A National Biosolids Regulation, Quality, End Use & Disposal Survey

FINAL REPORT

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ABBREVIATIONS USED

BDMS – Biosolids Data Management System
CWNS – Clean Watersheds Needs Survey
FTE – Full-Time Equivalency
MGD – Million Gallons per Day
NACWA – National Association of Clean Water Agencies
NBMA – Northwest Biosolids Management Association
NEBRA – North East Biosolids and Residuals Association
NPDES – National Pollution Discharge Elimination System
POTWs – Publicly-Owned Treatment Works
TWTDS – Treatment Works Treating Domestic Sewage
USEPA – United State Environmental Protection Agency
WEF – Water Environment Federation

Caution regarding use of data: *The data presented throughout this report are compiled from responses to surveys and other communications with diverse individuals. While every effort has been made in good faith to ensure data quality and present data objectively, the report authors and NEBRA assume no responsibility or liability for outcomes that may result from their use.*

TERMINOLOGY USED IN THIS REPORT

biosolids

The term "biosolids" is in widespread use amongst water quality professionals in North America. Its generally accepted definitions refer to agricultural uses or land application. For example, the National Research Council (2002) used the definition "sewage sludge that has been treated to meet the regulatory requirements for land application set out in the Code of Federal Regulations, Title 40 (Part 503)." *Merriam-Webster's Collegiate Dictionary, Tenth Edition* (1998) defines biosolids as follows: "biosolid n.: solid organic matter recovered from a sewage treatment process and used esp. as fertilizer -- usu. used in pl." The *New Oxford Dictionary of English*, 1998 edition defines it as "biosolids: plural noun: organic matter recycled from sewage especially for use in agriculture."

It is worth noting, however, that these dictionary definitions do not preclude using the term "biosolids" to refer to treated municipal wastewater solids that are incinerated or placed in a landfill or a surface disposal unit. U. S. EPA (1994) defined "biosolids" as "a primarily organic solid product produced by wastewater treatment processes that can be beneficially recycled. The fact that biosolids can be recycled does not preclude their being disposed." NACWA (2006) defines "biosolids" as "primary and waste activated organic matter (solids) removed from the wastewater that has been further processed (e.g. digested; chemically conditioned with lime, polymers, and other products; thermally conditioned)."

beneficial use

The term "beneficial use" is used in this report to refer to biosolids that are applied to soils to take advantage of the nutrients and organic matter they contain. This meaning of the term "beneficial use" has been in widespread use since at least 1984 (see EPA beneficial use policy in June 12, 1984 *Federal Register*) and was clearly defined in 1991 (see the July 18, 1991 *Federal Register*), when EPA joined with other federal agencies, including USDA, FDA, and Department of Interior, to issue the Interagency Policy on Beneficial Use of Municipal Sewage Sludge on Federal Land with the following definition: "Beneficial Use means any application of sludge on land specifically designed to take advantage of the nutrient and other characteristics of this material to improve soil fertility or structure and thereby further some natural resource management objective." Synonymous expressions used in this report are "end use," "biosolids recycling," and "biosolids recycling to soils."

disposal is used in this report to refer to disposition of solids in ways that do not take advantage of these soil-enhancing qualities – this includes incineration, landfilling, and surface disposal.

It is important to note, however, that, today, the term "beneficial use" is appropriately applied to uses of biosolids in other ways than application to soils, such as for energy production. Such beneficial uses are increasing. Indeed, as energy becomes an ever-more-important aspect of sustainable development (including biosolids management), "beneficial use" could be defined as "putting a particular biosolids product to its best and highest use by maximizing the utilization of nutrients, organic matter, moisture, and/or other qualities - including extracting the maximum amount of energy possible."

Nonetheless, this report continues to use the older, narrower definition of "beneficial use," partly because of precedent and common understanding of the term and partly because the surveys conducted for this report were based on past surveys that used this narrower definition. In addition, at this time, state agency staff and other biosolids management professionals have not established systems to differentiate between incineration or landfilling programs that involve energy recovery and those which do not. Thus there is scant data available regarding what portion of the biosolids incinerated and landfilled could be considered to fall under the newer, developing definition of "beneficial use."

EXECUTIVE SUMMARY

In the United States, the infrastructure that leads to the production of sewage sludge (also called "wastewater solids," and – when treated and tested – "biosolids") includes 16,583 wastewater treatment facilities, according to the Environmental Protection Agency (USEPA). Of these, the largest ~3,300 generate more than 92% of the total quantity of wastewater solids produced in the U. S. The data reported below are derived from reporting and compilation systems that account for these larger facilities and, to varying degrees, for minor and other smaller facilities as well.

The treated solids – biosolids – removed from wastewater at these wastewater treatment facilities – can be legally used or disposed of in three ways: by application to soils ("land application"), by landfilling (or surface disposal), and by incineration. The Clean Water Act provides the legal basis for management of biosolids nationwide, and regulations at 40 CFR Part 503 (Part 503) establish minimum national standards that are protective of public health and the environment. Each local wastewater treatment facility makes its own decision regarding how their solids are managed.

Data compiled from state regulatory agencies, U. S. Environmental Protection Agency (USEPA) offices, individual wastewater treatment facilities, and other sources indicate that 7,180,000 dry U. S. tons of biosolids were beneficially used or disposed in the fifty states in 2004.

Of that total, approximately 55% were applied to soils for agronomic, silvicultural, and/or land restoration purposes, or were likely stored for such uses. The remaining 45% were disposed of in municipal solid waste (MSW) landfills, surface disposal units, and/or incineration facilities.

Of the total applied to soils, 74% was used on farmlands for agricultural purposes. Another 22% were treated and tested to meet the USEPA's highest quality classification ("Class A EQ"), and were publicly distributed for a variety of uses, including landscaping, horticulture, and agriculture. Small percentages were used for land restoration and in silviculture.

Of the total not applied to soils, most (63%) were disposed of in MSW landfills. Thirty-three percent were processed in incinerators, while the remaining 4% were placed in biosolids-only surface disposal units.

Of the total 7,180,000 dry U. S. tons of biosolids in 2004, approximately 23% were treated to Class A standards – and almost all of that met Class A EQ standards. Another 34% were treated to Class B standards. For the remainder (43%), there is no data (or no data was obtained) regarding whether or not it met Class A or Class B standards. This lack of data is mostly due to the fact that wastewater solids that are landfilled or incinerated are not generally subjected to the same stabilization, testing, and reporting requirements.

Most states have additional regulatory programs that go above and beyond Part 503. Thirty-seven states require management practices for land application that are more stringent than those in Part 503, and sixteen have adopted pollutant limits that are more stringent than those in Part 503. Seven states have received formal delegation for administration of Part 503, and most state regulatory programs work with relatively up-to-date regulations and are addressing current issues. However, the number of full-time equivalent employees (FTEs) working on biosolids at state agencies nationwide appears to have declined over the past six years by at least eight.

Overall, current data suggest little change nationwide, since the late 1990s, in the rate of biosolids recycling to soils (USEPA, 1999), and half of state biosolids coordinators report that the amounts of biosolids applied to soils are not increasing in their states.

1. INTRODUCTION

How much wastewater solids (sewage sludge) is produced in the United States, and what happens to it? What is its quality? How much is Class A and how much is Class B? What solids treatment technologies are being used and how are these changing? How do the various states regulate biosolids? How comprehensive are these programs? What are the trends in biosolids management?

For the past ten years, agencies regulating wastewater solids and biosolids, scientists researching them, engineers designing for them, concerned citizens, policy makers, and other interested stakeholders have relied on limited and aging sources of information to answer these questions:

- a 1999 U. S. Environmental Protection Agency (USEPA) report (USEPA Office of Solid Waste, 1999) that estimated total solids production based on reported national wastewater flow, and
- surveys of state biosolids coordinators conducted by *BioCycle* – the most recent being from December 2000 (Goldstein, 2000).

As public interest in biosolids management has grown in recent years, so has reliance on the data presented by these two critical sources and partial data from a few other sources (e.g. see National Research Council, 2002). Public policy decisions are affected by such data, as are those in research and engineering. There is widespread agreement on the need for updated, accurate information on biosolids/wastewater solids regulation, quality, and end use and disposal.

Consistent data on biosolids management is difficult to obtain and compile. A great deal of data on biosolids is generated at individual treatment works treating domestic sewage (TWTDS), in accordance with regulatory requirements. Each year, TWTDS provide data to USEPA (and, in many cases, to states) in paper reports. While these are reviewed for enforcement purposes, only in some states are they compiled electronically. Encouraging electronic filing of biosolids data is being considered by USEPA and some states, but the diversity and abundance of data makes it difficult to attain such a goal. At this time, only about 30% of states have developed electronic record-keeping. Similarly, at USEPA, only a few of the regional offices have effective electronic record-keeping. Data collection and compilation are often of low priority in comparison to permitting and enforcement and other demands. Therefore, compiling national data efficiently remains a challenge.

With no centralized data collection and storage system yet in place, disparate pieces of data from various states and USEPA regions must be painstakingly collected and interpreted to produce a useful national picture. In conducting the surveys and other information-gathering for this report, those involved have come to appreciate the hard work represented by the *BioCycle* surveys of the late 1990s.

This current effort was made possible by a grant from USEPA's Office of Water. We hope this report takes the level of understanding of biosolids management in the U. S. one step further. What is remarkable is that the results of this project corroborate the effectiveness of past efforts.

This project's goals were to:

1. compile the most comprehensive "national picture" to date on regulation, quality, end use, and disposal of U. S. biosolids and septage, providing critical information for agencies, vendors, states, USEPA, and stakeholders to make informed decisions, and

2. document a replicable protocol for future repetitions to improve consistency for analysis of trends.

What is new in our approach?

- USEPA's 1999 approach of estimating biosolids production based on wastewater flow was effective in creating rough national totals (this current project has proven them to be fairly accurate). However, this current effort relied on such estimates only as a way to fill data gaps and to corroborate the accuracy of data compiled from reports of actual biosolids used and disposed.
- Building on *BioCycle*'s lead, we saw state biosolids coordinators (and USEPA regional staff and others) as the best potential sources of information, especially with regard to the regulations and management of biosolids. Most of the effort of this project was spent extracting information from these diverse sources, using a 10-page survey as a starting point (a copy of the survey appears as Appendix A).
- While it still has room for improvement, there is a growing volume of electronic biosolids data that we were able to obtain, including records kept in the USEPA-developed "Biosolids Data Management System" (BDMS), which a few states and USEPA regions have been using. In addition, new user-friendly online survey tools made it possible to conduct a pilot online survey of individual wastewater treatment facilities.
- Compiled and easily-accessible septage management information is even more lacking. One page of the survey of state biosolids (and septage) coordinators gathered information on septage management, in an attempt to begin to build a coherent national picture of this important activity.

