Section 7: Watershed Management

This section discusses the recommended watershed management activities to address nonpoint source pollution concerns in the Bill Williams Watershed. These recommendations are subject to revision by land use decision makers and stakeholders, and may be revised based on new data as it becomes available. It is understood that the application of any management activities will require site-specific design and may require licensed engineering design. These recommendations are only general in nature and are presented herein so as to allow land use decision makers and watershed stakeholders to conceptualize how best to address watershed management.

The Boulder Creek TMDL Implementation Plan is also summarized within this section. A TMDL plan is a study for an impaired water body that defines the maximum amount of a specified water quality parameter or pollutant that can be carried by a waterbody without causing an exceedance of water quality standards.

Management Methods

This section includes general watershed management methods, recommended strategies for addressing existing impairment in the watershed, stream channel and riparian restoration, and proposed education programs. The general watershed management methods include:

- Monitoring and enforcement activities;
- Water quality improvement and restoration projects; and
- Education.

Each of these methods is defined further below, and is addressed within each of the three pollutant categories – metals, organics, and nutrients.

Site Management on New Development:

Control the quantity and quality of water run-off from new development sites. The primary sources for future development in the Bill Williams Watershed include the mining industry, new housing developments and increased urbanization, and new road construction. The Trout and Kirkland Creek Natural Resource Areas are particularly at risk from future housing development due to the large percentage of private land within the area.

Although it is recognized that ADEQ requires Aquifer Protection Permitting and the issuance of Stormwater Management Plans for active mine sites, new mine development should continue to be monitored. It is important to promote the application of nonpoint source management measures on all new development sites through cooperation with local government, developers and private land owners.

Monitoring and Enforcement Activities:

- Continue and expand water quality monitoring programs in the watershed to measure the effectiveness of management
practices on protecting and restoring the Bill Williams Watershed's waters.

- Promote septic tank inspections and certification of septic systems by local government entities.
- Promote construction site inspection and enforcement actions for new development.

Water Quality Improvement and Restoration Projects:

- Promote efforts to protect and restore the natural functions and characteristics of impaired water bodies. Potential projects are discussed below.
- Integrate adaptive management methods and activities across the watershed to address existing and future problems.

Education:

- Develop programs to increase the awareness and participation of citizens, developers and local decision makers in the watershed management efforts. Education programs are discussed below.

Strategy for Addressing Existing Impairment

The major sources of water quality impairment and environmental damage in the Bill Williams waters are elevated concentrations of dissolved and particulate metals, sediment and organics. The high priority 10-digit HUC watersheds were identified for each constituent group in the previous section on Watershed Classification (Section 6).

The goal of this section is to describe a strategy for dealing with the sources of the impairment for each constituent group. The management measures discussed herein are brief and are meant to provide initial guidance to the land use decision makers and watershed stakeholders.

Detailed descriptions of the following management measures, in addition to a manual of additional nonpoint source Best Management Practices (BMPs), can be found at the NEMO website, www.srnr.arizona.edu/nemo.

Metals

The primary nonpoint source of anthropogenic metals in the Bill Williams Watershed is abandoned mines, although it is recognized that naturally occurring metals originating from local highly mineralized soils may contribute to elevated background concentrations in streams and lakes. Industrial and urban sources of metals are insignificant in this rural area, however, the watershed has a long history of mining with many abandoned and several active mines. In most cases the original owner or responsible party for an abandoned mine is unknown and the responsibility for the orphaned mine falls to the current landowner.

Abandoned / orphaned mines are found on all classes of land ownership in the Bill Williams Watershed, including federal, state and private lands, with the majority of the mines found on land administered by the Bureau of Land Management (BLM) and the State of Arizona. Surface runoff and erosion
from mine waste/tailings is the principal source of nonpoint source contamination. Subsurface drainage from mine waste/tailings can also be a concern. The recommended actions include:

- Inventory of existing abandoned mines;
- Revegetation of disturbed mined lands;
- Erosion control;
- Runoff and sediment capture;
- Tailings and mine waste removal; and
- Education.

