1982). Deficiencies in fish habitat appear to include highly silted stream substrate and poor bank stability. The level of impact of sedimentation on aquatic species is not known at this time. Under optimal conditions, habitat of this quality would likely support a number of cold water fish species.

*Aquatic Habitat - Lower Red Butte Creek* Lower Red Butte Creek extends from the mouth of Red Butte Canyon downstream to approximately 1100 East where all flow enters a stormwater conduit and eventually discharges into the Jordan River near 1300 South. Channel substrate is a heterogeneous mixture of cobble, gravel, and sand until 1500 East where it becomes dominated by gravel. The stream channel is entrenched and deeply incised at the canyon mouth (Salt Lake County, 2005) and becomes less entrenched as it passes over the valley floor. Channel widths vary between 5 and 15 feet. Channel gradients in the sub-watershed range from 4 to 7 percent with an overall average of 5 percent. Rosgen channel types range from B4 to G3.

Pfankuch bank and bed stability ratings are mainly fair to good for most of the creek's valley reaches but poor between 1500 and 1300 East (Salt Lake County, 2005). Between Sunnyside Avenue and 1300 East, vegetative bank protection is very poor. Nearly all segments maintain a low bank rock content and indicate some evidence of channel downcutting (Salt Lake County, 2005). Measurements of upper bank mass wasting range from very poor to excellent, with nearly half of the reaches rating fair to very poor (Salt Lake County, 2005). No information on other physical aquatic habitat parameters was found.


Red Butte Creek, Upper Red Butte Creek Sub-Watershed

The streambed between Red Butte Garden and Chipeta Way appears to be most degraded, having very poor Pfankuch ratings for consolidation of particles, fair to very poor ratings for bottom size distribution, excellent to very poor ratings for scouring and deposition, and poor ratings for aquatic vegetation. In other reaches, ratings for aquatic vegetation and rock angularity are generally fair. The overall Pfankuch streambed composite rating is fair to good in most areas but poor between Red Butte Garden and Chipeta Way and also between 1500 and 1300 East (Utah Division of Parks and Recreation, 1993).

Measurements of aquatic habitat characteristics indicate this portion of Red Butte Creek is capable of supporting cold water aquatic species. At present, impacts on aquatic habitat appear to be substantial with potential to limit self-sustaining populations.

No fish populations have been observed in aquatic surveys of this sub-watershed (Thompson et al., 2003). Degradation of the stream channel is due to urbanization encroachment, poor bank stability, and channelization in some areas (Salt Lake County, 2005).

View of a pond in Red Butte Gardens, Lower Red Butte Creek Sub-Watershed

*Riparian Habitat - Upper Red Butte Creek* Specific, detailed data on riparian habitat conditions in the Upper Red Butte Sub-Watershed is lacking. Overall streamside vegetation consists of birch, dogwood, elm, box elder, cottonwood/aspen trees, willow, horsetail, grasses, and scrub oak. The stream is well-shaded above Red Butte Reservoir.

GAP data indicate the presence of 2.3 miles of Rocky Mountain Lower Montane Riparian Woodland and Shrubland types along the upper reach of Red Butte Creek. No studies were located defining riparian canopy cover. Deficiencies in riparian habitat could not be identified due to data limitations.

*Riparian Habitat - Lower Red Butte Creek* Based on Salt Lake County's estimates, the lower Red Butte Creek riparian corridor is approximately 58 acres. In general, streamside vegetation consists of elm, maple, ash, and chestnut trees, scrub oak, rose, and grasses. GAP data identified approximately 0.5 miles of Rocky Mountain Lower Montane Riparian Woodland and Shrubland adjacent to Red Butte Creek. As noted above, downcutting and floodplain detachment are severe near the canyon mouth but decrease across the valley floor. Beyond that, riparian habitat deficiencies could not be defined due to the limited data available.

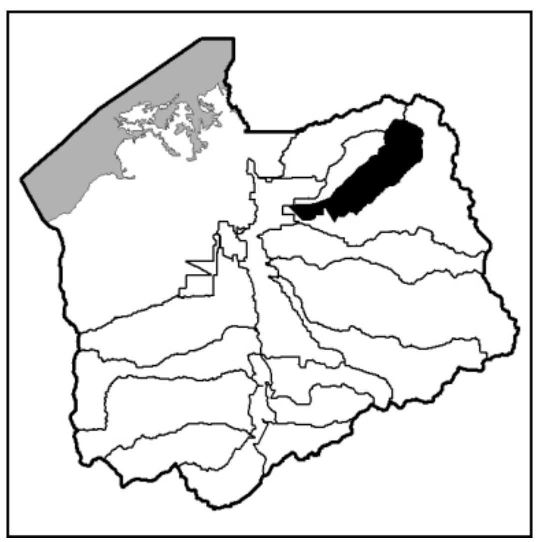
*Wetland Habitat - Upper Red Butte Creek* Based on the NWI, 26.8 acres are classified as wetlands in the sub-watershed. Of this total, 6 acres of Palustrine Scrub/Shrub and Forested wetlands are located on the north side of the sub-watershed away from the stream corridor. The remaining portion includes 5.7 acres of Palustrine Aquatic Bed, 0.7 acres of Palustrine Emergent wetlands found adjacent to Red Butte Creek, and 12.1 acres of Lacustrine Scrub/Shrub wetlands associated with Red Butte Reservoir. Based on limited data available, wetland habitat deficiencies could not be characterized.

*Wetland Habitat - Lower Red Butte Creek* The NWI classifies 6 acres of Palustrine Aquatic Bed wetlands adjacent to the stream channel and stormwater conduit including a wetland area near the sub-watershed outlet. Wetland habitat deficiencies could not be defined due to the limited data available.

## Emigration Creek

The Emigration Creek Watershed is located in the northeast corner of Salt Lake County in the Wasatch Mountains. The watershed comprises 15,377 acres and ranges in elevation from 6,000 feet at the headwaters to 4,300 feet in the Salt Lake Valley, in close proximity to shopping centers, a golf course, and a zoo.

The creek is 15.2 miles and is fed by convergent stream flow of Killyon and Burr Fork canyons along with several mountain springs near the headwaters. Stream headwaters commence in a small open valley near the top of Emigration



Emigration Creek Watershed

Canyon at an elevation of approximately 6,000 feet. The creek flows downstream past the entrance of the canyon and starts into the Salt Lake Valley at an elevation of 4,917 feet. If flow remains at this point, it continues past Westminister College into a storm drain at 1150 East which ultimately directs the creek to the 1300 South Conduit and into the Jordan River at approximately 4,300 feet elevation.

Of all the Wasatch Mountain streams, Emigration Creek is the most developed. Most of the stream corridor is on private property and follows the highway in most areas. Water use is primarily for irrigation in Pioneer and Liberty Parks and Mount Olivet Cemetery. Only spring water from Emigration Canyon is used for potable purposes.

Two sub-watersheds comprise the Emigration Creek Watershed. Upper Emigration Creek Sub-Watershed comprises 11,635 acres. The upper flows are predominately Intermittent mixed with Perennial flow conditions (Figure 3.10.1). Lower Emigration Creek Sub-Watershed is 3,742 acres. The lower reach flow conditions are predominantly Perennial-Reduced (Figure 3.10.1).

The average annual precipitation ranges from 32 inches at the headwaters to 11 inches in the Salt Lake Valley (Figure 3.9.1).

A total of four studies were located that documented aquatic and/or riparian habitat conditions (see Appendix D). No studies of wetland habitat were located. Information was located on all parameters considered in this assessment of aquatic, riparian, and wetland habitat with the exception of pool to riffle ratio and macroinvertebrate data on Emigration Creek. The watershed falls within the coverage area of the GIS resources described above under Methodology.

*Aquatic Habitat - Upper Emigration Creek* The channel gradient in the canyon ranges from 1 to 8 percent, with an overall average slope of about 3 percent. The dominant stream substrate throughout the canyon is cobble/gravel, but intermittently includes silt, bedrock, and boulders. From the top of the canyon downstream to the canyon mouth, the creek is characterized as a moderately entrenched channel dominated by cobble materials.

At mid-canyon elevations, the stream transitions to a slightly entrenched, meandering, riffle/pool, cobble and gravel-dominated channel. In the lower canyon elevations, the channel becomes moderately entrenched dominated by gravel material and characterized as a series of rapids with irregular spaced scour pools. Specific bank stability ratings have not been calculated; however, some sloughing, steep banks, and bank erosion is noted to occur in some reaches such as between Emigration Canyon Road switchbacks and 5584 E (Salt Lake County, 2005).

Upper Emigration Creek begins as a Rosgen stream type B3 at its headwaters and changes to types C3 and C4 at mid-canyon elevations. At lower canyon elevations, the channel is mainly characterized by stream types B3 and G4.

The Pfankuch rating for aquatic vegetation in the canyon portion is only fair in several areas. Impacts appear to minimally affect the streambed because the Pfankuch rating for overall stream bed composite is good in nearly all of the upper reaches of the creek.

Based on these physical characteristics, aquatic habitat in the sub-watershed is suitable for cold water fish species. HQI values ranging from 112 pounds per acre to 320 pounds per acre were calculated for upper elevation stream segments. The upper portion of this range exceeds any HQI values calculated for Wasatch Mountain streams in Salt Lake County.

Degradation of fish habitat has occurred due to the high degree of development. Impacts include

Emigration Creek, Upper Emigration Creek Sub-Watershed constructed step pools, pollution from nearby construction projects, sanitary wastes from holding and septic tanks, debris and litter from yard work, trash, etc. (Salt Lake County, 1978; Salt Lake County, 2005).

*Aquatic Habitat - Lower Emigration Creek* From the mouth of Emigration Canyon downstream to the entrance of the storm drain at 1150 East, Lower Emigration Creek is classified as a moderately entrenched stream dominated by sand-sized materials including grussic granite, eolian sand deposits, and colluvial deposits. The remaining two-thirds of the stream is dominated by gravel material. The channel gradient ranges from 2 to 4 percent, with an overall average of 3 percent. The creek begins as a Rosgen type B5 then transitions to type B4 for the remaining two-thirds of the distance to 1150 East.

Pfankuch bank and bed stability ratings for nearly the entire creek are very poor to fair with poor ratings concentrated between Bonneville Golf Course and 1700 East (Salt Lake County, 2005). No data is available on pool to riffle ratios for Lower Emigration Creek.

The streambed between 1700 East and 1300 East in Salt Lake City rates fair to very poor for Pfankuch rock angularity. Bottom size is fair in most areas, but very poor between Bonneville Golf Course and Foothill Boulevard. This area also rates very poor for the consolidation of particles category. Most reaches have fair scouring and aquatic vegetation ratings. Between 1700 East and 1900 East, these categories are very poor. The Pfankuch rating for overall stream bed composite is fair to poor for all reaches in the Lower Emigration Creek Sub-Watershed (Salt Lake County ,2005).

Emigration Creek, Lower Emigration Creek Sub-Watershed

Based on these physical characteristics, aquatic habitat in the sub-watershed is suitable for cold water fish species. Emigration Creek supports Bonneville cutthroat trout at the sub-watershed's higher reaches. Little of the natural habitat remains in the valley portions (Coon et al., 1982). Channelization, dewatering, and bank erosion degrade fish habitat in the valley portion of Emigration Creek.

*Riparian Habitat - Upper Emigration Creek* In general, streamside vegetation near the headwaters of upper Emigration Creek consists of box elder, cottonwood, maple, scrub oak, dogwood, alder, river birch, willow, grasses, mustard, clover and serviceberry. Based on the Pfankuch rating method, vegetative coverage ranges from bare to excellent in the sub-watershed. Vegetation is denser where development is more distant from the stream corridor. In some areas, the understory is discontinuous. Some riparian vegetation has been altered to landscape yards (Salt Lake County, 2005). The GAP data classified Rocky Mountain Lower Montane Riparian Woodland and Shrubland occurring along 6.8 miles of upper Emigration Creek.

The upper bank Pfankuch landform slope and vegetative bank protection ratings range from excellent to very poor, but many are fair to very poor in both categories. About half of the lower reaches rate fair to very poor for mass wasting and fair for debris jam potential. The composite rating for the upper bank is fair to poor in general. The lower bank Pfankuch bank rock content rating is fair to very poor throughout. Most reaches have good to excellent ratings for cutting, with some only rating fair. The middle reaches rate fair for deposition. The composite rating for the lower bank is good to fair for all reaches in the sub-watershed. This is also the case for the overall Pfankuch composite rating (Salt Lake County, 2005).

No other riparian habitat information was located for the Upper Emigration Creek Sub-Watershed. The major habitat deficiencies suggested by the information reviewed include encroachment, damage to/replacement of native vegetation, and localized damage due to sloughing, mass wasting, trampling, and other surface damage.

*Riparian Habitat - Lower Emigration Creek* Salt Lake County estimates that approximately 84 acres of riparian corridor lie along the lower reach of Emigration Creek. Urbanization and channelization have altered the natural character of the stream channel. Much of the native vegetation has been displaced; although in some areas box elder, scrub oak, willow, and June grass can be seen. Many areas contain no undergrowth (Salt Lake County, 2005).

Channel widths in the lower Emigration Creek vary between 10 and 15 feet. For the upper bank, Pfankuch landform slope ratings are very poor throughout. Mass wasting is fair and bordering poor for nearly all reaches and very poor in some reaches. Debris jam potential is good, in general, but some areas rate only fair. Vegetative bank protection ranges from good to very poor. Most fair to poor reaches occur at the top and bottom of the sub-watershed. The composite rating for the upper bank is fair to poor throughout. Nearly all reaches in the sub-watershed are very poor for bank rock content in the lower banks. Obstruction to flow is very poor between Foothill Boulevard and 1900 East and fair from this point downstream to 1300 East. Cutting and deposition ratings are fair for nearly all of the lower reaches, but some are very poor. The composite rating for the lower bank is mainly fair to poor throughout. This is also the case for the overall Pfankuch composite rating (Salt Lake County, 2005).

No other riparian habitat information was located for the Lower Emigration Creek Sub-Watershed. The major habitat deficiencies suggested by the information reviewed include floodplain detachment, lack of vegetation, particularly native undergrowth, and localized damage due to sloughing, mass wasting, trampling, and other surface damage as well as significant encroachment.

*Wetland Habitat - Upper Emigration Creek* NWI data for the sub-watershed indicates that approximately 11 acres of wetlands occur in the upper Emigration Creek Sub-Watershed. Of the total, 9 acres of Palustrine Emergent and Palustrine Scrub/Shrub types dominate the wetland areas. No conclusions can be drawn regarding habitat impairment based on the information reviewed.

*Wetland Habitat - Lower Emigration Creek* Based on the NWI, only 1 acre of intermittently exposed Palustrine Aquatic Bed wetland type occurs in the sub-watershed. No conclusions can be drawn regarding habitat impairment based on the information reviewed.

## Parley's Creek

The Parley's Creek watershed is located in the northeast corner of the Wasatch Mountains and is the largest mountain drainage area near Salt Lake City. The watershed contains a total of 37,383 acres.

Parley's Creek watershed contains 22.3 miles of stream (Lambs Canyon 5.3 miles, Mountain Dell Canyon 6.2 miles, Parley's Creek 10.8 miles). Stream headwaters commence in Mountain Dell Canyon to the northeast and Lambs Canyon to the southeast of Parley's Canyon, forming a "T" shape.

Much of the water from Parley's Creek is diverted and stored in Little Dell and Mountain Dell Reservoirs. These structures were initially constructed for water supply and flood control purposes and are currently managed by the Salt Lake City Department of Public Utilities (Army Corps of Engineers, 1993). Stored water is utilized to meet potable water and recreation needs as well as coldwater fishery habitat.

Parley's creek is directed to an underground conduit below Mountain Dell Reservoir until it surfaces at the mouth of the canyon and starts

Parley's Creek Watershed

Parley's Creek, Upper Parley's Creek Sub-Watershed

into the Salt Lake valley at an elevation of approximately 4,700 feet. It parallels Interstate 80 until reaching the Country Club Golf Course where it continues on through Sugar House Park, eventually flowing underground into the 1300 South Conduit. Flow from Parley's, Emigration, and Red Butte Creeks converge in the Conduit before terminating at the Jordan River at approximately 4,300 feet elevation.

Two sub-watersheds comprise Parley's Creek Watershed. The Upper Parley's Creek Sub-Watershed is 33,271 acres and contains 10.8 miles of Parley's Creek. Flows in the upper reaches of the sub-watershed are Perennial and Perennial-Reduced. Lower Parley's Creek Sub-Watershed is 4,112 acres and contains 3.3 miles of the lower reaches of Parley's Creek. Flow conditions in the lower sub-watershed are Perennial-Reduced and Intermittent-Reduced in the reaches until it reaches the 1300 South Drain Conduit (Figure 3.10.1).

The average annual precipitation ranges from 42 inches at the headwaters to 11 inches in the Salt Lake Valley (Figure 3.9.1).

A total of four studies were identified that described habitat conditions in the Parley's Creek watershed, each of which provided information and aquatic, riparian, and wetland habitat (see Appendix D). The watershed falls within the coverage area of the GIS resources described above under Methodology.

*Aquatic Habitat - Upper Parley's Creek* Very little specific information is available for aquatic habitat conditions in the upper reaches of Parley's Creek. The upper reaches of Parley's Creek are characterized by soil that is deep to shallow and well-drained. Based on information provided prior to the 1993 completion of Little Dell Reservoir, the stream was considered to be in good condition and bank stability was excellent above Mountain Dell Reservoir.

An HQI of 110 pounds per acre was calculated for the upper reaches of Parley's Creek from 5,420 feet to 6,052 feet in elevation. Mountain Dell Creek has an HQI of 51-124 pounds per acre. Both are mid to high range of values observed for the Wasatch Mountain Streams.

Within the canyon, Parley's Creek and its tributaries including Mountain Dell Creek, support Bonneville cutthroat trout; however brown trout, brook trout, and native cutthroat trout do occur in Little Dell Reservoir. Macroinvertebrates are present in Parley's Creek, but more detailed information could not be found.

Based on the available information, factors limiting aquatic habitat conditions suitable for fish populations include channelization and the installation of culverts below Mountain Dell Reservoir to the canyon mouth have degraded natural stream channel conditions of Parley's Creek (Coon et al., 1982). The proximity of Interstate 80 to the stream may reduce water quality.

*Aquatic Habitat - Lower Parley's Creek* Parley's Creek from the mouth of Parley's Canyon downstream to 1150 East at the beginning of a storm drain culvert is comprised of rocks and gravel covered in sediment, with occasional gravel bars. The channel is characterized as a moderately entrenched channel dominated by gravel material until the culvert entrance. The gradient here ranges from 2 to 3 percent, with an overall average of approximately 2 percent. Pfankuch bank and bed stability ratings in the valley range from fair to good.

Gabions or cement walls line the stream corridor in some areas. Channel widths vary between 10 and 25 feet. For the lower bank, Pfankuch bank-rock content is fair for all valley reaches, with the exception of Sugar House Park, which is very poor. The overall lower bank composite is good near the Country Club Golf Course, but fair for all other reaches. For the upper bank, Pfankuch landform slope is poor at the Country Club Golf Course, mass wasting is fair from Sugar House Park to Hidden Hollow. The overall upper bank composite is good near Parley's Historic Park, but fair for all other reaches. Aquatic vegetation is good at Sugar House Park, but fair for other valley stretches. Creek sites at Parley's Historic Park and Sugar House Park rate very poor for bank erosion, slumping, and sloughing and for scouring and deposition. High surface fines characterize overall sedimentation at Parley's Historic Park to Sugar House Park. The obstruction to flow rating is very poor for the entire valley creek. Very little information is available on pool to riffle ratios for the lower reaches of Parley's Creek. The overall Pfankuch composite rating for the valley reaches of Parley's Creek is fair for all reaches (Salt Lake County, 2005).

In the higher valley elevations, Parley's Creek supports Bonneville cutthroat trout. Macroinvertebrates are present in the valley reaches, but more detailed information could not be found.

Current habitat conditions can adequately sustain cold water species. Given the physical characteristics of these conditions, the habitat values have been degraded by urbanization encroachment and channelization (Salt Lake County, 1978; Coon et al., 1982).

*Riparian Habitat - Upper Parley's Creek* Streamside vegetation along the upper reaches of

Parley's Creek, Lower Parley's Creek Sub-Watershed

Parley's Creek Diversion Facility

Parley's Creek consists of conifer, aspen, scrub oak, birch, willow, hawthorne, and grasses. Based on visual assessments, stream shading is excellent above Mountain Dell Reservoir; although once again, this information has not been updated since the 1993 completion of Little Dell Reservoir, which is positioned just above Mountain Dell Reservoir. GAP data defines approximately 1.0 mile of Rocky Mountain Lower Montane Riparian Woodland and Shrubland that occur along the upper reaches of Parley's Creek. Deficiencies in riparian habitat could not be identified due to data limitations.

*Riparian Habitat - Lower Parley's Creek* The extent of the lower Parley's Creek riparian corridor has been estimated at approximately 36 acres. Urbanization and channelization have altered the natural character of the stream channel and much of the native vegetation has been displaced; although cottonwood, box elder, hawthorne, willow, and Russian olive can be found along the stream bank (Salt Lake County, 1978; Salt Lake County, 2005; Coon et al., 1982).

Based on the GAP data, approximately 0.6 miles of Rocky Mountain Lower Montane Riparian Woodland and Shrubland occur along the lower reaches of Parley's Creek. Deficiencies of the riparian habitat could not be characterized based on the limited available data.

*Wetland Habitat - Upper Parley's Creek* No site-specific studies on wetlands in the sub-watershed were located. The NWI classified approximately 121 acres of wetlands in the sub-watershed. Lacustrine Limnetic wetlands dominate the wetland types. Other types include Palustrine Aquatic Bed, Palustrine Scrub-Shrub, Palustrine Emergent, Palustrine Unconsolidated Shore, and Palustrine Forested. Based on the available data, wetland habitat deficiencies could not be defined.

*Wetland Habitat - Lower Parley's Creek* The NWI classified approximately 7 acres of Palustrine Aquatic Bed wetlands that occur in the sub-watershed. No additional data is available to characterize the wetland habitat deficiencies.

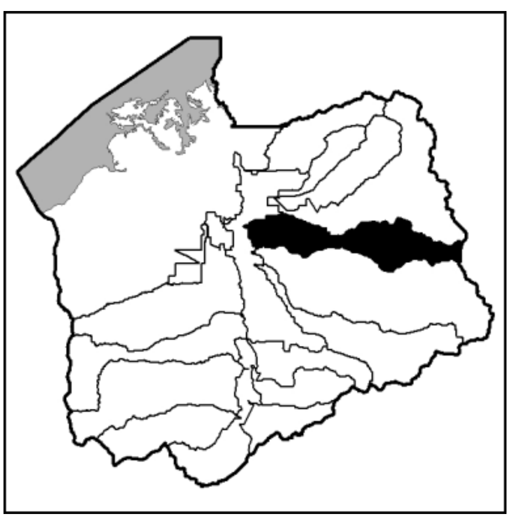
### Mill Creek

Mill Creek is located in the northern portion of the Wasatch Mountains. The watershed comprises 23,644 acres ranging in elevation from 4,221 feet to 8,700 feet. From its headwaters at the upper elevations of Mill Creek Canyon, the creek flows downstream past the entrance of the canyon and starts into the Salt Lake Valley at an elevation of approximately 5,000 feet. The creek is 18.5 miles in length and consists of Perennial and Perennial Reduced flows (Figure 3.10.1).

The average annual precipitation ranges from 42 inches at the headwaters to 11 inches in the Salt Lake Valley (Figure 3.9.1).

Two sub-watersheds comprise the Mill Creek Watershed. The Upper Mill Creek Sub-Watershed is 13,915 acres. The Lower Mill Creek Sub-Watershed is 9,729 acres.

Mill Creek Canyon is a popular recreation site for many Salt Lake residents. Prior to the 1990s, much of the canyon, including the stream channel of Mill Creek, had degraded largely because of human activities. Remediation has since been done at several picnic facilities, along with the installment of a fee station. User revenues are put toward the restoration and continued maintenance of the canyon and the creek's riparian zone. In addition, public awareness programs on responsible dog waste cleanup have improved understanding of this issue; however, water quality concerns still surround dog waste in Mill Creek (Fillmore and Jensen, 1997).



Mill Creek Watershed

Six studies were identified that assessed conditions of aquatic and/or riparian habitat conditions in the Mill Creek watershed (see Appendix D). No studies were located that describe wetland habitat in the watershed. The watershed falls within the coverage area of the GIS resources described above under Methodology.

*Aquatic Habitat - Upper Mill Creek* Very little specific information is available on existing aquatic conditions for the sub-watershed. In general, the sub-watershed is considered to be in excellent condition, especially at upper elevations.

The channel gradient in the canyon is moderate. Bank stability is very good near the headwaters, but this is not maintained further downstream toward the canyon mouth. Streambanks are lacking vegetation in many areas. These conditions may change following recent restoration projects.

Macroinvertebrate populations in the sub-watershed are generally considered to include mayflies and caddis flies. These species are intolerant of pollution and indicative of good water quality. HQI values for the sub-watershed range from 34-53 pounds per acre and are in the lower to mid range of values calculated for Wasatch Mountain streams (Thompson et al., 2003).

Although information describing the physical characteristics of aquatic habitat in the sub-watershed is limited, similarities between this and other Wasatch Mountain watersheds provide a basis for comparison. Given the general characteristics of aquatic habitat and the habitat preferences shown in Table 4.7.3, aquatic habitat in this sub-watershed is considered suitable for cold water aquatic species.

Mill Creek, Upper Mill Creek Sub-Watershed

The upper reaches of Mill Creek support populations of brown trout, rainbow trout, cutthroat trout, and rainbow-cutthroat trout crosses. Brown trout and rainbow-cutthroat trout crosses are mainly found at lower elevations, while cutthroat trout occurred at mid- to lower-elevations. Rainbow trout are found in all upper reaches of Mill Creek in the sub-watershed. Information on the size and health of fish populations is not available, but this species mix indicates that there are not major, sub-watershed wide habitat deficiencies.

Degradation to aquatic habitat in the sub-watershed often coincides in areas in close proximity to popular recreational sites such as picnicking facilities (Jensen, 1996; Utah Division of Health Bureau of Water Quality, 1975). Bank stability and canopy cover appear to be the main problematic issues for Mill Creek (Jensen, 1996; Templeton Linke & Alsup and Engineering Science Inc., 1975).

*Aquatic Habitat - Lower Mill Creek.* Mill Creek from the mouth of Mill Creek Canyon downstream to the Jordan River is characterized as an entrenched stream channel composed primarily of bedrock although boulders and, in smaller amounts, cobbles and gravels occur. The creek changes to moderately entrenched channel dominated by gravel material and then to a more deeply incised meandering channel dominated by gravel to its confluence with the Jordan River.

Overall, the channel gradient in the sub-watershed is moderate and ranges from 0.2 to 10 percent, with an overall average of about 2 percent. The gradient is steepest at the mouth of Mill Creek Canyon becoming gentler as it approaches the Jordan River. Rosgen channel types range from A – F4 with A type streams common near the canyon mouth and F type streams found near the Jordan River confluence. F type streams are entrenched, deeply incised channels with vertical eroding banks.

Pfankuch bank and bed stability ratings in the valley range from poor to excellent, but are on average fair to good. Poor ratings occur in the upper and lower valley elevations. Very little information is available on pool to riffle ratios for the lower reaches of Mill Creek. In the upper valley, mayflies and caddis flies are believed to be common, but in the lower valley the macroinvertebrate community is limited (Jensen, 1996). No HQI values were located for this sub-watershed.

Based on measurements of existing physical habitat characteristics, and the habitat preferences shown in Table 4.7.3, aquatic habitat in this sub-watershed is considered suitable for cold and warm water aquatic species.

The lower reaches of Mill Creek supports brown trout, rainbow trout, common carp, longnose dace, mountain sucker, Utah sucker, and Utah chub. Some cutthroat trout exist at higher valley elevations.

Channelization, dewatering, yard litter, and bank erosion degrade fish habitat in the valley portion of Mill Creek. A few sites have experienced recent bank sloughing, which may explain areas downstream containing high amounts of suspended sediment and siltation of substrate (CH2M Hill, 1992).

*Riparian Habitat - Upper Mill Creek* Streamside vegetation near the headwaters of Mill Creek consists of White and Douglas fir, dogwood, cow parsnip, and grasses. In mid- to lower-canyon reaches, box elder, birch, dogwood, maple, willow, and grasses line the riparian area. Stream shading is excellent, particularly at the higher elevations.

GAP data identified 0.7 miles of Rocky Mountain Lower Montane Riparian Woodland and Shrubland vegetation adjacent to Upper Mill


Mill Creek, Lower Mill Creek Sub-Watershed

Creek. Deficiencies in riparian habitat could not be identified due to data limitations.

*Riparian Habitat - Lower Mill Creek* Salt Lake County estimates approximately 108 acres of riparian corridor are located in the lower Mill Creek sub-watershed. Urbanization and channelization have altered the natural character of the stream channel and much of the native vegetation has been displaced; although in some areas box elder, birch, dogwood, maple, willow, grasses, and exotic plants can still be seen (CH2MHill, 1992). Vegetative coverage ranges from bare to excellent.

GAP vegetation data identified 0.8 miles of riparian vegetation including 0.1 miles of Great Basin Foothill and Lower Montane Riparian Woodland and Shrubland and 0.7 miles of Rocky Mountain Lower Montane Riparian Woodland and Shrubland.

Gabions or cement walls line the stream corridor in many areas. Channel widths vary between 10 and 40 feet. Particular widths are maintained throughout several reaches due to channelization or the presence of gabions and significantly reduces or eliminates access to floodplains (CH2MHill, 1992).

*Wetland Habitat - Upper Mill Creek* NWI data identified approximately 9 acres of wetlands that occur in higher elevations of the sub-watershed. These areas primarily consist of Palustrine Emergent wetlands. Wetland habitat deficiencies could not be defined due to the limited data available.

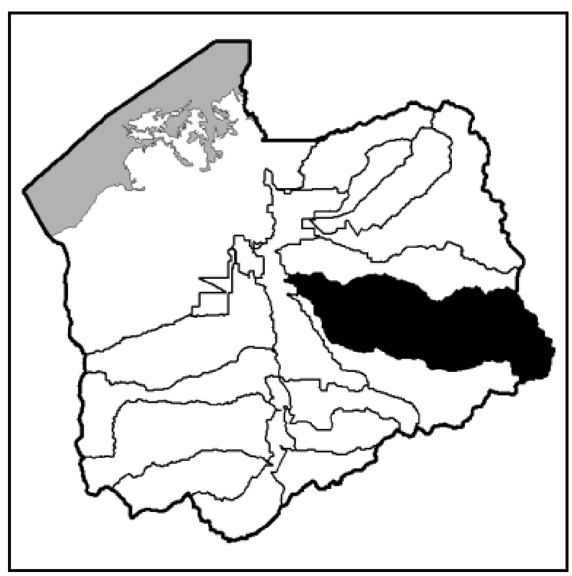
*Wetland Habitat - Lower Mill Creek* NWI data identified approximately 51 acres of wetland areas in the sub-watershed. These areas were mostly composed of Palustrine Emergent wetlands and smaller amounts of Palustrine Aquatic Bed and Palustrine Unconsolidated wetland types. Insufficient data was located to identify wetland habitat deficiencies.

## Big Cottonwood Creek

Big Cottonwood Creek Watershed is located between Mill Creek Canyon and Little Cottonwood Canyon. The watershed includes 52,203 acres ranging from approximately 4,000 to 9,600 feet in elevation. Stream headwaters commence in Brighton Basin at an elevation of approximately 9,600 feet. The creek flows downstream past the entrance of the canyon before heading into the Salt Lake valley at an elevation of approximately 5,000 feet. Big Cottonwood Creek terminates at its confluence with the Jordan River at an elevation of 4,235 feet in the Murray-Taylorsville area. Big Cottonwood Creek is 24.2 miles in length.

Big Cottonwood Creek is the largest source of surface water used by Salt Lake City for culinary purposes. The Big Cottonwood Creek Watershed is managed with strict guidelines designed to maintain and protect water quality.

The watershed includes two sub-watersheds that are separated at the valley margin. The Upper Big


Big Cottonwood Creek Watershed

Cottonwood Creek Sub-Watershed is 31,955 acres and contains Perennial stream channel. The Lower Big Cottonwood Creek Sub-Watershed is 20,248 acres and contains Perennial-Interrupted and Perennial-Reduced/Exchange (Figure 3.10.1).

The average annual precipitation ranges from 52 inches at the headwaters to 11 inches in the Salt Lake Valley (Figure 3.9.1).

Seven documented studies of aquatic, riparian, and wetland habitat were identified in Big Cottonwood Creek (see Appendix D).

Big Cottonwood Creek, Upper Big Cottonwood Creek Sub-Watershed

*Aquatic Habitat - Upper Big Cottonwood Creek* Big Cottonwood Creek begins as a shallow channel comprised of sand-sized particles and quickly transitions to a moderately-entrenched, cobble dominated channel interspersed with segments of down-cut gullies in the upper- and mid-canyon elevations. Bedrock and boulders dominate substrate composition at lower canyon elevations but intermittently include cobble and rubble. Stream channel entrenchment is low to moderate in upper elevations of Big Cottonwood Creek and moderate to high in the lower canyon elevations (Wasatch Cache National Forest, 2006). Channel gradients in the canyon range from 0.5 to 10 percent, with an overall average slope of about 4 percent. Rosgen channel types are predominately A and B type streams interspersed with few G type streams. Stream channels consistent with A and B type stream characteristics are typically found in upper- and mid- elevation watersheds. A limited amount of G type stream segments are located primarily in mid- to upper-elevations and are deeply incised in depositional material comprised of cobble, gravel, and sand (Wasatch Cache National Forest, 2006). These channel segments are considered highly unstable due to very high sediment loads supplied from upslope and channel sources.

Glacial activity in Big Cottonwood Canyon has resulted in a wide and fairly straight canyon floor in upper elevations, precipitous walls throughout, and U-shaped canyon features. Glacial till and talus remains including deposits of medium to large boulders in the lower canyon. Surface fines comprise 7 to 15 percent of channel surfaces in various segments. Measures of surface fines represent only a portion of total fine material in channel substrate that could potentially impact aquatic resources (Schwager and Cowley, 2000).

