GIS in Fire and Rescue:

Modern Approaches for Spatial GIS Data-Informed Decision Making

FAIRFAX COUNTY FIRE AND RESCUE DEPARTMENT

Introduction

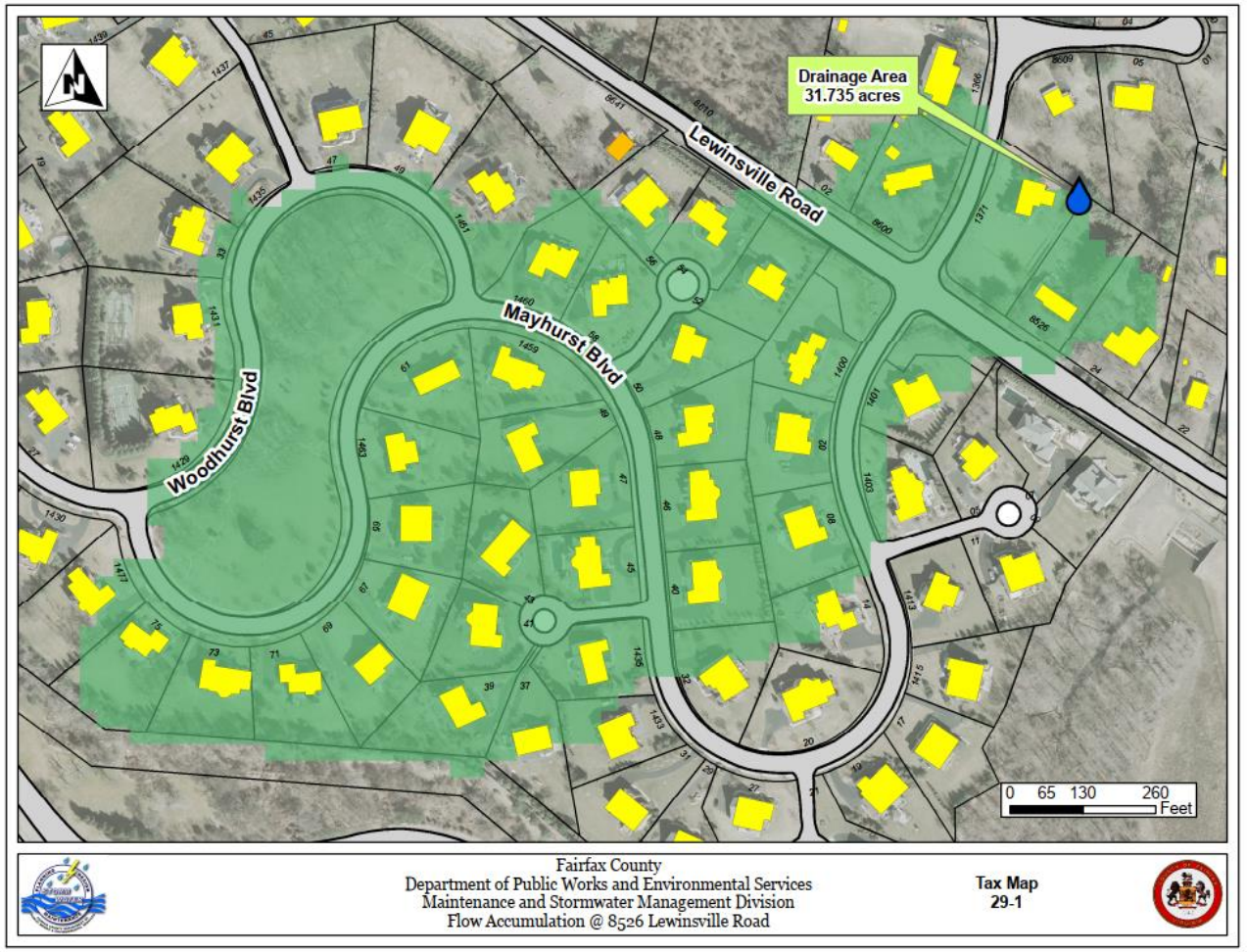
- Chip Galloway
- George Mason University BA in Geography 2008
- GIS Analyst since 2005
  - Federal contractor 2005 – 2006
  - Fairfax County Department of Transportation 2006 – 2008
  - Fairfax County Public Works (maintenance) 2008 – 2018
  - Fairfax County Public Works (planning) 2018 – 2021
  - Fairfax County Information Technology 2021 – 2024
  - Fairfax County Fire & Rescue Sept 2024

Overview

- Evolution of GIS
- A modern approach to GIS
  - Data Stewardship
  - Department use of SharePoint
  - Automation Tools
  - Federated GIS Services
  - Authoritative Data
  - UI/UX
- FRD Projects
  - PDF Map Projects
  - Fairfax Street Drills
  - Smoke Alarms
  - Hydrants

Evolution of GIS

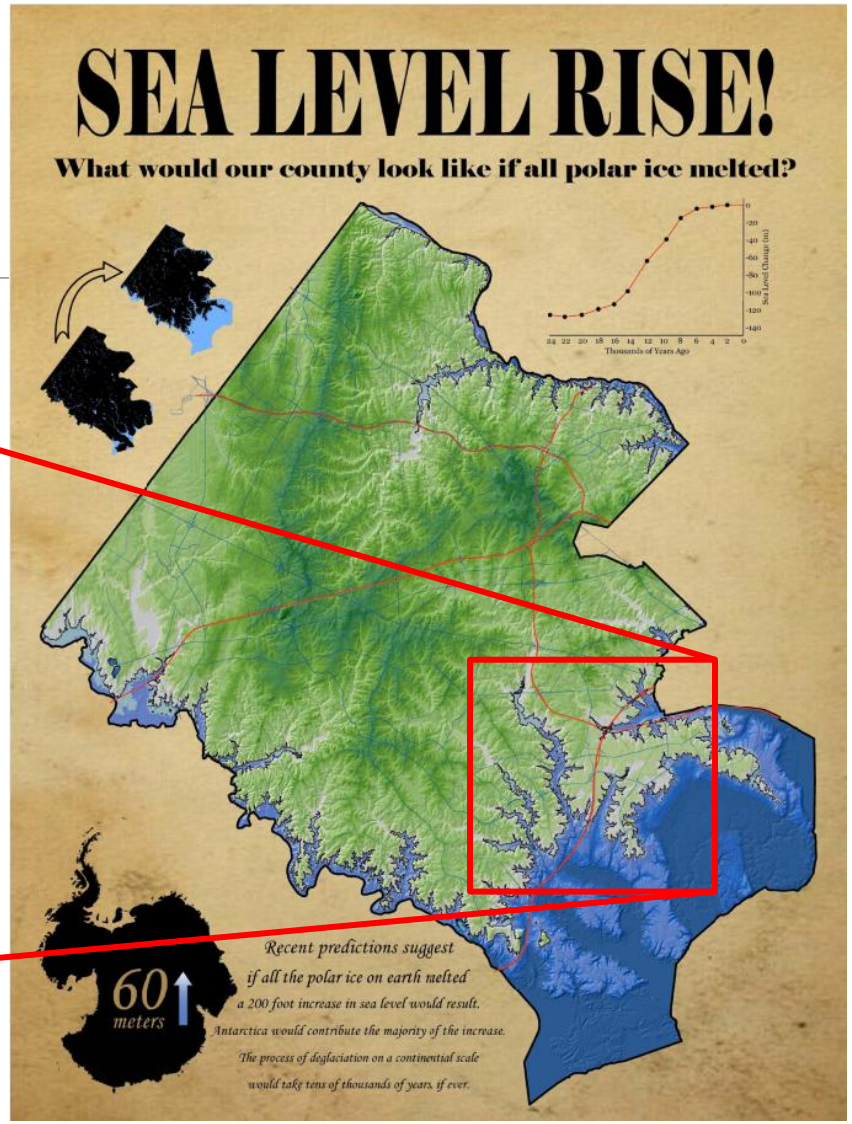
- 2008
  - ArcGIS Desktop (ArcMap 9.x)
    - Layout design & symbology
  - ArcCatalog
    - Enterprise data management
  - ModelBuilder
    - Building repeatable tools
  - Production Line Toolsets
    - Data editing
  - Trimble & Garmin GPS Devices
    - Field data collection
    - User experience



2008 – watershed delineation

Evolution of GIS

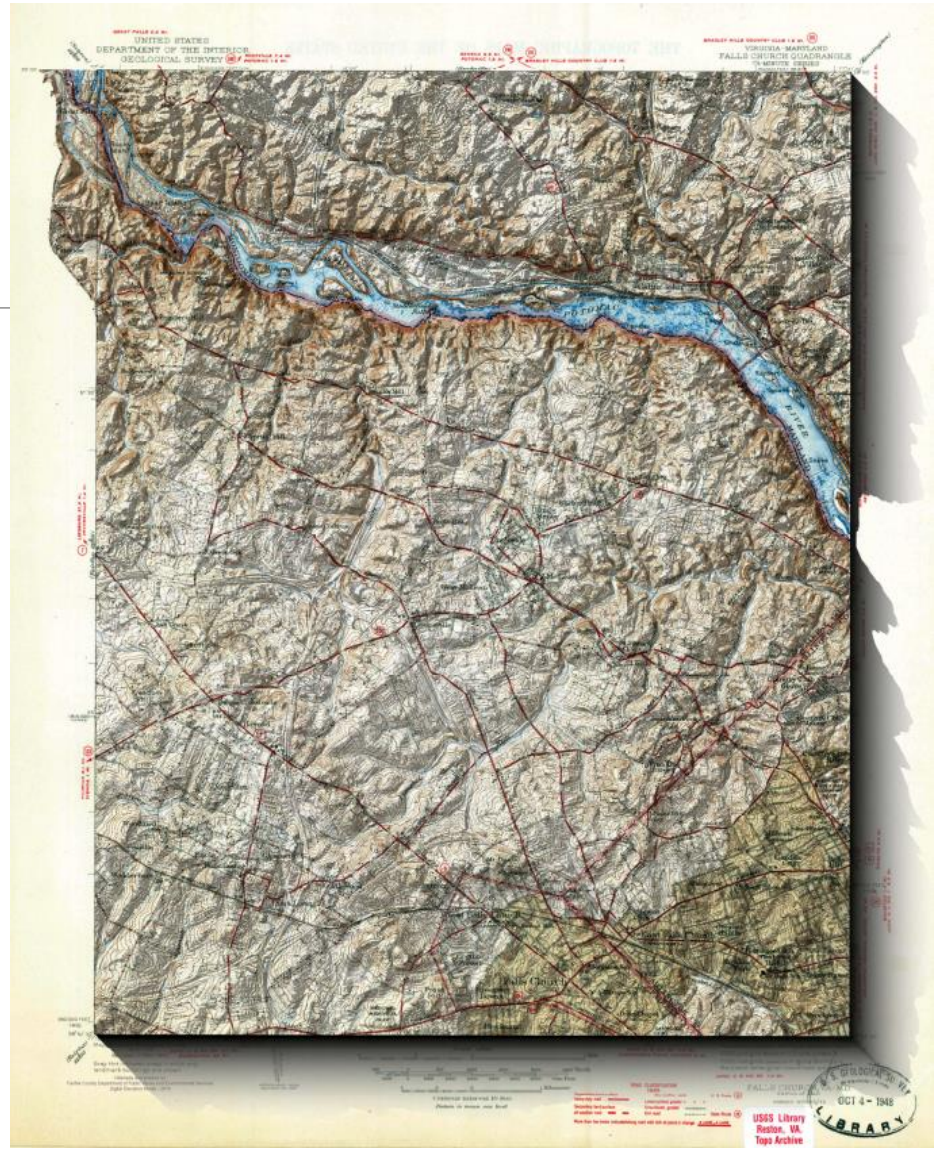
- 2011
  - ArcGIS Desktop (ArcMap 10.x)
    - Software upgrades
  - Raster/Imagery Web Servers
    - Elevation models
    - Imagery services
  - Basemap Layers
    - Time saver!
  - Adobe Flash & Illustrator
    - User interface
    - Digital cartography



2011 – propaganda style map

Evolution of GIS

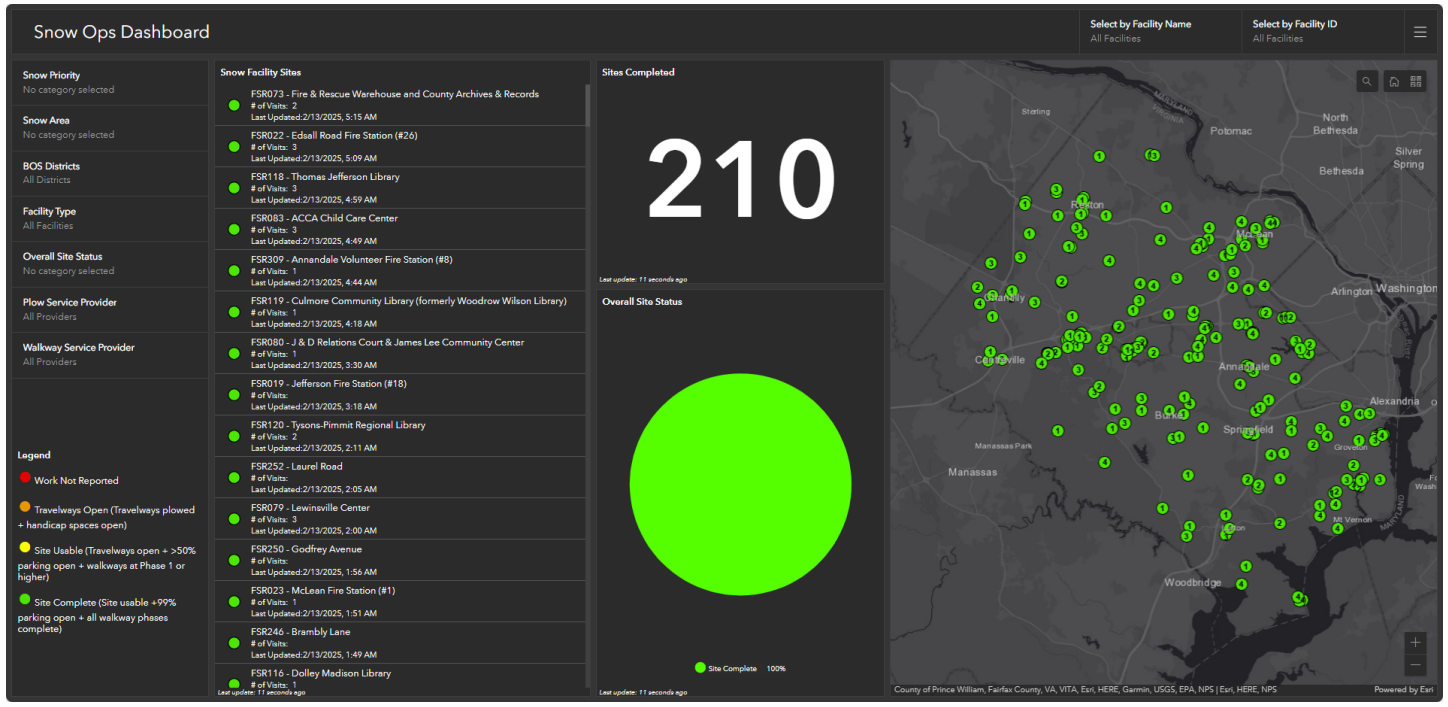
- 2015
  - ArcPro
    - New user interface – relearning the software
    - Renamed and enhanced tools
    - Learning curve
  - Advanced layout design
    - Design catching up to Adobe designer products
    - Map Series (Data Driven Pages)
    - Reports



2015 – shaded relief art

Evolution of GIS

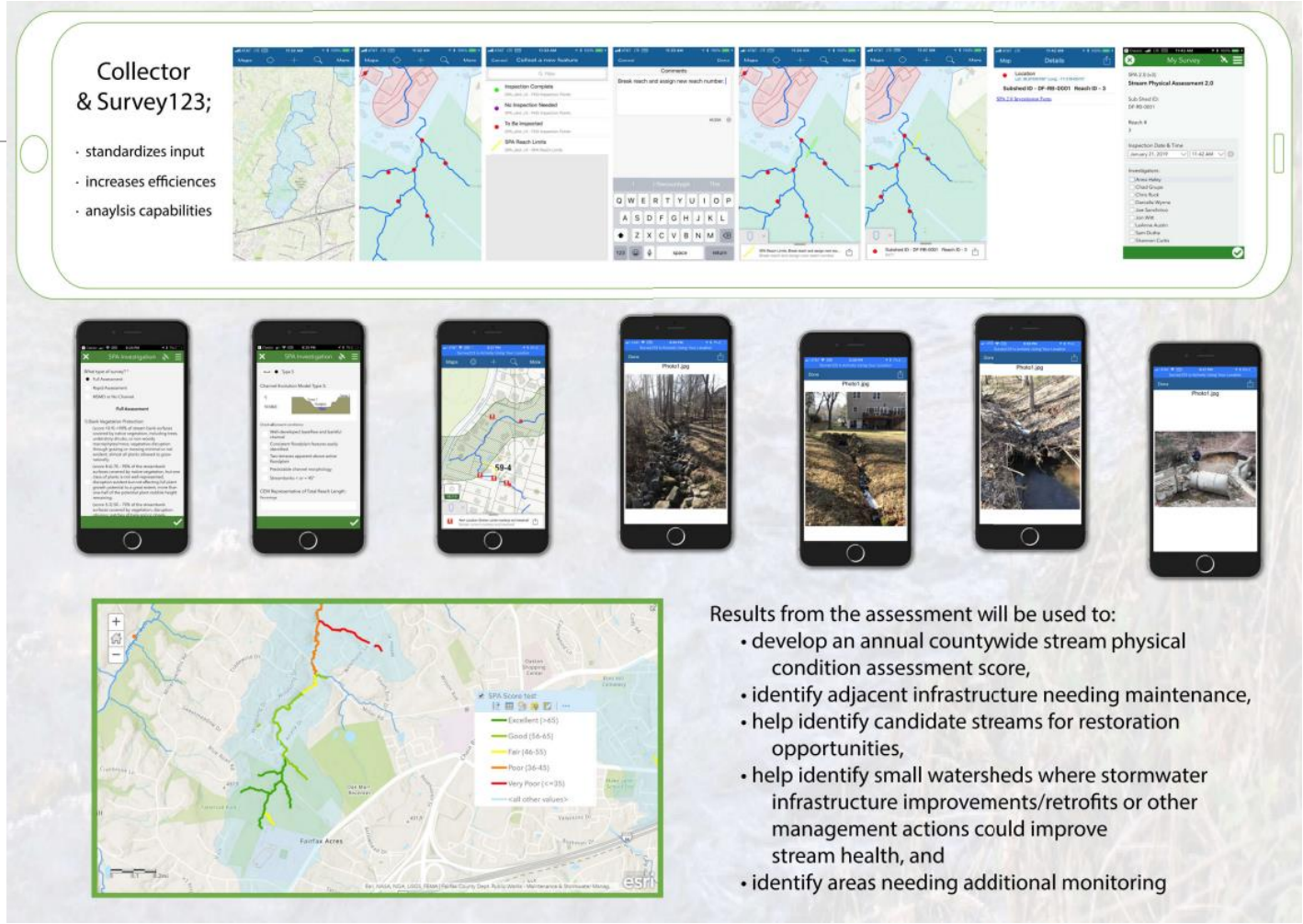
- 2016
  - ArcGIS Online
    - A new way to provide mapping products
  - Collector app
    - Mobile learning curve/reluctancy
    - User interaction
  - Web AppBuilder
    - Configurable applications
    - Widgets
  - Esri Dashboards
    - Still a go-to app
  - Hosted feature sets
    - Editing feature services
    - Wild west



