

Dam Construction Data Management in USACE

National Dam Safety Program Technical Seminar | 2024

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Agenda & Objectives

- Introduction to Data Management at USACE Dams
- History and Evolution of Project Specifications
- Major Components of Data Management Systems
- Examples and Case Studies
- Developing a Standard of Practice
- Applications to Smaller Projects

Data Management at USACE Dams

USACE (and other owners) need data to:

1. Make rapid data-driven decisions
 2. Verify that specifications are met
 3. Verify that that the design intent is met
- As construction and monitoring technologies have evolved, USACE has changed specifications to match



We are generating a huge amount of data FAST.
Need for specifications to “catch this wave”.



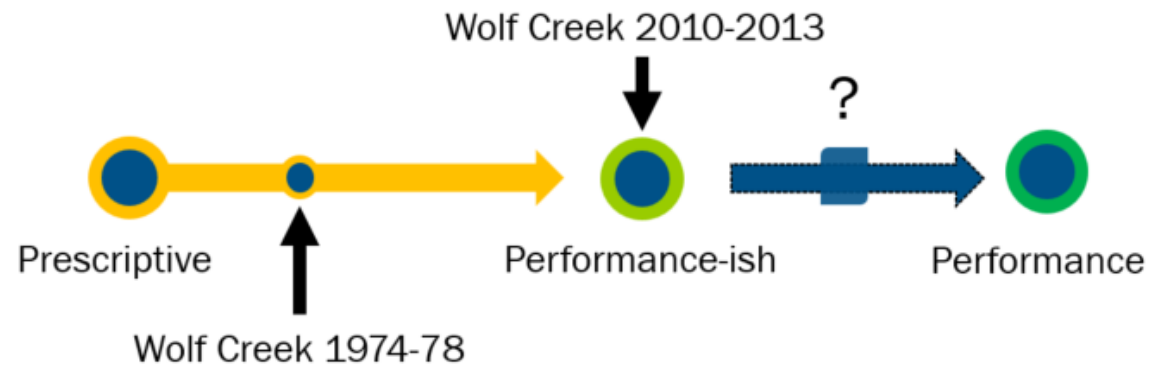
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Wolf Creek Dam, KY
Secant Pile Wall

National Dam Safety Program Technical Seminar

History and Evolution of Project Specifications

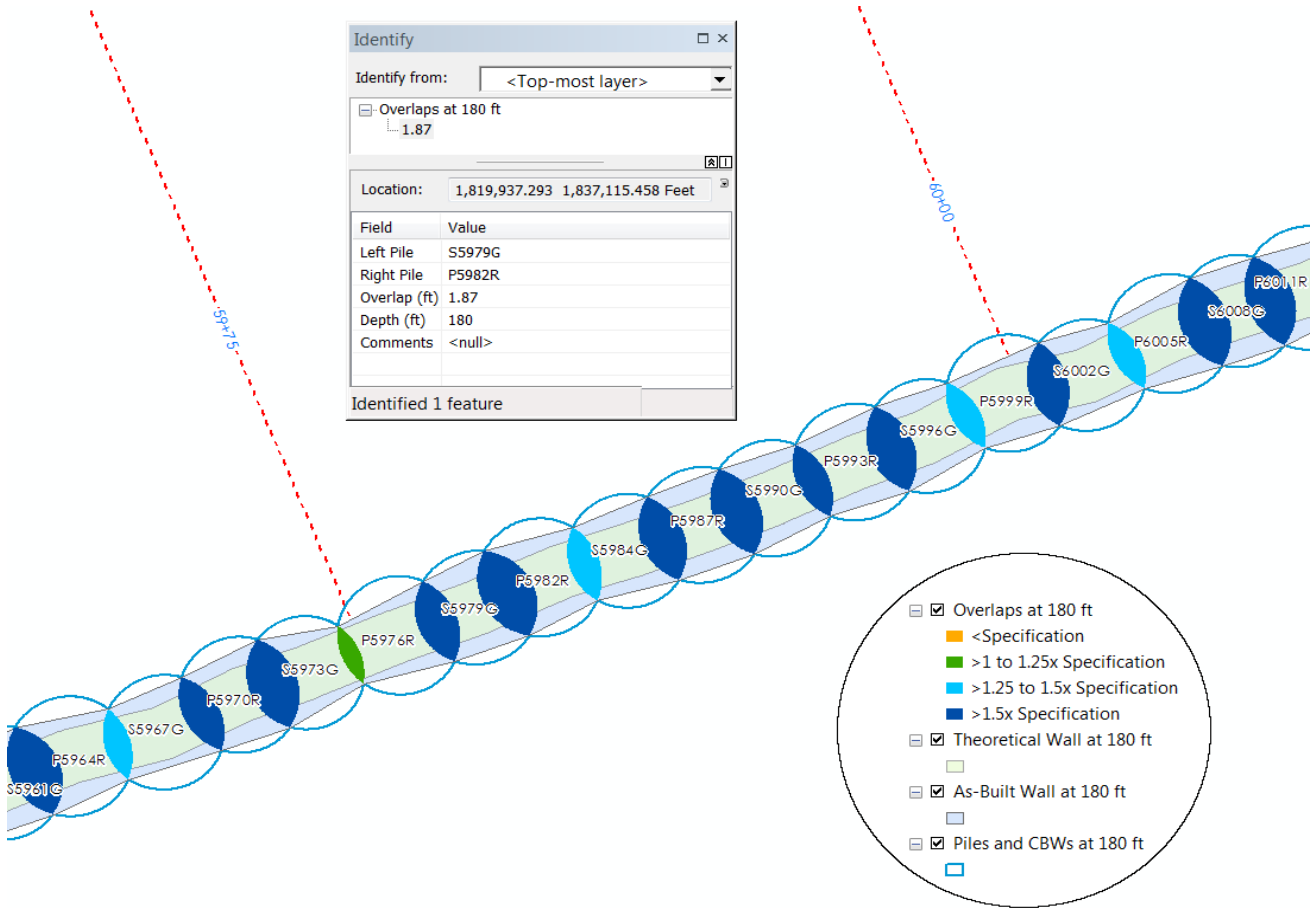
- Specifications have been getting more specific
 - Continuous Improvement; added new technologies and requirements, while making it easier for Contractors where possible
 - Trend towards more **performance-based** specifications to allow for innovation
 - Authorship of Guide Specification



