Leveraging Today's GIS for ROW and Infrastructure Management

Linda Foster, PLS, GISP, MGIS

TRB AKD70 Summer Meeting 2024

Agenda

- GIS and the Geographic Approach
- The Five S’s
- GIS and Right-of-Way
- Some Hot Topics
- Wrap Up and Questions

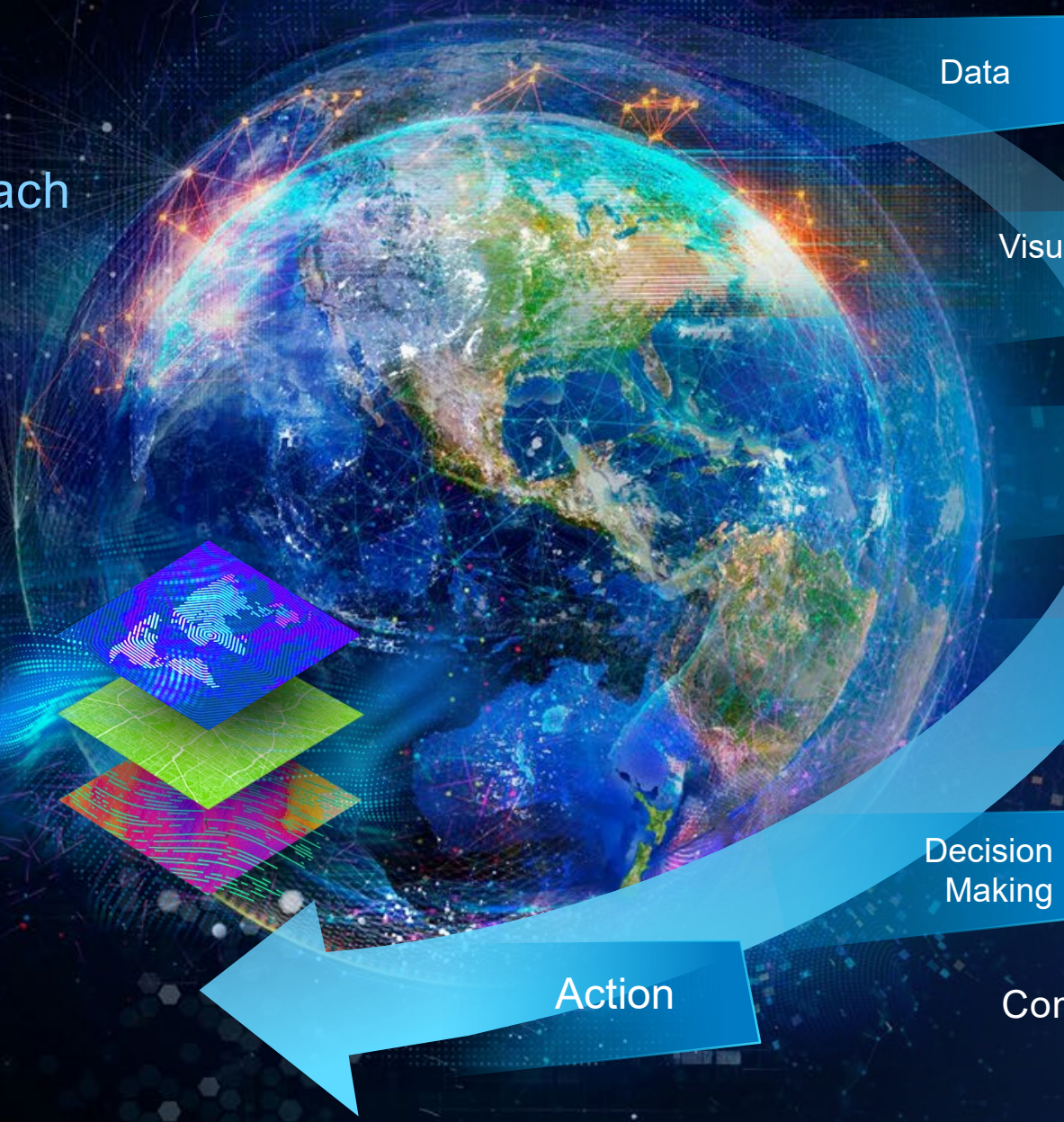
GIS and the Geographic Approach

GIS

Enables The Geographic Approach

Providing a Process and Framework . . .

. . . For Applying Geographic Knowledge Widely



Measuring

Data

Assessing

Visualization & Mapping

Predicting

Analysis & Modeling

Understanding

Planning & GeoDesign

Applying

Decision Making

Communicating

Action

GIS

A System for Managing, Sharing and Applying Geographic Information

Delivering Value Across Organizations
Improving Efficiency, Communications, Decision Making and Collaboration