2016 – snow removal dashboard

Evolution of GIS

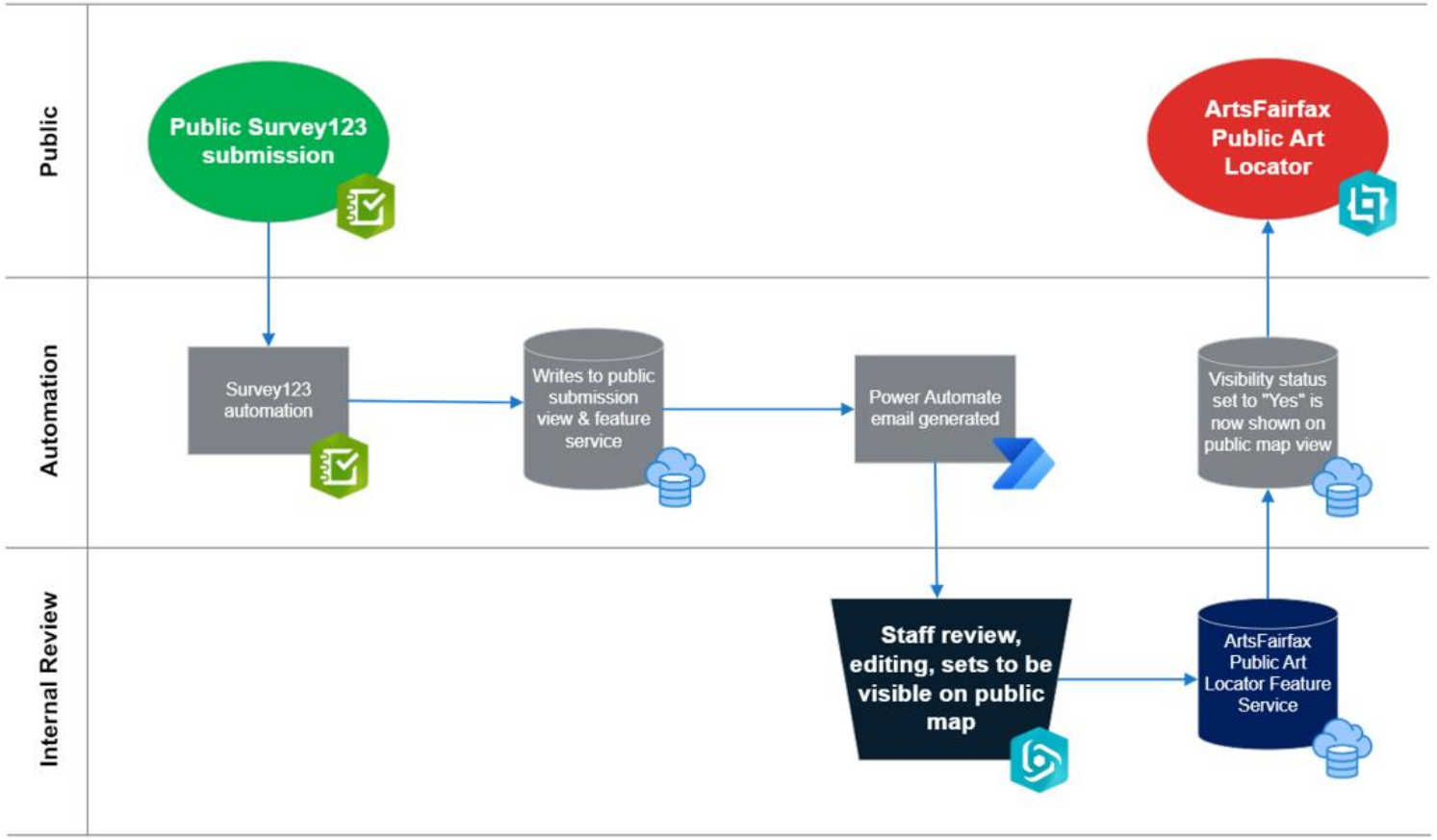
- 2019
  - Federated Services
    - Realtime data views
  - Enterprise Portal
    - Internal web GIS
  - Survey123
    - Automated calculations
    - Automated pull-data functions
  - Mobile Application Integration
    - Collector linked to Survey123
    - URL parameters



Stream Physical Assessment – mobile application

Evolution of GIS

- 2022
  - Experience Builder
    - Enhanced configuration
  - Survey123
    - Public data collection
  - Feature Views
    - Workflow specific web layers
  - Power Automate
    - Email notification actions
  - Chat GPT



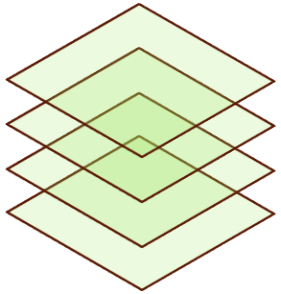
ArtsFairfax Public Art Locator – workflow

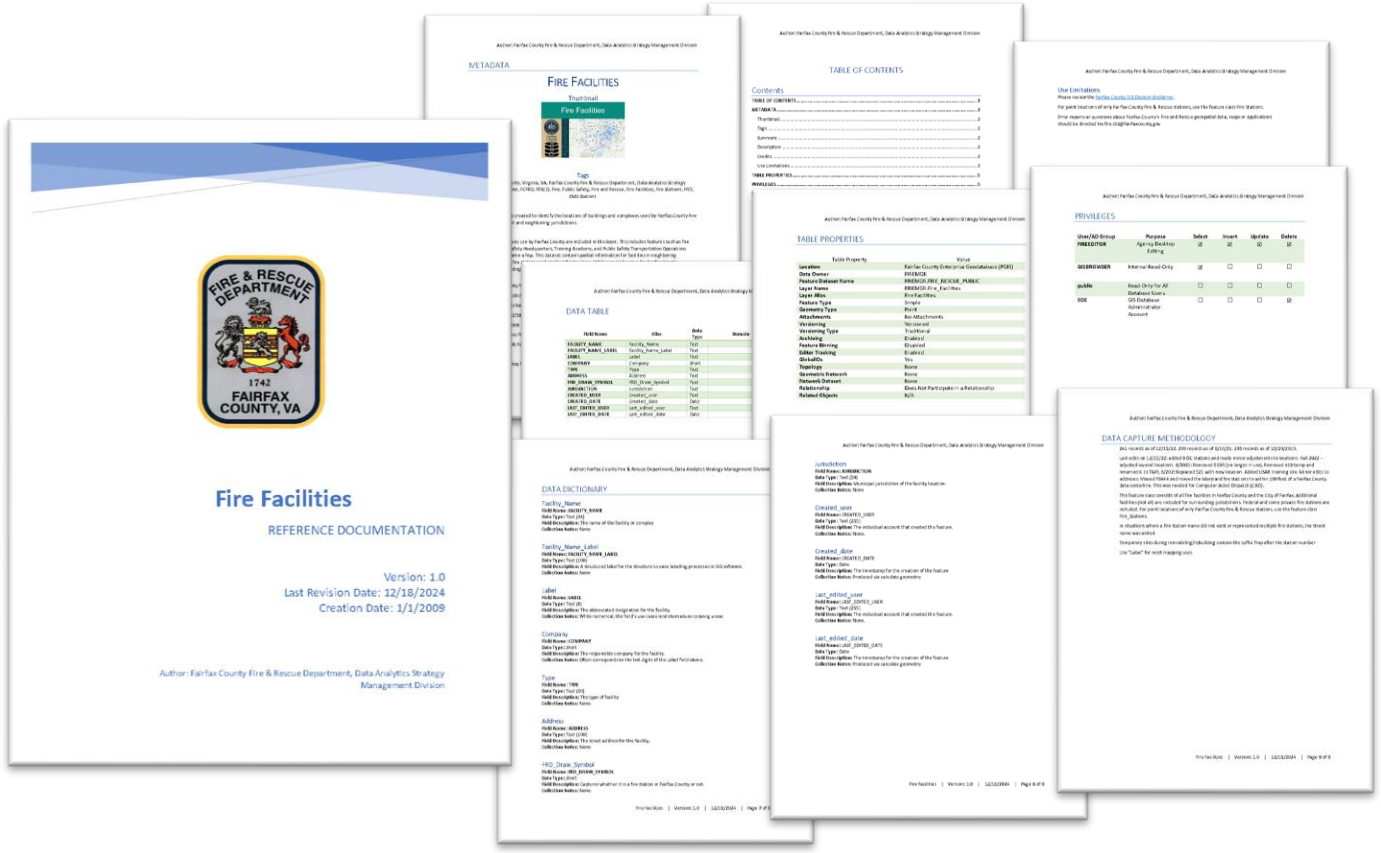
A modern GIS approach

- Data Stewardship
  - Storage and Documentation
  - Data Transparency
- Department use of SharePoint
  - Workflow Transparency
  - Easy to Find Materials
- Automation Tools
- Federated GIS Data Sources
- Authoritative Data
- User Interface & the User Experience (UI/UX)

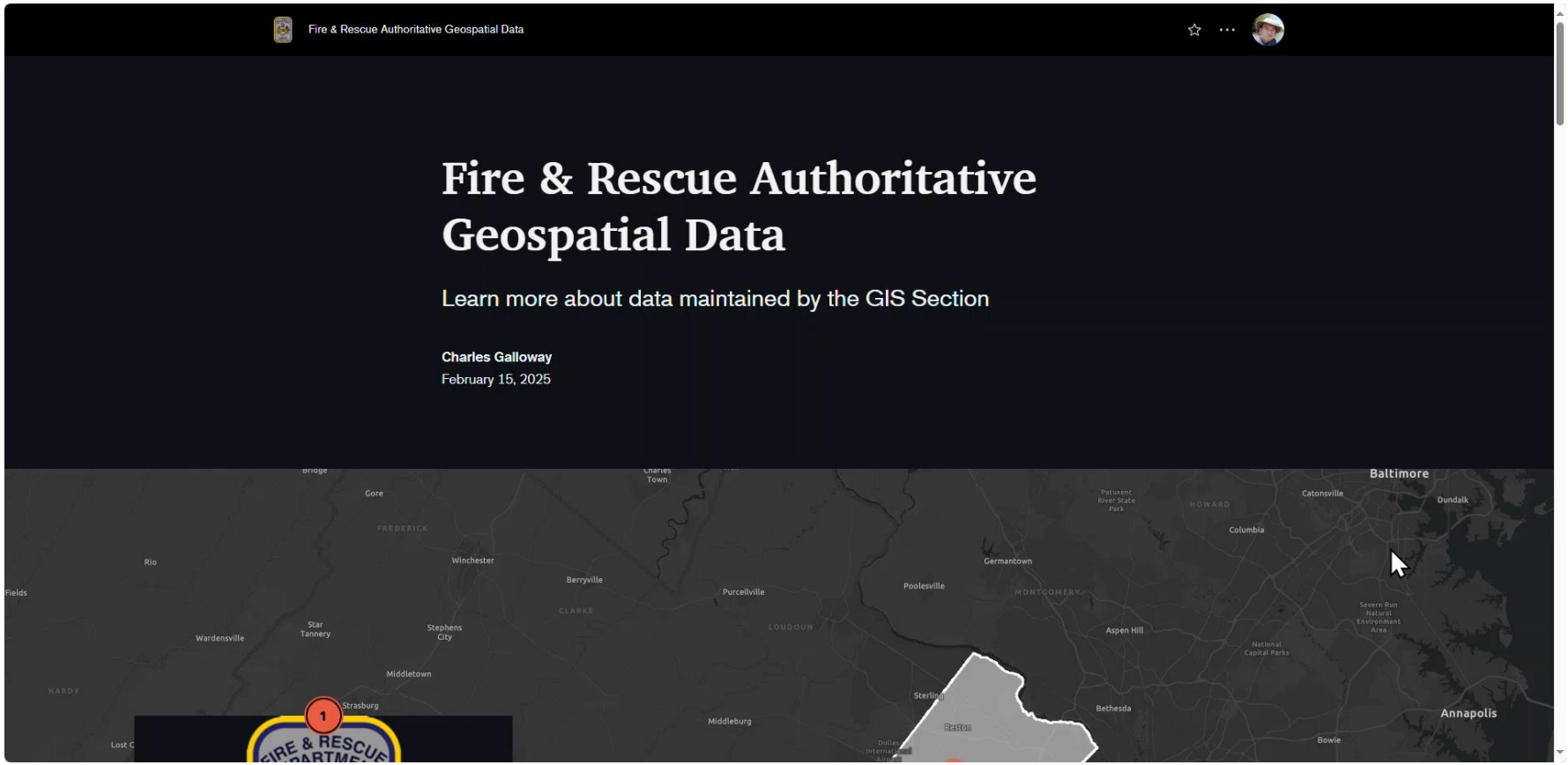
A modern GIS approach
Data Stewardship – Storage and Documentation

- Maintaining one source of truth
- Enterprise Geodatabase
- Standardized documentation
- Metadata





A modern GIS approach
Data Stewardship – Data Transparency

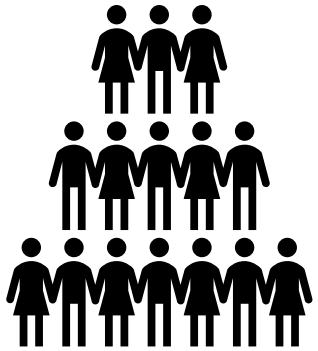


Fire and Rescue Authoritative Data – Story Map

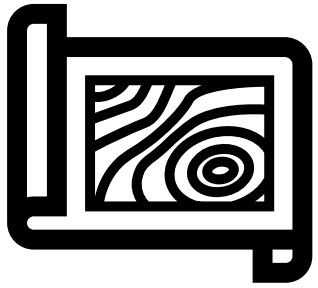
A modern GIS approach
SharePoint - Workflow Transparency

- Analysis and workflow transparency

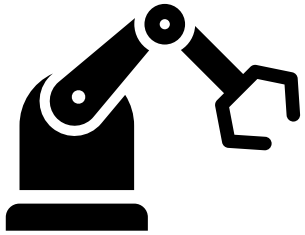
Who is Involved?



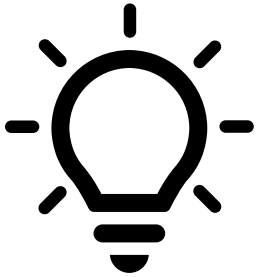
What data is used, and what output materials are created?



How do we go through the process?



Why do we make changes to the data?



A modern GIS approach
SharePoint - Easy to Find Materials

- PDF map organization with examples and explanations

Ops Maps (Fire Box Map Series) provide first responders with a reliable backup navigation resource when digital tools are unavailable. These map books include an overview of the first due area, a list of fire boxes within the first due, and individual maps for each fire box area. The maps also feature additional elements to enhance situational awareness, including hydrants to identify water supply points, gates to highlight key access points or barriers, and building outlines to aid in locating specific structures. While it is challenging to display all street labels due to map size and scale, we made every effort to include as many as possible to maximize clarity and usability.

Ops Maps

New | Upload | Edit in grid view | Share | Sync | ··· | All Documents

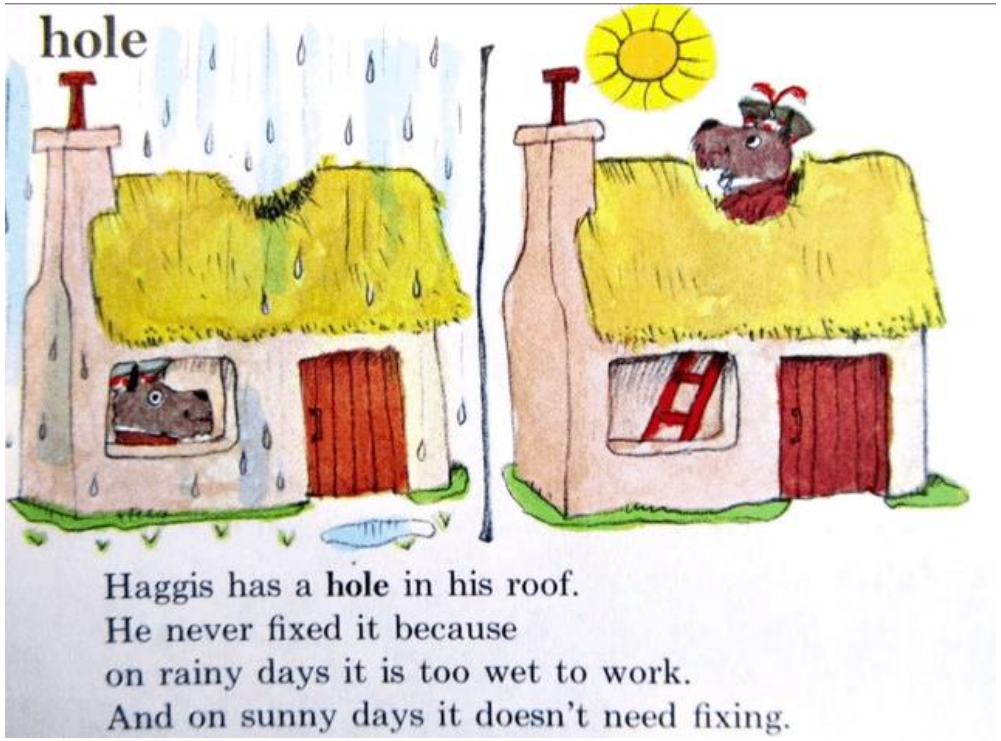
Name	Title	Modified	Modified By
OpsMaps_401.pdf		December 29, 2024	Galloway, Chi
OpsMaps_402.pdf		December 29, 2024	Galloway, Chi
OpsMaps_403.pdf		December 29, 2024	Galloway, Chi
OpsMaps_404.pdf		December 29, 2024	Galloway, Chi

A modern GIS approach
Automation Tools

- Why spend 10 minutes doing something when you can spend 8 hours automating it?

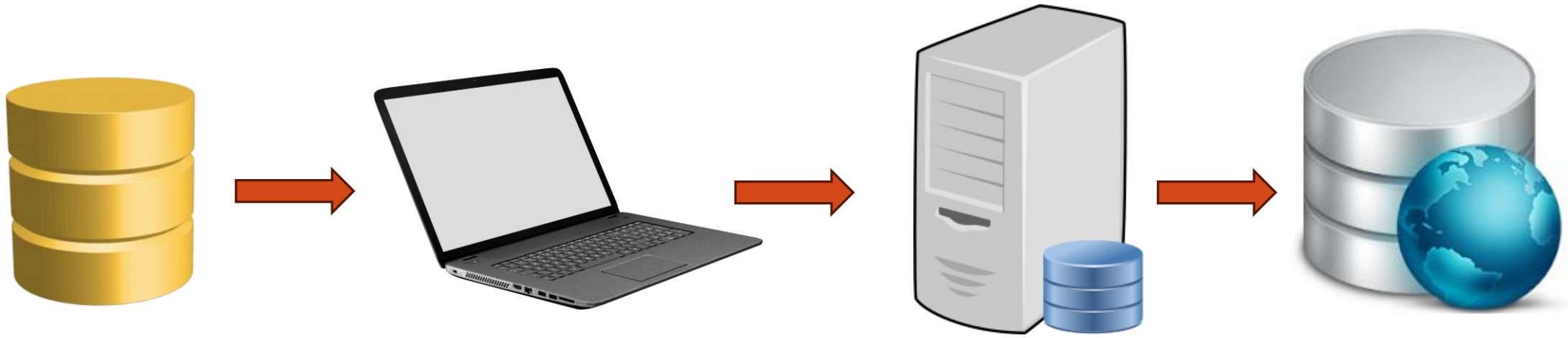
- Built-in GIS Tools
  - ModelBuilder
  - Scheduled tools
  - Attribute rules
  - Webhooks
  - Map Series
  - Collaborations

- Third-Party
  - Power Automate
  - Python



A modern GIS approach
Federated Services & Distributed Collaborations

- Real-time data view of authoritative GIS layers



Enterprise Geodatabase SQL Server

Publish GIS Layers

ArcGIS Enterprise Portal

ArcGIS Online

A modern GIS approach
Federated Services & Distributed Collaborations

- Real-time data view of authoritative GIS layers

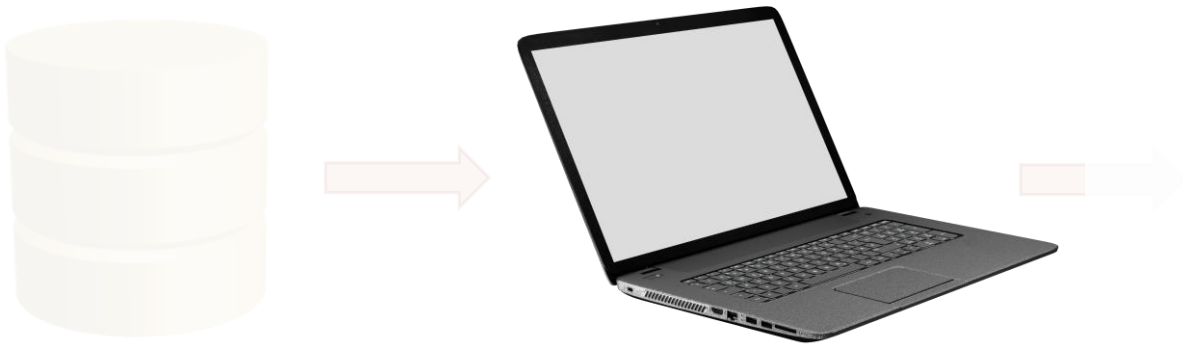
Enterprise Geodatabase SQL Server

Prerequisites

- ArcGIS Enterprise Deployment
  1. Portal for ArcGIS
  2. ArcGIS Server
  3. Federated GIS Server
- Your server is federated with your Portal
- Admin access to both Portal & ArcGIS Online

A modern GIS approach
Federated Services & Distributed Collaborations

- Real-time data view of authoritative GIS layers



Publish
GIS Layers

Prepare your data

- Load data from your server
- Configure your data
  1. Symbology
  2. Attributes
  3. Pop-up
  4. Drawing threshold

Publish your data

- Sign into your Portal
- Publish as: “reference registered data”
- Put into group with collaboration settings

A modern GIS approach
Federated Services & Distributed Collaborations

- Real-time data view of authoritative GIS layers

Prepare for Distributed Collaboration

- Portal Group participates in collaboration
- Everything in the group will be synced
- Features in this group are sent by reference (referencing the server content)

