Public Health Informatics Institute

Leveraging Informatics to Improve Environmental Health Practice and Innovation

Final project report

August 2021

THE TASK FORCE FOR GLOBAL HEALTH

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Acknowledgements

A summary of contributions to this work

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Consumers rely on regular public health inspections to keep restaurants like the one pictured safe for their use.
Image credit: Priscilla Du Preez

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PHII is also grateful for the active participation of the key informants whose insights informed this work. Key participants are identified by name and organization in Table 2 on page 7.

Introduction

About the project

The Public Health Informatics Institute (PHII), a program of The Task Force for Global Health, worked closely with the National Center for Environmental Health (NCEH), Division of Emergency and Environmental Health Services, local and state environmental health programs, and other key stakeholders over a 11-month period (August 2020-July 2021), to enhance and support the collection and use of environmental health data through standardized informatics methodologies or frameworks.

The PHII team worked with local health departments to evaluate their current environmental health restaurant inspection and recreational water inspection processes, systems and information. The project team utilized PHII's Collaborative Requirements Development Methodology CRDM™ to conduct business process analysis to identify environmental health processes that support local and state EH programs' ability to collect, analyze and use electronic environmental data and information. These activities supported the development of best practices recommendations to build a foundation for local and state environmental health programs' informatics capabilities to use electronic data for informed and timely decision-making.

Project strategy: conduct activities that improve collection, management, interpretation and dissemination of data to guide decision making for environmental health programs.

Project objectives

The overarching strategy for this project was to conduct activities that improve collection, management, interpretation and dissemination of data to guide decision making for environmental health programs. The specific objectives for this project were:

- Establish a project charter and a communications plan with the project sponsor.
- Conduct an environmental scan of relevant literature, tools and resources, which will inform development of a key informant questionnaire.
- Conduct formal key informant interviews and virtual site visits with selected local and state environmental health programs.
- Conduct a virtual CRDM™ workshop with key stakeholders to collaboratively validate, redesign and document a minimally viable product for a standard environmental health information system that can be used across state and local health departments.
- Develop and submit finalized business process documentation and recommendations for more efficient environmental health department restaurant and recreational water inspection processes.
- In partnership with the National Environmental Health Association (NEHA), develop a standard environmental health program informatics methodology or framework to increase capability to use data to inform decision-making and support evidence-based practices.

Project stakeholders

Table 1 lists the project stakeholders and their roles.

Table 1. Environmental health project stakeholders

Stakeholder or stakeholder domain	Project role
NCEH/WFEHSB leadership	Advisory
NEHA	Conduit to state and local environmental health contacts and resources
State and local environmental health professionals	Environmental health business process subject matter expert
General public	Information consumer of publicly available environmental health data

Recreational water facilities like the one pictured rely on regular environmental health inspections to remain safe for public use.
Image credit: AllGo

Methods

A summary of methodology for this project

The approach for the project utilized the Collaborative Requirements Development Methodology™ (CRDM™) developed by the Public Health Informatics Institute, a program of the Task Force for Global Health. CRDM™ focuses on collaboration and achieving consensus among the participants and stakeholders. In addition, PHII follows a well-established set of best practices designed to keep projects on time and within scope. CRDM™ gives project participants tools and a process for documenting workflows and defining functional requirements for information systems that support those workflows. This project included an environmental scan of environmental health inspection focused literature, key informant interviews that informed development of a current state business process analysis, and a review process that culminated in best practice recommendations.

The key informant interview questionnaire was developed in collaboration with CDC and NEHA. The survey was divided into two parts with similar questions for each: one set of questions for food inspections and another for recreational water inspections. An initial subset of the questionnaire was sent to the key informants in an electronic format via SurveyMonkey. The remaining questions were discussed during a phone conference. The key informants were asked to complete the electronic survey prior to the scheduled phone conference. In addition, the key informants were asked to provide any supporting documentation that they were able to share. Table 2 lists the project key informants.

Table 2. Key informants

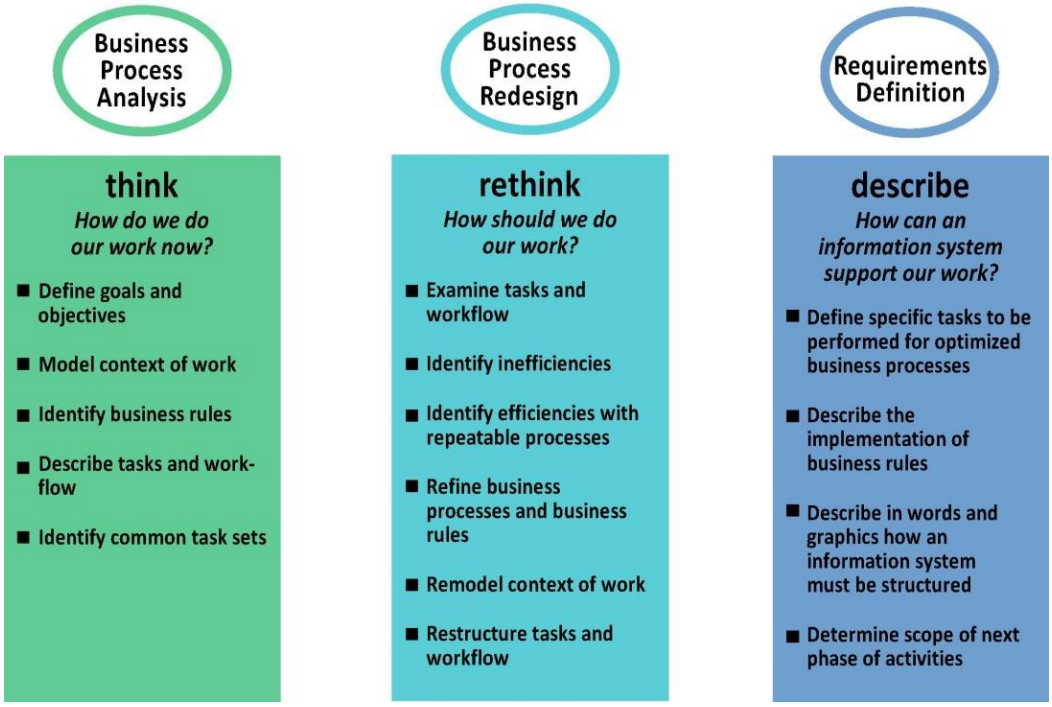
Key informant	Jurisdiction	Interview date
Tim Callahan	Georgia	01/14/2021
Aaron DelCotto	Southern Nevada	01/21/2021
Karla Shoup	Southern Nevada	01/20/2021
Brent Casey	Riverside County, California	01/26/2021
Sonal Iver	Virginia	02/23/2021
Cliff Mitchell	Maryland	03/10/2021

The current state analysis included development of business process matrices and task flow diagrams representing the business processes that were determined to be in scope for this project. The project team, NEHA, CDC and the environmental health program stakeholders met in a two-part virtual workshop to review and validate the business process matrices and task flow diagrams. During the virtual workshop, best practice discussions were conducted to develop recommendations for the environmental health community.

The project also included a pilot with the five key stakeholders (Georgia, Southern Nevada, Riverside County, Virginia and Maryland) to develop best practices recommendations for standardization of food and water inspection data processing. NEHA partnered with the project team to collect data and information during the virtual workshops from the selected jurisdictions on food and water inspection processes, data use and standardization, challenges, and recommendations. The data relating to the standardization of food and water inspection data were aggregated and summarized to understand the current data systems in place, challenges, strategies to move past identified challenges, recommendations from those in the field, and best practices.

Limitations

There were limitations to this project. The Paperwork Reduction Act governs how federal agencies collect information from the public. There is a limit of nine (9) stakeholder jurisdictions for participation for projects that require surveys. Based on these guidelines, the project team invited nine jurisdictions to participate in the project. However, only five responded and participated. Participation was also limited because of the COVID-19 pandemic response. Many jurisdictions are currently under-staffed and under-resourced because of the scale of the response.



PHII's Collaborative Requirements Development Methodology™

PHII's CRDM™ gives project partners tools and a process for documenting public health workflows and defining functional requirements for information systems that support those workflows.

Early project activities

Understanding the environmental health data landscape

Environmental scan

The purpose of the environmental scan was to examine the methods used for successful systematic collection, analysis, interpretation and use of environmental health-related data specifically around food safety, restaurant inspection, and recreational water health data collection and data sharing. A separate report was created for the environmental scan and disseminated to the project team, NEHA and CDC. The report was divided into two parts: a summary specific to the identified key stakeholder jurisdictions for the project and a general summary of literature relevant to environmental health food and water processes.

The specific key stakeholder research drew attention to various disclosure methods such as letter grades, numerical scores, emojis, and color-coding techniques and programs belonging to health departments across the country (see Appendix A). These techniques are aimed to help healthcare entities provide awareness to consumers at a local place of business. Further investigations revealed that posting inspection reports online through websites, social media and apps is a modern tool that governments use to provide consumers access to information any time and place; moreover, the inspection process may vary by location. The findings specifically captured the inspection processes for the initial invited jurisdictions: state of Georgia, state of Florida, state of Colorado, Southern Nevada Health District, Boston, US Virgin Islands, and Seattle and King County in Washington state.

A health inspector inspects the food safety protocols at a restaurant.

The most common inspection techniques used amongst these jurisdictions were letter grade and numerical score disclosing methods. The report analyzed these processes and concluded that accessibility to this environmental health information may vary depending on local policies. According to the literature, there is a lack of obtainable information on recreational water inspection practices from several healthcare entities. The environmental scan uncovered several potential recommendations and identified gaps including:

- Inspection processes should be made more accessible online to consumers.
- Increased inspection information for recreational water areas is needed.
- Increased consumer comprehensiveness of inspection processes is needed.

The full environmental scan report was made available as part of the final deliverables of the project.

Key informant interview summary

Process and findings of jurisdictional interviews

SurveyMonkey

All of the jurisdictions surveyed had more than 20 employees in the environmental health program. Of the jurisdictions surveyed, there were three state agencies (Georgia, Virginia and Maryland) and two local agencies (Southern Nevada and Riverside County). All of the key informant agencies perform both food and recreational water inspections. Among the individual key informants, only two key informants had less than 10 years of experience working in environmental health. The key informants all had experience performing inspections during their tenure, but most did not currently perform inspections as a part of their day-to-day work. Many of the key informants had management and oversight roles within their programs. Most were involved in policy development and provided technical expertise and training to the inspectors in their programs.

The number of facilities inspected and the number of inspections conducted annually (both food and recreational water) had a wide range.

- Food inspection facilities: 1,100 – 36,000
- Food inspections annually: 1,600 – 80,000
- Recreational water facilities: 80 – 8,500
- Recreational water inspections annually: 600 – 9,700

All of the key informants reported the use of an electronic system to record inspection data; however, not all inspectors within the jurisdictions collect data at the point of inspection. The interviews found a mix of paper and field data collection. In all jurisdictions, data input is the responsibility of the inspector. When asked about their system's ability to share data electronically, half of the key informants responded that their system did have data sharing capabilities.

Key informant interviews

The role of the key informant phone interviews was to expand upon the key findings from the electronic survey and to map out the food and recreational water inspection processes. Additionally, the key informants were asked about their successes and challenges when conducting inspections.