A preliminary report was provided to USEPA and the general public in April, 2007; it provided the most important data collected. This final report was released in July, 2007, and includes all of the preliminary report, as well as additional information on state regulations, trends, and recommendations for similar future surveys and data collection efforts. This report can be downloaded at no cost for individual, non-commercial use from these websites: www.nebiosolids.org or www.nwbiosolids.org.

2. METHODS

This project involved:

1. a literature review to learn from past data collection efforts;
2. a *Data Needs & Availability Survey* to learn from state agencies, USEPA regions, and others what information would be nice to have and what information is readily available;
3. a comprehensive survey of biosolids regulation, quality, end use, and disposal in each state, completed by the state coordinator and others (this survey was defined with the information from the Data Needs and Availability Survey);
4. additional data collection from USEPA regions and individual TWTDS;
5. an on-line survey of individual treatment works, which filled gaps where states had no data and served as a test of this method of gathering data;
6. comparisons to data from other sources (National Association of Clean Water Agencies, prior surveys, estimates applying USEPA's 1999 method); and
7. refinement of a working protocol for future data collection efforts.

From reviewing the literature and discussing data collection strategies with others who have collected such data in the recent past (e.g. Elliott, 2005), challenges were identified. The following is a listing of the most significant, with discussion of how they have been addressed in this survey effort:

- What kinds of facilities should data be collected for? just Publicly-Owned Treatment Works (POTWs)? or private & federal treatment works as well, e.g. all Treatment Works Treating Domestic Sewage (TWTDS)? In reality, as shown by USEPA (1999), the difference in numbers between the larger group of TWTDS and the subset of POTWs is relatively small, making the distinction less critical. This project requested data on all TWTDS.
- The diversity of 50 state programs (Puerto Rico and other territories were not included in this survey effort) yields data of diverse quality and comprehensiveness. To address this, state data was interpreted and fit into one survey structure, with the assistance of state biosolids coordinators. In addition, a rough numerical state data quality rating was applied (4 rating options: 0 for lowest quality to 3 for highest quality). The data from states with low data quality ratings were further analyzed for comprehensiveness and quality, using comparisons with other reported data (e.g. from the survey of members of the National Association of Clean Water Agencies – NACWA) and CWNS data. These measures made diverse data sets more comparable and compatible.
- TWTDS and states collect data using a diversity of units of measure; for example Maryland uses *wet* U.S. tons. Most states track data in dry U. S. tons and USEPA tends to use dry *metric* tons. The choice for standard measure for this report was dry U. S. tons, but, in order to maximize participation, the surveys allowed data to be provided in a variety of formats and the project team conducted conversions. Note that, while national totals are presented below in dry U. S. tons, the data presented in each of the state-by-state summaries in Appendix D are in the units used by that state's biosolids coordinator or the related EPA regional office (depending on the source of the data).
- Many small facilities send their wastewater solids to larger facilities; how to avoid double counting? This conundrum is further exacerbated by the fact that some facilities measure their final biosolids output *after* they are composted or otherwise amended (e.g. with alkaline products), whereas many facilities measure before such treatments. Avoiding errors

associated with this issue is difficult; this remains an unsolved issue and may affect the data reported here.

- Many small facilities (and a few larger ones) use lagoon or other storage systems that only use or dispose of solids every 5 to 20 years. Such events are assumed to be randomly and evenly distributed over the years, so that data from one year to the next will capture similar numbers of events and volumes of solids.
- When categorizing biosolids as "beneficially used," different people use differing definitions; for example, in their study in Pennsylvania, Elliott et al. (2005) considered biosolids used as alternate daily cover at landfills to be in the "disposal" category, because it is often difficult, in practice, to ensure the distinction at the final disposal site, and agronomic benefits are not realized. In this current project, biosolids used for alternate daily cover were classified as disposal. Although this report's definition of "beneficial use" is restricted to those biosolids applied to soils in one way or another (see p. *iv*), other non-agricultural beneficial uses are becoming more common, especially energy-related uses (biogas, incineration with recovery of heat, bioreactor landfill technology, etc.).

In summary, the strategy was to collect data from those sources most likely to have the highest amount and quality: the state agency biosolids coordinators. Then, as data gaps became apparent – and many did – the project team filled them with information from USEPA regional biosolids coordinators, online research of state biosolids regulatory programs, and through direct contact with the largest TWTDS in the state to acquire wastewater solids generation, quality, and end use and disposal data, facility-by-facility, until a reasonably high percentage of the state's wastewater flow (and population) were accounted for (a strategy utilized by Elliot et al., 2005). In a few cases (e.g. Connecticut, Missouri), no state data was collected, and solids production, end use, and disposal totals were estimated for use in national totals.

As the state data were collected, they were compiled in a Filemaker Pro 8 database, using the same format as the biosolids quality and end use survey of state coordinators (the survey is included in Appendix A). Subsets of data were exported into Excel spreadsheets for analysis, charting, and mapping. Data quality checks were conducted whenever data were entered or transferred.

In the end, this approach resulted in a significant refinement of overall data quality that has not been achieved by any prior nationwide effort. However, the quality of the data still requires reporting of our best estimates in *thousands* of dry U.S. tons in the case of most states. Data from relatively few states are of sufficient quality to be reported in *hundreds* or *tens* of dry U. S. tons.

THE NATIONAL SURVEY

The "Biosolids Quality and End Use Survey" was the major focus of this project. It was developed using concepts and questions from previous surveys (Goldstein, 2000; Elliott et al., 2005) and results from our cursory Data Needs and Availability Survey of ~20 state biosolids coordinators and other stakeholders in biosolids management.

The 10-page Biosolids Quality and End Use Survey asked for data and opinions regarding…

- state biosolids agency and coordinator contact information,
- wastewater treatment and biosolids infrastructure,

- regulation and permitting,
- biosolids quality (2004 data requested),
- biosolids end use and disposal (2004 data requested),
- trends in biosolids management,
- biosolids testing and reporting requirements,
- biosolids treatment practices, and
- septage management.

After review by NACWA biosolids committee members and others, this survey was sent to all 50 state agency biosolids coordinators, as well as some USEPA regional biosolids coordinators, in April, 2006 (Appendix A). During the next ten months, the project team collected and compiled the data and opinions provided by the state coordinators.

Upon completion of initial data entry, it was clear that more extensive data collection would be required. State coordinators had filled in the survey to varying degrees of completeness, and in order to proceed with further collection, each state's data had to be interpreted, compiled, and key data gaps identified. The information provided by state coordinators was converted into one narrative summary and one Excel spreadsheet summary of consistent format for each state. In order to check the quality of the data and its interpretation by the project team - as well as to fill data gaps – these two-document draft summaries were provided to state biosolids coordinators for review and follow-up phone discussion (a few state coordinators did not receive a summary and did not conduct this review). This was a process that had been utilized by *BioCycle* in some of their survey work. This "reflecting" of data back to state coordinators utilized the same units of measure (e.g. dry metric tons, dry U. S. tons) that the state coordinators had used. Some of the two-document summaries were also reviewed by the appropriate USEPA regional biosolids coordinator. The final, revised data summaries resulting from this process are included as state-by-state reports in Appendix D.

The final step in data analysis was to compile the information from all 50 states (including best estimates for a few states) into a national picture. All states' numerical data were maintained and kept consistent, by electronic transfers, in three formats:

1. in the individual state spreadsheets mentioned above,
2. in the original Filemaker database, and
3. in a single spreadsheet used to calculate national totals.

In the national totals spreadsheet, appropriate conversions were applied to biosolids quantity data from those states that provided their data in anything but dry U. S. tons. This national totals spreadsheet also included columns with data on state population and the state's total wastewater flow (from USEPA's CWNS data set for 2004). This allowed for easy direct comparison between each state's reported total biosolids quantity and the estimated total derived by using the USEPA Biosolids Generation Factor (U. S. EPA Office of Solid Waste and Emergency Response, 1999), thus helping ensure the accuracy of the reported data. The national totals data is discussed in the "results" below and is presented in a spreadsheet of "U. S. Totals" at the beginning of Appendix D.

ONLINE SURVEY OF TWTDS

One final step was taken: collection of data from individual Treatment Works Treating Domestic Sewage (TWTDS) using an online survey system, *Survey Monkey*. The online survey was intended to provide semi-independent data that could be used to corroborate data provided by the survey of state coordinators. Its design was derived using questions from the survey of state biosolids coordinators, with its target audience (individual TWTDS) in mind. Northwest Biosolids Management Association created the online survey structure and layout. It was intended to take 15 to 20 minutes for a knowledgeable person at a treatment facility to complete. 2004 data was requested. To generate responses, NEBRA sent (with the help of the National Biosolids Partnership) a formal email announcement to biosolids contacts around the country; the email included instructions and a link to the survey website. The email included a request that the email be forwarded to any U. S. wastewater treatment facility and be included in any pertinent newsletters. A deadline was also included, which allowed about three weeks for people to respond by completing the online survey. NEBRA's contact information was provided, and some questions and comments were received and addressed. This outreach was relatively minimal and simple; future efforts could likely gain far larger numbers of responses.

Once the online survey deadline was passed, the online survey data was downloaded into an Excel spreadsheet and thoroughly reviewed for quality and accuracy. Any questionable data were corrected by direct contact with the agency reporting (the survey provided the option of including contact information, but did not require it) or were deleted. Statistical analysis of the data was completed by Professors Tai Cheng and John Peckenham at the University of Maine, Orono.

The response rate to the online survey was 250 (1.5%) of the 16,000+ TWTDS in the country. This small response precluded much useful extrapolation from the survey data. However, the survey data proved useful in filling data gaps in several states. It also proved to be an excellent test of utilizing an online survey software service to collect key biosolids quality, end use, and disposal data. The online system proved efficient and easy to use. We recommend use of this kind of survey for collection of basic data on a regular basis in the future.

Information collected via the online survey is integrated in the results, below, and the online survey questionnaire appears in Appendix A.

DATA QUALITY

With the large volumes and variety of data being compiled in this project, the chance for data quality to be compromised was of concern. This was addressed by establishing protocols for data checking and tracking in those parts of the project where an error would have the most significant impacts. These included the following data quality control measures:

- After data was transferred from the Biosolids Quality and End Use Surveys completed by state coordinators into the Filemaker Pro 8 database, data entry was subsequently independently checked.
- Use of the standardized summaries for each state's data ensured consistency of compilation and reporting, which made errors stand out.

- As the regulation, quality, end use, and disposal data for each state was compiled in the summary Excel spreadsheet template, one standard calculator spreadsheet was utilized for all states, with consistent and comparable rows of data fed into the calculator from the Filemaker database. In addition, on the state summary spreadsheet, various estimates of total wastewater solids generation for the state (such as by using the USEPA 1999 method) appeared next to the total reported by the state coordinator, supplying a constant corroboration of overall data accuracy.
- One team member did a final review of each state's summary and state coordinators (and/or the USEPA regional coordinators) were asked to review the summary (this step was not completed for some states, due to lack of time or lack of response).
- In spreadsheets, all data was cleaned and checked logically and erroneous or suspicious data were investigated further.
- Data in final reports were spot checked again for accuracy, however, given the volumes of data involved, their accuracy is not 100% guaranteed.

