*Final Report*

# Solids Management Master Plan

March 2003

*Prepared for*

Snyderville Basin Water Reclamation District

*Prepared by*

CH2MHILL

# Contents

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# Executive Summary: Solids Management Master Plan

In 2002, the Snyderville Basin Water Reclamation District (District) determined the need to have a master plan for treatment and beneficial use or disposal for the solids generated at their two water reclamation facilities. Several consulting firms were interviewed and CH2M HILL was selected to perform this work. An important part of this master planning effort was the involvement of local citizens in the decision-making process. CH2M HILL participated in this community program as well. This document describes the solids management master planning process methodology, the final recommendations, as well as the participation of the citizenry in the development of all recommendations.

The Citizens Advisory Committee, the District staff, and CH2M HILL recommend the following Solids Management Master Plan. The Citizens Advisory Committee was a group formed to develop the master plan, and is comprised of local citizens, representatives from the local homeowners' associations, and local interest groups.

The District provides wastewater collection and treatment services for Park City, Deer Valley, the Canyons, Jeremy Ranch, and other residential, commercial, and recreational developments in unincorporated Summit County, Utah. There are two general drainage areas, one served by the East Canyon Water Reclamation Facility (WRF), and the other served by the Silver Creek WRF. Both WRFs produce unclassified, dewatered wastewater solids that are currently beneficially used in the E. T. Technologies soil regeneration operation at the Salt Lake Valley Solids Disposal Facility. The regenerated soil is a product of wastewater solids, commercial sludges, non-hazardous industrial sludges, and wood wastes or soil. It is used for alternative daily cover and top dressing for the landfill.

Park City, and the surrounding vicinity, is a renowned winter and summer resort that attracts large numbers of skiers and other tourists during peak recreational seasons. The area is growing rapidly, adding year-round residences and businesses as well as vacation homes and facilities to accommodate seasonal visitors. This growth is leading to increased wastewater flows. Therefore, the ultimate purpose of this solids management master plan is to:

*Identify an implementation strategy to enable reliable solids management for the next 20 years in a socially, financially, and environmentally responsible manner for the Snyderville Basin Water Reclamation District.*

## Recommendations

The Citizens Advisory Committee, the District staff, and CH2M HILL recommend the following plan for managing solids. The plan is to combine two methods — seasonal composting and alternative daily cover. These methods are described below.

**Seasonal Composting.** During the summer, the District's solids would be composted in an enclosed building. The Citizens Advisory Committee identified odor as the single most important factor to consider when identifying solids management processes. Composting in the summer will prevent the odor problems caused by inversions, because the most significant inversions typically occur during the non-summer months. The enclosed building would help mitigate the localized summer inversions. In addition, an odor control plan has been developed to further mitigate odors.

| COMPOSTING ODOR CONTROL PLAN |
|---|
| First, the mixing of dewatered solids and wood chips will be done inside the existing metal building. The building will be enclosed and properly ventilated, with all exhaust air treated in a new odor control biofilter.<br><br>Then, piles will be built over a new continuous vacuum distribution system that will prevent the odors from being released. This air will be exhausted to a second new biofilter. This will be a continuous operation, not intermittent as it is now, so some of the blowers may require replacement or the addition of variable-speed drives.<br><br>After about 15 days in the pile, the pile should be broken down and reconstructed. Air will again be vacuumed from the pile to prevent any odor release. Following this second active phase of composting the pile will again be broken down and moved to an open curing area. The piles in the curing area are also under vacuum with the air discharged to the biofilter.<br><br>Following curing, the mixture will be screened, with wood chips being recycled back to the active compost. The screened compost will be placed in open storage for eventual sale or give-away.<br><br>Piles should only be constructed or broken down from about 10 a.m. until about 3 p.m. to avoid natural daily inversions (which can trap odors). A weather station will also be installed to detect inversions. |

The Citizens Advisory Committee also indicated that it was very important to develop a local product. Seasonal composting meets both of these criteria – by mitigating odors while at the same time providing a local product (Class A compost).

**Alternative Daily Cover.** Alternative daily cover involves using solids to cover the active face of a landfill at the end of each operating day to control blowing litter and scavenging. This method will be used during the non-summer months, and at any other time that composting is not available. In effect, this provides a cost-effective, 100-percent backup to the composting process.

## Emergency Backup Plan

In the case of unforeseen circumstances such as emergency maintenance or equipment breakdowns, the District may need a quick solution for managing solids. The following emergency backup plan provides an immediate, although expensive, solution. Because of the costs of this option, it is anticipated that it would only be used for short periods of time.

The emergency option is to dispose at ECDC landfill, which is a large landfill south of Price, Utah. The District could haul dewatered solids to the landfill transfer station located in Salt Lake City. From the transfer station, the District's solids could be hauled via rail with municipal solid waste to the ECDC landfill for disposal. The advantage of this alternative is that it is an immediately available, albeit expensive, alternative. This alternative will be available for a long period because it has a 300-year life.

## Other Viable Options

The industry and community are constantly changing. The recommended plan may be affected by outside forces such odors, costs, and regulations. Therefore, several other viable options are discussed below.

**Alternative Daily Cover.** If composting odors become a problem, the District could use alternative daily cover and eliminate the seasonal composting. It is anticipated that E.T. Technologies would be receptive to meeting the District's changing needs —whether that is accepting solids for part of the year or year-round.

**Combining with a Larger Utility.** Buying into an alternative with a larger utility could give the District options that, while viable, may not be cost-effective for the relatively small amount of solids generated. The District is participating in ongoing discussions with South Valley Water

Reclamation Facility (SVWRF). SVWRF is currently investigating the option of a sludge-only monofill.

**Private Contractor [R³Company (**Resource, Recovery and Reuse**)].** Although more costly and having less benefit to the community than the above two alternatives, the District has the option to use a private contractor (R³) to manage solids. R³ has submitted a Term Sheet to the District for review. A copy of the Term Sheet is provided in Appendix J of the report. Currently, the SVWRF is involved in a pilot test program with R³ to determine if it is feasible for R³ to process the solids and beneficially use them on rangeland. It is recommended that the District review all materials and processes used in the R³ test program, as the solids produced by the District are similar to those produced by the SVWRF. If the test program proves the process to be feasible and economically viable, the District may desire to move forward with this option.

**Biosolids Utility.** Recently, CH2M HILL facilitated a meeting with 12 utilities concerning the feasibility of a publicly-owned Biosolids Utility using interagency agreements between several utilities. Staff from the District attended this meeting. This opportunity is especially interesting to the District because it may provide additional viable, cost-effective options. Although the Biosolids Utility will most likely not be available for at least 2 years, the District's current treatment and use options should be available for the interim period. In addition, this option could also include contracting with another utility to construct a process at another plant to enable solids processing prior to use or disposal.

## Additional Recommendations

In addition, it is recommended that the District become a member of the National Biosolids Partnership (NBP). The NBP, formed in 1997, was created to advance environmentally sound and accepted solids management practices — to implement programs that build public confidence and go beyond regulatory requirements. From the beginning, the partnership focused on developing an Environmental Management System (EMS) model, based on ISO 14001 principles for solids that would build improved management practices tailored to meet the needs of the community. CH2M HILL is a contractor for the NBP and can assist the District if it decides to move forward with the partnership commitment.

## Costs for Recommendations

Costs for the recommendations, as well as some of the options, are provided below. No costs are available for combining with a larger utility or participating in the Biosolids Utility.

| Recommended Program Costs | | |
|---|---|---|
| **Recommendations** | **Construction Cost** | **Annual Operating Cost[a]** |
| Recommended Plan — Seasonal Composting & Alternative Daily Cover | | |
| Composting, Total New Costs (Breakdown below) | $1,920,000 | $32,400 |
| Building Modifications to Enclose Mixing (Includes new biofilter and reconditioning of old biofilter) | $415,000 | |
| Addition of New Aeration System (Includes blowers and piping) | $329,000 | |
| New Star Screen | $207,000 | |
| Slab Modification for Aeration Piping | 30,000 | |
| Weather Station | $139,000 | |
| New Front End Loaders | $800,000 | |
| Hauling (East Canyon to Silver Creek for composting for 6 months and all solids to ADC for 6 months) | ----- | $25,700 |
| Alternative Daily Cover | $0 | $49,100 |
| **Total** | $1,920,000 | $568,000 |
| Emergency Backup Plan – ECDC | ----- | $40.20 per wet ton[b] |
| Other Viable Option – Alternative Daily Cover | $0 | $603,100 |
| Other Viable Option – Private Contractor ($R^3$) | $100,000[c] | $632,400 |
| Other Viable Option — Combining with Larger Utility | Unknown | Unknown |
| Other Viable Option – Biosolids Utility | Unknown | Unknown |
| Enhancement for Any Option – National Biosolids Partnership Involvement | Not Applicable | 0.75 FTE[d] |

[a]Each alternative includes $460,800 operating costs for the dewatering system.
[b]Annual cost unknown and will depend on the number of times this option is used.
[c]The private contractor requires a $100,000 initial payment.
[d]An FTE is a full time equivalent. This is not one person, but portions of time from several staff members.
Note: Costs are 20 years at present value.

# Methodology

A hasty decision can often lead to the wrong answer, can fail to achieve significant approvals, and thus, cannot be implemented successfully. This section describes the methodology that was used to develop the recommendations presented in this document. Decision science was used to objectively evaluate the hundreds of alternatives that were available for solids management. Decision science is a formalized process designed to focus on the criteria of highest importance.

The most important step in this process was soliciting input from the public. A Citizens Advisory Committee was formed that was made up of representatives from nearby homeowners' associations and local interest groups. This committee identified the criteria against which each alternative was judged. The criteria used, and their respective importance or weight, is provided in the table on the following page. These weights provided the basis for the evaluation model.

| Criteria Weights | |
|---|---|
| **Criterion** | **Weight** |
| Public Acceptance | 46.49 |
| Environmental Protection | 23.58 |
| Regulatory Compliance | 11.94 |
| Plant Operations | 17.99 |

Note: Total is 100.

**Research Existing Information Sources.** Large volumes of information were collected for this master plan to ensure that all alternatives and analyses were completed using all available data. The research portion of the project included reviewing the items discussed below.

- Public Acceptance: The public is becoming increasingly aware and interested in environmental issues, including solids management. The Citizens Advisory Committee provided information on public acceptance.
- Existing Regulatory Issues: Existing regulations were reviewed with respect to the District's solids quality.
- Future Regulatory Issues: Anticipated future regulatory changes were identified as they pertain to the District.
- National Practices and Trends: Several national initiatives were reviewed that are currently underway that will most likely affect how solids programs will be managed in the future.

**Development of Alternatives.** The next step in the process was to identify viable alternatives for the East Canyon and Silver Creek WRFs. Several alternatives were identified. Nearly 30 alternatives were considered viable and evaluated further.

**Public Involvement.** In addition to forming the Citizens Advisory Committee, the District maintained a link on its web site at www.sbwrd.org that provided a comprehensive explanation of the public meeting agendas and results. The web site provided a brief introduction to the decision-making process and how the District was using that process to bring all stakeholders, both internal and external, into the process. The results of the criteria weighting exercise, as well as other reports and project information, were posted on the web site. Each public meeting was advertised ahead of time through newspaper notices and mailings to individuals on the District's mailing list.

**Analysis of Alternatives.** Each of the alternatives was evaluated based on the criteria developed by the Citizens Advisory Committee. Each alternative was assigned a quantitative value describing its conformance to each criterion. Then, the criteria were weighted based on the relative importance that the Citizens Advisory Committee determined. Finally, costs were factored in to consider construction costs, operating and maintenance costs, present worth costs, and annualized costs.

**Benefit / Cost Evaluation.** To compare alternatives on an equal basis, the values for each alternative were then divided by the cost of each alternative to determine a benefit / cost ratio. Some alternatives may have a low cost, but a high benefit and this analysis allows this to be considered in selecting an alternative. All alternatives were compared using benefit / construction cost and benefit / present worth costs to portray the best result for the unique requirements of the Snyderville Basin Water Reclamation District and its ratepayers.

# Solids Management Master Plan
# Review of Existing Information

PREPARED FOR: Snyderville Basin Water Reclamation District

PREPARED BY: CH2M HILL

DATE: March 17, 2003

## Contents



## Introduction

Technical Memorandum 1 summarizes background data regarding plant operations and other information that may affect the evaluations for and development of the Solids Management Master Plan (SMMP). Included are summaries of operating data and plant performance, growth information, and permit requirements.

The Snyderville Basin Water Reclamation District (SBWRD or District) provides wastewater collection, treatment, and disposal services for Park City, Deer Valley, the Canyons, Jeremy Ranch, and other residential, commercial, and recreational developments in unincorporated Summit County, Utah. There are two general drainage areas, one served by the East Canyon Water Reclamation Facility (WRF), and the other served by the Silver Creek WRF.

Park City and the surrounding vicinity is a renowned winter and summer resort, and attracts large numbers of skiers and other tourists during peak recreational seasons. The area is growing rapidly, including both year-round residences as well as vacation homes and facilities to accommodate seasonal visitors. Baseline wastewater flows from permanent residents and related developments are increasing, as are contributions from short-term visitors and others who do not stay in the area year-round.

# Operating Data and Plant Performance (2001)

The operating data includes flow rates, total suspended solids (TSS), carbonaceous biochemical oxygen demand (CBOD), and biosolids production figures for the calendar year 2001.

## Flow Rates

The annual average daily flow rate at the East Canyon WRF for 2001 was 1.95 million gallons per day (mgd), and 1.49 mgd for the Silver Creek WRF. The combined annual average daily flow was 3.43 mgd. In Table 1-1, the maximum 30-day average flow, not including infiltration and inflow (I & I) flows, for the East Canyon WRF and the Silver Creek WRF are shown to be 2.21 mgd and 1.52 mgd, respectively. The maximum combined value is 3.69 mgd. Total annual flows are 709.5 million gallons (mg) for the East Canyon WRF, 542.8 mg for the Silver Creek WRF, and 1,252.3 mg total for both WRFs.

**TABLE 1-1**
Plant Flow Data for 2001

| Flow Condition | East Canyon WRF | Silver Creek WRF | Combined |
|---|---|---|---|
| Average Annual Daily Flow Rate, mgd | 1.95 | 1.49 | 3.43 |
| Maximum Average Daily Flow Rate Over a 30-Day Period (Including I & I), mgd (date) | 2.94<br>(3/21/01 to 4/19/01) | 1.63<br>(2/17/01 to 3/18/01) | 4.50<br>(3/10/01 – 4/08/01) |
| Maximum Average Daily Flow Rate Over a 30-Day Period (without I & I), mgd (date) | 2.21<br>(12/17/00 – 1/15/01) | 1.52<br>(1/2/01 – 1/31/01) | 3.69<br>(12/25/00 – 1/23/01) |
| Total Annual Flow, mg | 709.5 | 542.8 | 1,252.3 |

## Total Suspended Solids and Carbonaceous Biochemical Oxygen Demand

Both TSS and CBOD loading and removal data is shown in Table 1-2 for both facilities. TSS and CBOD are regulated for the discharge of both facilities. For 2001, the total combined TSS removal value from both plants was 958.4 tons (541.3 tons + 417.1 tons). The peak month values for each plant occurred at different times and therefore are not additive. However, for the highest combined month (April), the average daily removal rate was 7,685 pounds (lbs), and the monthly total was 116.9 tons. Table 1-2 also shows removal efficiencies above 96 percent for these parameters. This is directly attributable to excellent operation and maintenance at both facilities.

The values for incoming strength are typical for wastewater treatment plants with a primarily domestic service area. Water conservation measures and further I & I reduction efforts should serve to increase the strength of the influent while reducing the relative average daily flow. For purposes of the analysis performed for this study, however, these concentrations are assumed to remain constant.

**TABLE 1-2**
TSS and CBOD Data for 2001

| Parameter and Facility | Average. Daily Flow Rate, mgd | Influent Quality, mg/L | Effluent Quality, mg/L | Pounds Removed/ Day (from SBWRD) | Removal Efficiency, % (from SBWRD) | Tons Removed (Calculated) |
|---|---|---|---|---|---|---|
| **TSS – East Canyon WRF** | | | | | | |
| Peak Month (April) | 2.83 | 261 | 2.1 | 6,004 | 98.9 | 91.6/month |
| Annual Average | 1.95 | 188 | 2.6 | 3,007 | 98.4 | 45.1/month |
| Annual Total | | | | | | 541.3/year |
| **TSS – Silver Creek WRF** | | | | | | |
| Peak Month (March) | 1.62 | 228 | 3.4 | 2,887 | 98.4 | 45.4/month |
| Annual Average | 1.48 | 193 | 5.5 | 2,315 | 97.1 | 34.8/month |
| Annual Total | | | | | | 417.1/year |
| **CBOD – East Canyon WRF** | | | | | | |
| Peak Month (January) | 2.08 | 199 | 3.0 | 3,309 | 98.5 | 51.0/month |
| Annual Average | 1.95 | 148 | 2.3 | 2,291 | 98.4 | 35.5/month |
| **CBOD – Silver Creek WRF** | | | | | | |
| Peak Month (July) | 1.69 | 167 | 5.5 | 2,273 | 96.7 | 34.2/month |
| Annual Average | 1.48 | 152 | 4.1 | 1,827 | 97.3 | 27.4/month |

## Biosolids Production

Table 1-3 presents individual and combined biosolids production values for both plants. The total annual production was 780.6 dry tons, and the peak month production (March) was 100.0 dry tons.

Peak month peaking factors compared to average day for biosolids production are approximately 1.5, which is the value selected for process and equipment sizing. To ensure that the systems are capable of accommodating flows greater than peak month conditions, systems will be sized for maximum month plus redundant equipment or processes. Each plant dampens peak flows by holding solids in the liquid process, in storage, or processing tanks such that the peak month conditions approximate peak daily flows.

Solids production values in terms of dry tons per mgd range from 0.58 to 0.66 dry tons per mgd, which compares favorably with similar plants using extended aeration processes. For planning purposes, an average solids production rate of 0.70 dry tons per mgd will be used for this study.

**TABLE 1-3**
Biosolids Production Summary

| Period | East Canyon WRF | Silver Creek WRF | Combined |
|---|---|---|---|
| Peak Month (March), Dry Tons | 61.2 | 38.8 | 100.0 |
| Annual Average (per month), Dry Tons | 39.0 | 26.1 | 65.1 |
| Annual Total, Dry Tons | 468.0 | 312.6 | 780.6 |
| Average Daily, Dry Tons | 1.28 | 0.86 | 2.14 |
| Actual Peaking Factor (2001), Peak Month to Average Day | 1.54 | 1.45 | 1.51 |
| Actual Solids Production (2001), Dry Tons per mgd, Average | 0.66 | 0.58 | 0.62 |
| Future Peaking Factor (Design Value) Peak Month to Average Day | 1.5 | 1.5 | 1.5 |
| Future Solids Production (Design Value) Dry Tons per mgd, Average | 0.70 | 0.70 | 0.70 |

Note: Differences in combined values are due to rounding

# Growth Projections

As previously stated, the Snyderville service area is growing rapidly, including both year-round residences as well as vacation homes and facilities for seasonal visitors. As such, the baseline wastewater flows from permanent sources are increasing, as are contributions from short-term residents and visitors.

Estimates for 2002 from the SBWRD *Impact Fee Analysis*, shown in Appendix A, include a “residential” population of 8,862 Residential Equivalents (RE) in Park City and 6,087 REs outside Park City. The portion of the REs in Park City which are believed to be primary residences is estimated at 30 percent, while outside Park City the estimated portion is 68 percent.

Using the above RE values and proportions it can be seen that of the total of 14,949 REs, approximately 6,798 REs represent primary residences, with 8,151 REs being non-primary, approximately 55 percent of the total. The conclusion is that over half the annual “residential” wastewater contribution is attributable to non-full time residents. Similar patterns would be expected for retail/commercial contributions, while hotel contributions would reflect the seasonal variation even more heavily. These seasonal variations are reflected in the 2001 combined average daily flow contributions for the two plants which was lowest in October (a non-peak recreational period). The highest flows occur during December through March, the peak recreational season.

The magnitude of the seasonal wastewater flow variations is somewhat obscured or damped by I & I flows which increase during the warmer seasons due to snow melt, runoff, and higher groundwater levels, and decrease to presumed low values in the winter when the highest wastewater flows occur. The combined maximum 30-day average flow in 2001, when I & I was believed to be at its lowest levels, was 3.69 mgd in December and January. In March and April with higher I & I flows, the maximum 30-day average flow was 4.50 mgd.

It should be noted that, given the extent of the District's wastewater collection system, this is considered a modest amount of I & I flow compared to many systems in Utah and around the country. This is attributed to the overall relatively young age of the sewage collection system and other modern sewer construction materials which more effectively limit groundwater and surface water from entering the system compared to older construction methods.

The SBWRD *Impact Fee Analysis* growth projections for the residential equivalent population and capacity demand for the District's service area are used for this Solids Management Master Plan to represent both biosolids and chemical solids production growth rates. The growth rates are taken from the SBWRD *Impact Fee Analysis* and included in Appendix A.

The planning period for the Solids Management Master Plan is 20 years, running from 2002 through 2022. The annualized growth rate for this period derived from the SBWRD *Impact Fee Analysis* is 4.06 percent. This rate is used for solids production projections for both the East Canyon and Silver Creek WRFs.

Biosolids production is taken to vary in linear proportion to wastewater CBOD and TSS loads, and these loads are taken to vary linearly in proportion to wastewater flows, (represented by the solids production in terms of dry tons per day per mgd). Implicit are the assumptions that CBOD and TSS concentrations remain constant over the planning period, and that plant design and operations also remain unchanged.

The 2001 wastewater flows provided by the SBWRD and projected future flows are shown in Table 1-4. The recorded maximum 30-day flow for the East Canyon WRF was 2.21 mgd, and for the Silver Creek WRF was 1.52 mgd. These flows occurred in approximately the same period from mid-December 2000 to late January 2001 The total annual flows were 709.5 mg for East Canyon WRF and 542.8 mg for Silver Creek WRF, for a total of 1252.3 mg. For 2002 these figures were increased by 5.04 percent as determined from the SBWRD *Impact Fee Analysis*, and for 2022 the 4.06 percent annual growth rate was applied. The predicted peak 30-day flow of 8.69 mgd varies modestly from the value in SBWRD *Impact Fee Analysis* of 8.77 mgd because the actual flows in 2001 were slightly lower than those estimated in the SBWRD *Impact Fee Analysis.*

**TABLE 1-4**
Actual and Projected Wastewater Flows

| Facility | 2001 Actual | | | 2002 Projected | | | 2022 Projected | | |
|---|---|---|---|---|---|---|---|---|---|
| | Annual Flow, mg | Average Daily Flow, mgd | Peak Month Flow, mgd | Annual Flow, mg | Average Daily Flow, mgd | Peak Month Flow, mgd | Annual Flow, mg | Average Daily Flow, mgd | Peak Month Flow, mgd |
| East Canyon WRF | 709.5 | 1.95 | 2.21 | 745.3 | 2.04 | 2.32 | 1,652 | 4.53 | 5.14 |
| Silver Creek WRF | 542.8 | 1.49 | 1.52 | 570.2 | 1.56 | 1.60 | 1,264 | 3.46 | 3.55 |
| Combined | 1,252 | 3.43 | 3.73 | 1,316 | 3.60 | 3.92 | 2,916 | 7.99 | 8.69 |

Notes: Data in this table was obtained from the SBWRD *Impact Fee Analysis*

Table 1-5 contains the 2001 recorded biosolids production values for the East Canyon WRF and the Silver Creek WRF, and also the projected future production. The total combined annual biosolids production in 2001 was 781 dry tons, and the combined peak month production (which occurred in March) was 100 dry tons. These values are projected to 2002 and 2022 using the solids production rates developed in Table 1-3. A total biosolids production of 2,043 dry tons is projected for 2022. The peak month biosolids production that year is projected to be 252 dry tons.

**TABLE 1-5**
Actual and Projected Biosolids Production

| Facility | 2001 Actual | | | 2002 Projected | | | 2022 Projected | | |
|---|---|---|---|---|---|---|---|---|---|
| | Annual Solids, dT | Average Daily Solids, dT | Peak Month Solids, dT | Annual Solids, dT | Average Daily Solids, dT | Peak Month Solids, dT | Annual Solids, dT | Average Daily Solids, dT | Peak Month Solids, dT |
| East Canyon WRF | 468 | 1.28 | 61 | 522 | 1.43 | 64 | 1,158 | 3.17 | 143 |
| Silver Creek WRF | 313 | 0.86 | 39 | 398 | 1.09 | 49 | 885 | 2.42 | 109 |
| Combined | 781 | 2.14 | 100 | 920 | 2.52 | 113 | 2,043 | 5.59 | 252 |

In addition to the organic solids produced at the plants, chemical solids are also produced by the addition of aluminum salts (alum) to remove phosphorus from the treated wastewater to meet discharge permit requirements. Chemical sludge production from the phosphorus removal operation also is assumed to vary linearly with wastewater flow rates. Phosphorus loads are based upon concentrations that are also assumed to remain constant. Although only the East Canyon WRF currently uses chemical phosphorus removal, it is assumed that the Silver Creek WRF will also be required to remove phosphorus in the future. Because of this, chemical sludge production is assumed from both plants now and in the future for this study.

An alum dose of 60 milligrams per liter (mg/L) is assumed (based upon testing by the SBWRD), with a yield of 0.35 pounds of dry solids per pound of alum applied. It is also assumed that an additional 1 mg/L of chemical sludge will be produced per Nephelometric Turbidity Unit (NTU) of turbidity removed, and 8 NTU of turbidity is removed. Table 1-6 contains both the calculated and projected chemical sludge production, based on the flows in Table 1-4. The projected 2022 chemical sludge production is 353 dry tons, and the projected peak month value is 32 dry tons.

The projected 2022 combined biosolids and chemical sludge production is 2,396 dry tons (2,043 dry tons + 353 dry tons), and the combined peak month production is 284 dry tons (252 dry tons + 32 dry tons). The increase in average solids production due to chemical sludge is slightly over 17 percent, while the peak month increase is slightly over 12.5 percent. The average percentage increase is greater than the peak percentage increase because the levels of phosphorus in the incoming wastewater are more constant than the incoming solids content. Because this master plan looks at process sizing based upon peak month flows and loadings, the additional capacity required is approximately 12 percent, which will have a minimal effect on system sizing.

**TABLE 1-6**
Calculated and Projected Chemical Sludge Production

| | 2001 Calculated | | | 2002 Projected | | | 2022 Projected | | |
|---|---|---|---|---|---|---|---|---|---|
| Facility | Annual Chem. Sludge, dT | Average Daily Chem. Sludge, dT | Peak Month Alum Sludge, dT | Annual Chem. Sludge, dT | Average Daily Chem. Sludge, dT | Peak Month Alum Sludge, dT | Annual Chem. Sludge, dT | Average Daily Chem. Sludge, dT | Peak Month Alum Sludge, dT |
| East Canyon WRF | 86 | 0.24 | 8.1 | 90 | 0.25 | 8.5 | 200 | 0.55 | 18.6 |
| Silver Creek WRF | 66 | 0.18 | 5.6 | 69 | 0.19 | 5.9 | 153 | 0.42 | 12.9 |
| Combined | 152 | 0.42 | 13.7 | 159 | 0.44 | 14.4 | 353 | 0.97 | 31.5 |

# Permit Requirements

The SBWRD is currently permitted by the Utah Department of Environmental Quality (UDEQ) to dispose of its biosolids via land application following composting, which processes the solids to Class A standards, and by hauling to and disposing of its dewatered solids at E.T. Technologies where the solids are mixed with soil, stored for 1 year, and then applied as landfill daily cover or top dressing. The UDEQ has adopted verbatim the federal 40 CFR Part 503 regulations regarding treatment and disposal of biosolids and has been delegated primacy for enforcement of these standards. The District's composting operation was terminated in 1998 due to odor complaints, and all of the District's solids are currently delivered to E.T. Technologies. The current Utah Pollutant Discharge Elimination System (UPDES) permit (UTL-020001) became effective June 1, 1999, and will expire May 31, 2004. A copy of the UPDES permit is provided in Appendix B.

The permit currently allows three processes to further reduce pathogens for meeting Class A pathogen requirements including in-vessel/static aerated pile composting, windrow composting, and storage for two summer seasons. For Class B pathogen requirements the three processes to significantly reduce pathogens methods listed include aerobic digestion, in-vessel/static pile/windrow composting, and air or solar drying. Other pathogen reduction methods available in 40 CFR Part 503, but not specifically included in the permit, also may be allowed upon notification and approval of UDEQ. For vector attraction reduction, the seven methods listed in the permit are as follows:

1. 38 percent volatile solids reduction
2. Bench scale demonstration that aerobically-digested biosolids cannot meet the 38 percent volatile solids reduction requirement in Method 1 above
3. The Standard Oxygen Uptake Rate in an aerobic process is less than 1.5 mg Oxygen/hour/gram of total solids at 20 degrees C (°C)
4. Aerobic digestion for 14 days at 40 degrees °C minimum, 45 °C average temperature
5. Lime addition to pH 12 for 2 hours, and pH 11.5 minimum for 22 hours without the addition of more lime after the initial lime fed
6. Subsurface injection
7. Soil incorporation

The biosolids produced at both the East Canyon WRF and the Silver Creek WRF have consistently met UDEQ and federal standards for inorganic and organic contaminants.

A complete discussion of current and predicted regulations will be included in Technical Memorandum 3.

# Existing Solids Treatment Systems

Although many alternatives are being evaluated, some are able to use the existing facilities. As such, the following descriptions are for the solids treatment systems at each plant, as well as a determination of if this equipment is suitable for future use.

## East Canyon Water Reclamation Facility

East Canyon has the newest solids treatment system of both plants, and it is consistent with the future plans of the District. Centrifuges are the desired dewatering option unless costs or process considerations require a change. Table 1-7 shows the existing solids equipment in the East Canyon WRF.

The Waste Activated Sludge (WAS) pumps and the Liquid Storage Tanks are adequate for the future, but the centrifuges are undersized for the growth planned for the future. For cost estimating purposes, the existing centrifuges are assumed to be removed in 5 years and replaced with larger units. The key reasons requiring this change are: no thickening prior to dewatering (assumed 0.5 percent feed solids), and the operating period (6 days per week, 8 hours per day).

**TABLE 1-7**
Existing Solids Handling Facilities at the East Canyon WRF

| Process | Parameter | Value |
|---|---|---|
| WAS Pumping | | |
| | Number of Pumps | 3 |
| | Pump Type | Horizontal Non-Clog |
| | Design Conditions, each pump | 85 gpm at 46 feet TDH |
| | Horsepower, each pump | 5 |
| Liquid Storage | | |
| | Number of Tanks | 3 |
| | Size of Each Tank | 40 feet diameter, 24.5 aver. SWD |
| | Mixing Type | Aeration |
| | Capacity, each tank | 230,000 gallons |
| | Number of Transfer Pumps | 2 |
| | Type of Transfer Pumps | Air Diaphragm |
| | Design Conditions, each Transfer Pump | 100 gpm at 80 feet TDH |
| Centrifuge Feed Pumping | | |
| | Number of Pumps | 3 |
| | Pump Type | Progressing Cavity |
| | Design Conditions, each pump | 100 gpm at 45 feet TDH |
| | Horsepower, each pump | 15 |
| Thickening or Dewatering | | |
| | Equipment Type | Centrifuge |
| | Number of Centrifuges | 3 |
| | Design Conditions for Thickening, each centrifuge | 100 to 120 gpm |
| | Performance for Thickening | 5 percent solids |
| | Design Conditions for Dewatering, each centrifuge | 50 to 60 gpm |
| | Performance for Dewatering | 15 percent solids |
| | Horsepower, each centrifuge | 40 |
| | Centrifuge Manufacturer and Model Number | Sharples PM38000 |
| | Dewatered Cake Handling Capacity | 1 ton per hour |

For comparative purposes with other alternatives, this change is included in the cost opinions, but by operating the centrifuges 24 hours per day, 5 days per week, the size of the units reduces by about 60 percent, and a 24 hour per day, 7 day operating schedule would reduce the unit size by over 70 percent. By reducing the size, continuing to use the existing centrifuges becomes more viable. Adding thickening prior to dewatering causes several other problems as well as adding significant capital and operating cost, so thickening prior to dewatering is not considered a cost-effective option and is not evaluated further.

## Silver Creek Water Reclamation Facility

The Silver Creek solids handling system is quite old having been installed in about 1985. Most rotating equipment has a life of 10 years, up to 25 years, and the cost evaluation assumes a 20-year life with no salvage value. This existing equipment is already 17 years old and it is showing its age. Therefore, it has been assumed for this evaluation that the equipment at the Silver Creek WRF will be replaced. The building, however, is assumed to be adequate for up to two new units for either dewatering or thickening; the existing belt filter press having been removed. Table 1-8 presents the existing equipment at the Silver Creek WFR.

**TABLE 1-8**
Existing Solids Handling Facilities at the Silver Creek WFR

| Process | Parameter | Value |
|---|---|---|
| WAS Pumping | | |
| | Number of Pumps | 6 |
| | Pump Type | Horizontal Non-Clog |
| | Design Conditions, each of 4 pumps | 100 gpm |
| | Design Conditions, each of 2 pumps | 75 gpm |
| | Horsepower, each pump | 5 |
| Thickening | | |
| | Number of Thickeners | 1 |
| | Type of Thickener | Gravity |
| | Size of Gravity Thickener | 18 feet diameter 10 feet SWD |
| | Capacity of Thickener | 4,000 dry lbs/day with polymer |
| | Performance | 2 to 3 percent solids |
| | Number of Thickened Solids Pumps | 2 |
| | Type of Thickened Solids Pumps | Progressing Cavity |
| | Design Conditions, each Thickened Solids Pump | 75 gpm |
| | Horsepower, each Thickened Solids Pump | 5 |
| Dewatering | | |
| | Equipment Type | Belt Filter Press |
| | Number of Belt Filter Presses | 1 |
| | Design Conditions for Belt Filter Press | 100 gpm |
| | Performance | 15 percent solids |
| | Belt Filter Press Manufacturer and Model Number | Parkson 1.5 meter width |

# Solids Management Master Plan
# Biosolids Processing Alternatives

PREPARED FOR: Snyderville Basin Water Reclamation District

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DATE: March 17, 2003

## Contents

# Introduction

This technical memorandum (TM) describes biosolids processing alternatives that have been used successfully by wastewater treatment agencies across the United States and around the world.

The two Snyderville Basin Water Reclamation District (SBWRD or District) wastewater treatment plants, the East Canyon Water Reclamation Facility (WRF) and the Silver Creek WRF both produce unclassified, dewatered wastewater solids which are currently disposed of at the E. T. Technologies soil regeneration operation at the Salt Lake County Landfill. Table 2-1 presents the current and projected future solids production rates for the two WRFs.

**TABLE 2-1**
Current and Projected Biosolids Production

| | 2001 Actual [a] | | | 2022 Projected [a] | | | 2022 Projected Chemical Sludge Production [b] | | |
|---|---|---|---|---|---|---|---|---|---|
| **Facility** | **Annual Solids, dT** | **Average Daily Solids, dT** | **Peak Month Solids, dT** | **Annual Solids, dT** | **Average Daily Solids, dT** | **Peak Month Solids, dT** | **Annual Chem. Sludge, dT** | **Average Daily Chem. Sludge, dT** | **Peak Month Alum Sludge, dT** |
| East Canyon WRF | 468 | 1.28 | 61 | 1,158 | 3.17 | 143 | 200 | 0.55 | 18.6 |
| Silver Creek WRF | 313 | 0.86 | 39 | 885 | 2.42 | 109 | 153 | 0.42 | 12.9 |
| Combined | 781 | 2.14 | 100 | 2,043 | 5.59 | 252 | 353 | 0.97 | 31.5 |

[a] From Technical Memorandum 1, Table 1-5
[b] From Technical Memorandum 1, Table 1-6

The current combined dry solids production rate is approximately 781 dry tons per year, or a daily average of 2.14 dry tons per day. At a solids content of 14 percent, the wet weight for the daily average is 15.3 wet tons per day. The calendar year 2022 projected values are 2,043 dry tons per year and 5.59 dry tons per day of which approximately 60 percent of the solids are contributed by the East Canyon WRF and 40 percent by Silver Creek WRF. Solids treatment and disposal equipment and facilities will be sized with sufficient capacity to accommodate projected maximum month solids production quantities. For concept design and estimating purposes, peak month values will be used which are 252 dry tons per month or 8.4 dry tons per day (peak month value divided by 30). It is assumed that the peak day values are dampened by the mass of solids in the Carrousel process. Daily loads for chemical sludges add slightly over 17 percent to the dry solids quantities. Alum sludges tend to be more difficult to dewater, so if only 12 to 13 percent solids can be achieved, the associated hauling and disposal costs could increase by almost 34 percent. This issue could have a dramatic effect on the operating costs, but less on the construction costs. Without testing, however, it is impossible to determine what the resulting solids content would be. For example, although alum solids tend to be more difficult to dewater, many plants can achieve solids contents in excess of 15 percent with the same dewatering equipment used by the District.  As such, the net change in solids concentration will be assumed to be zero.

There are a number of possible approaches for managing the biosolids produced from wastewater treatment processes. The objectives common to each are to reduce volume, odors, vector attraction, and pathogens. Successful management practices also dispose of, or beneficially use, biosolids in an environmentally sound and efficient manner. Many factors, including volume and characterization of biosolids, available space, capital and operations costs, operation and maintenance considerations, public acceptance, and regulatory requirements determine which processes are best suited to a specific site. Table 2-2 lists the more commonly-used technologies and management practices. The purpose of this compilation is to identify the features, advantages, and disadvantages of each option for use in screening alternatives for more detailed evaluation.

Federal and state regulations may have an impact on the viability of certain alternatives. Although regulations do not specify the required method of treatment, they do specify the minimum performance of various processes prior to disposal or reuse of the resulting biosolids. TM 3 will address key regulatory issues as they relate to the selection and performance of treatment processes.

A variety of terms are used for the solids generated during wastewater treatment. These terms include residuals, sewage solids, solids, sludge, and biosolids. For this report, the Water Environment Federation (WEF) guidelines will be used. These guidelines define biosolids as the solids that have been treated to a level that meets or exceeds the requirements for land application. Other solids that have not been treated are referred to as solids, residuals, or sludge, with the preference toward solids or residuals to avoid confusion.

When reviewing these biosolids management technologies, each process category performs a different function that is explained in the following paragraphs.

**TABLE 2-2**
Common Biosolids Management Technologies

| Process Category | Process |
|---|---|
| Thickening: | Gravity Thickeners<br>Dissolved Air Flotation Thickeners<br>Gravity Belt Thickeners<br>Rotary Drum Thickeners<br>Centrifuges |
| Stabilization: | Conventional (Mesophilic) Anaerobic Digestion<br>Thermophilic Anaerobic Digestion<br>Aerobic Digestion<br>Autothermal Thermophilic Aerobic Digestion (ATAD)<br>Facultative Lagoon Stabilization<br>Thermal Hydrolysis and Pasteurization<br>Lime Stabilization of Undigested Solids |
| Post-Stabilization Thickening: | Gravity Belt Thickeners<br>Rotary Drum Thickeners<br>Centrifuges |
| Dewatering: | Belt Filter Presses<br>Centrifuges<br>Drying Beds<br>Pressure Filters<br>Vacuum Filters |
| Further Processing: | Thermal Dryers<br>Composting |
| Disposal/Beneficial Use: | Land Application – Agricultural<br>Land Application – Golf Courses and Parks<br>Land Application – Forested Areas (Silviculture)<br>Land Application – Rangeland<br>Land Application – Land Reclamation<br>Dedicated Land Disposal<br>Monofill Disposal<br>Landfill Disposal or Use as Daily Cover<br>Incineration and Ash Disposal<br>Marketing Composted Material<br>Marketing Thermally Dried Material |

# Solids Types

Wastewater treatment plants can use many different liquid processes to remove contaminants to meet the effluent discharge requirements, and each of these processes produce different solids characteristics and volumes. In treatment plants the size of the East Canyon WRF and Silver Creek WRF, oxidation ditches or long sludge-age plants are common and perform extremely well. This is witnessed by the excellent performance of both plants that use this process. The solids produced are primarily biological in nature, and are called waste activated sludge (WAS). Other plants may include primary clarifiers prior to the biological process to remove the heavier solids and reduce the size of the biological process. These solids are called primary solids. Both primary solids and WAS will be discussed only because some of the processes mentioned tend to be more applicable to one type of solids.

The liquid processes will not be reviewed as a part of this master plan since that effort has been done previously and the East Canyon WRF currently is being expanded using oxidation ditches.

# Thickening

Raw wastewater entering a treatment plant is quite dilute. Suspended solids concentrations in untreated wastewater generally range from 200 to 300 milligrams per liter (mg/L) or parts per million (ppm) (approximately 0.02 percent to 0.03 percent solids by weight). To put this into perspective, the concentration of solids in untreated wastewater is about the same as a 1-ounce shot glass in a 40-gallon tank. During treatment, a small amount of additional solids are generated due to biological activity.

Settling that occurs in a primary treatment process can produce a thicker material that is 1 to 4 percent solids by weight. Although this concentration equates to less than 1 gallon of solids in an 40-gallon tank, the total volume of the solids/water mixture is reduced by about 50 to 150 times. Thickening processes further concentrate solids removed through primary treatment to between 4 and 10 percent solids, which is equivalent to over 3 gallons of solids in a 40-gallon tank. Thickening is essential because many downstream solids processing systems are based upon detention time, so a thicker material can significantly reduce the size of downstream processes by removing excess water. However, thickening beyond about 10 percent solids creates a very heavy mud-like material that is difficult to process.

## Gravity Thickening

Gravity thickening has been used for concentrating raw solids for more than 50 years and is common in many wastewater treatment facilities. Solids removed during primary treatment are fed continuously to the gravity thickener, where they initially aggregate in a sedimentation zone and then become compressed by the pressure of overlying solids in a thickening zone. Displaced water flows upward through channels in the solid matrix to a zone of clear liquid, where it is drawn off into launders and returned to the liquid primary or secondary treatment process. The concentrated biosolids are collected and removed from the bottom of the gravity thickener and pumped to stabilization and/or dewatering processes. Most gravity thickeners are circular in plan view.

Design criteria for gravity thickeners are dependent upon the type and settling characteristics of the biosolids to be thickened. Typically, gravity thickeners are used to concentrate primary solids from primary clarification. Primary solids tend to be larger, denser, and easier to separate from water than solids produced in subsequent biological treatment processes. They can, however, be combined to thicken biological solids from secondary treatment processes (WAS), thermally conditioned solids, solids from tertiary treatment processes, or a variety of blended biosolids. Because biological solids do not settle well, gravity thickener loading rates and performance vary with different types of solids. Some typical design criteria for WAS are listed in Table 2-3.

**TABLE 2-3**
Typical Design Criteria for Gravity Thickeners on WAS

| Criteria | Values |
|---|---|
| Mass Loading Rate | 8 to 12 pounds (lbs)/day/square feet (sf) |
| Hydraulic Loading Rate | 400 to 600 gallons per day (gpd)/sf |
| Solids Retention Time | 0.5 to 2 days |
| Side Water Depth | 10 feet |
| Dilution Water Requirements | 100% to 200% |

The concentration of solids produced by gravity thickening of WAS produced by the two plants will vary, but generally can be expected to be in the range of 2 to 3 percent solids by weight. Some wastewater treatment facilities add polymer, alum, ferric chloride or other coagulant aids to the solids to improve flocculation and settling characteristics. While coagulant aids can improve solids capture, they generally have little effect on increasing underflow solids concentration.

An important consideration in the successful operation of gravity thickeners is the prevention of septic or anaerobic (without air) conditions. Anaerobic conditions cause severe odors and generate gases that prevent solids from settling properly. To prevent this condition, treatment plant effluent, which is highly aerobic, is usually added to the thickener (dilution water). Secondary effluent is normally blended with the solids feed to accomplish this objective. Limiting the time that solids remain in the thickener is also an important consideration in preventing excessive biological degradation. During warmer weather, the average solids retention time is usually reduced to prevent anaerobic conditions from developing. Because odors can be a significant concern with gravity thickeners, it is not uncommon for gravity thickeners to be covered. Foul air can be extracted from under the covers and treated by chemical scrubbers, biofilters, or other odor control devices. In addition, chlorine or ferric chloride is frequently used to enhance settling and reduce odors.

With respect to operation and maintenance, the labor and power requirements can be correlated with the thickener surface area. A general indication of the requirements for two different surface areas is shown in Table 2-4.

**TABLE 2-4**
Typical Operations and Maintenance Requirements for Gravity Thickeners

| Criteria | 1,000 sf Thickener Area | 10,000 sf Thickener Area |
|---|---|---|
| Annual Labor (hours) | 300 | 1,000 |
| Annual Power [kilowatt hour (kWh)] | 5,000 | 30,000 |

Major advantages and disadvantages of gravity thickeners are as follows:

### Advantages

- High solids storage capabilities
- Low level of operational skill required
- Low operation and maintenance costs
- Proven process with extensive experience, although poor performance on WAS

### Disadvantages

- Requires a relatively large land area
- Can be a contributor to odors
- For some types of solids, results can be erratic (especially with WAS)

### Applicability to SBWRD

Gravity thickening, although existing at the Silver Creek WRF, is not recommended for WAS and will not be evaluated further.

## Dissolved Air Flotation Thickening

Dissolved air flotation thickening is used to concentrate biosolids that have greater tendencies to float than to settle. Dissolved air flotation thickening is used primarily for WAS, but also has been applied to aerobically digested solids, blended primary solids and WAS, and other similar solids.

In the dissolved air flotation thickening process, air is added to incoming flow at a pressure in excess of atmospheric pressure. High pressure causes oxygen to dissolve into the flow stream. When the pressure is reduced as the flow enters the process tank, excess air is released from the solution as very small bubbles. The bubbles adhere to the suspended particles or become enmeshed in the solids matrix. The density of the solids-air aggregate is less than that of water, thereby causing it to float to the surface. Water drains from the "float," increasing the solids concentration. Float is continuously removed from the surface of the thickener by skimmers. Bottom collectors are also used to remove any settled solids or grit that may accumulate.

There are several ways of adding pressurized air, including adding it to the entire solids flow stream, adding it to only a part of the solids flow stream, or adding it to a recycled portion of the clarified effluent (or alternate source containing little suspended matter). Because pressurization of a relatively clear recycle stream eliminates clogging problems in pressurization pumps and minimizes high shear conditions in the floc, it is the most commonly used method in the United States. Dissolved air flotation thickeners can be either rectangular or circular.

Design criteria for dissolved air flotation thickeners depend on the nature of the solids being thickened and the specific features of the equipment being used. Some typical design criteria are listed in Table 2-5.

**TABLE 2-5**
Typical Design Criteria for Dissolved Air Flotation Thickening

| Criteria | Values |
|---|---|
| Air Pressure | 40 to 80 pounds per square inch gauge (psig) |
| Air to Solids Ratio | 0.02 – 0.1 weight ratio [depends on solids volume index (SVI)] |
| Solids Loading Rate | 2 –3 lbs/hour/sf (with coagulant addition)<br>0.4 – 1.2 lbs/hour/sf (without coagulant addition) |
| Recycle Flow Rate | Depends on manufacturer |
| Hydraulic Loading Rate | 0.8 – 2.5 gallons per minute (gpm)/sf (depends on whether or not recycle is included) |

The concentration of solids produced by dissolved air flotation thickening of WAS will vary, but generally can be expected to be in the range of 3 to 5 percent solids by weight. Removal efficiency will also vary but can be 95 percent or greater when flocculating chemicals are used. To improve solids-capture efficiency and reduce the size of the units, most dissolved air flotation facilities use a flocculent aid. The most common chemicals used are cationic polyelectrolytes (polymers). Polymers neutralize particle surface charges, causing the particles to coagulate so that air bubbles can attach to them. With the use of polymers, the size of the dissolved air flotation unit may be reduced and solids capture improved.

With respect to operation and maintenance, operator attention is required to maintain the chemical feed, recycle, and pressurization pumps, skimmers, and bottom-solids removal equipment. Because of air entrainment in the float, there can also be difficulties in pumping the thickened biosolids if the correct pumps are not selected. Because of the oxygen content in the thickened solids, the potential for odors is less than with gravity-thickening processes. With respect to power and labor, a general indication of the requirements for two different surface areas is shown in Table 2-6.

**TABLE 2-6**
Typical Operations and Maintenance Requirements for Dissolved Air Flotation Thickeners

| Criteria | 100 sf DAF Surface Area | 1,000 sf DAF Surface Area |
|---|---|---|
| Annual Labor (hours) | 400 | 2,500 |
| Annual Power (kWh) | 100,000 | 700,000 |

Major advantages and disadvantages of dissolved air flotation thickening are as follows:

### Advantages

- Provides better solids-liquid separation than gravity thickening
- For WAS, yields higher solids concentration than gravity thickening
- Requires relatively little land area
- Offers excellent solids equalization control
- Solids are maintained in aerobic condition, reducing potential odors
- Can remove grit from solids processing system
- Removes grease
- Relatively high reliability
- Proven track record
- Relatively high solids loading rates are possible

### Disadvantages

- Operating costs for dissolved air flotation are higher than for gravity thickening, especially for coagulants and power
- Has little solids storage capacity
- Thickened solids concentration is less than from a centrifuge or gravity belt
- Requires more land than a centrifuge or gravity belt
- Optimal performance requires expensive polymer addition

### Applicability to SBWRD

Dissolved air flotation is applicable to the solids produced at the Silver Creek and East Canyon WRFs; however, the cost is generally much higher than centrifuge, gravity belt or rotary drum thickening. A few area wastewater plants do use dissolved air flotation technologies (DAFTs) including Provo and Orem, and conversion of an existing gravity thickener at the South Valley Water Reclamation Facility to a DAFT is planned. Therefore, DAFT will be considered further for the SBWRD.

## Gravity Belt Thickeners

Gravity belt thickening is a solids-liquid separation process that relies on coagulation and flocculation of solids in a dilute slurry, and drainage of free water from the slurry through a moving fabric-mesh belt. It is essentially a modification of the upper gravity drainage zone of the belt filter press, which can be used for dewatering as described below. Gravity belt thickening has been used on a variety of solids having initial solids concentrations as low as 0.4 percent and as high as 8.0 percent. The process is polymer dependent and can achieve 95 percent or greater solids capture. Because of the relatively open-mesh filter belts that are used, a relatively high dose of polymer is required to create flocs large enough to be trapped by the mesh. The type and amount of polymer used is dependent upon the type of solids and the particular machine to be used. Cationic polymers are generally successful in these applications.

Gravity belt thickening systems are designed based on site-specific applications. However, some typical design criteria for thickening are listed in Table 2-7.

**TABLE 2-7**
Typical Design Criteria for Gravity Belt Thickeners

| Criteria | Values |
|---|---|
| Hydraulic Loading Rate | 100 to 300 gpm/meter of belt width |
| Solids Loading Rate | Up to 1,100 lbs/hour/meter for WAS thickening |
| | Up to 1,700 lbs/hour/meter for thickening digested solids |
| Thickened Solids Concentration | 5 to 7 percent solids by weight |
| Solids Capture Efficiency | 90 to 98 percent |
| Flocculation Time | 30 seconds, minimum |

Although gravity belt thickeners are relatively simple to operate, and produce good results with relatively little operator attention, there are a few operational issues that need to be addressed to meet thickening objectives. Probably the most important is proper type and mixing of polymer. Other operational features such as the solids feed rate, belt speed, and thorough washing of the belt are also important. Belt washing is particularly important to prevent binding of the belt. Odors can also be a problem, and this usually requires that gravity belt thickeners be installed in enclosed buildings with high ventilation rates and odor control on the exhaust from the building. Major advantages and disadvantages are as follows:

### Advantages

- Relatively low space requirements
- Low power usage
- Moderate capital costs compared to other thickening processes
- Simple operation, requiring little operator attention

### Disadvantages

- Generally requires moderate to high dosages of polymer
- May produce odors and may require enclosure and odor control
- May have fairly large variations in thickened solids concentration with fluctuations in characteristics of feed solids

### Applicability to SBWRD

Gravity belt thickening is recommended for further evaluation if thickening is needed, either before or after stabilization. Gravity belt thickening is not recommended prior to dewatering as it adds a costly step to the process and does not improve overall dewatering performance. Thickening will be considered only in conjunction with stabilization, as described later in this technical memorandum.

## Rotary Drum Thickening

A rotary drum thickener operates similarly to a gravity belt thickener, with free water draining through a moving porous medium while flocculated solids are retained on the medium. A rotary drum thickener consists of an internally fed rotary drum with an integral internal screw for transporting thickened solids out of the drum. The drum rotates and is driven by a variable or constant speed-drive. Generally, rotary drum thickeners are used in small treatment plants for WAS thickening. They are particularly well suited for high-fiber solids, such as those found in the pulp and paper industry. As with gravity belt thickeners, they are highly dependent upon polymer addition to achieve thickening objectives. The addition of large amounts of polymer, however, can be a concern because of cost, floc sensitivity, and the shear potential in the rotating drum.

There are many factors that influence the design of rotary drum thickeners, and generally pilot testing is performed to determine design criteria. The drums generally rotate at 5 to 20 revolutions per minute (rpm). With the proper polymer application and feed rate, rotary drum thickeners can produce a thickened solids concentration of 4 to 8 percent and a solids capture rate of 90 to 95 percent. Major advantages and disadvantages are as follows:

### Advantages

- Relatively low space requirements
- Low power usage
- Moderate capital costs
- Ease of enclosure, which improves housekeeping and odor control
- Good performance on a variety of solids

### Disadvantages

- Floc sensitivity and shear potential in the rotating drum
- Limited size units available, restricting use to small facilities
- Requires higher dosages of polymer than gravity belt thickeners

### Applicability to SBWRD

Rotary drum thickening is recommended for further evaluation if thickening is needed, either before or after stabilization. Rotary drum thickening is not recommended prior to dewatering as it adds a costly step to the process and will not significantly improve overall dewatering performance. Thickening will be considered only in conjunction with stabilization, as described later in this document.

## Centrifugal Thickening

Centrifuges have been used to thicken a wide range of solids. Their operation is based on the application of centrifugal force to a liquid-solids stream, which accelerates the separation of the liquid and solid fractions based upon specific gravity differences. The process involves both clarification of the centrate stream and compaction of the solids.

Solid bowl conveyor-type centrifuges are typically used to thicken and dewater municipal biosolids. This centrifuge unit operates with a continuous feed and discharge. The solids, which may be conditioned with polymer, are fed into the rotating bowl which has a conical shape at one end and an end plate at the other. The end plate has holes in it for the discharge of the centrate. These holes are equipped with adjustable weir plates to control the operating level of the liquid in the bowl. A motor drives the bowl at speeds ranging from 2,000 to 3,000 rpm. This spinning action creates the centrifugal forces required to concentrate the solids against the bowl wall. To remove these solids, a spiral conveyor in the bowl rotates at a slightly differing speed than the bowl and conveys the solids towards the conical solids discharge. The centrate water is discharged over the weir plates at the opposite end of the centrifuge and conveyed back to the treatment process.

Typical solids concentrations resulting from thickening using conventional centrifuges are roughly in the range of 6 to 10 percent dry solids, depending on the type of solids being thickened and the amount of polymer added.

Centrifuges have historically required a substantial level of maintenance, and frequent repairs and considerable downtime have been common. However, with recent advances, modern centrifuges are much more reliable than in the past. An important part of centrifuge maintenance is frequent internal cleaning. If a unit is to be shut down for more than a couple of hours, it is important that the solids inside be removed before they have a chance to dry. Newer centrifuges incorporate an automatic water flushing step as a part of the shutdown procedure. Dry solids can cause load imbalance. Centrifuges also may require a substantial amount of flocculent aid. Because centrifuges are totally enclosed, odors are usually minimal. Power and labor requirements are highly variable depending on the type of centrifuge used.

Major advantages and disadvantages are as follows:

### Advantages

- Contained process minimizes housekeeping and odor considerations
- Continuous operation provides flexible control capability for process performance
- Moderate or highly thickened solids concentration
- Relatively small area requirements
- Moderate to high throughput capabilities versus space requirements
- Low operator attention requirements
- High solids capture

### Disadvantages

- High capital costs
- Requires skilled maintenance personnel and a fairly high degree of maintenance
- Centrate may precipitate struvite (primarily when thickening anaerobically digested biosolids), which increases operation and maintenance costs
- Relatively high power requirements
- Moderate to high polymer requirements (thickening can be done without polymer, but the capture efficiency is reduced to 85 to 90 percent)
- High operating speeds
- High noise potential

### Applicability to SBWRD

Centrifuge thickening is recommended for further evaluation if thickening is needed, either before or after stabilization. Centrifuge thickening is not recommended prior to dewatering as it adds a costly step to the process.

## Stabilization

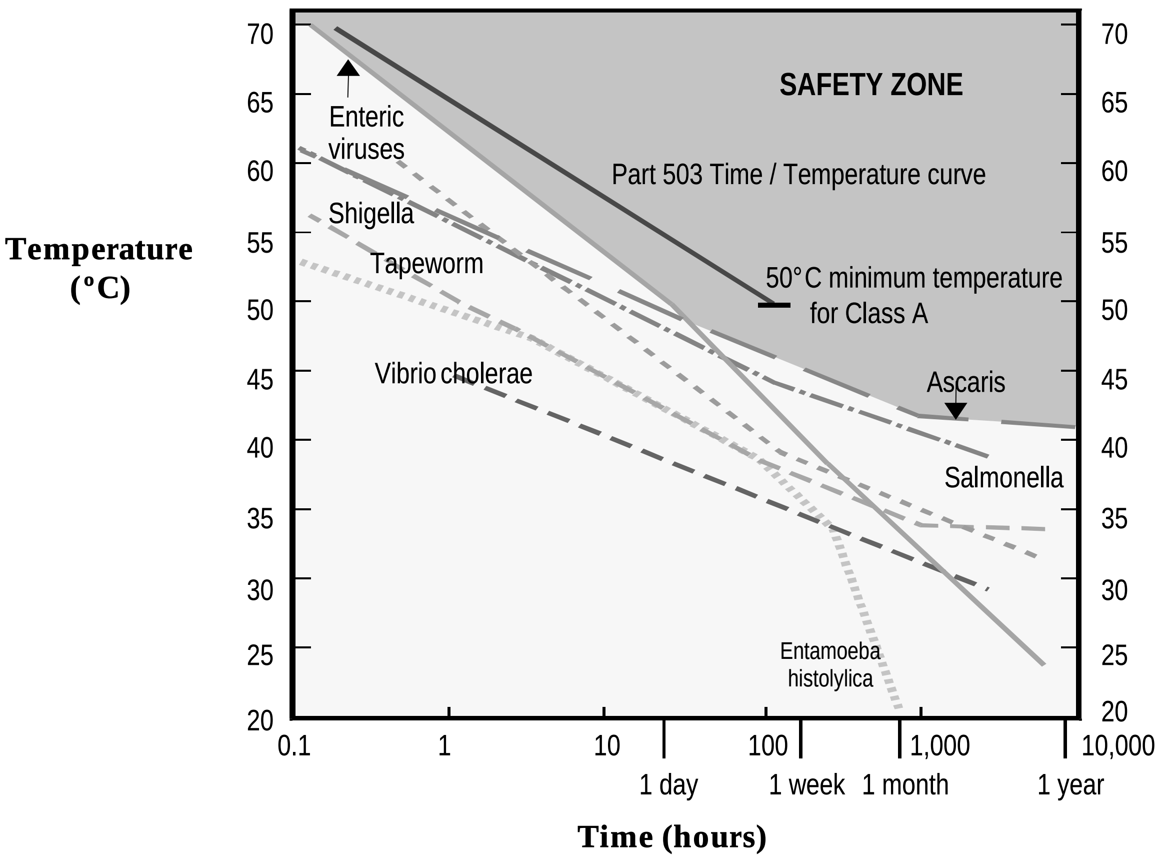
Stabilization involves reduction of pathogens and volatile components in the feed solids to meet regulatory requirements. Two different pathogen density levels in the finished biosolids are defined by the regulations. Class B biosolids are defined as having less than 2,000,000 most probably number (MPN) of fecal coliform per gram of total solids. Class A biosolids are defined as having less than 1,000 MPN of fecal coliform per gram of total solids. Although each class of biosolids is suitable for land application, there are very specific requirements for use and contact of both classes. Required levels of vector attraction reduction are also specified in the regulations. Although the technical issues concerning the two pathogen density levels will be discussed in more detail in Technical Memorandum 3, a summary is provided here with the importance of each level.

