Chapter 2

Potential Applications of the Recommended Sediment Quality Assessment Guidelines

2.0 Introduction

Contaminated sediments can be associated with a diverse array of adverse effects on aquatic organisms, including the plants and animals that live in, on, or near bed sediments. Numerical sediment quality assessment guidelines (SQAGs) may be used to identify and designate sediments that have high, moderate, and low probabilities of being associated with adverse effects on aquatic organisms. This feature of the SQAGs makes them useful in a range of management applications, including:

- interpreting sediment chemistry data;
- designing monitoring programs;
- supporting regulatory decisions;
- conducting risk assessments at contaminated sites;
- developing remediation objectives for contaminated sites; and,
- developing sediment quality objectives.

Each of these applications are briefly discussed in the following sections. In addition, the inappropriate uses of the guidelines are identified and discussed. Potential users of the SQAGs are encouraged to review the advantages and limitations of the weight of evidence approach used to derive the guidelines, as well as the results of the evaluation of the guidelines presented in MacDonald (1994).

2.1 Data Interpretation

Over the past decade, sediment chemistry data have been collected at a wide range of sites for many purposes. By themselves, these data may be used to assess the status and trends in environmental quality; however, they do not provide a basis for determining if the concentrations of contaminants represent potential hazards to aquatic organisms. Numerical

SQAGs contribute to the sediment quality assessment process by providing practical assessment tools or 'scientific yardsticks' against which the biological importance of sediment chemistry data can be assessed. In this context, SQAGs may be used as screening tools to identify areas and contaminants of concern on site-specific, regional, or national bases. To illustrate this process, an initial assessment of the potential for biological effects associated with measured concentrations of contaminants in Florida coastal waters is presented in Chapter 4 of this document.

As part of this study, two SQAGs were recommended for each contaminant of concern in Florida coastal waters, if sufficient data were available to support their development. Specifically, threshold effect levels (TELs) were formulated to define concentrations of contaminants below which biological effects are not expected. Likewise, probable effect levels (PELs) for each substance were developed to define ranges of concentrations above which biological effects are likely. When contaminant concentrations exceed one or more PELs, sediment samples are predicted to be toxic. Further investigations, including bioassessment, should be considered to be a high priority at sites with multiple exceedances of the PELs. Similarly, investigations into the sources and possible control measures should be conducted when the concentrations of individual contaminants exceed the PELs at multiple sites. Between the TELs and the PELs adverse biological effects are possible; however, further investigations are required to evaluate the actual nature and severity of these effects. The SQAGs provide the scientific information necessary to interpret the potential biological implications of contaminated sediments and, hence, a basis for focussing further investigations and identifying the need for remedial measures. The SQAGs also provide a basis for interpreting relationships between sediment chemistry and biological effects. In this application, the contaminants that are most likely to be associated with observed biological responses (e.g., acute toxicity) are those that exceed the PELs. Those substances which do not exceed the PELs are less likely to be one of the causative factors in the observed response, even if they are significantly correlated with toxicity. More detailed investigations of the contaminants that are associated most strongly with biological effects would require use of toxicity identification evaluation (TIE) procedures (Ankley and Thomas 1992).

2.2 Monitoring Program Design

Monitoring is an integral component of environmental surveillance programs. While such programs may be undertaken for a number of reasons (e.g., trend assessment, impact assessment, compliance, etc.), limitations on available resources dictate that they must be effective and efficient. For this reason, it is important for sediment quality monitoring programs to be well-focused and to provide the type of information that is necessary to manage contaminated sediments.

Numerical SQAGs support the design of environmental monitoring programs in several ways. First, comparison of existing sediment chemistry data with the SQAGs provides a systematic basis for identifying high priority areas for implementing monitoring activities. Second, when used in conjunction with existing sediment chemistry data, the SQAGs may be used to identify priority contaminants within an area of concern. By considering the potential sources of these contaminants, it may be possible to further identify priority sites for investigation. Lastly, the SQAGs assist in monitoring program design by identifying the required detection limits for each substance (e.g., TEL ÷ 2). Determination of the detection limits required for further interpretation of the data should help to avoid many of the difficulties that have resulted from the use of standard, yet inappropriate, analytical methods.

2.3 Support for Regulatory Decisions

Generally, SQAGs alone would not be used to make decisions on the management of contaminated sediments. However, the SQAGs are effective tools for identifying the need for site-specific investigations to support regulatory decisions, including source control and other remedial measures. In this context, SQAGs may be used to assess existing sediment chemistry data from contaminated sites and to identify substances of concern. Typically, further investigations would then be implemented to identify contaminant sources, assess the areal extent and severity of the contamination, evaluate potential source control measures, and determine the need for other remedial measures. The SQAGs would also be used to evaluate the success of any regulatory actions that are implemented at the site.

2.4 Ecological Risk Assessment

Ecological risk assessment is the process that evaluates the likelihood that adverse ecological effects may occur or are occurring as a result of exposure to one or more stressors (EPA 1992). By estimating the probabilities of observing adverse biological effects under a variety of exposure scenarios, ecological risk assessment strives to provide science-based guidance for managing environmental quality, particularly at contaminated sites. While the Society of Environmental Toxicology and Chemistry (SETAC) is currently in the process of developing procedures for assessing the risks associated with contaminated sediments, such methods are not yet available. In addition, the scientific information required to support ecological risk assessment has not been available in a summarized form. However, the SQAGs contribute directly to the ecological risk assessment process because they define three ranges of contaminant concentrations that are rarely, sometimes, and usually associated with adverse biological effects. Moreover, the supporting documentation (MacDonald *et al.* 1994) can be used to calculate the percent incidence (or probability) of adverse effects within each of these ranges (Long *et al.* In press). Furthermore, the evaluation of the predictability of the SQAGs

(presented in MacDonald 1994) provides a basis for assigning probabilities to the adverse effects that may be associated with contaminant concentrations that exceed the recommended guidelines. Hence, the SQAGs should form an integral part of ecological risk assessments that are conducted at sites with contaminated sediments in Florida.