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Data Management at USACE Dams 2

- Pre-2000 Requirement
 - Submit data
- Mid-2000s
 - Submit Raw Data
 - Visualize Data for USACE use
 - Use specified formats (GIS)



Bluestone Dam: Interactive Geospatial Model



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Herbert Hoover Dike: Web-Based Viewers

Layers

Filter Layers...

- CSM Panels
 - QC Samples
 - Verification Boring
 - Verification Boring Deviation
- CSM - As-Built (with hyperlinks)
 - CSM - As-Built Secondary
 - CSM - As-Built Primary
- CSM - As-Built Elevation Cuts
 - CSM - El. +25 ft NAVD88 Cut (TOP)
 - CSM - El. +15 ft NAVD88 Cut
 - CSM - El. +5 ft NAVD88 Cut (MID 2011+28-3010+00)
 - CSM - El. +2.5 ft NAVD88 Cut (MID 3010+00-3080+00)
 - CSM - El. 0 ft NAVD88 Cut (MID 3080+00-3348+00)
 - CSM - El. -5 ft NAVD88 Cut
 - CSM - El. -15 ft NAVD88 Cut (ROT 2011+28-3010+00)

Map Area

Aerial Im... State Plane Florida East (US Feet) X 700116.74198 Y 872701.60299 1:500 0 1.5 3ft

P3151836 (As-Built -25 ft)

JobSiteNumber 03P413300000000	ToeLevelOfElement_ft -27.58	Center_Y_ft 872699.589
TechniqueID CSM	DrillLength_ft 65.39	Azimuth_deg 119.73
State AsBuilt	ElementLength_ft 52.58	Layer P-CSM_Plan_DepthCuts
ReferenceLineNumber 3151-00_3161-00	DepthSection_ft -25	Color 3
ElementName P3151836	ToolLength_in 110.24	Label P3151836
MainElementType P	ToolWidth_in 27.95	DepthCut Bottom
ElementType F	elevation_ft -25	PanelGeom N/A



Moving Towards a Standard of Practice

- Data Management During Construction
 - USACE recognizes the value of data for real time quality management, long term O&M, future risk assessment and construction
 - Pressing need to eliminate manual processes and maximize personnel efficiency while delivering researchable data
 - Multiple pain points
 - Specific security guidelines can be barriers to full automation
 - Technology skill sets not guaranteed from project to project
 - DMS design is complex
 - With a recommended Standard of Practice USACE can better leverage existing work products, avoid making the same mistakes



Development of a Guide Specification

Some language and lessons learned incorporated:

- Bolivar Dam
 - East Branch Dam
 - Herbert Hoover Dike
 - Pine Creek Dam
 - C-43 & C-44
 - Kentucky Lock
 - Chickamauga Lock
 - Isabella Dam
- ...and other projects

1.2 REQUIREMENTS

1.2.1 Data Integrity

Maintain integrity of data such that records are accurate and internally consistent, that all data and records reflect the quality of the data gathered on the site, and that all data is preserved and archived for future use.

