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Environmental Monitoring Design

Depending on the area of concern, a monitoring program can be designed to measure chemical, biological or physical impacts. Monitoring can be as simple as having someone go to the site and periodically measure water quality parameters *in situ*, or as elaborate as examining a series of satellite images taken over a period of time to determine watershed changes.

An effective environmental monitoring program should:

Build on existing knowledge and experience

It should include information and results from previous studies of the environmental effects of relevant industrial effluents, and knowledge gained regarding appropriate sampling strategies, designs, and endpoints.

Clearly state monitoring objectives

Monitoring objectives should flow explicitly from management objectives, with results of monitoring used to assess and guide management and monitoring decisions.

Define testable hypotheses

Objectives for each monitoring component should be stated as clear questions (e.g., "Are fish safe to eat?"), which themselves can be presented as testable, scientific hypotheses: "H₀:

Concentrations of mercury in fish muscle tissue are below human consumption guidelines".

Define "effect"

Results of monitoring should be compared against specific criteria defining a relevant effect size that would trigger management action, such as a statistical and/or magnitude difference from a reference condition, change outside the range of natural variability, change over time, or concentration relative to a relevant guideline.

Use relevant, meaningful, and measurable endpoints

Relevant: all endpoints should provide information related to specific, potential effects (or lack thereof) of the industry.

Meaningful: all endpoints should provide information that can be used to guide environmental management decisions.

Measurable: all endpoints should provide data that are interpretable.

Use scientifically defensible (statistically robust) designs

Monitoring programs should employ designs that are scientifically appropriate and defensible in their methods and design, including designs that, where possible, target sufficient statistical power and precision to provide confidence in conclusions.

Work at appropriate scales

Sampling locations should be distributed in a way that encompasses meaningful spatial gradients of exposure, and clearly separates potentially affected areas from similar, but distant, reference areas.

Focus on valued ecosystem components or key indicator resources

Since it is impossible to sample everything in the environment, monitoring should focus on highly valued ecosystem components (for example, recreationally or commercially important fish species), or on other endpoints that adequately represent these valued components (such as "sentinel" fish species that are considered representative of other species).

Integrate and harmonize program components, where possible

For the greatest efficiency, and for greatest interpretability of results across ecological compartments, component programs (e.g., water quality, sediment quality, fish and fish habitat) should use consistent locations, sampling designs and sampling schedules where possible and appropriate, and should be designed to jointly address the requirements of all regulatory agencies (e.g., both provincial and federal).

Integrate and harmonize with other programs where appropriate

Where other, related monitoring or research programs are being undertaken locally by others, any new monitoring programs should integrate and harmonize with existing programs to the extent possible, to increase the value of data collected to both monitoring groups (and to regulators), and to increase the efficiency and effectiveness of sampling.



Source: Devon Coles www.devoncoles.com
(click to enlarge)

Include rigorous QA/QC

Field-based monitoring is susceptible to numerous sources of sampling error, which must be measured, minimized and managed, which requires rigorous quality assurance and quality control (QA/QC) protocols, particularly for sensitive or complex endpoints such as trace chemistry or invertebrate taxonomy.

Adaptive management (results-based)

A monitoring program should utilize a results-based, adaptive management approach to continually assess and improve its effectiveness, including expansion or modification of monitoring efforts where necessary, and streamlining of efforts deemed unnecessary.

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