Load reduction potential, maintenance, cost and estimated life of revegetation and erosion control treatments are found in Table 7-1.

Table 7-1. Proposed Treatments for Addressing Metals from Abandoned Mines.

<table>
<thead>
<tr>
<th>Action</th>
<th>Load Reduction Potential</th>
<th>Estimated Time Load Reduction</th>
<th>Expected Maintenance</th>
<th>Expected Cost</th>
<th>Estimated Life of Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Revegetation</td>
<td>Medium</td>
<td>&lt; 2 years</td>
<td>Low</td>
<td>Low-Medium</td>
<td>Long</td>
</tr>
<tr>
<td>Erosion Control Fabric</td>
<td>High</td>
<td>Immediate</td>
<td>Low</td>
<td>Low-Medium</td>
<td>Short</td>
</tr>
<tr>
<td>Plant Mulch</td>
<td>Low</td>
<td>Immediate</td>
<td>Low</td>
<td>Low</td>
<td>Short</td>
</tr>
<tr>
<td>Rock Mulch</td>
<td>High</td>
<td>Immediate</td>
<td>Medium</td>
<td>Low-High</td>
<td>Long</td>
</tr>
<tr>
<td>Toe Drains</td>
<td>High</td>
<td>Immediate</td>
<td>Medium</td>
<td>Medium</td>
<td>Medium</td>
</tr>
<tr>
<td>Detention Basin</td>
<td>High</td>
<td>Immediate</td>
<td>High</td>
<td>High</td>
<td>Medium-Long</td>
</tr>
<tr>
<td>Silt Fence</td>
<td>Medium</td>
<td>Immediate</td>
<td>Medium</td>
<td>Low</td>
<td>Short-Medium</td>
</tr>
<tr>
<td>Straw Roll/bale</td>
<td>Medium</td>
<td>Immediate</td>
<td>High</td>
<td>Low</td>
<td>Short</td>
</tr>
<tr>
<td>Removal</td>
<td>High</td>
<td>Immediate</td>
<td>Low</td>
<td>High</td>
<td>Long</td>
</tr>
</tbody>
</table>

Note: The actual cost, load reduction, or life expectancy of any treatment is dependant on site specific conditions. The terms used in this table express relative differences between treatments to assist users in evaluating potential alternatives. Only after a site-specific evaluation can these factors be quantified more rigorously.

Inventory of Existing Abandoned Mines:

All existing abandoned mines are not equal sources for elevated concentrations of metals. One of the difficulties in developing this assessment is the lack of thorough and centralized data on abandoned mine sites. Some of the mapped abandoned mine sites are prospector claims with limited land disturbance, while others are remote and disconnected from natural drainage features and represent a low risk pollutant source.

At sites where water and oxygen are in contact with waste rock containing sulfates, sulfuric acid is formed. As the water becomes more acidic, metals are leached from the soils and rock, generating toxic concentrations of heavy metals in the water. Acid rock drainage, also known as acid mine drainage, can be a significant water quality concern. Management of this important source of watershed impairment begins with compiling available information from the responsible agencies. Once located, an onsite inventory should be conducted to clarify the degree of risk the site exhibits towards discharging elevated concentrations of metals to a water body.
Risk factors, such as: area of and volume of waste/tailings; metal species present and toxicity; site drainage features and metal transport characteristics (air dispersion, sediment transport, acid mine drainage, etc.); distance to a water body; and evidence of active site erosion, should be assessed. Abandoned mine sites can then be ranked and prioritized for site management and restoration.

Revegetation:

Revegetation of the mine site is the only long-term, low maintenance restoration alternative in the absence of funding to install engineered site containment and capping. In semiarid environments, revegetation of a disturbed site is relatively difficult even under optimal conditions. The amount of effort that is required to revegetate an abandoned mine site depends on the chemical composition of the mine waste/tailings, which may be too toxic to sustain growth.

