Ethics Training Is Essential for Environmental Laboratories

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Key Takeaways

Ethics is a guiding moral philosophy for decision-making and is part of a sound quality assurance/quality control program; likewise, data integrity must be rooted in sound principles.

Analysts at water, wastewater, and public health laboratories owe it to their profession and the public to always maintain data integrity, otherwise risking potentially serious consequences.

Steps can be taken to better ensure ethical laboratory practices, such as ethics training, data review, policies, codes of ethics, and internal audits.

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ETHICS
COUNTABILITY
PRINCIPLES
INTEGRITY
VALUES

Ethics is the discipline of dealing with right versus wrong, moral duty, obligation, and a guiding philosophy that creates a system of moral values and principles. It helps determine whether practices are acceptable and conform to professional standards of conduct. In short, ethics is a complex subject; the complexity lies in that, while some ethical practices may be unacceptable, all unethical practices are unacceptable.

Importance of Ethics and Data Integrity

Data integrity falls under the overall umbrella of ethics. It is the generation, transformation, maintenance, and assurance of data accuracy, completeness, and consistency over data's entire life cycle to be in compliance with applicable regulations. Data integrity is a focal point of environmental laboratory quality assurance/quality control (QA/QC) programs, ensuring regulatory compliance. Even unintentional uncontrolled data integrity practices can quickly evolve into unethical practices.

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Water, wastewater, and public health laboratories all face public health consequences when laboratory personnel do not take pride in their work and act ethically. Lives are literally at stake if they don't perform their jobs with integrity. Environmental pollution is also a concern, especially when water and wastewater analysts don't act ethically. This means laboratory personnel also must be aware of environmental ethics, which is the study of the morality (rightness or wrongness) of actions that affect the environment.

Wildlife biologist Aldo Leopold proposed an ethical system in 1949 based on humans as being part of a continuum with animals, plants, and the nonliving chemical world, where all things are seen as related. This in turn produces an incentive for people to act ethically. Leopold called this the *land ethic*. He described how ethics evolved from responsibility to other people, to family then to all of society, including the land (Figure 1). As the boundaries of the community expand, a concentric hierarchy of responsibilities to larger and larger communities is created.

Water and wastewater laboratory analysts have a responsibility to protect public health, and they frequently have a deep connection to the principle of environmental quality. The connections to public health and the environment allow analysts to connect with the larger water industry, and as they do so, they are more likely to act ethically. The environmental laboratory testing industry—including water, wastewater, and public health laboratories—is an essential part of the nation's critical infrastructure. Laboratory analysts must understand that their work and the data they produce directly affect decision-making and ultimately public health. Data generation without adherence to an ethical system is indefensible.

While not always the case, unethical practices and data integrity failures can be indicative of some degree of laboratory fraud. Analysts do not generally fall into unethical practices overnight; rather, this is often a slow road of poor decision-making that leads to habitual patterns. According to the US Environmental Protection Agency (USEPA), fraud is the deliberate falsification of analytical and QA results, where failed method and contractual requirements are made to appear acceptable.

Mistakes will happen; the difference between an honest mistake and fraud lies in the decision to note the mistake or cover it up. Fraudulent laboratory practices can lead to compliance issues, loss of accreditation, and even legal consequences (civil and criminal). A September 2006 USEPA evaluation report recommended that all certified laboratories should have an ethics policy/program to actively discourage fraud and inappropriate procedures (Ferguson et al. 2006).

Examples of Unethical Practices

Environmental laboratory testing is not always straightforward. Analysts must sometimes use their best judgment when performing analyses, making sure to follow the laboratory's standard operating procedures (SOPs), which should always accurately reflect the referenced method and describe what should happen when QC fails. Once an analyst starts down the path of unethical practices, issues can quickly arise, with widespread ramifications. The following are examples of unethical practices that analysts should be aware of and take care to avoid.

Procedural Changes

Procedural practices are perhaps the most difficult unethical practices to notice as they typically are deviations from the laboratory's approved SOPs. A change in preparing samples for analysis by changing volume,

altering calibration values, or modifying instrument settings is a procedural change that takes shortcuts to reduce time and/or effort to complete an analysis. For example, an analyst who was short on time to complete a set of samples chose to delete a step—e.g., digestion or extraction. Another example could be adding a spike standard at an out-of-sequence step in the process because it "worked better," instead of following the SOP requirements.

