Storm and Wastewater

Quality Management for Biosolids Programs

This document is the twelfth in a series of best practices that deal with buried linear infrastructure as well as end of pipe treatment and management issues. For titles of other best practices in this and other series, please refer to ***<www.infraguide.ca>***.

National Guide to Sustainable Municipal Infrastructure

NRC · CNRC FCM Federation of Canadian Municipalities Fédération canadienne des municipalités Canada

Quality Management for Biosolids Programs

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InfraGuide® — Innovations and Best Practices

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Canadian municipalities spend $12 to $15 billion annually on infrastructure but it never seems to be enough. Existing infrastructure is aging while demand grows for more and better roads, and improved water and sewer systems responding both to higher standards of safety, health and environmental protection as well as population growth. The solution is to change the way we plan, design and manage infrastructure. Only by doing so can municipalities meet new demands within a fiscally responsible and environmentally sustainable framework, while preserving our quality of life.

This is what the National Guide to Sustainable Municipal Infrastructure (InfraGuide) seeks to accomplish.

In 2001, the federal government, through its Infrastructure Canada Program (IC) and the National Research Council (NRC), joined forces with the Federation of Canadian Municipalities (FCM) to create the National Guide to Sustainable Municipal Infrastructure (InfraGuide). InfraGuide is both a new, national network of people and a growing collection of published best practice documents for use by decision makers and technical personnel in the public and private sectors. Based on Canadian experience and research, the reports set out the best practices to support sustainable municipal infrastructure decisions and actions in six key areas: decision making and investment planning, potable water, storm and wastewater, municipal roads and sidewalks, environmental protocols, and transit. The best practices are available online and in hard copy.

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InfraGuide's creation is made possible through $12.5 million from Infrastructure Canada, in-kind contributions from various facets of the industry, technical resources, the collaborative effort of municipal practitioners, researchers and other experts, and a host of volunteers throughout the country. By gathering and synthesizing the best Canadian experience and knowledge, InfraGuide helps municipalities get the maximum return on every dollar they spend on infrastructure—while being mindful of the social and environmental implications of their decisions.

Volunteer technical committees and working groups —with the assistance of consultants and other stakeholders—are responsible for the research and publication of the best practices. This is a system of shared knowledge, shared responsibility and shared benefits. We urge you to become a part of the InfraGuide Network of Excellence. Whether you are a municipal plant operator, a planner or a municipal councillor, your input is critical to the quality of our work.

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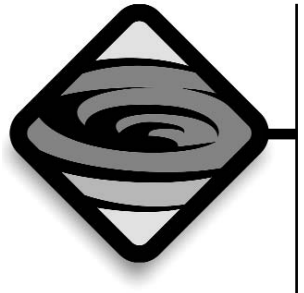


Storm and Wastewater

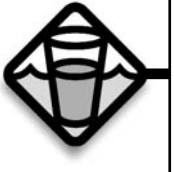
Ageing buried infrastructure, diminishing financial resources, stricter legislation for effluents, increasing public awareness of environmental impacts due to wastewater and contaminated stormwater are challenges that municipalities have to deal with. Events such as water contamination in Walkerton and North Battleford, as well as the recent CEPA classification of ammonia, road salt and chlorinated organics as toxic substances, have raised the bar for municipalities. Storm and wastewater best practices deal with buried linear infrastructure as well as end of pipe treatment and management issues. Examples include ways to control and reduce inflow and infiltration; how to secure relevant and consistent data sets; how to inspect and assess condition and performance of collections systems; treatment plant optimization; and management of biosolids.

Decision Making and Investment Planning

Elected officials and senior municipal administrators need a framework for articulating the value of infrastructure planning and maintenance, while balancing social, environmental and economic factors. Decision making and investment planning best practices transform complex and technical material into non-technical principles and guidelines for decision making, and facilitate the realization of adequate funding over the life cycle of the infrastructure. Examples include protocols for determining costs and benefits associated with desired levels of service; and strategic benchmarks, indicators or reference points for investment policy and planning decisions.

