Pennsylvania Citizens' Volunteer Monitoring Program

Designing Your Monitoring Program

A Technical Handbook for Community-Based Monitoring In Pennsylvania

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ABBREVIATIONS AND ACRONYMS

ALLARM	Alliance for Aquatic Resource Monitoring
AMD	Abandoned Mine Drainage
BOD	Biochemical Oxygen Demand
CVI	Canaan Valley Institute
CVMP	DEP's Citizens' Volunteer Monitoring Program
DCNR	Pa. Department of Conservation and Natural Resources
DEP	Pa. Department of Environmental Protection
DO	Dissolved Oxygen
DRKN	Delaware Riverkeeper Network
EASI	Environmental Alliance for Senior Involvement, Pa. Senior Environment Corps
EMAP	EPA's Environmental Monitoring and Assessment Protocol
EPA	US Environmental Protection Agency
EPT	Ephemeoptera (mayflies), Plecoptera (stoneflies) and Trichoptera (caddis flies)
FSN	DEP's Fixed Station Network
GWN	DEP's Ground Water Network
HDPE	High Density Polyethylene
IWLA	Izaak Walton League of America
mTEC	Membrane Filtration Thermotolerant *E. coli*
NCDC	National Climatic Data Center
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollution Discharge Elimination System
NTU	Nephelometric Turbidity Unit
NWS	National Weather Service
PA BSP	Pa. Bureau of State Parks
PA FBC	Pa. Fish and Boat Commission
PALMS	Pa. Lake Management Society
QA / QC	Quality Assurance / Quality Control
QAPP	Quality Assurance Project Plan
RBP	EPA's Rapid Bioassessment Protocols
RPD	Relative Percent Difference
RN	River Network (formerly River Watch Network)
SM	Standard Methods
SAC	Standard Analysis Codes
SOC	Synthetic Organic Compound
SWAP	DEP's Source Water Assessment Program
SWRC	Stroud Water Research Center
TKN	Total Kjedahl Nitrogen
TMDLs	Total Maximum Daily Loads
TSI	Trophic State Index
USFS	US Forest Service
USGS	US Geological Survey
VOC	Volatile Organic Compound
WQN	DEP's Water Quality Network

CHAPTER 1 – INTRODUCTION

In This Chapter . . .

A. An introduction to watershed monitoring in Pennsylvania

B. Background on monitoring

C. Basic requirements for monitoring

D. How to use this handbook

One of the hardest parts of monitoring a watershed, stream or lake is deciding what to do. What will you measure? Where and when will you sample? How will you collect and analyze samples? How will you assure that your results get used and make a difference? The purpose of this handbook is to help you make choices about the purpose and scope of your monitoring program.

A watershed is an area of land, including all the surface and ground waters within it, that drains to a body of water. It is an ever-changing and complex system. Monitoring this system to understand the way it works, its condition, and how it changes over time can be a daunting challenge – ideally, you would want to measure every characteristic of the watershed, everywhere, all the time! Well, no one has the time or resources to do that. So, you must make choices based on what you want to know and your capabilities. Yet, how do you decide among the bewildering array of things you could measure, methods you could use, and sites you could monitor? If you can't monitor all the time, how do you decide when?

We call this process of making choices "study design." Study design is a logical series of choices about the why, what, how, where, when and who of your monitoring program.

This handbook is designed to help you through the study design process by reducing and organizing your choices to a manageable number. Instead of deciding among the hundreds of possible things in the watershed you could track, we narrow your choices to those that are most feasible and produce the richest information for community-based monitoring programs in Pennsylvania. We've also organized these choices into five main packages which we call "assessments." Each of these is geared toward specific purposes that we think cover most of the reasons for monitoring and most of the information needs you may have.

Our hope is that you'll find this handbook a useful reference as you go through the process of designing your monitoring program.