3. RESULTS

The Biosolids Use and Disposal Survey, completed by state biosolids coordinators, provided the majority of the data reported below. Gaps in the state-reported data were filled with information from USEPA regional offices, individual TWTDS, and other sources. The results of the online survey of individual TWTDS are integrated into the discussions below, as appropriate.

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INFRASTRUCTURE

Enumerating Treatment Works Treating Domestic Sewage

In the U.S., the infrastructure that leads to production of sewage sludge (also called "wastewater solids," and, when treated, "biosolids") includes an estimated 16,583 Treatment Works Treating Domestic Sewage (TWTDS).[1] The vast majority of these treatment facilities are small: 13,261 treat wastewater flows equal to or less than 1 million gallons per day (MGD) – see Table 1. That leaves 3,322 that treat flows greater than 1 MGD, of which only 551 treat flows greater than 10 MGD.

USEPA uses a rough estimate that a population of 10,000 people accounts for 1 MGD of flow. Analysis of this project's online survey data of 250 TWTDS indicated that an increase of 10,000 people served by a TWTDS increases the daily wastewater flow by 1.54 MGD, which means that a

[1] USEPA's draft Clean Watershed Needs Survey (CWNS) database for 2004 included 33,852 NPDES-permitted dischargers – systems that discharge to waters of the U.S. in accordance with the Clean Water Act, about half of which do not perform treatment (are not TWTDS).

population of 6,500 people accounts for 1 MGD of flow. A cursory review of CWNS data for 2004 corroborates the fact that 1 MGD TWTDS serve this range of population: 6,500 to 10,000[2].

Table 1 *(courtesy of Robert K. Bastion, USEPA)*

Treatment Facilities in Operation in 2004		
Existing Flow Range (mgd)	**Number of Facilities**	**Total Existing Flow (mgd)**
0.000 -to- 0.100	6,830	298 (0.9%)
0.101 -to- 1.000	6,431	2,327 (6.9%)
1.001 -to- 10.000	2,771	8,766 (26.1%)
10.001 -to-100.000	503	13,233 (39.3%)
100.001 and greater	41	9,033 (26.8%)
Other[b]	7	-
TOTAL[c]	**16,583**	**33,657 (100.0%)**

[b] Flow data for these facilities were unavailable.

[c] Totals include best available information from States and Territories that did not have the resources to complete updating of the data or did not participate in the CWNS2004.

Thus, the 13,261 smallest TWTDS – considered "minors" by USEPA – are in relatively small communities. And as Elliott et al. (2005) discovered in their detailed survey work in Pennsylvania, these small TWTDS manage their wastewater solids in ways that are not necessarily represented by how larger TWTDS manage them. For example, minor (</= 1 MGD) facilities will often:

- store solids in wastewater or sludge lagoons that are only cleaned out every 5 – 20 years;
- utilize the lowest-cost and least-hassle method for managing solids, such as landfilling (as Elliott et al. found in PA); and/or
- transport untreated solids to larger TWTDS for treatment.

These, and other factors – including the sheer number of minor facilities –significantly impede accurate characterization of the management of wastewater solids from these small TWTDS. Prior national surveys, and, to a large extent this current research, have ignored the smallest TWTDS. This is justified, in part, because these facilities treat only 8% of total flow (MGD) and use or dispose of the same small – or even lesser – percentage of solids. These solids are insignificant on national, regional, and state scales. Many likely become part of larger TWTDS' solids production, but most cannot be easily counted on a state or national scale and these may not be included in the data presented in this report.

[2] The range in the number of MGD produced by a population of 10,000 is explained, in part, by:

- the amount of industrial flow discharged to the sewer and treated by the TWTDS, in addition to the population, in their service area (industrial flows can be low or as much as 90+% in some cases (e.g., Dalton, GA - home of indoor/outdoor carpet manufacturing).
- the amount of use of water conservation devices (low flush toilets, low flow showerheads, etc.)
- climate differences (desert vs high rainfall areas)
- TWTDS with combined sewers (and CSOs) vs those with separate sanitary and storm sewer systems

It is the ~3,300 TWTDS with flows greater than 1 MGD – and especially the ~550 over 10 MGD – that are most significant for understanding each state's biosolids management situation and the national picture. Facilities treating more than 1 MGD treat 93% of existing flow and, given the significant correlation between flow and solids production, an equivalently high percentage of wastewater solids production, end use, and disposal.

Industrial Pretreatment

There is considerable professional and public interest with regards to the ~3,300 largest TWTDS, because they include facilities in urban areas, where industrial inputs to wastewater flows (and, therefore, biosolids) are more likely. Under 40 CFR Part 403, USEPA requires local wastewater treatment facilities to implement and enforce industrial pretreatment programs aimed at reducing inputs to sewage systems of anything that could negatively impact the functions of the facility and the quality of the effluent and solids.

One measure of this program was assessed by asking of state biosolids coordinators the number of TWTDS that "currently have active industrial pretreatment programs." The aggregated total response was approximately 1,440, 43% of all major TWTDS. This is a minimum number, as the survey failed to obtain 100% response on this question. TWTDS that do not have active pretreatment programs – including many in the 1 to 10 MGD range (serving populations less than 65 to 100 thousand – are mostly not required to do so because of lack of Significant Industrial Users (SIU) of the sewage system, i.e. the threat of discharge to the sewers of potentially harmful substances is minimal. As has been reported elsewhere, the Part 403 pretreatment program – coupled with Part 503 and state regulations – has significantly improved the quality of biosolids (National Academy of Sciences, 2002).

Further data on pretreatment was compiled from the project's online survey. Respondents to that survey were biased significantly toward larger facilities.[3] Of the 219 responses to the pretreatment question, 77% said their facility has an active industrial pretreatment program (Figure 1).

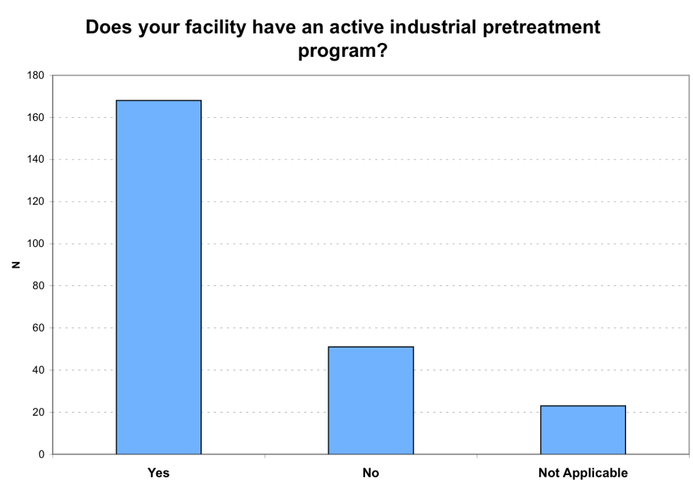


Figure 1 – Prevalence of industrial pre-treatment in larger TWTDS completing online survey

[3] Of the 250 responses, 199 were from major facilities (> 1 MGD); that's 80% of the sample. CWNS data indicate that, nationwide, only 8% of TWTDS are majors.

BIOSOLIDS END USE AND DISPOSAL

The data compilation efforts of this project build on prior estimates (USEPA Office of Solid Waste, 1999) and reports compiled from states (Goldstein, 2000). However, for the first time, at least some actual measured biosolids quantities were compiled for every state (the exception is Missouri, for which a rough estimate for total biosolids used or disposed was necessary to complete national totals.)

Ten states (Illinois, Massachusetts, Minnesota, New Hampshire, New Jersey, New York, Rhode Island, Vermont, Washington, Wisconsin) and the District of Columbia were able to efficiently provide comprehensive data on wastewater solids end use and disposal. Other states (e.g. Delaware, Georgia, Maryland) efficiently provided somewhat less comprehensive estimates (the difficulty with Maryland data is that it is reported in *wet* U. S. tons, requiring an estimate of the appropriate percent solids to apply to convert the data to dry equivalents).

For other states (e.g. California, Colorado, Hawaii, Montana, Nevada, North Dakota, South Dakota, Wyoming), it was relatively easy to compile robust data with the added help of EPA regional offices (Regions 8 & 9) that track biosolids closely using electronic databases. The use and disposal of biosolids in Pennsylvania had just been studied closely by researchers at Penn State University (Elliott et al., 2005), and their data was incorporated here.

Other states (e.g. Indiana, Kansas, Kentucky, Nebraska, New Mexico, North Carolina, South Carolina, Texas, Virginia) required painstaking compilation of data from incomplete information provided by state coordinators, EPA regional offices, the NACWA Financial Survey, and direct contact with individual TWTDS. In these cases, this required contacts with from three to fifteen of the largest individual TWTDS in the state. In each case, we managed to obtain data on solids end use and disposal from the largest TWTDS for at least 60% to 70% of the state's estimated total wastewater flow (as reported by the 2004 Clean Watersheds Needs Survey). We roughly estimate that achieving this level of data compilation likely accounts for 85% or more of the solids produced in the state, because many smaller TWTDS transport solids to larger facilities or store solids for longer periods, thus using or disposing no solids in a typical year.

The estimated total quantity of wastewater solids beneficially used or disposed in each state in 2004 is reported in Table 2.