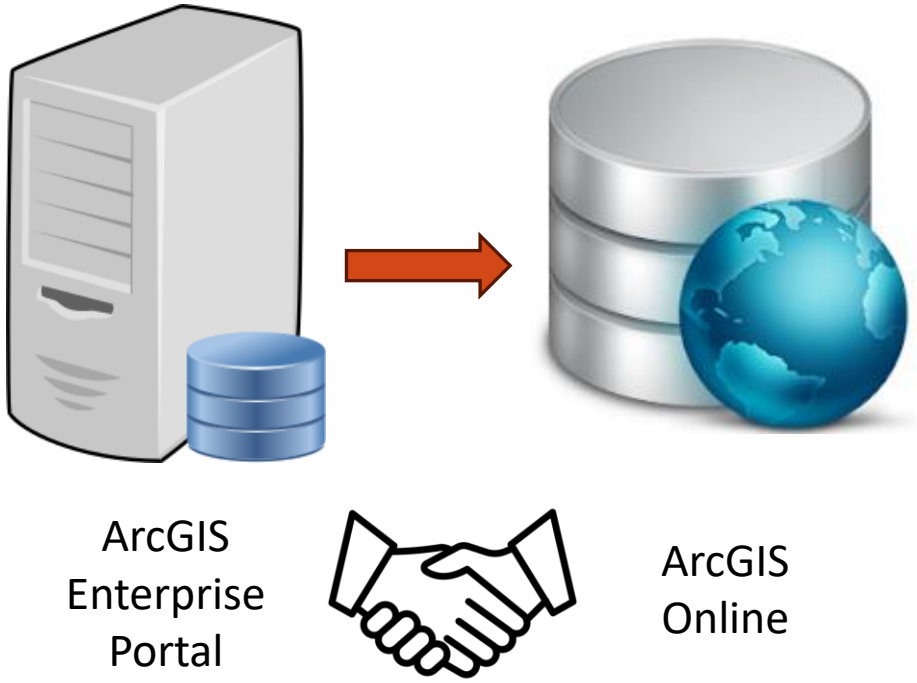
ArcGIS Enterprise Portal

A modern GIS approach
Federated Services & Distributed Collaborations

- Real-time data view of authoritative GIS layers

Create Collaboration

- Name your collaboration
- Send invitation from AGOL
- Set:
  - ArcGIS Online as the Host
  - Portal as the Guest
- Choose one or two-way sync



A modern GIS approach
Federated Services & Distributed Collaborations

- Real-time data view of authoritative GIS layers

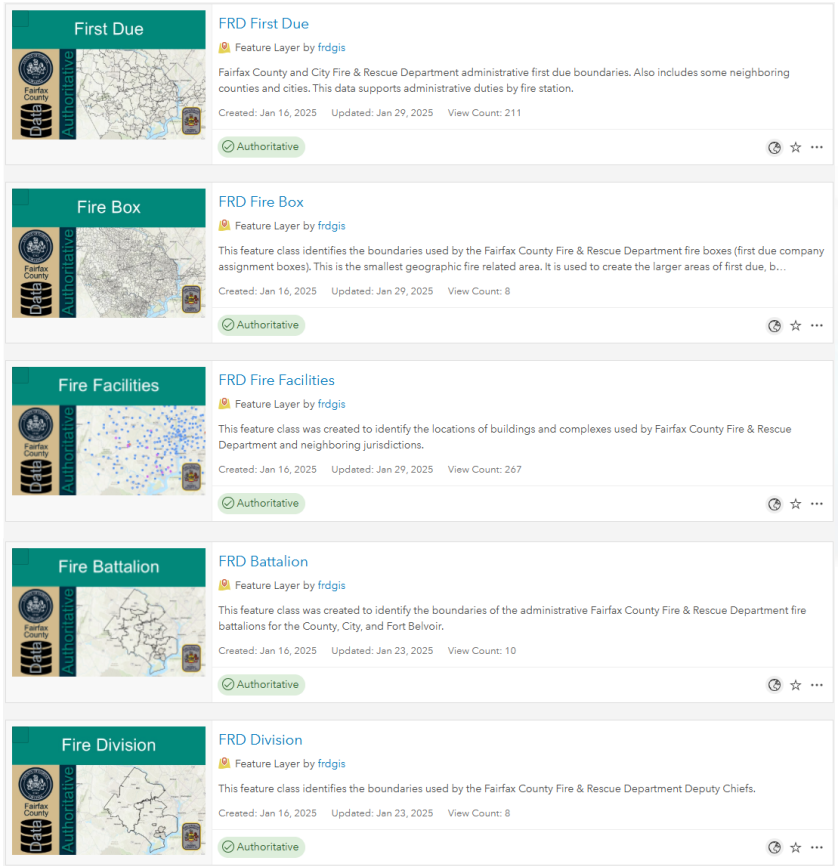
Test Your Collaboration

- You should now see identical layers in both Portal and ArcGIS Online
- When edits are applied in one environment, it will be reflected across all referenced datasets

ArcGIS Online

A modern GIS approach
Federated Services & Distributed Collaborations

- Real-time data view of authoritative GIS layers



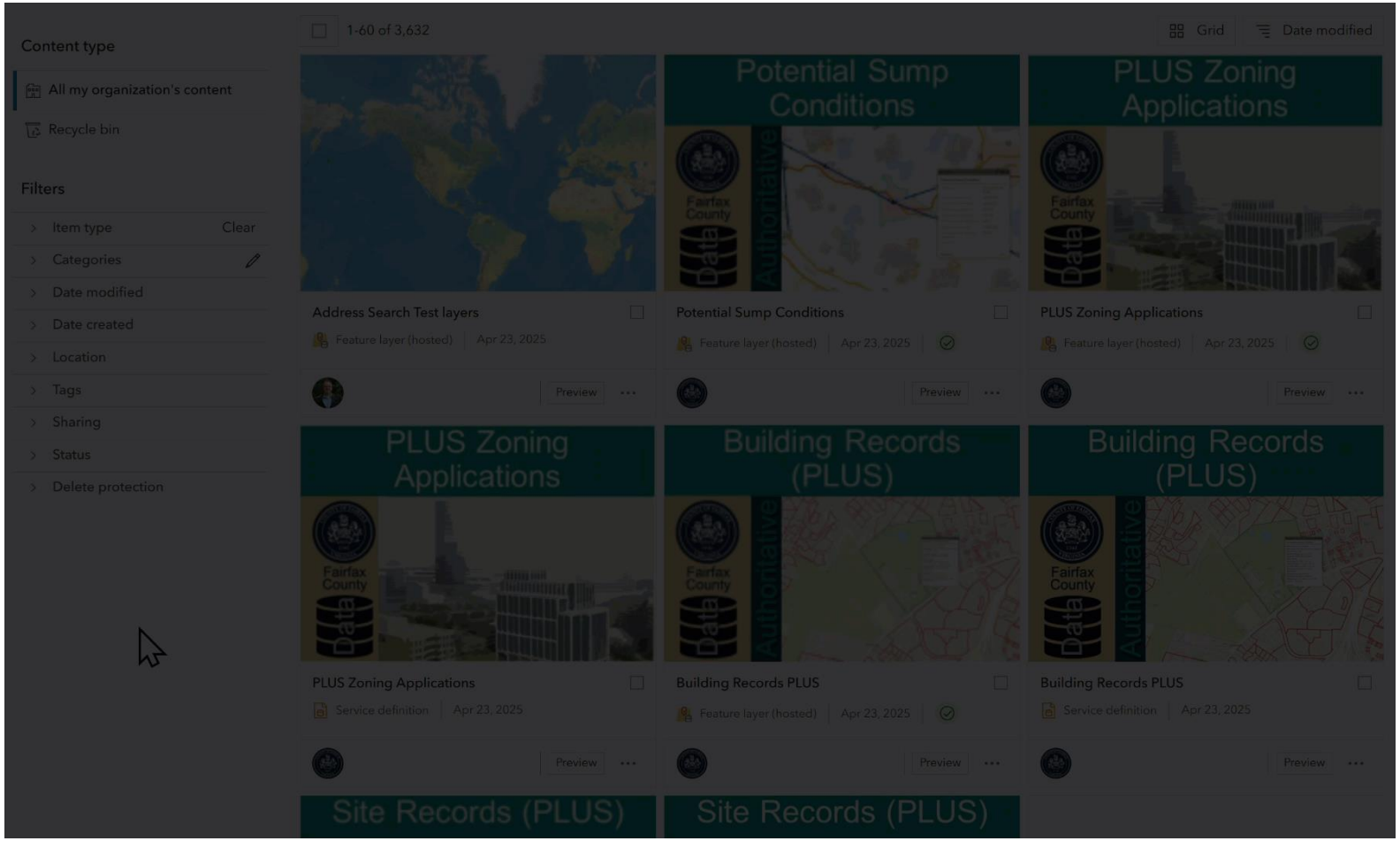
Benefits

- Centralized Access to Authoritative Data
- Secure, Scalable Sharing
- Available in Web & Mobile Applications, and more
- Real-Time Updates & Synchronization

Authoritative

A modern GIS approach
Authoritative Data

- Confidence in accuracy
- Verifiable sources
- Consistent standards
- Well documented
- Backed by organizations
- Reduces out-of-date risks



Authoritative

A modern GIS approach
User Interface & User Experience (UI/UX)

- Consistent
  - Symbology
  - Branding
  - Standardized Layouts
  - Documentation
- Concise Surveys
- Easy to find materials
- Intuitive Web Applications
- Minimal Clicks

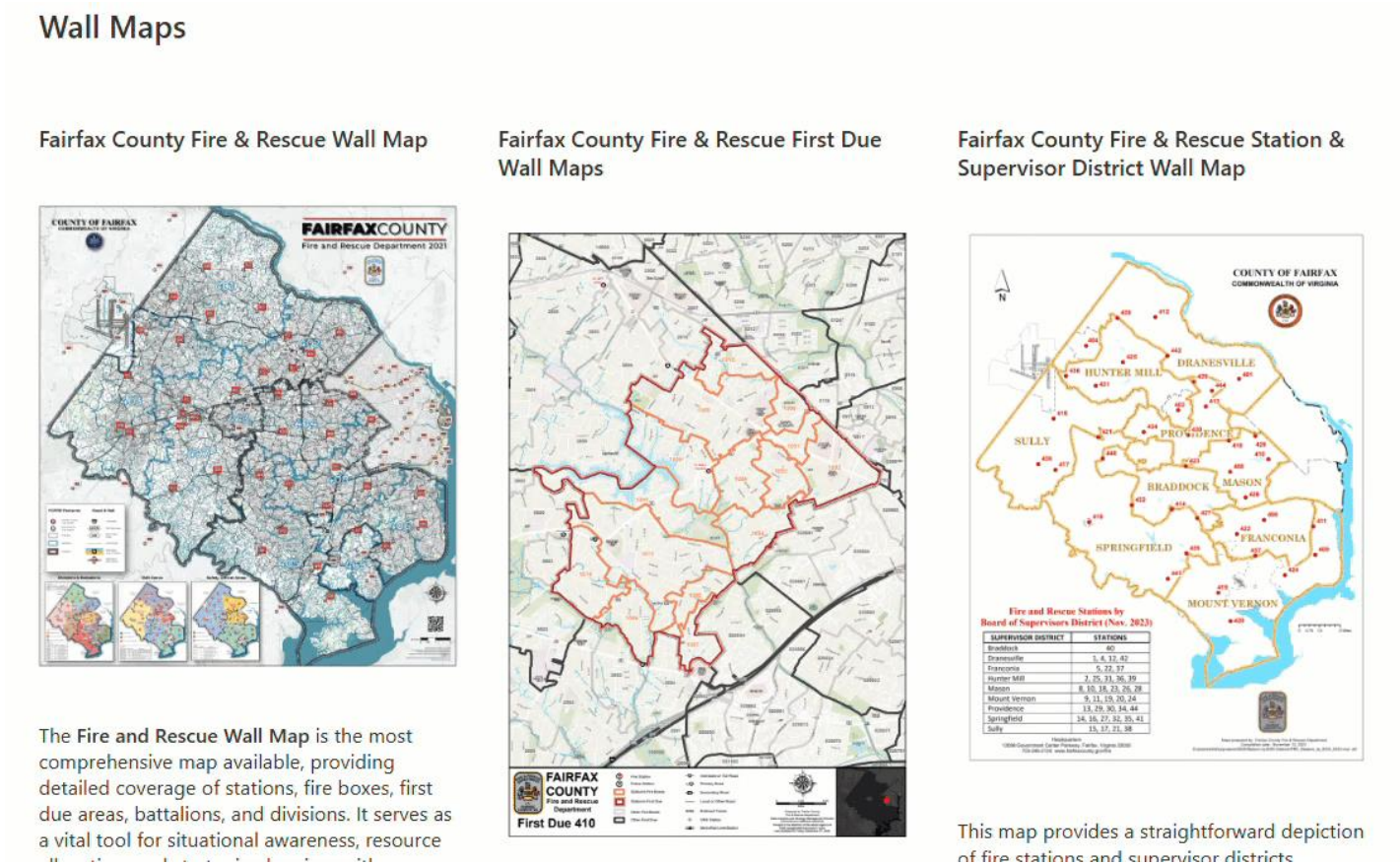
Fire and Rescue GIS Projects

- PDF Map Collection
- Street Drills
- Smoke Alarms
- Hydrants

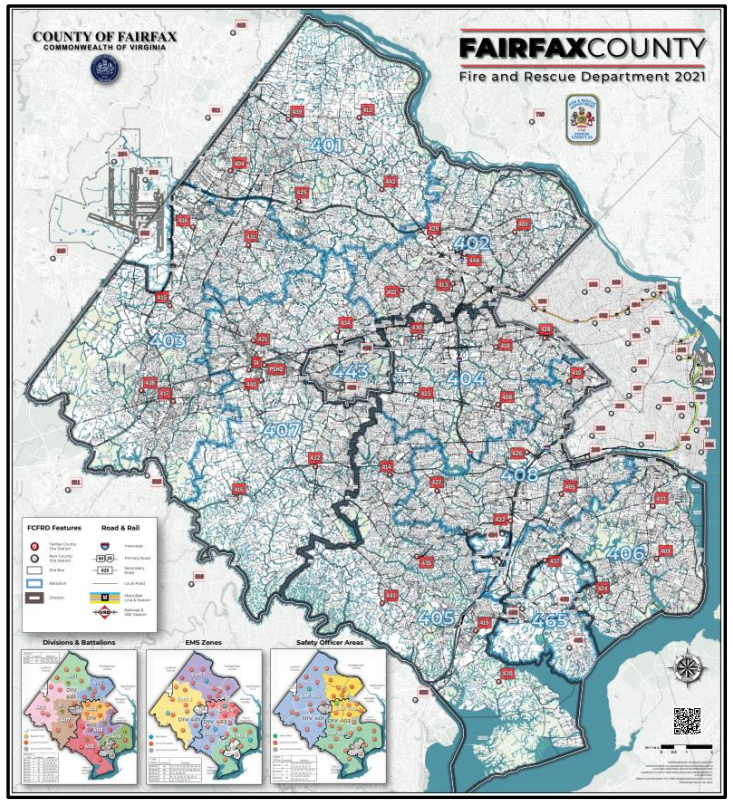
PDF maps
Fire & Rescue Map Collection

Department needs:

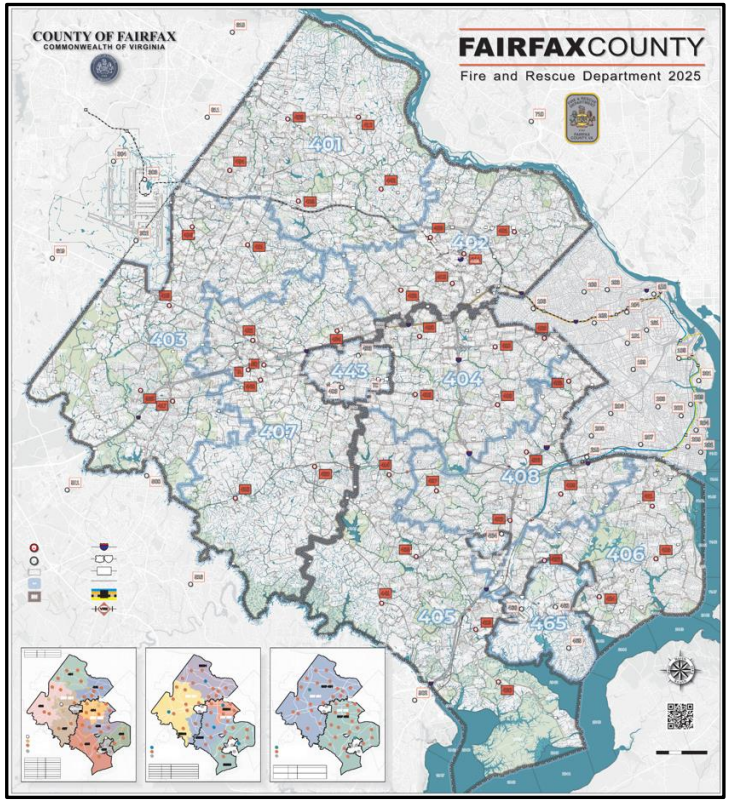
- Organization of Map Collection
- Consistent Branding & Symbolization
- Dynamic Map Projects
  - Dynamic Labeling
  - Dynamic Data Sources
  - Projects Ready to Export