### Class A Pathogen Density Levels

Class A biosolids can be considered pathogen-free, and there are several ways to delineated in the federal 40 CFR Part 503 (Part 503) regulation to achieve Class A pathogen density levels. The importance is both public perception as well as costs. Since Class A requires virtually no pathogens, the treatment processes used to achieve Class A levels are normally more expensive and more difficult to operate. In addition, a temperature and time relationship is specified to ensure that the pathogenic bacteria are consistently destroyed. In fact, the development of the time/temperature relationships are food based, principally eggnog. This is important because the public can easily understand how “clean” Class A biosolids are with respect to pathogens. However, Class A processes do not necessarily produce less odors; in fact, some Class A processes may generate products with greater odor intensities.

Figure 2-1 shows this time and temperature relationship between many of the virus, bacteria, and pathogens normally found in biosolids. The curve directly from the Part 503 regulations is superimposed on this figure and shows that if the biosolids treatment process satisfies the required time/temperature relationship, pathogenic organisms will be destroyed.

**FIGURE 2-1**
Class A Pathogen Density Level Safety Zone




**FROM:** Feachem, R.G., et.al. ***Sanitation and Disease - Health Aspects of Excreta and Wastewater Management***. John Wiley & Sons. 1983. Page 79.

On the technical side, all Class A options require pathogen reduction to show that the biosolids have met either a fecal coliform or *Salmonella* sp. bacteria requirement and one of six alternatives, as described below. In summary, the two steps for meeting Class A pathogen reduction requirements are:

- Demonstrate <1000 MPN fecal coliforms per gram total solids, or < 3 MPN *Salmonella* sp. per 4 grams of total solids
- Apply one of six alternatives:
  - **Alternative 1 –** Time and Temperature
  - **Alternative 2 –** High pH, High Temperature, and Time
  - **Alternative 3 –** Other Processes; Demonstrate pathogen reduction process by measuring reduction in enteric viruses and helminth ova
  - **Alternative 4 –** Unknown Processes; Test resulting biosolids at time of use to ensure biosolids meet required enteric viruses and helminth ova levels
  - **Alternative 5 –** Proven processes as set forth in the Part 503 regulation [also called Processes to Further Reduce Pathogens (PFRP)]

– **Alternative 6 –** Processes determined to be equivalent to a PFRP process by the Pathogen Equivalency Committee of the United States Environmental Protection Agency (EPA)

## Class B Pathogen Density Levels

Although Class B pathogen density levels are higher than Class A, there is still a significant reduction in pathogens from raw sewage. Raw sewage has up to 100 million MPN fecal coliforms per gram, while Class B biosolids have only 2 million MPN fecal coliform, which is a reduction of 50 times. Studies of Class B biosolids have shown that this reduction is sufficient to allow environmental attenuation to reduce pathogen levels to below detention limits within time periods specified by the Part 503 regulation. Environmental attenuation includes time, sunlight, and soil pathogens which destroy the remaining pathogens. Because Class B permits higher levels of pathogens, the treatment processes used to achieve Class B levels are normally less expensive and easier to operate. In addition, there is less monitoring required. There are several processes that will meet Class B pathogen density levels.

On the technical side, there are three options for Class B pathogen reduction:

- Demonstrate < 2,000,000 MPN or Coliform Forming Units (CFU) fecal coliforms per gram total solids
- Proven processes as set forth in the Part 503 Regulation [also called Processes to Significantly Reduce Pathogens (PSRP)]
- Processes determined to be equivalent to a PSRP process by the Pathogen Equivalency Committee of the EPA

In addition, there are a number of site restrictions for land application for Class B biosolids which are provide in Technical Memorandum 3.

## Vector Attraction Reduction

In addition to pathogen density requirements, there are also defined processes to reduce the attraction of the biosolids to vectors, which include rats and insects. There are 12 criteria specified in the regulation for vector attraction reduction and they are presented in Technical Memorandum 3. The application of vector attraction reduction criteria depends on the type of biosolids and how they are to be used. For example, for biosolids that are to be land-applied, biosolids must meet one of the Criteria 1 through 10. For surface disposal, any one of Criteria 1 through 11 may be used. Criterion 12 applies only to septage. These criteria are presented in Technical Memorandum 3.

## Mesophilic Anaerobic Digestion

Anaerobic digestion is a complex biochemical process in which several groups of anaerobic and facultative organisms simultaneously assimilate and break down organic matter in the absence of oxygen. Mesophilic anaerobic digestion involves operating temperatures ranging from 85 degrees Fahrenheit (ºF) to 100ºF [29 degrees Celsius (ºC) to 38ºC], which provides optimal conditions for methane-forming bacteria. The process is simple to operate and has proven reliability. Organic matter is converted into methane, carbon dioxide, water, and partly degraded intermediate organics. The digested biosolids are relatively stable compared to raw solids. Methane gas generated in the process is typically burned, and heat produced by combustion is used to maintain the optimum temperature in the digester.

Mesophilic digestion is one of the most common pathogen reduction processes used in the United States. It is classified by the EPA as a PSRP. This process has been demonstrated to consistently produce Class B pathogen levels in accordance with the EPA regulations. Pathogen destruction must be demonstrated in full-scale systems by maintaining a detention time of at least 15 days at a minimum temperature of 95ºF (35ºC). Vector attraction reduction is also achieved by a minimum of 38 percent volatile solids reduction in the digestion process.

There are several variations of mesophilic anaerobic digestion. These include combinations of single-stage, two-stage, low-rate, and high-rate processes. The single-stage, high-rate process is the most commonly used in the United States. In this process, the contents of the digester are both heated and mixed. Compared with an unheated and unmixed low-rate process, mixing and heating improve process control, reduce the required solids retention time, reduce in-tank settling problems, reduce the required volume of the digester, and allow operation at a higher loading rate.

In the two-stage process, the first stage provides digestion in a heated and mixed digester in a manner similar to a single-stage process. The purpose of a second stage is to store and concentrate the biosolids. The biosolids are concentrated by gravity thickening and by decanting of supernatant liquor. The design of the secondary stage is similar to the primary stage, except that it is neither heated nor mixed. Although this process was typical through the mid-1900s, it lost favor when waste activated sludge was included in the digestion process. Digesting only primary solids results in a relatively well defined separation between solids and the liquid surface so the clear supernatant could be removed. With biological solids (WAS), there is no clear separation and the supernatant liquor stream is high in solids and organic load.  Recycling this supernatant can overload the treatment plant process. Two-stage digestion is not recommended for mixed primary solids and WAS. Digesters fed only WAS are rare and can experience severe foaming. Ultrasound, thermal hydrolysis, and other techniques are in development to better digest WAS.

Some design criteria for the more common single-stage, high-rate digestion process are listed in Table 2-8.

**TABLE 2-8**
Typical Design Criteria for Single-Stage, High-Rate Mesophilic Anaerobic Digestion

| Criteria | Values |
|---|---|
| Solids Retention Time | 15 to 20 days |
| Solids Loading | 0.10 to 0.20 lbs Volatile Suspended Solids (VSS) / cf. / day |
| Ammonia levels | Below 1,000 mg/L |

For reducing high capital costs, thickening is typical before digestion

A moderate level of operator control is required to keep the process in proper balance. Methane-producing bacteria are highly sensitive to even slight changes in pH. The pH should be maintained as close as possible to 7.0. If the buffering capacity within the digester is not sufficient to neutralize the acetic acid produced by the biological reactions, it may be necessary to increase the alkalinity. The least expensive way of increasing alkalinity is by the addition of sodium bicarbonate. Other operational considerations include maintenance of temperature within a fairly narrow range (changes as small as 2 or 3 degrees can be enough to disrupt the balance between the acid and methane formers), minimization of foaming, and prevention of toxic materials such as heavy metals and sulfides from upsetting digestion. Digesters require a fairly high level of maintenance which primarily includes periodic cleaning to remove build-up of inert solids, maintenance of equipment for collecting and using or wasting digester gas, and maintenance of boilers or a cogeneration system for heating the digesters. Since the methane produced is usually used for heating the digesters, there is little energy cost for heating. There is, however, power cost for mixing the contents of the digester. Power costs can be reduced through cogeneration of electricity along with heat from combustion of methane gas produced in the digesters.

Several variations of mesophilic digestion are being tested by agencies around the United States. One of the more promising variations involves a two-stage acid / methane process. The first stage usually involves digestion by acid-forming bacteria that have relatively short reproduction cycles. The short reproduction cycle allows the first-stage reactors to be smaller and have shorter solids retention times, on the order of 1 to 2 days. The second stage has a longer retention time of about 15 days (and correspondingly larger digesters), which allows methane-forming bacteria to convert the acids generated in the first stage into methane. The second stage also breaks down odors that are developed in the first stage.

Advantages and disadvantages of the high-rate mesophilic anaerobic digestion process are as follows:

## Advantages

- Production of a valuable end-product, methane gas, that can be used to produce heat and electricity for the digestion process and other uses
- Relatively low operating costs
- The digested biosolids meet Class B pathogen levels and are suitable for reuse on land as a soil conditioner
- The mass of solids is reduced by volatile solids destruction
- No supernatant (single-stage)
- Commonly used and well understood process

## Disadvantages

- Methane-producing bacteria are slow growing and sensitive to process upsets
- Digesters have high capital costs
- Relatively complex operation
- Potential risk from methane gas leak
- Dewaterability is less than raw solids
- Supernatant (two-stage), which can be difficult to treat

### Applicability to SBWRD

Mesophilic anaerobic digestion is rarely used with only WAS and is not recommended for further evaluation.

## Thermophilic Anaerobic Digestion

Thermophilic anaerobic digestion is similar in principle to mesophilic anaerobic digestion, except that digester temperatures range from 122ºF to 140ºF (50ºC to 60ºC). Methane-forming bacteria are active in the thermophilic temperature zone. However, thermophilic microorganisms are very sensitive to temperature fluctuations. Therefore, it is essential to have excellent process control.

One advantage of thermophilic anaerobic digestion, as compared to mesophilic, is that there is a faster reaction time due to the higher temperatures. Thus a shorter detention time and smaller digesters can be used. For single-stage "conventional" thermophilic anaerobic digestion, a typical solids retention time might be 15 days or less. Thermophilic anaerobic digestion may also improve volatile solids destruction, pathogen destruction, and dewatering of the digested solids. The EPA has classified this process as a PFRP which has been demonstrated to produce Class A pathogen levels when operated in a batch mode.

Since volatile solids destruction can best be accomplished in a continuously mixed tank reactor, and pathogen destruction is favored by plug flow, it is not uncommon for thermophilic anaerobic digestion to include two or more reactors operating in series. The primary or secondary reactors can have very short detention times (solid retention times of about 1.5 to 5 days). The smaller reactors can also be operated in batch or continuous flow modes. This mode of operation is referred to as extended or staged thermophilic anaerobic digestion. Thermophilic systems inherently produce more alkalinity than mesophilic systems and are more resistant to pH changes, but less resistant to fluctuations in temperature.

Major advantages and disadvantages of thermophilic anaerobic digestion in comparison to mesophilic anaerobic digestion are as follows:

### Advantages

- Increased reaction rates, resulting in slightly smaller digester volumes
- Slightly more volatile solids destruction
- Higher gas production
- Possibly improved dewatering characteristics
- Decreased foaming
- With a staged system, may be able to produce Class A pathogen levels

### Disadvantages

- Greater microorganism sensitivity to temperature fluctuations
- Higher operation costs and temperature require increased energy and tight process control
- More offensive odors produced than mesophilic anaerobic digestion
- Increased moisture in digester gas
- Limited operating experience as compared to mesophilic digestion

### Applicability to SBWRD

Thermophilic anaerobic digestion is rarely used with only WAS. Therefore, it is not recommended for further evaluation.

## Thermal Hydrolysis and Pasteurization

Thermal hydrolysis and pasteurization processes use high pressures and temperatures to breakdown and dissolve solids. Solids are then transferred to an anaerobic digestion process for stabilization. The hydrolysis and pasteurization processes can provide Class A pathogen reduction and can increase the amount of volatile solids reduction that can be achieved in the digestion step. A thermal hydrolysis process can be integrated into existing and new solids treatment plants. This process is relatively new in the United States, but the City of San Francisco is currently conducting pilot tests. Several thermal hydrolysis facilities have been constructed in Europe.

In one proprietary, patented process developed by Cambi, solids are cooked under high pressure and temperature (133°C to200°C). The organic components in the solids dissolve in water. Cell structures in the sludge break open (lyse) under the temperature and pressure used. Energy-rich compounds from the cells are then dissolved. In addition, pathogens are destroyed so that Class A pathogen density levels are produced.

The hydrolysis process creates large amounts of organic acids, which are effectively broken down into biogas in a digester. Because of the solubilization of solids material, biogas production can increase significantly when compared to conventional processes. As much as 55 to 70 percent of the organic material can be converted to biogas. This increase in energy production may be larger than the energy consumption needed in the hydrolysis process, so the process can provide an energy surplus. The biogas can be burned in a cogeneration system to produce heat and electricity used by the treatment plant. The excess heat from this installation may be sufficient to supply the hydrolysis process with all required heat energy.

The hydrolysis process may improve the dewaterability of the digested solids since water inside cells is released when cell walls are lysed.

The hydrolysis process may reduce the volume of digesters required to stabilize the solids. Due to pre-dewatering and viscosity changes in the hydrolysis process, the digester can be loaded with a sludge concentration of 10 to 12 percent dry solids. In addition, because of cell lysing, the speed of digestion may increase. Together these factors can reduce the required digester volume.

The volume of material to be handled is reduced throughout the process. The process starts with a dewatering step that brings the concentration to around 15 percent before hydrolysis. The plant can therefore be compact when compared to conventional systems.

No plants using thermal hydrolysis exist in the United States, and only one plant in Europe uses thermal hydrolysis on a digester fed only WAS.

Major advantages and disadvantages of thermal hydrolysis and pasteurization are as follows:

### Advantages

- May increase biogas production
- Biosolids mass reduction; relatively high volatile solids reduction
- May increase capacity of existing digesters
- Relatively small footprint
- Produces Class A pathogen density levels

### Disadvantages

- Potentially strong odors from high temperature process
- High capital costs
- Minimal experience on WAS
- Mechanically complex

### Applicability to SBWRD

Thermal hydrolysis has been shown to be applicable to a WAS feed, and is recommended for further study. However, anaerobic digestion must follows this process. Costs and limited experience eliminate thermal hydrolysis from further consideration. Pasteurization, on the other hand, is not applicable to only WAS, and it also requires anaerobic digestion afterward. Therefore, pasteurization is not recommended for further evaluation.

## Lime Stabilization

Lime stabilization of biosolids has been a practical stabilization method for many years. The basic approach is to elevate the pH of the biosolids by the addition of one of several materials containing lime, either as calcium oxide (CaO - quicklime) or calcium hydroxide ($Ca[OH]_2$ - hydrated lime). Essentially, any material with sufficient alkalinity can be used. Certain methods of using cement-kiln dust for lime stabilization are covered by patents. Although there have been several claims, there are no known patents for use of other lime sources such as lime-kiln dust, fly ash, quicklime, and hydrated lime. There are, however, many proprietary equipment and associated process patents.

Lime stabilization can be used either before or after dewatering, or as part of the dewatering process. Lime dose requirements range from 10 to 50 percent of the dry solids weight, depending on a number of factors. Adding calcium oxide (quicklime) generates high pH values. It also generates high temperatures exceeding 55°C (131°F) when sufficient lime is added to dewatered biosolids. These high temperatures, if maintained for the approved time, help destroy pathogens in the biosolids. However, high pH volatilizes ammonia, and the high temperatures volatilize amines and other odorous compounds from the biosolids. Therefore, lime stabilization systems typically incorporate extensive odor control.

The objective of lime stabilization is to maintain the pH at a high enough level for a sufficient period of time to inactivate the microorganism population in the solids and control regrowth. Lime stabilization may also prevent odors from re-developing. EPA regulations dictate that the initial lime addition must maintain a pH of 12 or more for at least 2 hours to meet Class B pathogen levels. To meet these criteria, studies have found that the pH should be raised to 12.5 and maintained for at least 30 minutes at the start of the process, as the pH typically decreases slowly during and after stabilization. Stabilization by this process halts or substantially retards the microbial reactions that can otherwise lead to odor production and vector attraction. The process can also inactivate viruses, bacteria, and other microorganisms that are present. To meet the vector attraction reduction requirements set by the EPA, the above requirements for maintaining a pH of 12 for 2 hours must be satisfied, as well as maintaining the pH above 11.5 for the next 22 hours without the addition of more lime.

The dosage of a suitable stabilization product to achieve and maintain an elevated pH depends on a variety of factors, including:

- Chemical characteristics of the material used as the alkaline source (be careful of contaminants in the alkaline source)
- Chemical characteristics of the sewage solids, including both organic and inorganic constituents
- Physical characteristics of the sewage solids, including moisture content and viscosity
- Adequacy and speed of mixing the solids and the alkaline material
- Length of time high pH is to be maintained

Because of these variables, no systematic method has been developed that can predict the exact dose of stabilization product to meet a specific treatment objective, but there are many empirical methods.

The major advantages and disadvantages of the lime stabilization process are as follows:

### Advantages

- Simplicity of operation
- Low capital costs
- Organic nitrogen content of biosolids is not significantly reduced
- High pH and temperature reduce pathogens and the odor potential of the biosolids product
- Addition of lime may be seen as a benefit if biosolids are land-applied to acidic soils
- High temperature and conversion to calcium hydroxide increases the cake solids content

### Disadvantages

- High operating costs due to chemical consumption
- Difficult to handle chemicals
- Volatile solids are not oxidized, with risk of odors redeveloping
- Ammonia is released at high pH levels, requiring odor control
- The release of ammonia reduces the biosolids nitrogen levels significantly, and may therefore limit fertilizer value
- Biosolids products with a high pH may have restricted uses
- The dry mass and volume of the biosolids may be increased considerably
- Unlike anaerobic digestion, useable methane is not produced

### Applicability to SBWRD

Lime stabilization is recommended for further study. This is one option that may be accomplished by the District or outsourced. Use of lime on agricultural land may pose perception problems to local farmers as the soils in the area are primarily alkaline and the farmers normally do not want more alkaline material placed on the land.

## Facultative Solids Lagoons

Lagoons have been used for years to store, thicken, and stabilize wastewater biosolids. Because of the space requirements, aesthetics, and histories of process upsets, use of lagoons is often less desirable. Facultative solids lagoons, however, are designed to maintain an aerobic surface layer free of scum or film buildup. The aerobic layer is maintained by keeping the annual organic loading to the lagoon at or below a critical area-loading rate and by using surface mixers to maintain the dissolved oxygen level. Usually, the aerobic layer is between 1 to 3 feet deep. Organic matter is subject to aerobic stabilization in this top layer. In addition, algae growing in the lagoons use the nutrients and carbon dioxide that are released by both aerobic and anaerobic digestion. The algae growth helps keep the surface pH in the range of 7.5 to 8.5, which helps to minimize hydrogen sulfide release. Organic matter settles to an anaerobic layer which is generally in the range of 3 to 4 feet deep where anaerobic digestion takes place. In this layer, if the acid phase of digestion predominates, severe odors may be produced from the lagoons. For this reason, facultative solids lagoons are usually operated in conjunction with anaerobic digesters. Finally, solids settle to the bottom of the lagoon where some digestion continues to occur and the solids accumulate until they are harvested (removed).

Some of the common design criteria for facultative solids lagoons are listed in Table 2-9.

**TABLE 2-9**
Typical Design Criteria for Facultative Solids Lagoons

| Criteria | Values |
|---|---|
| Organic Loading Rate | 20 lbs VSS / 1,000 square foot of surface area / year |
| Surface Aeration | Varies (as needed to maintain aerobic conditions in top layer) |
| Depth | Aerobic Layer: 1 to 3 feet<br>Anaerobic Layer: up to 12 feet |

Other than periodic cleaning, facultative solids lagoons require very little operation and maintenance. When the lagoons are cleaned, however, a lagoon cell may be out of operation for 30 days or more, depending on the size of the cell. For this reason, multiple cells should be provided. One of the greatest concerns about facultative lagoons is the potential for odors. Lagoons have been operated successfully with minimal odors, but if odor emissions become a concern, they cannot be contained and treated because of the large surface area of the lagoons. Further, seasonal temperature changes can cause the lagoon to “turn-over” similar to lakes. When this occurs, odors are severe. Normally, this occurs with lagoons less that 12 feet-deep or lagoons which are over-loaded.

Major advantages and disadvantages of facultative solids lagoons are as follows:

### Advantages

- Provides long-term storage (may be 5 years or more)
- Continues anaerobic stabilization (20 percent more volatile solids reduction in first year)
- Low solids content in liquid supernatant which is returned to plant
- Natural means of pathogen reduction in biosolids, but still Class B pathogen levels
- Energy and operational efforts are minimal
- Once established, buffering capacity is difficult to upset
- Can provide flexibility of plant operations due to solids storage capacity
- Biosolids removal is independent of biosolids production

### Disadvantages

- Normally used following anaerobic digestion; if acid phase digestion takes place, lagoons will have odors
- Subject to process upsets due to rapid climate changes
- Requires large area
- Must be protected from flooding
- Supernatant return to treatment process will be high in total Kjeldahl nitrogen (TKN)
- Odors are difficult to mitigate

### Applicability to SBWRD

Facultative lagoons normally are used in conjunction with anaerobic digestion and are rarely used on raw solids. Because anaerobic digestion was dropped from further evaluation, the desirability of facultative lagoons is reduced, but they may be applicable at a remote site and to postpone disposal until more capital funds are available.

## Aerobic Digestion

Aerobic digestion is the biochemical oxidative stabilization of wastewater biosolids in open or closed tanks that are aerated. With the addition of oxygen and biological activity, organic matter is converted into cellular material and then, through endogenous respiration, to digested biosolids with the release of carbon dioxide and water. Because of its simplicity of operation and because it is less susceptible to upsets than anaerobic digestion, it became quite popular in the 1950s and 1960s. However, due to improvements in anaerobic digestion and high energy costs, today aerobic digestion is mostly used in smaller treatment facilities similar in size to the East Canyon and Silver Creek WRFs.

Aerobic digestion can be either performed in a semi-batch or in a continuous flow mode of operation. The continuous mode is probably the most common and is similar in operation to an activated sludge process. Aerobically digested biosolids overflow to a solids-liquid separation process where the solids are thickened. A portion of the thickened solids is recycled to the aerobic digester and the remaining solids are removed for further processing. There are many variables that affect the performance of aerobic digestion. Since most digesters are open to the atmosphere, the liquid temperature can vary considerably. With all biological processes, lower temperatures will retard the process and higher temperatures will accelerate the process. Oxygen transfer also has an impact on performance. While the amount of oxygen required is affected by factors such as temperature and biosolids age, in general, about 2 lbs of oxygen are required to degrade 1 lb of volatile solids. A concentration of 1 to 2 mg/L of oxygen should be maintained at all times in the digester. Aeration may be provided by mechanical surface aerators or by coarse or fine bubble diffusers at the bottom of the tank. Generally, the power requirement of aeration equipment are dictated by the mixing required to keep the solids in suspension rather than by the energy required to provide sufficient oxygen.

Aerobic digestion is classified as a PSRP for pathogen reduction, so it can produce Class B pathogen levels. To demonstrate that the process is performing properly for pathogen levels, the solids residence time and temperature must be between 40 days at 68ºF (20ºC) and 60 days at 59ºF (15ºC). To achieve vector attraction reduction, one of following three methods may be used:

- Volatile solids reduction must be greater than 38 percent, or
- If volatile solids reduction is not achieved, further testing may be done to show the solids are sufficiently stabilized, or
- A Standard Oxygen Uptake Rate (SOUR) test is done at 68ºF (20ºC) and must be less than or equal to 1.5 milligrams (mg) of oxygen per hour per gram of total solids

A summary of typical design parameters is listed in Table 2-10.

**TABLE 2-10**
Typical Design Criteria for Aerobic Digestion

| Criteria | Values |
|---|---|
| Solids Retention Time | 10 to 20 days<br>(depends on temperature and type of solids) |
| VSS Loading Rate | 0.02 to 0.14 lbs. / cubic foot / day<br>(depends on temperature and type of solids) |
| Aeration Requirements – Diffuser System | 20 – 60 cubic feet per minute (cfm) / 1,000 cubic foot<br>(1 – 2 mg/L dissolved oxygen plus mixing) |
| Aeration Requirements – Mechanical System | 1.0 – 1.25 horsepower (hp) / 1,000 cubic foot |
| VSS Reduction | 30 to 50 percent |
| Solids Concentration | 2 to 4 percent |

More work has been done in recent years to better define the aerobic digestion process so that it will meet the Class B pathogen density levels. It has been shown that two or more reactors in series (staged) can be designed to achieve 38 percent volatile solids reduction, something that has been difficult to do with the typical single-stage system. EPA recognizes the effectiveness of staged reactors and gives a 33 percent credit to the minimum times required for digestion. For example, instead of 40 days at 20ºC and 60 days at 15ºC, EPA will accept 28 days at 20ºC and 40 days at 15ºC when staged reactors are used.

Another variation of aerobic digestion is the use of pre-thickening and even covered tanks. Endogenous respiration generates heat, and if the system is properly designed, the temperature of the process can be consistently maintained at 20ºC so the design can be for 28 days, even in very cold climates such as the Snyderville area. Only a portion of the solids are thickened to maintain a preset solids content. Thickening to a higher solids content can cause the digester to achieve thermophilic temperature causing significant foam and very obnoxious and lingering odors. This system, if properly designed, is called Autothermal Thermophilic Aerobic Digestion (ATAD) and is discussed in a subsequent section of this document.

Aerobically-digested biosolids are difficult to dewater mechanically compared to raw solids or anaerobically digested biosolids. In addition, the dewatering properties of aerobically digested biosolids deteriorate with increasing solids age. Other advantages and disadvantages are as follows:

### Advantages

- Relatively simple to operate
- Requires a small capital expenditure compared with anaerobic digestion
- Does not generate significant odors
- Reduces pathogenic organisms to Class B levels
- Reduces the quantity of grease and hexane solubles
- Reduces the respiration rate of solids

### Disadvantages

- High power requirements and operating costs
- Highly variable design parameters
- Variable performance based on temperature, location, and tank design
- Thickened biosolids have poor mechanical dewatering properties
- Insufficient aeration will cause odors
- Unlike anaerobic digestion, useable methane is not produced

### Applicability to SBWRD

Aerobic digestion is the typical stabilization process for plants similar in size to the East Canyon and Silver Creek WRFs. It will therefore be evaluated further.

## Autothermal Thermophilic Aerobic Digestion

An off-shoot of aerobic digestion is ATAD. It achieves thermophilic temperatures (normally 60ºC to 65ºC [140ºF to 150ºF]) using endogenous respiration without supplemental fuel. The aerobic bacteria degrade organic matter to carbon dioxide, water, and nitrogen products (endogenous respiration) during which heat is released. Higher temperatures cause biological reactions to occur more rapidly, so this process can achieve the pathogen reduction necessary to produce Class A pathogen density levels via pasteurization and over 38 percent volatile solids reduction to meet vector attraction reduction regulations, all in less than 10 days.

As with any process to produce Class A, it must use staged batch reactors, normally two in series. As stated previously, one of the disadvantages of thermophilic temperatures is foam generation. Due to the amount of equipment used in this process, it is usually a patented system by a single manufacturer, and foam "cutters" are a standard part of every design.

Almost all of the systems in operation in North America and Europe apply the resulting biosolids on land as a liquid. Two plants in the United States included dewatering, and it was found that the polymer consumption was excessively high unless a metal salt such as ferric chloride was added prior to polymer addition. Prior to using metal salts, polymer costs were $140 to $160 per dry ton of feed solids. Using metal salts, the total costs of chemical conditioning (metal salts and polymer), was reduced to $60 to $80 per dry ton of solids, which is still very high. Typically, chemical conditioning for anaerobically- or aerobically-digested biosolids is in the range of $20 to $30 per dry ton of feed solids.

The other issue with ATAD has been odors. Thermophilic temperatures produce proprionic acids and many other odorous compounds that are reduced by lower temperature digestion. These odors are especially obnoxious to both the plant staff and the public. Mesophilic [~38ºC (100ºF)] aerobic digestion following the ATAD process has been found to reduce the odors significantly and improve the dewatering characteristics.

Other advantages and disadvantages include the following:

### Advantages

- Relatively simple to operate
- Requires a small capital expenditure compared with aerobic digestion (due to shorter detention time)
- Applicable to WAS
- No heat is required except for startup (unless oxidation ditch treatment achieves a very stable sludge with low volatile solids).
- Reduces pathogenic organisms to Class A levels
- Reduces the quantity of grease and hexane solubles

### Disadvantages

- High power requirements and operating costs for mixing and heating (if needed)
- High potential for odor control
- Forming may be a problem
- Pre-thickening required
- Biosolids have poor mechanical dewatering properties
- Unlike anaerobic digestion, useable methane is not produced

### Applicability to SBWRD

ATAD is a typical process for smaller treatment plants that only produce WAS such as the Silver Creek and East Canyon WRFs. However, with odors being a major issue at SBWRD and the high historical potential for odors with ATAD, this stabilization process will not be evaluated further.

# Post-Stabilization Thickening

After most stabilization processes, the solids content normally is reduced due to the destruction of volatile solids and production of water through oxidation. Some processes that follow stabilization benefit from higher solids content that can be achieved using the same pre-stabilization thickening processes noted above. The reason for post-thickening is to increase the solids content to reduce the volume to be hauled or stored. For example, some plants thicken digested biosolids so they require less storage during the cold winter months when biosolids cannot be applied to land.

Differences between pre-stabilization thickening and post-stabilization thickening are noted in the following sections.

## Applicability to SBWRD

Post-thickening is only required with alternatives which reuse or dispose of a thickened product. For virtually all alternatives, this will not be the case. As such, post-thickening will only be evaluated in very specific cases.

## Gravity Belt Thickeners

Gravity belt thickeners have been previously discussed. The only differences between pre- and post-stabilization thickening are:

- Higher solids loading to the thickener
- Greater concentrations of solids in the feed
- Greater polymer demand
- Similar to lower thickened solids content in the product

## Rotary Drum Thickeners

Rotary drum thickeners have been previously discussed. The only differences between pre- and post-stabilization thickening are the concentrations of solids in the feed, the amount of polymer required, and the concentration of the thickened solids. These differences in the pre- and post-stabilization thickening are very similar to the changes noted for the gravity belt thickener.

## Centrifuges

A discussion of centrifuges has been presented in a previous section. Centrifuges have been used to thicken and dewater a variety of different biosolids. Their performance varies depending on the solids concentration coming into the centrifuge and the amount of polymer used. For example, for aerobically digested waste-activated biosolids having a solids concentration of 2 to 4 percent, centrifuges are capable of producing 6 to 8 percent cake solids and 90 to 95 percent solids recovery with a polymer use of 10 to 15 lbs of dry polymer per ton of feed solids.

# Dewatering

The next physical step in the treatment process involves removing more water, or dewatering. Dewatering can occur directly after stabilization without post-stabilization thickening. In addition, raw solids may be dewatered prior to lime stabilization or other processes.

## Belt Filter Press

Belt filter presses are commonly used for dewatering biosolids. Since the 1960s they have become quite popular, and one is currently used in the Silver Creek WRF. With any belt filter press, there are four basic stages: chemical conditioning of the feed slurry, gravity drainage to a nonfluid consistency, preparing the solids for further shearing in the wedge section, and compaction and shearing of the biosolids. Good chemical conditioning is the key to consistent performance of a belt filter press which depends on the type and amount of polymer used and adequate mixing. In the gravity drainage stage, the conditioned solids are discharged onto a moving belt. Typically, 1 to 2 minutes are required for gravity drainage, and solids are reduced in volume by about 50 percent to a solids concentration of about 6 to 10 percent (similar to a gravity belt thickener). In the final stage, the solids are subjected to an increase in pressure, usually by the compression and shearing between the carrying belt and a cover belt. There are many manufacturers of belt filter presses and a large variation in the configuration of the different stages. Table 2-11 shows the typical performance of belt filter presses with different types of biosolids.

**TABLE 2-11**
Typical Performance Data For Belt Filter Presses

| Type of Biosolids | Dry Feed Solids (%) | Loading Per Meter Belt Width | | Dry Polymer[a] | Cake Solids (%) | |
|---|---|---|---|---|---|---|
| | | L/s[c] | Kg/h[d] | (g/kg[e] Dry Solids) | Typical | Range |
| Raw primary (P) | 3-7 | 1.9-3.2 | 360-550 | 1-4 | 28 | 26-32 |
| Waste activated Solids (WAS) | 1-4 | 0.6-2.5 | 45-180 | 3-10 | 15 | 12-20 |
| P + WAS (50:50)[b] | 3-6 | 1.3-3.2 | 180-320 | 2-8 | 23 | 20-28 |
| P + WAS (40:60)[b] | 3-6 | 1.3-3.2 | 180-320 | 2-10 | 20 | 18-25 |
| P + Trickling Filter (TF) | 3-6 | 1.3-3.2 | 180-320 | 2-8 | 25 | 23-30 |
| Anaerobically digested: | | | | | | |
| P | 3-7 | 1.9-3.2 | 360-550 | 2-5 | 28 | 24-30 |
| WAS | 3-4 | 0.6-2.5 | 45-135 | 4-10 | 15 | 12-20 |
| P + WAS | 3-6 | 1.3-3.2 | 180-320 | 3-8 | 22 | 20-25 |
| Aerobically digested: | | | | | | |
| P + WAS, unthickened | 1-3 | 0.6-3.2 | 135-225 | 2-8 | 16 | 12-20 |
| P + WAS (50:50), thickened | 4-8 | 0.6-3.2 | 135-225 | 2-8 | 18 | 12-25 |
| Oxygen activated | | | | | | |
| WAS | 1-3 | 0.6-2.5 | 90-180 | 4-10 | 18 | 15-23 |

**Notes:**
[a] Polymer needs based on high molecular weight polymer (100 percent strength, dry basis)
[b] Ratio is based on dry solids for the primary and WAS
[c] L/s x 15.85 = gpm
[d] kg/h x 2.205 = lbs. / hour
[e] g/kg x 2.0 = lbs. / ton

A considerable amount of washwater is required to keep the belts clean. Typically, secondary effluent or potable water is used for washwater. The combined filtrate and belt washwater flow is normally about one and one-half times the incoming flow. This combined flow contains between 100 and 1,000 mg/L of suspended solids and is typically returned to either the primary or the secondary treatment system. Belt presses have many moving parts that require maintenance and periodic replacement. Belts are the major wearing component and require replacement after every 3,000 hours of operation. Bearings and rollers are designed for longer operating lives, but without regular preventive maintenance, can require replacement in only a few years. Because of the large number of manufacturers and the differences between manufacturers, design criteria can best be determined by pilot testing specific equipment. Major advantages and disadvantages are as follows:

### Advantages

- Relatively low capital costs
- Relatively low power consumption
- High solids capture with minimum polymer requirements
- Continuous feed
- High reliability (high percentage of up-time)
- Moderate cake solids concentration
- Moderate throughput capabilities versus space requirement
- Open design provides good visual control capability for process performance

### Disadvantages

- Relatively high housekeeping required – containment is difficult
- Moderate operator attention requirements; larger installations may require continuous operator attention
- Odor potential due to filtrate splashing and lack of containment
- Sensitive to incoming feed characteristics

### Applicability to SBWRD

Belt filter presses are an excellent dewatering technology. The belt press at the Silver Creek WRF is older and approaching the end of it's useful life. Options for replacement will be evaluated. At the East Canyon WRF, the centrifuges are new and replacement will not be considered unless there is a significant process requirement for a different type of dewatering (see discussion of pressurized filter systems).

## Centrifuges

A discussion of centrifuges was presented in a previous section. Centrifuges have been used to thicken and dewater a variety of different biosolids. Their performance varies depending on the solids concentration coming into the centrifuge and the amount of polymer used. A summary of typical performance for other biosolids is presented in Table 2-12.

**TABLE 2-12**
Typical Performance Data for a Conventional Solids Bowl Centrifuge

| Biosolids Type | Feed Solids Concentration (% solids) | Average Cake Solids Concentration (% solids) | Dry Polymer Required g/kg Feed Solids (lbs/ton) | Recovery Based on Centrate Solids (%) |
|---|---|---|---|---|
| Raw primary | 5-8 | 25-36 | 0.5-2.5 (1-5) | 90-95 |
| | | 28-36 | 0 | 70-90 |
| Anaerobically digested primary | 2-5 | 28-35 | 3-5 (6-10) | 98+ |
| | 9-12 | 30-35 | 0 | 65-80 |
| | | 25-30 | 0.5-1.5 (1-3) | 82-92 |
| Anaerobically digested primary irradiated at 400 krad | 2-5 | 29-35 | 3-5 (6-10) | 95+ |
| Waste activated | 0.5-3.0 | 8-12 | 5-8 (10-15) | 85-90 |
| Anaerobically digested waste activated | 1.3 | 8-10 | 1.5-3 (3-6) | 90-95 |
| Thermally conditioned: | | | | |
| Primary + waste activated | 9-14 | 35-40 | 0 | 75-85 |
| | 13-15 | 29-35 | 0.5-2 (1-4) | 90-95 |
| Primary + trickling filter | 7-10 | 35-40 | 0 | 60-70 |
| | | 30-35 | 1-2 (2-4) | 98+ |
| High lime | 10-12 | 30-50 | 0 | 90-95 |
| Raw primary + waste activated | 4-5 | 18-25 | 1.5-3.5 (3-7) | 90-95 |
| Anaerobically digested: | 2-4 | 15-18 | 3.5-5 (7-10) | 90-95 |
| (primary + WAS) | 4-7 | 17-21 | 2-4 (4-8) | 90-95 |
| Anaerobically digested (primary + WAS + trickling filter) | 1.5-2.5 | 18-23 | 1-2.5 (2-5) | 85-90 |
| | | 14-16 | 6-8 (12-15) | 85-90 |

Within the past 10 years, technical advances have developed what is referred to in the industry as a "high solids" centrifuge. These machines are basically the same as a normal solid-bowl centrifuge, but operate at a very low differential speed between the bowl and scroll (normally 5 rpm difference compared to about 50 rpm or more for conventional centrifuges). This serves to completely fill the centrifuge and produces a high-pressure squeezing action. This change, coupled with significantly more polymer, can produce dewatered cakes 5 to 8 percent higher than conventional machines.

Historically it has been assumed since centrifuges entirely contain the solids during dewatering operations and the solids are not exposed to the ambient atmosphere, that centrifuges operate without release of odors. Recent installations, however, have found that odors can be and are released from the solids as they exit the centrifuge and are transported by conveying equipment and deposited into holding bins. As such, odor problems may be lower as compared to gravity belt thickeners or other more open systems, but are not entirely eliminated. It has also been found that storage of solids from high-solids centrifuges can result in very intensive odors.

## Drying Beds

Drying beds are primarily used in small communities because of the large land requirements and the potential for odors. However, there are a number of fairly large cities (population over 100,000) that use drying beds because little operator attention and skill is required. Air-drying is normally restricted to well-digested biosolids because raw biosolids are odorous, attract insects, and are generally nasty to handle. The design of drying beds is affected by many parameters. Climatic conditions, which include amount and rate of precipitation, percent of sunshine, air temperature, relative humidity and wind velocity are the most important. As a result, drying beds are favored in areas of low precipitation and high evaporation rates. Solids must be stabilized using aerobic or anaerobic digestion prior to application on the drying beds to reduce odors. In many third-world countries in Africa, drying beds are used for dewatering raw sludges because of the very high temperatures and vast expanses of land near the Sahara desert. In this process, only about 1 inch of liquid solids are applied to the beds. This dries very quickly and requires considerable land. Of course, odors and insects are a constant problem.

There are several designs commonly used in drying beds in the United States. Sand drying beds usually consist of 4 to 9 inches of sand over 8 to 18 inches of graded gravel and an underdrain system to collect filtrate that is returned to the treatment plant. Some drying beds are paved to facilitate removal of dried solids using mechanical equipment. Paving has the benefit of eliminating the need to periodically add more sand. Another variation is the wedge-wire drying bed. This approach uses a thin (1-inch) layer of water over a wedge wire. Solids are placed on top of this layer, allowing the solids to float without upward or downward pressure. The water is then drained by opening a control valve, which is throttled to prevent turbid effluent. After the free water has been drained, the bed is allowed to dry by drainage and evaporation until the solids can be removed. The wedge wire method is usually restricted to very small systems. Other drying bed configurations include vacuum-assisted drainage and addition of polymer as a coagulation aid to enhance solids/water separation.

Allowable solids loading rates for drying beds are highly variable. Factors influencing the allowable loading rate include the type of solids, climatic conditions, and drying bed design. Generally, loading rates are in the range of 15 to 30 lbs per square foot per year. The length of time the solids must remain on the drying bed also varies with climatic conditions. In dry weather, a cake of 45 percent solids can be achieved within 6 weeks. Solids contents of 85 to 90 percent have been achieved on drying beds. Most of the operation of a drying bed consists of removing the solids, which can be a considerable, but infrequent, effort.

Another possibility is to apply dewatered cake to land to obtain additional drying and further pathogen reduction. Research has found that this additional drying, coupled with long-term storage (at least one season), destroys pathogens such that Class A requirements are met. This is what some utilities in Utah are already doing. Also, private companies with large land holdings look at this method to beneficially use biosolids on rangeland.

A summary of advantages and disadvantages of drying beds is as follows:

### Advantages

- Where elaborate lining and leachate control is not necessary and where land is available, capital costs are low for small plants
- Low requirement for operator attention and skill
- Low electric power consumption
- Low sensitivity to biosolids variability
- Low or no polymer consumption
- Moderate to high dry cake solids contents

### Disadvantages

- Lack of standard design approach for sound economic analysis
- Large land requirement
- Solids must be stabilized before drying
- Impact of climatic effects on design are variable and difficult to predict
- High visibility to general public
- Labor-intensive biosolids removal
- Permitting and groundwater contamination concerns
- High fuel and equipment costs for bed cleaning systems
- Real or perceived odor and visual nuisances
- Effectiveness is weather dependent

### Applicability to SBWRD

Drying beds are not generally applicable for the District since the location of the plants would require many trucks to haul liquid biosolids to the drying operation. Also, unfavorable climatic conditions and potential odors would be major concerns. However, using remote sites for enhanced drying of already-dewatered cake may be viable, and for that reason, drying beds for dewatered cake will be evaluated further.

## Pressurized Filter Systems

Pressurized filter dewatering is usually accomplished by use of recessed-chamber filter presses. These systems operate on the principle of applying pressure to the material in a batch process to squeeze out water. There are two types of equipment that are commonly used: fixed and variable volume. In a fixed volume unit, cast iron, steel, or polypropylene plates are covered with filter cloths and compressed against the next plate to prevent leakage. Solids are added into the space between the plates (recessed chambers) and pressurized from 100 to 300 psig to force water from the solids through the cloth.

The variable-volume press uses a diaphragm constructed of rubber or other similar materials. Similar to the fixed-volume units, cloth is wrapped around the plates and the plate stack is assembled. The liquid material is introduced into the cavity between the plates. Pressure is applied to the material to separate the liquid from the solids as with the fixed-volume press. After a short time, air or water is forced in behind the diaphragms to squeeze the dewatering solids even further. The separated liquid is drained and the solids are retained in the press. The plates are opened at the end of the pressing cycle and the resulting cake is discharged to a hopper located below the press.

Pressure filtration is typically used for biosolids with poor dewaterability characteristics or where it is desirable to dewater to a solids content of above 30 percent solids. Typical solids cake concentrations can be in the range of 40 to 50 percent solids, depending on the amount of conditioning chemicals used. Lime, ferric chloride, fly ash, or polymer are used for conditioning. Each full cycle of operation requires about 1.5 to 2.0 hours for diaphragm systems, and up to 4 hours for fixed-volume systems. From an operation and maintenance perspective, removal of the solids cake and cleaning can require a fairly high level of labor. Design criteria are specific to the type of equipment used and the chemical conditioning that is applied. Depending on the chemical used for conditioning, odors can be a concern.

A recent development of the variable-volume filter press is the use of heat and vacuum. In this equipment, hot water or steam is applied to the diaphragm to squeeze the solids. This fluid is recycled sufficiently to heat the dewatering solids as well as perform the squeeze cycle. In addition, a vacuum is applied to the solids themselves. By using sufficiently high temperatures and a slight vacuum, water will evaporate at well under 100ºC (212ºF). Vacuum is applied in operating systems to cause evaporation at 160ºF to 180ºF. Using a longer cycle time, up to 8 hours, the cake solids can rise almost to 100 percent. During a 4 to 5 hour cycle, cake solids approaching 60 percent are possible. The use of steam has caused several plates to fail making this system most difficult to operate. The use of hot water, however, has been successful. The largest installation is currently under construction in Chattanooga, Tennessee.

Research by the two manufacturers, DryVac® and US Filter's J-Vap® has shown the cake to meet Class A pathogen density levels due to the time and temperature in the press. The high solids content, over 90 percent, will meet vector attraction reduction requirements. Use of this type of press will eliminate the need for the existing dewatering equipment.

Major advantages and disadvantages are as follows:

### Advantages

- Contained process minimizes housekeeping around the presses
- Relatively moderate power consumption
- High solids capture
- High cake solids concentration
- May produce Class A pathogen density levels if heat and vacuum are used
- Moderate noise potential.

### Disadvantages

- Batch operation
- Operator attention required during cake discharge, but none at other times
- Potential for poor cake release may require precoating on the press
- Odor potential
- Relatively high capital costs
- Moderate to high conditioning chemical requirements
- Hot water or steam and a vacuum system may be required
- Special support structure requirements

### Applicability to SBWRD

Conventional recessed chamber filter presses are not applicable to the District for the disadvantages cited above. The use of temperature and vacuum with a recessed chamber filter press may be viable, however. As such, this newer technology will remain for further evaluation.

## Vacuum Filtration

Rotary vacuum filtration is an old technology that is now used only for special applications such as dewatering thermally-conditioned biosolids and for some industrial applications that have a diatomaceous earth precoat. Its use has largely been diminished because of the high energy per unit of solids dewatered, the low cake solids content, and the high level of operator attention required.

### Applicability to SBWRD

Vacuum filtration is an antiquated technology and will not be evaluated further.

# Further Processing

There may be further processing steps required to meet the needs for the final use or disposal of wastewater solids. These processing steps may include further water removal to achieve solids contents greater than 90 percent or a product more favorable to the public. Thermally dried biosolids can be used directly on land or mixed with fertilizer. When composting, an organic peat-like product is produced which is appealing to landscape contractors and home gardeners.

## Thermal Drying

There are a number of thermal drying processes that can be used for evaporating water from wastewater solids. These include direct rotary dryers, indirect conductive dryers, vertical hearth dryers, flash dryers, infrared dryers and a number of proprietary processes that can produce a solids content of greater than 90 percent (e.g., 10 percent water). Dewatering using a process described above is required before solids can be thermally dried because the amount of energy required for thermal drying is greater than the energy required for mechanical dewatering. Thermal drying is usually used in conjunction with a final disposal option that requires Class A pathogen levels and a product that has commercial value. Thermal drying to a solids content greater than 85 percent achieves all vector attraction reduction requirements when no primary solids are included in the feed.

A stabilization process may be used ahead of thermal drying to reduce the total mass of feed solids to the dryer and to reduce product and processing odors. The drying processes considered are listed in Table 2-13.

**TABLE 2-13**
Thermal Drying Process Alternatives Used to Produce a Dried Product

| Thermal Drying Process Alternatives |
| --- |
| • Direct (Convective) Dryers<br>– Rotary Dryers<br>– Flash Dryers<br>• Indirect (Conductive) Dryers<br>• Other Processes<br>– Radiant<br>– Dielectric<br>– Microwave<br>– Carver Greenfield Process (multi-effect evaporation)<br>– Solvent extraction |

Methane gas produced by an anaerobic digestion process could be used to replace some or all of the fuel required in the thermal drying process.

## Direct (Convective) Dryers

Direct, convective heat dryers include rotary dryers and spray or flash dryers. Rotary dryers are the most common and are used at several facilities in the United States, including Cobb County, Georgia; Boston (Deer Island), Massachusetts; New York, New York; Ocean County, New Jersey; Hagerstown, Maryland; and Largo and Tampa, Florida. Manufacturers of drying systems have developed methods of improving the thermal efficiencies. For example, Andritz and US Filter continuously recycle the sweep gases used to evaporate the water. The sweep gases are indirectly superheated, passed through the dryer, and then cooled to condense water to allow the gases to be recycled. The advantages and disadvantages are as follows:

### *Advantages*

- High heat transfer rates due to direct contact of the drying medium with the biosolids, thereby decreasing the residence time of the biosolids within the dryer
- Flexibility of temperature control achievable by varying the flow and / or temperature of the hot gas over the biosolids
- Multiple passes in rotary dryer uses minimal floor space.

### *Disadvantages*

- Potential for combustion and explosion of the biosolids material in the dryer
- Thermal inefficiency due to high sensible heat loss in the stack gases
- The large volume of off-gas requiring treatment for dust entrainment and odors

Recycling a portion of the exhaust air, condensing and scrubbing the exhaust air, and then burning the non-condensable off-gases after scrubbing can overcome the disadvantages.

Flash dryers are used at two facilities in Houston, Texas. The operation and maintenance of flash drying facilities are relatively complex. Also, dust from the process is extremely abrasive and can create explosive conditions. Other than the two Houston facilities, there are no flash dryer systems currently in use at wastewater treatment plants in the United States, as the others have been abandoned due to high operating costs. Currently, Houston is planning to abandon one facility and install more efficient direct, rotary dryers.

#### *Applicability to SBWRD*

Thermal drying is a viable technology and the direct, rotary dryers will be evaluated further as they represent the most feasible thermal drying systems for SBWRD facilities.

### Indirect (Conductive) Dryers

Several different types of indirect dryers are available, including heated agitation equipment such as the hollow disk, paddle, and helical screw dryers. Also included in this category are drum-type dryers with jacketed walls for the heat medium.

Hollow disk dryers have had odor problems at full-scale biosolids drying demonstration projects for King County (Seattle), Washington, and the City of Los Angeles (Hyperion), California. In Buffalo, New York, belt filter press dewatered solids are thermally dewatered in an indirect dryer to 35 percent solids concentration prior to incineration. This provides an autogenous feed (self-burning without supplemental fuel) for the incineration process. Thin film and paddle-type indirect dryers have been used for drying biosolids in Europe and Japan, but no facilities are operating in the United States. Within the past 10 years, a different type of dryer for small plants has been developed and installed. This is a large screw conveyor, in a cylindrical tube, surrounded by hot oil. This process has proved to be safe and quite easy to operate. It is manufactured by US Filter as the Dragon Dryer™. These systems, typical of most drying systems, are packaged complete by a single manufacturer because it has been recognized that the dryer is only one small part of an overall thermal drying system design.

The advantages and disadvantages are as follows:

#### *Advantages*

- Minimal volumes of off-gas are produced when compared to direct drying; a relatively low flow rate of purge gas is required to discharge the vapor resulting from the evaporated liquid
- Dust entrainment in the exhaust air is minimized when compared to direct dryers because the heating medium does not contact the biosolids
- The atmosphere inside the dryer is inherently inert, minimizing the potential explosive and fire hazards
- A variety of thermal media can be used, including gas, oil, and steam

#### *Disadvantages*

- High costs for providing a thermal source such as steam, hot water, or hot oil (if such a source is not readily available)
- Heat transfer surfaces could become fouled if not cleaned regularly
- Odors may be produced from the incompletely dried solids in the dryer

- Indirect drying produces a dusty product with relatively fine particles compared to a direct-dried product

#### *Applicability to SBWRD*

Thermal drying is a viable technology and the indirect dryers will be evaluated further. Only those dryers with experience on wastewater solids will be considered.

### Other Drying Processes

Other drying processes, such as radiant drying, dielectric drying, and microwave drying have high capital costs and have not been successfully used for municipal sewage biosolids drying.

Solvent extraction was evaluated by the cities of Seattle, Washington and Los Angeles, California, where it was determined that the process was not cost-effective. No full-scale facilities using the process on wastewater solids have been constructed.

The Carver-Greenfield process has been used primarily in the food and agricultural industries. The process is used to dry biosolids at two facilities in Japan and was used at the Los Angeles, California (Hyperion plant); Trenton, New Jersey; Ocean County, New Jersey; and Omaha, Nebraska for several years. The system at the Hyperion plant was plagued by operating problems and never reached its design capacity before it was shut down. Other Carver-Greenfield dryers have also been shut down.

Air drying is a relatively new technology that is gaining momentum with smaller plants in Europe. Several manufacturers provide such systems, but none of these systems are currently installed in the United States.

#### *Applicability to SBWRD*

Thermal drying is a viable technology, but the success rate for the other systems described above has been poor. Air drying may be a viable option and will be evaluated further, but not to the same level as other proven technologies.

## Composting

Composting is an aerobic, biological stabilization process that is used to produce composted biosolids. Compost is a stable, humus-like material, suitable for land application and horticultural uses. In the composting process, dewatered biosolids are aerobically digested at thermophilic temperatures (55°C to 60°C).

The organic feedstock must have the correct physical and chemical properties for composting to operate successfully. The material must have a carbon to nitrogen ratio of about 30 and contain approximately 45 percent dry solids (combination of solids, a bulking material, and a carbon source, if needed) at the beginning of the process. Wastewater solids typically have a carbon to nitrogen ratio of about 6 to 15, so additional carbon is necessary. The material must also be porous enough to allow air to circulate through the material during processing. The correct consistency is achieved by mixing the dewatered biosolids with recycled compost and a carbon source, usually wood chips or sawdust, prior to composting.

For composting to be viable, the biosolids are first dewatered to 15 to 20 percent total solids. Also, a relatively inexpensive, readily available supply of bulking agent is required.

Composting systems can be grouped into two general types: enclosed systems and open systems. Enclosed systems are those systems in which composting material is processed in an enclosed vessel (reactor) or in an enclosed building. Open systems are those systems in which composting material is not processed in a building or reactor. Open systems can be further divided into windrow and aerated static pile systems. Vermicomposting, a process similar to aerobic composting, is a variation that uses earthworms to breakdown the organic matter.

Windrow composting systems are being used at facilities in Los Angeles County, California; Austin, Texas; San Antonio, Texas; South San Francisco, California; Yarmouth, Massachusetts; and several other smaller facilities. Aerated static pile systems are being used at facilities in Philadelphia ,Pennsylvania; Davenport, Iowa; and several other sites.

Capital costs are somewhat higher for aerated static-pile composting than for the windrow method, but the annual operating costs are generally lower because of the reduced need for operation of a front-end loader or other pile-turning equipment.

Enclosed or in-vessel composting systems are used at several large facilities in the United States, including Baltimore, Maryland; Portland, Oregon; Schenectady, New York; Springfield, Massachusetts; Las Virgenes, California; Cobb County, Georgia; and several other facilities. Enclosed composting systems have many different configurations. The types of systems available include agitated bed-, silo-, tunnel-, and bay-type systems. The agitated bed reactors are either circular vessels or long channels enclosed in a building. The silo- and tunnel-type systems are vertical and horizontal plug flow reactor systems, respectively.

Enclosed systems are designed to minimize odors and reduce composting process time by controlling environmental conditions such as air flow, temperature, and oxygen concentration.

The District has extensive experience with open composting at the Silver Creek WRF, but as many composting systems have discovered, odors are a major concern.

Major advantages and disadvantages of composting are as follows:

### Advantages

- Class A pathogen reduction if temperatures are maintained at greater than 55°C (131°F) for 3 consecutive days (aerated static pile system) or for 15 consecutive days and the pile is turned at least five times (windrow system)
- Good volatile solids destruction
- Easily handled product
- Odor-free final biosolids product
- Lower risk of groundwater and surface water contamination from compost product application

- Co-composting with municipal solid wastes (MSWs) and other organic wastes can be considered

#### Disadvantages

- High capital and operating costs
- Biosolids dewatering required prior to composting
- Relatively high land requirements (depending on the compost process used)
- Very high potential for odors during processing
- Regulations may restrict potential uses of compost product

#### Applicability to SBWRD

Composting is a viable alternative for further evaluation, although odors will be a primary concern. Composting may be used to stabilize all or a portion of the SBWRD solids, depending on local demand for the compost, and competing and cost-effective treatment and disposal options. From a process stability and uniformity of operations perspective, treatment of all the solids appears a more desirable scenario, especially since the demand for compost has historically exceeded the supply in the area.

Seasonal operation of outdoor composting likely would be necessary to avoid odors such as those experienced when the District operated composting through the winter months. Winter inversions have caused odors to travel to residences rather than be dispersed. Alternatively, enclosing the facilities and providing sufficient ventilation and scrubbing could enable year-round composting to take place.

# Beneficial Use or Disposal

The key to any solids treatment system is how the final product will be disposed or reused. After a decision has been made and verified for final product use or disposal, the treatment process can be designed to produce the required product.

## Land Application – Agricultural

Application of biosolids on agricultural land to help satisfy fertilizer requirements is a widely practiced method of biosolids use. As a partial replacement for commercial fertilizers, biosolids are a valuable source of nitrogen and phosphorus for grass and cereal crops. Biosolids also provide small amounts of potassium and many trace elements required by plants. A listing of essential plant nutrients is presented in Table 2-14.

Biosolids are also a good soil conditioner for soils with a low organic content, facilitating nutrient uptake, increasing water retention, permitting easier root penetration, and improving soil texture. However, biosolids may also contain elements that are not desirable for agricultural crops, such as certain metals and pathogens. The metals that are of most concern are defined in the regulations. Based on long-term experience from many years of biosolids application on land and extensive risk analyses, the risk to human and animal health is minimal when biosolids are processed and applied on land in accordance with existing regulations and management procedures.

Application limits are based on a wide variety of factors such as solids characteristics (particularly nutrients), soil chemistry, types of crops grown, method of application, climatic conditions, groundwater protection, and regulations. Nitrogen is typically the first biosolids component to limit the rate of biosolids application to land. Limits for heavy metals are defined in the regulations for annual and cumulative loadings that are based upon the amount of metals in the biosolids.

**TABLE 2-14**
Essential Nutrients for Life

| Type of Life | Macronutrients | Symbol | Micronutrients | Symbol |
|---|---|---|---|---|
| Essential to plants | Nitrogen | N | Chloride | Cl |
| | Phosphorus | P | Iron | Fe |
| | Potassium | K | Boron | B |
| | Sulfur | S | Manganese | Mn |
| | Calcium | Ca | Zinc | Zn |
| | Magnesium | Mg | Copper | Cu |
| | | | Molybdenum | Mo |
| | | | Cobalt [a] | Co |
| Essential to animals but not plants | None | | Selenium | Se |
| | | | Iodine | I |
| | | | Chromium | Cr |

[a] Cobalt is essential for nitrogen fixation in legumes.

Biosolids can generally be applied on agricultural land between April and December, depending on climatic conditions and when it is convenient for the farmer based on the type of crops being grown. Biosolids generally are not applied on frozen or snow-covered ground due to risks of runoff during thaw periods. Also, they cannot be applied during wet weather periods due to risks from runoff and because biosolids spreading equipment is unable to access the land. Generally, municipal programs apply biosolids 5 days per week (Monday to Friday). The number of spreading days available per year varies depending on the climate and rainfall, but is roughly 100 to 150 days per year.

The equipment and facilities needed for handling and applying liquid or dewatered biosolids include application vehicles, portable roadside storage tanks, road tankers or dump trucks, and a biosolids storage facility for storage during the winter months.

Generally, use of liquid or dewatered biosolids on agricultural lands is practiced in one of the following ways:

- Using liquid biosolids spreading vehicles equipped with flotation-type tires
- Using liquid biosolids spreading vehicles equipped with flotation-type tires and subsurface injection capabilities
- Using standard hauling vehicles not equipped with either flotation tires or subsurface injecting equipment
- Employing liquid biosolids spray irrigation

- Using spreading vehicles equipped with flotation-type tires; dewatered biosolids are incorporated into the soil following spreading using applicable equipment

Trucks are widely used for transporting both liquid and dewatered biosolids and are generally the most flexible means of transportation because terminal points and haul routes can be readily changed with minimal cost.

As noted above, many spreading configurations are available. The impact of method of incorporation on the ammonia and ammonium-N retained after biosolids application is shown in Table 2-15.

**TABLE 2-15**
Estimates of Ammonia + Ammonium-N Retained after Biosolids Application

| | Surface-Applied | | | | | |
|---|---|---|---|---|---|---|
| **Days to Incorporation by Tillage** | **Liquid Biosolids pH > 7 [a]** | **Dewatered Biosolids pH > 7 [a]** | **Liquid or Dewatered Biosolids pH < 7 [a]** | **Lime-Stabilized Biosolids [b]** | **Injected Biosolids** | **Composted or Drying Bed Biosolids** |
| | Ammonia + ammonium-N retained, percent of applied | | | | | |
| 0 to 2 | 80 | 60 | 90 | 10 | 100 | 100 |
| 3 to 6 | 70 | 50 | 90 | 10 | 100 | 100 |
| over 6 [c] | 60 | 40 | 90 | 10 | 100 | 100 |

[a] pH of biosolids immediately before application.
[b] For lime-stabilized biosolids analyzed for ammonia + ammonium-N before lime addition.
[c] If biosolids will not be incorporated by tillage, use over 6 days to incorporation.