A. An Introduction to Watershed Monitoring In Pennsylvania

Watersheds in Pennsylvania are monitored by a variety of organizations, schools and agencies. The result is a rich history of monitoring that goes back more than 30 years! The monitoring picture is complicated, but programs fall into three major groups:

Volunteer Monitoring

Volunteer monitoring includes a wide variety of activities undertaken by adults and children (outside of a school setting) where they donate their time to observe, measure, collect and analyze rivers, streams, lakes, ponds, wetlands, estuaries, beaches and wells.

In 2000, the Department of Environmental Protection (DEP) reported nearly 11,000 people in more than 140 groups spent $1 million to monitor more than 3000 stations statewide. Most of these groups (93 percent) report that they are monitoring streams. Twenty-three percent report monitoring lakes and ponds. Eighteen percent report monitoring wetlands, wells or estuaries. These groups are fairly evenly distributed around the state, though somewhat concentrated in the southeast corner.

The top 10 indicators monitored in Pennsylvania:

1) pH
2) Water Temperature
3) Dissolved Oxygen
4) Macroinvertebrates
5) Nutrients (Nitrates and Phosphates)
6) Alkalinity
7) Turbidity
8) Habitat Assessment
9) Flow
10) Hardness

Most groups use their data for (in order of frequency) education, problem identification, watershed planning, nonpoint assessment, restoration evaluation, research and waters classification / standards.

In addition to monitoring groups, there are a number of organizations that provide technical and organizational support services to the groups. These include:

• Alliance for Aquatic Resource Monitoring (ALLARM)	• Pa. Lake Management Society (PALMS)
• Alliance for the Chesapeake Bay	• Pa. Department of Environmental Protection (DEP)
• Canaan Valley Institute	• Pa. Bureau of State Parks (BSP)
• Chesapeake Bay Foundation	• PA Senior Environment Corps (PaSEC)
• Delaware Riverkeeper	• River Network (RN)
• Eastern Pa. Coalition for Abandoned Mine Reclamation (EPCAMR)	• Stroud Water Research Center (SWRC)
• Environmental Alliance for Senior Involvement (EASI)	• Western Pa. Coalition for Abandoned Mine Reclamation (WPCAMR)

School Monitoring

In 2000, DEP reported 42 schools were monitoring the waters of the state. This includes schools participating in the Pennsylvania Department of Conservation and Natural Resources, Bureau of State Parks Watershed Education program, the largest monitoring network of schools in the state. Watershed Education is a watershed-based, interdisciplinary program for students in grades 6-12, promoting classroom and field research, hands-on ecological investigations, networking, partnerships, stewardship and community service in an effort to produce environmentally literate citizens. Activities include monitoring physical, chemical and biological indicators of waterways. A Watershed Education

Program teacher manual is available. Contact the Bureau of State Parks at 717-783-4356 or email them to parkinfo@dcnr.state.pa.us and request information on the Watershed Education Program.

Agency Monitoring

There are a variety of agencies in the Commonwealth that monitor waters:

Department of Environmental Protection

DEP carries out a wide range of water monitoring activities.

1) *Water Quality Network (WQN):* The WQN is a long-term, network of 153 fixed monitoring stations on rivers, streams and lakes throughout the state. (See Appendix 3- page A3-1.)

2) *Unassessed Waters:* The majority of Pennsylvania's 83,160 miles of free-flowing surface waters are not covered by the Water Quality Network and have not been assessed. The unassessed waters strategy was formulated to assess these waters to locate and identify good quality waters; to locate and identify point and nonpoint sources of pollution; and to determine the extent of impacts from these sources. (See Appendix 3 - page A3-3.)

3) *Aquatic Life Special Water Quality Protection Surveys:* The purpose of these surveys is to assess the need for special water quality protection and, if needed, to revise the water quality standards to provide that protection in order to maintain existing high quality. (See Appendix 3 - page A3-7.)

4) *Cause/Effect Surveys:* The purpose of Cause / Effect Surveys is to see if specific sources of point or nonpoint source pollution are causing known or reported problems. (See Appendix 3 - page A3-7.)