Inspection processes

At a high level, the process steps for conducting a food inspection are similar to conducting a recreational water inspection (see Appendix A for the detailed task flow diagrams). There are several inspection types defined for both food and water inspections including:

- Planning/plan review (prior to operation)
- Training
- Routine
- Reinspection/follow-up (downgrade)
- Complaint

The most common type of inspection is a routine inspection. Most routine inspections are typically unannounced, except for inspections that are for follow-up or for a reinspection. The timing of both food and recreational water inspections varied across the key informant jurisdictions, with some routine inspections occurring once annually while others were conducted twice annually. One jurisdiction reported that routine food inspection timing was determined by facility risk type. For all jurisdictions, both food and water inspections were organized geographically, mostly at the county level. In some cases, multiple inspectors may be assigned to work together when inspecting specific facilities.

Both food and recreational water inspections are risk-based, with the inspector reviewing the areas of highest risk first. Food inspections focus on the five risk factors for foodborne illness:

1. Poor personal hygiene
2. Food from unsafe sources
3. Improper cooking temperatures/methods
4. Improper holding time and temperature
5. Food contamination

For water inspections, the focus is on imminent health hazards, facility safety and water chemistry.

At the end of the inspection processes, the inspector discusses the report and any violations with the facility's point of contact. Food facilities receive a grade, typically A, B, C or "closure." Recreational water facilities typically do not receive a grade, but can be closed if necessary.

A scientist prepares water samples for bacterial analysis.
Image credit: Dean Calma and IAEA

The key informants discussed challenges with their inspection processes including:

- Distance of inspection facility from the inspector's office (sometimes two or more hours away)
- Difficulty in conducting inspections in tourist areas with high traffic
- Issues with point of contact/operator information being up to date
- Lack of standardization across inspectors and how inspections are conducted
- Potential data quality and timeliness issues due to inspectors entering paper inspections into the system after returning to home base

Information systems

All of the key informant jurisdictions utilize an electronic information system to capture inspection data. There are a variety of systems in use including Envision Connect, Digital Health Department, PatTrac and some home-grown software solutions. Inspection data are mainly input at the point of inspection. However, some of the jurisdictions use a combination of paper data capture as well as electronic. Additionally, some jurisdictions upload pictures of areas inspected into the facility record. In most cases, electronic data must be synchronized or uploaded into the system database once an inspector reaches their office or home office.

The key informants discussed challenges with data capture and more generally:

- Time consuming to upload/synchronize data after data entry
- Poor connectivity/internet issues
- System that is outdated/not user friendly
- Technology not consistent across the health districts within the state
- Budgets and funding/purchasing cycle inconsistent across the state

- Implementation of a new system and the associated pain points, i.e., getting staff used to the new system and how different it is
- Issues with capturing an electronic signature (especially during the pandemic)
- Lack of standardization across the state for data entry (e.g., online vs. paper), which affects data quality and how up to date the data is in the system

Data sharing

When asked about sharing data electronically with both internal and external partners, all of the key informants indicated that they did not currently share data via their systems. However, most key informants indicated that their systems have robust reporting capabilities and that data were often shared via the generation of reports. Common reports that the key informants run include:

- Follow-up listings of which facilities need to be reinspected because of a violation or downgrade
- Open consumer complaints
- Violation/downgrade listing
- Inspector productivity/workload analysis
- Facility's last inspection listing (used for prioritizing facilities to be inspected)
- Inspection duration based on inspection type (helps with predicting staff levels/requirements)
- Inspection data for tracking foodborne illness outbreaks

Although data are not directly shared via electronic means with jurisdictional partners, all of the key informant jurisdictions (with the exception of just one) allow the general public to access inspection data via a web portal or mobile application (see Table 3).

Table 3. Public access to inspection data

Jurisdiction	Inspection site address	Comments/ details
Georgia	https://ga.healthinspections.us/stateofgeorgia/	Online portal
Southern Nevada	https://www.southernnevadahealthdistrict.org/permits-and-regulations/restaurant-inspections/restaurant-inspection-search/	Online complaint system and mobile application
Riverside County	http://restaurantgrading.rivcoeh.org/	Online portal
Maryland	N/A	Inspection data available upon request
Virginia	https://inspections.myhealthdepartment.com/virginia/districts	Inspections separated by health district

Other challenges

In addition to process and system challenges, the key informants discussed the challenges associated with the COVID-19 pandemic including:

- Loss in revenue both for inspection fees and violation fees
- Environmental health inspectors being asked to enforce COVID guidelines, which are out of scope
- Loss of staff
- Inability to capture point of contact signatures on inspection reports (must utilize email responses)
- Additional guidance and training needed for inspectors to manage changes during the pandemic
- Some inspections conducted in a virtual environment, which is not ideal

A health inspector takes samples for testing at a restaurant as part of a routine inspection.

Business process analysis

Understanding how existing processes typically function

The current state processes were developed based on key informant interviews and the virtual workgroup meetings. The processes were reviewed by the project team, NEHA, CDC and the key stakeholders. The project team utilized two tools for mapping the environmental health business processes, namely the business process matrix and the task flow diagram. The business process matrix is a text-based tool that allows for an "at a glance" view of the business process. Task flow diagrams are graphical tools that show the activities of the process in a linear fashion. The diagram represents who participates in the process, what types of information are exchanged, and how the work is accomplished. See Appendices B and C for the business process matrices and task flow diagrams for the in-scope environmental health processes. Table 4 lists the in-scope processes and their objectives.

Table 4. Environmental health business processes

Business process	Process objectives
Prepare for inspection	To identify facilities for inspection (food and recreational water) based on jurisdiction business rules
Conduct inspection	To conduct environmental health inspections (food and recreational water)

One of the decisions of the key informants during the virtual workshop was that the "conduct inspection" process covers both recreational water and food inspections. Initially, the inspection process was broken out into two separate processes, but after review by the project team and other stakeholders, the two were combined.

During the virtual workshop, the key stakeholders created a parking lot of points relevant to environmental health inspections that were out of scope for the project. These items, listed below, should be considered as efforts to develop best practices for inspections go forward.

- Review existing data standards, e.g., LOINC, HL7, NSFDX, etc., to determine how data standards for environmental health should be developed.
- The current state processes do not address specimen and laboratory testing; this should be considered in the next iteration of business process analysis.
- Consider standardizing risk levels/categories for food and recreational water facilities.
- The current state processes do not address the financial component of inspections, including fees and penalties; this should be considered in the next iteration.
- Consider how environmental health processes integrate with existing public health data flow and architecture in building best practices for data standardization and sharing.
- Continue investigating how inspection data are reviewed and approved prior to posting to public facing websites and portals.

Business process analysis recommendations and next steps

The virtual workshop uncovered several recommendations and next steps for understanding environmental health business processes.

Complete the current state business process analysis. This project outlined two key business processes for environmental health inspections for food and recreational water. These two processes do not represent all of the work that is accomplished by environmental health inspectors; additional discovery and analysis of current state processes is needed. In addition, the two processes identified in this report should be reviewed by other jurisdictions for their input.

Redesign the current state processes to represent best practices. The current state processes and additional recommendations from the project key stakeholders should be reviewed in more depth in order to develop future state processes that represent best practices for environmental health inspections. The redesign should include a representative sample across state, local, territorial and tribal jurisdictions.

Develop model standard operating procedure documentation. Standard operation procedures (SOPs) based on best practices and the redesigned processes should be developed. The model SOPs will allow for jurisdictions to modify based on their individual needs.

Recreational water being tested to measure silica

Image credit: Marco Verch

Standardization pilot results and best practices recommendations

Key workshop findings

Categories of data processes and systems

The objective of the two-day virtual workshop was to discuss and assess the data processes and systems among the jurisdictions and identify three phases needed to characterize the continuum of progress jurisdictions may go through as they undertake this work.

Phase 1

- Paper and pencil field data collection/multiple points of data transfer
- Minimal data entry quality controls
- Manual cleaning of data
- Multiple points of data collection, entry and transfer
- Data fields not yet standardized

Phase 2

- Electronic field data collection
- Defined data fields and data types, including a data dictionary (a set of information describing the contents, format and structure of a database and the relationship between its elements)
- Data required to be synchronized or uploaded into the system database once an inspector reaches their office or home office
- Reports available to the public
- Data systems siloed and restricted data sharing
- Some analysis of the data

Phase 3

- Automatic synchronization from electronic field collection to database
- Integration of data from other sources, e.g., pictures, GIS information, etc.
- Automated data cleaning and reconciliation
- Custom reports available to the public; ability for public to query data
- Share data across systems
- Data sharing agreements with other agencies
- Use of data to analyze, interpret and drive actions; real-time insights

Process and system challenges for food and water inspections

During the virtual workshop, participants were asked to reflect on the defined phases and consider where they would place their jurisdiction. Most participants felt their authority is currently in Phase 2, and all participants indicated their jurisdiction is working toward Phase 3. Several themes emerged as the representatives of the jurisdictions reflected on the challenges encountered when they started to standardize their inspection data and create data processes and systems to collect, maintain and share inspection data. These experiences and challenges are summarized in the following sections.

Moving from Phase 1 to 2

Jurisdictions encountered a variety of challenges when they first started on this work, including:

- Lack of vendor solutions from the beginning

- Lack of vendor knowledge of environmental health data
- Resistance to change within the Environmental Health Department
- Lack of documentation and data dictionaries in homegrown data systems
- The demand on time and resources demanded by changing over to electronic systems
- Lack of trust in sharing data
- Reduced demand for environmental health data

First, there were limited options for electronic systems when this effort began in these jurisdictions well over a decade ago. For instance, one participant expressed large software developers were not interested in developing data systems for the environmental health workforce. For those vendors who did work in the area, it was apparent that there was a general lack of vendor experience, especially with the environmental health field specifically. For example, there was little knowledge of what environmental health data encompassed, which created a steep learning curve for the vendor to work with and develop a system for data. Equally, there was a learning curve for the jurisdictional environmental health staff to learn how to use these new data systems.

Related to the data systems that were available at the time, jurisdictions found they needed system functions that were not readily available. Systems had to be built from the ground up. These "homegrown" systems came with their own set of challenges. The maintenance and underlying knowledge of how these systems work and how data can be shared and stored in that system were often not well documented. In many instances, there was no data dictionary, and the working knowledge of the systems existed informally within a few key staff. With an aging workforce and staff retirement and turnover, knowledge of the data system was at risk of being permanently lost. One individual stated, "it's hard to think about how to move the current system or build one on moving to the next phase when we don't, at a fundamental level, understand how the current systems function on its own."

The shift from paper-based inspection data collection to an electronic system takes time and resources. As one person shared, it took their jurisdiction nine years to roll out their information and data system. In another jurisdiction, there was a lack of time and resources for database development and testing. This, combined with both the jurisdictions and the vendor's inexperience with the work, made the process tedious and more complicated than it had to be.

There was still a lack of trust among health department staff in collection and security of data. Building trust with other agencies is essential because, as one person at the state level suggested, some local jurisdictions are hesitant to share their data with the state and have concerns about consequences for not doing something right. There are also concerns that the data would be used to monitor staff work and performance.