Environmental Protocols

Environmental protocols focus on the interaction of natural systems and their effects on human quality of life in relation to municipal infrastructure delivery. Environmental elements and systems include land (including flora), water, air (including noise and light) and soil. Example practices include how to factor in environmental considerations in establishing the desired level of municipal infrastructure service; and definition of local environmental conditions, challenges and opportunities with respect to municipal infrastructure.



Potable Water

Potable water best practices address various approaches to enhance a municipality's or water utility's ability to manage drinking water delivery in a way that ensures public health and safety at best value and on a sustainable basis. Issues such as water accountability, water use and loss, deterioration and inspection of distribution systems, renewal planning and technologies for rehabilitation of potable water systems and water quality in the distribution systems are examined.

Transit

Urbanization places pressure on an eroding, ageing infrastructure, and raises concerns about declining air and water quality. Transit systems contribute to reducing traffic gridlock and improving road safety. Transit best practices address the need to improve supply, influence demand and make operational improvements with the least environmental impact, while meeting social and business needs.

Municipal Roads and Sidewalks

Sound decision making and preventive maintenance are essential to managing municipal pavement infrastructure cost effectively. Municipal roads and sidewalks best practices address two priorities: front-end planning and decision making to identify and manage pavement infrastructures as a component of the infrastructure system; and a preventive approach to slow the deterioration of existing roadways. Example topics include timely preventative maintenance of municipal roads; construction and rehabilitation of utility boxes; and progressive improvement of asphalt and concrete pavement repair practices.

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EXECUTIVE SUMMARY

Public concern about the safety of biosolids management practices is increasing across North America, bringing biosolids management programs under much greater scrutiny. In Canada, several provinces—the primary regulators of Biosolids—have re-examined their legislation and practices.

This best practice can help Canadian municipalities improve biosolids management programs and gain public acceptance. It describes ways to develop, implement and integrate quality management principles into municipal biosolids management programs.

This best practice should be read in conjunction with InfraGuide's best practices on *Biosolids Management Programs*, and *Communication and Public Consultation for Biosolids Management*.

Municipalities that implement a quality management system for their biosolids management program can expect to realize several benefits, including improved product quality, better cost effectiveness, wider public acceptance and increased public confidence.

This best practice outlines a four-stage approach to developing and implementing a quality management program for biosolids:

1. **Plan** — *STATE clearly what you PLAN to achieve*. Develop a vision for the program that defines the goals and objectives and the roles and responsibilities of the various staff.
2. **Do** — *DO what you need to do to achieve your plan*. Train of staff and develop standard (and emergency) operating procedures to improve the quality of the product and achieve compliance.
3. **Check** — *CHECK that you are doing what you said you were going to do*. Monitor activities, processes and the final product, maintain records and report to the various interested parties including management, elected officials, the public and regulatory agencies.
4. **Review** — *REVIEW to see if what you are doing is achieving your plan*. Review and evaluate results against objectives and implement any corrective actions that are necessary to achieve what was planned.

The approach is not linear; it is a cycle of improvement. After the Review stage, planning begins again as the municipality seeks to improve on what it has built. Two elements are integral to all four stages—communication (internal and external) and documentation of the program.

This best practice makes reference to the National Biosolids Partnership's *Environmental Management System Guidance Manual*, which has been used as a guide. Readers are referred to this manual for more detailed information about specific elements. The document can be found at *<http://www.biosolids.policy.net/>*.

1. General

1.1 Introduction

This report, developed by the *National Guide to Sustainable Municipal Infrastructure (InfraGuide)*, outlines the best practice for building quality management principles into a municipal biosolids management program. InfraGuide defines a best practice as "state-of-the-art" methodologies and technologies for municipal infrastructure planning, design, construction, management, assessment, maintenance and rehabilitation that consider local economic, environmental and social factors.