Measurement Deception

Whether real or perceived, analysts may feel pressure to edit their results in a wide range of areas—i.e., to engage in measurement deception. For example, instead of recording a temperature that is out of range, an analyst fraudulently records a temperature that is within acceptance criteria so that analyses relying on that temperature do not need to be repeated. A small edit to a mass reading or pH measurement can also fraudulently pass acceptance criteria, which can be appealing when it supports the results of an analysis.

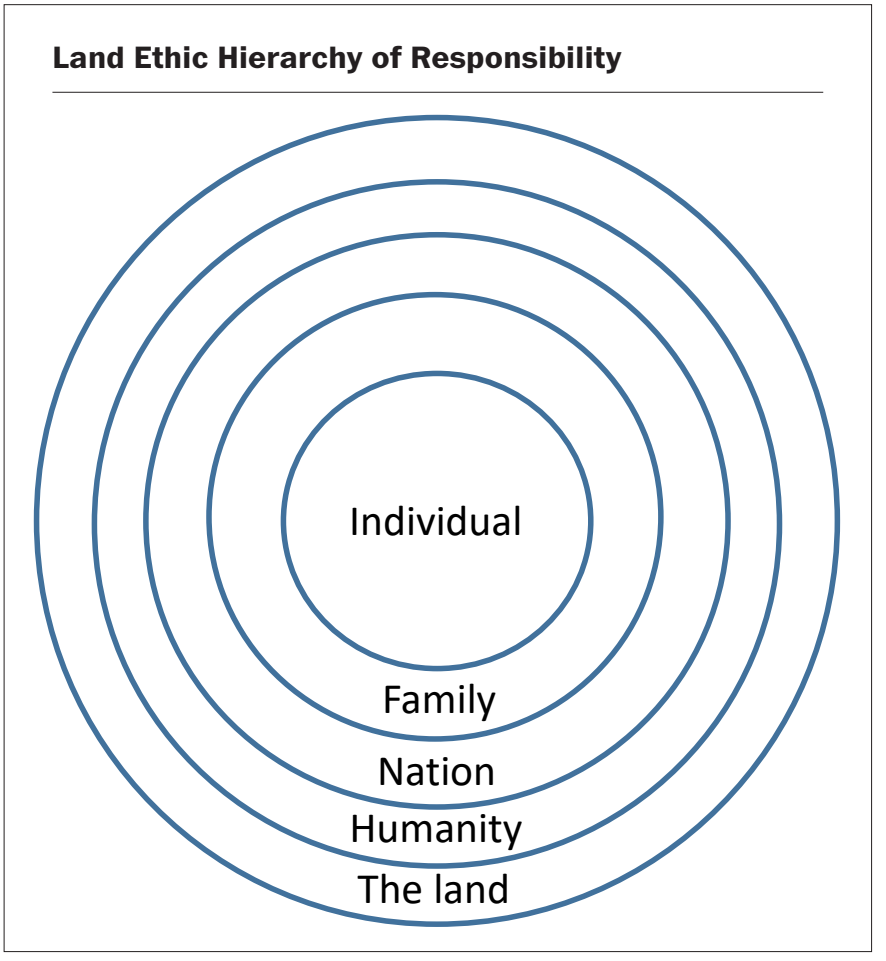

Figure 1

Data Deletion

Occasionally, an individual may consider deleting data either to reflect a result a client prefers (implied or otherwise) or to reduce workload. Data deletion is more often seen with electronic data production for chromatography or replicates in elemental analysis. As software that is used on many instruments is developed for more industries with various needs, software often provides options that are not always acceptable to other sectors or acceptable only under certain conditions.

For example, when testing for metals in water, replicate samples are required. If an analyst is having an issue with a calibration standard, QC, or blank, they could delete one or more replicates to pass QC. Another example is deleting a chromatogram peak height or area value on a quantitation report to make it appear that no peak was detected.