Lastly, there is always a general resistance to change. In one state, it is difficult to get user and jurisdictional adoption because they have a choice as to whether they want to implement an electronic system or not. In another state, the lack of buy-in from within their organization created challenges to

"It's hard to think about how to move the current system or build one on moving to the next phase when we don't, at a fundamental level, understand how the current systems function on its own."

get the work done to move the jurisdiction forward in the process. On a larger scale, there has been a lack of interest in public health operations for environmental health data. With decreased demand came a little need to invest time and resources for a more systematic approach to collecting, storing and using inspection data.

Lessons learned from Phase 1

From the many challenges in Phase 1 came several lessons learned. Having a dedicated person to act as the liaison or a program person on the data system development team is imperative.

One of the local jurisdiction participants indicated that when they updated their legacy system from 2003, a significant change occurred. Now one of the new core tasks of their division is to act as the business liaison between information technology (IT), be it a vendor or internal IT, and the programmatic staff. The environmental health data and IT language are aligned and translated for the other side in practical and meaningful ways. Also, understanding what testing needs to be done to improve the system is an essential competency for both sides.

It's important to "have the right people on the bus," as one participant explained. "The driver does not have to be the expert in all of it, but the project manager should have a general understanding of both." This process needs to be approached as a collaborative project with dedicated staff and a dedicated project manager to keep the momentum and deliverables on track.

And lastly, although environmental health data standardization and modernization may lag compared to other fields, there is great potential for how environmental health data are collected and used. As one person stated, "When you make data public, you create the demand."

"When you make data public, you create the demand."

Moving from Phase 2 to 3

As mentioned before, all the participating jurisdictions placed themselves in Phase 2 and are working toward Phase 3. Some of the challenges mentioned in Phase 1 are still evident; however, others have been resolved with new technology and expanded knowledge over the years. And still, new challenges occur as jurisdictions make progress.

First, the interaction with vendors has improved. Vendors better understand the needs, as they work together with environmental health partners, and some vendors even have specialists in environmental health. With this knowledge and understanding, vendors can meet the needs and customization requests of environmental health clients to administer more efficient and useful systems. One person described, "We don't speak computer language, and they don't speak inspection language, so that has been a barrier with trying to communicate. We have gotten better at that."

At the same time, there remain barriers to vendors and data access. Several jurisdictions explained many vendors do not give them immediate access to the raw data. In one jurisdiction, they explained that there are extensive "hoops" to jump through to retrieve the data. In some cases, it has taken up to six months to gain access to certain datasets. Security clearances and approvals also contribute to a delay in access. Another jurisdiction identified a common misconception that, as a public health agency, all the data are protected under the Health Insurance Portability and Accountability Act (HIPAA). This adds confusion about validation and security

measures for each piece of data, when in fact, most environmental health data are public record.

Some solutions shared by the jurisdictions to move toward Phase 3 were described:

- There is a need for a standardization of business processes across jurisdictions and a requirement to use a centralized data system.
- Increased awareness and understanding that the field client software data systems are very large is essential. Collecting and storing inspection data on a mobile tablet is not always possible and makes synchronization difficult.
- A data dictionary is essential for data integration, as is an entity relationship diagram (ERD) to know where data connect in the database.
- Data integrity is connected to data entry. For example, jurisdictions recommended specifying fields and not allowing open comment fields, but rather, using selection lists on the front end to minimize data cleaning on the back end.
- Data analysis tools are effective and beneficial to analyze and interpret data; however, knowledge of what is in the data dictionary and how tables are structured is still necessary.

Standardization of data processing for inspections

In the following sections, challenges, lessons learned and recommendations are summarized for each identified component of data processing and using data to drive actions and decisions. The standardization of data processing for food and water inspections has been divided into the following components:

- Standardization of data collection
- Data standardization and validation
- Data storage
- Data analysis

For each component, jurisdictions shared challenges and lessons learned. This information is summarized and then followed by best practice recommendations from the field for each component.

Standardization of data collection

Definition of data collection

The standardization of data collection refers to ensuring data collection is internally consistent, and that data have the same content and format. For example, the inspection data collected should be consistent across inspections; that is, all field inspectors are collecting the same type of data and information. Furthermore, the data fields should include the same content and format. A simple example is how a date is entered. The date is a common data element collected, but it also needs to be entered in the same format consistently. This is critical when considering surveys, applications and reports.

Standardization of data collection: challenges

All the participating jurisdictions utilize an electronic information system to capture inspection data. There are a variety of systems in use, including Envision Connect, Digital Health Department, PatTrac, as well as homegrown software solutions. Inspection data are mainly input at the point of inspection; however, some of the jurisdictions use a combination of paper data capture as well as electronic. The challenges and barriers with data collection standardization mentioned by jurisdictions included:

- Data collection methods inconsistent across state or local jurisdictions
- Challenges in the field with weather and heat, internet and bandwidth, and electronic hardware (e.g., laptops and tablets)
- Security measures for data that fall under HIPAA
- Data synchronization
- Limited local storage of data
- Data entry not standardized and is inconsistent

First, within a single state, jurisdictions may use a multitude of different systems and processes. For instance, in one state, some jurisdictions collect inspection data on paper. Some have a field client that is an iteration of the database on the laptop and is synchronized daily, but they do the data entry in the field. Some jurisdictions are dynamically connected to the database and working in the field using hotspots. Another state has the option to work offline and upload the data while back at the office. Interviewees explained there is an app they could use in the field, but the problem is it needs special approval because it's not a state-approved app. Because use of the app requires pre-planning and a different workflow that requires more user acceptance, it just is not used. And some jurisdictions simply prefer to collect data on paper, but as one person noted, for those that do data entry in the field, the user acceptance of it is high.

There are practical challenges when collecting data in the field and using an electronic system. Connectivity, internet and bandwidth issues in the inspection field are commonplace. In one state, 70% of the state is rural, so this is a significant challenge. Also, inspectors do not control the environment in which they are conducting an inspection, and the type of hardware they use may not be conducive to the environment. For example, LCD screens are invisible in sunlight, and this impacts pool inspections. In high heat, tablets, laptops and batteries overheat. "It's a significant hindrance in the field to worry about hardware," said one person.

In theory, using a field client is the gold standard, but many complexities make this challenging to implement. For example, issues arise when you have a system with local storage and multiple users. It's considered bad practice to have data elements like complainant disease investigation data as part of the system because of HIPAA restrictions for physical control of the data. Because storage on the laptop needs to adhere to the HIPAA requirements and be secure, one state pulled this type of information and financial information off the field client system.

Another issue is the size of the database. In one state, over 16 regulatory programs reside in the single state database. This impacts synchronization of data. For instance, if users don't synchronize regularly, the data become too large to synchronize, and at that point, the jurisdiction must work with the vendor and conduct a manual data upload and reinstall the field client. Similarly, others have experienced barriers with limited database storage and a system that didn't save or sync data because there was not enough storage space, and the data was lost.

Considering these challenges, one individual expressed that a paper option to collect inspection data cannot be eliminated. The need for paper as a backup was reiterated by most jurisdictions. Another person shared in their state, they do use an electronic field-based data collection, but every inspector also carries around paper forms because there are always certain situations where you just can't use electronics. Another state is working on a Salesforce interface, but given the complexity of inspections, finding a system that works well consistently and does not have data loss is very challenging, so they are often forced to still use paper.

Data entry issues, data incompleteness and lack of data collection standardization are common issues. For example, a common issue is inconsistency in the formatting of how basic information (name, address, etc.); in jurisdictions without collection standardization, some users may enter these data elements fully capitalized, while others enter it entirely lowercase, and others still use sentence casing, etc. This inconsistency creates challenges for looking up and relating data. Without knowing in advance exactly how a data element was entered, a user will be entirely unable to retrieve it from the system. Recommendations to improve data entry include:

- Create input mask (string expression, defined by a developer, that constrains user input).
- Utilize standardized "canned comments" that inspectors can choose from, so inspectors don't enter free text. This helps to standardize how inspectors write a violation.
- Develop standards documentation. For example, one jurisdiction developed a violations standards document with corrective actions. Each program is provided with a book with a map that details what a violation looks like, what the appropriate corrective action entails, and exactly how to write it up.
- Designate one person in IT who is dedicated to helping field staff with issues that occur in the field with the data system.
- Use drop-down options when appropriate.

The standardization of data collection has obvious benefits, especially when the data is entered into the system itself. The jurisdictions mentioned the following advantages to data standardization:

- Near-live posting of inspection data provides data assessment of what is happening across the state.
- No delay with data entry helps determine workload issues or resources and preparation for workforce training.
- During and after the inspection, everyone is on the same page, and the report is done when the inspector leaves the facility.
- If the system user ties the data to a public interface, then members of the public can go look at the most recent restaurant grades or see recent inspection reports.
- Those tasked with data entry don't have to read handwriting.
- It saves paper and administrative time to enter data directly into the system.

Best practices for standardization of data collection

The best practice for food and water inspection data collection is to have an electronic data system with automatic synchronization from an electronic field collection to a database. In addition, the use of input controls to help standardize data entry is crucial.

A standardized approach to food and water inspection data collection starts with an electronic data collection system. Inspection data will be most effective if collected and stored in a standardized, electronic format that is timely, accessible and compatible with other technology platforms, and that allows for the user to query the data. This approach will significantly increase data accuracy and data access, reduce human error, and improve reporting capabilities. Automated data upload to a database is an ideal practice. The use of tablets in the field is conducive to real-time information sharing, particularly for the facility if the inspector can give a printed or electronic version of the report immediately. In addition, current data can be accessed for consumers and other stakeholders to see.

Best practices for data entry, whether electronic or manual, are imperative to the standardization of data collection. Data entry should be complete, accurate, consistent and timely. One important step is to determine how missing values and information are documented. Jurisdictions must identify processes

and procedures to ensure data entry quality, such as use of a data entry log, methods to detect errors early, double key entry verification for manual data entry, and use of data validation rules.

To address some of the barriers to electronic inspection data collection, jurisdictions should:

- Identify the right technology to meet their needs.
- Use systems that upload data automatically and dynamically during the point of inspection and have a function to store data for upload later when internet connection is unavailable.
- Be cognizant of the equipment and hardware needs of inspectors in the field such as non-glare screens, equipment that can withstand heat exposure, etc.
- Always have paper forms available as a backup.
- Provide adequate training to inspectors to utilize electronic inspection data collection systems.
- Develop protocols for electronic data uploads to include when and how to upload the data.
- Establish goals and standards for data entry.

Data standardization and validation

Definition of data standardization and validation

Data validation is the process of checking that the data provided are valid and complete to ensure the integrity of the data. This is a check to make sure existing values fall within the valid parameters for the data field. Data validation can happen at the point of data entry. A simple example is a temperature field. If the value falls outside of what you might define as realistic temperature parameters (e.g., an ambient outdoor temperature of 160 degrees Fahrenheit), then you can assume the data is incorrect. Additional examples include data type (integer, float, string), range (a number between 35-40), uniqueness (inspection ID), consistent expressions (using one of St., Str. or Street), and no missing or null values.