GIS – A System of Systems

Geospatial infrastructure transforming operations

System of Record

Cadastral Mapping

Parcels

Data
Management
and Integration

System of Engagement

Open Data

Hubs

Sharing
Collaboration
Dissemination

System of Insight

Spatial Models

Visual Analytics

Planning & Analysis

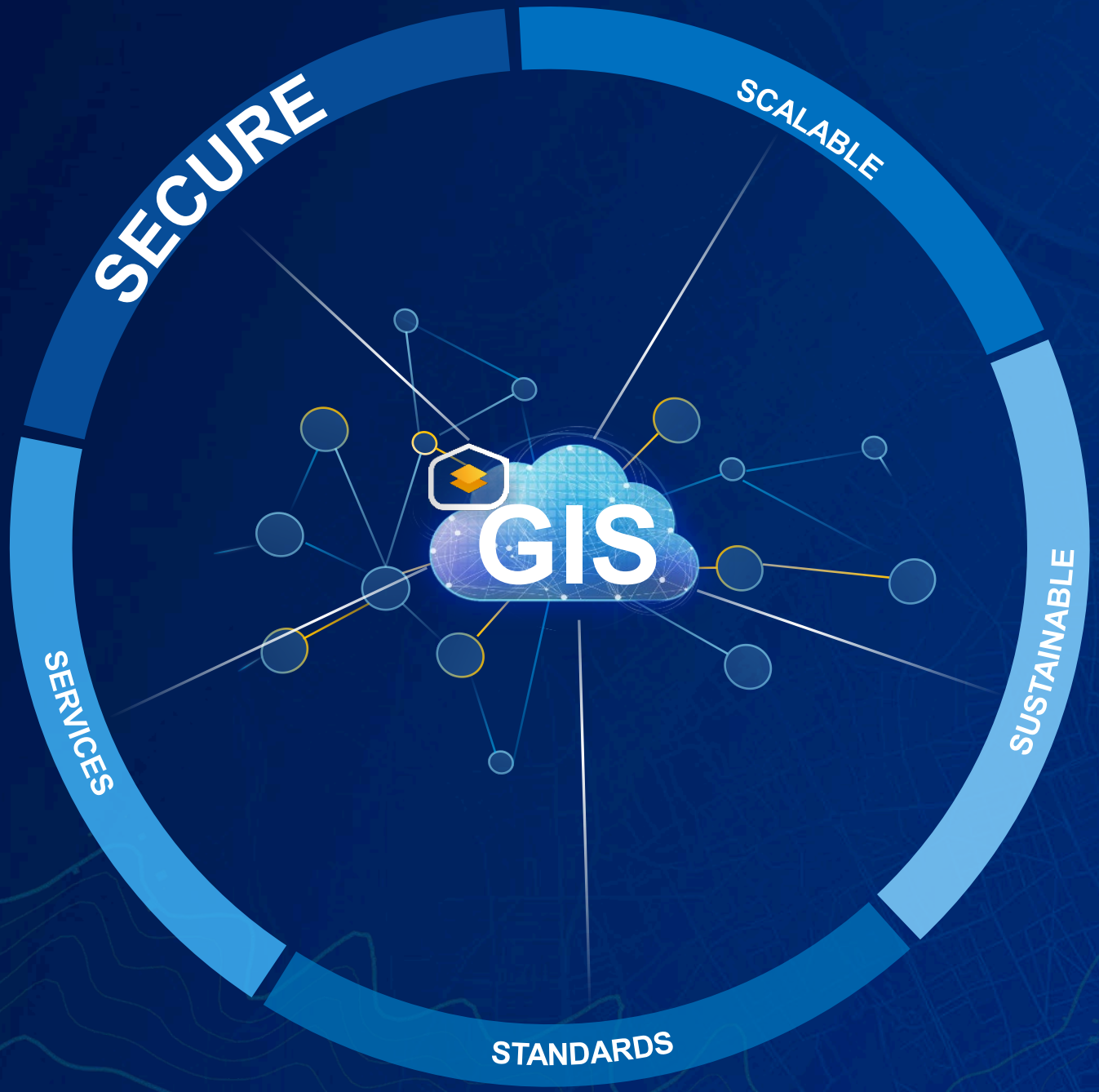
Analytics, Models,
and Data Exploration

The Five S’s

How GIS Changes the Dialogue

The Five "S's"…

How GIS Changes the Dialogue



The Five "S's"…

FedRAMP

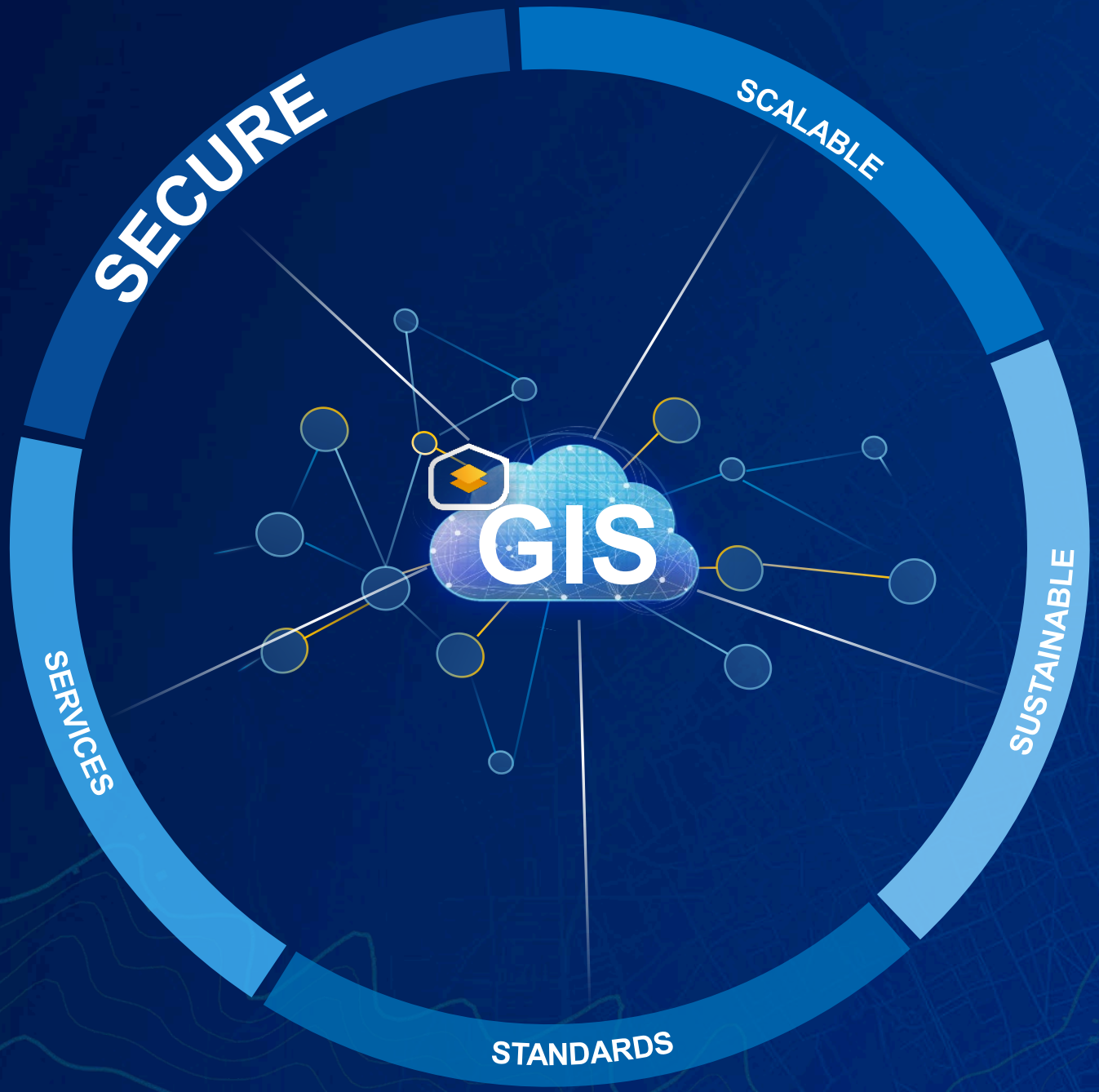
NIST 800-53

USGCB

CCPA

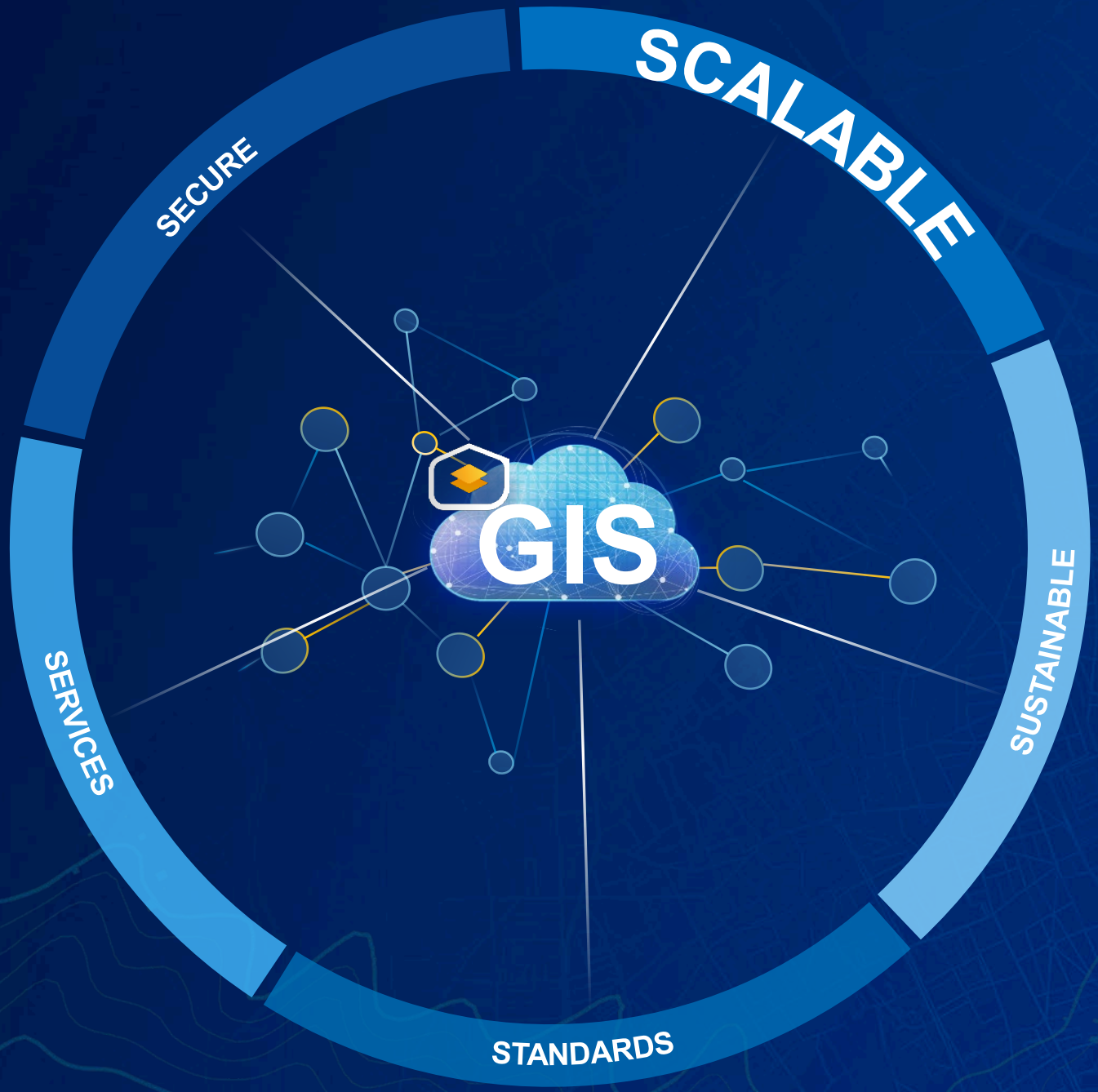
STIG

GDPR



The Five "S's"…

How GIS Changes the Dialogue



The Five "S's"…

Scalable

Projects
(Individuals or Small Groups)

Systems
(Organization-Wide)

Cloud Services
(Individuals to Organizations)

Geospatial Infrastructure
(System of Systems – Cross Department or Multiple Agency)

How GIS Changes the Dialogue

The Five "S's"…

COTS =

STABILITY

The Five "S's"…

How GIS Changes the Dialogue

The Five "S's"…

Standards-based GIS (operational)

ASCE

Open Standards and Formats

KML
XLSForm
WFS
GML
WCS
WMS
WWW
IFC
SQL
Web Scene (I3S)
OPeNDAP
SLD
SOAP
WMTS
LERC
JSON
LAS
CSW
REST
WaterML
INSPIRE
WPS
NetCDF
Shapefiles
OGC Principal Member
ISO
GeoPackage
OneGeology
CityGML
Many OGC Certifications

Systems Integration

MS Office
Adobe Creative Cloud
SharePoint
SQL Server
Azure
Jupyter Notebooks
Power BI
Netezza
Teradata
AWS
Python
R
AutoCAD
SAP HANA
IBM Cognos
Oracle

Open Software

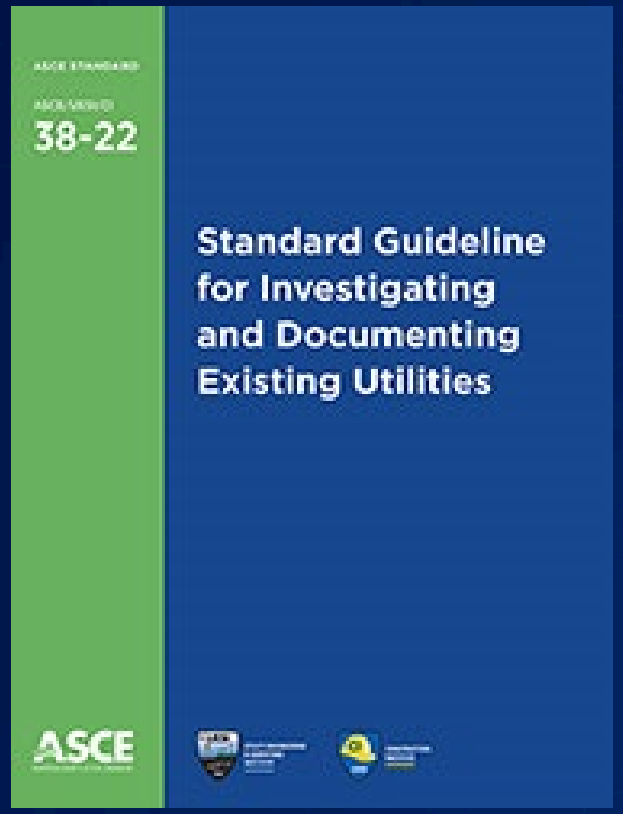
Open Data Access
Open APIs & SDKs
Extensible Architecture
Embeddable Components
Open-Source Contributions (500+)
Open-Source Integration

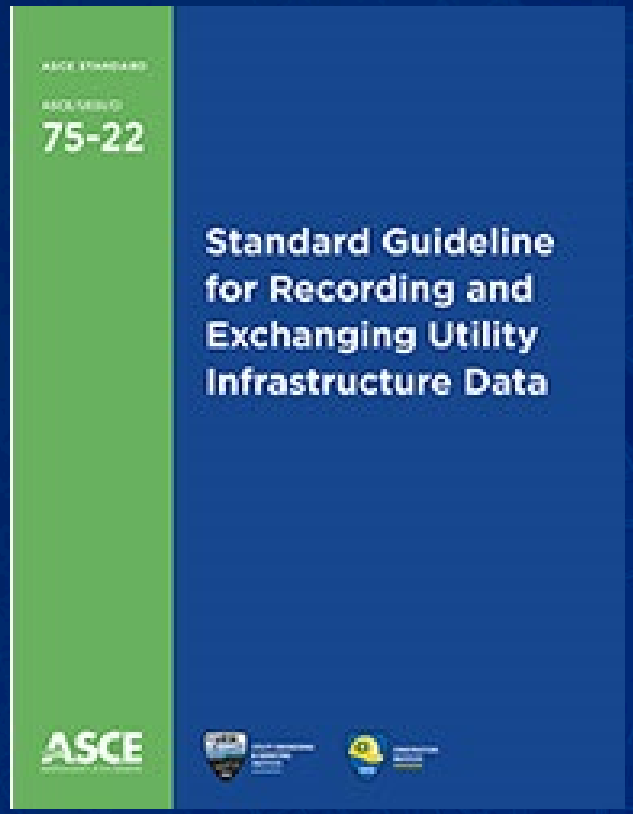
Data Interoperability
Legal Interoperability
Semantic Interoperability
Technical Interoperability

Future-Proof Systems with Standards

Standards-based GIS (industry-specific)

ASCE





The Five "S's"…

How GIS Changes the Dialogue

The Five "S's"…

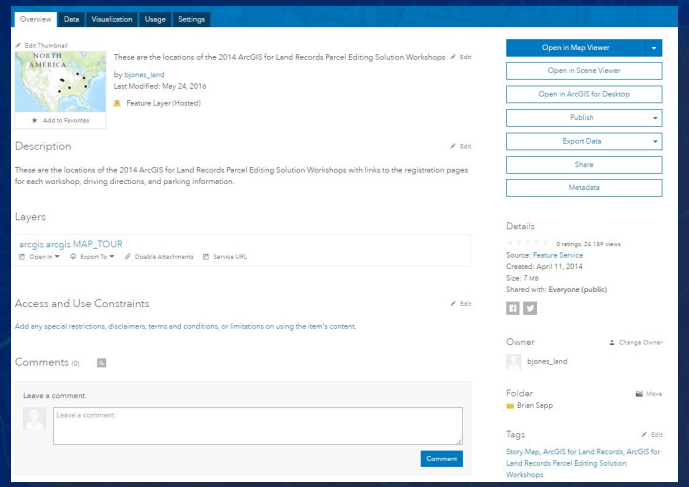
Services (Web)

Organizes and Securely Shares Data…..

- Secure
- Standards-based
- Controlled Access via Identity
- Control Who Does What
  - View
  - Query
  - Edit
- Monitor/Track

https://

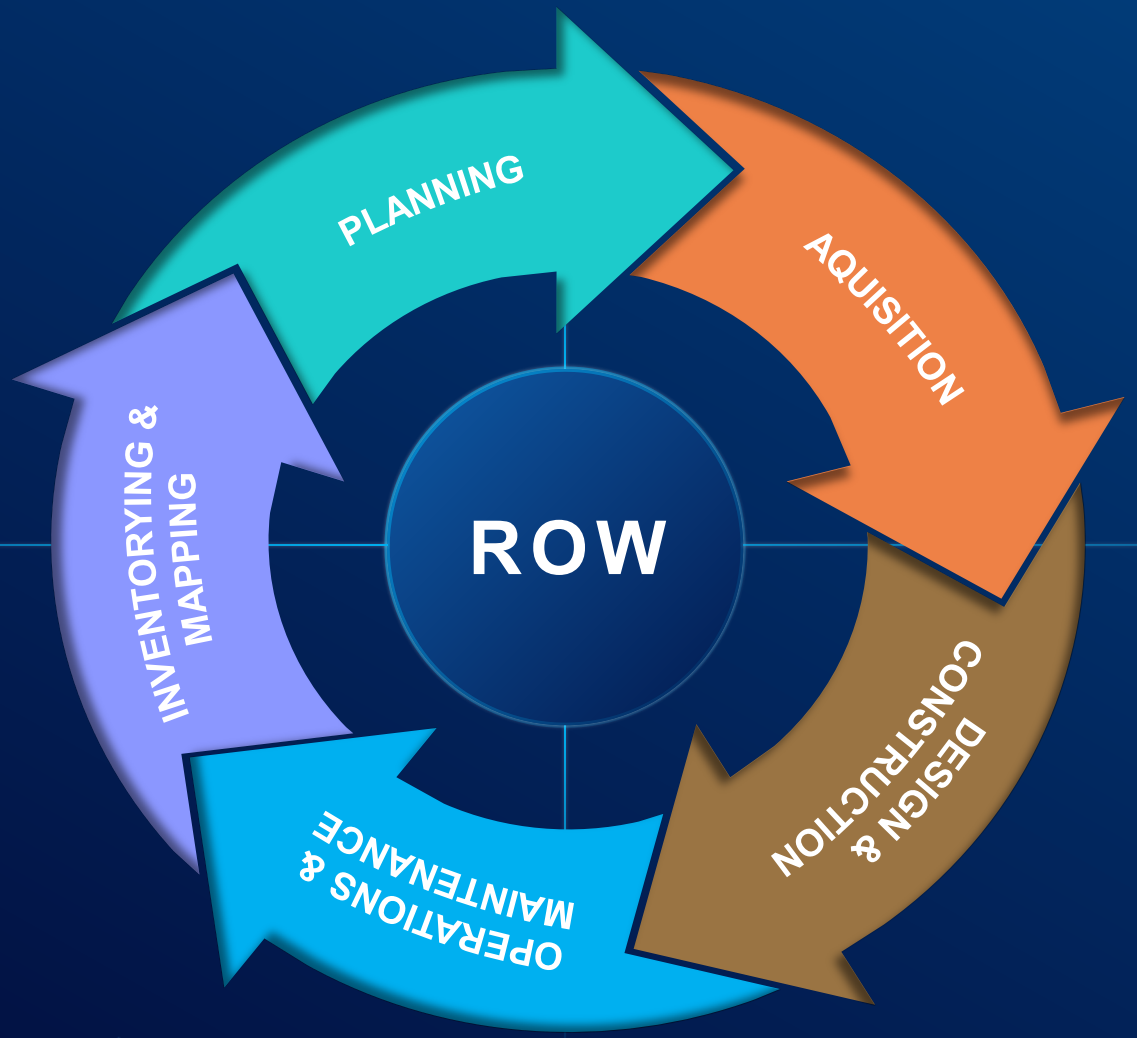
https://esriland.maps.arcgis.com/home/item.html?id=5969689b642840e39cf0491669484e0b



The Five "S's"…

GIS and Right-of-Way

Decades or centuries of legacy records
Resiliency
Regulatory Compliance
Increasing Demand on Infrastructure
Service Reliability
Operational Safety
Infrastructure Funding
Environment
Preserving Legacy Knowledge
Equity Sustainability
Improved Collaboration
Project Efficiency
Workforce Shortages
Data Accessibility
Finite Space for Infrastructure


PLANNING
AQUISITION
DESIGN & CONSTRUCTION
OPERATIONS & MAINTENANCE
INVENTORYING & MAPPING
ROW

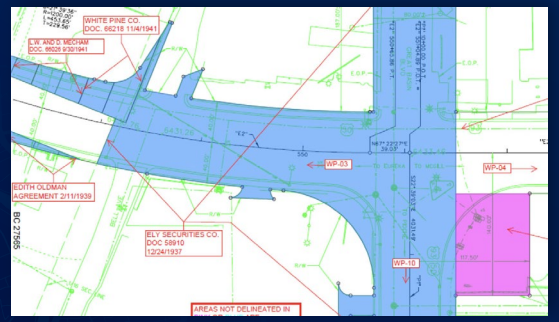
Inventorying and Mapping

GIS for Inventorying and Mapping

- Provide easy access to data
- Leverage data-driven decision making
- Reduce costs & liability; optimize revenue
- Protect public investments