Data Fabrication

One example of data fabrication is when an analyst receives a sample from a location or facility and "knows" what the result will be from routine testing; because the result will certainly be what it's always been over past measurements, the analyst does not analyze the sample (often a nondetect value). Sometimes managers or analysts determine that they need to manage costs or do not have resources to purchase additional testing materials, which can lead to a report generated without sample analysis.

This process of not performing an analysis at all, or not even collecting the sample, is called *dry labbing* or *pencil whipping*, and any data provided on the final report are completely fabricated. When dry labbing occurs, it is often the result of resource scarcity or resource concerns such as funding, analyst time, hold times, or even equipment or instrumentation problems.

Data Modification or Manipulation

Data modification or manipulation can occur in many ways and for a variety of reasons. For example, changing a date to show that a sample arrived within hold time or that the analysis was performed within the acceptable time frame can have major consequences for clients relying on the results. Data time stamps can be manipulated by changing the clock on an instrument before or after an analysis; this might be done to show an analysis met hold times, client turnaround times, or to address an instrument problem. (This does not include changes related to daylight saving time.)

Changing a date and/or time is called *time travel*, and while mainly seen with software, it also occurs in handwritten documents such as submission forms or meter and oven logs. Most software used with modern instruments documents when time records are modified. For example, almost all chromatographic data acquisition software flags data whenever something is modified, and those flags become part of the electronic file associated with that analysis. Software improvements like this make it difficult to hide data manipulation.

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In the absence of strong ethics training, an analyst may be moved to modify data by manipulating sample peaks, which is called *peak shaving* or *peak juicing* (Figure 2). Peak shaving occurs when a peak has too much area to pass QA/QC or is co-eluting with another peak. The analyst trims the peak so that it meets quality criteria or to have the sample drop below a required reporting level. Peak juicing occurs when the peak area is not great enough to meet detection criteria, and the analyst increases the peak's area to increase the area counts. Another manipulation occurs when a peak is not meeting signal-to-noise ratios, is not detectable, and an individual gathers noise on a baseline and sometimes additional peaks to increase the overall area to meet criteria.

Laboratory operations can be expensive, and there can be pressure to ensure costs are managed and that clients are happy, both of which could lead to data falsification. Robust ethics training educates staff on what practices are considered acceptable. This education reinforces the notion that even small changes that might not seem to be an issue can lead to problems down the road, including compromising public health. Regular ethics training demonstrates to laboratory partners and data users that measurements are made and reported reliably, and the QA/QC processes are well documented and followed.

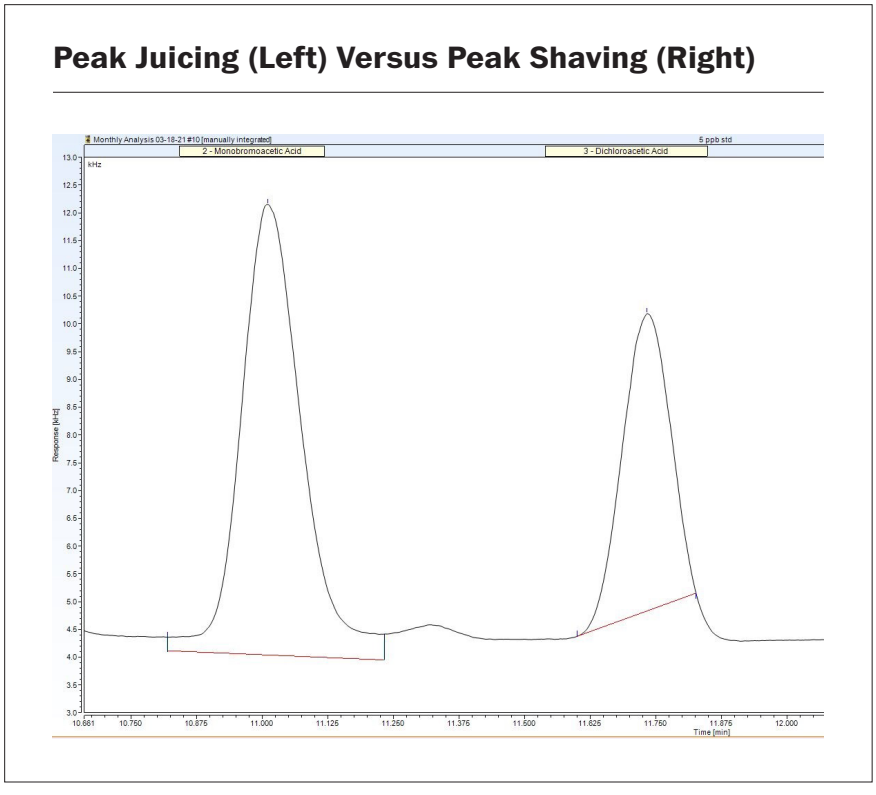

Figure 2

An Industry in Need

Some businesses, standards (such as the National Environmental Laboratory Accreditation Program), and organizations have