Based on methods prescribed by USDA (1992), streambanks are relatively stable throughout the sub-watershed ranging from 45 to 100 percent stable, with an average of 73 percent of channel banks considered stable. Bank stability in mid- to upper-canyon elevations was found to be quite high, ranging from 77 to 87 percent stable with an average of 81 percent of channel banks considered stable. Undercut banks are present in 1 to 32 percent of Big Cottonwood Creek in the canyon area. Rosgen classification of upper stream channel segments indicates the presence of step-pool features. Channel segments in the lower canyon maintain a boulder dominated substrate that results in many riffle and step-pool features. Pool to riffle ratios in the mid to lower canyon range from 1:0.5 to 1:2.5. Several channel segments throughout the sub-watershed are noted to have insufficient pool habitat and elevated pool riffle ratios (Schwager and Cowley, 2000).

Macroinvertebrate communities are considered to be substantial and generally dominated by mayflies and caddis flies. These species are intolerant to pollution and indicate the presence of good water quality at locations where they are observed.

HQI values reported for segments of Big Cottonwood Creek ranged from 3 – 155 pounds per acre. Most segments were above 60 pounds per acre with two segments reported at 3 and 5 pounds per acre (Thompson et al., 2003). The higher HQI values reported are among the highest values for Wasatch streams. Low HQI values are comparatively among the lowest scores reported and are likely associated with degraded and erosive channel segments where habitat deficiencies are present.

Based on characteristics documented in studies of this sub-watershed and habitat preferences shown in Table 4.7.3, aquatic habitat in this sub-watershed is suitable for cold water aquatic species. The upper reaches of Big Cottonwood Creek support populations of brown trout, brook trout, and rainbow trout. Historically, a healthy population of Bonneville Cutthroat trout existed in these waters; however none are currently found (Schwager and Cowley, 2000). Fish habitat degradation in the canyon portion of Big Cottonwood Creek often coincides with areas close to popular recreation sites including Storm Mountain Picnic Area, Jordan Pines Campground, and Spruces Campground. Easily accessible areas were deforested between 1800 and 1900 East and correspond with stream segments that contain low amounts of woody debris providing in-stream habitat.

Historic mill and mining activity, road construction, picnic and campground areas, residential developments, and ski resorts have all affected the health of upper Big Cottonwood Creek. Specific impacts to the canyon portion of Big Cottonwood Creek include sediment loading from the canyon road, bank instability, bank slumping and erosion, abnormally high width-to-depth ratios, and riparian vegetation degradation (Schwager and Cowley, 2000).

*Aquatic Habitat - Lower Big Cottonwood Creek*

Big Cottonwood Creek at the canyon mouth is characterized as a boulder/cobble channel. Cobble/gravel substrate dominates Big Cottonwood Creek throughout the mid-portions of the valley segment with gravel and silt becoming prevalent for the last third of the creek until the confluence. Channel segments are highly entrenched near the canyon mouth and transition to a moderately entrenched channel in most of the valley area. The creek ultimately changes to a deeply incised creek for the lowest reaches until its confluence with the Jordan River (Salt Lake County, 2005). Channel gradient ranges from 2 to 4 percent near the canyon and decreases in the valley, ranging from 0.04 to 4 percent, with an overall average of 1 percent. Rosgen channel types range from A2 – G6. In general, Rosgen A and B type streams are in stable condition. Where noted on the valley floor, G type streams are considered incised and unstable.

Pfankuch bank and bed stability ratings for nearly the entire creek are good to excellent with the exception of a stretch between 3000 East and Holladay Boulevard, which is rated poor to fair due to bare, unstable banks where slumping and erosive conditions exist (Salt Lake County, 2005). No information regarding pool riffle ratios, macroinvertebrate communities, or HQI values was located for this sub-watershed.

Based on characteristics documented in studies of this sub-watershed and habitat preferences shown in Table 4.7.3, aquatic habitat in this sub-watershed is suitable for cold water aquatic species in upper reaches and warmer water species in lower reaches. Aquatic species identified in the sub-watershed include brown trout, common carp, speckled dace, longnose dace, mountain sucker, and Utah sucker. Rainbow trout may also occur. Channelization, dewatering, yard litter, and bank erosion have also been noted to degrade fish habitat in the lower reaches of Big Cottonwood Creek (Salt Lake County, 2005).

*Riparian Habitat - Upper Big Cottonwood Creek*

Streamside vegetation near the headwaters of Big Cottonwood Creek consists of conifers, mountain alder, willow shrubs, and forbs. In mid-canyon reaches, cottonwoods, aspens, willow shrubs, some conifers, and dogwood can be found. In the lower elevations of the canyon, cottonwoods, aspens, dogwood, water birch, and grasses grow. Rocks and bare ground are more prevalent near the mouth of the canyon than at the headwaters.

GAP data identified 0.8 miles of riparian vegetation including 0.2 miles of Rocky Mountain Lower Montane Riparian Woodland and Shrubland as well as 0.6 miles of Rocky Mountain Subalpine-Montane Riparian Shrubland. In the mid- to upper-elevations, canopy cover for the stream channel ranges between 0 and 21 percent, with an average of 12 percent.

Degradation of riparian vegetation has occurred from construction projects in the riparian corridor, recreational traffic, and other human activities (Schwager and Cowley, 2000). As noted above, the channel is entrenched and is considered detached to some degree from its floodplain at these locations.

*Riparian Habitat - Lower Big Cottonwood Creek*
The riparian corridor is estimated at 193 acres. GAP data identified 0.7 miles of riparian vegetation including Rocky Mountain Lower Montane Riparian Woodland and Shrubland. Vegetative coverage in the riparian corridor ranges from bare to excellent (Salt Lake County, 2005).

Urbanization and channelization have altered the natural character of the stream channel and riparian corridor in this sub-watershed (Salt Lake County, 2005). Much of the native vegetation has been displaced; although in some areas willow, cottonwood, scrub oak, grasses, birch, dogwood, rose, grasses, and exotic plants can still be seen. Gabions or cement walls line the stream corridor in many areas. Designed channel widths are maintained throughout several reaches due to channelization or the presence of gabions and eliminate access of the stream channel to floodplains. Nearly all of the lower reaches of Big Cottonwood Creek rate fair to poor in vegetative bank cover (Salt Lake County, 2005).

*Wetland Habitat - Upper Big Cottonwood Creek*
Wetland studies completed on Brighton Basin, located in the headwaters of this sub-watershed have identified 724 acres of wetlands that comprise approximately 10 percent of the basin. Hydrologic regimes range from seasonally saturated, to temporarily, seasonally, and permanently flooded by groundwater springs, depressions, and adjacent to running water. Wetland sub-order types for the basin include combinations of Riverine, Riverine/ Shrub, Scrub-Shrub, Palustrine Forested, Emergent, and Shrub, and Lacustrine/Limnetic wetlands. Private developments are the main concern for degradation of the wetlands (Smith and Greenwood, 1984; Jensen, 2000). These areas are a particular concern due to their ability to store and discharge flows to the creek which are ultimately used for culinary water sources.


Big Cottonwood Creek, Lower Big Cottonwood Creek Sub-Watershed

Two additional studies defined wetlands in the study area including the NWI and WAIDS surveys. The NWI identified 187 acres that are located primarily on the south side of the sub-watershed in the mid to upper elevations. Wetland types are primarily Palustrine Aquatic Bed, Palustrine Scrub-Shrub and Lacustrine Limnetic. Smaller amounts of Palustrine Emergent and Palustrine Unconsolidated are also available. The WAIDS effort defined 672 acres of wetland types, which included some areas that overlapped with the NWI survey. WAIDS areas were located primarily in the upper sub-watershed.

*Wetland Habitat - Lower Big Cottonwood Creek*
The NWI identified 56 acres of wetland areas that primarily consist of Palustrine Aquatic Bed and Palustrine Emergent wetland types. Based on the available data, wetland habitat deficiencies could not be defined.

## Little Cottonwood Creek

Little Cottonwood Creek Watershed is located in the southeast corner of Salt Lake County. This watershed comprises 25,507 acres that range in elevation from 5,600 feet to 9,850 feet.

Stream headwaters commence in Albion Basin and continue for 22.3 miles to the confluence with the Jordan River at approximately 4800 South. Little Cottonwood Creek is the second largest surface water source used by Salt Lake City for culinary purposes. As a result, the watershed is protected and managed according to city guidelines designed to protect and sustain water quality.

Two sub-watersheds comprise the Little Cottonwood Creek Watershed. The Upper Little Cottonwood Creek Sub-Watershed is 17,366 acres. The upper flows are predominately Perennial with limited Perennial-Interrupted conditions (Figure 3.10.1). The Lower Little Cottonwood Creek Sub-Watershed is 8,141 acres. The lower segment flow conditions consist of Perennial-Interrupted at the higher elevations and Perennial-Reduced/Exchange in the valley (Figure 3.10.1).

The average annual precipitation ranges from 62 inches at the headwaters to 11 inches in the Salt Lake Valley (Figure 3.9.1).

Little Cottonwood Creek Watershed

A total of six studies were located that documented aquatic, riparian, and/or wetland habitat conditions (see Appendix D). Information was located on all parameters considered in this assessment of aquatic, riparian, and wetland habitat with the exception of macroinvertebrate data on Lower Little Cottonwood Creek. The watershed falls within the coverage area of the GIS resources described above under Methodology.

*Aquatic Habitat - Upper Little Cottonwood Creek*
Upper Little Cottonwood Creek begins as a cobble-dominated, entrenched to moderately-entrenched channel. The stream changes to a more boulder-dominated, deeply entrenched channel at lower elevations. Channel gradient in the canyon ranges from 3 to 12 percent, with an average of about 8 percent. The dominant stream substrate at upper canyon elevations is primarily cobble but may also include bedrock, gravel, and boulders. Substrate at the lower canyon elevations is comprised of boulders and large boulders but intermittently includes cobble and bedrock. Rosgen stream channel types are primarily headwater A stream channels but also include segments with characteristics similar to B and F steam channels.

This sub-watershed was extensively glaciated, which has resulted in wide and moderately steep canyon floors, precipitous walls, and a U-shaped cross section. Glacial till and talus can be found throughout the canyon, with deposits of medium to large boulders in the lower canyon area. Sedimentation is not a concern in most segments of Upper Little Cottonwood Creek, especially at the mid to lower canyon elevations. In these sections, fine sediments comprise less than 5 percent of substrate in various reaches of the creek.

Streambanks are relatively stable throughout Little Cottonwood Canyon, ranging from 75 to 98 percent stable, with an average of 80 percent considered stable according to Overton et al. (1997). In general, bank stability is considered greater at mid to lower canyon elevations with average bank stability increasing to 88 percent. Undercut banks are present in 6 to 8 percent of the upper reaches. Pool to riffle ratios in the mid to lower canyon range from 1:0.78 to 1:2.3 (Schwager and Cowley, 2001), slightly less than the optimal ratio of 1:1 identified in Habitat Suitability Index Models (Hickman and Raleigh, 1982). The degree of stream channel

Little Cottonwood Creek, Upper Little Cottonwood Creek Sub-Watershed

entrenchment is high for the majority of the canyon stream, although a minor number of stream segments are slight to moderately entrenched.

Macroinvertebrates have been monitored at three sites above and below discharge from the Wasatch Drain tunnel located on upper Little Cottonwood Creek. Based on the metrics from samples, which include abundance of taxa sensitive to organic pollution, taxa richness, and biotic indices, aquatic habitat improves with distance downstream below the drain tunnel. Average measurements from the three sites indicate generally good habitat conditions and slightly enriched water quality (Cirrus, 2006).

An HQI of 161 pounds per acre was calculated for upper elevation stream segments of this sub-watershed and is one of the highest values calculated for Wasatch streams. An HQI of 24 pounds per acre for lower stream segments in the sub-watershed was comparatively one of the lowest scores in Salt Lake County indicating that aquatic habitat deficiencies exist in this area (Thompson et al., 2003).

Based on characteristics documented in studies of this sub-watershed and habitat preferences shown in Table 4.7.3, aquatic habitat in this sub-watershed is suitable for cold water aquatic species. The sub-watershed currently supports populations of rainbow trout, brook trout and cutthroat trout including Bonneville cutthroat trout. It is generally believed that abundant populations were once found in the sub-watershed. Recent surveys indicate that existing fish populations are impacted by reduced flows, water quality degradation, and potential overfishing (Schwager and Cowley, 2001).

Limited aquatic habitat degradation in the sub-watershed appears to coincide with popular recreation sites such as Little Cottonwood Trail, Tanner's Flat Campground, and locations where Little Cottonwood Canyon Road approaches the creek. Specific impacts on aquatic habitat in these areas include sediment loading from roads, bank instability, erosion, and abnormally high width-to-depth ratios (Schwager and Cowley, 2001).

*Aquatic Habitat - Lower Little Cottonwood Creek*

Channel substrate is comprised of boulders at the canyon mouth and shifts to a cobble substrate throughout much of the valley portion, with gravel and sand becoming prevalent near the confluence. Little Cottonwood Creek is highly entrenched near the mouth of the canyon (Salt Lake County, 2005) as well as near the confluence with the Jordan River and slightly entrenched for most segments downstream from the canyon mouth.

From the canyon mouth downstream to the Jordan River, the creek quickly transitions from a moderately steep, entrenched channel to a low-gradient, slightly entrenched channel and continues in this manner through much of the valley portion. As it approaches the Jordan River, the creek becomes more entrenched and exhibits higher channel width-to-depth ratios. The channel gradient in the valley ranges from 0.4 to 4 percent, with an average of 1 percent. Stream channels in the sub-watershed range from Rosgen type A2 to F5.

Based on Overton et al. (1997), bank and bed stability ratings for the majority of the creek are good up to the State Street crossing. From this point downstream, bank and bed stability are mostly poor with only a small number of stream segments maintaining a fair rating (Salt Lake County, 2005). The higher incidence of poor ratings coincides with areas having gravel and sand as the dominant substrate (Schwager and Cowley, 2001). Overall streambed composition, including substrate size distribution, scouring, sediment deposition, and low rock content in banks is considered fair to poor for many

Little Cottonwood Creek, Lower Little Cottonwood Creek Sub-Watershed

segments (Salt Lake County, 2005). Sedimentation becomes particularly noticeable near the confluence with the Jordan River (Salt Lake County, 2005). Engineered channel widths are maintained through regular flood control activities or the presence of gabions and cement walls that restrict channel width to 15 – 40 feet (Utah Division of Health Bureau of Water Quality, 1975). In addition, dewatering, yard litter, bank erosion, and mass wasting degrade aquatic habitat in the sub-watershed (Salt Lake County, 2005). No information on other physical aquatic habitat parameters, macroinvertebrates, or HQI values was found.

Based on measurements of existing physical habitat characteristics, and the habitat preferences shown in Table 4.7.3, aquatic habitat in this sub-watershed is considered suitable for cold water aquatic species.

Near the mouth of the canyon, Little Cottonwood Creek supports cutthroat trout including Bonneville cutthroat trout for a short distance. Further downstream, brown trout, rainbow trout, black bullhead, channel catfish, common carp, longnose dace, and Utah sucker occur.

*Riparian Habitat - Upper Little Cottonwood Creek*
Streamside vegetation near the headwaters of Little Cottonwood Creek consists of willow shrubs, forbs, and water sedges. Mid-canyon reaches contain willow shrubs, mountain alder, conifers, cottonwoods, aspens, and rough bluegrass, with dogwood and water birch found as well in the lower canyon. Rocks and bare ground are more prevalent near the mouth of canyon than at the headwaters. Between elevations of 5,600 and 7,400 feet, canopy cover for the stream channel ranges between 40 and 49 percent, with an average canopy cover of 44 percent.

GAP data identifies two riparian vegetation classes adjacent to the stream channel including 1.3 miles of Rocky Mountain Lower Montane Riparian Woodland and Shrubland and 0.2 miles of Rocky Mountain Subalpine-Montane Riparian Shrubland.

Degradation of riparian vegetation has occurred through historic mining, construction projects in the riparian corridor, recreational traffic, and other human activities (Schwager and Cowley, 2001). As noted above, the channel is generally entrenched and detached to some degree from its floodplain.

*Riparian Habitat - Lower Little Cottonwood Creek*
Urbanization has severely altered most riparian vegetation (Utah Division of Health Bureau of Water Quality, 1975), although in some areas water birch, horsetail, cottonwood, willow, and alder can still be found.

Bank vegetation in the sub-watershed ranges from bare to excellent with the majority of stream segments considered fair/poor with respect to vegetative bank-protection. The area from 300 West upstream to 900 East is especially degraded, with many segments maintaining bare banks and little riparian vegetation (Utah Division of Health Bureau of Water Quality, 1975).

The lower Little Cottonwood Creek riparian corridor is estimated to be approximately 233 acres. GAP data indicates that 0.2 miles of Rocky Mountain Lower Montane Riparian Forest and Woodland occurs along upper stream segments in the sub-watershed. Floodplain detachment is evident below the canyon mouth and above the confluence.

*Wetland Habitat - Upper Little Cottonwood Creek*
Approximately 200 acres of wetlands were identified during 1993 in Albion Basin in the headwaters of the sub-watershed. Palustrine wetland subtypes include combinations of Scrub-Shrub, Emergent-Persistent, Forested, Aquatic Bed, and Moss-Lichen wetlands. Hydrologic

regimes range from saturated and seasonally saturated, temporarily, seasonally, and permanently flooded.

Wildlife habitat is abundant in Albion Basin. A diverse avian population frequents the wetlands as well as other terrestrial wildlife. Degradation of the wetlands and riparian resources has occurred through historic mining, construction projects, recreational traffic, and other human activities. Erosion, mine runoff, lack of healthy riparian vegetation, and the need for increased groundwater recharge and water-holding capacity are the main problematic issues in the wetlands of Albion Basin (Jensen, 1993).

Based on the NWI, 71 acres of wetlands occur in the sub-watershed and include a mix of Palustrine Forested, Emergent, and Scrub-Shrub wetlands.

*Wetland Habitat - Lower Little Cottonwood Creek* The NWI identifies a total of 37 acres of wetland types in the sub-watershed consisting of Palustrine Emergent and Palustrine Aquatic Bed wetlands. Most of these wetlands are located away from the stream channel on the south side of the watershed.

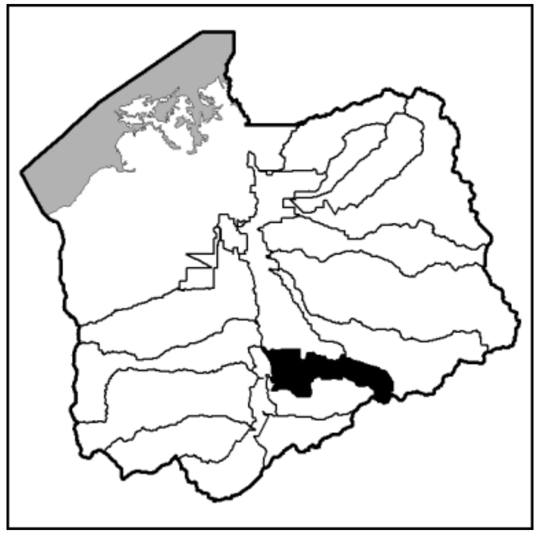
**Dry Creek**

The Dry Creek Watershed is located in the southeast corner of the Wasatch Mountains. The watershed comprises a total of 12,435 acres.

The creek originates from Middle and South Fork Dry Creek Canyons. Dry Creek starts into the Salt Lake Valley at an elevation of approximately 5,200 feet, where it flows into the Draper Irrigation Company Ditch. The creek is 11.5 miles in length and terminates at the confluence with the Jordan River at an elevation of approximately 4,200 to 4,300 feet. The water is used primarily for irrigation.

Upper Dry Creek Sub-Watershed is 3,878 acres consisting of 2.4 miles of Dry Creek. Flows in the sub-watershed are Perennial (Figure 3.10.1). The Lower Dry Creek Sub-Watershed is 8,557 acres. The lower reach flows of Dry Creek are Intermittent-Interrupted.

The average annual precipitation ranges from 52 inches at the headwaters to 11 inches in the Salt Lake Valley (Figure 3.9.1).



Dry Creek Watershed

Two studies were identified that described aquatic and riparian habitat conditions in the watershed (see Appendix D). No studies were located that describe wetland habitat in the watershed. The watershed falls within the coverage area of the GIS resources described above under Methodology.

*Aquatic Habitat - Upper Dry Creek* There is limited information documenting existing aquatic conditions in this sub-watershed, but some inferences can be drawn to determine fish habitat suitability. The upper reaches of Dry Creek could potentially support most cold water species found along the Wasatch Mountain including rainbow trout and potentially cutthroat trout.

*Aquatic Habitat - Lower Dry Creek* The dominant stream substrate is primarily boulders near the mountains, small cobble, gravel, and sand in the mid portions, and gravel/sand in the lower elevations. The lower reaches of Dry Creek from the canyon mouth downstream to the Jordan River, are characterized as a steep, deeply entrenched and confined channel associated with faults, scarps, folds, joints, and other structurally controlled drainages. The creek changes to a moderately entrenched channel in the mid regions, and to a gravel dominated, deeply incised, meandering channel at the lower valley elevations. The degree of entrenchment is high near the top and bottom of the valley and ranges from low to high in mid portions (Salt Lake County, 2005).

The channel gradient ranges from 0.2 to 13 percent, with an overall average of about 4 percent. In general, the gradient is steepest at higher elevations and becomes gentler as it approaches the Jordan River.

Pfankuch bank and bed stability ratings in the valley range from poor to excellent, but many reaches are only poor to fair. Very little information was found on pool to riffle ratios for this portion of Dry Creek.

Bank instability is an issue at various sites. Clearing of upper banks and placement of horse pastures near lower reaches may also be a concern. Pfankuch rock angularity ratings are fair to very poor for all reaches. With the exception of the stretch between the east Jordan Canal and the end of Riverside Drive, most areas have very poor aquatic vegetation. Brightness, bottom size distribution, scouring and deposition, and streambed composite categories are mainly fair to very poor throughout (Salt Lake County, 2005).

Channel widths vary between 6 and 20 feet, but are sometimes 40 feet in areas where the new and old channels overlap. For the upper bank, most reaches have poor ratings for landform slope. Many areas rate fair for mass wasting and debris jam potential. Stream channels are braided in some areas and new channels parallel or overlap with old channels (Salt Lake County, 2005).

Vegetative bank protection is mainly good to excellent, but some areas are only fair. The upper bank composite rating is fair for nearly all reaches, with a few rating poor. For the lower bank, most areas rate good to excellent in the channel capacity category; however, some are only fair. Nearly all regions rate poor for bank rock content. Between Dimple Dell Road and 700 East, several reaches rate only fair for the obstruction to flow category. Cutting and deposition ratings are generally fair, although deposition is poor between 700 East and 300 East. The creek rates excellent in the upper elevations for the lower bank composite until 1300 East. From this point downstream, most reaches rate only fair. The overall Pfankuch composite rating is fair to poor for most reaches (Salt Lake County, 2005).


Dry Creek, Lower Dry Creek Sub-Watershed

No fish are known to exist in the lower reaches of the sub-watershed; however, degradation to the physical stream has occurred. In general, aquatic habitat suitability has been diminished by dewatering and poor streambank cover and does not provide adequate conditions to support sustainable fish populations.

*Riparian Habitat - Upper Dry Creek* In general, riparian vegetation in upper elevations includes conifer and aspens with oakbrush, sage brush, grasses, and shrubs in lower elevations. GAP data defines approximately 2.4 miles of riparian habitat along the upper reaches of Dry Creek comprised of 0.2 miles of Rocky Mountain Lower Montane Riparian Woodland and Shrubland. Deficiencies in riparian habitat could not be identified due to data limitations.

*Riparian Habitat - Lower Dry Creek* The extent of the Lower Dry Creek riparian corridor has been estimated at approximately 141 acres. The general streamside on vegetation consists of oak, willow, Russian olive, cottonwood, Siberian elm, and grasses. GAP data indicates approximately 4.7 miles of Rocky Mountain Lower Montane Riparian Woodland and Shrubland occur along the lower reaches of Dry Creek.

Based on limited data available, riparian habitat deficiencies could not be characterized.

*Wetland Habitat - Upper Dry Creek* No site-specific studies on wetlands in this sub-watershed were located. NWI classified 24 acres of wetlands in the sub-watershed dominated by Palustrine Aquatic Bed and Palustrine Emergent. Wetland habitat deficiencies could not be defined due to limited availability of data.

*Wetland Habitat - Lower Dry Creek* The NWI classified 34 acres of wetlands in the lower Dry Creek sub-watershed. The dominant type is Palustrine Emergent, and other types include Palustrine Aquatic Bed, Palustrine Scrub-Shrub, and Riverine Intermittent. Wetland habitat deficiencies could not be defined due to the limited available data.

### Willow Creek

Willow Creek is located in the southeast corner of the Wasatch Mountains. The watershed comprises 10,451 acres ranging in elevation from 10,000 to 4,200 feet.

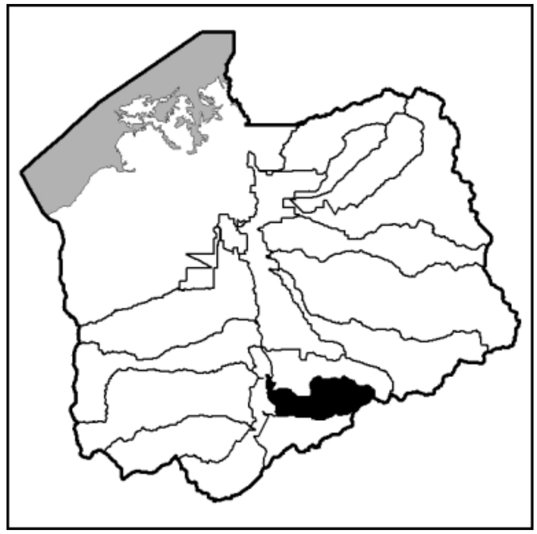
The stream is approximately 15.9 miles in length and originates from Big and Little Willow Creek Canyons before entering the Salt Lake Valley from below the canyon mouths at an elevation of approximately 5,200 feet. The streambed of Willow Creek terminates at the confluence with the Jordan River at an elevation of approximately 4,200 to 4,300 feet; although it is dewatered for portions of the year below the irrigation diversions.

Portions of flow are diverted from Big and Little Willow creeks to provide irrigation water for the Draper Irrigation Company Treatment Plant or Ditch and Little Willow Irrigation Company Ditch, respectively. The Willow Creek channel joins the Jordan River near 11000 South.

Two sub-watersheds comprise the watershed. The Upper Willow Creek Sub-Watershed is 4,450 acres. Flows in the upper sub-watershed are characterized as Perennial. The Lower Willow Creek Sub-Watershed is 6,001 acres. Flows in the lower reaches are primarily characterized as Intermittent-Interrupted with a few segments maintaining Perennial flow (Figure 3.10.1).

Annual precipitation in the watershed ranges from 32 inches at the highest elevations to 11 inches in the valley (Figure 3.9.1).

Two studies were identified that describe habitat conditions in the Willow Creek watershed, each of which provided information on aquatic and riparian habitat (see Appendix D). No studies were located that describe wetland habitat in the watershed. The watershed falls within the coverage area of the GIS resources described above under Methodology.



Willow Creek Watershed

*Aquatic Habitat - Upper Willow Creek* A limited amount of information was found on existing aquatic conditions for the mountain portions of Willow Creek. In Big Willow Creek Canyon, the channel gradient is very steep near the headwaters and becomes more gradual as it approaches the valley. In Little Willow Creek Canyon, the channel gradient is moderately steep near the headwaters and becomes steeper as it nears the valley. No additional information on the other physical aquatic habitat parameters was found.

An HQI of 103 – 146 pounds per acre was calculated for Little Willow Creek by the Utah DWR between elevations of 6,031 feet to 8,228 feet. This value is in the high range of values observed for Wasatch Mountain streams.

While specific information on the physical characteristics of the overall aquatic habitat is limited, some inferences can be drawn from the available data. Existing aquatic conditions in the upper Willow Creek Sub-Watershed could potentially support most cold water fishes.

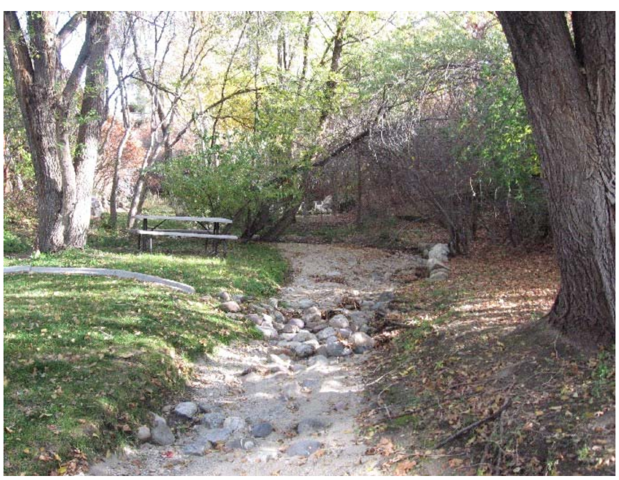
Little Willow Creek does support Bonneville cutthroat trout. The Utah Division of Wildlife Resources has identified Little Willow Creek as SFS water. Management priorities are to conserve and enhance genetically unique fish species in their historic range and to provide sport fish recreation when possible.

*Aquatic Habitat - Lower Willow Creek* No information could be found on existing aquatic conditions for the lower reaches of Willow Creek. Intermittent flows make sustainable fish populations impossible at this point.

*Riparian Habitat - Upper Willow Creek* Streamside vegetation is similar for both canyons. At upper elevations, it consists of conifer and aspen, scrub oak at mid-elevations, and at lower elevations, shrubs and grasses dominate. Deficiencies in riparian habitat could not be identified due to data limitations.

*Riparian Habitat - Lower Willow Creek* The riparian corridor for lower Willow Creek is estimated to be approximately 121 acres. GAP data indicates that approximately 1 mile of Rocky Mountain Lower Montane Riparian Woodland and Shrubland occurs along Big Willow Creek. Little Willow Creek has approximately 0.3 miles of Rocky Mountain Lower Montane Riparian Woodland and Shrubland cover along its length. Based on the limited available data, riparian deficiencies in the lower Willow Creek sub-watershed could not be characterized.

*Wetland Habitat - Upper Willow Creek* No additional wetland data is available for the upper Willow Creek Sub-Watershed. Wetland deficiencies could not be defined due to the limited data available.



Willow Creek, Lower Willow Creek Sub-Watershed

Willow Creek, Lower Willow Creek Sub-Watershed

*Wetland Habitat - Lower Willow Creek* No site-specific studies on wetlands in this sub-watershed were located. The NWI identifies 56 acres of classified wetlands in the sub-watershed, dominated by Palustrine Emergent wetlands. Other wetland types include Palustrine Aquatic Bed and Riverine Unconsolidated Shore. Wetland deficiencies could not be characterized based on the limited available data.

### Corner Canyon Creek

Corner Canyon Creek Watershed is located in the furthest southeast corner of the Wasatch Mountains. The watershed is comprised of a total of 9,344 acres.

Corner Canyon Creek is 7.9 miles in length. The creek originates as streamflow from Corner Canyon, entering the Salt Lake Valley at an elevation of approximately 4,800 feet. The creek terminates at the confluence with the Jordan River at an elevation of approximately 4,200 to 4,300 feet.

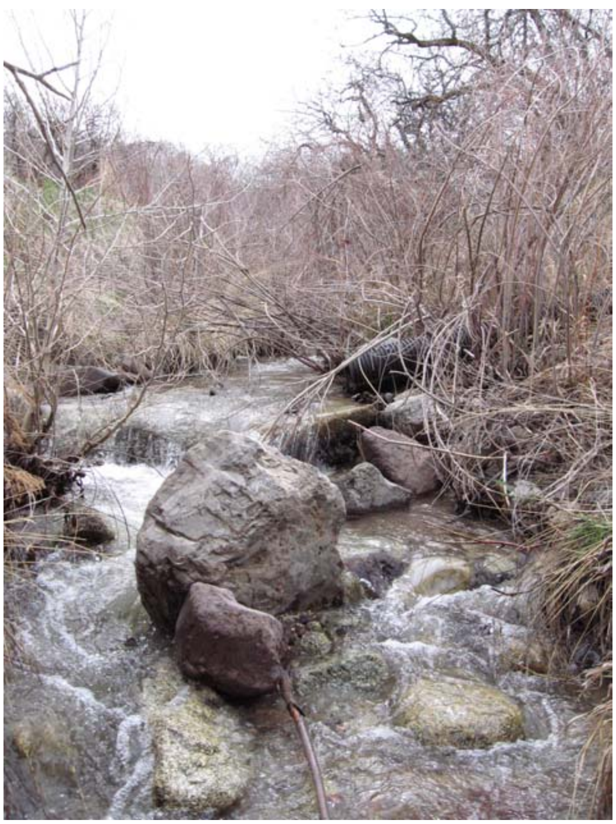
Stream flows are Intermittent until the canyon mouth where they become Intermittent-Interrupted (Figure 3.10.1). Portions of flow are diverted from Corner Canyon Creek to provide irrigation water.

The average annual precipitation is 22 inches in the upper reaches to 11 inches in the valley (Figure 3.9.1).

One study was identified that describes aquatic and riparian habitat conditions in the Corner Canyon Creek watershed (see Appendix D). No

Corner Canyon Creek Watershed

studies were located that describe wetland habitat in the watershed. The watershed falls within the coverage area of the GIS resources described above under Methodology.



Corner Canyon Creek, Corner Canyon Creek Sub-Watershed

Corner Canyon Creek, Corner Canyon Creek Sub-Watershed

*Aquatic Habitat—Corner Canyon Creek* A limited amount of information could be found on existing aquatic conditions for the mountain portions of Corner Canyon Creek. The channel gradient is very steep near the headwaters and becomes more gradual as it approaches the valley. No additional information on the other physical habitat parameters was found.

Based on the available information and known habitat preferences (Table 4.7.3), the current aquatic conditions are not suitable to support sustainable fish populations.

*Riparian Habitat—Corner Canyon Creek* The extent of the Corner Canyon Creek riparian corridor is 53 acres. General streamside vegetation includes grasses, shrubs, oak brush, and bitterbrush.

Based on the GAP data, less than one mile of Rocky Mountain Lower Montane Riparian Woodland and Shrubland occurs along the creek. Riparian deficiencies could not be characterized due to the lack of available information.

*Wetland Habitat—Corner Canyon Creek* No site-specific studies on wetlands in the watershed were located. The NWI indicates approximately 17 acres of classified wetlands occur in the watershed. Palustrine Aquatic Bed types dominate the wetlands. Additional types include Palustrine Emergent, Palustrine Scrub-Shrub, and Palustrine Unconsolidated Shore. Insufficient information is available to identify or characterize wetland habitat deficiencies in the watershed.

### 4.7.3.2 Oquirrh Mountain Streams

As noted above under Methods, most of these streams have not been well studied, so information with which to characterize existing conditions and identify habitat problems is very limited.