5) *Use Attainability Studies:* These studies are carried out to review and revise (if needed) water quality standards to ensure that designated fish and aquatic life uses are protected. (See Appendix 3 - page A3-8.)

6) *Lakes:* Pennsylvania's lakes are monitored at several levels. Trends in lake quality are monitored at selected lakes as part of the Water Quality Network. Aside from the ongoing WQN lake monitoring, there are three levels of DEP lake assessment (see Appendix 3 - page A3-10):

   A. **Evaluation of Trophic Status:** a broad assessment of the status of Pennsylvania's "significant lakes[1]."

   B. **Phase 1 Diagnostic - Feasibility Study** (EPA Clean Lakes Program): an intensive study that results in a management plan to control pollution sources and restore lake quality.

   C. **Phase 2 - Management Plan Implementation Assessment** (EPA Clean Lakes Program): ongoing monitoring to see if the protection and restoration efforts in the management plan are working.

7) *Groundwater*: The Groundwater Network (GWN) monitoring program includes monitoring of selected basins out of the 478 groundwater basins in Pennsylvania. Monitoring includes Ambient and Fixed Station Networks (FSN). Ambient groundwater basins are sampled twice in a hydrologic year; FSN monitoring (twice yearly) is long term monitoring of basins in southeastern Pennsylvania. (See Appendix 3 - page A3-13.)

Fish and Boat Commission

The Pennsylvania Fish and Boat Commission collects data on the physical, chemical and biological (fish and benthic communities) components of waters throughout the Commonwealth. The Division of

[1] Defined as a lake with publicly-owned access and a retention time of 14 days or greater.

Fisheries Management monitors streams, lakes and rivers for the purpose of managing sportfish populations. The Division of Environmental Services samples waterbodies throughout the Commonwealth for environmental risk, pollution assessment and habitat management purposes.

Contacts:

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Bureau of Fisheries
450 Robinson Lane
Bellefonte, PA 16823

John Arway, Chief
Division of Environmental Services
450 Robinson Lane
Bellefonte, PA 16823

Department of Health

The Department of Health (DOH), Bureau of Community Environmental Control, requires that operators of recreational bathing beaches undertake the following sanitary surveys prior to construction:

1) Survey of potential sources of contamination in the entire watershed upstream of the bathing beach.
2) Bathing Beach Water Quality Testing:
    a. fecal coliform analysis;
    b. water clarity;
    c. nuisance aquatic plant and animal life identification; and
    d. chemistry: pH and other chemicals identified in the survey of contamination sources that are expected to occur in the bathing water.

After construction, at permitted beaches, DOH requires weekly sampling and analysis for fecal coliform bacteria, with special emphasis on times of "high bather loads." If the results of any sample exceed 1,000 colonies per 100 mL, the DOH requires that the beach be closed and the water re-sampled. Five consecutive samples (no frequency is given) must be collected. If the geometric mean of these samples is less than 200 colonies per 100 mL, the beach can be re-opened.

B. Background on Watershed Monitoring

Monitoring is the observation or measurement of selected watershed features in order to:

- Assess watershed ecosystem health;
- Assess the ability of the watershed ecosystem to support human uses;
- Detect early warning of changes;
- Provide insight into the causes of problems; and
- Tell us whether we've achieved our management goals.

Why monitor?

There are numerous reasons why you might want to spend your limited human and financial resources monitoring your watershed.

- Monitoring is an essential tool that helps us understand what is going on in our watersheds.
- Monitoring builds public awareness and support for watershed programs and activities.
- Monitoring helps us identify, understand and treat the causes of problems, rather than symptoms.
- Monitoring tells us whether our solutions are actually making a difference in the ecosystem.
- Monitoring tells us whether changes in land and water uses are affecting the health of the ecosystem.
- Monitoring is a way to teach science.
- Monitoring can be a good way to involve people in our watershed work.
- Monitoring can create an informed constituency that understands the power and limitations of scientific information.
- Monitoring can result in better decision-making.