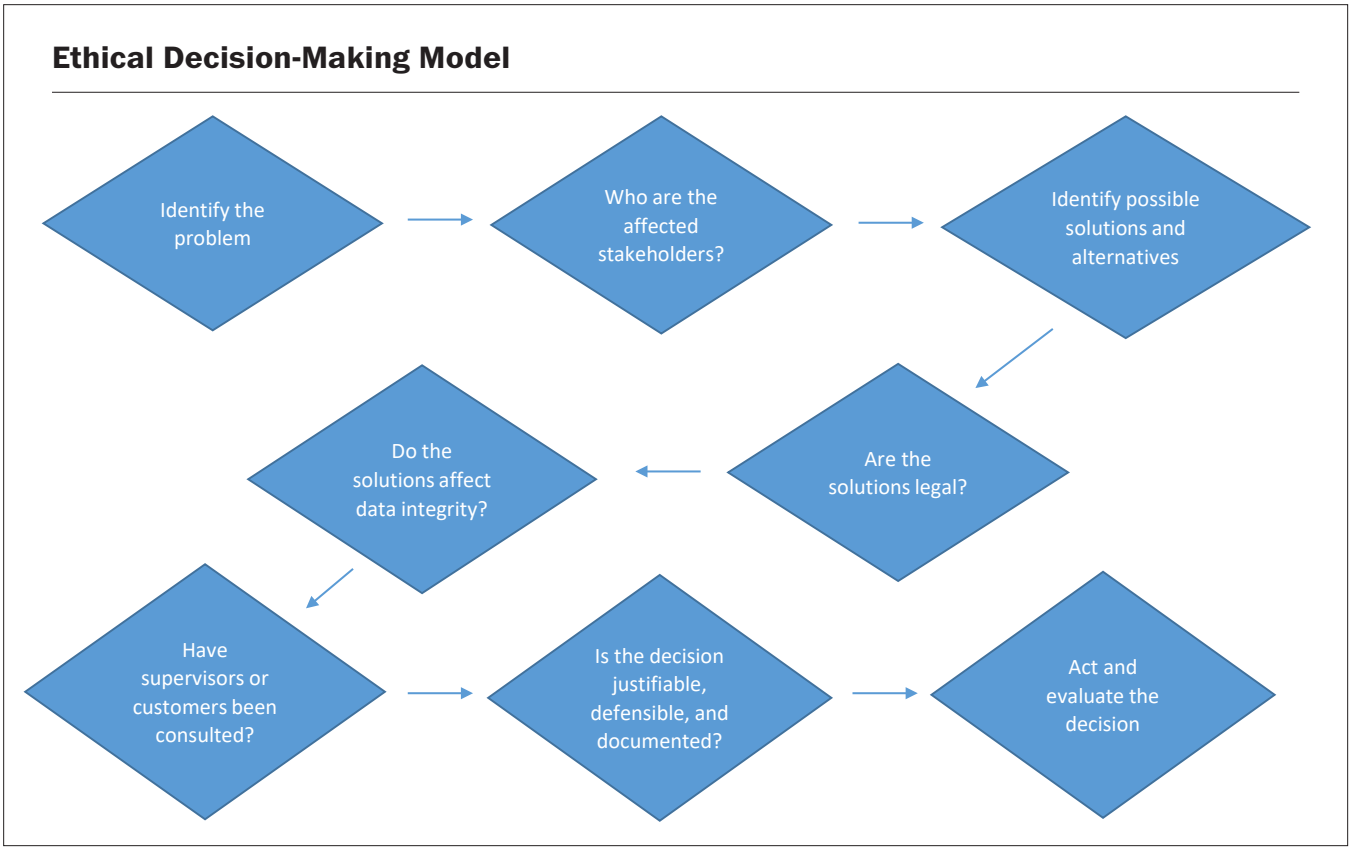

Figure 3

ethics requirements like trainings and codes of conduct (APHA n.d., PNWS AWWA n.d.). In meeting the various types of requirements, it may be easy to lose sight of why ethics is important to all laboratories.