Data standardization and validation: challenges

Building on what was discussed in the previous section, just as imperative as the data collection and data entry processes are the checks and balances in place to ensure the data are standardized and valid. The jurisdictions shared experiences about what happens when this is not in place to illustrate the importance of this component.

- One person shared an experience of working on a project using a state geological survey to standardize well water data as a pilot test in a jurisdiction. It was a homegrown database, and the data fields for water chemistry were text fields with no data checks and no standardization. Data for 1,000 different wells were pulled and it took the jurisdiction two years of data cleaning before they had a standardized dataset.
- A local jurisdiction did not put a limit on negative numbers, which caused issues with their data validity.
- In one state, the drop-down values or labels were not interpreted or understood the same across the state. "Interpretation of data entry. That impacts the data entry standardization and validation." This state is developing a job aid and working with the database and the program staff to include definitions and scenarios for when a user would choose a certain option from a specific set of answers.
- In one local jurisdiction, the staff was regularly delivering reports missing important data fields that are required, like dates and times, temperatures or the type of inspection. IT helped to make these required fields that must be filled out; the system now will not save the report if these fields are left blank.
- A state jurisdiction went through 12 different conversions to roll its new system out. "Migration and database conversion is when you feel lack of standardization and validation the most," a participant shared. When moving data from an older system to another, it is important to have data integrity.

As one person put into perspective, "What we are dealing with is chasing this afterward, and we need to figure this out on the front end first. Otherwise, you will fight it later." Some specific suggestions to improve data standardization and validation include:

- Make sure data fields and ranges are accurate. For example, use full dates to avoid "time traveling," or for longitude and latitude make sure the positive and negative values are correct.
- Use pre-defined comments for violations that are editable, so the field is populated by a standardized choice, but the inspector also has the option to write free comments to describe the situation in more detail. This provides some consistency in the framework in how a system user makes and documents a comment, while also allowing for additional qualitative data.
- Engage system users to determine how to set up a new system. For example, one state engaged about 70 users across the state and formed a transition team to identify and incorporate validation rules when designing the new system. For example, open text fields were kept to the bare minimum except for the comments box and ranges. Since this is a statewide system, there has been a lot of improvement in data quality.
- Ask who controls limitations for data entry. Don't have the vendor control what is in the selection list but have the environmental health agency control what's in the selection list. Decide on who is going to control and manage those limitations for data entry early on.

Best practices for data standardization and validation

As jurisdictions adopt a code, such as the FDA Food Code or the Model Aquatic Health Code, a standardized inspection form should be developed. Additionally, the version of the code should be noted in the data dictionary along with the acceptable ranges for each field. This will help to eliminate confusion when comparing data over time and as ranges change. The electronic inspection data collection system should be aligned with this form (and a paper form should be available). Utilize the code for the inspection form and ensure there is a consistent scoring methodology for the inspection data collection.

At the database level, make sure controls are in place for data validation. These checks can occur at the point of data entry or after quality data checks. It is essential to find and recognize inconsistent entries. Automated validation may help guarantee data is acceptable, but it does not check the data for being meaningful or correct. So, it is important to create additional procedures for data validation and standardization. These procedures could include validation rules, validation constraints and routine data checks.[1]

- Create validation rules to identify data errors for correction.
- Flag when a value is outside the min/max range to alert to a potential data quality problem. Then routine data checks show all the data entries that have been marked for follow up.
- Create rules for missing data.
- Use uniform violation categories/ types.
- Run integrity checks to remove duplicates and identify non-valid fields and cells.
- Run analyses to identify gaps and outlier values. There are different methods to identify non-valid cells; here are a few to consider:
    - Clustering involves grouping similar values and applying changes only when applicable. This process shows unique values, and if misspelling occurs, for example, it would be easy to visualize.
    - Patterns are used when the entered value needs to follow a format. For example, US

[1] For more on data collection principles, see Conducting Mobile Surveys Responsibly, a field book from the World Food Programme in collaboration with the International Data Responsibility Group and the Leiden University Centre for Innovation.

ZIP Code is a sequence of five numbers, and a U.S. Phone is ten numbers. Usually, the best way to enforce good patterns is by validating the value entered in the software used to record the data.

  - Ranges and domains are set, so any other value is not allowed. Recommendations include providing a list of inspector names and allowing only the names from the list, or using uniform violation categories. Set ranges in which the data must fall, such as a temperature range.

- Conduct data checks for correct data range, type (e.g., date, number, state), length (e.g., a password needs to be eight characters long), format (e.g., the date is MM/DD/YYYY), and check for required fields that cannot be left blank.
- Track and document all data issues so recurring issues are identified to help ensure proper preventive measures have been applied.

Data storage

Definition of data storage

Data storage refers to how and where the data are stored. This could be a centralized database, web-based, or cloud-based, and hosted internally or externally. Data can be stored in one centralized system or multiple databases. Data storage and the technology used impact access and reporting capabilities for secure data access and exchange. Examples include software-defined storage, cloud storage, network-attached storage, object storage, file storage and block storage.

Data storage: challenges

There are many challenges for jurisdictions associated with data storage. One person summed it up well: "Public health agencies have not been at the forefront of data management, so it is challenging for us as agencies to maintain robust data systems with robust failover data recovery, etc. While this may not be universally true, it is a common experience among myself and peers." Other challenges referenced by the jurisdictions include:

- Production database and issues running extensive reports and analysis
- Disaster recovery planning and processes
- Lack of experience with business intelligence (B.I.) tools and analysis
- Systems not connected to B.I. tools
- Poor data export capabilities
- Hidden costs

In discussions about cloud-based data storage versus a centralized data storage system, jurisdictions used both. According to one jurisdiction, agencies need to have a robust service level agreement in place, backup controls and disaster recovery plans, whether they are centralized or cloud-based storage. One person shared that in terms of accessing the data and production needs, one is not necessarily better than the other. Still, it rather depends on the software systems, what the user is trying to do and the vulnerabilities to production problems. It comes down to if the benefits outweigh the negatives for an agency to own their data vs. keep it in the cloud.

A centralized, SQL server database used in one state has many benefits, including being a one-stop-shop, and only one set of IP addresses need to be "whitelisted" with the IT department (white listing allows you to create lists of trusted IP addresses or IP ranges from which your users can access your domains). However, if the production database is used for data analysis, there are often issues with production capacity for a report. For example, using business intelligence (B.I.) tools or refreshing a page in a way that generates multiple queries can decrease the production capacity, slowing down the entire server with competing demands. A suggestion to avoid this slowdown is to have a mirror capacity/copy of the production system to access for analysis, which will not impact the user experience. In a different state, they use a vendor-supplied cloud-based system for the restaurant and

food inspection data, and the vendor did create a mirror system. Still, access is limited to data analytics only.

Another challenge is related to B.I. tools. As explained by one individual, "across environmental health, the general profession, data analysis is not our core competency. That is a huge pitfall. It's also not a core interest." This creates a gap for the environmental health workforce to utilize the system and tools to the full extent. There needs to be competency at the local level. Comparably, another state needs better access to secondary data analysis tools within the agency. The agency is working toward standardizing the tools and data sources, but staff can only use agency-approved tools.

Furthermore, the data collection and storage system itself is not connected to B.I. tools and has dismal exporting capabilities. To make data-informed decisions, being able to export data in the correct format would benefit the process—for example, using ArcGIS or another standardized tool for analysis and conclusions. If these capabilities were in place, "people would be more willing to use the data, which in turn improves the data quality."

A common issue raised by several jurisdictions related to data storage is the cost, specifically the hidden costs. Cost is significant, and if the system has been developed internally by the IT department, there are hidden costs that are not explicitly accounted for because they are considered "in kind." This makes it difficult to understand the actual cost of these systems, especially for planning purposes when it needs to be accounted for in a budget. About grant RFAs, one person said, "federal agencies that fund IT-related activities need to become much more explicit about allowing specific IT items as part of the grant cycle. Often it is considered an indirect cost, but they are no longer indirect costs in many cases."

Best practices for data storage

To provide access to food and water inspection data for consumers, regulators, industry and other stakeholders, the platform in which data is stored plays a critical role. Jurisdictions want to develop a centralized electronic database, whether web-based or cloud-based, with controlled access for inspection data. Ideally, the electronic data system will update when there is a new entry from a field application (e.g., tablet) and conduct automated updates and uploads on a regular basis. Jurisdictions need to maximize the workflow for inputting the inspection data in the system, set timelines and deadlines for data uploads or data entry and identify a person responsible. A data dictionary is an absolute necessity as it contains information vital to understanding the database including what is in it, who has access, and where it is stored. Data should be stored in a safe and secure location, whether it's electronic or paper.[2]

Some specific safeguards to secure stored data include:

- Ensure third-party providers abide by an agreement.
- Use a two-step or multi-factor authentication for database access.
- Group users by specific privileges depending on their role, such as read-only access, read/write access or editing privileges.
- Access revocation is conducted when needed (i.e., turning off access when people leave a program/job or should no longer have access).
- Follow guidelines from the jurisdiction and general best practices for the storage of sensitive and private data.

[2] For more information on securing cloud data, see How to Secure Private Data Stored and Accessed in the Cloud, a guidance document from the Principles for Digital Development.

- Monitor implementation of processes and procedures for data storage and create policies for data management.
- Provide professional development to identified staff responsible for database management or liaison to IT or the vendor.

Data analysis

Definition of data analysis

Data analysis, in the context of environmental health inspection data, is conducted to track trends and measure results to make decisions. Data analysis goes beyond descriptive metrics (e.g., descriptive analysis, inferential analysis, diagnostic analysis, predictive analysis) to provide data that are timely, accurate and actionable. When possible, to achieve a comprehensive picture, jurisdictions can integrate datasets and use other data sources for data-driven decisions.

Jurisdictions conduct data analysis for several purposes:

- To assess performance and productivity, using metrics such as number of closures, number of downgrades, field time, etc.
- Outcome-based analysis; for example, a jurisdiction uses risk factor analysis combined with whether a facility needs to be inspected one time or four times in a year based on the outcome of inspection (number of violations, etc.). This analysis helps to develop a focused training program for those with multiple violations to improve their awareness.
- Quality improvement
- Determine return on investment
- To understand real-time data, which takes specific activities to inform staff resources

Data analysis: challenges

According to one individual, there is limited interest and competency in the environmental health workforce to conduct data analysis beyond the standard quantitative metrics mentioned above, such as counts. Examining a data indicator such as inspection durations, by results, locale, business model, etc., is conducted on occasion. But most jurisdictions have not gotten into more advanced analysis, such as predictive analysis. "Slicing and dicing it by all these different things," as one interviewee put it, is very advanced. External factors play into the predictive analysis (number of sidewalks nearby, weather on the day in question, etc.) that make this type of analysis challenging.

Another challenge is the ability to efficiently analyze data stems because of the way data are stored and how queried results are returned. Sometimes additional time and expertise are needed to clean data before it can be used in a GIS or statistical program. Ensuring that the data storage structure meets these types of data analysis needs in terms of importing data into other analysis programs is important to keep at the forefront s to minimize the need to clean/manipulate data.

A specific challenge for a state jurisdiction is the buy-in for their state-level data analysis. Because they collect statewide data and share these results, the leaders of local health districts are hesitant to share their data for research or be compared with other jurisdictions. Lastly, the most significant challenge with data analysis, according to one person, is the time, capacity and knowledge of environmental health staff to perform the data analysis activities.