Biosolids application vehicles are generally used only to apply the biosolids on the agricultural land. Road tanker trucks for liquid biosolids and dump trucks for dewatered biosolids are used to transport the biosolids from the treatment plant or biosolids storage facility to the agricultural utilization site. Portable roadside storage tanks for liquid biosolids or front-end loaders for dewatered biosolids are used to transfer biosolids from the road tankers or dump trucks to the application vehicles.

Major advantages and disadvantages are as follows:

### Advantages

- Nutrients in biosolids recycled for crop growth
- Benefit to farmers by reducing fertilizer costs
- May eliminates the need for biosolids dewatering

### Disadvantages

- Seasonal application; large storage facilities required
- Dependent on willingness of farmers and community to accept biosolids
- May cause odors if improperly applied
- Weather dependent

#### Applicability to SBWRD

Land application on agricultural land is a viable option that will be evaluated further.

### Land Application – Golf Courses and Parks

Use of biosolids products on public contact sites, such as recreational parks, ball fields, golf courses, and road embankments, has many of the same advantages as application on agricultural land. To protect the public, a higher degree of stabilization and pathogen destruction is required than is necessary for application on agricultural land. Stabilization processes, such as composting, thermal drying, and advanced alkaline stabilization are examples of acceptable stabilization processes.

Advantages and disadvantages include the following:

#### Advantages

- Potential revenue from sale of biosolids
- Public relations opportunity to provide highly visible and beneficial reuse of product directly within the community

#### Disadvantages

- High degree of processing required, and therefore costs are higher (Class A)
- A consistent product must be produced
- Potential liability due to public perceptions

#### Applicability to SBWRD

Land application on golf courses and parks is a viable option that will be evaluated further. A major disadvantage of this alternative is that Class A biosolids must be provided. Class B biosolids may only be applied to sites were there is low public contact and barriers must be provided to limit access. As such, it is generally accepted that Class A is the only product which will not interfere with public access.

### Land Application – Rangeland

Use of biosolids on rangeland to produce crops for cattle feed is an excellent use of biosolids, especially in this area where many acres of land are available. Work in New Mexico and Texas on rangeland has shown that biosolids application to land is very positive in virtually all areas. Some of the findings are based upon long-term tests at application rates which varied from 3 dry tons per acre per year up to single applications of 40 dry tons per acre. In all cases, the grass production after biosolids application increased significantly, sometimes more than double. The results were not dependent on whether it rained or not. Biosolids also reduced runoff and inhibited crust formation on the soil surface. As a side issue, cattle feeding on biosolids-treated grasses gained more weight and preferred the biosolids-treated grass about 70 percent of the time.

The major disadvantage is distance to available land, which greatly impacts cost. There are some major land owners in the Salt Lake City area that are interested in using biosolids on their rangeland.

Advantages and disadvantages of land application on rangeland include the following:

### Advantages

- Nutrients in biosolids improve grass production
- Benefit to land owners by providing needed nutrients to soil
- Allows previously barren land to be used for cattle grazing
- It may be possible to combine the solids treatment and disposal operations of two or more agencies using rangeland disposal. Two ranching/trucking operations have already approached the District regarding rangeland disposal, and at least one other area wastewater agency is considering this option with one of the operators. A smaller agency such as SBWRD could benefit from improved economies of scale by participating with a larger wastewater agency.
- In addition to the above, a regional agency concept where a larger number of the over 15 Wasatch front wastewater treatment agencies could participate and treat and dispose of some or all of their solids might also be feasible, considering rangeland disposal opportunities. Several area wastewater agencies potentially could benefit from this approach, especially smaller agencies such as SBWRD.

### Disadvantages

- Seasonal application; large storage facilities required
- Dependent on willingness of ranchers to accept biosolids
- Distance to large acreage adds to cost
- Weather dependent

### Applicability to SBWRD

Land application on rangeland is a viable option that will be evaluated further.

## Land Application – Forested Areas (Silviculture)

As with agricultural crops, forests can benefit from the application of biosolids. Trees can use nitrogen, phosphorus, organic matter, and micronutrients in biosolids. The biosolids may also improve the texture of the soil. Extensive brush growth generally occurs after biosolids application, which is generally beneficial for wildlife habitats.

Typical forest soils have high infiltration rates that reduce the risks of runoff and ponding. Odor is generally not a problem when stabilized biosolids are applied and there is sufficient distance from residences.

In a University of Washington study, trees grown on soils conditioned with biosolids were found to grow significantly faster than trees grown on soils that were not conditioned. Tree growth rings increased in diameter by 50 to 400 percent, and the value of the timber on an annual basis increased by greater than 50 percent.

The primary environmental and public health concern when applying stabilized biosolids to forested land is contamination of water supplies. The high infiltration rates and low nutrient uptake rates typical of forest soils can result in groundwater supplies being contaminated by nitrates. Studies conducted in the United States indicate that limiting the biosolids application rates on typical forest soils can prevent nitrate contamination of the groundwater. Successive biosolids applications on forested land are controlled by the nutrient requirements of the trees and the frequency with which the trees are harvested.

Unlike agricultural land, forested lands are generally on rough terrain, requiring special application vehicles and construction of a road system. Application to recently cleared forest sites is easier than in established forest sites because of increased accessibility for application equipment. However, many tree seedlings grown on sites with recent biosolids applications have poor survival rates due to competition with weeds and brush growth. Also, seedlings have lower nutrient uptake rates. Application in established forests often requires the cutting and clearing of 3-meter-wide trails for the application vehicles to access the land.

Forest species in established forests have nitrogen uptake rates ranging from 100 to 400 kilograms per hectare per year (kg/ha/year), which is in the same range as agricultural crops. Recently cleared areas and seedlings would have lower nitrogen uptake rates.

Forest soils are typically more acidic than agricultural sites. Soil pH values of less than 5.5 are common. Biosolids application on agricultural land having acidic soils with a pH less than 6.0 is prohibited because, as soil pH decreases, metals uptake into plants and metals infiltration into groundwater increase. Forest products are not food chain crops. Therefore, the risks to the public are generally not as great.

Application on forested land has been used for many years by King County (Seattle), Washington. Advantages and disadvantages include the following:

### Advantages

- Nutrients recycled for tree growth
- Biosolids dewatering not required
- Can improve natural habitat

### Disadvantages

- Consistent application rate is difficult due to rough terrain and limited trails for application vehicles
- Application to clear-cuts may affect tree survival due to weed and brush growth
- Distance to forested land may be prohibitive
- Slopes on forested land may be prohibitive for biosolids application

### Applicability to SBWRD

Land application on forested land may be a viable option that will be evaluated further.

## Land Application – Reclamation

Biosolids application has been successfully used to turn barren land into productive land. Land disturbed by mines, quarries, and sand and gravel pits left unreclaimed are often unsightly and can be harmful to the environment. Environmental problems include acid runoff, high erosion rates, low nutrient levels, and toxic levels of trace metals. Biosolids application can help resolve these problems. Typically, either dewatered alkaline or composted biosolids are used for reclaiming disturbed lands.

High biosolids application rates are necessary to introduce sufficient organic matter and nutrients into the soil to support vegetation and create a self-sustaining productive soil. Application rates in other areas have ranged from 7 to 450 dry tons per hectare and are typically about 100 dry tons per hectare.

Some contamination of ground and surface waters by nitrates can occur after biosolids application. However, with good site management, contamination is minimized and, generally, the contamination is negligible compared to the problems before reclamation. Good site management includes prompt revegetation after biosolids application and site leveling to reduce slopes. Also, dewatered, alkaline and/or composted biosolids application may be preferred to reduce the soluble nitrogen added to the soil and to minimize the nitrogen leached to the groundwater or runoff to surface waters. Alkaline or composted biosolids may be preferred where odors cannot be tolerated. Land reclamation of barren lands by application of biosolids has been used at many locations in the United States.

The major advantages and disadvantages of this alternative include the following:

### Advantages

- Organic matter and nutrients support vegetative growth
- Reduces environmental impacts
- Allows high application rates

### Disadvantages

- Pre-treatments to reduce risks of nutrient and pathogen runoff may be required
- Possibly long travel distances to application sites
- Sites may not be viable for long-term disposal after being restored
- Long-term accumulation of metals in soils may be a concern for land owners

### Applicability to SBWRD

Land reclamation using biosolids is a viable option on the Kennecott tailings west of Salt Lake City. However, the volume of biosolids produced by SBWRD likely is not sufficient for tailings reclamation to be economically desirable. Longer trip mileage from SBWRD, and traverses over steep and rugged hauling roads to relatively remote tailings disposal sites will increase wear and tear, and maintenance and replacement requirements for SBWRD vehicles. Also, Kennecott historically has been unwilling to commit in writing to long-term solids disposal contracts. Therefore, this alternative will not be further evaluated.

## Dedicated Land Disposal

Several municipalities in the United States dispose of biosolids on dedicated land disposal (DLD) fields. This method is generally used to dispose of digested biosolids with a solids content of 3 to 5 percent, but it may also be used for disposal of dewatered biosolids. DLD is considered surface disposal, as the nutrients in the biosolids are generally not used.

The land requirements for DLD are similar to the requirements for disposal in landfills and substantially less than the requirements for use on agricultural and forested land. Since the municipalities usually own the land, there is no need to convince farmers and forestry companies to accept the biosolids. Transportation costs are very economical when the land is located adjacent to the treatment plant.

Odor problems often require the land to be some distance away from highway and residential areas. Also, high metal concentrations in the soil after successive biosolids applications to the land may limit the future land uses.

For DLD, typical biosolids application rates are 50 to 100 dry tons of digested biosolids per acre per year, which is 5 to 10 times the application rate on agricultural land or rangeland. Leachate and runoff water collection and treatment may be required depending on the depth to groundwater. Installation and operation of groundwater monitoring wells is normally required.

DLD has been a popular method for biosolids disposal in the past because disposal is simple and economical, especially if the land is adjacent to the treatment plant. However, requirements for collection and treatment of leachate and runoff water increase costs. Also, potential odor problems and risks from groundwater contamination may make these methods undesirable. Major advantages and disadvantages are as follows:

### Advantages

- Land is usually owned and therefore controlled by municipality
- Process is usually very simple and economical

### Disadvantages

- No beneficial use of nutrients
- Eliminates land from other beneficial use and may restrict future use
- Leachate from runoff may have to be collected and monitored
- Groundwater monitoring wells may be required
- Stabilization is required for application to DLD fields
- Permitting is similar to that of a municipal landfill and may be difficult
- Odors may require land to be in a remote area that is difficult to access and may require a long hauling distance

### Applicability to SBWRD

DLD is a viable alternative and will be considered further. Distance to a suitable site may be a significant cost factor.

## Landfill Disposal

Stabilized biosolids may not always be suitable for land application because of insufficient land or poor biosolids quality. One alternative to agricultural land application is utilization/disposal of the solids at an approved landfill.

Biosolids may be landfilled in one of three ways:

- Combined with municipal solid waste (MSW)
- By itself [biosolids-only landfill (monofill)]
- Soil blending for landfill daily cover and/or top dressing

### Co-Disposal with Municipal Solid Waste

Co-disposal of biosolids with MSW is commonly practiced. The biosolids are spread in a layer at the active face and immediately blended into the MSW. Generally, biosolids are applied just before closing time so they can be immediately topped with the daily cover soil to prevent odors.

Landfilling of biosolids just before applying the daily cover may reduce the daily cover requirements because the biosolids tend to fill the void spaces in the garbage. However, biosolids with a high moisture content may actually increase daily cover requirements. Approximately 6 to 9 inches of topsoil is generally added for daily cover, of which approximately half is used to fill the void spaces in the garbage. Therefore, the biosolids could potentially use only a minimal amount of landfill volume.

Biosolids application can adversely affect landfill gas production by stimulating acid souring, which could inhibit methane production. Biosolids application should be coordinated with landfill gas-handling initiatives. Conversely, in several landfills, gas production has increased with the addition of biosolids because of the increased moisture and organic material.

Public access to the area to which the biosolids are disposed must be controlled to minimize health risks. Often, biosolids cannot be disposed until all public vehicles have departed.

In co-disposal, the refuse absorbs moisture from the biosolids, which reduces and slows leachate migration. The biosolids can act as a conditioner, improving the rate of refuse decomposition. The biosolids also promote the revegetation of the site when mixed with soil and used as a daily landfill cover.

A solids content greater than 15 percent is generally required for co-disposal with MSW to minimize operational problems. The requirement is based upon a paint-filter test as set forth in Subtitle D of 40 CFR Part 258 for landfill operation. Regardless, equipment operators prefer to mix about ten volumes of MSW per volume of biosolids so moisture does not create handling problems. Biosolids that are too wet impair equipment movement and compaction of the waste because the biosolids make the area too slippery. Potential odor problems are also a concern.

Advantages and disadvantages of this alternative include the following:

#### *Advantages*

- Year-round operation (not weather dependent)
- Reliable disposal method
- May reduce daily cover requirements
- Stabilization not required
- Problems with high metal or other contaminants in the biosolids not usually a problem
- Acts as conditioner to improve rate of refuse decomposition

#### *Disadvantages*

- Consumes landfill space
- High tipping fees
- Potential odor concerns
- May impair landfill gas production

- Dependence on landfill operator and regulations
- Requires public access restriction

### *Applicability to SBWRD*

Landfilling of biosolids is a viable option and will be considered further. Availability of landfills and the goal of the regulators to reduce the flow to landfills may eliminate this option.

## Monofill

Monofills, or biosolids-only landfills, are landfills that are operated solely for the disposal of wastewater biosolids and other wastewater treatment by-products, such as screenings and grit.

The trench-fill method involves excavating trenches so that biosolids, dewatered to greater than 15 percent solids concentration, may be buried below the original ground surface. Two types of trenches are used depending on the solids content of the biosolids.

Narrow trenches, 10 feet deep and less than 10 feet wide, are used to dispose of biosolids with a solids content between 15 and 30 percent solids. The biosolids must be less than 30 percent solids so the biosolids will spread evenly when placed into the narrow trench.

Wide trenches, 10 feet deep and greater than 10 feet wide, are used to dispose of biosolids with a solids content greater than 30 percent solids. The wide trenches allow biosolids hauling vehicles to work within the trench. The biosolids must be greater than 30 percent solids so it will stay in piles and not slump. In order to support vehicles, the biosolids must be mixed with soil or lime to provide structural integrity.

The wide-trench-fill method requires one-third less land than the narrow trench fill method. Also, disposal of biosolids with greater than 30percent solids will generate one-third the volume of leachate, compared to biosolids with 20 percent solids.

Normal operating procedure requires daily coverage of the trenches with excavated soil. Stabilized and unstabilized biosolids can be disposed of because the immediate application of cover material reduces associated odors and vector attraction. However, stabilized biosolids are recommended for this type of landfilling method because stabilization processes reduce the odor and number of pathogens in the biosolids. Unstabilized biosolids should only be disposed of using this method in cases of emergency, such as process upsets or failures.

The area fill method involves mixing the biosolids with topsoil and depositing the mixture on the ground surface similar to a MSW landfill. Substantial amounts of imported soil may be required, proportional to the moisture content of the biosolids. Normally, a 3:1 volume ratio of soil to biosolids is used with clay soils. Sandy soils reduce the amount of soil needed for equipment access. Therefore, it is desirable to dewater biosolids to greater than 30 percent total solids concentration to minimize soil requirements. The biosolids should be stabilized to minimize odor problems. Stabilization is required if a daily cover is not provided. One possible option is to design the monofill in a way to allow mining of the monofilled material after 5 to 10 years. With this time, pathogen densities will be reduced to Class A levels and the biosolids will be further stabilized to look and smell like dirt, allowing time for the development of a suitable market. The mined solids could also be used for mixing soil, but the soil to biosolids ratio may be higher.

Significant advantages and disadvantages are as follows:

#### *Advantages*

- Municipality has complete control of site and disposal method
- Mining and reuse of the monofilled material may be possible
- Economical means of final disposal

#### *Disadvantages*

- Could require imported cover material
- Low ground pressure vehicles are needed for an area fill
- Siting, transportation, and odor issues

#### *Applicability to SBWRD*

Monofilling is a viable option and will be considered for all or a portion of the solids produced.

### Landfill Cover Material

Landfill disposal has been, and continues to be, a popular biosolids disposal option, but there is ever-increasing competition for available landfill space. Producing highly stabilized biosolids suitable for landfill cover is becoming more attractive to municipalities to avoid the high costs of landfill tipping fees. It also can be attractive to the landfill operator where the landfill has a shortage of topsoil. Currently, E.T. Technologies is using the District's biosolids in this manner.

Only biosolids that have been highly stabilized to Class A pathogen levels have been used for daily cover. Processes such as composting and advanced alkaline stabilization produce highly stabilized biosolids that may be acceptable for landfill cover. Locally, however, solids are simply mixed with soil, stored for over one-year, and used for cover. Utah regulators are comfortable with this method.

Biosolids can generally be used as landfill cover or disposed in a landfill if the biosolids are not classified as a hazardous waste. Solid waste leachate extraction tests [Toxicity Characteristic Leaching Procedure (TCLP)] are used to determine if the waste is classified as hazardous or non-hazardous.

Since disposal of biosolids can generate a significant amount of leachate, the landfill must have adequate leachate collection and control systems to prevent groundwater contamination.

The requirements for transport of the biosolids from the treatment plant to the landfill should consider traffic impacts and the application period. The transportation route should be as much as possible on major highways and away from residential areas to prevent traffic congestion, odor, and noise problems. Major advantages and disadvantages include the following:

### *Advantages*

- Beneficial use of the biosolids and demand for high-quality daily cover material
- Virtually guarantees continuous disposal
- Offsets high tipping fees

### *Disadvantages*

- May require stabilization
- May require a leachate collection and disposal system to protect groundwater
- May require significant transportation to access the landfill

### *Applicability to SBWRD*

This is a viable option, but may not be dependable. Landfill cover will be evaluated further.

## Incineration and Ash Disposal

Incineration is a two-step oxidation process involving drying followed by combustion. Drying and combustion may be accomplished in separate units or successively in the same unit, depending upon temperature constraints and control parameters. The process consists of raising the temperature of the feed solids to 100ºC (212ºF) to evaporate the water from the solids, and then increasing the temperature of the dried solids to the point of ignition. It is a complex process involving thermal and chemical reactions that occur at varying times, temperatures, and locations in the furnace.

While there are a variety of different types of incineration equipment, the types of furnaces that are most commonly used in the United States are the multiple-hearth and the fluidized-bed incinerators. The multiple-hearth furnace has been the most widely used biosolids incinerator in the past, but the fluidized-bed is now the preferred incineration method due to combustion efficiency and cost.

The multiple-hearth furnace is durable, relatively simple to operate, and can handle a wide fluctuation in feed quality and loading rates. It is designed for continuous operation, because the fuel requirements and time needed to bring the furnace up to temperature from a cold start do not make it suitable for intermittent operation. In a multiple-hearth, biosolids are fed from the top. As the solids drop down from hearth to hearth, they are exposed to a countercurrent flow of hot gas. The solids are incinerated at the bottom of the hearth and the ash is discharged from the bottom of the incinerator.

In a fluidized-bed furnace, biosolids are introduced either above or directly into a bed of fluidized sand. The bed is heated to 1,400 to 1,500ºF (760 - 816ºC) and both drying and combustion occur in either the dense or dilute phases in the sand bed. Combustion gases and ash are carried to the top of the furnace, where the ash is removed by venturi scrubbers or a similar air pollution device. Some of the sand is carried out with the ash and periodically has to be replaced (5 percent of the bed volume every 300 hours of operation).

The design criteria for incineration are highly dependent upon the data that is provided by each equipment manufacturer and vary dramatically from vendor to vendor and between the various types of furnaces. A critical component in design revolves around preparing a heat and material balance calculation for the furnace. Additional consideration must be given to meeting air quality requirements and final disposal of the ash. Typically, the ash is disposed of in a municipal landfill, but there are also some potential beneficial uses of the ash such as brick making. While there are advantages and disadvantage for each type of incineration furnace, some of the common advantages and disadvantages include the following:

### Advantages

- Maximum solids reduction
- Possible energy recovery
- Pathogens eliminated
- Stable, odorless ash

### Disadvantages

- High operation and maintenance costs
- High capital costs
- Ash may be hazardous due to metal leachability
- Air pollution control requirements can be prohibitive
- Maximum possible dewatering is essential to reduce cost of evaporating excess water
- Negative public perception

A key element of any incineration device is permitting. Both the Clean Air Act Amendments and the biosolids regulations impact incineration and govern its performance and use. Further, the Snyderville Basin inversions would require excessively tall stacks to prevent a severe air quality impact locally. In addition, public perceptions of incineration still tend to be negative, which has eliminated some otherwise technically viable projects.

### Applicability to SBWRD

Incineration will not be evaluated further due to high cost and air quality issues.

## Summary

Table 2-16 summarizes the conclusions discussed in each discussion of the various biosolids processing alternatives.

**TABLE 2-16**
Summary of Biosolids Management Technologies

| Process | Further Evaluation | | Comments |
|---|---|---|---|
| | Accept | Reject | |
| **Pre-Stabilization Thickening:** | | | |
| Gravity Thickeners | | X | Proven poor performance on WAS |
| Dissolved Air Flotation Thickeners | X | | Only to be used with stabilization |
| Gravity Belt Thickeners | X | | Only to be used with stabilization |
| Rotary Drum Thickeners | X | | Only to be used with stabilization |

**TABLE 2-16**
Summary of Biosolids Management Technologies

| Process | Further Evaluation Accept | Further Evaluation Reject | Comments |
|---|---|---|---|
| Centrifuges | X | | Only to be used with stabilization |
| **Stabilization:** | | | |
| Conventional (Mesophilic) Anaerobic Digestion | | X | Infrequently used with WAS only |
| Thermophilic Anaerobic Digestion | | X | Rarely used with WAS only |
| Aerobic Digestion | X | | Common process |
| Autothermal Thermophilic Aerobic Digestion (ATAD) | | X | Odors, high operation costs, tight process control |
| Facultative Lagoon Stabilization | X | | Normally used after digestion |
| Thermal Hydrolysis | | X | High cost due to need for anaerobic digestion. |
| Pasteurization | | X | High cost due to need for anaerobic digestion. Not used with WAS. |
| Lime Stabilization of Undigested Solids | X | | Class A or B pathogen levels can be produced |
| **Post-Stabilization Thickening:** | | | |
| Gravity Belt Thickeners | X | | Not to be used with dewatering |
| Rotary Drum Thickeners | X | | Not to be used with dewatering |
| Centrifuges | X | | Not to be used with dewatering |
| **Dewatering:** | | | |
| Belt Filter Presses | X | | Presently used at Silver Creek WRF |
| Centrifuges | X | | Presently used at East Canyon WRF |
| Drying Beds | X | | Only for remote off-site application |
| Pressure Filters | X | | Only with heat and vacuum technology |
| Vacuum Filters | | X | Antiquated and inefficient |
| **Further Processing:** | | | |
| Thermal Dryers | X | | Only rotary or belt dryers to be considered |
| Composting | X | | Odors are major concern |
| **Disposal/Beneficial Use:** | | | |
| Land Application – Agricultural | X | | Limited agricultural land available |
| Land Application – Golf Courses and Parks | X | | Class A must be produced |

**TABLE 2-16**
Summary of Biosolids Management Technologies

| Process | Further Evaluation | | Comments |
|---|---|---|---|
| | Accept | Reject | |
| Land Application – Forested Areas (Silviculture) | X | | |
| Land Application – Rangeland | X | | |
| Land Application – Land Reclamation | X | | Kennecott |
| Dedicated Land Disposal | X | | |
| Monofill Disposal | X | | |
| Landfill Disposal or Use as Daily Cover | X | | |
| Incineration and Ash Disposal | | X | High cost and air quality issues |

# Solids Management Master Plan
# Biosolids Regulations

PREPARED FOR: Snyderville Basin Water Reclamation District

PREPARED BY: CH2M HILL

DATE: March 17, 2003

## Contents



## Introduction

This technical memorandum describes existing federal, state, and local regulations for biosolids management methods, such as land application (which includes the distribution and marketing of compost, alkaline stabilized biosolids, heat-dried pellets, etc.), surface disposal, and incineration. In addition, potential impacts of regulatory trends are provided to envisage how certain biosolids management practices may be affected in the future. It is important to note that these potential impacts are based on best professional judgement and available information. Final regulations and associated impacts may differ from the views contained in this report.

The following regulations, issues, and potential impacts to the Snyderville Basin Water Reclamation District's (SBWRD or District) biosolids management program are discussed:

- Federal 40 CFR Part 503 Regulations, *Standards for the Use and Disposal of Sewage Sludge*
- Federal Clean Air Act Amendments (CAAA)
- State of Utah regulations
- Local county and city regulations
- Future regulations (pertaining to dioxins, incineration, radioactivity, mercury, and nutrient management)

Table 3-1 presents a summary of the regulations affecting the District.

# Purpose

The purpose of this TM is to identify and evaluate biosolids issues with respect to the District's biosolids management program.

There are four major categories of issues addressed:

- **Existing Regulatory Issues**. Existing regulations are discussed with respect to the District's biosolids quality.
- **Future Regulatory Issues**. Future regulations are discussed pertaining to dioxins, dibenzofurans, polychlorinated biphenyls (PCBs), incineration, radioactivity, mercury, and nutrients.
- **Public Acceptance**. The public is becoming increasingly aware and interested in environmental issues, including biosolids management. Factors for consideration when evaluating viable biosolids management options are presented.
- **National Practices and Trends**. Several national initiatives are currently underway that will most likely affect how biosolids programs are managed in the future. This TM introduces several of these initiatives and projects how they may affect biosolids programs across the United States.

**TABLE 3-1**

Summary of Issues and Potential Impacts

| Biosolids Issue | General Description | Comments |
|---|---|---|
| Existing Regulatory Issues<br>*Federal 40 CFR Part 503 Regulations* | The EPA promulgated the Part 503 Regulations in February 1993 and amended them in August 1999.<br>**Subpart A, General Provisions** – The Part 503 regulation applies to biosolids that are land-applied, surface disposed, or incinerated. Several exclusions are noted in the rule.<br>**Subpart B, Land Application** – Numerical limits and associated management practices are specified.<br>**Subpart C, Surface Disposal** – Surface disposal refers to biosolids-only landfills and dedicated land disposal practices. Pollutant concentration limits are specified for the biosolids; nitrogen in the groundwater must be monitored. If a daily cover is placed, pathogen requirements do not have to be satisfied.<br>**Subpart D, Pathogen and Vector Attraction Reduction** – Criteria are specified for two categories: Class A or Class B. Reduction of vector attraction (e.g., control of flies, rats, etc.) is also required. Management options and reduction standards are provided.<br>**Subpart E, Incineration**–Pollutant limits, operational standards, and monitoring and reporting requirements are specified. | The District produces unclassified solids that are suitable for blending to produce alternative daily cover. The Part 503 Regulations do not apply to this disposal option.<br>Depending on the type of end-use/disposal option, additional pathogen and vector attraction reduction may be required. |
| Existing Regulatory Issues<br>*CAAA* | The CAAA regulate biosolids incinerators. Particulate emissions and opacity limits are required. Monitoring, reporting, and performance testing are also required. | This is not applicable to the District at this time. |
| Existing Regulatory Issues<br>Utah Department of Environmental Quality *(UDEQ)* | The UDEQ has accepted the Part 503 Regulations without modification. EPA has also delegated the enforcement of this regulation to the UDEQ. | See Existing Regulatory Issues *Federal Part 503 Regulations* above. |
| Existing Regulatory Issues<br>*Regulation of Land Application of Biosolids by Local Governments* | Local county and city governments in Utah may have authority to impose more stringent regulations on use of biosolids than those adopted by the state and federal governments. There are currently no known local regulations affecting biosolids use or disposal. | If such regulations are implemented in the future, they may have an effect depending upon the use or disposal method selected by the District. |
| Future Regulatory Issues<br>*Dioxins* | The Part 503 Regulations do not include limits on concentrations of dioxins, dibenzofurans, or PCBs in biosolids. Proposed guidelines for dioxins in biosolids that are land applied are pending. No federal regulations for dioxins are planned for biosolids that are surface disposed or incinerated. | There is no impact to the District's current program. The viability of land application for a long-term biosolids management method could be affected. Additional monitoring and record keeping would be required. |

**TABLE 3-1**

Summary of Issues and Potential Impacts

| Biosolids Issue | General Description | Comments |
|---|---|---|
| Future Regulatory Issues<br>*Radioactivity* | Radioactive materials are ubiquitous in the environment and can enter the collection system and wastewater treatment plant (WWTP) from a variety of sources. While elevated levels of radioactivity in biosolids are typically localized, monitoring of radioactive materials is required to identify the potential for radiological incidents.<br>No criteria for radionuclides currently exist for biosolids management practices. | Radioactivity is not expected to be an issue for the District. Analysis of biosolids is required to determine if there is an elevated level of radioactivity.<br>A phased approach for monitoring and specific testing is recommended if contamination is detected or suspected. |
| Future Regulatory Issues<br>*Mercury* | Most EPA programs are concerned with some aspect of mercury exposure. Stringent water quality criteria are being developed for mercury under the Great Lakes Initiatives (GLI), and this will be used as a model by regulators in the EPA and many states. Wastewater treatment plants, such as the District's, will be expected to play an important role in mercury reduction through pretreatment, and strategies to develop Total Maximum Daily Loads (TMDLs).<br>Future requirements will likely place pressure on the state to address emissions of mercury.<br>Most of the mercury that comes into a WWTP is concentrated in the biosolids, with a large percentage of that contained in the emissions if incineration is employed. However, the fate and transport through thermal processes are not well defined at this time. | Mercury levels in the District's biosolids are too low to trigger any current regulations on reuse or disposal of biosolids.<br>Depending on the results of future modeling efforts and regulatory developments, stringent emission limits on mercury may affect the viability of incineration, or other thermal processes. Additional air pollution control (APC) devices may be required. |
| Future Regulatory Issues<br>*Nutrient Management* | Biosolids are sources of nutrients, such as nitrogen and phosphorus, that can be used beneficially by crops and other vegetation. However, future regulations may limit the amount of nutrients (specifically phosphorus) that can be applied at a site to the amount that can be used by vegetation. Agronomic application rates are currently based on the nitrogen content of the biosolids and the crop nitrogen needs. | Future nutrient management regulations could limit land application rates, thereby requiring more land area for a land application program. |
| Public Acceptance | The public has become more sensitive to all types of waste issues, including biosolids management. For a biosolids land application program to be successful, a targeted program is needed that is based on environmentally sound processes and practices, communication to key stakeholders, and development of strategic messages and outreach materials. | By collaborating with the community, the District can be assured of a more successful program.<br>Without public education and outreach efforts, significant public opposition can arise and costly facilities may be closed as a result. |

**TABLE 3-1**
Summary of Issues and Potential Impacts

| Biosolids Issue | General Description | Comments |
|---|---|---|
| National Practices and Trends | The EPA, Association of Metropolitan Sewerage Agencies (AMSA), and the Water Environment Federation (WEF) joined together in August 1997 to form the National Biosolids Partnership (NBP). The NBP has undertaken several initiatives, including the development of: Code of Good Practices; Manual of Good Practices; Environmental Management System (EMS) guidelines; and a program for third-party verification of the EMS.<br>Other trends are that because of public acceptance problems and local bans on land application, most utilities are hesitating to outsource and want full control. | An EMS could complement the District's existing regulatory program. However, several utilities are in various stages of completion of their EMS programs, with only one or two actually completed. No utilities have been audited as yet, and the national certification program is just beginning. As such, the full impact of the NBP is yet to be determined. Regardless, the EMS program is excellent. |

# Existing Regulatory Issues

Existing regulatory issues the District faces are federal, state and local laws which include primarily: the federal EPA Part 503 Regulations, the Clean Air Act Amendments, the UDEQ regulations, and local jurisdictional regulations. These primary regulations are discussed in detail below, including their potential applicability to the District.

## Federal Regulation – Standards for the Use and Disposal of Sewage Sludge 40 CFR Part 503 (Part 503 Regulations)

There are five subparts of this regulation, each of which has important criteria to understand and may apply depending upon the alternative selected. These subparts are:

A. General Provisions
B. Land Application
C. Surface Disposal
D. Pathogens and Vector Attraction Reduction
E. Incineration

### Subpart A: General Provisions

With the promulgation of the Part 503 Regulations on February 19, 1993, the EPA met its long-standing obligation under the Clean Water Act (CWA) to establish standards for the use and disposal of sewage sludge (i.e., biosolids). This undertaking represented an unprecedented effort on the part of the EPA to assess the potential for pollutants in biosolids that affect public health and the environment through various routes of exposure.

Compliance with the Part 503 Regulations was required by February 19, 1994 if no new facility construction was needed for compliance, and by February 19, 1995 if facility construction was necessary. Monitoring, record-keeping, and reporting requirements were effective July 20, 1993, except for total hydrocarbons (THC) from incinerators, which had to meet the 1-year or 2-year schedule depending on facility construction. EPA amended the Part 503 Regulations in 1994 and 1999.

The Part 503 Regulations establish numerical, management, and operational standards for the use or disposal of biosolids that are applied to land (including products sold or given away), placed in or on surface disposal sites, or incinerated. These standards apply to the persons who operate the systems or prepare the biosolids, or who practice these three basic use/disposal methods.

There are several obvious and not-so-obvious exclusions to the Part 503 Regulations. Part 503 Regulations do not regulate the following:

- Treatment processes, except as required for pathogen and vector attraction reduction
- Selection of a use or disposal practice
- Co-combustion of biosolids with other wastes
- Industrial or hazardous sludge
- Sewage sludge with PCBs equal to or higher than 50 milligrams per kilogram (mg/kg)
- Incinerator ash
- Grit and screenings
- Water treatment plant residuals
- Industrial septage

When biosolids are prepared to be applied to land, placed in a surface disposal site, or incinerated, the person who performs such preparation must meet the applicable requirements specified in the Part 503 Regulation. This preparer could be the person who generates biosolids during the treatment of domestic wastewater or a person who derives a material from biosolids. The latter would include, for example, a person that blends biosolids with some other material or a private contractor who receives biosolids from a treatment works and then blends the biosolids with some other material (e.g., a bulking agent).

The record-keeping and reporting requirements of the Part 503 Regulations specify who must develop and retain information, what information must be developed, and the length of time such information must be kept. Section 405(f) of the CWA provides that permits issued to a publicly owned treatment works (POTWs) or any treatment works treating domestic sewage shall include conditions to implement the Part 503 Regulations unless such are included in permits issued under other federal or approved state programs. It should be noted that the requirements in the Part 503 Regulations must be met even in the *absence* of a permit, or in other words, the Part 503 Regulations are self-implementing. Thus a responsible person must become aware of the Part 503 Regulations, comply with them, perform appropriate monitoring and record keeping and if applicable, report information to the permitting authority even when a permit is not issued. These standards are also directly enforceable against any person who uses or disposes of biosolids through any of the practices addressed in the final regulations. An enforcement action can be taken against a person who does not meet those requirements even in the absence of a permit.

The remainder of this section focuses on the various subparts of the Part 503 Regulations (Subparts B through E) and existing Clean Air Act (CAA) and state regulations.

### Subpart B: Land Application

The land application category includes agricultural land application, forest application, land reclamation, rangeland application, and distribution and marketing of any biosolids product that will eventually be applied to land. Figure 3-1 illustrates the process for compliance with Subpart B of the Part 503 Regulation.

The land application requirements specify maximum concentrations and annual and cumulative loading for metals; the applicability of each is dependent on the biosolids quality and use. Land application management practices are identified. Operational standards for pathogen reduction and vector attraction reduction are also required.

The state and local governments (see discussion below) further regulate land application of biosolids in Utah.

#### *Pollutant Limits for Land Application*

Pollutant limits in Tables 1 through 4 of Subpart B, of the Part 503 Regulations are presented in Table 3-2. The use of each table is explained in Figure 3-1 and as follows. Whenever any value from monitoring biosolids exceeds any one of the pollutant levels presented in Table 1 of Subpart B, those biosolids cannot be land applied. Whenever the average of the samples take during the monitoring period are below the pollutant levels in Table 3 of Subpart B, then the biosolids are considered “clean” with respect to metals and there are no land application limitations based upon pollutants levels. Table 2 and 4 of Subpart B are only used when the value of any or many pollutant levels are between Tables 1 and 3 of Subpart B. Figure 3-1 presents when Tables 2 and 4 of Subpart B must be used.

The District’s solids from both plants are below all Table 1 and Table 3 (of Subpart B) levels as shown in Table 3-2, so there are no pollutant limitations for land application.

#### *Management Practices for Land Application*

The Part 503 Regulations preclude land application in the following circumstances:

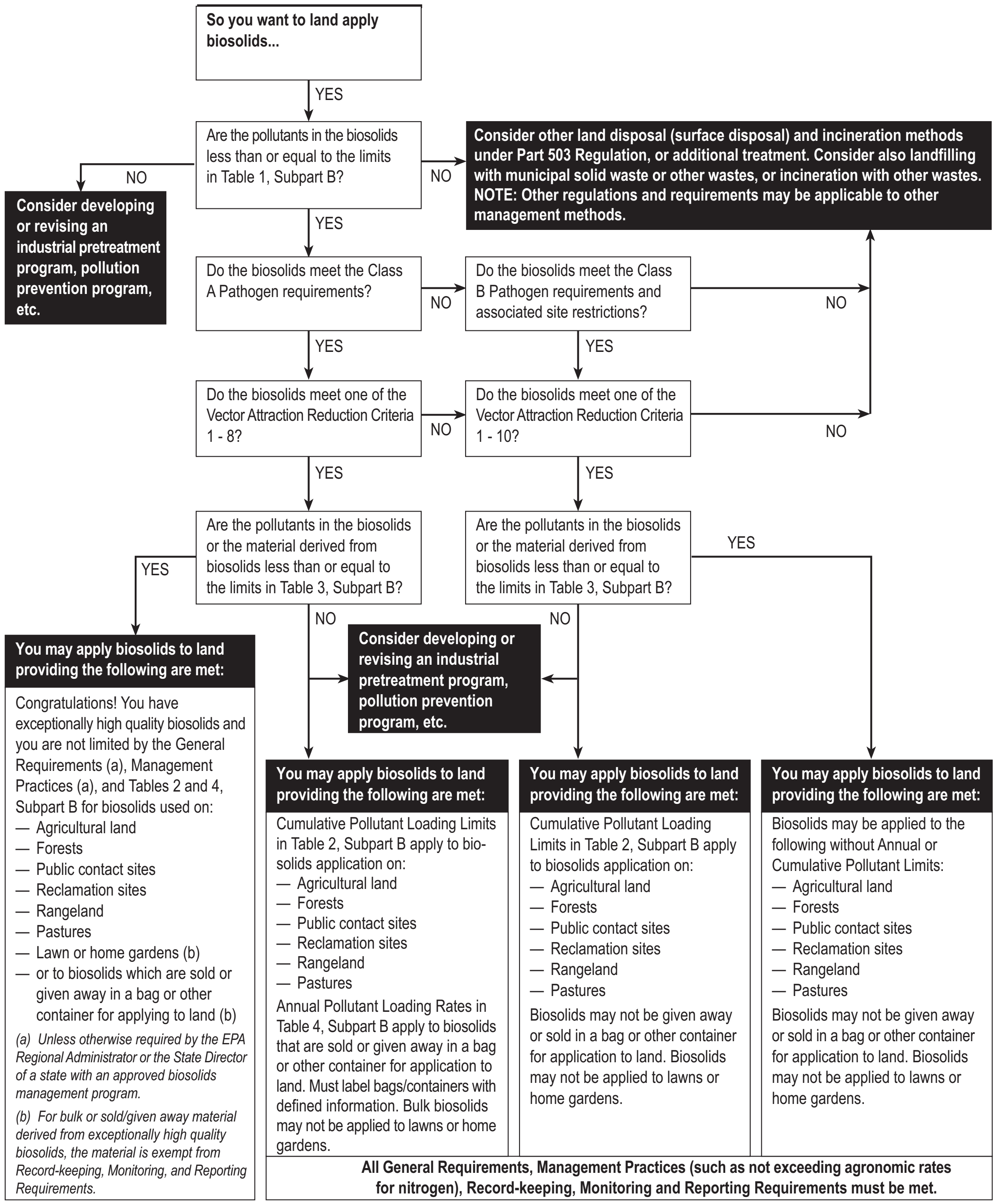
- Where it is likely to adversely affect a threatened or endangered species or habitat
- Where land is flooded, frozen, or snow-covered so that biosolids enter a wetland or other waters of the United States
- Within 10 meters of waters of the United States
- At a biosolids application rate greater than the agronomic rate (nitrogen based) of the site, unless otherwise specified by the permitting agency for a reclamation site

If biosolids are sold or given away in a bag or other container, a label or an information sheet may be required. The information must include the name and address of the preparer, application instructions, and loading rates that will not exceed the limits in Table 4 of Subpart B (see Table 3-2).

**FIGURE 3-1**
Flow Chart For Subpart B – Land Application

## *Pathogen and Vector Attraction Reduction for Land Application*

W151151.RM.03<LandApp SubB>wdc.cac.12/8/99

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**FLOW CHART FOR SUBPART B — LAND APPLICATION**

The Part 503 Regulation necessitates separate requirements for pathogen and vector attraction reduction. Pathogen requirements have two classifications: Class A and Class B, with Class A being the more stringent. Current processes to further reduce pathogens and processes to significantly reduce pathogens technologies are recognized, but pathogen density criteria must be met in addition to the use of a specific process. This is fully explained in the discussion of Subpart B below.

**TABLE 3-2**
Summary Tables for Land Application Subpart B Compared with the Snyderville Data

| Pollutant | Subpart B TABLE 1 Pollutant Ceiling Concentrations (mg/kg) [a] | Subpart B TABLE 2 Cumulative Pollutant Loading Rates (kg/ha) [b, c] | Subpart B TABLE 3 Pollutant Concentrations (mg/kg) [c] | Subpart B TABLE 4 Annual Pollutant Loading Rates (kg/ha/year) [b, d] | East Canyon / Silver Creek Pollutant Concentrations for 2001 (mg/kg) [e] |
|---|---|---|---|---|---|
| Arsenic | 75 | 41 | 41 | 2 | 4 / <1.5 |
| Cadmium | 85 | 39 | 39 | 1.9 | 1.0 / 0.12 |
| Copper | 4,300 | 1,500 | 1,500 | 75 | 288.0 [f] |
| Lead | 840 | 300 | 300 | 15 | 5.5 / 2 |
| Mercury | 57 | 17 | 17 | 0.85 | 0.47 / 0.13 |
| Molybdenum | 75 | NA | TBD | NA | 2.0 [f] |
| Nickel | 420 | 420 | 420 | 21 | 7.9 [f] |
| Selenium | 100 | 100 | 36 | 5 | 2 / 2 |
| Zinc | 7,500 | 2,800 | 2,800 | 140 | 928 [f] |

Note:
Table numbers are from Subpart B, Part 503 Regulations. All values are on a dry weight basis.
[a] Applies to all biosolids to be land-applied.
[b] Multiply by 0.9 to convert to lb/ac
[c] Applies to bulk biosolids land-applied.
[d] Applies to biosolids sold or given away in bag or other container for land application.
[e] Values from 2001 Biosolids Annual Report to the UDEQ.
[f] Values from UDEQ Biosolids Management Statement of Basis dated 1997 (average for both plants).

Application requirements for biosolids that meet Class A pathogen density levels and vector attraction reduction requirements are shown in the flowchart as well.

Biosolids that are Class B with respect to pathogen density requirements are restricted to bulk application to agricultural land, forest, or reclamation sites. There are additional site restrictions specific to Class B biosolids, such as food crop, grazing, and public access restrictions. These site restraints are presented in the discussion of Subpart D below.

### *Potential Impacts to the District — Land Application*

The District's biosolids are able to meet the specified Part 503 Regulations numerical limits for land application, but because they are not subjected to a pathogen reduction process, they cannot be land applied without further treatment. Research by the Water Environment Research Foundation (WERF) has shown that long-term storage (greater than 1 year) has the potential of producing Class A pathogen density levels. This would make the biosolids produced by the District acceptable for land application and provide greater flexibility in choosing the best option for beneficial use or disposal. Every applier of biosolids must consider individual state and local requirements. State requirements are discussed later.

### Subpart C: Surface Disposal

Generally, surface disposal refers to sludge-only landfills (monofills) and dedicated land disposal practices. Subpart C of the Part 503 Regulations applies to any person who prepares biosolids that are placed on a surface disposal site, to the owner/operator of the site, and to the surface disposal site itself. This subpart does not apply to biosolids stored on an area of land or to the land on which the material is stored.

As stated previously, the Part 503 Regulations do not apply to disposal of sewage solids in municipal solid waste (MSW) landfills. Disposal or use of sewage solids at MSW landfills are regulated under 40 *Code of Federal Regulations (CFR)* Part 258. Biosolids disposed in an MSW landfill must be non-hazardous and pass the paint filter test. Other site-specific requirements may be required depending on the state and landfill. Figure 3-2 illustrates the process for compliance with Subpart C of the Part 503 Regulations.

#### *Pollutant Limits for Surface Disposal*

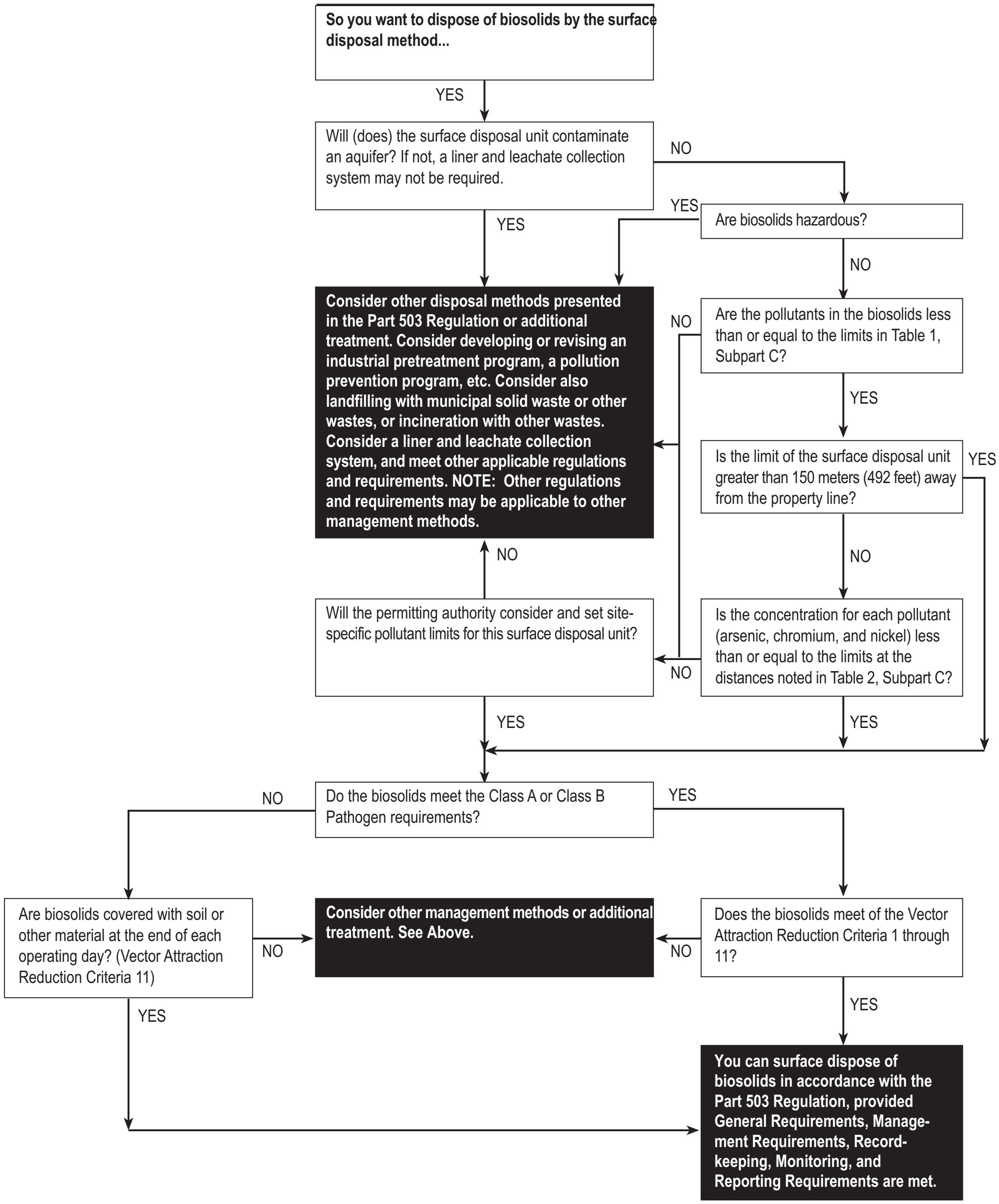
Pollutant limits are specified for surface disposal units without a liner and leachate collection system for three metals: arsenic, 73 mg/kg; chromium, 600 mg/kg; and nickel, 420 mg/kg. The District's solids are well below these metal limits. If the pollutant concentrations exceed the specified limits ***and*** the site does not have a liner or leachate collection system, testing for site-specific pollutants may be requested at the time of permit application. The permitting authority must determine if site-specific pollutant limits are appropriate.

#### *Management Practices for Surface Disposal*

- A surface disposal site must not adversely affect a threatened or endangered species or its habitat, and it must not restrict the flow of a base flood.
- A surface disposal site must be designed to withstand certain seismic zone conditions.
- Runoff and leachate (for systems with a leachate collection system) must be collected and disposed in accordance with the site permit.
- Methane gas must be controlled and monitored if the unit is covered.
- Food, feed, and fiber crops must not be grown and animals must not graze on active sites unless it is demonstrated that that public health and environment are protected. Public access to the site must be restricted until 3 years after closure.
- A groundwater monitoring program must be developed to demonstrate that biosolids do not contaminate the aquifer.

**FIGURE 3-2**
Flow Chart For Subpart C – Surface Disposal

W151151.RM.03<Surf Disposal SubC>wdc.cac.12/8/99

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FLOW CHART FOR SUBPART C — SURFACE DISPOSAL

### *Pathogen and Vector Attraction Reduction for Surface Disposal*

Class A or Class B pathogen reduction requirements must be met for biosolids disposed in a surface disposal unit unless a daily soil cover is placed. If daily cover is not used, the biosolids must be Class A or Class B, and must meet one of the alternative vector attraction reduction criteria specified in Subpart D of the Part 503 Regulations.

### *Potential Impacts to District – Surface Disposal*

Presently the District's biosolids management practice is outsourcing to a landfill which produces alternative daily cover for the landfill, but may include monofilling or dedicated land disposal at a remote site, either by the District or outsourced to a private entity. As such, nitrogen in the groundwater must be monitored to ensure no degradation of groundwater quality. The District's solids meet the specified pollutant limits.

## Subpart D: Pathogen and Vector Attraction Reduction

Prior to the promulgation of the Part 503 Regulations, EPA used a technology-based approach to pathogen and vector attraction reduction by requiring biosolids to undergo either processes to significantly reduce pathogens or process to further reduce pathogens prior to applying biosolids to land. Although these processes are still recognized, additional requirements are specified to ensure process reliability.

As specified in the Part 503 Regulations, either Class A or Class B pathogen reduction levels must be met when biosolids are applied to the land or placed on a surface disposal site. In addition, the regulations require reduction of vector attraction, that is, control of those characteristics of biosolids that attract disease-spreading agents (e.g., flies or rats) when applied to the land or placed on a surface disposal site. There are no pathogen or vector attraction reduction requirements for biosolids fired in an incinerator that achieve such reduction during the incineration process. Subpart B of the Part 503 Regulations prescribe operational standards that designate the level of pathogen reduction for certain management methods, as shown in Table 3-3.

**TABLE 3-3**
Pathogen Reduction Requirements

| Management Method | Requirement |
|---|---|
| Land Application (any) | Class A or B |
| Surface Disposal | Class A or B [a] |
| Lawn or Home Garden | Class A |
| Sold or Given Away in a Bag or Other Container | Class A |

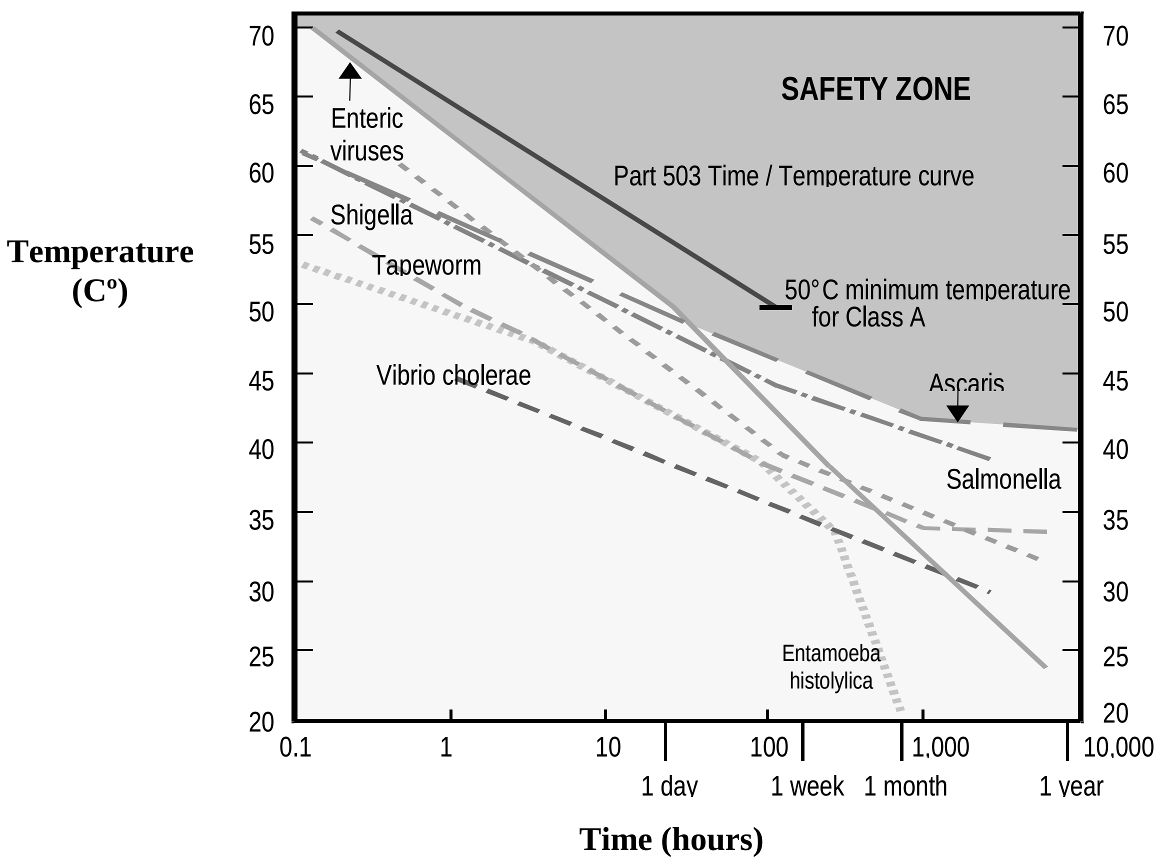
[a] May be unclassified if covered daily (vector attraction reduction requirement 11 only).

### *Class A Pathogen Density Level*

Biosolids with Class A pathogen density levels have regulatory requirements which are more stringent than biosolids with Class B pathogen density levels. This is because Class A levels are considered pathogen free. There are several ways delineated in the Part 503 Regulations to achieve Class A pathogen density levels. The importance is both public perception as well as cost. Since Class A requires virtually no pathogens, the treatment processes used to achieve Class A levels are normally more expensive and more difficult to operate. In addition, a temperature and time relationship is specified to ensure that the pathogenic bacteria are consistently destroyed. In fact, the development of the time:temperature relationships are food-based, principally eggnog. This is important because the public can easily understand how “clean” Class A biosolids are with respect to pathogens. However, Class A processes do not necessarily produce less odors; in fact, some Class A processes may generate products with greater odor intensities.

Figure 3-3 shows this time and temperature relationship between many of the virus, bacteria, and pathogens normally found in biosolids. The curve directly from the Part 503 Regulations formula is superimposed on this figure and shows that if the biosolids treatment process satisfies the required time:temperature relationship, pathogenic organisms will be destroyed.

**FIGURE 3-3**
Class A Pathogen Density Level Safety Zone




**FROM:** Feachem, R.G., et.al. ***Sanitation and Disease - Health Aspects of Excreta and Wastewater Management***. John Wiley & Sons. 1983. Page 79.

In order to satisfy Class A pathogen density levels, one of the following six alternatives must be met either prior to or simultaneously as the vector attraction reduction requirements, which are noted in the following subsection. To meet any Class A alternative the biosolids must meet either a fecal coliform or *Salmonella* sp. bacteria requirement and one of six alternatives. To better understand these alternatives, a summary is provided below, followed by the detailed requirements.

- Demonstrate < 1,000 Most Probable Number (MPN) fecal coliforms per gram total solids, or <3 MPN *Salmonella* sp. per 4 grams of total solids, and
- Apply one of six alternatives:
  - **Alternative 1 –** Time and Temperature
  - **Alternative 2 –** High pH, High Temperature, and Time
  - **Alternative 3 –** Other Processes; Demonstrate pathogen reduction process by measuring reduction in enteric viruses and helminth ova
  - **Alternative 4 –** Unknown Processes; Test resulting biosolids at time of use to insure biosolids meet required enteric viruses and helminth ova levels
  - **Alternative 5 –** Proven processes as set forth in the Part 503 Regulations (also called processes to further reduce pathogens)
  - **Alternative 6 –** Processes determined to be equivalent to a process to further reduce pathogens by the EPA's Pathogen Equivalency Committee or the permitting authority

For biosolids meeting Class A pathogen density levels and being used by the public, only one of the first eight vector attraction reduction requirements may be used. The following is the detailed requirements to meet Class A.

**Alternative 1 (typical for digestion and pasteurization processes)**

A. Meet fecal coliform density or *Salmonella* sp. bacteria density described above

B. Solids must be held at one of the following time / temperature relationships:

1. Total solids concentration greater than or equal to 7% (excludes heating sludge by warm gases or immiscible liquid) – time / temperature relationship primarily for batch processing systems
   - Minimum solids temperature: 50°C
   - Minimum detention time: 20 minutes
   - Time / temperature relationship: $D=131{,}700{,}000/(10^{0.14*t})$, D (days) and t (°C)
2. Total solids concentration greater than or equal to 7%
   - Applies to sludge particles heated by warm gases or immiscible liquid
   - Minimum solids temperature: 50°C
   - Minimum detention time: 15 seconds
   - Time / temperature relationship: $D=131{,}700{,}000/(10^{0.14*t})$, D (days) and t (°C)
3. Total solids concentration less than 7%

- Time period between 15 seconds and 30 minutes
- Time / temperature relationship: $D=131{,}700{,}000 / (10^{0.14*t})$, D (days) and t (°C)

4. Total solids concentration less than 7%
- Minimum solids temperature: 50°C
- Minimum detention time: 30 minutes
- Time / temperature relationship: $D=50{,}070{,}000 / (10^{0.14*t})$, D (days) and t (°C)

**Alternative 2 (alkaline [lime] stabilization processes)**

A. Meet fecal coliform density or *Salmonella* sp. bacteria density described above

B. Solids must be held at or above a pH of 12 for 72 hours. For 12 hours, the temperature must exceed 52°C. Following this period, the solids must be air-dried to achieve a total solids concentration greater than 50%.

**Alternative 3 (new or innovative processes without history of performance)**

A. Meet fecal coliform density or *Salmonella* sp. bacteria density described above

B. Solids must meet a minimum enteric virus density of less than 1 Plaque-Forming Unit (PFU) per 4 grams of total solids (dry weight basis).

C. Solids must meet a minimum viable helminth ova density of less than 1 per 4 grams of total solids (dry weight basis).

**Alternative 4 (unknown processes; no history of performance)**

A. Meet fecal coliform density or *Salmonella* sp. bacteria density described above

B. Solids must meet a minimum enteric virus density of less than 1 PFU per 4 grams of total solids (dry weight basis).

C. Solids must meet a minimum viable helminth ova density of less than 1 per 4 grams of total solids (dry weight basis).

**Alternative 5 (conventional processes)**

A. Meet fecal coliform density or *Salmonella* sp. bacteria density described above

B. Solids shall be treated using one of the defined processes to further reduce pathogens.

**Alternative 6 (new or innovative processes without history of performance)**

A. Meet fecal coliform density or *Salmonella* sp. bacteria density described above

B. Solids must be treated in an equivalent process to one of the defined process to further reduce pathogens, as determined by the EPA Pathogen Equivalency Committee or the permitting authority.

