CHAPTER 8 – BIOSOLIDS MANAGEMENT

8.1 Introduction

Often referred to as sewage sludge, biosolids consist of a solid, semisolid, or liquid residue generated during the treatment of domestic sewage in a wastewater treatment facility. Biosolids are removed from primary, secondary, or advanced treatment processes, but do not include the grit and screenings. Of the constituents removed during wastewater treatment processes, biosolids are the largest by volume, creating a complex problem for their treatment and disposal. This chapter outlines the EPA regulations for the handling and disposal of biosolids, and specifically details beneficial reuse alternatives for biosolids generated on Guam.

Presently, GWA does not adhere to EPA's biosolids regulations governing the reuse of biosolids on agricultural lands by local farmers. GWA's current practice is to transport the liquid biosolids produced by the island's sewage treatment plants (approximately 90% percent of the island's sludge is produced at NDSTP) to the NDSTP for drying in the STP's sludge drying beds. The dried biosolids are then moved to a staging area that consists of a concrete pad, not large enough to hold all the biosolids produced. The biosolids are dried further in this covered area before they are distributed to local farmers. There are three local farmers that utilize the material and occasionally the Ordot Landfill accepts the material as landfill cover. GWA has one dump truck to truck the biosolids, but will hire a private truck when production volumes are high. There is no testing of the biosolids prior to final disposal.

8.2 Regulation for the Reuse and Disposal of Biosolids

In 1993, EPA put into effect Title 40 of the Code of Federal Regulations (CFR), Part 503, *The Standards for the Use or Disposal of Sewage Sludge* (EPA, 1993). This regulation was developed as a requirement by the Clean Water Act Amendments of 1987, to protect public health and the environment from any reasonably anticipated adverse effects of certain pollutants that might be present in sewage sludge. The Part 503 rule established a set of requirements for the three most common final use or disposal methods of biosolids generated at a wastewater treatment plant: (1) land application as a soil conditioner or fertilizer, (2) surface disposal at a specific final disposal site and (3) incineration. The EPA has established regulations for each of the use or disposal methods, which are summarized below and ultimately used for evaluating beneficial use alternatives specific to Guam.

It is important to note that GEPA does not have the local legislative authority to develop and enforce EPA's 40 CFR 503 regulations. Until a local regulation is adopted, GEPA cannot issue NOV to enforce the 40 CFR 503 requirements. The process to incorporate 40 CFR 503 regulations into public law is lengthy, estimating to take up to two years to complete. GEPA has prepared a draft law for consideration by the Guam Legislature, but has not submitted the final to the legislature for consideration. In the absence of a local regulation, GWA must meet the existing Part 503 federal regulation.

8.2.1 Land Application to Condition or Fertilize Soil

Land application of biosolids to condition or fertilize soil for crops or other vegetation is the most common beneficial use of biosolids in the United States. Some examples of land that benefits from biosolids application and are not frequently visited by the public, include

agricultural land, forest land and reclamation sites. Some examples of land where the public is likely to come into contact with biosolids include public parks, plant nurseries, roadsides, golf courses, lawns, and home gardens. Depending upon the land application use, three EPA regulation categories must be addressed: pollutant concentration limits for 10 heavy metals, Class A or Class B pathogen reduction, and vector attraction reduction. Record keeping and reporting requirements are also required by the EPA in conjunction with monitoring and are detailed in Part 503.

The EPA has established four options for meeting land application requirements pertaining to pollutant limits, pathogen class, and vector attraction reduction. Each of the four options as listed represents a subset of biosolids quality. Their associated beneficial reuse for alternative land applications are described below.

Exceptional Quality (EQ): EQ biosolids meet a low pollutant limit and a Class A pathogen reduction. They can be used in bulk or either given or sold in containers for unrestricted use where the general public may come into contact with the biosolids.

Pollutant Concentration (PC): PC biosolids meet the same low pollutant concentrations limits as EQ biosolids, but only meet a Class B pathogen reduction. PC biosolids may only be applied to land in bulk and are subject to management practices.

Cumulative Pollutant Loading Rate (CPLR): CPLR biosolids typically exceed at least one of the pollutant concentration limits for EQ and PC biosolids, but they meet the ceiling concentration limits. CPLR biosolids must be applied to land in bulk form and the pollutant levels must be tracked and cannot exceed the CPLR.

Annual Pollutant Loading Rate (APLR): APLR biosolids exceed the pollutant limits for EQ biosolids but meet the ceiling concentration limits. They are sold or given away in a bag or other container for land application.

8.2.1.1 Pollutant Limits of Heavy Metals for Land Application

All land-applied biosolids, including the four options defined above, must not exceed EPA's maximum concentration limits for 10 heavy metals. These metals are arsenic, cadmium, chromium, copper, lead, mercury, molybdenum, nickel, selenium and zinc. The concentration limits for each of the 10 pollutants are detailed in Part 503 and are listed in Table 8-1.