Perhaps the most compelling reason is this: *if you are not monitoring, how do you know that your watershed work is succeeding?*

Types of Monitoring

When you think of monitoring, you may think primarily of collecting water samples or measuring with some sort of meter. In fact, there's quite a bit more to watershed monitoring!

Watershed monitoring is usually grouped into three categories: physical, chemical and biological. These terms refer to the types of characteristics that are measured. We prefer to think of not only the type of characteristics that are measured, but *where* they are measured.

So we've grouped monitoring into two broad categories: 1) watershed ecosystem monitoring, and 2) human uses monitoring.

The purpose of the list below is to encourage you to think about monitoring as a menu of options. You select monitoring that meets your needs and capabilities.

1) Watershed Ecosystem Monitoring

This involves monitoring characteristics that determine the health and functioning of the watershed ecosystem.

Biological Monitoring

This includes living things in their various habitats.

Water Column: Bacteria, plants and animals floating or swimming in the water column are sampled and analyzed. Examples include: plankton, macroinvertebrates and fish.

Channel: Plants and animals attached to the channel are sampled and analyzed. Examples include: algae, macroinvertebrates, fish, rooted plants.

Shorelines and Riparian Areas: Plants and animals living in the area near the water whose life cycles or feeding habits are dependent on the health of the water body are inventoried. Examples include: amphibians, grasses, shrubs, trees and mammals.

Physical and Chemical Water Column Monitoring

This environment includes the water column of the stream or lake itself.

Physical: Characteristics like temperature, clarity, turbidity, solids and flow are measured.

Chemical: Chemical elements and compounds dissolved or suspended in the water column are measured.

Flow Regime

This includes the various factors that affect the amount of water in the system and when and where it flows.

Flow: Current velocity and channel cross-sections are combined to determine the amount of water flowing past a given point.

Flow Regime: Precipitation, runoff patterns, groundwater flows and land characteristics are measured in order to determine the amount of water in the system at various points, given various conditions, and are used to predict flow conditions that affect aquatic life and human uses.

Habitat Quality

This includes the various factors that determine the quality of the habitat for living things.

Water Column: Physical and chemical water quality and quantity conditions are measured to determine if they are capable of supporting aquatic life.

Channel: The physical structure and biota of the channel are measured and assessed to determine if the structure provides attachment, feeding, spawning, resting and rearing opportunities for aquatic life (algae, invertebrates, fish, rooted plants).

Shorelines and Riparian Areas: The physical and biological characteristics of the near water land areas are inventoried to see if they can support amphibians, grasses, shrubs, trees and mammals.

2) Monitoring Human Users and Uses

This involves monitoring characteristics that determine whether the water supports human uses and whether the uses themselves are supporting public health, safety and welfare.

Water and Fish/Shellfish Quality

This includes the water column of the stream or lake itself and the flesh of the organisms that people consume.

Bacteria Densities: Bacteria levels are measured as indicators of the possible presence of disease-causing organisms.

Chemical: Chemical elements and compounds dissolved or suspended in the water column that are potentially harmful are measured.

Fish/Shellfish Contamination: Contamination is measured by sampling and analyzing potentially harmful substances in the meat of the organism.

Water Uses

This includes the human uses of the water and aquatic life as food.

User Surveys: People who use surface waters are surveyed as to the frequency of their exposure to contaminants in the water or in fish/shellfish they consume.

Public Health

This includes the stressors, exposure and response of humans to the use of the water or consumption of fish and shellfish.

Epidemiological Surveys: Human populations are surveyed as to their use of surface or groundwaters, their exposure to pathogens, and the incidence of disease in order to assess the link between water-borne contamination and illness. Example: Users of a swimming hole are surveyed to see if they contract gastro-enteric illness following swimming.

Discharge Permit Compliance: The discharge monitoring reports produced by dischargers are compared with the permitted discharge levels to see if they are meeting permit conditions.