The addition of soil amendments, buffering agents, or capping with top soil to sustain vegetation often approaches the costs associated with engineered capping. If acid mine drainage is a significant concern, intercepting and managing the acidic water may necessitate extensive site drainage control systems and water treatment, a significant increase in cost and requiring on-going site operation and maintenance.

Erosion Control:

If revegetation is impractical, site drainage and erosion control treatments are alternatives. Erosion control actions can also be applied in combination with revegetation to control erosion as the vegetation cover is established. Erosion control fabric and plant mulch are two short-term erosion treatments that are usually applied in combination with revegetation.

Rock mulch (i.e. rock riprap) is a long-term treatment, but can be costly and impractical on an isolated site. Rock mulch can be an inexpensive acid buffering treatment if carbonate rocks (limestone) are locally available. As the acidic mine drainage comes in contact with the rock mulch, the water loses its acidity and dissolved metals precipitate out of the water column.

A disadvantage of erosion control treatments is that they do not assist in dewatering a site and may have little impact on subsurface acidic leaching.
Runoff and Sediment Capture:

The capture and containment of site runoff and sediment, and prevention of the waste rock and tailings from contact with a water body are other management approaches. Short-term treatments include installing straw roll/bale or silt fence barriers at the toe of the source area to capture sediment.

A long-term treatment includes trenching the toe of the source area to capture the runoff and sediment. If the source area is large, the construction of a detention basin may be warranted.

Disadvantages of runoff and sediment capture and containment treatments are that they may concentrate the contaminated material, especially if dissolved metals are concentrated by evaporation in retention ponds. Structural failure can lead to downstream transport of pollutants. The retention/detention of site runoff can also escalate subsurface drainage problems by ponding water.

Removal:

The mine waste/tailing material can be excavated and removed. This treatment is very expensive and infeasible for some sites due to lack of accessibility.

Education:

Land use decision makers and stakeholders need to be educated on the problems associated with abandoned mines and the available treatments to mitigate the problems. In addition, abandoned mine sites are health and safety concerns and the public should be warned about entering open shafts that may collapse, or traversing unstable slopes. Due to the financial liability associated with site restoration, the legal and regulatory constraints must also be addressed.

The target audiences for education programs are private land owners, watershed groups, local officials, and land management agencies (U.S. Forest Service, Bureau of Land Management, Tribal entities).
Figure 7-1 identifies land ownership across the 10-digit HUCs. Table 7-2 provides a listing of percentage of land ownership as distributed across the subwatershed areas. This table provides a basis from which to identify stakeholders pertinent to each subwatershed area, and is repeated here in more detail than the brief discussion of land ownership in Section 4, Social and Economic Characteristics of the watershed.

Note that recommendations for those subwatersheds owned by tribal groups are not provided in this document.

