Executive Summary

for the

Big Goose Creek Diversion
(Sheridan Raw Water
Intake Facilities)
Level II

November 1999

Prepared for:

Wyoming Water Development Commission

Prepared by:

MSE-HKM, Inc.
Sheridan, Wyoming
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Prepared for:
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Herschler Building, 4th Floor-West
122 W. 25th Street
Cheyenne, WY 82002

Prepared by:
MSE-HKM
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INTRODUCTION

PURPOSE OF STUDY

This Executive Summary of the Final Report for the City of Sheridan Big Goose Creek Diversion Facilities provides background information, analysis of existing facilities, recommendations, and cost estimates pertinent to the proposed improvement plan. The Final Report should be referred to for additional information not included in this summary.

This Level II Study will:

1. Determine diversion requirements to meet the water supply needs of the Sheridan Area Water Supply Joint Powers Board’s Big Goose Water Treatment Plant (BGWTP), Sheridan Water Treatment Plant (SWTP) and the other facilities that are served by this site,
2. Inventory and assess existing City and Joint Powers Board water rights,
3. Evaluate water quality, water yield and the condition of the existing City of Sheridan Big Goose Creek diversion facilities,
4. Evaluate diversion facility expansion alternatives,
5. Prepare conceptual level designs and cost estimates for the enlargement,
6. Complete an economic study and ability to pay analysis, and
7. Determine permitting and environmental constraints.

This report provides the Wyoming Water Development Commission (WWDC) and the City of Sheridan the results of this investigation. These results include not only recommended new facilities needed to address the above items, but modifications to existing facilities which will be beneficial to the long-term operation of this site. Improvements are required to expand the capacity of the existing facilities to meet 25-year diversion estimates, including supplying the recently constructed BGWTP and expanded SWTP.

This report also provides a proposed implementation plan, as well as background information used to develop the recommendations. Cost estimates and an economic evaluation are included. It is intended this report be used to allow this project to proceed into Level III in the year 2000. However, construction is not expected to take place until 2001 at the earliest.

AUTHORIZATION

The Sheridan Big Goose Creek Diversion Level II Study was authorized by the WWDC in a contract with MSE-HKM, Inc. of Sheridan, Wyoming dated June 4, 1998. The contract authorizes two phases for this project (Phase I-Analysis of Alternatives and Phase II-Conceptual Design and Cost Estimates). The Study is to be completed by November 1, 1999. CH2MHILL of Denver, Colorado was a subconsultant that assisted with the evaluation of alternatives for the new facilities.

PROJECT LOCATION

The existing site is located approximately 12 miles southwest of Sheridan on Big Goose Creek at the edge of the Big Horn Mountains. This site is near the center of Section 35, T55N, R86W. A layout of the site is shown in Figure 1.
FACILITIES

The existing facilities at this diversion site are shown in Figure 1 at the back of this Executive Summary. These facilities include the following elements:

- Diversion Dam
- Bar screen and inlet baffle
- Sand trap channel
- Two 24-inch pipelines to the debris removal facilities
- Three flow paths for debris removal
  - traveling screen and presedimentation basin (primary path)
  - microstrainer (secondary path)
  - manual screening facility (emergency path)
- SCADA monitoring of flows, turbidity and certain water levels
- Electrically operated throttling valves connected to the SCADA system, and isolation valves
- Metering of flows
- 70 kW emergency power generator
- Original diversion dam, presedimentation basin and 12-inch piping through site
- Waste flow facilities from basins (returned to creek)
- Support buildings such as house (office), garage and storage building (generator building)

This site diverts raw water from Big Goose Creek, provides some debris removal of naturally occurring debris such as twigs, pine cones, leaves, sand and sediment, and delivers the water to three raw water transmission mains (RWTMs) which take the water to four usage points. These points are:

- Big Goose Water Treatment Plant (capacity 4.5 million gallons per day (mgd))
- Sheridan Water Treatment Plant (capacity 14.0 mgd)
- Veterans Affairs Medical Center (VAMC) Water Treatment Plant and irrigation system (capacity 1.9 mgd)
- Kendrick Golf Course for irrigation and fire flows (capacity 2.5 mgd)

SITE HISTORY

The development of this site by the City of Sheridan commenced in 1904 when the city allowed Fort McKenzie (VAMC) to use 3 cubic feet per second (cfs) of their 1882 Territorial Water Rights Appropriation to be diverted at this site for use at Fort McKenzie. A diversion facility and pipeline to Fort McKenzie was constructed for this purpose. The State Board of Control granted a petition on April 16, 1909 allowing the City of Sheridan to change the location of its intake to this site. This then became the primary point of diversion for the city's water supply. In 1909, a 10-inch cast iron pipeline was constructed from this location to the City of Sheridan.