Water Supply System Compliance: Water supply systems are tested to see if they contain unsafe levels of contaminants.

Sanitary Surveys: Sources of fecal contamination are traced to one or more sources by seeing if there's a direct connection between a septic system and the surface water.

How you select a type of monitoring that's right for you is described in Chapter 2.

C. Basic Requirements for Monitoring

Before you and your volunteers get your feet wet, there are some basic requirements to think about. These relate to liability, permits and/or licenses required and a suggested "code of ethics" to assure the integrity of your program and good relations with landowners.

Liability Considerations

1) **The responsibility of the sponsoring organization for the conduct of its volunteers.** Require that your volunteers sign a "liability waiver" giving up their right to seek compensation for injuries. Following is a sample form:

> ***Waiver of Liability***
>
> *I, _____, have volunteered to (generally describe activity). I understand that participation in this activity can be hazardous, that my participation in this activity is entirely voluntary, and that (name sponsoring agency) assumes no additional liability as a result of my activity. As a precondition to my participation in (name activity), I therefore hereby waive and release all claim of liability against (name sponsoring agency) for any injuries, foreseen or unforeseen occurring or sustained as a result of my participation.*
>
> *Signature:* _____ *Date:* _____

2) **The responsibility of landowners for injuries that happen to volunteer monitors on their property**. This issue is very similar to the one above, except the focus for liability damages is the landowner instead of, or in addition to, the sponsoring organization. Here is another sample waiver form. This one releases the landowner from responsibility for injury:

> ***Landowner Release Form***
>
> *I, _____, do hereby release _____ the owner of property at _____from any responsibility for any physical harm that may befall me while using the above mentioned land for the purposes of physical, biological or chemical monitoring.*
>
> *Date:*_____ *Signature:* _____
>
> *To verify the identity or intent of the volunteer in question, or for any other information, contact (name and phone number of your coordinator).*

Permits/Licenses Required

Collecting aquatic organisms (fish or macroinvertebrates) requires at least a fishing license and possibly one of two special permits from the Fish and Boat Commission. If you will not be collecting more than 50 organisms, all you need is a fishing license.

- **Fishing License:** Allows the holder to capture and possess fish bait. Benthic macroinvertebrates are fish bait under the Pa. Fishing Regulations. In all but specially regulated or trout-stocked waters during the closed season, as long as you use a net that is smaller than four feet square or in diameter, and you don't catch more than 50 organisms, a fishing license is all you will need. In specially regulated or trout-stocked waters during the closed season, you need a Scientific Collector's Permit.

You can download the Fishing License application from the Web:
http://www.fish.state.pa.us/Fish/licapp.htm

If you will be collecting more than 50 organisms, you will also need one of the following two permits:

- **Scientific Collector's Permit:** Allows the holder to use alternate methods to collect more than 50 organisms and operate in specially regulated waters. There are three types of Scientific Collector's Permits.

  Type I *Nonprofit Research and Education:* Individuals deemed qualified by the Commission to "competently and capably conduct research or educational programs" and who are not being paid for collecting (e.g. a private consultant). This covers the permit holder and no more than five assistants (though exceptions to this limit may be granted for students). Anyone may apply who:

  a. needs to collect organisms in pursuit of an advanced degree; OR

  b. has an advanced degree and need field specimens for their biological research; OR

  c. is associated with a museum, college or university; or have a valid need for collecting specimens for education or science; OR

  d. is a recognized expert in aquatic science that the Commission deems qualified.

  Cost: $10

  Type II *Governmental:* Issued to state and federal employees whose jobs require scientific collecting.

  Cost: Free

  Type III *Consulting:* Individuals deemed by the Commission to be "qualified to engage in scientific collecting" and are engaged in private consulting for profit. This covers the permit holder and no more than five assistants. Permits are NOT issued to corporations or companies.