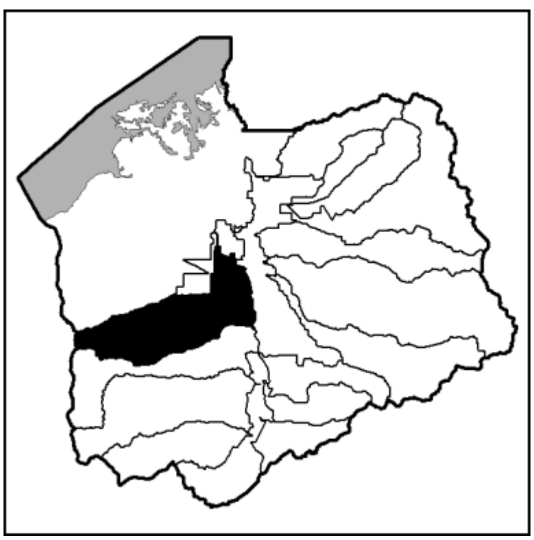
### Barney's Creek

Barney's Creek Watershed is located near the middle of the Oquirrh Mountain range. The watershed comprises 31,873 acres and ranges in elevation from 5,300 to 8,000 feet.

Barney's Creek is 8.4 miles long. Flows in the watershed are primarily Intermittent with a portion in the canyon classified as Perennial. The average annual precipitation ranges from 11 to 21 inches (Figure 3.9.1).

One study was located that documented aquatic, riparian, and wetland habitat conditions within the watershed (see Appendix D). The watershed falls within the coverage area of the GIS resources described above under Methodology.

*Aquatic Habitat—Barney's Creek* The channel gradient in Barney's Canyon is moderate at higher elevations and similar in characteristics to Bingham Creek in the lower or valley portion of the watershed. The channel gradient is low along the valley's west bench becoming gentler as it approaches the Jordan River; however, Barney's Creek does not typically reach the River. Gullies created by erosive forces are typical along the west bench (Coon et al., 1982).



Barney's Creek Watershed

Barney's Creek, Barney's Creek Sub-Watershed

No survey data is available on the occurrence and types of fish in Barney's Creek Watershed, and additional specific information on the physical characteristics of this aquatic habitat is insufficient to make inferences about what species could be there. Based on what is known about the stream and fish habitat preferences (Table 4.7.3), suitable aquatic habitat is limited by intermittent flows and inadequate streambank cover throughout much of the watershed. It is likely that the current conditions cannot adequately support cold water aquatic species. Some use by warm water species, especially low in the watershed is possible.

*Riparian Habitat—Barney's Creek* Although shrubs and grasses dominate the vegetation community, nearly all of the native streamside vegetation has been displaced and substituted with agricultural

Barney's Creek, Barney's Creek Sub-Watershed crops at lower elevations (Coon et al., 1982).

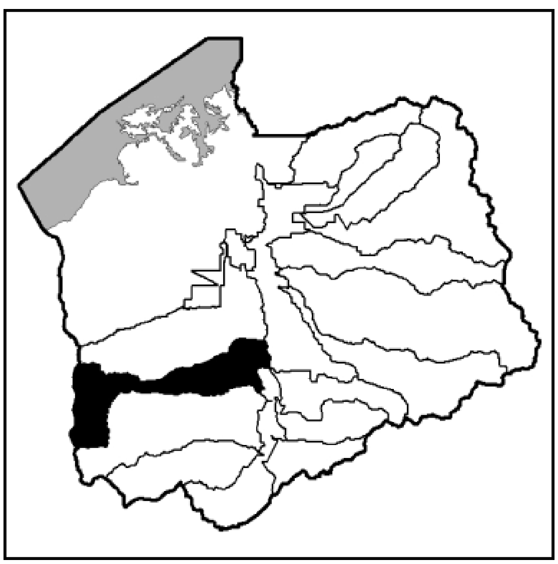
GAP data defines approximately 0.7 miles of riparian habitat comprised of Great Basin Foothill and Lower Montane Riparian Woodland and Shrubland, along the upper reaches of Barney's Creek. Riparian habitat deficiencies could not be characterized based on the limited data available.

*Wetland Habitat—Barney's Creek* No site-specific wetland studies have been conducted in the watershed. The NWI classified approximately 18 acres of wetlands within the watershed, located primarily in the valley. Palustrine Emergent wetlands are the dominate type. The remaining types are a mix of Palustrine Aquatic Bed, Palustrine Scrub-Shrub, and Palustrine Unconsolidated Bottom wetlands. Wetland habitat deficiencies could not be defined due to the limited available data.

### Bingham Creek

The Bingham Creek Watershed borders the southwest boundary of the Barney's Creek Watershed, mid-range of the Oquirrh Mountains. The watershed comprises 23,172 acres.

Bingham Creek is 10.2 miles in length. The natural channel is characterized as Perennial-Interrupted in the canyon and Intermittent-Interrupted in the valley. The upper Bingham Creek channel has been substantially impacted by KUCC mining operations. These activities include dumping of waste rock in the upper canyon areas, resulting in a loss of entire channel segments and adjacent riparian corridors. Surface and shallow groundwater flows in the canyon are diverted to the KUCC process system upstream of the canyon mouth. As a result, no flows from Upper Bingham Creek enter the Salt Lake Valley. Stream segments in the valley are fed by groundwater recharge, stormwater, and irrigation return flows that accumulate in the channel down to the confluence with the Jordan River.



Bingham Creek Watershed

Bingham Creek, Bingham Creek Sub-Watershed

Average precipitation ranges from 11 to 21 inches annually (Figure 3.9.1).

Two studies were available that described aquatic and riparian habitat conditions in the Bingham Creek watershed (see Appendix D). No studies were located that describe wetland habitat in the watershed. The watershed falls within the coverage area of the GIS resources described above under Methodology.

*Aquatic Habitat—Bingham Creek* In Bingham Canyon, many channel segments have been covered by waste rock. Where uncovered, the channel gradient is slight. In the valley, the natural channel gradient slightly slopes along the west bench and becomes gentler as it approaches the Jordan River. Gullies created by erosive forces are typical along the west bench (Coon et al., 1982).

An HQI of 1 pound per acre was calculated for the lower elevation reaches of Bingham Creek by the Utah DWR. No fish are found to occur in the stream. Based on this limited information on current aquatic habitat characteristics and fish

Bingham Creek, Bingham Creek Sub-Watershed

habitat preferences detailed in Table 4.7.3, the current aquatic habitat might support warm water species in its lower reaches but be unsuitable for fish above the valley floor.

*Riparian Habitat—Bingham Creek* In general, riparian vegetation in the watershed has been displaced by mining activities, but firs, spruce, shrubs, and grasses remain in some areas in the upper reaches of the watershed. Similarly, nearly all of the native streamside vegetation has been displaced and substituted with agricultural crops from the bench to the valley (Coon et al., 1982).

Based on the limited available data, the riparian habitat deficiencies could not be characterized.

*Wetland Habitat—Bingham Creek* The NWI identified 119 acres of wetlands within the watershed. Lacustrine Limnetic wetlands are the dominant wetland type. The remaining wetlands consist of Lacustrine Littoral, Palustrine Aquatic Bed, Palustrine Emergent, Palustrine Scrub-Shrub, Palustrine Unconsolidated Bottom, Palustrine Unconsolidated Shore, and Riverine Intermittent.

Insufficient information is available to identify or characterize wetland habitat deficiencies in the watershed.

## Midas/Butterfield Creek

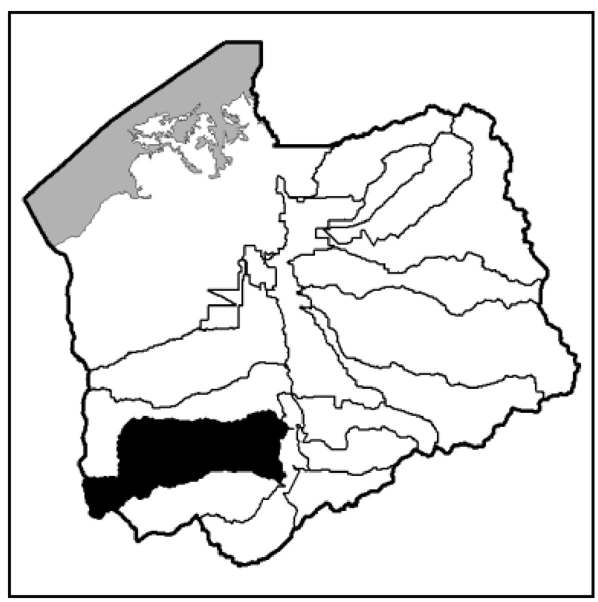
The Midas/Butterfield Creek Watershed is located in the southwest corner of the Oquirrh Mountains. The watershed comprises a total of 32,173 acres.

Butterfield Creek is 8.1 miles long and originates high up in Butterfield Canyon. Butterfield Creek merges with Copper Creek (5.3 miles in length) before reaching Midas Creek, past the entrance of the canyon and starts into the west bench of the Salt Lake Valley at an elevation of 5,500 feet. Butterfield Creek flows into Midas Creek along the bench. Midas Creek continues to the Jordan River and has a length of 10.1 miles.

Flows are mostly Intermittent with a small portion of the upper Butterfield reach flow conditions characterized as Perennial (Figure 3.10.1). The average annual precipitation ranges from 11 inches to 21 inches (Figure 3.9.1).

One study was identified that describes aquatic, riparian, and wetland habitat conditions (see Appendix D). The watershed falls within the GIS coverage area described above under Methodology.

*Aquatic Habitat—Midas/Butterfield Creek* In general, the channel gradient in Butterfield Canyon is moderately steep, but becomes gentler as it nears the valley.



Midas/Butterfield Creek Watershed

Midas Creek, Midas/Butterfield Creek Sub-Watershed

An HQI of 2 pounds per acre was calculated for the creek. No fish are known to exist in the creek. No information is available for Midas Creek.

Based on the limited available data on the current physical aquatic habitat parameters and on fish habitat preferences (Table 4.7.3), conditions in Midas Creek and Butterfield Creek are not suitable to support sustainable fish populations.

*Riparian Habitat—Midas/Butterfield Creek* The extent of the riparian corridor in the valley portion of the watershed has been estimated at approximately 64 acres. Streamside vegetation is generally comprised of grasses and shrubs including big sage, wheatgrass, bitterbrush, oak brush, maple, bluegrass, and mountain brome. Nearly all of the native streamside vegetation has been displaced in the lower reaches and substituted with agricultural crops (Coon et al., 1982).

Midas/Butterfield Creek Sub-Watershed

GAP data indicates that approximately 2 miles of Great Basin foothill and lower montane riparian woodland and shrubland occurs along the upper reaches of Butterfield Creek. Approximately 0.1 miles of Great Basin Foothill and Lower Montane Riparian Woodland and Shrubland occur along Midas Creek. Based on limited available data, riparian habitat deficiencies could not be characterized.

*Wetland Habitat—Midas/Butterfield Creek* No site-specific studies of wetlands in the watershed were located. The NWI classified approximately 116 acres of wetland occur in the watershed. The dominant type is Palustrine Emergent wetlands. Less common types include Palustrine Unconsolidated Shore, Palustrine Unconsolidated Bottom, Palustrine Aquatic Bed, Palustrine Scrub-Shrub, and Riverine Lower Perennial. The wetlands typically occur in flat areas adjacent to the meanders of the mountain stream. Willow shrubs are abundant and are accompanied by rushes, sedges, bulrushes, wild rose, wild raspberries, and other vegetation.

Wetland habitat deficiencies could not be defined due limited available data.

### Rose Creek

Rose Creek Watershed is located in the southwest corner of the Oquirrh Mountains. The watershed comprises 17,654 acres ranging in elevation from 6,900 feet at the headwaters to 4,200 feet in the valley. The creek is 11.2 miles in length and originates from mountain springs in Rose Canyon at an elevation of approximately 6,900 feet. The creek flows downstream past the entrance of the gently sloping canyon and starts into the west bench of the Salt Lake Valley. Flows eventually are channeled into the Jordan River.

Rose Creek Watershed

Rose Creek, Rose Creek Sub-Watershed

Rose Creek flows are characterized as Intermittent-Interrupted. The average annual precipitation ranges from 22 inches in the headwaters to 11 inches in the Salt Lake Valley (Figure 3.9.1).

One study was identified that described aquatic and riparian habitat conditions in the Rose Creek watershed (see Appendix D). No studies were located that describe wetland habitat in the watershed. The watershed falls within the coverage area of the GIS resources described above under Methodology.

*Aquatic Habitat—Rose Creek* Limited information documenting existing aquatic conditions in the watershed. In general, the channel gradient is quite gentle in Rose Canyon and maintains a gentle gradient as the creek flows through the valley. Gully erosion is typical within the watershed (Coon et al., 1982). No additional information was located to describe aquatic habitat conditions in the Rose Creek watershed.

Rose Creek, Rose Creek Sub-Watershed

Based on the limited available information, some inferences can be drawn regarding fish habitat suitability. Given the habitat preferences detailed in Table 4.7.3, current aquatic habitat conditions in Rose Creek, including inadequate water flows and poor streambank cover, limit the potential for fish populations. Due to intermittent flows, it is unlikely that the stream can support a sustainable fish population.

*Riparian Habitat—Rose Creek* The riparian corridor in the valley portion of the watershed has been estimated at approximately 73 acres. Streamside vegetation includes grasses, shrubs, bitterbrush, and sage brush. Nearly all of the native streamside vegetation has been displaced, being substituted by agricultural crops of alfalfa and small dryland grains (Coon et al., 1982).

GAP data indicates that approximately 1.3 miles of Great Basin Foothill and Lower Montane Riparian

Rose Creek, Rose Creek Sub-Watershed

Woodland and Shrubland occur along Rose Creek. Based on insufficient data, riparian habitat deficiencies could not be characterized.

*Wetland Habitat—Rose Creek* No site-specific studies on wetlands in this watershed were located. The NWI classified 43 acres of wetlands. The most common wetland type is Palustrine Aquatic Bed wetlands. Other types include Riverine Intermittent, Palustrine Emergent, Palustrine Scrub-Shrub, and Palustrine Unconsolidated Shore. Insufficient information is available to identify or characterize wetland habitat deficiencies in the watershed.

### 4.7.3.3 Decker Lake

The Decker Lake watershed comprises 6,238 acres that feed Decker Lake, which is a detention basin. Decker Lake is located on the west side of the Jordan River at an elevation of 4,230 feet. Water to Decker Lake is provided through groundwater discharge, stormwater runoff, and irrigation canal overflows. Storage capacity of Decker Lake is approximately 100 acre-feet. The Decker Lake Drain is the basin's only outlet, which flows into the Jordan River.

The average annual precipitation ranges from 11 to 12 inches (Figure 3.9.1).

Two studies were identified that describe the aquatic habitat conditions in the Decker Lake watershed (see Appendix D, Table DL1). No studies were located that describe riparian and wetland habitat in the watershed. The watershed falls within the coverage area of the GIS resources described above under Methodology.

Decker Lake Watershed

*Aquatic Habitat—Decker Lake* Very little information could be found on existing aquatic conditions for Decker Lake Drain. The dominant stream substrate is silt and debris with some cobble/rubble. Slow, shallow runs comprise most of the stream habitat, although, some small riffles are present. Anecdotally, people have been observed fishing at Decker Lake.

Decker Lake itself is approximately 2,159 feet long and 1,214 feet wide with a surface area of 30 acres and an average depth of 3.5 feet. It is a hyper-eutrophic system containing an abundance

Decker Lake, Decker Lake Sub-Watershed

Decker Lake, Decker Lake Sub-Watershed

of noxious algal species. Recent restoration work has been completed including dredging, redesigning of lake access facilities, and stormwater pollutant reduction (Salt Lake County, 1999).

Based on the limited available data describing the physical characteristics of the lake and drain and what is known about fish habitat preferences (Table 4.7.3), it is uncertain what species could be supported by current aquatic conditions. Among other beneficial use classifications assigned by the Division of Water Quality, Decker Lake is protected as a warm water fishery. No information is available on which species, if any, occur there.

*Riparian Habitat—Decker Lake* No data is available on riparian habitat conditions within the watershed. Riparian habitat deficiencies could not be characterized.

*Wetland Habitat—Decker Lake* Based on the National Wetlands Inventory, approximately 26 acres of wetland occur in the watershed. Palustrine Emergent wetlands are the dominant type. The remaining types include Palustrine Unconsolidated Shore, Palustrine Aquatic Bed, and Lacustrine Littoral.

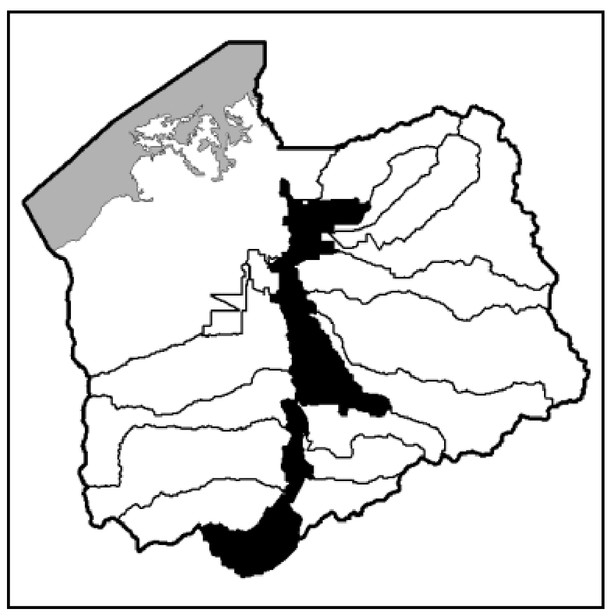
Wetland deficiencies could not be defined due to the limited available data.

### 4.7.3.4 Jordan River Corridor

The Jordan River Corridor includes 43,238 acres and incorporates the main water artery that flows northward through the Salt Lake Valley from Utah Lake downstream to the Great Salt Lake. The Jordan River in Salt Lake County is 44 miles in length and descends from the outlet of Utah Lake in Utah County for approximately 10 miles before entering Salt Lake County through the Jordan Narrows. The Jordan River flows through Salt Lake County and eventually terminates at Burton Dam near Farmington Bay.

The Jordan River receives water from Wasatch and Oquirrh mountain tributary streams, water treatment plants, and irrigation diversions before much of the volume is redirected into the Surplus Canal at 2100 South, which eventually terminates at the Great Salt Lake. Flow rates in the Jordan River are managed by regulating discharge from Utah Lake and diversion to the Surplus Canal. A detailed description of Jordan River hydrology is provided in Section 4.6.2.4. Flow conditions in the Jordan River are characterized as Perennial-Reduced (Figure 3.10.1).

The average annual precipitation for the Jordan River corridor ranges between 11 and 12 inches (Figure 3.9.1).



Jordan River Corridor Watershed


Jordan River, Jordan River Corridor Sub-Watershed

Numerous studies have been completed on the Jordan River, both historically and during the recent past. Many of these studies have focused on various aspects such as hydrology, water rights, and water quality. Fewer studies have identified habitat issues in this heavily developed urban region of Utah. As mentioned above, the focus of this assessment is on aquatic, wetland and riparian habitat degradation. To that end, a total of 24 studies were identified that address riparian, aquatic, and wetland habitat in the Jordan River Corridor (Appendix D). The majority of these studies were focused on assessing aquatic and/or riparian habitat (17) while fewer studies assessed wetland habitat (7). In terms of location, the majority of studies looked at the Jordan River above 2100 South, where a majority of flow is diverted to the Surplus Canal.

*Aquatic Habitat—Jordan River Corridor* The Jordan River, from Turner Dam (just within the Salt Lake County boundary) at 14600 South to Salt Lake City, is characterized as a moderately entrenched channel dominated by gravel material. It gradually transitions to a slightly entrenched, meandering, riffle/pool channel downstream to the Brighton Diversion. Channel substrate through this segment includes gravel and sand. Below the Brighton Diversion downstream to Mill Creek, a well developed floodplain is evident. From the Mill Creek confluence to 2100 South, the stream is a sand-dominated, entrenched, channelized segment that is deeply incised in more gentle terrain (Fillmore and Jensen, 1997).

At 2100 South a majority of streamflow is diverted to the Surplus Canal for flood control purposes. Below 2100 South the Jordan River channel is comprised of silt and sand particles except in riffle areas where cobble and rubble is predominant. Channel form below 2100 South has been altered on a regular basis through dredging, channelization, and other flood control activities (Holden and Crist, 1986; BioWest, 1988). In general, the Jordan River below 2100 South remains an entrenched channel with fewer meanders and more channelized segments than above this location.

The channel gradient between Turner Dam and 2100 South ranges from 0.2 to 0.7 percent, with an overall average slope of about 0.4 percent. Channel gradient decreases below 2100 South as the Jordan River approaches its terminus at Burton Dam.

Rosgen channel types from Turner Dam to 2100 South range from B4 to F5. Type B4 and C4/C5 channels exist from Turner Dam down to the Mill Creek confluence and exhibit some degree of natural stream features interspersed by segments that are straightened and dredged. Below the Mill Creek confluence, the Jordan River becomes an F5 channel with high levels of entrenchment and bank erosion (Fillmore and Jensen, 1997). No studies were located documenting Rosgen channel type below 2100 South. Based on general descriptions of stream features, it is likely that the Jordan River below 2100 South is a combination of type C and F channels. Many segments of the Jordan River are considered degraded based on low sinuosity levels and other features that reflect the historical influence of development (Fillmore and Jensen, 1997).

Several processes influence bank stability of Jordan River segments including long-term channel bed degradation, sediment deposition, bridge scour, and natural channel migration (CH2M Hill, 1992). Unstable channel banks are, in many instances, the result of channel downcutting in segments that have been degraded through channel straightening and dredging. Removal of channel material in these segments produces vertical cut banks that are susceptible to bank sloughing. Other segments experience sediment deposition from tributaries and upstream diversion structures. These sediment deposits serve to deflect flow velocities into channel banks and increase bank erosion. Sediment deposits regularly occur near the confluence of tributary streams including Big and Little Cottonwood Creeks as well as upstream of the North Jordan Canal diversion. In a similar manner, flows are deflected at bridge piers and constrictions that occur at crossings, resulting in increased levels of bank erosion.

Channel migration is a process that occurs in response to erosion and deposition processes that are evident in natural rivers. This process is minimized in most areas of the Jordan River through regular maintenance. Channel banks are considered generally stable from Turner Dam downstream through 14600 South with the exception of isolated bank erosion during flood events. Channel banks are generally unstable downstream of 14600 South to the North Jordan Canal diversion. Some segments in the upper portion of this reach are highly unstable and experienced severe bank erosion from flood events in the early 1980,s (Fillmore and Jensen, 1997). Bank stability is typically good below the North Jordan Canal down to Mill Creek with the exception of localized scour points at bridge crossings and a few channel bends in the lower portion of this reach. Channel stability is good from Mill Creek to 2100 South. Little bank stability is available below 2100 South. However general descriptions of channel banks obtained from aquatic surveys indicate that most banks are relatively stable (Holden and Crist, 1986; BioWest, 1988).

Jordan River, Jordan River Corridor Sub-Watershed

Jordan River restoration site (Murray, UT), Jordan River Corridor Sub-Watershed

Aquatic habitat features are dominated by runs, ranging from 64 to 99 percent of total habitat features found in various river segments from Bluffdale to 2100 South. Other in-stream forms include riffles (0-27 percent), backwater (0-17 percent), and eddies (0-9 percent). Below 2100 South, habitat features are comprised of slow runs interspersed with some deep pools. The extent of these features throughout the length of the Jordan River has been historically influenced by human activities such as dredging, channelization, and management of flows from Utah Lake, tributaries, and irrigation diversions (Fillmore and Jensen, 1997).

The macroinvertebrate community is substantial and diverse in upper river segments and dominated by diptera, oligochaeta, coleoptera, isopoda, ephemeroptera, and trichoptera. Many of these species are intolerant of pollution and indicate good water quality. Higher macroinvertebrate densities are found in the Riverton and Bluffdale areas, while lower densities are observed downstream of these locations (Nabrotzky, 1986). Macroinvertebrate populations in lower Jordan River segments, including those found below 2100 South, are dominated by pollutant tolerant species, including oligochaeta and chironomidae, and indicate relatively poor water quality (Holden and Crist, 1986) Both fish and macroinvertebrates appear to be limited not by water quality but by the lack of suitable riffle and backwater habitats (Holden and Crist, 1986; BioWest, 1988).

Measured physical habitat parameters and habitat preference information included in Table 4.7.3

Jordan River Parkway Trail, Jordan River Corridor Sub-Watershed

indicate that upper Jordan River segments above the confluence of Little Cottonwood Creek are generally suitable for cold water aquatic species. River segments below this point are suitable for warm water species. An exact delineation between suitable cold water and warm water aquatic habitat is difficult to determine and is dependent upon such factors as water temperature, pollutant loading, and instream habitat. It is likely that the range and extent of cold water aquatic habitat would improve with water quality and the number and type of aquatic habitat features.

As of 2003, the Jordan River is known to support at least 12 fish types. However, previous studies note 11 additional fish species found in the Jordan River within the past 30 years, which may or may not still exist. In general, the number and amount of rough fish species increases with distance downstream from Turner Dam. The dominant aquatic species throughout the Jordan River include common carp and the Utah sucker. From the County line to 14600 South, channel catfish, rainbow trout, white bass, walleye, common carp, and Utah sucker have been identified. Larger numbers of rainbow trout and brown trout are present from 14600 South downstream to 9000 South as well as bluegill sunfish, common carp, black bullhead, mountain sucker, Utah sucker, and fathead minnow. Between 9000 south and 2100 South, common carp, Utah sucker, and few rainbow trout have been identified. Common carp, Utah sucker, and Utah chub live between 2100 South and the Great Salt Lake. Previous studies have noted 11 other types of fish in the Jordan River within the past 30 years, including: cutthroat trout, rainbow-cutthroat trout crosses, green sunfish, black crappie, yellow perch, largemouth bass, mosquitofish (also known as "gambusia"), longnose dace, goldfish, and mottled sculpin.

Urbanization and historic modifications such as channelization, dredging, straightening, and diking have resulted in destruction of the natural aquatic habitat of the Jordan River (Jensen, 1996; CH2M Hill, 1992; Utah Division of Parks and Recreation, 1993; Johnson, 1993; Holden and Crist, 1986; Wilson, 1987; Salt Lake County, 1978; Bio/West, 1988; Giddings and Stephens, 1999; National Audobon Society, 2002). Straightening of the channel in particular may be the primary cause of subsequent long-term degradation (CH2M Hill, 1992). In some areas, the channel has been completely relocated, straightened, and channelized to allow for industrial and residential development. Uniform trapezoidal channel dimensions with homogeneous flow and little cover or aquatic vegetation are typical of the Jordan River and often requiring routine maintenance such as dredging which removes natural instream habitat features. Irrigation and municipal water needs are also concerns for the Salt Lake Valley which result in inadequate remaining volumes for fish habitat in the Jordan River and its tributaries.

*Riparian Habitat—Jordan River Corridor* The area of the Jordan River riparian corridor is estimated at approximately 1,167 acres. Modifications to the composition and structure of vegetation in the corridor have taken place over time along with modifications to the stream channel. A riparian gallery forest is thought to have once surrounded the Jordan River, consisting of a variety of large tree and understory species. As a result of channel modifications, much of the native vegetation has been replaced by exotic species of grass and few trees, shrubs and forbs (Johnson, 1993; Jensen, 1986; BioWest, 1988; National Audobon Society, 2002). Where riparian vegetation does occur, it is dominated by willow, Russian olive, tamarisk, and grasses. Cottonwood, elm, box elder, and various wetland plants occur intermittently throughout the riparian corridor as well.

The composition of riparian vegetation at eight monitoring locations on the Jordan River between

Bluffdale Road and 1000 North has been estimated to contain as much as 97 percent grass cover. Vegetation composition at Bluffdale road contained nearly 60 percent riparian vegetation and was generally in better condition than other downstream locations (Holden and Crist, 1986).

GAP data identified 4 miles of Great Basin Foothill and Lower Montane Riparian Woodland and Shrubland along a total of 4 miles of upper river segments in Draper and Bluffdale.

Entrenchment data described above under Aquatic Habitat provides some indication of access by Jordan River flows to the adjacent floodplain. Channel segments that are deeply entrenched are seldom capable, or entirely incapable, of accessing floodplains while high flows in segments that are slightly entrenched could access floodplains regularly. Based on these assumptions, the Jordan River is capable of accessing floodplains from the Brighton Canal diversion down to the Mill Creek confluence. Some potential for floodplain access is evident above the Brighton Canal diversion, although opportunities diminishes rapidly with distance above this location.

Avian species rely on the riparian corridor for breeding, wintering, and migrational resting habitat. A general list of birds observed in the Jordan River riparian area include: grebe, pelican, heron, duck, hawk, eagle, falcon, crane, gull, dove, tern, owl, hummingbird, woodpecker, swallow, wren, bluebird, lark, blackbird, sparrow, and finches.

Jordan River at the Riverbend Restoration Site, Jordan River Corridor Sub-Watershed

Jordan River at 9000 South, Jordan River Corridor Sub-Watershed

Loss of riparian vegetation consequently reduces the value of associated wildlife habitat and can result in increased stream temperatures by exposing the water to more sunlight (Johnson, 1993; National Audobon Society, 2002). Canopy cover is sparse or nonexistent in many locations; although recent restoration projects have improved upon these conditions (Jensen 1986, Salt Lake County, 1978). Riparian conditions continue to be degraded by grazing activities and by the spread of invasive plant species in some areas (National Audobon Society, 2002). Mass wasting is also a concern (Jensen, 1986).

As the land has become more developed, the habitat has morphed into a more homogeneous and fragmented state and the quantity of birds has decreased. Riparian obligate bird species and neotropical migrant birds have suffered noticeable declines in the Salt Lake Valley. Ungrazed willow plant communities appear to be richest in avian species of concern and are recommended as a target area for restoration projects (Norvell, 1997).

*Wetland Habitat—Jordan River Corridor* A number of studies and data are available to provide a picture of wetland habitat composition and conditions in the Jordan River Corridor. A Wetland Advanced Identification Study (WAIDS) identified 22 basins containing nearly 2,000 acres of mostly Palustrine Emergent wetlands adjacent to the Jordan River from the Narrows to 2100 South. Wetland effectiveness ratings were assigned to each basin and included the following functions: groundwater discharge, flood storage, shoreline anchoring, sediment trapping, nutrient and pollution retention, food chain support, fishery habitat, wildlife habitat, and recreation. Effectiveness scores were totaled for each basin to determine which basins provided the highest benefit to the

Salt Lake Valley (i.e., higher effectiveness equates to greater benefit, lower effectiveness equates to lower benefit). In regard to fishery habitat, the effectiveness ratings were low for wetlands between Bluffdale and 9000 South, moderate from the Narrows downstream to Bluffdale, and high for wetland areas located between 9000 South and 3300 South. With regard to wildlife habitat, the effective ratings were low for wetlands at the Narrows, moderate from Bluffdale down to 9000 South, and high for wetland areas from 9000 South to 3300 South.

NWI data identified 1,232 acres of wetlands in the watershed. The dominant type is Palustrine Emergent wetlands followed by approximately 160 acres each of Palustrine Aquatic Bed and Riverine Lower Perennial. The vast majority of these features are located upstream of the confluence with Little Cottonwood Creek with many large areas found between Bangerter Highway and 9000 South.

Wildlife inhabiting Salt Lake Valley wetlands include: muskrat, beaver, red fox, long-tailed weasel, mule deer, vole, rabbit, rock squirrel, and raccoon. Amphibians include toads and frogs, while reptiles such as the garter snake have also been observed. Wetland degradation due to human encroachment, filling of oxbows, and draining of wetlands is a concern throughout the Jordan River Corridor (Wilson, 1987; National Audubon Society, 2002).

### 4.7.3.5 Great Salt Lake Shorelands

The Great Salt Lake of Salt Lake County Watershed includes Kersey Creek, Lee Creek, and Coon Creek as well as Great Salt Lake shorelands. The boundary for this watershed contains areas in Salt Lake County that drain directly to the lake as well as a portion of the lake itself as defined by the north County line. Several municipalities, state, and federal agencies have land within the watershed, including West Valley City (15,043 acres), Salt Lake City (40,015 acres), Utah Division of Sovereign Lands (10,023 acres), Utah State land (1,255 acres), U.S. Forest Service lands (1,236 acres), and BLM lands (59 acres). In addition, several private and non-profit entities own and manage shoreland for their wetland values, including Kennecott (3,933 acres), National Audubon Society (1,998 acres), and private duck clubs (13,843 acres). The shorelands area includes Farmington Bay located in the northeast corner of the watershed.

Great Salt Lake of Salt Lake County Watershed

Kersey Creek originates from groundwater discharge and surface drainage in the vicinity of 2400 S. 7800 W. Stream headwaters are initially formed by groundwater seepage and supplemented downstream by discharge from the Magna Water and Sewer Improvement District Wastewater Treatment Plant. Below this point, the creek flows northward and converges with Lee Creek before entering the east branch of the C-7 Ditch (a discharge ditch from Kennecott's tailings pond), which eventually terminates downstream into Gilbert Bay and the Great Salt Lake.

Lee Creek originates north and east of Kersey Creek and is relatively small in terms of channel size and flow. The area surrounding Lee Creek (305 acres) is part of Kennecott's Inland Sea Shorebird Reserve and the South Shore Preserve because of its importance as highly valued avian habitat. In 2004, Gilbert Bay and the surrounding area became classified as a Birdlife International and National Audubon Important Bird Area among other sites in the global network as "a place with outstanding value to bird conservation."

Kennecott's 6,000 acre tailings pond sits at the toe of the northern Oquirrh Mountains and is a disposal site for their industrial tailings.


Great Salt Lake, Great Salt Lake of Salt Lake County Sub-Watershed

The Great Salt Lake is a large, shallow, terminal saline lake which extends into Salt Lake, Davis, Weber, Box Elder, and Tooele counties. It is fed mainly by water from the Bear, Weber, and Jordan rivers. Water leaves the lake primarily by the process of evaporation. In Salt Lake County, a small portion of the Great Salt Lake is adjacent to the northwest county line. Lake elevation varies, but in general, is approximately 4,200 feet. Farmington Bay comprises the south-eastern portion of the Great Salt Lake, bounded from the rest of the lake by Antelope Island and its southern causeway to the west and the Davis County causeway to the northwest. Freshwater enters the bay via canals fed by the Jordan River and groundwater inflow.

The Great Salt Lake wetlands, including those around Farmington Bay, are considered to be extremely important habitat for over 250 species of migratory birds and waterfowl since they lie within a flight corridor that extends from South America to the Arctic. Many birds rely on the food provided to them by the Great Salt Lake ecosystem to supply energy for the migratory flight.