Table 8-1 – Pollutant Limits for all Land-Applied Biosolids (EPA, 1993)

Pollutant	Ceiling Concentration Limits for All Biosolids Applied to Land (milligrams per kilogram)[a]	Pollutant Concentration Limits for EQ and PC Biosolids (milligrams per kilogram)[a]	Cumulative Pollutant Loading Rate Limits for CPLR Biosolids (kilograms per hectare)	Annual Pollutant Loading Rate Limits for APLR Biosolids (kilograms per hectare per 365-day period)
Arsenic	75	41	41	2.0
Cadmium	85	39	39	1.9
Chromium	3,000	1,200	3,000	150
Copper	4,300	1,500	1,500	75
Lead	840	300	300	15
Mercury	57	17	17	0.85
Molybdenum[b]	75	-	-	-

Table 8-1 – Pollutant Limits for all Land-Applied Biosolids (EPA, 1993) [continued]

Pollutant	Ceiling Concentration Limits for All Biosolids Applied to Land (milligrams per kilogram)[a]	Pollutant Concentration Limits for EQ and PC Biosolids (milligrams per kilogram)[a]	Cumulative Pollutant Loading Rate Limits for CPLR Biosolids (kilograms per hectare)	Annual Pollutant Loading Rate Limits for APLR Biosolids (kilograms per hectare per 365-day period)
Nickel	420	420	420	21
Selenium	100	36	100	5.0
Zinc	7,500	2,800	2,800	140
Applies to:	All biosolids that are land applied	Bulk biosolids and bagged biosolids[c]	Bulk biosolids	Bagged biosolids[c]

[a] Dry-weight basis.

[b] As a result of the February 25, 1994, Amendment to the rule, the limits for molybdenum were deleted from the Part 503 rule pending EPA reconsideration.

[c] Bagged biosolids are sold or given away in a bag or other container.

The EPA has set requirements for land application of biosolids that depend on the level of pathogen reduction achieved at the wastewater treatment plant. The level of pathogens present in treated biosolids governs the designation of either a Class A or Class B biosolids. In general, if pathogens have been reduced below detectable levels, the biosolids meet Class A designation. If pathogens have been reduced to levels that do not pose a threat to public health or the environment and actions are taken to prevent exposure to the biosolids after disposal, the biosolids meet Class B designation. Specific EPA treatment criteria for meeting both Class A and Class B levels are discussed in further detail below.

8.2.1.2 Class A Biosolids

Class A biosolids can be land applied to areas where public contact is likely, such as parks, lawns, gardens and golf courses and they can be used as a soil conditioner or fertilizer where food crops are grown. The EPA has established six treatment alternatives for achieving a Class A level biosolids with respect to pathogens, as listed in Table 8-2.

Table 8-2 – EPA Approved Treatment Alternatives for Meeting Class A Pathogen Requirements (EPA, 1993)

Treatment Alternative		Treatment Description
1	Thermally Treated Biosolids	Biosolids must be subjected to one of four time-temperature regimes.
2	Biosolids Treated in a High pH-High Temperature Process	Biosolids must meet specific pH, temperature and air-drying requirements.
3	Biosolids Treated in Other Processes	Demonstrate that the process can reduce enteric viruses and viable helminth ova. Maintain operating conditions used in the demonstration after pathogen reduction demonstration is completed.
4	Biosolids Treated in Unknown Processes	Biosolids must be tested for pathogens – *Salmonella* sp. or fecal coliform bacteria, enteric viruses and viable helminth ova – at the time the biosolids are used or disposed of, or, in certain situations, prepared for use or disposal.
5	Biosolids Treated in a PFRP	Biosolids must be treated in one of the Processes to Further Reduce Pathogens (PFRP) (see Table 5-4 of Part 503).
6	Biosolids Treated in a Process Equivalent to a PFRP	Biosolids must be treated in a process equivalent to one of the PFRPs, as determined by the permitting authority.

The treatment alternatives listed above, involve such technologies as composting, heat drying, thermophilic aerobic digestion, beta ray irradiation, gamma ray irradiation and pasteurization. The EPA has specific time and temperature criteria for each treatment alternative that must be met in order to achieve a Class A level. By the time Class A biosolids are used, sold, or disposed of, the EPA requires that one of the following criteria must be met by any of the approved treatment processes:

- The density of fecal coliform in the biosolids must be less than a 1,000 most probable number (MPN) per gram of total solids (dry-weight basis), or
- The density of *Salmonella* sp. bacteria in the biosolids must be less than 3 MPN per 4 grams of total solids (dry-weight basis).

8.2.1.3 Class B Biosolids

Standards for treatment of Class B biosolids are less stringent than those for Class A biosolids. Site restrictions for land application specific to crop harvesting, animal grazing and potential public contact are required through EPA regulations, as listed in Table 8-3.