PDF maps
Dynamic map Projects in ArcPro



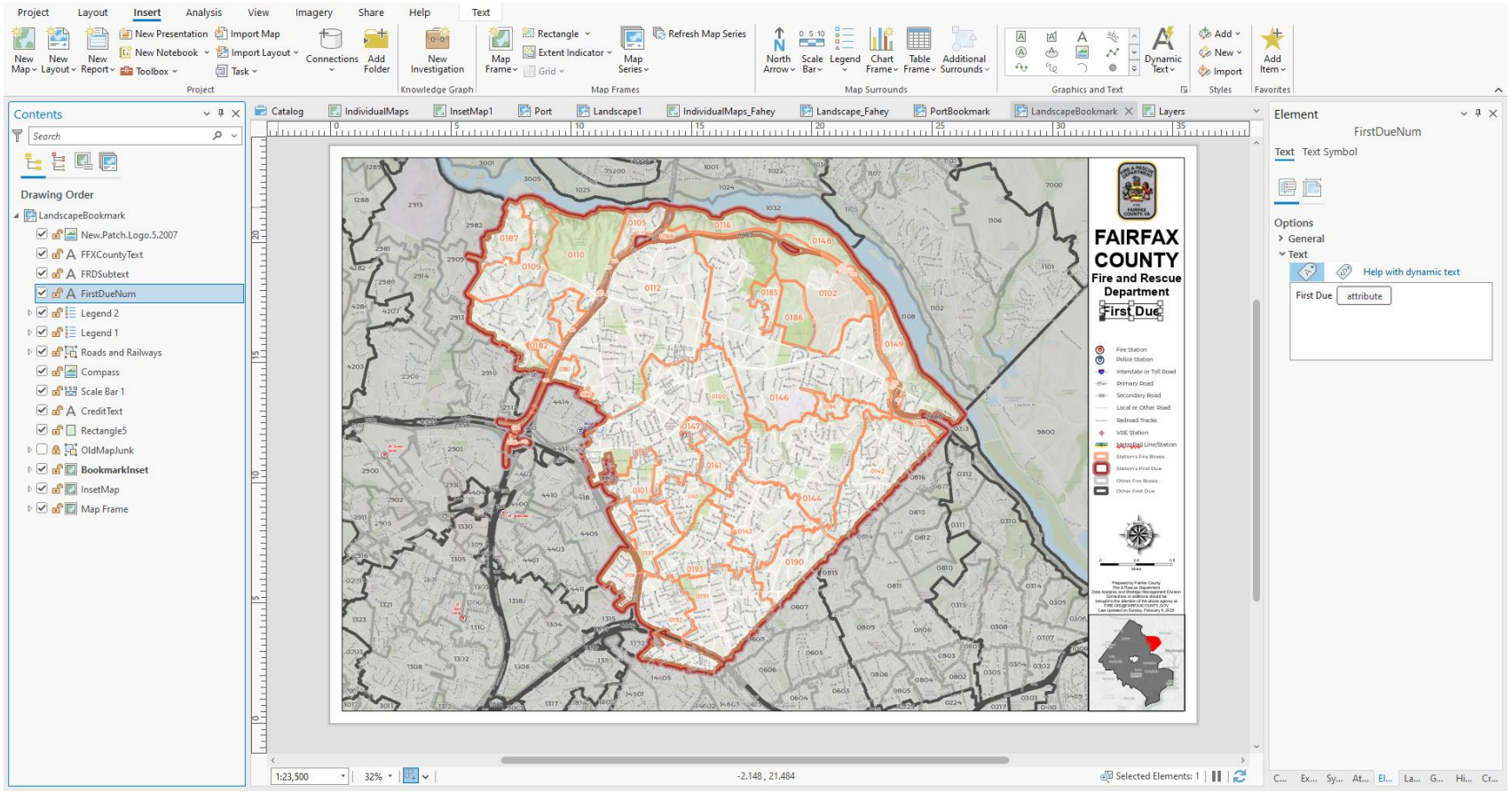
2021
Created in Adobe Illustrator



2025
Created in ArcPro

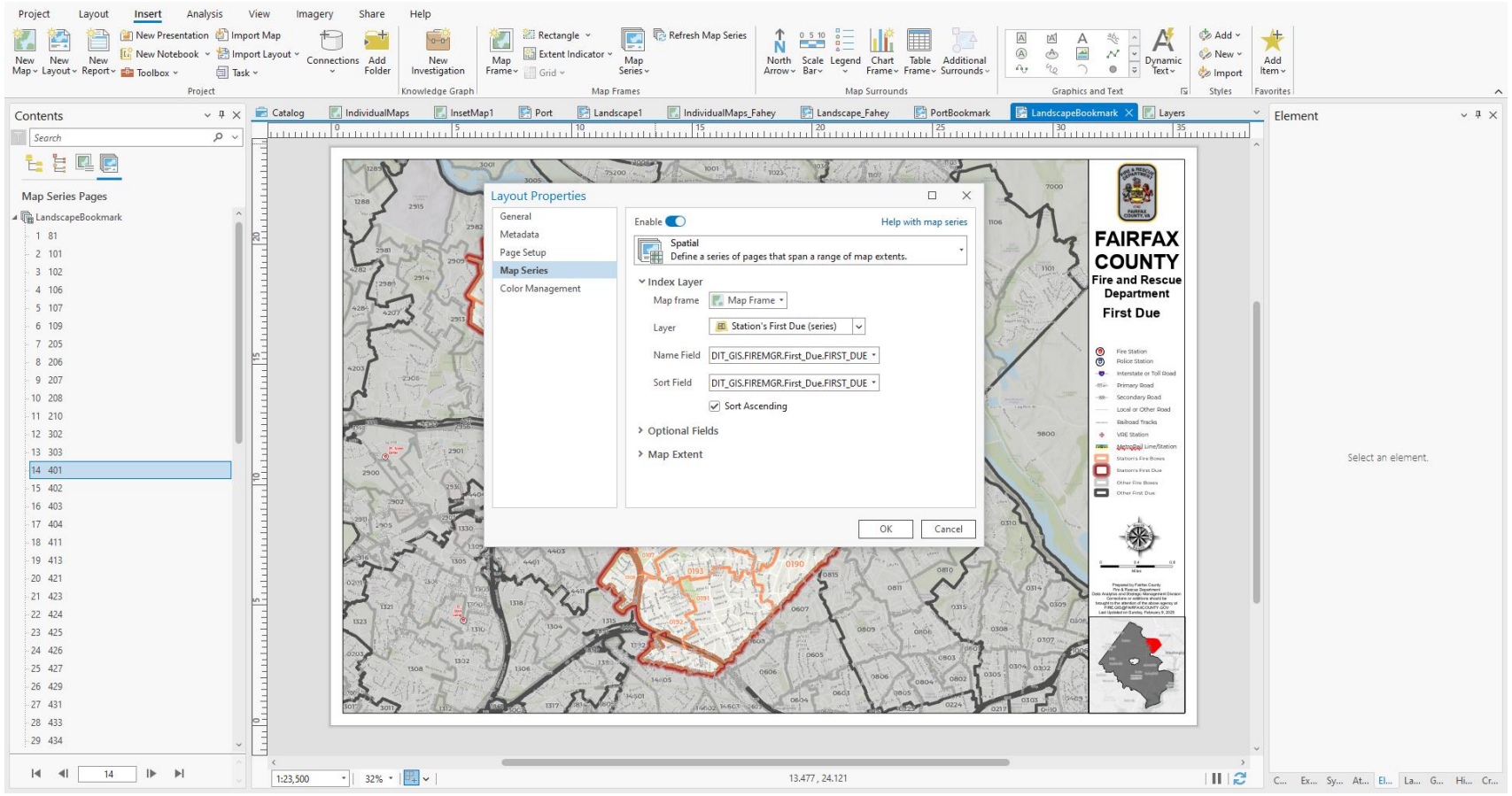
PDF maps
Dynamic map Projects in ArcPro

- Layout configuration
  - Organization in your Table of Contents
  - Smart Legend
  - Dynamic disclaimer



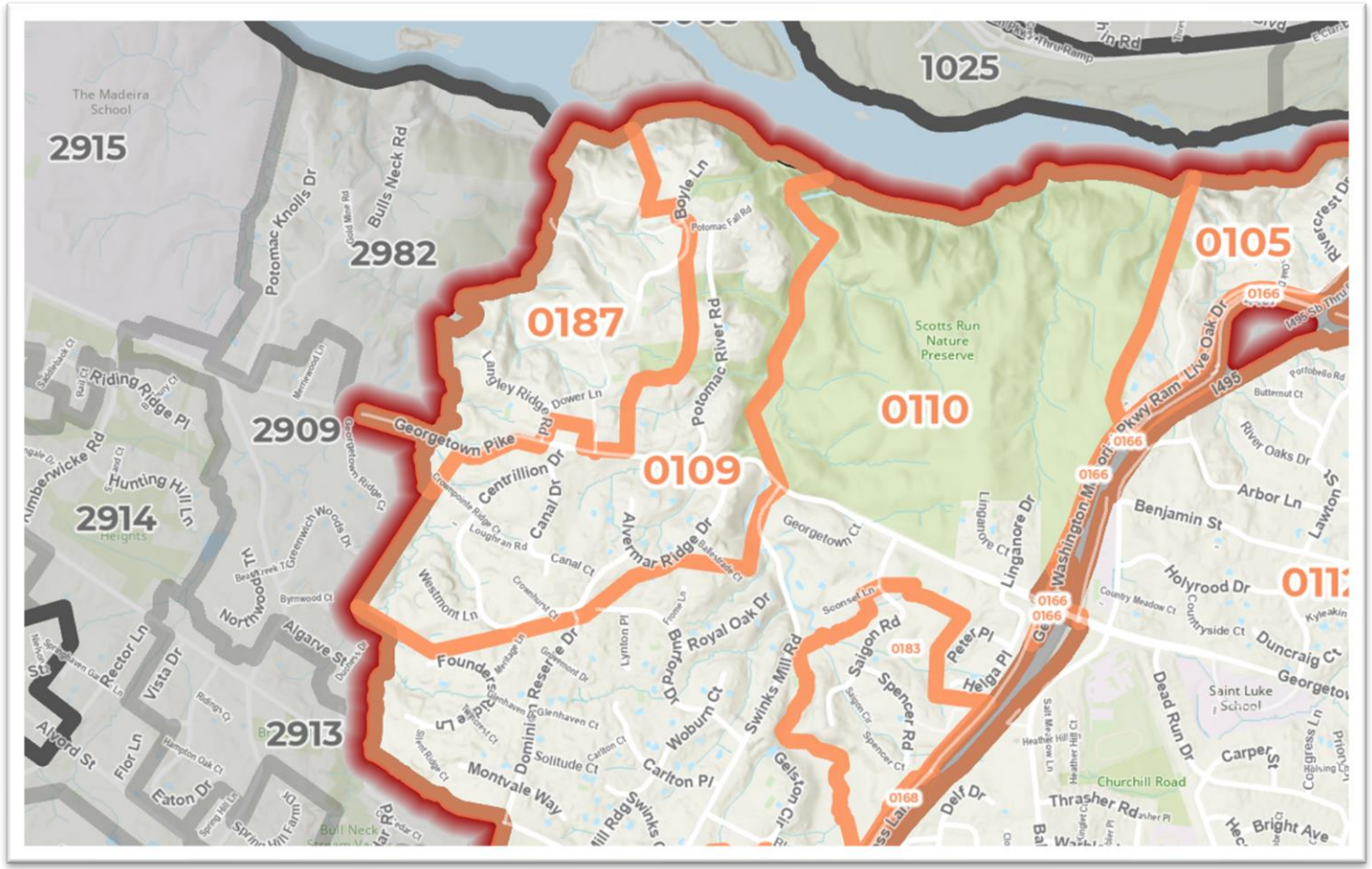
PDF maps
Dynamic map Projects in ArcPro

- Map Series
  - Single layout
  - Batch map production
  - Smart scale options



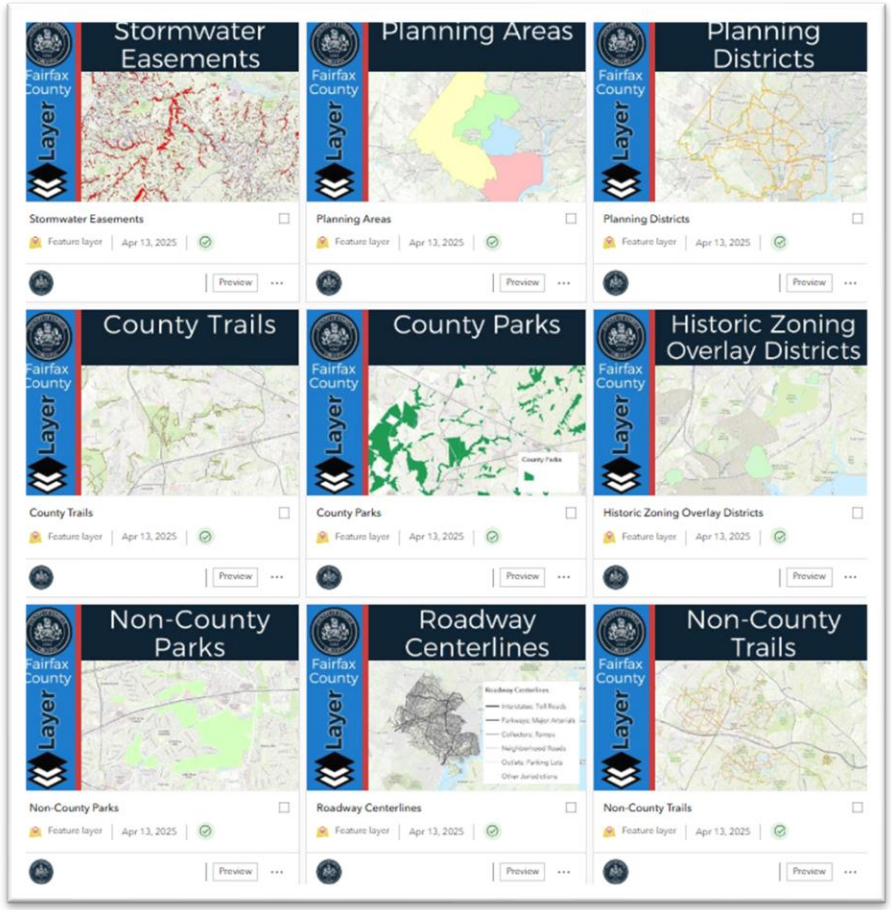
PDF maps
Dynamic map Projects in ArcPro

- Dynamic labeling
  - Roadways (all)
  - Inside and outside focus area
    - Symbology
    - Labels



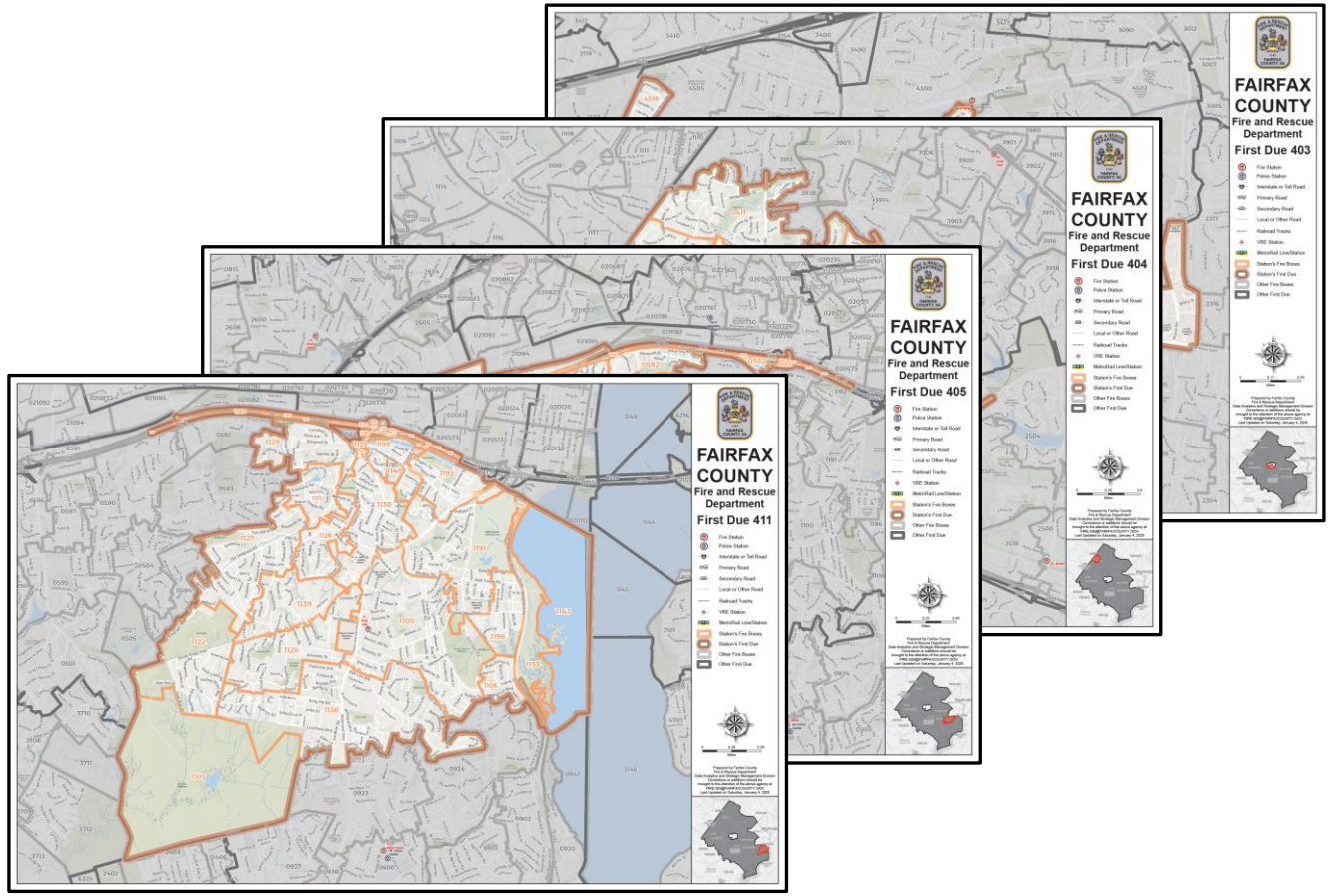
PDF maps
Dynamic map Projects in ArcPro

- Authoritative data sources
  - Live Data Integration
  - Centralized
  - Automatic Updates, No Manual Refresh
  - Use other sources of quality data



PDF maps
Dynamic map Projects in ArcPro

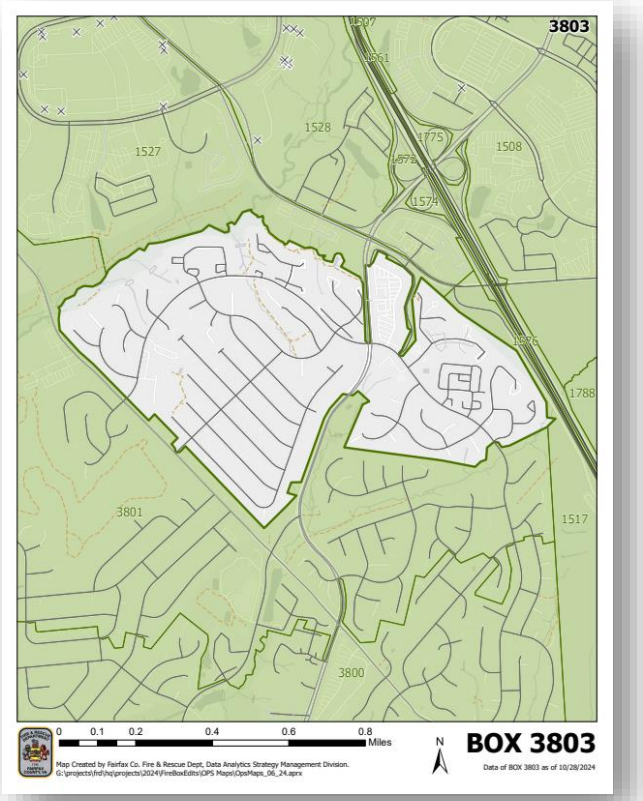
- Benefits
  - Repeatability & Consistency
  - Live Data Integration
  - Layer Reusability
  - Layout Flexibility
  - Map Series (Data-Driven Pages)
  - Project Organization
  - Collaboration-Ready



Fairfax Street Drills

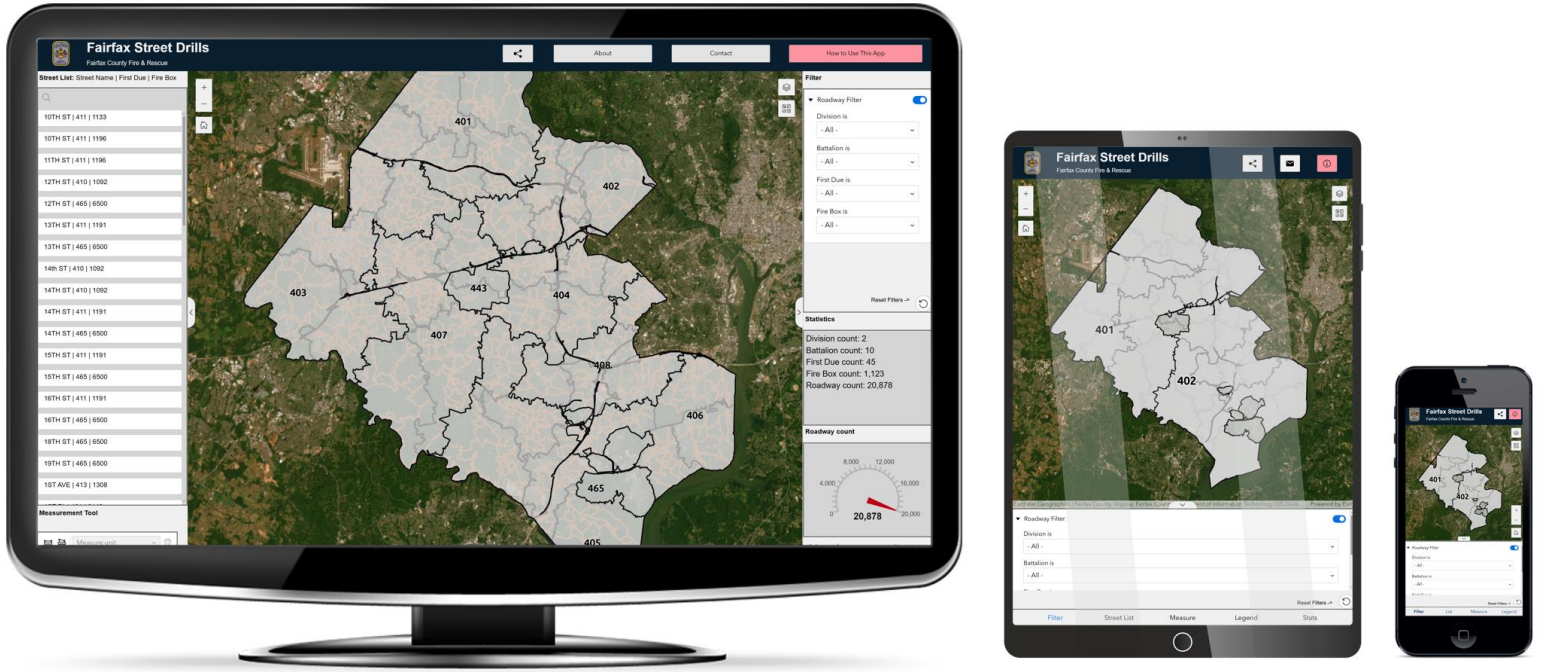
Street drills are a long-standing training method used by firefighters to learn and retain knowledge of their local streets, neighborhoods, and response areas.