In 1936, a slow sand filtration treatment plant was constructed at this site. Also constructed at that time was a second diversion dam approximately 400 feet below the original diversion dam. A new 16-inch steel pipeline was also installed to deliver treated water from this site to the city. This facility remained in service until 1966 when the water treatment plant was constructed on the west edge of Sheridan.

In 1971 the travelling screen, covered presedimentation basin and chlorination facilities were installed. Chlorination was stopped in 1993 when the BGWTP was completed. The BGWTP has provided treated water to the Big Goose Valley since that time. In 1986 the diversion dam was raised and in 1987 the microstrainer was installed to provide an increased flow capacity.
through these facilities. In 1996 the 30-inch RWTM was completed. This pipeline delivers raw water from the diversion site to the four usage points.

DESIGN FLOW

This study has a 25-year planning period. Since these facilities must pass a peak day demand for the entire water system, the design day is the peak day at the end of this 25-year period. From the 1998 Utilities Master Plan, estimated population and projected population growth were obtained. Also from the Utilities Master Plan, which considered design criteria for the Sheridan Area Water Project and actual water usage records, design criteria for peak day per capita flows were obtained. These were 690 gallons per capita per day (gpcd) for the city and 100 gpcd for the rural areas.

Water diversion records from 1995 through 1999 were examined. The peak usage at the four facilities (BGWTP, SWTP, VAWTP and Kendrick Golf Course) is summarized in Table 1.

<table>
<thead>
<tr>
<th>Year</th>
<th>BGWTP</th>
<th>SWTP</th>
<th>VAWTP</th>
<th>Kendrick</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1995</td>
<td>1.2</td>
<td>9.4</td>
<td>--</td>
<td>--</td>
<td>10.6</td>
</tr>
<tr>
<td>1996</td>
<td>1.4</td>
<td>8.8</td>
<td>1.7</td>
<td>--</td>
<td>11.9</td>
</tr>
<tr>
<td>1997</td>
<td>1.3</td>
<td>7.8</td>
<td>1.6</td>
<td>1.2</td>
<td>11.9</td>
</tr>
<tr>
<td>1998</td>
<td>1.9</td>
<td>9.1</td>
<td>1.1</td>
<td>1.4</td>
<td>13.5</td>
</tr>
<tr>
<td>1999</td>
<td>2.2</td>
<td>9.0</td>
<td>1.1</td>
<td>1.2</td>
<td>13.5</td>
</tr>
<tr>
<td>Average</td>
<td>1.6</td>
<td>8.8</td>
<td>1.4</td>
<td>1.3</td>
<td>13.0</td>
</tr>
</tbody>
</table>

Based on the above peak demand records and the population projections, the design flow requirements for the Sheridan Regional Water System (does not include VAWTP or Kendrick Golf Course) is shown in Table 2.

<table>
<thead>
<tr>
<th>Item</th>
<th>City of Sheridan</th>
<th>Rural Areas</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1998 population</td>
<td>15,325</td>
<td>3,175</td>
<td>18,500</td>
</tr>
<tr>
<td>2025 population</td>
<td>26,158</td>
<td>5,419</td>
<td>31,577</td>
</tr>
<tr>
<td>Per capita demand</td>
<td>690 gpcd</td>
<td>100 gpcd</td>
<td>590 gpcd (average)</td>
</tr>
<tr>
<td>Total design flow</td>
<td>18.1 MGD</td>
<td>0.5 MGD</td>
<td>18.6 MGD</td>
</tr>
</tbody>
</table>

Based on historical usage and projected needs, the design flow for the VAMC and Kendrick Golf Course are 1.9 and 2.0 mgd respectively. This results in a total flow requirement for the 25-year planning period of approximately 23 mgd.