Table 8-3 – EPA Site Restrictions for Class B Biosolids Applied to Land (EPA, 1993)

Potential Site	Site Restrictions
Food Crops with Harvested Parts That Touch the Biosolids/Soil Mixture	Food crops with harvested parts that touch the biosolids/soil mixture and are totally above the land surface shall not be harvested for 1-4 months after application of biosolids.
Food Crops with Harvested Parts Below the Land Surface	Food crops with harvested parts below the surface of the land shall not be harvested for 20 months after the application of biosolids when the biosolids remain on the land surface for 4 months or longer prior to incorporation into the soil.
	Food crops with harvested parts below the surface of the land shall not be harvested for 38 months after application of biosolids when the biosolids remain on the land surface for less than 4 months prior to incorporation into the soil.
Food Crops with Harvested Parts That Do Not Touch the Biosolids/Soil Mixture, Feed Crops and Fiber Crops	Food crops with harvested parts that do not touch the biosolids/soil mixture, feed crops and fiber crops shall not be harvested for 30 days after application of biosolids.
Animal Grazing	Animals shall not be grazed on the land for 30 days after application of biosolids.
Turf Growing	Turf grown on land where biosolids are applied shall not be harvested for 1 year after application of the biosolids when the harvested turf is placed on land with either a high potential for public exposure or a lawn, unless otherwise specified by the permitting authority.
Public Access	Public access to land with a high potential for public exposure shall be restricted for 1 year after application of biosolids.
	Public access to land with a low potential for public exposure shall be restricted for 30 days after application of biosolids.

Similar to EPA-approved Class A treatment technologies, the EPA has established three treatment alternatives for achieving a Class B level biosolids with respect to pathogens, as listed in Table 8-4.

Table 8-4 – EPA Approved Treatment Alternatives for Meeting Class B Pathogen Requirements (EPA, 1993)

Treatment Alternative		Treatment Description
1	Monitoring of Indicator Organisms	Test for fecal coliform density as a factor for all pathogens. The geometric mean of seven samples shall be less than 2 million Most Probable Numbers (MPNs) per gram per total solids or less than 2 million Colony Forming Units (CFUs) per gram of total solids at the time of use or disposal.
2	Biosolids Treated in a Processes to Significantly Reduce Pathogens	Biosolids must be treated in one of the Processes to Significantly Reduce Pathogens (see Table 5-7 of Part 503).
3	Biosolids Treated in a Process Equivalent to a Processes to Significantly Reduce Pathogens	Biosolids must be treated in a process equivalent to one of the Processes to Significantly Reduce Pathogens, as determined by the permitting authority.

These treatment technologies include aerobic digestion, air drying, anaerobic digestion, composting, and lime stabilization. The EPA has specific time and temperature criteria for each treatment alternative that must be met for a Class B level to be achieved. If the time and temperature criteria are met for the specific treatment alternative, it is assumed that a Class B level has been achieved. These values are listed in Table 8-5.

Table 8-5 – Process to Significantly Reduce Pathogens for meeting Class B Pathogen Requirements (EPA, 1993)

Process	Process Requirements
Aerobic Digestion	Biosolids are agitated with air or oxygen to maintain aerobic conditions for a specific mean cell residence time at a specific temperature. Values for the mean cell residence time and temperature shall be between 40 days at 20°C and 60 days at 15°C.
Air Drying	Biosolids are dried on sand beds or on paved or unpaved basins. The biosolids dry for a minimum of 3 months. During 2 of the 3 months, the ambient average daily temperature is above 0°C.
Anaerobic Digestion	Biosolids are treated in the absence of air for a specific mean cell residence time at a specific temperature. Values for the mean cell residence time and temperature shall be between 15 days at 35°C to 55°C and 60 days at 20°C.
Composting	Using either the within-vessel, static aerated pile or the window composting methods, the temperature of the biosolids is raised to 40°C or higher and maintained for 5 days. For 4 hours during the 5-day period, the temperature in the compost pile exceeds 55°C.
Lime Stabilization	Sufficient lime is added to the biosolids to raise the pH of the biosolids to 12 after 2 hours of contact.

8.2.1.4 Vector Attraction Reduction for Land Application

Reducing the attractiveness of biosolids to such vectors as flies, mosquitoes, fleas, rodents and birds reduces the potential for transmitting diseases from pathogens in biosolids. The EPA has established 12 treatment options for reducing vector attraction, as listed in Table 8-6. Depending upon the land application use or disposal method, one of the 12 treatment options is required.

Table 8-6 – EPA Approved Options for meeting Vector Attraction Reduction (EPA, 1993)

Option	Description of Option
1	Meet 38% reduction in volatile solids content.
2	Demonstrate vector attraction reduction with additional anaerobic digestion in a bench-scale unit.
3	Demonstrate vector attraction reduction with additional aerobic digestion in a bench-scale unit.
4	Meet a specific oxygen uptake rate for aerobically digested biosolids.
5	Use aerobic processes at greater than 40°C for 14 days or longer.
6	Alkali addition under specified conditions.
7	Dry biosolids with no unstabilized solids to at least 75% solids.
8	Dry biosolids with unstabilized solids to at least 90% solids.
9	Inject biosolids beneath the soil surface.
10	Incorporate biosolids into the soil within 6 hours of application to or placement on the land.
11	Cover biosolids placed on a surface disposal site with soil or other material at the end of each operating day. (Note: Only for surface disposal.)
12	Alkaline treatment of domestic septage to pH 12 or above for 30 minutes without adding more alkaline material.