- Paper maps
- Whiteboards
- PowerPoint Presentations
- Web applications



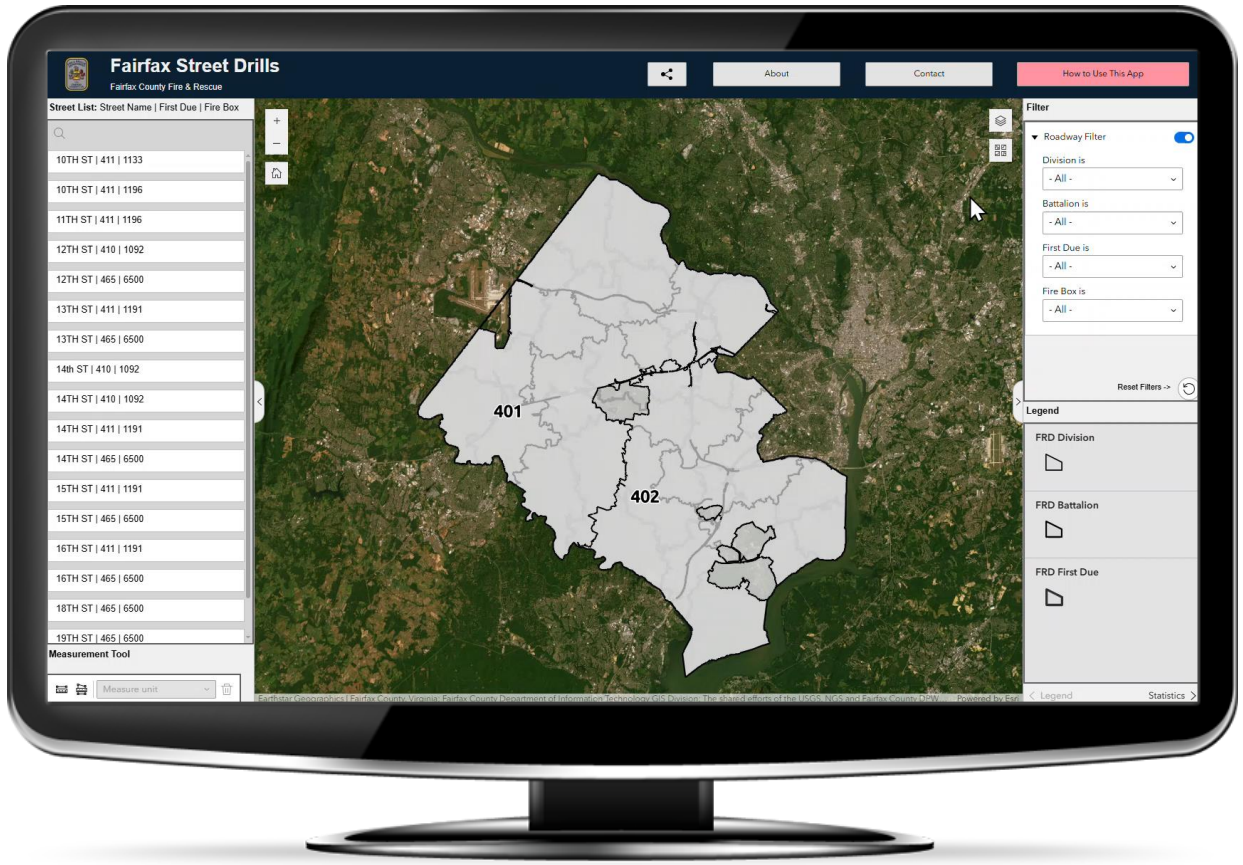
Fairfax Street Drills

- A data viewer and a learning tool
- Weekly roadway centerline data processing
- On-demand training
- Public facing



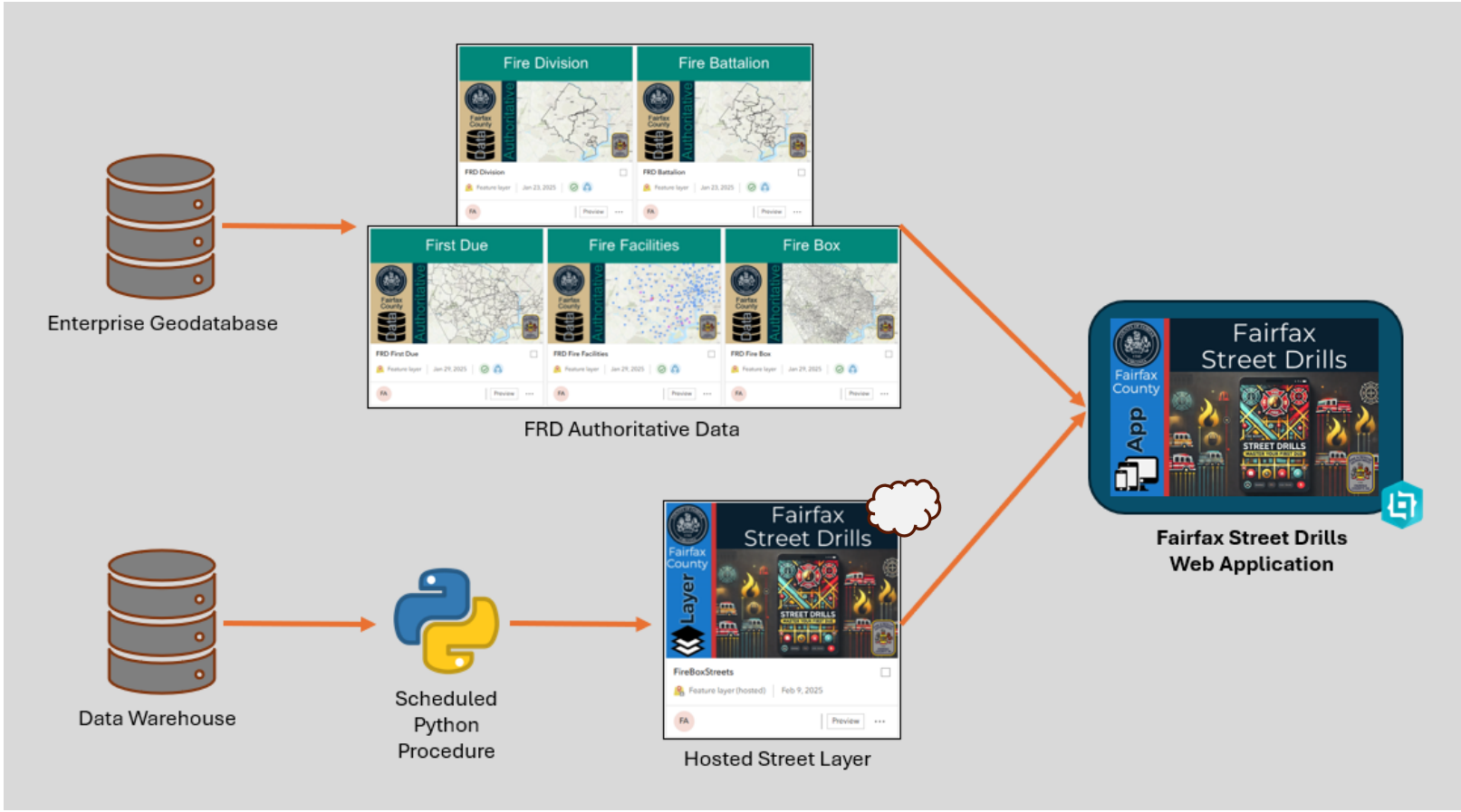
Fairfax Street Drills

- On-demand training
  - Filter roadways
  - Search street list
  - Turn on labels
  - Change basemap
  - Highlight streets
  - Measurement tool
  - Hide street list
  - Mobile/desktop access



Fairfax Street Drills

- Streamlined workflow
  - Enterprise geodatabase
    - All FRD Authoritative Data
  - Data Warehouse
    - Stored Procedure
    - Overwrites hosted dataset
  - Fairfax Street Drills

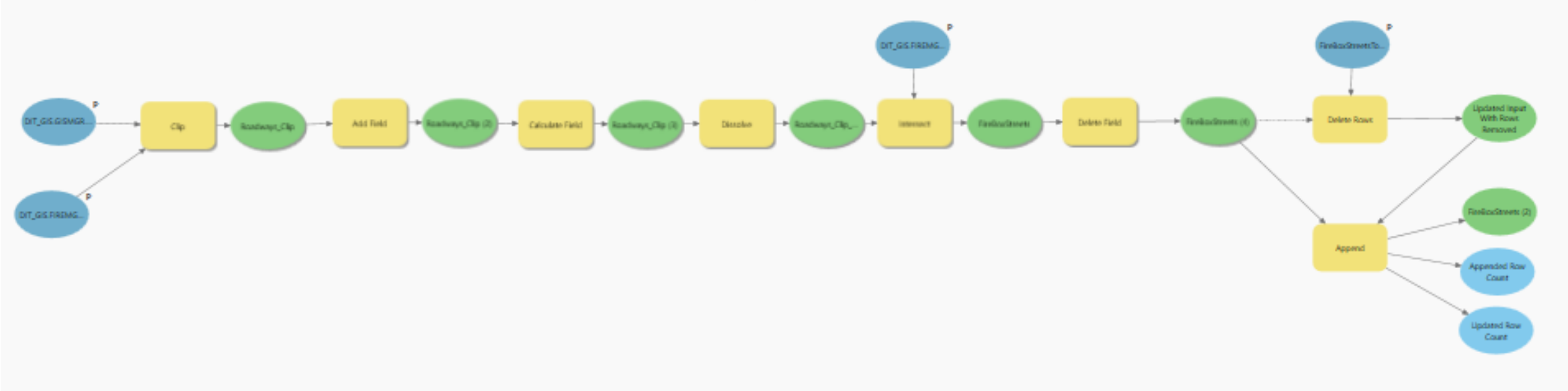


Fairfax Street Drills

Weekly roadway centerline data processing

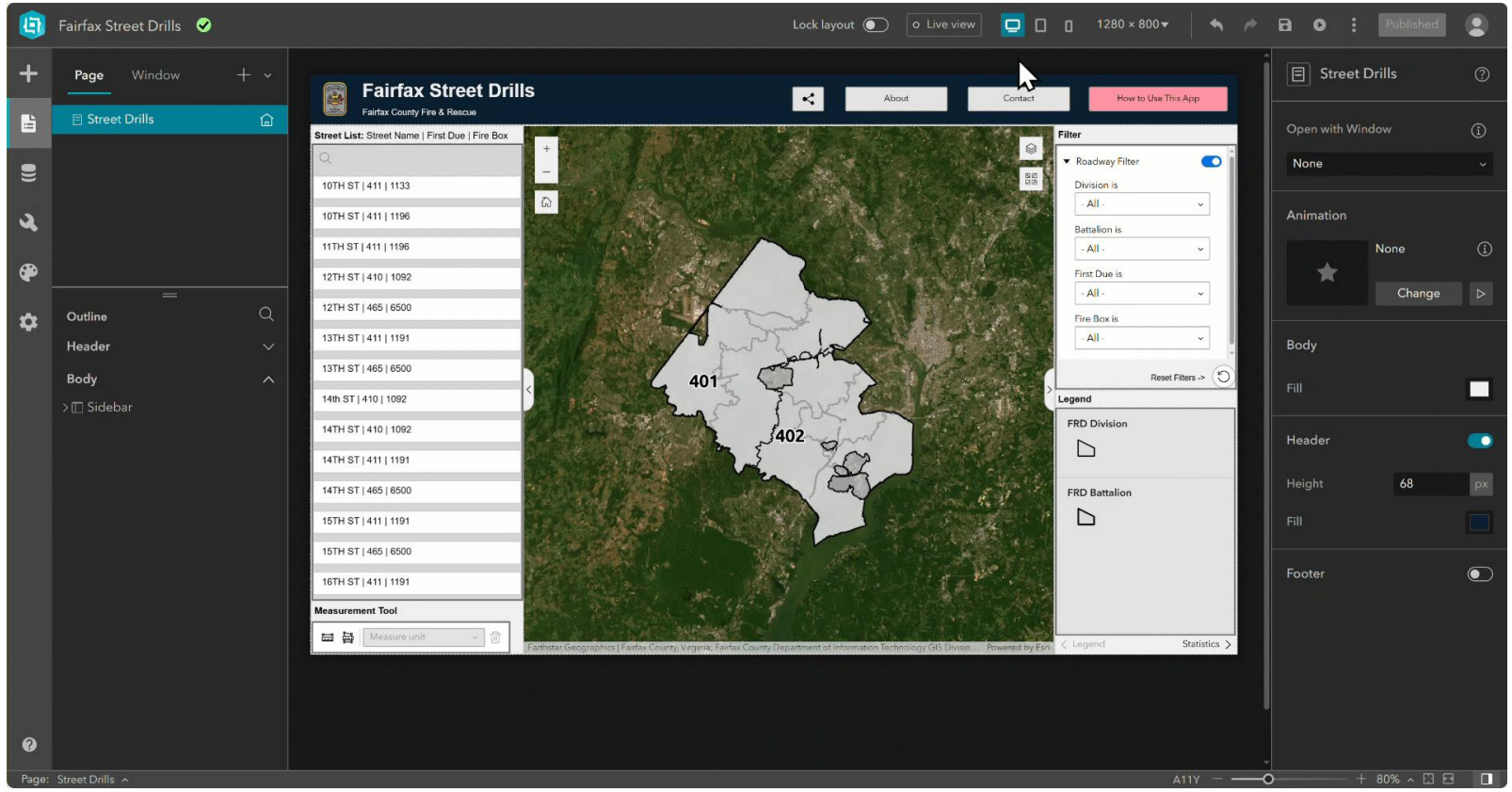
Python (ArcGIS Pro ModelBuilder) as a scheduled stored procedure Monday @ 8am

Clip roadways to county border → Add roadway name field → Calculate roadway name → Dissolve roads by name (merge) → Intersect roadways by fire boxes → Delete unnecessary fields → Append to hosted feature layer



Fairfax Street Drills

- Benefits
  - On Demand Training
  - Automated data intake
  - Dynamic – new functionality can be added later
  - Desktop, tablet, and mobile



Experience Builder application screen size interface

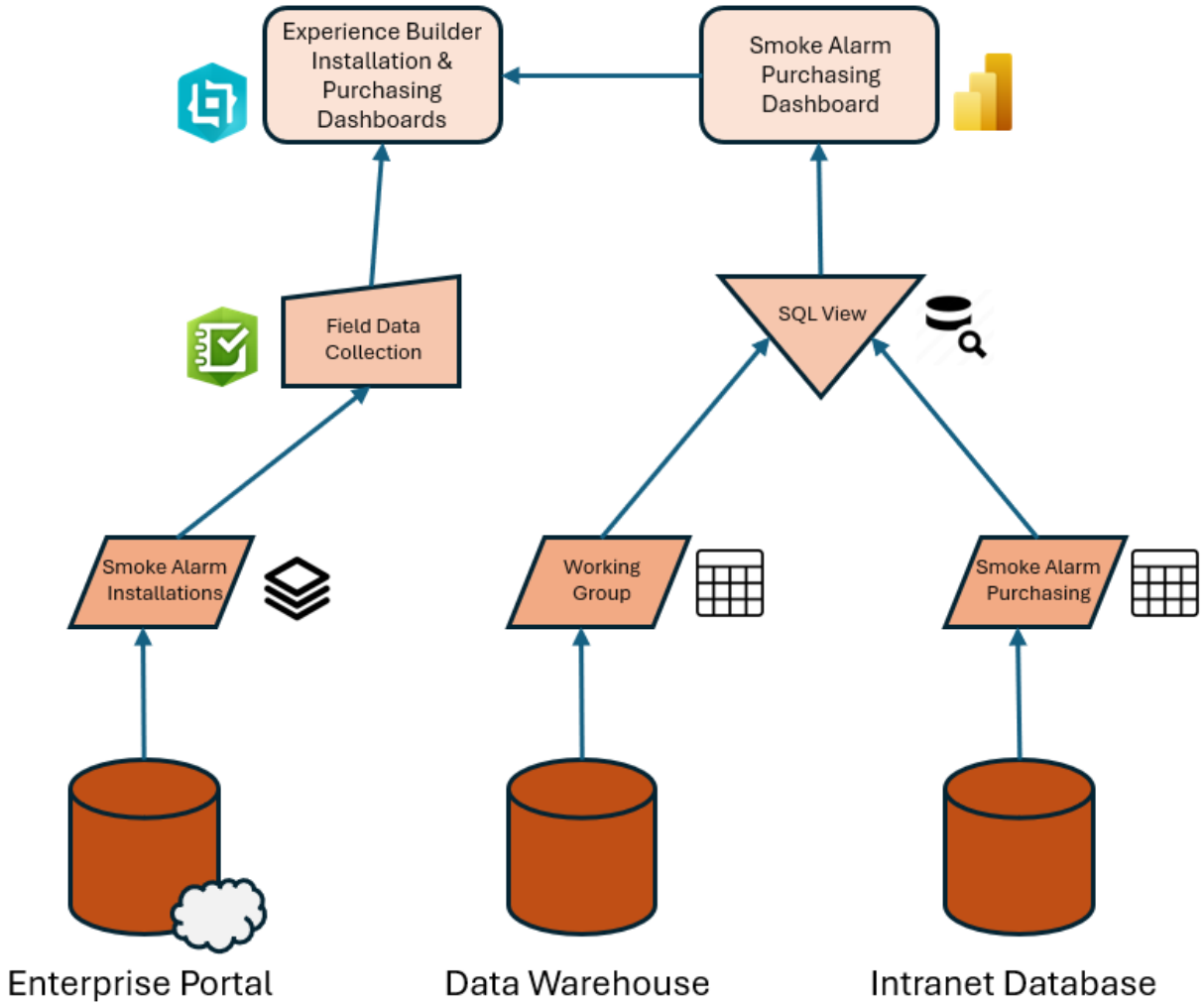
Smoke Alarms

- Community Risk Reduction
  - A multi-stakeholder process used to identify risk factors unique to your community and mitigate them using a coordinated, strategic approach.
- Need a dashboard to track both initiatives
  - Smoke Alarms purchased by fire stations with a grant through our Intranet site.
  - Public outreach donation & installation of smoke alarms.

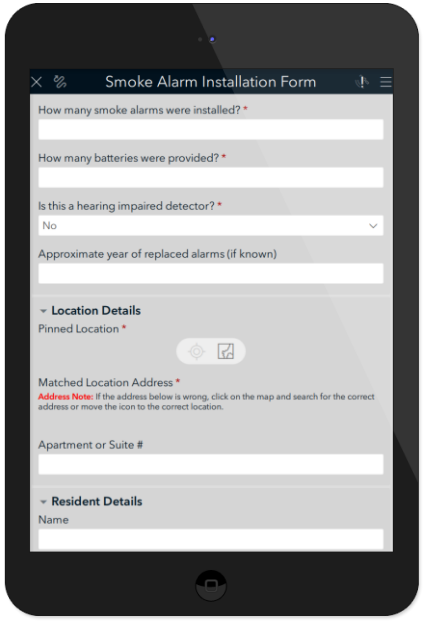
Community Risk Reduction Outreach – March 2025

Smoke Alarms

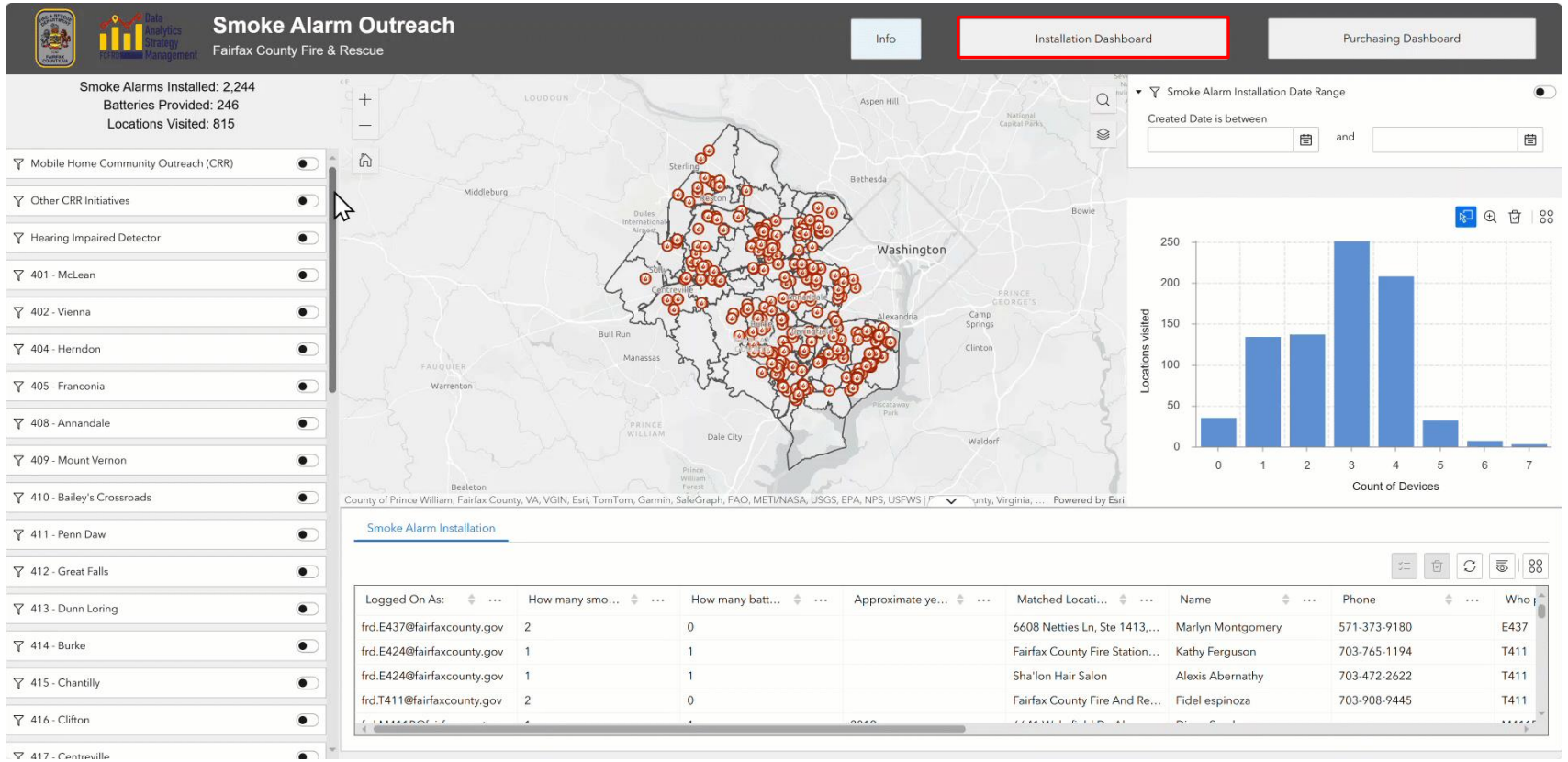
- Comparing different databases in one application
  - 3 data sources
  - Survey123 data collection (installations)
  - SQL Query
  - Power BI Dashboard
- Contained in one Experience Builder app