Subwatershed areas prioritized for educational outreach on problems associated with abandoned mines include Alamo Lake, Boulder Creek, Upper Big Sand River, Lower Burro Creek, Upper Santa Maria River, and Kirkland Creek.
Figure 7-1: Bill Williams Watershed Land Ownership by Subwatershed
Table 7-2: Percentage Land Ownership by Subwatershed in the Bill Williams Watershed.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
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<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
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<td>0.00</td>
<td>0.00</td>
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<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
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<td>Upper Burro Creek</td>
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<td>0.00</td>
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<td>Middle Big Sandy River</td>
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<td>84.36</td>
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<td>0.00</td>
<td>0.00</td>
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<td>Lower Burro Creek</td>
<td>13.47</td>
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<td>0.00</td>
<td>0.00</td>
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<td>Mohave Wash</td>
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<td>0.00</td>
<td>0.00</td>
<td>0.04</td>
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<td>Upper Santa Maria River</td>
<td>5.88</td>
<td>71.40</td>
<td>22.72</td>
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<td>Lower Big Sandy River</td>
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<td>0.00</td>
<td>0.00</td>
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<td>Kirkland Creek</td>
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<td>45.89</td>
<td>3.30</td>
<td>18.29</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.06</td>
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<td>Castaneda Wash(3)</td>
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<td>0.18</td>
<td>80.27</td>
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<td>0.62</td>
<td>2.90</td>
<td>0.00</td>
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<td>Alamo Lake</td>
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<td>88.09</td>
<td>4.93</td>
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<td>0.00</td>
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<tr>
<td>Lower Santa Maria River</td>
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<td>47.01</td>
<td>1.24</td>
<td>0.00</td>
<td>0.00</td>
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<td>Date Creek</td>
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<td>40.11</td>
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<td>0.00</td>
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<td>Bullard Wash</td>
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<td>22.60</td>
<td>76.23</td>
<td>0.72</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
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<tr>
<td>Percentage of Bill Williams</td>
<td>26.32</td>
<td>28.07</td>
<td>39.77</td>
<td>5.10</td>
<td>0.48</td>
<td>0.08</td>
<td>0.14</td>
<td>0.02</td>
</tr>
</tbody>
</table>

(1) Non-Federally designated Indian Tribal land allotments.

(2) Federally designated Indian Tribal lands (Reservations) comprise 0.03% of the Upper Big Sandy River subwatershed, representing less than 0.001% of the overall Bill Williams Watershed.

(3) Bureau of Reclamation owns 0.28% of the Castaneda Wash – Bill Williams River, for a total of 0.01% of the Bill Williams Watershed area.
Boulder Creek TMDL Implementation Plan:

Boulder Creek is a 37 mile intermittent waterway that drains seasonal precipitation from its headwaters near Camp Wood Mountain, 7,000 feet above mean sea level, to its confluence with Burro Creek at 2,460 feet. It is delineated within the 10-digit HUC Boulder Creek subwatershed.


ADEQ has concluded that historic mining within Boulder Creek's watershed has impaired the intermittent waterway from Wilder to Burro Creek. The plan defines an action strategy to implement cleanup of the four main sources of pollution defined by ADEQ's TMDL report: three tailings piles and an adit discharge from the Hillside Mine.

A TMDL is comprised of the sum of individual waste load allocations within the receiving water body for point sources, load allocations for nonpoint sources, and natural background levels. An adit is a horizontal mine shaft that usually is used for mine dewatering. The three tailings piles are located on land owned by the Bureau of Land management (BLM), a private owner, and the State of Arizona.

Using TMDL endpoints calculated specifically for the impaired reach, Boulder Creek has been identified as an impaired surface water due to excessive amounts of arsenic, copper, and zinc due to historic metal mining from the Hillside Mine. TMDL endpoints are precise values calculated as a reasonable goal for the surface water. TMDL endpoints represent the in-stream water quality targets, and different TMDL endpoints are necessary for each parameter.

The Boulder Creek TMDL implementation plan makes recommendations for the cleanup of the identified source areas. Daily load allocations for arsenic, copper, and zinc have been reported by ADEQ (ADEQ, 2004).

The process of selecting management measures for Boulder Creek was a collaborative effort among stakeholders, including state agencies, local land owners, and Phelps Dodge (the active mining company near the Bagdad area). BLM conducted their own research and hired an engineering consultant to identify and design solutions towards restoring surface water quality located on BLM land. Proposed management measures, anticipated load reductions, measurable milestones, and costs of implementation of selected measures are included in the TMDL Implementation Plan (ADEQ, 2004).
Sediment

Erosion and sedimentation are major environment problems in the western United States, including the Bill Williams Watershed. In semiarid regions, the primary source of sediment is from channel scour. Excessive channel scour and down-cutting can lead to deterioration of the extent and condition of a riparian system. Increases in channel scour are caused by increased surface runoff produced by changing watershed conditions. Restoration of impaired channel riparian systems can also mitigate erosion damage.