8.2.1.5 Land Application Alternatives

Land application alternatives depend on the physical characteristics of the biosolids (percent solid), site topography, soils and type of vegetation present (annual field crops, existing forage crops, or trees). Depending upon the pathogen Class level and assuming that treatment standards for both vector attraction reduction and heavy metal pollutant limits are met, one of EPA's options for land application can be designated (EQ, PC, CPLR, or APLR). These four options, with respect to various types of land application, are listed in Table 8-7.

Table 8-7 – Land Application Alternatives based on EPA Biosolids Treatment Options (EPA, 1993)

Biosolids Option	Pathogen Class	VAR[1] Options (see Table 8-6)	Type of Land	Other Restrictions
EQ	A	1-8	All[2]	None
PC	A	9 or 10	All except lawn and home gardens[3]	Management practices
	B	1-10	All except lawn and home gardens[3]	Management practices and site restrictions
CPLR	A	1-10	All except lawn and home gardens[4]	Management practices
	B	1-10	All except lawn and home gardens[3,4]	Management practices and site restrictions
APLR	A	1-8	All, but most likely lawns and home gardens	Labeling management practice

1. VAR - vector attraction reduction.
2. Agricultural land, forest, reclamation sites, lawns and home gardens.
3. It is not possible to impose site restrictions on lawns and home gardens.
4. It is not possible to track cumulative additions of pollutants on lawns and home gardens.

It should be noted that additional monitoring and reporting regulations are required and should be referred to in 40 CFR Part 503. Specific state regulations can also apply to biosolids reuse and disposal and these regulations can deviate from Part 503 rules from one state to another.

8.2.2 Surface Disposal

Surface disposal sites are defined as areas of land designated specifically for biosolids final disposal and can include sites for beneficial use. Some examples of surface disposal sites include monofills, surface impoundments/lagoons, waste piles, dedicated disposal sites and dedicated beneficial use sites. Similar to land application regulations, a specific set of EPA requirements for pathogen, vector attraction and heavy metal concentrations must be met for surface disposal in addition to record keeping, reporting and monitoring. The regulations for surface disposed biosolids are not as stringent as those outlined for land application.

8.2.2.1 Pollutant Limits of Heavy Metals for Surface Disposal

The EPA requires that one of two options for meeting pollutant limits be met for surface disposal. The first option requires that all surface-disposed biosolids must not exceed the maximum concentration limits (in milligrams per kilogram, mg/kg) for arsenic, chromium and nickel detailed in Table 8-8.

Table 8-8 – EPA Pollutant Limits for Surface Disposal of Biosolids (EPA, 1993)

Distance from the Boundary of Active Biosolids Unit to Surface Disposal Site Property Line (meters)	Pollutant Concentration*		
	Arsenic (mg/kg)	Chromium (mg/kg)	Nickel (mg/kg)
0 to less than 25	30	200	210
25 to less than 50	34	220	240
50 to less than 75	39	260	270
75 to less than 100	46	300	320
100 to less than 125	53	360	390
125 to less than 150	62	450	420
Equal to or greater than 150	73	600	420

* Dry-weight basis (basically, 100% solids content).

8.2.2.2 Pathogen Class and Vector Attraction Reduction for Surface Disposal

Surface disposal of biosolids requires a Class A or Class B pathogen level, as defined in the previous section. The EPA requires that one of three alternatives must be met to address pathogen reduction for surface disposal of biosolids, as listed in Table 8-9.

Table 8-9 – Pathogen and Vector Attraction Reduction Requirements for Surface Disposal (EPA, 1993)

Type of Requirement	One of the Following Options Must Be Met for Each Requirement
Pathogen Reduction Requirements	Place a daily cover on the active biosolids unit
	Meet one of six Class A pathogen reduction requirements
	Meet one of three Class B pathogen reduction requirements, except Site Restrictions
Vector Attraction Reduction Requirements	Place a daily cover on the active biosolids unit
	Reduce volatile solids content by a minimum of 38% or less under specific laboratory test conditions with anaerobically and aerobically digested biosolids
	Meet a specific oxygen uptake rate
	Treat the biosolids in an aerobic process for a specified number of days at a specified temperature
	Raise the pH of the biosolids with an alkaline material to a specified level for a specified time
	Meet a minimum percent solids content
	Inject or incorporate the biosolids into soil

8.2.2.3 Surface Disposal Alternatives

The process of scoping potential surface disposal sites is a function of not just the quality of the biosolids to be disposed of, but also the characteristics of the proposed site. Detailed site restrictions are listed in 40 CFR Part 503, and they include protection of groundwater, protection from base flood flows, seismically active sites and unstable geology, protection of wetlands, collection of surface and subsurface runoff, and restrictions to crop production and grazing. Additional monitoring and reporting regulations are required, and should be referred to in 40 CFR Part 503. State regulations also apply to biosolids reuse and disposal, and they can deviate from Part 503 rules from one state to another.

