CHAPTER 5

Biosolids

Chapter 5 - Biosolids

5.1 Introduction

Biosolids processing at wastewater treatment facilities is an integral and often costly part of the treatment plant operations. Incorporating sufficient facilities to remove solids from the wastewater stream, adequately stabilize these solids, and reliably dispose of the resultant product continues to challenge municipal agencies. Added to the more traditional needs of biosolids processing is the increasing pressure to provide higher level stabilization to the biosolids and continue to identify additional outlets for disposal and reuse. An evaluation of existing biosolids practices with respect to the Part 503 regulations has been made. Also, the drivers and alternative improvements required associated with achieving a Class A product will be discussed. The overall goal of these evaluations is to provide a road map for biosolids processing and handling that will allow the County to cost effectively process and dispose of biosolids now and through the 25-year planning period that can adapt to changes in the disposal markets. This chapter of the Regional Optimization Master Plan Report is arranged into the following topics:

- Discussion of existing Class B biosolids processing
- Estimated future biosolids production
- Class B and Class A requirements
- Discussion of available markets
- Process alternatives for Class A biosolids production
- Class B and Class A arrangements for the “existing plan”, “transfer all”, and “transfer some” options
- PCRWRD energy evaluation findings
- Biosolids processing recommendations
- Recommended biosolids management plan

5.2 Existing Class B Biosolids Processing

A condition assessment of all facilities at the Roger Road WRF and Ina Road WRF has been performed for this master planning effort and is summarized in this report. Thus, only a brief summary of existing facilities and the condition of these facilities will be provided in this chapter.

5.2.1 Roger Road WRF Biosolids Processing

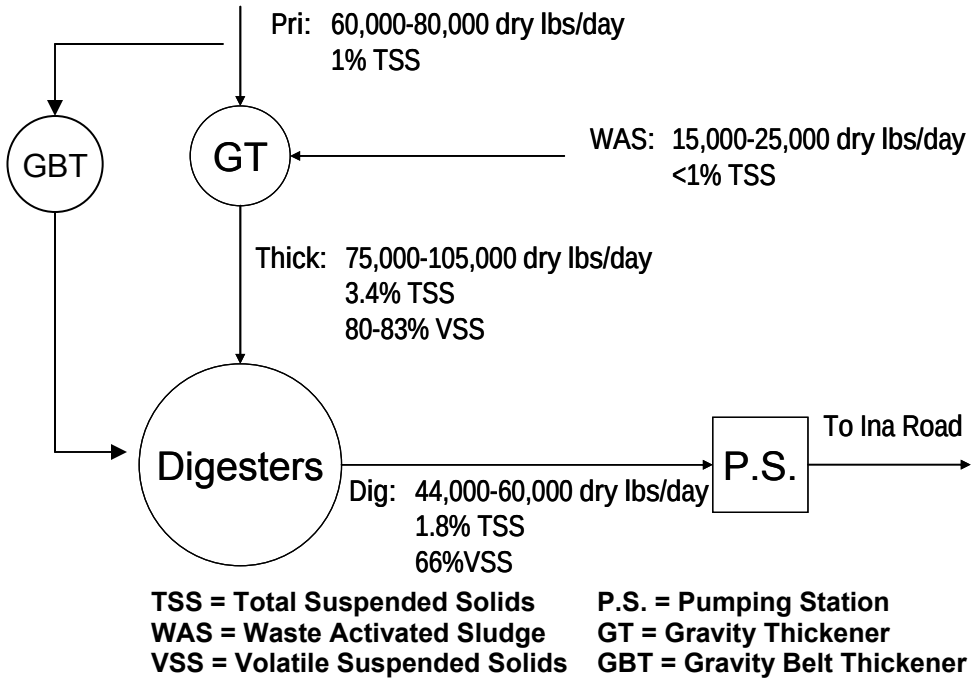
The existing Roger Road WRF biosolids processing facilities and a summary of the condition assessment results are provided in **Table 5-1**. The existing digestion facilities are designed to produce Class B biosolids through mesophilic anaerobic digestion. The design parameter for mesophilic anaerobic digestion to meet Class B 503 regulatory requirements is a 15 day hydraulic detention time to meet pathogen reduction requirements, which typically results in volatile solids destructions of approximately 45-55 percent. The digestion process must also attain at least 38 percent destruction of volatile solids to comply with the Part 503 requirements for Vector Attraction Reduction. Based on data provided by the County, the existing facilities are typically achieving volatile solids destructions of 50 to 54 percent. This reduction rate indicates good digestion operation at the plant, but as indicated in the table below, this

requires all four primary digesters to be in service and is at a plant influent flow of approximately 38 mgd (under existing plant capacity of 41 mgd). If the plant were at capacity, the existing digestion process could become stressed and volatile solids destructions could be reduced. The digested sludge is transported to the Ina Road WRF in a dedicated pipeline for further thickening/dewatering prior to land application. **Figure 5-1** summarizes existing biosolids facilities and mass transfers at the Roger Road WRF.

Table 5-1
Summary of Roger Road WRF Biosolids Facilities

Unit Process	Facilities	Condition
Solids Thickening (Primary Sludge and Waste Activated Sludge)	3 – Covered Gravity Thickeners	Uncertain structural stability and corrosive environment for equipment tankage
	2 – Dissolved Air Flotation Thickeners	Broken parts – currently not in use and not expected to be utilized due to labor intensity
	1 – Gravity Belt Thickener	Currently just beginning service for WAS thickening, excellent condition
Digestion	6 –Anaerobic Digesters (4 Primary and 2 Secondary)	No. 3 has gas leakage through roof, all un-inspected internally for 50 years, potential solids deposition in all, mixing issues with No. 6
Sludge Transfer to Ina Road WRF	Sludge Pumping Station and 5.3 mile 8-inch Force Main	Cavitation issues with pumping units, potential corrosion issues in force main, and single element redundancy issues

Figure 5-1
Existing Roger Road WRF Biosolids Diagram (at 38.3 mgd)



5.2.2 Ina Road WRF Biosolids Processing

The existing Ina Road WRF biosolids processing facilities and a summary of the condition assessment results are provided in **Table 5-2**. The existing digestion facilities are designed to produce Class B biosolids through mesophilic anaerobic digestion. Based on data provided by the County, the existing facilities are typically achieving volatile solids destructions of 55 percent. This reduction rate indicates good digestion operation at the plant. **Figure 5-2** summarizes existing biosolids facilities and mass transfers at the Ina Road WRF.

Stabilized Class B biosolids are currently thickened to approximately 8 percent solids using centrifuges and are disposed of through an existing contract for agricultural land application. This disposal option is preferred to thickened rather than dewatered solids as the water in the biosolids is beneficial in the region and the existing contractor's equipment is consistent with this product up to 10 percent solids.

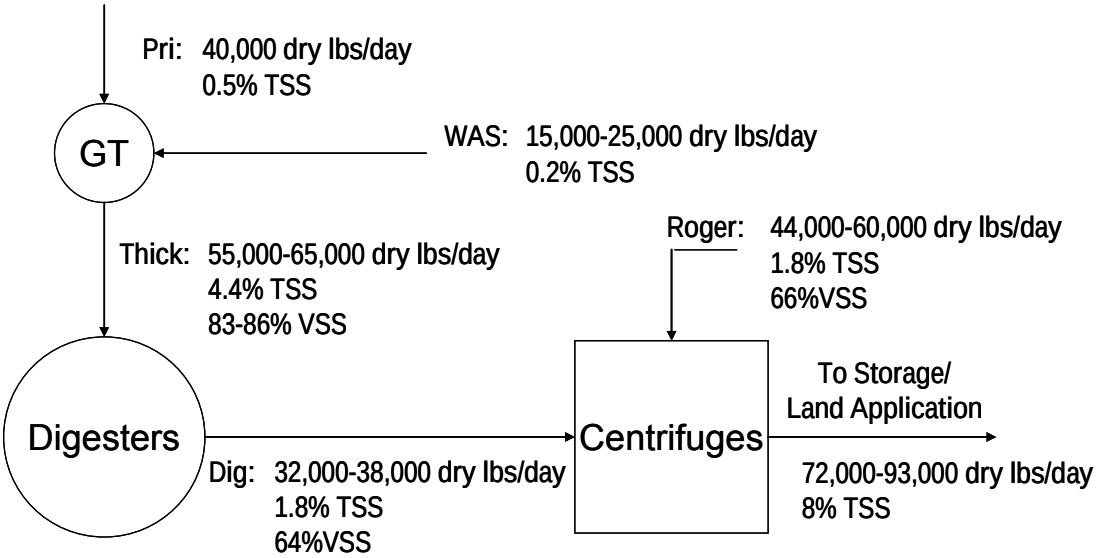
The current land application option has been successful for the County and provides a beneficial use of its biosolids. It is expected that land application will continue to be an option for biosolids disposal in the area in the future. However, some issues of concern with this disposal method have arisen. Currently, hauling distances for disposal are approximately 25 miles round trip and are through a single disposal contractor that controls the majority of available land in the area. It is expected that this hauling distance

could increase to 40 miles roundtrip at some point in the future as development pushes available land further out from the existing Ina Road WRF. Concerns over the quality of Class B biosolids have arisen in other parts of the U.S. If similar concerns arise in the area, disposal of Class B biosolids by land application could become difficult or unacceptable, requiring Class A processing. Also, the County wishes to have additional options for disposal.