Smoke Alarms



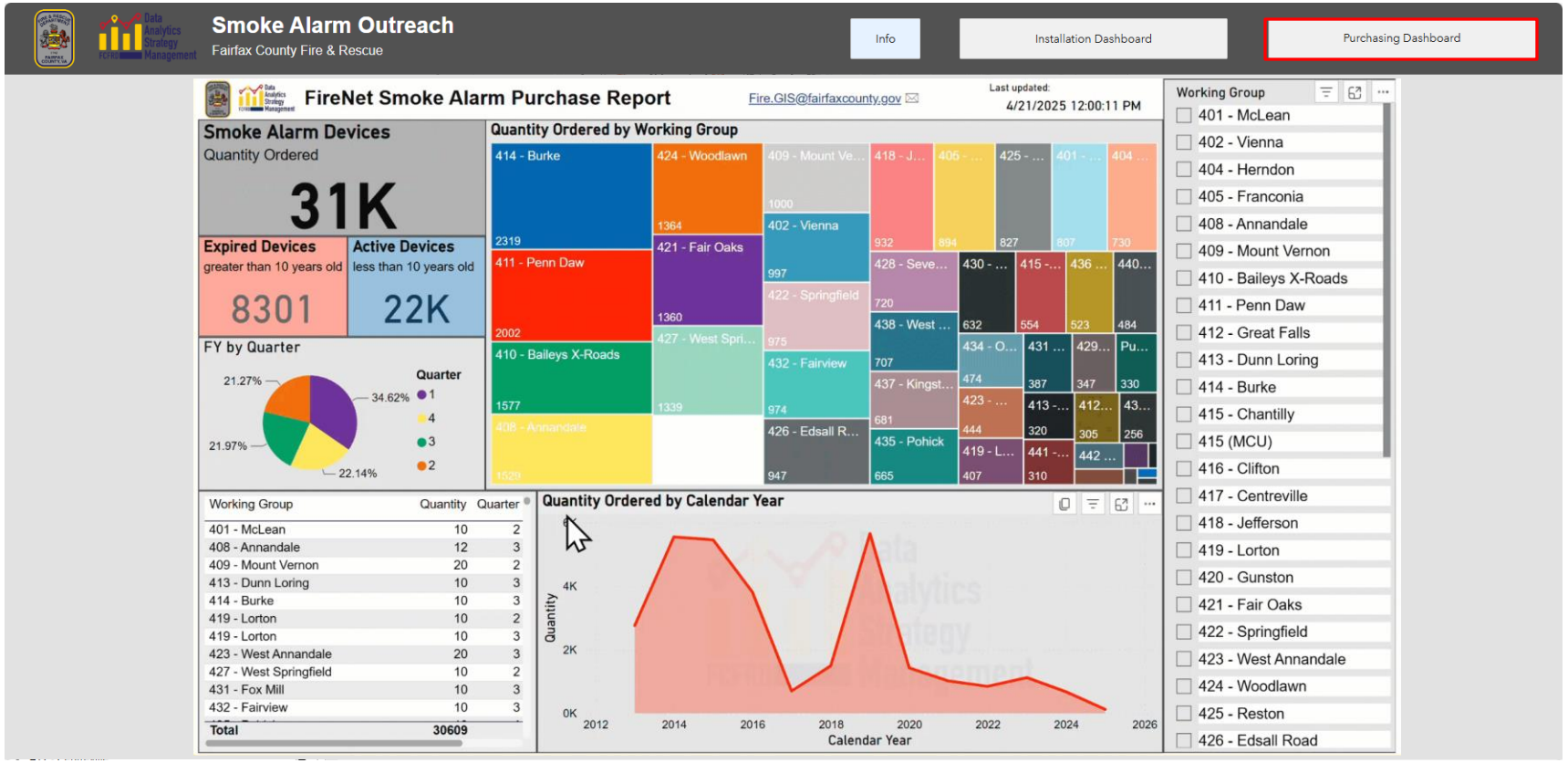
Smoke alarm installation Survey123



Smoke alarm installation dashboard

Smoke Alarms

Intranet Online Ordering



Smoke alarm purchasing dashboard

Smoke Alarms

- Comparing different databases in one application
  - Surveys since 2021
  - Online Ordering since 2013
- Benefits
  - Targeted outreach for vulnerable communities
  - Remind stations about grant program
  - Identify stations to coordinate with Community Risk Reduction for continued outreach

Smoke Alarm

Purchasing & Installation Dashboards

These dashboards are used by Community Risk Reduction to track:

- Purchasing of Smoke Alarms from FireNet
- Installation of Smoke Alarms logged in Survey123

Data Analytics Strategy Management

FCFRD

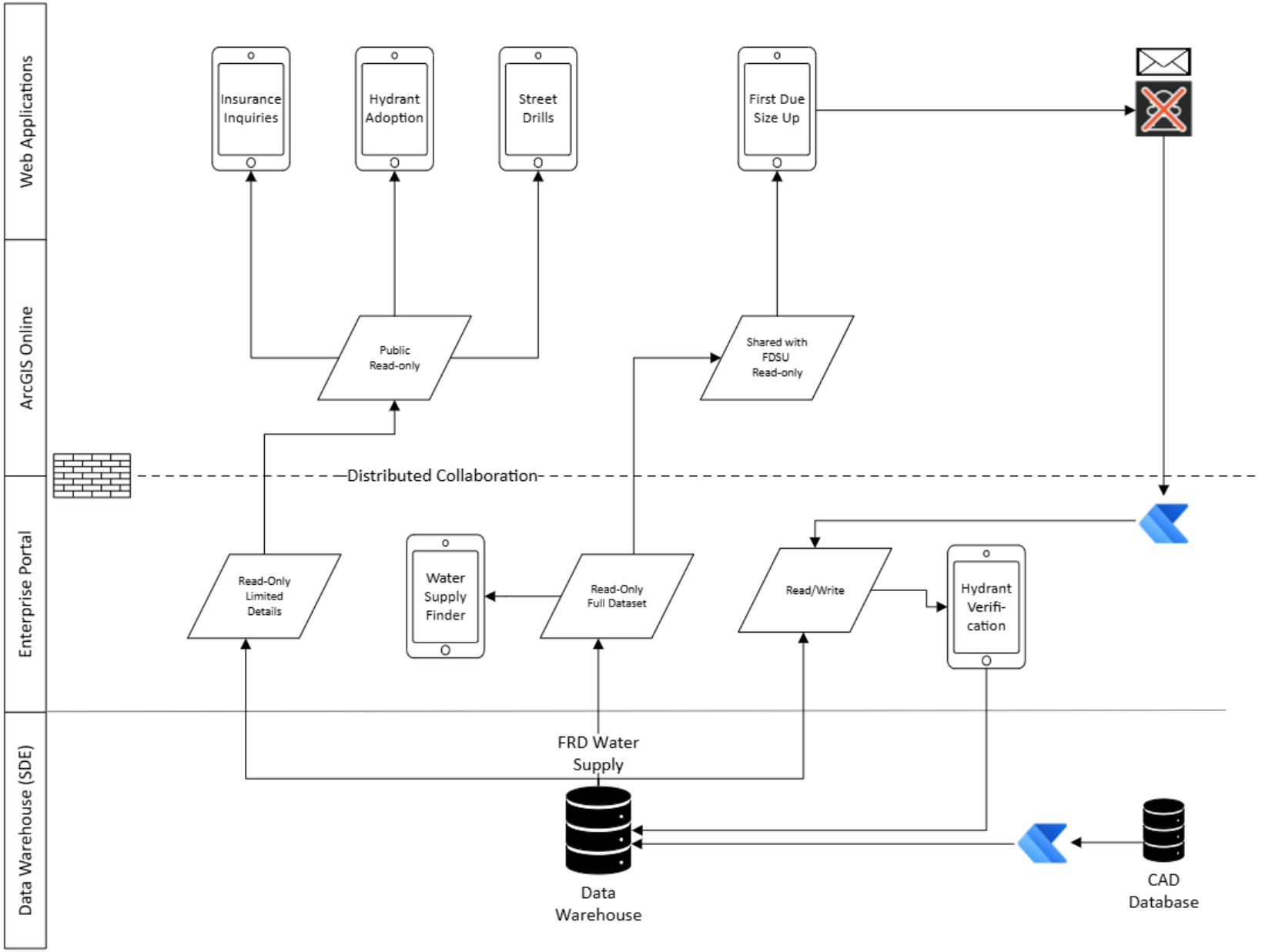
Hydrants
Automating water supply data

Department Needs:

- Centralized data storage
- Tracking in/out of service notifications
- Maintaining an accurate inventory
- Quarterly updates from water authority
  - Attribute rules
- Display modeled flow rates (new)
- Feeding multiple apps
  - Public engagement
  - Internal workflows

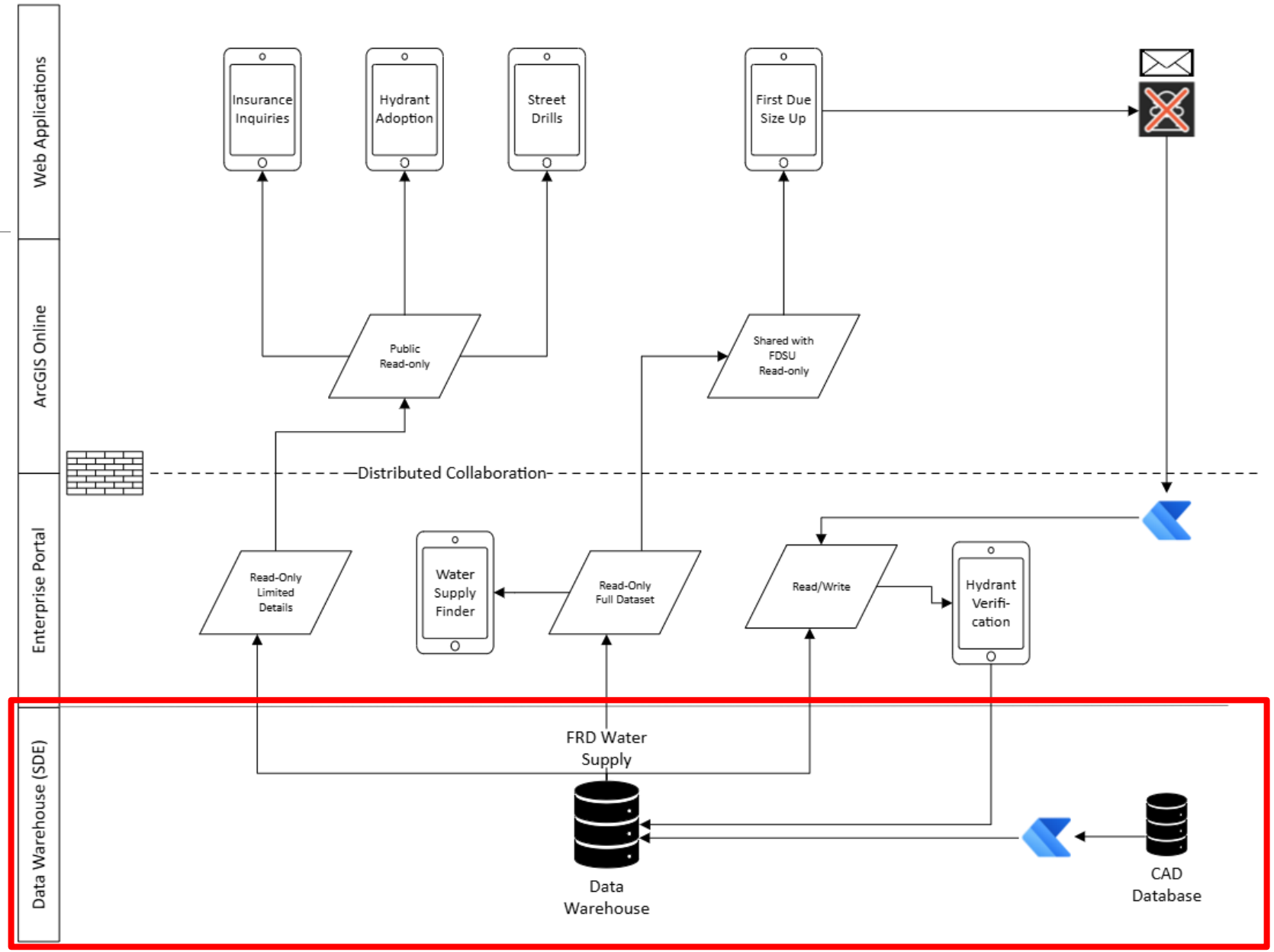
Hydrants Workflow

- 1 data source
- 2 Power Automate Flows
- 3 Published Services
- 6+ Web Applications



Hydrants Workflow

- Database Tier
  - Data Warehouse
    - Water Supply
  - CAD Database
    - Hyd In
    - Hyd Out
  - Automation
    - CAD Status change



Hydrants Workflow

- Data Schema Design
  - Streamlined redundant fields
  - Domain dropdown lists
  - Supporting documentation

Field Name	Alias	Data Type	Domain	Length
FRD_HYD_ID	FRD Hydrant ID	Text		20
HYDTYPE	Hydrant Type	Text	FRD_HYD_TYPE	15
HYD_SUBTYPE	Water Supply Subtype	Text	FRD_HYD_SUBTYPE	15
STATUS	Status	Text	FRD_HYD_STATUS	20
FLOW	Modeled Flow Rate	Long		
FIRST_DUE	First Due	Short		
FIRE_BOX	Fire Box	Text		50
ADDRESS	Nearest Address	Text		80
LOC_DESC	Location Description	Text		255
LOC_DETAILS	Location Details	Text		50
ZIP	ZIP Code	Text		10
JURISDICTION	Jurisdiction	Text		25
CAD_CODE	CAD Code	Text		30
IN_FDSU	In First Due Size Up	Text	YES_NO	3
DATA_SOURCE	Data Source	Text		20
SOURCE_ID	ID From Data Source	Text		30
SOURCE_TYPE	Source Type	Text		50
SOURCE_STATUS	Source Hydrant Status	Text		20
MAINTAINED_BY	Maintained By	Text		30
OWNERSHIP	Ownership	Text	FRD_HYD_OWNER	50
DATA_STEWARD	Data Steward	Text		20
X_COORD	X State Plane	Double		
Y_COORD	Y State Plane	Double		
X_DD	X Decimal Degrees	Double		
Y_DD	Y Decimal Degrees	Double		
WHAT_THREE_WORDS	What 3 Words	Text		40
VERIFIED_METHOD	Verified Method	Text		10
VERIFIED_BY	Verified By	Text		3
VERIFIED_DATE	Last Verified Date	Date		
DATA_NOTES	Data Notes	Text		255
HYDRANT_NOTES	Hydrant Notes	Text		255
BUILDING_QUADRANT	Building Quadrant	Text	FRD_HYD_QUAD	1
SEQ_NUM	Sequential Number	Long		

METADATA

WATER SUPPLY

Thumbnail

Tags

FFX, Fairfax County, Virginia, VA, Fire and Rescue Department, Data Analytics Strategy Management Division, FCFRD, FFXCO, FRD, Fire, Public Safety, Fire and Rescue, Water Supply, Hydrant

Summary

This layer contains water supply sources used for firefighting. Data supports Fairfax County Computer Aided Dispatch (CAD), First Due Size Up (FDSU), Insurance Inquiries, Adopt a Hydrant, Street Drills, Water Supply Finder, and Hydrant Verification applications.

Description

The layer is a combination of multiple data sources from internal jurisdictions including but not limited to the towns of Vienna, Clifton, and Herndon, and Ft. Belvoir. It also includes some private hydrants from neighboring jurisdictions which include the City of Fairfax and Falls Church, Loudoun County, Prince Williams County, Montgomery County (MD), Prince George County (MD), Washington, D.C. Most of this data is provided by the Fairfax Water Authority.

Contact: Fire and Rescue Department

Data Accessibility: Publicly Available

Update Frequency: As Needed

Last Revision Date: 3/10/2025

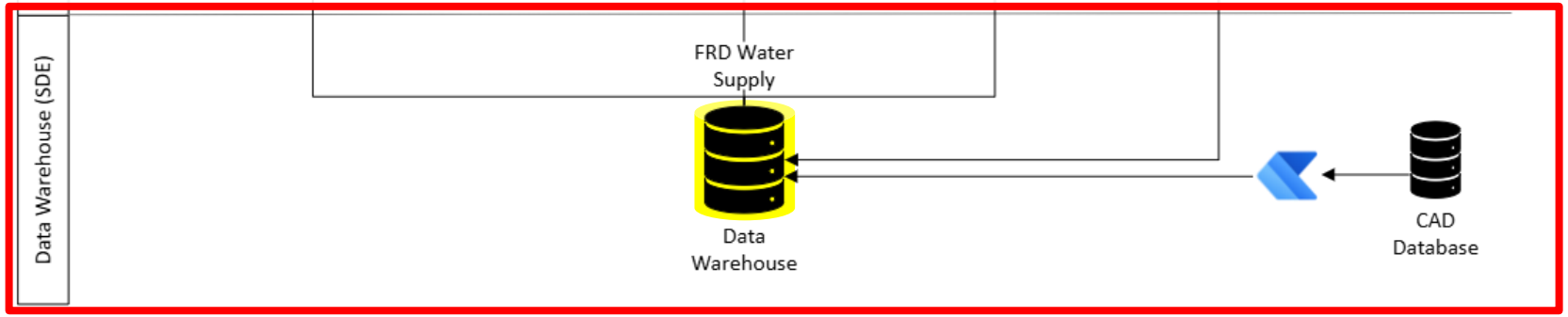
Creation Date: 1/1/2009

Feature Dataset Name: FIREMGR.FIRE_RESCUE_PUBLIC

Layer Name: FIREMGR.WATERSUPPLY

Credits

Fairfax County, Virginia; Fire and Rescue Department;



Hydrants Workflow

- Attribute Rules
  - Immediate
    - First Due
    - Fire Box
    - Jurisdiction
    - CAD Code
    - ZIP Code
    - FRD Hydrant ID
  - Batch
    - X State
    - Y State Plane
    - X Decimal Degrees
    - Y Decimal Degrees

Field Name	Alias	Data Type	Domain	Length
FRD_HYD_ID	FRD Hydrant ID	Text		20
HYDTYPE	Hydrant Type	Text	FRD_HYD_TYPE	15
HYD_SUBTYPE	Water Supply Subtype	Text	FRD_HYD_SUBTYPE	15
STATUS	Status	Text	FRD_HYD_STATUS	20
FLOW	Modeled Flow Rate	Long		
FIRST_DUE	First Due	Short		
FIRE_BOX	Fire Box	Text		50
ADDRESS	Nearest Address	Text		80
LOC_DESC	Location Description	Text		255
LOC_DETAILS	Location Details	Text		50
ZIP	ZIP Code	Text		10
JURISDICTION	Jurisdiction	Text		25
CAD_CODE	CAD Code	Text		30
IN_FDSU	In First Due Size Up	Text	YES_NO	3
DATA_SOURCE	Data Source	Text		20
SOURCE_ID	ID From Data Source	Text		30
SOURCE_TYPE	Source Type	Text		50
SOURCE_STATUS	Source Hydrant Status	Text		20
MAINTAINED_BY	Maintained By	Text		30
OWNERSHIP	Ownership	Text	FRD_HYD_OWNER	50
DATA_STEWARD	Data Steward	Text		20
X_COORD	X State Plane	Double		
Y_COORD	Y State Plane	Double		
X_DD	X Decimal Degrees	Double		
Y_DD	Y Decimal Degrees	Double		
WHAT_THREE_WORDS	What 3 Words	Text		40
VERIFIED_METHOD	Verified Method	Text		10
VERIFIED_BY	Verified By	Text		3
VERIFIED_DATE	Last Verified Date	Date		
DATA_NOTES	Data Notes	Text		255
HYDRANT_NOTES	Hydrant Notes	Text		255
BUILDING_QUADRANT	Building Quadrant	Text	FRD_HYD_QUAD	1
SEQ_NUM	Sequential Number	Long		