Table 2 – State-by-State Population, Wastewater, and Total Solids Used / Disposed in 2004

State	Estimated State Population (U. S. Census, 2004)	Number of TWTDS (CWNS 2004)	Total Est. Wastewater Flow (MGD) (CWNS 2004)	Reported Solids Used & Disposed (dry U. S. tons)
Alabama	4,525,375	278	470	**68,000**
Alaska	657,755	172	78	**17,000**
Arizona	5,739,879	166	465	**99,500**
Arkansas	2,750,000	350	279	**58,000**
California	35,842,038	633	4,170	**788,500**
Colorado	4,601,821	315	425	**113,500**
Connecticut	3,498,966	94	386	**99,000**
Delaware	830,069	19	103	**23,500**
Dist. of Columbia	554,239	1	370	**105,800**
Florida	17,385,430	322	1,429	**300,000**
Georgia	8,918,129	350	755	**200,000**
Hawaii	1,262,124	21	136	**22,000**
Idaho	1,395,140	186	135	**23,300**
Illinois	12,712,016	721	2,231	**348,000**
Indiana	6,226,537	411	1,033	**197,000**
Iowa	2,952,904	730	358	**67,000**
Kansas	2,733,697	634	273	**32,000**
Kentucky	4,141,835	245	331	**94,500**
Louisiana	4,506,685	353	546	**63,500**
Maine	1,314,985	148	137	**32,200**
Maryland	5,561,332	161	444	**111,500**
Massachusetts	6,407,382	128	780	**168,800**
Michigan	10,104,206	404	1,409	**374,000**
Minnesota	5,096,546	516	462	**152,000**
Mississippi	2,900,768	317	295	**61,000**
Missouri	5,759,532	732	805	**170,000**
Montana	926,920	211	82	**12,000**
Nebraska	1,747,704	469	197	**34,000**
Nevada	2,332,898	57	136	**62,300**
New Hampshire	1,299,169	88	101	**27,000**
New Jersey	8,685,166	156	1,216	**261,200**
New Mexico	1,903,006	66	102	**80,500**
New York	19,280,727	588	2,766	**353,300**
North Carolina	8,540,468	457	645	**135,000**
North Dakota	636,308	284	56	**8,600**
Ohio	11,450,143	780	1,853	**358,000**
Oklahoma	3,523,546	493	355	**58,500**
Oregon	3,591,363	213	392	**61,000**
Pennsylvania	12,394,471	856	1,600	**304,000**
Rhode Island	1,079,916	20	131	**30,300**
South Carolina	4,197,892	173	462	**54,000**
South Dakota	770,621	280	61	**10,500**
Tennessee	5,893,298	245	742	**241,000**
Texas	22,471,549	1380	2,221	**708,000**
Utah	2,420,708	106	305	**58,400**
Vermont	621,233	87	45	**9,000**
Virginia	7,481,332	225	682	**176,400**
Washington	6,207,046	246	838	**110,600**
West Virginia	1,812,548	217	194	**29,000**
Wisconsin	5,503,533	597	667	**179,800**
Wyoming	505,887	123	47	**27,000**
U. S. TOTALS	**293,656,842**	**16,824**	**34,201**	**7,180,000**

In 2004, 49% of U. S. wastewater solids were beneficially used (applied to land for agronomic, silvicultural, or land restoration purposes), while 45% were disposed (Table 3, Figures 2 and 3). Another 6% were stored, or their final use or disposal was not reported. However, the following key factors apply:

- It is likely that most of the 6% "other" was also destined for beneficial uses (application to land). This means that the rate of beneficial use of biosolids tracked in 2004 was probably close to 55%.
- In this survey, biosolids reported as used for landfill daily cover were included in the "disposal" side of the equation. Some states (e.g. California, Washington) define landfill daily cover as a beneficial use, as did Elliott et al. (2005). By these state's definitions, the national rate of beneficial use might be a percentage point higher.
- Tracking by states and data compilation for this project rely predominantly on data from major TWTDS (> 1 MGD). Elliott et al. found that, in Pennsylvania, what larger TWTDS do with their solids is not a good predictor of what smaller TWTDS do. In addition, because some TWTDS use more than one method of end use and/or disposal, some TWTDS are double-counted. Thus, data on *number of entities* throughout this report are approximate and only provide some sense of relative proportions; *they not reliable for extrapolations*.
- Data on wastewater solids in Puerto Rico and other territories were not collected for this report and are not included in the totals. They are estimated to total no more than 30,000 dry U. S. tons.

Table 3 – Biosolids Use and Disposal Practices, 2004 U. S. Totals

	Quantity of Biosolids	Percentage (by quantity)
Beneficial Use (applied to soils)	3,507,000	49%
Disposal	3,252,000	45%
Other (long-term storage, etc.)	421,000	6%
Total	7,180,000	100.00%

Figure 2

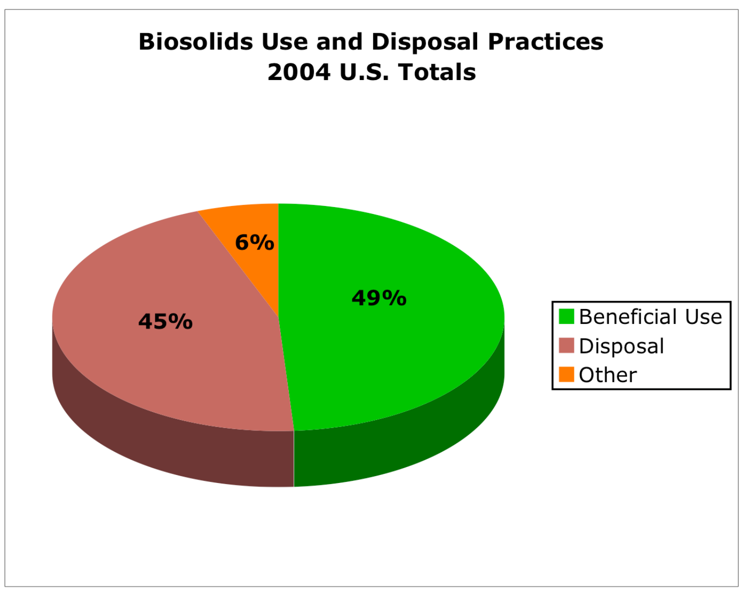
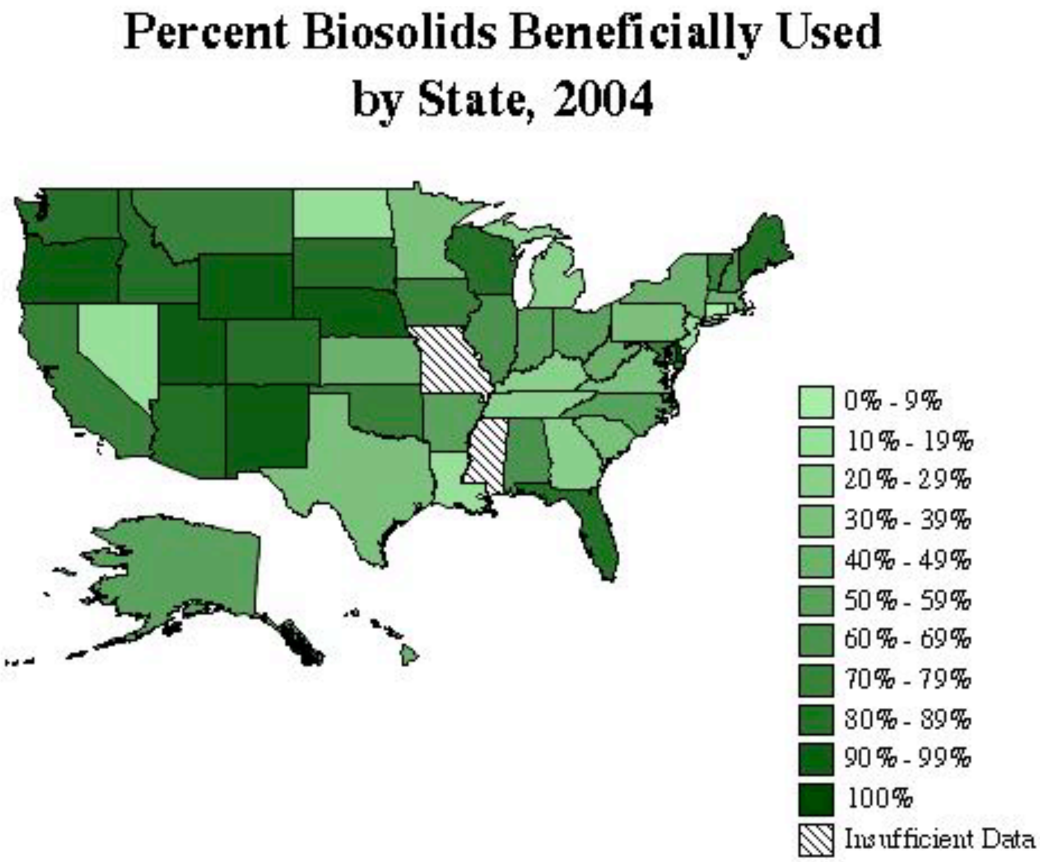


Figure 3



Agricultural uses of biosolids dominate the beneficial use practices (Figure 4). Most of this is traditional Class B land application, but a good portion is Class A – at least 613,000 dry U. S. tons. The distribution of Class A "Exceptional Quality" (EQ) biosolids makes up one quarter of the U. S. total and includes significant amounts of biosolids compost and heat-dried pellet fertilizer. Reclamation – the use of biosolids to improve disturbed or marginal soils and lands (e.g. mine lands) – requires relatively large amounts of biosolids per acre of land, but only 3% of beneficially used biosolids are land applied for this purpose. Some biosolids that were specified as having been applied to rangeland are included in the "forestland" category; clearly, silvicultural uses of biosolids are limited.

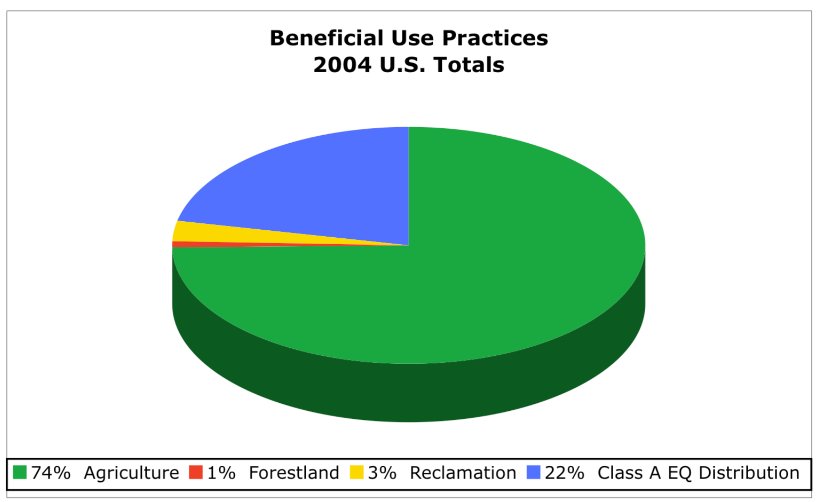
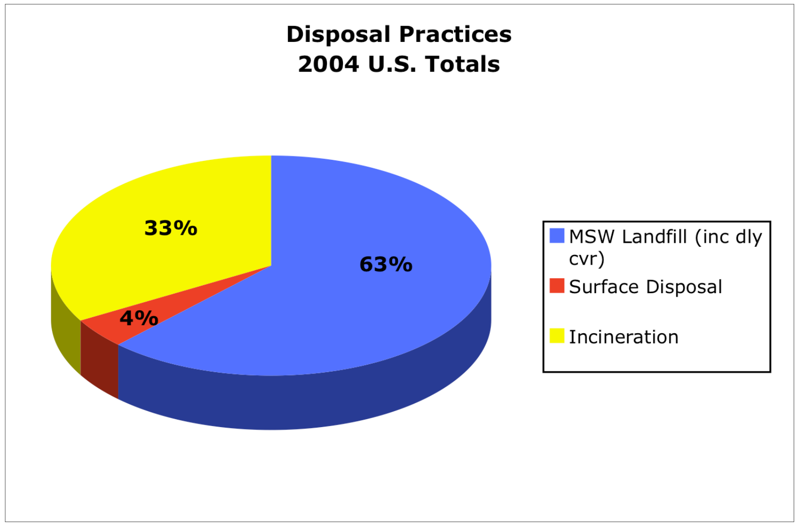


Figure 4

Most U. S. wastewater solids that are not applied to soils go to municipal solid waste (MSW) landfills (Figure 5). The 63% landfilled reported here for 2004 includes some that was used as alternative daily cover. Disposition of wastewater solids by incineration (thermal oxidation) predominates in a few densely populated states (e.g. Connecticut, Rhode Island) and manages large volumes of solids in several other states (e.g. at Anchorage, Cleveland, and Indianapolis). Data collected by NACWA's Biosolids Committee (Dominak, pers. comm., 2007) indicates that, in 2004, there were 234 operating incinerators in the U. S. (a state-by-state listing of operating incinerators appears in Appendix C). Dedicated surface disposal units, also known as monofills, handle only a small percentage of the nation's wastewater solids.