1.2.2 Data Ownership

All data generated on-site by instrumentation, monitoring, construction equipment, sampling, concrete and soil testing, grouting, blasting, surveying, concrete production, conveyance and placement, tunneling, mapping, calibration, maintenance, and all other data associated with the work performed is the property of the Government. All calculations and formulae and any

constants or variables used to produce data, reports, or analytical products are the property of the Government and must be included in any required database fields, and turned over in an editable or otherwise specified format upon request.

If software developed by or for the Contractor will be used for processing of data provided to the Government, it is required to detail to the Government the algorithms and procedures used to process the data. The Contractor maintains ownership of its computer code, unless otherwise specified in the Contract, but must allow the Government access to the algorithms (with all variables and values defined) and procedures to verify how the data is processed so that the quality of the final can be assessed. Where the Contract specifies software development by the Contractor and that development is paid by the Government, the ownership of the software will transfer to the Government.

This may not be part of most contracts, but it is not bad boilerplate language to leave in just in case

For any data the Contractor wishes to exclude from the system, the Contractor must submit a written request for a Government determination of whether data can be classified as proprietary, along with a detailed justification. No data source is exempt from these data requirements unless a specific exemption is requested of and granted by the COR. Under no circumstances shall "proprietary data" impede the Government's ability to monitor construction, perform analyses, or evaluate the effectiveness of construction.



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Components of Project Specifications

- Prior to construction, the Contractor will:
 - Build a GIS with the construction layout
 - Compile historical data, including geological borings
 - Author a Data Management Plan so the government knows that data will be managed effectively before any construction data are collected
- During construction, the contractor will:
 - Maintain a live GIS to allow the government to track and view progress
 - Populate a live database to allow the government to view and analyze data



Components of Project Specifications 2

- Following construction, the contractor will:
 - Submit a full-scale GIS to allow the government to combine geospatial features with data from other work phases
 - Submit a complete database to serve as the authoritative project archive



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Components of Project Specifications 3

SECTION TABLE OF CONTENTS
DIVISION 01 - GENERAL REQUIREMENTS
SECTION 01 31 00
DATA MANAGEMENT
05/22

PART 1 GENERAL

- 1.1 SCOPE OF WORK
 - 1.1.1 Overview of Goals and Components
- 1.2 DATA REQUIREMENTS
 - 1.2.1 Data Integrity
 - 1.2.2 Data Ownership
 - 1.2.2.1 Custom Algorithms
 - 1.2.3 Disclosure of Data or Advertisement of Project
 - 1.2.4 Backups, Archiving and Disaster Recovery
 - 1.2.5 Contractor Quality Control of Data
 - 1.2.6 Raw Data Requirements
 - 1.2.6.1 Digital Raw Data
 - 1.2.6.2 Analog Raw Data
 - 1.2.7 Data Turnover Timeframes
 - 1.2.8 Record Tracking Requirements
 - 1.2.9 Naming Conventions
 - 1.2.9.1 Fields of Database, ArcGIS Feature Classes or Tables
 - 1.2.9.2 Folder and Filenames
 - 1.2.9.3 Site Feature ID's
 - 1.2.9.4 Photograph naming convention
 - 1.2.10 Spatial Data Projections and Datums in GIS
 - 1.2.11 Geospatial Metadata
 - 1.2.11.1 Vector Datasets
 - 1.2.11.2 Raster Datasets
 - 1.2.12 Photographs
 - 1.2.13 SDSFIE
 - 1.2.14 Network Infrastructure
 - 1.2.15 COR Access to Data
 - 1.2.16 Conflicts of Data Requirements
 - 1.2.17 Data Collection Prior to Full Approval of the Data Management System Components
- 1.3 RELATED WORK SPECIFIED ELSEWHERE
- 1.4 REFERENCES
- 1.5 DEFINITIONS
 - 1.5.1 Data
 - 1.5.2 Data Cleaning
 - 1.5.3 Data Management
 - 1.5.4 Data Management System
 - 1.5.5 Data Validation/Verification
 - 1.5.6 Documented Enterprise Database (EDB)
 - 1.5.7 Metadata
 - 1.5.8 Relational Database Management System (RDBMS)
 - 1.5.9 Report
 - 1.5.10 Schema
 - 1.5.11 Secure File Transfer Protocol (SFTP)

- 1.5.12 Tabular Data
- 1.5.13 Tag
- 1.6 SUBMITTALS
- 1.7 PERSONNEL
 - 1.7.1 Qualifications
 - 1.7.1.1 Data Manager
 - 1.7.1.2 Assistant Data Manager
 - 1.7.1.3 CAD Supervisor
 - 1.7.1.4 CAD Technician(s)
 - 1.7.2 Roles and Responsibilities
 - 1.7.2.1 Data Manager
 - 1.7.2.2 Assistant Data Manager
 - 1.7.2.3 CAD Supervisor