  Cost: $50

  You can download the **Scientific Collector's Permit** application from the Web:
  http://www.fish.state.pa.us/Fish/scicoll.pdf

- **Educational Aquatic Field Study Permit:** Exempts students (16 years and older) who are participating in a high school or undergraduate course-sponsored field study from having to purchase a fishing license. The teacher, however, must have a fishing license and participants are limited to 50 critters per license.

You can download the **Educational Aquatic Field Study Permit** application from the Web:
http://www.fish.state.pa.us/Fish/edstu.pdf

Volunteer Monitoring Code of Ethics

When we gather field information on environmental conditions for the benefit of our watersheds and the community, we must bear two things in mind:

- We may be working on private property; and
- Our results may affect people's livelihood and/or use of their property.

Therefore, it is particularly important that we carry out our monitoring ethically and with integrity in our relationships with other members of the community. Consider that your behavior will be the basis for what some people think about volunteer monitoring!

Below is a "Code of Ethics" gleaned from various sources including the discussions in workshops for volunteer monitoring groups held in 1998 and 1999:

Volunteer Monitoring Code Of Ethics

We Carry Out Our Monitoring With Integrity

1. We use proper scientific methodology.
2. We fully document our technical observations.
3. We accept the responsibility to report our data, our interpretations and our conclusions so they can be reviewed by decision-makers and those who use or may be affected by the results.
4. We truthfully answer questions about sampling techniques, frequency and location.
5. We make a good faith effort to include as many different interests and perspectives in our monitoring programs as possible.

We Develop Good Relations with Private Landowners

1. We request written permission from the landowner if access to private property is necessary in our monitoring plan.
2. In contacting the landowner, we offer explanations about who we are, the purpose of our group, what the project entails and the intended use of the data.
3. After receiving written permission, we contact the landowners in advance to let them know the exact date(s) of sampling events.
4. We do no harm to private property.
5. We take complete responsibility for our personal safety while on private property.
6. We contact landowners after sampling to share the results.

D. How to Use This Handbook

This handbook is intended to help you design a community-based monitoring study that meets your needs and capabilities. To get the most out of it, we recommend that you use it as follows:

- Read **Chapter 2 and the worksheets in Appendix 6** to get an overview of the study design process.
- Do you need help with the study design process? If so, look in **Appendix 5** for a list of organizations that can help you, or call the DEP staff at (717) 787-5259.
- **Chapter 2** is your guide through the study design process. There is a lot of basic information that will help you fill out the worksheets in this chapter. The **worksheets in Appendix 6** are your written record of the decisions you make in the study design process.
- Following are the parts of the handbook that will help you with the *content* for each step:

  Step 1: *Chapter 2* guides you through finding out what is already known about your watershed.

  Step 2: *Chapter 3* will help you decide on a monitoring purpose.

  Chapter 4 will help you decide on a monitoring question.

  Step 3: *Chapter 5* describes different packages of monitoring activities known as "assessments." These are packages of indicators, methods and guidance on site selection and scheduling. Chapter 5 will also help you decide on an assessment and a set of indicators.

  Appendix 3 describes DEP's monitoring programs. This may help you select assessments and indicators, as well as help you understand the rigor and scope of a professional monitoring program.

  Step 4: *Chapter 2* describes the process of setting data quality objectives.

  Step 5: *Chapter 5* suggests appropriate monitoring methods for each indicator for each assessment.

  Appendix 2 explains the basics of the monitoring methods for selected indicators. Use this appendix for more information referred to in the "Monitoring Options" tables in Chapter 5.

  Step 6: *Chapter 5* contains guidance on selecting monitoring sites for each assessment.