The Great Salt Lake area has been designated as one of only 11 hemisphere reserves and one of four international reserves in the Western Hemispheric Shorebirds Reserve Network. In addition to the avian habitat, the wetlands also provide a nurturing living space for fish, macroinvertebrates, amphibians, and mammals, which are fed on by the abundant flocks of birds.

Eight studies were reviewed that describe aquatic and riparian, and wetland habitat for streams and shoreland areas in the watershed (see Appendix D).

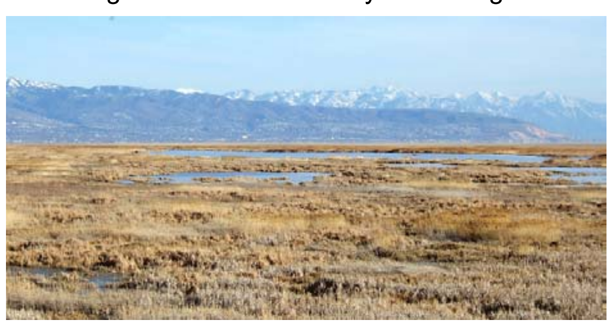
*Aquatic Habitat—Great Salt Lake* No information was found describing aquatic habitat in Kersey Creek or Lee Creek.

The Great Salt Lake is approximately 70 miles long and 40 miles wide with a surface area of 1,500 square miles and an average depth of 13 feet. Salinity levels vary due to constructed dikes and causeways. In areas of high salinity, use of the lake is limited to wildlife, recreation, and mineral extraction.

Farmington Bay has a surface area of approximately 100 square miles and an average depth of 3.3 feet. Due to restricted exchange of water with the rest of the lake and a voluminous inflow of freshwater, Farmington Bay water has a lower salinity than most other portions of the Great Salt Lake. Openings in the causeway allow dense brines to enter Farmington Bay, thus preventing the area from becoming entirely freshwater. Salinity ranges between 2 to 6 percent but ultimately depends on lake elevation.

No fish exist in the Great Salt Lake under normal circumstances, although there have been occasions in certain locations when the salt water was overlain by sufficient volumes of freshwater to temporarily allow fish to enter the shore area of the lake. These fish species include carp, minnows, and occasionally Utah chub.

Aquatic organisms that permanently inhabit the Great Salt Lake include: pre-adult brine fly, corixids, brine shrimp, bacteria, and algae. The density of these organisms tends to vary according to salinity


Great Salt Lake Shorelands, Great Salt Lake of Salt Lake County Sub-Watershed

levels. Brine shrimp eggs, cysts, and nauplii from the lake are commercially harvested and make for a profitable industry. They are used internationally as food for hatchery marine finfish and crustaceans. Over-harvesting of all life stages of brine shrimp is a concern (Utah Department of Natural Resources , 1999).

As in other portions of the Great Salt Lake, no fish exist in Farmington Bay. The aquatic species inhabiting this area are mainly the same as those found in the Great Salt Lake, although they occur in different densities as a response to differences in water salinity. Greater numbers of algae and bacteria species are found here in comparison to other areas of the lake.

Recent intense algal blooms and the occurrence of Legionnaires bacteria in Farmington Bay have raised health concerns for both humans and wildlife, and a recommendation has been made to change the designated uses for Farmington Bay in order to protect those organisms which might be affected (Wurtsbaugh and Marcarelli, 2006).

In addition to industrial wastewater, effluent from seven municipal wastewater plants flows into Farmington Bay, providing increased nutrients to the system and resulting in algal blooms and a hypereutrophic state. With a Trophic State Index of 87 in 2005, Farmington Bay was the most eutrophic water body in the entire state of Utah (Wurtsbaugh and Marcarelli, 2006).

Kersey Creek, Great Salt Lake of Salt Lake County Sub-Watershed

Lee Creek, Great Salt Lake of Salt Lake County Sub-Watershed

*Riparian Habitat—Great Salt Lake* Little information was located that characterized riparian habitat for the intermittent stream channels in this watershed. However, past activites associated with the Kersey Creek and Lee Creek stream channels have undoubtedly altered riparian corridors and resulted in a temporary loss of habitat. The upper reaches of Kersey Creek have been modified to better manage surface runoff during critical seasons of the year. Lee Creek has also been modified to redirect flow around the Kennecott tailings pond.

Oak brush, sagebrush, bitterbrush, mountain brome, maple, and various grasses comprise the vegetation community in Coon Canyon. No riparian vegetation was noted by GAP data adjacent to Lee and Kersey Creek.

This limited information indicates that riparian habitat along Kersey and Lee, Creeks has been highly modified and provides little habitat value.

*Wetland Habitat—Great Salt Lake* Fed by water from the Jordan River and Surplus Canal, the shorelands area adjacent to the Great Salt Lake and Farmington Bay is a landscape of diverse wetland habitat. Of all land in Utah, a mere 1 percent is comprised of wetland habitat, and approximately 70 percent of this is situated along the Great Salt Lake shorelands. NWI data identified over 61,000 acres of wetland in this watershed including areas in Kersey, Lee, and Coon Creek Sub-Watersheds. The most dominant wetland type is Lacustrine Littoral followed by Palustrine Emergent.

Great Salt Lake, Great Salt Lake of Salt Lake County Sub-Watershed

GAP vegetation data is defined at a 30-meter pixel resolution and may sometimes miss smaller pockets of wetland vegetation in Salt Lake County watersheds. The Great Salt Lake shorelands area is dominated by wetland vegetation types. Therefore, GAP data can provide useful information in this area. GAP vegetation data indicates the dominant wetland associated vegetation type in the watershed is Intermountain Basins and Playa comprising 7,892 acres of the watershed. North American Arid West Emergent Marsh are also common totaling 7,243 acres overall. The remaining wetland associated vegetation types include Great Basin Foothill and Lower Montane Riparian Woodland and Shrubland (1,637 acres) and Rocky Mountain Lower Montane Riparian Woodland and Shrubland (4 acres).

More descriptive studies of wetlands in this watershed have built upon NWI data. This information has defined approximately 70,000 of 100,000 acres in the northwest quadrant of Salt Lake County as wetland areas that can be classified as one of the following five wetland types: saline/fresh open water (Lacustrine Unconsolidated Bottom), saline/freshwater marshes (Lacustrine Emergent), saline mudflats and playas (Palustrine Unconsolidated Shore), saline meadows (Palustrine Emergent), and saline plains (Palustrine Emergent). The majority of wetlands near the Great Salt Lake in Salt Lake County are saline plains and saline mudflats and playas.

Open saline water wetlands are formed when diked water from the Jordan River and irrigation canals accumulates in natural depressions. They are permanently flooded with a water depth of 3 feet or more. These wetlands are usually void of surface vegetation, but submerged species such as algae, diatoms, and duckweed may be present. Open saline water wetlands comprise approximately 38,034 acres of the total wetlands, and are mainly concentrated in the northeast corner of Salt Lake County near saline marshes.

Saline marshes are formed in the same manner as open saline water wetlands, but saline marshes are shallower. The wetland is permanently or semi-permanently flooded with a water depth of 3 feet or less. Saline marshes contain more than 30 percent emergent surface vegetation cover and include bulrush, cattail, water parsnip, and pond weed. Saline marshes are mainly concentrated in the northeast corner of Salt Lake County near open saline water wetlands.

Saline mudflats and playas occur in the floodplains of the Great Salt Lake. They are fed by groundwater as well as overflow from rising lake levels and are seasonally saturated to seasonally flooded. Saline mudflats and playas have less than 30 percent surface vegetation cover and include inkweed, iodine bush, pickleweed, and salt grass. Saline mudflats and playas are among the most dominant wetland types near the Great Salt Lake in Salt Lake County. Approximately 1,505 acres of this wetland subtype occurs adjacent to the shore of the lake, but include several fingers which extend out in a south easterly direction beyond 2100 South and Interstate 15 in Salt Lake City.

Saline meadows are usually near a large body of open water or playa and can be seasonally flooded to seasonally saturated. They contain more than 30 percent surface vegetation cover and are dominated by arctic rush and saltgrass. Saline meadows are among the least dominant wetland types near the Great Salt Lake in Salt Lake County. Their locations are dispersed, but seem to occur near saline flats and playas, in general.

Saline plains are upland areas that contain a high water table. The wetland is rarely flooded, but may become saturated in the spring. They usually contain more than 30 percent cover and include greasewood, shadscale, rubber rabbitbrush, ragweed, Indian paintbrush, and more. Saline plains are also among the most dominant wetland types near the Great Salt Lake in Salt Lake County totaling 13,635 acres. They extend in a south-easterly direction from near the lake to beyond 2100 South and Interstate 15 in Salt Lake City.

Water regimes and vegetation communities vary according to wetland type. Average precipitation years yield nearly sufficient water volumes to sustain the biological demand for wetlands in the Farmington Bay area which are fed by water from the lower Jordan River beyond the Surplus Canal Diversion. However, a deficit of 867 af remains in July, even during wet years. The deficit in dry years is about 1,174 af. Periods of drought threaten these wetland communities, and wet years provide critical support to sustain the extent and complexity of wetland types in the shorelands area. Duck clubs make the best use of available water by moving volumes to different storage cells in order to optimize growth of aquatic vegetation used by birds that inhabit these areas.

The biological demand for wetlands fed by the Surplus Canal, including those along the Great Salt Lake outside of Farmington Bay is met by average precipitation, except during July, August, October, and November (Branson and Davies, 2007). The deficit in wet years occurs mainly in August and is approximately 196 af. In dry years, the deficit occurs in March and April and is approximately 6,804 af, and also from June through November and is about 23,553 af. Many of the wetlands are managed by the privately-owned duck clubs that have some control of flow volumes and timing of flow releases. Some loss of wetland areas has occurred due to changes in water supply (Davies and Stewart, 2007; Utah Department of Natural Resources, 1999).

Additional impacts to wetlands have occurred from agriculture and other forms of land development (Envision Utah, 2003). The influence of these impacts is not fully known at this time but the potential exists to impact areas of critical habitat for avian wildlife species.

## Coon Creek

The Coon Creek Sub-Watershed is 14,409 acres located on the northern end of the Oquirrh Mountains. Stream headwaters commence in a fan-like formation where several small drainages converge. Flows are mostly Intermittent, with the exception of a small Perennial segment at the headwaters. Flows are supplemented by several tributaries including those from Harker's Canyon. Coon Creek flows downstream past the canyon mouth and starts into the Salt Lake Valley at an elevation of approximately 5,000 feet. At this point, a portion of flow is diverted for irrigation and the remaining flow dissipates not far below. Coon Creek passes below the Utah and Salt Lake Canal and terminates at the C-7 ditch. Additional detail on this creek is provided in the Instream Flows Section. Kennecott Copper Corporation owns the majority of water shares in Coon Canyon.

*Aquatic Habitat—Coon Creek* A limited amount of information could be found on existing aquatic conditions for the mountain portion of Coon Creek. In Coon Canyon, the channel gradient is moderate. No additional information was located for Coon Creek.

*Riparian Habitat—Coon Creek* GAP data indicated 1.7 miles of Great Basin and Lower Montane Riparian Woodland and Shrubland vegetation adjacent to the mountain segments of Coon Creek, including 0.4 miles located in Harkers Canyon.

Coon Creek, Coon Creek Sub-Watershed

### 4.7.3.6 Aquatic, Riparian or Wetland Dependent Wildlife

As discussed above under Methodology (Section 4.7.2), a number of sources were consulted to provide an overview of the special status wildlife species dependent on Salt Lake County's aquatic, riparian, and wetland habitats. The Utah Sensitive Species List identifies those species for which "there is credible scientific evidence to substantiate a threat to continued population viability" (DWR, 2005). The Utah Partners in Flight Priority List, which was established between federal and state agencies, foundations, conservation groups, industry and the academic community to address the problem of bird population declines, was used to identify species of concern that are not formally special status species. The Utah DWR's Action Plan includes additional wildlife species that are indicators of habitat health, including mammals, reptiles, mollusks, and plants as well as bird species. Finally, the Wasatch-Cache National Forest has identified several species as Management Indicator Species (MIS). These species are considered to represent habitat types that occur within the U.S. Forest Service boundary and to be sensitive to U.S. Forest Service management activities. These lists were cross-referenced and, based on habitat preference and recorded occurrence in the planning area, are discussed below.

Many bird species, in particular, require riparian areas for nesting and breeding. Of the 25 species on the Utah Sensitive Species List, four bird species are riparian-obligates, which means that more than 90 percent of their nests occur in riparian vegetation or more than 90 percent of their population occupies riparian vegetation during the breeding season. Many birds not listed as special status species require riparian vegetation for breeding/nesting as well. The Utah Partners in Flight Priority List, developed in coordination with the Utah DWR, lists one riparian-obligate (broad-billed hummingbird) that may potentially occur in the watershed. These riparian-obligate bird species are listed in Table 4.7.4 with the region of the planning area and the land cover type where they are most likely to occur.

Bird species considered dependent on riparian vegetation (i.e., those that place 60 to 90 percent of their nests in riparian vegetation or for which 60 to 90 percent of their population occurs in riparian vegetation during the breeding season) also frequent the planning area. The riparian dependents might still occur in an area if riparian vegetation were seriously degraded but their populations would be greatly reduced and they might not persist in the long-term. These wetland dependent bird species are listed in Table 4.7.5 with the region of the planning area and the land cover type where they are most likely to occur.

Shifting from riparian habitat to the other two habitats of concern here, Table 4.7.6 lists species that are found only in wetland or aquatic habitats or that need functional access to a wetland or aquatic habitat during their life cycle. These can include, for example, dry meadow margins, the shade of riparian vegetation, soils derived from parent material created by spring outflows, or the shore zones of lakes or ponds.

**Table 4.7.4 Riparian-Obligate Utah/Federal Special Status and Utah Partners in Flight Priority Species**

| Species | Most Likely Occurrence by Region (based on land cover type[3]) |
|---|---|
| American white pelican | Great Salt Lake Shorelands (Intermountain Basins Playa and Open Water). |
| Bald eagle | Wasatch Mountains, Oquirrh Mountains, and Great Salt Lake Shorelands (Rocky Mountain Montane Mesic Mixed Conifer Forest and Woodland, Rocky Mountain Aspen Forest and Woodland, and Open Water). |
| Black swift | Wasatch Mountains (Rocky Mountain Montane Mesic Mixed Conifer Forest and Woodland, Rocky Mountain Aspen Forest and Woodland, and Open Water). |
| Yellow-billed cuckoo | Jordan River at Utah Lake outlet and Oquirrh Mountains, south end (Rocky Mountain Aspen Forest and Woodland and Great Basin Foothill and Lower Montane Riparian Woodland and Shrubland). |
| Broad-billed hummingbird[2] | Jordan River at Utah Lakeoutlet (Rocky Mountain Aspen Forest and Woodland). |

[1]Based on the USGS *"Birds as Indicators of Riparian Vegetation in the Western U.S.: Riparian Obligate Species"* definition.
[2]Utah Partners in Flight Conservation Priority Species.
[3]Southwest Regional GAP land cover types.

**Table 4.7.5 Riparian-Dependent Utah/Federal Special Status and Utah Partners in Flight Priority Species**

| Species | Most Likely Occurrence by Region (based on land cover type[2]) |
|---|---|
| Northern Goshawk | Wasatch Mountains (Rocky Mountain Montane Dry-Mesic Mixed Conifer Forest and Woodland). |
| Lewis's Wood-pecker | Wasatch Mountains and Oquirrh Mountains (all vegetation cover types except Intermountain Basins Playa). |

[1]Based on the USGS *"Birds as Indicators of Riparian Vegetation in the Western U.S.: Riparian Obligate Species"* definition.
[2] Southwest Regional GAP land cover types.

While only limited quantitative data exists on the status of these species in Salt Lake County, scientists studying aquatic, riparian, and wetland areas agree that the health of these ecosystems is generally in decline. These habitats have increasingly been filled for housing, roads, and sports fields. Native vegetation has been replaced with lawns and ornamental trees. Streams have been rip-rapped and channeled, and roads and development block the movement of wildlife to and from the riparian and wetland areas. Further wildlife surveys are necessary to accurately determine the presence of species and condition of their habitat within the watershed, but most indicators suggest both are in decline.

## 4.7.4 Future Conditions

A number of the factors that have led to the aquatic, riparian, and wetland habitat conditions observed today will likely continue. These include population growth, conversion of natural land cover types and habitats by development, conversion of agricultural land to industrial and residential use, increased recreational use of key habitats, increased water consumption, groundwater drawdown, transbasin water imports, water supply exchange agreements, increased impermeable surfaces, etc. Other factors that have been limited or nonexistent in the past will also come into play, such as redevelopment of industrial areas, and water reuse. Most importantly, planning at all levels will likely improve, and will incorporate growing awareness of the importance of aquatic, riparian, and wetland habitats for their ecological as well as aesthetic values.

This section discusses how these trends are likely to bear on habitat conditions in the future and particularly on what constraints and opportunities they will pose for maintaining or improving habitat values. The emphasis in this discussion is development in riparian corridors and wetlands, changing water demands and supplies, and recreational use of these habitats. As instream flows and water quality are addressed in detail in other sections of this plan (Sections 4.6 and 3.13, respectively), they are touched on only briefly. This discussion draws on the projected changes in population and land from 2005 to 2030 as presented in Section 3.5. General trends and their effects are outlined below at the County level, followed by issues specific to the four sub-areas and specific watersheds.

**Table 4.7.6 Wetland and Aquatic-Dependent Utah/Federal Special Status Species**

| Species | Most Likely Occurrence by Region |
|---|---|
| Columbia spotted frog | Wasatch Mountains and Oquirrh Mountains. |
| Western pearlshell | Wasatch Mountains. |
| Western toad | Wasatch Mountains. |
| Northern leopard frog[2] | Wasatch Mountains, Oquirrh Mountains, and Jordan River Corridor. |
| Northern River Otter[2] | Wasatch Mountains. |
| American avocet[2] | Great Salt Lake shore-lands. |
| Black-necked Stilt[2,3] | The Great Salt Lake shorelands and the Jordan River Corridor. |
| Bobolink | Wasatch Mountains. |
| Long-billed curlew | Jordan River Corridor. |
| Beaver[4] | Wasatch Mountains and Jordan River Corridor. |
| Bonneville cutthroat trout | Wasatch Mountains. |
| June sucker | Jordan River Corridor. |
| Least chub | Great Salt Lake shore-lands and the Jordan River Corridor. |

[1] Based on the USGS "National Water Summary on Wetland Resources, Technical Aspects of Wetlands".
[2] Utah Division of Wildlife Action Plan species list.
[3] Utah Partners in Flight Priority Species.
[4] Wasatch Cache National Forest Management Indicator Species.

### 4.7.4.1 Salt Lake County

Salt Lake County's population is projected to increase 42 percent by 2030, to 1.38 million residents. This will translate to increased density in current residential areas, residential redevelopment of areas currently used for other purposes, and residential development in previously undeveloped areas. In brief terms, residential development is expected to expand along the Oquirrh Mountain front, replacing agriculture, industrial use, and open space (undeveloped land). Commercial development will expand along the I-15 corridor and along all major highways in the County. (See Section 3.5 for more detailed discussion).

Each of these patterns has different implications for potential development in riparian or wetland habitat. To the extent that riparian corridors and wetlands have been defined and protected with set-back requirements, increased density in existing residential areas poses little threat. Where these features have not been defined and protected, they are threatened by in-fill development.

Redevelopment of areas under other uses, particularly industrial and agricultural areas, offers opportunities to improve habitats degraded by past use. In a sense, redevelopment cleans the slate, allowing municipalities to work with developers in planning for, designing, and constructing developments that protect, restore, or improve, as appropriate, these important habitat types. Again, having a policy and planning structure in place mandating such efforts is a prerequisite; otherwise redevelopment can maintain or worsen the original habitat damage.

Residential development in previously undeveloped areas also offers a generally clean slate and an opportunity to develop in ways that protect key habitats. The main difference from redevelopment is that habitat values are generally higher to start with, so maintaining and perhaps improving them rather than restoring them is generally the objective. An appropriate policy and planning setting is necessary as a starting point.

Projected changes in the acreage of open space in the County provide another perspective on the trend in habitat quality, as that land use category describes the status of most stream buffers and protected riparian corridors and wetlands. This analysis (Section 3.5) indicates that by 2030, 13,707 acres of open space, or 6 percent of the current total, will be lost. This trend is not expected to be uniform; specifically, some lower Wasatch Mountain sub-watersheds are projected to gain open space as a result of designations of land for open space and recreation. Wider adoption of such progressive policies and planning could reverse the Countywide trend, setting the stage for maintaining or increasing protected riparian and wetland habitats.

Overall, the development projected for Salt Lake County over the next 25 years has the potential to sustain the downward trend in the extent of aquatic, riparian, and wetland resources characteristic of past development. However, with the support of growing recognition of the importance of these habitats, reflected in an emerging policy and planning framework to guide development appropriately, this potential may not be realized. These habitats may never be as extensive as they were prior to human settlement, but we certainly have the means to maintain, if not improve what we have now. Upland habitats in the County will likely continue to be developed at a rapid pace.

In regard to the water component of these habitats, anticipated changes in supply and demand also pose both opportunities and constraints. The increasing population will consume more water, maximizing use of surface water, testing the limits of groundwater, and leaving less water to sustain habitat values. While the net effect is likely to be adverse, several measures currently underway or being planned will at least break from a linear relationship between population and water available for these habitats. Trans-basin water imports and exchange agreements will increase the supply available in the County (see Section 4.5). Conservation efforts will reduce per capita consumption, and reuse programs will get double duty from a given gallon.

If sufficient water is conserved or obtained, additional opportunities for specific improvements may occur (e.g., restoring instream flows in stream reaches currently seasonally dried due to culinary or agricultural diversions). While these measures will help to minimize habitat impacts, the greatest causes of habitat loss will continue to be land use and development.

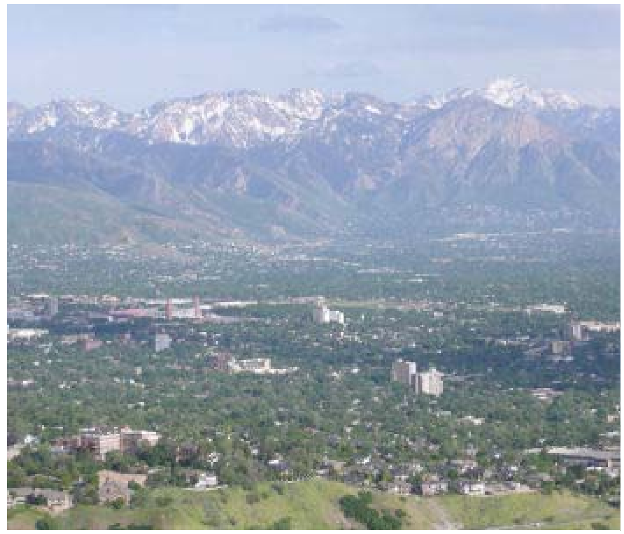
One more intractable, water related effect of population growth is the associated increase in impermeable surfaces. This analysis (Section 3.5) projects a Countywide increase of 5,429 acres, or 3.7 percent, in impermeable surfaces over the next 35 years if current practices continue. This will reduce groundwater recharge and storage capacity, affecting the flows from springs and seeps that support many streams and wetlands. It will also increase surface runoff to streams, decreasing water quality and increasing flood potential and associated channel damage. A policy and planning structure that minimized increases in impermeable surfaces, protected or improved recharge areas, and properly managed surface runoff would be the first step toward offsetting these impacts. Holladay City is an example of one municipality that is managing surface runoff through a maximum percent impervious surface area ordinance.

The last potentially two-sided correlate with population growth is recreational use of these three habitat types. As discussed above under Existing Conditions, recreational use can damage all three types through soil compaction, vegetation trampling, trash accumulation, and other effects. On the other hand, recreational demand can become a force for protecting, improving, or restoring these resources as recreational amenities.

### 4.7.4.2 Wasatch Mountain Streams

Growth projections for the Wasatch Mountain streams vary considerably. City Creek and Red Butte Canyons have no development potential (Lower Red Butte Creek Sub-Watershed has the lowest projected population growth at 4.8 percent),

View of Wasatch Mountains



View of Wasatch Mountains

while Upper Big Cottonwood Creek Sub-Watershed is sixth on the list at 47.6 percent. Regardless of their potential for residential development, all the canyons will face sustained growth in recreational use.

In terms of open space, Lower Mill Creek Sub-Watershed faces the greatest projected loss in the County at 66 percent. Conversely, three sub-watersheds in the area are projected to gain open space through designation of open space and recreational areas – Corner Canyon Creek (23.8 percent), Lower Red Butte Creek (12.2 percent), and Lower City Creek (7.2 percent). Changes in impervious surfaces reflect these trends, with large increases in Lower Emigration Creek (17.1 percent), Lower Mill Creek (14.6 percent), and Lower Parley's Creek (11.3 percent).

A number of streams in this portion of the County are dewatered seasonally by diversions. Water imports, reuse efforts, and shifts in land use patterns may make it possible to re-establish perennial flows, to the benefit of aquatic and riparian habitats.

Based on these trends, the Wasatch Mountain streams face the full range of threat levels to habitat resources, from minimal to extreme. Lower Mill Creek is a particular concern. This area also appears to show the most progressive policies and planning to safeguard these resources through open space dedications in the lower, urban portions of other sub-watersheds. Given the relatively high quality of aquatic, riparian, and wetland resources in this area and its importance as a municipal watershed and recreational destination, the shift toward progressive policies and planning to protect, enhance, and restore these habitats is vital.

### 4.7.4.3 Oquirrh Mountain Streams

As noted above, the sub-watersheds in this area are the focal point of projected population growth in Salt Lake County. The Midas/Butterfield and Barney's Creek Sub-Watersheds will experience the highest net population gains in the County, gaining over 170,000 residents by 2030. In percentage terms, Rose Creek is projected to add 74.0 percent, followed by Midas/Butterfield Creek (71.8 percent).

Residential development will eclipse industrial and agricultural land uses, as well as undeveloped open space. Two of the four greatest losses of open space will occur in this area (Midas/ Butterfield Creek 60.8 percent and Barney's Creek 53.4 percent). Similarly, projected increases in impervious surfaces are topped by Midas/ Butterfield Creek (20.9 percent), and Barney's Creek falls in the top six with 11.7 percent.

Overall, the extensive growth and development projected for the Oquirrh Mountain area pose the greatest risk to aquatic, riparian, and wetland habitats in the County. However, this is tempered by the fact that these resources are relatively limited in the Oquirrh Mountain area and currently not functioning at high levels. As the sub-watersheds in this area are among the least studied in the County, additional survey work is necessary to identify high potential sites to target with protection and/or restoration efforts as development and redevelopment proceed.

View of Oquirrh Mountains

Jordan River, Jordan River Corridor Sub-Watershed

### 4.7.4.4 Jordan River Corridor

Projections indicate that the Jordan River Corridor Sub-Watershed will have the highest population in the County in 2030, adding over 57,000 residents (22.3 percent). As most of this sub-watershed is already developed, accommodating this growth will involve primarily redevelopment of industrial areas and in-fill development. As a result, the potential for notable changes in open space or impervious surfaces is limited.

However, the Jordan River is the main water artery connecting Utah Lake downstream to the Great Salt Lake, supporting numerous irrigation diversions and receiving substantial inflows from stormwater, treatment plants, and irrigation return flows – in a sense, it is the drain for the County.

As a result of its position in the bottom of the watershed and the functions it serves, the Jordan River's aquatic, riparian, and wetland habitats are in relatively poor condition and functioning at low levels (see Section 4.7.3.4). On the other hand, based on its location, functions, and condition, the river and its corridor have increasingly become the main target for habitat restoration of all kinds in the County. These range from TMDL water quality improvement plans, to tamarisk replacement efforts, to litter cleanups, to canoe trips to publicize its condition. In a sense it has become the poster child for habitat restoration in the County, and as a result will likely improve as time goes on.

#### 4.7.4.5 Great Salt Lake Shorelands

This portion of the County is projected to be second only to the Oquirrh Mountain streams area in terms of population growth over the next 25 years, adding over 48,000 residents for a growth rate of 28.2 percent. The Coon Creek Sub-Watershed's population will jump by 50.5 percent, near the top of the Countywide list, though its current base population is small. Much of the shorelands area is undevelopable salt flats and wetlands, so redevelopment of industrial areas will be the primary means of accommodating this growth. As a result, large changes in open space are not anticipated.

It should be noted, however, that re-development of Kennecott industrial/mining lands in the Coon Creek Sub-Watershed, most occurring after 2030, should result in a 22.4 percent reduction in impervious surfaces due to progressive policies and planning regarding integration of parks, open space, and agriculture with residential development.

As discussed above (see Section 4.7.3.5), the wetlands of the Great Salt Lake shorelands are internationally recognized for their importance to migratory birds, particularly waterfowl. These wetlands are generally not subject to encroachment themselves due to protections already in place, but they are located at the lowest point in the watershed and thus vulnerable to effects generated up stream. The Jordan River's water supports many critical wetlands in and adjacent to Farmington Bay, making management of that watershed vital. And, as noted above, the Jordan River is similarly subject to impacts from virtually the entire County.

Efforts to bring new water into the County and to reuse treated wastewater will have widespread effects but will culminate in impacts on the Jordan River and the Great Salt Lake shoreland wetlands it supports. For example, if reuse efforts reduced flows at the river's outfall, less water might be available for the wetlands. Conversely, more net water in the watershed could result in increased Jordan River flows. Given the importance of the wetlands, these issues warrant ongoing attention.

Overall, the Great Salt Lake shoreland wetlands provide unique and highly valuable habitat in their own right. At another level, they are a barometer for habitat quality and health throughout the County. Both of these factors support the need for careful monitoring and maintenance of these important habitats.

### 4.7.5 Habitat Deficiencies

A key step in planning to address deficiencies in Salt Lake County's aquatic, riparian, and wetland habitats is organizing and categorizing them in a logical way. Since the intent is to set the stage for responsive management actions, using the causes of the deficiencies as the framework for categorizing them makes the most sense.

The following summary of habitat deficiencies lists and describes problem types and potential causes that have been documented in Salt Lake County during previous surveys and assessments of aquatic, riparian, and wetland habitat. This summary provides an accurate view of the significant conditions and processes that are affecting the habitats of concern. Note that some problem types affect one or more habitat types discussed in this section and that some overlap exists among problem types. While the typology is generally comprehensive, the extent of problem types is undoubtedly greater than what has been identified to date by documented field surveys.

*1. Stream Channelization:* Many stream channel segments have historically been dredged and straightened in response to flood control and general maintenance concerns by county and municipal entities. These activities have influenced both the cross-sectional profile and longitudinal form of stream channels. Dredging has increased width and depth of stream channels and removed

Mill Creek through channelized section, Lower Mill Creek Sub-Watershed instream aquatic habitat features such as pools, riffles, large woody debris, boulders, and coarse channel substrate. Removal of meander bends and channel sinuosity has increased flow velocities and promoted channel bed and bank erosion.

*2. Unstable Channel Banks:* In many areas channel banks are eroded, cracking, or sloughing. Documented factors that lead to this condition include lack of vegetation, vertical channel banks, and low bank rock content. Lack of vegetation can result from human or livestock activities as well as decreased water in the rooting zone due to channel downcutting. Removal of channel material during dredging produces vertical cut banks that are susceptible to bank sloughing. Bank rock content is primarily a factor of local soil types.

Other factors such as long-term channel bed degradation, sediment deposition, bridge scour, and natural channel migration also contribute to unstable banks. Channel degradation results from straightening and dredging activities which lead to increased flow velocities and channel downcutting. Sediment deposition occurs at points of inflow or diversion and serves to deflect flow velocities into channel banks and increase bank erosion. Flows are also deflected at bridge piers and constrictions that occur at crossings, resulting in increased levels of bank erosion. Natural channel migration is limited in many urban areas by engineered structures and development on floodplains.

Mass wasting in Corner Canyon Creek, Lower Corner Canyon Creek Sub-Watershed

*3. Incised Channel Beds:* Instability in stream channel beds is generally evident in many areas of channel entrenchment, downcutting, and scour. Stream channels that are entrenched and incised have little or no access to floodplains during peak flow events. Groundwater recharge to floodplains and riparian corridors by entrenched stream channels is also limited.

Channels beds begin to erode when flow velocities increase and the amount of sediment removed from a given segment exceeds the amount that is deposited from upstream sources. Flow velocities increase when channel gradients are changed during dredging and channelization efforts. Flow volumes (and velocities) in the Jordan River are influenced by releases from Utah Lake which subsequently influence rates of sediment transport as well as stream bed and bank erosion.

*4. Insufficient Instream Structural Features:* Aquatic species depend on instream structural features that provide opportunities for rest, spawning, and hiding, as well as development of juvenile aquatic life stages. These features include: proper proportions of pools, riffles, and runs; undercut banks; aquatic vegetation; large woody debris; and coarse channel substrate. A lack of these features limits the number and type of aquatic species present in many planning area stream segments. Streams that are void of these features tend to be inhabited by species of fish and macroinvertebrates that are tolerant of degraded conditions and generally less desirable.

*5. Restricted Fish Passage:* Free movement of fish species is limited, particularly in urban portions of the planning area, by structures that interrupt normal stream gradient and create substantial drops (12 inches or more). Such structures include culverts and irrigation diversions that span the entire stream channel. Stream segments that are dewatered or suffer substantially reduced flows for purposes of irrigation or municipal water treatment are also a barrier to fish passage.

*6. Sediment From Upstream Sources:* Fine sediment material can be deposited on channel beds by inflow from tributaries or direct surface runoff and by structures that divert or restrict flow, such as irrigation diversions or beaver dams. Sediment loading from tributary flow is particularly evident at the confluence of tributaries to the Jordan River. Many of these locations need regularly scheduled dredging in order to maintain desired flow rates.

Sediment loading through direct surface runoff can occur from areas with hardened surfaces such as roads, parking lots, campgrounds, and trails. Erosion from barren soil surfaces such as historic mining claims and construction sites is also a concern. Unstable areas that are located adjacent to and upslope from stream channels have contributed sediment loading and flow restrictions during mass wasting events. Another potential sediment source is upstream bank and channel erosion, a deficiency considered in the Nonpoint Sources Planning Element (Section 4.4).

Flow velocities are reduced by irrigation diversions and beaver dams and provide an opportunity for sediment to settle and accumulate. Once this material is deposited on a channel bed it can degrade aquatic habitat by removing interstitial spaces required by macroinvertebrates and fish. Removal of sediment deposits can damage channel beds and banks.

*7. Trash:* Accumulations of trash and debris from urban areas degrades riparian vegetation and contributes to water quality problems. Some forms of trash are detrimental to aquatic life forms as they are ingested. Debris has accumulated at various locations and created unsightly views of the riparian corridor along the Jordan River and elsewhere in the planning area.