PART 2 PRODUCTS

- 2.1 DOCUMENTED ENTERPRISE DATABASE
- 2.2 CLOUD-BASED DATABASE SERVICES
- 2.3 SFTP SITE
- 2.4 DATA TRANSFER AND QC REPORTS
- 2.5 ESRI GIS REST SERVICES
- 2.6 DESKTOP GIS FILES AND GEODATABASE
- 2.7 SQL EDB AND FEATURE GENERATION SCRIPTS/VIEWS
- 2.8 PHOTOGRAPH PDFS AND RAW DIGITAL PHOTOS
- 2.9 OPENGROUD CLOUD DATABASE AND RECORDS
- 2.10 QUICK REFERENCE GUIDE
- 2.11 DIGITAL CAD MODEL
 - 2.11.1 Spatial Referencing
- 2.12 DATA MANAGEMENT PLANS AND ADDENDA TO 100 PERCENT PLAN
 - 2.12.1 50 Percent Data Management Plan
 - 2.12.2 100 Percent Data Management Plan
 - 2.12.3 Addenda to the 100 Percent Data Management Plan
 - 2.12.3.1 Automated and Manual Data Collection Output Examples
 - 2.12.3.2 Data Cleaning and Verification Plan
 - 2.12.3.3 QC Daily Information Collection Plan
 - 2.12.3.4 Backups, Archiving and Disaster Recovery Plan
 - 2.12.3.5 Data Transfer Workflow
 - 2.12.3.6 Proposed Changes to the Enterprise Database Schema
 - 2.12.3.7 Data Management System Demobilization Plan
 - 2.12.3.8 Data Management System Demobilization Plan Updates
- 2.13 DATA MANAGEMENT PLANNING MEETING
 - 2.13.1 Additional Planning Meetings
 - 2.13.2 Coordination and Technical Meetings
- 2.14 TRAINING
 - 2.14.1 Initial Training Session
 - 2.14.2 Intermediate and Final Sessions

PART 3 EXECUTION

- 3.1 DOCUMENTED ENTERPRISE (SQL) DATABASE
 - 3.1.1 EDB Structure
 - 3.1.2 Schema Changes
 - 3.1.3 Database Mirror
 - 3.1.4 Ongoing Schema Updates
 - 3.1.5 Database Views
- 3.2 SYSTEM TESTING
- 3.3 ESRI DESKTOP AND ENTERPRISE PRODUCTS
- 3.4 FIELD OR MONITORING DATA COLLECTION
- 3.5 DATA MANAGEMENT PLAN



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Data Management Plan

- Required by Specifications
- Includes:
 - Automated and Manual Data Collection Output Examples
 - Data Cleaning and Verification Plan
 - QC Daily Information Collection Plan
 - Backups, Archiving and Disaster Recovery Plan
 - Data Transfer Workflow
 - Proposed Changes to the Enterprise Database Schema
 - Data Management System Demobilization Plan

1.1	Related Submittals	3
1.2	Requirements and Content	3
1.3	Data Manager	7
2.	IMS Overview	8
2.1	IMS Components	8
3.	Data Sources	10
3.1	Planned Elements	13
3.2	B-Tronic Instrumentation Data	13
3.3	Manual Observations During Drilling, Excavation, and Jet Grouting	17
3.4	Borehole Log Data	17
3.5	Quality Control Data	19
3.6	Field Documents	21
3.7	Photographs	21
3.7.1	Photograph naming	21
3.7.2	Photograph metadata	22
3.8	USACE-Provided Data	23
3.8.1	Historical Data	23
3.8.2	USACE QA Data	23
4.	Data Storage And Transfer Tools	24
4.1	SFTP Site	24
4.1.1	SFTP Access	24
4.1.2	SFTP Structure	24
4.2	Enterprise Database (EDB)	26
4.2.1	EDB Schema	27
4.2.2	Utility Tables	31
4.2.3	Utility Fields	31
5.	Data Access	32
5.1	EDB Tables in Mirror Database	32
5.2	Reports	32
5.3	Drawings	33
5.4	GIS	34
5.4.1	GIS Introduction	34
5.4.2	GIS Coordinate System	34



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Implementation of Database Schema