This best practice, a subset to another InfraGuide Storm and Wastewater best practice *Biosolids Management Programs* (InfraGuide, 2003), specifically explores the Quality Management for Biosolids Programs.[1]

It is based on review of existing literature as well as a 2003 survey of selected municipalities across Canada. The questionnaire identified current methodologies and technologies used by Canadian municipalities in their biosolids programs.

1.2 Purpose and Scope

By presenting ways to develop, implement, and integrate quality management principles into municipal biosolids programs, this best practice aims to help Canadian municipalities improve their biosolids programs.

The solids stabilization process at municipal wastewater treatment facilities produces Biosolids. As noted in InfraGuide's best practice for *Biosolids Management Programs* (InfraGuide, 2003), several classes of biosolids may be produced—liquid biosolids or cake (Category 2 or 3), pellets or compost (Category 1 or 2), and soil products (Category 1 or 2). See **Appendix A** for tables listing biosolids categories and quality parameters.

This document considers the stabilization process as the starting point for biosolids programs with two exceptions: source control programs and solids conditioning (thickening prior to stabilization). Source control has a direct effect on the quality of the biosolids. The reader is referred to InfraGuide's Storm and Wastewater best practice: *Wastewater Source Control* (InfraGuide, 2004a).

1.3 How to Use this Document

The practices and methodologies presented in this report give guidance towards the achievement of the best practice. They should not be construed as the definitive best practice.

Section 2 provides an overview of why it is important for municipalities to integrate quality management principles into their biosolids programs, outlining the associated benefits and risks. Biosolids managers can draw on this section to develop an understanding of their program's practices and to evaluate the current state of their quality management.

Section 3 describes the underlying principles of the best practice. Municipal practitioners can refer to this section for an overview of common elements of quality management. This section provides overall guidance on Quality Management System (QMS) methods and concepts that can be applied to biosolids programs to improve biosolids quality, increase management effectiveness, and upgrade overall efficiency.

This document considers the stabilization process as the starting point for biosolids programs with two exceptions: source control programs and solids conditioning (thickening prior to stabilization).

1. In this document, biosolids management programs are simply referred to as biosolids programs to avoid confusion with quality management.

Section 4 describes the application of quality management principles to biosolids programs. Municipal staff can refer to this section for examples of quality management initiatives that can be undertaken for their biosolids programs.

Section 5 outlines methods for evaluating the quality management system. The section also discusses an audit process to evaluate and improve the quality management system.

The appendices and references provide more detailed information. Readers can use them to identify tools for their biosolids programs and to find more detail on what other municipalities are doing.

1.4 Glossary

Beneficial Use — For the purpose of this Guide, taking advantage of the nutrient content and soil conditioning properties of a biosolids product to supply some or all of the fertilizer needs of an agronomic crop or for stabilizing vegetative cover (in land reclamation, silviculture, landfill cover, or similar ventures); or using the biosolids as a fuel source.

Biosolids — A primarily organic product produced by wastewater treatment processes that can be beneficially used. They are the treated solid or semi-solid residues generated during the treatment of domestic sewage in a municipal wastewater treatment facility. (Such facilities may also receive an industrial component). Biosolids must meet regulations of the jurisdiction where they are produced or applied. Requirements may include pollutant concentration, pathogen reduction, and vector attraction reduction criteria.

Composting — The controlled biological oxidation and decomposition of organic matter, including sludge and biosolids at controlled time and temperature conditions specified in the criteria used in that jurisdiction.

Heat Drying — Dewatered cake is dried by direct or indirect contact with a heat source, and the moisture content is reduced to 10 percent or lower. Sludge particles reach temperatures well in excess of 100°C.

Land Application — The placement of biosolids at a predetermined rate and in accordance with relevant site management policies and regulations to support vegetative growth either on the surface or in the subsurface.