The primary land uses in the Bill Williams Watershed that can contribute to sediment erosion are livestock grazing and mining. Development is also increasing in some areas, notably the Kirkland Watershed. The increase in impervious land surface associated with development accelerates surface runoff, increases flow velocity, and exacerbates channel scour. Dirt roads, a common feature in the watershed, can also be an important source of sediment. The recommended sediment management actions (see Table 7-3) are:

- Grazing Management
- Filter Strips
- Fencing
- Watering Facilities
- Rock Riprap
- Erosion Control Fabrics
- Toe Rock
- Water Bars
- Erosion Control on Dirt Roads
- Channel and Riparian Restoration
- Education

Grazing Management:

Livestock grazing is currently the primary land use in the Bill Williams Watershed. Implementing grazing management practices to improve or maintain the health and vigor of plant communities will lead to reductions in surface runoff and erosion. Sustainable livestock grazing can be achieved in all plant communities by changing the duration, frequency and intensity of grazing.

Management may include exclusion of the land from grazing, seasonal rotation, rest, or some combination of these options. Proper grazing land management provides for a healthy riparian plant community that stabilizes stream banks, creates habitat and slows flood velocities.

Filter Strips:

Creating a filter strip along a waterbody will retard the movement of sediment into the waterbody, and may remove pollutants from runoff before the material enters the body of water. Filter strips will reduce sedimentation of streams, lakes and other bodies of water, and protect channel and riparian systems from livestock grazing and trampling. Fencing the filter strip is usually required when livestock are present. Filter strips and fencing can be used to protect other sensitive ecological resources.

Fencing:

Restricting access to riparian corridors by fencing will allow for the
reestablishment of riparian vegetation.
Straw bale fencing slows runoff and traps sediment from sheet flow or channelized flow in areas of soil disturbance.

Table 7-3. Proposed Treatments for Addressing Erosion and Sedimentation.

<table>
<thead>
<tr>
<th>Action</th>
<th>Load Reduction Potential</th>
<th>Estimated Time Load Reduction</th>
<th>Expected Maintenance</th>
<th>Expected Cost</th>
<th>Estimated Life of Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grazing Mgt.</td>
<td>Medium</td>
<td>&lt; 2 years</td>
<td>Low</td>
<td>Low</td>
<td>Long</td>
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<td>Filter Strips</td>
<td>High</td>
<td>&lt; 2 years</td>
<td>Low</td>
<td>Low</td>
<td>Long</td>
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<td>Fencing</td>
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<td>Low</td>
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<tr>
<td>Watering Facility</td>
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<td>Medium</td>
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<td>Rock Riprap</td>
<td>High</td>
<td>Immediate</td>
<td>Medium</td>
<td>Medium-High</td>
<td>Long</td>
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<td>Erosion Control Fabric</td>
<td>High</td>
<td>Immediate</td>
<td>Low</td>
<td>Low-Medium</td>
<td>Short</td>
</tr>
<tr>
<td>Toe Rock</td>
<td>High</td>
<td>Immediate</td>
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<td>Medium</td>
<td>Long</td>
</tr>
<tr>
<td>Water Bars</td>
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<td>Immediate</td>
<td>Medium</td>
<td>Medium</td>
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</tr>
<tr>
<td>Road Surface</td>
<td>High</td>
<td>Immediate</td>
<td>Medium</td>
<td>High</td>
<td>Long</td>
</tr>
</tbody>
</table>

Note: The actual cost, load reduction, or life expectancy of any treatment is dependant on site specific conditions. Low costs could range from nominal to $10,000, medium costs could range between $5,000 and $50,000, and high costs could be anything greater than $25,000. The terms used in this table express relative differences between treatments to assist users in evaluating potential alternatives. Only after a site-specific evaluation can these factors be quantified more rigorously.