Ethics is the foundation on which we build our data. It provides analysts a framework for evaluating data that do not meet QC acceptance criteria. Without reliable data, users—the engineers who design our water infrastructure, the operators who manage treatment plants, and the regulators who make decisions—can't effectively do their jobs. In the end, the public is most affected if it doesn't have safe water or healthy communities.

It is expected that analysts naturally want to produce high-quality data. They also want to avoid rerunning samples, missing hold times, and shutting down instruments for necessary routine maintenance. When laboratory circumstances could affect data quality, analysts should decide how to proceed by relying on laboratory ethics as a model to make correct decisions (Figure 3).

A well-referenced and easy-to-use quality manual provides answers to routine laboratory situations, such as those listed below:

- What should I do if a sample is not properly preserved?
- Should I analyze a sample that has exceeded its hold time?
- What should I do when a sample batch does not meet quality criteria?
- What if a quality control sample is out of range by "just a little bit"?
- Is it OK to release data with poor quality control if I notify the end user of the situation?
- What do I say to management staff when they want results faster?
- Do I have to rerun this sample?
- What if I don't have time to perform instrument maintenance?
- Is the sample workflow traceable—from receiving, to analyzing, to reporting?

For example, a laboratory's QA/QC program that includes an ethics program may allow reporting results

for samples exceeding hold time if the client is informed and the data are properly qualified. Unfortunately, whether intentional or not, data that do not meet quality guidelines can be reported by the laboratory. A strong ethics program can minimize this. Multifaceted, well-built QA/QC programs (comprising ethics training) include data review, internal audits, and whistleblower policies.

Data Review

Data review should be a routine laboratory task. Analytical batches can include

- instrument blanks,
- method blanks,
- standards of known concentration,
- matrix spikes,
- duplicates,
- internal standards, and
- surrogates.

Reviewing these data should show whether analyses are in control. Analysts assume sample analyses are accurate and precise when quality control data are accurate and precise. Data review should also include routine and random calculation checks, along with general inspection of bench sheets or notebooks, to verify instrument calibration and complete recordkeeping.

Internal Audits

Periodic audits provide a more in-depth examination of laboratory practices than routine data review. A thorough audit follows a sample through the complete laboratory process, starting with sample receipt and ending with sample disposal. The audit looks at all items that contribute to reliable analysis results and can reveal sources of potential error. Audits can verify several actions:

- Samples are delivered to the laboratory in a timely manner and with proper preservation.
- Sample labels and chains of custody are indicative of proper identification.
- Samples are correctly entered into laboratory information systems.
- Samples are split and stored according to method requirements.
- Analysis methods are appropriate and traceable to approved reference methods.
- Analysts follow SOPs.
- Reagents and standards are properly prepared and within expiration dates.
- Instrument calibration is appropriate and verified.
- Analyst training is appropriate and documented.
- Recordkeeping is complete.
- Analytical reports include all relevant information.
- There is no fraud such as reporting data for samples not analyzed (dry labbing), data manipulation, or falsifying data.

Whistleblower Policy

Unethical behavior can still occur, even with ethics policies and training, so bench analysts must know they are protected when they report an issue. To operate effectively, workers need assurance that there will be no adverse consequences when reporting questionable practices. This should be stated in the laboratory's whistleblower policy and made clear to all analysts (WEF 2021).

Ethics Toolkit

Understanding that ethics training is an essential but often overlooked facet of training in environmental laboratory quality management systems, the Association of Public Health Laboratories (APHL) has created a set of resources to help laboratory managers easily find available tools for laboratory staff to fulfill their ethics requirements (APHL n.d.). These resources will help laboratories meet accreditation requirements and help ensure compliance, provide proof of data accountability, and establish acceptable practices for laboratories to produce reliable and defensible data.