Table 5-2
Summary of Ina Road WRF Biosolids Facilities

Unit Process	Facilities	Condition
Solids Thickening (Primary Sludge and Waste Activated Sludge)	1 –Gravity Thickener	Tankage in good condition, odor issues
	3 – Dissolved Air Flotation Thickeners	Tankage in good condition, wear on pumping and gas equipment, odor issues
Digestion	4 –Anaerobic Digesters (All Primary)	Fair condition, no major issues
Thickening/Dewatering	3 – Thickening/Dewatering Centrifuges	Centrate pumping capacity issues, struvite buildup problems, lack of cake pumping equipment, odor issues
Digested Sludge Storage and Transfer Station	1 – Bladder Storage Basin and Transfer Station	Inadequate and aging storage capacity; odor, safety and electrical system issues at transfer facility

Figure 5-2
Existing Ina Road WRF Biosolids Diagram (at 23.4 mgd)



5.2.3 Non-Metro Facilities

Pima County operates a number of wastewater treatment facilities besides the Roger Road WRF and Ina Road WRF termed the "Non-Metro Facilities". Biosolids processing at each of these facilities varies significantly from one facility to another and appears to have been based on size of facility, available land for evaporation, distance to existing sewers to Ina Road WRF and Roger Road WRF, etc. **Table 5-3** summarizes approximate solids production rates from these facilities and the type of processing and disposal used. Three of the plants, Marana WRF, Mt. Lemmon WRF, and Avra Valley WRF, have solids generated at the facility hauled to either Ina Road WRF or Roger Road WRF influent sewers. Thus, the sludge generated at these facilities become part of the treatment and disposal processes at Ina and Roger Road as well. For the purposes of evaluating treatment alternatives for the Ina Road WRF and Roger Road WRF during the planning period, it was assumed that these Non-Metro facilities would continue the current practice.

The Green Valley WRF, a 4.1-mgd facility, has the most significant biosolids processing facilities. This plant also has an alternative disposal method that has allowed Pima County to diversify its disposal options into a new market, mine reclamation. Dried solids (greater than 90 percent TSS) are transported to the ASARCO Mission Mine Facility for utilization to as a soil amendment for establishing vegetation on mine tailings. This disposal option is occurring through a research project associated with the University of Arizona. Results have been promising to date.

Table 5-3
Regional Facilities Current Biosolids Generation and Processing

Location	Current, dry tpd(1)	Processing, Disposal
Marana WRF	0.28	storage, hauled ⇒ Ina Road WRF
Rillito Vista WRF	0.014	dried, scraped, hauled to landfill
Avra Valley WRF	2.2	storage, hauled ⇒ Roger Road WRF
Green Valley WRF	5.7	GBTs, Aerobic Dig., Belt Filter Press (BFPs), Drying ⇒ Mine
Arivaca Junction WRF	0.09	dried, scraped, hauled to landfill
Corona de Tucson WRF	0.16	Evaporation, hauled to landfill when pond is cleaned
Pima Co. Fairgrounds WRF	0.004	Evaporation, hauled to landfill when pond is cleaned
Mt. Lemmon WRF	0.018	storage, hauled ⇒ Ina Road WRF
Randolph Park WRF	0.007	Conveyed by sewer to Roger Road WRF
Total	8.47	

(1) Based on 2,800 dry lbs/day raw biosolids produced per mgd of flow treated

5.3 Estimated Future Biosolids Production

Through development of wastewater projections and treatment alternatives analysis associated with this project, future biosolids production rates have been estimated for the Roger Road WRF and Ina Road WRF for the three main arrangement alternatives – existing plan, transfer all, transfer some. The liquid stream treatment alternatives are impacted by recycles from the solids treatment processes, particularly from solids thickening and post stabilization thickening or dewatering. The type of solids stabilization utilized greatly impacts the constituents in the recycle streams, such as ammonia and phosphorus. Mass balances have been developed for the facilities to account for these recycle streams.

At the Biosolids Workshop (No. 7), it was agreed that Pima County will continue to utilize anaerobic digestion for solids stabilization of sludge streams from the Ina Road and Roger Road plants. Prior to this study, all three of the major system configuration alternatives considered (existing plan, transfer all, transfer some) included a central biosolids processing facility at Ina Road WRF and the digestion facilities at Roger Road WRF were to be decommissioned. Centralization of solids handling and treatment is cost effective, particularly if Class A biosolids are required. Thus, a centralized biosolids processing facility serves as the starting point for development of biosolids processing alternatives. Additionally, in the existing plan and transfer some alternatives, the scenario of a Roger Road WRF have been developed. In this scenario, Roger Road WRF solids would be handled as follows: primary sludge (if primary tanks are provided) would be transferred to Ina Road WRF in the influent sewer, and waste activated sludge would be thickened to 3 percent solids at Roger Road WRF and then pumped to digestion at Ina Road WRF.

5.3.1 Biosolids Production Assumptions

Major assumptions in developing biosolids production rates at the Roger Road and Ina Road plants are summarized below.

Non-Metro facility solids generation and contribution to Roger Road WRF or Ina Road WRF are determined for planning purposes**.** As these solids come into the plants with the influent, wastewater characteristics and concentrations were developed for these loads. **Table 5-4** summarizes the assumptions made for Non-Metro facility solids contributed to Roger Road WRF and Ina Road WRF.

Table 5-4
Non-Metro Facility Sludge Wastewater Characteristic Assumptions

Parameter	Assumption
Percent Solids	1%
TSS	**See estimates in Table 5-15 Non-Metro Facilities Future Biosolids Production**
BOD	0.5 *TSS
COD	2 * BOD

Parameter	Assumption
sBOD	0.23 * BOD
VSS	0.76 * TSS
TKN	0.05 * TSS
TP	0.02 * TSS

Primary treatment removals were estimated. The removal rates were established based on which treatment facility was being addressed and, for Ina Road WRF, the capacity being treated. Primary removal of BOD was estimated at approximately 31% and TSS removal at 60%.

Other major assumption for treatment to generate biosolids produced for the alternatives are summarized in **Table 5-5**.

Table 5-5
Additional Biosolids Generation Assumptions

Process	Parameter	Assumption
Secondary Treatment	Solids Yield with Primary Tanks	0.8 lb TSS/lb BOD applied
	Solids Yield without Primary Tanks	1.2 lb TSS/lb BOD applied
	WAS Concentration	7,000 mg/L
	TP Removal to Sludge	60% of Primary Effluent TP
	Sludge VSS	76% of Sludge TSS
Thickening	TSS	90% Removal
	Thickened Concentration	4.5%
Digestion	Minimum VSS Destruction	50%
Digested Sludge Thickening	Concentration	8%
Roger Road WRF Assumptions	Primary Sludge	Sent to Ina Road in Sewer
	WAS	Thicken to 3% and Pump to Ina Road WRF

Using the assumptions summarized above, biosolids quantities were developed for each of the major treatment alternatives.

5.3.1.1 Roger Road WRF

The treated flow at Roger Road WRF for each of the major system configurations (existing plan, transfer all, transfer some) is 32 mgd, 0 mgd, or 20 mgd, respectively. Also, the 32-mgd WRF alternative would have differing thickened sludge flows and recycles. **Table 5-6, Table 5-7, Table 5-8** and **Table 5-9** summarize sludge flows generated at the Roger Road WRF or the system configurations for 32 mgd, 32 mgd WRF (with primary tanks), 32-mgd WRF (no primary tanks), and 20 mgd.

Table 5-6
Roger Road WRF 32-mgd Solids Streams

Solids Stream	Flow, mgd	% Solids	TSS Mass, dry lbs/day	VSS Mass, dry lbs/day
Primary Sludge	0.62	1.0	51,900	39,400
Waste Activated Sludge	0.80	0.7	46,600	35,400
Thickened Sludge	0.24	4.5	88,700	67,400
Thickener Overflow	1.18	0.1	9,900	7,500

Table 5-7
Roger Road WRF 32-mgd Solids Streams (With Primary Tanks)

Solids Stream	Flow, mgd	% Solids	TSS Mass, dry lbs/day	VSS Mass, dry lbs/day
Primary Sludge (to Ina Road WRF Influent)	0.58	1.0	48,700	37,000
Waste Activated Sludge	0.77	0.7	45,100	34,300
Thickened WAS (to Ina Road WRF Digestion)	0.24	2.0	40,600	30,900
Thickener Overflow	0.53	0.1	4,500	3,400

Table 5-8
Roger Road WRF 32-mgd Solids Streams (No Primary Tanks)

Solids Stream	Flow, mgd	% Solids	TSS Mass, dry lbs/day	VSS Mass, dry lbs/day
Waste Activated Sludge	1.72	0.7	100,600	76,400
Thickened WAS (to Ina Road WRF Digestion)	0.36	3.0	90,500	68,800
Thickener Overflow	1.36	0.1	10,100	7,600

Table 5-9
Roger Road WRF 20-mgd Solids Streams

Solids Stream	Flow, mgd	% Solids	TSS Mass, dry lbs/day	VSS Mass, dry lbs/day
Primary Sludge	0.41	1.0	34,500	26,200
Waste Activated Sludge	0.52	0.7	30,100	22,900

Solids Stream	Flow, mgd	% Solids	TSS Mass, dry lbs/day	VSS Mass, dry lbs/day
Thickened Sludge	0.16	4.5	58,100	44,200
Thickener Overflow	0.77	0.1	6,500	4,900

5.3.1.2 Ina Road WRF

The treated flow at Ina Road WRF for each of the major system configurations (existing plan, transfer all, transfer some) is 50 mgd, 82 mgd, or 62 mgd, respectively. Also, the 32-mgd Roger Road WRF alternative would result in differing sludge flows and recycles at Ina Road WRF as the Roger Road WRF solids handling will impact to the Ina Road WRF influent. **Table 5-10,** **Table** 5-11**, Table 5-12, Table 5-13** and **Table 5-14** summarize Ina Road WRF sludge flows for the major system configurations. Additional sludge from Roger Road WRF pumped to the plant via the 8-inch interconnect (loads shown in Subchapter 5.3.1.1) would be added to obtain total solids to digestion at Ina Road WRF. The following tables present only the solids generated from Ina Road WRF wastewater liquid stream processes.