Figure 5



Data for the entire U. S., as well as each individual state and the District of Columbia (in alphabetical order) appear in Appendix D.

BIOSOLIDS QUALITY

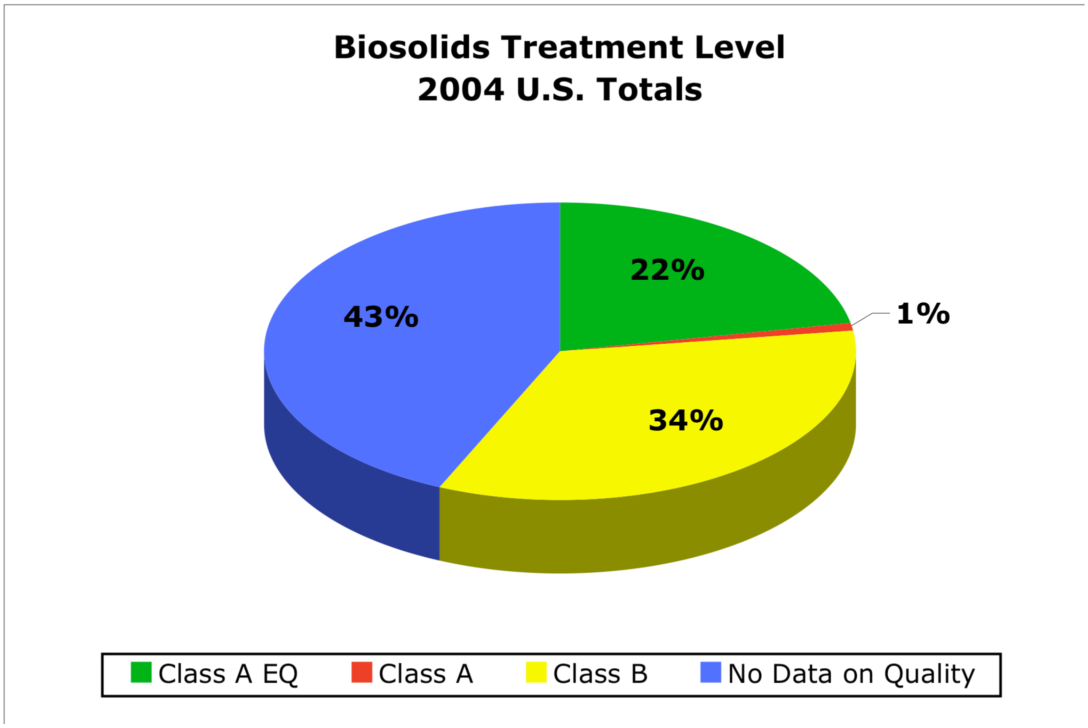
National Data Regarding Class A, Class B

The survey of state biosolids coordinators included a table requesting information on the numbers of TWTDS producing biosolids of various qualities (e.g. Class A or Class B), as well as the amounts of biosolids of each quality. It attempted to attain details to the level of separating Class A Exceptional Quality (EQ) biosolids of various kinds ("heat dried," "composted," and "other") from other Class A biosolids, as well as differentiating between Class B biosolids that meet Table 3 (the "high quality" standard) or only Table 1 ("ceiling limits") of the federal Part 503 regulations.

As it turned out, data collected only supported reporting of the quantities and percents of Class A, Class B, and biosolids for which no data was available (Figure 6). Note that the total amount of data compiled regarding biosolids quality was 94% of the total biosolids quantity reported used or disposed. Therefore, the following data is intended only to provide a general picture and should be used with caution.

For a large percentage of wastewater solids (2,903,000 dry U. S. tons or 43%), there is no data (or no data was obtained) regarding whether or not it met Class A or Class B standards. This lack of data is mostly due to the fact that wastewater solids that are landfilled or incinerated are not generally subjected to the same stabilization, testing, and reporting requirements. It should be noted that there are some TWTDS that produce Class A biosolids (e.g. heat dried pellets) that are burned in incinerators and can provide an energy recovery benefit.

Figure 6



Of the remaining 57% of biosolids for which quality data *were* available for 2004, 60% (2,273,000 dry U. S. tons) were Class B and 40% (1,532,000 dry U. S. tons) were Class A. Almost all of the Class A biosolids met the Exceptional Quality (EQ) criteria.

Note that Figure 6 shows a total larger percentage of Class A and B biosolids (57%) than the percentage of beneficially used biosolids in Figure 2 (55%, with the assumption that the 6% other were stored for eventual beneficial use). This is mostly because some Class A and Class B biosolids were not applied to soils (i.e., they were landfilled or incinerated).

Data on biosolids quality for the entire U. S., as well as each individual state and the District of Columbia (in alphabetical order) appear in Appendix D.

Metals and Organic Chemicals

There is considerable robust data on the quality of biosolids with regards to elements regulated by Part 503 ("heavy metals"). The volumes of data, and the compilation of such data required to conduct significant analysis, makes this difficult on a national scale – and beyond the scope of this project. The best sources of information regarding metals data are published papers that focus on particular elements or particular states or situations (e.g. Stehouwer, 2000; Chaney et al., 1999).

Data regarding unregulated elements (e.g. boron, silver) and unregulated organic chemicals are even less available, but, where they do exist, can be voluminous. Some states, such as Maine and New Hampshire, require biosolids to be tested for scores of compounds on at least an occasional basis. Such data is sometimes compiled and reported in state agency documents. Many larger public wastewater treatment facilities conduct testing on their biosolids for many different parameters to ensure product quality (e.g. Milorganite® and Boston's MWRA fertilizer pellets). However, compiling such information on a national scale is difficult at this time, in part because of lack of standardized data reporting and compilation in electronic formats. As with the regulated elements, the best current sources of information are published papers (e.g. Overcash et al., 2005; Kinney et al., 2006).

TREATMENT PRACTICES

There is a diversity of technologies used to manage the solids (sewage sludges) removed during the treatment of wastewater. In order to allow for efficient handling and transport, they are stabilized and, in most cases, dewatered. Stabilization processes generally reduce putrescibility and potential odors, as well as pathogen and vector-attraction levels. Dewatering processes convert solids that are at least 95% water to a semi-solid material that is from 50% to 85% water.

The survey of state biosolids coordinators requested estimates of the number of TWTDS utilizing each kind of common stabilization and dewatering technology. Responses were received from only ~50% of states regarding numbers of TWTDS using each technology and ~25% of states regarding quantities of biosolids treated by each technology. Nonetheless, the data provided (Table 4) gives a sense of the relative abundance of different treatment technologies.

Table 4 – Reported Estimates of Biosolids Treatment Technologies in Use

	Reported Estimates of Number of TWTDS Using*…	Estimated Quantity of Biosolids Produced Using*…
Stabilization Technology		
Aerobic Digestion	2200	85,000
Digestion-anaer./other	1000	1,217,000
Lime/Alkaline	900	285,000
Long-term (lagoons, reed beds, etc.)	500	97,000
Composting	200	471,000
Thermal (not incineration)	60	112,000
Other	20	5,400
Dewatering Technology		
Belt Filter Press	650	415,000
Drying beds	400	380,000
Centrifuge	150	880,000
Plate & Frame Press	50	65,500
Vaccuum Filter	20	4,200
Screw Press	10	3,400
Other	40	600

*CAUTIONS IN USING THIS DATA: These are minimum estimates from incomplete data from states and other sources. They serve only to provide a rough sense of the relative importance of various technologies.

STATE REGULATIONS, PERMITTING, AND OTHER REQUIREMENTS

In the U.S., the use and disposal of wastewater solids (sewage sludge) and biosolids is governed by USEPA regulations, 40 CFR Part 503. The Part 503 rule established risk-based standards for pollutants, pathogen and vector attraction reduction, and basic management requirements (e.g. agronomic loading rate). Most states have additional, state-level regulations that impose additional restrictions and require additional management practices, treatment processes, and/or testing requirements. The data presented below were derived from responses by state biosolids coordinators to questions in the 10-page Biosolids Quality and End Use Survey. One objective of the national survey was to characterize the comprehensiveness and strictness of state regulatory programs, as they build requirements above and beyond the Part 503 program.

Responsible Agencies and Divisions

Over half of states (58%) assign biosolids regulatory oversight to the water/wastewater division of their state environmental agency (Table 5). In another 30% of states, the solid waste division of the state environmental agency is responsible, either entirely or in part. In Arkansas, the environmental agency's water/wastewater program and solid waste program, as well as the public health department are involved. In Connecticut, where incineration is the prevalent disposal method, the air quality division of the environmental agency is involved, along with the water/wastewater division (air quality involvement in other states with incinerators is also likely). In New Jersey and other states, the solid waste division is involved in some biosolids disposal options (in many states, landfilling biosolids involves solid waste divisions). In Virginia, three environmental agency divisions (water, solid waste, and air) – as well as the public health department – have been involved in biosolids management. However, as of 2007, new Virginia legislation has turned over most responsibility to the environmental agency.

Table 5 – State agency and division responsible for regulation

water/wastewater program of the state environmental agency	solid waste program of the state environmental agency	water/wastewater program & solid waste program of the state environmental agency
29 States 58% Alabama, Delaware, Florida, Hawaii, Illinois, Iowa, Kansas, Louisiana, Massachusetts, Michigan Minnesota, Missouri, Nebraska, New Hampshire, New Mexico, North Carolina, North Dakota, Ohio, Oklahoma, Oregon, Rhode Island, South Carolina, South Dakota, Tennessee, Texas, Utah, West Virginia, Wisconsin, Wyoming	8 States 16% Alaska, Indiana, Kentucky, Maine, Maryland, Mississippi, New York, Washington	8 States 16% California, Colorado, Georgia, Idaho, Montana, Nevada, Pennsylvania, Vermont

Delegation for 40 CFR Part 503

Since 1993, when the Part 503 rule was adopted, USEPA has offered states the option of becoming delegated to administer the rule. Delegation requires that states have robust regulatory and enforcement programs that ensure that TWTDS' compliance with Part 503 (at a minimum) is demonstrated. Delegation allows states some autonomy, and can streamline the regulatory process by avoiding involvement of, and reporting to, both state and federal authorities. As of 2006, relatively few states have decided to pursue the delegation option; delegated states are Arizona, Michigan, Ohio, Oklahoma, South Dakota, Texas, Utah, and Wisconsin (Figure 7).