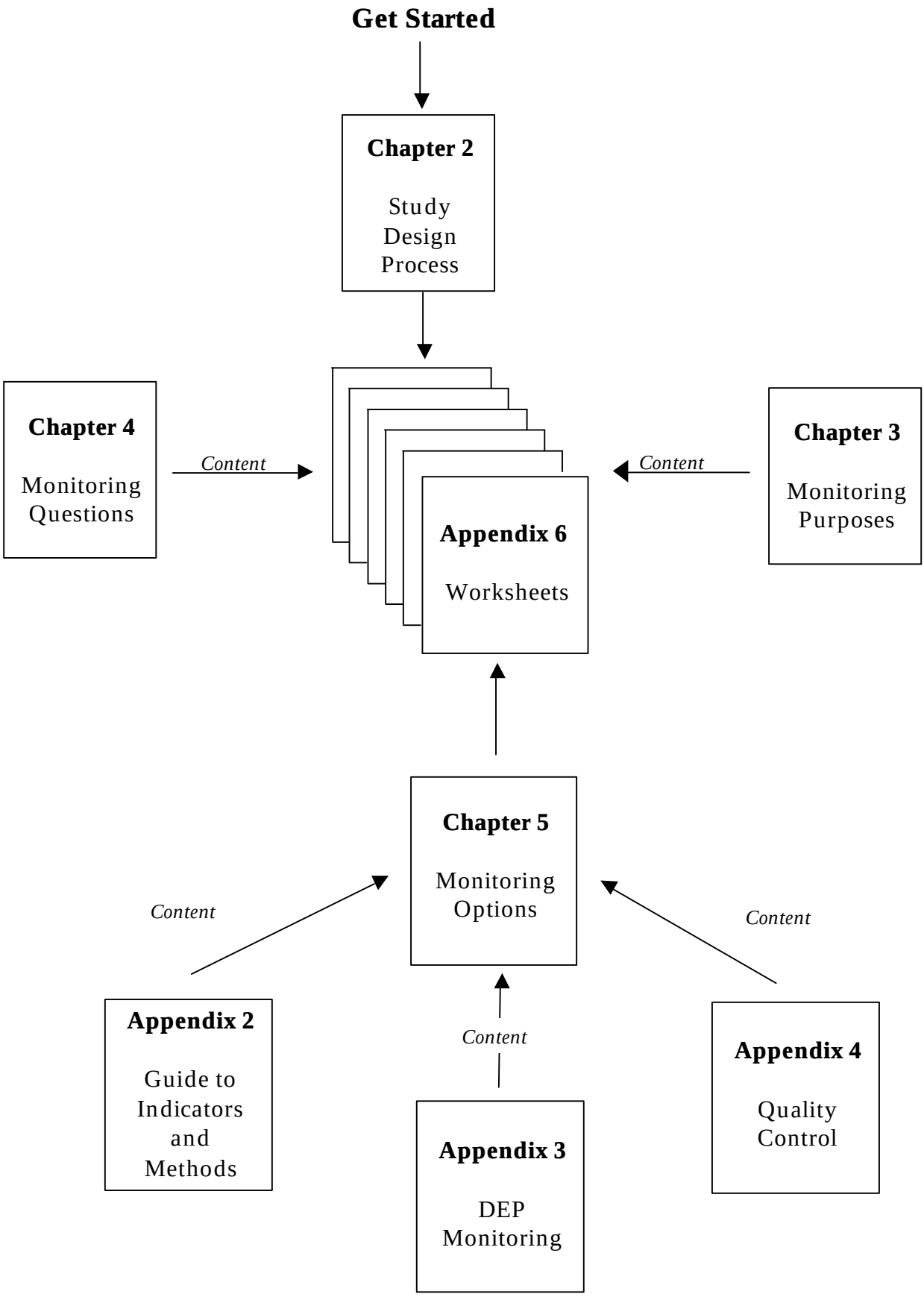
  Step 7: *Chapter 5* contains guidance on setting up a sampling schedule, including frequency, time of year, time of day and weather..

  Step 8: *Chapter 5* suggests basic approaches to quality assurance for each assessment.

  Appendix 4 describes the different quality control measures from which you will select.

  Step 9: *Chapter 2* guides you through the basic options and choices you must make.

  Step 10: *Chapter 2* suggests the tasks and jobs to consider.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