Watering Facilities:

Alternative watering facilities, such as a tank, trough, or other watertight container at a location removed from the waterbody, can provide animal access to water and protect and enhance vegetative cover, provide erosion control through better management of grazing stock and wildlife, and protect streams, ponds and water supplies from biological contamination. Providing alternative water sources is usually required when creating filter strips.

Rock Riprap:

Large diameter rock riprap reduces erosion when installed along stream channels and in areas subject to head cutting. Regrading may be necessary.
before placing the rocks, boulders or coarse stones.

Erosion Control Fabric:

Geotextile filter fabrics reduce the potential for soil erosion as well as volunteer (weed) vegetation, and are often installed beneath rock riprap.

Toe Rock:

Placement of rock and riprap along the toe of soil slopes reduces erosion and increases slope stability.

Water Bars:

A water bar is a shallow trench with mounding long the down-slope edge that intercepts and redirects runoff water in areas of soil disturbance (tailings piles, dirt roads).

Erosion Control on Dirt Roads:

In collaboration with responsible parties, implement runoff and erosion control treatments on dirt roads and other disturbed areas. Dirt roads can contribute significant quantities of runoff and sediment if not properly constructed and managed. Water bars and surfacing are potential treatments. If a road is adjacent to a stream, engineered road stabilization treatments may be necessary.

The stabilization of roads and other embankments reduces sediment inputs from erosion and protects the related infrastructure. Traditional stabilization relied on expensive rock (riprap) treatments. Other options are available including the use of erosion control fabric, toe rock, and revegetation to stabilize banks.

Channel and Riparian Restoration:

Restoration or reconstruction of a stream reach is used when it has approached or crossed a threshold of stability from which natural recovery may take too long or be unachievable. This practice significantly reduces sediment input to a system and will promote the riparian recovery process. Channel and riparian restoration will be discussed in more detail below.
Education:

Education programs should be developed to address the impact of livestock grazing and promote the implementation of erosion control treatments. In the Kirkland Creek Watershed, education programs should address stormwater management from land development and target citizen groups, developers, and watershed partnerships.

Subwatershed areas prioritized for educational outreach to address erosion control include Kirkland Creek, Boulder Creek and Sycamore Creek.

Organics

At several locations within the Bill Williams Watershed, water quality problems associated with the introduction of animal waste were observed. The two primary sources of animal waste in the Bill Williams Watershed are livestock grazing in riparian areas and failing septic systems. The failure of residential septic systems is an issue in both the Kirkland Creek and Burro Creek Watersheds. Livestock grazing is common across the entire watershed. The recommended actions (Table 7-4) are:

- Filter Strips
- Fencing
- Watering Facilities
- Septic System Repair
- Education

Filter Strips:

Creating a filter strip along a water body will reduce and may remove pollutants from runoff before the material enters a body of water. Filter strips have been found to be very effective in removing animal waste due to livestock grazing, allowing the organics to bio-attenuate (i.e. be used by the plants) and degrade. Fencing the filter strip is usually required when livestock are present.

Table 7-4. Proposed Treatments for Addressing Organics.

<table>
<thead>
<tr>
<th>Action</th>
<th>Load Reduction Potential</th>
<th>Estimated Time Load Reduction</th>
<th>Expected Maintenance</th>
<th>Expected Cost</th>
<th>Estimated Life of Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Filter Strips</td>
<td>High</td>
<td>&lt; 2 years</td>
<td>Low</td>
<td>Low</td>
<td>Long</td>
</tr>
<tr>
<td>Fencing</td>
<td>Low</td>
<td>Immediate</td>
<td>Low</td>
<td>Low</td>
<td>Medium</td>
</tr>
<tr>
<td>Watering Facility</td>
<td>Medium</td>
<td>Immediate</td>
<td>Low</td>
<td>Low-Medium</td>
<td>Medium</td>
</tr>
<tr>
<td>Septic System Repair</td>
<td>High</td>
<td>Medium</td>
<td>High</td>
<td>High</td>
<td>Medium</td>
</tr>
</tbody>
</table>

Note: The actual cost, load reduction, or life expectancy of any treatment is dependant on site specific conditions. Low costs could range from nominal to $10,000, medium costs could range between $5,000 and $20,000, and high costs could be anything greater than $15,000. The terms used in this table express relative differences between treatments to assist users in evaluating potential alternatives. Only after a site-specific evaluation can these factors be quantified more rigorously.
Fencing:

Restricting access to riparian corridors by fencing will allow for the reestablishment of riparian vegetation. Straw bale fencing slows runoff and traps organics from sheet flow or channelized flow in areas of soil disturbance.