Trash in Mill Creek, Lower Mill Creek Sub-Watershed

*8. Absence of Native Fish:* A limited number of stream segments in the County appear to have all required aspects of aquatic habitat yet do not currently support native fish populations, including but not limited to, Bonneville cutthroat trout. It is likely that habitat in these locations is degraded in some manner that allows other, less-desirable species to out compete native species. In other situations, there may be no breeding population of native species to provide recruitment.

*9. Poor Water Quality:* Water quality standards are expressed in terms of the beneficial uses assigned by the State to waterbodies. These uses generally include providing habitat for aquatic species. If sample measurements are found to violate assigned beneficial use standards, a waterbody is placed on the 303(d) list of impaired waterbodies until a detailed assessment and improvement plan is completed. The assessment determines the maximum allowable load of pollution or Total Maximum Daily Load (TMDL) that a waterbody can receive from pollutant sources and still meet the required standards. The implementation plan describes how the necessary reductions are to be achieved. At present, segments of the Jordan River, Big Cottonwood Creek, Little Cottonwood Creek Parley's Creek and Emigration Creek are considered impaired for the designated beneficial *use.*

*10. Degraded Vegetation Cover:* Vegetation is degraded or absent in many planning area riparian corridors and wetlands. Degraded vegetation cover provides opportunities for soil erosion and is less effective in stabilizing channel banks and wetlands than a healthy vegetation community. Further, degraded vegetation typically does not meet structural or other habitat needs of terrestrial and aquatic species.

Non-native and other opportunistic species can encroach into areas of degraded vegetation and begin to compete for water, light, and nutrients. Over time these species can out-compete and replace desired native vegetation, generally reducing biodiversity overall. Important non-native species that have invaded riparian corridors in Salt

Lake County include purple loosestrife, tamarisk, phragmites, thistle, and knapweed.

Several factors account for degradation or removal of riparian and wetland vegetation. Mismanagement of riparian corridors and wetlands results in vegetation clearing and alteration. Large tree and shrubs species are typically lost when these areas are landscaped. As noted above, channel entrenchment and incisement can remove water from the riparian root zone. Recreation sites result in degradation from creation of user-created trails and dispersed camping activities. Poor livestock management practices can also impact vegetation. A natural loss of riparian vegetation can occur as a result of avalanche activity.

*11. Loss of Open Space and Habitat Due to Development:* Development in the County's riparian corridors and wetland areas has resulted in a loss of vegetated surface area to building footprints, parking lots, and roads. This loss of habitat has served to fragment landscapes and restrict movement of terrestrial, avian, and aquatic wildlife species that inhabit and pass through these areas. A significant loss of land area has also reduced the ability of riparian corridors and wetlands to buffer peak flow events and to store and release water during the summer and fall season.

Structure over Red Butte Creek, Lower Red Butte Creek Sub-Watershed

*12. Loss of Habitat Due to Limited Water*: Development of surface and groundwater resources has resulted in impacts on stream channels, riparian corridors, and on wetlands. Downcutting and channelization have disconnected streams from their floodplains. Diversions for municipal and irrigation use routinely dewater a number of stream segments completely, damaging riparian and aquatic vegetation, macroinvertebrate populations, and fish passage. Wetland vegetation and habitat functions have been lost when points of groundwater discharge have dried out. Riparian vegetation has been lost when stream segments that were formerly gaining streams, as a result of groundwater contributions, transitioned into losing streams in response to lowered groundwater levels. The issue of instream flows, both current limitations and options for alleviating them, is discussed in the Instream Flows Planning Element (Section 4.6).

Locations where the reviewed studies have documented these problem types are shown in Table 4.7.7 and Table 4.7.8. Note that the occurrence of problem types follows a distribution similar to the information available to define existing conditions (i.e., more specific deficiencies have been identified in the Wasatch Mountains and the Jordan River than other watersheds). Due to this inconsistent coverage, only limited conclusions can be made as to the extent of these habitat deficiencies Countywide.

**Table 4.7.7 Known Habitat Deficiency Types Occurring in Wasatch Mountain Sub-Watersheds**

| Problem Type | SUB-WATERSHED | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | UCC | LCC | URB | LRB | UEM | LEM | UPC | LPC | UMC | LMC | UBC | LBC | ULC | LLC | UDC | LDC | UWC | LWC | CY |
| Stream Channelization | x | x | | x | | x | x | | | x | | x | | x | | x | | x | x |
| Unstable Channel Banks | | | x | x | x | x | | x | x | x | x | x | x | x | | x | | | |
| Incised Channel Beds | | | | x | x | x | | x | | x | x | x | | x | | x | | | |
| Poor Instream Aquatic Habitat | | | | x | x | x | | x | | x | x | | x | x | | x | | | |
| Restricted Fish Passage | | x | | x | | x | | x | | x | | x | | x | x | x | | x | x |
| Sediment from Upstream Sources | | | x | x | x | x | | x | | x | x | x | x | x | | x | | | |
| Trash | | | | | x | x | | | | x | | x | | x | | | | | |
| Absence of Native Fish | | | | | | | | | | | x | | | | | | | | |
| Water Quality Standards Exceeded | | | | | | | | | | | | x | x | x | | | | | |
| Degraded Vegetation Cover | | | x | | | x | | x | x | | x | x | x | x | | | | | |
| Loss of Habitat Due to Development | | x | | x | x | x | x | x | x | x | x | x | x | x | | x | | x | x |
| Loss of Habitat Due to Limited Water | | x | | x | | x | | x | | x | | x | | x | | x | | x | x |

[1] Habitat deficiency types marked by an "x" indicate the documented presence of a habitat deficiency only and do not indicate either the magnitude of a given instance or the extent of deficiencies in each sub-watershed. Habitat deficiency types were identified based on a review of published documentation and local knowledge of existing conditions.

Note: Abbreviations shown in column headings are defined in Table 3.3.1.

**Table 4.7.8 Known Habitat Deficiency Types Occurring in Oquirrh Mountain, Decker Lake, Jordan River Corridor and Great Salt Lake of Salt Lake County Sub-Watersheds.**

| Problem Type | SUB-WATERSHED | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | BN | BG | MBC | RC | DL | JR | GSL CN | GSL Kersey | GSL Lee | GSL Shorelands | GSL Farmington Bay |
| Stream Channelization | x | x | x | x | | x | x | | x | | |
| Unstable Channel Banks | x | x | | x | | x | | | | | |
| Incised Channel Beds | | | | | | x | | | | | |
| Poor Instream Aquatic Habitat | | | | | | x | | | | | |
| Restricted Fish Passage | x | x | x | x | | x | x | x | x | | |
| Sediment From Upstream Sources | | | | | x | x | | | | x | x |
| Trash | | | | | | x | | | | | |
| Absence of Native Fish | | | | | | | | | | | |
| Water Quality Standards Exceeded | | | | | | x | | | | | |
| Degraded Vegetation Cover | x | x | x | x | | x | | | | | |
| Loss of Habitat Due to Development | | x | x | x | | x | | | | x | x |
| Loss of Habitat Due to Limited Water | x | | | x | | x | | | | x | x |

[1] Habitat deficiency types marked by an "x" indicate the documented presence of a habitat deficiency only and do not indicate either the magnitude of a given instance or the extent of deficiencies in each sub-watershed. Habitat deficiency types were identified based on a review of published documentation and local knowledge of existing conditions.

Note: Abbreviations shown in column headings are defined in Table 3.3.1

### 4.7.6 Preservation, Conservation, and Restoration Opportunities and Techniques

#### 4.7.6.1 Previous Enhancement Projects

Efforts to restore aquatic, riparian, and wetland habitats have generally increased over the past several decades in response to federal legislation such as the Clean Water Act, State water quality standards designed to support such legislation, and growing public awareness of the importance of these habitat types. In order to meet water quality standards, reductions in pollution from point and nonpoint sources must occur. Actions to achieve these reductions sometimes require restoration of riparian and wetland habitat. Maintaining and restoring habitat is also a concern for federal and state agencies responsible for supporting native aquatic species or sport fish populations. Pollution control is a priority for Salt Lake County and other municipalities of the Wasatch Front. Maintaining high-quality, functional, aquatic and riparian habitat in municipal watersheds preserves water quality needed for municipal use.

Enhancement projects have occurred at many locations throughout Salt Lake County. A list of documented projects and, where available, cost information is provided in Table 4.7.9. This list includes work associated with structural improvements, monitoring, and public awareness. The list is not comprehensive as many enhancement projects have not been documented. However, it does include many of the larger-scale efforts associated with habitat improvement in Salt Lake County during the recent past. As discussed above, the Jordan River has been the most common target of such efforts and remains so.

The success of these individual efforts has varied considerably. The net effect is that the upper Mill Creek, Little Cottonwood Creek, and Big Cottonwood Creek Sub-Watersheds are generally in good condition and functioning at a high level. Much remains to be done to achieve management objectives for the Jordan River Corridor, but momentum is increasing on many fronts to continue and expand enhancement efforts.

#### 4.7.6.2 Enhancement Options and Techniques

The following enhancement options and techniques address the deficiency types described above (Section 4.7.5). Note that some of the options address multiple habitat deficiency types due to the overlap in processes that influence each type. Cost information provided below was obtained from current agency cost lists and various sources of local knowledge of costs associated with enhancement techniques and assessment of ecological conditions. Exact project costs will be highly dependent upon site specific conditions such as the severity of habitat loss, channel dimension, accessibility, etc.

*1. Restoring Stream Channels (*Deficiency Type 1)
As discussed above, a number of planning area streams have been channelized for flood conveyance or related purposes, severely limiting their habitat value. Restoration in this context means returning these channels to a more natural condition (i.e., streams rather than canals, in effect). The starting point for restoration of a stream channel is a definitive, geomorphic assessment of channel characteristics that documents existing conditions and trends of channel dimension, pattern, and profile. In addition, a clear understanding of the hydrologic regime including magnitude and duration of flows is needed. Any watershed conditions that influence the quantity and timing of stream flows or sediment loading to the stream should also be understood. These processes significantly influence the formation of stable channel features including dimension, pattern, and profile. Once these values have been defined, restoration measures can be selected that will move the channel toward a desired condition. It is important to note that restoration goals should be based upon representative geomorphic conditions. Features that are desirable from a management or aesthetic perspective but not in harmony with the river system will produce unstable and costly results if they are implemented.

In most instances, the desired stream condition will be determined by a stable, undisturbed reference reach with natural geomorphic features (e.g., meander patterns, width:depth ratios, channel gradient, spacing of pools and riffles, etc.). Once the desired condition has been defined, the difference between that condition and actual

### Table 4.7.9 Previous Enhancement Projects in Salt Lake County

| Watershed | Description | Year | Cost |
|---|---|---|---|
| Upper Mill Creek | Regulated access to canyon. Improvements to riparian corridor near Church Fork, Box Elder, and Terraces campgrounds supported by access revenues. | 1992 – 2000 | $50,000 |
| | Public awareness program. Education regarding dog waste cleanup and other watershed issues. | Ongoing program. | $40,000 |
| | Improved restroom facilities. Replacement of pit toilets with vault toilets at Forest Service campgrounds, picnic areas and trailheads. | Several projects at various times. | Various ($10 – 20,000 per vault toilet). |
| Upper Little Cottonwood | Parking lot paving and treatment of runoff. A combination of paving, engineered catch basins, wetlands, and riparian vegetation were used to filter runoff prior to entering Little Cottonwood Creek. | Various projects at Alta and Snowbird. | Various |
| | Maintenance of instream flows. Installation of structures that preclude snowmaking withdrawals from stream at Alta when flows drop to minimum requirement. | 1997 | $3,000 |
| | TMDL water quality study. Assessment of river segments above Red Pine campground for elevated levels of dissolved zinc and copper. | 2002 | Supporting data collection $250,000; report preparation $60,000. |
| | Sanitary sewer. Installation of sewer line connecting Town of Alta and nearby ski resorts to Salt Lake valley. | 1971 to Snowbird, 1972 to Alta | $600,000 |
| | Improved restroom facilities. Replacement of pit toilets with vault toilets at Forest Service campgrounds, and tying Tanner Flat Campground into sewer. | Several projects at various times. | Various |

**Table 4.7.9 Previous Enhancement Projects in Salt Lake County (continued)**

| Watershed | Description | Year | Cost |
|---|---|---|---|
| Upper Big Cottonwood | Parking lot paving and treatment of runoff. A combination of paving, engineered catch basins, wetlands, and riparian vegetation were used to filter runoff prior to entering Big Cottonwood Creek. | Various projects at Brighton and Solitude. | Various |
| | Sanitary sewer. Installation of sewer line connecting ski resorts to Salt Lake valley. | 1993 | $5.4 million |
| | Maintenance of instream flows. Installation of structures that preclude snowmaking withdrawals from stream at Solitude when flows drop to minimum requirement. | 2006 | $3,000 |
| | Improved restroom facilities. Replacement of pit toilets with vault toilets at Forest Service campgrounds. Of note, if a new facility is within 300 foot of the existing sewer line, they are required to connect to that sewer line. | Several projects at various times. | Various |
| Jordan River | River Restoration (13000 South). Installation of approximately 0.5 miles of emergent bench along eroding section of Jordan River. | 2002 | $365,000 |
| | River Restoration (11200 South–10600 South). Removal of dredge piles and restoration of riparian corridor. | 2000 | $616,000 |
| | COIR Bank Stabilization (10600 South-10200 South). Installation of bank terraces and biodegradable mat to halt active erosion. | 2000 | $80,000 |
| | River Restoration (9400 South-9000 South). Installation of emergent bench and creation of flood plain inhabited by riparian and wetland vegetation. | 2000 | $700,000 |
| | Constructed Wetland Ponds (7800 South). Treatment of flows from 7800 South drain through 5-acre wetland pond prior to entering Jordan River. | 2002 | $1,107,000 |
| | River Restoration (Winchester Street–I215). Removal of riprap and debris. Re-contoured banks and restored riparian vegetation. | 1992 | $80,000 |
| | River Restoration (I215-Bullion Street). Removal of riprap and debris. Re-contoured banks and restored riparian vegetation. | 1999 | $215,000 |
| | River Cleanup and Restoration (3900 South). Removal of up to 12 feet of garbage and debris from a remnant channel feature. Planting excavated basins with riparian vegetation. | 2002 | $268,000 |
| | COIR Bank Stabilization (3600 South). Regrading of vertical banks, Installation of bank terraces and bio-degradeable mat to halt active erosion. | 1998 | $40,000 |

condition determines the extent of restoration required. If implemented correctly, such restoration efforts will enhance natural stability processes and eventually return the stream channel to a state of equilibrium.

Large-scale restoration efforts that involve relocating stream channels to create meander patterns or other features that increase stream corridor width may not be possible in urban areas. In such cases, a hybrid approach can be used to optimize channel restoration given the constraints of property ownership or management policies. Such options might include redesign of channel profiles or adding instream aquatic habitat features (discussed below) while maintaining the general form of the channel.

Estimated Unit Costs:

- Geomorphic assessment: $1,000 – 1,250/mile
- Channel restoration: $50,000 – 100,000/mile

*2. Stabilizing Channel Bed and Banks (Deficiency Type 2 & 3)* The stability of a stream channel and its banks is a major factor in evaluating the existing condition of a stream. A stream channel is considered stable when it can maintain natural dimensions over time without aggrading or degrading. It should also be able to transport a range of flows and materials that is typical for that channel type without adverse affects to the bed or banks.

Unstable bed and banks will be present following major restoration efforts such as those described above. Instability of channel beds can also occur when transport of sediment and bedload material is unbalanced; i.e. upstream loading exceeds downstream loading or vice versa. If upstream loads exceed the amount of material being removed from a given section, sediment deposits

Stabilization structure on Little Cottonwood Creek, Lower Little Cottonwood Creek Sub-Watershed

will accumulate and divert flows into channel banks. If the amount of bed material removed from a section exceeds upstream loading rates, channel scour will occur and may result in entrenchment and upstream migration of headcuts.

Instability of channel banks, to some degree, is a part of natural channel migration and occurs over time as stream channels seek to achieve a state of equilibrium. However, bank erosion can be accelerated by human induced conditions such as degraded vegetation, development, or increased flow velocities.

Channel bed stability can be achieved through efforts that balance sediment loading rates. Measures to reduce nonpoint source loading of sediment are addressed in the Nonpoint Sources Planning Element (Section 4.4.). Channel headcuts can be restored through placement of grade control structures. Localized sediment loads can also be reduced through channel bank stabilization measures.

Bank stability can be achieved through “hard” engineering approaches, including armoring of banks with rip-rap, concrete, or other hardened materials. Many bank stabilization projects include a combination of grading and restructuring of channel banks, followed by vegetation planting. It is anticipated this combination of engineering (hard approach) and ecological measures will produce desired levels of stability for most stream segments in Salt Lake County. As a last resort, some channel segments may require temporary hardening (e.g., rip-rap, concrete channels, etc.) to prevent short-term losses of channel bank material. Long-term channel stability in these locations will generally require some combination of vegetation as well as hardened materials.

Estimated Unit Costs:

- Gabion Baskets— $95/cubic yard
- Vegetative plantings—$5,800/mile
- Bank Shaping—$29,000/mile
- Bank Protection (Revetment)disturbed—$18,000/mile
- Hardening of channel banks: - $50/square yard

*3. Developing Instream Habitat Features (Deficiency Type 4)* These features are considered as a separate component of habitat improvements in order to address biological problems and their influence on aquatic ecosystems separately. A trapezoidal stream channel can meet requirements for stability yet have no aquatic features. Instream habitat features provide critical locations for aquatic species to live and carry out key life-cycle stages. When these features are limited or absent, aquatic communities are lost or diminish to species that are tolerant of degraded conditions.

The type and distribution of habitat features such as pools, riffles, runs, undercut banks, woody debris, and coarse channel substrate should be based on a detailed geomorphic survey, as described above. Engineered structures can be placed in the channel at critical locations to dissipate flow energy, promote channel stability, and preserve existing habitat features. At the same time, these structures can be designed to provide additional habitat opportunities in themselves. Some of the more common designs include drop structures, root wads, rock vanes, barbs, or J-hooks. Once flow energy has been properly directed, channel dimensions that support aquatic habitat will be maintained over time.

Panorama of a Jordan River Channel Restoration Site

Estimated Unit Costs:

- Drop structures:
  $100,000 – 200,000/each
- Root wad: - $55/each
- Rock vane, barb, or J-hook
  $200/cubic yard

*4. Improving Fish Passage (Deficiency Type 5*) Free movement of aquatic species between stream segments provides them an opportunity to seek out optimal habitat in different seasons or years, including periods of drought. Improvements to fish passage involve providing alternate routes, removing structures that limit migration, and providing supplemental flow to dewatered segments. Alternate routes around irrigation diversions or elevation drops are provided by fish ladders that allow migrating fish to move around the barrier. Engineered structures such as irrigation diversions or culverts that are inactive can be removed entirely. Flows can be supplemented in dewatered segments through purchase of water rights and returning flow volumes to the stream.

Estimated Unit Costs:

- Fish ladder:
  $10,000 – 15,000/each
- Removal of diversion or culvert:
  $2,500 – 5,000/each
- Purchase of water rights:
  $1,000 – 1,500/acre-foot

*5. Controlling Nonpoint Sources of Sediment (Deficiency Type 6)* Reducing erosion from upslope sediment sources can reduce formation of instream sediment deposits. Erosion control in urban and rural areas involves an initial assessment of sediment sources and the routes by which sediment is transported to stream channels. Once sources have been identified, control measures can be implemented that will minimize the production of sediment. Additional measures can be used to treat flows that transport sediment before they enter stream channels.

Urban areas typically deliver sediment through stormwater collection systems that route surface runoff to points of concentration. Flows are then routed through storm drains that eventually discharge to stream systems. The amount of sediment delivered to collection systems can be minimized through the use of Best Management Practices (BMPs) that include multiple measures designed to reduce the processes of soil detachment, transport, and deposition.

BMPs should first be applied to areas where erosion potential is high, such as construction sites and other areas where large amounts of disturbed soil are temporarily exposed to storm events. BMPs at these locations include use of silt fencing/ wattles, erosion control mats, water bars, vegetation planting, and other activities designed to protect soil surfaces. Project timing can also be modified to minimize exposure to precipitation events. Proper use of construction BMPs can be influenced with local codes and ordinance that require these measures as terms of building permits.

Unstable areas such as mass wasting sites or historic mine operations should also be assessed for potential erosion. Soil surfaces in these areas can be stabilized through the use of vegetation cover and regrading to promote infiltration and manage surface flows.

Post-construction stormwater management practices are applied to previously developed areas and reflect the size of catchments that contribute runoff to points of concentration. BMPs for treating runoff include stormwater collection systems, settling basins and/or filtration systems, grassed swales or bioretention ponds for treating runoff from smaller catchments and stormwater wetlands for larger catchments. Costs for such systems vary considerably and cannot be meaningfully estimated. Reviewing recent, local projects involving such systems to determine costs as a percentage of total project costs would provide a planning estimate.

For additional discussion of nonpoint sources and management, refer to the Nonpoint Source Planning Element (Section 4.4).

<u>Estimated Unit Costs:</u>

- Silt fencing/erosion control matting: $1/square foot
- Revegetation: $250 – 10,000/acre
- Surface roughening: $13/acre
- Equipment transport: $3/mile
- Grading: $5/cubic yard

*6. Managing Trash/Debris (Deficiency Type 7)* At present, no standards are established by the Utah Division of Water Quality to regulate trash and debris in and around waterbodies. As a result, control of trash and debris that accumulates in riparian corridors and stream channels is a function of local ordinances and their enforcement. Support for measures to remove trash and debris and to keep it from re-accumulating can be increased by promoting public awareness and innovative measures such as watershed adoption programs that build involvement and stewardship by local stakeholders. Public awareness programs can cost as much or as little as a community feels is necessary and chooses to allocate.

*7. Establishing Native Fish Populations (Deficiency Type 8)* Native fish populations are desired in all stream segments where habitat parameters are, or could be, suitable. Absent or limited native fish populations can be the result of habitat constraints or a lack of recruitment. As a first step toward addressing this deficiency, aquatic habitat conditions should be assessed by field surveys to determine whether habitat factors are preventing establishment of native species and, if so, which factors. This can be accomplished as part of the geomorphic assessment discussed above or as a stand-alone survey. Once any limiting conditions are identified, appropriate restoration efforts can be prescribed as outlined above (Enhancement Techniques 1-6). If habitat factors are not the explanation, or if they have been identified and restored, fish stocking at appropriate locations may be necessary to establish a breeding population of native fish.

Estimated Unit Costs:

- Fish habitat assessment:
  $500 – 1,000/mile

- Fish stocking:
  $0.10 – 0.15/fish

*8. Improving Water Quality (Deficiency Type 9)* Addressing water quality concerns must occur at a watershed level. Sources of pollution, including point and nonpoint sources, should be linked to impairment of water bodies in each watershed. This process begins by comparing water chemistry to standards and pollution indicator values. These standards are designed to protect beneficial use of waterbodies, including providing quality habitat for aquatic species. The focus of water quality concerns in this section is the parameters and standards associated with aquatic life.

If sample measurements are found to violate the assigned standards, a water body is placed on the 303(d) list of impaired waters until an assessment of water quality can be made. This assessment determines the maximum allowable load of pollution or Total Maximum Daily Load (TMDL) that a waterbody can receive from pollutant sources and still meet the required standards. At present, segments of the Jordan River, Big Cottonwood Creek, Little Cottonwood Creek Parley's Creek and Emigration Creek are considered impaired for the designated beneficial use.

The TMDL report identifies and assigns responsibility for measures to reduce pollutant loading and achieve assigned standards. These measures can take many forms. This process is described in more detail in Section 1.8 of this plan.

9. Restoring Degraded Vegetation (Deficiency Type 10) Two prerequisites for maintaining or restoring desired streambank, riparian, or wetland vegetation are: 1) restricting or managing development in these habitats to maintain conditions favorable for native vegetation, and 2) insuring adequate soil moisture in the rooting zone. These two issues are discussed under the next two headings. Here the focus is on measures to maintain or re-establish the vegetation itself.

It is much easier to maintain these vegetation types than to re-establish them. Toward that end, and aside from the protective status and/or development restrictions discussed below, tree and shrub vegetation should be protected. Multi-layered vegetation is an important habitat factor in most riparian areas and some wetlands, and larger species are more effective in anchoring streambanks with their root systems. Through regulation or voluntary efforts, as appropriate, management actions – particularly landscaping – should avoid native tree and shrub removal unless it is necessary to achieve other, higher objectives. These efforts are largely either administrative or promotional, so costs cannot be estimated.

In many instances, invasive, non-native plants are the main constraint to re-establishment of native vegetation. Control measures vary widely in type and cost, but can involve physical (e.g., picking, mowing, or digging out), chemical (e.g., spraying), or biological methods (e.g., introduction of a species-specific parasite or disease), separately or in combination. Working around water poses some difficulties, particularly by limiting the choice of herbicides. While forbs and some grasses are generally the target species, tamarisk, and aggressive non-native tree, is a major issue in Salt Lake County.

Estimated Unit Costs:

- Herbicide spraying:
  $50 – 200/acre

- Tamarisk removal:
  $100 – 1,500/acre

- Tamarisk beetle:
  $10/acre

Actual revegetation efforts, on bare sites or following control of invasive species, can also follow different methods depending on site conditions and objectives. Broadcast seeding, using the range from hand seeders to aircraft, is often the only logical option for large tracts but is generally less effective than other methods for streambanks, riparian corridors, and wetlands. These situations often require hand planting of containerized plants, and some specialized methods such as burying willow bundles along stream edges have proven especially effective. Where seeding is needed, drilling or broadcasting and dragging are generally more effective than just broadcasting seed. Seedbed preparation may be necessary in some cases (e.g., soil scarification, mulching, pitting, etc.). Use of native species, as seed or containerized stock, is becoming a nearly universal requirement, and this can increase the cost substantially depending on the species involved. Seed and containerized stock of some riparian and wetland species is among the most expensive on the market, which can drive the costs of revegetation in these habitat types up considerably.

Estimated Unit Costs:

- Broadcast seeding:
  $250 – 1,500/acre
- Drill seeding:
  $450 – 1,700/acre
- Hand planting
  $2,500 – 10,000/acre
- Integrated streambank revegetation program $10 – 25/foot

A student canoeing the Jordan River to remove trash, Jordan River Corridor Sub-Watershed

Dispersed recreation, user-created trails, and recreation related bank damage have had notable adverse effects on streambank, riparian, and wetland vegetation in this urbanized, highly populated, and heavily recreated County. Similar to the litter issue discussed above, such impacts are addressed through enactment and enforcement of ordinances to protect sensitive areas and voluntary actions by user groups. The latter can be facilitated through awareness campaigns, interpretive programs, and signage. Costs are dependent on the level of effort extended.

*10. Preventing or Reversing Development Encroachment (Deficiency Type 11)* Encroachment of development into riparian and wetland areas has probably eliminated or degraded more habitat than any other single factor in Salt Lake County. Development in riparian corridors has likewise resulted in detaching stream channels from their floodplains. The first step toward slowing and stopping this trend is to incorporate appropriate buffers, setbacks, and other protective mechanisms into municipal policy and planning. This curbs further encroachment if effectively implemented.

A number of progressive models are emerging in communities across the nation, so there are strategies to choose from that are likely to approximate the desires of Salt Lake County's municipalities regarding the balance among riparian and wetland resources, development, and private property rights. No "one size fits all" approach is likely to be effective in itself or appropriate to all the municipalities in the County. Some of the current efforts designed to limit encroachment include Salt Lake County's land acquisition and open space programs, Salt Lake City's watershed plan, West Jordan's land acquisition program, and conservation easements sponsored by federal, state, and local entities. Participation and support of these programs will help to preserve riparian corridors and maintain connectivity between rivers and floodplains.

Reversing past encroachment is more difficult. Redevelopment provides the best opportunity, and it is likely to occur extensively in Salt Lake County over the next 25 years, as discussed above. Municipalities can establish requirements or provide incentives to developers involved in redevelopment projects to cede riparian corridors and wetlands back to the municipality, so the municipality can restore it as discussed above. Rezoning riparian and wetland areas during redevelopment may be a preferable alternative in some situations, and this can be linked to a requirement for developers to restore these areas as a condition of approval. The Federal Emergency Management Agency (FEMA) also makes grants available to municipalities to buy out flood plains, setting the stage for restoration.

These processes range from purely administrative actions to on-the-ground work, and the right fit for any given situation is Salt Lake County may vary widely. As a result, the associated costs are impossible to estimate.

*11. Meeting Moisture Requirements of Riparian Vegetation (Deficiency Type 12)* Several factors are identified above (Section 4.7.5) that limit water in the rooting zone of riparian areas and wetlands. These include channelization and channel downcutting that disconnect streams from their floodplains, seasonal dewatering of stream segments, and lowering groundwater levels through drawdown and reduction of recharge. Where any of these factors dry rooting zone soils beyond the limits of the existing or potential vegetation, riparian and wetland habitats are lost.

In general, the measures discussed above (Enhancement Technique 1) to restore stream channels address channelization and downcutting. Techniques and costs are discussed there. Dewatering and the means for addressing it are touched on in this section from various habitat perspectives, but it is addressed in detail in the Instream Flows Planning Element (Section 4.6). In brief, to address habitat concerns, the first step is to assess the amount of water needed to maintain an adequate wetted perimeter (to support aquatic resources) and to provide the water needed to maintain adjacent riparian vegetation.

Similar to the fisheries assessment discussed above, these factors could be addressed as part of the larger geomorphic assessment (Enhancement Technique 1) or completed as a stand alone. In some cases in Salt Lake County, stream segments have been seasonally dried that riparian vegetation no longer exists, so initial assessments need to address site potential.

Groundwater is a more difficult issue, as its dynamics are generally invisible. Ideally, water imports will equalize groundwater drawdowns. The main factors behind reduced groundwater recharge are probably the increase in impermeable surfaces and the loss of wetlands. While increases in impermeable surfaces are generally a fact of life as urban development spreads, its effects can be mitigated by some of the measures discussed above. Redevelopment can be guided so it reduces impermeable surfaces and increases riparian areas and wetlands. Post-construction stormwater management systems can include engineered recharge areas (Enhancement Technique 5). Efforts to maintain and restore riparian corridors and wetlands generally result in more groundwater infiltration and recharge, improving groundwater availability throughout the watershed. Again, the costs associated with these diverse options vary considerably, making meaningful cost estimation impossible.

<u>Estimated Unit Costs:</u>

- Riparian habitat assessment: $500 – 1,000/mile

### 4.7.6.3 Prioritizing Enhancement Efforts

This discussion demonstrates that the range of aquatic, riparian, and wetland habitat deficiencies is wide, as is the range of options to address them. The most appropriate method to address these deficiencies in any given situation will depend on several factors, each of which will be defined by a wide range of site-specific conditions. As a result, application of certain methods recommended above may not be feasible. Likewise, it is anticipated that costs associated with the application of each method will vary considerably according to conditions specific to each site.

The objective here is to identify methods that are technically effective and feasible, leaving other variables in the administrative, financial, and political realm to the responsible planners and decision makers. Key variables to consider in prioritizing habitat enhancement needs include:

- Identification of key, limiting factors to be addressed first. For example, if a stream has segments with interrupted flows, it makes little sense to try to restore aquatic or riparian habitat below, or to establish a native fish population that would not be able to spawn upstream.
- Viewing each local habitat deficiency in the larger context of the watershed. Each situation is a building block in the watershed-wide ecosystem, and some blocks are more critical than others to the function of the system as a whole.
- Coordination among municipalities. From a political and administrative perspective as well as an ecological one, the system is integrated, and enhancement efforts will be more effective if coordinated on a Countywide basis.
- Land ownership and management responsibility. Some enhancement options are a logical function of municipal governments while others fall in the private sphere.
- Opportunities to dovetail with other efforts to achieve economies of scale. This is true for surveys and assessments (e.g., the key geomorphic assessment as well as fish and riparian habitat assessments) as well as physical enhancement actions.
- Opportunities to secure outside funding. Enhancement actions are generally expensive, but funding from Federal and other sources is often available for environmental improvement projects.

## 4.7.7 Recommendations

As noted above under methods (section 4.7.2), this analysis is based largely on existing information, gained from previous studies and other documented sources. Coverage overall is spotty, both by issue (e.g., more information available on aquatic habitat than wetland habitat) and area (e.g., the Wasatch Mountain sub-watersheds being better studied than those of the Oquirrh Mountains). Further, some key categories of information are missing entirely.

Current information shortages limited the utility of this analysis in reaching concrete conclusions regarding the extent of habitat deficiencies, which in turn makes prioritization of enhancement needs difficult. As a result, ongoing efforts to collect the information needed to fill the gaps should be an integral part of the habitat enhancement effort. Priority information needs include the following:

- Develop wetland mapping that goes beyond existing data (NWI, SAMP, Jordan River WAIDS, Albion and Brighton Basins data).
- Develop a watershed-wide inventory and functional analysis of stream segments and/or riparian corridors that are interrupted or disconnected.
- Develop a comprehensive inventory of fish and eventually macroinvertebrates in County streams.
- Develop a staged, comprehensive geomophological assessment of County streams and rivers.
- Conduct a Countywide mapping of past and current riparian corridors.
- Work with established programs to acquire easements and parcels adjacent to Salt Lake County streams and river.

## 4.8 UTAH LAKE

This section is written to discuss and analyze the influence of Utah Lake on water quality in Salt Lake County. Utah Lake, located south of Salt Lake County, in Utah County, is the headwaters of the Jordan River. Therefore, the water quality of Utah Lake has a direct effect on water quality of the Jordan River.

### 4.8.1 Background

The flow of water from Utah Lake to the Jordan River is controlled through agreements, and is managed for flood control, irrigation, and industrial uses. Through agricultural diversions on the upper section of the Jordan River, irrigation waters are conveyed through the Salt Lake Countywide Watershed. These irrigation canals have overflows and discharges to streams, creeks and storm drain systems. Therefore, the water quality of Utah Lake affects the water quality of the irrigation water that is ultimately conveyed to the Salt Lake Countywide Watershed.

Due to the fact that Utah Lake is a major source water for the Jordan River, and the majority of agricultural irrigation water in Salt Lake County, the water quality and water quantity released from Utah Lake has direct and indirect effects on surface waters throughout the Salt Lake Countywide Watershed. The following surface water influences will be discussed in this chapter:

- Jordan River: The relationship between the water quality and quantity releases between Utah Lake and the Jordan River will be reviewed.