Table 5-10
Roger Road WRF 50-mgd Solids Streams

Solids Stream	Flow, mgd	% Solids	TSS Mass, dry lbs/day	VSS Mass, dry lbs/day
Primary Sludge	1.14	1.0	95,200	72,400
Waste Activated Sludge	1.35	0.7	78,800	59,900
Thickened Sludge (WAS + Primary)	0.42	4.5	156,600	119,000
Thickener Overflow	2.07	0.1	17,400	13,200

Table 5-11
Ina Road WRF 50-mgd Solids Streams (Roger Road WRF, With Primary Tanks)

Solids Stream	Flow, mgd	% Solids	TSS Mass, dry lbs/day	VSS Mass, dry lbs/day
Primary Sludge	1.52	1.0	127,200	96,600
Waste Activated Sludge	1.60	0.7	93,700	71,200
Thickened Sludge (WAS + Primary)	0.53	4.5	198,700	151,000
Thickener Overflow	2.60	0.1	22,100	16,800

Table 5-12
Ina Road WRF 50-mgd Solids Streams (Roger Road WRF, No Primary Tanks)

Solids Stream	Flow, mgd	% Solids	TSS Mass, dry lbs/day	VSS Mass, dry lbs/day
Primary Sludge	1.15	1.0	95,300	72,400
Waste Activated Sludge	1.35	0.7	78,800	59,900
Thickened Sludge (WAS + Primary)	0.42	4.5	156,600	119,000
Thickener Overflow	2.07	0.1	17,400	13,200

Table 5-13
Ina Road WRF 82-mgd Solids Streams

Solids Stream	Flow, mgd	% Solids	TSS Mass, dry lbs/day	VSS Mass, dry lbs/day
Primary Sludge	1.75	1.0	145,900	110,900
Waste Activated Sludge	2.14	0.7	124,800	94,900
Thickened Sludge (WAS + Primary)	0.65	4.5	243,700	185,200
Thickener Overflow	3.24	0.1	27,100	20,600

Table 5-14
Ina Road WRF 62-mgd Solids Streams

Solids Stream	Flow, mgd	% Solids	TSS Mass, dry lbs/day	VSS Mass, dry lbs/day
Primary Sludge	1.35	1.0	112,600	85,600
Waste Activated Sludge	1.63	0.7	95,200	72,300
Thickened Sludge (WAS + Primary)	0.50	4.5	187,000	142,100
Thickener Overflow	2.48	0.1	20,800	15,800

5.3.1.3 Non-Metro Facilities

To estimate future production rates from the Non-Metro facilities, an assumed production rate of 2,800 dry lbs/day raw biosolids produced per mgd of flow treated was applied to the expected future capacities of the facilities. A new Non-Metro Southlands WRF has been proposed that would have a capacity of approximately 13.7 mgd. Solids generated at this future facility were assumed to have separate processing and disposal as currently provided at Green Valley WRF. **Table 5-15** summarizes the assumed future biosolids production rates for the Non-Metro facilities.

Table 5-15
Regional Facilities Future Biosolids Production (2030)

Location	Future, raw dry tpd(1)	Processing, Disposal
Arivaca Junction WRF	0.00	Facility decommissioned, flow transferred to Green Valley WRF
Avra Valley WRF	4.20	storage, hauled ⇒ Roger Road WRF
Corona de Tucson WRF	2.94	storage, hauled ⇒ Ina Road WRF
Green Valley WRF	6.16	GBTs, Aerobic Dig., BFPs, Drying ⇒ Mine
Marana WRF	6.16	storage, hauled ⇒ Ina Road WRF
Mt. Lemmon WRF	0.003	storage, hauled ⇒ Ina Road WRF
Pima Co. Fairgrounds WRF	0.00	Facility decommissioned, flow transferred to Southeast Interceptor (SEI)
Rillito Vista WRF	0.00	Facility decommissioned, flow transferred to Marana WRF
Randolph Park WRF	0.007	Conveyed by sewer to new WRC/Ina Road WRF
Southlands WRF (future)	14.70	Thicken/haul to interceptor for discharge
Total	**28.0**	

(1) Based on 2,800 dry lbs/day raw biosolids produced per mgd of flow treated

5.4 Class B and Class A Biosolids Requirements

The 40 Code of Federal Register (CFR) Part 503 regulations set forth requirements for the stabilization and disposal of biosolids. The regulations are divided into sections by type of disposal method as well as general provisions and pathogen and vector attraction reduction requirements. A full summary of the regulations is not provided here as a number of other sources provide good descriptions of the requirements. The requirements associated with land application and specific Class A and Class B production is briefly reviewed in this chapter.

5.4.1 General Land Application Requirements

Based on the current regulations, bulk biosolids applied to land must meet pollutant ceiling concentrations and cumulative pollutant loading rates, Class B pathogen requirements, vector attraction reduction requirements, and management practices requirements. Vector attraction reduction can be accomplished in a number of ways listed in the regulations, such as digestion to achieve greater than 38 percent VSS reduction, alkaline stabilization, drying, injection, or incorporation. Management practices requirements apply to application of both Class A and Class B biosolids, but the restrictions associated with Class B products are considerably more stringent. If Class A pathogen reduction requirements are met, the biosolids can also be utilized for lawns and home garden applications.

5.4.2 Class B Requirements

The EPA Part 503 regulations provide three approaches to produce a Class B product. The first approach is to use a technology on the EPA list of PSRPs. The other two approaches require continuous monitoring for pathogens or submitting pathogens data to EPA to demonstrate that the process is equivalent to a PSRP process. The processes considered to meet the criterion for Class B biosolids associated with this study are all on the EPA PSRP list. **Table 5-16** summarizes the criteria for PSRPs process considered for this study.

Table 5-16
Class B Processes

Process	Requirements
Aerobic Digestion	MCRT of 40 days at 20°C or MCRT of 60 days at 15°C
Air Drying	Dry on beds for 3 months, with 2 months ≥ 0°C
Anaerobic Digestion	MCRT of 15 days at 35-55°C or MCRT of 60 days at 20°C
Composting	5 days at 40°C and 4 hours of the 5 days at 55°C
Lime Stabilization	Lime addition to pH 12 and maintained for 2 hours

5.4.3 Class A Requirements

The Part 503 regulations establish six alternatives to demonstrate meeting Class A requirements. As in the case of the Class B requirements, one approach is to use a technology that is on the list of PFRP. The other five alternatives prescribe a time-temperature requirement, a high pH-temperature requirement, continuous monitoring for pathogens to demonstrate compliance (alternatives 3 and 4) or obtaining a PFRP equivalency approval from EPA. Most of the process considered for Pima County for obtaining a Class A designation fall on the list of PSRP processes. **Table 5-17** summarizes the processes considered in this study to achieve Class A compliance.

Table 5-17
Class A Processes

Process	Requirements
Thermophilic Aerobic Digestion (1)	MCRT of 10 days at 55-60°C
Heat Drying (1)	Direct or Indirect Gas Drying to ≤ 10% moisture content and solids temperature of 80°C
Heat Treatment (1)	MCRT of 30 minutes at 180°C

Process	Requirements
Composting (1)	3 days at 55°C for in-vessel or static pile 15 days at 55°C for windrow
Pasteurization (1)	30 minutes at 70°C
Alkaline Stabilization (2)	pH 12 and maintained for 72 hours with biosolids ≥ 52°C for 12 hours, followed by air drying to 50% TS
Time/temperature (3)	Process meets detention time at temperature requirements by solids concentrations given in 503 regulations or has been given equivalency by U.S. EPA (temperature phased anaerobic digestion (TPAD) and batch thermophilic digestion for example)

(1) PSRP process (complies with Part 503 Alternative 5)
(2) Meets high pH-temperature requirement (complies with Part 503 Alternative 2)
(3) Meets Time-temperature requirement (complies with Part 503 Alternative 1)

5.5 Available Markets

5.5.1 Agricultural Land Application

Currently, Pima County is disposing of all biosolids from the Ina Road WRF and Roger Road WRF facilities through a land application contract for a liquid product at approximately 8 percent solids. As previously noted, concerns over having a single disposal option, future increased hauling distances, and potential pressure to provide Class A biosolids for land application have arisen. However, this current disposal method has been cost effective for Pima County and should be considered for future disposal. In a telephone interview with the current land application contractor, the potential need to produce Class A biosolids for land application and future loss of land sites for application were discussed. The Avragro Incorporated representative indicates that he sees no pressure to utilize Class A biosolids for land application. Also, the current contractor is capable of handling up to 10 percent solids with current application equipment. Thus, the Avragro representative's opinion is that land application, based on current haul distances of 25 miles and utilizing Class B biosolids, is viable for 20 to 25 years into the future even with increasing solids production from Pima County. Other land application contractors have bid on the Pima County contract in the past, thus competition does exist in the land application market. These other land application contractors may prefer a dewatered product. Thus, when considering land application with respect to processing alternatives, it is appropriate to have the capability to produce either a liquid or dewatered product.

5.5.2 Landfilling

Disposing of biosolids in a municipal solids waste landfill is not considered a beneficial use, but does represent a viable disposal option. A recent survey of biosolids management in Arizona indicated that a large number of municipalities rely on landfilling for biosolids disposal. Just as concerns have arisen about land applying Class B biosolids, there are some places where groups are concerned about land applying biosolids in general. Landfilling remains a viable and cost effective approach, especially as a backup or contingency plan. This disposal method can often be utilized without stabilization of solids as

long as the biosolids meet the EPA paint filter test (dewatered to 12-15 percent solids) and Toxicity Characteristics Leachate Procedure (TCLP). The paint filter test requires no free water and the TCLP test sets limits on the heavy metal content of water leached through a sample of the dewatered sludge. It is often advantageous to dewater biosolids to a greater degree (such as 25 percent) for landfilling to minimize disposal cost and to make the material easier to transport and place in the landfill. A past trial of disposing of biosolids at a Pima County landfill indicated that the solids were too wet and caused equipment problems at the landfill.

Landfill space is available in Arizona. Nearby landfills include: the Tangerine Road Landfill operated by Pima County, the Sahuarita Landfill operated by Pima County, and the Los Reales Landfill operated by the City of Tucson. The Tangerine Road landfill is expected to reach capacity in 2009. The Sahuarita Landfill is expected to have capacity for approximately 15 more years. The Los Reales Landfill is expected to have capacity for 60 years. Tipping fees at the Pima County landfills are approximately $100 per ton for non-standard waste. Tipping fees at the City of Tucson landfill is approximately $75 per ton for special handling rate. Given the tipping fees, minimizing the amount of water in the biosolids is advantageous. Thus, dewatering to approximately 25 percent solids would be recommended for this disposal option.

