ERG

ECHO Quality Assurance

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1. **INTRODUCTION**

EPA's Enforcement and Compliance History Online (ECHO) site is a primary EPA vehicle for providing environmental compliance and enforcement data to the public and to government employees. Following ECHO's launch in 2002, demand has increased for access to environmental compliance and enforcement data. In addition, the breadth of information and the types of entities requesting the information have expanded. ECHO users include the general public, regulated entities, non-governmental organizations, press, all levels of government regulators, and academic researchers. ECHO supports the agency's "Improve Transparency" enforcement goal. ECHO was modernized in 2013 and 2014 and now operates more efficiently. In addition to providing enforcement and compliance data to the public, ECHO provides access to data analysis and program management tools. ECHO must continue to grow in utility, improve in performance, operate reliably and efficiently, and stay relevant.

ERG is supporting EPA by conducting the following tasks:

- Providing operation and maintenance support for all interfaces and associated reports, including public ECHO features and restricted ECHO features (ECHO Gov);
- Web design, development, and documentation of new ECHO and ECHO Gov web queries and reports; and
- Developing and maintaining ECHO data tables; extraction, transformation, and loading (ETL) flows; and web services.

This document details the quality specifications and verification methods used to assure ECHO's quality, and is responsive to all applicable elements of *EPA Requirements for Quality Assurance Project Plans QA/R-5* (EPA, 2001). The organization of this document is as follows:

- Section 2   Project Management
- Section 3   Project Description and Objectives
- Section 4   Quality Criteria, Verification, and Reporting
- Section 5   Software Development and Testing Procedures
- Section 6   References

2. **PROJECT MANAGEMENT**

This section addresses project management, including:

- Project organization and responsibilities;
- Project records; and
- Assessment of the implementation of the ECHO Quality Assurance Project Plan (QAPP) (ERG, 2016).

2.1 <u>Project Organization and Responsibilities</u>

Project Organization is depicted in Figure 2-1, for staff with program management and technical responsibilities and those with QA/QC roles. It shows the relationship and lines of authority, reporting, and communication among all project participants, including those from EPA.
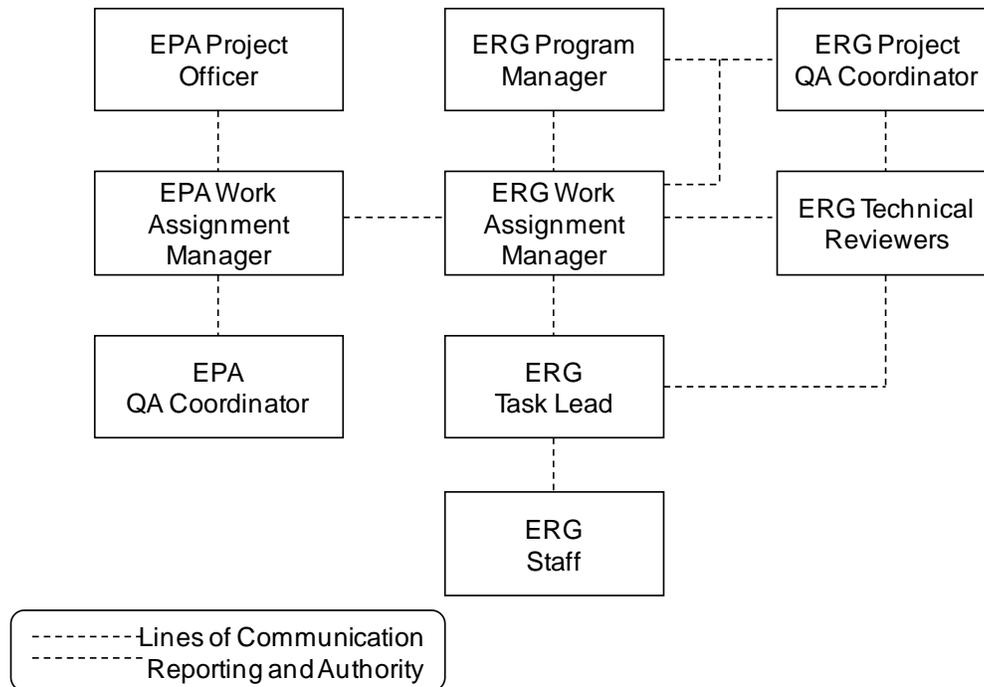
The ERG WAM is the principal contact for the EPA Work Assignment Contracting Officer's Representative (WACOR) on project issues, deliverables, and schedule. The ERG WAM is responsible for:

- Ensuring that the quality of work, schedule, and budget meet the requirements of the ECHO project;
- Providing technical direction to ERG staff and managing the daily activities on the project;
- Maintaining the official, approved QAPP;
- Obtaining appropriate technical review of all deliverables and ensuring deliverables conform to EPA's technical review requirements; and
- Keeping the Project QA Coordinator and the Program Manager advised of any quality problems that arise.

ERG's Project QA Coordinator is responsible for ensuring that the requirements of the ECHO QAPP are implemented and documented. The Project QA Coordinator works with the ERG WAM in developing and executing QA activities throughout the project, including review of the QAPP, data review, software testing, and results reporting. The Project QA Coordinator also ensures that the ERG WAM is obtaining appropriate technical review of all deliverables.

ERG's development team provides technical support for all programming, web development, and deployment activities. ERG's database analysts provide support for database, ETL, and web service development and maintenance. ERG project staff also support software and data quality testing and documentation.