Utah Lake

- Irrigation Canals: There are seven (7) major canal diversions from the Jordan River that provide agricultural and municipal irrigation water throughout the watershed. The effect of these canals, diversions and irrigation practices will be discussed.
- Irrigation Return Flows: The unconsumed portion of diverted irrigation flows drain back to the Jordan River and its tributaries. These flows are referred to as "irrigation return flows." The quality and quantity of the irrigation return flows to the surface waters within the watershed will be reviewed.
- Exchange Flows: Exchange agreements exist between water right holders. These exchange agreements generally allow for the conveyance of Utah Lake water, through diversions and the canal systems, to streams and creeks in order to satisfy water rights. The effect of the exchange flows, as the water is discharged into streams and creeks, will be reviewed both from the water quality and flow perspective.
- Stormwater Overflows: As the canals traverse urban areas of the watershed, stormwater is discharged to the canal systems and conveyed to streams and tributaries. The mixing of Utah Lake irrigation water with stormwater occurs during storm events, resulting in discharges to the tributaries through overflow structures. The water quality of the canal water and the locations of these overflows will be identified and discussed.

### 4.8.2 Utah Lake

Utah Lake, located in Utah County, is the source of the northward flowing Jordan River. The outlet from the lake is approximately ten river miles south of Salt Lake County. It is one of the largest natural freshwater lakes in the western United States, covering approximately 96,000 acres (DWQ, 2000). Utah Lake, as well as the Great Salt Lake, are remnants of Lake Bonneville, a huge freshwater lake that covered much of western Utah and eastern Nevada 10,000 to 20,000 years ago. However, Utah Lake remains a freshwater lake, as it has an outlet, whereas the Great Salt Lake, which does not have an outlet and is highly saline. The major inflows to Utah Lake are the Provo, Spanish Fork and American Fork Rivers.

The outlet of Utah Lake is currently controlled by facilities including a dam and pump station. The Lake has been managed since the late 1800's when a dam was constructed where the present Turner Dam is located. The dam was originally constructed for agricultural irrigation storage and distribution purposes. However, it is now used for flood emergency management on the Jordan River as well. The pumps at the outlet are used to lift water out of the Lake when free flow through the outlet gates will not supply downstream water rights quantities. A "compromise agreement" was reached in 1885 and established the maximum operation level of the Lake to reduce Utah County flooding and provide for irrigation in Salt Lake County. A "compromise level" for the Lake surface elevation was set at 4515.799 feet (Hooten, undated). A lawsuit in 1983 further established the compromise level at 4489.045 feet (USGS survey datum), as well as set flow restrictions for flood management (CH2M Hill, 1986). The releases from Utah Lake are respective of the compromise level, water rights and flood control, as agreed upon between Utah County, Salt Lake County, Utah State Engineer's Office and state and federal resource agencies.

The water quality of inflow sources to Utah Lake is higher than that of the outflow (Psomas, 2005; Wham, personal communication). Table 4.8.1 shows comparison data for selected water quality parameters for inflow and outflow at Utah Lake. Reasons for the decline in water quality include discharges from surrounding urban areas (e.g. treated municipal and industrial wastewater, urban and agricultural runoff), discharges to the Lake of naturally saline springs, natural physical features of the Lake including high evaporation rates during the summer months and the shallowness of the Lake. With a maximum depth of the Lake of approximately 14 feet and mean depth of 9.5 feet, wave action from wind conditions continually re-suspends settled materials resulting in the turbid nature of the Lake.

The major surface inflows to Utah Lake are the American Fork, Provo and Spanish Fork Rivers. Additional significant inflows are wastewater treatment plant discharges, agricultural return flows

**Table 4.8.1 Comparison of Utah Lake Inflow and Outflow Quality for Selected Parameters,**

| STATION (STORET #) | Total Dis-solved Solids (TDS) | | Total Suspended Solids (TSS) | | Ammonia ($NH_3$) | | Total Phosphorus (TP) | | Biological Oxygen Demand ($BOD_5$) | |
|---|---|---|---|---|---|---|---|---|---|---|
| | mg/L | #/ND[1] | mg/L | #/ND[2] | mg/L | #/ND[3] | mg/L | #/ND[3] | mg/L | #/ND[1] |
| American Fork River[4] (499496) | 277 | 4/0 | 83[5] | 5/2 | 0.043 | 5/3 | 0.012 | 11/7 | - | - |
| Provo River (499669) | 273 | 238/0 | 10 | 241/20 | 0.023 | 221/188 | 0.074 | 231/34 | 1.5 | 4/1 |
| Spanish Fork River (499558) | 468 | 146/0 | 89 | 149/3 | 0.088 | 117/58 | 0.129 | 146/6 | - | - |
| Utah Lake Outlet (499479) | 1285 | 134/0 | 90 | 137/3 | 0.129 | 137/80 | 0.154 | 131/13 | 5.3 | 4/0 |

[1] Number of samples/number of "non-detect" results
[2] Number of samples/number of "non-detect" results. Non-detect evaluated as 0 mg/L
[3] Number of samples/number of "non-detect" results. Non-detect evaluated as 0.005 mg/L
[4] Data from 1990 - 2006
[5] One result of 398 mg/L
*Source: EPA STORET Database*

### Table 4.8.2 Jordan River Average Flow

| Station | Flow (ac-ft) | Period of Record | Number of Observations |
|---|---|---|---|
| Utah Lake Outlet | 358,426 | 1980-2005 | 9279 |
| 9000 South | 303,991 | 1980-2004 | 9029 |
| 2100 South | 573,900 | 1980-2003 | 8309 |
| 500 North | 158,640 | 1980-2002 | 7002 |
| *Source: Cirrus Ecological Solutions, 2007* | | | |

and groundwater. The influences of all sources are being analyzed in the Utah Lake Total Maximum Daily Load (TMDL) study currently underway. Table 4.8.1 summarizes inflow quality from the three rivers and outflow quality (Jordan River) for selected water quality parameters. It should be noted that there are a significant number of “non-detect” results reported for the nutrients.

## 4.8.3 Jordan River

The Jordan River flows northward from Utah Lake approximately 10 miles before entering Salt Lake County. The River continues flowing northward approximately 44 miles before entering the Great Salt Lake (in accordance with the Jordan River TMDL). Along the River’s course, there are major agricultural diversions and major discharges to the River, as well as surface water flows from major tributaries (7) and numerous minor tributaries. There are also stormwater flows, urban and return agricultural flows and inflow from groundwater sources.

Due to water rights and seasonal irrigation demands on the River, flows are controlled and regulated by legal agreements and court decree, resulting in flow patterns that do not represent the prevailing climate or natural hydrologic cycle. Table 4.8.2 shows the average annual flow for the Jordan River at four stations.

The State of Utah Division of Water Quality (DWQ) monitors water quality through the Jordan River system. The Jordan River is currently being studied as part of a TMDL investigation for non-attainment of dissolved oxygen standards in the lower reaches (Cirrus, 2007). It is beyond the scope of this discussion to reevaluate the quality and sources of impacts contributing to non-attainment.

## 4.8.4 Irrigation Canals

The general irrigation system in Salt Lake County is shown in Figure 4.8.1. The first diversion of Jordan River water for irrigation purposes was constructed in 1850 for the Bennion Mill (5 cfs) and the Gardner Mill Race (11 cfs). Since that time, the irrigation system has grown to seven major and several minor irrigation diversions on the River. The Jordan Valley Pump Station diverts water to the Utah Lake Distributing Canal and Welby-Jacob Canal. Turner Dam, a major diversion structure at the Utah County and Salt Lake County line (Jordan Narrows), diverts two major canals: the East Jordan Canal and the Utah and Salt Lake Canal. The Joint Dam, another diversion structure a few miles downstream, diverts another two major canals; the South Jordan Canal and the Jordan and Salt Lake City Canal. The final major irrigation canal, the North Jordan Canal, is diverted about five miles downstream from the Joint Dam.

Jordan River, Jordan River Corridor Sub-Watershed

Smaller irrigation diversion and delivery systems exist throughout Salt Lake County. These divert water from the Jordan River as well as from tributaries to the River. Most notably, this includes the Upper Canal on the east side of the valley.

Approximately 24,365 acres in Salt Lake County are irrigated with Utah Lake water (Psomas, 2005). The place of usage is shown in Figure 4.8.2. Note that this figure does not show those areas in Lower Big Cottonwood and Lower Little Cottonwood Sub-Watersheds that are irrigated via exchange agreements most likely due to the changes made in point of diversion/point of use change with the water right.

The irrigation canal system in the County has been incorporated into the storm drainage system. The orientation of the canal system, parallel to the Jordan River and perpendicular to the River's tributaries, has allowed the discharge of local stormwater drainage into the irrigation canal system to be conveyed to the next downstream tributary crossing, where it is discharged to the stream. Where a tributary is not available for the overflow, a piped system has been constructed.

## 4.8.5 Issues

The effects of Utah Lake on the Jordan River and its tributaries are both quality and quantity in nature. These issues can be grouped into three categories: Utah Lake outflow regime, irrigation diversions/exchanges, and the source water quality of the Jordan River.

### 4.8.5.1 Utah Lake Management's Affect on Jordan River Flow Regime

Natural stream systems in the western United States typically have a low winter flow, high and cold snowmelt runoff in the late spring to early summer, a recession of flow throughout late summer and into fall, and a low flow late fall, winter, and early spring seasons. The natural cycles in the Jordan River and its tributaries have been disrupted by diversions for irrigation and for potable water supply. Mill Creek and Red Butte Creek are free-flowing streams from their headwaters to the Jordan River (for the most part). Small diversions along Mill Creek and Red Butte do not significantly disrupt or interrupt flow. A dam was built in Upper Red Butte Creek sub-watershed;

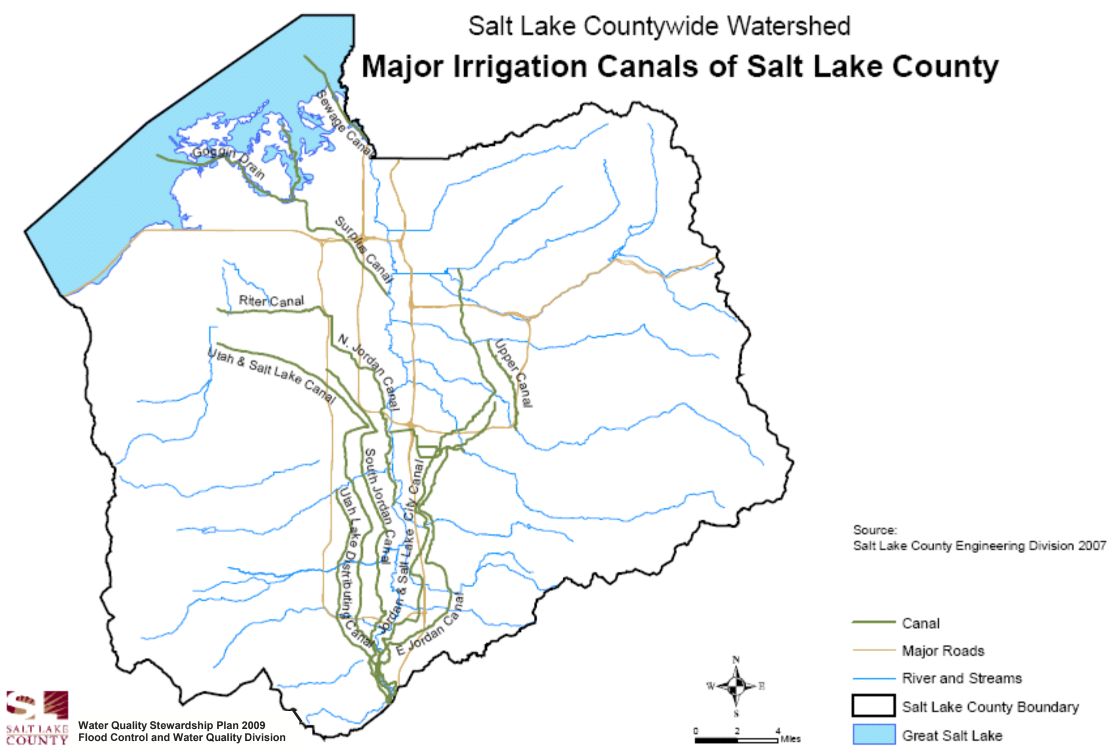
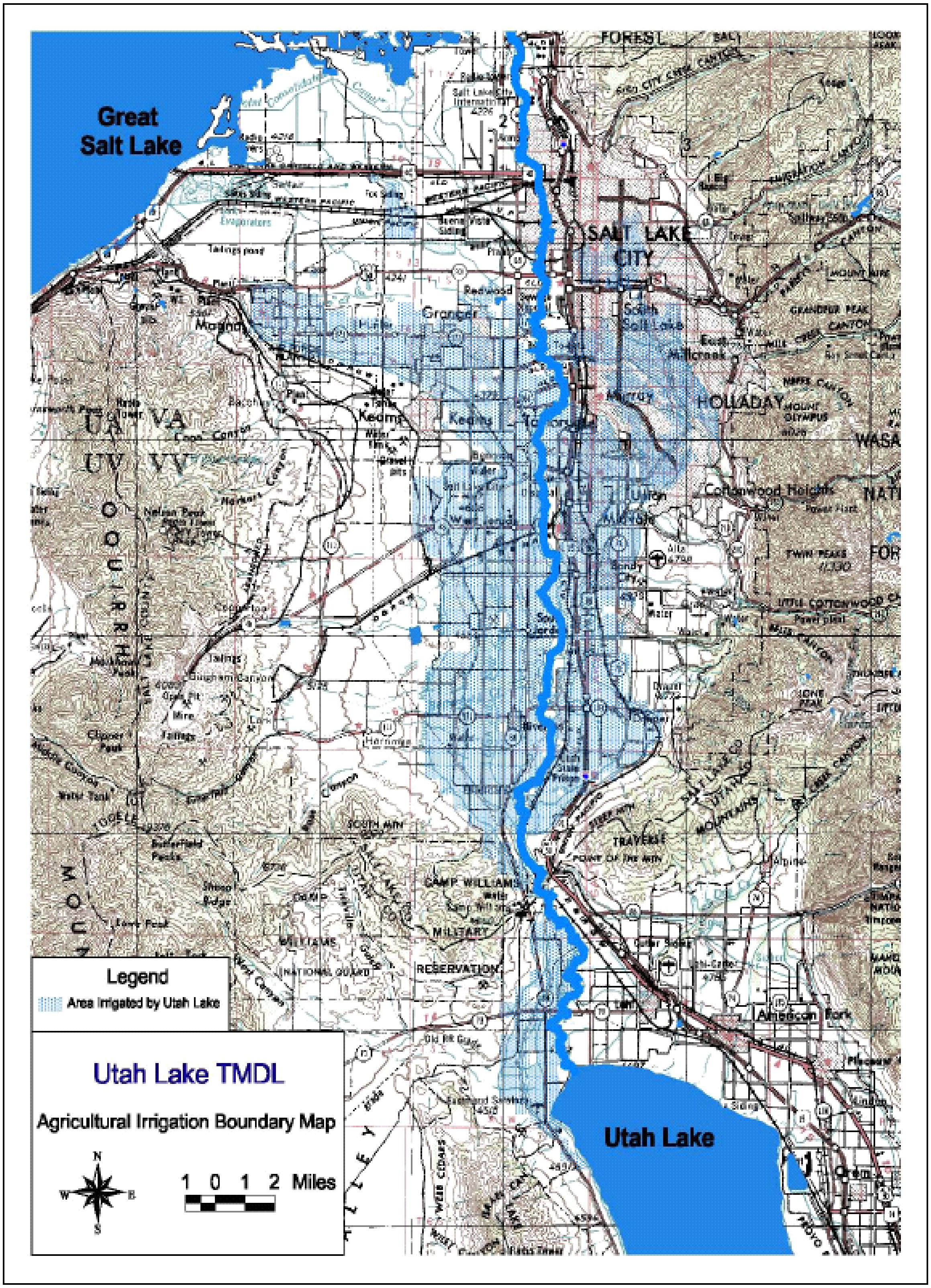
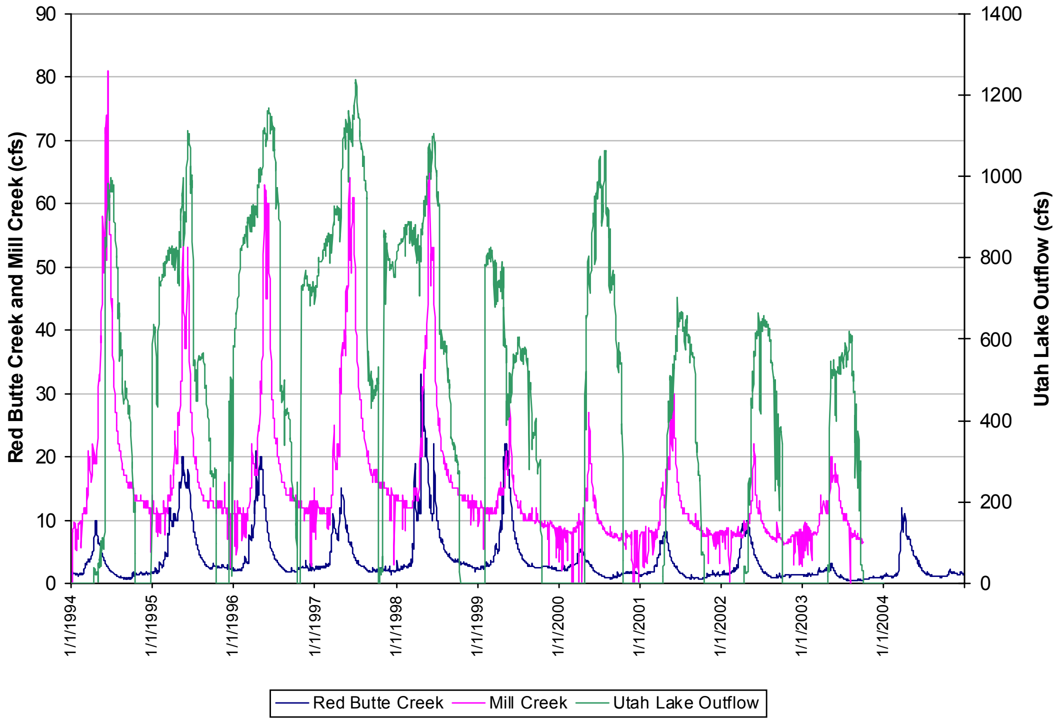



**Figure 4.8.1 Salt Lake County General Irrigation System**




*Source: Psomas, 2007*

**Figure 4.8.2 Area Irrigated by Utah Lake Water**




*Source: DWRi and SLCo flow records*

**Figure 4.8.3 Average Daily Flow: Mill Creek, Red Butte Creek and Utah Lake Outflow (1995–2004)**

however, due to seismic and inadequate spillway concerns, this dam is not currently used for storage and flow is essentially free-flowing. As is shown in Figure 4.8.3, Red Butte Creek and Mill Creek follow As is shown in Figure 4.8.3, Mill Creek follows this pattern, while Utah Lake outflow does not. In a natural setting, the outflow should somewhat follow this pattern, but would be attenuated by lake storage.

The implications of the altered flow regimes are both biological and social. The ecological balance of the

**Table 4.8.3 Utah Lake Jordan River Flood Management Program Scenarios**

| PLAN | NAME | DESCRIPTION | EVALUATION |
|---|---|---|---|
| A | Constant Flood Control Release – NWS (National Weather Service) Forecast | Limit releases to the capacity of the outlet when Lake is above compromise | Not effective due to limited outlet capacity |
| B | Using NWS Forecasts as Basis for Releases | Use NWS forecasts for precipitation and evaporation, storage and manage for compromise level | Most complicated. Did not respond to model inputs as well as Plans C-E |
| C | Release Lake Inflows | Release inflows from the Lake as long as above compromise | Could reduce storage if wet spring followed by dry summer |
| D | The Range Approach | Open or closed gates based upon agreed upon thresholds | Appears to work satisfactorily when thresholds are set at +1 and -1 foot from compromise |
| E | "Compromise Agreement" | Gates open when level above compromise, closed when below | Most simple, had satisfactory results and didn't require major change in existing agreements |

*Source: CH2M Hill, 1986*

river system is altered, affecting biological life cycles in fish spawning and affecting improvements constructed within the flood zones.

Salt Lake County's irrigation and water supply system has evolved from the first diversion of City Creek for drinking and irrigation supply to a complex system of canals, pipelines, reservoirs, diversion structures and treatment facilities all controlled by complex agreements, funding arrangements and institutional and governmental controls that are not conducive to change. However, the operation and management of Utah Lake as a storage reservoir for irrigation flows should be revisited since last studied in 1986 (CH2M Hill, 1986).

The Utah Lake Jordan River Flood Management Program modeled the levels of Utah Lake during the high runoff years of September 1982 through September 1984. The effort ran five management scenarios, Plans A through E, through the program. A brief description of these Plans and the subsequent evaluation is shown in Table 4.8.3.

The management option that was chosen for implementation was Plan E - "Compromise Agreement." The hydrograph of Utah Lake outflow resulting from the implementation of Plan E is shown in Figure 4.8.4. It was reasoned at the time that it was the most simple to implement and required no major changes to existing agreements. It was noted, though, "that as the NWS (National Weather Service) inflow predictions become more accurate, Plan B will perform better than Plans C and E." NWS predictions have become more accurate in the intervening 21 years since this study was published.

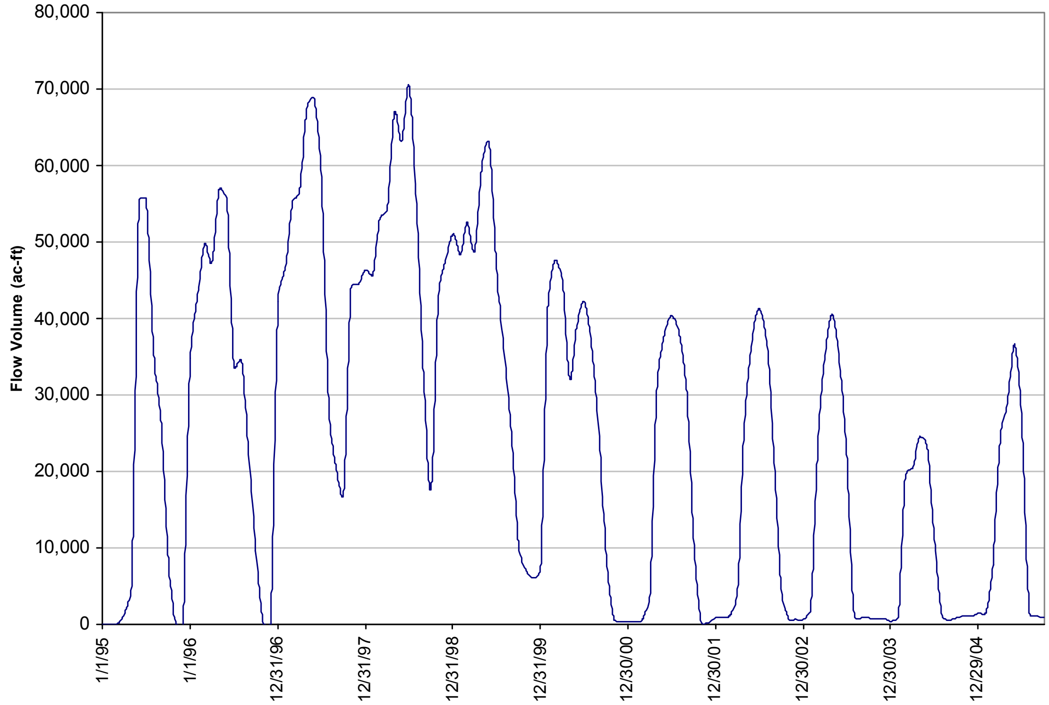
It should be noted that the Flood Management Plan was only developed to manage floods, with no consideration given to riparian and aquatic habitat, water quality, and recreational use. Currently, additional emphasis is being put on other functions of the River such as terrestrial and aquatic habitat, recreational facilities, and streambank restoration/ stabilization.

### 4.8.5.2 Diversions for Irrigation and Potable Treatment

Seasonality is exacerbated by the geological location of Salt Lake County. The County is in a semi-arid desert environment where water for agricultural irrigation is imperative and water sources are scarce. When water resources are highest (spring runoff), the need for the resource is lagging. Conversely, when water resources are near their lowest, the requirement for water to meet needs is at its highest. Simply storing spring runoff for later summer use is not practical in Salt Lake County because of population growth and land costs. Diversions for irrigation and treatment often interrupt the flow of east side tributaries, sometimes drying portions of the streams for months.

As noted earlier, Utah Lake flows have been diverted for over 150 years for irrigation. The east side tributaries have also been diverted for irrigation for the same time period. With urban development in the County, the demand for higher quality source water for potable uses outgrew the sources from the mountains surrounding the valley. Irrigation diversions from the east side tributaries that had previously been applied to agricultural areas were

Utah Lake




*Source: DWRi flow records*

**Figure 4.8.4 Utah Lake Outflow (1995-2004)**

identified as possible sources for additional potable waters. Therefore, Salt Lake City entered into negotiations with canal companies to exchange Utah Lake flows for tributary flows. This resulted in changing the point of diversion from the Jordan River tributaries to Utah Lake and conveying these flows through the Jordan & Salt Lake City and East Jordan Canals to the smaller distribution canals and ditches. These exchanges kept the original priority date of the water right, which means that some of these water rights are senior. Salt Lake City then diverts the exchanged higher quality tributary water into its treatment plant for treatment prior to distribution. Currently, Salt Lake City has 23 individual exchange agreements with canal companies.

Jordan Valley Water Conservancy District (JVWCD) has negotiated an exchange agreement for Provo River water for irrigation water from the Jordan River (Bowen, Collins & Associates, 2007). JVWCD owns 100 percent of the Welby and Jacobs Districts of the Provo River Water Users Company. The impact that this irrigation exchange water has on west-side tributary streams is probably minimal since irrigation is supplied through a series of distribution canals and ditches and is essentially completely consumed at the tail end of the system. Unlike the east-side distribution systems, the waters exchanged do not utilize natural tributaries for delivery.

Exchange agreements are individually negotiated and are unique to the distribution canal company. Some agreements are for a specific flow or volume independent from the natural flow of the tributary, while some are tied to the flow of the stream. Some provide irrigation water later in the irrigation season when natural flows might be insufficient for irrigation, and some are linked with water quality. Some exchanges are supplied with pumped groundwater.

Exchange flows are conveyed from the Jordan River through the two major east side canals, which then discharge the exchange flows into tributaries upstream from the diversion, to fulfill the exchange agreement. The tributary is used for conveyance of the exchange flow. These flows are carried by excess water, usually requiring an additional one (1) cubic foot per second (cfs) to deliver three (3) cfs (think of "pushing" the required flow through the canal system). Resultant water quality in the tributaries is degraded due to mixing with Utah Lake flows.

The extent that exchange flows degrade Big and Little Cottonwood Creeks is not well known at this time. Data show general water quality degradation in these Creeks from the canyon mouth to their confluence with the Jordan River. Data shown in Table 4.8.4 indicate that TDS, TSS and BOD levels increase with downstream flow. However, nutrients do not follow the same pattern. Other pollutant sources that contribute to degradation of water quality are irrigation return flows and urban drainage including stormwater runoff, which contributes pollutants to streamflow through canal overflows.

Irrigation return flows may have a significant impact on the water quality of the streams when compared with the contribution of exchange flows. During the period 1995-2004, 324,900 af was diverted into the East Jordan Canal for irrigation purposes (Utah Department of Natural Resources, 2007). Of that amount, 60,850 af (19%) was diverted to fulfill exchange agreement flows (Salt Lake City, 2007). These flows are shown in Figure 4.8.5. and Figure 4.8.6.

The values, though slightly less, are similar for Jordan and Salt Lake City canal diversions (Figures 4.8.7 and 4.8.8).

### 4.8.5.3 Jordan River Water Quality

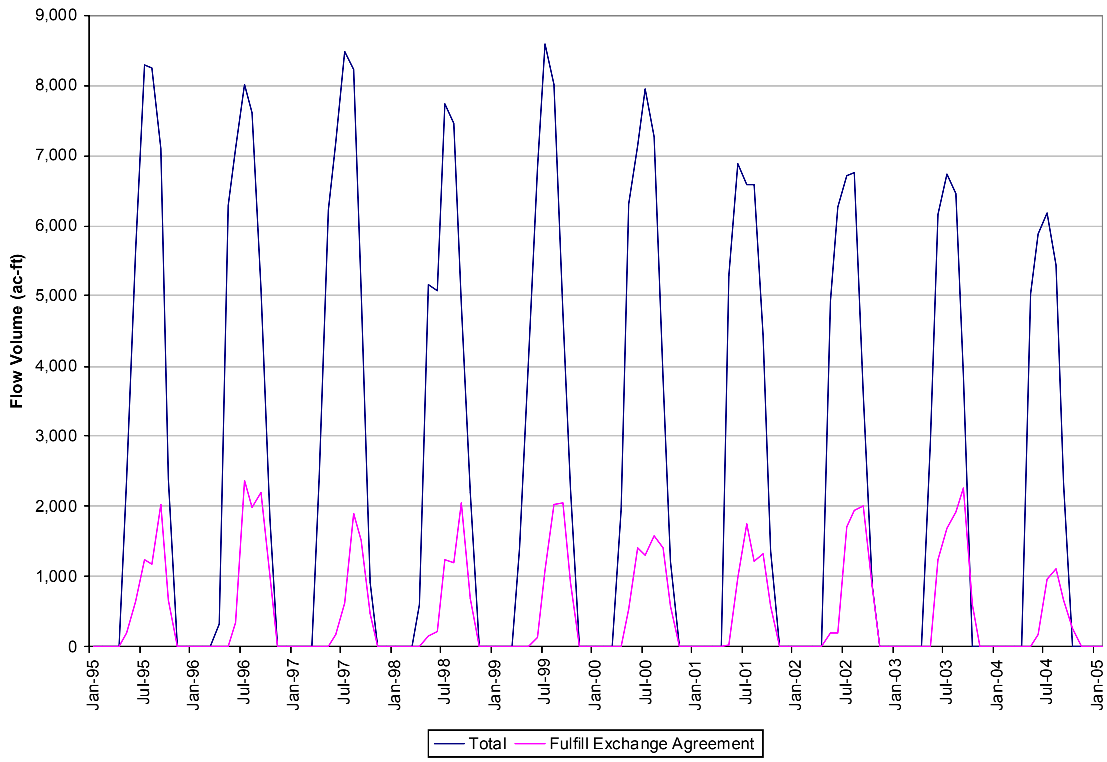
As stated previously, Utah Lake is a major source of the Jordan River, and is a highly complex system that is currently undergoing a TMDL study. Additionally, a legislatively appointed steering committee has been convened to develop a management plan for a more economic benefit to be derived from Utah Lake. The Jordan River is also undergoing a TMDL study. The outcome of these studies, with the input from the steering committee when implemented, should improve the quality of the

**Table 4.8.4 Selected Water Quality Parameters for Big and Little Cottonwood Creeks**

| Big Cottonwood Creek | Sampling Station | | |
|---|---|---|---|
| Constituent | 600 West Street (4992970) | 1300 East Street (4993040) | USFS Boundary (4993100) |
| TDS (mg/L) | 571 | 601 | 171 |
| Total Phosphorus (mg/L) | 0.11 | 0.06 | 0.16 |
| Ammonia (mg/L) | 0.22 | 0.22 | 0.02 |
| TSS (mg/L) | 52 | 61 | 4 |
| $BOD_5$ (mg/L) | 5 | 2 | 1 |

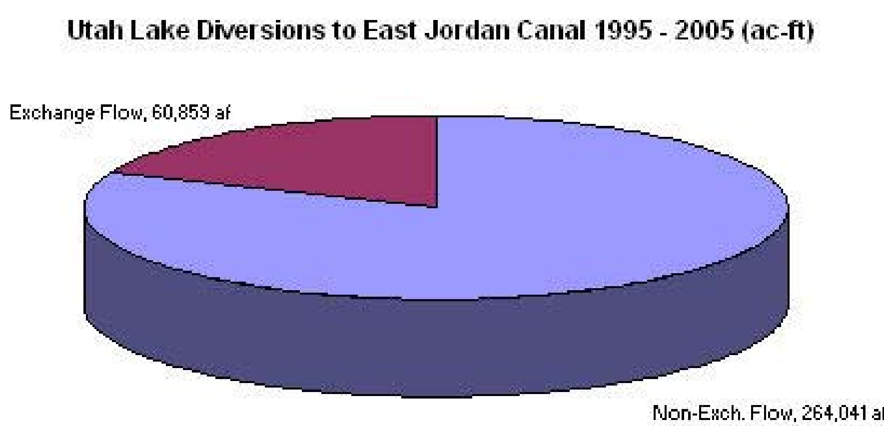
| Little Cottonwood Creek | Sampling Station | | |
|---|---|---|---|
| Constituent | 600 West Street (4993580) | 1300 East Street (4993630) | Wasatch Blvd.(4993650) |
| TDS (mg/L) | 772 | 281 | 129 |
| Total Phosphorus (mg/L) | 0.07 | 0.07 | 0.02* |
| Ammonia (mg/L) | 0.05 | 0.26 | 0.03* |
| TSS (mg/L) | 35 | 53 | 13 |
| $BOD_5$ (mg/L) | 5 | 2 | 1 |

*Source: EPA STORET Database*



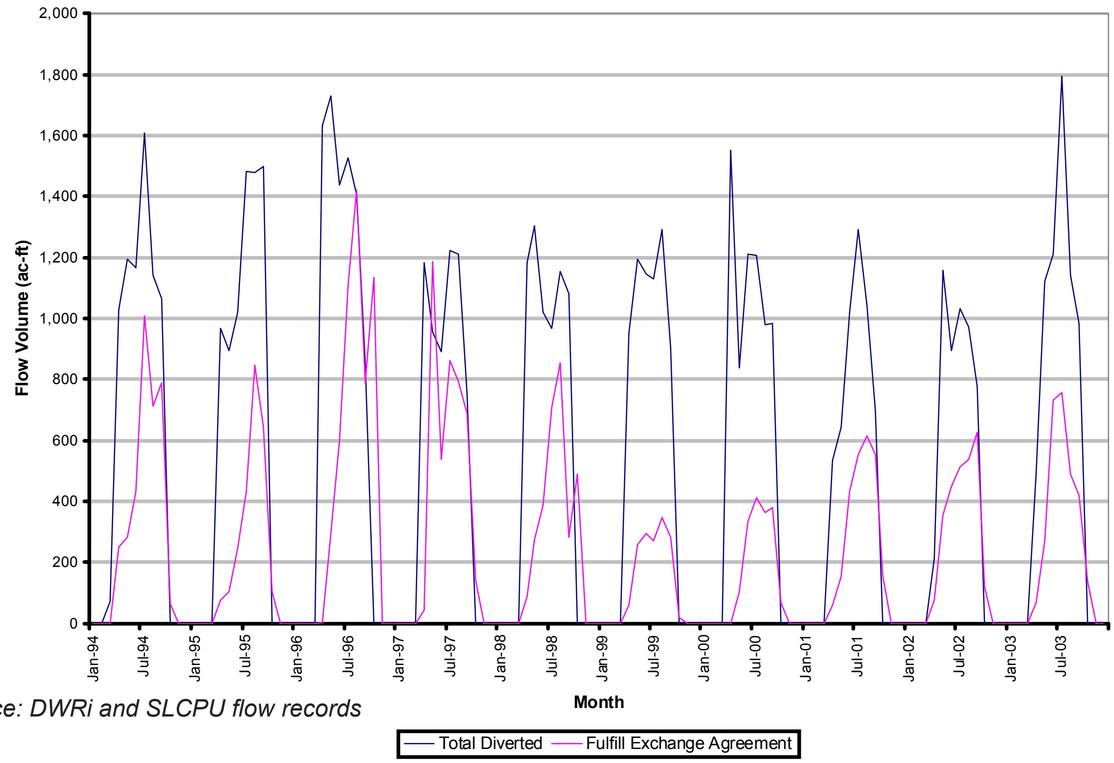

*Source: DWRi and SLCPU flow records*

**Figure 4.8.5 Utah Lake Diversions to East Jordan Canal**



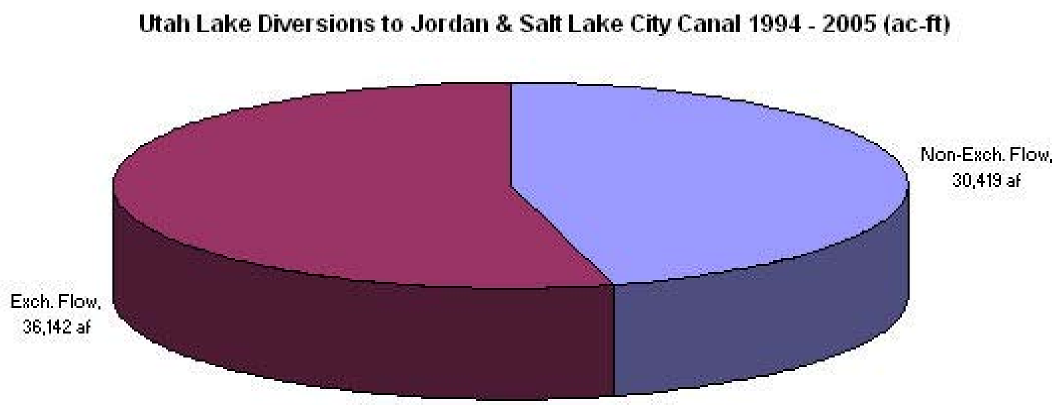

*Source: DWRi and SLCPU flow records*

**Figure 4.8.6 East Jordan Canal Diversion Exchange Flow Volume**




*Source: DWRi and SLCPU flow records*

**Figure 4.8.7 Utah Lake Diversions to Jordan and Salt Lake City Canal**




*Source: DWRi and SLCPU flow records*

**Figure 4.8.8 Jordan and Salt Lake City Canal Diversion Exchange Flow Volume**

Jordan River. It is beyond the scope of this portion of the WaQSP to restudy Utah Lake/Jordan River water quality relationships. The TMDL studies should be completed by the time this plan is revisited and the findings of the studies used when possible.