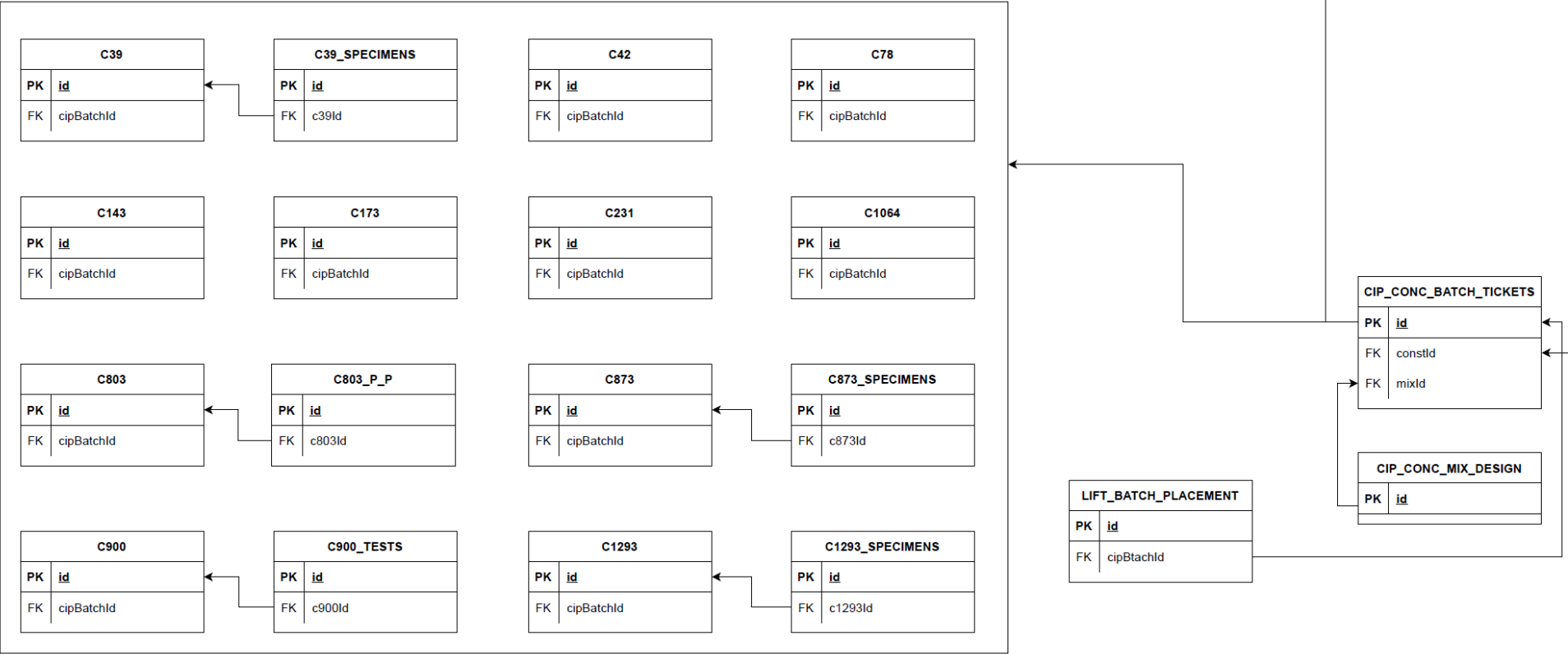
- Earlier Specifications required Contractor to design and document a Database Schema (definitions of tables and their columns)
 - This limited USACE in combining data from multiple projects, and relied on Contractor to determine data to be submitted
- Modern Specifications provide a schema
 - Allows USACE complete control over data provided



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Implementation of Database Schema 2

Detail from Database Schema: Quality Control Data from Concrete Placements



GIS Services

- Ongoing improvement in GIS Specifications
- Variable requirements for map viewers, 3D Models as desktop and/or web files
- Modern Specifications require Contractor to host and deploy GIS web services
- Allows USACE to view services and add them to owner dashboards, models, etc.
- Real-time update of data

The screenshot shows a web interface for a GIS service titled "Structure Drawing". The interface has a blue header with tabs for "Overview", "Data", "Visualization", and "Settings". Below the header, there is a thumbnail of a map with a green area, labeled "Pipestem Dam Spillway Baseline Features". The thumbnail includes an "Edit thumbnail" link and an "Add to Favorites" button. To the right of the thumbnail, the title "Pipestem Dam Spillway Baseline Features" is displayed, along with an "Edit" link. Below the title, it says "Feature Layer (hosted) by SSomnarain@GEOSYNTEC" and provides metadata: "Created: Oct 26, 2022", "Updated: Oct 26, 2022", and "View Count: 21".