Figure 2-1. Project-Level QA Organization

2.2   Project Records

The ERG WAM is responsible for establishing and ensuring that version control is used for all project deliverables. The version of interim and working deliverables is identified in the electronic file name using a dating scheme. Historical files are kept and maintained in the project file on ERG's network. Final versions of documents are identified in the electronic filename as "FINAL." These procedures apply to project deliverables such as requirements documents, design presentations, planning documents, Word versions of formal test cases, work plans, and technical progress reports. However, most ECHO work products and deliverables are developed using tools that are external to the ERG network, which the EPA WACOR and other EPA technical staff can access at any time:

- Programming code: Developers work directly on EPA servers and maintain their code on ECHO development branches. Programming code is version controlled using a revision control system.
- Help files and site documentation: ECHO documentation is developed, stored, tracked, and maintained in EPA's WebCMS environment.
- ETL and web service code: Database developers work directly in EPA's DataMart and store code updates in ECHO's centralized client-server software revision control system.
- Automated test cases: Test cases are stored in EPA's centralized web-based code repository.
- Design documents: To facilitate coordination among EPA and ERG team members and to maintain version control, design documents are developed using cloud-based collaboration tools. Frozen copies of documents are stored on ERG's

network for documentation purposes following initial approval of design and any major design updates.

At the EPA WACOR's request, ERG will provide all electronic project files stored on ERG's network. At the conclusion of the project, ERG will retain a copy of project electronic files in the ERG archive.

2.3   Assessment of QAPP Implementation

ERG conducts several stages of review during the planning and execution of this project to assess that the procedures outlined in the ECHO QAPP are followed. All tasks conducted and products generated receive (1) a conceptual review, (2) a developmental review, and (3) a final product review.

A **conceptual review** is performed during the initial stages of work development and ensures that the final product and associated documentation address the needs set forth by the EPA WACOR, the work assignment, and the QAPP. Conceptual review is provided by senior analysts knowledgeable about web development, but not directly involved in the work assignment.

The quality of intermediate deliverables and final products is also evaluated as these work products evolve. This **developmental review** includes, for example, (1) checks on calculations and data quality and (2) reviews of draft deliverables to ensure that the direction of work is consistent with the conceptual review outline.

Final product technical review is conducted on all deliverables prior to delivery to EPA. Technical review is a documented critical review of work that has been performed within the "state of the art." ERG's WAM conducts this review. In addition, reports and memoranda to the record are reviewed by a senior-level analyst not directly involved with the project. All deliverables are subsequently reviewed by the EPA WACOR. Reviewer comments in tracked changes are stored on ERG's network in the same directory as the final document with the reviewer's initials in the file name. This provides a review history of the deliverable and documents reviewer comments.

ERG's Project QA Coordinator for this project or her designee assesses the implementation of QA/QC procedures on this project as follows:

- Review the QAPP for completeness and applicability; and
- Audit project files to ensure and verify the following:
    — That project staff have developed QC procedures and that these procedures are used; and
    — That project staff are documenting their use of these QC procedures by completing checklists, review spreadsheets, workflows, and other project-specific tracking methods.

Any quality deficiencies detected by technical reviewers or the Project QA Coordinator are communicated, in writing, to the ERG WAM. The ERG WAM is responsible for ensuring that appropriate corrective action is taken and reported to the Project QA Coordinator. The

Project QA Coordinator will notify the ERG Program Manager if, at any time, she considers the project to have quality deficiencies and they are not being remedied in a timely manner. Upon notification, the ERG Program Manager will conduct a project review. If she concurs that the work is deficient, she may issue a stop work order until the deficiencies are remedied. The ERG WAM will be notified immediately should this occur.

ERG will include any reports of corrective actions in the project QA files. At any time or at the end of the project or work assignment, the Program Manager or her designee may inspect the project QA files.

2.4   <u>Project Status Reports for Management</u>

Monthly, ERG will electronically submit to the EPA WACOR and Project Officer a progress report that documents the costs incurred and work performed during the previous accounting period and work planned for the current accounting period. At the request of the EPA WACOR, ERG will provide a description of QA activities conducted for major project deliverables.

3.   PROJECT DESCRIPTION AND OBJECTIVES

This section defines the purpose of the project. Planned execution of the project is detailed in the following sections:

- Section 4 describes how ERG will implement quality control procedures during ECHO operation and maintenance activities, development of ECHO queries and reports, and development of data tables, ETL, and web services; and

- Section 5 describes the software development and testing procedures for ECHO.

3.1   Problem Definition/Background

EPA's Office of Compliance (OC) created and modernized ECHO to:

- Increase public and government agency access to environmental compliance and enforcement data;
- Support the Agency's "Improve Transparency" Enforcement Goal; and
- Improve operation and maintenance efficiency of the ECHO website.

OC implemented ECHO modernization using a phased approach. The first phase of modernized ECHO primarily replaced existing functionality. Continued development of ECHO will build new tools and improve existing functionality based on user feedback and OC priorities. The overall objectives of the ECHO project include:

- Increase utility of ECHO by adding new data, query tools, and reports, including:
  – Incorporating modern technology and off-the-shelf products to promote cutting-edge data presentations, development and maintenance efficiencies, Web 2.0 concepts (including support for future mobile reports and applications), and ease of navigation;
  – Maximizing data availability, transparency, and usability for each target audience, unless otherwise prohibited. This means that all presented data will be documented and available for download. Summary or calculated data will have drill downs to see the underlying data in calculations, and new web services will be built and documented to increase data usage;
  – Providing additional search features and data to support stronger inspection and enforcement targeting;
- Maintain and improve performance levels; and
- Ensure site operates reliably and efficiently, including:
  – Maintaining interface with ECHO DataMart at the National Computing Center (NCC);
  – Minimizing operation and maintenance costs by using efficient code and template design, including overall use of style sheets and web application framework; and
  – Implementing security best practices.