Pathogens — Organisms such as bacteria, protozoa, viruses, and parasites causing disease in humans and animals.

Public Consultation — Two-way information exchange between the municipality and the public before decisions are made. It is an open and accountable process whereby individuals and groups can participate in decision-making processes and influence the outcomes.

SOP — Standard Operating Procedure — A step-by-step description of how to carry out an operational or maintenance procedure. The intention of SOPs is that all personnel are required to follow the steps in the SOP in their day-to-day functions.

Stabilization — The use of various processes used to reduce volume, pathogens, vector attraction, and odour potential in order to produce a uniform biosolids product, which meets the requirements for the selected management method.

Stakeholders — Those who have an interest in a particular decision or action, either as individuals or as a group. They include people who can influence a decision, as well as those affected by the decision.

Note: Some definitions have been adapted from the following documents:

1. InfraGuide, 2003. Storm and Wastewater best practice: *Biosolids Management Programs*, Ottawa, Ontario.
2. California Water Environment Association (CWEA), 1998. *Manual of Good Practice — Agricultural Land Application of Biosolids*.
3. United States Environmental Protection Agency, *Use and Disposal of Municipal Wastewater Sludge*, EPA 625/10–84–003.
4. Metcalf & Eddy, 1991. *Wastewater Engineering: Treatment, Disposal, Reuse*, Third Edition.
5. National Biosolids Partnership, *Biosolids EMS Guidance Manual*, March 2001.

2. Rationale

2.1 Background

For the last 30 or more years, common methods of biosolids management have included application of biosolids on agricultural land, use as landfill, and incineration—a method often used in larger urban areas. As governments promoted waste reduction and recycling, application on land and on reclamation sites became more popular. At the same time, regulations and guidelines aimed at protecting human health and the environment were also developed. Land application, in particular, allowed municipalities and farmers to take advantage of the valuable nutrients present in the biosolids.

Recently, however, there has been growing public concern about the safety of biosolids management practices. As a result, several provinces have reviewed their legislation and practices. Some jurisdictions have enacted more stringent requirements to address increasing public concern about safety. Other jurisdictions have encountered little public opposition to date. Information on existing legislation can be found on the Web sites listed in **Appendix B**. To alleviate public concern, it is important to apply principles of quality management that will continuously improve biosolids management.

2.2 Benefits

By incorporating quality management principles into biosolids programs, municipalities can, over time, achieve regulatory compliance, address public concerns and enhance end-user satisfaction. Municipalities can realize the benefits of a good biosolids program through the implementation of a quality management system (QMS), outlined in InfraGuide's Storm and Wastewater best practice: *Biosolids Management Programs* (InfraGuide, 2003).

Through the process of continuous improvement—an essential element of a QMS—municipalities can show long-term improvements in their biosolids programs, enhancing public trust and acceptance as a result.

Applying quality management principles to a biosolids program can realize significant benefits. In addition to improved public acceptance and trust, other benefits could include:

- improved biosolids quality;
- improved consistency in the biosolids product;
- improved compliance with regulatory requirements;
- more open communications with their biosolids customers and the public;
- well-founded safety record for the program;
- better documentation of the program; and
- the ability to prove due diligence.

2.3 Risks

Applying a QMS will entail additional investment, especially during its development. However, it is expected that the benefits will out-weigh the investment, particularly the benefit of broader public acceptance.

A QMS demands the assignment of sufficient personnel who possess the knowledge to plan, develop and implement the program. Commitment from the organization's management is crucial for the success of the QMS initiative.

The risks of not adopting quality management principles could include:

- deterioration of biosolids product quality;
- erosion of public confidence and increased public concern that may lead to the curtailment of the biosolids program;
- higher number of non-compliance events;
- higher operating costs; and
- the inability to establish due diligence in the event that an incident occurs related to the management of biosolids.

By incorporating quality management principles into biosolids programs, municipalities can, over time, achieve regulatory compliance, address public concerns and enhance end-user satisfaction.