Watering Facilities:

Alternative watering facilities, such as a tank, trough, or other watertight container at a location removed from the waterbody, can provide animal access to water and protect streams, ponds and water supplies from biological contamination by grazing cattle. Providing alternative water sources is usually required when creating filter strips.

Septic System Repair:

One of the difficulties in assessing the impact of failing septic systems to streams is the lack of thorough and centralized data on septic systems. Although it can be assumed that residential development in areas not served by sanitary sewers will rely on private, on-site septic systems, the status of the systems are usually unknown until failure is obvious to the home owner.

Currently, the construction of new septic systems requires a permit from ADEQ in the State of Arizona (some exemptions apply). In addition, ADEQ requires that the septic system be inspected when a property is sold if it was originally approved for use on or after Jan. 1, 2001 by ADEQ or a delegated county agency. This is to help selling and buying property owners understand the physical and operational condition of the septic system serving the home or business. The ADEQ website http://www.azdeq.gov/environ/water/permits/wastewater.html contains more information on permitting septic systems.

Although not required by ADEQ, older septic systems should be inspected when purchasing a home with an existing system.

At a minimum, conduct an inventory of locations where private septic systems occur to clarify the degree of risk a stream reach may exhibit due to failure of these systems. Risk factors can be assessed with GIS mapping tools, such as: proximity to a waterbody, soil type, depth to the water table, and density of development. Septic system sites can then be ranked and prioritized for further evaluation.

Education:

Develop education programs to address the impact of livestock grazing and promote the implementation of filter strips and alternative watering facilities.

Education programs should also be developed on residential septic system maintenance. These programs should promote septic tank inspections and certification of septic systems by local municipalities or government entities.

Subwatershed areas that are prioritized for educational outreach to address organics include Knight Creek, Upper Santa Maria River and Kirkland Creek.
Selenium

Selenium occurs naturally in the environment; however, it can enter groundwater or surface water from hazardous waste-sites or irrigated farmland. The recommended action for the management of selenium is to avoid flood irrigation of croplands, and install a mechanized irrigation system.

Mechanized irrigation systems include center pivot, linear move, gated pipe, wheelline or drip irrigation. Based on a 1998 study, (Hoffman and Willett, 1998) costs range from a low of $340 per acre for the PVC gated pipe to a high of $1,095 per acre for the linear move. The center pivot cost per acre is $550, and wheelline is $805 per acre.

Education:

Develop educational programs that explain the sources of selenium, and illustrate the various alternative irrigation systems.

Strategy for Channel and Riparian Protection and Restoration

Riparian areas are one of the most critical resources in the Bill Williams Watershed. Healthy riparian areas stabilize stream banks, decrease channel erosion and sedimentation, remove pollutants from surface runoff, create wildlife habitat, slow flood velocities, promote aquifer recharge, and provide recreational opportunities.

As ground water resources are tapped for water supply, many riparian areas across the watershed are in danger of being dewatered as the water table drops below the base of the stream channel. A large portion of the riparian systems in the Bill Williams Watershed are managed by federal agencies, principally the Bureau of Land Management and U.S. Fish and Wildlife Service. In cooperation with responsible management agencies, riparian protection and restoration efforts should be implemented across the watershed.