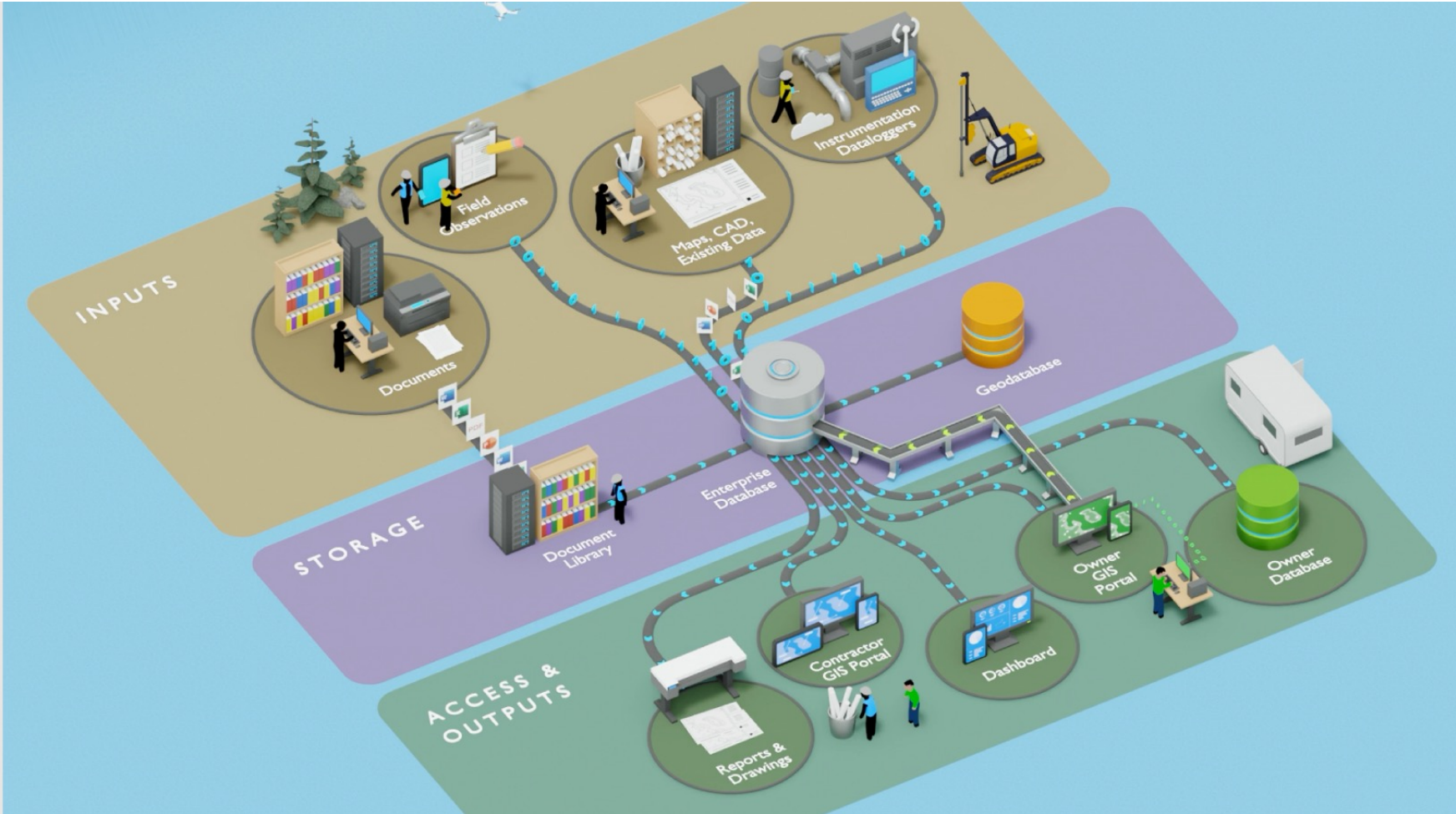
The "Description" section contains the text: "Design files of Terminal Structure and Spillway Grading Outline". There is an "Edit" link next to the description.

The "Layers" section lists two layers:

- Terminal Structure
Polyline Layer
- Spillway Grading Outline
Polyline Layer

On the right side of the interface, there are several buttons: "Open in Map Viewer Classic", "Open in Scene Viewer", "Open in ArcGIS Desktop", and "Metadata". Below these buttons is an "Item Information" section with a progress bar and a "Learn more" link. The progress bar is labeled "Low" and "High". Below the progress bar, there is a lightbulb icon and the text "Top Improvement: Add a longer summary". At the bottom right, there is a "Details" section with the following information: "Source: Feature Service", "Created from: Structure Drawing, Service Definition", "Size: 199 KB", and a star rating of five stars.