3. Methodology

3.1 General

The development and implementation of a biosolids program should be carried out using quality management system (QMS) principles. All components of a biosolids program should be captured within the QMS[2]. In conjunction with a sound public communication strategy, this should increase the transparency of the biosolids program and raise the level of public confidence and trust.

A comprehensive approach to managing and controlling the process will lead to a biosolids program with a quality product. The ultimate outcomes of a well-planned and implemented QMS will be enhanced product quality and improved public acceptance.

An Environmental Management System (EMS) is one type of QMS. The National Biosolids Partnership (NBP) in the US has developed an EMS and a Code of Practice for all types of biosolids programs. The *Biosolids EMS Guidance Manual* (NBP, 2001a) and the *Biosolids Manual of Good Practice* (NBP, 2001b) can be downloaded from the NBP's Web site[3].

The most important ingredients of a quality management system are:

- considering quality at each stage of the biosolids program—not just at the end;
- committing to a cycle of continuous improvement;
- involving the public in open communication about the program and its performance; and
- developing and using a proper documentation and reporting system.

While there may be several approaches to implementing quality management, the overriding principle of the QMS is continuous improvement brought about by the implementation of a Plan – Do – Check – Review approach, a methodology that is the foundation of all quality management systems.

This approach may be applied to each element of the biosolids program as follows:

- **Plan** — State clearly what and how you PLAN to achieve.
- **Do** — DO what you need to do to achieve your plan.
- **Check** — CHECK that you are doing what you said you were going to do.
- **Review** — REVIEW to see if what you are doing is achieving your plan.

Figure 3–1 shows the continuous improvement aspect of quality management. A more comprehensive illustration is included in **Appendix F**.

Figure 3–1: Flow Diagram for Quality Mananagement

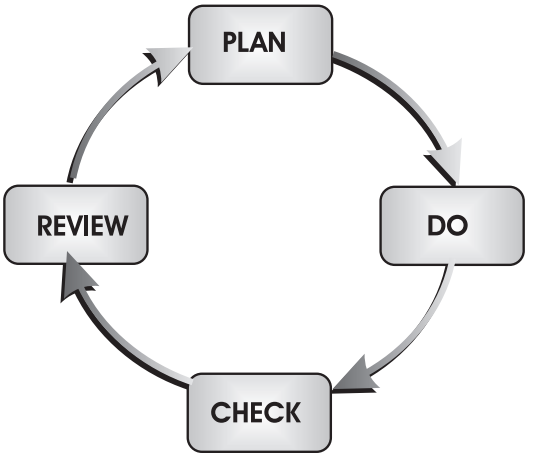

Figure 3–1
Flow Diagram for Quality Mananagement

The ultimate outcomes of a well-planned and implemented QMS will be enhanced product quality and improved public acceptance.

2. See InfraGuide's Storm and Wastewater best practice: *Biosolids Management Programs* (InfraGuide, 2003). See reference sections of documents (NBP, 2001a and b).
3. See reference sections of documents (NBP, 2001a and b).

Figure 3–2
Hierarchy of Planning Activities

3.2 Planning

3.2.1 Setting a Vision

Planning is one of the key components of the quality management process. All planning, should keep in mind the mission and core values of the municipality. It is important, in the initial planning stage, to develop a roadmap that will guide all future planning, decision-making and activities. **Figure 3–2** presents the hierarchy of the planning process.

All planning, should keep in mind the mission and core values of the municipality.

Figure 3–2: Hierarchy of Planning Activities

Planning will include the following:

- Development of a Mission Statement for the program. This statement should reflect the core values of the municipality and form the basis for policy decisions. A code of practice is a useful planning document. See **Appendix C** for examples of core values and a sample code of practice.
- Development of a Vision for the program and Policies arising from the Mission Statement. The Vision should be consistent with the Mission Statement and set out clearly the desired outcomes of the QMS.
- Identification of long-term goals for the program. Long-term goals should be stated clearly, be specific, measurable, achievable, relevant and time-bounded.
- Identification of short-term objectives. The objectives are the interim targets that will lead to the achievement of long-term goal and should also be clearly stated and meet the same criteria as the long-term goals. See **Appendix D** for examples of goal setting and identification of objectives.