### *Class B Pathogen Density Level*

Biosolids with Class B pathogen density levels have similar disposal and use options as biosolids with Class A pathogen density levels, but differ by additional site specific restrictions. Biosolids which meet Class B pathogen density levels are restricted to bulk application to agricultural land, forest, public contact sites, or reclamation sites. Site restrictions specific to biosolids with Class B pathogen density levels application are summarized below:

- Food crops with above-ground harvested parts that contact the sludge/soil mixture shall not be harvested for 14 months after biosolids application.
- Food crops with below-ground harvested parts shall not be harvested for 20 months after application if the biosolids remain on the surface for 4 months or longer prior to incorporation, or for 38 months after application if the biosolids remain on the surface less than 4 months prior to incorporation.
- Food crops, feed crops, and fiber crops shall not be harvested and animals shall not be allowed to graze for 30 days after biosolids application.
- Turf grown on biosolids augmented soil shall not be harvested for 1 year following application if turf is placed on a lawn or land with high potential for public exposure, unless otherwise specified by the permitting authority.
- Public access to land with a high potential for public exposure shall be restricted for 1 year after sludge application.
- Public access to land with a low potential for public exposure shall be restricted for 30 days following application of biosolids.

In order to satisfy Class B pathogen requirements, one of the following three criteria must be satisfied in addition to compliance with specified site restrictions.

**Alternative 1 (any stabilization process)**

Seven samples of the solids shall be collected at time of usage or disposal. The geometric mean of the fecal coliform densities shall be less than either 2,000,000 MPN per gram of total solids (dry weight basis) or 2,000,000 colony forming units (CFU) per gram of total solids (dry weight basis).

**Alternative 2 (conventional processes)**

Solids must be treated using one of the defined Processes to Significantly Reduce Pathogens (PSRP) methods.

**Alternative 3 (innovative processes without history of performance)**

Solids must be treated using an equivalent process to one of the defined processes to significantly reduce pathogens, as determined by the EPA Pathogen Equivalency Committee or the permitting authority.

### *Processes to Significantly Reduce Pathogens and Processes to Further Reduce Pathogens*

The EPA defined several processes in the Part 503 Regulations. Processes to significantly reduce pathogens are those processes which are considered to consistently produce Class B pathogen density levels. These processes and the associated requirements are presented in Table 3-4.

**TABLE 3-4**
Processes to Significantly Reduce Pathogens

| Process | Design Criteria |
|---|---|
| Aerobic Digestion | Sewage sludge is agitated with air or oxygen to maintain aerobic conditions for specific mean cell residence time (i.e., solids retention time) at a specific temperature. Values for the mean cell residence time and temperature shall be between 40 days at 30°C (68°F) and 60 days at 15°C (59°F). Plug flow systems are more effective than completely mixed tanks (typical aerobic digester), so by using multiple cells in series, the detention time may be reduced by one third. |
| Air Drying | Sewage sludge is dried on sand beds or on paved or unpaved basins. The sewage sludge dries for a minimum of 3 months. During 2 of the 3 months, the ambient average daily temperature is above 0°C (32°F). |
| Anaerobic Digestion | Sewage sludge is treated in the absence of air for a specific mean cell residence time (i.e., solids retention time) at a specific temperature. Values for the mean cell residence time and temperature shall be between 15 days at 35C to 55°C (131°F) and 60 days at 20°C (68°F). |
| Composting | Using either the in-vessel, static aerated pile, or windrow composting methods, the temperature of the sewage sludge is raised to 40°C (104°F) or higher and remains at 40°C (104°F) or higher for 5 days. For 4 hours during the 5 day period, the temperature in the compost pile exceeds 55°C (131°F). |
| Lime Stabilization | Sufficient lime is added to the sewage sludge to raise the pH of the sewage sludge to 12 for 2 hours of contact. |

Note: Information in table is from Part 503 Regulations

Processes to further reduce pathogens are those which are considered to consistently produce Class A pathogen density levels. These processes and the associated requirements are presented in Table 3-5.

**TABLE 3-5**
Processes to Further Reduce Pathogens

| Process | Design Criteria |
|---|---|
| Composting | Using either the within-vessel composting method or the static aerated pile composting method, the temperature of sewage sludge is maintained at 55°C (131°F) or higher for 3 consecutive days. Using the windrow composting method, the temperature of the sewage sludge is maintained at 55°C (131°F) or higher for 15 consecutive days or longer. During the period when the compost is maintained at 55°C (131°F) or higher, there shall be a minimum of five turnings of the windrow. |
| Heat Drying | Sewage sludge is dried by direct or indirect contact with hot gases to reduce the moisture content of the sewage sludge to 10% or lower. Either the temperature of the sewage sludge particles exceeds 80°C (176°F) or the wet bulb temperature of the gas in contact with the sewage sludge as the sewage sludge leaves the dryer exceeds 80°C (176°F). |
| Heat Treatment | Liquid sewage sludge is heated to a temperature of 180°C (356°F) or higher for 30 minutes |
| Thermophilic Aerobic Digestion | Liquid sewage sludge is agitated with air or oxygen to maintain aerobic conditions and the mean cell residence time (i.e., the solids retention time) of the sewage sludge is 10 days at 55°C (131°F) to 60°C (140°F). |

**TABLE 3-5**
Processes to Further Reduce Pathogens

| Process | Design Criteria |
|---|---|
| Beta Ray Irradiation | Sewage sludge is irradiated with beta rays from an electron accelerator at dosages of at least 1.0 megarad at room temperature (ca. 20°C [68°F]). |
| Gamma Ray Irradiation | Sewage sludge is irradiated with gamma rays form certain isotopes, such as Cobalt 60 and Cesium 137, at dosages of at least 1.0 megarad at room temperature (ca. 20°C[68F]). |
| Pasteurization | The temperature of the sewage sludge is maintained at 70°C (158°F) or higher for 30 minutes or longer. |

Note: Information in this table is from the Part 503 Regulations

## Vector Attraction Reduction

In order to land apply biosolids, they must satisfy vector attraction reduction (VAR) requirements to prevent attraction of insects, rats, birds, and other vermin. For bulk biosolids applied to agricultural land, forests, public contact sites, or reclamation sites, one of the following requirements may be adopted, depending on the biosolids classification. For unrestricted use of biosolids with Class A pathogen density levels, any one of the first eight VAR requirements must be satisfied. The last four of the twelve VAR requirements do not apply for exception quality biosolids management practices (refer to the Exceptional Quality EQ Biosolids section below). For biosolids meeting Class B pathogen density levels, any one of the first ten requirements must be met since these products are not normally distributed to the public. The 11$^{th}$ requirement is specifically for monofills and the last for domestic septage. The last two requirements are not applicable for any other processes. In addition, EPA is attempting to establish an equivalency method to obtain certification as a VAR process, similar to the Pathogen Equivalency Committee for pathogen reduction processes.

- **Requirement 1: (Anaerobic or Aerobic Digestion)**
  Volatile solids must have a minimum 38% reduction.
- **Requirement 2: (Anaerobic Digestion)**
  If anaerobically digested solids do not satisfy Requirement 1, vector attraction reduction can be obtained by demonstrating a 17% volatile solids reduction. This can be achieved by performing a bench-scale lab unit for 40 additional days at a temperature between 30°C and 37°C.
- **Requirement 3: (Aerobic Digestion)**
  If aerobically digested biosolids do not satisfy Requirement 1, vector attraction reduction can be obtained by demonstrating a 15% volatile solids reduction. This can be achieved by performing a bench-scale lab unit on sludge containing a 2% solids concentration or less for 30 additional days at 20°C.
- **Requirement 4: (Aerobic Processes)**
  The specific oxygen uptake rate (SOUR) for aerobically treated solids shall be equal to or less than 1.5 mg $O_2$/hr/gram of total solids (dry weight basis) at 20°C.

- **Requirement 5: (Composting)**
  A minimum retention time of 14 days at 40°C is required for aerobic processes. The average solids temperature must exceed 45°C.

- **Requirement 6: (Alkaline [lime] Stabilization)**
  Sufficient alkali must be added to raise the solids pH to 12 or higher for a 2-hour period. For an additional 22 hours without further alkali addition, the solids must remain at pH 11.5 or higher.

- **Requirement 7: (Thermal Drying)**
  The percent solids of sludge not containing unstabilized primary treatment solids shall be a minimum of 75% based on the moisture content and total solids prior to mixing with other materials.

- **Requirement 8: (Thermal Drying)**
  The percent solids of sludge containing unstabilized primary treatment solids shall be a minimum of 90% based on the moisture content and total solids prior to mixing with other materials.

- **Requirement 9: (Subsurface Injection)**
  Within one hour of subsurface biosolids injection, no significant amount of biosolids should remain on the surface. For Class A biosolids, injection must occur within 8 hours after discharge from the pathogen treatment process.

- **Requirement 10: (Incorporation)**
  Surface applied biosolids must be incorporated within 6 hours after land application. For Class A biosolids, application must occur within 8 hours after discharge from the pathogen treatment process.

- **Requirement 11: (Daily Cover – Monofill Only)**
  Solids place on an active surface disposal site must be covered with soil or other material at the end of each operating day.

- **Requirement 12: (Septage Only)**
  The pH of domestic septage must be raised to pH 12 by sufficient alkali addition to hold the pH at 12 for at least 30 minutes without the addition of more alkali.

### *Exceptional Quality Biosolids*

Once biosolids meet exceptional quality (EQ) requirements, land application general requirements and management practices do not apply. Biosolids assigned the EQ status can be applied as freely as any other fertilizer or soil amendment to any type of land. For biosolids to qualify under the EQ option the following requirements must be satisfied:

- Maximum pollutant concentrations in Table 1 of the Part 503 Regulations may not be exceeded.

- Average pollutant concentrations in Table 3 of the Part 503 Regulations may not be exceeded.

- One of the six Class A pathogen alternatives noted above must be met.

- One of the first eight vector attraction reduction requirements noted above must be achieved.

#### *Existing Biosolids Pathogen Treatment at District's WWTPs*

All solids produced at the District's treatment plant are not stabilized and therefore the solids are considered as unclassified or raw. Any process alternative recommended, except for continuing to haul to the landfill to produce landfill cover material or disposal in an MSW landfill, requires reduction of the pathogen density levels and satisfying one of the first 11 vector attraction reduction requirements.

#### *Potential Impacts to the District – Pathogen and Vector Attraction Reduction*

There are few options for disposal/use of unclassified solids. In fact, there are only four current alternatives:

- Landfill with MSW
- Contract for preparing solids for alternative daily cover for a landfill
- Contract for a private firm or another utility to stabilize the solids prior to disposal/use
- Construct a monofill and cover daily (to meet VAR requirements).

When evaluating future biosolids management options, the District should consider the following pros and cons associated with producing Class A versus Class B or unclassified material.

- More alternatives are available for end use.
- Regulatory monitoring and record-keeping requirements are less stringent for Class A products compared to Class B materials. Unclassified material to an MSW landfill has less regulatory monitoring than either.
- Typically, Class A or B stabilization requires additional capital facilities, which may increase overall processing costs.
- Producing Class A products may alleviate growing public perceptions and concerns about health effects associated with pathogens.

### Subpart E: Incineration

Subpart E of the Part 503 Regulation covers incineration. In particular, the following are specified: pollutant limits, operational standards, frequency of monitoring, record keeping and reporting. The following is a summary of the regulatory requirements, including amendments.

#### *Pollutant Limits for Incineration*

Several heavy metals are required to be monitored for incineration.

- Beryllium – maximum 10 grams per 24 hours [National Emission Standards for Hazardous Air Pollutants (NESHAP) 40 *CFR* Part 61 Subpart C].
- Mercury – maximum 3,200 grams per 24 hours (NESHAP 40 *CFR* Part 61 Subpart E).
- Lead, Arsenic, Cadmium, Nickel, and Chromium – determined by a site-specific formula that takes into account National Ambient Air Quality Standards (NAAQS) or Risk

Specific Concentrations developed by EPA, the dilution effected between the stack discharge and the nearest receptors as determined by an EPA-approved model, and the APC system efficiency. The result is the maximum allowable metal concentration in the biosolids feed to the incinerator.

### *Operational Standards for Incineration*

THCs are the critical operational standard for incinerators. Carbon dioxide may be monitored instead of THCs.

THCs must be less than 100 parts per million by volume (ppmv) measured as propane, corrected to 7 percent oxygen and 0 percent moisture, on a monthly average basis. If carbon dioxide is monitored in lieu of THC, it too must be less than 100 ppmv, corrected to 7 percent oxygen and 0 percent moisture, on a monthly average basis.

### *Management Practices for Incineration*

There are several management practices that are presented below.

- Sewage sludge incinerators shall not be operated if likely to adversely affect a threatened or endangered species listed under Section 4 of the Endangered Species Act.
- Continuous monitoring of the following parameters must be done:
  - THC or carbon monoxide in exhaust gases
  - Oxygen in exhaust gases
  - Moisture in exhaust gases
  - Biosolids feed rate to the incinerator
  - Maximum incinerator burning zone temperature
  - Operating parameter of APC devices established during performance testing
  - Operating conditions of the APC devices

### *Frequency of Monitoring*

In addition, biosolids, THCs, and the APC device must be monitored.

- Biosolids
  - Beryllium and mercury in accordance with NESHAP
  - Lead, arsenic, cadmium, nickel, and chromium in the biosolids feed to the incinerator monitored once per month to once per year, based on the amount of biosolids incinerated; the District must monitor once per month
- THC, oxygen, and combustion temperatures monitored continuously
- APC device operating parameters monitored at least daily

### *Record Keeping*

Record-keeping requirements are 5 years for all continuous emissions required under management practices plus regular biosolids analyses for metals, APC efficiency, and a calibration and maintenance log for key instruments.

### *Reporting*

Required annually for all facilities greater than 1 mgd, or 10,000 connected population, or facilities with pretreatment programs

## Federal Regulation – Clean Air Act Amendments

The Clean Air Act Amendments (CAAA) of 1990 also regulate biosolids incinerators under Standards of Performance for Sewage Treatment Plants (40 *CFR* Part 60, Subpart O) and apply to incinerators installed or modified after June 1973. This regulation limits particulate matter emissions to 1.3 pounds per ton of dry solids incinerated and visible emissions (opacity) to less than 20 percent. It also requires monitoring and reporting, and requires performance testing. Table 3 of Subpart O identifies the regulations that currently may govern the operations of these incinerators. Under the CAA, relevant areas of legislation include New Source Performance Standards (NSPS), NESHAP, and NAAQS. Particulate matter, opacity, metals, and organics are regulated, and permitted emission limits must be met. Other pollutants may be regulated, depending on the state. In addition, any source emitting more than 100 tons per year (tpy) of carbon monoxide, particulate matter ($PM_{10}$), sulfur oxides, or 50 to 100 tpy of nitrogen oxide (depending on area attainment classification), as well as more than 10 tpy of a single HAP or more than 25 tpy of two or more hazardous air pollutant (HAPs), is classified as a major source under Title V and must obtain a Title V operating permit. If a Title V operating permit is required, all regulated pollutants under the CAA are included in the permit and it typically supercedes the existing Part 70 operating permit. Table 3-6 summarizes the applicable biosolids incinerator regulations.

**TABLE 3-6**
Summary of Existing Biosolids Incinerator Emission Regulations

| Pollutant | Act | Regulation | Remarks |
|---|---|---|---|
| Particulate Matter ($PM_{10}$) | CAA – Title I | 40 CFR 60 Subpart O | NSPS |
| Opacity | CAA – Title I | 40 CFR 60 Subpart O | NSPS |
| Beryllium | CAA – Title III | 40 CFR 61 Subpart C | NESHAP |
| Mercury | CAA – Title III | 40 CFR 61 Subpart E | NESHAP |
| Nitrogen Oxides and Carbon Monoxide [a] | CAA – Title I and V | | NAAQS |

[a] Title V includes all criteria for biosolids incinerators.

Before construction can begin, an agency must obtain a permit to install (PTI) when (1) a new incinerator is constructed; (2) rehabilitation results in an increase in emissions or the cost of rehabilitation is more than 50 percent of the cost to construct a new incinerator; or (3) replacing an existing biosolids incinerator. The permitting process can be lengthy depending on the type of permit application. For example, if a new incinerator is being planned, a New Source Review (NSR) and / or Prevention of Significant Deterioration (PSD) analysis may be required. NSR / PSD can require ambient monitoring to establish baseline conditions and a Best Available Control Technology (BACT) analysis to determine the appropriate APC technology for the facility. Once construction is complete, a permit to operate must be obtained. In most states, including Utah, the state permitting authority issues the permits. In the case of an operating permit, the state may issue it under 40 *CFR* Part 70 or under Title V, depending on whether the facility is a major Title V source.

#### Potential Impacts to the District – CAAA

Since the District has no incinerators and is not planning to construct any incinerators, there are no impacts.

### State and Local Regulations

The State of Utah, Department of Environmental Quality, Division of Water Quality has adopted the federal Part 503 Regulations in total, without exception or addition, and has been delegated the authority from EPA to enforce these standards for treatment and disposal of sewage sludge in Utah. UDEQ encourages beneficial use of treated biosolids, and a large percentage of municipal wastewater treatment plants within the state follow this practice. However, all approved treatment and disposal processes allowed by the Part 503 Regulations are acceptable to UDEQ. Utah has stringent groundwater protection rules that prohibit use of sand drying beds or other systems for solar drying which could result in groundwater contamination.

At the present, there are no county or local regulations known that would affect biosolids use or disposal. However, odor issues due to composting and land application have the potential to force the local community to lobby for more stringent regulations to protect their quality of life. As such, it behooves the District to continue to do the best job possible and be very responsive to community complaints.

## Future Regulatory Issues

There are two basic issues of concern regarding regulatory issues and they are the upcoming Round II Part 503 Regulations and the results of the National Research Council’s (NRC’s) recent review of the Part 503 Regulations.

### Round II Part 503 Regulations

EPA is proposing limits for dioxins, dibenzofurans, and coplanar PCBs for biosolids that are land-applied. The proposed rule was published in the *Federal Register* on December 23, 1999, with final promulgation scheduled for December 2001. However, the rule has since been retracted (and has not been republished) so that additional scientific analysis can be conducted by the EPA’s Science Advisory Board. EPA is considering a dioxin guideline limit of 300 parts per trillion (ppt) total equivalence (TEQ) for biosolids that are land-applied. This means that if the sum of all congeners is equal to or greater than 300 ppt, the utility should do everything it can to reduce dioxins. Recent surveys showed the average dioxin levels to be about 30 ppt, with only one utility exceeding 300 ppt (approximately 10,000 ppt). Even at this high level, the EPA risk assessment showed no health problem, which is why the 300 ppt is considered a guideline. EPA is not presently considering a dioxin limit for biosolids that are incinerated or placed in a surface disposal site.

### Potential Dioxin, Dibenzofuran, and PCB Limits

Dioxins and dioxin-like compounds can be found in trace levels in the air, soil, sediments, food, and human tissues. Occasional exposure may not pose a significant human health risk. However, with increased frequency of exposure, the health risk also increases. To reduce this risk, EPA has developed regulations that address most major dioxin sources. Although there is not an acceptable daily dose for dioxin established in the United States, EPA is addressing dioxins based on quantitative risk assessments and specific information from individual cases. A summary of sources, background exposure, and health effects may be found in EPA's *Fact Sheet, Dioxin Exposure and Risk*, June 1999. Additional studies are ongoing.

The Round I Part 503 Regulations did not include limits on concentrations of polychlorinated dibenzo-p-dioxins (CDDs) or polychlorinated dibenzofurans (CDFs) in biosolids. Similarly, there are no limits to PCBs, except that, if biosolids contain 50 parts per million (ppm) or more of PCBs, the material must be handled in accordance with Resource Conservation and Recovery Act (RCRA) regulations. Nonetheless, there is evidence that these compounds are commonly found in biosolids. Thus, as a contribution to EPA's dioxin reassessment efforts, AMSA commissioned a study of CDD, CDF, and PCB concentrations in biosolids of participating municipal wastewater treatment plants to identify typical levels in biosolids.

The EPA is proposing to amend management and monitoring, record-keeping, and reporting standards for biosolids by adding a numeric concentration guideline for dioxin and dioxin-like compounds ("dioxins") in biosolids that are applied to the land. The requirements will be the result of risk assessments for dioxins in biosolids that are applied to the land, placed in surface disposal units, or incinerated. Based on these risk assessments, the agency is not proposing additional numeric standards or management practice requirements for dioxins in sewage sludge that is placed in surface disposal units or incinerated.

### Potential Impacts to the District – Future Dioxin, Dibenzofuran, and PCB Regulations

The proposed dioxin regulation does not include biosolids that are incinerated or surface disposed. While the dioxin concentrations in the District's biosolids should be well below EPA's proposed guideline for land-applied biosolids, the District should continue to follow the progress of this proposed regulation as it pertains to the viability of future management options. In addition, the District should consider sampling and analyzing for dioxin.

## National Research Council's Review of the Part 503 Regulations

After 18 months of intense study, the NRC's Committee on Toxicants and Pathogens in Biosolids Applied to Land has reported that "there is no documented scientific evidence that the [federal] Part 503 rule has failed to protect public health." However, in its report, *Biosolids Applied to Land: Advancing Standards and Practices* (*NRC, 2002*), it strongly urged the U.S. Environmental Protection Agency (EPA) to update the scientific basis of the standards. The NRC is part of the National Academy of Science (NAS). Its biosolids committee is a diverse group of distinguished scientists, academicians, and regulators representing varying perspectives on biosolids use, though it had no members from the biosolids land-application industry, but it did include one state regulator.

The NRC suggested that the review was driven by advances in technology and risk assessment methods since the standards were established, by gaps in data used for risk assessment, by greater biosolids production and use, and by increased public interest and concern.

Following are the committee's main recommendations, which are supported by many wastewater industry organizations, including the Water Environment Federation (WEF) and the Association of Metropolitan Sewerage Agencies (AMSA), both members of the NBP:

- Use improved risk-assessment methods to better establish standards for chemicals and pathogens
- Conduct a new national survey of chemicals and pathogens in sewage sludge
- Establish a framework for an approach to implement human health investigations
- Increase the resources devoted to EPA's biosolids program

While the committee recommended beefing up enforcement efforts, lack of enforcement does not mean the requirements of the Part 503 Regulations are not being met.

The committee returned several times to the issue of odors: "Since odors are a primary source of public complaints, adequacy of treatment cannot be over-emphasized. Odors are a function of treatment quality and are minimized with effective treatment and management." The committee concluded that minimum treatment design standards must be tightened to be consistent with requirements in the Part 503 Regulations.

It also considered potential risks from odors and disease vectors, but did not find any epidemiological studies of such risks related to biosolids. While odors are categorized as nuisance or aesthetic issues, it states that "odors can have adverse physiological and psychological effects and vectors can transmit disease. These are issues that need careful consideration, as there appears to be a fine line between when odors or disease vectors are merely nuisance issues and when they are health issues."

Pathogens standards are operational standards intended to reduce concentrations to acceptable levels. The committee determined that "EPA considered an appropriate spectrum of pathogens and indicator organisms in setting its standards, but new information on those and other pathogens not considered are now available."

Available methods for detecting and quantifying pathogens in biosolids have not been validated. Yet there have been many advances in this field, with no consensus on standards for measurement. The committee recommended that EPA support validated methods for detecting and quantifying pathogens and indicator organisms. The committee's recommendations are summarized in the following section.

### Conclusions of the NRC Review of the Part 503 Rule

The following conclusions can be drawn from the NRC's review of the Part 503 Regulations land application pollutant limits and pathogen operational standards:

- The current Part 503 Regulations land application pollutant limits and pathogen operational standards protect public health from the reasonably anticipated adverse effects of pollutants in biosolids.
- The risk assessment for the Part 503 Regulations for land application pollutant limits needs to be updated, as required by the Clean Water Act.
- The main issue with the Part 503 Regulations for land application pollutant limits and pathogen operational standards is the perception that they do not protect public health.
- Supporters of land application of biosolids and those who oppose land application will use information in the NRC report to support their positions.
- To implement the recommendations in the NRC report, EPA has to make a major reinvestment in its biosolids program, and commit more staff and funds to the program.
- EPA should validate the analytical methods for pollutants and pathogens in the biosolids matrix, and gather data through a new national sewage sludge survey.
- The baseline aggregate risk assessment for the Part 503 Regulations for land application has not been updated to document risk from exposure to land-applied biosolids that meet the current Part 503 Regulations land application pollutant limits.
- There are limitations in the process used to select pollutants for which limits were established in Part 503 Regulations. For example, frequency of detection may not be an appropriate basis for deleting a pollutant from the list of regulated pollutants.
- The exposure pathways in the land application risk assessment are outdated.
- The default assumptions used in the land application risk assessment also are outdated.
- The algorithms used in the land application risk assessment are still valid.
- EPA used the appropriate pathogens and indicator organisms in establishing pathogen operational standard.
- The use of pathogen reduction requirements, site restrictions, and monitoring of indicator organisms is an appropriate approach for controlling pathogens in land-applied biosolids.
- Pollutant risk assessment cannot be integrated with pathogen risk assessment to develop limits for pollutants in biosolids

### Potential Impacts to the District – NRC Review of the Part 503 Rule

While the report states there is no evidence that land application of biosolids is harmful, the need for updates to the rule means the perception that it is not as protective as it could be must be addressed.

EPA's biosolids program will require substantial reinvestment, including in a new national survey and in compliance and enforcement. It will be important to ensure validated analytical methods are used, and that the data collected are national and representative. It is important that the District understand the details in the report, because it will be used to support multiple and sometimes-opposing sides of public (and private) biosolids safety discussions.

The report's emphasis on biosolids management by EPA, which seemed to go beyond the committee's assigned scope, supports the industry's mushrooming focus on biosolids EMS.

Assuming EPA concurs with the recommendations by the NRC, there will be much more research and updated risk assessments. One key area will be research on pathogens in biosolids; with an early look at the safety of Class B pathogen density levels.

Although it is impossible to predict, it appears that both Class A and B pathogen density levels will survive, but more monitoring may be required as well as more management procedures. Also, more enforcement will occur.

## Clean Air Act Issues

It appears that EPA does not intend to change incineration regulations under Round II of the Part 503 Regulations. However, there may be changes to the regulations under the CAA that would impact biosolids incineration. One of the issues that may impact incineration is the list of pollutants to be regulated under Section 112 of the CAAA. Section 112 requires incinerators that qualify as major or area sources to meet technology-based standards for approximately 189 hazardous air pollutant HAPs. However, in January 1997, EPA indicated in the *Federal Register* that biosolids incinerators will be delisted from Section 112 of the CAAA and regulated under Section 129 of the CAAA.

However, if additional biosolids incinerator regulations are promulgated under Section 129, there may be some biosolids quality parameters that may affect the incinerators' ability to meet these regulations. Potential compounds could be mercury, dioxin, or dioxin-like compounds. For example, if dioxin and dioxin-like compound emissions from biosolids incinerators are regulated, the concentrations of these pollutants in the biosolids may impact emissions. Emission of these pollutants is primarily controlled by maintaining a high enough exhaust gas temperature, usually 1,550°F to 1,800°F, through the use of afterburners. Where this is not practical, removal by use of sorbents, such as activated carbon, has been applied successfully to municipal waste combustors and hazardous waste incinerators in the United States and to these and biosolids incinerators in Europe. If mercury emissions are further regulated, additional APC equipment may be required to meet regulated limits. Mercury removal by use of sorbents has been applied successfully to municipal waste combustors and hazardous waste incinerators in the United States and to these and biosolids incinerators in Europe. Applying new technologies to biosolids incinerators will require research, testing, and cost evaluations to demonstrate feasibility, ensure that reliability is achievable, and determine that the addition of this new technology is economically achievable.

### Potential Impacts to the District – Future Incineration Regulations

Future biosolids incinerator regulations under Section 129, if promulgated, may require operational changes to existing processes and/or the research and application of new technologies to meet regulatory limits. Since incinerators are not planned, there would be no impact to the District.

## Radioactivity

Over the last decade, issues and concerns regarding radioactivity in municipal wastewater and biosolids have been increasing. This growing concern can be largely attributed to the discovery of elevated radioactivity at several WWTPs in the United States. While these incidents did not contribute to radiation exposure to the public or plant operators, significant clean-up projects resulted.

Radioactive material enters the collection system from a variety of sources. Naturally occurring radioactive material (NORM) is ubiquitous in the environment – it is found in soil, building materials, fertilizer, air, and human wastes. Consequently, wastewater and surface runoff will contain small amounts of NORM. All municipal solids, including biosolids, will contain some NORM and will be naturally radioactive to some extent. Analysis of biosolids will be necessary to determine if there is an elevated level of radioactivity. Guidance documents pertaining to the evaluation of radioactivity in industry, including municipal wastewater treatment, are focused primarily on the discharge of man-made radioactive material.

Elevated levels of radioactivity in biosolids are generally very localized problems, which occur only in a small number of WWTPs downstream of radioactive dischargers. To better characterize the extent and level of radioactivity, the Nuclear Regulatory Commission (NRC), in conjunction with the EPA, has received approval to complete a national survey of municipal biosolids and ash by June 2001. Participation in this survey was voluntary.

Currently, no criteria exist for radionuclides that are directly applicable to biosolids management practices, although some states have effluent quality criteria. Due to dilution effects, most WWTPs do not have problems meeting the effluent criteria. However, like heavy metals, radionuclides can concentrate in the biosolids.

There are some existing criteria for radionuclide soil concentrations, as well as acceptable soil levels for facilities undergoing decommissioning prior to being released from NRC license conditions. These soil criteria are provided in the Appendix C of the *Guidance Document for Pretreatment Coordinators and Biosolids Managers*. If, for example, these soil criteria were used for determining application rates for land application, the soil criteria would most likely be conservative since the biosolids are typically incorporated into the soil, thereby diluting the concentration of radionuclides present in the biosolids. For other biosolids management options, such as landfilling/surface disposal or incineration, the potential impacts of elevated radionuclides in the biosolids would likely be less than the land application.

Monitoring of radioactive materials discharging to the WWTP will be required to identify the potential for radiological incidents. Information provided by the NRC should enable the municipality to identify facilities of concern. To identify sources and quantities of radioactivity coming into the WWTP, a survey and sampling program should be instituted. If there are no significant dischargers of licensed radionuclides within the service area, such a program will most likely confirm that any radioactivity found in the biosolids are primarily NORM, similar to those found in area soils. If it is determined that a significant amount of man-made radioactive materials are discharged into the collection system, the survey and sampling program will help demonstrate what impact, if any, such discharges are having on the plant and biosolids quality. The sampling program should be conducted in two phases:

- **Exposure Monitoring.** Using survey instruments, radiation exposure rates within the treatment plant are determined. If these levels exceed background rates, a more specific testing protocol should be implemented. This type of monitoring does not indicate which radionuclides are present or specific concentrations.

- **Specific Testing and Limits.** If the exposure amount is above background rates, additional analyses should be conducted to determine specific radionuclides and concentrations.

If contamination is detected or suspected, biosolids should be sampled and tested for radionuclides. These analyses may be costly. Initial gamma scans exceed $100 per test, and gross alpha and beta tests are approximately $50 per test. More specific testing, such as alpha spectroscopy, cost from $100 to $250 per sample. Sample collection procedures and sample transport to the laboratory should be coordinated with the qualified laboratory.

Once the levels of contamination are determined, worker and public safety should be ensured. Next, the source(s) of contamination needs to be identified. The NRC and/or state agency should be able to provide assistance to locate potential sources. However, the burden of dealing with elevated radioactivity levels will fall primarily on the municipality and the WWTP. Solutions to address elevated concentrations at the plant will continue to be determined on a case-by-case basis by the municipality, appropriate regulatory authority, and the discharger of the material. Given the potential liabilities and public sensitivities involved, any municipality that has discovered elevated levels should contact a qualified radiation consultant and seek competent legal advice.

### Potential Impacts to the District – Radioactivity

Radioactivity regulations and criteria for biosolids management practices do not currently exist. The District should continue to stay involved in national committees that represent the wastewater treatment industry to protect the interests of the District and similar municipalities.

Monitoring and record-keeping requirements may increase, as well as analytical costs to determine extent of radioactivity, if any, and sources.

Because solutions to address elevated concentrations at the plant are determined on a case-by-case basis by the municipality, appropriate regulatory authority, and the discharger of the material, the District should contact a qualified radiation consultant and seek competent legal advice regarding potential liabilities if elevated levels are suspected or found.

## Mercury

Mercury is a pollutant known to have toxic effects on humans and wildlife. According to the EPA's *Action Plan for Mercury,* mercury is the most frequent basis for fish advisories, represented in 60 percent of all water bodies with advisories. Almost every EPA program is concerned with some aspect of mercury exposure. Some important programs and initiatives pertaining to mercury are summarized below:

- *Great Water Reports to Congress*, 1995 and 1997, highlighted the risks of mercury in the Great Lakes, Chesapeake Bay, Gulf of Mexico, Lake Champlain, and coastal waters.
- Executive Order issued by President Clinton, April 1997, required each federal agency to assess risks that disproportionately affect children, including mercury.
- Binational Toxics Strategy, developed under the Great Lakes Water Quality Agreement, was signed by the United States and Canada in April 1997 to meet a 50 percent reduction of aggregate mercury releases to the air and water within the Great Lakes Basin by 2006.
- *Mercury Study Report to Congress*, required by the CAAA of 1990, was issued in December 1997 and inventoried the quantity of mercury emissions from numerous sources.
- *Clean Water Action Plan*, February 1998, provided guidelines for restoring the nation's water resources, including specific actions to address mercury contamination.

Mercury concentrations in the environment have been increasing since the industrial age. Fish consumption dominates the pathway for human and wildlife exposure to methylmercury. Methylmercury is a form of mercury that is significantly toxic and is readily accumulated by fish and wildlife. The *Mercury Study Report to Congress* states a link between releases of mercury from industrial and combustion sources in the United States and bioaccumulation in fish. However, given the current scientific understanding of the fate and transport of mercury, it is not possible to quantify how much methylmercury in fish consumed by the United States population is contributed by United States emissions relative to other sources of mercury (e.g., natural sources or re-emissions from the global pool). Approximately 95 percent of mercury contamination is estimated to come from air deposition. In the United States, power plants that burn coal emit 50 tpy of mercury, which is almost half of the total mercury emissions nationwide. The remaining amount either occurs naturally or is attributed to medical waste and solid waste incineration.

Stringent water quality criteria have been developed for mercury under the Great Lakes Initiative (GLI). For example, the GLI water quality criterion for wildlife effective October 1997 in the Ohio Lake Erie Basin is 1.3 ppt. This criterion is more stringent than the criterion to protect human health. AMSA petitioned the EPA to "revise the 1995 GLI wildlife criterion for mercury to be consistent with EPA's conclusion in its 1997 Mercury Study Report to Congress (using the same toxicological data)." However, it appears unlikely that these limits will be revised as petitioned by AMSA.

In June 1999, the EPA adopted a new Method 1631 for the analysis of mercury in effluent discharges. This new method has much lower detection limits than other analytical methods for mercury. While the analytical costs are approximately the same as previous analyses, it is not widely available. Ultra-clean sample collection techniques are required – extraordinary measures must be taken to prevent dust or vapor contamination.

Wastewater treatment works such as the District's will be expected to play an important role in mercury reduction, primarily through the implementation of pretreatment programs to limit mercury discharges and strategies to develop TMDLs. The EPA is currently working with Duluth, Minnesota and Detroit, Michigan to develop mercury-pollution prevention information and pretreatment requirements. Many dischargers may need variances from water quality-based effluent limits for mercury to avoid violating their NPDES permits.

### Potential Impacts to the District – Mercury

Most of the mercury that comes into the WWTP is concentrated in the biosolids, with a large percentage of that contained in the emissions if incineration is employed.

The viability of incineration as a disposal method may be severely limited by potential changes in mercury emissions limits. However, it is estimated that WWTPs contribute only a minimal percentage of the total deposition. In the Report to Congress, *An Inventory of Anthropogenic Mercury Emissions in the United States,* contribution of mercury from incineration of wastewater biosolids is estimated to be 0.6 percent. The fate and transport through thermal processes are not well defined at this time. Additional modeling and evaluations of more advanced removal techniques for mercury are needed before mercury emissions from incineration can be fully assessed.

Depending on the results of additional deposition modeling and future regulatory developments, stringent emission limits on mercury may detrimentally affect the viability of incineration, unless pretreatment efforts drastically reduce mercury concentrations in the influent. This same potential exists for other thermal processes such as heat drying.

Because the District is not considering incineration and the major effect will be on incineration, at this time, there will be minimal, if any, impact on the District.

## Nutrient Management

Biosolids are good sources of nutrients, particularly nitrogen and phosphorus. Since nitrogen and phosphorus are essential for healthy and vigorous plant growth, biosolids provide significant fertilizer value for agricultural, silvicultural, horticultural, and reclamation purposes. The management of nutrients is a critical component of any program to ensure that biosolids are used in an environmentally sound manner.

The term *agronomic* refers to the use of biosolids at a rate that provides adequate nutrients for crop growth, without causing environmental pollution. The nutrient content in biosolids, as well as in animal manure, will not be in total balance with the nutrient needs of all crops. For example, if biosolids are applied at the rate that meets the plant needs for a particular nutrient or trace element, other nutrients / elements may not necessarily be present in the amounts needed by that crop. Chemical composition and characteristics of biosolids are dependent on many factors (e.g., liquid and solids handling treatment processes, bulking agents). Most biosolids have two to three times more phosphorus than nitrogen available for plant uptake. Therefore, if biosolids were applied to satisfy the plant nitrogen requirements, over-application of phosphorus could result. The same would be true for animal manure. For chicken and dairy manure, the ratios of phosphorus to nitrogen are approximately 4:1 and 2.5:1, respectively. Generally speaking, the land area required for biosolids application, when limits are based on phosphorus, are two to five times that required when limits are based on nitrogen.

Excess phosphorus, unlike nitrogen, is seldom a concern in groundwater due primarily to its tendency to sorb to the soil matrix. Applying some additional phosphorus, beyond what is recommended based on soil fertility tests, can be tolerated without resulting in environmental degradation or adverse impacts. However, continuous over-application can increase the soil phosphorus concentration and result in runoff over time.

While the Part 503 Regulations do not directly specify agronomic requirements for a particular crop, it does preclude the application of biosolids at a rate greater than the agronomic rate of the site – unless otherwise specified by the permitting agency for a reclamation site. The preamble of the Part 503 Regulations addresses only nitrogen and metals when defining agronomic rates, however.

Most states regulate land application loading rates based on metals concentrations, pH, and crop nitrogen requirements. Some states are considering developing guidance and/or regulations that would place limits on phosphorus application to protect against potential water quality degradation to nearby surface waters. These regulatory efforts are based on long-standing concerns that nutrients are key contributors to excess algae blooms, as well as harmful bacteria such as *Pfiesteria*. Legislation has been passed or introduced in Maryland and Virginia to implement nutrient management practices that consider both nitrogen and phosphorus. The Delaware Department of Natural Resources and Environmental Control has identified phosphorus as a key factor in non-point pollution of surface waters and called for a nutrient control strategy to reduce nutrient losses to surface water by 2007. The Wisconsin Department of Natural Resources requires that biosolids application to certain lands adjacent to lakes be limited by crop phosphorus requirements. In addition, the state of Illinois also limits biosolids application based on crop phosphorus requirements for specific soil characteristics and land areas.

### Potential Impacts to the District – Nutrient Management

The nutrient concentrations in biosolids are dependent on the treatment process used. Research by the University of Maryland presents variability in average phosphorus concentrations ranging from 0.8 percent in digested, limed biosolids to 4.6 percent in iron-conditioned solids. Other research is currently ongoing to further investigate variations in available phosphorus and potential water quality impacts. Therefore, generalizations regarding phosphorus availability in biosolids may not be representative.

Depending on the concentrations of nutrients in the biosolids and site characteristics, future nutrient management regulations could limit the application rate, thereby requiring more land base for a land application program.

## Public Acceptance

Municipalities across the United States, like SBWRD, continue to face pressures associated with increasing regulations, public awareness, concerns about waste management, urbanization, odors, and competition for land. In many regions, counties are either banning or further restricting biosolids application by implementing local ordinances. The public has become extremely sensitive, and in some cases, quite organized in opposing almost all types of waste management options with little or no differentiation between trash, biomedical waste, animal manure, or biosolids. To them it is still *sludge,* and it is not always perceived as a beneficial-use product.

The elements of successful biosolids-management programs include more than just operating an effective treatment process and meeting regulations. In fact, creative mechanisms to educate the community on the process and issues surrounding the environmental benefits of biosolids-management approaches greatly enhance the opportunity for successful projects. However, such communication efforts are not simple. The complexity of identifying and engaging numerous stakeholders can seriously disrupt a sound, cost-effective plan if not developed in concert with a defined decision-making process. A targeted program is needed that is based on an understanding of technical and approval processes, as well as those individuals or organizations whose support is necessary for implementation.

The elements of a communications program include:

- **Identify Stakeholders**. Who is likely to be concerned? Which groups or individuals must provide support for implementation? Who is too powerful to ignore? What are stakeholders' expectations?
- **Develop a Communications Plan**. This plan must integrate the technical elements of the program with the major concerns of the key stakeholders. It determines how and where to target the vital component of public education and what modes of communication are required.
- **Develop Strategic Messages**. The public needs to understand the treatment processes, management practices, and safeguards that are in place to ensure program acceptance. The strategic message must share this common objective.
- **Develop Outreach Materials**. Various media may be selected for outreach materials, such as brochures, telephone hotlines, Internet sites, etc.

## Potential Impacts to the District – Public Acceptance

As the District investigates alternative technologies and end-use practices for its long-term program, the following appear to be the primary issues that need to be considered from the community's perspective:

- Potential for odors both onsite and offsite for specific technologies
- Biosolids quality including any pollutants of public concern
- Relative volumes of material to be trucked offsite depending on method of stabilization and processing employed (ash, pellets, compost, lime-stabilized material, dewatered cake)
- Siting issues, including land application sites, as well as off-site processing and storage facilities
- Other sensitive, community-specific issues, based on previous experience with the District's or other waste management programs

By collaborating with the communities affected by biosolids management activities, the District can be assured of a more successful program. Future program adjustments to respond to indeterminate requirements and conditions would be less complex.

Without public education and outreach efforts, significant public opposition can arise and costly facilities may be closed as a result.

# National Practices and Trends

There are two sets of trends that seem to be occurring nationally and are described in the following paragraphs: the effects of the National Biosolids Partnership and the general management direction of utilities that CH2M HILL has observed.

## National Biosolids Partnership

In August 1997, the EPA, AMSA, and the WEF joined together to form the NBP. The partnership's goal is to assist in the planning and implementation of environmentally sound management programs to promote the public acceptance of biosolids. The partnership has undertaken several initiatives to further responsible management of biosolids beyond regulatory compliance, and to gain community support for various biosolids management options. These initiatives include the development of the following:

- **Code of Good Practice**. This code is a pledge containing a list of broad goals and commitments to guide the production, management, transportation, storage, and use or disposal of biosolids.
- **Manual of Good Practices**. The manual will describe the full range of biosolids management practices available. Agencies with biosolids management programs are encouraged to adopt the specific practices depending on the end-use or disposal method employed.
- **Procedural Guidelines for the Implementation of an EMS**. These guidelines are intended to help agencies develop their own management system to ensure not only regulatory compliance, but also to enhance the efficiency of their programs.
- **Program for Independent Third-Party Verification for Each EMS.** Part of the EMS will include an ongoing program for third-party verification. Audits would be conducted to determine how the agency is progressing and can continue to improve based on its own established goals and objectives.

### Potential Impacts to the District – NBP

A voluntary EMS could complement the existing regulatory program by enhancing compliance with applicable regulations and requirements. It would also help to address other non-regulatory issues such as internal and external communication, environmental policies and planning, training, program management and responsibilities, operations, and emergency preparedness and response.

The partnership is in the preliminary stages of the development of the Manual of Good Practices and the formation of an EMS pilot program. The impacts of these initiatives are yet to be determined. There should be additional information and "lessons learned" available during the upcoming year as the partnership progresses.

## National Management Trends

The trends mentioned are based upon observations of and discussions with many utilities around the US about their specific biosolids management concerns.

First, regulations and ordinances are believed to be becoming more restrictive for biosolids management. Although changes in the federal regulations that would affect the District will not occur for some time, the NRC report discussed previously (*NRC, 2002*) will spark some tightening of the regulations. In addition, when research that has been strongly encouraged by the NRC report is conducted and completed, regulatory changes may be required.

Because of the above and public concerns, utilities are more interested in taking control of their own destiny. Although biosolids management may be outsourced to a private entity, there is more monitoring and control by the utilities to ensure few problems can occur. Regardless of the issue, utilities have found that concerns come directly to the utility and not the private entity.

Biosolids use is getting considerable attention, especially with respect to health effects. This is similar to the issues wastewater reuse faced in the 1980s and 1990s. We can only hope that biosolids use will become as widely accepted as wastewater reuse. Recently, however, wastewater reuse has been exposed to even higher levels of public scrutiny and concern about health effects.

All of the above issues are somewhat grounded in the public demanding more involvement in public utility direction, if not actual decision-making. Public involvement committees, advisory committees, and other public relations activities are becoming the norm for utilities, and the public will continue to want to be involved in decisions that affect their rates or quality of life.

Disposal and use are critical to the success of any utility treating wastewater. Many are now looking at purchasing their own property rather than depending upon farmers or private landowners. In this way, they more completely control all decisions.

One item that is a bit different is the desire of several utilities to look toward regionalization for biosolids management. More and more utilities are beginning to work together to diversify use and disposal options to avoid competition for sites and take advantage of economies of scale, but ensure all avenues for use and disposal are investigated. Thee is also a move toward public-private partnerships. One of the concerns by utilities is the survivability of the utility versus a private business. For example, death or severe trauma of a business owner could cause a business to fail if the family or partners decide against continuing, while personal changes by utility generally have minimal affect on the continuance of the responsibilities of the utility.

Last, but certainly not least is the way phased approaches are being used to meet ever changing regulations and economic opportunities. Most utilities are planning to achieve Class A pathogen density levels at some time in the future. So, all current and future project are being structured to enable an easy and quick change to meet changing regulations or public concerns. This holds the additional cost of sophisticated Class A projects in abeyance until regulatory changes or public demands require it.

Regardless of all of the above trends, it behooves the District to maintain the following to continue to be as successful as the District has been:

- Involve the key stakeholders
- Operate the plants in the most efficient mode possible
- Keep aware of regulatory changes
- Consider implementing an EMS program through the NBP

# References

1. *Biosolids Applied to Land, Advancing Standards and Practices*. National Research Council of the National Academies. The National Academies Press. Washington, D.C. July 2002.

# Solids Management Master Plan Public Involvement Process and Evaluation Methodology

PREPARED FOR: Snyderville Basin Water Reclamation District

PREPARED BY: CH2M HILL

DATE: March 17, 2003

## Contents



## Introduction

The Snyderville Basin Water Reclamation District (SBWRD or District) has multiple options for managing its biosolids. Because each option has different advantages and disadvantages, a cursory review alone cannot clearly identify the preferred option. Many attributes of biosolids management need to be considered to make educated decisions. Some of the major criteria to be considered include:

- **Aesthetics and Public Acceptance.** Good public relations are important to SBWRD, and odors are an important issue to the local public.
- **Environmental Protection.** SBWRD and the citizens in the Snyderville Basin area are environmentally conscious and concerned with preserving water, air, and soil quality.
- **Regulations and Political Influences that May Change in the Future.** The District is interested in finding an alternative that has long-term viability, that meets or exceeds all current and project regulations, and that will meet the projected growth of the area for the next several years.
- **Reliable and Efficient Operation of the Treatment Plant.** It is important that the chosen alternative facilitate reliable and efficient operation of the treatment plant.

- **Cost.** Residuals management can be expensive. On average in the United States over 60 percent of WWTP operating costs are due to residuals management, ranging from $50 to $1,000 per dry ton for treatment and disposal or reuse.

In order to choose the management plan that will result in the most efficient use of funds, while also achieving non-economic goals such as public approval and environmental responsibility, the District used the decision-making process detailed below.

# Public Involvement Process

The public involvement process implemented by the SBWRD for this project included public meetings and use of the District's website to disseminate information on the project.

## Public Meetings

Public support is an important aspect of the management objectives of SBWRD, and public concerns were an integral part of the decision-making process. There were three public workshops held to inform the public of progress in the decision-making process and to solicit input. The public provided important input that was used to develop evaluation criteria, establish value weights, and support other parts of the evaluation. A summary from each of the three public meetings is provided in Appendix C. A copy of the slides presented at each of the three public meetings is provided in Appendix D.

The first public workshop was held on August 14, 2002. The project team solicited input on the public's values, goals, and objectives related to residuals management and the evaluation criteria that would be incorporated into the decision model. The team provided an overview of the project and decision-making process as well as information on wastewater treatment and biosolids management processes.

In the second public workshop, held on September 11, 2002, the team solicited feedback on the preliminary list of alternatives and the draft evaluation criteria. The meeting included a recap of the first workshop, a discussion of the evaluation criteria, and a criteria weighting exercise. The next steps in the process were outlined at this time.

In the third public workshop, held on December 11, 2002, the team presented the preliminary evaluation results. They discussed the alternatives screening process and presented a recap of the previous workshops. They described the short list of biosolids management alternatives and recommended a direction for biosolids management. The workshop concluded with a wrap-up of the process and an opportunity for the public to ask questions and provide comments.

## Outreach Efforts

SBWRD maintained a link on its website that provided a comprehensive explanation of the public meeting agendas and results. The website provided a brief introduction to the decision-making process and how the District was using that process to bring all stakeholders, both internal and external, into the process. The results of the criteria weighting exercise, as well as other reports and project information, were posted on the website, www.sbwrd.org, during the decision-making process. Each public meeting was advertised ahead of time through newspaper notices and mailings to individuals on the District's mailing list.

## Decision-Making Process

SBWRD contracted with CH2M HILL to guide the decision-making process. CH2M HILL uses a six-step process to address organizational and analytical issues in decision-making. This process helps to efficiently and effectively make and implement multi-attribute decisions. The benefits of a systematic decision-making process are that it identifies the right problem, identifies all important alternatives, provides efficient information gathering, deals effectively with competing objectives, provides tools for conflict resolution, provides documentation of the decision, and clearly guides implementation.

The six steps are listed below and are shown in Figure 4-1.

**Step 1. Develop Leadership and Commitment**

This step is designed to enhance leadership and commitment to the decision-making process. Commitment from leadership is essential to having stakeholders fully engaged in the process and to make sure that the solution is implemented. This step also provides tools for conflict mediation and methods for dealing effectively with competing objectives.

SBWRD's commitment to finding the best solution to meet the needs of the community and operation staff was demonstrated by SBWRD's action to engage a consultant in this process to assure its success, and to fund the process and the outreach activities.

**Step 2. Frame the Problem**

This step identifies constraints and boundaries of the decision and focuses stakeholders on the real problem that needs to be solved. Examples of constraints and boundaries include budget limits, regulatory requirements, and District policies.

**Step 3. Build Evaluation Model and Formulate Alternatives**

In this step, evaluation criteria and weights are developed. Criteria are characteristics of the alternatives that are based on identified values, goals, and objectives. The criteria represent the attributes of the alternatives that should be considered. Weights are developed to show the relative importance of the criteria to the stakeholders.

**Step 4. Collect Meaningful and Reliable Information**

By focusing on information needed for the decision, as indicated by the criteria, this step saves money and time in data collection. This step is conducted after the stakeholder values have been identified, and measurement criteria for evaluating alternatives with respect to all values have been defined. Sources of data used include engineering analysis and cost estimates, empirical measurements, and regulatory documents. Measurement scales are developed to translate technical measures or qualitative features into "scores" that are used to compare alternatives.

**Step 5. Evaluate Alternatives and Make Decision**

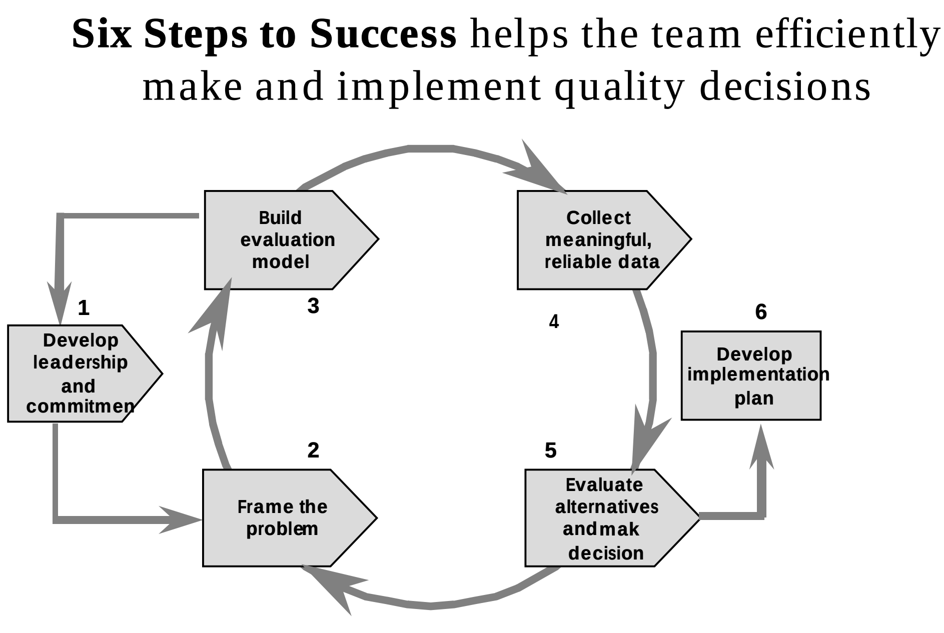
This step combines criteria and weight information to develop a benefit score that quantifies the relative benefits of each alternative.

The traditional approach to evaluation typically leads to recommending the least costly alternative and / or the alternative most consistent with traditional engineering values. In the decision-making process, however, the alternatives are evaluated on the basis of both the economic and non-economic values. This allows alternatives to be compared from stakeholder perspectives that place different relative values on the economic and non-economic factors.

**Step 6. Develop an Implementation Plan**

This step provides a clear record of the decision-making process, allowing the process to be audited and improved. It clearly guides implementation of the preferred project. This step is essential to ensure that the decision is carried out.

**FIGURE 4-1**
Decision Analysis Process




The consultant team and the stakeholders have completed Steps 1 through 5, and have recommended a short list of alternatives based on the analysis up to this point. The next phase of the project is to develop an implementation plan.

# Problem Framing

A workshop was held with internal stakeholders to determine the problem and objectives. The first public workshop presented a problem definition to the public and confirmed that the values, goals, and objectives identified in the internal stakeholder meeting were an accurate representation of external stakeholder concerns. The results were generally consistent between the external and internal stakeholders.

The key problem needing to be addressed and the objective of the decision-making process are:

> Problem: The current biosolids processing system has a limited life and may not be able to accommodate the planned growth of the District's service area.
>
> Objective: Identify an implementation strategy to allow reliable solids management for the next 20 years in a socially, financially, and environmentally responsible manner for the:
>
> – East Canyon WRF
> – Silver Creek WRF

The outcome of the decision-making process will be a recommendation of a combination of one to three socially and environmentally acceptable alternatives, representing the best solutions to the problem among the available alternatives. The SBWRD Board make the final decision of which alternative will be used.

## Alternative Analysis

Once the problem to be addressed was framed, an analysis of alternatives to meet the objectives was undertaken. Technical Memorandum 5 presents the results of the benefit analysis, Technical Memorandum 6 presents the cost analysis, and Technical Memorandum 7 provides the benefit-to-cost-ratio analysis.

# Solids Management Master Plan
# Identification and Discussion of Alternatives

**PREPARED FOR:** Snyderville Basin Water Reclamation District

**PREPARED BY:** CH2M HILL

**DATE:** March 17, 2003

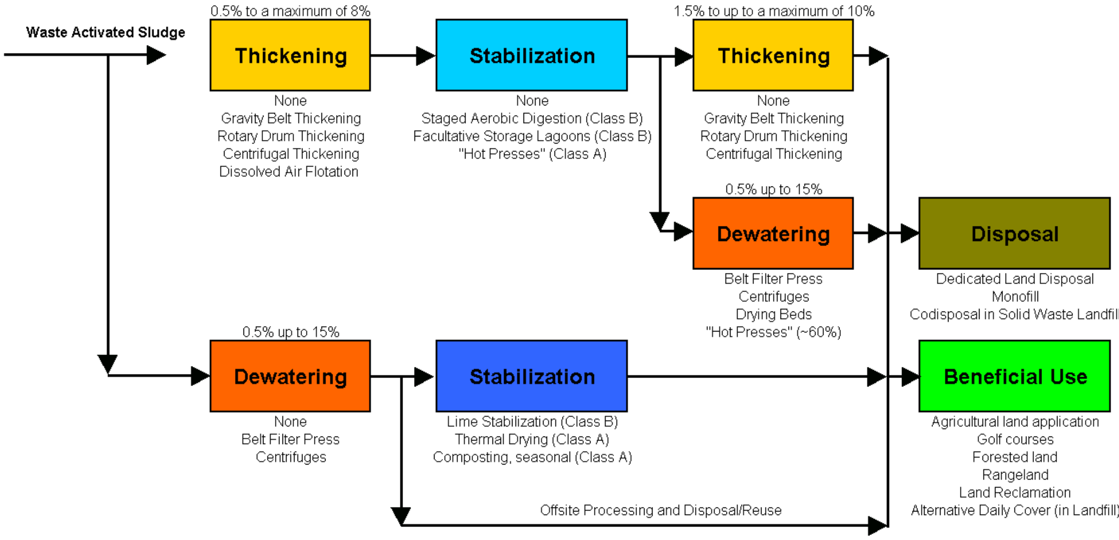
## Contents



## Introduction

In Technical Memorandum 2, Solids Processing Alternatives, several individual processes were identified. These processes must now be combined to form viable alternatives for the East Canyon and Silver Creek Water Reclamation Facilities (WRFs). Such a combination is shown in Figure 5-1.

**FIGURE 5-1**
Overview of Alternatives




As is readily seen from Figure 5-1, there many different alternatives have been identified for evaluation. In the thickening and dewatering options, however, the options are equipment only, so there can be a direct comparison of these without regard to the processes before or after the equipment, as long as the solids stream feeding the equipment is well defined.

From the evaluation of equipment options, the cost-effective option will be included in each alternative evaluation as appropriate. The alternatives for evaluation have been divided into liquid stabilization (LS) and solids stabilization (SS) for ease in keeping track of the alternatives and because there are similarities between the alternatives in the particular grouping. Liquid or solid refers to condition of the solids when stabilization occurs. As such, liquid stabilization alternatives use a liquid process to stabilize solids such as aerobic digestion or facultative storage lagoons. Solids stabilization alternatives, on the other hand, use a stabilization process that requires the sludge to have a solids content about 15 percent or greater prior to stabilization.

Where the thickening, stabilization, or dewatering occurs does not matter for the classification of the alternative, although it is most important for the individual evaluation. Another point is that the term stabilization refers to the ability of the process to reduce pathogen density levels (see Technical Memorandum 3). The pathogen density levels produced are unclassified (or raw, with no reduction in pathogens), Class B, or Class A. Class A pathogen density levels may be considered as pathogen-free, while Class B pathogen levels are below 2 million fecal coliform most probable number (MPN) per gram of total solids (see Technical Memorandum 3) and must include both limited access at the point of beneficial use and the site restrictions required in the United States Environmental Protection Agency (EPA) Part 503 regulations.

Similar to the equipment options, beneficial use and disposal options are common to many alternatives.

Each equipment option will be described in subsequent sections, as well as each liquid and solids stabilization alternatives, and beneficial use and disposal options.

# Equipment Options

Thickening and dewatering options can occur both before and after a stabilization process. As such, each type of equipment has a different performance because the characteristics of the feed solids are different. Therefore, there are four separate equipment evaluations:

- Pre-Stabilization Thickening
- Biosolids Thickening
- Raw Waste Activated Sludge (WAS) Dewatering
- Biosolids Dewatering

Each of these have different design criteria and performance, albeit similar, and each option has different types of equipment that can be used. These are described below.