3.2   Project Description

ERG supported EPA in modernizing the existing ECHO content and features, and provided O&M support for the modernized site. ERG's continued support of ECHO includes adding functionality enhancements and providing O&M support. ERG's support of ECHO involves using several tools which are described in **Error! Reference source not found.**. More information about the tasks that ERG will support is described below.

Tool	QA Purpose
Enhanced wiki, issue tracking, and version control repository system for software development	Centralized bug and task tracking system. Documentation of practices, procedures, and instructions. Centralized tool for tracking code changes.
Hybrid centralized and distributed version control system.	Track historical changes made to source code
Web-based code repository	Centralized repository for automated testing software. Version control
Client-server software revision control system	Centralized repository for ETL scripts. Version control.
Automated software testing framework for web applications	Runs ECHO test cases. Detects functionality issues. Extracts results and maintains a testing log.
Automated web service testing application	Runs ECHO web service test cases. Detects functionality issues. Extracts results and maintains a testing log.
Web-based task management tool used to support agile workflows	Manage and discuss issues and detailed tasks related to project goals and milestones. Allows EPA to communicate potential issues.
EPA's content management system	Built-in revision tracking. Enforcement of roles (editing, publishing).
EPA's automated website testing software	Scans site content for broken links, spelling and grammar errors, and accessibility issues.
Cloud-based customer service platform	Macros for standardizing responses to common questions. Allows messages to be categorized and assigned.
Web-based spreadsheet app that allows ERG, EPA, and other contractors to work simultaneously	Built in revision history and review tracking

Operation and Maintenance Support: ERG will assist EPA in providing on-going operation and maintenance support for all current and future ECHO and ECHO Gov interfaces and associated reports, including the following types of tasks:

- Implement enhancements and revisions to existing interfaces;
- Perform regular testing for functionality, data quality, security, and accessibility;
- Maintain current documentation, edit site content, and load documents onto ECHO; and
- Provide user support.

Web Design, Development, and Documentation: ERG will support EPA in the design, development, testing, and documentation of ECHO and ECHO Gov web queries and reports. This task includes requirements gathering, design specifications and prototyping, integrated development environment architecture support, programming, testing, documentation, and deployment of new ECHO and ECHO Gov features. This task also includes coordination of development activities with the EPA technical lead and other EPA contractors.

Development of Data Tables, ETL, and Web Services. This task covers DataMart modifications and maintenance tasks needed to support existing ECHO and ECHO Gov tools, including the following types of tasks:

- Physical and logical design of data tables;
- Development and documentation of ETL data flows to extract data from the assigned source databases, transform the data, and load the data tables;
- Support of ECHO mapping capabilities on the Oracle spatial and an ArcGIS server;
- Documentation and automation of regular data refreshes;
- Development, deployment, and timely documentation of web services;
- Identification and resolution of performance bottlenecks in ETL and web services; and
- Database tuning to improve performance and efficiency.

The key products ERG will produce and milestones for ECHO are listed in Table 3-1.

Table 3-1. Key Products and Milestones

Key Products and Milestones	Date
New/updated code and associated Drupal database updates. Support for database, ETL data flows, and REST Services.	As directed by EPA WACOR (typically every two weeks)
Current record of automated test cases	Upon request by the EPA WACOR
Annual log of usage for each interface	Each November-December
Final response to user questions/feedback	Within 48 business hours for 90% of questions

4.   QUALITY CRITERIA, VERIFICATION, AND REPORTING

This section identifies the quality specifications for ECHO products developed by ERG, including web queries and reports, DataMart ETL flows and web services, ECHO static content, and user support activities; how ERG will verify ECHO products against the specified criteria; and how ERG will communicate quality with the EPA WACOR.

4.1   <u>Quality Criteria and Verification</u>

Table 4-1 describes the quality specifications and verification methods for the ECHO web queries and reports, web services, database tables and ETL, static content, and user support processes.

Prior to development, ERG will develop software design documents (SDD) and technical requirement reports for each ECHO page, query, and report. Testers will refer to this documentation while performing testing to verify that the page implementation matches design and technical requirements.

In addition to ensuring that the ECHO site meets EPA's technical requirements and SDD specifications, ERG will continuously monitor data quality throughout ECHO:

- **Data Review**. According to EPA's Guidance for QAPPs (QA/G-5), data review is "the in-house examination to ensure that the data have been recorded, transmitted, and processed correctly. That includes, for example, checking for data entry, transcription, calculation, and reduction errors… It is a completeness check to determine if there are any deficiencies, such as data missing…" The ECHO DataMart extracts data from established EPA data systems. Therefore, ERG assumes that the data sources are of sufficient quality for the ECHO site, and does not perform an upfront data review to verify the quality of the source. If data quality issues, identified through site testing or data verification processes, trace back to errors in the underlying source data, ERG will report these data quality issues to the EPA WACOR.

- **Data Verification**. According to EPA's Guidance for QAPPs (QA/G-5), data verification is "the process of evaluating the completeness, correctness, and conformance of a specific data set against the method, procedural or contractual specifications." For this task, data verification means the process by which ERG will determine whether data compiled and summarized are accurate and complete. Table 4-1 describes the procedures that ERG will use to verify the output of ETL data flows, data services, and data presentation in ECHO.