2.5 Development of Sediment Quality Remediation Objectives

While the majority of coastal sites in Florida are likely to be relatively uncontaminated, high and biologically-significant concentrations of certain substances in sediments may be present in the vicinity of major urban and/or industrial developments. At these sites, further investigations would be required to evaluate the extent, severity, and effects of sediment-associated contaminants. When the results of focused environmental assessments indicate that aquatic habitats are seriously degraded, remediation may be required to restore the designated water uses at the site and achieve long-term water management goals.

Sediment quality remediation objectives are an essential component of the remediation process because they help establish the target clean-up levels for a site. In this context, SQAGs are useful because they provide the basic scientific information required to formulate site-specific remediation objectives. In addition, the SQAGs provide information that help evaluate the costs and benefits associated with various remediation options. However, the SQAGs should not be used directly as target clean-up levels at contaminated sites. Procedures for deriving site-specific remediation objectives have been recommended by MacDonald and Sobolewski (1993), and these could be employed on an interim basis in the state.

2.6 Development of Sediment Quality Objectives

Sediment quality issues are rarely entirely the province of one agency or one level of government. For this reason, it may be necessary to establish agreements between various levels of government to define their respective responsibilities with respect to the prevention, assessment, and remediation of sediment contamination. Multi-jurisdictional agreements may include accords on a number of issues; however, establishment of site-specific sediment quality objectives is important because they provide a common yardstick against which the success of a range of environmental management activities can be measured. In this context, sediment quality objectives are defined as numerical concentrations of sediment-associated contaminants which have been established to support and protect aquatic life at a specific site (MacDonald and Sobolewski 1993).

Numerical SQAGs contribute significantly to the objectives development process because they provide basic scientific information on the biological effects of sediment-associated contaminants. As such, the SQAGs may be used as the technical basis for establishing site-specific sediment quality objectives. It is important to note, however, that these guidelines should not be regarded as blanket values for regional sediment quality. Variations in environmental conditions throughout the state could affect sediment quality in different ways and, hence, necessitate the modification of the guidelines to reflect local conditions. While no specific guidance on the derivation of site-specific sediment quality objectives for Florida coastal waters is available, MacDonald and Sobolewski (1993) provide some general instructions that may help address this issue.

2.7 Inappropriate Uses of the Sediment Quality Assessment Guidelines

While the recommended SQAGs are likely to have a number of important uses in Florida and elsewhere, they have certain limitations that should be recognized. First, the SQAGs should not be used as mandatory target clean-up levels, or standards, at contaminated sites (e.g., Superfund sites) unless additional site-specific studies are conducted (Sediment Quality Subcommittee 1992). However, the SQAGs and the supporting documentation may be used, in conjunction with other information, as a technical basis for establishing target clean-up levels. MacDonald and Sobolewski (1993) provide explicit guidance on the derivation of site-specific sediment quality remediation objectives for contaminated sites in Canada. It is likely that these recommendations would apply in other areas, including Florida coastal waters.

The recommended SQAGs are not intended to define uniform values for sediment quality on a state-wide basis. That is, the SQAGs should not be used as sediment quality criteria. In certain areas, local conditions may influence the applicability of the guidelines. For example, high background levels of certain trace metals (e.g., lead) have been reported in Apalachicola Bay. Some of the samples collected from this area exceed the threshold effect level (TEL) for lead, even though there is no evidence of significant anthropogenic enrichment (FDEP 1994; see Section 3.4). Therefore, it would not be appropriate to evaluate sediment quality in Apalachicola Bay using the recommended TEL for lead by itself. This example illustrates the importance of using the SQAGs in conjunction with other tools (such as the metals interpretive tool and various bioassessment tools) for conducting sediment quality assessments.

Various organizations have expressed concerns regarding the potential use of the SQAGs as criteria for the disposal of dredged material. It is important for potential users to remember that the SQAGs are not intended to be used as pass/fail criteria for dredged disposal analysis, nor are they intended to replace formal assessment protocols developed by federal agencies (EPA and ACE 1991). Nonetheless, the SQAGs may provide useful information for

evaluating the quality of dredged material and could be utilized as part of the dredged disposal analysis process, subject to approval by the responsible agencies.

The SQAGs are not intended to replace the water quality criteria that are used in various state programs. However, the SQAGs do provide useful information for evaluating the effectiveness of certain regulatory programs. For example, more stringent regulations may be required at sites where water quality criteria (WQC) have been established, ambient monitoring data indicate compliance with the WQC, and the SQAGs have been exceeded. This situation could occur because water quality regulations generally do not consider the potential for contamination of bed sediments. Consideration of both sediment quality and water quality will increase the probability that the beneficial uses of aquatic ecosystems are adequately protected.

Lastly, it is important to note that SQAGs developed using the weight of evidence do not provide a basis for identifying the substance or substances that **caused** an effect in field-collected samples. Instead, the SQAGs define contaminant concentrations that are unlikely or usually **associated** with adverse effects. Exceedance of the PEL for a certain substance indicates that the chemical may be, in part, responsible for the observed effects; however, confirmation of the role of individual chemicals which occur in complex mixtures in sediment toxicity requires the use of toxicity identification evaluation procedures (Ankley and Thomas 1992). Alternatively, toxicity tests using sediments that have been spiked with individual chemicals or contaminant mixtures may be conducted to establish dose-response relationships (Lamberson and Swartz 1992). Once the cause(s) of sediment toxicity has been identified, better decisions can be made regarding sediment management.