## Pre-Stabilization Thickening

In this equipment option, pre-stabilization thickening, all conventional thickening devices are considered. These include:

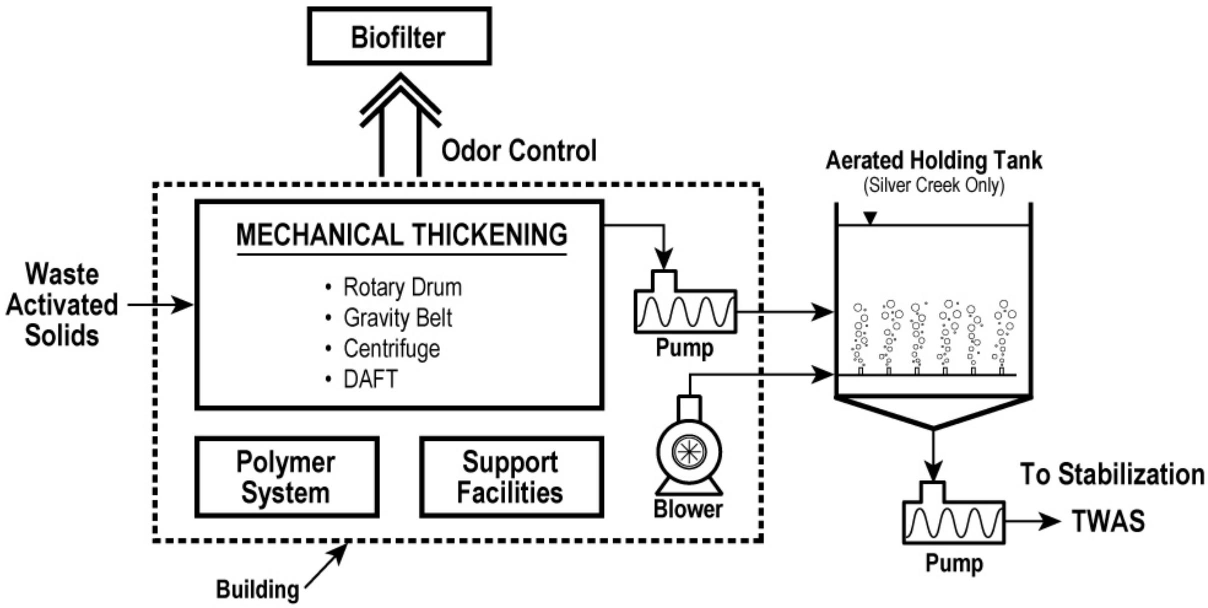
- Gravity Belt Thickeners
- Rotary Drum Thickeners
- Centrifugal Thickeners
- Dissolved Air Flotation Thickeners

Each of these equipment options was described in Technical Memorandum 2. Because the liquid process only generates WAS, these solids are more difficult to thicken and dewater than primary solids because they are composed primarily of active biomass. As such, thickened solids concentrations are lower and polymer consumption is higher than solids from a plant having both primary sludge and WAS. Figure 5-2 shows a typical schematic for these thickening options and Table 5-1 presents the design data for each type of equipment as used in this evaluation. An operating schedule of 7 hours per day was assumed because the thickening processes can generally achieve thickened solids concentrations that are higher than can be used in the subsequent stabilization process. Therefore, the intent was that thickening would be used during the day shift and then blended with the unthickened solids the rest of the day to achieve the desired concentration in the stabilization process. Operation was assumed to be 7 hours per day, which allows ½ hour each for startup and shutdown cleaning to make up a full 8-hour day.

**TABLE 5-1**
Pre-Stabilization Thickening Design Data

| Parameter | Gravity Belt | Rotary Drum | Centrifuge | Dissolved Air Flotation |
|---|---|---|---|---|
| Operating schedule | 7 hour / day, 6 day / week | 7 hour / day, 6 day / week | 7 hour / day, 6 day / week | Continuous |
| Feed solids, % | 0.5 | 0.5 | 0.5 | 0.5 |
| Thickened solids, % | 6 | 5 | 6 | 4 |
| Polymer consumption, lbs. / ton DS | 4 | 6 | 5 | 4 |
| Maximum solids loading | 700 lbs. / hour / meter | | Depends on size | 24 lbs. / square foot / day |
| Maximum hydraulic loading | 250 gpm / meter | | | |
| Recycle, % | NA | NA | NA | 100 |
| Typical equipment type | 2 meters | | | Circular with odor cover |
| Location of equipment | At WRFs | At WRFs | At WRFs | At WRFs |

**FIGURE 5-2**
Solids Thickening
*(Pre-Stabilization)*




**DAFT =** Dissolved Air Flotation Thickener
**TWAS =** Thickened Waste Activated Sludge
**Support Facilities =** Controls, Booster Pumps, Pipelines, Etc.

## Biosolids Thickening

In the stabilization process, the bacteria breaks down the substrate even further than it was in the liquid aerobic process. This make the solids even more difficult to thicken or dewater, so the loading rates are lower and polymer consumption higher than raw or pre-stabilization thickening equipment. The goal of thickening stabilized biosolids is to get the highest solids possible to reduce the hauling cost. Therefore, dissolved air flotation thickening is not included because the best it could do is about 4 to 4.5 percent, which is not enough to make it a viable option. With this in mind, only three biosolids thickening processes are being further evaluated. These three thickening processes are shown on Figure 5-3 and their design data are presented in Table 5-2.

It should be noted that the operating schedule is virtually continuous at 24 hours per day, 6 days per week. This is to reduce the size and cost of the equipment. Thickening equipment is easily automated, so full-time operation is quite common.

**TABLE 5-2**
Stabilized Biosolids Thickening Design Data

| Parameter | Gravity Belt | Rotary Drum | Centrifuge |
|---|---|---|---|
| Operating schedule | 24 hours / day<br>6 days / week | 24 hours / day<br>6 days / week | 24 hours / day<br>6 days / week |
| Feed solids, % | 0.5 to 4 | 0.5 to 4 | 0.5 to 4 |
| Thickened solids, % | 6 | 4 | 6 |
| Polymer consumption, lbs. / ton DS | 5 | 9 | 7 |
| Maximum solids loading | 500 lbs. / hour / meter | | Depends on size |
| Maximum hydraulic loading | 200 gpm / meter | | |
| Typical equipment type | 2 meters | | |
| Location of equipment | With stabilization process | With stabilization process | With stabilization process |

## Raw WAS Dewatering

Dewatering increases the solids concentration to a heavy mud-like consistency which varies from 15 percent solids minimum up to 40 , or even 90 percent depending upon the characteristics of the equipment and the conditioning chemicals (polymer, lime, ferric chloride, and others). As with thickening of a WAS, dewatering is also difficult at best, which is why 15 percent is considered excellent using conventional equipment. For dewatering, the following equipment is considered and is further described in Technical Memorandum 2.

- Belt Filter Press (one old unit existing at Silver Creek)
- Centrifuges (three units existing at East Canyon)
- “Hot Presses” (variation of the variable-volume, recessed chamber filter press)

The belt filter press and the centrifuge are equipment normally found in wastewater treatment plants for dewatering WAS. There are continual improvements by the manufacturers of these equipment, and the normal life is 15 to 20 years, although most utilities replace dewatering equipment every 10 to 15 years due to advancements in the technology that reduce operating cost. These are shown on Figure 5-4.

The "hot presses" were developed over 10 years ago and have been available only over the past 5 years. It is a batch process where the WAS is fed to the device and held for several hours under pressure. With the use of hot water or steam and a vacuum, water evaporates at a lower temperature so solids contents of 60 percent or greater, depending upon time, are achievable. A primary difference in the hot press is a stabilization process as well. Because of this, the hot presses are evaluated as a stabilization process as well as a dewatering process. For dewatering, the goal is to achieve 40 to 60 percent solids using polymer conditioners, whereas in stabilization, lime and ferric is used to meet the VAR requirement as well as pathogen kill requirements.

**FIGURE 5-3**
Solids Thickening
*(Post-Stabilization)*

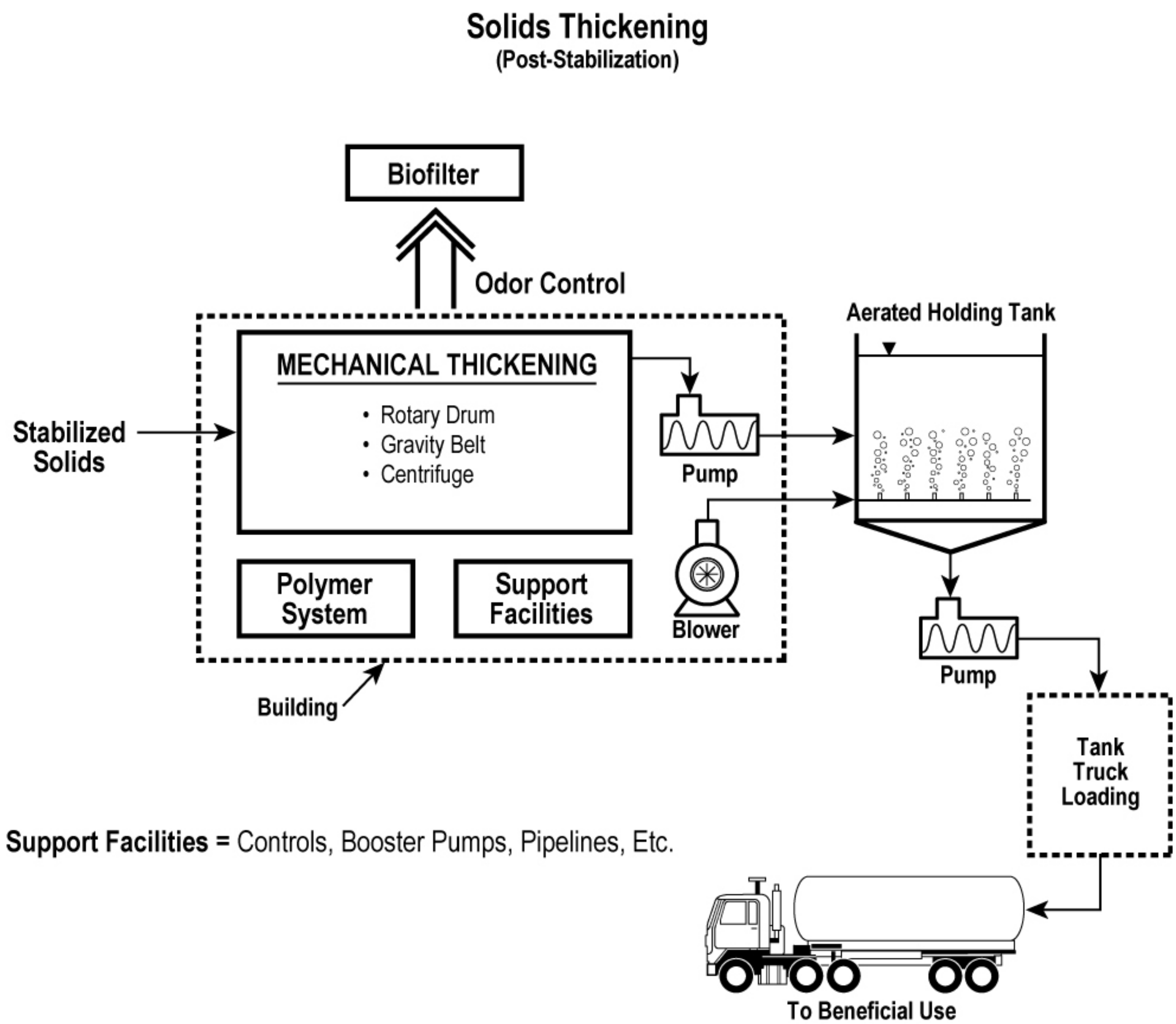
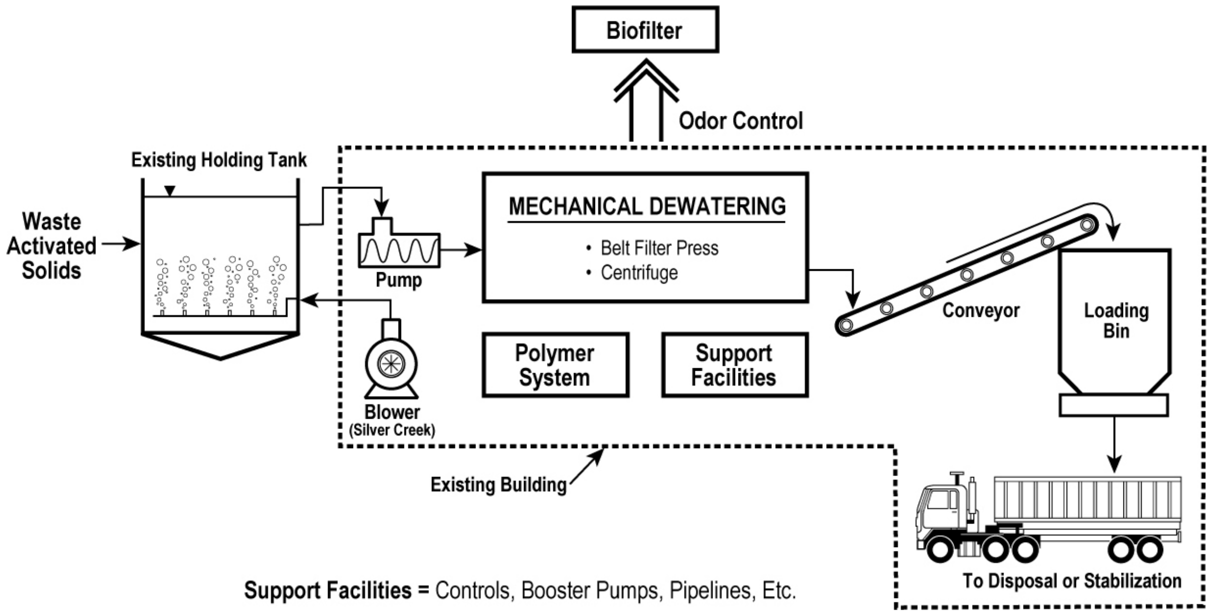


**FIGURE 5-4**
Solids Dewatering
*(Pre-Stabilization)*



Due to the long cycle times of 4 to 6 hours to achieve appropriate cake dryness and the heat added, the solids have been tested to prove that Class A biosolids result. If the cake is to be land applied and either Class A or Class B pathogen density levels are desired, however, one of the 12 vector attraction reduction (VAR) requirements must be satisfied. VAR requirements are described in Technical Memorandum 3. Applicable VAR requirements for the hot presses are either: the cake solids must be greater than 75 percent (Requirement 7) or sufficient lime must be added in the conditioning step to maintain the pH at 12 or higher for 12 hours (Requirement 6). Other VAR requirements may be useable if composting of the cake is done or if the cake is incorporated or covered daily. For this evaluation, however, it is assumed the pH requirement will be the VAR method. Another difference in this process is that thickening is required ahead of this option. A dilute solids feed extends the cycle considerably and makes the size and performance of the equipment not cost effective. Therefore, thickening ahead of the hot press must be used. A flowsheet for this option is presented in Figure 5-5.

The design data for raw WAS dewatering is include in Table 5-3.

**FIGURE 5-5**
Dewatered Solids Stabilization
*(JVAP "Hot Press" Recessed Chamber Filter Press System)*

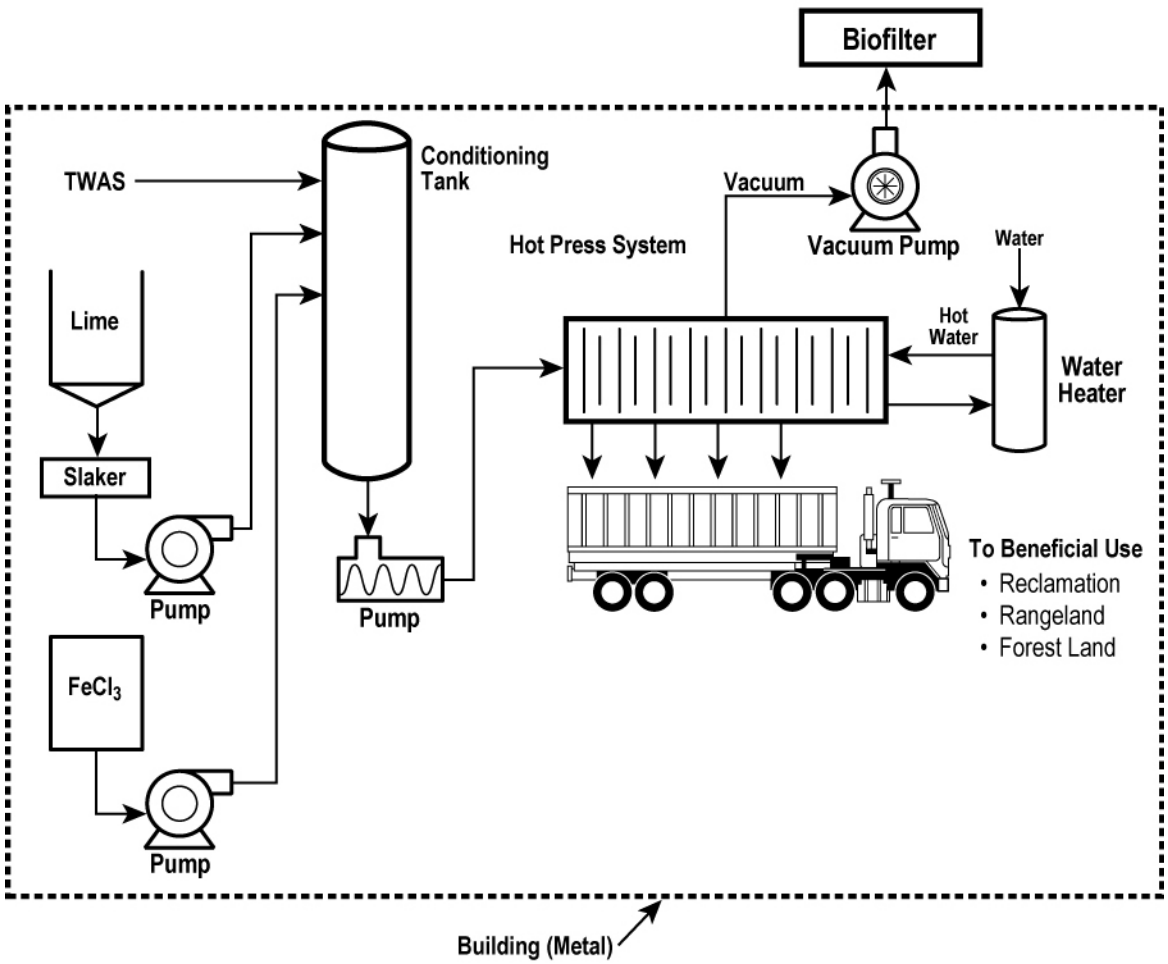


**TABLE 5-3**
Raw WAS Dewatering Design Data

| Parameter | Belt Filter Press | Centrifuge | Hot Press |
|---|---|---|---|
| Operating schedule | 7 hours / day<br>6 days / week | 7 hours / day<br>6 days / week | 16 hours / day<br>6 day / week [a] |
| Feed solids, % | 0.5 | 0.5 | 4 to 6 [b] |
| Dewatered cake solids, % | 15 | 15 | 60 |
| Polymer consumption, lbs. / ton DS | 12 | 20 | 0 |
| Conditioning chemicals / dose in % of dry solids fed | None | None | Lime / 25%<br>Ferric chloride / 8% |
| Process type | Continuous | Continuous | Batch (6 hour cycle time) |
| Maximum solids loading | 1,200 lbs. / hour / meter | Depends on size of equipment used | Depends on size and number of plates |
| Maximum hydraulic loading | 300 gpm | Depends on size of equipment used | Depends on size and number of plates |
| Typical equipment type | 2 meters | | 1200 mm x 1200 mm plates |
| Location | At WRFs | At WRFs | At WRFs |

[a] Actual operator time is 8 hours per day. Drop load from previous day, complete one cycle, start new cycle (to be completed next day)
[b] Must have thickening ahead of process – not economical to use unthickened feed.

## Biosolids Dewatering

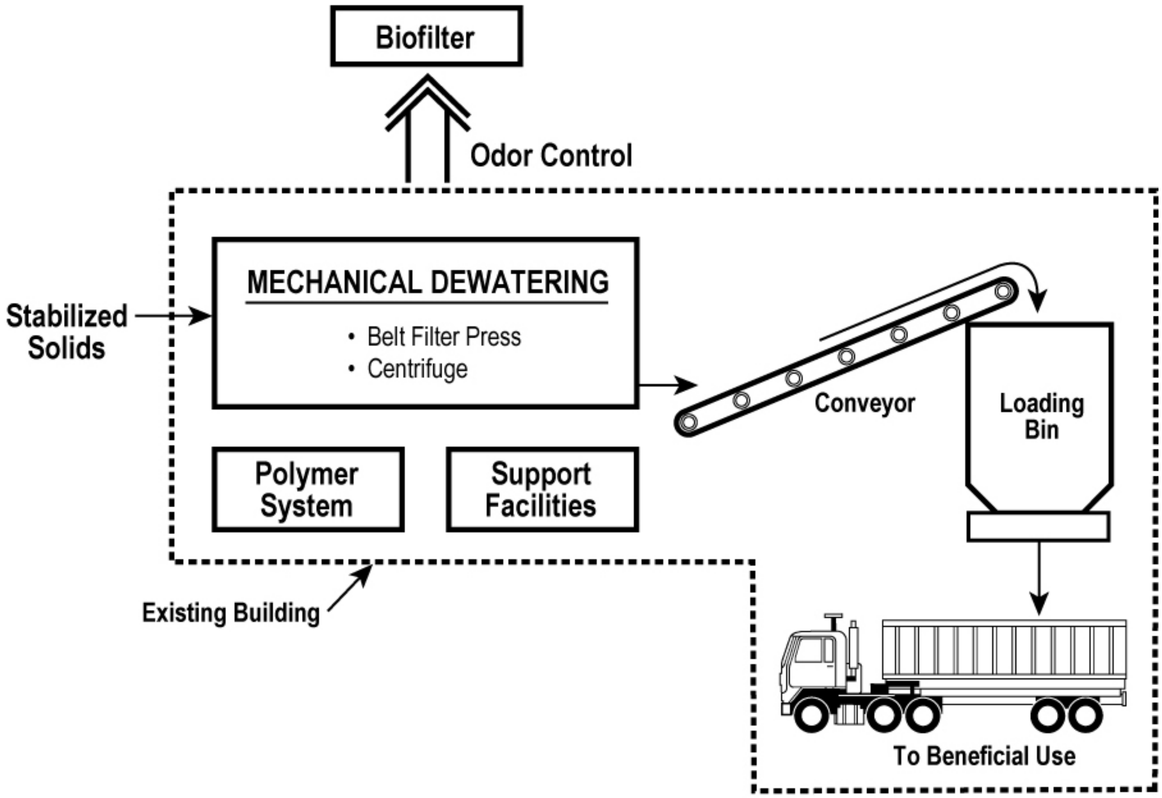
Biosolids (which is defined as being stabilized) are more difficult to dewater than raw WAS, similar to thickening processes. Reduced loading rates as well as increased polymer consumption are required. Dewatering equipment for biosolids is somewhat different than for raw WAS and are described in Technical Memorandum 2. Those selected include:

- Belt Filter Presses
- Centrifuges
- Solar Drying Beds

A flowsheet for the belt filter press and centrifuge dewatering options is shown on Figure 5-6. Solar drying beds are used only for stabilized solids due to the odors. Considerable land is needed to enable evaporation to achieve the dryness necessary and to hold the solids over the winter months. In addition, to remove the solids from the bed, the cake dryness is usually above 40 percent. Polymer can be added to increase performance and is included with the option. This option is presented on Figure 5-7.

Hot presses are not included for stabilized solids because the hot press itself stabilizes the solids with heat and time to meet the EPA Part 503 regulations, so not adding a stabilization process ahead of the hot press is not appropriate.

**FIGURE 5-6**
Solids Dewatering
*(Post-Stabilization)*




**Support Facilities =** Controls, Booster Pumps, Pipelines, Etc.

**FIGURE 5-7**
Solids Stabilization
*(Drying Beds at Remote Site)*

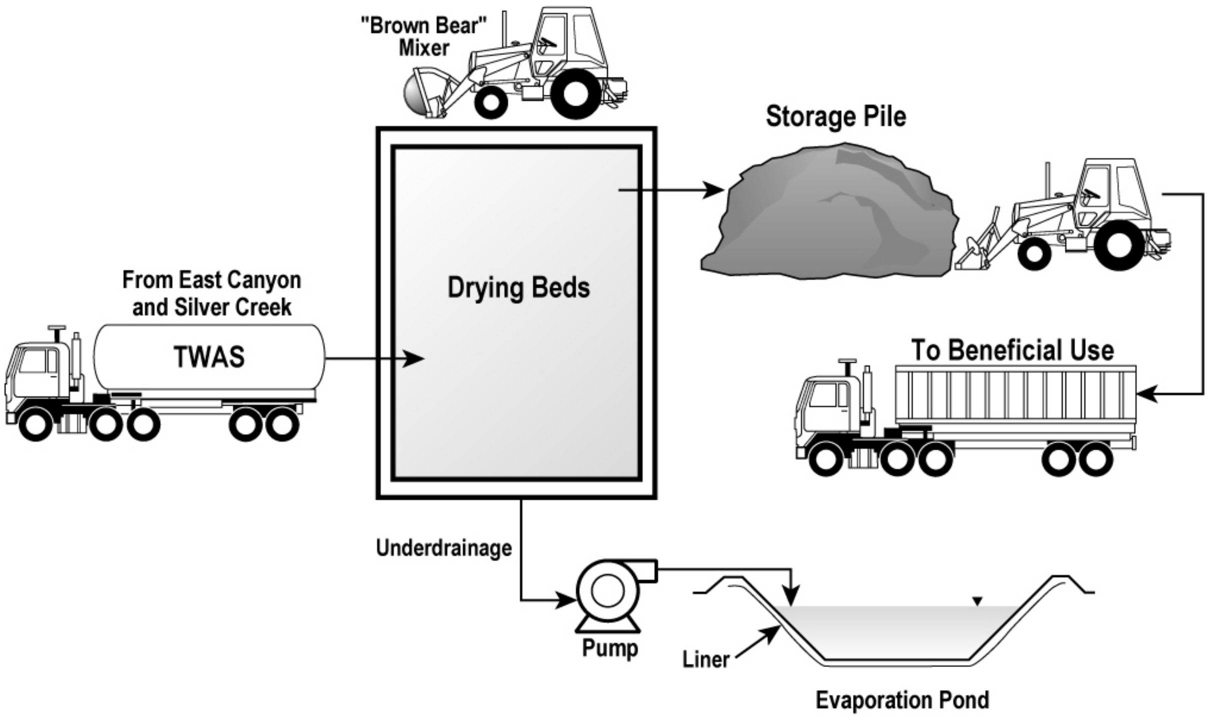



**TABLE 5-4**
Stabilized Biosolids Dewatering Design Data

| Parameter | Belt Filter Press | Centrifuge | Drying Beds |
|---|---|---|---|
| Operating schedule | 7 hours / day<br>6 days / week | 7 hours / day<br>6 days / week | Day shift only |
| Feed solids, % | 0.5 to 4 | 0.5 to 4 | 0.5 to 4 |
| Dewatered cake solids, % | 15 | 15 | 40 |
| Polymer consumption, lb/ton DS | 15 | 25 | 4 |
| Maximum solids loading | 1,200 lbs. / hour / meter | Depends on size of equipment used | |
| Maximum hydraulic loading | 300 gpm | Depends on size of equipment used | |
| Typical equipment type | 2 meters | | |
| Location | With stabilization process | With stabilization process | At remote site |

The design criteria for the three options to dewater stabilized cake are presented in Table 5-4.

# Liquid Stabilization Alternatives

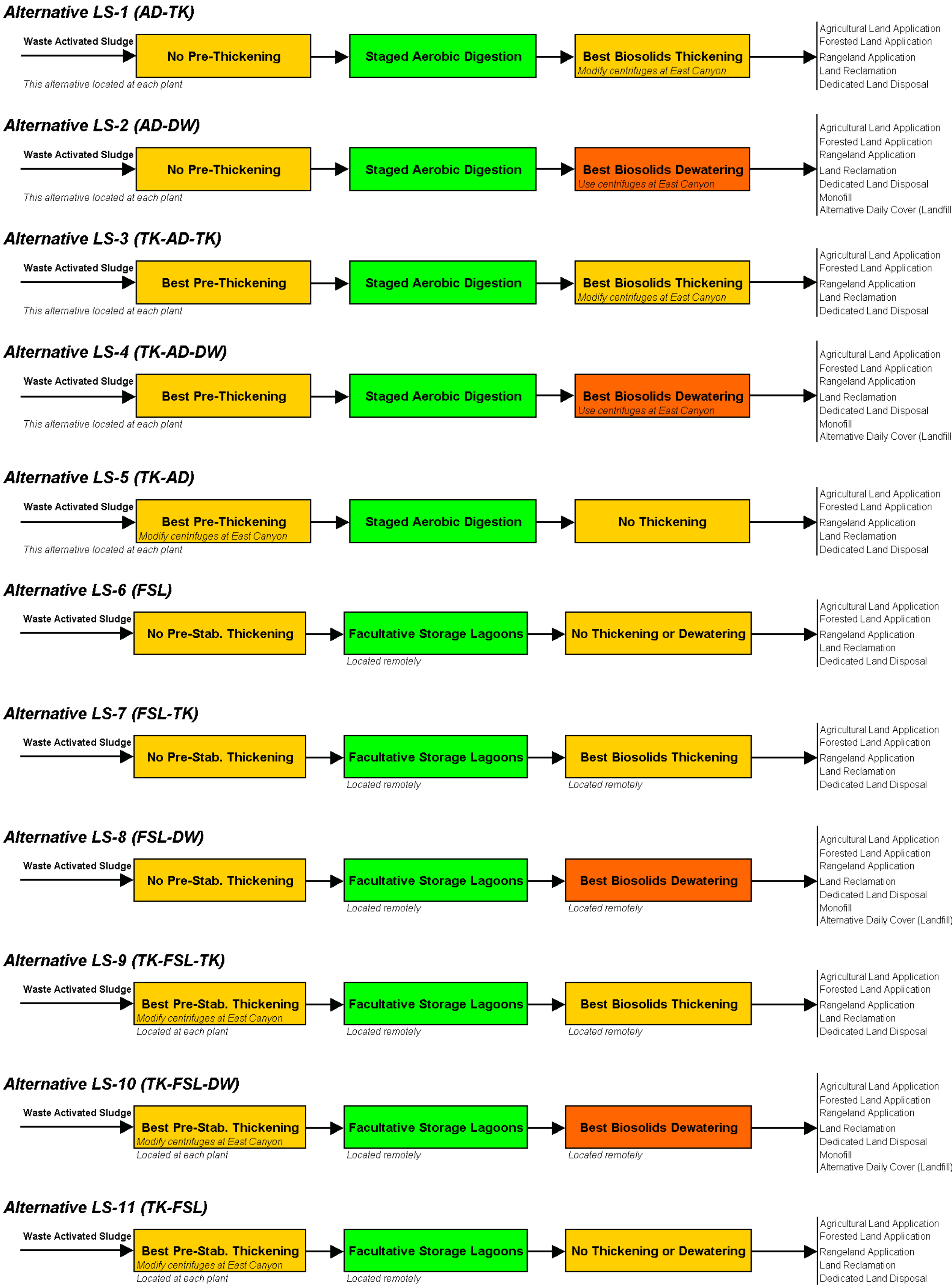
Figure 5-8 includes all liquid process stabilization alternatives for evaluation and this includes thickening as well as no thickening. This results in 11 separate, but similar alternative in this set. Unstabilized liquid solids are difficult, if not impossible, to dispose of because of long haul distances which are uneconomical and the inability of landfills to accept them because of the high water content. Therefore, all liquid stabilization alternatives must be stabilized to be able to beneficially use or dispose of the resulting product.

Each alternative, and it's associated design criteria, is described below.

## Alternative LS-1 (AD-TK)

This alternative includes the staged aerobic digestion of liquid solids direct from the wastewater treatment process. Staged aerobic digestion was selected to take advantage of the plug flow characteristics of multiple stages. Incorporating this allows a reduction in detention time of 33 percent, but by using an unthickened feed, the cost for the stabilization process will be quite high. By not having the additional unit process of thickening, there is an opportunity to reduce the overall cost of this alternative. The aerobic digestion process will normally achieve a 38 percent volatile solids reduction which is the minimum required to achieve VAR (Requirement 1, described in Technical Memorandum 3). If the process does not achieve 38 percent volatile solids reduction, then Requirement 4 [Standard Oxygen Uptake Rate (SOUR)] or Requirement 3 may be used to determine compliance. Regardless of the VAR, aerobic digestion is a Process to Significantly Reduce Pathogens

**FIGURE 5-8**
Liquid Stabilization Alternatives



(PSRP, described in more detail in Technical Memorandum 3) as long as the design criteria meets the above description. If there is a time when this criteria is exceeded, monitoring for pathogens may also be used. Pathogen levels must be below 2 million fecal coliform per gram total solids to meet the pathogen density levels for Class B. There is no process in the liquid stabilization alternatives that can achieve Class A pathogen density levels. A schematic of the staged aerobic digestion process is presented on Figure 5-9.
Disposal or use is by thickening to reduce the volume of the material to be hauled for beneficial use or for further stabilization. The flowsheet and design criteria for this alternative is included in Figures 5-10.

## Alternative LS-2 (AD-DW)

This alternative is similar to Alternative LS-1, but includes dewatering instead of post thickening. The use of dewatering allows many more use and disposal alternatives due to the less expensive haul volume. As with Alternative LS-1, the large volume of aerobic digestion required may be offset by having no pre-thickening.

The flowsheet and design information for use in the evaluation is presented in Figure 5-11.

## Alternative LS-3 (TK-AD-TK)

Although this alternative continues to use staged aerobic digestion, it includes pre-stabilization thickening which will take advantage of the heat of endogenous respiration in the process. As such, it can be shown that the process will remain at 20ºC or greater, which requires a minimum of 40 days. This requires a covered tank for the first stage. Because the system is staged, this detention time can be further reduced by one-third or to 28 days. As with Alternative LS-1, the stabilized solids are thickened prior to use or disposal.

The flowsheet and design criteria for this alternative is presented in Figure 5-12.

## Alternative LS-4 (TK-AD-DW)

Similar to Alternative LS-3, this alternative incorporates dewatering after the stabilization process to provide more opportunities for beneficial use or disposal and to reduce hauling cost for these options. By combining both pre-stabilization and post-dewatering, this alternative makes the best use of aerobic digestion and reduces the resulting volume from the system.

Figure 5-13 presents the design and operating criteria for Alternative LS-4.

## Alternative LS-5 (TK-AD)

This alternative may offset the cost of enhanced staged aerobic digestion by eliminating any post processing, either thickening or dewatering. The downside is that dilute biosolids must be hauled directly from the aerobic digesters. Assuming 38 percent volatile solids reduction and a high of 4 percent feed solids, the resulting solids would be 2.9 percent, a very dilute product for hauling. Using this same example, the number of trucks used to haul 2.9 percent versus 8 percent is almost three time greater.

The flowsheet and design criteria for Alternative LS-5 is shown in Figure 5-14.

**FIGURE 5-9**
Solids Stabilization
*(Aerobic Digestion)*

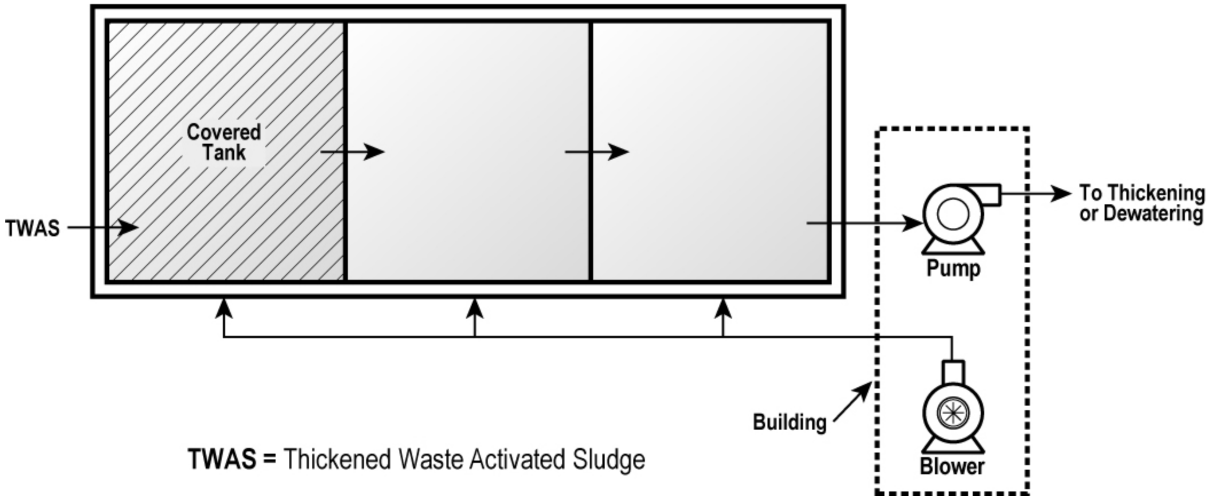
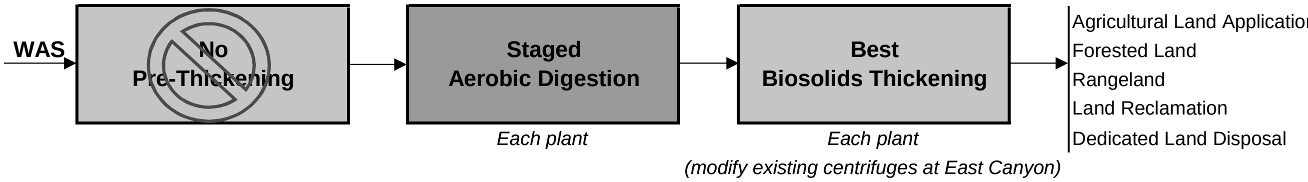


**FIGURE 5-10**
Alternative LS-1

## *Flowsheet*



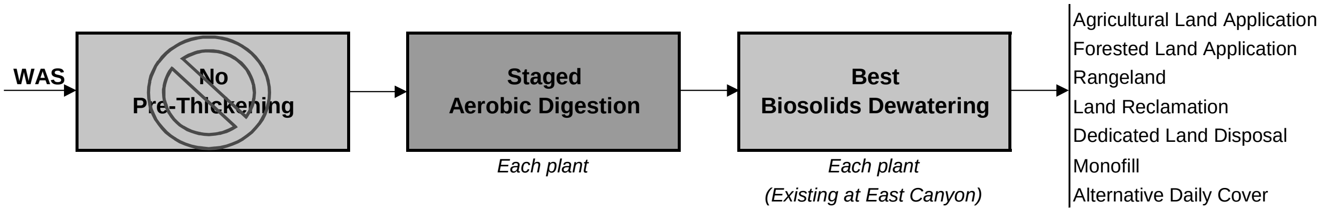

## *Design Data*

Aerobic Digestion and Biosolids Thickening

| Process and Design Criteria | Design Values | Normal Range and Comments |
|---|---|---|
| **Pre-stabilization Thickening** | NONE | |
| **Staged Aerobic Digestion** | | |
| Operating time | Continuous, 24 hours/day, 7 days per week | With the long detention time, feed to the process may be intermittent, but the process will be operating continuously |
| Feed solids, percent | 0.5 | 0.5 to 4 |
| Detention time, days | 40 days at 15ºC | Staged aerobic digestion requires multiple tanks in series to emulate a plug-flow system which is considerably better for pathogen reduction. EPA recognizes this and permits a 1/3 reduction of the minimum time (60 day) for staged systems. |
| Configuration | Staged with three tanks in series | |
| Air Demand | 40 cfm / 1,000 cubic foot | |
| Process Performance | Class B and 38% volatile solids reduction | Minimum required for EPA Part 503 Regulations |
| **Biosolids Thickening** | Determined by Equipment Option Evaluation | |
| Operating time | 7 hours/day, 6 days/week | 7 hours/day allows ½ hour for startup and ½ hour fore shutdown everyday, so an 8 hour shift is maintained |

**FIGURE 5-11**
Alternative LS-2

## *Flowsheet*



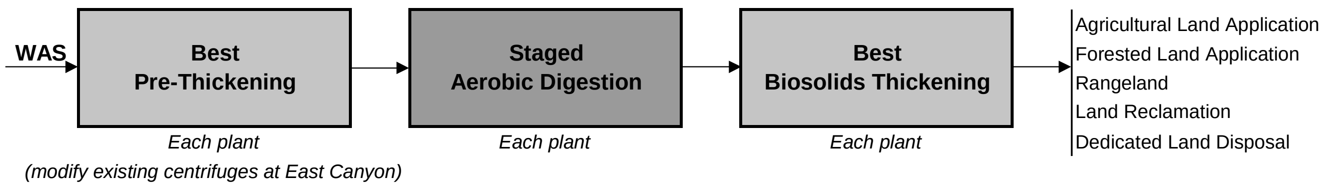

## *Design Data*

Aerobic Digestion and Biosolids Dewatering

| Process and Design Criteria | Design Values | Normal Range and Comments |
|---|---|---|
| **Pre-stabilization Thickening** | NONE | |
| **Staged Aerobic Digestion** | | |
| Operating time | Continuous, 24 hours/day, 7 days per week | With the long detention time, feed to the process may be intermittent, but the process will be operating continuously |
| Feed solids, percent | 0.5 | 0.5 to 4 |
| Detention time, days | 40 days at 15ºC | Staged aerobic digestion requires multiple tanks in series to emulate a plug-flow system which is considerably better for pathogen reduction. EPA recognizes this and permits a 1/3 reduction of the minimum time (60 day) for staged systems. |
| Configuration | Staged, with three stages | |
| Air Demand | 40 cfm / 1,000 cubic foot | |
| Process Performance | Class B and 38% volatile solids reduction | Minimum required for EPA Part 503 Regulations |
| **Biosolids Dewatering** | Determined by Equipment Option Evaluation | |
| Operating time | 7 hours/day, 6 days/week | 7 hours/day allows ½ hour for startup and ½ hour fore shutdown everyday, so an 8 hour shift is maintained |

**FIGURE 5-12**
Alternative LS-3

## *Flowsheet*



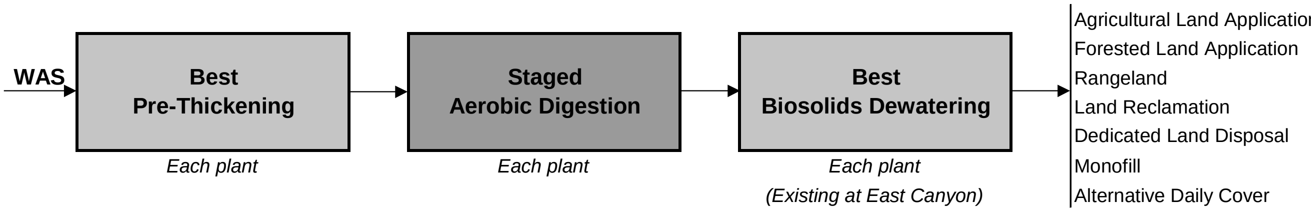

## *Design Data*

Pre-stabilization Thickening, Aerobic Digestion and Biosolids Thickening

| Process and Design Criteria | Design Values | Normal Range and Comments |
|---|---|---|
| **Pre-stabilization Thickening** | Determined by Equipment Option Evaluation | |
| Operating time | 7 hours/day, 6 days per week | Since only 3 to 4% required, thickening will only be required on a portion of the flow. |
| **Staged Aerobic Digestion** | | |
| Operating time | Continuous, 24 hours/day, 7 days per week | With the long detention time, feed to the process may be intermittent, but the process will be operating continuously |
| Feed solids, percent | 0.5 | 0.5 to 4 |
| Detention time, days | 40 days at 15ºC | Staged aerobic digestion requires multiple tanks in series to emulate a plug-flow system which is considerably better for pathogen reduction. EPA recognizes this and permits a 1/3 reduction of the minimum time (60 day) for staged systems. |
| Configuration | Staged, with three stages | |
| Air Demand | 40 cfm / 1,000 cubic foot | |
| Process Performance | Class B and 38% volatile solids reduction | Minimum required for EPA Part 503 Regulations |
| **Biosolids Thickening** | Determined by Equipment Option Evaluation | |
| Operating time | 7 hours/day, 6 days/week | 7 hours/day allows ½ hour for startup and ½ hour fore shutdown everyday, so an 8 hour shift is maintained |

**FIGURE 5-13**
Alternative LS-4

## *Flowsheet*



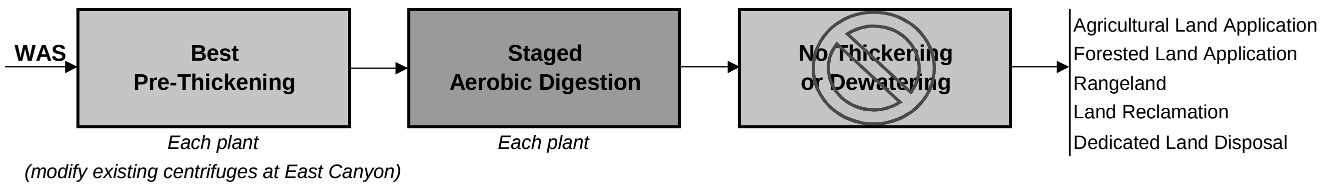

## *Design Data*

Pre-stabilization Thickening, Aerobic Digestion, and Biosolids Dewatering

| Process and Design Criteria | Design Values | Normal Range and Comments |
|---|---|---|
| **Pre-stabilization Thickening** | Determined by Equipment Option Evaluation | |
| Operating time | 7 hours/day, 6 days per week | Since only 3 to 4% required, thickening will only be required on a portion of the flow. |
| **Staged Aerobic Digestion** | | |
| Operating time | Continuous, 24 hours/day, 7 days per week | With the long detention time, feed to the process may be intermittent, but the process will be operating continuously |
| Feed solids, percent | 0.5 | 0.5 to 4 |
| Detention time, days | 40 days at 15ºC | Staged aerobic digestion requires multiple tanks in series to emulate a plug-flow system which is considerably better for pathogen reduction. EPA recognizes this and permits a 1/3 reduction of the minimum time (60 day) for staged systems. |
| Configuration | Staged, with three stages | |
| Air Demand | 40 cfm / 1,000 cubic foot | |
| Process Performance | Class B and 38% volatile solids reduction | Minimum required for EPA Part 503 Regulations |
| **Biosolids Thickening** | Determined by Equipment Option Evaluation | |
| Operating time | 7 hours/day, 6 days/week | 7 hours/day allows ½ hour for startup and ½ hour fore shutdown everyday, so an 8 hour shift is maintained |

**FIGURE 5-14**
Alternative LS-5

## *Flowsheet*




## *Design Data*

Pre-stabilization Thickening and Aerobic Digestion

| Process and Design Criteria | Design Values | Normal Range and Comments |
|---|---|---|
| **Pre-stabilization Thickening** | Determined by Equipment Option Evaluation | |
| Operating time | 7 hours/day, 6 days per week | Since only 3 to 4% required, thickening will only be required on a portion of the flow. |
| **Staged Aerobic Digestion** | | |
| Operating time | Continuous, 24 hours/day, 7 days per week | With the long detention time, feed to the process may be intermittent, but the process will be operating continuously |
| Feed solids, percent | 0.5 | 0.5 to 4 |
| Detention time, days | 40 days at 15ºC | Staged aerobic digestion requires multiple tanks in series to emulate a plug-flow system which is considerably better for pathogen reduction. EPA recognizes this and permits a 1/3 reduction of the minimum time (60 day) for staged systems. |
| Configuration | Staged, with three stages | |
| Air Demand | 40 cfm / 1,000 cubic foot | |
| Process Performance | Class B and 38% volatile solids reduction | Minimum required for EPA Part 503 Regulations |
| **Biosolids Thickening** | NONE | |

## Alternative LS-6 (FSL)

All subsequent liquid stabilization alternatives use Facultative Storage Lagoons or FSLs. Facultative lagoons are quite common and similar lagoons have been used for many years, normally for biosolids stabilized in anaerobic digestion. But it has been recognized that this method, if loaded properly, can stabilize raw solids. The difficulty is the very low loading rate. Facultative bacteria (survive in both aerobic and anaerobic conditions) in the solids at the bottom of the lagoon break down the volatile solids and slowly release the gases from decomposition of the solids. Because of the large surface area, these gases dissipate quickly. The advantages of such a system is the potential long-term storage. For example, it will take three to five years just to “fill” the lagoons before any solids removal (harvesting) can take place. The major downside, however, is odors. Once or twice a year, the lagoon may turn over due to the temperature density difference in the water. This will bring the digesting solids to the surface and will cause severe odors. As such, we have assumed that the FSLs are located remote from either plant. Therefore, the feed solids must be hauled to the FSLs. Excess water is assumed to evaporate in lined evaporation ponds. During an extremely wet season, the excess water could be hauled back to the plants in the tank trucks used to haul the solids to the FSLs. This water would be pumped into the raw sewage feed stream of the plant. A diagram of the facultative storage lagoon system is presented in Figure 5-15.

Alternative LS-6 uses the FSLs to handle all WAS from both plants, without pre-stabilization thickening. Although this requires significant liquid to haul, it may offset the odors and operating thickening or dewatering process at both plants. Because the FSLs serve to concentrate solids in the lagoon bottom, this option assumes that these thickened solids would be useable on nearby land. The solids on the bottom of an FSL can be as high as 8 percent, but with the movement of the dredge pump and the churning action, the solids are assumed to be only about 4 percent, which is about the same as a dissolved air flotation thickener can produce. This alternative is shown and the design data presented on Figure 5-16.

## Alternative LS-7 (FSL-TK)

Alternative LS-7 uses the FSLs to handle all WAS from both plants, without pre-stabilization thickening of the raw WAS, but with thickening of the biosolids from the FSL. Although this requires significant liquid to haul (same as Alternative LS-6), it may offset the odors and thickening processes at both plants. One thickening process would be used (instead of two dewatering processes) at the remote FSLs to prepare solids for use or disposal. The existing centrifuges at East Canyon could be relocated to the remote site. This alternative is shown and the design data presented on Figure 5-17

## Alternative LS-8 (FSL-DW)

Alternative LS-8 also uses the FSLs to handle all WAS from both plants, without pre-stabilization thickening, but dewatering at the remote FSL site. Although this requires significant liquid to haul, it may offset the odors and dewatering process at both plants. One dewatering process would be used (instead of two) at the FSLs to prepare solids for beneficial use or disposal. The existing centrifuges at East Canyon could be relocated to the remote site. This alternative is shown and the design data presented on Figure 5-18.

**FIGURE 5-15**
Solids Stabilization
*(Facultative Storage Lagoons at Remote Site)*

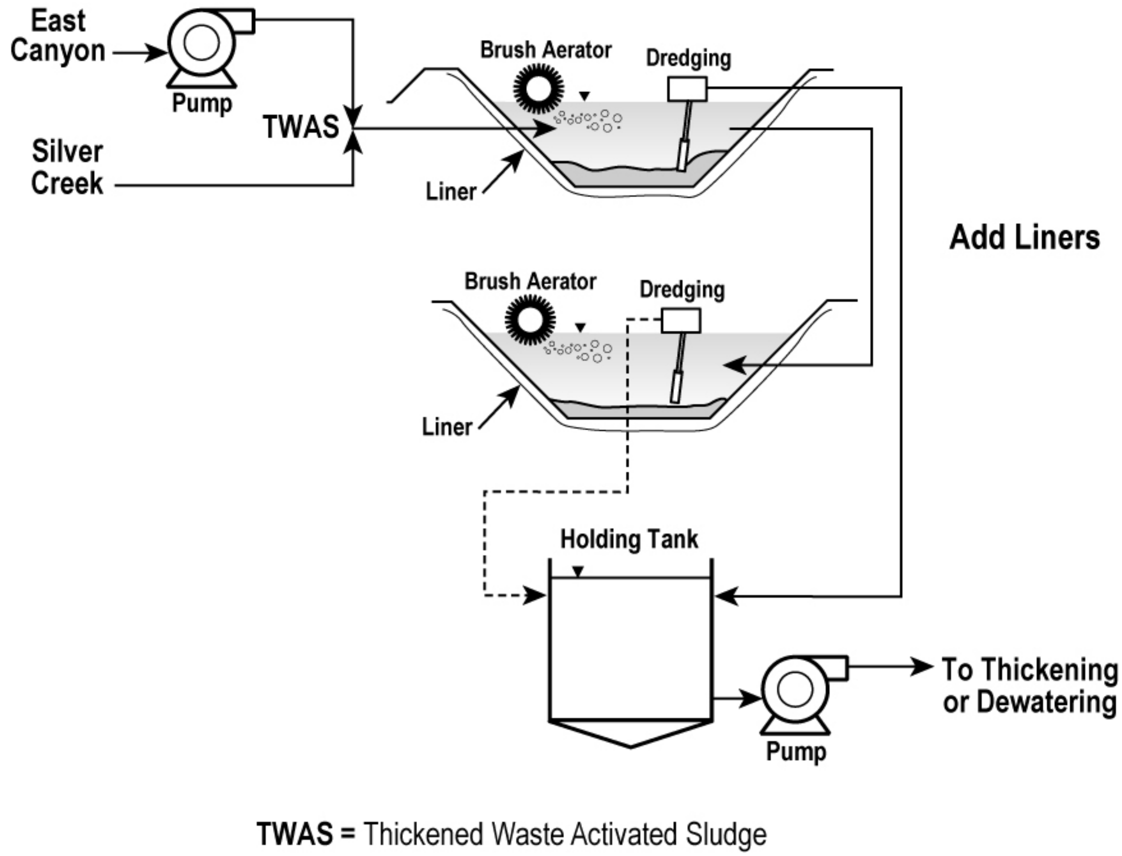
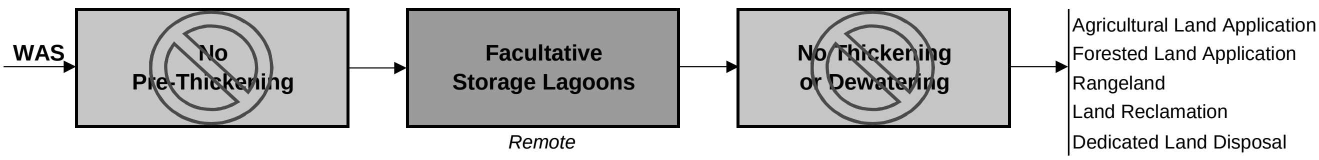


**FIGURE 5-16**
Alternative LS-6

## *Flowsheet*



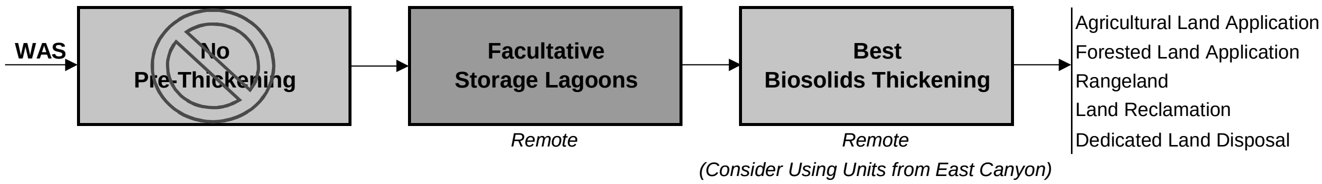

## *Design Data*

Facultative Storage Lagoons

| Process and Design Criteria | Design Values | Normal Range and Comments |
|---|---|---|
| **Pre-stabilization Thickening** | NONE | |
| **Facultative Storage Lagoons** | | |
| Operating time | Continuous, 24 hours/day, 7 days per week | With the long detention time, feed to the process may be intermittent, but the process will be operating continuously |
| Feed solids, percent | 0.5 | |
| Volatile solids loading rate, lb VS/1000 sf | 20 | From EPA Manual |
| Detention time, days | Several years | |
| Configuration | Four independent lagoons | |
| Air Demand | 15 hp brush aerator on each lagoon | Operated about 1/4 time |
| Operation | One lagoon fed until full, then rested for several years prior to harvesting | Requires one moveable dredge when harvesting is begun |
| Process Performance | Class B and 38% volatile solids reduction | Minimum required for EPA Part 503 Regulations |
| **Biosolids Thickening** | NONE | |

**FIGURE 5-17**
Alternative LS-7

## *Flowsheet*



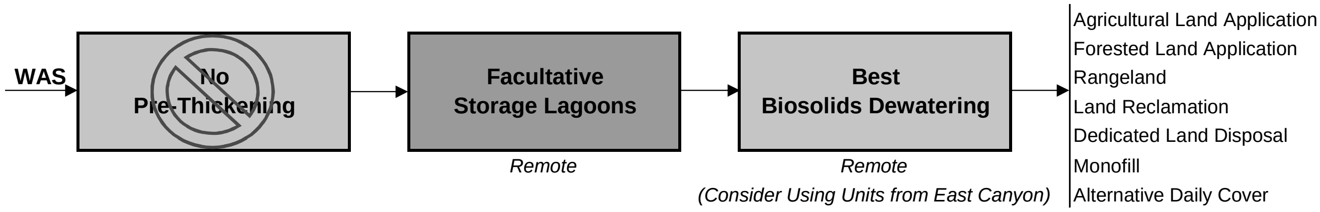

## *Design Data*

Facultative Storage Lagoons and Biosolids Thickening

| Process and Design Criteria | Design Values | Normal Range and Comments |
|---|---|---|
| **Pre-stabilization Thickening** | NONE | |
| **Facultative Storage Lagoons** | | |
| Operating time | Continuous, 24 hours/day, 7 days per week | With the long detention time, feed to the process may be intermittent, but the process will be operating continuously |
| Feed solids, percent | 0.5 | |
| Volatile solids loading rate, lb VS/1000 sf | 20 | From EPA Manual |
| Detention time, days | Several years | |
| Configuration | Four independent lagoons | |
| Air Demand | 15 hp brush aerator on each lagoon | Operated about 1/4 time |
| Operation | One lagoon fed until full, then rested for several years prior to harvesting | Requires one moveable dredge when harvesting is begun |
| Process Performance | Class B and 38% volatile solids reduction | Minimum required for EPA Part 503 Regulations |
| **Biosolids Thickening** | Determined by Equipment Option Evaluation | |
| Feed solids, percent | 4.0 | |
| Operating time | 7 hours/day, 6 days per week, to start 3 years later | Goal is to achieve highest solids content possible to reduce hauling and use/ disposal costs |

**FIGURE 5-18**
Alternative LS-8

## *Flowsheet*




## *Design Data*

Facultative Storage Lagoons and Biosolids Dewatering

| Process and Design Criteria | Design Values | Normal Range and Comments |
|---|---|---|
| **Pre-stabilization Thickening** | NONE | |
| **Facultative Storage Lagoons** | | |
| Operating time | Continuous, 24 hours/day, 7 days per week | With the long detention time, feed to the process may be intermittent, but the process will be operating continuously |
| Feed solids, percent | 0.5 | |
| Volatile solids loading rate, lb VS/1000 sf | 20 | From EPA Manual |
| Detention time, days | Several years | |
| Configuration | Four independent lagoons | |
| Air Demand | 15 hp brush aerator on each lagoon | Operated about 1/4 time |
| Operation | One lagoon fed until full, then rested for several years prior to harvesting | Requires one moveable dredge when harvesting is begun |
| Process Performance | Class B and 38% volatile solids reduction | Minimum required for EPA Part 503 Regulations |
| **Biosolids Dewatering** | Determined by Equipment Option Evaluation | |
| Feed solids, percent | 4.0 | |
| Operating time | 7 hours/day, 6 days per week, to start 3 years later | Goal is to achieve highest solids content possible to reduce hauling and use/ disposal costs |

### Alternative LS-9 (TK-FSL-TK)

This Alternative LS-9 thickens the raw WAS at each plant to reduce hauling costs as compared to Alternatives LS-6, 7, and 8. Although the FSLs will not be any smaller, because the size is set by the volatile solids loading, the hauling costs will be considerably less. This alternative has solids processing at each plant (thickening) and will reuse the modify the existing centrifuges at East Canon for this purpose. The solids from the FSL will be further thickened at the FSL site for final beneficial use or disposal.

Alternative LS-9 is shown and the design data presented on Figure 5-19.

### Alternative LS-10 (TK-FSL-DW)

This alternative takes the advantages of Alternatives LS-8 and LS-9 to provide both thickening of the raw solids at both plants as well as dewatering the biosolids from the FSL. The existing centrifuges at East Canyon will be modified to thicken solids and one new dewatering facility will be located at the FSL site. This alternative is presented on Figure 5-20.

### Alternative LS-11 (TK-FSL)

Including pre-stabilization thickening allows for a lesser haul cost and the reuse of the centrifuges at the East Canyon WRF. Then, the thickened solids are further thickened in the FSL and harvested periodically, when beneficial use or disposal occurs, using a dredge pump. This alternative avoids having a separate remote processing system at the FSL and is described on Figure 5-21.