Since this is a constrained site and this project will utilize almost all of the available area, a more conservative design flow of 25 mgd (17,000 gpm or 39 cfs) will be used for this project.
WATER RIGHTS

City of Sheridan water rights for this location date back to 1904 when a portion of the city's 1882 territorial rights were transferred to this site for supplying Fort McKenzie, and then in 1909 when the city's water right was also transferred to this location. One of the more significant issues relating to the city water rights took place in 1995 when three agricultural irrigators filed a petition seeking to abandon 4.5 cfs of the city's territorial right. The State Board of Control issued an order in February 1997 which clarified this issue and also some questions concerning the city's water rights. The details of that order may be referred to in Section 3.7 of the city's 1998 Utilities Master Plan. This order includes confirmation that the city may divert their entire 16.0 cfs territorial appropriation at this location during the period of October 1 to April 30 each year. During the period of May 1 to September 30 when Big Goose Creek is under non-surplus conditions the city (together with the VAMC) may not take more than 13.0 cfs, with the remaining 3.0 cfs taken at an alternate diversion point downstream.

Additional water supply requirements are met by releasing stored water from the newly constructed Twin Lakes Reservoir or one of the reservoirs where the Sheridan Area Water Supply Joint Powers Board holds a stored right (Park, Dome and Sawmill). Therefore, the City of Sheridan has adequate water rights to support the proposed improvements at this site including the expansion of its capacity.

EXISTING FACILITIES

REVIEW OF EXISTING FACILITIES

A detailed review of existing facilities is included in the Final Report. Figure 1 shows the location of most of these facilities. A brief description of these facilities is given below.

Original Diversion Dam. The original dam was constructed in 1909. It diverts water to a small presedimentation basin that connects to a 12-inch pipeline which then connects into other facilities at this site. These original facilities are important for emergency use and to provide higher pressure for the site as the original diversion dam is located upstream from the primary diversion dam. These facilities should remain in service as they currently exist.

Primary Diversion Dam. This diversion dam was originally constructed in 1936 and raised in 1986. It is keyed into the limestone bedrock and appears to be in very good condition. Its capacity is acceptable for the design. Therefore, no improvements are proposed.

Baffle and Bar Screen. The baffle and bar screen are located adjacent to the south bank of the creek immediately above the diversion dam. These facilities are also in acceptable condition with adequate capacity, therefore they will not be modified by the improvement project.

Sand Trap Channel. The sand trap channel is designed to remove the courser sand which is carried along the bed of the creek, prior to the water entering the pipelines. The north wall of the sand trap channel is in very poor condition and the channel is not very effective in removing the bed load carried by the creek. The north wall will need to be reconstructed and improvements will be made in its configuration for enhanced sand removal.

24-inch Pipelines. Two 24-inch steel pipelines deliver the water from the sand trap channel to the debris removal facilities to the east. These pipelines are believed to be in good condition, however they have an internal roughness which reduces their capacity below what would normally be expected for this age of pipe. The combined capacity of these pipelines is
insufficient for the planning period, therefore it is recommended to upgrade one of these lines to 36-inch.

Site Piping and Valves. Site piping consists of various cast iron and ductile iron pipelines and primarily butterfly isolation valves, installed under many projects over the past 90 years. Generally it is believed these are in good condition and they will not be replaced except as necessary to accommodate the new facilities. The northern pipeline leads into a manual screening facility which will remain in service as an emergency backup. Three electrically operated butterfly valves are connected to the SCADA system for monitoring their position and adjustment as necessary to control flows. This type of flow control will continue with the new facilities.

Traveling Screen. The traveling screen is located in a brick building and was installed in 1971. This 3/8-inch mesh screen is intended to remove larger floating debris such as pine cones, twigs, bark, leaves and the like. While the screen is in generally good condition, replacement of worn parts is recommended once the new primary flow path is on-line. It is recommended this facility remain in service to help meet peaking flows and as a backup facility.

Presedimentation Basin. The existing circular presedimentation basin was also installed in 1971. This basin is in generally good condition, with some corrosion pitting occurring on the metal facilities in the basin such as the scraper, piping and center baffle. Sediment collected at the bottom of the basin is returned to the creek. It is recommended to attach ribbon anodes to the metal components within this basin to control future corrosion. The city reports the operating flow through the travelling screen/presedimentation basin flow path is approximately 8 mgd.