ECHO static pages and helpline responses are developed according to standards and procedures developed by EPA and ERG. Table 4-1 describes the quality objectives and verification methods for those products used to ensure they meet the established standards and follow procedures appropriately.

Table 4-1. Quality Specifications and Verification Methods for ECHO

Quality Criterion	Specification	Verification Method
Web Queries and Reports		
Completeness	Includes all appropriate search options, data fields and records specified in the technical requirements.	Compare the page, query, and report elements to the list of elements specified in the software design document (SDD). Verify that all elements are displayed on the page as specified in the SDD.
Functionality	Queries execute and pages load without error. Behavior of user interface objects matches design specifications.	Click all links, buttons, and other user interface controls. Verify behavior matches SDD specifications.
Accuracy	Search results reflect the underlying web services, apply appropriate logic for selecting/interpreting service output, and display service output in appropriate fields/columns. All search criteria are captured in the web query's service call.	Compare values displayed in ECHO reports to results found by calling the web service directly. Confirm search criteria are displayed correctly on results pages. For reports that use visual data displays, review the underlying data services to ensure that the visual display is correctly capturing and interpreting the data.
Format	Output format is appropriate for data type.	Verify that the output format matches the SDD specifications. Check high- and low-end numeric values for appropriate number of digits/decimals.
Speed	ECHO queries perform at the same level or faster than historic tests.	Record the times required to return results for select test case using the production ECHO website. Run queries multiple times to obtain an average query return time for each of the test cases. Record and compare the times required to run the same test cases in the revised website.
Security	Information displayed on page matches the user role and permissions. Code complies with NCC security standards.	Use test user accounts to check user authorization and authentication on the site for public and privileged roles. Test the ECHO login, site display, and secondary menus against the SDD specifications for the different levels of access to ensure that the proper page elements and features are displaying for each user type. Submit all code to NCC security review prior to production deployments. Respond to issues, as needed.
Accessibility	All pages, queries, and reports meet Section 508 Accessibility requirements.	Complete the Accessibility checklist[1] for each ECHO page, query, and report. ERG accessibility experts will periodically conduct an external accessibility review of new designs and features.

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[1] https://www.epa.gov/sites/production/files/2013-09/documents/eit-procurement-checklist.pdf

Table 4-1. Quality Specifications and Verification Methods for ECHO

Quality Criterion	Specification	Verification Method
Browser Compatibility	All pages, queries, and reports function consistently in target browsers.	Test the ECHO site in Internet Explorer 9, 10 and 11, Chrome, and Firefox. Address browser incompatibility issues according to priorities set by the EPA WACOR. Test the ECHO site on desktop computers, and emulators representing laptops, tablets, and smart phones.
Web Services/Site Data Quality		
Completeness	Service includes all input parameters for all search options and output tags for all results.	Perform direct service calls using the list of parameters and expected inputs from the SDD. Verify output tags match the SDD list.
Accuracy	Services correctly applies data transformations and calculations. Service correctly applies query criteria.	Verify that summary information and statistics accurately reflect the underlying detailed data. Service output contains data for all expected elements based on query criteria (e.g., service has RCRA IDs for all facilities if query specified "facility must have RCRA ID").
Format	Output format is appropriate for data type.	Verify that the output format matches the SDD specifications.
Reasonableness	Number of records returned by query matches expectations established by legacy ECHO results and historic tests. Maximum and minimum values fall within the range of reasonable results.	Compare search and query results to documented expected results from the legacy site and results of previous test cases. Test search results and reports against expectations established by team members familiar with the underlying data and subject matter (e.g., industries or states expected to return a large number of results). These expected results are documented in the formal test cases.
Comparability	Search results from one query (e.g., All Data Search) are consistent with results generated from other queries in ECHO (e.g., Summary information on a Detailed Facility Report). Trends reports show reasonable year-to-year variability.	Compare results for different reports in ECHO. For example, verify that compliance status information on the facility search results is consistent with the Detailed Facility Report. Compare ECHO results to other web applications for consistency, such as Envirofacts, TRI, and the DMR Pollutant Loading Tool.
Speed	ECHO services perform at the same level or faster than historic tests.	Record the times required to return results for select test case using the production ECHO web services. Run queries multiple times to obtain an average query return time for each of the test cases. Record and compare the times required to run the same test cases in the revised web services.
Application Source Code		
Readability	Adheres to internal coding standards available to all developers from the internal project wiki.	Production ready code changes are reviewed by lead developer for adherence to the code quality standard. Standards are revised and expanded when appropriate.