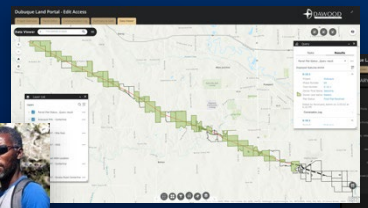
Parcel Capabilities in GIS - Examples

ROW Parcel Management



Nevada DOT

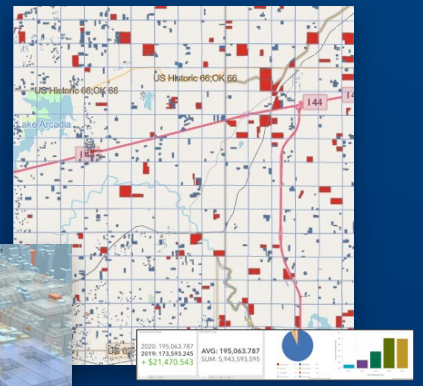
Land Acquisition Management for Pipeline



Acquisition Portal

Dawood Engineering
Illinois

Deed Transaction Dashboard



County Assessor
Oklahoma County, Oklahoma

Mapping Boundaries of Agricultural Co-ops

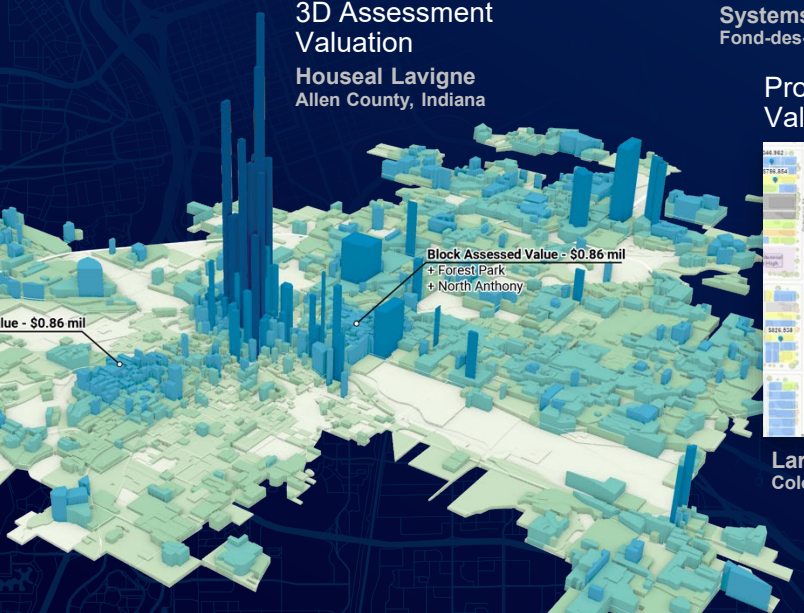
Eos Positioning Systems
Fond-des-Blancs, Haiti

3D Property Zoning

GDS Latam Group
City of Buenos Aires, Argentina

3D Assessment Valuation

Houseal Lavigne
Allen County, Indiana



Property Valuation

Larimer County
Colorado

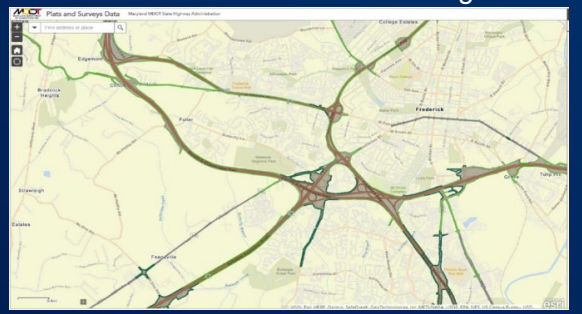
Parcel Fabric Tax Map

County of Whiteside
Sterling, Illinois

Land Parcel Reporting

Central Appraisal District
El Paso, Texas

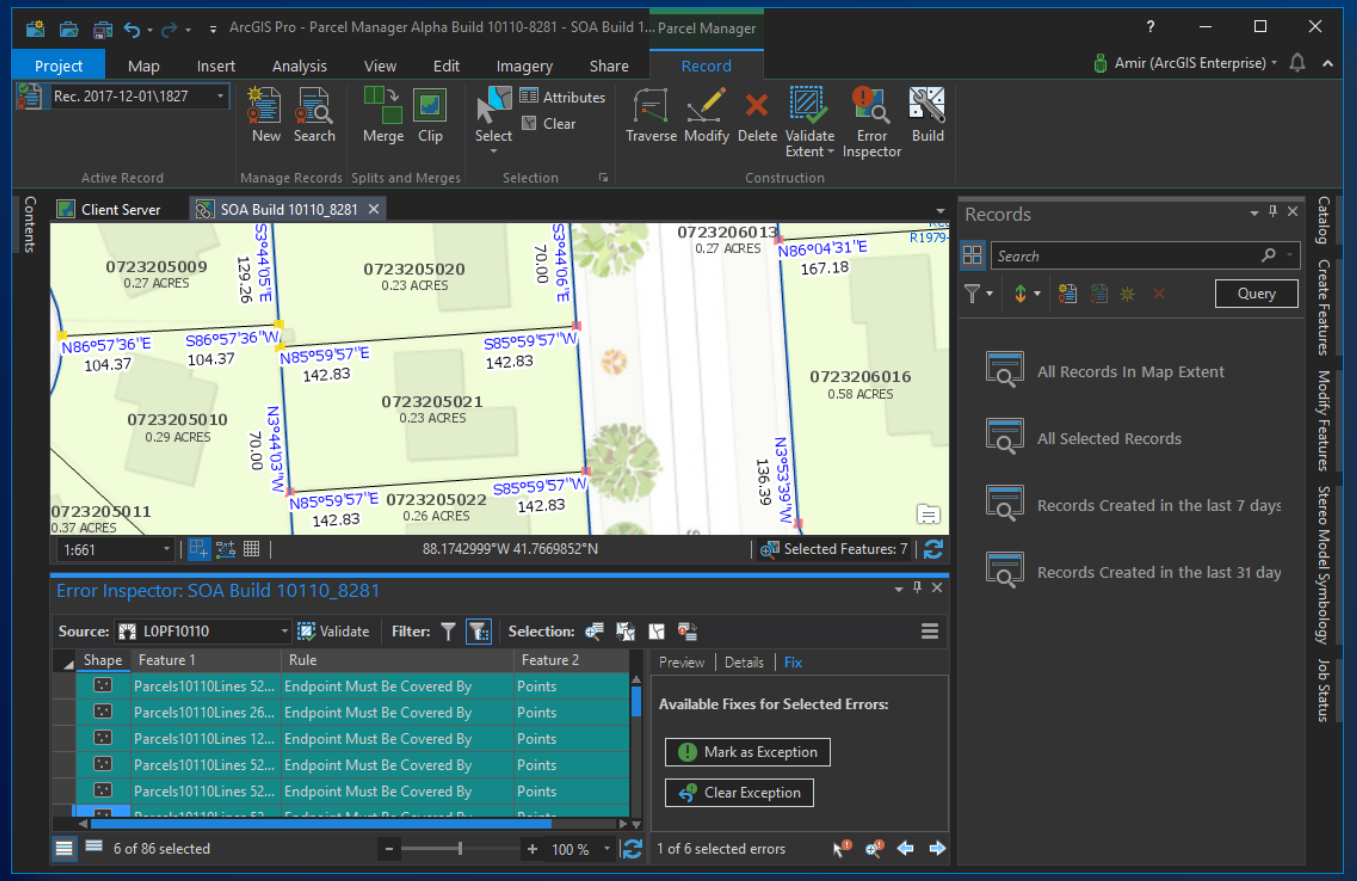
ROW Parcel Management



Maryland DOT

Parcel Fabric – Efficient, Scalable, Industry Standard

- COTS Parcel Management
- Defined workflows
- Tasks
- Standards-based
- Multi-user
- Integrate with other business systems

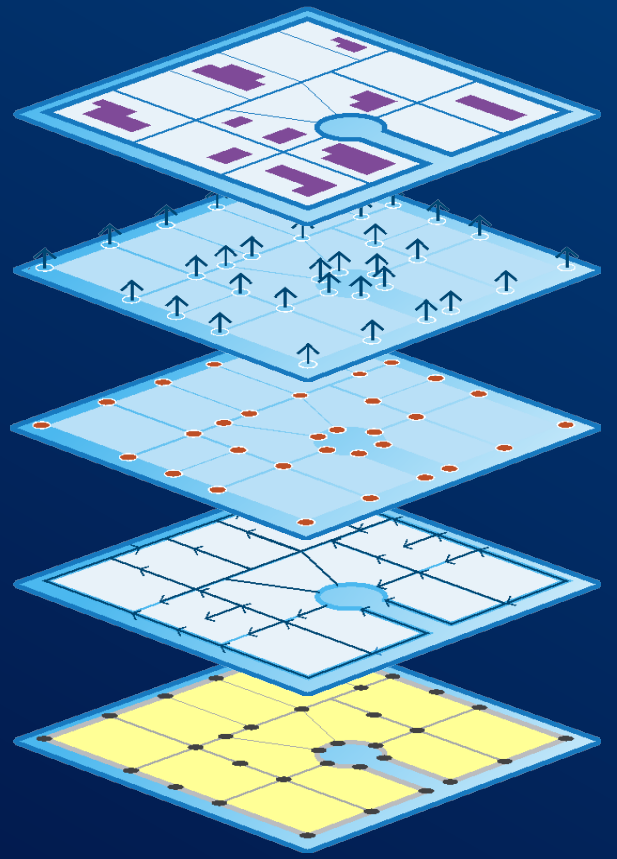


Efficient Data Management

Purpose-Built Tools – Data Integrity, Topology, History

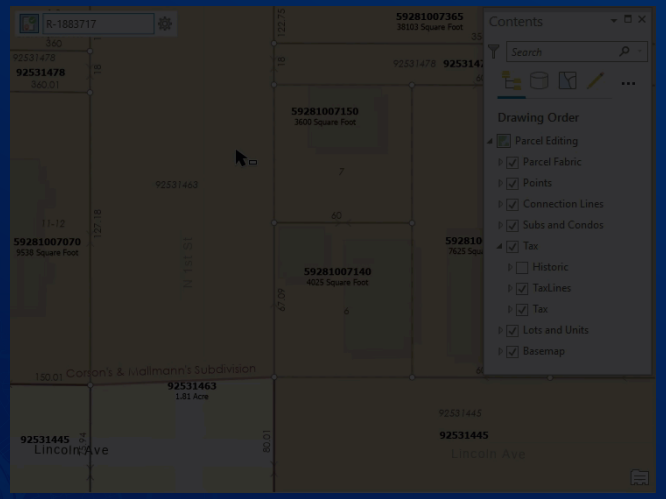
Many Updates –

KML
WFS
WMS
WMTS
GeoJSON
…..

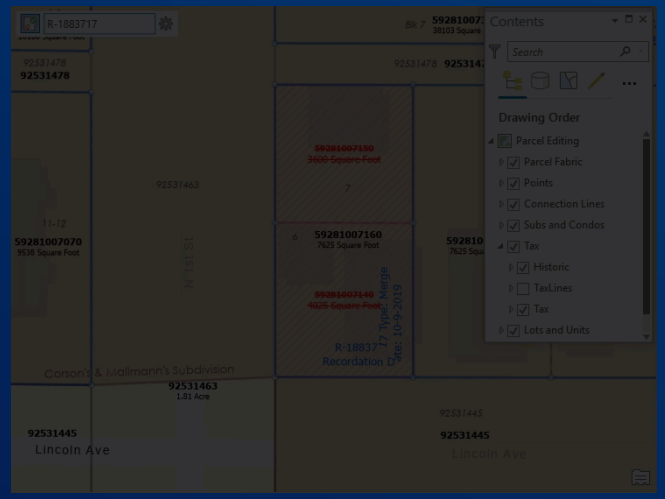


Improving Parcel Data With Survey Measurements....