Microstrainer. The microstrainer was installed in 1987 as a parallel flow path to the traveling screen/presedimentation basin. This unit has not performed very effectively and has required a high level of maintenance. It is recommended it be removed from service with the completion of the construction of the new facilities.

Auxiliary Generator. An auxiliary generator is located in the garage/storage shed adjacent to the manual screening facility. The unit is a 70 kW generator that is powered by propane which is stored at the site. The generator will automatically start itself in the event of a power outage and will provide necessary power for controls, pumps and other electrical facilities at the site. There are no reported problems associated with this generating system.

Metering/SCADA. Metering at the site consists of three propeller meters which were installed in 1996 with the 30-inch RWTM project. These meters are connected to the SCADA system so flows are automatically recorded. The meters are located in manholes at the east end of the site. The meter readings are also used to document diversions for water rights. The SCADA system is being upgraded in 1999 as part of an overall control project. Therefore no additional SCADA improvements required at the site, other than to accommodate the new facilities being constructed.

WATER QUALITY AND SEDIMENT SAMPLES

Organic debris such as leaves, twigs, pine cones can occur throughout the year, however are particularly present during spring runoff, intense rainfall events, and the fall (in the case of leaves). Inorganic bedload which consists of sand and heavier sediment is present throughout the year, however the loadings are increased as flow in the creek increases. Runoff events have the principal influence on turbidity and suspended solids throughout the water column in the creek. The debris removal facilities (travelling screen and presedimentation basin) are
essential to reducing the debris reaching the raw water transmission mains throughout the year. 
Even though at times the turbidity levels in the creek are very low, the amount organic and 
inorganic materials entering these pipelines must be minimized.

Several sediment samples were collected at various locations throughout the facilities during the 
1998 fall cleaning. The particle size analysis of these samples, as well as the water quality 
samples collected, were used to select and size the proposed facilities. The capture efficiency 
of the existing facilities and the analysis of the particle size, assisted with the sizing of the new 
facilities and establishing their design criteria.

HYDRAULIC ANALYSIS

Several hydraulic runs were conducted throughout the facilities at various creek level conditions. 
Actual runs where flow and pressure data were gathered were used because of the complex 
nature of the hydraulics at this site, which includes many pipelines, automatic throttling valves, 
debris removal facilities and alternate flow paths. Friction losses in the two 24-inch pipelines 
were greater than expected. This appeared to be due to the presence of cadyss fly larvae hatch 
sites being attached to the inside of the pipeline. The results of these flow tests are included in 
the Final Report. A summary of conclusions resulting from these flow tests include:

> Peak flows through the various flow paths and the facility as a whole were estimated.
> A rating curve was developed for the diversion dam and inlet. It was determined these 
facilities had sufficient capacity for the expansion.
> The friction factor for the existing pipelines was calculated. This was used in the analysis of 
system capacity.
> One of the two 24-inch pipelines leading from the sand trap channel must be increased to 
36-inch.
> Several flow controls (restrictions) were identified. These must be taken into account as the 
new facilities are designed.
> It is recommended to raise the weir in the travelling screen basin by 0.3 feet. This should 
increase the capacity of this flow path to at least 10 mgd.
> The size of the piping and debris removal facilities for the new primary flow path should be 
in the 15 to 16 mgd range.

PRVS ON THE 30-INCH RWTM

Also considered in this study were the pressure reducing valves (PRVs) on the 30-inch RWTM. 
These valves are housed in two vaults, the Beckton vault and the SWTP vault. Each vault 
consists of three Roll Seal PRVs. Cone screens are located ahead of these valves to keep 
debris out of them. Maintenance required on these PRVs has been more than anticipated at 
times due to debris passing through the facilities at the diversion site, and plugging the cone 
screens. The cone screens require periodic backflushing. The frequency of the backflushing 
depends on the debris level in the creek, the rate of flow through the pipeline, and the facilities 
being used at the diversion site to remove debris.