## Solids Stabilization Alternatives

The other classification or set of alternatives is solids stabilization and all six alternatives are shown on Figure 5-22. Generally, all of the alternatives use dewatered, but in one alternative, all of the processing is outsourced. In addition, four of the alternatives use stabilization. The two alternatives that do not include stabilization were located in this set for ease in numbering. Perhaps a third set of alternatives could have been developed, but it was decided to include the two unrelated alternatives in this set.

Each alternative is described below with the associated design criteria.

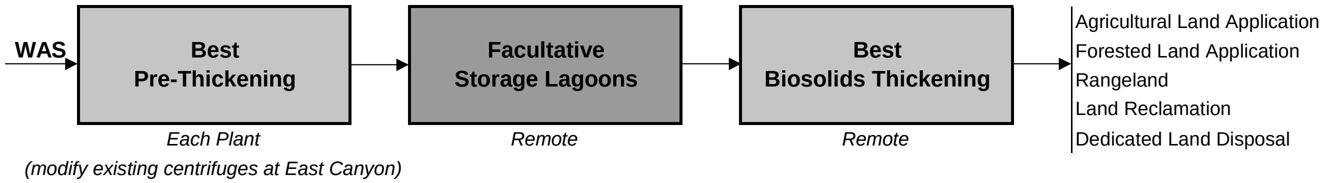
### Alternative SS-1 (DW-LS)

This alternative uses dewatering at both plants and keeps the existing centrifuges at the East Canyon WRF. Solids are hauled from the East Canyon WRF to the Silver Creek WRF for stabilization using lime. The stabilization step is located at Silver Creek because of potential odors, even though the lime stabilization process will be fully enclosed and the air in the structure treated in an odor control device.

Lime would be added and mixed with the dewatered cake to produce a Class B quality solids. Although lime addition can be used for pasteurization, the added cost may not be economical. Basically, it would more than double the equipment cost and space, as well as not significantly reducing the odors. Although the process occurs quickly, it must remain

**FIGURE 5-19**
Alternative LS-9

## *Flowsheet*



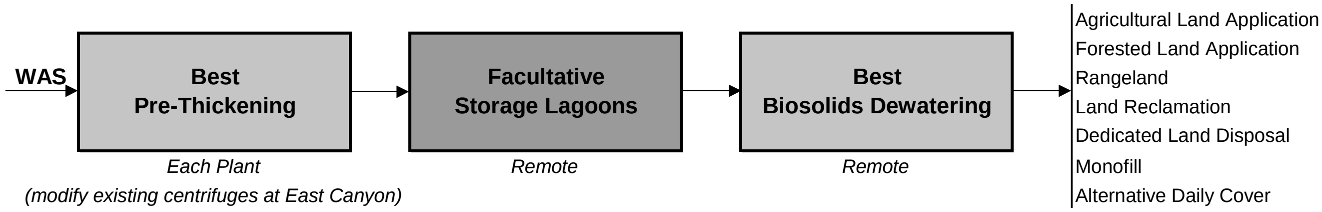

## *Design Data*

Pre-Thickening, Facultative Storage Lagoons, and Biosolids Thickening

| Process and Design Criteria | Design Values | Normal Range and Comments |
|---|---|---|
| **Pre-stabilization Thickening** | Determined by Equipment Option Evaluation | |
| Operating time | 24 hours/day, 6 days/week with storage tank at each WRF | Automate thickening process to make it smaller |
| **Facultative Storage Lagoons** | | |
| Operating time | Continuous, 24 hours/day, 7 days per week | With the long detention time, feed to the process may be intermittent, but the process will be operating continuously |
| Feed solids, percent | 0.5 | |
| Volatile solids loading rate, lb VS/1000 sf | 20 | From EPA Manual |
| Detention time, days | Several years | |
| Configuration | Four independent lagoons | |
| Air Demand | 15 hp brush aerator on each lagoon | Operated about 1/4 time |
| Operation | One lagoon fed until full, then rested for several years prior to harvesting | Requires one moveable dredge when harvesting is begun |
| Process Performance | Class B and 38% volatile solids reduction | Minimum required for EPA Part 503 Regulations |
| **Biosolids Thickening** | Determined by Equipment Option Evaluation | |
| Feed solids, percent | 4.0 | |
| Operating time | 7 hours/day, 6 days per week, to start 3 years later | Goal is to achieve highest solids content possible to reduce hauling and use/ disposal costs |

**FIGURE 5-20**
Alternative LS-10

## *Flowsheet*



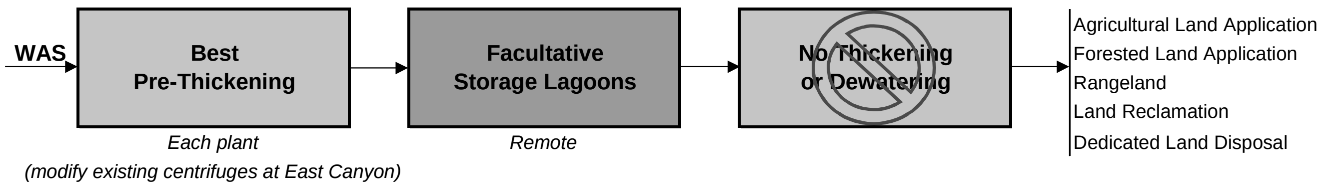

## *Design Data*

Pre-stabilization Thickening, Facultative Storage Lagoons, and Biosolids Dewatering

| Process and Design Criteria | Design Values | Normal Range and Comments |
|---|---|---|
| **Pre-stabilization Thickening** | Determined by Equipment Option Evaluation | |
| Operating time | 24 hours/day, 6 days/week with storage tank at each WRF | Automate thickening process to make it smaller |
| **Facultative Storage Lagoons** | | |
| Operating time | Continuous, 24 hours/day, 7 days per week | With the long detention time, feed to the process may be intermittent, but the process will be operating continuously |
| Feed solids, percent | 0.5 | |
| Volatile solids loading rate, lb VS/1000 sf | 20 | From EPA Manual |
| Detention time, days | Several years | |
| Configuration | Four independent lagoons | |
| Air Demand | 15 hp brush aerator on each lagoon | Operated about 1/4 time |
| Operation | One lagoon fed until full, then rested for several years prior to harvesting | Requires one moveable dredge when harvesting is begun |
| Process Performance | Class B and 38% volatile solids reduction | Minimum required for EPA Part 503 Regulations |
| **Biosolids Dewatering** | Determined by Equipment Option Evaluation | |
| Feed solids, percent | 4.0 | |
| Operating time | 7 hours/day, 6 days per week, to start 3 years later | Goal is to achieve highest solids content possible to reduce hauling and use/ disposal costs |

**FIGURE 5-21**
Alternative LS-11

## *Flowsheet*

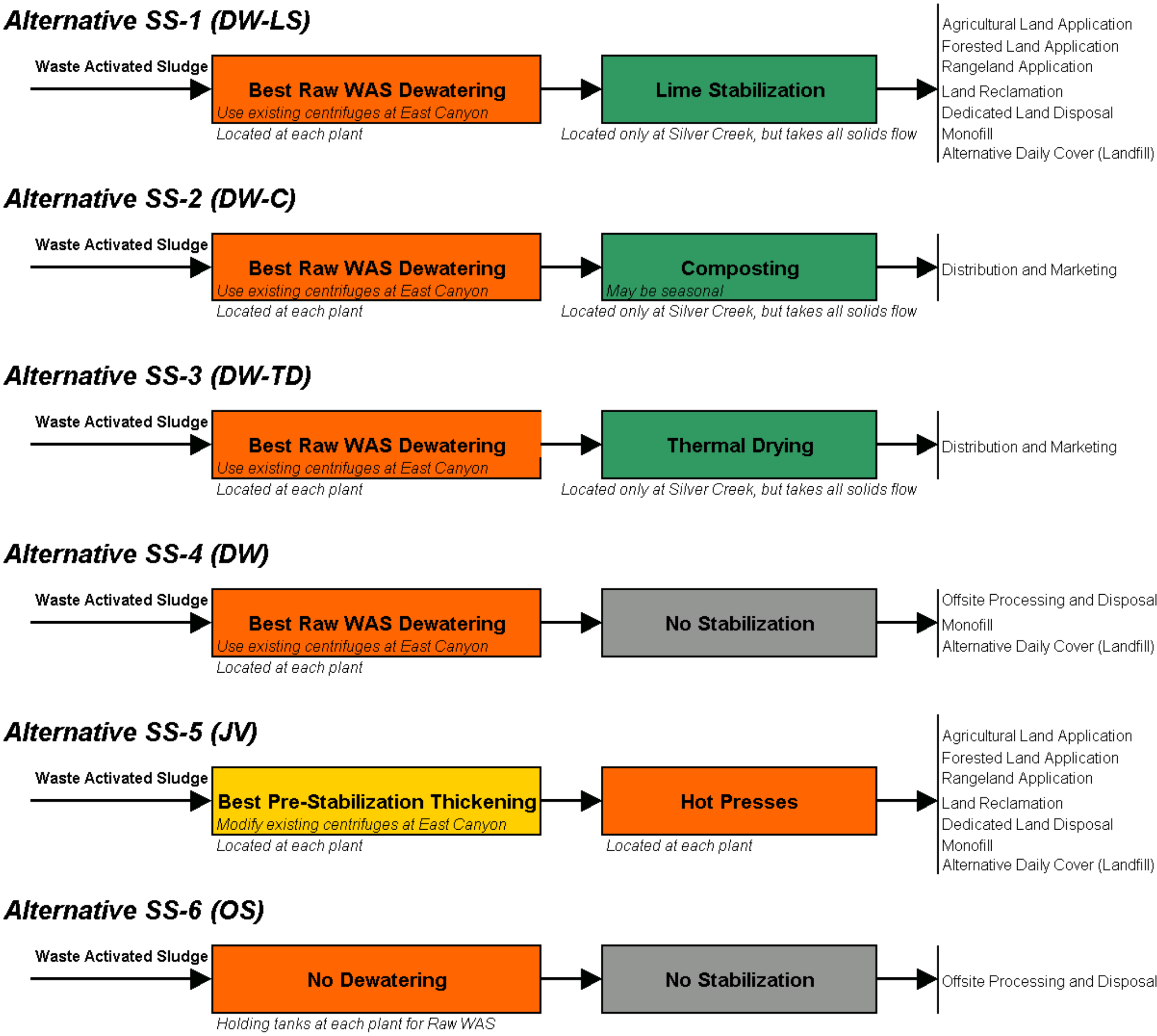



## *Design Data*

Pre-stabilization Thickening and Facultative Storage Lagoons

| Process and Design Criteria | Design Values | Normal Range and Comments |
|---|---|---|
| **Pre-stabilization Thickening** | Determined by Equipment Option Evaluation | |
| Operating time | 24 hours/day, 6 days/week with storage tank at each WRF | Automate thickening process to make it smaller |
| **Facultative Storage Lagoons** | | |
| Operating time | Continuous, 24 hours/day, 7 days per week | With the long detention time, feed to the process may be intermittent, but the process will be operating continuously |
| Feed solids, percent | 0.5 | |
| Volatile solids loading rate, lb VS/1000 sf | 20 | From EPA Manual |
| Detention time, days | Several years | |
| Configuration | Four independent lagoons | |
| Air Demand | 15 hp brush aerator on each lagoon | Operated about 1/4 time |
| Operation | One lagoon fed until full, then rested for several years prior to harvesting | Requires one moveable dredge when harvesting is begun |
| Process Performance | Class B and 38% volatile solids reduction | Minimum required for EPA Part 503 Regulations |
| **Biosolids Thickening** | NONE | |

**FIGURE 5-22**
Solids Stabilization Alternatives



on site for 24 four hours to meet VAR requirements (pH 12 for 2 hours and pH 11.5 for the next 22 hours without the addition of more lime). The product is still very wet at about 20 percent solids assuming the addition of 30 percent lime based upon the dry solids in the cake. For example, if there are 3 wet tons at 15 percent solids, there would be 900 pounds of dry solids (3 x 2000 / 15%). The lime addition would be 30 percent or 300 pounds of lime (900 x 30%). The addition of lime increases the pH of the mixture to over 12 and effectively removes all of the ammonia, which is much of the available nitrogen in the solids. As such, farmers usually do not want these low nitrogen biosolids. If the soil tends to be acidic, the farmers do want these biosolids for use as agricultural lime to increase the pH of the soil to promote better plant growth.

The lime stabilization process is shown in Figure 5-23 and Alternative SS-1 is shown on Figure 5-24 with design criteria.

## Alternative SS-2 (DW-C)

Alternative SS-2 includes raw WAS dewatering followed by aerated static pile composting. There are actually two subsets to this alternative because composting is looked upon as a desirable, albeit odorous alternative as presently configured at the Silver Creek WRF. The two subsets are: seasonal operation and continuous operation. All composting would occur at the Silver Creek WRF regardless. For the seasonal operation, only the mixing would be enclosed, using the existing facilities but enclosing the mixing (SSI Mixing trailer). The continuous composting subset would enclose the mixing and the active composting area with all air collected and passed through a biofilter for odor control. The curing piles would be located outside. In addition the curing piles would be aerated to provide the highest quality product for the users. One Star screen would be included as well. The bulking agent would be purchased and could be green waste, ground pallets, or other wood waste.

The composting process is shown on Figure 5-25 and Alternative SS-2 is presented on Figure 5-26 including design details.

## Alternative SS-3 (DW-TD)

This alternative includes thermal drying, the most complex process evaluated. Dewatering of raw WAS is required before the process because it is much less expensive to mechanically remove excess water than to evaporate it. Conventional technologies of direct rotary dryers (Andritz) and indirect dryers (Dragon Dryer by USFilter) are included in the evaluation. In addition, belt dryers are being introduced in the US after a few years of operation in Europe. Belt dryers offer lower temperatures, hot air, and as such are subject to less regulatory standards because they are inherently safer. By using hot air, however, the units need significantly more time in the dryer to achieve high solids contents required for VAR, so the units tend to be quite large. Preliminarily, the prices appear to be relatively similar so the lighter weight construction appears to offset the larger unit. The Andritz belt dryer is included representing this technology.

Conventional direct drying is shown on Figure 5-27, and this is very similar to the indirect dryers as well. Final screening is dependent upon the product demands. This alternative is presented on Figure 5-28 with design information for the direct and indirect dryers.

**FIGURE 5-23**
Dewatered Solids Stabilization
*(Lime Stabilization at Silver Creek)*

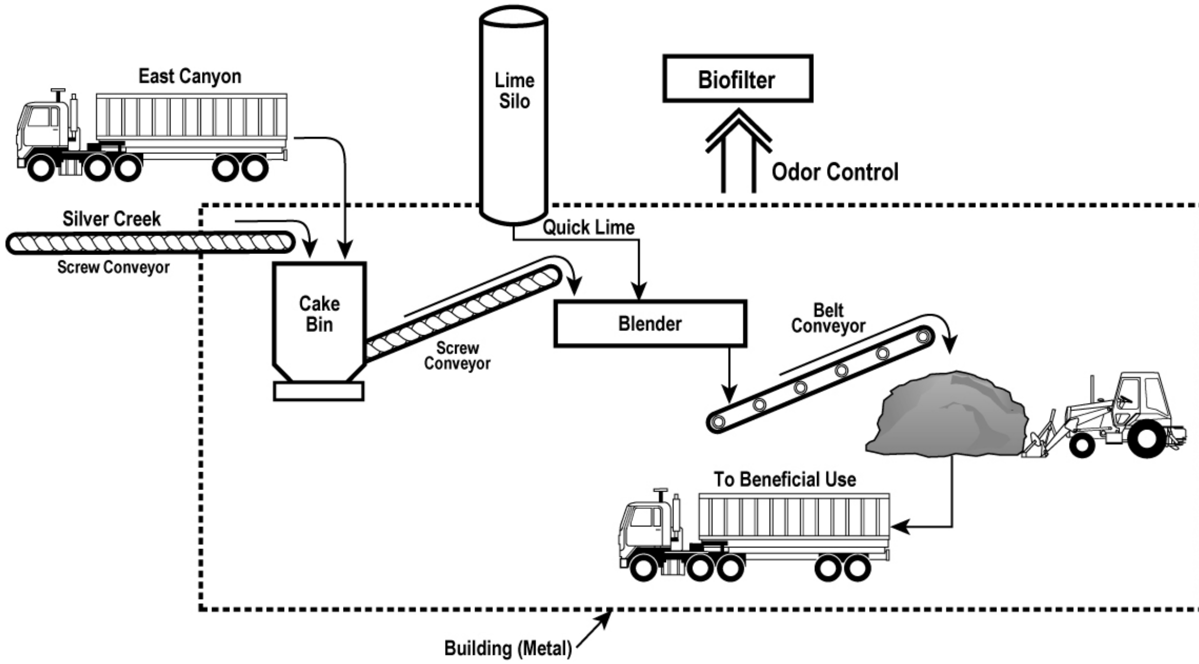
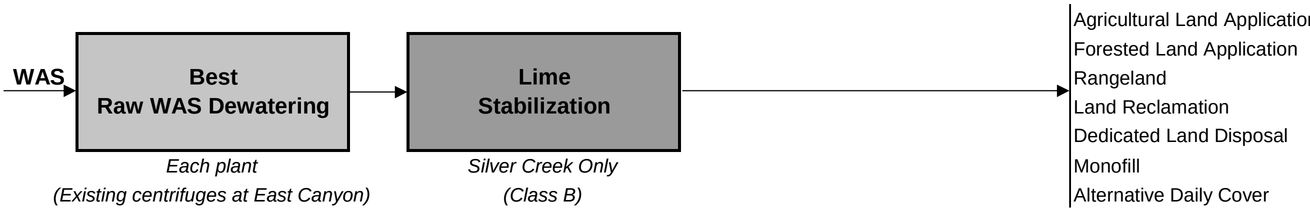


**FIGURE 5-24**
Alternative SS-1




## *Design Data*

Raw WAS Dewatering and Lime Stabilization

| Process and Design Criteria | Design Values | Normal Range and Comments |
|---|---|---|
| **Raw WAS Dewatering** | Determined by Equipment Option Evaluation | |
| Operating time | 7 hours/day, 6 days/week | 7 hours/day allows ½ hour for startup and ½ hour fore shutdown everyday, so an 8 hour shift is maintained |
| **Lime Stabilization** | | |
| Operating time | 7 hours/day, 6 days/week | Must be operated with dewatering equipment |
| Feed solids, percent | 15 | |
| Lime dose, % of dry solids | 30 | |
| Biosolids pathogen density | Class B | |
| Final solids content, % | 20 | |

**FIGURE 5-25**
Dewatered Solids Stabilization
*(Composting)*

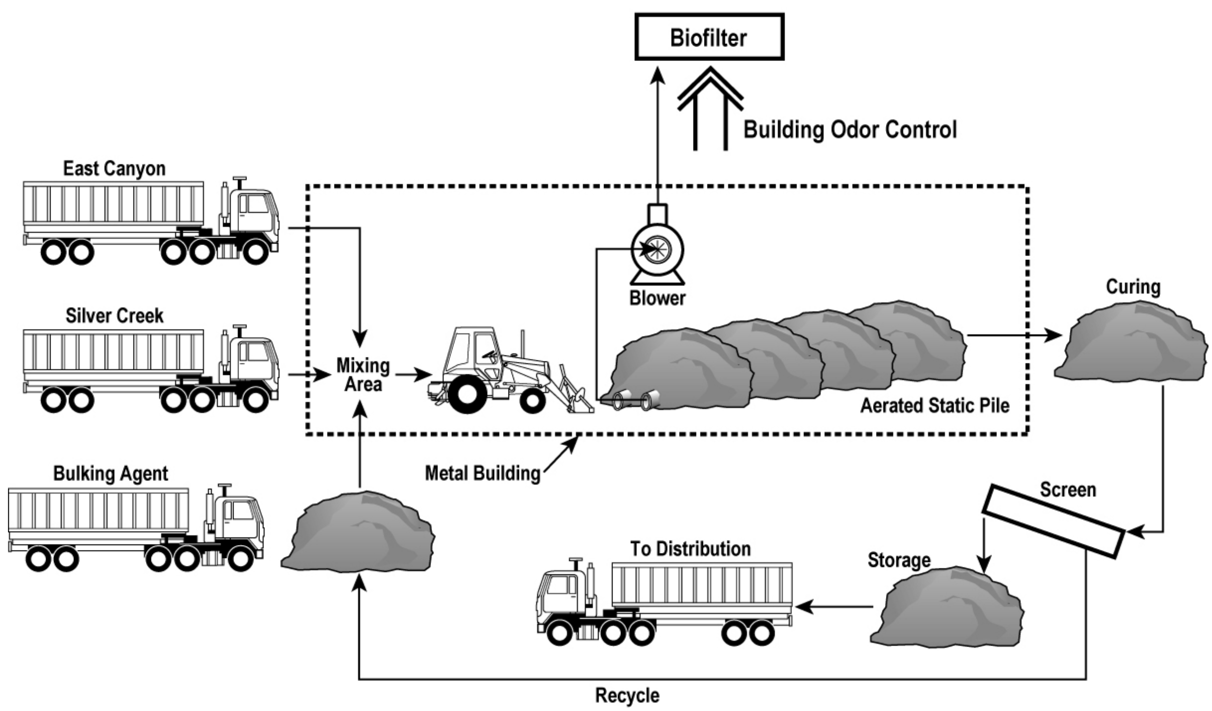
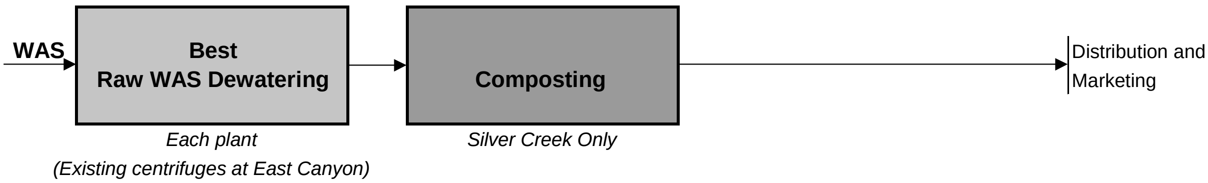


**FIGURE 5-26**
Alternative SS-2




## *Design Data*

Raw WAS Dewatering and Composting (may be seasonal)

| Process and Design Criteria | Design Values | Normal Range and Comments |
|---|---|---|
| **Raw WAS Dewatering** | Determined by Equipment Option Evaluation | |
| Operating time | 7 hours/day, 6 days/week | 7 hours/day allows ½ hour for startup and ½ hour fore shutdown everyday, so an 8 hour shift is maintained |
| **Composting** | | |
| Composting process | Aerated static pile | |
| Processes covered, seasonal | Mixing | |
| Processes covered, continuous | Mixing and active composting | |
| Operating time | 8 hours/day, 6 days/week | |
| Minimum composting time, days | 28 | |
| Minimum curing time, days | 30 | Outside and aerated |
| Feed solids, percent | 15 | |
| Mixture solids, percent | 40 | |
| Bulking agent : cake volume ratio | 3 : 1 | |
| Compost pile and curing pile height, feet | 8 | |
| Dewatered cake bulk density | 1600 lb/cyd | |
| Bulking agent bulk density | 520 lb/cyd | |
| Mixture bulk density | 700 lb/cyd | |
| Finished compost density | 550 lb/cyd | |
| Compost pile air requirement, cfm/cyd | 2.5 | |
| Curing pile air requirement, cfm/cyd | 1.5 | |
| Screen | Star screen | |
| Screen operation | During day shift only | |
| Process Performance | Class A and meets VAR | Minimum required for EPA Part 503 Regulations |

**FIGURE 5-27**
Dewatered Solids Stabilization
*(Thermal Drying at Silver Creek)*

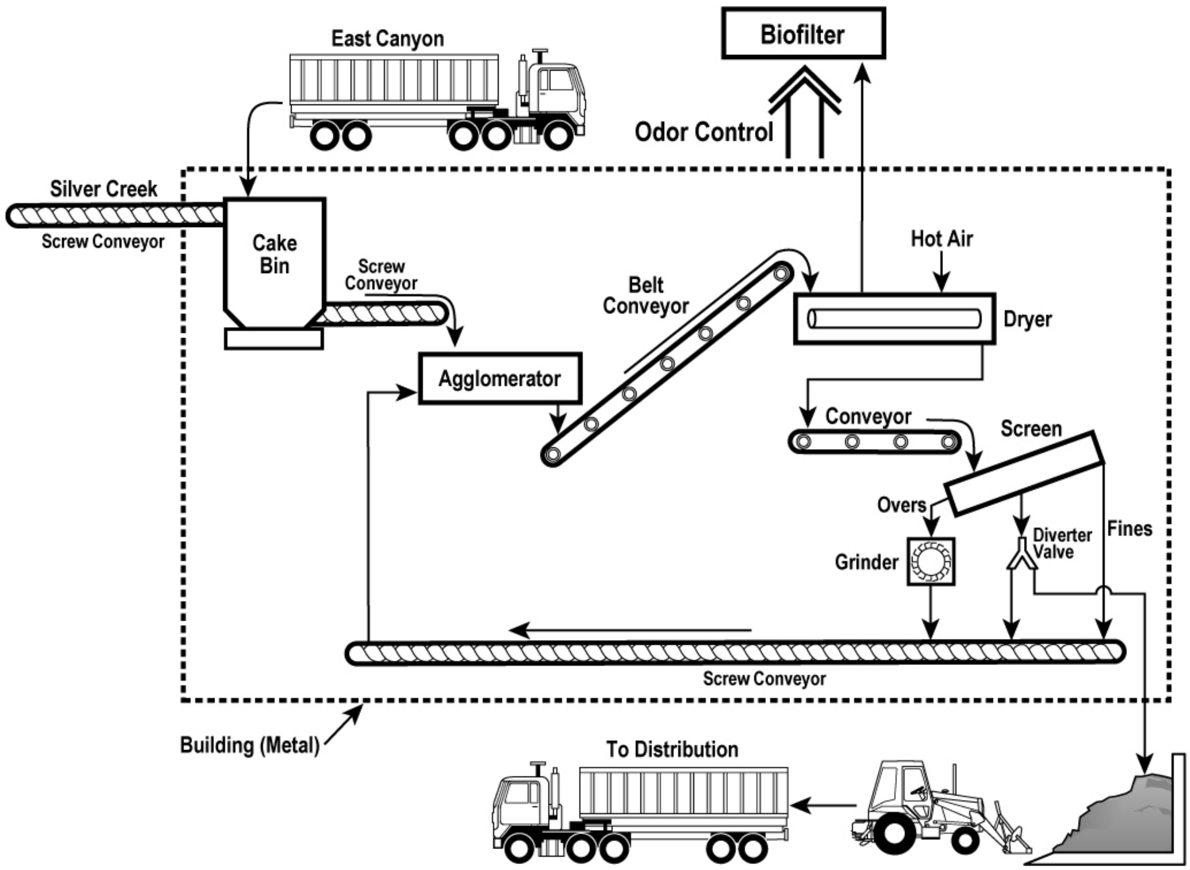
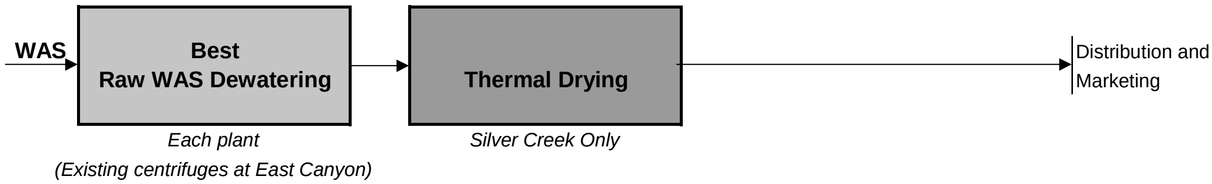


**FIGURE 5-28**
Alternative SS-3




## *Design Data*

Raw WAS Dewatering and Thermal Drying

| Process and Design Criteria | Design Values | Normal Range and Comments |
|---|---|---|
| **Raw WAS Dewatering** | Determined by Equipment Option Evaluation | |
| Operating time | 24 hours/day, 5 days/week | To match thermal dryer |
| **Thermal Drying** | | |
| Operating time | Continuous, 24 hours/day, 5 days per week | Desirable to keep at temperature with infrequent shutdowns. Need weekend for repairs. |
| Feed solids, percent | 15 | |
| Recycle product | As required by manufacturer | Normally 50% to 100% of feed volume |
| Number of dryers | 1 | |
| Assumed heat rate, btu/lb of water evaporated | 1,500 | |
| Product quality | Small, hard pellet, low dust | |
| Process Performance | 95% solids, Class A and meets VAR | Minimum required for EPA Part 503 Regulations |

### Alternative SS-4 (DW)

This alternative continues the present solids processing system at both plants, with the replacement of the old Parkson belt filter press at the Silver Creek WRF with a new centrifuge, similar to the existing centrifuges at the East Canyon WRF. Capacities are confirmed and additional units recommended as needed. There is no stabilization included in this alternative.

The dewatering alternative with design criteria are shown on Figure 5-29.

### Alternative SS-5 (JV)

The J-Vap recessed chamber filter press by USFilter is a conventional recessed chamber filter press with diaphragm plates to provide a squeeze cycle. The difference is that this unit uses hot water behind the diaphragms to heat the confined solids. In addition, a vacuum is pulled on the solids which allows the water to evaporate at a much lower temperature. This unit is also called a “hot press.” This process is discussed in more detail under Equipment Options, Raw WAS Dewatering, and in TM 2. Design details are provided in Figure 5-30.

### Alternative SS-6 (OS)

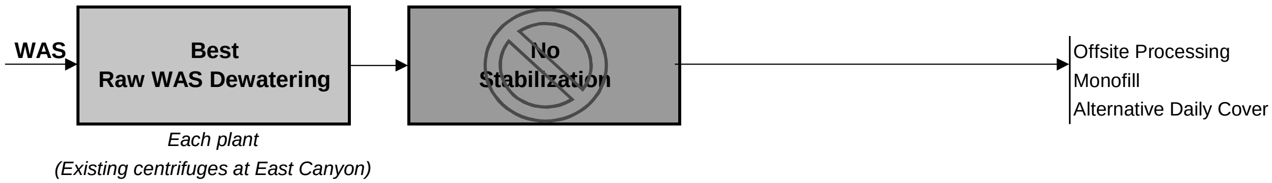
Solids in this alternative are simply hauled away as a liquid to offsite processing by others. The only changes to the existing WRF sites is the addition of storage tanks and tank-truck loading facilities. The details of this alternative are presented on Figure 5-31.

## Beneficial Use and Disposal Options

Each alternative noted in the liquid and solids stabilization sets must have a final resting place for the solids produced in the plant. Because each processing alternative produces a different quality of product, the beneficial use and disposal options can vary.

Table 5-5 presents the array of beneficial use and disposal options evaluated as a part of this master plan. A complete description for each option was presented in Technical Memorandum 2.

**FIGURE 5-29**
Alternative SS-4



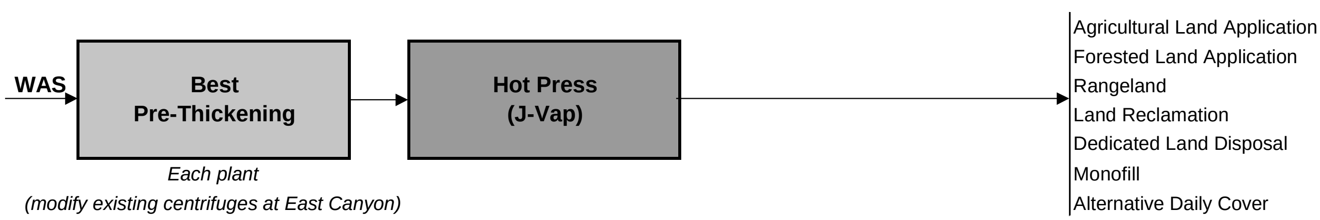

## *Design Data*

Raw WAS Dewatering

| Process and Design Criteria | Design Values | Normal Range and Comments |
|---|---|---|
| **Raw WAS Dewatering** | Determined by Equipment Option Evaluation | |
| Operating time | 7 hours/day, 6 days/week | 7 hours/day allows ½ hour for startup and ½ hour fore shutdown everyday, so an 8 hour shift is maintained |
| **Stabilization** | NONE | |

**FIGURE 5-30**
Alternative SS-5

## *Flowsheet*



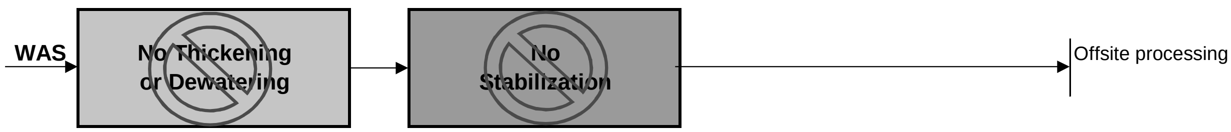

## *Design Data*

Raw WAS Dewatering and Lime Stabilization

| Process and Design Criteria | Design Values | Normal Range and Comments |
|---|---|---|
| **Pre-stabilization Thickening** | Determined by Equipment Option Evaluation | |
| Operating time | 14 hours/day, 6 days/week | Automate thickening process to make it smaller |
| **Hot Press** | | |
| Number of presses | 2 | |
| Cycles per day | 2 | |
| Cycle time | 6 hours | From start of one dewatering cycle to start of second dewatering cycle |
| Conditioning Tank size | 1.3 x one load of press | From EPA Manual |
| Conditioning chemicals / dosage in percent of dry solids | Lime / 25; ferric chloride / 8 | |
| Plate size, mm | 1200 x 1200 | |
| Number of plates per press | Determined by manufacturer | |
| Additional information | Table 5-3 | |
| Cake solids, percent | 60 | |
| Process Performance | Class A solids meets VAR | Minimum required for EPA Part 503 Regulations |

**FIGURE 5-31**
Alternative SS-6

## *Flowsheet*




## *Design Data*

Outsource All Processing

| Process and Design Criteria | Design Values | Normal Range and Comments |
|---|---|---|
| **Thickening or Dewatering** | None | Must provide tank truck loading facility and storage tanks to accommodate hauling vehicles |
| **Stabilization** | None | |

**TABLE 5-5**
Beneficial Use and Disposal Options

| Options | Product Physical Properties | | | Product Quality | | |
|---|---|---|---|---|---|---|
| | **Liquid (0.5% to 10%)** | **Dewatered Cake (15% to 40%)** | **Product (>45% solids)** | **Raw WAS** | **Class B Biosolids** | **Class A Biosolids** |
| **Beneficial Use Options** | | | | | | |
| Agriculture land application | Acceptable | Acceptable | NO [a] | NO | Yes | Yes |
| Golf courses | NO | NO | Acceptable | NO | NO | Yes |
| Forested land application | Acceptable | Acceptable | NO [a] | NO | Yes | Yes |
| Rangeland | Acceptable | Acceptable | NO [a] | NO | Yes | Yes |
| Land reclamation | Acceptable | Acceptable | NO [a] | NO | Yes | Yes |
| Distribution and marketing | NO | | Acceptable | NO | NO | Yes |
| Alternative daily cover | NO | Acceptable | NO [a] | Yes | Yes | Yes |
| **Disposal Option** | | | | | | |
| Dedicated land disposal | Acceptable | Acceptable | NO [a] | NO | Yes | NO [a] |
| Monofill | NO | Acceptable | NO [a] | Yes | Yes | NO [a] |
| Offsite processing and use/disposal | Acceptable | Acceptable | Acceptable | Yes | Yes | Yes |

[a] Although these options may be able to use these solids, it is not considered economical to do so.

The loading rates for the above categories are presented in Table 5-6. As can be seen, loading rates are not applicable to Class A biosolids produced by the District because they meet Exception Quality Standards.

**TABLE 5-6**
Lading Rates for Beneficial Use and Disposal Options

| Options | Raw WAS | Class B | Class A |
|---|---|---|---|
| **Beneficial Use Options** | | | |
| Agriculture land application | NA | 8 dry tons / acre / year | Limited only by good management |
| Golf courses | NA | NA | Limited only by good management |
| Forested land application | NA | 12 dry tons / acre / year | Limited only by good management |
| Rangeland | NA | 6 dry tons / acre / year | Limited only by good management |
| Land reclamation | NA | 20 dry tons / acre (one time) | Limited only by good management |
| Distribution and marketing | NA | NA | Limited only by good management |
| Alternative daily cover | Unlimited | Unlimited | Unlimited |
| **Disposal Option** | | | |
| Dedicated land disposal | NA | 50 dry tons / acre / year | 50 dry tons/acre/year |
| Monofill | Unlimited | Unlimited | Unlimited |
| Offsite processing and use/disposal | Limited by use or disposal option requirements of UDEQ | | |

**FIGURE 5-32**
Dedicated Land Disposal
*(Located at Remote Site)*

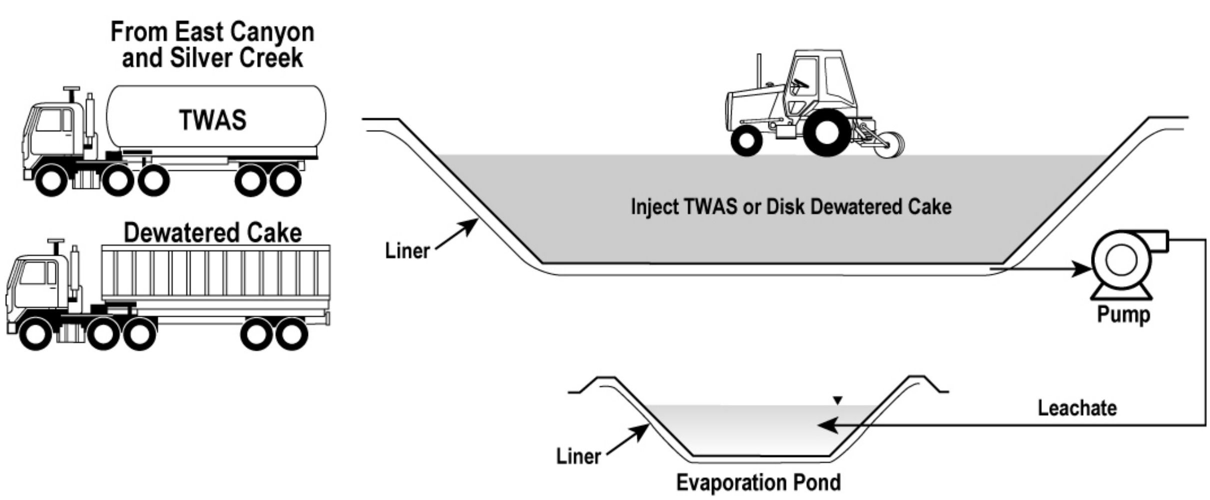
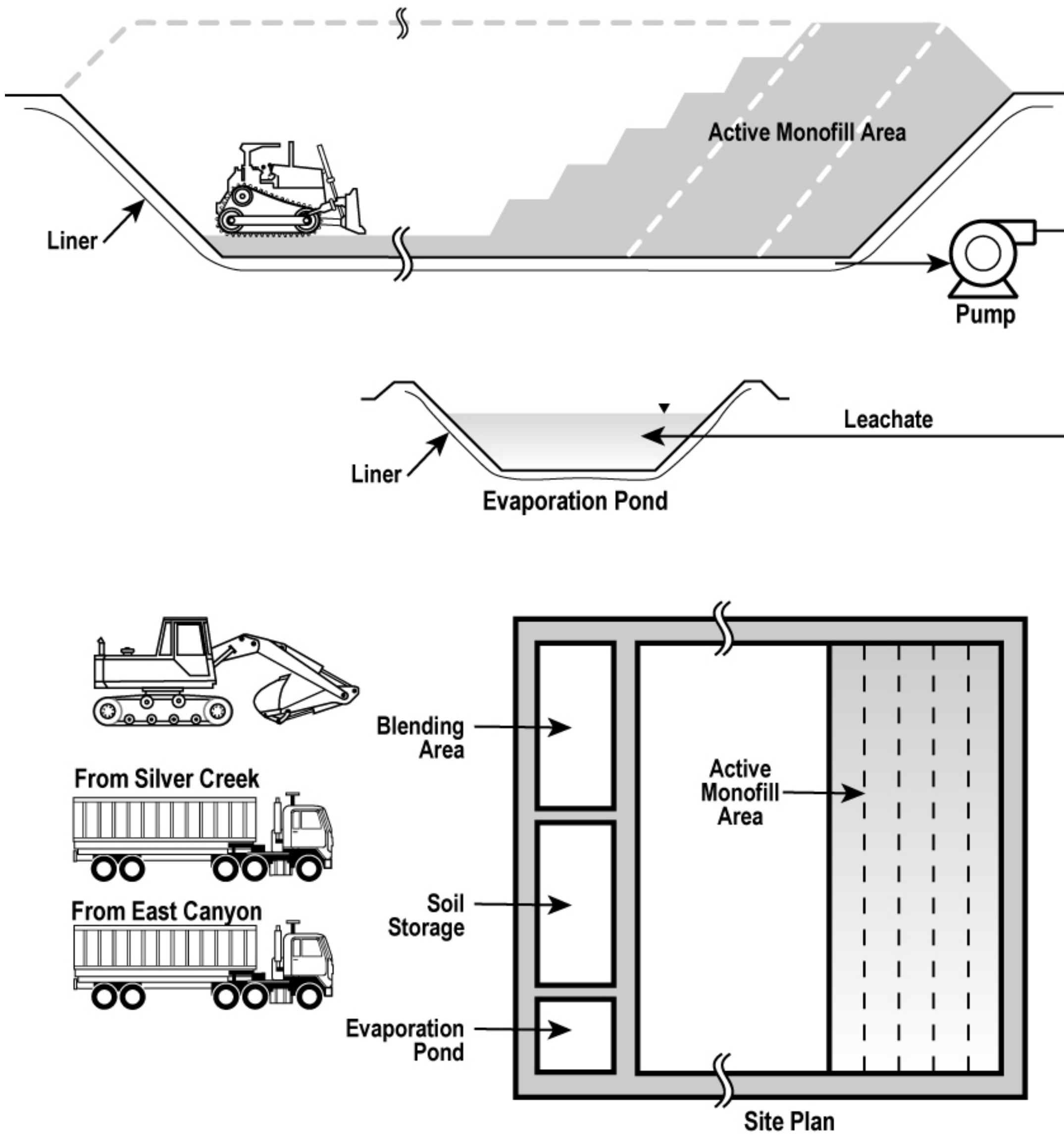


**FIGURE 5-33**
Monofill Disposal Located at Remote Site



# Solids Management Master Plan Benefit Analysis

**PREPARED FOR:** Snyderville Basin Water Reclamation District

**PREPARED BY:** CH2M HILL

**DATE:** March 17, 2003

## Contents



## Introduction

This benefits analysis conducted by CH2M HILL provided an objective method to a subjective process. Criteria were determined, values assigned, and the alternatives ranked using the process described in this document.

## Evaluation Model

SBWRD has multiple objectives to consider in making a decision about the best strategy for biosolids management. These objectives include public acceptance such as odor potential and creating a local product, environmental protection such as air and water quality, and many others. To incorporate these multiple objectives, the citizen's advisory committee (CAC), SBWRD staff, and the consultant team identified internal and external stakeholder values that became the basis for the evaluation model. The key components of the evaluation model are: (1) the criteria, which provide a way to measure an alternative's contribution to specific values; (2) the weights, which show relative importance of the criteria; and (3) cost, both in terms of construction cost and life-cycle cost. The criteria and weights are combined to provide an overall benefit score for each alternative. The cost of the alternative is then used to derive the "benefit-to-cost ratio" for each alternative. The development of the evaluation model is detailed below. Costs and benefit-to-cost ratios are addressed in Technical Memorandums 7 and 8, respectively. This technical memorandum presents the results of the benefits analysis.

## Values and Criteria

Values were elicited from the public, SBWRD staff, and CH2M HILL at the first CAC workshop. These values were further developed in the second CAC workshop by assigning weights or levels of importance. These values and the associated weights are used to evaluate each alternative identified in Technical Memorandum 5.

### Values

In the first workshop, the CAC, SBWRD staff and the consultant team identified four higher-level values (aesthetics, environmental protection, plant operations, and regulatory issues), as well as a number of more specific values in each of these four categories. Members of the CAC, the SBWRD staff and the consultant team also provided input on their values, and these results were incorporated into the values hierarchy. The values are subjective and reflect community concerns and goals for the project.

### Criteria

Criteria help to measure the benefit or importance an alternative provides for a particular value. A particular value may have more than one criterion. However, no two criteria should measure the same attribute of a project, which could result in "double-counting" of value. For example, square footage of a building would not be used as criteria for both the aesthetics and environmental protection categories. Measurement scales are then developed by the consultant team to give each criterion an objective score that can be easily applied to each alternative in the evaluation model. Measurement scales can be numerical (e.g., pounds per day of a pollutant emitted) or qualitative (e.g., odor levels equivalent to current normal operations). Table 6-1 includes a list of criteria organized by high-level value, and the approach for measuring each criterion.

**TABLE 6-1**
Decision Criteria and Measurement Approaches

| **Public Acceptance** | |
|---|---|
| Odor Potential | This criterion is a measure of potential odor emissions from a process, regardless of whether or not odor control is provided. Although each alternative would be designed to eliminate odor emissions, odor control systems can fail. In addition, controlling odor from fugitive (or uncontrolled) emission sources is difficult, and different processes create odors of different strengths. Odor potential will be compared to current normal operations and the composting process that operated in 1997. Alternatives that would not increase odors from current normal levels will be given higher scores. |
| Local Product | A high-quality local product is desirable as it is a way for the District to give back to the community. In addition, revenues generated from the sale of a local product would help defray the cost of operations. In evaluating this criterion, alternatives that would produce a "Class A" product that would be desired for local use will be given higher scores. |

**TABLE 6-1 (CONTINUED)**
Decision Criteria and Measurement Approaches

| | |
|---|---|
| **Public Acceptance** | |
| Dust Pollution | This criterion includes dust caused by plant employee traffic, off-site hauling operations, construction of new facilities, and operation of on-site processing equipment. Dust that is subject to being carried by winds can be created by some processes and construction work that are conducted in the open atmosphere. This criterion will be measured in terms of the amount of traffic generated by each alternative for employees, off-site hauling, and by the amount of construction required. |
| Traffic Congestion | Traffic congestion associated with plant employee traffic and off-site hauling operations will be evaluated as part of this criterion. Traffic will be analyzed to determine its impact on local traffic, canyon traffic, and safety. Safety is an important factor to consider due to the nearby elementary school. Noise and dust pollution caused by traffic will not be evaluated in this criterion because they are each a separate criterion. This criterion is measured in terms of the amount of traffic generated by each alternative. |
| Noise Pollution | This criterion includes noise caused by plant employee traffic, off-site hauling operations, and operation of on-site processing equipment. Some alternatives would have less noise by enclosing processing facilities in buildings and providing sound attenuation barriers. |
| Light Pollution | This criterion is a measure of the amount of lighting that can be seen by the surrounding community and is necessary for operation of a process. Facilities that would be operated at night would have higher lighting impacts than other processes, especially if they must be operated outdoors. Processes that can be enclosed in a building would have less impact. The criterion will be measured in terms of the amount of processing that occurs during nighttime hours and the amount of processing that is conducted in the open (i.e., not enclosed in a building). |
| **Environmental Protection** | |
| Beneficial Use | Some biosolids disposal and reuse options are considered to be environmentally and socially beneficial. Biosolids can be beneficially used as soil amendment, a low-grade fertilizer, and cover in landfills and for environmentally damaged areas. This criterion will be measured in terms of percentage of total biosolids production that is beneficially reused. |
| Air Quality | Air quality is a measure of air pollutants emitted by each process, including nitrogen oxides, sulfur oxides, carbon monoxide, volatile organic compounds, particulate matter, and other air pollutants regulated by the Utah Department of Air Quality. (Odors are not included in this criterion.) Pollutants can be emitted from combustion of natural gas and diesel fuel (used during hauling operations), incineration of biosolids, and volatilization of compounds from wastewater in treatment processes. This criterion will be measured in terms of the two primary air pollutants that usually dominate emissions from treatment plants: nitrogen oxides and carbon monoxide. |

**TABLE 6-1 (CONTINUED)**
Decision Criteria and Measurement Approaches

| | |
|---|---|
| **Environmental Protection** | |
| Surface Water Contamination | All viable alternatives must be in compliance with the Utah Department of Water Quality regulations governing surface water. However, certain processes may have greater potential to impact surface water quality but still be in compliance with the regulations. Such contamination is undesirable because of potential negative impacts on beneficial use of the water. |
| Groundwater Contamination | All viable alternatives must be in compliance with the Utah Department of Water Quality regulations governing groundwater. However, certain processes may have greater potential to impact groundwater quality but still be in compliance with the regulations. Certain processes may impact groundwater underlying the treatment plant through leaching and transport of wastewater and biosolids constituents into the groundwater table. Such contamination is undesirable because of potential negative impacts on beneficial use of the water. |
| **Regulatory Compliance** | |
| Long-Term Viability | Although an alternative may be viable from a regulatory standpoint, it may not be politically or socially acceptable over the long-term. Changes in political or social values can make certain processes less viable over the long-term. This criterion will be measured in terms of each alternative’s susceptibility to external political and social influence. |
| Flexibility to Meet Future Regulations | Only alternatives that meet current regulations will be evaluated. However, Federal, state, and local authorities are continually updating regulations regarding biosolids processing and disposal. In general, the updated regulations have become more stringent. Regulations typically govern the level of treatment required, amount of process emissions allowed, and disposal/reuse alternatives available. Biosolids processing regulations cover the level of pathogen destruction, the amounts of certain pollutants in the biosolids, and the degree to which the biosolids have been stabilized. Some alternatives provide a higher level of treatment that make them more likely to be acceptable under future regulations. This criterion will be measured in terms of each alternative’s susceptibility to external political and social influence. |
| **Plant Operations** | |
| Product Quality | A high-quality product is important in considering beneficial reuse alternatives. Products that could be developed include landfill cover and soil amendments. In evaluating this criterion, alternatives that would produce a “Class A” product will be given higher scores. |
| Control | Certain processes are more prone to breakdown and require higher levels of maintenance. In addition, some processes can be adversely impacted by inclement weather. Moreover, biological treatment processes are susceptible to process upsets, which can make them less reliable than physical and chemical treatment processes. Since the processes are essential for maintaining levels of treatment and limits on emissions contained in SBWRD’s operating permits, a high degree of control is desirable. This criterion is measured in terms of the reliance on weather and type of process (i.e., biological vs. chemical/physical). |

**TABLE 6-1 (CONTINUED)**
Decision Criteria and Measurement Approaches

| **Plant Operations** | |
|---|---|
| Liability | This criterion evaluates liability of potential spills or accidents associated with off-site hauling operations. The distance of the hauling will be evaluated. Hauling longer distances will equate to lower scores for this criterion based on the increased risk of accidents or spills. |
| Operational Flexibility | It is important to have back up alternatives that are redundant in case the chosen alternative fails. For example, some alternatives may provide secondary storage or processing systems that can be used whenever the primary process is out of service. In addition, some alternatives may provide flexibility in final reuse or disposal of the processed biosolids. Operational flexibility is important for managing upsets in the treatment plant and for maintaining compliance with operating permits. This criterion will be evaluated based on the number of processing and disposal alternatives provided and the extent to which SBWRD is in control of the alternatives. |
| Recycle Streams | Many biosolids processes produce reject streams that are returned to the treatment plant. Some of these are similar to raw wastewater, while others may be high in ammonia or phosphorus, which could negatively impact the treatment process. This could reduce the capacity of the liquid treatment plant and may cause violations. This criterion will evaluate the relative strengths of the recycle streams. |

## Criteria Weights

Criteria scores provide the objective content of the evaluation model and are based on technical analysis. Not all values and criteria, however, are equally important. Weights are the subjective content of the model that represent the relative importance of stakeholder values. The weighting exercise performed for this decision process allowed stakeholders to indicate which values are most important to them, and how much more important they are as compared to the other values.

Internal and external stakeholders participated in the weighting exercise. Participants were asked individually to distribute 100 points among the four high-level values (public acceptance, environmental protection, regulatory compliance, and plant operations) to indicate their relative importance. For example, if all four were equally important to a participant, 25 points would be given to each value. If one value were twice as important as another, it might get 40 points compared to 20 points for the second.

Participants were then asked to distribute the points assigned to each high-level value to the lower-level values (the criteria). For example, if 25 points had been given to public acceptance, then these 25 points would be distributed among odor potential, local product, dust pollution, traffic congestion, noise pollution, and light pollution. This was repeated for each high-level value. Finally, participants were asked to compare the criteria points relative to each other to ensure that the points had been distributed appropriately.

The CAC members, SBWRD staff, and the consultant participated in the weighting exercise. All scores were averaged for each criterion to get the final weight. Various analyses were performed to determine if there was significant "spread" for any of the criteria, and if there were any significant differences between the CAC members, SBWRD staff, and the consultant.

To properly reflect the public's involvement, yet reflect the SBWRD staff concerns (since they are more aware of the impacts on plant operations), a weighting system was used for the CAC, SBWRD staff, and consultant team scores. A simple average of all attendees was not determined to be appropriate since there were 7 CAC members present (58 percent of total attendance), 2 SBWRD staff (17 percent of total attendance), and 3 consultant team staff (25 percent of total attendance). Of all participants, the scores of the consultant were assigned the lowest importance, the public scores were ranked highest, and the SBWRD staff scores close second in importance because they have to manage any facilities or processes which are implemented as a result of this evaluation. Weights used were 50 percent for the public scores, 38 percent for SBWRD staff scores, and 12 percent for the consultant team scores. Incidentally, several different weighting ratios were evaluated, but this ratio is believed to most appropriately reflect all stakeholders. When these weights were combined, they were then normalized to a score of 100. The weights used in the evaluation model are shown in Table 6-2.

**TABLE 6-2**
Criteria Weights

| Criterion | Weight |
|---|---|
| **Public Acceptance** | **46.49** |
| Odor Potential | 19.57 |
| Local Product | 6.69 |
| Dust Pollution | 6.85 |
| Traffic Congestion | 3.54 |
| Noise Pollution | 5.77 |
| Light Pollution | 4.07 |
| **Environmental Protection** | **23.58** |
| Beneficial Use | 5.27 |
| Air Quality | 5.10 |
| Surface Water Contamination | 6.35 |
| Groundwater Contamination | 6.86 |
| **Regulatory Compliance** | **11.94** |
| Long-Term Viability | 6.02 |
| Flexibility to Meet Future Regulations | 5.92 |
| **Plant Operations** | **17.99** |
| Product Quality | 4.13 |
| Control | 3.72 |
| Liability | 4.73 |
| Operational Flexibility | 3.59 |
| Recycle Streams | 1.82 |

**Note:** Normalized to total 100.

Public Acceptance has the greatest high-level weight, almost 50 percent of the total. Regulatory Compliance is the lowest at about 12 percent. Individually, odor has the highest criterion weight, over three times the weight of any other criterion, and its value is greater than two of the high-level weights. At almost 20 percent, it is apparent that potential odors are very important part of any alternative. The criterion with the lowest weight is recycle streams, which are important to plant operations, but were not deemed important to the alternative evaluation because the effects of recycle streams will be reflected in cost.

# Initial Screening and Alternatives Analysis

In a typical decision analysis process, a list of alternatives is developed and then analyzed with the evaluation model. However, over 2,000 alternatives were initially identified based on possible combinations of different technologies or components used at different stages of biosolids management. Because this list was too large to evaluate using the model, an initial analysis and screening step was performed to reduce the number of alternatives that would be analyzed in detail. This initial screening was performed or discussed in Technical Memorandum 2, and the remaining alternatives and combinations were discussed in Technical Memorandum 5.

Options were developed when possible to limit the number of alternatives. For example, when thickening of raw waste activated sludge (WAS) was required by the alternative, it included four separate technologies: gravity belt thickeners, centrifuges, rotary drum thickeners, and dissolved air flotation. Rather than consider four separate complete alternatives, a separate analysis was made of this option and the best option was included in the overall alternative analysis.

The screening described in Technical Memorandum 2, coupled with the use of options, resulted in a list of 18 complete alternatives that were retained for more detailed evaluation. Steps used to evaluate the remaining alternatives were as follows:

1. Data were collected so that the evaluation model could be applied to the alternatives. Data sources included SBWRD treatment plant operating data, information from comparable plants, and expert opinions of the consultant team.
2. Using the data obtained in Step 1, raw scores were assigned to all criteria for each alternative based on the objective scoring scales shown in Appendix E. For example, if an alternative would have reduced the strength and frequency of odor emissions it was given a score of 3 for the Odor Potential criterion. The odor potential criteria scores are shown in Table 6-3 (from Appendix E). Because all scores were set up from 0 to 3, there was no need to normalize the scores. (Normalizing scores is only used if one criterion score was from 0 to 5 and another was different, such as 0 to 2. With these variations, the criterion using a maximum score of 5 would necessarily have a greater impact than the criterion with a maximum score of 2. Scoring must be objective and equal among all criteria so the weights developed by the CAC, the SBWRD staff, and the consultant team could be applied fairly.)

**TABLE 6-3**
Odor Potential Criteria Scoring

| Score | Evaluation Criteria |
|---|---|
| 0 | Same odor frequency/duration potential, or intensity/magnitude potential as previous composting operation |
| 1 | Reduced odor frequency/duration potential, or intensity/magnitude potential compared to previous composting operation |
| 2 | Reduced odor frequency/duration potential, and intensity/magnitude potential compared to previous composting operation |
| 3 | Same or reduced odor frequency/duration potential, and/or intensity/magnitude potential as current operations |

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3. Next, weighted scores were calculated by multiplying the criterion scores by the respective weights for each criterion which were previously established by the stakeholder group.
4. A total weighted score for each alternative was calculated by summing the weighted scores for each criterion.
5. A comparison of the weighted total scores for each alternative was then conducted. The scores show how much overall benefit an alternative provides compared to other alternatives. For example, if Alternative A had a score of 50 and Alternative B had a score of 100, then Alternative B would have twice as much benefit as Alternative A. In general, the higher the score, the greater the benefits of an alternative.

# Results

The options and alternative programs were analyzed and scored using the process described above. The resulting weighted benefit scores for each option are shown in Table 6-4, and the weighted benefit scores for each alternative are presented in Table 6-5. Details of the option and alternative scoring analyses are provided in Appendix F. Graphs that more thoroughly illustrate the results are also provided in Appendix F.

**TABLE 6-4**
Weighted Benefit Scores for Options Evaluated

| Category | Raw Total | Weighted Total | Rank | Percent Difference | Recommendations for Consideration |
|---|---|---|---|---|---|
| **Thickening and Dewatering Options** | | | | | |
| ***Pre-Stabilization Thickening*** | | | | | |
| Gravity Belt Thickening | 22 | 132.10 | 3 | -16.34% | Include in subsequent analysis |
| Rotary Drum Thickening | 24 | 157.91 | 1 | 0.00% | Include in subsequent analysis |

**TABLE 6-4 (CONTINUED)**
Weighted Benefit Scores for Options Evaluated

| Category | Raw Total | Weighted Total | Rank | Percent Difference | Recommendations for Consideration |
|---|---|---|---|---|---|
| **Thickening and Dewatering Options** | | | | | |
| ***Pre-Stabilization Thickening*** | | | | | |
| Centrifuge Thickening | 23 | 155.40 | 2 | -1.59% | Include in subsequent analysis |
| Dissolved Air Flotation | 13 | 77.28 | 4 | -51.06% | DROP from further analysis - NO benefit |
| ***Biosolids Thickening*** | | | | | |
| Gravity Belt Thickening | 23 | 146.23 | 3 | -15.53% | Include in subsequent analysis |
| Rotary Drum Thickening | 25 | 172.04 | 2 | -0.62% | Include in subsequent analysis |
| Centrifuge Thickening | 25 | 173.12 | 1 | 0.00% | Include in subsequent analysis |
| ***Raw WAS Dewatering*** | | | | | |
| Belt Filter Press Dewatering | 25 | 143.91 | 2 | -9.62% | Include in subsequent analysis |
| Centrifuge Dewatering | 25 | 159.22 | 1 | 0.00% | Include in subsequent analysis |
| ***Biosolids Dewatering*** | | | | | |
| Belt Filter Press Dewatering | 33 | 197.09 | 2 | -7.21% | Include in subsequent analysis |
| Centrifuge Dewatering | 33 | 212.40 | 1 | 0.00% | Include in subsequent analysis |
| Solar Drying Beds | 27 | 132.63 | 4 | -37.56% | DROP from further analysis - NO benefit |
| "Hot Press" Dewatering | 32 | 188.74 | 3 | -11.14% | Include in subsequent analysis |
| **Use and Disposal Options** | | | | | |
| ***Beneficial Use*** | | | | | |
| Agricultural Land Application | 26 | 155.60 | 9 | -34.53% | DROP from further analysis - NO benefit |
| Golf Courses | 30 | 189.58 | 6 | -20.23% | Include in subsequent analysis |
| Forest Land Application | 26 | 154.68 | 10 | -34.91% | DROP from further analysis - NO benefit |
| Rangeland Application | 35 | 226.40 | 4 | -4.73% | Include in subsequent analysis |
| Land Reclamation | 37 | 237.65 | 1 | 0.00% | Include in subsequent analysis |
| Alternative Daily Cover | 36 | 231.63 | 3 | -2.53% | Include in subsequent analysis |
| Distribution & Marketing | 34 | 231.84 | 2 | -2.44% | Include in subsequent analysis |
| ***Disposal*** | | | | | |
| Dedicated Land Disposal | 26 | 180.93 | 8 | -23.87% | DROP from further analysis - NO benefit |
| Monofill | 27 | 185.88 | 7 | -21.78% | Include in subsequent analysis |
| Landfill (with Municipal Solids Waste) | 29 | 192.76 | 5 | -18.89% | Include in subsequent analysis |

As shown by the weighted benefit scores, dissolved air flotation thickening is not desirable, and rotary drums and centrifuges are desirable. Gravity belt thickening resides between these alternatives. Solar drying beds provide minimal benefit and will be dropped from further investigation.