3.2.2 Committing Resources

A key component of the planning process is commitment to the program from all levels of the municipality. Without this commitment, the initiative will ultimately fail even if all the other elements are properly planned and executed. The initiative may fail because of inadequate resources and competing priorities. Staff may lose motivation in the absence of support and feedback from senior management.

Management's Role

The role of management—i.e., anyone in a supervisory role who is not involved in the day-to-day operation of the biosolids program—will include:

- formally adopting the vision and objectives of the program;
- assigning sufficient resources;
- identifying and providing staff training geared to the program objectives;
- assuring that all stakeholders are given sufficient opportunity to participate in the process; and
- being part of the solution and participating in regular review and implementation of corrective measures as appropriate.

Biosolids/QMS Program Staff

Staff involved in the program will have the following roles:

- Implement the policy on a day-to-day basis;
- Participate in training initiatives when necessary;
- Understand and follow standard procedures;
- Look for ways to improve operations;
- Act as a program ambassador, particularly when dealing with the public and other stakeholders;
- Report incidents and participate in evaluation; and
- Take ownership of the program in the day-to-day operational quality of the program.

3.3 Doing

The "doing" or implementation stage of the QMS will involve the following activities:

- Development of standard operating procedures (SOPs);
- Training of staff;
- Development of emergency response procedures; and
- Operating the program in accordance with the SOPs and emergency response procedures.

3.3.1 Standard Operating Procedures

Development of standard operating procedures is essential to improved performance. When all staff use standard procedures, it is easier to troubleshoot failures, to take corrective measures and to introduce preventive actions—all leading to better quality. Standard operating procedures should include safety considerations so that workers will be protected when they properly follow the procedures.

The following are important in the development and use of standard operating procedures:

- Each step in a procedure should be clearly stated and listed in the exact order that it is to be carried out.
- The language used must be simple and concise.
- The procedures should be verified in the field by the staff that will be using them.
- The procedures must be readily accessible either in hard copy or on the network so that staff can easily refer to them.
- There must be proper control of issuing revisions and identifying which version is current (See the section on documentation).

3.3.2 Training

Staff employed must be trained in the standard operating procedures for biosolids as well as the QMS. Training should address:

- knowledge of SOPs and an understanding of the importance of adhering to the standards;
- understanding of the requirements of the QMS and the importance of achieving program goals;
- general operating knowledge of biosolids (source, content and variability), biosolids processes and end-use; and
- appropriate knowledge of regulations.

Training should also be provided to contractors and their staff. Staff training will be more effective if it is developed to meet the needs of individual staff members, taking into account their existing skill levels and the requirements of their job position. Records of training should be maintained for each member of staff.

3.3.3 Emergency Procedures

One of the often-overlooked elements of any program is planning for the unforeseen. Emergency response and contingency planning is necessary to maintain the effectiveness of the program, be consistent with the vision, comply with regulatory requirements and demonstrate due diligence.

There are two elements-first, recognizing the potential for occurrence (the risk) and determining the possible consequences, and second, planning the measures necessary to counteract the event. There should be a documented response procedure for each risk or emergency event that is identified. In some cases, it may be necessary to conduct simulation drills and training exercises to see if the procedure is adequate, e.g., fire in a facility, haulage truck accident.

Emergency response and contingency planning is necessary to maintain the effectiveness of the program, be consistent with the vision, comply with regulatory requirements and demonstrate due diligence.