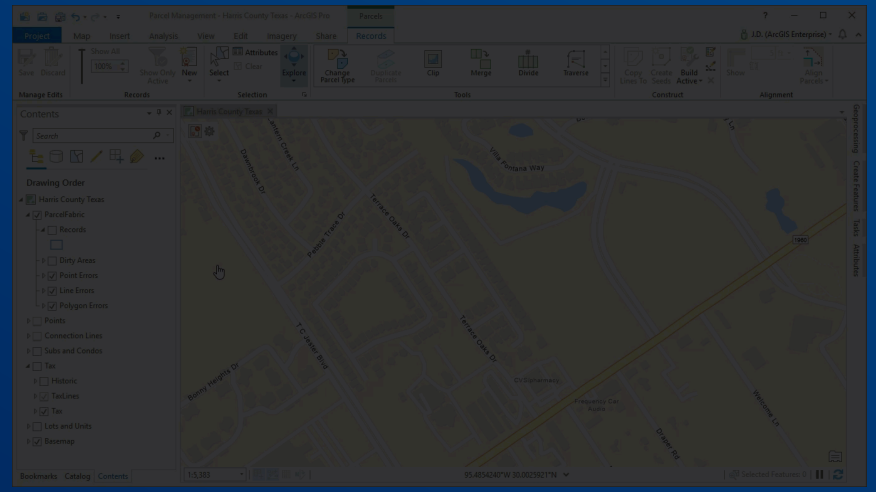
Topological Integrity



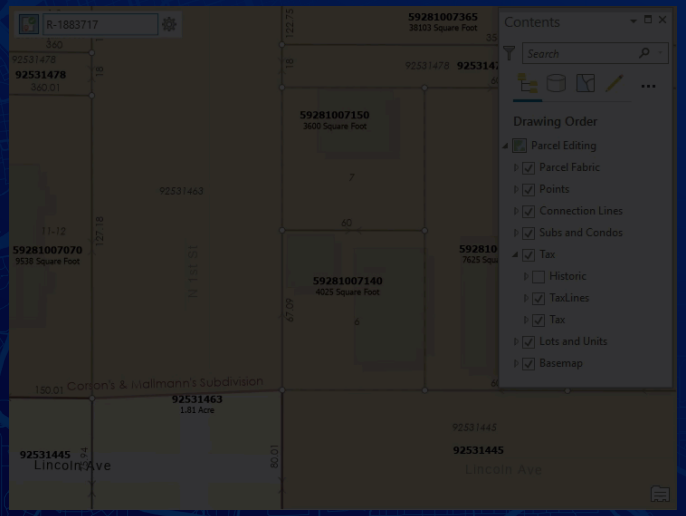
Lineage



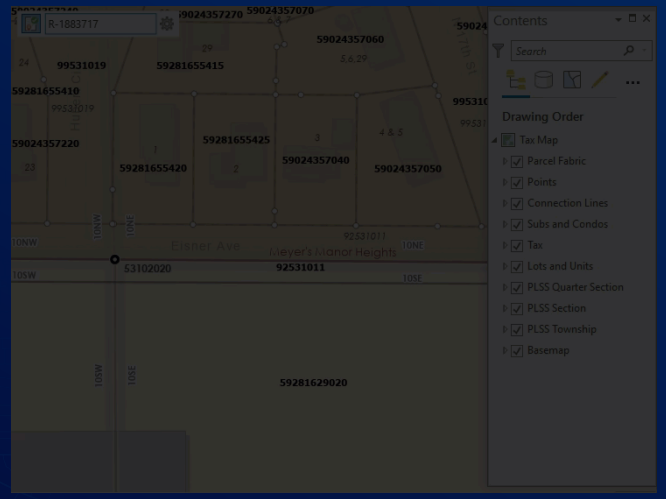
Survey Record



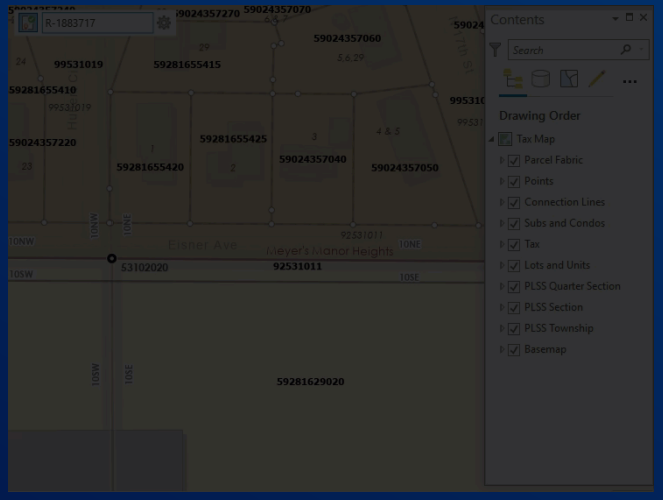
History



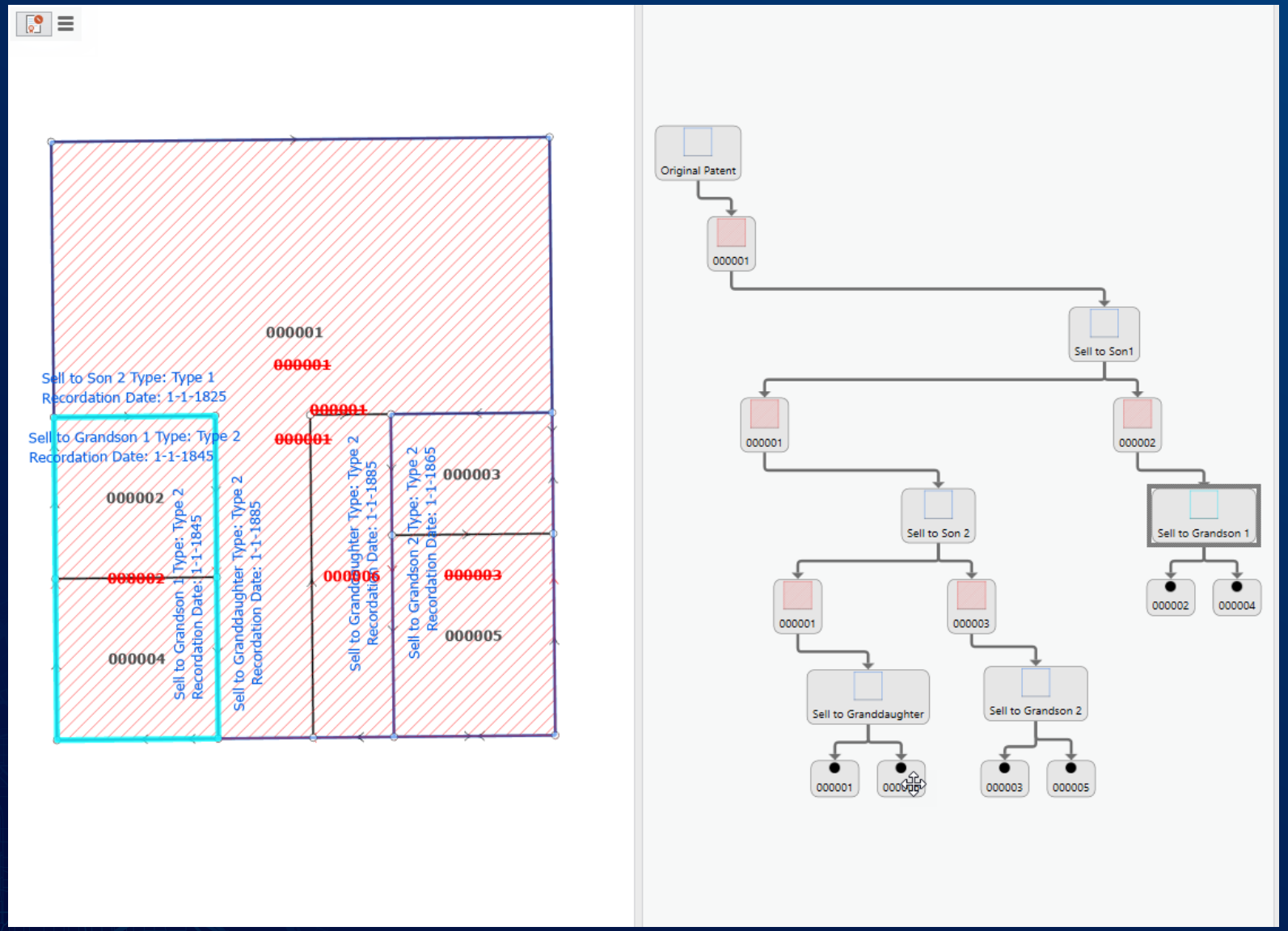
Vertical Alignment



Built-in Workflows



Link Charts = Chain of Title

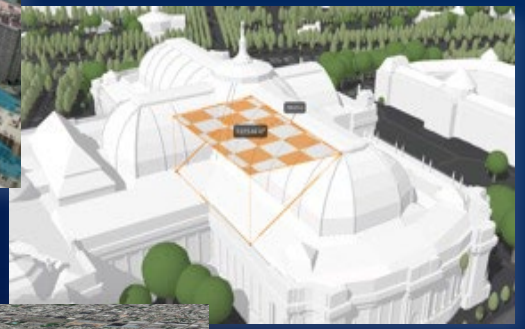


3D Parcels – Managing and Analyzing Strata Rights…

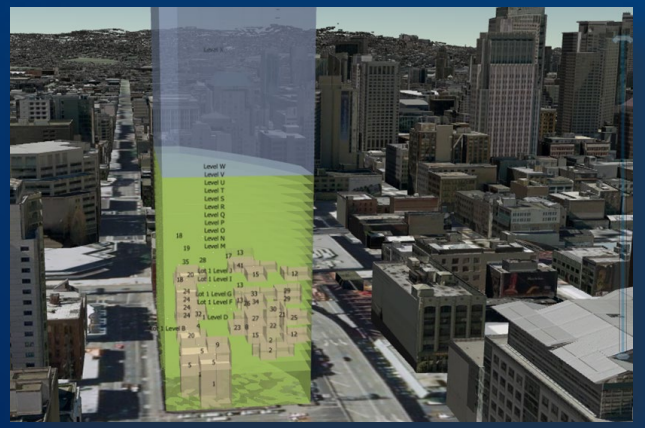
Scenarios
and Dashboards

Shadow Analysis

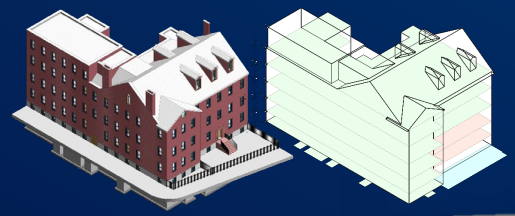
3D Measurement



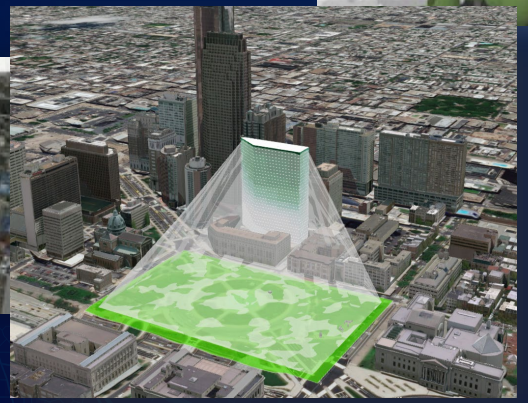
3D Parcels



BIM Integration

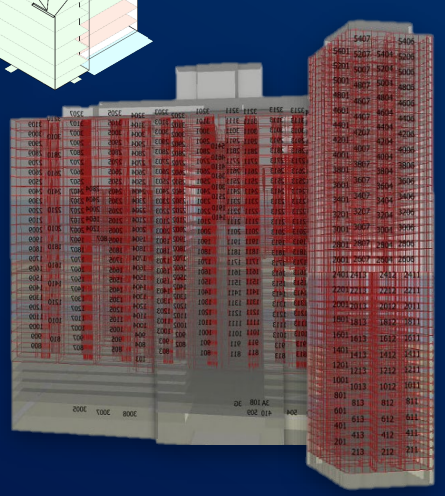


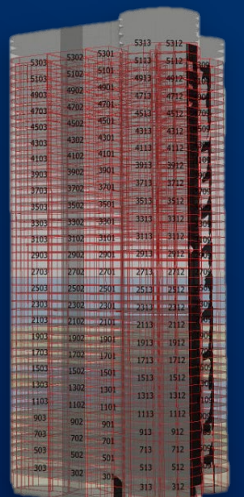
Line of Sight



Viewshed Analyses

3D Value Assessment





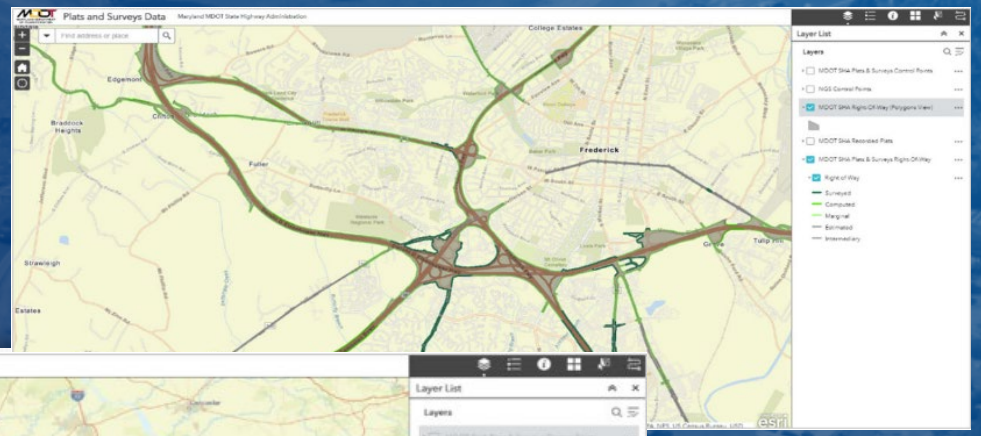
INVENTORYING & MAPPING

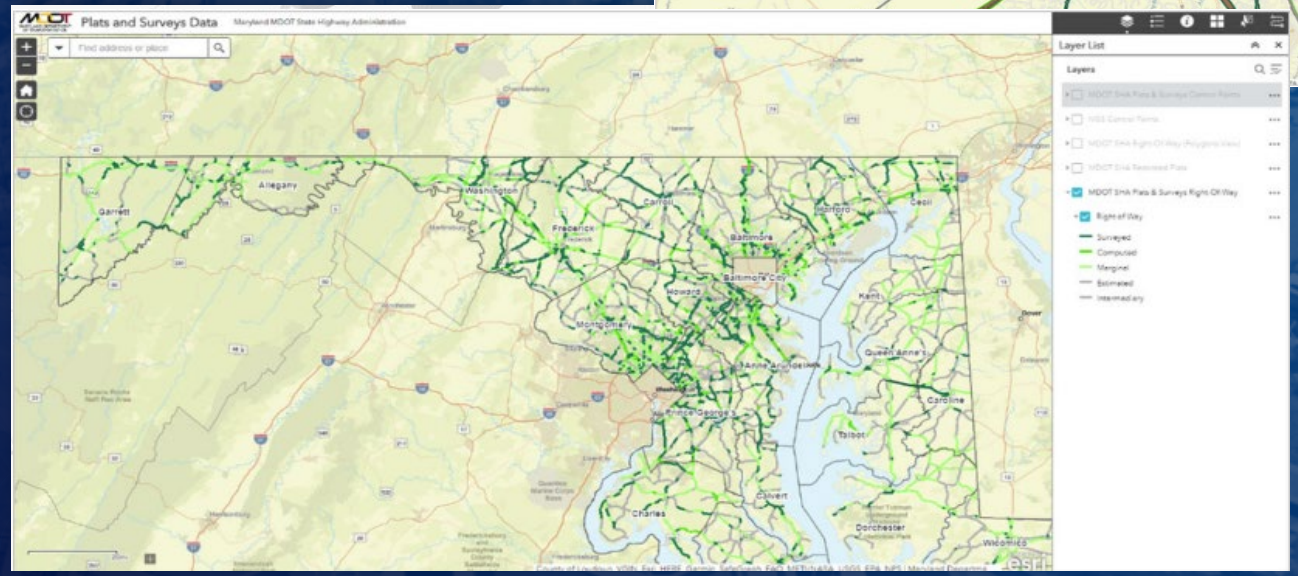
Innovation Leads to ROW Boundaries in GIS

Maryland DOT

The MDOT SHA's Plats and Surveys Division's georeferencing and right-of-way digitization initiatives demonstrate how technology and innovation can be used to preserve and make critical information accessible for public use.