With the tipping fees and required hauling for landfilling it is likely that this disposal method will be more expensive than the current land disposal option. However, landfilling could provide a backup to other disposal options and reduce reliance on a single outlet.

5.5.3 Mine Tailings Reclamation

This disposal option has promise for Pima County. The current University of Arizona project utilizing Green Valley WRF biosolids has been successful. The dried biosolids from Green Valley WRF are taken to the ASARCO mine. The Dodge Phelps mine has also been identified as a possible reclamation site. Other mines within a 100 mile radius of Pima County exist and could be potential sites. This market requires a dewatered or dried product. Given the significant increase in biosolids for disposal if Ina Road WRF and Roger Road WRF sludge was added to the program, other disposal sites would have to be identified and utilized. Additionally, this market is dependent on mining conditions. Reclamation is performed when a site, or a portion of a site, is no longer being mined. There is a federal requirement that mines be reclaimed after they are closed. However, the amount of biosolids that can be dedicated to this market could be variable from year to year, depending upon mining operations.

This disposal option could be viable for Pima County in the future. It may be most applicable to the Non-Metro facilities as regionalization of these plants is considered. To further explore the potential of this option, a separate market study would be appropriate and expansion of the current project may be advisable to determine stability and actual costs for this alternative.

5.5.4 Dedicated Land Disposal

An alternative that may have future merit for Pima County is the development of a dedicated land disposal site. This alternative consists of acquiring a dedicated parcel of land to apply biosolids that is not accessible to the public. Biosolids would be applied to the site and incorporated into the soil. This

disposal option would not require solids stabilization, if the biosolids are covered on a daily basis. Otherwise, they would need to meet the Class B requirements. Vector attraction controls would be required either in the form of stabilization or by applying management practices such as daily incorporation into the soil. The primary requirements for dedicated land disposal is that the biosolids must meet the heavy metal limit, groundwater monitoring wells need to be installed and maintained, and surface runoff needs to be contained and monitored. There are restrictions on public access to the land and how the land can be used in the future. There are also reporting requirements that are prescribed in the Part 503 regulations. Dewatered solids could be trucked to the site or a solids pipeline could deliver solids to the site. If the solids are pumped to the site, an onsite dewatering facility may be beneficial. The alternative should be considered with a significant buffer zone around the site, such as a 1,000 foot setback to application areas. Other siting requirements are described in the Part 503 regulations.

This disposal method is being utilized effectively by the Dallas Water Utilities in Dallas, Texas. Based on experience in Dallas, an active area loading rate of approximately 0.1 dry ton per day per acre has been manageable. **Table 5-18** summarizes conceptual sizing information for this option.

Table 5-18
Dedicated Land Disposal Conceptual Sizing

Parameter	For Ina Road and Roger Road WRF Biosolids	For all County Biosolids
Application Rate, dry tons/day/acre active	0.1	0.1
Future Biosolids Production, dry tons/day	75	103
Required Active Site Area, acres	750	1,170
Active Site Parameter Sides (as square), feet	5,700	7,140
With 1,000 foot setback, parameter sides, feet	7,700	9,140
Total Required Area with Setback, acres	1,360	1,920

5.5.5 Other Land Application

Alternative land application options include use of biosolids on golf courses and other landscaping projects such as roadway improvements. Landscaping contractors could use biosolids for a variety of projects. These markets would require production of Class A biosolids. Additionally, dewatered or dried product would be required. The viability of these markets would require a detailed market analysis. A major issue to consider is stability of the market continually and long term given the high amount of solids to be disposed of. These markets may be more appropriate for some of the Non-Metro facilities with smaller and less frequent disposal needs.

5.5.6 Sale as Fertilizer

A few municipal agencies produce bagged fertilizer from biosolids. This market would require a dry, Class A product. Amendments to the biosolids to increase its value as fertilizer would likely be required. While this market has the highest public relations benefit potential, it requires significant capital and operations investment. Thus, such a market would require focused market research prior to investment.

5.5.7 Other Emerging Markets

Agencies around the U.S. continue to look for alternative markets for biosolids. One such market is waste to energy. Many of the energy markets utilize heat drying as a first step, and then further process the biosolids to produce a gas, liquid or solid fuel. It is expected that alternative markets will continue to grow over time. A way to handle such emerging markets, without the often high risk, is to utilize a design-build-operate contract for these disposal options. While analyzing emerging markets is beyond the scope of this project, the alternatives developed should allow for such future changes.

5.6 Process Alternatives for Class A Biosolids Production

In evaluating process alternatives to produce Class A biosolids, consideration should be given to the type of end product generated by the process and whether or not this type of product is marketable. For example, for the current land application arrangements in place at Pima County, the applicator prefers a liquid biosolids product with a solids concentration of approximately 8 percent. Thus, a heat dried product of more than 90 percent solids or alkaline stabilized product with total solids of 50 percent would not be consistent with this current market.

As noted in this chapter there are a number of PFRPs that by definition will result in Class A biosolids, such as heat drying, composting, pasteurization, and alkaline stabilization. Additionally, anaerobic digestion can be used to produce Class A biosolids if it meets the time temperature requirements. The currently accepted forms of Class A anaerobic digestion is a batch thermophilic process or a batch thermophilic process followed by a mesophilic process. As only anaerobic digestion with a batch process is given Class A status based on process design criteria, this study has limited the anaerobic digestion options to those with batch processing. Based on input from a U.S. EPA representative, it has been verified that continuous feed thermophilic digestion is not considered a Class A process without a batch step. Testing for equivalency may be occurring at some locations currently, but none have been given Class A status at this point in time.

The testing equivalency process requires significant data collection and obtaining results takes some time. If the biosolids do not meet the testing requirements, they can not be disposed of as Class A product. Thus, issues could result with disposal arrangements if the testing does not provide the verifications required.

For evaluating Class A biosolids production, the assumption that all biosolids stabilization would occur at the Ina Road WRF was made. As producing Class A biosolids will require significant capital investment and generally is more costly to operate than the current Class B production, it is logical that such facilities

would likely be most cost effective if centralized for the Ina Road WRF and Roger Road WRF sludge streams. This does not apply to major Non-Metro facilities such as Green Valley WRF and the future Southlands facility, both of which generate significant biosolids and do not have close proximity to the Ina Road WRF plant.

5.6.1 Class A Drivers

Significant drivers exist that require giving consideration to producing Class A biosolids. Regulations are subject to change. Public reaction to Class B biosolids land application and land application in general is increasingly negative is some areas of the U.S. Political pressure could result in state or national legislation that would require agencies to produce Class A biosolids. Finally, Pima County's commitment to achieving environmental management system (EMS) certification through the National Biosolids Partnership could drive production of Class A biosolids.

Participation in the National Biosolids Partnership requires of the County: utilization of a comprehensive EMS, demonstration of commitment to the community, and involving the community in defining performance improvements to the County's biosolids program. This community involvement could be a local trigger to future Class A biosolids processing.

5.6.2 Screening of Class A Processes

At Workshop No. 7 that dealt with biosolids, major Class A processes were screened. Digestion, alkaline stabilization, composting, heat drying, and advanced air drying were presented for consideration. This subchapter provides a summary of the major Class A processes considered and the results of that screening.

5.6.2.1 Digestion

The major digestion processes given screening consideration were: thermophilic aerobic digestion, temperature phased aerobic digestion, thermophilic anaerobic digestion, and temperature phased anaerobic digestion.

As both the Ina Road WRF and the Roger Road WRF currently utilize anaerobic digestion, conversion to aerobic digestion would require significant capital investment. Additionally, aerobic digestion does not produce methane gas. Thus, methane could not be beneficially used to heat the digestion process or for power production as currently utilized at the Ina Road WRF. Thus, thermophilic aerobic digestion and temperature phased aerobic digestion were not given further consideration.

Thermophilic anaerobic digestion utilizes digesters operating at 55°C. Thermophilic digestion is similar to the current practice of continuously feeding the anaerobic digesters except the digesters are operated at a higher temperature. Thermophilic anaerobic digestion is considered to achieve higher volatile solids destruction rates than mesophilic digestion thus reducing required volume. Also, some reports indicate improved dewaterability of solids and greater reductions in pathogen levels from thermophilic digestion over mesophilic digestion. Thermophilic digesters are more difficult and costly to operate than mesophilic digesters. Currently, thermophilic anaerobic digestion is classified as a Class B PSRP process

along with mesophilic digestion by the 503 regulations. In order to demonstrate compliance with Class A requirements, it would be necessary to continuously monitor pathogens or obtain approval as an equivalent PFRP process. Thus, continuous feed thermophilic digestion was prescreened from the digestion processes.

Temperature phased anaerobic digestion (TPAD) utilizes a batch thermophilic stage followed by a mesophilic stage. In this process solids are retained in a batch reactor for a sufficient period of time to demonstrate compliance with the EPA time-temperature criteria (Alternative Method 1). The process is therefore considered to produce a Class A equivalent sludge by USEPA. Higher volatile solids destructions and methane gas production are realized. Also, the quality of the methane gas is often better, odor generation associated with thermophilic digestion is reduced, and process stability is improved. Dewaterability of solids is reported to be better than with mesophilic digestion alone. Thus, this process was carried forward as the digestion process for screening.

The TPAD process is most consistent with the current facilities utilized at the Roger WRF and Ina Road WRF as mesophilic digestion is being utilized. This alternative would thus require addition of a thermophilic batch stage to the process. Typically, TPAD is designed with a 5 day batch detention time for the thermophilic stage and a 10 day detention time in the mesophilic stage. Resulting solids could continue to be thickened to 8 percent or dewatered to produce a cake.