Emergency response plans should:

- outline the roles of management and staff;
- describe procedures that need to be followed;
- identify when to involve emergency services (fire, police and ambulance);
- note if any regulatory agencies are to be notified; and
- outline the location of, or how to procure, special vehicles or equipment.

3.4 Checking

This step involves "checking" that you are doing what you said you were going to do. Checking will include the following:

- Verifying that SOPs are being followed on an on-going basis;
- Confirming that staff training is being carried out in all areas of the program and at the required frequency;
- Checking that regulatory and license requirements are being met on an on-going basis; and
- Confirming that required reports are being prepared and submitted.

To improve public acceptance of biosolids program, municipalities should strongly consider going beyond minimum legislated requirements.

3.4.1 Compliance

Compliance with applicable legislation is a minimum requirement. In some cases, operations may need to go beyond the legal requirements to address public concerns. In others, the municipality may identify a linkage to its corporate vision or simply believe it is appropriate to do so voluntarily. To improve public acceptance of biosolids program, municipalities should strongly consider going beyond minimum legislated requirements.

A key element of good practice in regard to compliance is a thorough knowledge and understanding of applicable laws and regulation, including certificates of approval, licenses, or permits that govern operations. Resources will be required to obtain (and update) a library of the applicable legislation and guidelines. In addition, investments, both financial and staff (including management) resources will be required, to provide and maintain training of personnel.

Should there be no applicable guideline, then the municipality should consider basing its operations on the regulations from a neighbouring jurisdiction or creating a set of guidelines that could become a voluntary code of practice.

3.4.2 Reporting

Generally, two types of reports are required. First, mandatory reports are required by a regulatory agency. In Ontario, for example, owners of wastewater treatment plants are required to submit annual reports that describe their operation and performance. Second, reports are required by the QMS, such as internal reports for senior management to assess program performance and efficiency, or reports to the public to demonstrate accountability.

Both reports should be prepared according to templates adopted by the QMS, following its standards for content and presentation. Templates should be developed that address all essential reporting requirements, both mandatory and voluntary requirements.

In addition to reporting the operation and performance, the QMS reports should also include incidents that affect the program during the period.

Reporting requirements under the QMS should be viewed as one of the most important elements.

3.5 Reviewing

As indicated in **Figure 3–1**, quality management requires repeated reviews as part of the on-going cycle. The "review" stage compares goals and objectives (legal or voluntary) with performance results that are obtained through the "checking" phase. If the results indicate that the objectives are being met, the only required follow-up is to record and report on the findings. This stage also includes a determination

of whether new goals and objectives are necessary to deal with changing regulatory requirements, emerging issues or new public concerns.

If, however, the results of the monitoring indicate that objectives are not being met, then the program would be in a state of non-conformance. Non-conformance is defined as a deviation from the agreed-upon objectives of the QMS. Non-conformances can relate to legal or voluntary objectives. Non-conformances could also arise as a result of an emergency, or complaints from the public, or affected stakeholders.

Once a non-conformance has been discovered, the primary effort is to determine its root cause, take corrective actions and put preventive measures in place. The QMS team should consider the following questions:

- *Has the non-conformance been verified? Is the non-conformance also a non-compliance?*
- *Who needs to be informed?*
- *Why did this happen? What is the primary (root) cause? What can be done to correct this?*
- *Is there any way that we could have discovered the non-conformance earlier?*
- *How can we prevent this from happening again?*
- *How can we be better prepared the next time?*

The QMS team must take a structured approach to determining the root cause of a non-conformance. It is occasionally difficult to pinpoint an exact cause in a biological process. But applying measures that are not directed to the real cause could produce other problems.

Corrective action is a systematic process that addresses non-conformance problems. It also includes any steps necessary to mitigate or eliminate environmental or social impacts.

Preventive action aims to prevent problems before they occur, or before they become more severe. In all cases of non-conformance, preventive action measures should automatically be developed and put in place. Preventive action could also focus on identifying potential problems that could eventually lead to non-conformances.