8.2.3 Biosolids Incineration

The EPA defines biosolids incineration as the firing of biosolids at high temperatures in an enclosed device such as an incinerator. A pollutant limit for hydrocarbons and seven metals must be met for biosolids that are fired in an incinerator, in addition to record keeping, reporting and monitoring. Because of the detailed matrix of EPA requirements pertaining to the pollutant concentration levels for biosolids incineration, additional information is not summarized in this report but it can be reviewed in 40 CFR Part 503.

8.3 General Biosolids Treatment Processes

The solid stream treatment processes required at each wastewater treatment plant depends on the final use or disposal of the biosolids. Two principal functions are used in the treatment of biosolids in the preparation for final use: organic material stabilization and moisture removal. For each of these two functions, there are a variety of process alternatives. Some of the processes used for stabilizing organic material within the biosolids include digestion, composting, incineration, wet-air oxidation and vertical tube reactors. Some of the processes used for removing moisture include thickening, conditioning, dewatering and drying. These two principal functions are considered key components in the overall biosolids treatment process to ensure that reuse or disposal standards are met.

8.4 Current Biosolids Production, Treatment and Disposal on Guam

Of the seven STPs on Guam, five are currently generating and treating biosolids to various levels. These five STPs are Hagatna, Northern District, Baza Gardens, Agat-Santa Rita, and Inarajan. Current GWA biosolids production and treatment does not comply with the EPA-approved treatment criteria for meeting Class A or Class B pathogen requirements. Presently, all biosolids generated at the Agat-Santa Rita, Hagatna, Baza Gardens and Northern District STPs are disposed of through agriculture land application, with approximately 90% of the biosolids originating from NDSTP. The biosolids are transported by GWA off-site to local farmers and applied to agricultural land. Three local farmers receive the biosolids for crop production of aboveground fruit, trees and bushes. Prior to delivering the material to local farmers, the sludge is dried in the drying beds at NDSTP and then moved to a covered concrete pad staging area. The concrete staging area is too small to accommodate all the sludge, which causes an overrun of the concrete pad. The sludge is allowed to dry in the staging area before it is trucked off-site. Recently, GWA has started maintaining more complete records that include where the material originates, where it is delivered, and the amount that is delivered to the farmers.

GWA has awarded a construction project to rehabilitate the aerobic digesters and install new solid bowl dewatering centrifuges at the Hagatna STP to comply with the EPA governing regulations. GWA projects that the Hagatna STP centrifuges will be operational by February 2007. Table 8-10 summarizes the current solid stream treatment processes at each of the seven STPs.

Table 8-10 – Solid Stream Treatment Processes and Current End Uses for each of Guam's Seven STPs
(Information adapted from Volume 3, Chapter 5)

STP and Treatment Level	Current Solid Treatment Process	Current End Use of Biosolids
Agat-Santa Rita (Secondary)	Waste sludge from the secondary clarifier is transferred to the aerobic digester by an airlift pump, stabilized and thickened. The sludge does not remain at Agat-Santa Rita for drying due to the recent occurrence of drying beds being over-topped resulting from poor maintenance.	Thickened digested sludge is trucked to the Northern District STP for dewatering at the sludge drying beds.
Hagatna (Primary)	Primary sludge and scum are removed and pumped from the primary clarifiers to the four aerobic digesters. Digested sludge is transferred from the aerobic digesters to a sludge decant tank. Supernatant from the sludge decant tank is returned to the inlet of primary clarifiers.	Currently, the sludge dewatering equipment (centrifuges) is inoperable and contents of the sludge decant tank are trucked to the Northern District STP for dewatering at the sludge drying beds.
Baza Gardens (Secondary)	Waste activated sludge is stabilized in the aerobic digestion tank; however, no sludge has been removed for approximately the last 6 years (since 2000).	Stabilized digested sludge in the aerated digester is thickened and then pumped into a tanker truck for drying at the Northern District STP.
Umatac-Merizo (Secondary)	Sludge accumulation from the bottom of the aerated lagoon is dredged when it is necessary; 40,000 gallons of sludge was removed in 1992. Next dredging planned for fiscal year 2007.	No available biosolids for final use.
Northern District (Primary)	Four air-operated diaphragm pumps are installed as primary pumps to transfer the primary clarifiers sludge to the primary anaerobic digester. From the primary digester, the stabilized sludge is pumped into the secondary anaerobic digester tank for thickening. None of the gas recirculation or sludge heating and recirculation systems are presently functioning. The secondary sludge is designed to be pumped to two sludge dewatering centrifuges (inoperable).	Eight sludge drying beds are also available for sludge drying. Because the dewatering systems (centrifuges) are not operational, the drying beds are used exclusively. Sludge from Baza Gardens and Hagatna STPs are dried in the beds prior to being distributed to local farmers for land application.
Inarajan (Secondary)	Solids that accumulate in each lagoon are anaerobically stabilized in the lagoon. The stabilized solids are transferred to the decant well for thickening, where they are allowed to settle. The top layer of water is decanted back to cells 1 or 2 and the thickened waste sludge is pumped to the sludge drying beds.	Very little to no biosolids remain for use.
Pago Socio (Secondary)	No available information.	No available information.