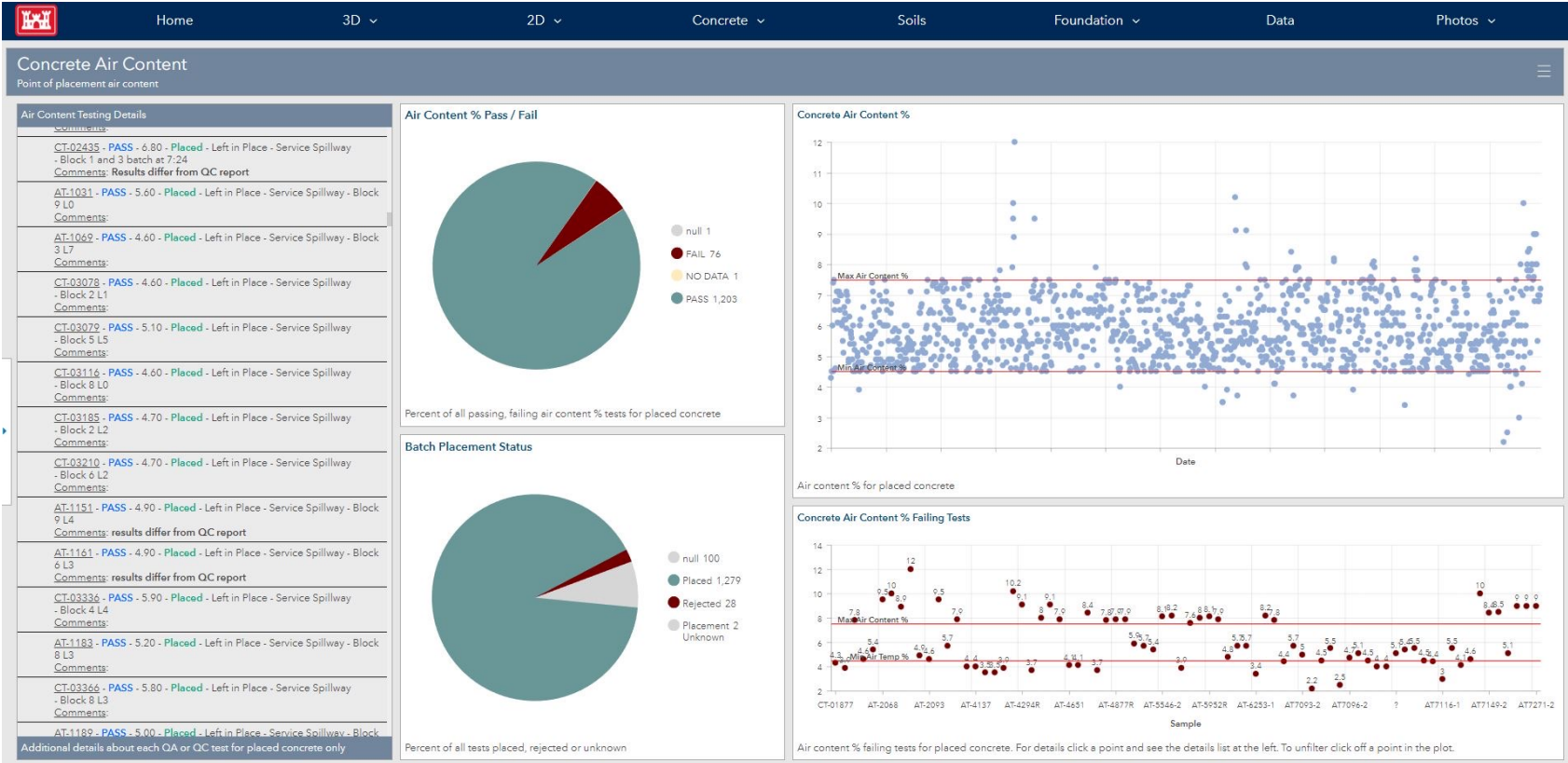
Putting It All Together



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USACE Data Visualization Hubs