"We are seen as providing an accurate representation of the right-of-way data, with the different qualities reflected in the levels…"



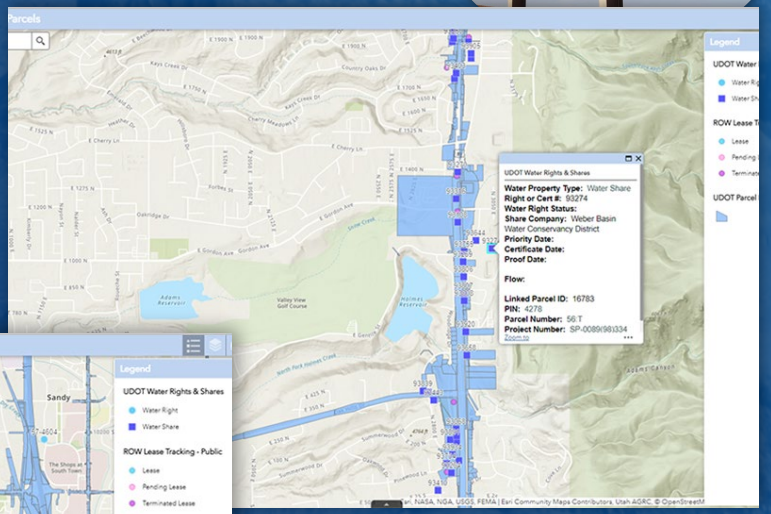


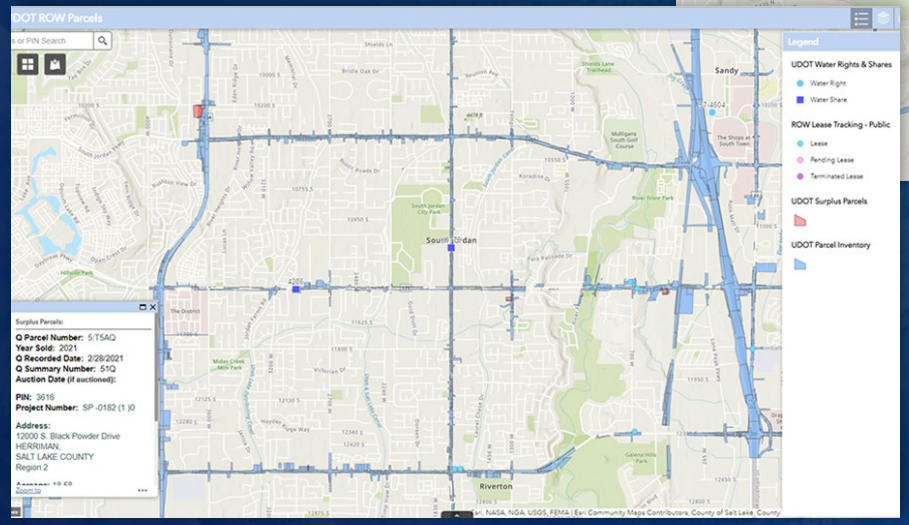
INVENTORYING & MAPPING

ROW Team Gains Multiple Benefits with GIS

Utah DOT

UDOT's central right-of-way geographic information system (GIS) team relies on its ROW GIS to inventory and map all property owned by UDOT. This has helped the state agency generate millions of dollars in surplus property revenue, eliminated hours of clerical work, reduced property ownership discrepancies, and streamlined cross-departmental collaboration.





Planning

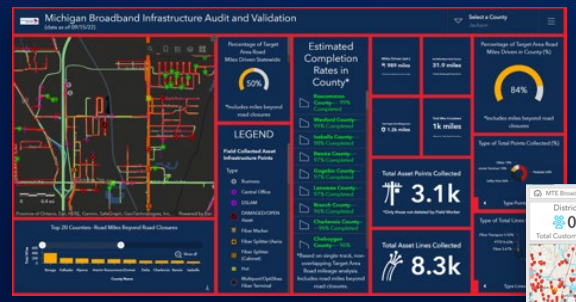
GIS for Planning

- 3D modeling for feasibility determination
- Enhance understanding of project impacts
- Provide robust visualization for stakeholder engagement
- Improve project budgets and schedules

Broadband Infrastructure Planning - Examples

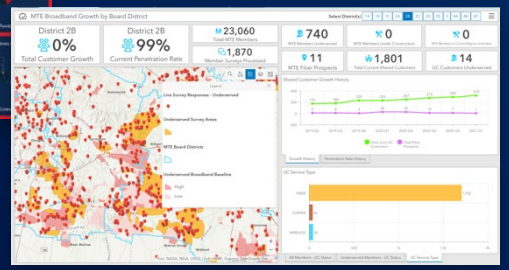
Coverage

Broadband Infrastructure Inventory



Connected Nation
Michigan

Underserved Broadband Reporting

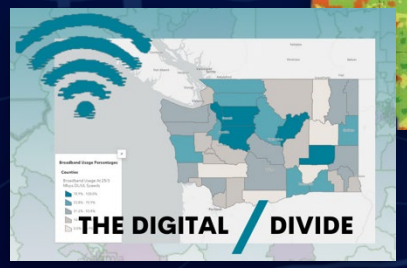


True North Geographic Technologies
Tennessee

Internet Speeds

Platte River Analytics
Ohio

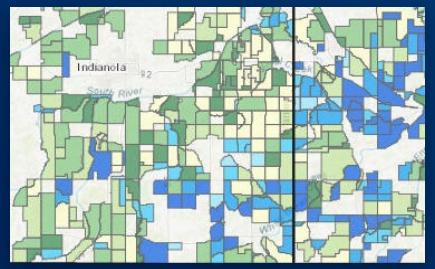
Broadband Access



Timmons Group
Washington

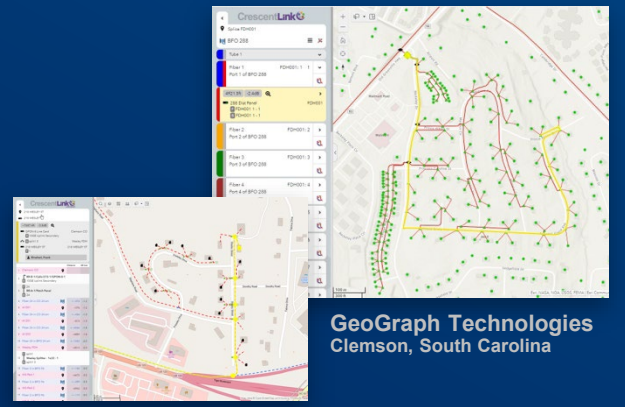
Planning & Design

Broadband Planning



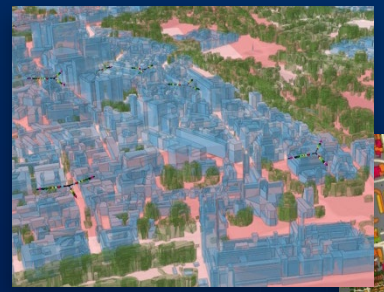
HR Green
Iowa

Fiber Network Management (FTTH)



GeoGraph Technologies
Clemson, South Carolina

5G Planning & Design

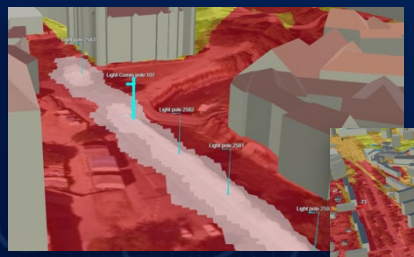


Vodafone UK
United Kingdom

5G Planning Data

Cellular Expert
Global

Modeling Wi-Fi Coverage



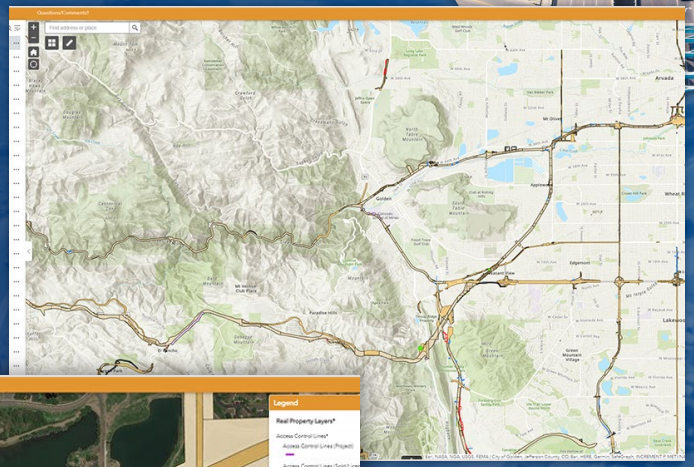
Cellular Expert
Lithuania and Latvia

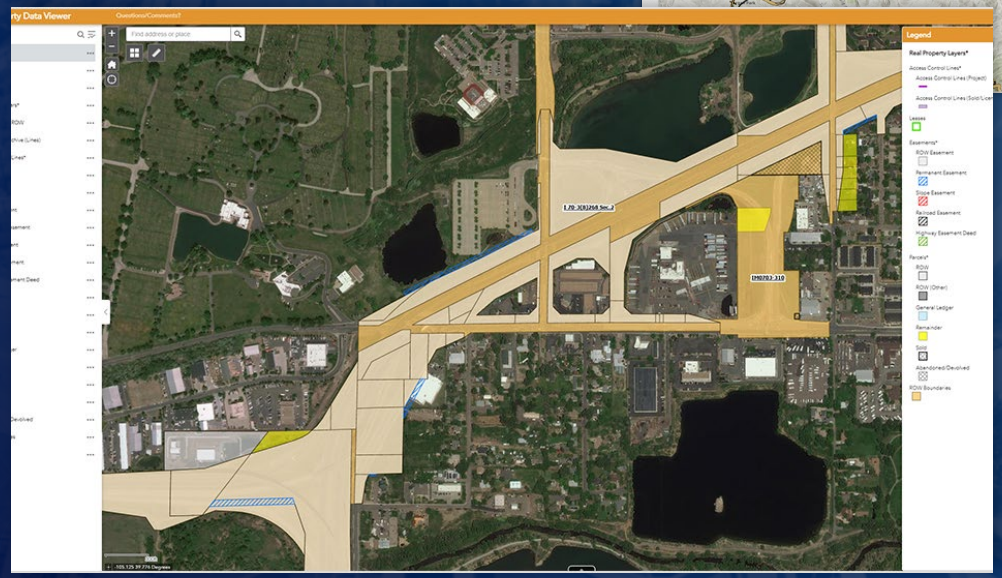
INVENTORYING & MAPPING

GIS Allows Full Capture of Property Value

Colorado DOT

Bringing right-of-way data into a GIS environment is enabling CDOT to maximize the performance and potential of its real estate assets.