The information provided in Table 8-10 was adapted from Chapter 5 - Wastewater Treatment Facilities of this volume, and was originally compiled from wastewater facility plans developed in prior years. The table also includes recent information from the GWA Calendar Year 2005 Biosolids Report for EPA Region IX regarding biosolids handling and disposal on Guam.

8.4.1 Northern District STP (Including Hagatna and Baza Gardens STPs)

As mentioned above, digested biosolids from Agat-Santa Rita, Hagatna and Baza Gardens are trucked to the NDSTP for drying. The majority of the biosolids produced, approximately 90%, originate from the NDSTP. Currently, the sludge heating and recirculation systems on the anaerobic digester at the NDSTP are not working, so the level of pathogen reduction of the stabilized primary biosolids is unknown. In addition, aerobically digested biosolids from Agat-Santa Rita, Hagatna and Baza Gardens STPs are combined and dried with anaerobically digested biosolids from the NDSTP, so the pathogen level of the combined biosolids entering the drying beds is unknown. Rehabilitation,

upgrade, and expansion of the NDSTP biosolids treatment systems are needed to meet existing regulations. Recommended NDSTP biosolids treatment improvements are described in Chapter 5, Section 5.7 in this volume. Additionally, the Hagatna STP is undergoing rehabilitation of existing biosolids treatment processes as noted above in Section 8.4.

Under EPA's approved processes to significantly reduce pathogens to achieve a Class B level, aerobic and anaerobic digestion are both accepted methods, if adequate time and temperature criteria are met. Air drying of biosolids in drying beds is another approved process to achieve a Class B level. If the time and temperature criteria stated in Table 8-5 above are currently being met by either the digestion or drying processes, the biosolids from the NDSTP that were formerly available to local farmers for agricultural purposes could be considered Class B with respect to pathogens. However, to comply with EPA land application standards, additional treatment to reduce vector attraction and to ensure that heavy metal concentration limits are not exceeded would be required. Monitoring to verify that these ceiling concentrations are not being exceeded must be incorporated into the wastewater treatment plant processes if land application is to resume. Currently, the NPDES permits for the Northern District, Baza Gardens, Agat-Santa Rita and Hagatna STPs do not require sampling for any heavy metals, nor do the facilities meet the EPA time and temperature criteria of vector attraction reduction for land application. GWA is not following the regulations included in the NPDES permits for the STPs regarding biosolids disposal. No testing is done on the biosolids and there is no local laboratory to even perform such tests.

8.4.2 Inarajan STP

The Inarajan STP anaerobically stabilizes all biosolids in a lagoon prior to their transfer into drying beds. Anaerobically stabilizing biosolids through lagoon processes is not an EPA-approved treatment process to reduce pathogens to a Class B level. However, if the time and temperature criteria meet the EPA regulations for air drying in drying beds listed in Table 8-5, the production of Class B biosolids with respect to pathogens can be assumed.

Currently, there are little or no biosolids produced at the Inarajan STP. If production increased and land application of the biosolids were utilized, additional treatment to reduce vector attraction would have to be implemented. Pollutant requirements for specific heavy metals should be considered as well. Similar to the Agat-Santa Rita and NDSTPs, monitoring for the EPA-specified heavy metals would have to be incorporated into the facility processes if GWA wishes to pursue land application as a reuse option.

8.4.3 Umatac-Merizo STP

Records have shown that the biosolids that accumulate at the bottom of the aerated lagoon at the Umatac-Merizo STP were dredged once in 1992 and 40,000 gallons were removed. The fate of the dredged material is not known. The lagoon is projected to be scheduled for dredging in the 2007 fiscal year. Because of this low frequency, it will be assumed that the Umatac-Merizo STP will not be contributing biosolids to a potential beneficial end use on Guam. One possible use might be to dispose of dredged material in liquid form on the overland grassland treatment site, maintaining a record of the solids characteristics. This should only be done after gaining concurrence from GEPA and EPA. GWA will be required to follow the regulations attached to the NPDES permits for the STPs regarding

biosolids disposal. Testing will need to be performed according to the regulations in the permit.