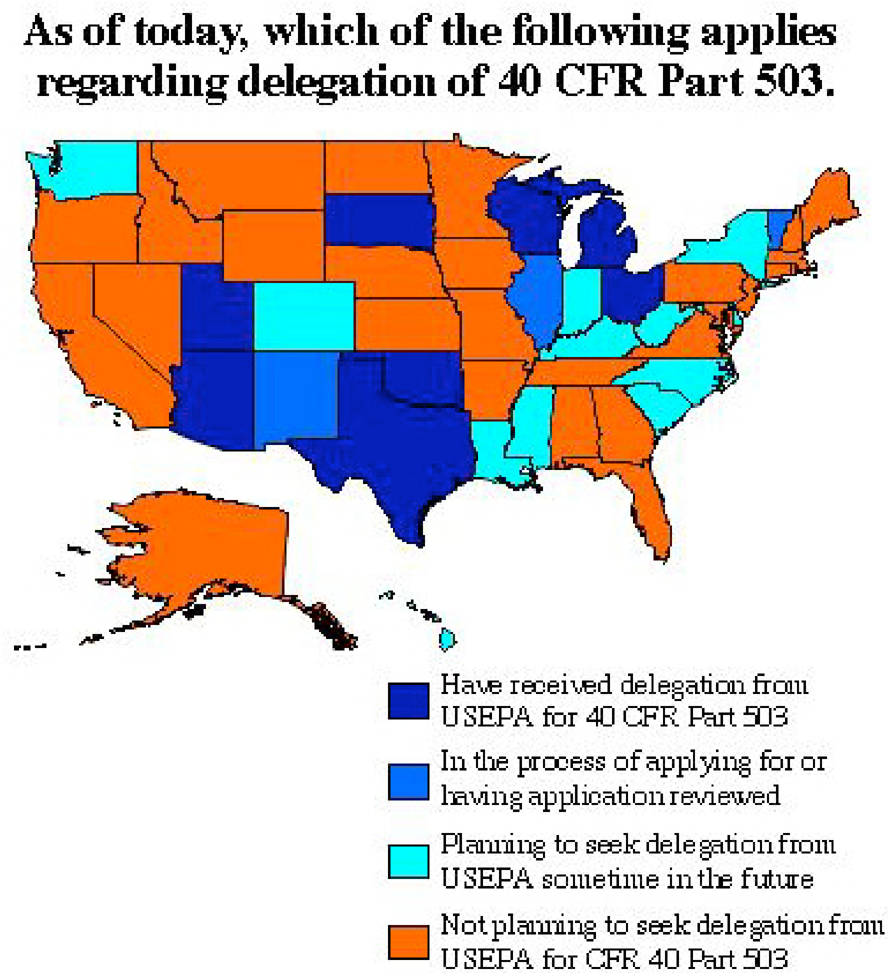


Figure 7 – Delegation

NOTES: South Dakota and Utah adopted all of Part 503 by reference. Michigan is delegated for land application only. Ohio and Wisconsin are delegated for land application, landfilling, and surface disposal (not incineration and septage). Oklahoma and Texas reported only that they are delegated.

Agency biosolids program FTEs
Staff time applied to a particular program area can be expressed as full-time equivalents: the total staff hours per week divided by 40. USEPA has used this statistic in past reports, such as in its response to the Inspector General's report (USEPA Inspector General, 2000 & 2002). Table 6 compares this survey's data and that past data.

When all states are combined (except the three for which no data was provided in 2006), there appears to be a reduction in staffing for biosolids programs of close to 19 FTEs between 2000 and 2006. A few states seem to account for large amounts of these trends. Even if these large changes in these few states are ignored (e.g. Florida's apparent reduction of 7.5 FTEs), the overall change appears to be a loss nationwide of at least 8 FTEs. These reductions in staffing are likely a result of increasing demands on environmental agencies and the resultant shifting of priorities and staff assignments.

It is important to recognize that, in the case of states in USEPA Region 8 (and, to some extent, Region 9), considerable regulatory permitting, oversight, and enforcement are conducted by the

Table 6 – Number of reported FTEs, FTEs per million population and change since 2000

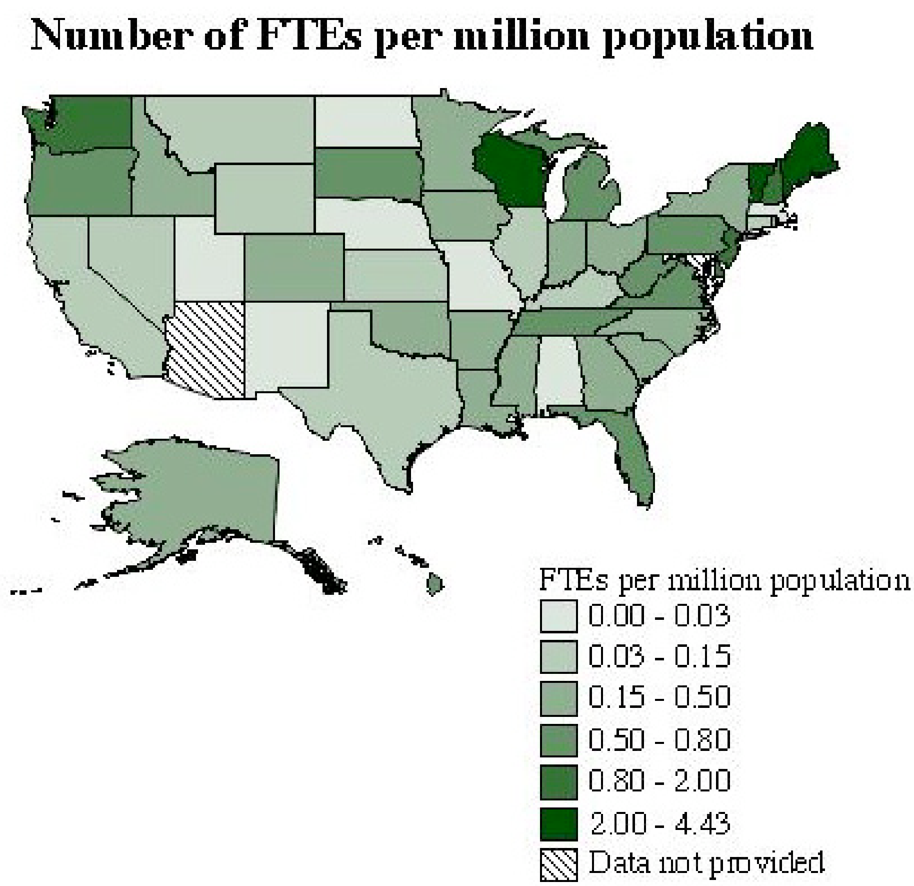
State	Estimated FTEs per million population	Estimated number of full-time equivalents in biosolids program 2006	Estimated number of full-time equivalents in biosolids program 2000 (NRC, 2002)	CHANGE from 2000 to 2006
Alabama	0.00	0	1.5	-1.5
Alaska	0.30	0.2	0.1	0.1
Arizona	ND	ND*	0.25	ND
Arkansas	0.18	0.5	0.75	-0.25
California	0.05	1.8	1.75	0.05
Colorado	0.22	1	1	0
Connecticut	0.03	0.1	1	-0.9
Delaware	1.20	1	1	0
Florida	0.55	9.5	2	7.5
Georgia	0.22	2	1	1
Hawaii	0.59	0.75	1	-0.25
Idaho	0.43	0.6	0.25	0.35
Illinois	0.12	1.5	2	-0.5
Indiana	0.48	3	3	0
Iowa	0.17	0.5	0.33	0.17
Kansas	0.09	0.25	0.25	0
Kentucky	0.14	0.6	0.6	0
Louisiana	0.33	1.5	1.75	-0.25
Maine	3.04	4	4	0
Maryland	0.00	ND*	12	ND
Massachusetts	0.20	1.3	2.5	-1.2
Michigan	0.54	5.5	6	-0.5
Minnesota	0.29	1.5	1.5	0
Mississippi	0.24	0.7	0.67	0.03
Missouri	0.00	0.01	0.1	-0.09
Montana	0.05	0.05	0.1	-0.05
Nebraska	0.01	0.01	1	-0.99
Nevada	0.09	0.2	0.25	-0.05
New Hampshire	1.92	2.5	4	-1.5
New Jersey	1.30	11.33	11.33	0
New Mexico	0.00	0	0.1	-0.1
New York	0.23	4.5	4.5	0
North Carolina	0.47	4	7	-3
North Dakota	0.00	0	0.25	-0.25
Ohio	0.17	2	4	-2
Oklahoma	0.28	1	2	-1
Oregon	0.56	2	2.4	-0.4
Pennsylvania	0.65	8	12	-4
Rhode Island	0.46	0.5	1	-0.5
South Carolina	0.24	1	6	-5
South Dakota	0.65	0.5	0.5	0
Tennessee	0.51	3	2.2	0.8
Texas	0.13	ND*	11.5	ND
Utah	0.02	0.05	1	-0.95
Vermont	4.43	2.75	3	-0.25
Virginia	0.53	4	7	-3
Washington	0.81	5	3.9	1.1
West Virginia	0.77	1.4	3	-1.6
Wisconsin	2.18	12	12	0
Wyoming	0.10	0.05	0.25	-0.2
TOTALS		**103.7 (*no 2006 data for 3 states)**	**146.0 (125.2 if exclude 3 states with no 2006 data)**	**-18.5**

USEPA regional offices, working in conjunction with state staff. In addition, in many states, additional oversight and enforcement are provided through state agency district offices and at the county level – meaning that the numbers of state agency FTEs in Table 6 do not paint the entire picture for any state.

Also included in Table 6 and depicted in Figure 8 is the calculation of FTEs per million people in the state population; this creates a fairer comparison of the relative involvement by different state regulatory agencies. The results show that, for example, Vermont, with its 2.75 FTEs, really has the greatest commitment of staff time relative to its small population (4.43).

What is USEPA's commitment to the biosolids program? This data was not collected in this study. However, as of 2002, according to the National Research Council (2002), "each of the 10 EPA Regions have between 0.2 and 2 full-time employees (FTEs), and a total nationwide of 8.8 FTEs, working in all areas of biosolids management. The EPA ORD has 2 FTEs devoted to the program, and EPA headquarters has 4.8 FTEs."

Figure 8 – Number of FTEs per million people (graduated color scheme: darkest shading equals most FTEs)



Updated regulations

Three states have regulations that have not been updated since the 1980s: Illinois, Missouri, and Vermont. Fifteen states adopted updated regulations in the 1990s – almost all after the promulgation of the federal Part 503 rules in 1993. All other states have been actively updating their biosolids regulations over the past six years, a good indication of state commitment to regulatory oversight and enforcement (except no data was provided for AZ, ID, and ND). An example is South Dakota, which was delegated in 2001; that involved updating state rules to reference Part 503.