Fire Box

Calculation

2.3

Rule Name: Fire Box

Description:

pull FIRE_BOX_TEXT from DIT_GIS.FIREMGR.Fire_Box

Subtype:

Field: FIRE_BOX

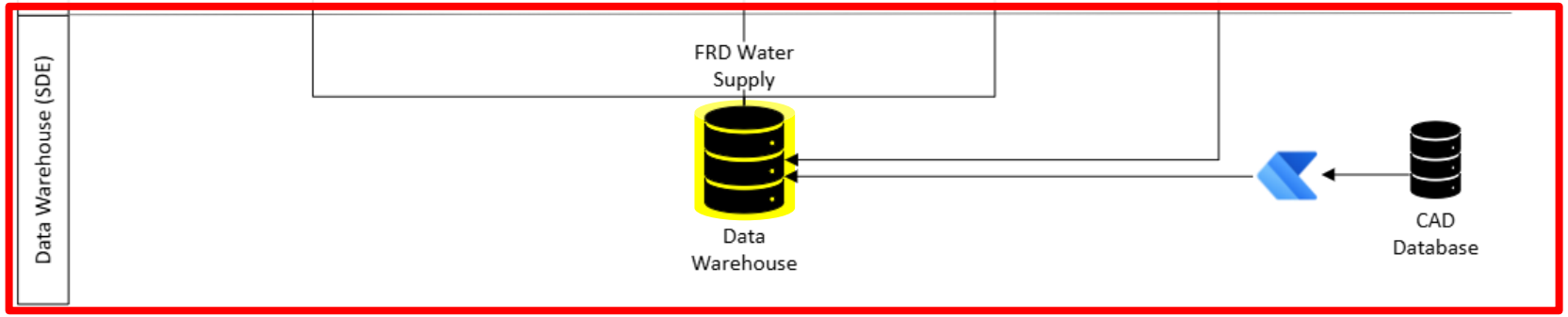
Editable

Expression

```
// Access the Fire_Box layer and retrieve the COG_BOX_NUM field
var gridLayer = FeatureSetByName($datastore, "Fire_Box", ["COG_BOX_NUM"], true);

// Find the first feature that intersects with the current feature
var matchingFeature = First(Intersects(gridLayer, $feature));

// Check if a matching feature is found
if (!IsEmpty(matchingFeature)) {
    var cogBoxNum = matchingFeature["COG_BOX_NUM"];

    // Ensure the number is 6 digits, padding with leading zeros if necessary
    return Text(cogBoxNum, "000000");
}

// Return a default value (e.g., "000000") if no match is found
return "000000";
```

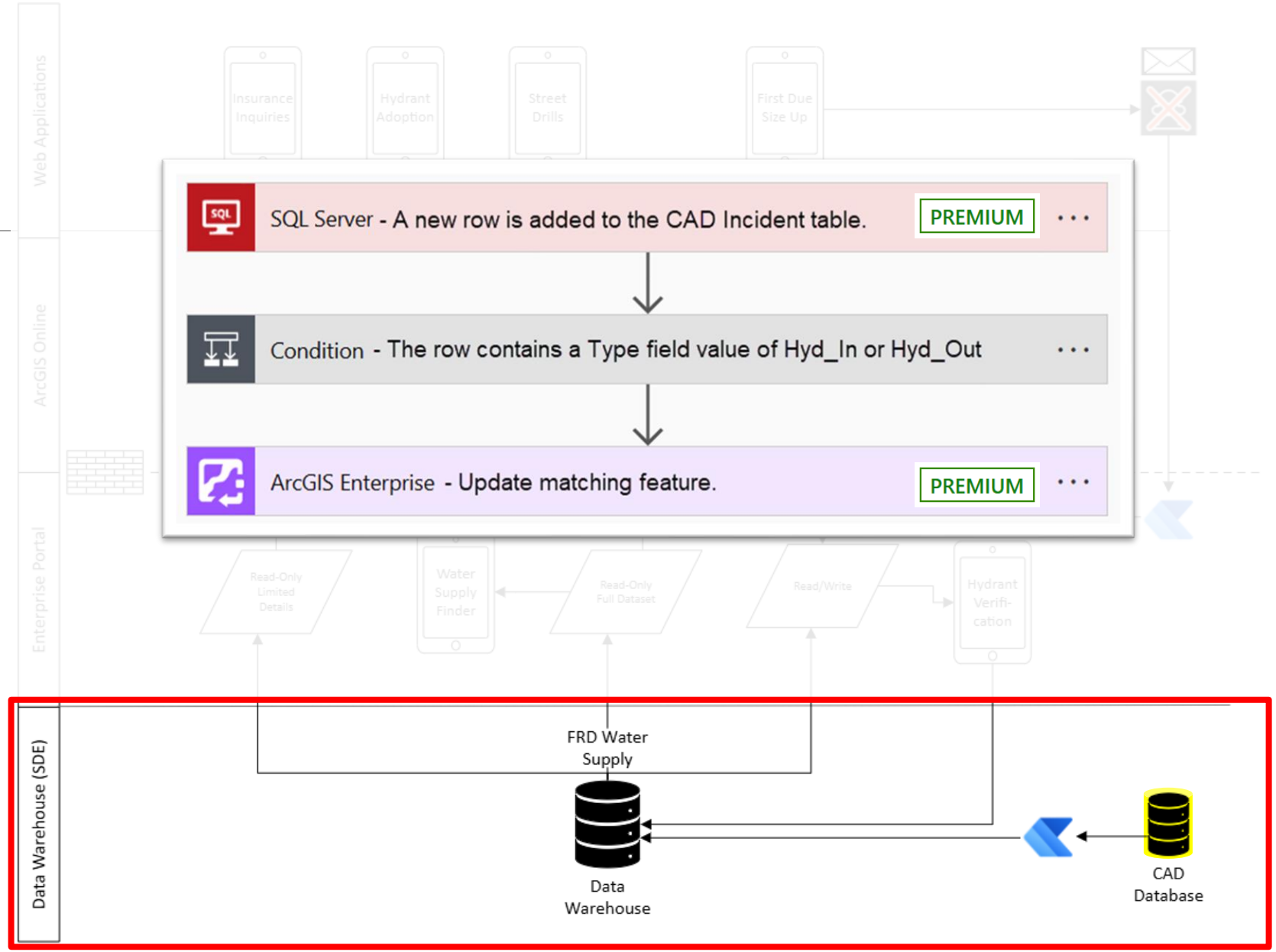
Triggers

Insert ☑ Update ☑ Delete ☐



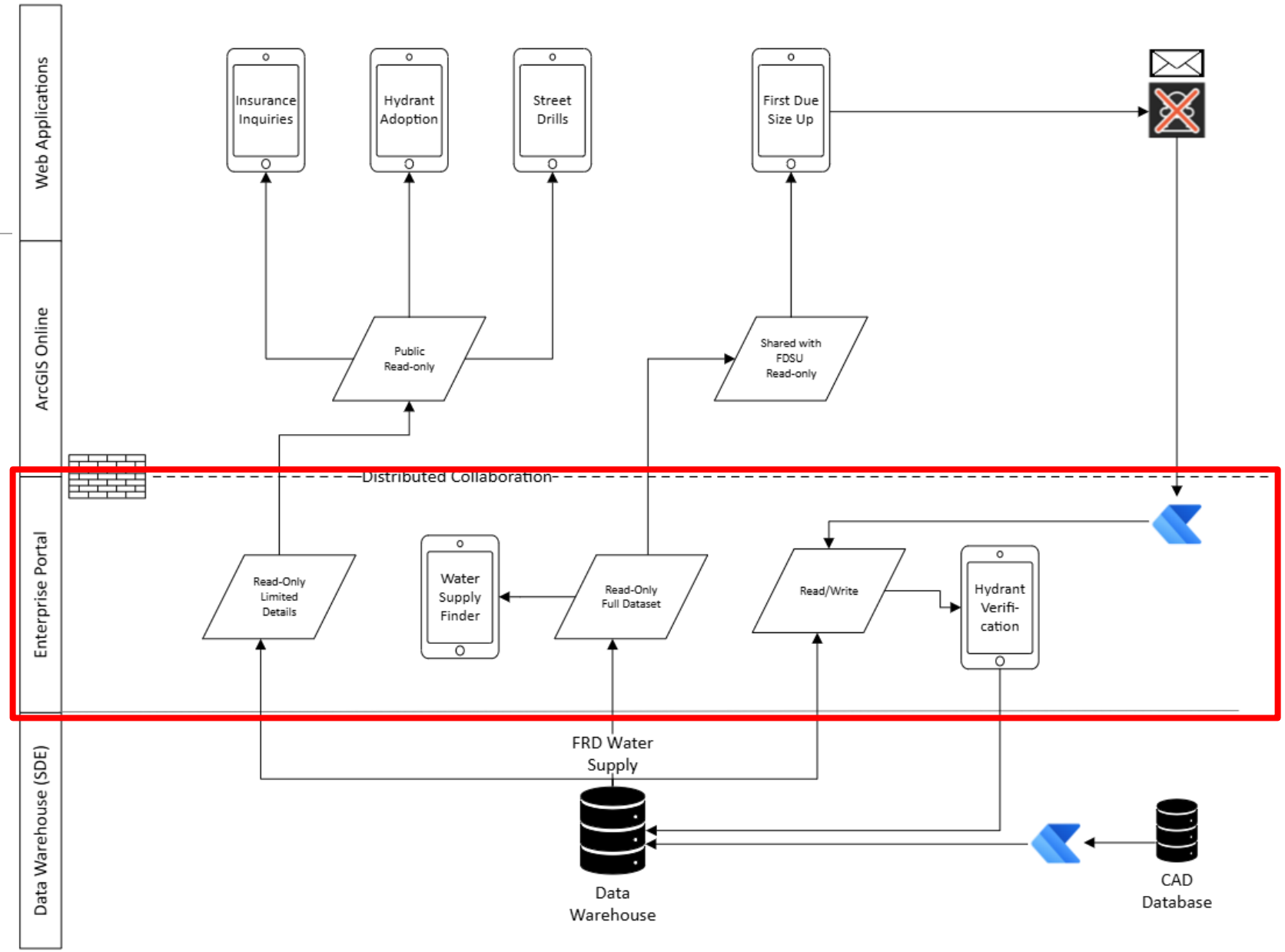
Hydrants Workflow

- CAD Incident Database
  - Hydrant In Service
  - Hydrant Out of Service
- Power Automate
  - Look for these incident types
  - Update row in Data Warehouse



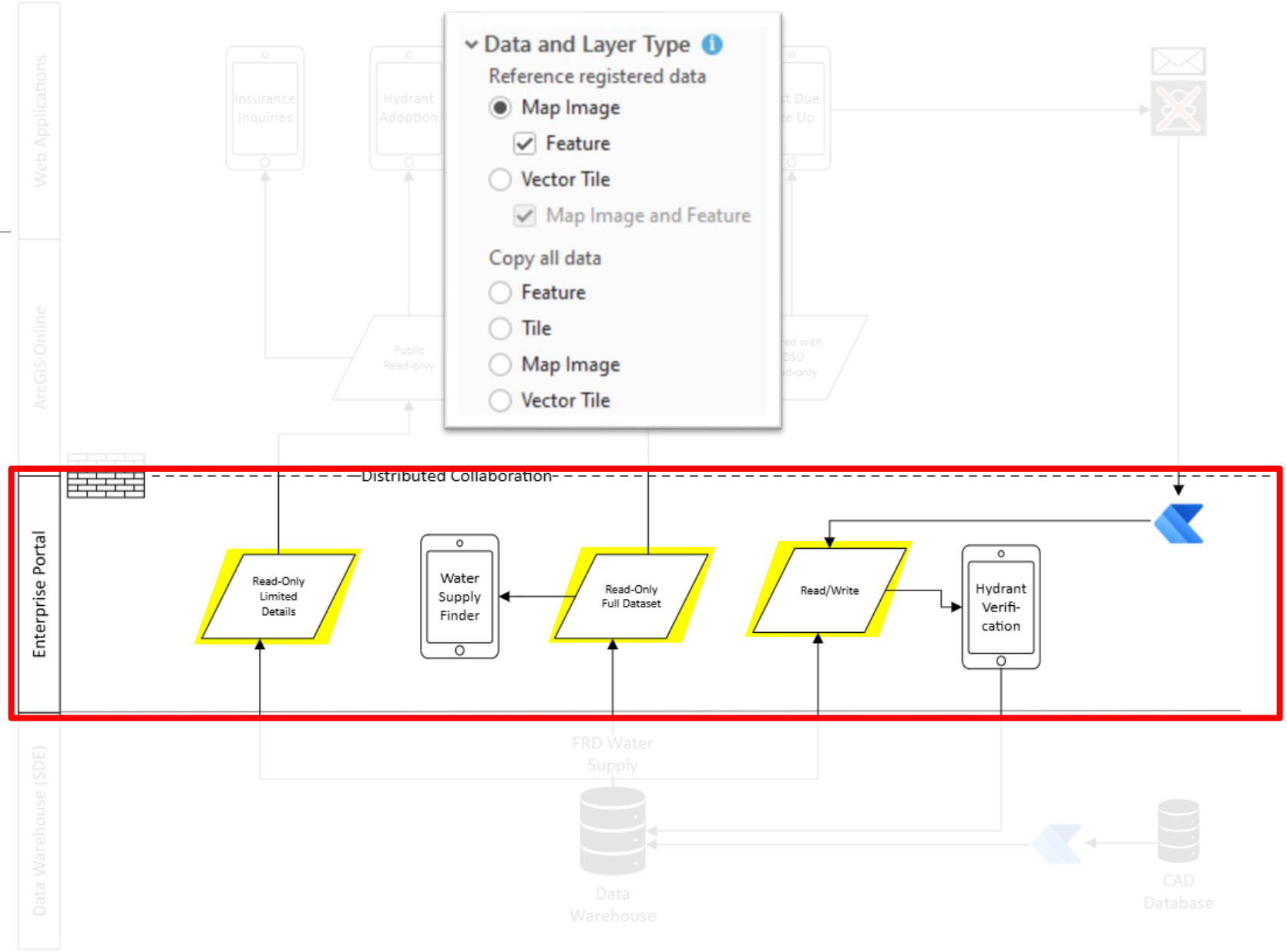
Hydrants Workflow

- Enterprise Portal Tier
  - Published Services
    - Public read-only
    - Protected read-only
    - Internal editing
  - Applications
    - Water Supply Finder
    - Hydrant Verification
  - Automation
    - Status change



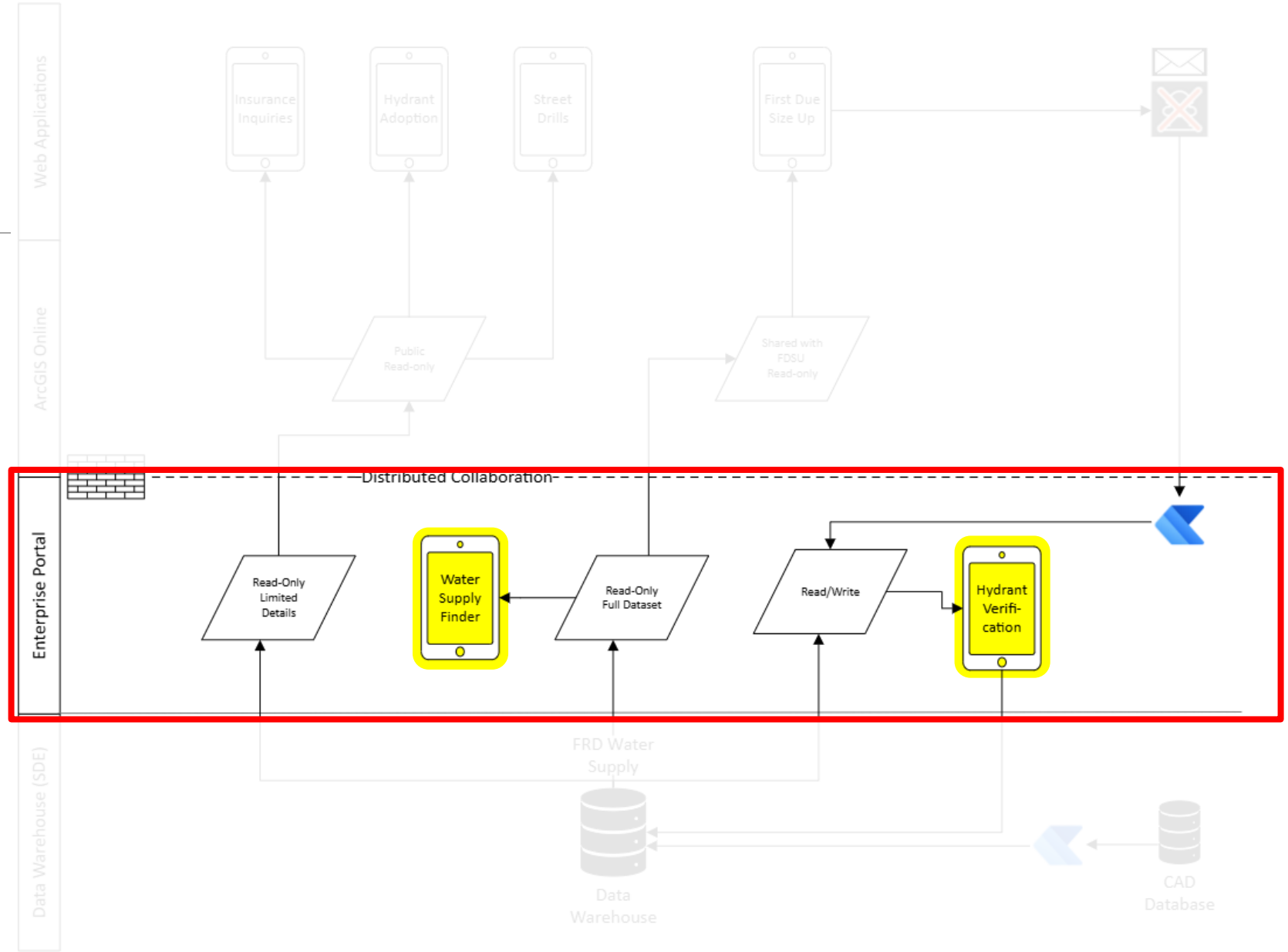
Hydrants Workflow

- Published Services
  - Public read-only
    - Hydrants Only
    - Minimal Details
    - Federated
  - Protected read-only
    - All Details (attributes)
    - Federated
    - Shared to protected group
  - Internal editing
    - All details
    - Full edit control



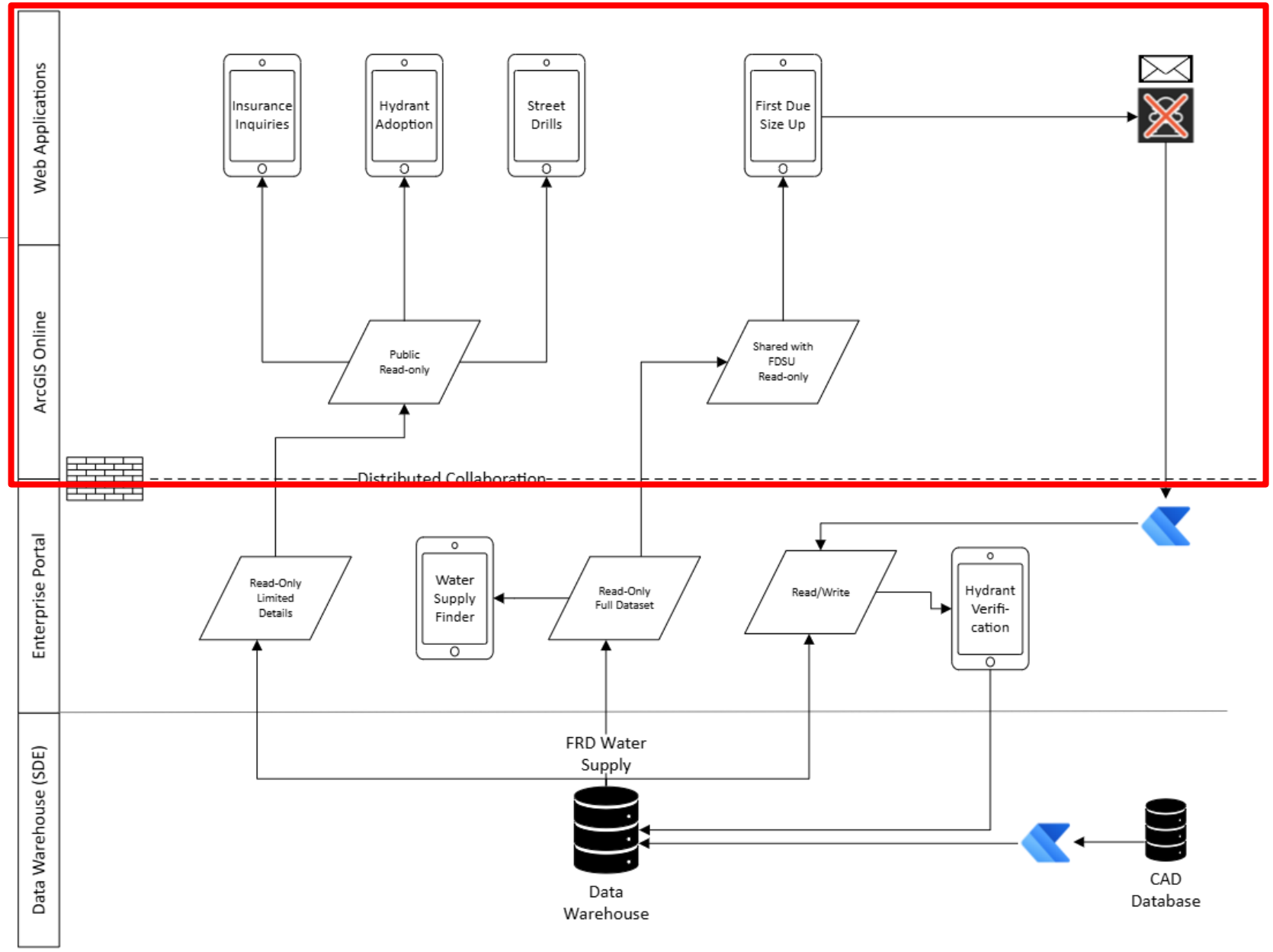
Hydrants Workflow

- Internal Applications
  - Water Supply Finder
    - All Water Supply Types
      - Hydrants
      - Dry Hydrants
      - Draft Sites
      - Interstate Standpipes
      - Tanks
    - Modeled Flow Data
  - Hydrant Verification
    - Full editing control
    - GIS staff only