It is interesting to note that for the use and disposal options, agricultural land application is not seen as having any benefit by the stakeholders, nor is forest land application. Also, dedicated land disposal provides minimal benefit and should not be carried forward.

**TABLE 6-5**
Weighted Benefit Scores for Complete Alternatives

| Category | Raw Total | Weighted Total | Rank | Percent Difference | Recommendations for Consideration |
|---|---|---|---|---|---|
| **Liquid Stabilization Alternatives** | | | | | |
| Alternative LS-1 (AD-TK) | 17 | 113.41 | 18 | -51.79% | DROP from further analysis - NO benefit |
| Alternative LS-2 (AD-DW) | 26 | 174.07 | 9 | -26.00% | Include in subsequent analysis |
| Alternative LS-3 (TK-AD-TK) | 17 | 100.69 | 19 | -57.20% | DROP from further analysis - NO benefit |
| Alternative LS-4 (TK-AD-DW) | 25 | 141.78 | 14 | -39.73% | DROP from further analysis - NO benefit |
| Alternative LS-5 (TK-AD) | 15 | 88.75 | 20 | -62.27% | DROP from further analysis - NO benefit |
| Alternative LS-6 (FSL) | 23 | 150.16 | 11 | -36.16% | DROP from further analysis - NO benefit |
| Alternative LS-7 (FSL-TK) | 22 | 146.44 | 12 | -37.75% | DROP from further analysis - NO benefit |
| Alternative LS-8 (FSL-DW) | 24 | 159.65 | 10 | -32.13% | DROP from further analysis - NO benefit |
| Alternative LS-9 (TK-FSL-TK) | 21.5 | 131.08 | 17 | -44.28% | DROP from further analysis - NO benefit |
| Alternative LS-10 (TK-FSL-DW) | 23.5 | 144.29 | 13 | -38.66% | DROP from further analysis - NO benefit |
| Alternative LS-11 (TK-FSL) | 22.5 | 134.80 | 16 | -42.69% | DROP from further analysis - NO benefit |
| **Solids Stabilization Alternatives** | | | | | |
| Alternative SS-1 (DW-LS) | 28.5 | 146.77 | 15 | -40.27% | DROP from further analysis - NO benefit |
| Alternative SS-2c (DW-C year round) | 39 | 228.03 | 3 | -7.21% | Include in subsequent analysis |
| Alternative SS-2s (DW-C seasonal) | 37.5 | 220.33 | 4 | -10.34% | Include in subsequent analysis |
| Alternative SS-2r (DW-C remote site) | 42 | 245.74 | 1 | 0.00% | Include in subsequent analysis |
| Alternative SS-3 (DW-TD) | 40 | 235.23 | 2 | -4.28% | Include in subsequent analysis |

**TABLE 6-5 (CONTINUED)**
Weighted Benefit Scores for Complete Alternatives

| Category | Raw Total | Weighted Total | Rank | Percent Difference | Recommendations for Consideration |
|---|---|---|---|---|---|
| Alternative SS-4 (DW) | 33.5 | 211.71 | 5 | -13.85% | Include in subsequent analysis |
| Alternative SS-5 (JV) | 32.5 | 184.28 | 8 | -25.01% | Include in subsequent analysis |
| Alternative SS-6 (OS) | 30 | 190.06 | 7 | -22.66% | Include in subsequent analysis |
| Alternative SS-7 (DW-R3) | 30.5 | 196.24 | 6 | -20.15% | Include in subsequent analysis |

Alternative abbreviations are described in Technical Memorandum 5, but are provided below for reference:

AD – Aerobic digestion
C – Composting
DW – Dewatering Option
FSL – Facultative Storage Lagoons
JV – J-Vap “Hot Press”
LA – Lime Stabilization
OS – Outside Services (Private)
R3 – Private Contractor Bid
TD – Thermal Drying
THK – Thickening Option

In general, alternatives involving marketing and distribution (compost and thermally-dried pellets) have the highest weighted benefit scores. This is due primarily to stakeholder desire for a local product, a high degree of operational flexibility in the process, and high future regulatory compliance. Thermal drying also greatly reduces the water content and hence the volume of the biosolids, so far less diesel fuel is required to haul off the dried biosolids. Thermal drying is also not subject to weather upsets as composting may be.

Alternatives that involve liquid treatment processes including aerobic digestion and facultative storage lagoons had relatively low scores for odor criteria and having no local product, which impacted their overall scores.

The solids treatment alternatives faired quite well, while the liquid alternatives showed very little desirability as shown by the weighted benefit scores. Only one of the 11 liquid alternatives was considered for further review, and all of the solids alternatives, except for lime stabilization, were recommended for further consideration.

The results of this analysis are presented in graphical form in Appendix F.

# Solids Management Master Plan Cost Analysis

**PREPARED FOR:** Snyderville Basin Water Reclamation District

**PREPARED BY:** CH2M HILL

**DATE:** March 17, 2003

## Contents



## Cost Evaluation Methodology

Cost opinions were developed to aid in comparing all of the alternative biosolids management programs. The cost opinions are based upon specific cost factors, which are presented in Table 7-1. These cost factors include factors for construction costs, operating and maintenance costs, present worth costs, and annualized costs. All alternatives use these factors.

**TABLE 7-1**
Cost Factors Used in Cost Opinions for Each Alternative

| Description | Item | Units | Comments |
|---|---|---|---|
| **Construction Cost Factors** | | | |
| Structural Excavation | 6 | $/cubic yard | |
| Native Material Backfill | 12 | $/cubic yard | |
| Site Grading | 1 | $/square foot | |
| Lining | 0.6 | $/square foot | HDPE liner installed cost |
| Concrete Tank Construction | 1.2 | $/gallon | Includes mixing system |
| Concrete – Walls & Elevated Decks | 500 | $/cubic yard | |
| Concrete Paving | 35 | $/square yard | 8 inches thick |
| Masonry Building Construction | 100 | $/square foot | |
| Building Concrete - 1 Story | 150 | $/square foot | |
| Building Concrete - 2 Story | 100 | $/square foot | Based on total floor area not building footprint |
| Metal Building Construction | 35 | $/square foot | Used off plant site or for composting |
| Conveyor | 1,500 | $/linear foot | Galvanized steel construction |
| Equipment Installation Costs [a] | 15 | Percent | Of equipment purchase price |
| **Contractor Markups** | | | |
| Mobilization | 8 | Percent | |
| Contract Indirects | 1 | Percent | |
| Contractors Overhead & Profit | 15 | Percent | |
| Contractors Bonds | 1.5 | Percent | |
| Contingency | 20 | Percent | For items not included in above costs |
| **Operation and Maintenance Cost Factors** | | | |
| Electricity | 0.06 | $/kilowatt-hour | |
| Natural Gas | 4.5 | $/decatherm | |
| Fuel | 1.5 | $/gallon | #2 diesel |
| Manpower | 25 | $/hour | Includes fringe benefits |
| Equipment Maintenance | 5 | Percent | Of equipment purchase price |
| Centrifugal Pump Efficiency | 80 | Percent | |
| Progressing Cavity Pump Efficiency | 50 | Percent | |
| Chemical – Polymer | 2.25 | $/pound | Active basis |
| Hauling Cost | 0.12 | $/wet ton-mile | |

**TABLE 7-1 (CONTINUED)**
Cost Factors Used in Cost Opinions for Each Alternative

| Description | Item | Units | Comments |
|---|---|---|---|
| Revenue – Compost | 15 | $/cubic yard | |
| Revenue – Thermal Dried | 24 | $/wet ton | 90 percent solids |
| **Economic Factors** | | | |
| Years for Analysis | 20 | Years | Period of study |
| Discount Rate | 5.0 | Percent | |
| Inflation Rate | 2.5 | Percent | |
| Quantity Increase | 4.0 | Percent | |

[a] Only used if no installation cost was provided by the equipment manufacturer

## Opinion of Construction Cost

Construction cost opinions include only the costs of construction. They do not include engineering, construction management, legal counsel, and administration costs. The construction cost estimates include a 20 percent contingency to account for elements that have not been defined in detail. A 20 percent contingency is standard practice for estimating costs at this level of planning. The costs for engineering, construction management, legal counsel, and administration are not included because they simply add 30 percent to the construction cost, and the District handles those costs separately from construction. Cost factors used for construction cost opinions are provided in Table 7-1. Detailed cost opinions are included in Appendix G.

The construction costs used in this evaluation are for comparative purposes only because they are based upon construction of projects today to meet year 2022 loads. There is no phasing or scheduling included which would be an important part of any recommended alternative.

Because the replacement of the Silver Creek WRF belt filter press with centrifuges and a new building have already been approved by the SBWRD Board and included in the Capital Improvements Program (CIP), those costs are considered as spent and the facilities existing. For comparison of costs, new facilities are sometimes included in the analysis, but the recommended plan will assume the existence of the centrifuges at Silver Creek WRF.

## Operation and Maintenance Costs

Operations and maintenance (O&M) costs were developed for each alternative using unit cost factors listed in Table 7-1. Detailed breakdowns of the O&M costs are provided in Appendix G for each option and alternative. These costs were based upon current District costs.

Unlike construction costs, the costs for operation and maintenance of the Silver Creek WRF centrifuges, although included in the CIP, are included in the cost evaluation, as are the existing East Canyon WRF centrifuges.

## Present Worth and Annualized Costs

Present worth and annualized costs, which include construction and annual O&M costs, are considered life-cycle costs. A life-cycle cost analysis was completed for this project. Present worth costs are the construction costs plus the O&M costs brought forward. Present worth costs were then spread over the 20-year project period to obtain the annualized costs. Present worth costs were developed using a discount rate of 5 percent, an inflation rate of 2.5 percent, and a useful life of 20 years. Annualized costs were simply developed from the present worth costs using a discount rate of 5 percent spread over 20 years.

Present worth construction costs and O&M costs were used to compare the value for the different alternatives. All of the construction and O&M costs were calculated for the volume of waste activated sludge (WAS) projected for the year 2022. This assumed a 20-year life cycle. However, the amount of WAS being produced today is less than half of that projected in 2022. In addition, the O&M costs were calculated in 2002 dollars and will increase at some inflation rate which is not normal in a typical present worth analysis. Therefore, the net present worth of the O&M costs would be over valued. The variable O&M costs due to increasing WAS volumes was accounted for in calculation of the net present worth to provide an accurate comparison of alternatives.

The conversion of O&M costs to present day WAS volumes were calculated by applying a quantity factor which could be multiplied by the O&M cost for the year 2022. This quantity factor was calculated by comparing the 2002 WAS volume and the projected 2022 WAS volume, which resulted in a compounded growth of 4 percent, which is the same as the projected population growth in the SBWRD service area. For example, if one unit cost of WAS was produced in year one, then 1.04 unit costs of WAS would be produced in the second year, 1.0816 in the third year, and so on.

Another calculation was needed to determine the inflationary impact. Similarly, the first year was assumed to be one and the next year was one times the inflation rate plus one. For example, using a 2.5 percent inflation rate, the second year inflation was 1.025 times the cost for year two. For year three, the inflation factor multiplier would be 1.025 times 1.025 or 1.050625.

The resulting cost factor was simply the quantity factor multiplied by the inflation factor for each year. Year one is one and year two would be 1.04 time 1.025. Once all these factors were determined, the net present value of the twenty annual unit costs was calculated. This cost factor could then be multiplied by the estimated O&M cost for each option to determine the present worth of O&M costs for 20 years with increasing WAS volumes and a constant inflation. This results in an accurate representation of O&M cost.

The series of annual costs were then brought into year 2002 by applying a discount rate of 5 percent which factors in the annual cost of money. This is added to the construction cost, which results in the present worth cost. This cost, which includes both construction and annual O&M costs, is spread over the 20-year project life resulting in the annualized cost for each alternative. Annualized costs are another representation of present worth cost, because the same factor is multiplied by the present worth cost of each alternative to obtain the annualized cost of each alternative.

### Accuracy of Cost Opinions

The opinions of cost shown, and any resulting conclusions on project financial or economic feasibility or funding requirements, have been prepared for guidance in project evaluation and implementation from the information available at the time the opinion was prepared. The final costs of the project and resulting feasibility will depend on actual labor and material costs, competitive market conditions, actual site conditions, final project scope, implementation schedule, continuity of personnel and engineering, and other variable factors. As a result, the final project costs will vary from the opinions of cost presented herein. Because of these factors, project feasibility, benefit/cost ratios, risks, and funding needs must be carefully reviewed prior to making specific financial decisions or establishing project budgets to help ensure proper project evaluation and adequate funding.

These estimates are planning level, also called budget, estimates. Preliminary flow sheets, layouts, and major equipment quantities, type, and sizing details were used. A budget estimate is used to establish the District's budget and is not to be confused with an estimate used to control the budget on a project. An estimate of this type is expected to be accurate to within plus 30 percent to minus 15 percent of the estimated cost.

When comparing alternative costs, values within plus or minus 10 to 15 percent are considered equal.

## Cost Results for Options

The economic analysis was divided into several categories for evaluation. There were several options that formed a part of each alternative (as explained in Technical Memorandum 4). These options included thickening, dewatering, stabilization, hauling, beneficial use and disposal. In most cases, the least cost options were together to calculate the overall alternative cost. The costs for all options also followed the cost factors presented in Table 7-1. The cost for each alternative was calculated by adding together the costs of the appropriate options.

The cost results for all options are presented in Tables 7-2 for thickening and dewatering options, Table 7-3 for stabilization options, Table 7-4 for hauling options, and Table 7-5 for beneficial use and disposal options. Although tables are used in this technical memorandum, a graphical presentation of each option is provided in Appendix H.

**TABLE 7-2**
Cost Comparison for Thickening and Dewatering Options

| Options | Construction Cost Opinion | Annual O&M Cost | Present Worth Cost | Annualized Cost |
|---|---|---|---|---|
| **Pre-stabilization Thickening (feed 0.5 percent solids; to ~ 6 percent solids)** | | | | |
| Gravity Belt Thickener | $5,040,000 | $297,000 | $8,193,000 | $648,800 |
| Rotary Drum Thickener | $3,010,000 | $283,000 | $6,015,000 | $476,300 |
| Centrifugal Thickening | $6,460,000 | $364,000 | $10,319,000 | $817,200 |
| Dissolved Air Flotation | $3,180,000 | $305,000 | $6,417,000 | $508,200 |

**TABLE 7-2 (CONTINUED)**
Cost Comparison for Thickening and Dewatering Options

| Options | Construction Cost Opinion | Annual O&M Cost | Present Worth Cost | Annualized Cost |
|---|---|---|---|---|
| **Biosolids Thickening (feed solids vary; to ~ 7 percent solids)** | | | | |
| Gravity Belt Thickener | $5,320,000 | $210,000 | $7,552,000 | $598,100 |
| Rotary Drum Thickener | $4,010,000 | $220,000 | $6,341,000 | $502,100 |
| Centrifugal Thickening | $6,280,000 | $244,000 | $8,869,000 | $702,300 |
| **Raw WAS Dewatering (feed 0.5 percent solids; to 15 percent solids)** | | | | |
| Belt Filter Press | $11,570,000 | $308,000 | $14,835,000 | $1,174,800 |
| Centrifuges | $12,950,000 | $1,004,000 | $23,601,000 | $1,869,100 |
| Hot Presses | $23,430,000 | $591,000 | $29,696,000 | $2,351,800 |
| Centrifuges – Use Existing Facilities | $4,340,000 | $1,023,000 | $15,189,000 | $1,202,900 |
| **Biosolids Dewatering (feed solids vary; to 15 percent solids)** | | | | |
| Belt Filter Press | $5,940,000 | $248,000 | $8,593,000 | $678,900 |
| Centrifuges | $5,360,000 | $515,000 | 10,823,000 | $857,200 |
| Drying Beds | $4,820,000 | $210,000 | $7,043,000 | $557,800 |

Costs do not include stabilization, hauling, beneficial use or disposal
Note: Only stabilization produces biosolids

The data in Table 7-2 includes improvements to both the East Canyon WRF and the Silver Creek WRF to meet year 2022 flow conditions, assuming a 4 percent growth. As shown in Table 7-2, thickening, when used, is either by rotary drums or dissolved air flotation, with gravity belts slightly higher, and new centrifuges are even more expensive. For Raw WAS dewatering, however, using the existing centrifuges at the East Canyon WRF (useful for another five to fifteen years depending on the operating schedule) and the centrifuges already included in the CIP for the Silver Creek WRF (considered as existing), is the lowest present worth cost with belt filter presses. Compared to a belt filter press, a centrifuge will use slightly more polymer and significantly more energy, but a centrifuge has considerably more opportunity to produce drier solids than a belt filter press. In addition, the District's investment in centrifuges must be a part of any evaluation.

As is clearly evident, the cost for dewatering is very significant cost of any recommended program. These capital costs do not include the replacement of the belt filter press at the Silver Creek WRF with centrifuges because this cost is already included in the District's CIP and is considered a sunk cost. The costs for replacement of the existing centrifuges at the East Canyon WRF in approximately 5 to 8 years is included, however. This replacement period is dependent upon two major items:

1. Growth of the District's service Residential Units (R.E.)
2. Operating time for the centrifuges

Assuming the growth is as projected, the existing East Canyon WRF centrifuges will only have enough capacity for the next 5 years. This high capital expenditure can be postponed by operating the existing centrifuges over a longer period of time; that is, operate on Sundays or operate longer than one shift per day, six days per week. Based upon 6 days per week, 8 hours per day, approximately 42 hours per week of run time is possible (assumes 1 hour per day total for startup and shutdown). Extending this to 7 days per week provides for an addition 7 hours per week or an increase of 4.3 percent. Operating for 15 hours per day (2 shift operation, with 1 hour total for startup and shutdown), provides for 114.3 percent additional capacity for 6 days of operation and 150 percent additional capacity if run for 7 days per week. The present capacity of two centrifuges is 240 gpm, whereas the 2022 peak capacity demand for 7 hours per day, 6 days per week operation is 633 gpm (average for this period is 423 gpm). These centrifuges would be sufficient for average flows operating two shifts per day, 6 days per week. But, for peak flows, even 7 days per week requires 253 gpm capacity, so overtime would be required to handle these flows. Therefore, the existing centrifuges are properly sized, assuming two shifts per day minimum. For consistency in the alternative analysis, however, we used a maximum operating time of 7 hours per day, 6 days per week. This results in a significantly larger machine (320 gpm versus 120 gpm), and hence more cost and greater installed horsepower.

Extending the operating period does increase the operating cost for the operator, and assuming a second shift for 6 days per week, this would increase the labor cost by $62,400 per year, but it is easy to see that even in 20 years, the cost of added labor is less than purchasing large equipment.

**TABLE 7-3**
Cost Comparison for Stabilization Options

| Options | Construction Cost Opinion | Annual O&M Cost | Present Worth Cost | Annualized Cost |
|---|---|---|---|---|
| On-Site Staged Aerobic Digestion w/ Thickening | $4,460,000 | $336,000 | $8,025,000 | $635,500 |
| On-Site Staged Aerobic Digestion w/o Thickening | $14,850,000 | $393,000 | $19,013,000 | $1,505,800 |
| Off-Site Facultative Storage Lagoons | $6,100,000 | $160,000 | $7,796,000 | $617,400 |
| Lime Stabilization only at Silver Creek WRF | $6,140,000 | $284,000 | $9,154,000 | $724,900 |
| Thermal Drying only at Silver Creek WRF | $6,820,000 | $490,000 | $12,013,000 | $951,300 |
| Seasonal Composting only at Silver Creek WRF | $1,920,000 | $97,000 | $2,952,000 | $233,800 |
| Year-Round Composting at Silver Creek WRF | $10,500,000 | $160,000 | $12,013,000 | $966,100 |
| Year-Round Composting at Remote Site | $6,490,000 | $84,000 | $7,381,000 | $584,500 |

Costs do not include thickening, dewatering, hauling, beneficial use, or disposal

It is clear, based on both construction costs and present worth costs, that aerobic digestion of raw WAS without thickening and year-round composting at the Silver Creek WRF are not cost effective. Although seasonal composting is the least expensive option, it must be remembered that this only includes composting solids for half of the year and another option must be provided for the rest of the year.

**TABLE 7-4**
Cost Comparison for Hauling Options

| Distance | Option | Wet Tons/ Year (2022) | Annual O&M Cost | Present Worth Cost | Annualized Cost |
|---|---|---|---|---|---|
| Short | Dewatered Raw WAS (15% Solids) | 13,612 | $28,600 | $356,000 | $28,200 |
| Remote | Raw WAS (0.5% Solids) | 408,350 | $4,900,200 | $61,067,000 | $4,836,200 |
| Remote | Thickened Raw WAS (5% Solids) | 40,835 | $490,000 | $6,107,000 | $483,600 |
| Local | Dewatered Raw WAS (15% Solids) | 13,612 | $98,000 | $1,221,000 | $96,700 |
| Remote | Dewatered Raw WAS (15% Solids) | 13,612 | $163,300 | $2,036,000 | $161,200 |
| Local | Pre-stabilization Thickened Biosolids (3% Solids) | 48,700 | $350,600 | $4,370,000 | $346,100 |
| Remote | Pre-stabilization Thickened Biosolids (3% Solids) | 48,700 | $584,400 | $7,283,000 | $576,800 |
| Local | Post-Stabilization Thickened Biosolids (7% Solids) | 20,871 | $150,300 | $1,873,000 | $148,300 |
| Remote | Post-Stabilization Thickened Biosolids (7% Solids) | 20,871 | $250,500 | $3,121,000 | $247,200 |
| Local | Dewatered Biosolids (15% Solids) | 9,740 | $70,100 | $874,000 | $69,200 |
| Remote | Dewatered Biosolids (15% Solids) | 9,740 | $116,900 | $1,457,000 | $115,400 |

Costs do not include thickening, dewatering, stabilization, beneficial use, or disposal
Hauling costs based upon the following factors:
$0.12/wet ton-mile (remote 100 miles round trip; local 60 miles round trip)
$0.15/wet ton-mile (short 14 miles round trip, East Canyon WRF to Silver Creek WRF)

Hauling cost do not include a construction cost component because the cost per wet ton-mile includes the amortized cost of the trucks as well as the driver, maintenance, insurance, etc. The other critical parameters are distance and volume to be hauled. Although it is readily apparent that a local haul with dewatered biosolids is the lowest life-cycle cost, the hauling options are dependent upon the process location as well as the location of beneficial use or disposal.

When hauling and processing are not required, alternative daily cover is the lowest cost, because very little construction cost is required. Land application to agricultural land, rangeland, or for land reclamation is also cost effective when dewatered biosolids are used instead of liquid biosolids. Stabilization in some form is required for all beneficial use options except for alternative daily cover. Disposal of raw WAS is possible using a monofill or landfill disposal option, but stabilization may be required for dedicated land disposal depending upon UDEQ attitudes and odors.

**TABLE 7-5**
Cost Comparison for Beneficial Use and Disposal Options

| Location | Option | Construction Cost Opinion | Annual O&M Cost | Present Worth Cost | Annualized Cost |
|---|---|---|---|---|---|
| **Beneficial Use Options** | | | | | |
| Local | Agricultural Land Application | | | | |
| | *With liquid (0.5%) biosolids application* | $1,320,000 | $963,600 | $13,329,000 | $1,055,600 |
| | *With thickened (3%) biosolids application* | $1,320,000 | $233,100 | $4,225,000 | $334,600 |
| | *With thickened (8%) biosolids application* | $1,320,000 | $141,800 | $3,087,000 | $244,500 |
| | *With dewatered (15%) biosolids application* | $1,320,000 | $116,200 | $2,768,000 | $219,200 |
| Local | Forested Land Application | | | | |
| | *With liquid (0.5%) biosolids application* | $3,090,000 | $963,600 | $15,099,000 | $1,195,700 |
| | *With thickened (8%) biosolids application* | $3,090,000 | $141,800 | $4,857,000 | $384,600 |
| | *With dewatered (15%) biosolids application* | $3,090,000 | $116,200 | $4,538,000 | $359,400 |
| Remote | Rangeland Application | | | | |
| | *With liquid (0.5%) biosolids application* | $1,940,000 | $956,600 | $13,861,000 | $1,097,700 |
| | *With thickened (4%) biosolids application* | $1,940,000 | $189,600 | $4,303,000 | $340,700 |
| | *With thickened (8%) biosolids application* | $1,940,000 | $134,800 | $3,620,000 | $286,700 |
| | *With dewatered (15%) biosolids application* | $1,940,000 | $109,200 | $3,301,000 | $261,400 |
| Remote | Land Reclamation (Kennecott) * | $1,250,000 | $79,700 | $2,095,000 | $166,000 |
| Local | Alternative Daily Cover (Dewatered) | $100,000 | $218,000 | $2,417,000 | $191,400 |
| NA | Ensign Ranch / R3 (Dewatered) | $100,000 | $381,000 | $4,142,000 | $328,000 |
| **Disposal Options** | | | | | |
| Remote | Dedicated Land Disposal | | | | |
| | *With liquid (0.5%) biosolids application* | $3,410,000 | $997,600 | $15,842,000 | $1,254,600 |
| | *With thickened (8%) biosolids application* | $3,410,000 | $175,800 | $5,601,000 | $443,500 |
| | *With dewatered (15%) biosolids application* | $3,410,000 | $150,200 | $5,282,000 | $418,300 |
| Remote | Monofill (Dewatered) | $2,970,000 | $960,000 | $13,150,000 | $1,041,400 |
| Local | Landfill (Dewatered) | $100,000 | $476,000 | $5,152,000 | $408,000 |

Costs do not include thickening, dewatering, stabilization, or hauling
Location is only used when applying hauling costs to the alternative

## Cost Results for Alternatives

Using the information from Tables 7-1 through 7-5, costs were summed, as appropriate and an opinion of cost for each alternative was developed and is presented in Table 7-6. Unlike the options costs, however, these alternative costs include all facets of the alternative and are directly comparable. The opinion of construction cost, annual O&M cost, present worth cost, and the annualized cost for each alternative have been developed and are shown in Table 7-6. As with the options, a graphical presentation of the alternative costs is provided in Appendix H.

**TABLE 7-6**
Cost Comparison of Alternatives

| Alternatives | Comparative Construction Cost Opinion | Annual O&M Cost | Present Worth Cost | Annualized Cost |
|---|---|---|---|---|
| **Liquid Stabilization Alternatives** | | | | |
| Alternative LS-1 (AD-TK-Local-AgL) | $20,180,000 | $905,000 | $30,314,000 | $2,401,000 |
| Alternative LS-2 (AD-DW-Local-ADC) | $19,770,000 | $891,000 | $29,347,000 | $2,324,000 |
| Alternative LS-3 (TK-AD-TK-Local-AgL) | $12,800,000 | $1,131,000 | $25,341,000 | $2,007,000 |
| Alternative LS-4 (TK-AD-DW-Local-ADC) | $12,930,000 | $1,422,000 | $28,154,000 | $2,230,000 |
| Alternative LS-5 (TK-AD-Local-AgL) | $8,790,000 | $1,203,000 | $22,635,000 | $1,792,000 |
| Alternative LS-6 (Remote-FSL-RL) | $8,040,000 | $5,250,000 | $73,166,000 | $5,794,000 |
| Alternative LS-7 (Remote-FSL-TK-RL) | $12,050,000 | $5,360,000 | $77,989,000 | $6,176,000 |
| Alternative LS-8 (Remote-FSL-DW-RL) | $12,710,000 | $5,350,000 | $78,001,000 | $6,177,000 |
| Alternative LS-9 (TK-Remote-FSL-TK-RL) | $15,060,000 | $1,288,000 | $29,878,000 | $2,366,000 |
| Alternative LS-10 (TK-Remote-FSL-DW-RL) | $16,410,000 | $1,528,000 | $30,148,000 | $2,388,000 |
| Alternative LS-11 (TK-Remote-FSL-RL) | $11,050,000 | $1,123,000 | $24,622,000 | $1,950,000 |
| **Solids Stabilization Alternatives** | | | | |
| Alternative SS-1 (DW-LS-Local-ADC) | $10,580,000 | $1,624,000 | $27,990,000 | $4,442,000 |
| Alternative SS-2c (DW-C-None) | $14,840,000 | $1,212,000 | $27,745,000 | $2,197,000 |
| Alternative SS-2s (DW-C-None) | $6,360,000 | $1,258,000 | $19,701,000 | $1,581,000 |
| Alternative SS-2r (DW-Remote-C-None) | $10,830,000 | $1,270,000 | $24,606,000 | $1,949,000 |
| Alternative SS-3 (DW-TD-None) | $11,160,000 | $1,542,000 | $27,558,000 | $2,182,000 |
| Alternative SS-4 (DW-Local-ADC) | $4,440,000 | $1,339,000 | $18,827,000 | $1,491,000 |
| Alternative SS-5 (TK-JV-Local-ADC) | $26,540,000 | $1,162,000 | $39,585,000 | $3,135,000 |
| Alternative SS-6 (OS-Remote) | $2,360,000 | $18,992,000 | $77,519,000 | $6,139,000 |
| Alternative SS-7 (DW-R3) | $4,440,000 | $1,404,000 | $19,331,000 | $1,531,000 |

Table 7-6 is difficult to evaluate simply due to the number of alternatives investigated and the different cost values. Table 7-7 presents each alternative, similar to Table 7-6, but provides a simple comparison of alternatives for construction cost and annual O&M cost. Based upon the data in Table 7-6, a ratio is calculated with the lowest cost being 0 percent. Then, the ranking is done based upon the ratio of costs. These ratios and rankings are included in Table 7-7. Only construction cost and present worth cost were used, because they are most representative initial costs and life-cycle costs, respectively.

**TABLE 7-7**
Cost Evaluation of Alternatives

| Alternatives | Comparative Construction Cost Rank | Ratio to Lowest Construction Cost | Present Worth Cost Rank | Ratio to Lowest Present Worth Cost |
|---|---|---|---|---|
| **Liquid Stabilization Alternatives** | | | | |
| Alternative LS-1 (AD-TK-Local-AgL) | 19 | 755% | 15 | 61.0% |
| Alternative LS-2 (AD-DW-Local-ADC) | 18 | 738% | 12 | 55.9% |
| Alternative LS-3 (TK-AD-TK-Local-AgL) | 10 | 442% | 7 | 34.6% |
| Alternative LS-4 (TK-AD-DW-Local-ADC) | 11 | 448% | 11 | 49.5% |
| Alternative LS-5 (TK-AD-Local-AgL) | 3 | 272% | 4 | 20.2% |
| Alternative LS-6 (Remote-FSL-RL) | 2 | 241% | 17 | 288.6% |
| Alternative LS-7 (Remote-FSL-TK-RL) | 8 | 411% | 19 | 314.2% |
| Alternative LS-8 (Remote-FSL-DW-RL) | 9 | 439% | 20 | 314.3% |
| Alternative LS-9 (TK-Remote-FSL-TK-RL) | 12 | 538% | 13 | 58.7% |
| Alternative LS-10 (TK-Remote-FSL-DW-RL) | 16 | 595% | 14 | 60.1% |
| Alternative LS-11 (TK-Remote-FSL-RL) | 7 | 368% | 6 | 30.8% |
| **Solids Stabilization Alternatives** | | | | |
| Alternative SS-1 (DW-LS-Local-ADC) | 13 | 348% | 10 | 48.7% |
| Alternative SS-2c (DW-C-None) | 17 | 529% | 9 | 47.4% |
| Alternative SS-2s (DW-C-None) | 6 | 169% | 3 | 4.6% |
| Alternative SS-2r (DW-Remote-C-None) | 14 | 359% | 5 | 30.7% |
| Alternative SS-3 (DW-TD-None) | 15 | 373% | 8 | 46.4% |
| Alternative SS-4 (DW-Local-ADC) | 4 | 88% | 1 | 0% |
| Alternative SS-5 (TK-JV-Local-ADC) | 20 | 1025% | 16 | 110.3% |
| Alternative SS-6 (OS-Remote) | 1 | 0% | 18 | 311.7% |
| Alternative SS-7 (DW-R3) | 4 | 88% | 2 | 2.7% |

As can be seen in Tables 7-6 and 7-7, there is a wide range of both construction and O&M costs, which reflects the difference in processing and disposal or use. It is not appropriate to assume that the District will spend over $10,000,000 for construction, regardless of the present worth cost. This results in a value of about 400 percent of the lowest cost alternative, which had an opinion of construction cost of $2,360,000. This alternative has such a low construction cost because it includes only liquid storage tanks at each plant and no increase in dewatering capability. In addition, it does not include any processing costs since processing would be done by the outsourcing contractor. Therefore, all alternatives ranked 8th or higher will be dropped from further consideration.

Regarding present worth costs, this is a better reflection of the total cost of the alternative. As is shown in Table 7-7, the alternative with the lowest construction cost (SS-6) has one of the highest present worth costs, which demonstrates the high annual costs of hauling and dewatering. The District cannot accept an alternative with high present worth costs. For evaluation purposes, all alternatives ranked 8h or higher (> $26,000,000 present worth cost) will be dropped from further consideration. The lowest present worth cost alternative includes continued dewatering of raw WAS at both plants and beneficial use as a landfill top dressing. The lowest present worth cost alternative for liquid processing includes thickening followed by staged aerobic digestion and local agricultural use. Although this alternative has a high construction cost, the overall cost over 20 years is reduced due to the low annual O&M cost associated with a short haul and minimal effort to beneficially use the Class B pathogen density level product.

Using the above criteria for both construction cost and present worth cost, only five alternatives remain for further evaluation and those alternatives are presented in Table 7-8.

**TABLE 7-8**
Alternatives Remaining for Further Evaluation

| Alternatives | Comparative Construction Cost Rank | Ratio to Lowest Construction Cost | Present Worth Cost Rank | Ratio to Lowest Present Worth Cost |
|---|---|---|---|---|
| **Liquid Stabilization Alternatives** | | | | |
| Alternative LS-5 (TK-AD-Local-AgL) | 3 | 272% | 4 | 20.2% |
| Alternative LS-11 (TK-Remote-FSL-RL) | 7 | 368% | 6 | 30.8% |
| **Solids Stabilization Alternatives** | | | | |
| Alternative SS-2s (DW-C-None) | 6 | 169% | 3 | 4.6% |
| Alternative SS-4 (DW-Local-ADC) | 4 | 88% | 1 | 0% |
| Alternative SS-7 (DW-R3) | 4 | 88% | 2 | 2.7% |

# Summary Description of Remaining Alternatives

Each alternative is described in detail in Technical Memorandum 5, so only the key parameters are noted in the following summary.

## Alternative LS-5 (Aerobic Digestion)

This alternative includes thickening of raw WAS to about 6 percent solids, which is blended with raw WAS to provide a feed to the staged aerobic digestion process of about 4 percent solids. Both thickening and digestion are located at each plant. Aerobic digestion will consistently meet Class B pathogen density requirements and is considered a Process to

Significantly Reduce Pathogens, so limited monitoring is required. Beneficial use to local agricultural land is provide with a liquid Class B product.

### Alternative LS-11 (Facultative Storage Lagoons)

This alternative has thickening at both plants followed by hauling of the thickened unstabilized solids to facultative storage lagoons (FSL) at a remote site. Facultative lagoons are quite common and similar lagoons have been used for many years, normally for biosolids stabilized in anaerobic digestion. However, it is also recognized that facultative lagoons, if loaded properly, can stabilize raw solids. The advantage of this alternative is the long-term storage. For example, it will take 3 to 5 years just to “fill” the lagoons before any solids removal (harvesting) can take place. The major downside, however, is odors. Once or twice a year, the lagoon may turn over due to the temperature density difference in the water. This will bring the digesting solids to the surface and will cause severe odors.

Harvesting the biosolids will be by a floating dredge which will remove solids from the bottom of the FSL and pump these solids to nearby rangeland or tank trucks for subsequent liquid application to rangeland.

### Alternative SS-2s (Seasonal Composting and Alternative Daily Cover)

This alternative dewaters raw WAS at each plant, similar to current operations. During the warm weather half of the year, dewatered solids are hauled from the East Canyon WRF to the Silver Creek WRF where they are combined with the Silver Creek solids and composted. The composted product is sold or given away to local groups or the public.

During the cooler periods of climate inversions, composting operations cease and the dewatered cake is hauled from each plant to a landfill where it is processed into alternative daily cover for landfill top dressing.

### Alternative SS-4 (Alternative Daily Cover)

This alternative continues the present operation by dewatering raw WAS at each plant. The dewatered cake is then hauled from each plant to a municipal solid waste landfill where it is processed into alternative daily cover for landfill top dressing.

### Alternative SS-7 (Private Contractor)

Similar to the above two alternatives, the dewatering of raw WAS continues. In this alternative, however, the dewatered cake is hauled to a private company located at a remote site. The private company is then responsible to process and use or dispose of the delivered cake.

## Next Step in the Alternative Evaluation

All alternatives are subjected to a benefit-cost analysis, which is presented in Technical Memorandum 8. Although only five alternatives survived the cost analysis, the benefit cost analysis reviews all alternatives. In some rare instances, a particular alternative may produce such a high benefit that the District may want to reconsider its viability.

# Solids Management Master Plan Benefit to Cost Analysis

PREPARED FOR: Snyderville Basin Water Reclamation District

PREPARED BY: CH2M HILL

DATE: March 17, 2003

## Contents



## Benefit-to-Cost Analysis Methodology

This analysis uses the information detailed in the benefit analysis (Technical Memorandum 6) and the costs developed in the cost analysis (Technical Memorandum 7) to provide a different evaluation – benefit to cost. The advantage of a benefit-to-cost analysis is that it is very difficult to understand what is the best alternative based only on costs. Using cost, several alternatives tend to have similar costs, and when coupled with the accuracy of planning level or budget estimates, the acceptable variations can be quite large. Using benefits on the other hand, without considering cost, can be disastrous. Therefore, a benefit-to-cost analysis shows the cost as well as the benefit so the decision can be based upon the alternative with acceptable costs and having a high benefit to the stakeholders.

Once the two factors are known, weighted benefits and costs, either construction or present worth, the benefit score is divided by the cost and this ratio is plotted to clearly show the differences. From this information, a decision can be made with confidence that all factors have been included.

## Benefit and Cost Analyses for Options

The alternative analysis was divided into several categories for evaluation. There were several options that formed a part of each alternative (as explained in Technical Memorandum 5). These options included thickening, dewatering, beneficial use, and disposal. In most cases, the least cost/highest benefit option was generally added to the appropriate alternative to produce the overall alternative.

The benefit and cost results for all options are presented in Tables 8-1 for thickening and dewatering options, and Table 8-2, for beneficial use and disposal options.

**TABLE 8-1**
Benefit and Cost Comparison for Thickening and Dewatering Options

| Options | Comparative Construction Cost Opinion | Present Worth Cost | Cost Analysis Results | Weighted Benefit Scores | Benefit Analysis Results |
|---|---|---|---|---|---|
| **Pre-Stabilization Thickening (feed 0.5 percent solids; to ~ 6 percent solids)** | | | | | |
| Gravity Belt Thickener | $5,040,000 | $8,193,000 | Include | 132.10 | Include |
| Rotary Drum Thickener | $3,010,000 | $6,015,000 | Include | 157.91 | Include |
| Centrifugal Thickening | $6,460,000 | $10,319,000 | Include | 155.40 | Include |
| Dissolved Air Flotation | $3,180,000 | $6,417,000 | Include | 77.28 | DROP |
| **Biosolids Thickening (feed solids vary; to ~ 7 percent solids)** | | | | | |
| Gravity Belt Thickener | $5,320,000 | $7,552,000 | Include | 146.23 | Include |
| Rotary Drum Thickener | $4,010,000 | $6,341,000 | Include | 172.04 | Include |
| Centrifugal Thickening | $6,280,000 | $8,869,000 | Include | 173.12 | Include |
| **Raw WAS Dewatering (feed 0.5 percent solids; to 15 percent solids)** | | | | | |
| Belt Filter Press | $11,570,000 | $14,835,000 | Include | 143.91 | Include |
| Centrifuges | $12,950,000 | $23,601,000 | Include | 159.22 | Include |
| Hot Presses | $23,430,000 | $29,696,000 | Include | 188.74 | Include |
| Centrifuges – Use Existing Facilities | $4,340,000 | $15,189,000 | Include | 159.22 | Include |
| **Biosolids Dewatering (feed solids vary; to 15 percent solids)** | | | | | |
| Belt Filter Press | $5,940,000 | $8,573,000 | Include | 197.09 | Include |
| Centrifuges | $5,360,000 | $10,823,000 | Include | 212.40 | Include |
| Drying Beds | $4,820,000 | $7,043,000 | Include | 132.63 | Include |

Costs do not include stabilization, hauling, beneficial use, or disposal
Note: Only stabilization produces biosolids
Benefit analysis results from Technical Memorandum 6
Cost analysis results from Technical Memorandum 7

Virtually all options are recommended for inclusion into the benefit-to-cost evaluation, except for the dissolved air flotation because it had a very low benefit coupled with moderately high costs. Although new raw WAS centrifuges are expensive, the cost for using the existing centrifuges at the East Canyon WRF (replacing in 5 years) and the budgeted centrifuges at the Silver Creek WRF (included in the District's CIP) are tied with belt filter presses as the least expensive dewatering option.

**TABLE 8-2**
Benefit and Cost Comparison for Beneficial Use and Disposal Options

| Location | Option | Comparative Construction Cost Opinion | Present Worth Cost | Cost Analysis Results | Weighted Benefit Scores | Benefit Analysis Results |
|---|---|---|---|---|---|---|
| **Beneficial Use Options** | | | | | | |
| Local | Agricultural Land Application | $1,320,000 | $2,768,000 | Include | 155.60 | DROP |
| Local | Golf Courses | [a] | [a] | [a] | 189.58 | Include |
| Local | Forested Land Application | $3,090,000 | $4,538,000 | Include | 154.68 | DROP |
| Remote | Rangeland Application | $1,940,000 | $3,301,000 | Include | 226.40 | Include |
| Remote | Land Reclamation (Kennecott) | $1,250,000 | $2,095,000 | Include | 237.65 | Include |
| Local | Alternative Daily Cover (Dewatered) | $100,000 | $2,417,000 | Include | 231.63 | Include |
| Local | Distribution and Marketing (compost or pellets) | [b] | [b] | [b] | 231.84 | Include |
| Remote | Ensign Ranch / R3 (Dewatered) | $100,000 | $4,142,000 | Include | NA | Include |
| **Disposal Options** | | | | | | |
| Remote | Dedicated Land Disposal | $3,410,000 | $5,282,000 | Include | 180.93 | DROP |
| Remote | Monofill (Dewatered) | $2,970,000 | $13,150,000 | Include | 185.88 | Include |
| Local | Landfill (Dewatered) | $100,000 | $5,152,000 | Include | 192.76 | Include |

Costs do not include thickening, dewatering, stabilization, or hauling
Benefit analysis results from Technical Memorandum 6
Cost analysis results from Technical Memorandum 7
[a] No cost estimate provided – same as distribution and marketing
[b] No cost estimate provided – included in alternative cost (as revenue)

When hauling and processing are not required, alternative daily cover is the lowest cost, because very little construction cost is required. Land application to agricultural land, rangeland, or for land reclamation also shows similar costs, but the benefits of land application and forest land application are both low.

Benefit-to-cost ratios, for both construction and present worth costs, were calculated for each option. Figures 8-1 through 8-5 present the benefit-to-present worth cost graphs for all options considered. The presentation used for these graphs is unique in that the benefit-to-cost ratio is shown by the symbol for each alternative and is read to the left hand side of the graph. The associated present worth costs are on the bottom scale. The unique part of these figures is the leg from the symbol, either up or down with the end of the leg representing the weighted benefit score which is read on the right hand vertical axis. In this way, it is possible to see all features of an option at one time. The graphs for construction cost are included in Appendix I.

**FIGURE 8-1**
Benefit/Present Worth Analysis for Pre-Stabilization Thickening

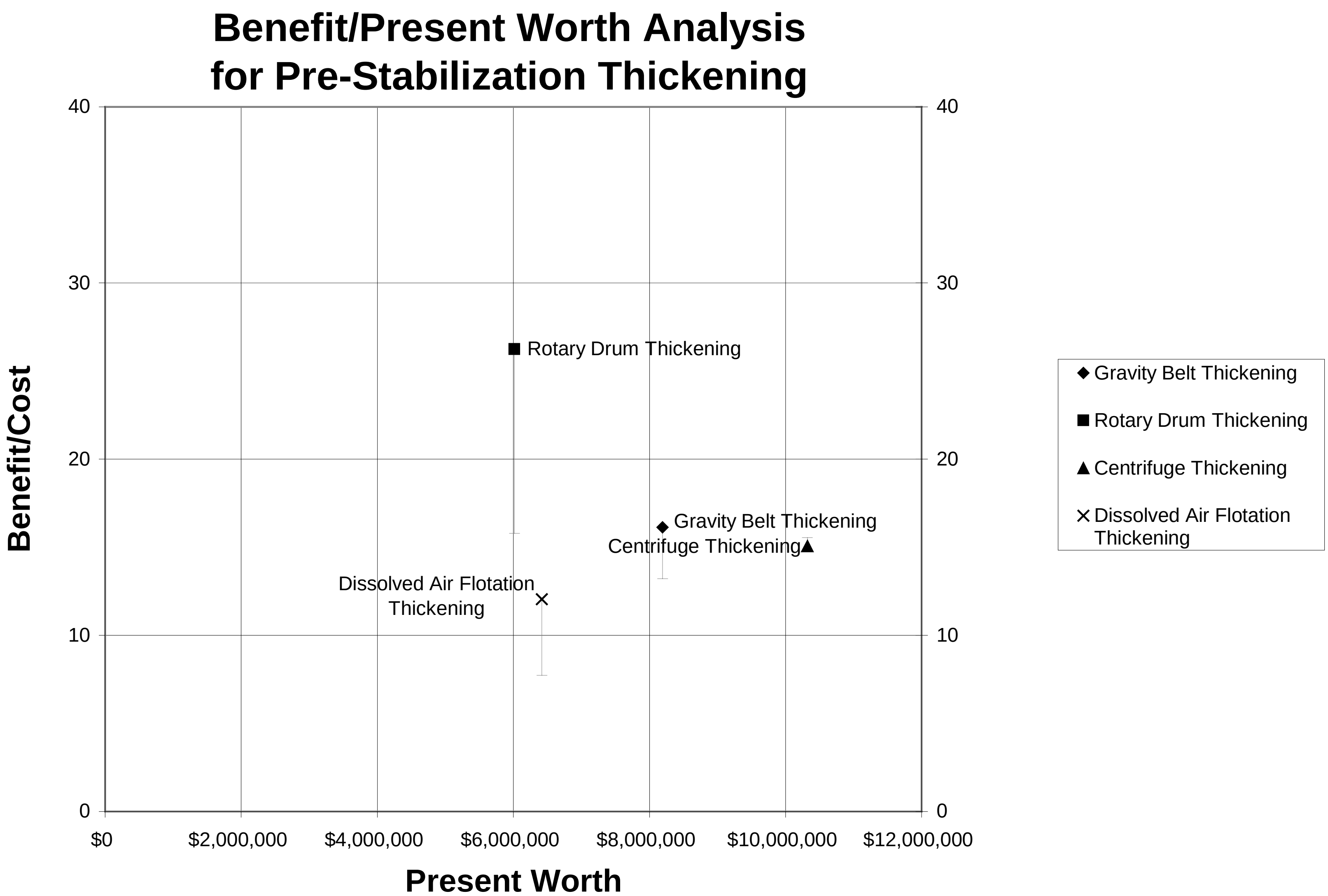


**FIGURE 8-2**
Benefit/Present Worth Analysis for Biosolids Thickening

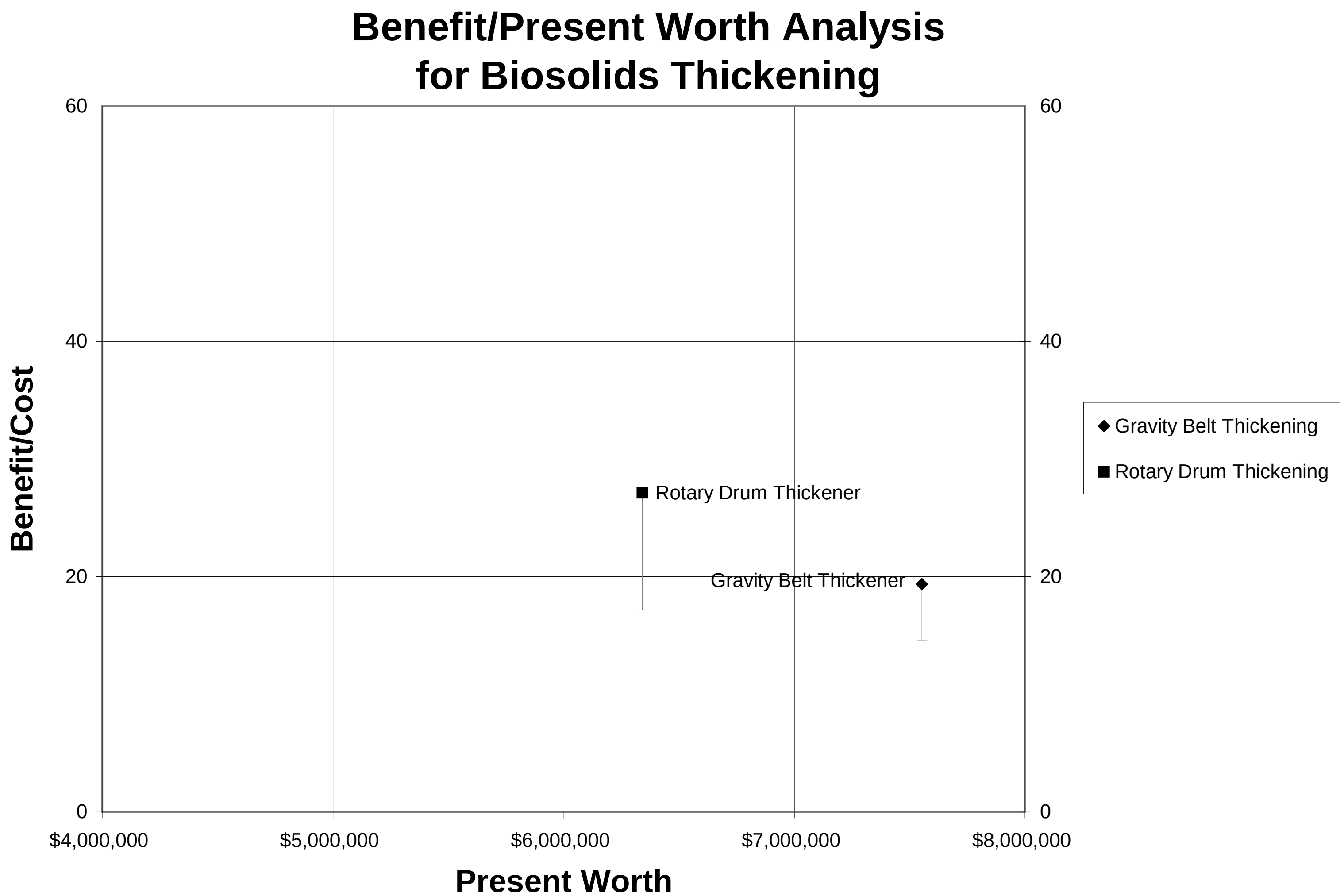


**FIGURE 8-3**
Benefit/Present Worth Analysis for Raw WAS Dewatering

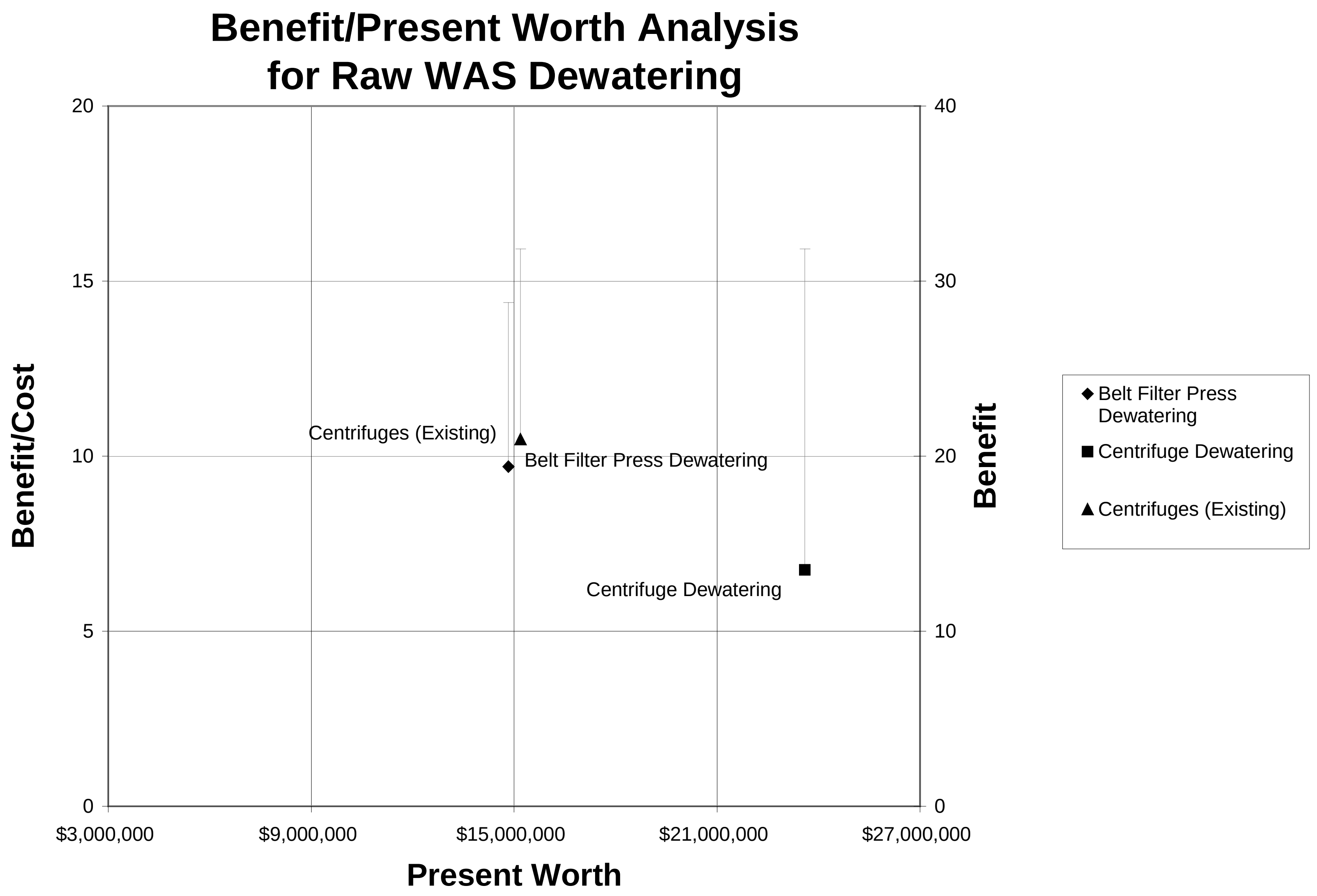


**FIGURE 8-4**
Benefit/Present Worth Analysis for Biosolids Dewatering

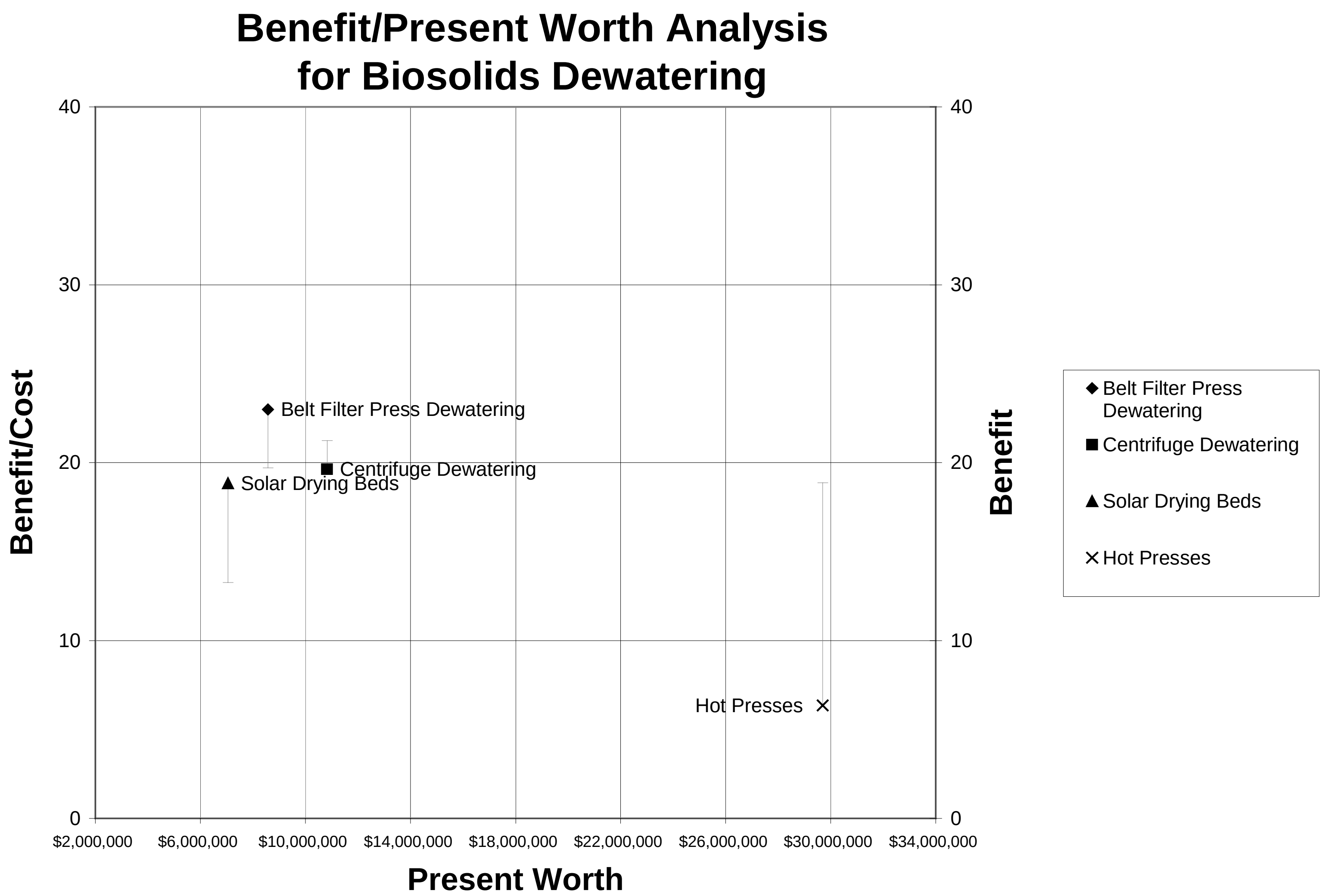
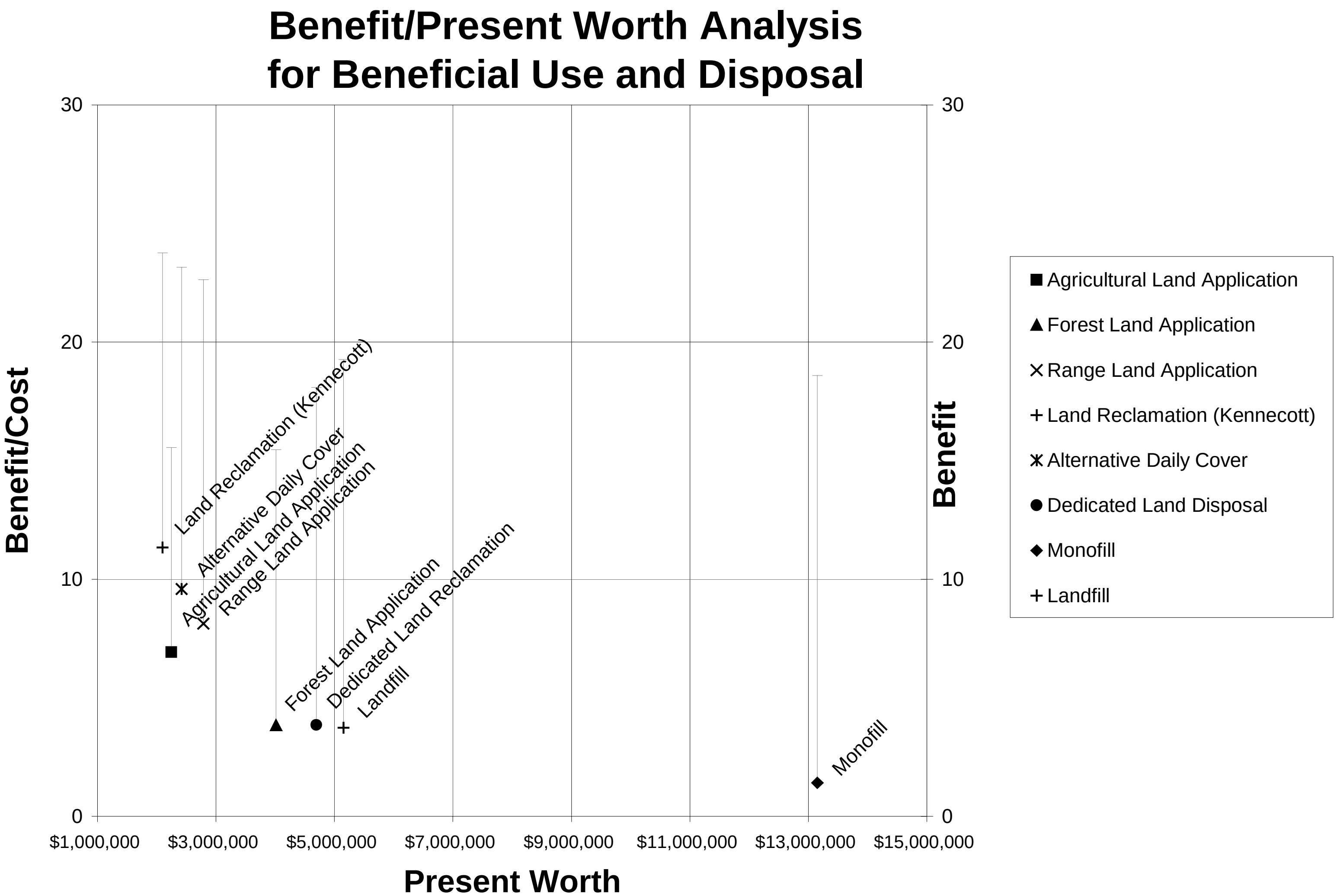


**FIGURE 8-5**
Benefit/Present Worth Analysis for Beneficial Use and Disposal



# Benefit and Cost Analyses for Alternatives

The alternative analysis for both cost and benefit included the appropriate options. The alternatives are all inclusive and have treatment, processing, hauling, and use or disposal. The description of each alternative includes abbreviations of the key processes, and these abbreviations are included in Table 8-3 to provide the reader an easy understanding of the alternatives.