Several options were reviewed for these valves and modifications to these vaults. Current 
operational procedures and these options were discussed with the City Maintenance Foreman. 
Based on the analysis of options, it is recommended to maintain the use of the existing Roll 
Seal valves but modify appurtenances within the vaults to better facilitate the maintenance. The 
proposed modifications include replacing four gate valves in the high pressure Beckton vault 
with plug valves, and installing a pump in the SWTP vault to increase the back-pressure 
available to backwash the cone screens in that location.
DISCHARGE PERMIT ISSUES

The city has a discharge permit for this site which was recently reissued by the state Department of Environmental Quality (DEQ). The current permit is good through January 31, 2004. This permit and potentially more stringent future regulations were discussed with Leah Kraft, permits coordinator for DEQ. The current permit for these facilities only addresses suspended solids. The monthly average for total suspended solids (TSS) is 30 mg/L. It also allows a weekly average of 45 mg/L and a daily maximum of 90 mg/L. The permit states there can be no discharge of floating solids, sheen, or water containing a chlorine residual. The discharge also cannot cause formation of visible deposits on the bottom of the creek.

Big Goose Creek is a Class 2 stream. The classification is unlikely to change according to Ms. Kraft. If it did change to Class 1, existing permits would be grandfathered, based on current Class 2 loading calculations. Total maximum daily load (TMDL) issues were reportedly not a factor in possible future changes to the permit. Volume is also not a factor, should the facilities expand and the quantity of discharge back to the creek increase. The only issue is concentration of TSS in the discharge. If the type of discharge changed with new facilities, that change would have to be addressed.

Therefore, if the type of discharge remains the same, DEQ does not expect changes in the permit. Limits would also likely remain where they are. From 20 quarterly self-monitoring discharge reports that were examined, only one sample (second quarter 1995), exceeded the 30 mg/L standard (see Final Report).

At this time, it is believed the debris removal processes used at this site will remain basically as they are. Additional basins and screening units will be added, but they will be similar to the existing processes. Waste steams should be able to be operated and controlled similarly to current practices, with the quantity of flow increased as needed to keep concentrations within permit limits.

Discussions with city staff indicate they would much prefer not to construct any solids removal facilities (such as settling ponds) at this site to receive waste streams from the various processes. Site size and topography constraints make the locating of any ponds difficult. Based on this preference by the city and comments from DEQ on the likelihood that the discharge permit will not become more stringent in the future, it is recommended waste stream treatment facilities not be constructed as part of this project. This decision does not effect the type of debris removal processes proposed to be constructed. If it is determined at a future date that treatment of the waste streams is required, facilities can be added at that time.

GEOTECHNICAL

The log of the well drilled in 1985 at this site was reviewed to assess existing soils and depths to bedrock. Also, a second boring was made in 1999. These logs show bedrock was encountered at approximately 30 feet at the west end of the site proposed for the new basins, and 70 feet at the east end (see Figure 2). This depth will allow construction of the proposed basins without encountering bedrock. Large boulders will be encountered however, and must be removed during excavation.
PROPOSED IMPROVEMENTS

MODIFICATIONS TO EXISTING FACILITIES

The following summarizes the proposed modifications to the existing facilities. For more detail on these proposed modifications please refer to the Final Report.

1. Reconstruct the sand trap channel.
2. Pipelines. Replace the south 24-inch pipeline with a new 36-inch line and raise the road where these two pipelines are located to accommodate the increased pipe size. Use a steel pipe with 40-mil polyurethane coating and lining.
3. Travelling Screen. Replace worn parts in the 30-year old travelling screen so it is available to help meet peaking demands in the future.
4. Presedimentation Basin. Attach ribbon anodes to the metal components of this basin to control future corrosion. Also replace the valve on the drain line.
5. Microstrainer. Abandon this facility.
6. Pressure Reducing Valves. Leave the existing Roll Seal valves in place, however replace four gate valves in the Beckton vault with plug valves. Install a pump system for backwashing the cone screens in the SWTP vault. Also install a remote transmitting unit at this location to bring pressures across the cone screens and PRVs into the SCADA system.
7. Other existing facilities will remain as is.

NEW FACILITIES

The proposed new facilities will primarily consist of a new flow path to parallel the existing travelling screen/presedimentation basin. The microstrainer will be eliminated.