Nine states have no formal regulations specifically addressing biosolids management (some of these may have guidelines or other regulations, such as groundwater protection requirements, that are applied): Alabama, Arkansas, Connecticut, Kansas, Montana, Nebraska, Nevada, New Mexico, and Wyoming. Wastewater treatment facilities and biosolids management programs in these states adhere to the Part 503 rules, which are enforced by USEPA.

Details regarding the updating of each state's regulations are provided in Appendix B-1.

State regulations more restrictive than Part 503

When asked "are your state's biosolids regulations *more restrictive* than the federal Part 503 rule?," 37 states answered "yes" with regards to management practices, four answered "yes" with regards to pathogen and/or vector attraction standards, and sixteen answered "yes" with regards to pollutant limits. Ten states do not have state regulations more restrictive than Part 503 (Figure 9).

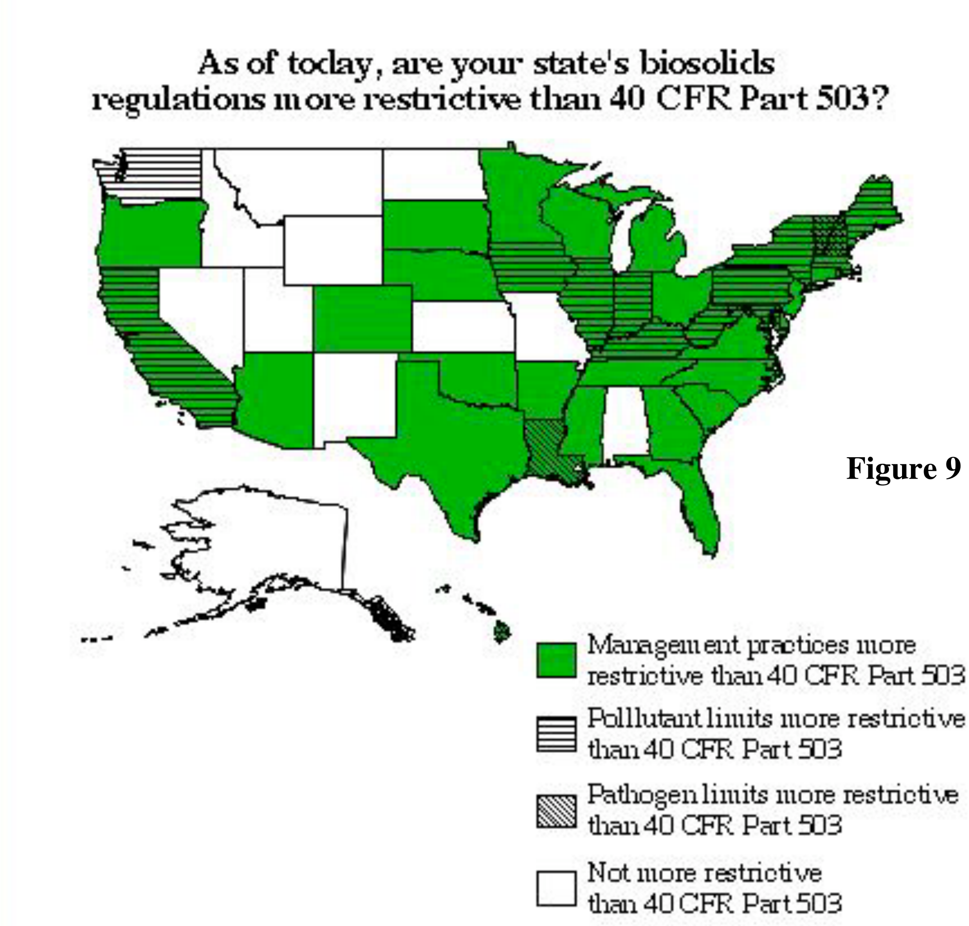


Figure 9

Additional details about more stringent state regulatory structures are provided in Appendix B.

More stringent pollutant limits

Tables 7 and 8 show the numerical pollutant ("heavy metal") limits that have been adopted by those states that have pollutant standards different than the federal USEPA Part 503 limits. Table 7 shows the "ceiling" limits (higher numerical limits – no biosolids exceeding these may be applied to land) and Table 8 shows the lower ("high quality") limits. Additional states may have pollutant limits different from Part 503; a few state coordinators indicated as much, but did not provide details.

Few states have adopted different numerical limits for Cumulative Pollutant Loading Rates (CPLR), as compared to Part 503. Those that have are Indiana, Maine, New Hampshire, New York, Illinois, Maryland, and Vermont. Even fewer states diverge from Part 503 numerical standards for Annual Pollutant Loading Rates (APLR); they are Indiana, Kentucky, Maine, and Vermont.

Table 7 – Pollutant ceiling limits for land application of biosolids for those states with limits different from 40 CFR Part 503

State	As	Cd	Cr	Cu	Pb	Hg	Mo	Ni	Se	Zn
Part 503 Table 1	**75**	**85**		**4300**	**840**	**57**	**75**	**420**	**100**	**7500**
Hawaii	20	15	200	1500	300	10	15	100	25	2000
Indiana	75	85	N/A	4300	840	57	75	420	100	7500
Iowa			3000				75			
Kentucky	TCLP									
Maine	41	39	3000	1500	300	10	75	420	100	2800
Maryland		25		1000	1000	10		200		2500
New Hampshire	32	14	1000	1500	300	10	35	200	28	2500
New York	75	85	1000	4300	840	57	75	420	100	7500
Rhode Island	75	85	3000	4300	840	57	75	420	100	7500
Vermont		25	1000	1000	1000	10		200		2500
Washington	75	85		4300	840	57	75	420	100	7500
West Virginia	75	85	3000	4300	840	57	75	420	100	7500

Other indicators of state regulatory activity

Other questions in the survey of state biosolids coordinators addressed a variety of other state regulatory details, including current, "cutting edge" biosolids land application issues, such as management of phosphorus and other nutrients. The responses to these questions provide a further glimpse of state regulatory involvement in biosolids management and show to what extent states go above and beyond Part 503 requirements. See Appendix B for this additional information, including:

- State regulation updates
- State mechanisms used to regulate end use / disposal and permitting of land application sites
- Legal liability
- Different Class B biosolids to one site
- Allowing more restrictive local ordinances
- Who must report biosolids data to state?
- State regulatory requirements for testing and reporting
- Additional indicators of state regulatory activity
- Top 3 pressures on biosolids recycling.

Table 8 – High quality pollutant limits for land application of biosolids for those states different from 40 CFR Part 503

State	As	Cd	Cr	Cu	Pb	Hg	Mo	Ni	Se	Zn
EPA Table 3	**41**	**39**		**1500**	**300**	**17**		**420**	**36**	**2800**
Hawaii	20	15	200	1500	300	10	15	100	25	2000
Illinois										
Indiana	41	39		1500	300	17	75	420	100	2800
Iowa			1000				75		36	
Kentucky		10		450	250			50		900
Maine	10	10	1000	1000	300	6	75	200	100	2000
Maryland		12.5		500	500	5		100		1250
Massachusetts	41	14	1000	1000	300	10	10	200	36	2500
New Hampshire	10	10	160	1000	270	7	18	98	18	1780
New York	41	21	1000	1500	300	10	40	200	100	2500
Rhode Island	41	39	1200	840	300	17	75	420	36	2800
Vermont*		25	1000	1000	1000	10		200		2500
Washington	41	39		1500	300	17	75	420	36	2800
West Virginia	20	39	1000	1500	250	10	18	200	36	2800

* In some states, such as Vermont, older state regulations have not been updated to be consistent with federal Part 503 standards; in such cases, the more stringent regulatory standards – that of Part 503 – apply.

TRENDS

Is the beneficial use of biosolids increasing?

In 2000, the *BioCycle* survey of state biosolids programs noted that "out of the 43 states responding, 20 states answered yes and 22 answered no" to the question "is beneficial use of biosolids increasing in your state?" In the current survey, the responses to the same question were 19 and 26, respectively, out of a total of 45 responses (Figures 10 and 11).

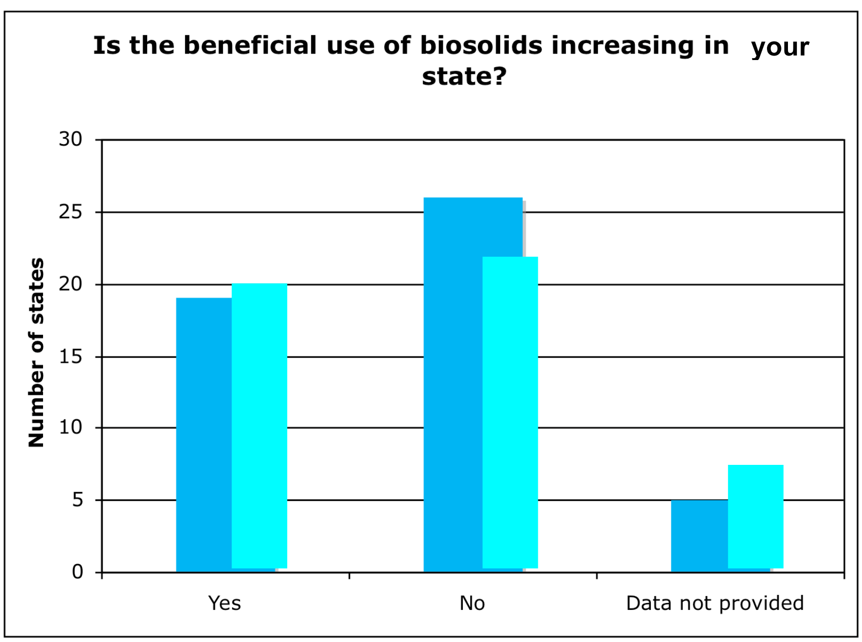


Figure 10 - Is the beneficial use of biosolids increasing in your state? Responses of state biosolids coordinators in 2006 and 2000 (Goldstein, 2000).