Table 4-1. Quality Specifications and Verification Methods for ECHO

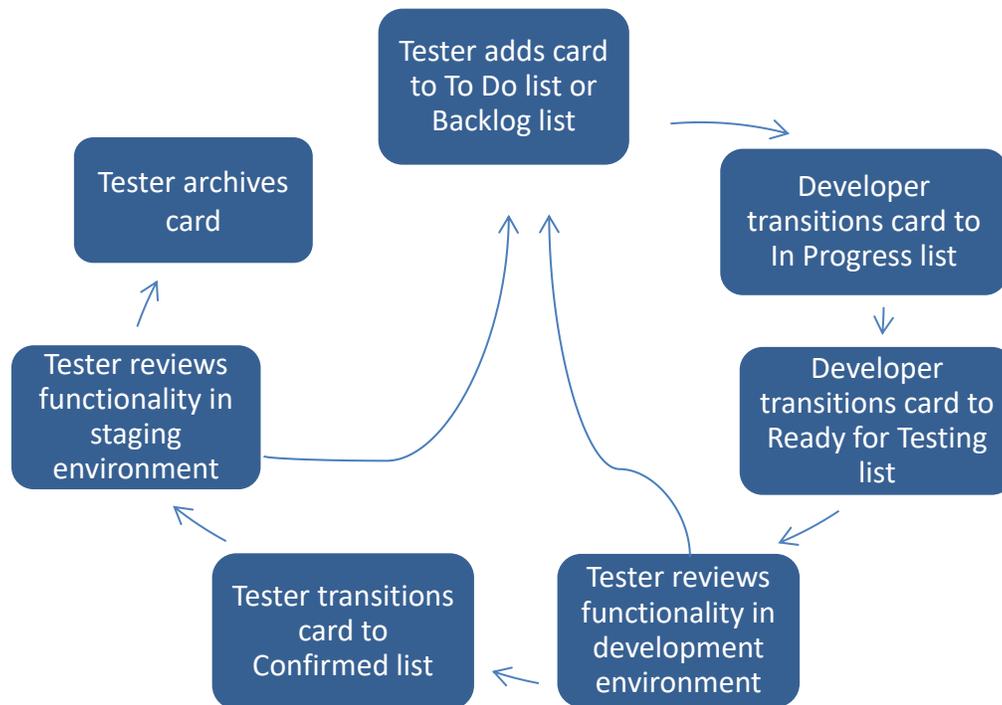| Quality Criterion	Specification	Verification Method
Security	Custom application code is written to mitigate potential security issues, such as Cross-Site Scripting (XSS) and Cross-Site Request Forgery (CSRF). Modifications and additions to custom application code do not negatively impact the overall security of the ECHO system.	Production ready code changes are reviewed by lead developer for adherence to security standards.
Speed	Custom application code is written to optimize page load time and appropriately balance new features. Modifications and additions to custom application code do not negatively impact the overall performance of the ECHO system.	Record the times required to return results for select test case using the production ECHO web services. Run queries multiple times to obtain an average query return time for each of the test cases. Record and compare the times required to run the same test cases in the revised web services.
Data Tables and ETL		
Completeness	Scope of data in final tables (e.g., geographic coverage, reporting programs, pollutant coverage, industry coverage, facility counts) matches scope of source data, except for intentional exclusions.	Review statistics of final output tables, such as total number of records, records by state, SIC/NAICS code, reporting program, or pollutant as appropriate for the data set. Compare to statistics for source data tables. After any modification to the ETL code, review output table statistics to the previous output to ensure consistency.
Functionality	All scripts, procedures, and views compile and execute without error.	Perform unit testing on scripts and procedures to ensure they complete without error. Compile all invalid objects and address errors.
Accuracy	Data transformations and calculations have been correctly applied (e.g., aggregated values can be verified against the raw data). Data outliers can be verified in source data.	For data outliers, review underlying data and verify calculations and transformations by hand. Ensure accuracy of source data by comparing outliers to the source database or website.
Integrity	All data table records are unique and relate appropriately to other data tables.	Database schemas include appropriate constraints (e.g., primary keys, foreign keys).
Speed	Large database tables are structured appropriately to optimize performance.	Review data tables to ensure indexes are applied to columns appropriately and are using the appropriate type of index (e.g., bitmap indexes are applied to low-cardinality columns). Ensure table statistics are analyzed and up to date.
	Modifications and additions to ETL process do not negatively impact the overall performance of the ECHO refresh.	Run time trials prior to integrating new ETL with ECHO refresh. Output timestamps to monitor how long database takes to complete each processing step. Review output to identify process bottlenecks.

Table 4-1. Quality Specifications and Verification Methods for ECHO

Quality Criterion	Specification	Verification Method
Static Pages and Site Documentation		
Currency	Help content reflects most recent updates to web queries, reports, and web services.	Content editors use a centralized bug and task tracking system to monitor developer tasks for updates that affect help content.
Format	Content follows EPA web styles. HTML formatting and commands follow ECHO guidance.	Content editors audit recently edited content for web style standards. Content editors periodically run module that scans for redundant HTML.
Functionality	Links to other pages and documents function properly.	Content editors test links after publishing content. Content editors review EPA's Sitebeam reports for broken links and missing files.
Accuracy	Content accurately describes ECHO data sources and query logic. Site does not contain typos or spelling errors.	Content is reviewed by another ERG team member before being published in EPA's web content management system. Content editors review Sitebeam reports for spelling errors.
Accessibility	All content meets Section 508 Accessibility requirements.	ERG will complete the Accessibility checklist provided in the Technical requirement report for each ECHO page. ERG will review the Sitebeam report for accessibility recommendations. In addition, ERG will periodically conduct an external accessibility review of static content and documentation.
User Support		
Timeliness	Respond to all inquiries within 48 hours.	Team members check timestamp within help system interface to ensure all tickets are acknowledged or closed within the specified time period.
Accuracy	Responses are accurate based on current knowledge and available documentation, provide appropriate level of detail, and have a formal, but friendly tone.	Responses to frequently asked questions use standard, EPA-approved language. Non-standard responses receive review by another ERG team member. Advanced technical questions are elevated to the EPA WACOR.