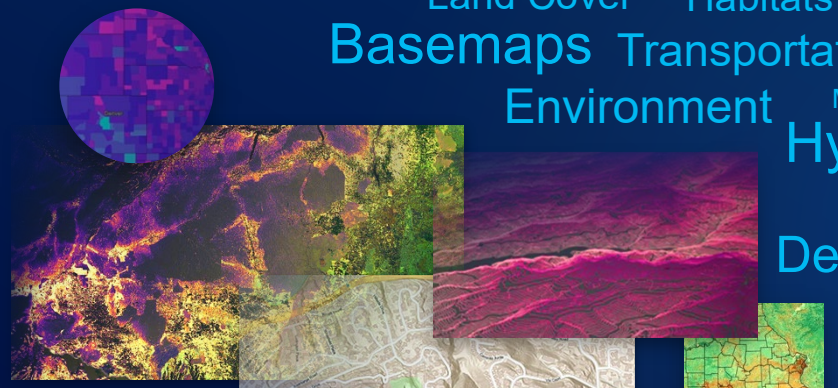


“We’ve been working with our Electric Vehicle Planning group to look at charging station placement, at solar power generation on rights-of-way…

GIS – Includes Ready-to-Use Content…

ArcGIS
Living Atlas

Land Cover
Habitats
Biodiversity
Basemaps
Transportation
Landscape
Environment
Movement
Infrastructure
Hydro
Traffic
Business
Elevation
Boundaries
Demographics
Imagery
POI
Oceans
Hazards
Weather
Soils

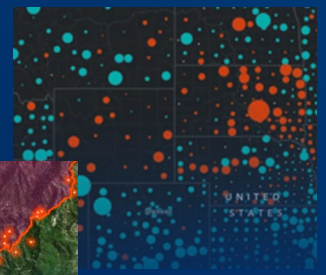


Authoritative
Community Content

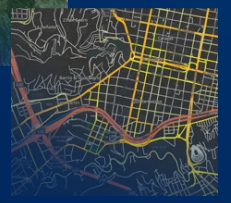
Pre-trained
Deep Learning Models

User-Shared
Maps & Data

Monthly Unemployment
Statistics (BLS)



Real-Time
Observations



OpenStreetMap
Layers

Supporting Individuals, Teams,
Enterprises and Communities

GIS – A Complete Analysis System…

Powerful Capabilities

AI, ML & DL

Mapping

Data Engineering

Vector Analytics

Image & Raster Analytics

Spatiotemporal Statistics

Graph Analytics

Advanced Visualization

GeoAI

3D Visualization

Modeling

Big Data

Real-Time

Network Analysis

Statistical Modeling

Python Scripting

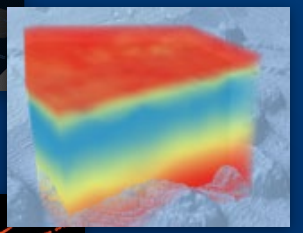
Interactive Charts

Visual Modeling

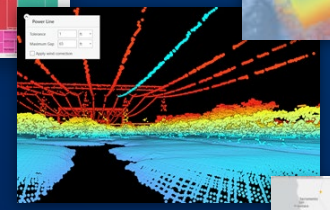
Graph Analytics

Density-Based Clustering with Time

Spatial Data Exploration

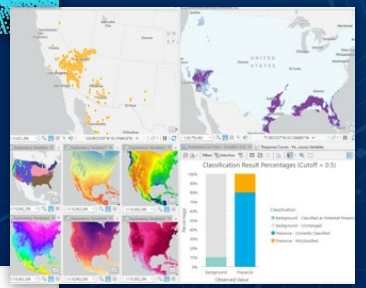


Voxels



Point Cloud Classification

Presence-Only Prediction



Raster Analytics & Modeling

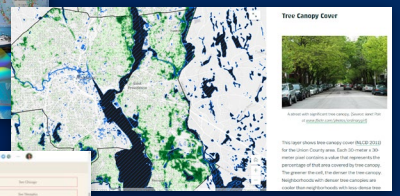
Supporting Analytics Across the Organization
. . . Empowering Analysts & Data Scientists

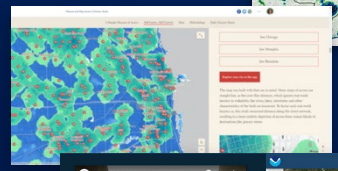
Acquisition

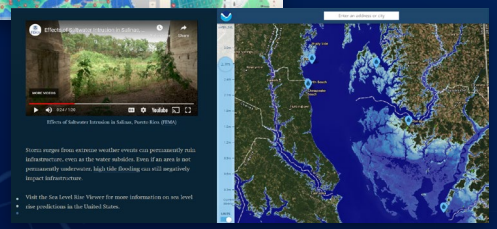
GIS for Acquisition

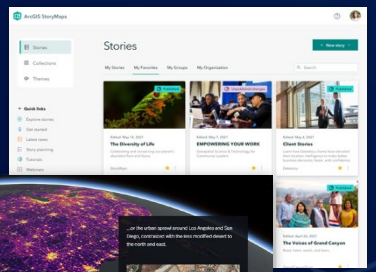
- Engage with landowners to tell project story
- Provide real-time analytics of negotiations
- Improve schedule and cost projections
- Ensure compliance with acquisition regulations

Tell Your Project Story with GIS - Storymaps





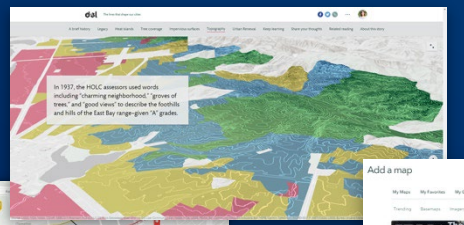


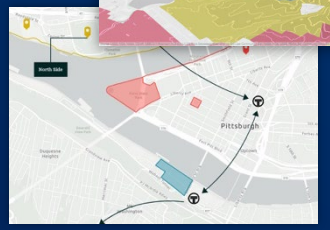


Multimedia — Images, Videos, Audio

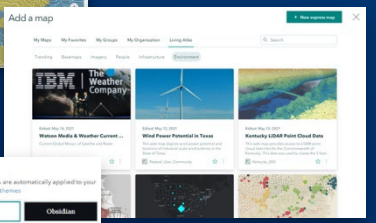
Many Styles
& Templates

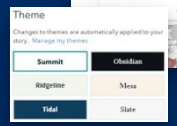
Integrates Any Web Map & Scene





Simple Drawing Tools

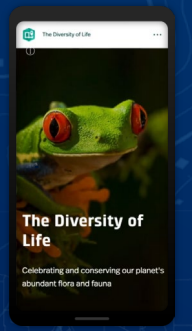


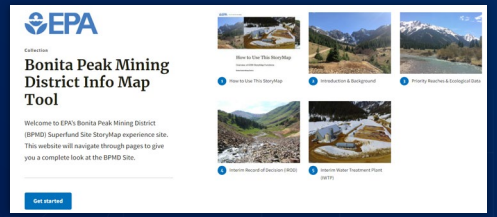


Shareable Design
Themes

Swipe

Mobile
Optimized



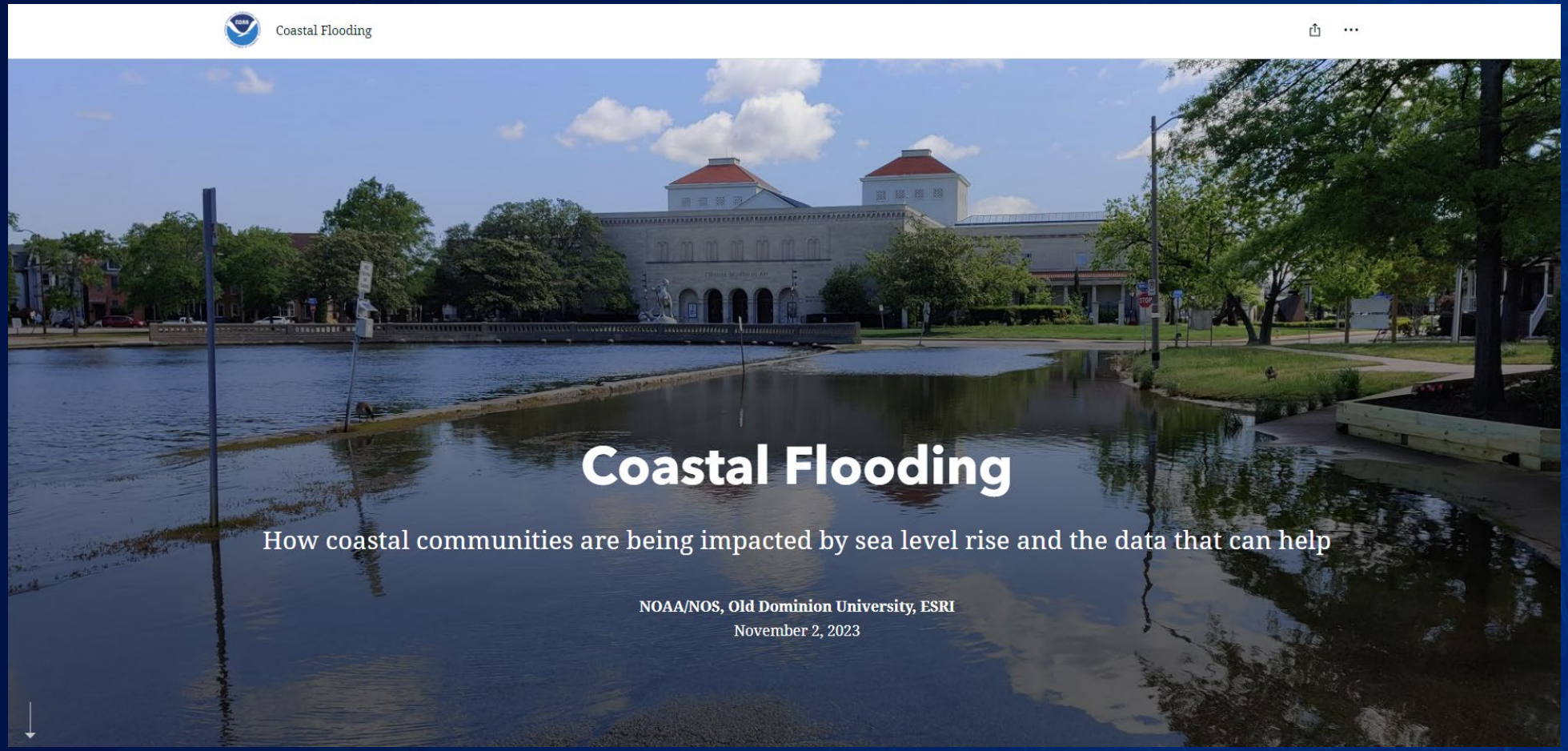


Collections — Groups of StoryMaps

Integrated Closely
with ArcGIS

Transforming Communication
with Project Stakeholders

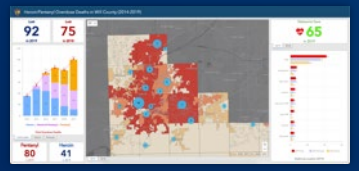
NOAA – Coastal Flooding



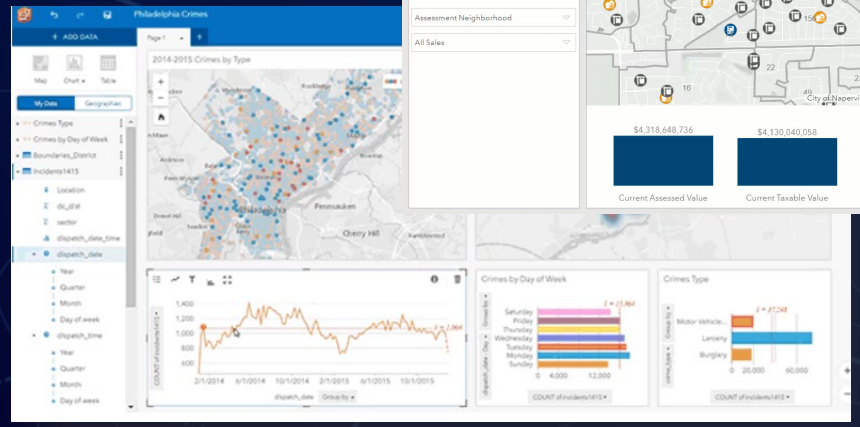
Monitor Acquisition Status - Dashboards

- Easy to Configure
- Ready to Use
- Interactive
- Flexible
- Highly Scalable
- Embeddable

Visualize Trends



Manage Backlog



- Mapping
- Data Expression
- Authoring Tools
- Summary Statistics
- Data Download
- Visualization
- Filtering

- Mobile
- Accessibility
- Filtering
- Visualizations
- Charts

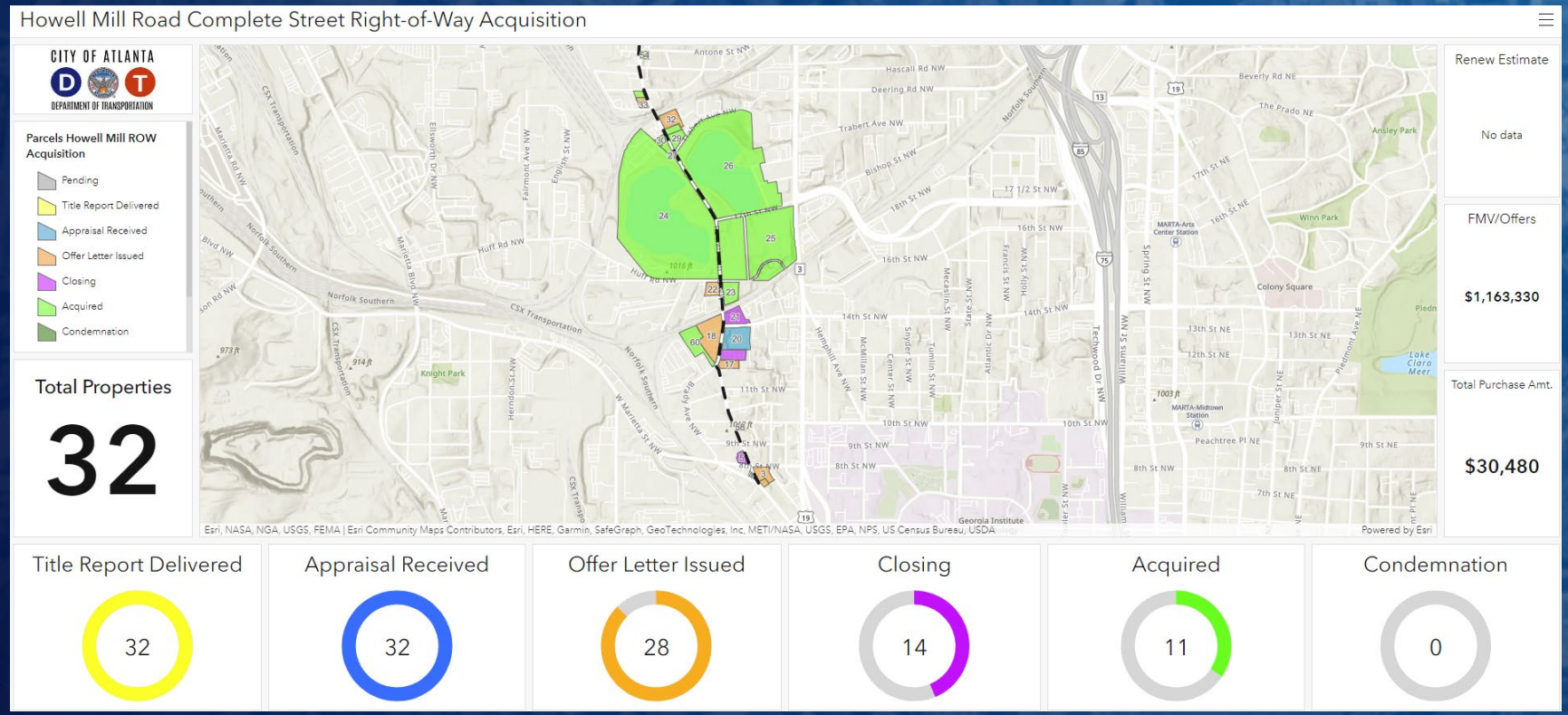
Providing Situational Awareness . . .
Anywhere, Anytime and on Any Device

ACQUISITION

Managing ROW Acquisitions with GIS

City of Atlanta, GA

Using GIS technology, the City of Atlanta, GA, Department of Transportation used dashboards to monitor the progress of right-of-way negotiations in real-time.