The APHL toolkit consists of resources from a variety of organizations spanning different areas of public health ethics (see Figure 4 and visit APHL.org). The section on general laboratory ethics resources informs users of the overall importance of proper ethical practices in the laboratory through publications, webinars, and trainings. Users learn what defines data integrity and how to achieve and maintain it in their laboratory practices. Examples are provided of codes of ethics from different organizations that can be used as a template for developing a laboratory code of ethics. The toolkit provides key resources, such as publications, webinars, and sample documents (see the "Ethics Toolkit Resources" sidebar for examples).

Significance of Ethics and Data Integrity Training

Ethics and data integrity are important parts of laboratory work as they help produce reliable and defensible data. Without regular ethics training, analysts may make a few poor decisions, which can lead to habitual patterns that include procedural changes; measurement deception; and data deletion, fabrication, or modification and manipulation.

Some companies require ethics training, while others have codes or policies for their analysts to follow to ensure high-quality results. The purpose of either approach is to foster a culture of ethical behavior and to make staff aware of what is plainly acceptable and unacceptable.

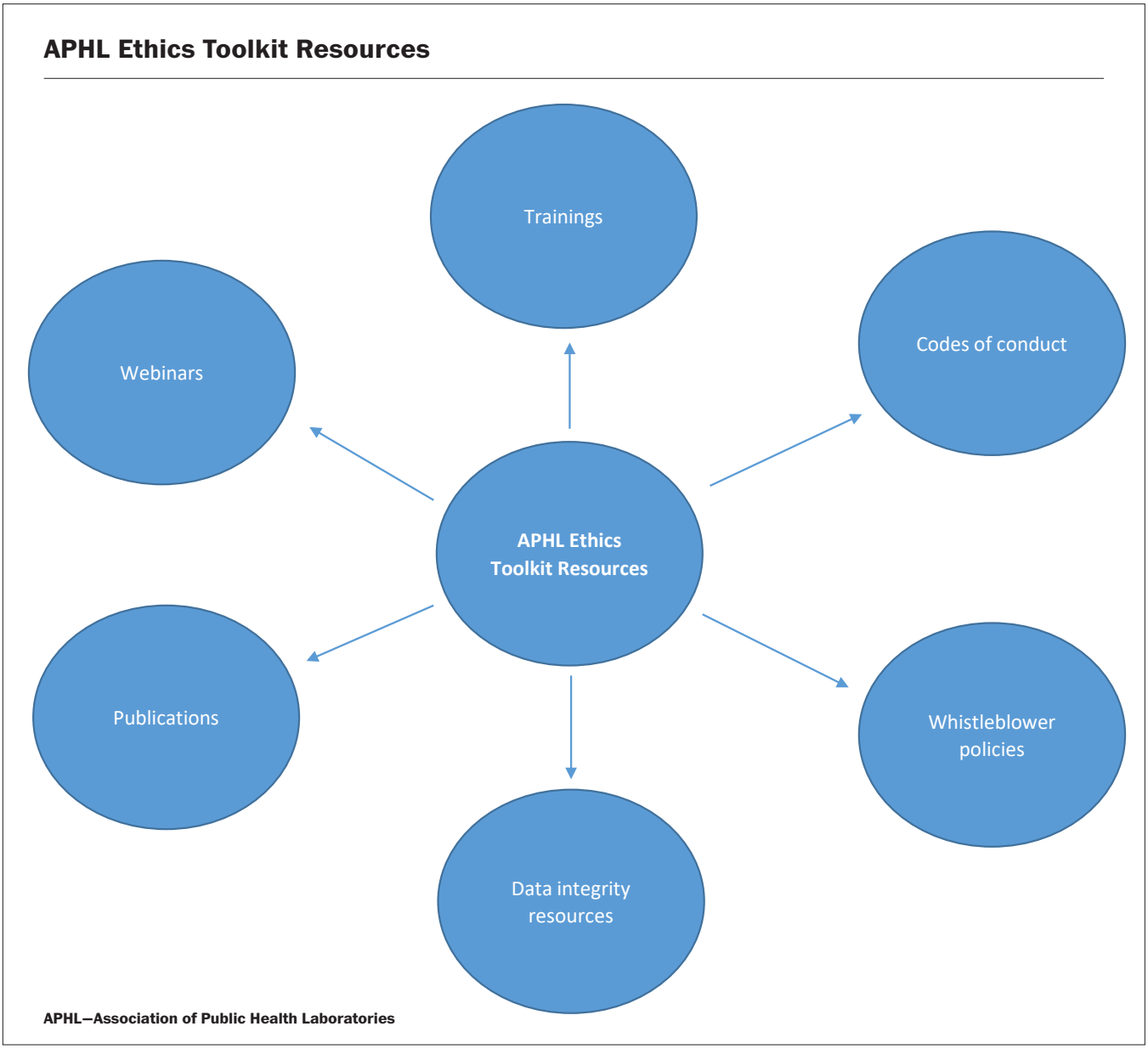

Figure 4

Data review and audits are two other practices used to instill ethical vigilance. APHL has created an ethics toolkit to help organizations easily access resources and training to complete their ethics requirements.

It is important to note that no single ethics training program or ethics policy can be all-encompassing; it is ultimately the analyst's responsibility to think through situations and make ethical decisions to ensure the integrity of the data, themselves, and their laboratory.

Following proper ethical guidelines will minimize or eliminate compliance issues, loss of accreditation, and even legal problems. Most importantly, the environmental testing industry—including water, wastewater, and public health laboratories—should understand that ethics training is essential. When used to create a culture of ethical decision-making, it helps produce reliable data that can be used to protect the environment and public health.