Best practices for data analysis

The analysis of inspection data falls mainly under two categories. The primary analysis of inspection data is used to gather metrics for such things as ascertaining the type of inspection, number of violations, type of violations, number of inspections conducted and other counts of interest to a jurisdiction. These data are often reported to leadership, used for performance metrics, used to determine staff needs and FTE, etc.

A holistic approach to data analysis includes reviewing inspection data to identify trends, make changes to the program, develop interventions for jurisdictions, and develop policies and practices. Many of the activities and target outcomes of the CDC Data Modernization Initiative are grounded in quality analytics.[3] The following are actions jurisdictions should aim for described in the Data Modernization Initiative Roadmap:

- Recruit and train workforce in data science, analytics, modeling and informatics
- Quickly analyze, interpret and act on data
- Translate data into actionable recommendations
- Use modeling, visualization, predictive analysis and forecasting

One of the challenges mentioned was staff capacity related to data analysis. Strengthening the workforce in data science is also addressed in the CDC Data Modernization Initiative. Considering this is at the forefront, jurisdictions should pay special attention to building the capacity of their workforce in this area. A needs assessment to identify staff needs and opportunities to strengthen staff data skills is the first step. As outlined in the Federal Data Strategy 2020 Action Plan Improving Agency Data Skills,[4] an assessment to identify gaps in data skills includes the following steps:

1. Identify critical data skills needed for the agency.
2. Assess the current staff capacity for those data skills.
3. Perform a data skills gap analysis to prioritize the agency's needs.
4. Identify and execute approaches to fill those needs.

Data-driven approach to food and water inspections

The data-driven approach for food and water inspection data has been divided into the following components:

- Data-driven approach to inspections
- Data sharing among internal and external local, state and national agencies
- Data sharing with consumers
- Integration of external data

Data-driven approach to inspections

Definition of data-driven approach to inspections

A data-driven approach to inspections involves making strategic decisions based on data analysis and interpretation. A data-driven approach enables organizations to examine and organize their data to serve their constituents with more efficiency better. An example is determining routes for inspections by region or location using mapping.

Data-driven approach to inspections: challenges

Jurisdictions are using inspection data to inform decisions but to a limited extent. A common approach is to use inspection data to determine when a facility is due for an inspection.

- Facilities that receive a grade of A are usually at the bottom of the priority list for inspection, while facilities that have more downgrades are of higher priority to visit more frequently.
- The highest priority facilities to be inspected in one state are determined by the amount of time since the facility was last inspected and staffing for the inspection. There is not enough staff to do all the inspections, so prioritization and modification of inspection frequency based on data are essential.

[3] See the CDC Data Modernization Initiative.
[4] See the Federal Data Strategy Improving Agency Data Skills Playbook.

- To provide some randomization to inspections, the time of day of past inspections is proper. For example, chlorine levels go down throughout the day from sunlight and people, so the time-of-day pool inspections are important to consider when planning for the next inspection.

In one state, some districts use data for planning purposes, but it depends on the environmental health manager's interests and the resources they have. "People aren't asking questions to jumpstart this type of approach. [They] need to come up with ideas for using data more creatively" said one representative from a state jurisdiction. For instance, a group at the state level in a jurisdiction did some pool data analysis. The group used this information for a grant application to create education and training materials to prevent deaths. A local jurisdiction, similarly, looked at data on drowning and accident investigations to determine where they were occurring for adults. The state used the data and plotted the locations on a map, and decided the incidents were happening at apartment complexes and resorts. This information drove new policy recommendations for the risk manager at these resort properties to improve training, signage, lifeguarding plans, etc. "Starting with these data is very important."

Best practices for a data-driven approach to inspections

Using data to drive decisions is tied strongly to the quality of the data collected, the accessibility of the data, and the data analyses conducted.[5] Data-driven decisions based on inspection data have an impact on the facility owner as well as on regulatory practices. Real-time communication of inspection results increases the awareness of facilities of the results so they can remediate critical violations and other inspection outcomes promptly. For jurisdictions, inspection data can be used to decide how to allocate resources, optimize the quality of inspections, better manage poor-performing establishments and improve public health. Included in the CDC Data Modernization Initiative is the goal to use data to promote proven behaviors, interventions, and solutions to protect the health and well-being of communities.

An example of this in action is Chicago's pilot to build a municipal open-source, predictive analytics platform to predict food inspection outcomes.[6] The city used food inspection reports, 311 service data, weather data, and the city's open data portal for pulling community indicators for the predictive analyses. The analytics team was able to detect establishments with critical violations earlier using the predictive analyses model. A data-driven decision based on these data includes having inspectors visit the facilities identified by the predictive analyses. By doing so, the city was able to detect violations earlier, and additional establishments with violations were found. This example illustrates how advanced analytics can drive decisions for practices.

An innovative strategy by the city of Boston is using social media and yelp reviews to predict violations.[7] As part of a competition, the city developed an algorithm using Yelp reviews, which was later studied by a researcher who found the algorithm detected 25% more health violations while also discovering around 60% of critical violations earlier than before. Using existing inspection data and combining it with new data sources (e.g., Yelp reviews), the city has been able to catch risks sooner and use this information to allocate appropriate public resources.

Another example is the Denver Public Health Inspections division. This division conducted an analysis of their inspection database focusing on

[5] See 10 Steps to Creating a Data-Driven Culture from the Harvard Business Review.
[6] See this summary of the Chicago pilot.
[7] See the page of the now-closed contest, which includes a description of Boston's winning entry.

information related to complaints, contact information, inspections scheduling and violation tracking.[8] The analysis revealed large caseloads per investigator and cases that remained open for an extended time. These data were the catalyst for changes in practices and policies which resulted in closed cases, reduced re-inspection rates, and ultimately reduction in the caseload for investigators and more focus on enforcement consistency.

Data sharing among internal and external local, state and national agencies

Definition of data sharing

Data sharing among internal and external stakeholders is defined as sharing the same data resource with multiple applications or users and integrating data. An example of data sharing is providing COVID testing and or vaccination data based on ZIP code, county and state-level data.

Data sharing: challenges

All jurisdictions agree the concept of sharing data is, in theory, a beneficial action for all involved. The more data an organization has access to, the better equipped it is to fulfill its roles and responsibilities more effectively. Data and information are what advances environmental health. However, the challenges with data sharing are numerous according to several jurisdictions. As one interview participant stated, "we are all sharing data. There is no one who is not sharing data. The question is are we sharing data effectively, and should we be sharing more?"

At a higher level, federal agencies work independently of each other and have different sets of standards. Explained by a jurisdiction, "we have the alphabet soup at the federal level and each one of them working independently without communication or regard to each other. That is a huge challenge. It is a moving target, for each one no less." This lack of a standard data message is a hindrance for jurisdictions. All of the critical agencies (CDC, EPA, FDA) are working on something related to data, yet they don't talk to each other. To further complicate the issue, there is the challenge of conflicting data standards. One participant explained, unlike public health, which has advanced in terms of information exchanges and public health records, environmental health is behind in its ability to share data because effective data sharing requires data standardization, standard messaging and a definition of what is going to be shared. Some think a grassroots approach to developing data standards (jurisdictions coming together and identifying measures) would be better as opposed to following federal level standards which are not cohesive.

In one state, they respond primarily to ad-hoc requests for data sharing. They work with other agencies and universities to share data, but this is accomplished on a project-by-project basis. With no formal data sharing in place, it takes time to develop data-sharing agreements. In this state, there are locally administered health districts, and they are not required to use the state database. The underlying challenge with this is that these agencies don't always see the advantage of sharing data unless doing so is mandated. Also, there was a sense of possessiveness over their data and a fear that they don't know what data are being collected and if it is being used appropriately. Another challenge is that environmental health covers so many areas and may deal with many different agencies depending on how things are structured. There can be many data sources and data systems, making it challenging to manage data requests to share efficiently.

Data sharing best practices among internal and external local, state and national agencies

At the agency level, consistent and standard practices to share data internally and with external agencies are imperative. This may include creating a memorandum of understanding, data sharing agreements, interagency agreements, etc. Many

[8] For more on this initiative, see How Data-Driven Decisions Inspired Empathy at Public Health Inspections – Denver Peak Academy.

data collection efforts have statutes, regulations and policies that govern the collection and access to the data. A jurisdiction may choose to enact a data governance group to manage the data stewardship, that is, that the data is appropriately entered, stored, used and shared.[9]

The CDC National Center for HIV/AIDS, Viral Hepatitis, STD, and TB Prevention recommends following 10 guiding principles for data collection, storage, sharing and use.[10] These include:

1. Public health data should be acquired, used, disclosed and stored for legitimate public health purposes.
2. Programs should collect the minimum amount of personally identifiable information necessary to conduct public health activities.
3. Programs should have strong policies to protect the privacy and security of personally identifiable data.
4. Data collection and use policies should reflect respect for the rights of individuals and community groups and minimize the undue burden.
5. Programs should have policies and procedures to ensure the quality of any data they collect or use.
6. Programs should use and disseminate summary data to relevant stakeholders promptly.
7. Programs should share data for legitimate public health purposes and may establish data-use agreements to facilitating sharing of data promptly.
8. Public health data should be maintained in a secure environment and transmitted through secure methods.
9. Minimize the number of persons and entities granted access to identifiable data.
10. Program officials should be active, responsible stewards of public health data.

Capability 6 of the Public Health Preparedness Capabilities: National Standards for State and Local Planning is about data sharing.[11] These are relevant and quality guidelines for any data sharing practices, regardless of the environmental health area. The direct data sharing functions include:

1. Identify the stakeholders to be incorporated into the information flow.
2. Identify and develop rules and data elements for data sharing:
   a. When should data be shared?
   b. Who is authorized to receive data?
   c. Who is authorized to share data?
   d. What types of data can be shared?
   e. What are needed data use and re-release parameters?
   f. What data protection is sufficient?
   g. What are legal, statutory, privacy and intellectual property considerations?
3. Exchange information to determine a common operating picture.

Overall, data sharing will reduce data silos internally and support interagency sharing. Data sharing paves the way for jurisdictions and other agencies to conduct extensive analyses to predict outcomes and make policy and procedure changes. Jurisdictions should offer multiple static file formats (Excel, CSV, SAS, etc.), non-proprietary file formats (e.g. CSV, TXT, etc.), and machine readable formats to increase accessibility, access and utilization to support data sharing.

[9] See SAP's resource What is Data Governance?
[10] See Ten Guiding Principles for Data Collection, Storage, Sharing, and Use to Ensure Security and Confidentiality from the CDC.
[11] See Capability 6 from the CDC.

An exemplary example is CDC's Wide-ranging Online Data for Epidemiologic Research (WONDER).[12] This is a public resource of 20 plus data collections. The system's application programming interface (API) offers access to data for other applications and databases for data analysis. The information is available in a variety of file formats. Functions of WONDER include creating tables, charts, maps and summary statistics, as well as organizing data by categories and comparing them by population, location and custom measures. Agencies can access and use these data for many purposes, such as identifying community trends or comparing their community with others.