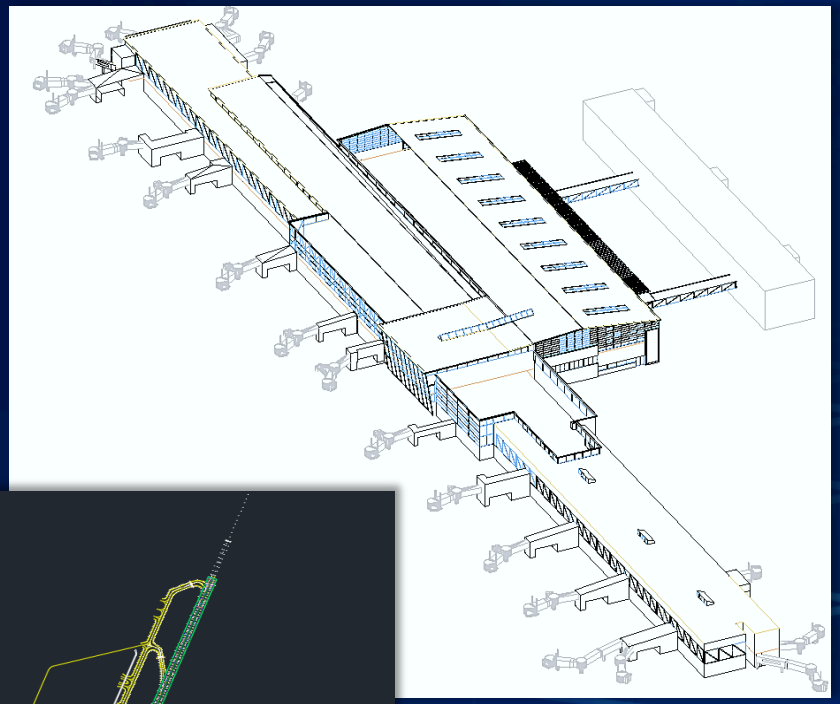
Design and Construction

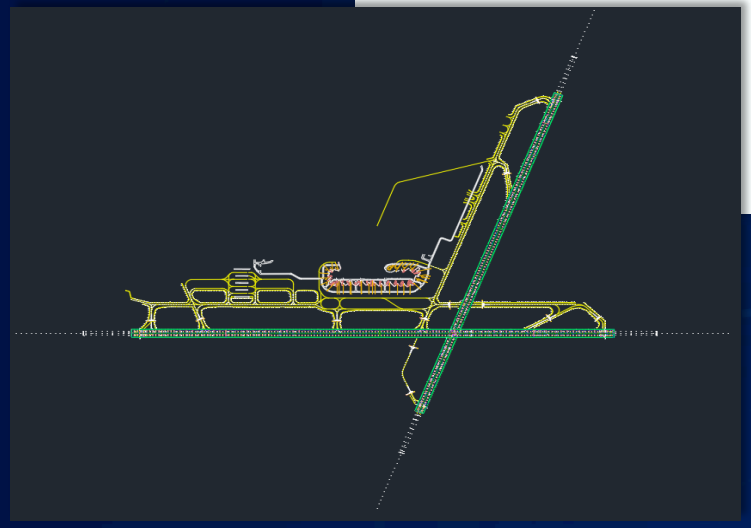
GIS for Design and Construction

- Leverage data across departments and organizations dynamically
- Enable multidisciplinary teams to work seamlessly
- Promote data sustainability
- Make better design decisions through system integration

BIM

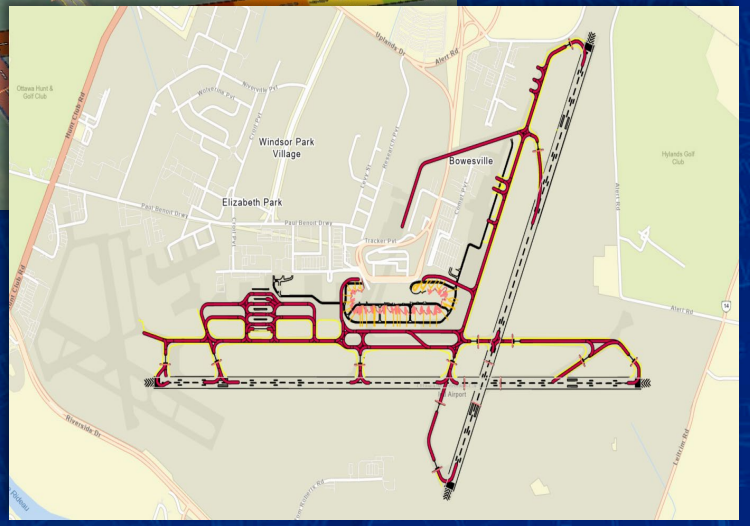
Supplies detailed information about *developed assets*





GIS

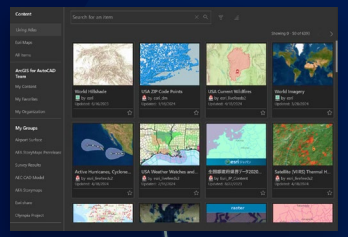
Provides information about assets in the context of the *built* and *natural environment*



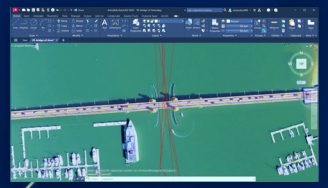
ArcGIS

Integrates GIS-BIM workflows

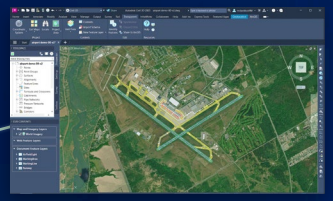
Access Maps & Data in Autodesk Apps



AutoCAD



Map 3D

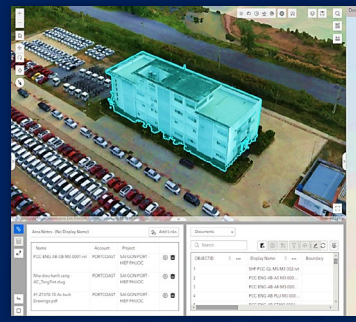


Civil 3D

InfraWorks

ArcGIS Online & Enterprise

Link GIS Features to Design & Construction Documents



ArcGIS Online & Enterprise

Interconnecting Systems

Autodesk Construction Cloud

ArcGIS GeoBIM

Strategic Partnership with Autodesk

Access CAD & BIM in ArcGIS

RVT

IFC

DWG & DGN

ArcGIS Pro

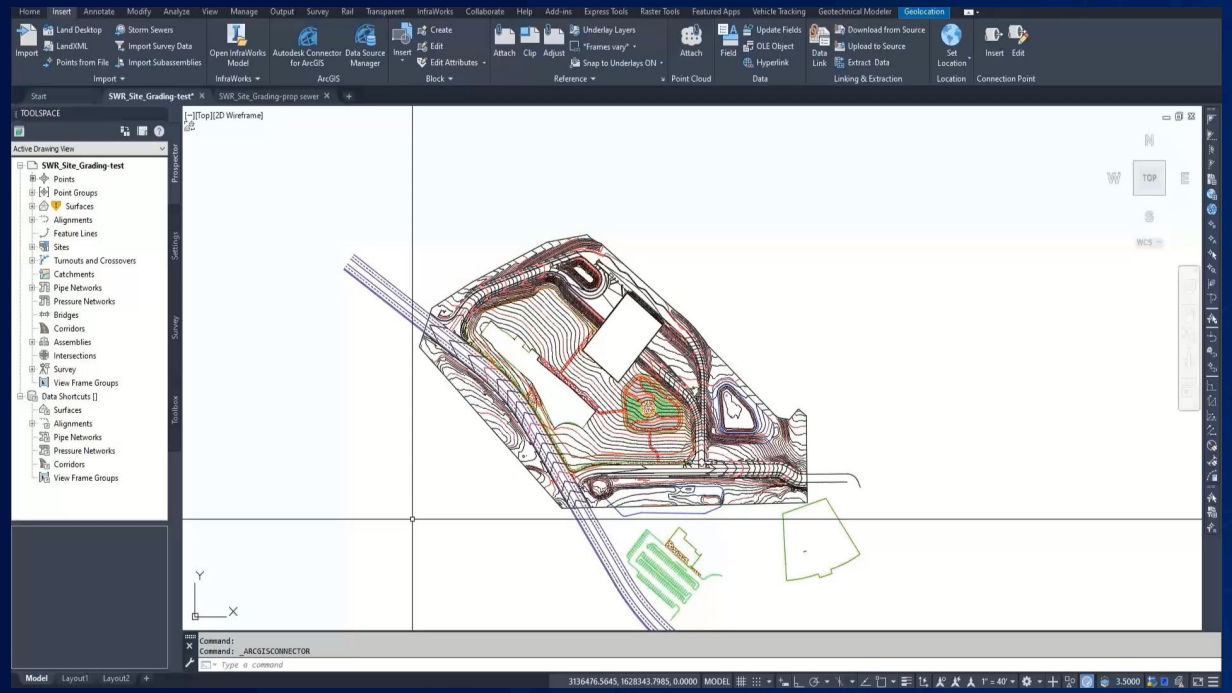
Bring Location to Design

Know Where You Are from the Start – **Surveyors & Metadata!**

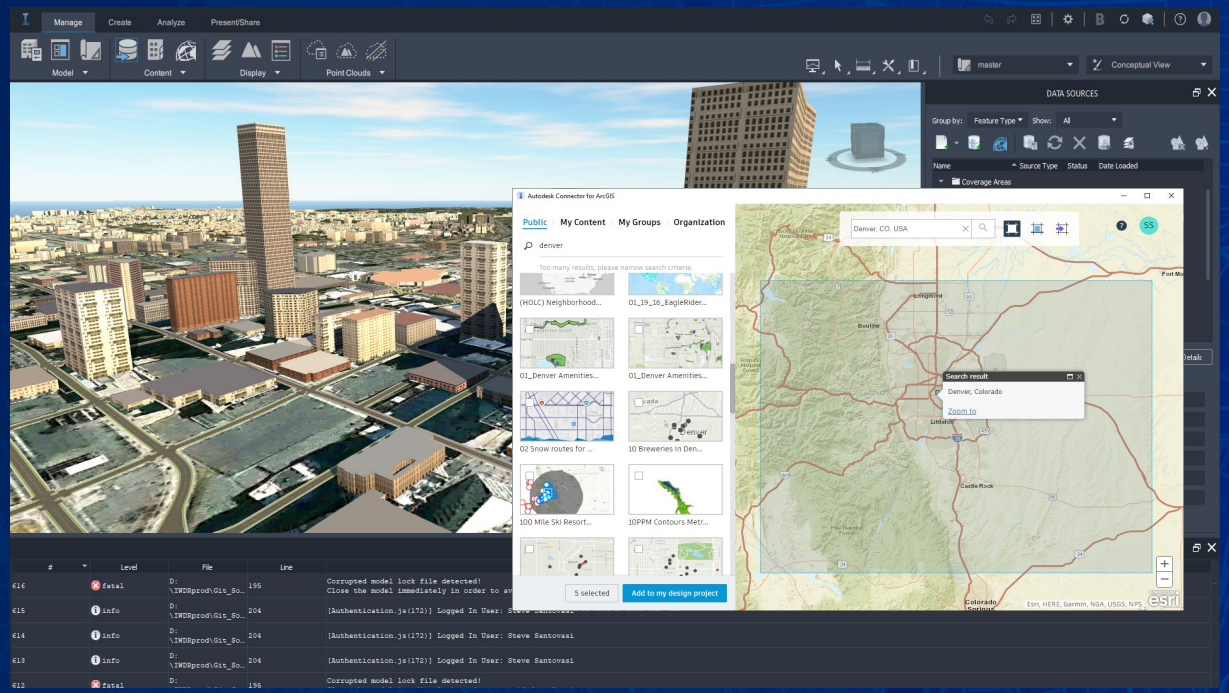
- Critical to collaboration and integration strategies
- Model controls location
- Ideally - from the source software