The creation of filter strips should be considered surrounding all important water bodies and riparian systems within the four natural resource areas, including: the extensive riparian forests of the Lower Bill Williams Natural Resource Area; the perennial stream of the Upper Burro Creek Wilderness; the Trout Creek perennial stream that support an intact riparian area; and the Kirkland Creek riparian environment. This will require fencing and, in many cases, providing alternative water sources for livestock and wildlife. Riparian areas have been an important source of forage for most livestock growers, but to protect these delicate ecosystems, low impact riparian grazing systems should be developed and applied where feasible.

In impaired stream reaches restoration treatments may be necessary. Treatments may involve engineered channel re-alignment, grade control and bank stabilization structures and a variety of revegetation and other bioengineering practices.

Additional information will need to be collected on the existing impairment of stream reaches and riparian areas to better understand which stream segments should be prioritized for
restoration projects. Data needs include:

- Studying the existing stream corridor structure, function and disturbances.
- Determining the natural stream conditions before disturbance. This entails identifying a “reference site” that illustrates the potential pristine stream conditions.
- Identifying the causes for the impairment and restoration alternatives.
- Identifying stream reaches that have a high potential to successfully respond to restoration treatments.

This watershed classifications is one method used to identify stream impairment and restoration alternatives, but other data needs may also include identifying important issues, examining historic conditions, evaluating present conditions and processes, and determining the effects of human activities. It can mean describing the parts and processes of the whole watershed and analyzing their functions in general, or relative to some standard (such as a water quality standard or historic condition). It also can mean focusing on particular concerns about human activities, conditions, or processes in the watershed.

Stream and riparian restoration projects are costly and should be viewed as a long-term endeavor. Stream and riparian restoration projects cannot be conducted in isolation from other watershed activities. If the root cause of channel and riparian impairment is upstream watershed conditions, onsite restoration efforts are likely to fail unless the overall watershed conditions are also improved. This requires an integrated approach that crosses the entire watershed.

Citizen groups also have a role in the restoration efforts. Volunteers can be used in the tree planting and seeding treatments, and can also be used for grade control and bank stabilization construction.

Education programs, such as ‘Adopt A Stream’, should be developed to encourage public understanding of the importance of maintaining natural riparian systems and restoration of degraded streams.

Education Programs

The education effort will be partly conducted by the Arizona Nonpoint Education of Municipal Officials (NEMO) program. Arizona NEMO works through the University of Arizona Cooperative Extension Service, in partnership with the Arizona Department of Environmental Quality (ADEQ) Water Quality Division, and the Water Resources Research Center. The goal of Arizona NEMO is to educate land use decision-makers to take voluntary actions that will mitigate nonpoint source pollution and protect our natural resources.
Education Needs

Education programs need to be developed for land use decision makers and stakeholders that will address the various sources of water quality degradation and present management options. The key sources of concern for educational programs are:

- Abandoned Mines (control of runoff and sediment)
- Grazing Management (erosion control treatments and riparian area protection)
- Streamside Protection (filter strips and alternative watering facilities)
- Riparian Management (erosion control, grazing management)
- Septic Systems (residential septic system maintenance, licensing and inspection programs)
- Stormwater Management (control of stormwater runoff from urbanized and developing areas)
- Water Conservation (for private residents and to prevent dewatering of natural stream flow and riparian areas)

Targeted Audiences:

The target audiences will include developers, private land owners, livestock growers, home owners and citizen groups. Several programs, including those addressing septic systems, stormwater management, and water conservation, will target the Kirkland Watershed, the fastest growing area in the Bill Williams Watershed. Development of an ‘Adopt a Stream’ Program will be considered.

References:


**Data Sources**:  
Arizona State Land Department, Arizona Land Resource Information System (ALRIS), http://www.land.state.az.us/alris/index.html  

*Note: Dates for each data set refer to when data was downloaded from the website. Metadata (information about how and when the GIS data were created) is available from the website in most cases. Metadata includes the original source of the data, when it was created, its geographic projection and scale, the name(s) of the contact person and/or organization, and general description of the data.