Data sharing with consumers

Definition of data sharing with consumers

Data sharing is the ability to share the same data resource with multiple applications, and that can be easily integrated. For consumers, data sharing is a primary feature of a database management system (DBMS). An example is to make data readily available on a website (e.g., FDA, CDC, U.S. Census, EPA, data.gov) through downloading files.

Data sharing with consumers: challenges

A key challenge with sharing data with consumers is clarity around what data are and are not subject to the Public Information Act (PIA) or data that are considered business confidential. This distinction has become complicated for some agencies. Most data are not covered under HIPAA or fall under personally identifiable information (PII), but there are times that it's business confidential information. It's essential to understand and specify what data are subject to disclosure beforehand rather than after.

Some examples of the challenges are with temporary food establishments and mobile food units. Many times, with these types of businesses, they are registered to a residential address. In one state, this is considered a protected piece of information and can't be released to the public without written approval. However, in another state, the information on a business license is public. For some privacy, their state legislature passed a law that allows businesses to be assigned a number instead of an address for public documents. In another state, an address does not fall under protected health information (PHI) unless it's directly related to HIPAA.

Lastly, staff capacity and expertise are lacking to be able to manage a database that is downloadable to consumers such as the U.S. Census Bureau. In one person's opinion, the best option for consumer access to data is to allow for a query-based approach.

Best practices for data sharing with consumers

Many of the best practices for data sharing among internal and external local, state and national agencies also apply to sharing data with consumers. Data file formats should meet the same recommendations for non-proprietary, machine-readable formats described in the previous section to support data sharing with consumers. Data sharing with consumers is essential to link health departments to their communities, increase communication and encourage transparency. Data sharing also enables the public to make informed decisions.

Consumers should be held to standards related to accountability and responsibility for how they use and interpret the data. Data agreements with consumers ensure consumers understand the "authoritative source of data" and any data constraints for its usage, as well as to make sure consumers are complying with any data governance policies and procedures. Consumers should work to resolve any data issues as requested by the jurisdiction and likewise identify and bring to the attention any data issues to the jurisdiction.[13]

[12] See this summary from CDC on the CDC WONDER initiative.
[13] See "The Importance of Recognizing our Data Consumers" from Collibra.

For consumers, jurisdictions should provide information on who to contact for questions and issues about the data, include access to a data dictionary for critical data elements, and guide consumers through how to understand inspection data, violations and results. For example, the FDA' Inspection Classification Database is a searchable database for information on facilities' inspection results.[14] The FDA shares only a segment of the information from the inspection. The website includes a brief overview of what an inspection is, definitions of classifications and other useful information for a consumer to have about the database.

The U.S. Environmental Protection Agency (EPA) developed the Enforcement Compliance History Online (ECHO), a searchable database of facilities around the nation.[15] Users can search for facilities, find EPA enforcement cases, analyze compliance and enforcement data, and access data services. Data can be downloaded or displayed in dashboards, maps and charts; consumers also have access to ECHO web services and map services. There are also features for users to inform/communicate with the EPA to report a data error or report a violation. Simple searches in ECHO lend themselves to more broad-level analyses, but ECHO also provides a host of advanced search functions and tools for those with more expertise.

Integration of external data

Definition of integration of external data

Integration of external data is the assimilation of data that are found from an external source to enhance data that are being collected through a system of seamless transition based upon a shared reference identifier. For example, a car has a unique identifier called a vehicle identification number (VIN), and this is shared with the DMV (Department of Motor Vehicles) as well as state law enforcement. The VIN acts as a reference identifier to link to multiple databases.

Integration of external data: challenges

Most integration with external data sources is done after an inspection and not incorporated into the core data system. Most jurisdictions use external data sources with post analysis and interpretation. Examples include:

- Incorporating county population demographics into the analysis.
- Using GIS mapping to identify areas at risk for water contamination.
- Using Google Maps for address checks and verification.

States have also been able to integrate with their finance systems. By providing online payments and financial information, the system can track fee assignment if there were violations, payments made and payments still outstanding, what has been assigned, and who has jurisdiction to assign it. This is an absolute "essential for agency acceptance," said one individual, as it enables inspectors to have that information on hand while at an inspection. This is crucial since the inspectors often remind facilities of unpaid fees and need to document this information.

Jurisdictions recognize the benefit of using and accessing external data sources; however, environmental health has not reached a proficient level related to data integration with external sources. A "wish list" of system capabilities to integrate external data during inspections from jurisdictions are to:

- Be able to scan equipment, food menus or products during an inspection that would upload the information into the system automatically.
- Access information from a data logger or chemical feeder at a pool inspection.

[14] See the FDA's Inspection Classification Database.
[15] See the EPA's ECHO Quick Start guide.

- Use external data sources integrated into the data systems as a reference element during inspections, such as the FDA Food Code or a tool that grabs latitude and longitude data based on an address check.
- Include recall lists and have product data information available during an inspection.
- Utilize the SKU for product sampling to automatically populate a sample requisition with the lot number.

Best practices for integration of external data

Jurisdictions will benefit from looking outside the box to use, analyze and interpret data, especially if other data sources are integrated to create a comprehensive picture. Data from multiple sources will help to identify community needs, identify regions or areas to target resources, investigate relationships between an issue and contextual factors, and can help fill gaps in the data and knowledge.

CDC's National Environmental Public Health Tracking Program collects, integrates and analyzes data from health, exposure and hazards data including health conditions and diseases, contaminants in the environment, climate, community design, behaviors and population characteristics.[16] This data can develop, implement, evaluate and improve practices. A success story example from Colorado shares how water monitoring revealed uranium levels in the drinking water at a state correctional facility. Using data from the Colorado Tracking Program, the natural range of uranium in Colorado water supplies was determined. While the level was ordinary in Colorado, the correctional facility brought in drinking water and installed a water treatment system.[17]

Data integration is a "process for bringing together available datasets in creative and informative ways to help refine research questions and inform the next cycle of data acquisition and analysis," explained Lance Waller, a speaker at the 2018 National Academies of Sciences, Engineering, and Medicine's Standing Committee on the Use of Emerging Science for Environmental Health Decisions.[18] There are many large-scale and small-scale data sources publicly available. When looking at external data sources, it's essential to understand the data to establish their quality and usefulness.[19]

These include:

- Learn about the external data: for what purpose were they collected, how were they collected, how have the data been used?
- What expertise is needed to manage the external data source?
- What data cleaning is needed for the data to be usable?
- What is the data quality?
    - Are the data accurate?
    - Are the data relevant?
    - Are the data timely?
    - Are the data accessible?
- Do the data provide the right strengths and fit for why they are needed?

[16] See the CDC's description of their National Environmental Public Health Tracking program for more information.
[17] See more on the Colorado case study from the CDC.
[18] See workshop proceedings from the National Academies of Sciences.
[19] See Uses of Alternative Data Sources for Public Health Statistics and Policymaking: Challenges and Opportunities from NORC at the University of Chicago.

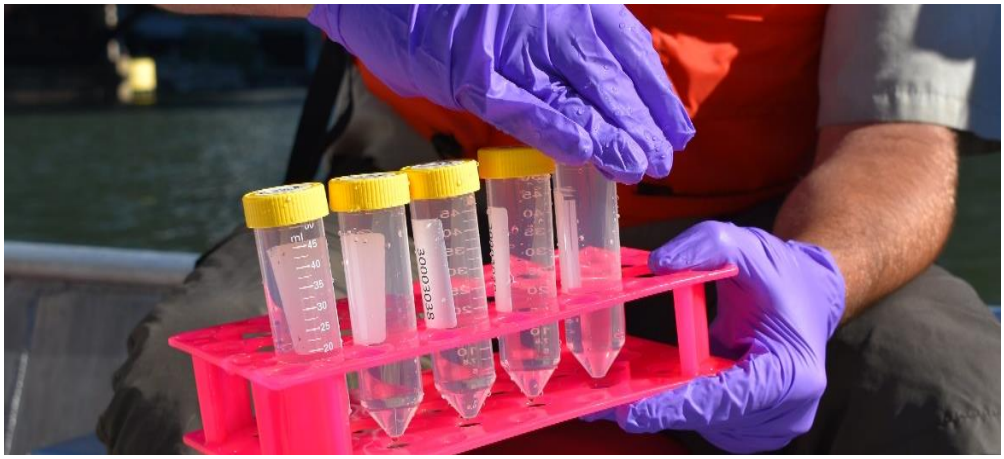
Best practices conclusions and next steps

The data and information collected to inform this guidance document come with limitations. First, this project was based on a small cohort of jurisdictions. It would be difficult to extrapolate these results to represent jurisdictions across the nation. The recruitment of sites and the gathering of information also occurred during the COVID-19 pandemic. This timing presented challenges with the number of sites targeted to participate and the actual number that did, especially as jurisdictions were tasked with new and unprecedented responsibilities and priorities related to the pandemic.

Even so, the information collected is rich and provides a foundation for the challenges, lessons learned and strategies to overcome the identified challenges as a jurisdiction works to modernize environmental health data practices. While the approaches, processes and procedures may vary as to standardized data collection, sharing and use for food and water inspection data, there are more similarities than differences among jurisdictions. An electronic data collection system is key, as well as the standardization of the information collected. For instance, the use of uniform inspection forms based on food or water codes, standard data fields, and knowledge of data integrity as it relates to data entry, storage and analysis are essential. Data will be more effective if they can be standardized from the collection stage all the way down to the storage stage. This standardization inherently will facilitate data sharing across agencies and jurisdictions; raise awareness of results, trends and real-time information; and optimize analytics.

For jurisdictions looking to digitize and standardize their food and water inspection data, it may be beneficial to partner with a jurisdiction that is well advanced in this process. This would help serve as an opportunity for a jurisdiction in the early stages to gain real world insights on the steps and actions needed to move along the continuum, as well as obtain support and technical assistance from a jurisdiction who has firsthand experience. NEHA can utilize our vast network of members and environmental health professionals to recommend jurisdictions who could offer support and resources in this process.

A larger environmental scan is needed to understand the full picture of the challenges, successful strategies and actions required for jurisdictions to standardize data collection, implement electronic data collection systems, and create procedures and processes for data use, data sharing, data analysis and data storage. This more extensive assessment can support the development of a standard operating procedure (SOP) at a national level.