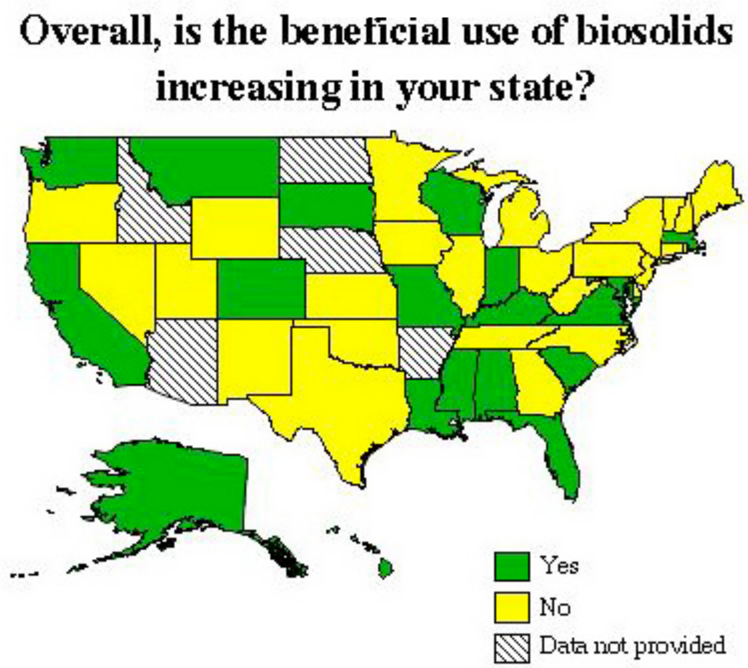
Current 2006 data

2000 data

While the rate of beneficial use of biosolids, in terms of application to soils (see discussion of terminology, p. *iv*), has apparently not increased significantly in recent years, other beneficial uses of biosolids are likely increasing – although this was not measured by this current survey work. For examples, increasing numbers of TWTDS today are…
utilizing methane from digestors to produce energy;
recovering heat from incinerators;
using biosolids incinerator ash as clean daily cover at landfills, as a soil conditioner, in cement and asphalt, and as clean fill material at a variety of locations; and

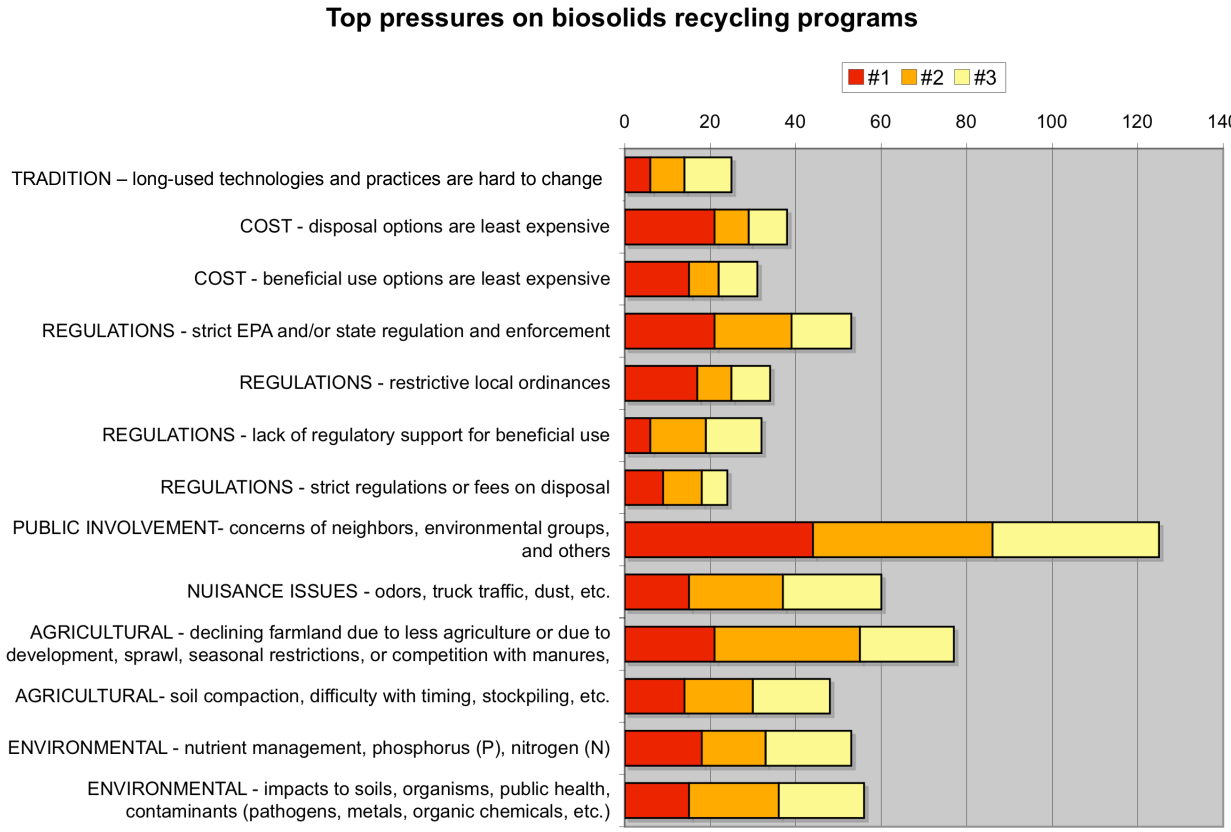
- piloting recovery of energy from landfilled biosolids ("bioreactor landfills").

Figure 11



Pressures on biosolids recycling
The online survey of individual TWTDS asked respondents to identify the three most important pressures on biosolids recycling. Figure 12 is a compilation of the ~250 responses from around the nation. The #1 priority responses appear in the darkest color; the #3 priority responses appear in the lightest color.

Figure 12

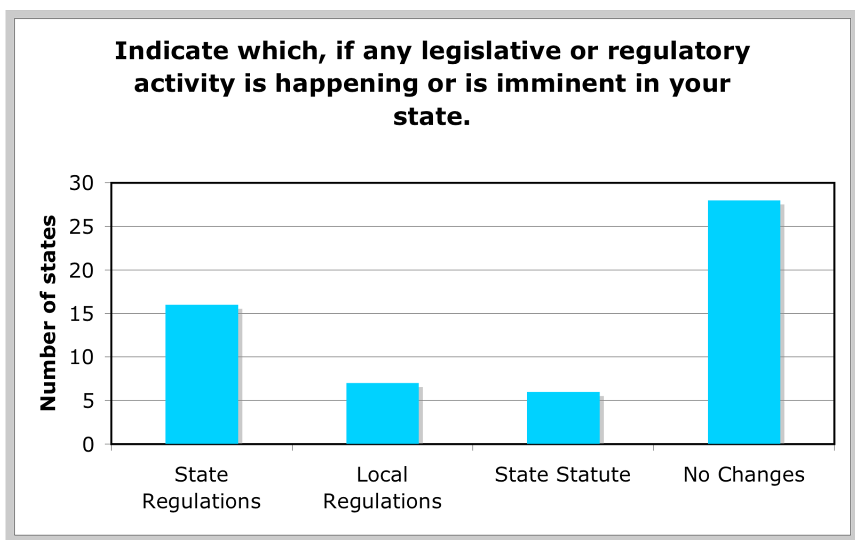


State coordinators were also asked to identify the top three pressures on biosolids recycling. Their compiled responses appear as Appendix B-10.

Legislative or regulatory activity happening or imminent pertaining to biosolids

State biosolids coordinators were asked to indicate if any state legislative or regulatory activities that would affect biosolids management were happening or were imminent. Figure 13 displays their responses: half of the states are not experiencing such activities.

Figure 13



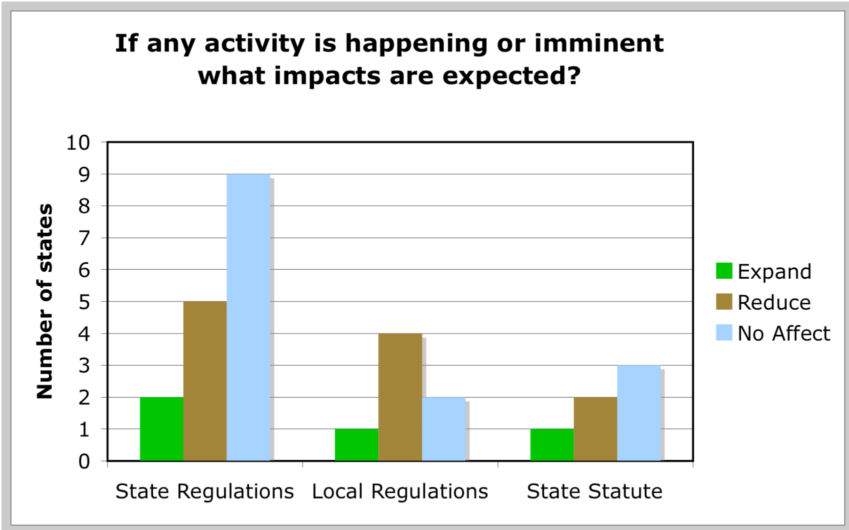


Figure 14

Of those states that are experiencing or expecting changes to regulations or statutes, most (14) expect the changes to have no affect on beneficial use of biosolids (Figure 14). However, five state coordinators expect state regulatory changes to reduce the beneficial use of biosolids (applications to soils), four state coordinators expect local regulations to reduce the beneficial use of biosolids, and two expect changes in state statute to reduce beneficial use. Overall, few of the expected changes are expected to increase beneficial use (applications to soils).

SEPTAGE MANAGEMENT

The survey of state coordinators also requested information on septage management. In some states, the biosolids coordinator is involved in the state regulatory program for septage. In others, a different person was the source of data on septage management.

Overall, in most states, less septage management data is available than biosolids management data. This is partly due to the fact that, in many states, septage management is partly or wholly overseen by local county or even municipal structures.

The state-by-state data collected by this survey regarding septage management in the U. S. is presented in Appendix C.

RECOMMENDATIONS FOR FUTURE STUDIES

The process of collecting and compiling data on biosolids management in the U.S. for this report underscored the importance of robust state-based data collection and compilation efforts. Those states with robust electronic biosolids data programs were able provide detailed reports on demand, helping make an efficient national compilation of data possible. There are many states, however, that do not yet have this capability, and USEPA, while considering expanding its data reporting requirements and electronic data compilation systems, is still many years away from establishing such a system.

Therefore, in the near future (ten years), it is likely that the process used for this study – compilation of data obtained from the fifty state biosolids coordinators, various USEPA offices, and individual large TWTDS – will be necessary. It is a time-consuming and difficult process that yields adequate, but not precise, results.

What this study did determine to have considerable potential as a future tool for compiling national data was the use of an online survey system. The online survey pilot was deemed a success: it was relatively simple to set up and yielded useful data in a format that is easily manipulated and analyzed. A nationwide online survey of individual TWTDS is currently the most promising and cost-efficient way to update the most essential data on biosolids management.

CONCLUSIONS

Data collected from state biosolids coordinators, USEPA regional offices, individual wastewater treatment facilities, and others present a comprehensive picture of the management of wastewater solids in the U. S. for the year 2004. An estimated 55% of wastewater solids were applied to soils – mostly as Class B biosolids. The remainder was disposed of in landfills and incinerators. The treatment of biosolids to the Class A level seems to be increasing, accounting for almost ¼ of total wastewater solids applied to soils in 2004. Many state biosolids regulatory programs continue to advance, addressing current new topics (e.g. nutrient management), even as some have reduced the number of staff hours devoted to their biosolids programs. Overall, current data suggest little change nationwide, since the late 1990s, in the rate of biosolids recycling to soils (USEPA, 1999), and half of state biosolids coordinators report that the amounts of biosolids applied to soils are not increasing in their states.

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