5.6.2.2 Alkaline Stabilization

A number of alkaline stabilization processes are available. These include: N-Viro, Biofix, Leopold, Envesssel, Chemfix, and Bioset. The N-Viro process has the most installations (more than 50) with the Bioset process having the least (less than 5). Any of these processes could be utilized. They all utilize hydration as a source of heat and lime as one of the additives. Specific processes vary somewhat in additives use of other heat sources. For prescreening, the Bioset process, which is relatively new, was utilized.

Bioset requires the addition of lime and acid. This process uses less alkaline additives then the other processes, which may be an advantage because of the alkaline nature or Arizona soils. Heat is generated in hydration as well as in the acid reaction. This process requires dewatering biosolids to a minimum of 15 percent solids prior to processing. Digestion is not required. The process arrangement is relatively portable and compact. It produces a Class A, granular product. The product also has some value associated with the alkaline content that is beneficial for acidic soils. This benefit is not realized in the Southwest because most of the solids are alkaline in nature.

Major advantages of alkaline stabilization include a relatively small footprint, ability to be fully enclosed, moderate system complexity, and the ability to process raw or digested biosolids. Major disadvantages include increase in volume of solids due to lime addition, cost of chemicals, the potential for significant odor and dust generation, and potential ammonia recycle from odor scrubbers.

5.6.2.3 Composting

Composting biosolids can be performed as windrow, extended pile, or in-vessel. Both windrow and extended pile operations require significant space and thus are difficult to provide with odor control. Thus, composting was prescreened to the in-vessel process. In-vessel composting requires dewatering the biosolids to greater than 15 percent and requires the addition of a bulking agent. It does not require digestion to produce a quality product, although digesting the solids prior to composting significantly reduces the potential to produce odors during the composting process. Significant material handling is required in the process. Major advantages of this process include: high quality product, perception as a "green" process, and the ability to handle raw or digested solids. Major disadvantages include odor generation, complex material handling, and fire potential issues. The process also increases the volume of material that needs to be handled because of the added bulking agents.

One composting possibility that may have promise particularly for the Non-Metro facilities is a composting project being initiated at the Los Reales Landfill owned by the City of Tucson. Los Reales is performing pilot testing at this time on composting. One of the needs that they have is a good source of nitrogen for the composting process, which could be provided by biosolids. Composting at Los Reales is unlikely to require the significant volumes of biosolids that are generated at Ina Road WRF, but this outlet could be explored for biosolids from one of the Non-Metro facilities. An issue that would need to be evaluated is whether the biosolids provided can be essentially free of metal content, as this is one of the requirements for this composting operation.

5.6.2.4 Heat Drying

Heat drying systems can be broken down into three categories: direct, indirect, or combination direct/indirect. Direct drying systems bring the sludge into immediate contact with the drying medium. Indirect systems utilize an intermediate exchange surface to transfer the drying heat. Combination systems utilize both modes. The most prominent drying system with the largest number of installations is the rotary drum direct dryer. This type of system is manufactured by a number of companies. The process is enclosed, utilizes recirculation of gas to reduce energy consumption, and can be used to form very dry (90 percent solids) pellets. The process does not require digestion, but does require dewatering to approximately 15 percent solids. However, a higher quality and less odorous product is achieved if the biosolids are digested prior to heat drying. The digestion gas can also be used as a source of energy for the dryer. The product is high quality and marketable and can be used as low grade fuel. It has a small footprint and does not generate any recycle streams. Disadvantages include high energy consumption, complex equipment, and fire and explosion potential.

5.6.2.5 Accelerated Air Drying

This relatively new process utilizes a green house type of enclosure for solar drying of solids. A robotic turning machine accelerates the drying process. The process has low chemical and energy requirements, no nutrient recycle to the wastewater process, can process digested or raw solids, and produces approximately 75 percent solids. Disadvantages include a large system footprint, the need to establish

Class A equivalency to date, and limited experience to date. The process may have applicability at some of the Non-Metro plants that have been using air drying.

5.6.2.6 Screening Results

Screening criteria were utilized to reduce the number of Class A processes for further consideration. These criteria included: operability, proven process, expected present worth cost, marketability, resource consumption, ease of maintaining treatment during construction, and recycle impacts. Processes were graded with a +, 0, or -. The resultant matrix evaluation based on input during Workshop No. 7 is presented in **Table 5-19.**

Table 5-19
Screening Matrix Evaluation of Class A Processes

	Phased Anaerobic Digestion (TPAD)	Alkaline Stabilization	Composting	Heat Drying	Advanced Air Drying
Operability	+	0	–	–	0
Proven Process	+	+	+	+	–
Present Worth Cost, Capital + O&M	+	0	–	–	–
Marketability	–	–	+	+	–
Resource Consumption	+	–	–	–	+
Ease of Maintaining Treatment Capacity during Construction	0	+	0	+	0
Recycle Impacts	0	0	0	0	0
Recommended Processes	**Ina/Roger Road √**		**Non-Metro Sites √**	**Ina/Roger Road √**	**Non-Metro Sites √**

Based on the discussion in the workshop, it was determined that for the Ina Road WRF and Roger Road WRF biosolids, temperature phased anaerobic digestion and heat drying would be given further consideration. Additionally, the Cambi process was added at the workshop for consideration. For the Non-Metro facilities, advanced air drying or composting may be appropriate technologies.

It was also determined in the workshop that all Class A options would include anaerobic digestion. Thus, if heat drying were utilized, it would be added following mesophilic digestion.

5.6.2.7 Cambi Process

The Cambi process was developed in Norway in the early 1990s. The process utilizes a thickened sludge (15 to 20 percent solids), a hydrolization process, digestion, and final dewatering. The final stabilized product is typically dewatered to 35-40 percent solids. The hydrolization process uses steam and pressure to solublize organic compounds in the sludge. The hydrolysis step includes three tanks: a preheat tank, the steam and pressure reactor tank, and a flash tank. The pressure is released rapidly in a flash tank to rupture biomass cells. Heat is returned from the flash tank to the preheat tank. The solids are then sent on to mesophilic digestion. The manufacturer reports a 50 percent reduction in the required digestion volume, increased gas production, reduced foaming, and high VSS destructions (up to 60 percent). The process could be added on to the existing mesophilic digestion process much like TPAD can be. Disadvantages of this process include: no existing U.S. installations, it is currently not listed as a Class A process (although a USEPA representative has indicated that with the first stage heat treatment it is likely to meet the requirements), safety issues of handling high temperature steam and high pressure vessels, need for pre-thickening to 15 percent solids, complex system arrangement, and need to find stable market for the product. There is also some concern that the mixing system in the anaerobic digesters may need to be modified to mix a 15 percent solids material. However, there are some data that suggested that the changes in viscosity that result from the thermal conditioning may counteract the affect of the higher solids concentration. In addition, the process generates a high strength recycle stream which can be a source of odors. The final product will also be too dry to be applied with liquid application equipment. The process has many similarities with the Zimpro and Porteous processes that have largely been abandoned in the US because of odor issues.

Even with the noted issues, the process appears to have some potential to fit in with the existing mesophilic process at the Ina Road WRF and could in the future be considered as a Class A process. Thus, it appears to be valuable to keep this option open for future Class A biosolids production. At this time, with no existing U.S. experience and no approval by USEPA, implementation of this process for Class A in the immediate future could constitute a high risk. If the Cambi process is given significant consideration in the future, pilot testing is recommended as well as verification that sufficient markets exist to dispose of the drier product (35-40 percent solids).

5.7 Class B and Class A Arrangements for the “Existing Plan”, “Transfer All”, and “Transfer Some” Options

For both Class B and Class A plant arrangements, bases of design criteria for the alternatives needed to be determined at a master planning level. Often maximum month solids values are used in conjunction with the design criteria instead of annual average values, especially for Class B processing. This approach will be used for this master planning effort for producing Class B biosolids. Annual average values will be used for Class A processing alternatives. Based on previous analysis of wastewater characteristic performed for this master plan, a maximum month loading factor of 1.15 was established.

5.7.1 Class B Facility Arrangements

As the County currently produces a Class B product using mesophilic digestion, changing to an alternative Class B process for either the Ina Road WRF or Roger Road WRF facilities would require significant capital investment. Additionally, methane is produced in the anaerobic digestion process that is currently used at Ina Road WRF for electricity generation. If another Class B process, such as aerobic digestion was used, this energy source would be lost. Thus, the only process given consideration for the production of Class B biosolids in this master plan is anaerobic digestion. Typically, the main process design parameter used in determining mesophilic digestion volume is the SRT which equals the hydraulic retention time (HRT). For combined primary and secondary solids fed to the digesters, a design HRT is typically 15-20 days under average annual loading or a minimum of 15 days at maximum month loading.

5.7.1.1 Class B Existing Plan

The existing plan for this master plan provides for a 32 mgd capacity at Roger Road WRF and a 50-mgd capacity at Ina Road WRF. A sub-alternative to the existing plan is the Roger Road water reclamation option. In this option, the means for handling, transferring to Ina Road WRF, and thickening biosolids at Roger Road WRF differs. Thus, the resultant biosolids loads to digestion are significantly different than for the original existing plan. All biosolids stabilization would be at Ina Road WRF for Class B production in this alternative and sub-alternative. The Roger Road WRF digesters have structural and solids deposition issues that would require rehabilitation or expansion if they were utilized with a plant capacity of 32 mgd. This coupled with the desire to minimize facilities at Roger Road WRF, make digestion at Roger Road WRF unattractive at a 32-mgd capacity. **Table 5-20** summarizes the maximum month sludge loading rates and resultant required volumes for mesophilic digestion for the existing plan alternatives. The water reclamation alternative associated with Roger Road WRF is shown for the plant having no primary tanks. In this arrangement, WAS is assumed to be thickened to 3 percent solids prior to pumping to Ina Road WRF. This concentration was chosen to balance head loss issues in the transfer line while still allowing for reasonable sizing of facilities. If a thinner WAS concentration is found to be necessary to reduce pumping head losses during further development of this master plan, it is recommended that additional thickening of the Roger Road WAS is performed at Ina Road WRF to allow the stabilization facilities to remain as currently sized.