Water samples being prepared for safety testing

Image credit: USFWS Midwest Region

Appendices

Supplementary report material

Appendix A. Environmental scan for invited environmental health programs

Jurisdiction	Inspection rating system	Notes
Florida	Satisfactory-unsatisfactory-incomplete rating system[4]	Inspections performed by county health department[4] All counties responsible for restaurant in county Routine, re-inspections and complaint inspections Routine-periodic inspections that are performed as part of the on-going food safety system Re-inspections- completed when a facility has violations that need corrections in more than the standard time frame Complaint- performed in response to a citizen's complaint Routine and complaint inspections are unannounced No prior notice or prearranged time frame before inspector arrives Re-inspections get specific dates Department of Business and Professional Regulation NO Grades for Public Restaurants Restaurants are not forced to post information publicly Satisfactory, unsatisfactory, incomplete Past legislative changes, the DOH no longer works with food service facilities in hospitals, nursing homes, childcare facilities, many group homes, and churches and other not-for-profit religious organizations. Florida Administrative codes for food safety and recreational water facilities made available with search portal[3]

Jurisdiction	Inspection rating system	Notes
		Search portal for swimming pool and spa inspections[3]
Georgia	Numeric score grading system[5] Recreational water: satisfactory/unsatisfactory rating system	Georgia Department of Public Health[5] Gwinnett, Newton, Rockdale not included in state-wide search Numeric score Inspection search portal for food facilities and swimming pools Satisfactory/unsatisfactory rating system
Southern Nevada	Letter grade system[8]	Conducts unannounced inspections of food establishments at least once a year[8] Inspections posted online approximately five business days following inspection May not be representative of overall, long-term cleanliness Inspections available from 2005 Some records may not appear in the search for up to 60 days due to an upgrade of their computer systems All data downloadable on site. Full inspection reports require records-request form Complaint form in Spanish and English Letter grade system, provides FAQ Inspection process downloadable Responsible for permitting and regulatory oversight of aquatic venues[9] Operational inspections (routine)

Jurisdiction	Inspection rating system	Notes
		Plan review activities include review and approval of plans and specifications submitted for new and remodeled aquatic venues Imminent health hazards-violations that require immediate correction or closure to prevent harm
Seattle & King County, Washington	Emoji and color rating system[6]	Food safety rating system[6] Info available in other languages Launched in January 2017 New restaurant signage Number of restaurants in King County that have perfect scores of 0 critical food safety violations increased in 2017 from 52 to 55%. Emoji and color rating system Excellent, good, okay, needs to improve Rating determined by trend of food safety practices over time; scale of performance; ZIP code adjustments Required to post window sign at entrance Virtual food safety assessments- routine inspections abbreviated through video conferencing platform Two routine inspections performed each year[7] Test for free chlorine residual, pH, alkalinity and, when necessary, cyanuric acid Safety evaluation of walking spaces, access doors and fences, recirculation equipment, safety and emergency equipment Able to see status of pool permit, pool inspection report not available or not easy to find

Jurisdiction	Inspection rating system	Notes
Boston, Massachusetts	Letter grading system[1]	Letter grading system: A, B, C Grade placed outside establishment Restaurant grading info sheet in multiple languages Provides "Mayor's Food Court" portal for restaurant information Information on pool inspections limited
Colorado	Varies by county[2]	Provides food inspection search portal[10] Inspection reports from July 2013 to present Provides guide for inspections Inspections performed twice per year Factors: food served, operations, weekly meal volume, inspection history Information on pool inspections limited
US Virgin Islands	Pending	Food Inspections conducted by the USVI Department of Health, Division of Environmental Health[11] Virgin Islands Food Code adopted in 2004, never enforced Announced national initiative for food inspections Information on recreational water inspections limited

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Note: See Appendix D for a link to the full environmental scan, including the literature review.

Appendix B. Business process matrices

Leveraging Informatics to Improve Environmental Health Practice and Innovation
Business Process Matrix Template
Business Process Name

OBJECTIVES	BUSINESS RULES	TRIGGERS	TASK SET	INPUTS	OUTPUTS	MEASURABLE OUTCOMES
A concrete statement describing what the business process seeks to achieve. A well-worded objective will be SMART: Specific, Measurable, Attainable/ Achievable, Realistic, and Time bound.	A set of criteria that defines or constrains some aspect of the business process. Business rules are intended to assert business structure or to control or influence the behavior. Examples in healthcare and public health include laws, standards, and guidelines.	An event, action or state that indicates the first course of action in a business process. In some case, a trigger is also an input.	The key set of activities that are carried out in a business process.	Information received by the business process from external sources. Inputs are not generated within the process.	Information transferred out from a process. The information may have been the resulting transformation of an input, or it may have been information created within the business process.	The resulting transaction of a business process that indicates the objectives have been met.

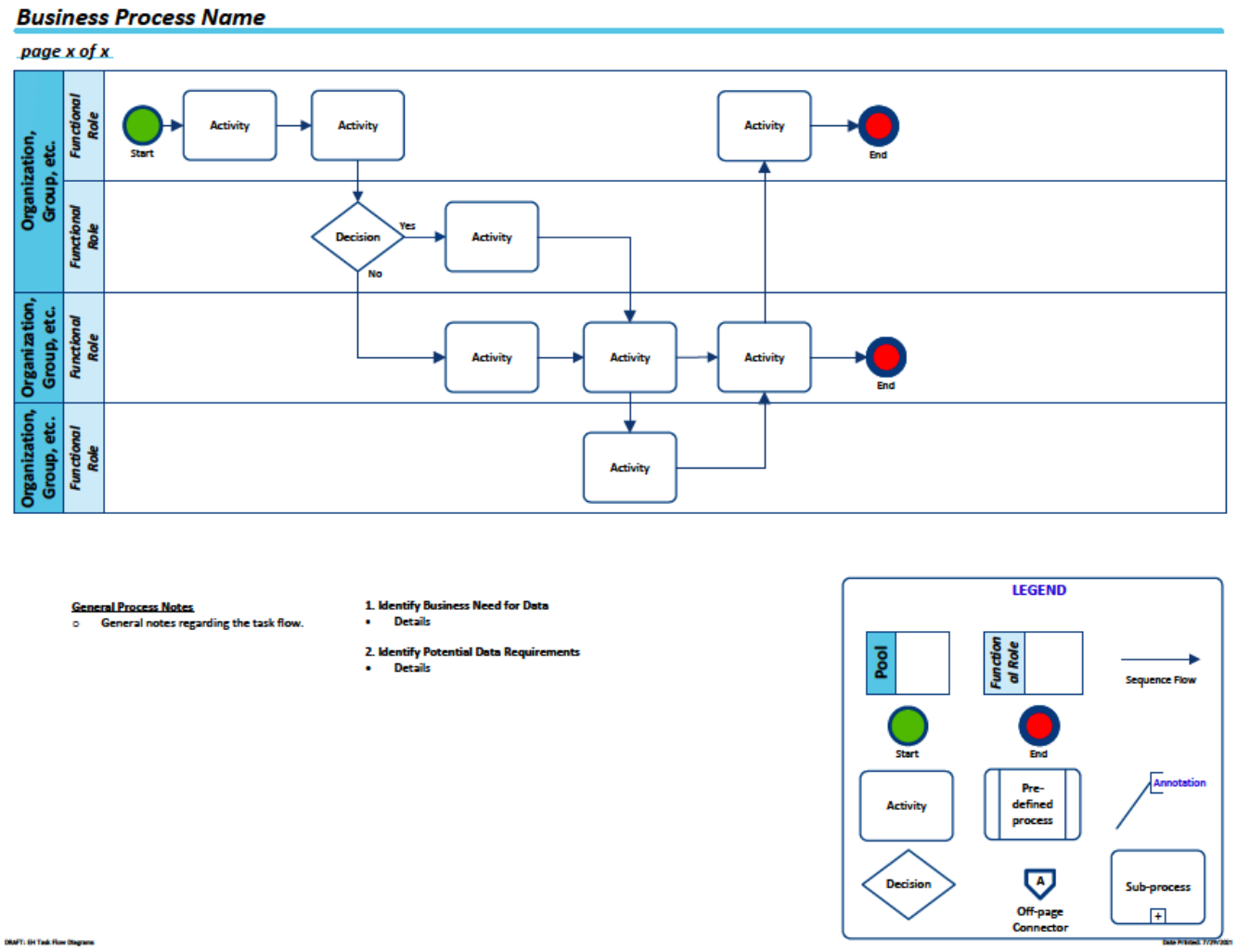
Leveraging Informatics to Improve Environmental Health Practice and Innovation
Business process matrix
Prepare for inspection

OBJECTIVES	BUSINESS RULES	TRIGGERS	TASK SET	INPUTS	OUTPUTS	MEASURABLE OUTCOMES
• To identify facilities for inspection (food and recreational water) based on jurisdiction business rules	• Jurisdiction inspection policies and standard operating procedures	• Routine inspection due • Reinspection due • Complaint • Foodborne illness investigation • Accident at aquatic venue • RWI investigation	1. Determine facilities to inspect 2. Review documentation 3. Collect inspection tools 4. Identify point of contact 5. Travel to inspection facility	• Facility inspection history • Current complaint • Inspection frequency guidance • Notification of FBI or RWI outbreak • Description or notice of accident	• List of facilities to be inspected by inspection type • Point of contact information • Inspection routing to increase efficiency • Linkage to cases under investigation (e.g., outbreaks)	• Workload by inspector

Leveraging Informatics to Improve Environmental Health Practice and Innovation
Business process matrix
Conduct inspection

OBJECTIVES	BUSINESS RULES	TRIGGERS	TASK SET	INPUTS	OUTPUTS	MEASURABLE OUTCOMES
• To conduct environmental health inspections (food and recreational water)	• Food code (FDA or jurisdiction specific) • Recreational water code • Jurisdiction inspection policies and standard operating procedures	• Facility due for inspection • Complaint, accident or outbreak • Training and education	1. Arrive at inspection facility 2. Greet point of contact 3. Gain entry into inspection area 4. Conduct inspection 5. Collect samples for analysis 6. Record inspection data 7. Create inspection report 8. Review inspection report 9. Violations? 10. Discuss violations and fees 11. Corrective action 12. Schedule reinspection 13. Sign inspection report	• List of facilities to be inspected • Facility inspection history • Point of contact information • Operational hours • Past inspection timing • Expected busy times	• Facility grade • Inspection report • Violations & fees associated • Corrective actions/outbreak mitigation measures • Reinspection date	• Number of facilities inspected • Facility grades/ downgrades • Number of facilities closed • Number of violations • Number of samples collected

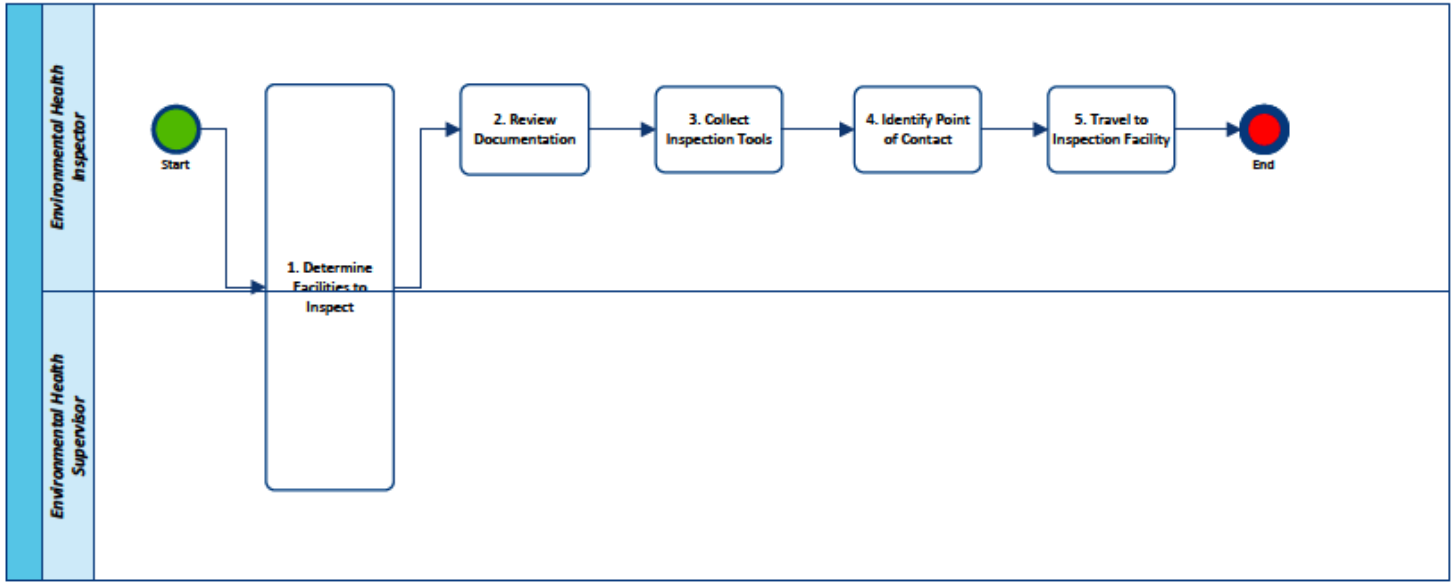
Appendix C. Task flow diagrams



Prepare for Inspection

Environmental Health

1 of 1



Activity Details / Narrative

Objective:
- **Identify facilities for inspection (food and water) based on jurisdiction business rules**