### 4.8.6 Recommendations

Based on the foregoing discussions, the following recommendations are made to address the affect of Utah Lake flows on the Jordan River and its tributaries.

1. Adjudication of Irrigation Water Rights

The State Engineer's Office has the responsibility and duty to adjudicate water rights in basins throughout the State. Salt Lake County, in particular, has evolved from an agricultural land use base to an urban land use base. Water rights have not been diligently updated by developers as agricultural land is converted to urban usage. Furthermore, the Utah Lake-Jordan River basins water rights are severely over-appropriated. It is recommended that the State Engineer perform a study to determine whether water is being used for what it is intended for in the County. Also, it is noted that the State Engineer has an on-going adjudication process in place in the County. It is recommended that the State Engineer's Office place higher priority on the adjudication process in the County while also being sensitive to existing rights and State law.

2. Countywide Water Quality Model

It is recommended that a Countywide water quality model be developed, calibrated and verified using the most recent climatic, hydrologic, land use, GIS and other data available. The model should include water quality, quantity, habitat, recreation and other aspects beyond the usual water supply and flood control/drainage aspects. The model should then be used as a tool to evaluate various hydrological management strategies as they arise.

3. Restudy Utah Lake Management

The management of Utah Lake should be re-evaluated. Management options must include considerations of flow on the Jordan River from both a physical and a habitat perspective. Predictive capabilities of Federal, State and local agencies have improved greatly in the previous 25 years. Current management is counter-productive to the efforts that are being undertaken by the County and Cities along the Jordan River to enhance recreational opportunities and reduce economic losses by providing flood flow conveyance. A goal would be to manage Utah Lake as closely as possible, mimic a more natural flow regime, given the institutional setting with water rights, storage, etc.

4. Utah Lake Quality Studies

Utah Lake is the water source of the Jordan River. There are currently TMDL studies underway on the Lake and on the Jordan River. It is recommended that the County closely monitor these studies and provide input as much as possible. Salt Lake County will coordinate with the Utah Lake Commission, State of Utah, and other relevant agencies to develop and implement future water quality management plans for Utah Lake. Additionally, the County is interested in cooperating with the June Sucker Recovery Implementation Program (JSRIP). It is recommended that the County monitor and cooperate with the JSRIP Technical Committee to assure that water quality and habitat are preserved/ enhanced for both the Jordan River and Utah Lake.

5. Assess Water Right Exchange Impacts

A clear understanding of the impacts of Utah Lake flows on Jordan River tributaries is lacking. Additional assessment is needed to determine the impacts these exchanges are having on the tributaries. The assessment should include the habitat impact that would occur if the flows were removed and not replaced resulting in dewatered segments of the tributaries. Lesser quality flow is better than no flow at all. However, the temperature impairments of Lower Big Cottonwood Creek and Lower Little Cottonwood Creek may be due to Utah Lake flows, and need further study.

## 4.9 HEADWATERS PROTECTION

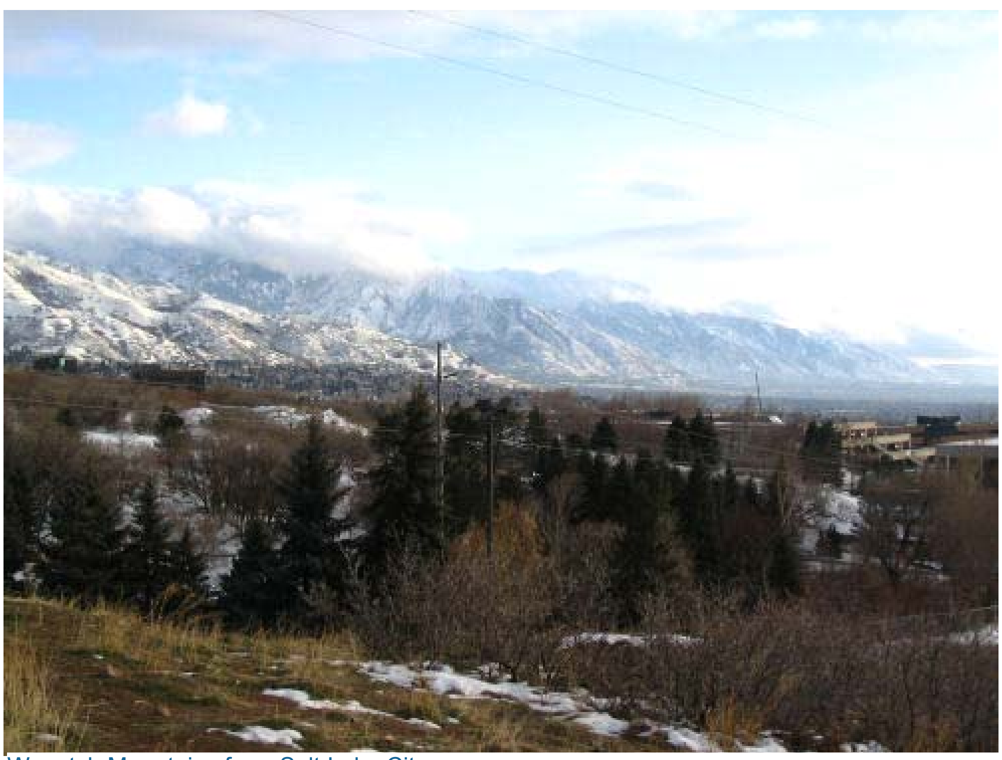
Protecting headwater resources is a critical component of preserving overall watershed health. The Salt Lake Countywide Watershed contains two major headwater areas; the Wasatch and the Oquirrh Mountains. These areas provide water supply, habitat, recreational, and aesthetic resources in Salt Lake County. This section is written to: 1) review the characteristics of the Wasatch and Oquirrh Mountains, 2) discuss jurisdictional responsibilities in each of these areas, 3) review plans written for these respective areas, and 4) make recommendations for future management of these resources.

### 4.9.1 Wasatch Mountains

The Wasatch Mountain Range (Wasatch Mountains) is approximately 160 miles in length and stretches from the Utah/Idaho border south to central Utah. These mountains establish the boundary between the western edge of the Rocky Mountains and the Great Basin and constitute the eastern boundary of Salt Lake County. In addition to supporting essential watershed functions, nearly eighty-five percent of Utah's population lives within 15 miles of the Wasatch Mountains and 26% of the water supply in the County comes from streams that originate in the Wasatch Mountains (USFS, 2003).

The Wasatch Mountains rise from the Salt Lake Valley elevation of approximately 4,330 feet to heights of over 10,000 feet. The highest elevation in the Wasatch Mountains is Twin Peaks (between Big and Little Cottonwood Canyons) at 11,330 feet.

Throughout the Wasatch Mountains, riparian vegetation and large woody debris reduce erosion, maintain water quality, filter sediment, aid floodplain development, improve floodwater retention and groundwater recharge, stabilize stream banks, and develop diverse channel characteristics. These channel characteristics provide habitat for desired native and non-native fish. Generally, the Wasatch Mountain streams are the least altered streams in Salt Lake County; however, various factors may affect the environment and watershed health of these headwater areas including: drought and flood conditions, development, climate change, fire, insects, disease, roads, livestock grazing (currently prohibited), mining (currently prohibited), diversions (in the lower sections), and dams (USFS, 2003).



Wasatch Mountains from Salt Lake City

Residential development continues to increase on several private parcels within Big and Little Cottonwood Canyons. Additionally, residential and commercial development pressures continue to occur on some private lands without adequate services.

Recreation use in the Wasatch mountain area is increasing year round due, in part, to the rapidly growing metropolitan population in Salt Lake County and increasing tourism. With increased recreational use, it is progressively more difficult to balance competing interests. In addition to robust riparian corridors and large groundwater recharge areas, hiking trails, rock climbing, mountain biking, backcountry recreation, and picnicking opportunities are abundant in the Wasatch. Of note, this area is home to four world class ski resorts (Alta, Brighton, Snowbird, and Solitude). Snowbird and Solitude, to a lesser extent, operate their facilities as both ski and summer resorts. These ski resorts, and the revenue that the ski industry generates, provide a large economic contribution to the State and local governments. Balancing social and recreational desires with ecological functions is a major challenge in the Wasatch Mountains.

Big Cottonwood Creek, Upper Big Cottonwood Creek Sub-Watershed

#### 4.9.1.1 State of Utah Nonpoint Source Plan

The Utah Department of Environmental Quality, Division of Drinking Water (DDW) and Division of Water Quality (DWQ) administer Utah's water quality laws (Appendix A). The Utah Nonpoint Source (NPS) Task Force facilitates Utah's NPS Pollution Control Program. As part of the NPS program, Utah has designated the Wasatch Mountain streams as high quality waters in priority watersheds. High quality waters and priority watersheds are defined as unique natural areas that have exceptional recreational or ecological significance or are determined to be a State or National resource requiring special attention to protect and restore. Due to their status as high quality waters, the Wasatch Mountain streams receive protection from detrimental development practices and over use.

The NPS Plan requires waters whose existing water quality is better than the established state standards be maintained at the higher quality, unless it is determined that allowing lower water quality is necessary to accommodate important economic or social development. However, degrading these high quality waters is not allowed if it interferes with, or becomes injurious to, existing instream water uses (BLM website, 2007).

#### 4.9.1.2 Wasatch Mountains Jurisdiction, Land Use, Plans and Ordinances

Jurisdictional and management responsibilities in the Wasatch Mountains are shared by the United States Forest Service (USFS), Salt Lake County (SLCo), the Salt Lake Valley Health Department (SLVHD), Salt Lake City Public Utilities (SLCPU), the State of Utah, the Town of Alta, Sandy City and Draper City. This section is written to provide an overview of these jurisdiction and management responsibilities. For a more detailed discussion of these respective authorities and jurisdictions, refer to Appendix A.

Multiple planning efforts and documents have focused on the Wasatch Mountains. In order to avoid duplication, this section also summarizes existing Master Plans and Ordinances that pertain to the Wasatch Mountain areas in Salt Lake County. Additionally, this section reviews the status of implementation recommendations made in the respective plans.

*United States Forest Service* The United States Forest Service (USFS) oversees local National Forests including the Wasatch-Cache National Forest (WCNF) which manages three wilderness areas and authorizes special use permits for recreational use of Forest Lands in the Wasatch

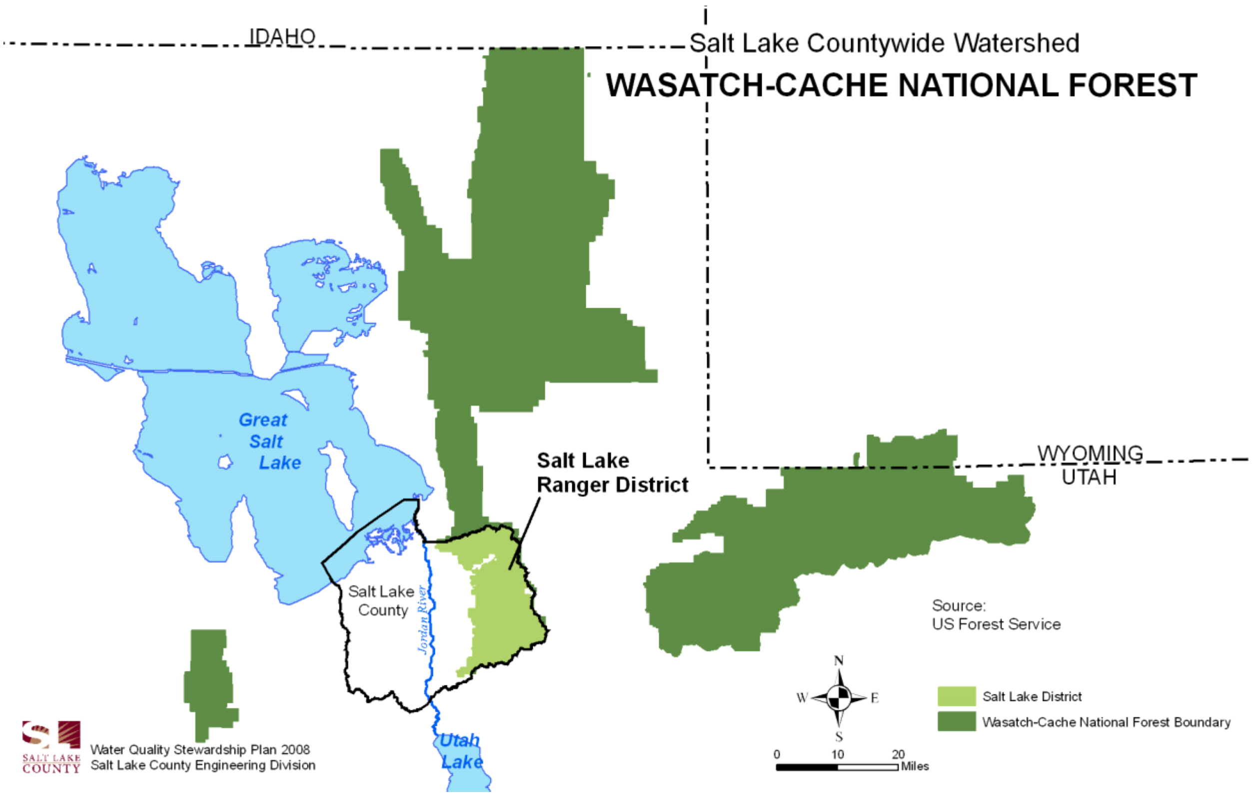



**Figure 4.9.1 Wasatch-Cache National Forest and Salt Lake City District Boundaries**

Mountains (Figure 4.9.1). The money collected by the WCNF goes into the USFS general fund and is distributed throughout the U.S. Only a small portion of the money collected by the WCNF is used for management of the local Forest. The money that does return is used to hire employees, perform routine maintenance of trails, parking lots, and other facilities, and build, upgrade, and/or repair existing facilities (Schied, 2007). The Salt Lake Ranger District is part of the WCNF. Notably, the WCNF and Uinta National Forest are currently in the process of combining to become one National Forest.

The USFS is the largest land manager in the Wasatch Mountains and is the largest provider of recreation opportunities therein. With an estimated population increase in Salt Lake County of just over 400,000 by 2030, and an expected increase in tourist visits, the pressure to provide recreation opportunities will only intensify in the Wasatch Mountains.

The Wasatch-Cache National Forest (WCNF) Land and Resource Management Plan (WCNF Plan), adopted in 1985 and updated in 2003, directs the activities of the WCNF within the Salt Lake City Watershed Management Plan area. The management priority of this Plan is to provide long-term, high quality culinary water to the large urban population of the Salt Lake Valley. This section summarizes the sections of the WCNF Plan that address watershed and water quality concerns in Salt Lake County.

The Central Wasatch Management Area (CWMA), a portion of the greater WCNF, is located east of Salt Lake City in the Wasatch Mountain Range. The CWMA extends from the Davis and Salt Lake County line on the North to the Salt Lake and Utah County line on the South (Figure 4.9.1). It contains three designated Wilderness areas (Mt. Olympus, Twin Peaks, and Lone Peak) and four major ski areas (Brighton, Solitude, Alta and Snowbird). The canyons in this area are valuable headwater areas for Salt Lake and adjoining cities along the Wasatch Front. Ephemeral, intermittent, and perennial streams support numerous wetland and riparian areas throughout the CWMA. Additionally, small natural alpine lakes and reservoirs are found in higher elevations. Seeps and springs are also abundant throughout the area. Several large population bases, including Salt Lake City and

Sandy, rely on the waters that originate in these Forest lands. Waters originating in the CWMA are also used for recreation, irrigation, and hydroelectric power (WCNF website, 2007).

Under the provisions of federal statutes and regulations, the WCNF plays a special role in the management of the Salt City Watershed area located in the Wasatch Mountains (Figure 4.9.1). To protect the water supplies for Salt Lake City, the WCNF has entered into agreements with authorized cities to manage the use of Forest Service lands to protect water supplies. In 1981, the WCNF and Salt Lake City Corporation prepared a Memorandum of Understanding (MOU) to carry out federal mandates. The MOU cites the congressional acts that recognize Salt Lake City's extraterritorial jurisdiction in the watershed and the need to prevent the contamination of streams or watercourses from which the inhabitants of the city derive their water supply.

The underlying premise of resource management in the WCNF Plan is the need to provide long-term, high quality culinary water to the large urban population of the Salt Lake Valley. Salt Lake City owns the majority of water rights in each of the Wasatch Canyons with the exception of Red Butte, and has congressionally delegated authority to protect the water supply. The WCNF has been directed to manage designated watersheds in cooperation with Salt Lake City for the purpose of storing, conserving and protecting water from pollution.

Given the importance of water coming from this area, watershed maintenance, protection and enhancement will be a primary consideration in all management decisions. Continued coordination and cooperation among federal, state, and local government agencies, residents, businesses, and the recreating public will be imperative in order to meet these growing demands.

A Preliminary Analysis of the Management Situation for the WCNF was published in 1999 as part of the Forest Plan Revisions. This preliminary analysis reviewed Desired Future Conditions (DFCs) and made recommendations to achieve these conditions. The desired recommendations made for each of these eight topics are summarized in Appendix I. Additionally, the implementation status of each of these recommendations is listed.

White Pine Parking at Height of Summer Season

Of importance, the USFS Plan confines new ski resort developments on Forest land to their existing permit boundaries. No net increase in parking lot area is allowed in the Tri-Canyons (Mill Creek, Big and Little Cottonwood), unless needed for watershed protection or to facilitate mass transit. Additionally, the USFS Plan directs the Forest Service to work with other parties to reduce private vehicular use in canyons.

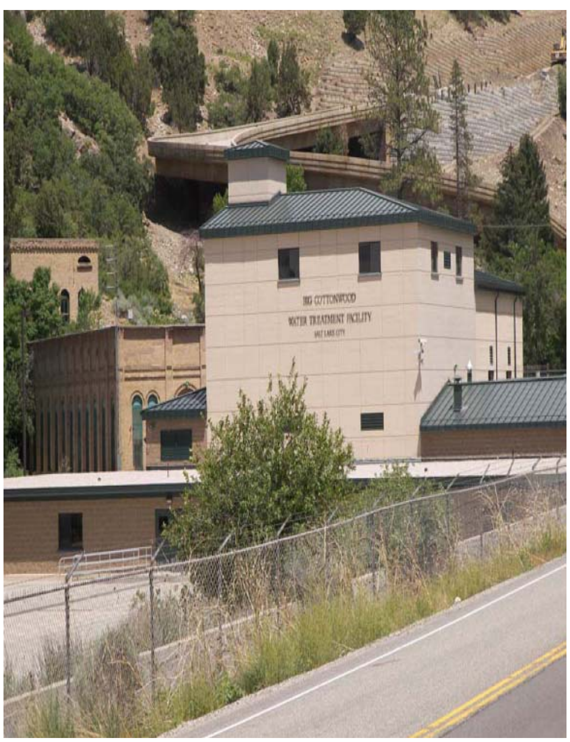
*Salt Lake County* Salt Lake County (SLCo) has primary land use jurisdiction over private lands in the Wasatch Canyons. The majority of the Wasatch Mountains are part of Unincorporated County. Salt Lake County has the authority to enforce land use regulations in the unincorporated areas.

In 2001, Salt Lake County combined the Planning Division and the Development Service Division. The Planning and Development Services Division is responsible for all long range planning; including site plan approval and issuance of building permits for privately owned land in the unincorporated areas of the Wasatch Mountains.

Zoning in the Wasatch Canyons occurred in 1972, with the exception of Emigration Canyon. In 1989 the Wasatch Canyons Master Plan (WCMP) established county policies regarding land use and other issues in the Wasatch Mountains. The Salt Lake County zoning ordinance Title 19, and subdivision ordinance Title 18, are the main tools used to implement the WCMP and other plans and control development in the Wasatch Mountains. Originally zoned in the early 1950's, Emigration Canyon was re-zoned in 1987 to Forestry Recreation (FR) zones, similar to the other canyons. The purpose of the FR zones is to address the development limitation in the canyon and foothill areas. Through the administration of planning (adopted general plans) and the zoning and subdivision ordinances, the County attempts to balance development and protection of the Wasatch Mountains.

Salt Lake County adopted the Wasatch Canyons Master Plan (WCMP) in September of 1989. The purpose of the plan is to “guide and coordinate the allocation of future uses in accordance with the present and future needs and resources within the seven major Wasatch Canyons through the year 2010”. The plan pertains to the use of privately owned land in the unincorporated areas of the Wasatch Mountains.

The goal of the WCMP is to “provide diverse opportunities for public enjoyment of the canyons within the constraints of a limited geographic setting and the capacities of the natural environment to accommodate uses without significantly diminishing the quality of the canyon resources or the quality of the canyon experience.” Notably, the WCMP defines a watershed as, “a land area that is drained by a single network of streams.” Therefore, the WCMP addresses seven “watershed canyons.”



Big Cottonwood Water Treatment Facility

Foot Bridge over Big Cottonwood Creek, Upper Big Cottonwood Creek Sub-Watershed

In the WCMP, a healthy watershed requires, “a steady flow of water that sustains all of its water-related or water-dependent species without degrading the quality of its soil despite periodic disturbances.” In order to preserve and enhance watershed health, the WCMP identified three requirements:

- Maintain the integrity of water systems and soil quality
- Meet the needs of thriving terrestrial and aquatic ecosystems
- Supply values for people, such as drinking water, recreation and other uses that do not compromise watershed health

In order to support these healthy watershed requirements, the WCMP recommends county land use policies in the Wasatch Mountains and recommends land use policies for the USFS. These land use policies apply to interactions with other management agencies. WCMP recommendations and implementation status are summarized in Appendix I.

All the unincorporated Wasatch Canyon areas are in the Foothill Canyons Overlay Zone (FCOZ). Along with site development and design standards, the FCOZ is a sensitive land regulation that was adopted by Salt Lake County in January 1998 and replaced the Hillside Protection Zone. The intent of the FCOZ is to preserve the visual and aesthetic qualities of the foothills and canyons and reduce the risk to development from natural hazards. The FCOZ: 1) encourages development that fits the natural slope and will minimize scarring/erosion, 2) prohibits activities that would result in degradation of fragile soils on steep slopes, 3) seeks to preserve water quality, 4) defines environmentally sensitive areas, 5) minimizes disturbance to existing trees and vegetation, 6) preserves wildlife habitat, and 7) protects aquifer recharge areas. The FCOZ also seeks to reduce flooding hazards by protecting streams, drainage channels, absorption areas, and floodplains from alteration of their natural functions.

The FCOZ site development and design standards are intended to preserve and enhance the beauty of the landscape by encouraging the maximum retention of natural topographic features and encouraging planning, design, and development of sites to provide maximum enjoyment and safety while taking advantage of the natural terrain.

Identifying and protecting wetlands is an important component of watershed planning and stewardship. Wetlands are natural topographic features, where runoff from snowmelt and rainwater collect. The collected water is temporarily stored before seeping into the ground and eventually enters the stream. This temporary storage delays the water from entering the stream during peak runoff period and help support late season stream flows. Late season stream flows are important to sustain drinking water supply as well as riparian and fish habitat.

Wetlands function by trapping sediments and pollutants thus improving water quality. Habitat and wildlife flourish in a watershed due to high quality streams and wetlands. Alpine wetlands of the Wasatch Mountains do not fit within the classical definition used by the US Army Corps of Engineers to delineate jurisdictional wetlands. Alpine wetlands have a short period when they contain water and the underlying soils have a different composition. The soils are humic or organic rather than mineral clays and saturation occurs for a very short time during the spring snowmelt runoff. Vegetation consists of a wide range of grasses, forbs, and trees not generally identified in wetlands. However, alpine wetlands provide the same critical functions as the more typical wetlands.

Although the majority of lands in the Wasatch Mountains are managed by the USFS, several areas with private land holdings are under increasing pressure to be developed. In managing the Wasatch Mountains, it is essential to understand the impacts and trade-offs created by development and the potential impacts on social and ecological values. Since many public values are influenced by wetlands, the relative importance of individual sub-basin contributions is an important tool for future conservation efforts and watershed management. In order to identify and quantify watershed functional values in the Wasatch Mountains, Salt Lake County developed and coordinated several local studies. Although these studies do not apply to the entire Wasatch Mountain area, they serve as examples of efforts that have been completed, and may be beneficial for watershed planning documents. This section is written to review existing studies and provide an example of what may be done elsewhere in the Wasatch Mountains.

*Willow Heights* - In October 2003, Salt Lake County Public Works Engineering Division contracted with the University of Utah Geology and Geophysics Department to perform a geophysical investigation in the Willow Heights area of Big Cottonwood Canyon. The purpose of the study was to perform a subsurface geological investigation of a small pond underneath and adjacent to Willow Creek. Items studied as part of this effort include: 1) depth of bedrock, 2) stream shape and orientation, and 3) thickness and character of overlying glacial debris, such as lacustrine sediments and alluvium/ colluvium.

Dry Creek, Lower Dry Creek Sub-Watershed

The results of this investigation indicated that directly under the pond the subsurface layer is composed of near-surface fine, well-sorted sediments, clays and organics. This changes to coarser sands and gravels as one moves laterally away from the pond, especially to the north. The water table averages six (6) feet below the ground surface and mimics the topography, but gets shallower under the pond and deeper toward the edges. The response towards the groundwater suggests that the pond is a source of recharge, at least to some degree.


Little Cottonwood Creek, Upper Little Cottonwood Creek Sub-Watershed

The bedrock in Willow Heights was found to be approximately 32 feet below the pond and dipping 6 degrees to the southwest. A weathered bedrock layer is 25 feet below the pond and is 5 to 10 feet thick depending on the location, which is thin for a weathered layer. That combined with relatively high velocity; suggested that this layer is only slightly to moderately weathered. Glacial activity scoured the area down to bedrock and not enough time has elapsed for a well-developed layer to appear.

*Brighton and Albion Basins* Wetland Identification studies have been prepared for Brighton and Albion Basins. These comprehensive studies identified wetlands using Remote Sensing Aerial Photography and on-site field investigations to verify data. These studies analyzed factors such as, topography, geology, soils and surface hydrology.

The Brighton Basin, Wetland Advanced Identification Study (WAIDS) prepared by Salt Lake County Public Works, Engineering Division (SLCo, 2000) provides information and education about wetland types and the benefits they provide directly or indirectly.

The wetlands in the Albion Basin (Little Cottonwood Canyon) were evaluated in 1993 by the Salt Lake County Public Works, Engineering Division (SLCo, 1993) in partnership with the EPA and the Town of Alta. This study consisted of an inventory and functional assessment of the wetlands in the Albion Basin.

*Mill "F" Fork* By using existing studies and additional datasets, a comprehensive view of potential wetland areas may be developed. To demonstrate this process, the Mill "F" Fork area, in Upper Big Cottonwood Sub-Watershed was selected as a pilot study site (Figure 4.9.2). It is important to note that using this method of advanced identification does not eliminate the need for site-specific, field investigation.

The datasets used to create the Mill "F" composite map were: hydrophytic vegetation (from the USGS 2004, Southwest Regional Gap analysis), the Brighton Basin WAIDS, lands in public and private ownership from the Salt Lake County Assessors records and the WCNF. Additionally, a slope analysis identifies areas with slopes of 30 degrees or less. Slopes of 30 degrees or less are significant because the Salt Lake County FCOZ only allows development on slopes up to 30 degrees. Property with a slope greater than 30 degrees is not developable, except for a lot of record. A lot of record is a parcel of land created before the current zoning was developed. Figure 4.9.2 also shows a 100-foot set back on each side of the streams. The FCOZ requires new development to be setback 100-feet from the centerline of a perennial stream to preserve the riparian zone and protect the structure during times of high water.

Figure 4.9.2 displays the most developable land in Mill "F" with potential wetlands. With the exception of the WAIDS study, the above information can be duplicated throughout the Salt Lake Countywide Watershed. It is important to note that the information shown in Figure 4.9.2 is provisional and for general planning purposes only. It is not intended to substitute for site-specific analysis.

The above discussion underscores some of the varied studies prepared by local government

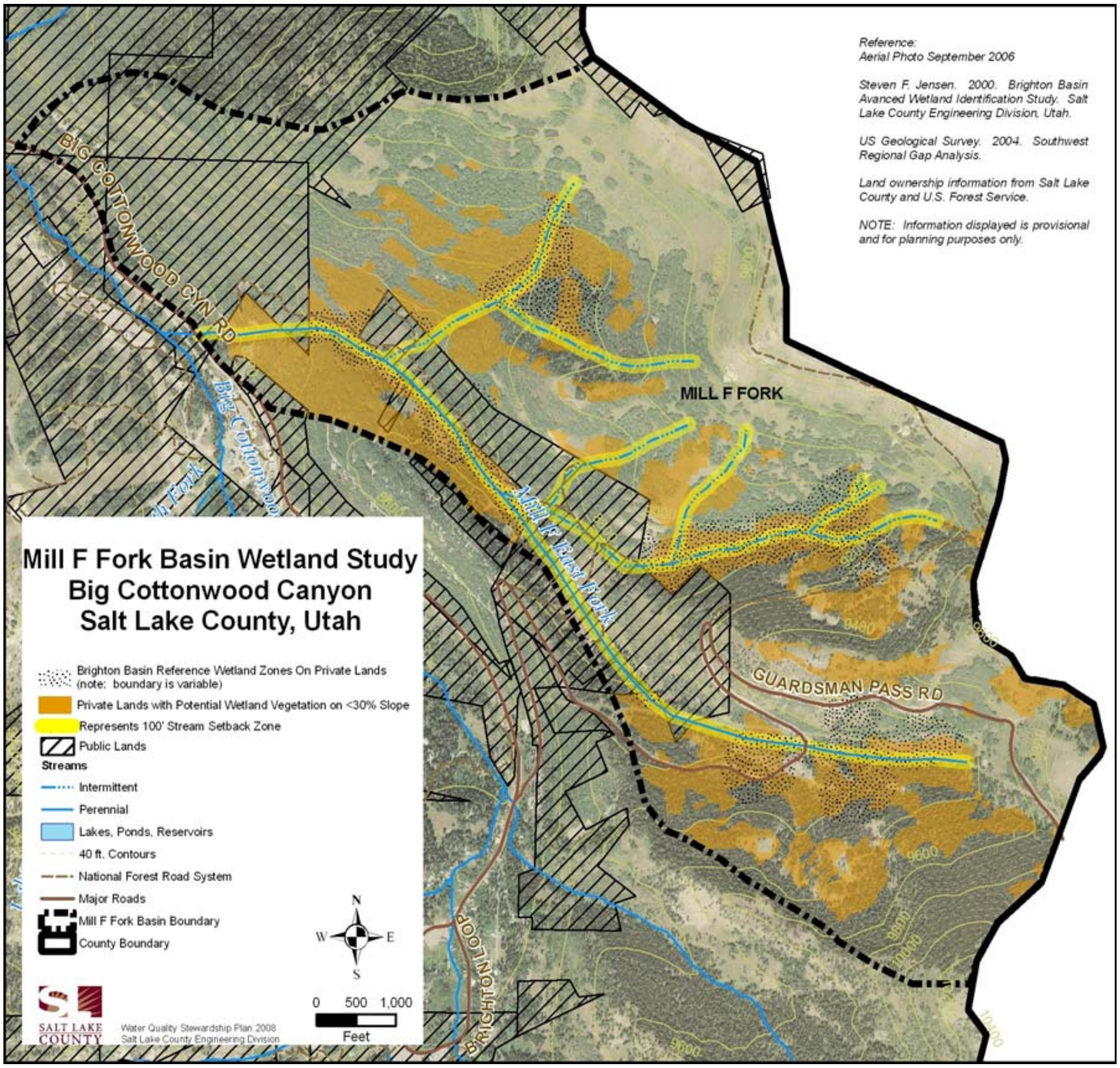



**Figure 4.9.2 Mill "F" Fork Wetland Demonstration Assessment**

agencies pertaining to the Wasatch Mountains. This type of analysis may be used to identify critical watershed areas; however, as stated earlier, advanced identification studies useful primarily in their ability to identify areas that should be studied more.