Table 5-20
Summary of Class B Processing Existing Plan Bases of Design

Parameter	Existing Plan		Existing Plan WRF	
Plant	IR 50 mgd	RR 32 mgd	IR 50 mgd	RR 32 mgd
Thickening Facilities (24 hours / 7 days per week operation)				
Primary Sludge	6 GTs*	at Ina	4 GTs	None
WAS	3 GBTs	2 GBTs	3 GBTs	4 GBTs

Parameter	Existing Plan		Existing Plan WRF	
Total Max. Month Thickened Sludge, lb/day	180,100	102,000	180,100	104,100
Total Max. Month Thickened Sludge Flow, mgd	0.48	0.27	0.48	0.42
Total Solids to Digestion at Plant, lb/day	282,100	none	284,200	none
Total Solids Flow to Digestion at Plant, mgd	0.75	none	0.90	none
Minimum HRT, days	15	15	15	15
Required Volume, MG	11.3	none	13.5	none
Existing Digester Volume, each, MG	1.33	1.1	1.33	1.1
Existing Total Digester Volume, MG	5.3	4.4	5.3	4.4
Existing Number of Digesters	4	4	4	4
Total Number of Digesters Required	8.5 (9)	none	10.1 (10)	none
Additional Digesters Required	**5**	**None**	**6**	**None**
Dewatering Facilities Centrifuges (8/5 operation) Centrifuges (24/7 operation)	 6 4	 None None	 6 4	 None None
Sludge Storage, minimum days	10		10	
Minimum Storage Capacity at 8% solids, MG	2.5	None	2.5	None

GT = gravity thickener

5.7.1.2 Class B Transfer All

If all wastewater is transferred from the Roger Road WRF to the Ina Road WRF so that the Roger Road WRF site is completely decommissioned, solids processing would all occur at the Ina Road WRF site. **Table 5-21** summarizes the maximum month sludge loading rates and resultant required volumes for mesophilic digestion for the transfer all alternative at Ina Road WRF.

Table 5-21
Summary of Class B Processing Transfer All Bases of Design

Parameter	Transfer All Ina Road WRF
Thickening Facilities (24 hours / 7 days per week operation) Primary Sludge WAS	 6 GTs 4 GBTs
Total Max. Month Thickened Sludge, lb/day	280,300

Parameter	Transfer All Ina Road WRF
Total Max. Month Thickened Sludge Flow, mgd	0.75
Minimum HRT, days	15
Required Volume, MG	11.3
Existing Digester Volume, each, MG	1.33
Existing Total Digester Volume, MG	5.3
Existing Number of Digesters	4
Total Number of Digesters Required	8.5 (9)
Additional Digesters Required	**5**
Dewatering Facilities Centrifuges (8/5 operation) Centrifuges (24/7 operation)	 6 4
Sludge Storage, minimum days	10
Minimum Storage Capacity at 8% solids, MG	2.5

5.7.1.3 Class B Transfer Some

In the transfer some alternative, 62 mgd would be treated at Ina Road WRF and 20 mgd would be treated at Roger Road WRF. Biosolids processing could be performed all at Ina Road WRF or digestion could occur at Roger Road WRF as well during Class B production. This would be applicable if the existing Roger Road WRF digester volume was sufficient to achieve stabilization while allowing at least one digester out of service to address current condition issues. **Table 5-22** summarizes the maximum month sludge loading rates and resultant required volumes for mesophilic digestion for the transfer some alternative. Both all biosolids stabilization at Ina Road WRF and some stabilization at Roger Road WRF are shown in the table.

Table 5-22
Summary of Class B Processing Transfer Some Bases of Design

Parameter	All Processing at Ina Road WRF		With Digestion at Roger Road WRF and Ina Road WRF	
Plant	IR 62 mgd	RR 20 mgd	IR 62 mgd	RR 20 mgd
Thickening Facilities (24 hours / 7 days per week operation) Primary Sludge WAS	 6 GTs 4 GBTs	 @ Ina 2 GBTs	 5 GTs 4 GBTs	 2 GTs 2 GBTs

Parameter	All Processing at Ina Road WRF		With Digestion at Roger Road WRF and Ina Road WRF	
Total Max. Month Thickened Sludge, lb/day	215,100	66,800	215,100	66,800
Total Max. Month Thickened Sludge Flow, mgd	0.57	0.18	0.57	0.18
Total Solids to Digestion at Plant, lb/day	281,900	none	215,100	66,800
Total Solids Flow to Digestion at Plant, mgd	0.75	none	0.57	0.18
Minimum HRT, days	15	15	15	15
Required Volume, MG	11.3	none	8.6	2.7
Existing Digester Volume, each, MG	1.33	1.1	1.33	1.1
Existing Total Digester Volume, MG	5.3	4.4	5.3	4.4
Existing Number of Digesters	4	4	4	4
Total Number of Digesters Required	8.5 (9)	none	6.4 (7)	2.4 (3)
Additional Digesters Required	**5**	**None**	**3**	**None**
Dewatering Facilities				
Centrifuges (8/5 operation)	6	None	6	None
Centrifuges (24/7 operation)	4	None	4	None
Dewatered Sludge Storage, minimum days	10		10	
Minimum Storage Capacity at 8% solids, MG	2.5	None	2.5	None

5.7.2 Class A Facility Arrangements

To achieve a Class A product, two options were given development based on the Biosolids Workshop (No. 7) screening and further analysis, TPAD and mesophilic digestion followed by heat drying. As previously noted, the Cambi process may be an option for further consideration if Class A is implemented at a later date, but at this time, insufficient experience and the lack of Class A status make this alternative too high of a risk for development.

If the Cambi process were to be utilized in the future for the production of Class A biosolids, it would be added ahead of the mesophilic digesters. It would require addition of predewatering, typically performed via centrifuge or belt filter press technology, and patented Cambi hydrolysis chambers. These facilities would be provided instead of the thermophilic digestion shown in the alternatives. The mixing system in digesters would need to be evaluated to be sure it could handle the higher solids concentration.

For all Class A biosolids processing alternatives, the original assumption for this master planning effort – that all biosolids stabilization occurs at the Ina Road WRF - was employed. This approach will result in minimizing capital expenditure as well as providing consolidated facilities to efficiently operate and

maintain. Additionally, as the Roger Road WRF digesters are of questionable condition, this arrangement eliminates the need to investigate and renovate these facilities.

5.7.2.1 Class A Existing Plan

The existing plan alternatives for 50/32 mgd, either with Roger Road as a water reclamation facility option or with a rehabilitated existing Roger Road facility, would require additional mesophilic digestion at Ina Road WRF and either pre-thermophilic digestion or post heat drying. The Roger Road water reclamation alternative will result in a higher total solids mass and flow for processing due to the higher solids yield at Roger Road WRF in the secondary process without primary tanks and thickening Roger Road WAS to only 3 percent prior to pumping to Ina Road WRF. This concentration was chosen to balance head loss issues in the transfer line while still allowing for reasonable sizing of facilities. If a thinner WAS concentration is found to be necessary to reduce pumping head losses during further development of this master plan, it is recommended that additional thickening of the Roger Road WAS is performed at Ina Road WRF to allow the stabilization facilities to remain as currently sized. **Table 5-23** summarizes the annual average sludge loading rates and resultant required volumes for TPAD and heat drying for the existing plan alternatives.

Table 5-23
Summary of Class A Processing Existing Plan Bases of Design

Parameter	TPAD		Heat Drying	
Plant	Existing Plan	RR WRF	Existing Plan	RR WRF
Total Solids to Digestion at Ina Road WRF, lb/day	245,300	247,100	245,300	247,100
Total Solids Flow to Digestion at Ina Road WRF, mgd	0.66	0.78	0.66	0.78
Minimum Mesophilic HRT, days	10	10	15	15
Required Mesophilic Volume, MG	6.6	7.8	9.9	11.7
Existing Digester Volume, each, MG	1.33	1.33	1.33	1.33
Existing Total Digester Volume, MG	5.3	5.3	5.3	5.3
Existing Number of Digesters	4	4	4	4
Total Number of Mesophilic Digesters Required	4.9 (5)	5.8 (6)	7.4 (8)	8.8 (9)
Additional Mesophilic Digesters Required	**1**	**2**	**4**	**5**
Minimum Thermophilic HRT, days	5	5	–	–
Required Thermophilic Volume, MG	3.3	3.9	–	–
Number of Active Batch Thermophilic Digesters Required (same size as existing digesters)	2.5 (3)	2.9 (3)	–	–
Number of Fill/Draw Digesters (2*active digesters)	6	6	–	–

Parameter	TPAD		Heat Drying	
Total Number of Thermophilic Digesters	**9**	**9**	–	–
Dewatering Facilities Centrifuges (8/5 operation) Centrifuges (24/7 operation)	 5 3	 6 4	 5 3	 6 4
Dewatered Sludge Storage, minimum days	10	10	3	3
Minimum Storage Capacity at 8% solids, MG	2.5	2.5	–	–
Minimum Storage Capacity at 20% solids, MG	–	–	0.25	0.25
Dewatered Cake to Drying, lbs/day tons/week	 – –	 – –	 145,000 510	 145,000 510
Drying Train Capacity, ton/day	–	–	20	20
Heat Drying Operation	–	–	24 hrs/5 day	24 hrs/5 day
Drying Trains Required	–	–	5.1 (6)	5.1 (6)

5.7.2.2 Class A Transfer All and Transfer Some

The transfer all and transfer some alternatives would require additional mesophilic digestion at Ina Road WRF and either pre-thermophilic digestion or post heat drying. As the total solids to digestion are approximately the same for these alternatives and all digestion was assumed to occur at Ina Road, WRF the required biosolids facilities for both alternatives are the same. **Table 5-24** summarizes the annual average sludge loading rates and resultant required volumes for TPAD and heat drying for the transfer all and transfer some alternatives.