8.4.4 Current Proposal for Centralized Biosolids Treatment

Current upgrades under construction at the Hagatna STP, projected for completion by February 2007, will allow for biosolids generated at each of the wastewater treatment plants to be trucked to the Hagatna STP for dewatering. GWA plans for Hagatna STP to use digesters and centrifuge processes to stabilize and dewater the sludge and targets to meet Class B treatment level requirements. A centralized biosolids treatment facility, similar to the proposal of the Hagatna STP, would be the most economically viable method for effectively treating all biosolids generated on the island. However, the 40 CFR Part 503 regulations should be followed closely so that the treatment upgrades will meet the standards of the beneficial reuse alternatives discussed below. Otherwise, these improvements may not address all of the requirements needed to provide biosolids that are suitable for the desired beneficial uses.

8.5 Evaluation of Beneficial Reuse and Disposal Alternatives for Guam's Biosolids

Because of the unknowns associated with both the proposed centralized biosolids treatment at the Hagatna STP and the STP's current solid stream treatment performance, it is difficult to make reuse recommendations for the near future. The number of reuse and disposal alternatives for biosolids has become limited since EPA's inception of Part 503 in 1993. Yet, there continues to be an increasing effort to develop creative reuse opportunities that comply with EPA regulations. Because of its limited land base, Guam has fewer reuse opportunities compared with most of the mainland United States. Five reuse alternatives are presented below, reflecting the more feasible options in reusing or disposing of Guam's biosolids. Many alternatives that would typically be applicable under different conditions are not discussed below. The discussion of these alternatives primarily focuses on potential reuse opportunities, with little emphasis on the associated treatment upgrades that would be required to meet the proposed regulations. Biosolids regulations have not been adopted by Guam, so GWA must meet the federal Part 503 regulations. A focused feasibility plan is recommended to evaluate alternatives presented below and refine associated treatment facility upgrade projects proposed.

8.5.1 Alternative I: Landfill Alternative Daily Cover (ADC)

As previously discussed, biosolids generated on Guam are currently used for agricultural land application by local farmers. This practice is unregulated by GEPA, so a continuation of this disposal method is not recommended until regulations have been set forth and current biosolids treatment levels verified. The biosolids cannot be used for landfill ADC because they do not meet Class B treatment criteria and an approved EPA vector attraction reduction treatment process has not been employed.

Title 40 CFR Part 258.21, *Criteria for Municipal Solid Waste Landfills*, states that an alternative material and thickness (other than the minimum six inches of earthen material) can be used as an ADC if it is approved by the GEPA Director. If biosolids were to be used as an ADC, it would have to be proven that the thickness and biosolids material control disease vectors, fires, odors, blowing litter and scavenging. Additionally, the biosolids must not exceed a moisture content of 50% prior to utilization, as required by the municipal solid waste landfill Paint Filter Test. Furthermore, the minimum six-inch daily cover applied to the active face of the landfill shall not exceed 25% biosolids content, with the remaining 75% consisting of

soil. In California, approximately 12% of the biosolids generated are used as ADC. Because of the limited resources on Guam, such as landfill space and earthen material for daily cover, using biosolids to supplement daily cover material would be a feasible beneficial use alternative, at a relatively low capital cost for treatment upgrades. If this beneficial use alternative is further pursued, it is recommended that the digestion and drying bed processes be expanded at either the NDSTP or the Hagatna STP to accommodate treatment of biosolids generated at all STPs.

8.5.2 Alternative II: Landfilling of Biosolids

Until the current biosolids production can meet the ADC criteria, landfilling of the biosolids should be considered as an alternative for final disposal. The cost of trucking the biosolids from NDSTP to Ordot Landfill or a new landfill site and paying the landfill tipping fees cause this option to be rather costly. The 40 CFR 503 requirements for surface disposal of biosolids are detailed in Section 8.2.2 of this WRMP and these would apply to landfill disposal. The pathogen reduction, vector attraction reduction and heavy metal concentration requirements must be met for surface disposal in addition to proper record keeping, reporting and monitoring. The landfill operating permit requirements drive the extent to which pathogen, vector attraction and heavy metal concentrations are regulated. These requirements are subject to the approval of the GEPA Administrator and must comply with the existing 40 CFR 503 regulations.

8.5.3 Alternative III: Incineration of Biosolids

A centralized biosolids incineration facility could be implemented on Guam. However, because of the expected high capital cost of implementation of an incinerator—specifically the air pollution control devices, combined with the energy costs of operation—this alternative is not considered cost-effective or practical.

8.5.4 Alternative IV: Liquid Biosolids Application on Agriculture Land

This common method of disposal involves the reuse of biosolids in the liquid state as a soil fertilizer or conditioner taken directly from the digestion process. This is an attractive method because dewatering processes are not required at the STP. In addition, the liquefied biosolids can be transferred by pumping and applied by means of vehicle or irrigation implements. Proper crop management must be practiced on the receiving agriculture lands to allow such disposal. This alternative assumes that the biosolids do not meet EPA's Exceptional Quality standards, so site restrictions for public contact and crop management are strict. Careful attention must be taken to ensure that more biosolids are not applied than is needed by the vegetation. In cases where the amount applied exceeds the need, unused nutrients may reach surface water bodies or leach through the subsurface to the groundwater.