Measurable Outcomes:
- **Inspection workload**

General Notes:
- **This process is inclusive of both food and water**

Activity Description:

1. Determine Facilities to Inspect
- The EH Inspector determines which facilities to inspect (this could be based on type of inspection – routine, follow-up, or complaint, risk category, previous inspection grade, or report of foodborne illness)
- Supervisors are sometimes involved in determining daily assignments

2. Review Documentation
- Review appropriate documentation to prepare for the visit, i.e. previous inspections, complaints, permit, accident details, notice of outbreak, etc.

3. Collect Inspection Tools
- Identify and collect inspection tools needed

4. Identify Point of Contact
- Identify facility point of contact prior to arriving on site at the facility

5. Travel to Inspection Facility
- Inspector travels to facility

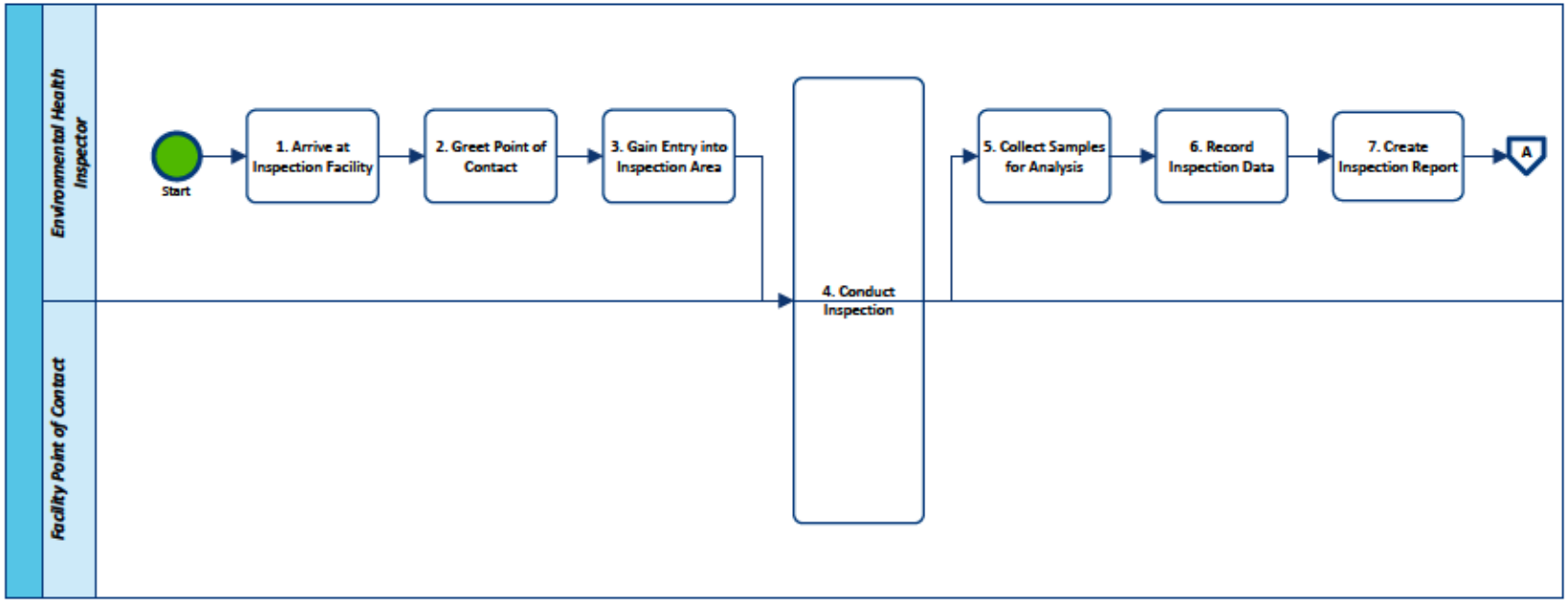
DRAFT: EH Task Flow Diagrams

Date Printed: 7/29/2021

Conduct Inspection

Environmental Health

1 of 2



Activity Details / Narrative

Objective:
- **Conduct environmental health inspections (food and recreational water)**

Measurable Outcomes:
- **Number of facilities inspected**
- **Facility grades/downgrades**

General Notes:
- **This process is inclusive of both food and water**

Activity Description:

1. Arrive at Inspection Facility
- EH Inspector arrives at the facility for the inspection and records time of arrival

2. Greet Point of Contact
- Inspector greets facility point of contact
- Match the point of contact name to the permit, if individual on permit is not available meet with the facility manager or health & safety officer
- Brief POC on the reason for the inspection and the protocol/process
- Sometimes POC is not available and the inspection is conducted without the POC (recreational water)

3. Gain Entry into Inspection Area
- POC directs Inspector to the inspection area

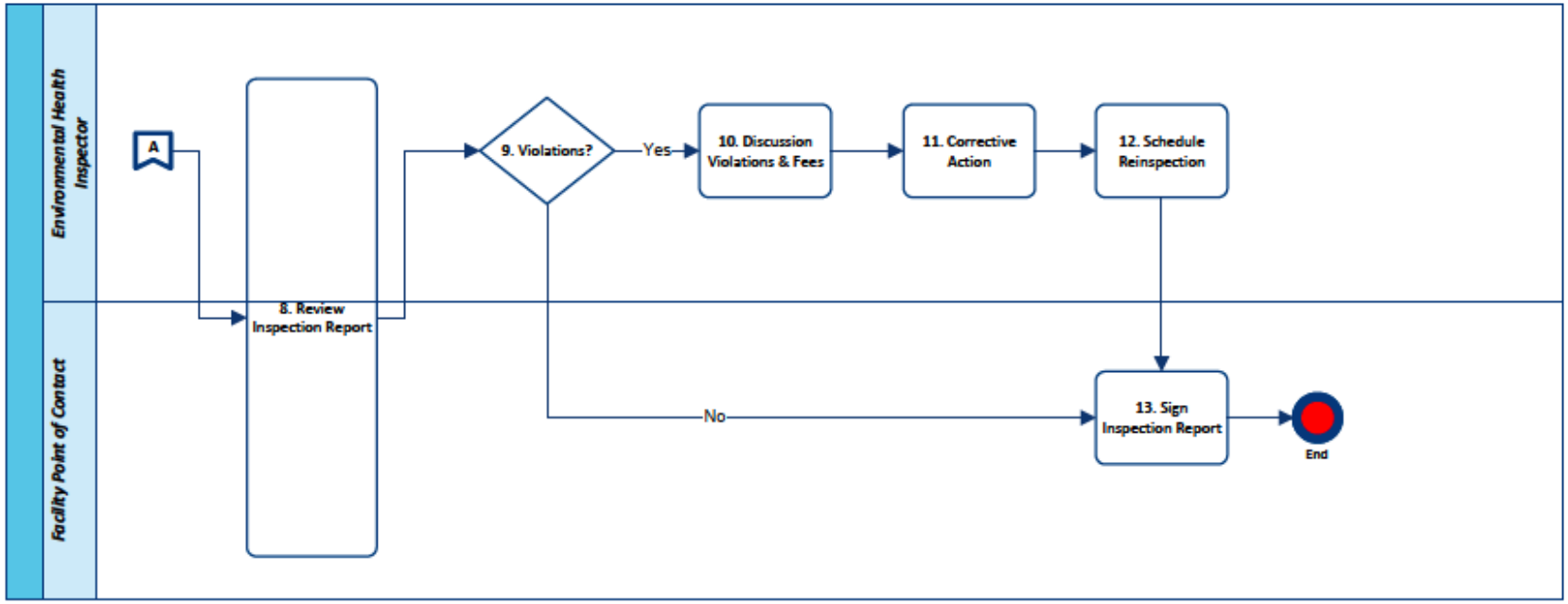
4. Conduct Inspection
- Inspector conducts the inspection with the POC
- Inspector begins with the highest risk area for the inspection
- Food inspection focus is o the five risk factors for foodborne illness (poor personal hygiene, food from unsafe sources, improper cooking temperatures/methods, improper holding, time and temperature, and food contamination)
- Recreational water inspection focus on imminent health hazards (safety and water chemistry)

5. Collect Samples for Analysis
- Inspector collects food or water samples for laboratory analysis if needed

6. Record Inspection Data
- Inspector records inspection data either on paper or in the information system

7. Create Inspection Report
- The inspection report is created as a result of the data input by the inspector
- A grade is assigned to the facility (food)

Conduct Inspection



Activity Details / Narrative

Activity Description:

8. Review Inspection Report

- The inspector will review and answer questions about the inspection report findings with the POC
- The inspector and POC will identify and discuss potential improvements and solutions for identified issues

9. Violations?

- If there are violations the Inspector will review those with the POC

10. Discuss Violations & Fees

- The Inspector will review violations with the POC and provide education on mitigation strategies
- The Inspector will discuss any fees associated with the violations and how to pay those fees
- Inspector will provide re-inspection, follow-up, or closure information

11. Corrective Action

- In addition to corrective action violations can include closure or suspension/revocation of permits

12. Schedule Reinspection

- The inspector will work with the Point of Contact to schedule the reinspection
- Reinspection dates are determined based on the jurisdictions business rules

13. Sign Inspection Report

- The POC signs the inspection report either on paper or electronically
- A copy of the inspection report is provided to the POC either on paper or via email

Appendix D. Links and downloads to additional project materials

Environmental scan

The environmental scan contains the jurisdictional findings excerpted in Appendix A, with additional detail and a full literature review.

CRDM™ presentation

This approximately 20-minute recorded summary of the CRDM™ was originally presented in May 2021 to provide context of how CRDM™ is typically conducted, and the principles that underpin business process analysis.

Dissemination plan from the National Environmental Health Association (NEHA)

NEHA created this dissemination plan to provide guidance for disseminating project pilot results and best practices recommendations for standardizing how food and water data processing is conducted.