**TABLE 8-3**
Commonly Used Abbreviations in Alternative Descriptions

| Abbre-viation | Description | Abbre-viation | Description |
|---|---|---|---|
| AD | Aerobic digestion (located on the plant sites) to stabilize liquid WAS to Class B pathogen density levels in the biosolids. | OS | Outside services, private contractor, are used to fully process, treat and use or dispose of raw WAS from both plants at a remote site. |
| C | Composting which stabilizes dewatered WAS to Class A pathogen density levels in the biosolids. | R3 | Private contractor, Ensign Ranch, which submitted a bid to take dewatered WAS from each plant and haul to remote site for processing and use on rangeland. |
| DW | Dewatering option, either for raw WAS or biosolids, to achieve about 15 percent solids concentration. Result is called dewatered cake. | TD | Thermal drying (located on at the Silver Creek WRF) to produce Class A pathogen density levels in the resulting biosolids pellets which are dried to over 90 percent solids. |
| FSL | Facultative Storage Lagoons (located remote for the plant sites) which stabilize liquid WAS to Class B pathogen density levels in the biosolids. | THK | Thickening option, either for raw WAS or biosolids, to achieve about 4 to 8 percent solids concentration in the thickened product. |
| JV | USFilter's J-Vap$^{tm}$ "Hot Press" which is a recessed chamber filter press using heat and vacuum. Claimed to produce Class A pathogen density levels in the biosolids. | WAS | Waste activated sludge which is generated as the waste byproduct of the treatment of wastewater. This Master Plan deals with the WAS. |
| LS | Lime stabilization (located only at Silver Creek WRF) uses quicklime addition to produce either Class A or Class B pathogen density levels in the biosolids. | | |

Table 8-4 presents a summary of the benefit analysis included in Technical Memorandum 6 and Table 8-5 presents a summary of the cost analysis from Technical Memorandum 7.

**TABLE 8-4**
Summary of Weighted Benefit Analysis for Alternatives

| Category | Weighted Total | Percent Difference | Rank | Benefit Analysis Results |
|---|---|---|---|---|
| **Liquid Stabilization Alternatives** | | | | |
| Alternative LS-1 (AD-TK-Local-AgL) | 113.41 | -51.79% | 18 | DROP |
| Alternative LS-2 (AD-DW-Local-ADC) | 174.07 | -26.00% | 9 | Include |
| Alternative LS-3 (TK-AD-TK-Local-AgL) | 100.69 | -57.20% | 19 | DROP |
| Alternative LS-4 (TK-AD-DW-Local-ADC) | 141.78 | -39.73% | 14 | DROP |
| Alternative LS-5 (TK-AD-Local-AgL) | 88.75 | -62.27% | 20 | DROP |
| Alternative LS-6 (Remote-FSL-RL) | 150.16 | -36.16% | 11 | DROP |
| Alternative LS-7 (Remote-FSL-TK-RL) | 146.44 | -37.75% | 12 | DROP |
| Alternative LS-8 (Remote-FSL-DW-RL) | 159.65 | -32.13% | 10 | DROP |
| Alternative LS-9 (TK-Remote-FSL-TK-RL) | 131.08 | -44.28% | 17 | DROP |
| Alternative LS-10 (TK-Remote-FSL-DW-RL) | 144.29 | -38.66% | 13 | DROP |
| Alternative LS-11 (TK-Remote-FSL-RL) | 134.80 | -42.69% | 16 | DROP |
| **Solids Stabilization Alternatives** | | | | |
| Alternative SS-1 (DW-LS-Local-ADC) | 146.77 | -40.27% | 15 | DROP |
| Alternative SS-2c (DW-C-None) | 228.03 | -7.21% | 3 | Include |
| Alternative SS-2s (DW-C-None) | 220.33 | -10.34% | 4 | Include |
| Alternative SS-2r (DW-Remote-C-None) | 245.74 | 0.00% | 1 | Include |
| Alternative SS-3 (DW-TD-None) | 235.23 | -4.28% | 2 | Include |
| Alternative SS-4 (DW-Local-ADC) | 211.71 | -13.85% | 5 | Include |
| Alternative SS-5 (TK-JV-Local-ADC) | 184.28 | -25.01% | 8 | Include |
| Alternative SS-6 (OS-Remote) | 190.06 | -22.66% | 7 | Include |
| Alternative SS-7 (DW-R3) | 196.24 | -20.15% | 6 | Include |

All information from Technical Memorandum 6

From the benefit analysis, all but one liquid stabilization alternative are recommended not to be evaluated further. For the solids stabilization alternative, the reverse is true; all but one alternative is recommended for further evaluation.

These results must be considered with the cost analysis provided below before any decision is forthcoming.

**TABLE 8-5**
Summary of Cost Analysis for Alternatives

| Alternatives | Comparative Construction Cost Opinion | Present Worth Cost | Present Worth Cost Differences | Cost Analysis Results |
|---|---|---|---|---|
| **Liquid Stabilization Alternatives** | | | | |
| Alternative LS-1 (AD-TK-Local-AgL) | $20,180,000 | $30,314,000 | 61.0% | DROP |
| Alternative LS-2 (AD-DW-Local-ADC) | $19,770,000 | $29,347,000 | 55.9% | DROP |
| Alternative LS-3 (TK-AD-TK-Local-AgL) | $12,800,000 | $25,341,000 | 34.6% | Include |
| Alternative LS-4 (TK-AD-DW-Local-ADC) | $12,930,000 | $28,154,000 | 49.5% | DROP |
| Alternative LS-5 (TK-AD-Local-AgL) | $8,790,000 | $22,635,000 | 20.2% | Include |
| Alternative LS-6 (Remote-FSL-RL) | $8,040,000 | $73,166,000 | 288.6% | DROP |
| Alternative LS-7 (Remote-FSL-TK-RL) | $12,050,000 | $77,989,000 | 314.2% | DROP |
| Alternative LS-8 (Remote-FSL-DW-RL) | $12,710,000 | $78,001,000 | 314.3% | DROP |
| Alternative LS-9 (TK-Remote-FSL-TK-RL) | $15,060,000 | $29,878,000 | 58.7% | DROP |
| Alternative LS-10 (TK-Remote-FSL-DW-RL) | $16,410,000 | $30,148,000 | 60.1% | DROP |
| Alternative LS-11 (TK-Remote-FSL-RL) | $11,050,000 | $24,622,000 | 30.8% | Include |
| **Solids Stabilization Alternatives** | | | | |
| Alternative SS-1 (DW-LS-Local-ADC) | $15,240,000 | $28,310,000 | 48.7% | DROP |
| Alternative SS-2c (DW-C-None) | $19,500,000 | $28,065,000 | 47.4% | DROP |
| Alternative SS-2s (DW-C-None) | $11,020,000 | $24,096,000 | 4.6% | Include |
| Alternative SS-2r (DW-Remote-C-None) | $15,490,000 | $24,926,000 | 30.7% | DROP [a] |
| Alternative SS-3 (DW-TD-None) | $15,750,000 | $27,878,000 | 46.4% | DROP |
| Alternative SS-4 (DW-Local-ADC) | $9,100,000 | $19,147,000 | 0% | Include |
| Alternative SS-5 (TK-JV-Local-ADC) | $26,540,000 | $25,245,000 | 110.3% | DROP |
| Alternative SS-6 (OS-Remote) | $2,360,000 | $77,519,000 | 311.7% | DROP |
| Alternative SS-7 (DW-R3) | $9,100,000 | $19,651,000 | 2.7% | Include |

All information from Technical Memorandum 7
[a] Due to high construction cost

The cost analysis recommended only five alternatives remain for further consideration. These include three liquid stabilization alternatives and three solids stabilization alternatives. These recommendations must be compared with the benefit analysis before an alternative is eliminated, and this is presented in Table 8-6.

**TABLE 8-6**
Summary of Cost and Benefit Evaluations of Alternatives

| Alternatives | Present Worth Cost Differences | Cost Analysis Results | Weighted Benefit Analysis Differences | Benefit Analysis Results |
|---|---|---|---|---|
| **Liquid Stabilization Alternatives** | | | | |
| Alternative LS-1 (AD-TK-Local-AgL) | 61.0% | DROP | -51.79% | DROP |
| Alternative LS-2 (AD-DW-Local-ADC) | 55.9% | DROP | -26.00% | Include |
| Alternative LS-3 (TK-AD-TK-Local-AgL) | 34.6% | Include | -57.20% | DROP |
| Alternative LS-4 (TK-AD-DW-Local-ADC) | 49.5% | DROP | -39.73% | DROP |
| Alternative LS-5 (TK-AD-Local-AgL) | 20.2% | Include | -62.27% | DROP |
| Alternative LS-6 (Remote-FSL-RL) | 288.6% | DROP | -36.16% | DROP |
| Alternative LS-7 (Remote-FSL-TK-RL) | 314.2% | DROP | -37.75% | DROP |
| Alternative LS-8 (Remote-FSL-DW-RL) | 314.3% | DROP | -32.13% | DROP |
| Alternative LS-9 (TK-Remote-FSL-TK-RL) | 58.7% | DROP | -44.28% | DROP |
| Alternative LS-10 (TK-Remote-FSL-DW-RL) | 60.1% | DROP | -38.66% | DROP |
| Alternative LS-11 (TK-Remote-FSL-RL) | 30.8% | Include | -42.69% | DROP |
| **Solids Stabilization Alternatives** | | | | |
| Alternative SS-1 (DW-LS-Local-ADC) | 48.7% | DROP | -40.27% | DROP |
| Alternative SS-2c (DW-C-None) | 47.4% | DROP | -7.21% | Include |
| Alternative SS-2s (DW-C-None) | 4.6% | Include | -10.34% | Include |
| Alternative SS-2r (DW-Remote-C-None) | 30.7% | DROP | 0.00% | Include |
| Alternative SS-3 (DW-TD-None) | 46.4% | DROP | -4.28% | Include |
| Alternative SS-4 (DW-Local-ADC) | 0% | Include | -13.85% | Include |
| Alternative SS-5 (TK-JV-Local-ADC) | 110.3% | DROP | -25.01% | Include |
| Alternative SS-6 (OS-Remote) | 311.7% | DROP | -22.66% | Include |
| Alternative SS-7 (DW-R3) | 2.7% | Include | -20.15% | Include |

Benefit information from Table 8-4
Cost information from Table 8-5

The results from Tables 8-5 and 8-6 are presented again in Table 8-7 to make it easy to compare the recommendations as well as decide which alternatives should go forward as the recommended plan.

**TABLE 8-7**
Benefit and Cost Comparison and Recommendations

| Alternatives | Cost Analysis Results | Benefit Analysis Results | Recommendation for Project |
|---|---|---|---|
| **Liquid Stabilization Alternatives** | | | |
| Alternative LS-1 (AD-TK-Local-AgL) | DROP | DROP | DROP |
| Alternative LS-2 (AD-DW-Local-ADC) | DROP | Include | Include |
| Alternative LS-3 (TK-AD-TK-Local-AgL) | Include | DROP | DROP |
| Alternative LS-4 (TK-AD-DW-Local-ADC) | DROP | DROP | DROP |
| Alternative LS-5 (TK-AD-Local-AgL) | Include | DROP | DROP |
| Alternative LS-6 (Remote-FSL-RL) | DROP | DROP | DROP |
| Alternative LS-7 (Remote-FSL-TK-RL) | DROP | DROP | DROP |
| Alternative LS-8 (Remote-FSL-DW-RL) | DROP | DROP | DROP |
| Alternative LS-9 (TK-Remote-FSL-TK-RL) | DROP | DROP | DROP |
| Alternative LS-10 (TK-Remote-FSL-DW-RL) | DROP | DROP | DROP |
| Alternative LS-11 (TK-Remote-FSL-RL) | Include | DROP | DROP |
| **Solids Stabilization Alternatives** | | | |
| Alternative SS-1 (DW-LS-Local-ADC) | DROP | DROP | DROP |
| Alternative SS-2c (DW-C-None) | DROP | Include | DROP |
| Alternative SS-2s (DW-C-None) | Include | Include | Include |
| Alternative SS-2r (DW-Remote-C-None) | DROP | Include | DROP |
| Alternative SS-3 (DW-TD-None) | DROP | Include | DROP |
| Alternative SS-4 (DW-Local-ADC) | Include | Include | Include |
| Alternative SS-5 (TK-JV-Local-ADC) | DROP | Include | DROP |
| Alternative SS-6 (OS-Remote) | DROP | Include | DROP |
| Alternative SS-7 (DW-R3) | Include | Include | Include |

It is very clear that if any alternative is dropped due to low benefit scores or high construction or present worth costs, only three alternatives remain for further evaluation:

- Seasonal composting (SS-2s) which must be combined with another alternative such as SS-4 for the rest of the year. The cost analysis assumes this alternative is combined with alternative daily cover.
- Alternative daily cover (SS-4) which is the present mode of biosolids use
- Private contractor hauling from the plant sites and treating it at a remote site adjacent to a rangeland application site (SS-7)

Rather than only evaluate these three alternatives, a benefit to cost analysis was done on all alternatives for both construction cost and present worth cost. As can be seen in Figures 8-6 and 8-7, there is a definite grouping of alternatives making it difficult to read. As previously explained for the benefit-to-cost graphs for the options, each graph shows the benefit-cost ratio, the cost, and the associated benefit. To better read the graphs, another graph was prepared which dropped the cluster of alternatives with higher costs (greater than $30,000,000 present worth). Figure 8-7 presents this graph. It is apparent that the alternatives with the highest benefits coupled with lowest costs are Alternative SS-4 (Alternative Daily Cover) and Alternative SS-7 (R3), which is expected. These highest benefit score relate to producing a product. The most reasonable alternative using this factor is seasonal composting. So, the results of the benefit cost analysis demonstrate that the alternatives set forth previously are, in fact, the alternatives that satisfy both cost and benefit issues.

# Summary Description of Remaining Alternatives

Each alternative is described in detail in Technical Memorandum 5, so only the key parameters are noted in the following summary.

## Alternative SS-2s (Seasonal Composting and Alternative Daily Cover)

This alternative dewaters raw WAS at each plant, similar to current operations. During the warm weather half of the year, dewatered solids are hauled from the East Canyon WRF to the Silver Creek WRF where they are combined with the Silver Creek solids and composted. The composted product is sold or given away to local groups or the public.

During periods of climate inversions, principally during the cooler months, composting operations cease and the dewatered cake is hauled from each plant to a landfill where it is processed into alternative daily cover for landfill top dressing.

## Alternative SS-4 (Alternative Daily Cover)

This alternative continues the present operation by dewatering raw WAS at each plant. The dewatered cake is then hauled from each plant to a municipal solid waste landfill where it is processed into alternative daily cover for landfill top dressing.

## Alternative SS-7 (Private Contractor)

Similar to the above two alternative, the dewatering of raw WAS continues. In this alternative, however, the dewatered cake is hauled to a private company located at a remote site. The private company is then responsible to process and use or dispose of the delivered cake.

**FIGURE 8-6**
Benefit/Present Worth Analysis for Alternatives

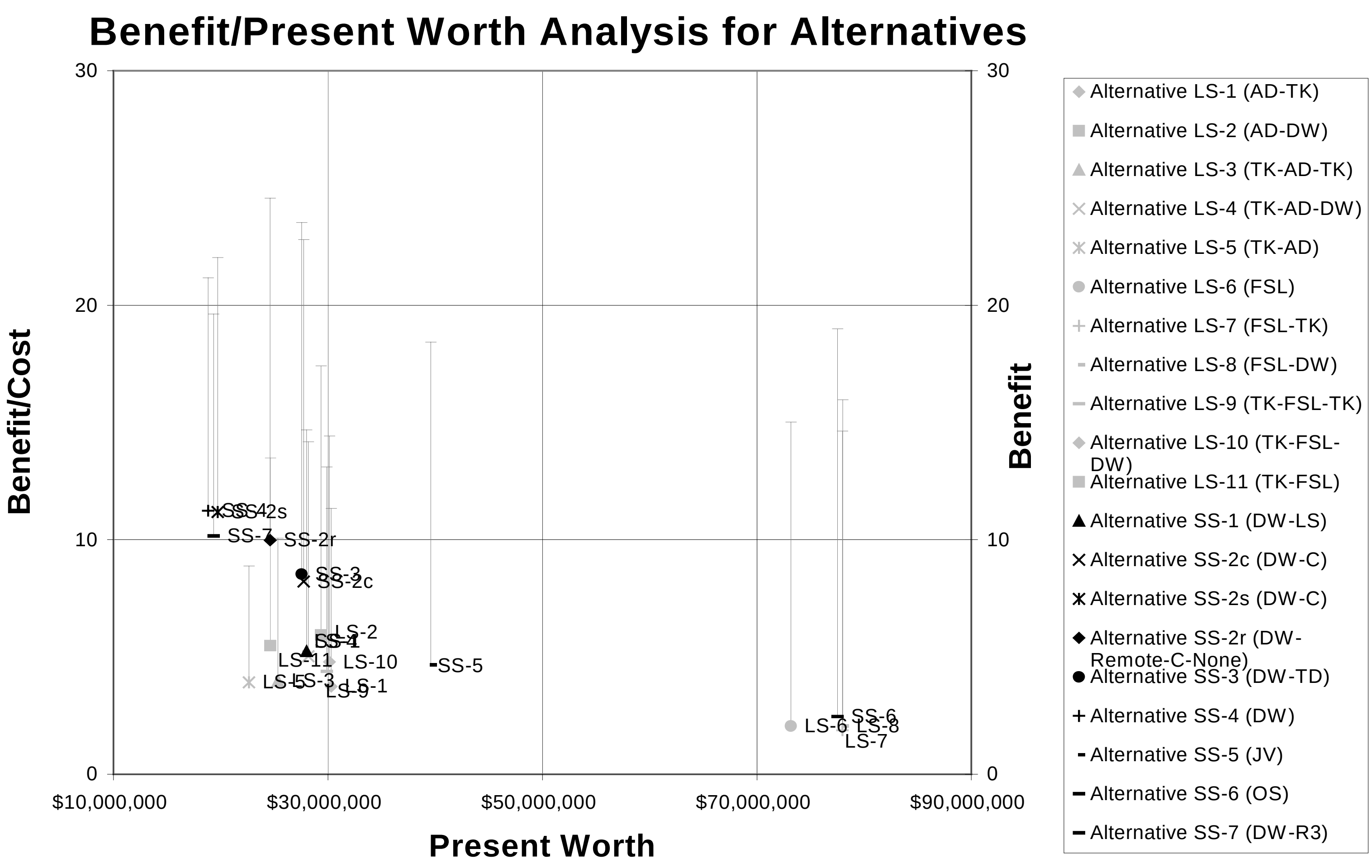
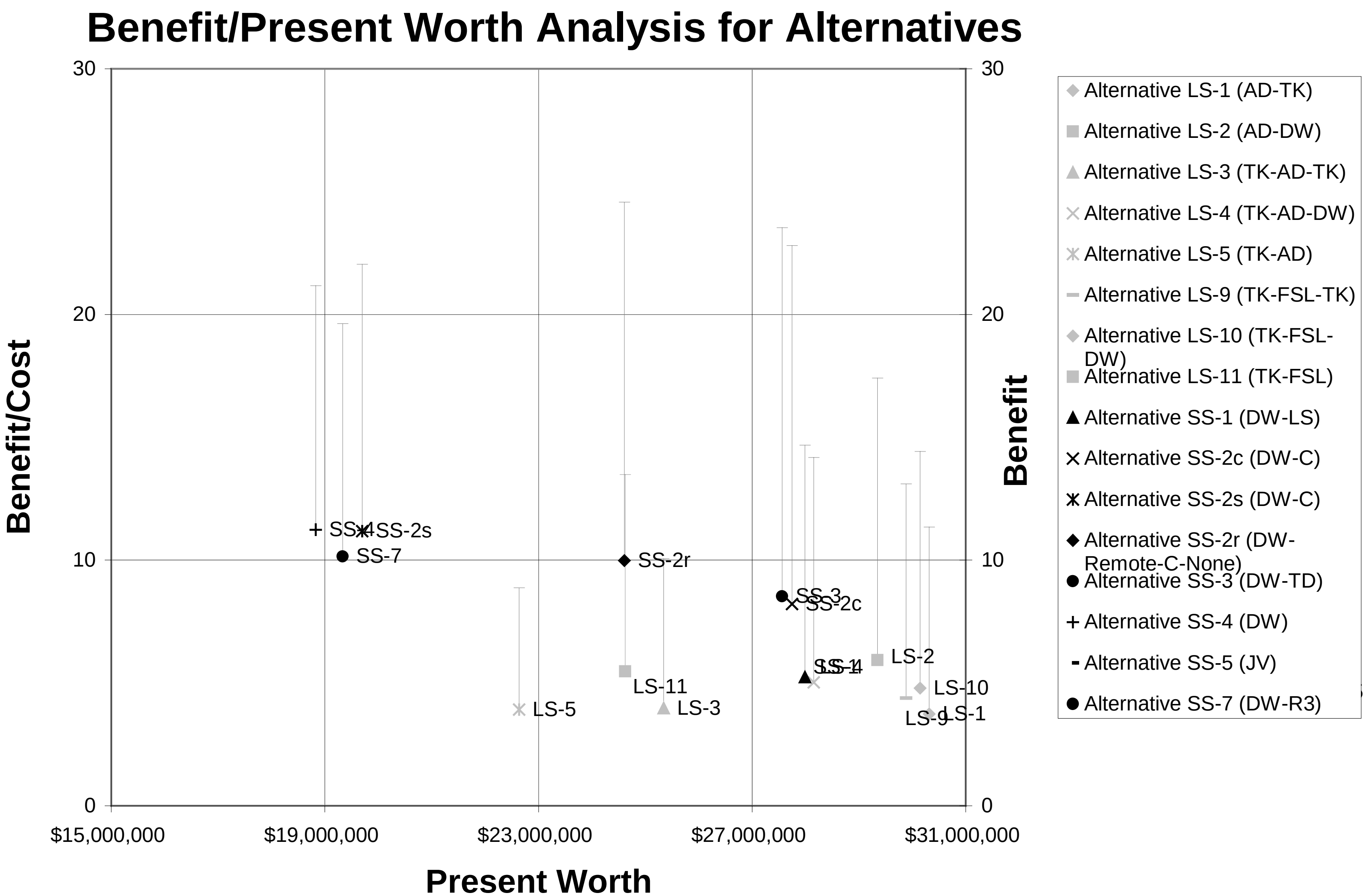


**FIGURE 8-7**
Benefit/Present Worth Analysis for Alternatives



## Next Step in the Alternative Evaluation

Initially, several thousand alternatives were identified. These alternatives were first screened into viable options for the SBWRD (Technical Memorandum 2). Subsequent analyses reduced this number to several options and 18 separate and definable alternatives. Using both independent cost and benefit evaluations, as well as a benefit-to-cost analysis, the number of alternatives has been reduced to three. Each alternative has very definite similarities and the SBWRD should take advantage of these similarities to enable maximum flexibility for changing conditions. Technical Memorandum 9 will present the recommended solids management program which satisfies these analyses.

# Solids Management Master Plan
# Recommended Solids Management Program

PREPARED FOR: Snyderville Basin Water Reclamation District

PREPARED BY: CH2M HILL

DATE: March 17, 2003

## Contents



## Summary of Benefit to Cost Analysis

Technical Memorandum (TM) 6 and TM 7 were used to develop the benefit to cost analysis which was completed in TM 8. The results of each analysis are presented in Table 9-1. The alternatives recommended in TM 8 are in bold and are outlined.

**TABLE 9-1**
Summary of Weighted Benefit Analysis, Cost Analyses, and Benefit to Cost Evaluation

| Alternative | Benefit Score | Rank | Benefit Status | Constr. Cost [a] | Rank | Present Worth Cost | Rank | Cost Status | Benefit to Cost Status |
|---|---|---|---|---|---|---|---|---|---|
| **Liquid Stabilization Alternatives** | | | | | | | | | |
| Alternative LS-1 (AD-TK) | 113 | 18 | Reject | $20.2 | 19 | $30.3 | 15 | Reject | Reject |
| **Alternative LS-2 (AD-DW)** | **174** | **9** | **Accept** | **$19.8** | **18** | **$29.3** | **12** | **Reject** | **Accept** |
| Alternative LS-3 (TK-AD-TK) | 101 | 19 | Reject | $12.8 | 10 | $25.3 | 7 | Reject | Reject |
| Alternative LS-4 (TK-AD-DW) | 142 | 14 | Reject | $12.9 | 11 | $28.2 | 11 | Reject | Reject |
| Alternative LS-5 (TK-AD) | 89 | 20 | Reject | $8.8 | 3 | $22.6 | 4 | Accept | Reject |
| Alternative LS-6 (FSL) | 150 | 11 | Reject | $8.0 | 2 | $73.2 | 17 | Reject | Reject |
| Alternative LS-7 (FSL-TK) | 146 | 12 | Reject | $12.1 | 8 | $78.0 | 19 | Reject | Reject |
| Alternative LS-8 (FSL-DW) | 160 | 10 | Reject | $12.7 | 9 | $78.0 | 20 | Reject | Reject |
| Alternative LS-9 (TK-FSL-TK) | 131 | 17 | Reject | $15.1 | 12 | $29.9 | 13 | Reject | Reject |
| Alternative LS-10 (TK-FSL-DW) | 144 | 13 | Reject | $16.4 | 16 | $30.1 | 14 | Reject | Reject |
| Alternative LS-11 (TK-FSL) | 135 | 16 | Reject | $11.1 | 7 | $24.6 | 6 | Accept | Reject |
| **Solids Stabilization Alternatives** | | | | | | | | | |
| Alternative SS-1 (DW-LS) | 147 | 15 | Reject | $10.6 | 13 | $28.0 | 10 | Reject | Reject |
| Alternative SS-2c (DW-C year round) | 228 | 3 | **Accept** | $14.8 | 17 | $27.7 | 9 | Reject | Reject |
| **Alternative SS-2s (DW-C seasonal)** | **220** | **4** | **Accept** | **$6.4** | **6** | **$19.7** | **3** | **Accept** | **Accept** |
| Alternative SS-2r (DW-C remote site) | 246 | 1 | **Accept** | $10.8 | 14 | $24.6 | 5 | Reject | Reject |
| Alternative SS-3 (DW-TD) | 235 | 2 | **Accept** | $11.2 | 15 | $27.6 | 8 | Reject | Reject |
| **Alternative SS-4 (DW)** | **212** | **5** | **Accept** | **$4.4** | **4** | **$18.8** | **1** | **Accept** | **Accept** |
| Alternative SS-5 (JV) | 184 | 8 | **Accept** | $26.5 | 20 | $39.6 | 16 | Reject | Reject |
| Alternative SS-6 (OS) | 190 | 7 | **Accept** | $2.4 | 1 | $77.5 | 18 | Reject | Reject |
| **Alternative SS-7 (DW-R[3])** | **196** | **6** | **Accept** | **$4.4** | **4** | **$19.3** | **2** | **Accept** | **Accept** |

[a] Construction cost values are to construct facilities to handle the Year 2022 needs.

A brief description of each acceptable alternative from Table 9-1 is presented below.

### Alternative LS-2 (Aerobic Digestion and Dewatering)

Included in this alternative is the construction of aerobic digesters at each plant to stabilize the liquid waste activated sludge (WAS) to Class B pathogen density levels. The resulting biosolids are dewatered on centrifuges as is done now, but the existing belt filter press at the Silver Creek WRF will be replaced with centrifuges and this project is already included in the existing Capital Improvements Plan (CIP). Therefore, it is considered existing for this analysis.

The dewatered biosolids are then hauled to nearby agricultural land for beneficial use. Dewatered biosolids storage was planned at the agricultural land application sites to prevent further odors at the treatment plants.

### Alternative SS-2s (Seasonal Composting and Alternative Daily Cover)

This alternative includes dewatering of raw WAS at each plant, similar to current operations. During approximately half of the year, warm weather, dewatered solids are hauled from the East Canyon WRF to the Silver Creek WRF where they are combined with the Silver Creek solids and composted. The composted product is sold or given away to local groups or the public.

During periods of climate inversions, principally during the cooler months, composting operations cease and the dewatered cake is hauled from each plant to a landfill where it is processed into alternative daily cover for landfill top dressing.

### Alternative SS-4 (Alternative Daily Cover)

This alternative continues the present operation by dewatering raw WAS at each plant. The dewatered cake is then hauled from each plant to a municipal solid waste landfill where it is processed into alternative daily cover for landfill top dressing.

### Alternative SS-7 (Private Contractor)

Similar to the above two alternative, the dewatering of raw WAS continues. In this alternative, however, the dewatered cake is hauled to a private company located at a remote site. The private company is then responsible to process and use or dispose of the delivered cake.

## Observations

All of the remaining alternatives include beneficial use of biosolids, including agricultural land application, alternative daily cover for the Salt Lake County Solids Waste Landfill, marketing and distribution of compost, and rangeland application. This conforms well with the community desires expressed through the Citizens Advisory Committee (CAC). Only one alternative, however, provides a local product, which was also an important benefit expressed by the CAC.

There is only one liquid stabilization alternative remaining, and that has one of the highest construction costs (18th highest out of 20). In addition, this alternative depends upon agricultural land for beneficial use of a Class B product. Unfortunately, Class B land application is slowly being eliminated as an option due to public opinion, and was also rated very low by the CAC in terms of potential benefit. The goal of any utility is to reduce costs, so land closest to the treatment plant is normally used for beneficial use. Unfortunately, land closest to the community is usually most quickly lost to urban sprawl. As the public encroaches on agricultural land, odors have become a problem in many communities causing the utility to look for alternative locations for land application. In the worst case, the affected public influences political opinion to ban land application of biosolids (reference California, North Carolina, and several other states). Therefore, the beneficial use option is believed to be limited, although technically feasible. Because of the high construction cost, concern for availability of agricultural land over the 20-year planning period, and the low benefit score from the CAC, this alternative is rejected.

The three solids stabilization alternatives remaining have several similarities. Of course, none of the three alternatives include liquid treatment to produce biosolids, but all three alternatives include dewatering of raw WAS. In addition, two of the three alternatives require off-site processing of the dewatered raw WAS, while the third includes both off-site processing for half of the year, and on-site composting for the other half.

# Concerns with Remaining Alternatives

During the development of the Solids Management Master Plan, several issues were raised. These issues were discussed with the CAC, but continued to come more to the forefront as the master plan progressed. These issues can be summarized into three key concerns with the three remaining alternatives.

1. **Odors –** A local developer notified the District that a new housing development was to be constructed on the property line of the Silver Canyon WRF. The location of this development is on the property line close to the composting system that was shutdown over a year ago due to odors. Any on-site processing of solids, regardless of the season, may be in jeopardy. This affects the seasonal composting alternative.

2. **Alternative Daily Cover –** The company that uses the District dewatered solids to make alternative daily cover, E.T. Technologies, is being required to move from its present site due to landfill expansion and odor complaints. The concern is that because of odor complaints, they may have to shutdown operations and therefore not be able to receive the dewatered cake. This affects the alternative daily cover alternative and the seasonal composting / alternative daily cover alternatives; two of the remaining three alternatives. Although odors have been a problem with the South Valley Water Reclamation Facility (SVWRF) solids, there have not been any complaints with the District's solids. This is probably because the volume of the District's solids is considerably less than the SVWRF solids, and because E.T. Technologies believes that the microbes in sewage sludge may be needed for the soil regeneration process to work.

3. **Private Contractor –** Only one company is actively involved with a proposal to take dewatered raw WAS from both plants, and has proposed a cost that appears to be

competitive. This company, $R^3$, has only worked with anaerobically digested biosolids from the Central Valley plant. They have also attempted to use raw WAS from the SVWRF and have found it to be quite difficult to handle and messy. These solids are virtually identical to the District solids, so there is a concern that $R^3$ may not want to process raw WAS. In addition, the District believes that if the SVWRF does not contract with $R^3$, it may not be cost-effective for $R^3$ to process only the District solids due to the small volume of the solids compared with the SVWRF. This affects the private contractor alternative.

The recommended alternative must seriously consider each of these concerns, evaluate the probability of occurrence, and determine what must be done if this concern was realized.

# Overview of Remaining Alternatives

The recommended solids management alternative includes both dewatering options, as well as processing and beneficial use.

## Dewatering of Raw WAS

Because of the requirement of all three alternatives to dewater raw WAS, the recommended alternative is to use the existing centrifuges at the East Canyon WRF and replace the existing belt filter press with centrifuges at the Silver Creek WRF. The project to replace the centrifuges is already planned and included in the District's CIP. As such, this option has the lowest construction cost and the lowest present worth cost.

Therefore, centrifuges are recommended at both the East Canyon and the Silver Creek WRFs. There are no concerns with the use of centrifuges that must be addressed.

## Processing and Beneficial Use

The three remaining alternatives include both on-site and off-site processing, both of which have concerns as expressed previously.

### *Alternative Daily Cover (Off-site Processing)*

E.T. Technologies, Inc. (E.T.) provides a soil regeneration process on the site of the Salt Lake County Solid Waste Landfill in West Valley. The landfill is reaching capacity in its existing cells and has notified E.T. that it must move so that the landfill can expand into the space where E.T. is located. E.T. accepts both liquid and solid industrial, commercial, and residential non-hazardous liquids and sludges. The sludges are blended in clay-lined lagoons with dozers, and soil may be added if the mixture is too liquid. Once a lagoon is filled, it is left for approximately 1 year to allow the biomass from the sewage solids and soil to breakdown the other sludges. Figure 9-1 shows one of the clay-lined soil regeneration lagoons. Liquid wastes are first held in separate lagoons, with synthetic liners. The liquid is allowed to evaporate and the solids are eventually blended with the other sludges.

**FIGURE 9-1**
Soil Regeneration System at Right

E.T. has been in business since the mid-90s and has successfully provided both daily and final cover for the landfill, although the landfill presently uses the processed soil for final cover. The regenerated soil produced by E.T. is simply stacked at a site designated by the landfill, and the landfill uses what it needs from this pile. E.T. leases its site from the landfill and has 23 months remaining on its lease as of February 2003. It is attempting to negotiate an extension to 5 years to allow more time to fully develop an alternative site. In addition to leasing the site, E.T. pays the landfill a fee per wet ton for use of the scale and other facilities. The landfill does not pay for the regenerated soil, but has agreed to accept 100 percent of it. As such, E.T. charges a fee for each wet ton of material it receives to cover the lease, processing, on-site hauling, incidental costs, and profit.

A possible new site is on the back part of the landfill, close to the existing site, but further from public areas which have complained about odors. The property is presently owned by Kennecott, but the management of E.T. believes it will be able to negotiate a long-term lease.

Although E.T. charges a fee for sludges it receives, presently $16.05 for each wet ton, for both the District and SVWRF solids, it does not have contracts with either. As such, although the price is low, the control of price and possible trust in the long-term viability of E.T. are non-existent. Due to site preparation requirements for the new site, it is expected that the disposal cost will be increased, but that is unknown at the present time.

### *Seasonal Composting (On-site Processing)*

The District had a viable composting operation at the Silver Creek WRF, but was shutdown due to odor complaints from the community. Seasonal composting was recommended because the inversion climatic effect, which holds the odors close to the ground and allows them to move to nearby residents, only occurs during the colder period in the late fall, winter, and early spring. As such, seasonal composting was recommended to satisfy the benefits expressed by the CAC. The advantage of combining composting with alternative daily cover is that either one may be started or stopped at will. Composting piles are normally constructed daily, so if there was a probability for odors due to weather conditions, the solids dewatered could simply be hauled to E.T. for processing, because there is no contract or guarantee of solids. To attempt to avoid any composting operations during weather inversions, it is recommended that the District obtain a weather station at the Silver Creek site and provide a second velocity measurement at least 50 feet high. When the two velocity measurements are significantly different, an inversion is probably occurring so mixing or breakdown of pile should be stopped immediately.

Another recommendation is to operate the composting system differently from what is presently done. First, the mixing of dewatered solids and wood chips must be done inside an area provided with odor control. It is proposed that the existing metal building be enclosed and properly ventilated with all exhaust air going to a biofilter. Then, after the piles are first constructed, air will be exhausted from the static piles using a vacuum, which will prevent the odors from being released. This air will be exhausted to a second biofilter. This is a continuous operation, not intermittent as it is now, so some of the blowers may require replacement or the addition of variable speed drives. After about 15 days in the pile, the pile should be broken down and reconstructed. Air will again be vacuumed from the pile to prevent any odor release. Piles should only be constructed or broken down between 10 a.m. and 3 p.m. to avoid natural daily inversions.

The resulting compost will then be placed in a curing pile where it will be held for at least 2 months, again under a vacuum, but with very low airflow. The compost in the curing pile is very stable, but needs some further curing for odor and quality control. Other than fully enclosing the composting operation, this is the best way to limit and control odors.

### *Rangeland Application (Off-Site Processing)*

Using a private contractor, such as $R^3$, will include off-site processing of the dewatered raw WAS and processing in a long-term compost-like system to produce a Class A product. This will be applied to adjacent rangeland, at agronomic rates, for promoting growth of hay for cattle feed. With the acreage proposed by $R^3$, there will be sufficient land available for a large pad to conduct the composting process. To ensure that $R^3$ is capable of processing raw WAS, $R^3$ has submitted a permit application to perform a pilot test using the SVWRF dewatered raw WAS. The permit request has been prepared and submitted to the Utah Department of Environmental Quality (UDEQ). In addition, $R^3$ staff and its consultant have met with the UDEQ staff to explain the proposed operation. Copies of the permit application have also been given to the District.

The viability of this process is unknown at this time, and will not be recognized until the test work is well underway and if the SVWRF and others, including the District, participate in this process. Regardless, this is believed to be a reasonable alternative and it behooves the District to maintain an awareness of the progress on the test program.

## National Biosolids Partnership Involvement

An important part of the recommended plan is that the District becomes a part of the National Biosolids Partnership (NBP), regardless of any alternative implemented. In August 1998, the U.S. Environmental Protection Agency (EPA), the Association of Metropolitan

Sewerage Agencies (AMSA), and the Water Environment Federation (WEF) joined together to form the NBP. The NBP has undertaken several initiatives, including the development of: Code of Good Practices; Manual of Good Practices; Environmental Management System (EMS) guidelines; and a program for third-party verification of the EMS.

A voluntary EMS could complement the existing regulatory program by enhancing compliance with applicable regulations and requirements. It would also help to address other non-regulatory issues such as internal and external communication, environmental policies and planning, training, program management and responsibilities, operations, and emergency preparedness and response.

There are 17 specific elements required as a part of the EMS that are presented in Table 9-2.

**TABLE 9-2**
EMS Elements

| No. | EMS Element | Purpose of Element |
|---|---|---|
| 1 | Documentation of EMS for Biosolids | Provide a summary “blueprint” of the EMS |
| | | Describe the structure of the EMS and how it works |
| 2 | Biosolids Management Policy | Organizational commitment to Biosolids Code of Practice |
| 3 | Critical Control Points | Identification of critical control points for effective biosolids management |
| 4 | Legal and Other Requirements | Stay up-to-date on federal, state and local legal requirements |
| | | Stay up-to-date on other requirements, technology and best practices that are voluntarily adopted by the organization |
| 5 | Goals and Objectives for Continual Improvement | Drive continual improvement by establishing long-term biosolids program goals and associated short-term objectives for biosolids management activities |
| | | Establish action plan to implement goals and objectives based on SMART criteria (Specific, Measurable, Achievable, Relevant and Time-bounded) |
| 6 | Public Participation in Planning | To establish proactive public involvement in planning process, including input into biosolids program performance improvements and third party verification process |
| 7 | Roles and Responsibilities | Defining organizational roles and responsibilities for biosolids management activities throughout the biosolids value chain, including contractors |
| 8 | Training | Training program to provide the necessary awareness, skill and knowledge to employees and contractors involved in biosolids management activities |
| 9 | Communication | Formal program for communicating information about the biosolids management program and EMS to employees, contractors and interested parties |
| 10 | Operational Controls | Effective procedures and management processes at all critical control points (locations, unit processes, events and activities that require active management to consistently achieve biosolids legal, quality and public acceptance requirements and prevent environmental impacts) |

**TABLE 9-2**
EMS Elements

| No. | EMS Element | Purpose of Element |
|---|---|---|
| 11 | Emergency Preparedness and Response | Plan/procedures to prepare for and respond effectively to accidents, weather-related emergency situations, abnormal conditions and other contingencies for biosolids management activities |
| 12 | Documentation, Document Control and Record keeping | Assure that personnel involved in biosolids management activities have the appropriate, latest approved versions of the EMS documents and SOPs |
| | | Assure and effective system for record keeping and records retention |
| 13 | Monitoring and Measurement | Monitor conform with permit, regulatory and compost quality requirements |
| | | Monitor progress toward goals and objectives |
| | | Track performance trends |
| 14 | Nonconformance Preventive and Corrective Action | Procedures for identifying, analyzing root causes and correcting noncompliance/ non-conformances with biosolids management program and EMS requirements |
| 15 | Biosolids Mgmt. Program Performance Report | Periodic evaluation and summary of Biosolids Management Program and EMS Performance to drive continual improvement |
| 16 | Internal EMS Audit | Systematic process for verifying the Biosolids Management Program and EMS are meeting the requirements of the *EMS Elements* |
| 17 | Periodic Management Review of Performance | Periodic reviews of biosolids management program and EMS performance with management to drive continual improvement |

As an example, the second element, Biosolids Management Policy (Biosolids Policy), commits the organization to the principles of conduct set forth in the National Biosolids Code of Good Practice and may include other biosolids commitments the organization voluntarily chooses to adopt. The organization's Biosolids Management Policy shall be communicated to employees, contractors and all interested parties and incorporated into the organization's biosolids programs, procedures and practices.

To conform with the NBP's Biosolids EMS Policy Element, you must explicitly or by reference incorporate the Code of Good Practice into the policy that governs your EMS.

You may simply adopt the Code as your policy. Or, you can integrate the Code into an existing policy with authority over biosolids management activity. This may be accomplished by inclusion, or by reference. The strongest, clearest policy statement will include the Code. Inclusion by reference only, where the language of the Code is less visible, will generally be considered a weaker policy statement without supplementary statements regarding environmental quality and management commitments. The National Biosolids Code of Good Practice is presented in Table 9-3.

**TABLE 9-3**
National Biosolids Partnership, Code of Good Practice

| Item | Description |
|---|---|
| Compliance | To commit to compliance with all applicable federal, state and local requirements regarding the production at the wastewater treatment facility, and management, transportation, storage, and use or disposal of biosolids away from the facility. |
| Product | To provide biosolids that meet the applicable standards for their intended use or disposal. |
| Environmental Management System | To develop an environmental management system for biosolids that includes a method of independent third-party verification to ensure effective ongoing biosolids operations. |
| Quality Monitoring | To enhance the monitoring of biosolids production and management practices. |
| Quality Practices | To require good housekeeping practices for biosolids production, processing, transport and storage, and during final use or disposal operations. |
| Contingency and Emergency Response Plans | To develop response plans for unanticipated events such as inclement weather, spills, and equipment malfunctions. |
| Sustainable Management Practices and Operations | To enhance the environment by committing to sustainable, environmentally acceptable biosolids management practices and operations through an environmental management system. |
| Preventive Maintenance | To prepare and implement a plan for preventive maintenance for equipment used to manage biosolids and wastewater solids. |
| Continual Improvement | To seek continual improvement in all aspects of biosolids management. |
| Communications | To provide methods of effective communication with gatekeepers, stakeholders, and interested citizens regarding the key elements of each environmental management system, including information relative to system performance. |

## Liability Concerns

As is well known, the solids generated by the District are the responsibility of the District; from cradle to grave. The Part 503 Regulations require a treatment works treating domestic sewage (TWTDS) to apply for a permit, which the District already has, but would require a permit amendment for any change of process or disposal method. In addition the Part 503 Regulations require any entity who changes the quality of the biosolids to also apply for a separate, specific permit. The regulations are clear that any landowner who uses biosolids in accordance with the Part 503 Regulations is protected from liability under the Superfund legislation (Comprehensive Environmental Response, Compensation and Liability Act – CERCLA) as well as any enforcement action by EPA under the Part 503 Regulations. However, if the requirements of the Part 503 Regulations are not followed, then the applicators are subject to EPA enforcement actions as well as citizen-initiated suits and, if found to be liable, can be required to remediate any associated problems.

Regardless of the direction of the District, frequent, unannounced visits by a management representative to either their site or a private site to confirm what is actually being done is important to protect the interests and liability of the District.

### Liability if the District Operates the Composting Process

Since the District would control all parts of the composting process and ensure the product fully meets all of the part 503 requirements, the liability should be low. The District would be required to ensure all permit conditions were consistently met and any violations identified, the UDEQ notified, and corrections quickly made. This is exactly the same procedure currently used under the discharge permit, of which the biosolids permit is a part.

### Liability Using a Private Contractor

Because the quality of the product produced by $R^3$ would be different in quality than what is currently being produced, they would be required to have a permit from the UDEQ. And, by using the product on their own land, as landowners, they would not have any liability for biosolids use. As processors, however, they would be responsible for meeting the Part 503 Regulations and certifying to the UDEQ that the product meets all requirements. Pollutant levels, however, would require certification by the District because the $R^3$ is not changing any metal levels.

The issue is one of trust. If the District trusts $R^3$ to process and apply the biosolids in full accordance with all provisions of the Part 503 Regulations, and $R^3$ commits to this trust by meeting all requirements, it would be a successful arrangement. The concern arises when changes occur. Changes could include an ownership change, management change, change in business goals, etc. The impetus for a private entity to change can be based upon many outside forces, not having anything to do with application of biosolids.

One important difference between a private entity and the District is that the sole objective of the District can be summed up as follows:

*To treat all incoming wastewater from its service area and dispose of all resulting products, be they in liquid or solid form, to meet all applicable regulations and community standards, all in an environmentally-sound manner, and while being cost-efficient.*

Because of our meetings with $R^3$, their vision and mission statements probably include the goal to be stewards of the land they own, but also to return value to their shareholders. While this is most appropriate and valuable, there are many factors a private entity considers in its overall business strategy which are not solely focused on the management of wastewater and biosolids which is the goal for District.

## Recommended Solids Management Plan

Based upon the above discussion, the recommended biosolids management plan is discussed below. With the volatility of any alternative, the recommended plan is provided first, but the other viable options are discussed as well. Unfortunately, the processing and use options can be affected by outside forces such as odors and cost.

## Baseline Plan - Seasonal Composting with Alternative Daily Cover

This alternative uses both processes, each at appropriate times during the year. In effect, this provides a cost-effective 100 percent backup to the composting process. During the winter months, however, alternative daily cover is the only alternative.

The composting process should be modified as follows, which was noted above. These improvements are included in the cost opinion.

1. Enclose the existing metal building to include both mixing and screening
2. Modify blowers to operate only in suction condition and provide variable speed or other control mechanism to achieve continuous flow
3. Construct an area for 24 months of curing with blowers to provide suction on the pile
4. Recondition the biofilter and construct a second biofilter if needed

The alternative daily cover option includes minimal construction cost at the E.T. site to allow for intermittent operation and possible odor control. The District must maintain a close watch on the progress of E.T. toward obtaining a new site and the odor control test program with SVWRF. The failure of the odor control program may directly affect this option's viability.

## Back-Up Option - Alternative Daily Cover

This alternative was discussed under the above alternative. This option may become the sole recommended option if the seasonal composting alternative is eliminated by odors at the adjacent new housing development.

It is important to maintain a good relationship with E.T. so any changes will be acceptable to E.T. Because E.T. understands the importance of the sewage solids providing the necessary bacteria for their soil regeneration process, the District may want to consider reducing the size of the composting operation and providing E.T. with dewatered cake year round, albeit at a smaller volume when the composting operation is underway.

## Emergency Option – ECDC Landfill

There will be times when, due to unforeseen circumstances out of the District's control, an emergency option for disposal of the solids from either or both plants is needed. And, when it is needed, it will be needed virtually immediately. The East Carbon Development Corporation (ECDC) operates a landfill about 15 miles south of Price, Utah. In Salt Lake City at 502 West 3300 South, there is a transfer stations that will receive the District's solids on a one-time or all of the time basis. The solids are transferred to rail cars and hauled with municipal solids waste approximately 150 miles to the ECDC landfill. This alternative was not considered as a viable option simply because the cost for disposing of solids is $33 per wet ton plus another $7.20 per wet ton for hauling. As such, it is one of the most expensive alternatives available to the District, but for emergency use, it is definitely appropriate.

This option will always be available because ECDC owns about 3,000 acres, of which 2,200 acres are permitted as a landfill. The projected life of this landfill is 300 years. ECDC and the transfer station have both indicated no difficulty now or in the future for receiving the

District's solids. Of course, the District would have to provide Toxicity Characteristic Leaching Procedure (TCLP) results to demonstrate the solids are not hazardous. In addition, the paint filter test is needed and probably other minor tests that the District already does.

## Added Back-Up Option - Private Contractor ($R^3$)

Although more costly and having less benefit to the community than the above two alternatives, the District must maintain awareness of this option especially the pilot test program with the SVWRF. Failure of the test program will eliminate a potential alternative, but success will provide the District with a option if there is any change in the soil regeneration process by E.T. Technologies or odor issues with the composting operation. Snyderville is in a unique situation in that it has several alternatives that may or may not be viable, but it is small enough to be able to wait for another option to prove acceptable.

We also recommend that the Term Sheet provided by $R^3$ be reviewed by the District's attorney to determine what the missing terms and conditions are, and which are not acceptable to the District. A copy of the Term Sheet is included in Appendix J. In this way, the District can continue negotiations with $R^3$ without jeopardizing the back-up option.

## Added Back-Up Option - Biosolids Utility

Recently, CH2M HILL facilitated a meeting with 12 utilities concerning the feasibility of a publicly-owned, biosolids utility using inter-local agreements between several utilities. Staff from the District attended this meeting. This opportunity is especially interesting to the District because of the volatility of all available cost-effective alternatives afforded to the District. Although the biosolids utility will most likely not be available for at least 2 years, the District's current treatment and use options should be available for the interim period.

It must be recognized that a biosolids utility is not just participating with a group of utilities for disposal or use, it may also be contracting with another utility to construct a process at another plant to enable processing prior to use or disposal. For example, anaerobic digestion is used at the Central Valley plant. It may be desirable to contract with Central Valley to contribute to the cost of a new digester so that both Central Valley and District's raw solids can be combined and fed to the digester to produce Class B biosolids. The dewatered cake can be hauled to Central Valley and blended with the raw solids from Central Valley. Mixing dewatered cake and liquid solids is not easy, but does provide some advantages, such as increasing the feed solids concentration to the digester, which is desirable. Doing so will increase the capacity of the existing digesters, and effectively reduce the cost to the District. Another example is to work with the SVWRF who is considering development of a sludge-only monofill with their solids which are virtually the same as the District's solids. By investing in the project with the SVWRF, this may be a cost-effective option for continuous or intermittent use. Although this does not meet the benefit of beneficial use or a local product, it is a safe and reliable disposal option with minimal liability, that may also be cost-effective. From the analysis provided in this master plan, it is clearly not cost-effective for the District to do this alone, but there may be opportunities for combining efforts with another utility. These are only two examples, and there may be other possibilities available.

### National Biosolids Partnership (Enhancement of Recommended Option)

Although not a disposal or use option, involvement in the NBP is considered important to the long-term viability of any option. To be involved in the NBP, the District must contact the NBP and participate in the program. The costs expended by the District are assumed to be about 0.75 full-time equivalents (by the NBP), but this has been found to be a bit low by the currently involved utilities. This is not one person, but portions of time from several people. Because of the size of the District and the work to date by many other utilities, this expected time estimate may be reasonable. Because CH2M HILL is a contractor for the NBP, we should be able to assist the District if it decides to move forward with the partnership commitment.

### Additional Solids Due to Nutrient Removal

The East Canyon WRF expansion will permit the addition of aluminum sulfate (alum) to remove phosphorous from the treated effluent flow to meet the discharge requirements. Adding alum will increase the volume of solids produced as well as the quality of those solids. The average quantity of solids will increase about 17.3 percent with the addition of alum, but the peak will only increase about 12.5 percent. These values were provided by the testing conducted by Carollo Engineers for the District at the East Canyon WRF and are assumed to be similar for the Silver Creek WRF. Although this is a significant increase of solids, the alum may allow the solids to flocculate and settle better, thereby making the quantity removed about the same, only at a higher solids concentration. Alum sludges tend to be more sticky and slightly more difficult to dewater than biological sludges without alum, but the experience is varied. Until full-scale operation is underway, the actual effects are unknown. Regardless, there will be a greater solids load to consider. Another consideration is if or when the Silver Creek WRF will be required to remove alum. Although the use of chemical is quite typical and normal, biological phosphorus removal is getting more attention. With the low phosphorus requirement, some alum addition will be required, but may be much less than currently projected.

The master plan covers a 20-year planning period with a projected growth over this period of about 122 percent. This high growth rate coupled with the uncertainty as to the volume of alum sludge produced and its effects on the solids system has led to a decision to not include this additional 17.3 percent volume to the solids stream at this time. Realistically, the addition of alum solids would simply increase both the construction and operating costs by a similar amount, but the conclusions and recommendations would not change.

Although the recommendations do not included the effect of alum solids, it is suggested that the District monitor the effects of alum addition to determine the actual impact, in terms of quality and quantity, on both water reclamation facilities. An adjustment of this small magnitude would only require a slightly longer operating day (8 hours versus 9 hours at peak conditions) and an associated operating cost increase.

## Recommended Program Cost

The comparative cost basis and the alternative costs were developed in TM 7. Cost from that analysis have been modified to be more specific and to take into account scheduling of the recommended improvements. These costs are included in Table 9-4 for the recommended baseline alternative as well as all of the support options. Of course, since the development of a biosolids utility is in its infancy, no costs are available.

**TABLE 9-4**
Recommended Program Costs

| Recommended Plan | Construction Cost | Annual O&M Cost |
|---|---|---|
| **Baseline – Seasonal Composting and Alternative Daily Cover** | | |
| Dewatering | $0 | $460,800 |
| Composting, Total New Costs (Breakdown below) | $1,920,000 | $32,400 |
| Building Modifications to Enclose Mixing (Includes new biofilter and reconditioning of old biofilter) | $415,000 | |
| Addition of new Aeration System (Includes blowers and piping) | $329,000 | |
| New Star Screen | $207,000 | |
| Slab Modification for Aeration Piping | 30,000 | |
| Weather Station | $139,000 | |
| New Front End Loaders | $800,000 | |
| Hauling (East Canyon to Silver Creek for composting for 6 months and all solids to ADC for 6 months) | ----- | $25,700 |
| Alternative Daily Cover | $0 | $49,100 |
| **Total** | $1,920,000 | $568,000 |
| **Option – Alternative Daily Cover** | | |
| Dewatering | $0 | $460,800 |
| Hauling | ----- | $44,100 |
| Alternative Daily Cover | $0 [c] | $98,200 |
| **Total** | $0 | $603,100 [d] |
| **Option – Private Contractor ($R^3$)** | | |
| Dewatering | $0 | $460,800 |
| Hauling and Processing | $100,000 | $171,600 |
| **Total** | $100,000 | $632,400 |
| **Option – Biosolids Utility** | | |
| Dewatering | $0 | $460,800 |
| Hauling | Unknown | Unknown |
| Processing and Use/Disposal | Unknown | Unknown |
| **Total** | Unknown | Unknown |

**TABLE 9-4**
Recommended Program Costs

| Recommended Plan | Construction Cost | Annual O&M Cost |
|---|---|---|

Notes: Costs are 20 years at present value.

Annual operating costs are for Year 2022 flows reduced by 55% to account for today's solids loads.

No construction required at this time for dewatering. Costs included in evaluation are for replacement of centrifuges at East Canyon WRF in the future based upon the capacity needed for Year 2022. Silver Creek WRF centrifuge cost included in current CIP.

No costs for Alternative Daily Cover with E.T. Technologies, but evaluation included a $100,000 allowance for a storage pad and minor improvements for odor control that may be required at some later date.

Costs do not include NBP Involvement because it is a management cost applied to all alternatives.

# Schedule for Implementation of Recommended Program

The recommended program includes seasonal composting to satisfy the desires of the local community to provide a local product. Conflicting with this is the high potential for odors due to typical composting operations complicated by inversions in the winter months. As such, additional work is required to enclose the mixing area, construct another biofilter and recondition the first biofilter, and include a weather station to enable identification of inversion conditions. In addition, the operation of the composting site during the summer months must be revised to limit potentially odorous activities during weather inversions or still conditions. A phased schedule is provided in Table 9-5.

**TABLE 9-5**
Schedule for Recommended Improvements

| No. | Item | Recommended Implementation |
|---|---|---|
| 1 | Install Weather Station at Silver Creek | As soon as possible to enable documentation of weather conditions |
| 2 | Enclose Building, Add New Biofilter, Recondition Existing Biofilter | Must be done before resuming composting |
| 3 | Modify Static Pile Composting Pad | Desirable, but may be done at a later date (Should be done as an odor control method) |
| 4 | Provide New Aeration Blowers to Allow for Vacuum Conditions | Desirable, but may be done at a later date (Should be done as an odor control method) |
| 5 | Add Star Screen | Desirable, but included to produce high quality product. |
| 6 | Front-End Loaders | Need for composting operation. May want to recondition existing front-end loaders or purchase used vehicles. |
| 7 | Silver Creek Centrifuge Facilities | Currently in CIP. Implementation desired in next 1 to 3 years |
| 8 | Upgrade East Canyon Centrifuges | Growth will limit use of existing centrifuges in 5 to 8 years. Changing operating time will extend life of existing units (See discussion in TM 7). District must determine appropriate time for replacement. |