A foreign company is currently developing a marketing proposal for selling liquid fertilizer on Guam from biosolids generated from the NDSTP's solid stream. The exact treatment processes are unknown, but they would likely include digestion through the existing anaerobic digesters while excluding the drying bed dewatering processes. Because the proposal is still in the developmental phases, there are many unknowns. If this treatment alternative is further pursued, the sustainability of the reuse market for liquid biosolids on Guam should be investigated. A long-term agreement would have to be established between GWA and the receiving landowner(s), who must be committed to proper management of

crop rotation and biosolids application in the form of liquid fertilizer. Auxiliary biosolids treatment processes targeting a supplemental reuse market should be incorporated into the solid stream treatment processes, in the event that the liquid fertilizer reuse does not sustain the needed level of reuse.

8.5.5 Alternative V: Dewatered Biosolids Application on Agriculture Land

The current agricultural land application of all biosolids generated on Guam proves there is currently a local dedicated reuse market. However, site restrictions in the current EPA regulations summarized earlier may prohibit future application of biosolids on areas that are currently receiving them. Assuming the current level of treatment remains constant, which consists of a Class B level with the absence of vector attraction reduction and heavy metal treatment processes, the current reuse market for land application will likely become limited. Consequently, treatment processes would have to be upgraded to meet the EPA standards for application on agricultural lands that consist of various crop management practices. After local regulations have been adopted and are being enforced, a detailed feasibility study to evaluate the treatment alternatives and associated capital costs for various reuse markets is recommended. It may be determined that a demand exists for various levels of treated biosolids, such as Exceptional Quality Class A biosolids for fertilizing golf courses, park turfs and food crops or Class B biosolids potentially used for application on grazing lands. Table 8-11 summarizes the reuse alternatives presented above, including the relative cost of associated treatment upgrades.

Table 8-11 – Summarization of Five Biosolids Reuse Alternatives and Associated EPA Recommended Treatment Levels with Associated Cost for Upgrading Treatment Levels

Alternative		Pollutant Limits for Heavy Metals	Pathogen Reduction	Vector Attraction Reduction	Relative Cost to Implement
1	Landfill Alternative Daily Cover	Guam's EPA Administrator Approval and Landfill Requirements	Class B	Meet One Approved Option	Low - Moderate
2	Landfilling of Biosolids	Guam's EPA Administrator Approval and Landfill Requirements	Guam's EPA Administrator Approval and Landfill Requirements	Guam's EPA Administrator Approval and Landfill Requirements	Moderate - High
3	Biosolids Incineration	N/A Air Pollution Control Device	N/A Air Pollution Control Device	N/A Air Pollution Control Device	High
4	Liquid Land Application	Depends on Land to be Applied to	Depends on Land to be Applied to	Meet One Approved Option	Moderate
5	Dewatered Land Application	Depends on Land to be Applied to	Depends on Land to be Applied to	Meet One Approved Option	Moderate - High

8.6 Conclusions

This chapter reviewed existing regulatory requirements for biosolids management and reuse as well as options available to GWA for handling biosolids. Although GEPA does not have a set of specific regulations for biosolids reuse, there are requirements in existing NPDES permits identifying the need to meet Part 503 EPA regulations.

Presently, all biosolids generated at the Agat-Santa Rita, Hagatna, Baza Gardens and the NDSTPs are disposed of through agriculture land application, with approximately 90% of the biosolids originating from NDSTP. As the NDSTP biosolids handling unit processes are upgraded, GWA will come closer to meeting the EPA guidelines for agricultural use.

8.7 Recommendations

- Because there is a potential dedicated market demand for biosolids for agricultural land application on Guam, it is recommended that generated biosolids be treated to a level that meets EPA regulations for various agricultural practices. Agricultural land application of the biosolids is considered to be a more sustainable reuse alternative with greater benefit relative to daily cover for the island's landfills.
- Further development of biosolids treatment processes at the Hagatna and NDSTPs are recommended to ensure the consistency of treatment needed for meeting the proposed regulations and any additional requirements placed on the biosolids end product as a part of the GEPA Director's approval. These two STPs would process all of the biosolids generated on Guam, which is considered to be the most cost-effective approach.
- It is recommend that a facility plan be developed that evaluates the cost associated with retrofitting the Hagatna and NDSTP facilities to meet the required EPA treatment standards. As part of the focused facility plan, the analyses should include the facility footprint, odor control at the facility, power consumption, expected permitting process and ease of operation and maintenance.

8.8 CIP Impacts

CIP projects having a direct or indirect impact on various facilities include:

- Facilities Plan/Design Agat-Santa Rita STP Replacement
- Agat-Santa Rita STP Replacement
- Facilities Plan/Design Baza Gardens STP Replacement
- Baza Gardens STP Replacement
- Facilities Plan/Design Hagatna STP Improvements
- Hagatna STP Improvements
- Facilities Plan Northern District STP Centralized Biosolids
- NDSTP Centralized Biosolids and Plant Expansion

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