Based on the analysis of the particles in this raw water source, the past history of operating the travelling screen, presedimentation basin and microstrainer, an evaluation of current technologies, and discussion with city staff, the following units are proposed as the debris removal facilities in the new primary flow path. These are:

- Dual travelling screens
- Vortex grit unit
- Two rectangular presedimentation basins

The travelling screens will remove organic debris as does the existing travelling screen. This debris primarily consists of leaves, pine cones, twigs, and pieces of bark. Two travelling screens are recommended for increased flexibility in the operation. One building will be constructed with dual basins. Valving will allow both travelling screens to normally operate, however either side can be isolated if necessary. The isolation valves ahead of each unit will be manual, while the electrically operated throttling valve will be a single upstream valve. The proposed improvements are shown in Figure 2.

The vortex grit unit is proposed to remove the heavier sand and sediment which currently can pass through the pipelines and reach the basins where the velocity slows down. The vortex grit unit, which utilizes centrifugal force to remove these heavier particles, will more effectively remove them than the presedimentation basin. This should remove particles down to approximately 0.15 mm. A drain line will be connected from the hopper in the grit unit to the discharge facilities for this site.
Both circular and rectangular presedimentation basins were considered. Rectangular basins were selected because they are less expensive to construct since they share a common wall and a roof over the two longer basins, rather than two domes over circular basins. The plug flow characteristics of a long rectangular basin are also attractive. Debris removal is recommended to consist of a vacuum system which will result in a shallower basin than one with more steeply sloped floors and a sump. This will be particularly advantageous in this rocky soil. Dual travelling screens and presedimentation basins are recommended for flexibility.

SCADA points will be required on this new flow path similar to the existing travelling screen/presedimentation basin flow path. These include an electrically operated valve for throttling and water level measurements in the basins. Associated site piping and valving will be required, again as summarized in Figure 2.

As stated, the design capacity in the new facilities will be 25 mgd. The new flow path will become the primary flow path and will have a design capacity of 15 to 16 mgd while the existing travelling screen/presedimentation basin will become the supplemental flow path with a design capacity of 10 mgd.

The capacities depend on the creek level and the friction factors assumed for the pipelines. Based on an analysis of the existing facilities, it is believed the above capacities are conservative. The 24-inch bypass line north of the existing presedimentation basin will remain in service as an emergency backup and is not included in sizing considerations.

The presedimentation basin retention time will be approximately 70 minutes at the design flow rate of 16 mgd. The effective capture particle size diameter at this rate should be approximately 0.035 mm at 10°C.

PERMITTING

Site permitting primarily consists of considerations during construction. As previously discussed, it is not believed the discharge permitting for the completed facilities will change from what currently exists. Construction permitting primarily relates to requirements of the US Army Corps of Engineers and the State Department of Environmental Quality. Their permitting requirements are summarized in the Final Report.

The Corps of Engineers indicates the work will come under their Nationwide Permit, primary Permit No. 3 which relates to maintenance of existing facilities. DEQ requirements include control of construction water to minimize the impact on the adjacent creek. The contractor will need to address these permitting requirements during construction.

ECONOMIC ANALYSIS

This section presents the project cost estimates, funding plan, budgets, and considers other economic and ability to pay issues. Construction costs estimates presented are the engineer’s opinion at this time, based on the work completed under the Level II Study. As this project moves into final design, these estimates should be reviewed with adjustments made as appropriate. Table 3 presents the summary of the cost estimate on this project.
The project is proposed to be funded by the City of Sheridan and the WWDC. Other grant programs are not considered pertinent to this particular project. WWDC will fund the improvements at a 60% level while the city will provide the 40% matching share. The city has been evaluating their water rates over the last two years and has completed a detailed Cost of Service Study and also a Capital Improvement Plan. This project currently sits at the top of their priority list for capital improvements. The city's proposed rate adjustments are based on implementing their Capital Improvements Plan, therefore the city has a funding program to provide the necessary matching funds for this project in place.

WWDC funds are expected to be requested as part of the funding package presented to the 2000 legislative session. City matching funds will need to be raised to allow design to occur in 2000, with construction to begin in 2001.

These new facilities are similar to the existing facilities and will not significantly impact operation and maintenance (O&M) requirements and costs. Some improvements in O&M will occur as the microstrainer is abandoned, and with the general upgrading of facilities. Increased O&M will result primarily from growth in flows through the facilities, rather than the types of facilities proposed under this improvement project. Therefore, O&M cost considerations are not believed to be a significant issue when evaluating the options for site improvements for the implementation of the recommended plan.