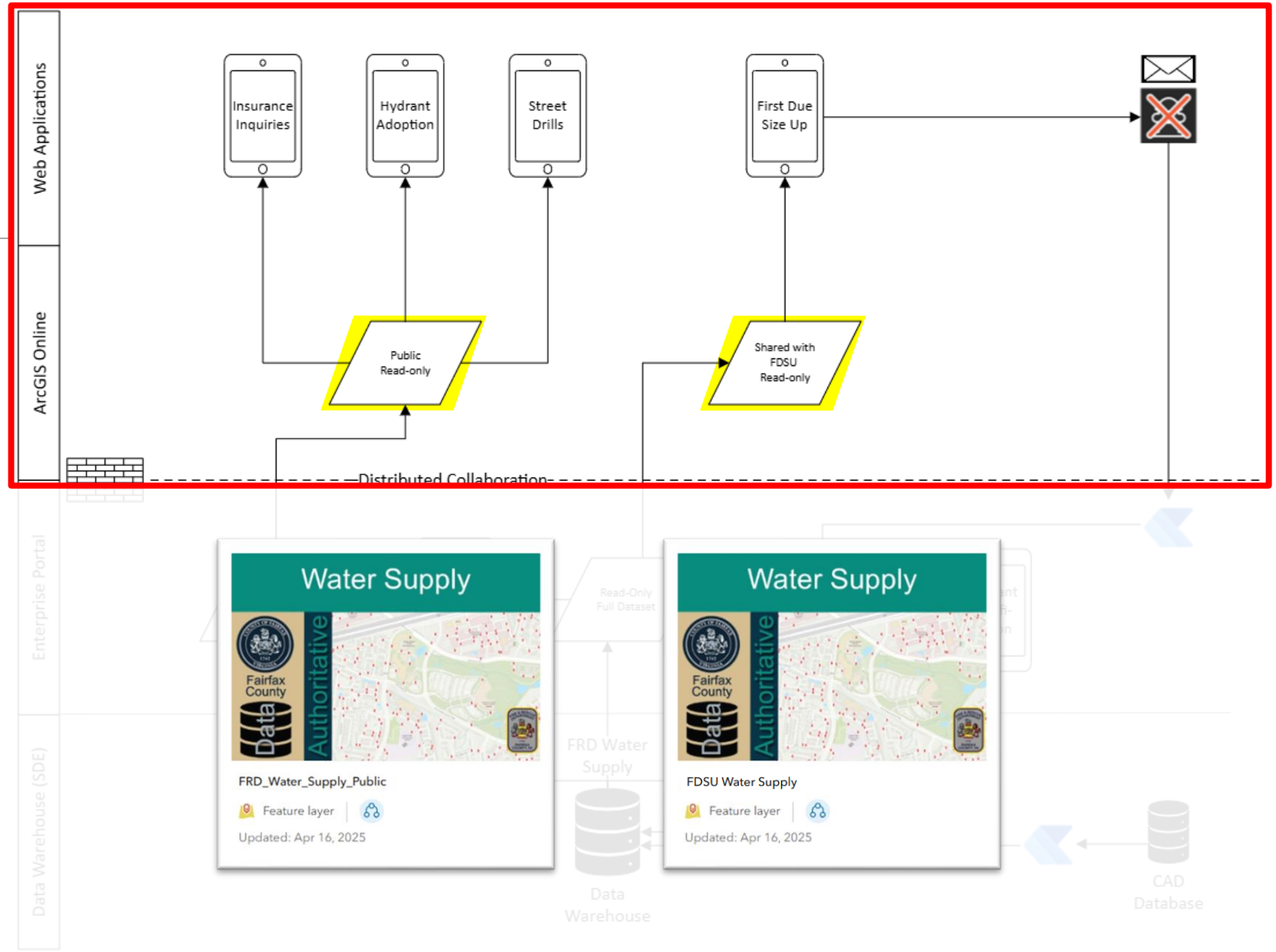
Hydrants Workflow

- ArcGIS Online Tier
  - Collaborated Services
    - Public read-only
    - Protected read-only
  - Applications
    - Insurance Inquiries
    - Hydrant Adoption
    - Street Drills
    - First Due Size Up
  - Automation
    - Status change



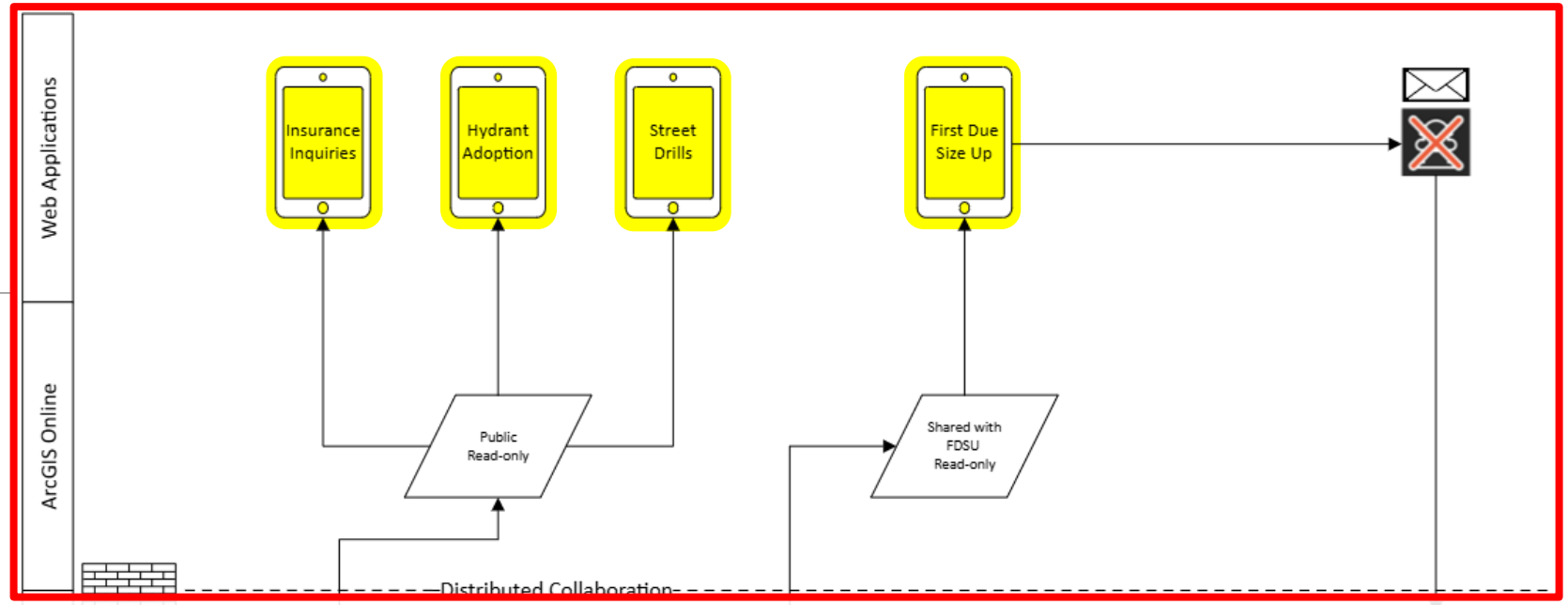
Hydrants Workflow

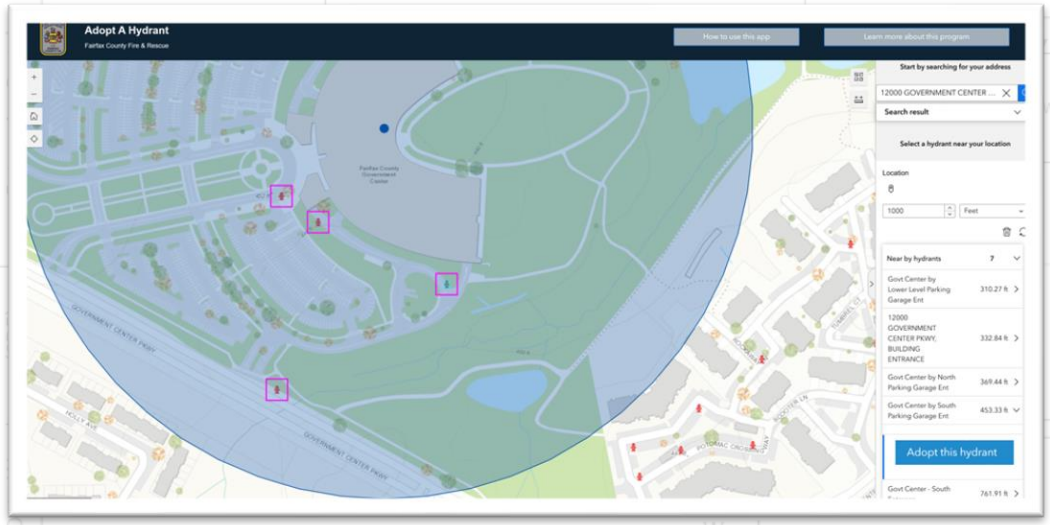
- Collaborated Services
  - Public read-only
  - Protected read-only



Hydrants Workflow

- Applications
  - Public facing
    - Insurance Inquiries
    - Hydrant Adoption
    - Street Drills
  - Protected
    - First Due Size Up



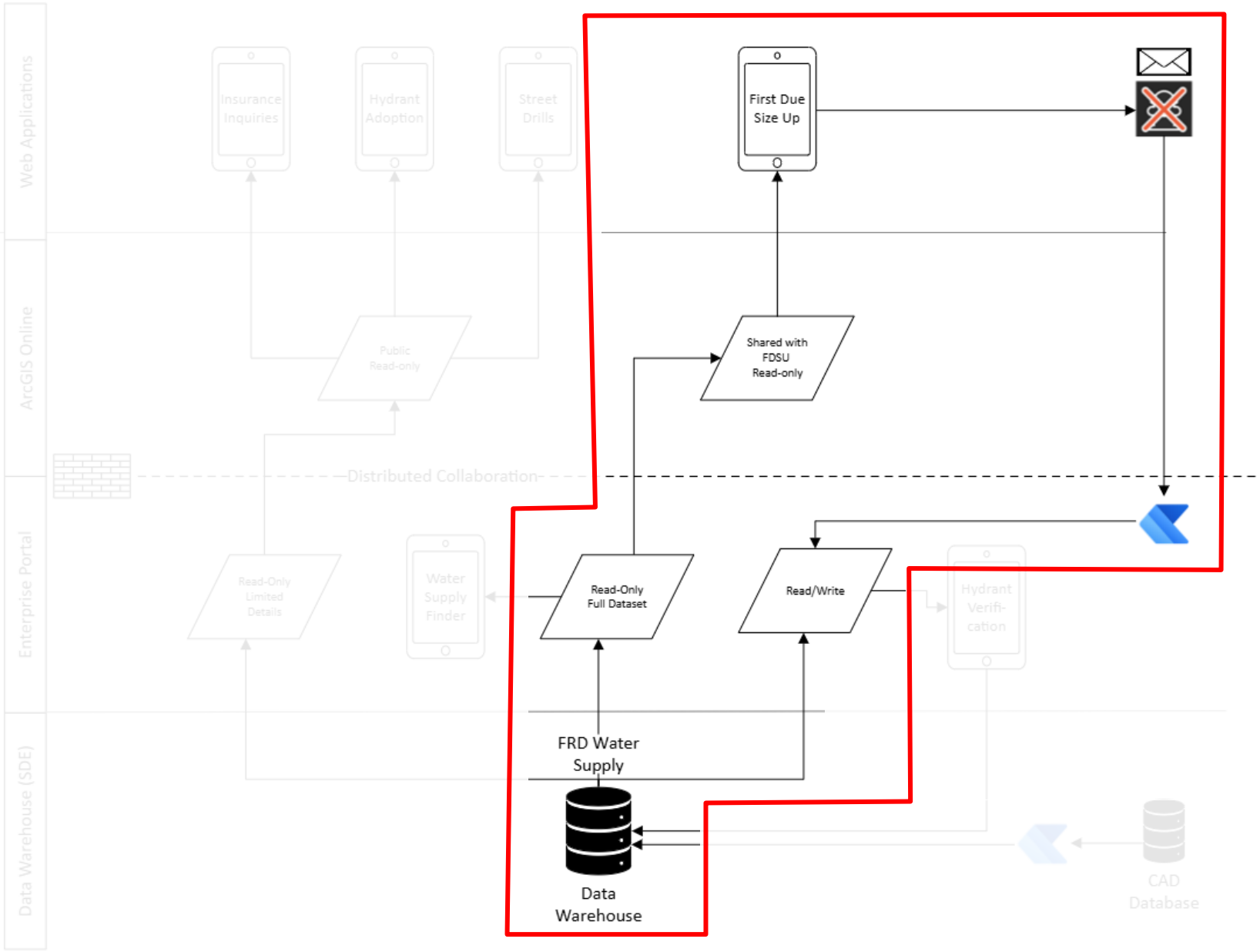


Adopt A Hydrant web app

First Due Size Up

Hydrants Workflow

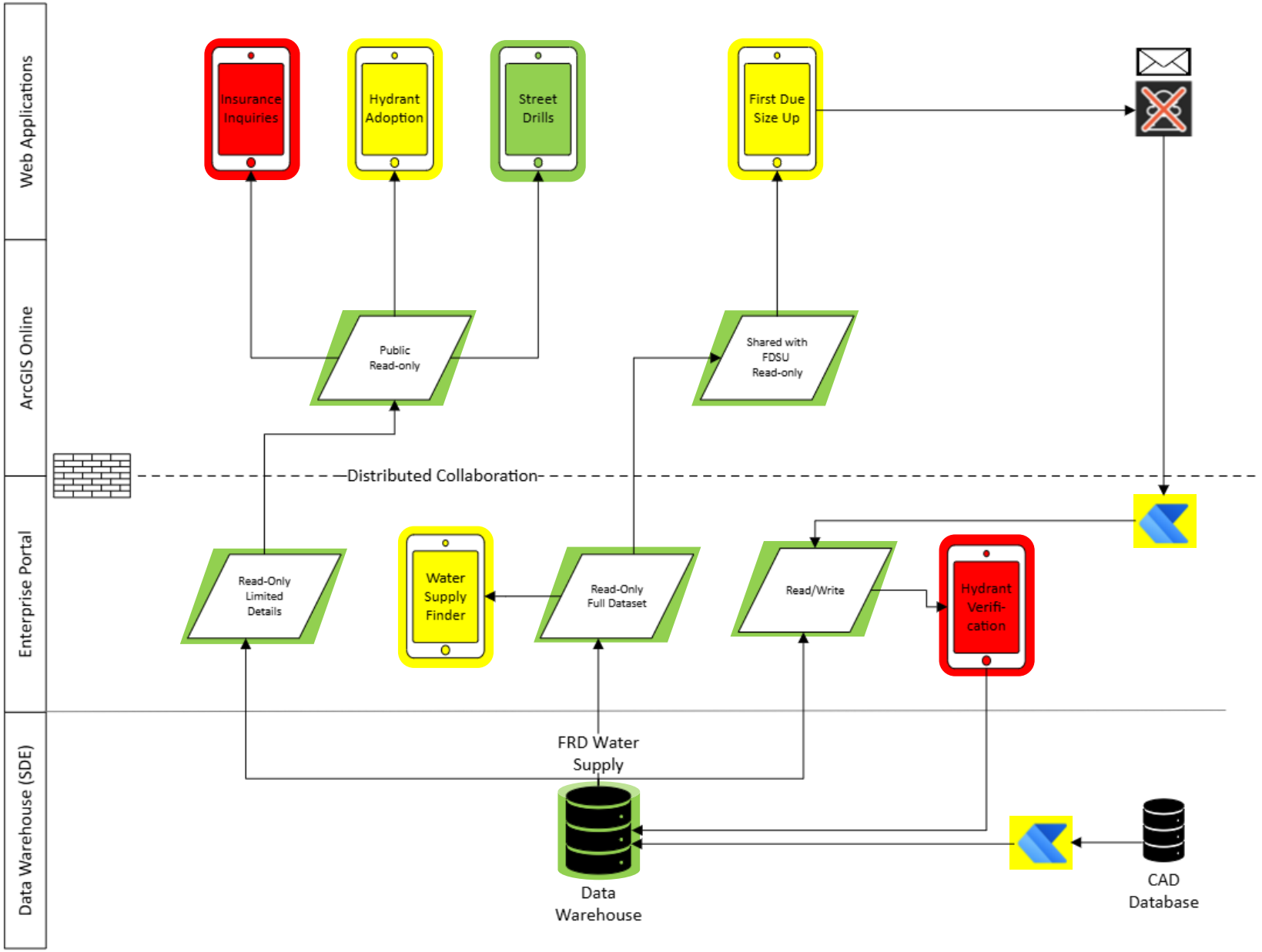
- Automation
  1. SQL Database
  2. Portal read-only
  3. Protected AGOL group
  4. 3rd party application
  5. Email notifications
  6. Power Automate
  7. Portal editable
  8. SQL Database



Hydrants Workflow

- Benefits
  - Real-time data across all applications
  - Single data source
  - Published references (federated services)
  - Portal based editing
  - Future proofing

- Complete
- In Development
- Future Development



Hydrants Information Bulletin

FAIRFAX COUNTY FIRE AND RESCUE DEPARTMENT
INFORMATIONAL BULLETIN

NUMBER: 2025 **CFAI PI:** XXX	**DATE:** April 18, 2025
ISSUED BY: Chip Galloway, GIS Analyst IV Data Analytics Strategy Management Division	
SUBJECT: First Due Size Up – Hydrant Map Symbols	

Data Analytics Strategy Management (DASM) has implemented a new Water Supply (fire hydrants and other water resources for firefighting purposes) GIS layer incorporating modeled flow rate data provided by Fairfax Water Authority. This updated layer reflects a standardized symbology and color-coding scheme based on National Fire Protection Association (NFPA) guidelines for Gallons Per Minute (GPM).

The new Water Supply layer will be maintained by the DASM GIS Section as the authoritative source for water supply information. It includes detailed attributes for hydrant status, flow capacity, supply type (e.g., hydrant, dry hydrant, draft site, interstate standpipe, tank), and location information. Personnel should refer to this layer for up-to-date information during planning, response, and pre-incident coordination.

Users should continue reporting Out of Service (OOS) hydrants through the First Due Size Up application. Status reports are processed and preserved in the Water Supply data to maintain a consistent inventory of available water resources for firefighting purposes. The DASM GIS Section will coordinate with the Fairfax Water Authority and other entities to ensure their awareness, time frame for repair, and updated status changes.

For more information about Water Supply, visit the DASM GIS SharePoint webpage. To report any issues, please contact fire.GIS@fairfaxcounty.gov.

Symbol	Water Supply Description
	Hydrant Capacity <500 GPM (red)
	Hydrant Capacity 500 - 999 GPM (orange)
	Hydrant Capacity 1000 - 1499 GPM (green)
	Hydrant Capacity >1500 GPM (light blue)
	Hydrant Out of Service
	Dry Hydrant
	Draft Site
	Interstate Standpipe
	Tank

Questions?

Contact Info:

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GIS Analyst IV

Data Analytics Strategy Management

Fairfax County Fire & Rescue Department

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charles.galloway@fairfaxcounty.gov