4.2   Quality Reporting

ERG uses a web-based agile task management tool to track issues identified during testing. Figure 4-1 illustrates the process that ERG uses to manage tasks on the ERG Development/Sprint task board. Testers identify issues that impact the user interface or web services and add descriptions of the issues to the Development/Sprint task board. The ERG task lead reviews the Development/Sprint task board and prioritizes issues for developers to address for the next development cycle. After developers have addressed the high priority issues, testers retest the code and update the Development/Sprint task board accordingly.

Prior to deployment, ERG testers communicate the remaining known issues to the EPA WACOR via the task management tool. The EPA WACOR determines whether the website is of adequate quality for deployment. After the website is approved for deployment, the ERG testing lead provides the final list of known issues to the EPA WACOR via the Known Issues task board. Based on that board, ERG also summarizes the list of issues for posting on the public ECHO website. ERG maintains a history, on ERG's network, of test cases performed and their results for each ECHO code deployment.

Figure 4-1. Known Issues Task Management Process for ERG Development/Sprint Task Board

5. **SOFTWARE DEVELOPMENT AND TESTING PROCEDURES**

This section describes the ECHO architecture, development workflow, and testing and maintenance procedures.

ERG performs the following types of testing on the calculation modules' codes following any major updates to the programming code:

- Unit Testing;
- Integration Testing;
- System Testing;
- User Acceptance Testing;
- Automated Regression Testing; and
- Source Code Review and Testing.

5.1   Unit Testing

Individual developers conduct unit testing as they code individual functions or blocks of code. Although the developers do not generate a unit testing report and documentation, they are required to confirm the following before releasing materials for integration testing:

- Functional requirements are completely fulfilled for the pages in question;
- Functionality of new functions and methods is documented; and
- New code does not break any existing unit tests.

5.2   Integration Testing

The lead programmer conducts system testing by examining integrated units and modules, grouped as appropriate. During integration testing, the lead programmer ensures that the new code addition does not impact the stable code base and that all parts of the integrated code function properly. The lead programmer alerts the developers of any bugs identified during testing and the developers revise and retest the code. The lead programmer also reviews code to ensure that it meets design specifications, as described in the SDD and technical requirements report. These documents are drafted by ERG and reviewed and approved by EPA prior to development.

5.3   System Testing

An ERG testing team conducts functional testing to verify that the code functions as expected. The ERG testing team performs test cases to evaluate the website code against the quality criteria described in Section 4. ERG testers communicate any issues to the ERG programming team to identify and correct the source of the error. ERG retests code following revisions. ERG testers also perform random monthly testing of searches and reports on ECHO's production site, and communicate any issues to the EPA WACOR in writing. Individual test cases specify:

- Scenarios users are expected to execute;
- Values that should work in each scenario;

- Values that should return errors;
- The appropriate error messages according to the type of value;
- Output to be checked against expected values;
- Levels of access to be tested; and
- Any other relevant functional or technical specifications.

5.4 User Acceptance Testing

The ERG WAM coordinates with the EPA WACOR to determine when the website is of adequate quality for user acceptance testing (UAT). The EPA WACOR coordinates UAT, collects comments, and prioritizes comments to be addressed in future development cycles.

5.5 Automated Regression Testing

ERG testers maintain automated test cases and conduct automated testing procedures on a regular basis to verify the ECHO front end interface as well as web services. Automated test cases are maintained on centralized EPA repositories to assure version control. The results of manual and automated front end and web service testing are documented on ERG's local network.

Front end test cases test ECHO features according to ERG's current formal test cases (see Appendix A for a formal front end test case example). Front end test cases are developed using an automation framework and executed with custom VBA. Front end test cases produce a log file containing test results, including any errors that occurred. Log files are maintained as documentation. Testers review log files for errors, manually investigate and confirm the errors, and report error details to the EPA WACOR.

Web service test cases verify all ECHO web services for data quality. Web service test cases are developed based on ERG's formal ECHO test cases, informal ECHO testing knowledge, and historical issues identified during testing of the ECHO DataMart. ERG maintains web service test cases using automated testing software. The web service test cases produce testing result files that describe data quality issues. Testers manually review the results, investigate any data quality errors, and report issues to the EPA WACOR. Documentation describing web service test cases is maintained on ERG's local network and on the ECHO Development Wiki.

ERG conducts front end automated testing on the staging environment prior to requesting NCC code reviews on ECHO or ECHO Lab (typically on a bimonthly basis). ERG also conducts front end automated testing on echo.epa.gov after each software release, and within the ECHO Lab environment after significant code merges.

ERG conducts web service automated test cases on a weekly basis, consistent with the ECHO DataMart weekly refresh schedule. ERG reports issues immediately when they are detected, and conducts bi-weekly quality review meetings with the EPA WACOR. At the quality review meetings, ERG and EPA discuss issues that the automated test cases detect, as well as new automated test cases to be developed.

5.6   Source Code Review and Documentation

ERG developers include 'developer comments' in the source code. Source code also adheres to internal coding standards to ensure code is reasonably self-documenting and readable. Comments enable future developers to understand the purpose and flow of each module. The ERG lead developer reviews all changes to source code to ensure that the ERG programming team follows all coding standards and provides the appropriate level of detail in the documentation embedded in the source code.

5.7   ECHO Static Content

New and updated content is drafted in EPA's web content management system and reviewed by the EPA WACOR prior to publication. Revisions are automatically saved to facilitate comparison of previously published content.

ERG team members regularly review existing ECHO help pages and other documentation to ensure that help content is consistent with new development during each code release. ERG drafts and publishes minor updates accompanying code releases (e.g., adding or modifying search results column descriptions). Content with substantial revisions is drafted for review by an ERG Editor, and as appropriate, the EPA WACOR.