*Salt Lake Valley Health Department* The Salt Lake Valley Health Department (SLVHD) enforces water quality and wastewater treatment standards countywide. This authority is established by Utah Code Annotated 26-24-20 that authorizes SLVHD Regulation No. 14. According to this regulation, it is unlawful for any person:

- To take a dog into the watershed, unless it is a seeing eye/hearing dog or law enforcement dogs.
- To pollute or allow pollution of any water in the watershed.
- To operate any type of motor vehicle upon any property within the watershed (without permission) except on a highway or road open for public use, approved roads in residential/cabin areas, official picnic/ camping area roads, and ski area parking lots.
- Emergency and official government vehicles are exempt when on official business.
- To deposit any human excreta within the

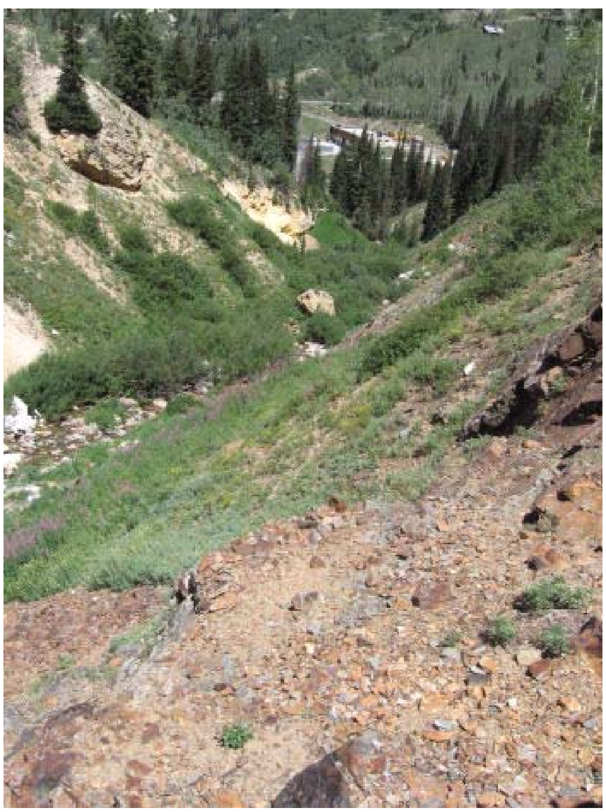
watershed areas other than into approved toilets. Cesspools are prohibited.

- To take a horse or any domestic animal into the watershed without first obtaining a permit.
- To camp overnight except in officially designed campgrounds. This does not apply to backpacking.
- To camp in the backcountry unless the campsite is located over 200 feet from the nearest water source, and 1/2-mile from any road.
- To bathe, swim or wash clothes, diapers, eating utensils or any other object in any spring, marsh, stream or other water source.
- To throw or break glass.

These regulations apply in the Wasatch Mountains from ridge top to ridge top, not just in the immediate area of surface water. These regulations also give the public utilities director, or health department director, the authority to revoke a water permit for waste of water, for violating

Road Parking in Big Cottonwood Canyon

sanitary regulations or impairment of the health, safety, or welfare of city inhabitants.



Upper Little Cottonwood Creek Sub-Watershed

The SLVHD is the regional health agency of all valley governments (Appendix A). Additionally, under section 26-24-20, Utah Code Annotated, 1953, the SLVHD prescribes its own health regulations for watersheds (Health Department Regulation #14 Watersheds). These regulations seek to prevent damage to property, the spread of disease, the creation of nuisances, and air and water pollution.

SLVHD regulations establish standards for setbacks from water sources, animal use in the headwater areas, and on-site waste disposal (septic) systems. Additionally, the SLVHD provides water supply certification and reviews reports, plans and specifications for development proposals before Salt Lake County issues a building permit. The SLVHD also administers watershed enforcement activities.

*Salt Lake City* The Utah Constitution grants broad authority (extraterritorial jurisdiction) to Salt Lake City to manage and protect its watershed. Additionally, the Utah Administrative Code (UAC) allows all cities to maintain and/or protect waterworks for up to “fifteen miles above the point from which the water is taken for a distance of three hundred feet on each side of the stream” (UAC, 10-8-15). To date, Salt Lake City, Town of Alta, Sandy City, and Draper City have been the most actively involved in headwater protection in Salt Lake County. Understandably, these cities hold water rights in Wasatch Mountain streams.

Salt Lake City is one of the largest providers of culinary water in the State of Utah. The Salt Lake City Public Utilities Department (SLCPU) provides 92,344 water connections and 28,774,670,00 gallons of culinary water to an estimated population of 328,190 in 135,000 square miles annually. Additionally, SLCPU manages a protected watershed of 190 square miles in the Wasatch Mountains (SLC website, 2007).

Salt Lake City uses the term "watershed" to identify the canyon areas where drinking water sources originate. Salt Lake City is "granted extraterritorial jurisdiction for the construction, operation, and maintenance of waterworks, and to protect the water from pollution that is 'used in and necessary for' city waterworks." Additional watershed protection jurisdiction for first class cities (municipalities with over 100,000 people) extends further than other cities to include protection of the "entire watershed". Therefore, Salt Lake City is granted management responsibility in all the canyon watersheds where Salt Lake City owns water rights to protect canyon waters from activities anywhere in the watersheds that are detrimental to water quality or quantity" (SLC Management Plan, 1988). These canyons include City Creek, Red Butte, Emigration, Parleys, Mill Creek, Big Cottonwood and Little Cottonwood Canyons. Culinary drinking water is collected from City Creek, Parleys Canyon, north and east of Mountain Dell Reservoir (including Lamb's and Dell Canyons), all of Big Cottonwood Creek, and all of Little Cottonwood Creek (Figure 4.9.3).

Alternatively, the WaQSP uses the term "Watershed" in a much more broad sense. It identifies watersheds and sub-watershed basins in Salt Lake County where Salt Lake City does not have special management authority. This includes, but is not limited to Midas/Butterfield Watershed, Rose Creek Watershed, and Willow Creek Watershed for purposes of discussion.

To protect its watershed areas Salt Lake City has implemented state statutory authority through the adoption of ordinances. General watershed protection provisions are located in Title 17 of the Salt Lake City Code which addresses all ordinances under the jurisdiction of Salt Lake City Department of Public Utilities. Chapter 17.04

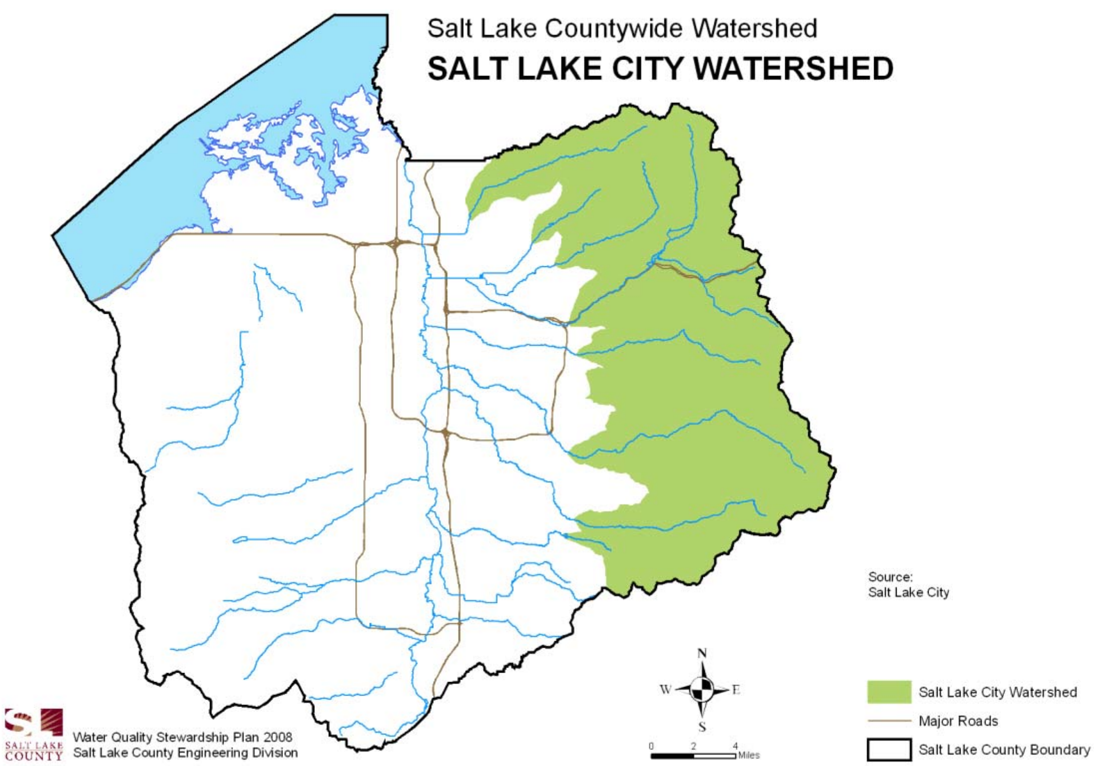



**Figure 4.9.3 Salt Lake City Watershed Boundary**


Mill Creek, Upper Mill Creek Sub-Watershed

contains Salt Lake City's watershed related ordinances. The Public Utilities Director is the general supervisor of all city watershed activities. In the Salt Lake City watershed area, the SLVHD, USFS, Salt Lake County Sheriff, Alta Town Marshals and Watershed Officers of the SLCPU enforce watershed ordinances. Violations of these watershed ordinances constitute a Class "B" misdemeanor.

In addition to the areas managed through extraterritorial jurisdiction, Upper City Creek is a watershed area within the corporate limits of Salt Lake City. Therefore, this area is subject to all Salt Lake City Ordinances. Chapter 17.08 of the Salt Lake City Code specifically governs the City Creek sub-watershed. This ordinance regulates reservation and fees, driving restrictions, animals, camping and fire restrictions, and discharge of firearms. Additionally, the ordinance requires permits for removal of vegetation and prohibited nuisances.

The Salt Lake City Watershed Management Plan (SLC Plan) was originally adopted in 1988 and updated in 1999. The primary goal of the 1988 Plan was to "guide Salt Lake City in the management of it's watersheds in the Wasatch canyons, from City Creek on the north end to Little Cottonwood on the south end". The main goal of the 1999 SLC Plan is to maintain excellent water quality for culinary uses first, and secondly to provide for multiple uses of the watershed areas. Additionally, maintaining a healthy ecological balance with stable environment conditions, healthy streams and riparian areas, and minimal sources of pollution, is also a high priority.

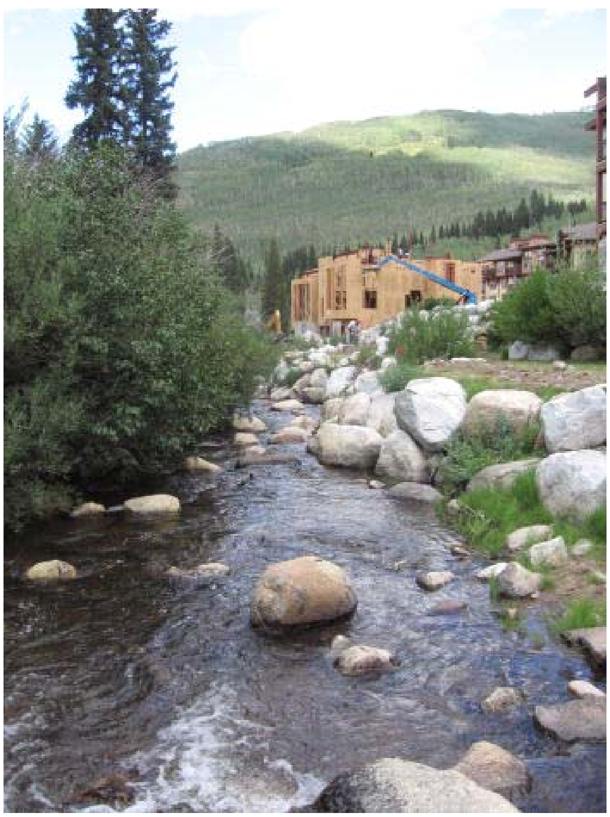
The SLC Plan makes both area-wide and canyon specific recommendations to achieve these management goals. These recommendations, along with their implementation status, are summarized in Appendix I. Generally, the SLC Plan recommends that existing and potential uses of the Wasatch Canyons that could lead to the deterioration of water quality be limited, mitigated or eliminated.

*Town of Alta* The Town of Alta (Town) comprises approximately 2,890 acres at the top of the Little Cottonwood Canyon headwater, including the Albion Basin, which is an important recharge area for the Little Cottonwood Canyon headwater. The Town maintains land use controls (zoning and planning) within the Town's boundaries. The Town enforces land use regulations including building codes and other zoning regulations for land within its boundaries. The Town of Alta is uniquely situated as the only incorporated municipality within the Wasatch headwaters area. As such, the Town is very active in watershed protection and management issues, and routinely collaborates with Salt Lake City, Salt Lake County, Sandy City, and the US Forest Service on watershed issues.

Keep It Pure Information Board

The Town, with its approximately four square miles of area and the highest total annual precipitation of any similar area of the state, is a significant source of water, making watershed protection in the Town an essential issue. In addition to addressing and highlighting watershed and water quality concerns in its General Plan (updated in 2005), the Town of Alta operates under two interagency Memorandum of Understandings (MOUs) that specifically focus on watershed protection. The first MOU was recorded in 1994, and is an agreement between the US Forest Service, Salt Lake County, Salt Lake City, and the Town of Alta with the purpose of preserving land in the Albion Basin. The second MOU was signed in 1995, and is an agreement between the Town and Forest Service outlining procedures for maintaining a cooperative relationship for the "management and protection of the ecosystem and watershed within the Town limits". Details regarding the Town of Alta's General Plan, land use ordinances, and MOU's are provided in Appendix I.

The Town of Alta also works closely with local land trust organizations, particularly Friends of Alta, in situations where sensitive watershed land



Development in Upper Big Cottonwood Creek Sub-Watershed

Little Cottonwood Creek, Upper Little Cottonwood Creek Sub-Watershed

in the Albion Basin becomes available for conservation. Friends of Alta has been incorporated as a non-profit organization since 1982, and holds and maintains conservation easements on several parcels of private land in the Albion Basin.

*Sandy City* Sandy City manages its headwater resources through its extraterritorial jurisdiction (UAC, 10-8-15). The area encompassed by the Sandy City Watershed includes seven canyons used by the City as culinary water sources. The canyons are: Little Cottonwood, Bell, Middle Fork of Dry Creek, South Fork of Dry Creek, Rocky Mouth, Big Willow and Little Willow. Sandy City also receives a significant portion of its culinary water from the Provo River through the Salt Lake City Aqueduct. Additionally, Sandy City has a source water protection plan in place to protect public drinking water.

Consistent with Sandy City's primary watershed management objectives of maintaining water quality and protecting water resources, the Sandy City Watershed Plan (SCWP) encourages multiple uses within the watershed as long as these activities do not negatively degrade water quality (Sandy City, 2002).

Although Sandy City has not adopted watershed protection ordinances, several land use regulations complement the community's watershed management objectives. Specific regulations include the Sandy City Land Development Code (SCLDC) and the Sensitive Lands Overlay Zone (SLOZ). The overlay zone requires review of the following:

- Development Site Plan Review
- Floodplains
- Streams and Waterways
- Slopes
- Vegetation
- Grading and Excavation
- Erosion
- Storm Water Management
- Road and Trail location and construction
- Fire Protection
- Septic Tanks
- Groundwater Protection
- Household Waste

Adopted in 2002, Sandy City's SCWP area includes seven canyons used by the City and others as culinary water sources. From north to south, these canyons include: Little Cottonwood, Bell, Middle Fork of Dry Creek, Rocky Mouth, Big Willow and Little Willow.

The goal of SCWP is to maintain excellent water quality and protect watershed resources. The City's Department of Public utilities management policies and procedures that emphasize water quality first and multiple use second. According to the SCWP, existing and potential uses that could lead to the deterioration of water quality will be limited, mitigated, or eliminated. Additionally, protecting the canyons to maintain a healthy ecological balance with stable environmental conditions, healthy streams and riparian area, and minimal sources of pollution is a high priority.

The pertinent watershed and water quality recommendations from the SCWP and implementation status is provided in Appendix I.

*Draper City* Although Draper City does not manage any headwater areas, the Draper City General Plan recommends that creeks and creek channels be protected. Additionally, the Draper City General Plan recommends the preservation of natural features such as groundwater recharge areas, wetlands, steep slopes, vegetation, and wildlife habitat.

Upper Willow Creek Sub-Watershed

Although the major objective of the Draper City General Plan (DCGP) is to provide "a clear future vision for City decision-makers, residents, and others working with the City to evaluate policy changes and to make funding and budget decisions", numerous water quality and watershed issues are addressed in the DCGP. The pertinent watershed and water quality recommendations from the DCGP and implementation status is provided in Appendix I.

*Hydrology and Flooding* The report, "Flood Insurance Study, Salt Lake County, Utah, and Incorporated Areas" has been applied and adopted as part of the Title 9, Land Use and Development, of the Draper City Code, as a guide for development.

In most areas of the city, the creeks have well-defined channels that have experienced flooding in the past. Sediment collecting in the stream channels can cause significant damage from flooding along adjacent properties. There are several small drainages that flow continuously and some intermittently throughout the year, with potential high flows during the spring run-off period.


Oquirrh Mountains

*Open Space* Several years ago, Draper City purchased Corner Canyon from several property owners and re-zoned it for open space. The lower section is in Draper and the upper section is in unincorporated Salt Lake County. The Salt Lake County Parks and Recreation Division, which holds the Conservation Easement, manages the lower section of Corner Canyon as a regional park with trailheads, and hiking trails. The USFS manages the majority of the upper Canyon. Salt Lake City's Watershed boundary extends south to the County boundary and encompasses the upper part of the canyon.

### 4.9.2 Oquirrh Mountains

The Oquirrh Mountains separate the West Desert from the extensive development in Salt Lake County. The Oquirrhs are steep, rugged, and dissected with numerous canyons that are deep and narrow and that twist and turn their way down the mountain. Oquirrh Canyon bottoms are densely forested with a wide variety of trees and shrubs consisting mainly of conifers and aspen. In the winter months, the mountains become home to a small population of bald eagles, which can often be found in the cliffs on the west side of the range. The area is also home to thriving populations of butterflies, deer, mountain lions, and squirrels.

In the past, the Oquirrh Mountains have been overlooked as a source of developable land, recreation, and wildlife habitat. There are areas within the Oquirrh Range where mining activities have dramatically changed the landscape. These changes have created negative impacts for wildlife and vegetation. Due to liability issues, and use conflicts, the northern area of the Oquirrh's has been off-limits for the public for many years. However, this area is set for a significant change in the years to come.

The Oquirrh Mountains receive less moisture than the Wasatch Mountain due to their location, lower elevation and other weather related factors. Without a deep snow pack, most streams run dry by mid-summer.

Unlike the Wasatch Mountains, the Oquirrh Mountains have not been used or protected as a headwater area. However, Kennecott plans to develop their land for a full range of urban uses. As this occurs, protecting the available water will become critical for success of the new communities.

The Oquirrh Mountains contain several canyons. The Oquirrh Canyons include: Coon Creek, Barney's Creek, Bingham Creek, Butterfield Creek, Rose Creek, Wood Creek, and Beef Hollow. The majority of these streams drain into the Jordan River or are intercepted by canals; however, two streams, Lee Creek and Coon Creek, drain directly into the Great Salt Lake.

Historically, the Oquirrh Mountains have been mined for gold, silver, and most famously for copper, as the home of Kennecott Copper Mine (the world's largest open pit mine). Water from the Oquirrh Mountain creeks is used in various aspects of the mining operation. Streams have been de-watered, channels altered and the groundwater, in some areas, has been polluted. Overall, it has


Coon Creek, Coon Creek Sub-Watershed

been estimated that about 50,000 acres of groundwater has been contaminated and is now unfit for use. In other words, that is 50,000 acre-feet of water for every foot of depth that the contamination has penetrated. One acre-foot of water will supply all the water needs of an average Utah family for an entire year (Williams, 2008). To address this contamination, Kennecott has done a lot to improve and protect the watershed in the Oquirrhs, especially in the last few decades. A brief history remediation activities is contained in Table 4.9.1.

Although the Oquirrh Mountains are in unincorporated Salt Lake County, Kennecott Utah Copper owns the majority of land in the Oquirrh Mountains in unincorporated Salt Lake County. Significantly, Kennecott owns the land area from Butterfield Canyon north to I-80. However, there is currently no specific County general land use plan for this area. Kennecott Utah Copper and Kennecott Land Company manage the land consistent with legal requirements and land use stewardship and other environmental standards adopted by Rio Tinto, their parent company. A component of Rio Tinto standards is the development of a land use management plan. The management plan is intended to cover a wide range of land use factors, including establishing baseline data, changes in land use, vegetative cover, and a fire management plan.

The south-side of Butterfield and Rose Creek Sub-Watersheds contain mostly private land. Yellow Fork is a Salt Lake County Regional Park containing 808 acres in Rose Canyon. Using the open space bond money, Salt Lake County recently purchased another 400 acres to add to the park and the Bureau of Land Management (BLM) is contributing 1000 acres, which will make Yellow Fork the largest park in the County. The U.S. Army Camp Williams is located at the south tip of Salt Lake County and straddles the boundary between Salt Lake and Utah Counties. This area is off-limits for the general public.

The southwest part of the County has experienced significant growth during the last decade. The land in this area that is part of the unincorporated County is in the Foothill Canyons Overlay Zone (FCOZ) and Salt Lake County regulates land use. Herriman City regulates land use within their city boundary. Although the area has large lot zoning (1 to 20 acres), considerable residential development occurred before the adoption of current standards.

Kennecott is in the process of developing a comprehensive land use plan for the Oquirrh Mountains. The management plan will cover a wide range of land use factors including: establishing baseline data, changes in land use, vegetative cover, and a fire management plan. The fire management plan will address weed control and identify plans that will enhance fire management.

**Table 4.9.1. Brief History of Kennecott Groundwater Remediation Efforts**

| Year | Activity |
|---|---|
| 1983 | Investigations began into the possible contamination of groundwater from the mining activities of Kennecott Utah Copper by the US EPA and the State of Utah. |
| 1986 | The State of Utah filed a Natural Resource Damage (NRD) Claim against Kennecott Utah Copper (Kennecott) |
| 1995 | With Salt Lake County Water Conservancy District (now JVWCD) as intervener in the proceedings, a settlement was reached with the issuance of a Consent Decree, establishing remediation actions, as well as a trust fund for insurance of compliance |
| 2000 | A Record of Decision was signed for the proposed remediation actions necessary to settle the CERCLA issues with the designated "Zone A" portion of the plume. |
| 2004 | A formal groundwater extraction and treatment remedial project proposal was made to the NRD trustee (the director of DEQ), the EPA, and the CERCLA manager. |

### 4.9.3 Headwaters Protection Recommendations

#### 4.9.3.1 Wasatch Mountains

In reviewing existing plans for the Wasatch Canyons, and working with stakeholders during the WaQSP development, several common recommendations and key concerns were identified. These concerns and recommendations include: 1) Funding, 2) Sanitation and Facility Maintenance, 3) Transportation, 4) Recreation Resource Impacts, and 5) Protection of Critical Watershed Lands. This section is written to summarize common recommendations from existing Wasatch Mountain plans and highlight current concerns.

Little Cottonwood Creek Culvert, Upper Little Cottonwood Creek Sub-Watershed

*Funding* The WCNF receives close to six million visitors a year and is ranked fifth highest in visitation in the United States. Many visitors are from Utah; however, hundreds of thousands are tourists from other States and Countries (Majeske, 2007). Although recreation pressure is anticipated to increase in the WCNF, the USFS, and subsequently WCNF, budget(s) continue to fall short of funding basic maintenance needs. In order to mitigate budget depletion, the WCNF has a Memorandum of Understanding (MOU) with Salt Lake City Public Utilities (SLCPU) to facilitate watershed patrols and maintenance activities. Additionally, SLCPU has a MOU with the Salt Lake County Sheriff to provide law enforcement for watershed violations and other illegal activities in the Wasatch Canyons. With anticipated growth in population and tourism, it is anticipated that violations and illegal activities may increase in the Wasatch Mountains.

*Water Quality* Based on their respective plans the number one priority of all the agencies with management responsibility in the Wasatch Mountains is to maintain excellent water quality. The WaQSP fully supports this priority. Water quality preservation is best accomplished by maintaining a healthy ecological balance, which includes stable environmental conditions, healthy streams and riparian areas, and minimizing sources of pollution. Existing and potential uses that could lead to the deterioration of water quality must be mitigated or eliminated. In addition, recharge area protection requirements should be incorporated into the proposed Salt Lake County Source Water Protection Ordinance.

*Inter-Agency Coordination* Due to the checkerboard ownership pattern in the Wasatch Mountains, and the overriding goal to protect water quality and quantity, inter-agency coordination is crucial. Salt Lake City, Salt Lake County, the Town of Alta and the USFS have had an ongoing relationship for many years. Although each agency has its own jurisdictional responsibilities, they recognize the importance of working together to coordinate activities. Coordinating activities and sharing responsibilities maximizes the efficacy of limited funding and is vital to protection of the Wasatch Mountain headwater area.

To achieve better coordination it is recommended that a core working group consisting of Salt Lake County Planning and Development Services and Sheriff office, USFS, Salt Lake City Public Utilities, the Town of Alta, Sandy City and Salt Lake Valley Health Department be formed by a MOU. Utah Transit Authority, the Utah Department of Transportation, the Ski Resorts, the canyon Community Councils, and environmental groups are advisory groups to consider once the MOU is formalized.

One of the first tasks of this working group should be to create a list of shared management strategies that should include:

- Sharing responsibility for management activities
- Long-term funding sources

- Identify ways to provide better law enforcement
- Utah Department of Transportation highway management practices and its effect on water quality
- Mass Transit Options

The management coordination group should look at a broad range of options to help manage and protect the Wasatch Mountains and accomplish recognized priorities. Implementation options should not be limited to local solutions, but should recognize that existing laws may need to be changed. Long-term funding options to consider should include:


Park and Ride in Little Cottonwood Canyon

- Voluntary Donations (public and private)
- Yearly passes (could be available through the internet) similar to the fee program implemented on the Uinta National Forest or scenic by-ways
- Improve overall management

*Land Acquisition* Acquiring key properties in the Wasatch Mountains is critical to achieving the goal of maintaining excellent water quality and preserving the quantity of water supplies. As more development occurs in the Wasatch and recreation use levels increase, there will be greater impact on groundwater recharge ability, increased stormwater runoff, and potentially more pollutant loading.

It is recommended that Salt Lake County, the Town of Alta, Salt Lake City, and the USFS should jointly develop criteria for land acquisition setting forth purposes, priorities, and funding options for land purchases and coordinate acquisition efforts. Once this criteria has been developed, Salt Lake County should work with Salt Lake City and local interest groups to fund the purchase of key properties in the Wasatch Mountains. Innovative strategies such as conservation easements and the purchase of tax sale properties for tax value should be part of the plan.

It is also generally recommended that the USFS should maintain jurisdiction over their land in the watershed by discouraging land trades and the sale of land for development. However, it is noted that some land exchanges may have water quality and watershed benefits. It is anticipated, that through the National Environmental Policy Act (NEPA) process, any potential harm or benefit would be identified.

*Transportation* Transportation challenges continue to threaten water quality and watershed health in the Wasatch Mountain areas. Impacts from transportation include: 1) reduced public safety, 2) increased soil erosion, 3) spills into the creek, 4) reduced air quality, and 5) reduced recreation experience. The number of automobiles in the Wasatch Mountains increases every year with increased recreational use. Locals and tourist alike continue to rely on private vehicles for transportation. As a result, parking overflows at trailheads is common, especially during summer months when no public transportation is available.

To address these concerns, it is recommended that management and regulatory agencies in the Wasatch Mountains: 1) work with local stakeholder groups to explore visitor fee programs for Big and Little Cottonwood Canyons similar to the program established in Mill Creek Canyon, and 2) work with local stakeholders to explore enhanced public transportation programs in the Wasatch Canyons – specifically in the summer months.


Restroom Facility in Upper City Creek Sub-Watershed

*Information and Education* Public education regarding appropriate behavior in the watersheds can be accomplished through cooperation and partnerships. A consistent and concerted effort is needed to keep the general public aware of watershed issues and ways they can minimize their impact on the watershed. Therefore, it is recommended that management and regulatory agencies in the Wasatch Mountains continue to work collaboratively to increase public awareness of water quality issues.

*Sanitation* Human waste may increase bacteria loads to surface waters and degrade water quality. In the WCNF, restrooms are critical to preserving water quality. Recently, the WCNF installed additional restrooms to accommodate increased recreational use. Although these facilities are intended to enhance management options for the

Development in Big Cottonwood Canyon

Wasatch Canyons, pumping, cleaning and repair of these facilities is currently consuming a large portion of the Salt Lake City Ranger District budget. As a result, Salt Lake City Public Utilities (SLCPU) provides some funding to clean these restrooms. Un-maintained or under-maintained restrooms quickly become a health and safety hazard. Additionally, failure to maintain these facilities may result in closure, which is detrimental to both local water quality and public perception. Additional employees, or a funding source for private contracting, are needed to properly maintain restroom facilities.

In addition to human waste facilities, sanitation problems at dispersed (backcountry) recreation sites continue to pose a threat to water quality. Dog waste is also a concern in these headwater areas. Although regulations exist to prevent both dog and human waste in the backcountry, these regulations cannot be properly enforced without sufficient staff.

Some potential solutions to address sanitation concerns include:

- Establish a Watershed Protection Fund
- Encourage and facilitate intergovernmental coordination to develop funding source ideas and oversight
- Contract restroom cleaning and maintenance to private or public entities
- Study the feasibility to install sanitation facilities at dispersed recreation sites

*Enforcement* Salt Lake City Public Utilities (through an MOU) contracts with the Salt Lake County Sheriff to patrol the canyons for illegal activities and protect the watershed. Salt Lake City contracts with the sheriff for this service, because the Salt Lake City Police Department does not have jurisdiction in the canyon

- Procure additional funds for Forest Service seasonal backcountry rangers, the Silver Lake Information Center, and watershed education projects
- Work with local stakeholder groups and other agencies to increase public information and education programs, sponsor trail restoration, enhance the invasive weed program, and develop/improve the rare plant inventory

*Development* Maintaining a healthy watershed is key to preserving excellent water quality. Many factors go towards protecting the watershed. Limiting commercial and residential development to the most suitable sites will alleviate paved surfaces that blocks water infiltration into aquifers and increases runoff into streams. Building on the most suitable sites will reduce the amount of soil and vegetation disturbance

*Stream Set-backs* Maintaining a minimum stream set-backs is crucial in protecting riparian vegetation and are essential for fish, wildlife, and water quality requirements. Riparian vegetation and large woody debris reduce erosion, maintain water quality, filter sediment, aid floodplain development, improve floodwater retention, improve groundwater recharge, develop root masses that stabilize stream banks, and develop diverse channel characteristics. These channel characteristics provide habitat, water depth, duration, and temperature necessary for desired native and non-native fish viability and other designated beneficial uses, while supporting biodiversity.

*Wetland Delineation* Protecting key wetland areas is necessary to preserve and enhance watershed function in the Wasatch Mountains. Although the majority of lands in the Wasatch Mountains are managed by the USFS, several areas with private land holdings are under increasing pressure to be developed. In order to identify and quantify watershed functional values in the Wasatch Mountains, Salt Lake County developed and coordinated several local studies. To preserve watershed functions and water supply resources, it is recommended that: 1) management and regulatory agencies work collaboratively to identify properties that are important for both watershed protection and recreational use, 2) management and regulatory agencies work collaboratively to identifying long-term funding sources for land acquisition, and 3) management and regulatory agencies continue adherence to planning and zoning regulations.

#### 4.9.3.2 Oquirrh Mountains

As the Oquirrh Mountains transition from mining to urban development, it is important to extend sensitive land protection standards to ensure the long-term protection of the creeks, discourage development on steep slopes, establish reduced grading and vegetation removal, and establish re-vegetation standards. The ordinance provisions below focus on protection of water and water quality.

This plan recommends that the sensitive land regulations similar to those used in the Wasatch Canyons be extended to the Oquirrh Mountains. Salt Lake County and Kennecott have spent considerable time working on mutual agreements to ensure that their long-term interests be protected. However, certain standards should be required as part of future Kennecott development agreements. It is recommended that the following provisions from the Foothill Canyons Overlay Zone (FCOZ) be incorporated into future developments in and around the Oquirrh Mountains.

Little Willow Creek, Lower Willow Creek Sub-Watershed

A. The standards for development contained herein are intended specifically to accomplish the following purposes:

1. Preserve the visual and aesthetic qualities of the foothills and canyons, including prominent ridgelines, which are vital to the attractiveness and economic viability of the county;
2. Encourage development designed to reduce risks associated with natural hazards and to provide maximum safety for inhabitants;
3. Provide adequate and safe vehicular and pedestrian circulation;
4. Encourage development that fits the natural slope of the land in order to minimize the scarring and erosion effects of cutting, filling, and grading related to construction on hillsides, ridgelines, and steep slopes;
5. Prohibit activities and uses that would result in degradation of fragile soils, steep slopes, and water quality;

6. Provide for preservation of environmentally sensitive areas and open space by encouraging clustering or other design techniques to preserve the natural terrain, minimize disturbance to existing trees and vegetation, preserve wildlife habitat, and protect aquifer recharge areas;
7. Reduce flooding by protecting streams, drainage channels, absorption areas, and floodplains from substantial alteration of their natural functions.

Butterfield Creek, Midas/Butterfield Creek Sub-Watershed

In addition, the following provisions in FCOZ are recommended for inclusion in future development in and around the Oquirrh Mountains. Further detail regarding these sections is provided in Appendix I.

- Development Standards
- Slope Protection Standards
- Grading Standards
- Tree and Vegetation Protection
- Tree/Vegetation Removal
- Stream Corridor and Wetlands Protection
- Ephemeral Streams
- Bridges
- Establishment of Limits of Disturbance
- Maximum Limits of Disturbance