Table 5-24
Summary of Class A Processing Transfer All/Some Bases of Design

Parameter	TPAD	Heat Drying
Total Solids to Digestion at Ina Road WRF, lbs/day	245,100	245,100
Total Solids Flow to Digestion at Ina Road WRF, mgd	0.66	0.66
Minimum Mesophilic HRT, days	10	15
Required Mesophilic Volume, MG	6.6	9.9
Existing Digester Volume, each, MG	1.33	1.33
Existing Total Digester Volume, MG	5.3	5.3
Existing Number of Digesters	4	4
Total Number of Mesophilic Digesters Required (Rounded Up)	4.9 (5)	7.4 (8)
Additional Mesophilic Digesters Required	**1**	**4**

Parameter	TPAD	Heat Drying
Minimum Thermophilic HRT, days	5	–
Required Thermophilic Volume, MG	3.3	–
Number of Active Batch Thermophilic Digesters Required (same size as existing digesters)	2.5 (3)	–
Number of Fill/Draw Digesters (2*active digesters)	6	–
Total Number of Thermophilic Digesters	**9**	–
Dewatering Facilities Centrifuges (8/5 operation) Centrifuges (24/7 operation)	 5 3	 5 3
Dewatered Sludge Storage, minimum days	10	3
Minimum Storage Capacity at 8% solids, MG	2.5	–
Minimum Storage Capacity at 20% solids, MG	–	0.25
Dewatered Cake to Drying, lbs/day tons/week	 – –	 145,000 510
Drying Train Capacity, ton/day	–	20
Heat Drying Operation	–	24 hrs/5 day
Drying Trains Required	–	5.1 (6)

5.8 PCRWRD Energy Evaluation - Findings

5.8.1 Summary

The master plan recommends moving all biosolids handling and biogas production to Ina Road WRF by the year 2014. Further, it is recommended that mesophilic anaerobic digestion continue to be utilized with Class B or Class A stabilization. Thus, biogas will be produced at the Ina Road WRF throughout the planning period. This chapter of the master plan report presents preliminary findings and recommendations on how to best utilize the nearly 500 million cubic feet per year of biogas that will be produced in biosolids stabilization.

Options for evaluation of power supply facilities, listed in order of their current recommendation ranking, are:

A. *Continue the practice of biogas utilization for engine driven equipment and power generation onsite* (also referred to as Combined Heat & Power (CHP) in this chapter). Two alternatives are developed for this option: CHP1 matches system capacity to burn only the biogas that will be produced and CHP2 further increases system capacity to meet the total electric demand of the Ina Road facilities by burning supplemental natural gas to generate the additional electricity. The system could be operated by PCRWRD or an outside contractor.
B. *Sell all biogas to a third party for commercial use* (Third Party Use – TPU). Two alternatives are presented for this option: TPU1 contracts with an energy developer to transport the biogas offsite for energy recovery and under TPU2 the energy developer operates energy recovery systems onsite.

C. *Purchase power from a local utility and use biogas for heating and cooling functions* (Heating and Cooling Use – HCU). HCU1 decommissions the engines and replaces the lost thermal output capacity with boilers.

5.8.2 Ranking

The ranking of the options in order of economic potential is:

1. Combined Heat and Power (CHP1 and CHP2)
   - Internal combustion engine generators are the superior technology for both the CHP1 and CHP2 alternatives because they are a proven, familiar technology with maximum electrical output when compared to other system technologies like microturbines, fuel cells and Stirling engines.
   - High energy recovery system energy savings occur when they are limited to consuming only digester gas (CHP1), and the peak savings occur when the all the electricity and heat produced are put to beneficial use. Ina Road WRF, in the year 2014, will be close to this ideal match. The Ina Road WRF will consume all the biogas produced electricity and well over eighty percent of the engine thermal output at that point.
   - CHP2 is inferior to CHP1 economically because the cost of natural gas used to generate power above that which can be produced from biogas is roughly equal to the equivalent cost of utility electricity. There is also no projected use for the additional 'free' heat produced by the generator equipment during natural gas utilization to produce power.
2. Third Party Use (TPU1 and TPU2)
   - Pressure on utilities to generate greater portions of their power using renewable energy (e.g., the Arizona Corporation Commission's (ACC's) Environmental Portfolio Standard) will continue between now and 2014. This should increase the value of the renewable biogas. However, as of yet, sufficient credits are not available to provide the energy developer significant economic benefit.
   - TPU2 presumes an agreement could be reached with an energy developer to run the existing (on-site, upgraded) energy recovery facility. This alternative is cumbersome from a labor relations perspective as it is essentially CHP1 with the substitution of contract labor.
   - The off-site alternative (TPU1) requires energy recovery system modifications to replace the engine heat used to drive cooling, space heating and digester heating systems and loses the electrical reliability provided by the on-site engine-generators. PCRWRD would still have to incur the operating costs for the on-site heating and central cooling systems. Also, the energy developer will incur a considerable capital cost.
   - The economic viability of TPU2 is highly dependent upon whether an energy developer can significantly reduce maintenance and operating costs below those incurred by PCRWRD, without sacrificing reliability. The economic viability of TPU1 depends more upon what future incentives,

especially for investment, will be available to the energy developer. Additionally, the developer will need to find an end use for the biogas elsewhere that is superior to the already good 'match' at the Ina Road WRF.

3. Heating and Cooling Use – HCU1
   - This option would use boilers, which have nearly twice the heat output of engines per unit of biogas, to replace the thermal output of the engines.
   - This alternative has a far greater thermal output than is needed at the plant and would result in the loss of more than half of the beneficial biogas use.
   - The plant will have a far greater need for electricity than for heating and cooling.
   - A potential hybrid TPU-HCU option that would consume biogas for thermal loads on-site and sell the remainder to an energy developer may have merit.

5.8.3 Economic Comparison Summary of Options

The project cost ranges, savings and 20-year net present worth ranges of the options are shown in **Table 5-25**.

Table 5-25
Alternatives Economic Comparison

($ x 1,000)	CHP1	CHP2	TPU1 (off-site)	TPU2 (on-site)	HCU1
Project Cost	(5,500) to (12,000)	(25000) to (30,000)	(2,000) to (3,000)	(5,500) to (12,000)	(1,500) to (2,000)
Energy Savings/Yr	3,271	3,271	834*	3,271*	1,071
Energy Costs/Yr	(1,971)	(2,100)	(5,147)	(1,971)	(4,170)
Operating Costs/Yr	(1,475)	(1,977)	(400)	(1,844)*	(500)
Present Worth**	684 to (8,200)	(21,200) to (24,700)	(71,030) to (71,750)	(3,516) to (8,180)	(57,840) to (58,200)

* TPU1 Contract savings assumed to be same as CHP1, operating costs are those for CHP1 plus 25%.
** TPU2 Contract assumed to be 50% of the maximum utility replacement value of CHP electric and thermal energy of the gas less operating costs.
** 20 year net present worth: 8% discount rate, 6% energy escalation rate, 3% general and maintenance escalation rates, construction midpoint in 2013 and energy savings/costs commence in 2014.

5.8.4 Conclusions and Recommendations

CHP1 has the highest net present worth to PCRWRD. Its advantages include:

- The existing engine-generator capacity is a good match for the projected biogas production. The engines' thermal output is also a good match for the projected process and space thermal usages. This coincidence is one that produces maximum energy recovery and energy savings.
- Maintaining the existing engine capacities has air permitting advantages.
- Much of the energy recovery infrastructure is in place and serviceable. Even if field condition assessments recommend that the engine, generator and generator control equipment should be replaced, the costs are less than replicating the serviceable equipment already in place.
- The projected increase in plant electrical demand warrants that the utility service connections to Ina Road WRF be rationalized and that more redundant plant electrical distribution be included in the upgrade. Automatic generator synchronization is recommended as part of this work.

The economics of the energy developer alternatives, TPU1 and TPU2, are based upon reasonable assumptions but without any preliminary negotiation to assess a market value for the biogas.

5.8.5 Combined Heat & Power (CHP) Alternatives

5.8.5.1 Alternatives Listing

CHP alternatives selected for preliminary evaluation and the criteria used to compare them are shown in **Table 5-26**.

Table 5-26
Comparison of CHP Selection Criteria

Combined Heat & Power System					
Comparison Criteria	**IC Engine**	**Microturbine**	**Turbine**	**Fuel Cell**	**Stirling Eng**
Technology Status	Proven	Proven in Landfill Gas	Effective in large apps.	Emerging	Emerging
Mechanical Efficiency (% of input)	35%	26%	20-30%	>40%	25-30%
Heat Recovery Potential (% of input)	25% 45 or higher with exhaust heat recovery	40%	45% and higher	~30%	30%
Heating Temperature (hot water)	200-220 deg, steam with exhaust heat rec.	180-200	high temp hw, steam or both	160-200, emerging types higher	180-220
Emission Challenges	NOx, CO, VOCs	none	potential NOx	none	minor
Gas Pressure	<5 pounds per square inch (psig)	~50 psig	~200 psig	3-10 psig	<1 psig
Sulfur Dioxide Limits	<1000 parts per million (ppm)	75-100 ppm	varies greatly	<100 ppm	1000+
Siloxane Limits	~4000 parts per billion by volume (ppbv)	5-10 ppbv	~80 ppbv	50-100 ppbv	high tolerance
Capital Cost, $/kW	1000- 1600	1800-3000	900-2100	>4000	>2000
Hours Between Overhauls	20000- 40000	5000- 40000	30000- 40000	10000- 40000	10000- 20000
Gas Conditioning Cost	moderate	very high	high	very high	moderate
Overall Maintenance Cost, ¢/kWh	1.5, up to 4.0 with emissions control	1.5- 3.5	1.0- 2.0, higher with emissions	1.0- 1.5	2.0- 4.0
Startup Time	10-15 seconds	60 seconds	5-10 minutes	3 hours- 2 days	~5 minutes
Load Following	excellent	fair	fair	fair	fair

Combined Heat & Power System					
Comparison Criteria	IC Engine	Microturbine	Turbine	Fuel Cell	Stirling Eng
Motor Starting Capability	excellent	poor (synchronous utility translation system: good)	good	poor	fair

5.8.5.2 Alternatives Comparison Summary

Almost all the comparison criteria favor IC engine-generators at Ina Road WRF. Especially important criteria are the high mechanical efficiency, best gas impurity tolerance, personnel familiarity and lower capital cost.