Content created in ECHO follows EPA web styles. Since ECHO maintains a separate instance of Drupal from the EPA WebCMS, ERG developed a guidance page for creating ECHO content to clarify site-specific standards, such as content organization and restrictions ERG periodically reviews pages to make sure content, formatting, and organization are consistent with EPA web style and ECHO guidance. The location of a new page within the site organization is approved by the EPA WACOR before the content is drafted.

Site content is written by default in Filtered HTML text format, which restricts the types of formatting and commands that can be used in HTML. However, the text format may be upgraded to Advanced HTML to allow enhanced formatting and functionality. ERG developed a function to scan the WebCMS database for unnecessary or redundant HTML. ERG periodically runs the report to assess whether specific pages formatted in Advanced HTML can be downgraded to Filtered HTML, and remove redundant code.

EPA maintains a subscription to Sitebeam, a software tool for automated website testing. Sitebeam provides a suite of metrics that scan and provide feedback on usability and accessibility features on web pages, including spelling and grammar, broken links, speed, accessibility standards compliance, and search engine results. EPA provided two ERG team members access to the Sitebeam website. ERG reviews the reports each month to identify and correct updated or broken links, missing files, and spelling errors that may exist in ECHO. ERG also periodically reviews other content and accessibility summaries and recommendations from the Sitebeam reports.

5.8   ECHO Support

ERG manages ECHO's technical user support services. Most support requests are received through the Contact Us page in ECHO, with additional requests forwarded from the

EPA WACOR. All messages sent through the ECHO Contact Us page are routed to Zendesk customer service software. ERG responds to messages using Zendesk, and occasionally via phone, upon request. ERG developed SOPs that are shared with all ERG team members (ERG, 2015). ERG will update the SOPs throughout the course of the project as needed.

ERG Support team members use macros within Zendesk to maintain and retrieve responses to common questions. This feature enables ERG to write responses quickly and easily with standard, EPA WACOR-approved language (e.g., login issues, historical data requests, error reporting). Each non-standard response is reviewed by a second team member for accuracy, clarity, and tone. Questions that cannot be answered by an ERG team member are elevated to the EPA WACOR or specific EPA staff, as outlined in the ECHO Support SOPs.

ERG monitors Zendesk several times a day. ERG staff strive to respond to all messages within 48 hours. Urgent messages, such as registration or site access issues and potential bugs, are addressed as soon as possible (usually within 2 hours of receipt). If a particular response or resolution will require additional time (e.g., to request input from an EPA subject matter expert), ERG will provide acknowledgement to the commenter that the inquiry is in-progress.

Zendesk retains all messages and responses together as tickets. Zendesk allows tickets to be quickly retrieved by organizing tickets by ECHO user name, category (customized by ECHO topics), and other message metadata. Categories used to flag tickets by topic are described in the ECHO Support SOPs. The complete message history enables ECHO help desk staff to better respond to individual users and streamlines recordkeeping. ERG discusses feedback received through the helpline and support requests forwarded by EPA with the EPA WACOR during weekly status meetings. ERG reports the number of tickets received each month to the EPA WACOR.

6. REFERENCES

EPA, 2001. U.S. Environmental Protection Agency. *EPA Requirements for Quality Assurance Project Plans QA/R-5*. EPA/240/B-01/003. Office of Environmental Information. March 2001.

EPA, 2002. U.S. Environmental Protection Agency. *Guidance for Quality Assurance Project Plans QA/G-5*. EPA/240/R-02/009. Office of Environmental Information. March 2001.

ERG, 2016. Eastern Research Group, Inc. *Quality Assurance Project Plan for ECHO Website*. September 2016.

Appendix A: FORMAL TEST CASE EXAMPLE

Test Name:	Effluent Charts – Chart High-Level Display and Functionality
Test Case ID:	TC-6C

Tester:	**Date of Test:**
Testing Phase:	**Priority:**

Objective: Verify that charts are correctly hiding and displaying the data series and limit lines using the dual-purpose legend, charts are correctly zooming to the desired date range, and data points and limit lines are displaying values after mouse over, and other high-level features. Facility-specific information has been changed.

Test Conditions/Requirements: Access to ECHO staging environment.

Browser:

Step #	Description	Expected Results	Actual Results	Pass/ Fail
1	Navigate to http://[URL redacted]/effluent-charts #ST0000001	Displays the Effluent Charts page for Company A.		
2	Click the cell in the summary grid for BOD, 5-day, 20 deg. C, Outfall 001.	Two charts are displayed below the summary grid, one Concentration chart and one Quantity Chart. A header above both charts displays BOD, 5-day, 20 deg. C. Each chart has 4 labels above the chart area: Parameter, Discharge Point, Monitoring Location, and Sampling Period. The x-axis displays dates for a 3-year period. The y-axis displays the units for measurements. A legend is displayed below each chart. Two limit lines and two data series are displayed for each chart. Certain data points are red indicating a violation. Circular data points are shown above the chart areas indicating reporting/monitoring violations.		
3	Click the MX MO AV LIMIT label in the legend below the quantity chart.	The MX MO AV LIMIT line no longer displays on the chart area.		