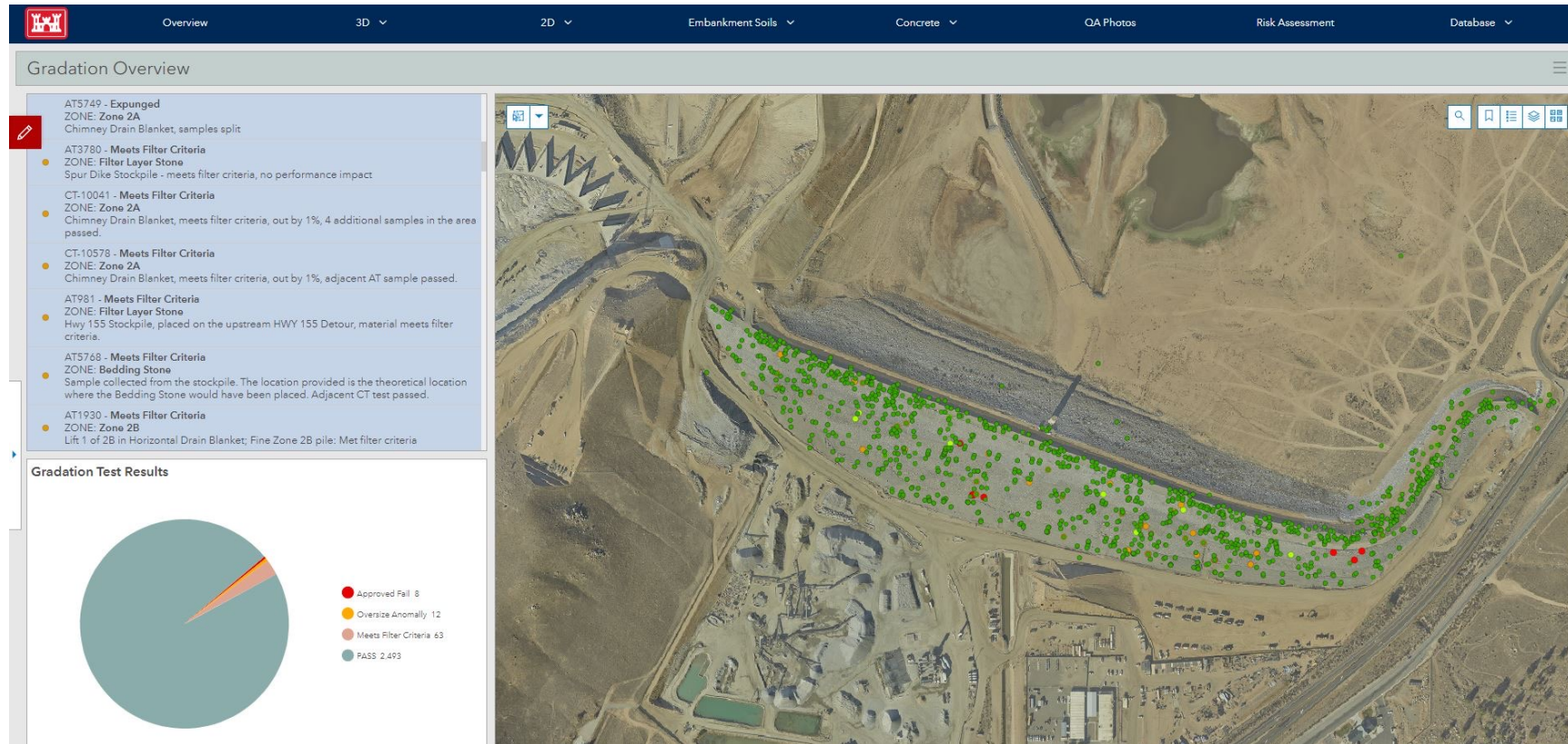
Dashboard Example for Concrete Fresh Properties Data



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USACE Data Visualization Hubs 2

Dashboard Example for Concrete Fresh Properties Data



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Upcoming Projects and Next Steps

- **Many Projects Will Leverage Full Automation**
 - Pipestem Spillway DSMP
 - Prado Spillway DSMP
 - Rough River Phase II DSMP
 - Kentucky Lock - Chamber Contract
 - Montgomery Lock - Chamber Contract
 - Upper Ohio Lock - Chamber Contract

- **Some Projects Have Only Minimum Standards**
 - Sacramento Weir
 - Folsom Dam Raise
 - Natomas Reaches



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Maximize Data Usability with Small Budgets

- Systems are scalable
 - Technologies developed on larger USACE dams can be applied inexpensively to smaller projects
 - Full automation is not needed for small projects
 - Experienced DM providers can pass on economies of scale
- Know what data you want ahead of time, and list it specifically in the contract
 - Ensure you have contract support to ask for any other data any time
 - Require native files for all visual products (as-builts, BIM Model, etc)
- Minimum data quality standards
- Formatting standards - for minimal processing to make it machine readable, no proprietary formats



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What Can Owners Do?

- Use existing Specifications
 - Example: DFI Guide Specification – free download from dfi.org
- Identify what you need and can reasonably achieve scaled to the project, include it in contracts:
 - Data deliverables as spreadsheets?
 - Drawings generated weekly?
 - Shared folder with daily reports?
 - Web dashboard?
 - Live collection of QA data via field tools?



The Technology is There for You

Grouting

Boreholes Grouted

1071

Total Grout Placed (gal or L)

96,150.36

Boreholes Grouted



Water Testing

Boreholes Water Tested

1073

Stages Water

5621

- Introduction
- Grout Holes
- Grout Closure
- Water Test Closure
- Lugeon Closure
- Total Grout Take by Series
- Average Water Test by Series
- Lugeon vs. Grout Take

Use the "Page Selector"

Units

Imperial (gallons)

SI (litres)

Southern Company - Sample Collection Form

1. Sample Information:

Location: *
Access Path Cell 3

SampleID: *

Sample Datetime: *
Tuesday, Aug... 2:43 PM

2. Sample Collection Information:

Photo #1 (optional):