Air emissions limits are a potential drawback to the use of IC engines. Engine replacement can include low NO_X machines and limiting sizing of the energy recovery systems, specifically engines, to digester gas production only the potential to stay within existing air permit criteria.

Good biogas conditioning is especially crucial to the effective operation of all these combined heat and power systems and especially so for the microturbines and fuel cells. They have an order of magnitude more stringent (and expensive) requirements. IC engines are tolerant of occasional lapses in gas treated gas quality. Of the systems listed, IC engines have the lowest biogas treatment energy costs.

Gas conditioning, especially for siloxanes, is still an emerging technology. The Ina Road WRF project has the advantage of enough lead time to better prove and establish good H_2S and siloxane treatment processes and systems.

5.8.6 Existing Ina Road WRF Energy Recovery Systems Overview

The heart of the systems are seven 650 kW engine generators that can operate on propane, biogas or natural gas. Heat is recovered from engine jacket water and exhaust. Jacket water leaving the engines is piped to ebullient (exhaust heat recovery) boilers that generate low-pressure steam. A boiler having three fuel input capability supplements engine steam generation.

Steam feeds four heat exchangers that generate domestic hot water, heating water and sludge heating water. The fourth heat exchanger transfers excess heat not used for heating to plant effluent water.

Steam also fires an absorption chiller that serves a majority of the cooling loads at the plant through a chilled water distribution system. Most of the plant heating loads are served by the energy recovery system through a hot water distribution system. **Table 5-27** lists the electric and thermal output and input capacities of major energy recovery equipment.

Table 5-27
Major Energy Recover Equipment Capacities

Equipment	MBH (1000 BTUs/hour)		Electric Output (kW)
	Input	Output	
Engine Generators	49000	17864	4550
Heat Rec Silencers		3200	
Steam Boiler		5300	
Domestic Hot Water Tank (HW) and Heat Exhaust (HEX)		2000	
HW HEX		8400	
Sludge HEXs		6500	
Heat Rej HEX		18000	
Adsorption Chiller	12000	600 (tons)	

Preliminary projections of the 2014 digester heating, space heating and space cooling loads reveal that these thermal systems have roughly the same demands as the system capacities listed above. Matching engine heat output with thermal loads greatly improves energy savings and return on investment.

5.9 Biosolids Processing Recommendations

Biosolids processing at wastewater treatment facilities is an integral and often costly part of the treatment plant operations. Incorporating sufficient facilities to remove solids from the wastewater stream, adequately stabilize these solids, and reliably dispose of the resultant product continues to be a challenge. The possibility that Class B biosolids could not be viable for traditional land application or other beneficial uses in the future requires attention and planning. The overall goal of these evaluations is to provide a road map for biosolids processing and handling that will allow the County to cost effectively process and dispose of biosolids now and through the 25-year planning period that can adapt to changes in the disposal markets. To that end, this chapter summarizes recommendations for consideration by the County in planning future biosolids processing at the wastewater treatment facilities.

5.9.1 Available Markets and Disposal Options

The County is currently utilizing land application through a local contractor to dispose of biosolids at approximately 8 percent solids to agricultural lands within an approximate 25 mile haul distance. This option appears to be viable through the planning period for Class B biosolids based on discussions with the existing contractor (see Chapter 2.5 for details). There is concern that most of the proximate agricultural lands are controlled by a single contractor, although other contractors have bid for disposal in the past. Alternative disposal options that could be promising even for Class B biosolids include: landfilling as a backup disposal method and investigation of dedicated land application.

Another market that shows promise in the area is mine reclamation. A number of mines are located in Arizona. The current University of Arizona project utilizing Green Valley WRF biosolids has been

successful. This market should be given further investigation. A dry, Class A product would be required. This disposal option may be most applicable to the Non-Metro facilities as regional biosolids disposal from these facilities is considered.

In an effort to provide PCRWRD with the optimal biosolids processing strategy, an extensive market study should be performed. The market assessment should address elements of a long-term biosolids management plan and include, at a minimum, the following items.

- Analysis of current biosolids program to establish baseline conditions
- Projected quantity and quality of biosolids and the effects of liquid treatment process changes
- Determine demand for a Class A and/or Class B product
- Identify multiple biosolids disposal options/outlets
- Determine appropriate liquid and/or dry forms
- Determine regulatory and social issues
  - Regulatory pressures
  - Public concerns
  - Increased urbanization
  - National trends
- Identify and screen process technologies
- Screen process technologies using economic and non-economic criteria
- Develop preliminary alternatives
- Evaluate shortlisted alternatives
- Examine possible design, build, operate options
- Determine if Ina Road WRF biosolids processing facility, a separate regional processing facility, or a combination of both are needed
- Conclude location of a regional solids processing facility if one is deemed necessary
- Recommend long-term plan
- Cost summary
- Implementation plan

A market assessment of this scale requires approximately 12 – 15 months to complete.

5.9.2 Recommended Level of Biosolids Stabilization

The County currently produces Class B biosolids at the Ina Road WRF and Roger Road WRF. This product is and is expected to remain consistent with land application into the future. The cost of producing Class A biosolids is considerably higher in capital investment as well as operation and maintenance costs regardless of the Class A process utilized. For example, TPAD will require significant additional digesters, heating equipment, and heat exchangers to meet the Class A requirements.

The need for Class A biosolids in the current regulatory and public environment is not clear. It is appropriate to have a plan in place such that future Class A facilities could be added on to the treatment trains. However, it does not appear to be in the County's best interest to make the considerable capital investment to produce Class A biosolids at this point in time when a direct need has not been identified. Additionally, in some areas of the country, land application of any biosolids has been seen as

unacceptable, regardless of whether it is a Class A product. If that future situation were to be encountered, the type of Class A product desired could be very different than envisioned at this time, which could require different processing.

Thus, it is recommended that the County continue to produce Class B biosolids using consolidated mesophilic digestion facilities at Ina Road WRF. This stabilization process will provide digester gas for use at the plant. Additionally, TPAD, heat drying, or possibly the Cambi process could be added in the future to produce Class A biosolids if necessary. An arrangement has been determined for the required Class A TPAD facilities on the Ina Road WRF site based on the conceptual sizing performed in this chapter. Finally, the centrifuges should be designed to operate in either a thickening or dewatering mode that will permit the use of landfilling as a backup or contingency plan for biosolids handling.

An alternative arrangement for consideration is to provide one thermophilic digester or arrange one of the mesophilic digesters to operate in thermophilic mode. This digester could be used to produce equivalent Class A biosolids. The County could then evaluate whether these solids could be disposed of at a lower cost than Class B biosolids and plant personnel could become familiar with its operation.

5.9.3 Recommended Biosolids Processing Improvements

In order to provide reliable biosolids processing and disposal through the planning period, the following biosolids processing improvements are recommended. The improvement recommendations are based on the Existing Plan WRF subalternative (50-mgd Ina Road WRF and 32-mgd Roger Road WRF without primary tanks).

Roger Road WRF

- Decommission existing gravity thickeners and dissolved air flotation thickeners
- Provide waste activated sludge gravity belt thickening facilities with 4 gravity belt thickeners to produce a minimum of 3 percent solids
- Decommission existing digesters
- Improve transfer pump station facilities to transfer 3 percent waste activated sludge to Ina Road WRF through the existing transfer force main
- Consider providing redundancy to the single sludge force main through construction of a parallel force main

Ina Road WRF

- Expand existing gravity thickening facilities for primary sludge at the same size as existing for a total of 4 gravity thickeners to produce 5 percent solids. (If no thickening is provided at Roger Road WRF, 6 gravity thickeners would be required.)
- Provide waste activated sludge gravity belt thickening facilities with 3 gravity belt thickeners to produce a minimum of 5 percent solids. (If no thickening is provided at Roger Road WRF, 6 gravity belt thickeners would be required.)
- Expand existing mesophilic digestion capacity with 6 additional digesters at the same size as existing

- Expand centrifuge facility to have 6 units (for 5 days per week operation) or 4 units (for 7 days per week operation) that can be operated to produce either thickened or dewatered solids
- Replace and expand centrate and cake pumping systems at the centrifuge facility
- Make provisions for struvite control in design of facilities with glass lined piping and possible chemical feed systems
- If 5 days per week operation is desired for dewatering, provide digested sludge storage upstream of centrifuges
- Provide thickened/dewatered solids storage with storage capacity to hold 10 days of solids production
- Replace existing solids transfer station
- Additional digesters may be required if the biosolids market study determines Southlands WRF biosolids be treated at Ina Road WRF's biosolids processing facility. The market study should determine the extent (number of digesters, dewatering process, etc.) processing improvement requirements are to be made

5.9.4 Recommended Biogas Utilization

It is recommended that the biogas be utilized for onsite power and thermal generation. The recommendation includes improving the gas cleaning process and the provision for new engine generator sets.

5.10 Recommended Biosolids Management Plan

The County is currently utilizing land application through a local contractor to dispose of biosolids. This approach is viable through the planning period for Class B biosolids, however, there is concern that most of the agricultural lands in close proximity of the plants are controlled by a single contractor, although other contractors have bid for biosolids disposal services in the past. Alternative disposal options for Class B biosolids include: landfilling, as a backup disposal method, and a dedicated land application.

Another market that shows promise is a dry Class A product for mine reclamation. A current University of Arizona project utilizing Green Valley WRF biosolids for reclamation on Asarco Mission Mine has been successful. This market should be given further investigation as there are a number of mines located in Arizona, many in the southern region of the County. This disposal option may be most applicable to the Non-Metro facilities.

An extensive market study is required to provide PCRWRD with the optimal biosolids processing strategy. The market assessment needs to address elements of a long-term biosolids management plan, most notably to determine the demand for a Class A, or Class B product or both; identify multiple biosolids disposal options and outlets; and determine if processing on a Metro or Non-Metro scale is required.