Step #	Description	Expected Results	Actual Results	Pass/ Fail
4	Click the MX WK AV LIMIT label in the legend below the quantity chart.	The MX WK AV LIMIT line no longer displays on the chart area. All that remains on the chart area are triangular data points.		
5	Click the MX MO AV label in the legend below the quantity chart.	The MX MO AV data series no long displays on the chart area. Only one data series remains on the chart.		
6	Click on the concentration chart area at Jan 16 and drag the cursor to the right to May 16.	The chart area zooms into the selected date range (Jan 163 – May 16). A Reset Zoom button appears on the chart area. 6 data points are displayed.		
7	Hover mouse over the far right data point.	A text box appears above the data point: "April 30, 2016. MX WK AV: 20.3"		
8	Click Reset Zoom.	The chart area reverts back to displaying the 3-year date range.		
9	Click the MX WK AV LIMIT label in the legend.	The limit line appears on the chart area.		
10	Hover mouse over the limit line over Jan '16.	A text box appears above the data point: "Dec 31, 2015. MX WK AV LIMIT: 45"		
11	Click the Chart Legend link in the chart header.	An image of the detailed legend is displayed in an overlay window.		
12	Click the Help link in the chart header.	A new tab opens with the Effluent Charts help page.		
13	Click the Download Data button in the chart header.	A download prompt appears and all data from the BOD Quantity and Concentration charts are downloaded in a CSV file.		

Test Name:	Effluent Charts – Chart Data Display and Quality	
Test Case ID:	TC-6D	
Tester:		**Date of Test:**
Testing Phase:		**Priority:**
Objective: Verify that individual charts are correctly displaying data points, including violation indicators and measurement indicators. Verify that chart data points match data in the web service. Facility-specific information has been changed.		
Test Conditions/Requirements: Access to ECHO staging environment.		
Browser:		

Step #	Description	Expected Results	Actual Results	Pass/ Fail
1	Navigate to https://[URL redacted]/effluent-charts#ST0000002	Displays the Effluent Charts page for Company B.		
2	Change the start date to 10/1/2013 and the end date to 1/1/2016.	The summary grid is updated to reflect the selected date range.		
3	Click the cell in the summary grid for Copper, total recoverable, Outfall 001.	Concentration and Quantity charts display below the summary grid for Copper, Outfall 001. The Concentration chart displays mg/L units on the y-axis, and the Quantity chart displays lb/d units on the y-axis. The Avg limit line is dashes and the Max limit line is solid.		
4	From the concentration chart, click the legend labels to hide MO AVG LIMIT, DAILY MX LIMIT, and DAILY MX data points from the chart area.	Only MO AVG data points remain on the chart.		
5	Examine the MO AVG data point shapes/colors using the legend link above each chart.	All average measurements (e.g., MO AVG) should be diamond shaped. The following points are displayed: 1 yellow unfilled at 11/13. 5 purple filled from 1/14 to 5/14. 2 green filled at 8/13 and 12/13. 5 red filled from 7/15 to 12/15. The remaining points are red unfilled. There are 10 blue or green circles on the late/missing reports timeline.		

Step #	Description	Expected Results	Actual Results	Pass/ Fail
6	Click the Show/Hide Table button above the chart.	A data table is displayed containing data from the chart.		
7	Confirm that the MO AVG violation indicators in the chart match the table data.	The color of the data point matches the Violation Severity column (SNC: Red, RNC: Yellow, Effluent: Purple). If the RNC Resolution Code column is 1, A, or null, the data point should be filled. If the RNC Resolution Code is anything else, the data point should be unfilled.		
8	Navigate to http://[URL redacted]/eff_rest_services3.get_effl uent_chart?&p_id=ST0000002&para meter_code=01119&outfall=001&st art_date=12/31/2014&end_date=02/ 28/2015	Displays the raw service data for the Copper, Outfall 001 charts from the previous steps. The date range is set in the URL to only show data from 12/31/2014 to 02/28/2015.		
9	Compare the three MO AVG data points (12/31/2014, 1/31/2014, 2/28/2015) on the chart with the service data	The ViolationCode service parameter should contain an "E90" value for all three points. Under the E90 service data, the RNCResolutionCode parameter value should be "2" for 12/31/14, and null for 1/31/15 and 2/28/15, and the ViolationSeverity value should be "SNC" for 12/31/14, and "Effluent" for 1/31/15 and 2/28/16. There should be a second ViolationCode parameter for 1/31/15, populated with "D90". The DMRValueNmbr parameter matches the value in the chart for each data point, and the LimitValueNmbr parameter matches the MO AVG limit value in the chart.		
10	Navigate to https://[URL redacted]/effluent-charts# ST0000003	Displays the Effluent Charts page for Municipal Wastewater Treatment Plant 1		
11	Click the cell in the summary grid for Phosphorous, Total, Outfall 001.	Two quantity charts display. One for Monitoring Location: Effluent Net, and one for Monitoring Location: Effluent Gross. Both charts display two Total data series. Both series' data points are green diamonds. Both charts display "Quantity (lb)" on the y-axis.		

Step #	Description	Expected Results	Actual Results	Pass/ Fail
12	Click the cell in the summary grid for pH, Outfall 001.	One concentration chart displays with one Min data series and on Max. The Min data points are orange downward-pointing triangles and the Min limit line is solid. The chart displays "Concentration (SU)" on the y-axis.		
13	Navigate to https:// [URL redacted]/effluent-charts#ST0000004GU0020222	Displays the Effluent Charts page for Wastewater Treatment Plant 2.		
14	Click the All Pollutants-All Outfalls cell in the summary grid	All available charts are displayed that have limit data, effluent data, or violation data. Charts that do not have any limit data, effluent data, or violation data are not displayed, and there are no empty chart headers displayed for these charts.		