ETHICS TOOLKIT RESOURCES

The Association of Public Health Laboratories' (APHL's) ethics toolkit provides guidance, along with numerous resources, to help laboratories ensure they are meeting requirements and following ethical practices. The following are examples of resources listed in the toolkit:

- APHL webinar, Ethical Vigilance: Lessons for Environmental Laboratories and Beyond—https://bit.ly/2VRUDKh
- APHL webinar, Laboratory Ethics and Data Integrity—https://bit.ly/3g0V4c5
- APHL *Public Health Code of Ethics*—https://bit.ly/3m77VNT
- Page from the Centers for Disease Control and Prevention's website, "Public Health Ethics"—www.cdc.gov/os/integrity/phethics/index.htm
- Virginia Section AWWA, "Code of Ethics & Standards of Practice for Water Works Professionals"—https://bit.ly/3jSlAp7
- WEF Ethics for the Environmental Laboratory Webcast—https://learn.wef.org/local/catalog/view/product.php?productid=96

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APHL (American Public Health Laboratories). n.d. Environmental Laboratory Ethics Resources. APHL, Silver Spring, Md. https://bit.ly/2UHusW1

Ferguson J, Fencil J, Brass I, et al. 2006. *Promising Techniques Identified to Improve Drinking Water Laboratory Integrity and Reduce Public Health Risks*. Report No. 2006-P-00036. Office of Inspector General, US Environmental Protection Agency, Washington. www.epa.gov/sites/production/files/2015-11/documents/20060921-2006-p-00036.pdf

PNWS (Pacific Northwest Section) AWWA. n.d. AWWA Members' Code of Practice. PNWA AWWA, Vancouver, Wash. https://bit.ly/3gr9ti0

WEF (Water Environment Federation). 2021. Whistleblower Policy. In *Water Environment Federation Volunteer Handbook.* WEF, Alexandria, Va. https://bit.ly/2WgQm36

AWWA Resources

- **Supporting the Water Quality Laboratory's Role in Ensuring Safe Drinking Water. AWWA Water Quality Laboratory Committee. 2004. *Journal AWWA.* 96:1:33. https://doi.org/10.1002/j.1551-8833.2004.tb10517.x**
- **Disinfection Data Integrity in Washington State. Deem S, Feagin N. 2016. *Journal AWWA.* 108:10:24. https://doi.org/10.5942/jawwa.2016.108.0157**
- **MCL Noncompliance: Is the Laboratory at Fault? Koorse SJ. 1990. *Journal AWWA.* 82:2:53. https://doi.org/10.1002/j.1551-8833.1990.tb06919.x**

These resources have been supplied by *Journal AWWA* staff. For information on these and other AWWA resources, visit www.awwa.org.