One frequent omission in corrective/preventive action programs is the failure to adequately address the recurrence of identified problems. In most cases the process ends once the problem is "fixed", with little attention given to prevention. The analysis of every non-conformance should include the identification of measures to prevent a recurrence.

3.6 Communications

Greater public acceptance is one of the major goals of a biosolids QMS, and an effective communication strategy will be the cornerstone for achieving this goal. In addition to an internal communication program, a proactive external communication must be implemented to reach out to interested parties (stakeholders), including local regulators, farmers and the general public.

An effective communication strategy is open, educational, responsive and candid and delivered in a way to achieve the goals and objectives set out at the start of the QMS. The communications program should be designed to promote awareness, knowledge, and understanding of the biosolids program and its activities.

The importance of the communications program is often overlooked. A breakdown in the communications program could lead to failure of the QMS. More information about building an effective communications program may be found in the Storm and Wastewater best practice: *Communication and Public Consultation for Biosolids Management* (InfraGuide, 2004b).

In addition to an internal communication program, a proactive external communication must be implemented to reach out to interested parties (stakeholders), including local regulators, farmers and the general public.

3.7 Documentation

Documentation for the QMS, like communication, is an activity that touches all four stages of the system. It is necessary for:

- compliance with legislative requirements;
- providing information to elected officials and the public;
- providing feedback to management and employees on the effects of the QMS; and
- demonstrating due diligence.

It is important that a document management system be developed for all electronic and hardcopy data. This will make it easier to retrieve these files at a later date.[4]

4 The reader is referred to InfraGuide's Multi-Discipline best practice: *Best Practices for Utility-Based Data* (InfraGuide, 2002).

4. Applications and Limitations

4.1 General

This section examines how the quality management principles described in Section 3 can be applied to a biosolids program. The discussion is not exhaustive; rather it provides an overview. More comprehensive information may be found in the references.

This section takes the principles presented in **Figure 3–1**: Flow Diagram for Quality Management and applies them to a biosolids program element. Biosolids land application is used as the example. The importance of communication and documentation is also discussed.

The reader should keep in mind that any QMS must be specific to the municipality and the size of the biosolids program to which it is applied.

4.2 Limitations

In developing a QMS for biosolids programs, it is important to recognize the key stages that affect the quality of the program and end product. The quality of any biosolids product depends on a sequence of stages listed in **Table 4–1**.

The general sequence of stages and points of control presented in **Figure 4–1** are applicable to a range of biosolids programs. Each stage has a number of points of control—locations or processes—to which systematic quality management procedures should be applied according to the four-step process outlined in Section 3.

The production and operation sequence will vary for each biosolids program. It is important to document the sequence so that attention can be focused on each stage and the municipality can then identify the key points of control at which QMS principles need to be applied.

Table 4–1: Program Stages and Points of Control

Stages of a Biosolids Program				
COLLECTION	**LIQUID TREATMENT**	**SOLIDS TREATMENT**	**STORAGE AND TRANSPORT**	**END USE**
Points of Control				
■ Industrial dischargers ■ Commercial dischargers ■ Sewer use by-law ■ Residential ■ Combined sewer overflows	■ Headworks ■ Preliminary treatment ■ Primary treatment ■ Secondary treatment ■ Tertiary treatment	■ Aerobic digestion ■ Anaerobic digestion ■ Chemical stabilization ■ Composting air & thermal drying ■ Solids storage ■ Solids thickening	■ Biosolids storage ■ Truck loading ■ Transportation equipment, routes and procedures	■ Storage & staging ■ Land application sites and procedures ■ Incineration ■ Land-fill disposal applications ■ Sale of biosolids for beneficial use

Table 4–1
Program Stages and Points of Control

The production and operation sequence will vary for each biosolids program. It is important to document the sequence so that attention can be focused on each stage and the municipality can then identify the key points of control at which QMS principles need to be applied.