Bring GIS to Partner Applications

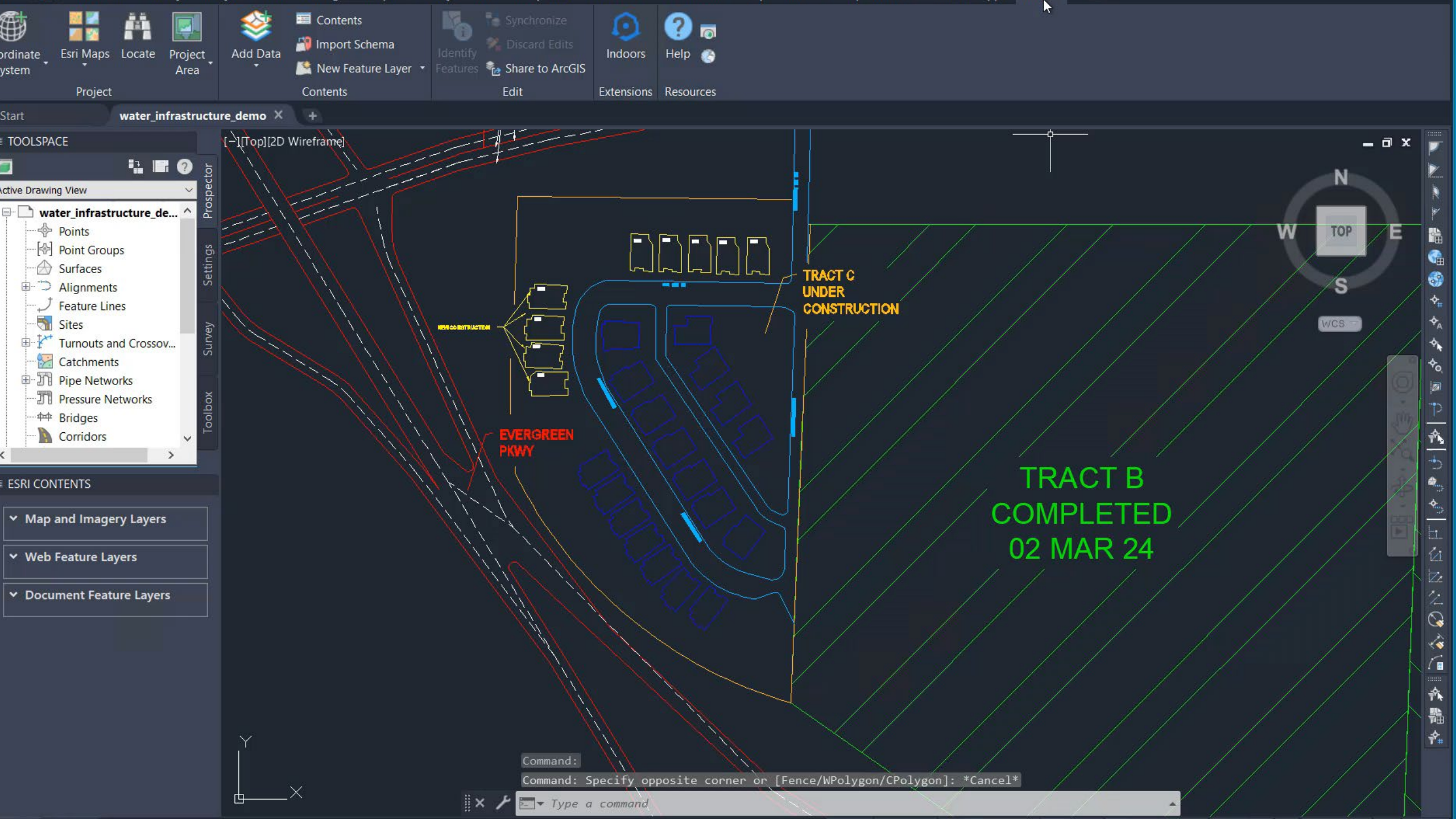
Support design, engineering, construction workflows



Autodesk Connector for ArcGIS in Civil 3D

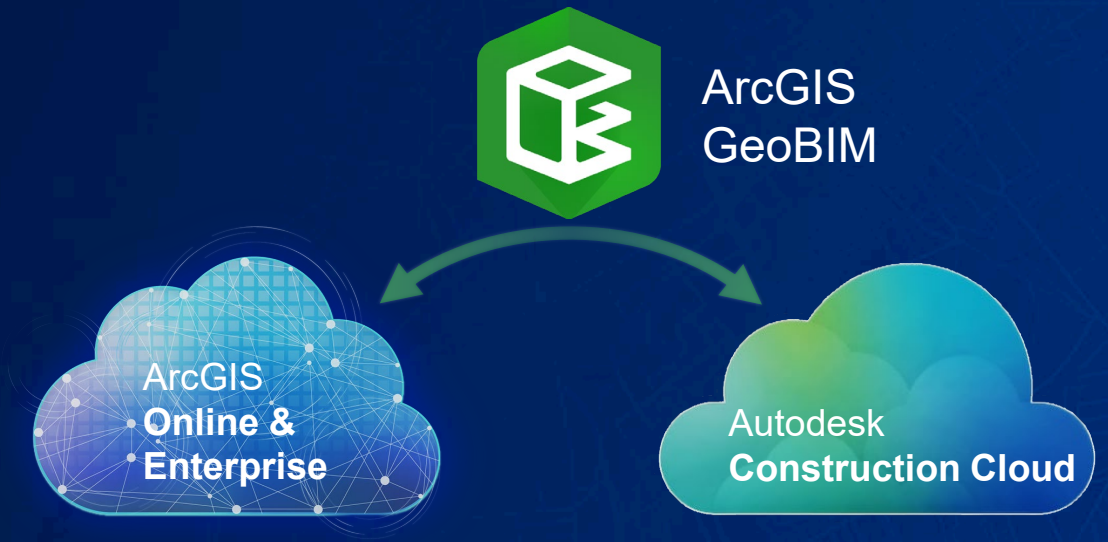


Autodesk Connector for ArcGIS in InfraWorks


Ordinate System
Esri Maps
Locate
Project Area
Project
Add Data
Contents
Import Schema
New Feature Layer
Contents
Identify Features
Synchronize
Discard Edits
Share to ArcGIS
Edit
Indoors
Extensions
Help
Resources
Start
water_infrastructure_demo
TOOLSPACE
Active Drawing View
water_infrastructure_de...
Points
Point Groups
Surfaces
Alignments
Feature Lines
Sites
Turnouts and Crossov...
Catchments
Pipe Networks
Pressure Networks
Bridges
Corridors
Prospector
Settings
Survey
Toolbox
ESRI CONTENTS
Map and Imagery Layers
Web Feature Layers
Document Feature Layers
[-][Top][2D Wireframe]
TRACT C
UNDER
CONSTRUCTION
EVERGREEN
PKWY
TRACT B
COMPLETED
02 MAR 24
N
W
TOP
E
S
WCS
Command:
Command: Specify opposite corner or [Fence/WPolygon/CPolygon]: *Cancel*
Type a command

Link GIS to Design & Construction Documents

Cloud-cloud integration

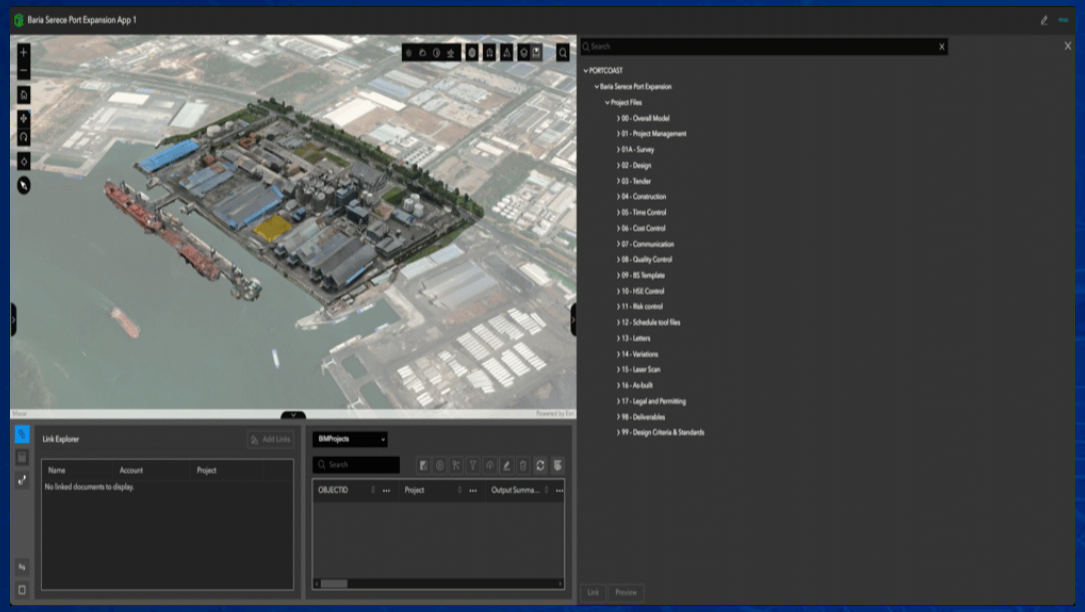


A collaborative web application that connects the leading GIS and AEC platforms to tell the story of the built world and its relationships where stakeholders find common insights through maps.

ArcGIS GeoBIM

Examples and use cases

- Evaluate a portfolio of projects or assets
- Map BIM Issues
- Monitor status via dashboard
- Visualize project schedule
- Share information with stakeholders



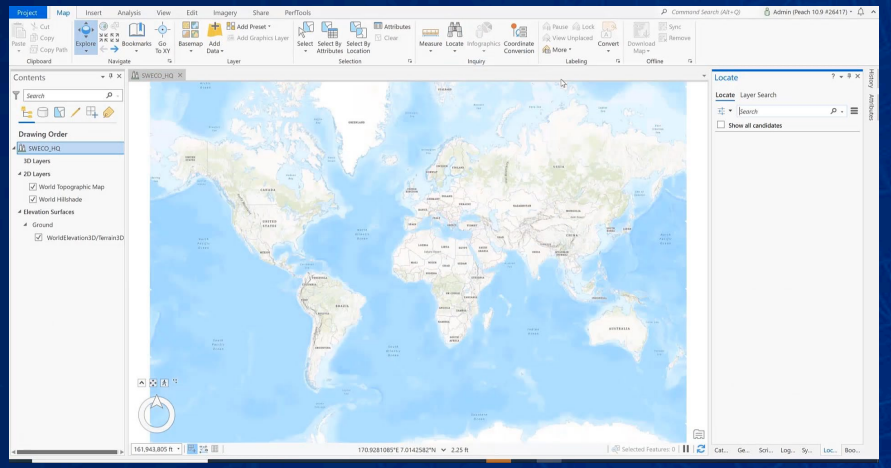
PORTCOAST

ArcGIS Pro

Direct-read of Industry Foundation Classes (IFC)

- Globally recognized, open standard for exchanging and sharing BIM files
  - Adoption across Autodesk®, Vectorworks®, Bentley Systems®, ArchiCAD®, Hexagon®, Dassault®
  - Esri works with buildingSmart International® (bSI) and the Open Design Alliance (ODA) to support the schemas and libraries we use for these integrations
- Expands the ability of GIS users to incorporate BIM content from different disciplines and sources into their workflows throughout the asset lifecycle

IFC
2x3, 4, and 4x3



Operations and Maintenance

GIS for Operations and Maintenance

- Understand the location of assets and encroachments
- Improve operator safety and efficiency
- Ensure compliance with regulatory requirements
- Support sustainable infrastructure

Field Operations with GIS

Connected &
Disconnected

Map Centric

Form Centric

Rapid Collection

Dashboards

High Accuracy Options

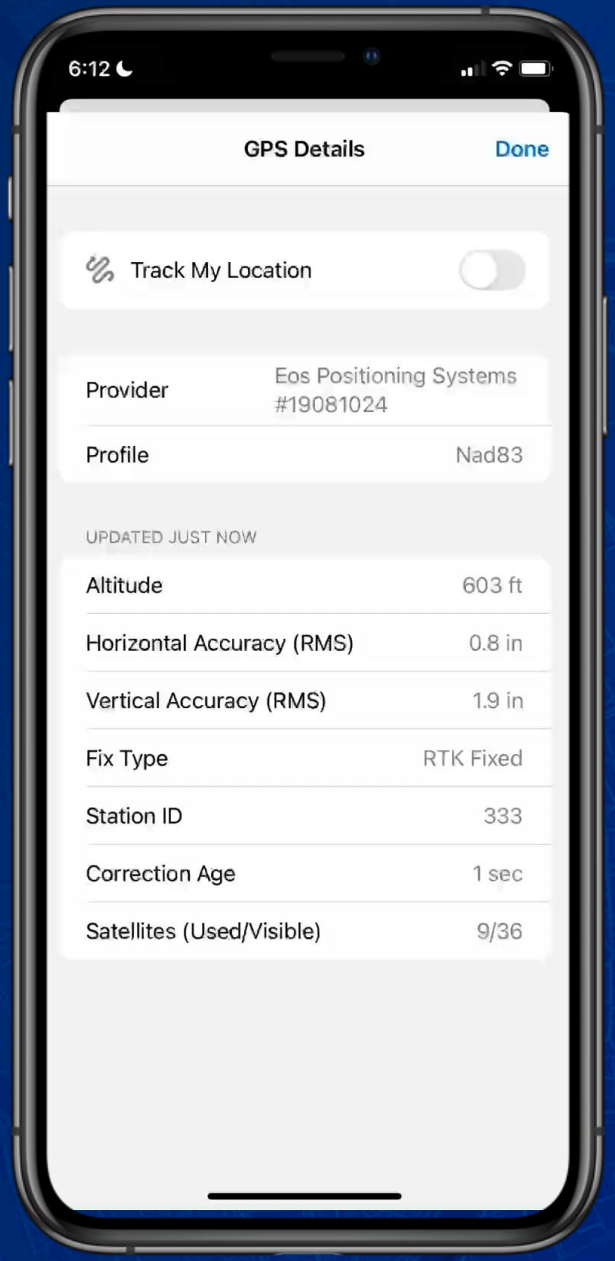
Includes Workforce
Management & Navigation . . .

Connecting & Transforming Mobile Workflows

High Accuracy Data Collection

Intuitive and powerful data capture

- GPS Capture capabilities
  - Single Point/vertex capture (w/ Z-value)
  - Streaming data capture (lines/areas)
  - Averaging
- Supported receivers
  - Bluetooth, Pole mounted, All-in-one
  - Extend capabilities with partner integrations
    - Trimble, Eos Positioning, Bad Elf, etc.
    - Connecting to receiver
  - Location Provider
  - Location Profile



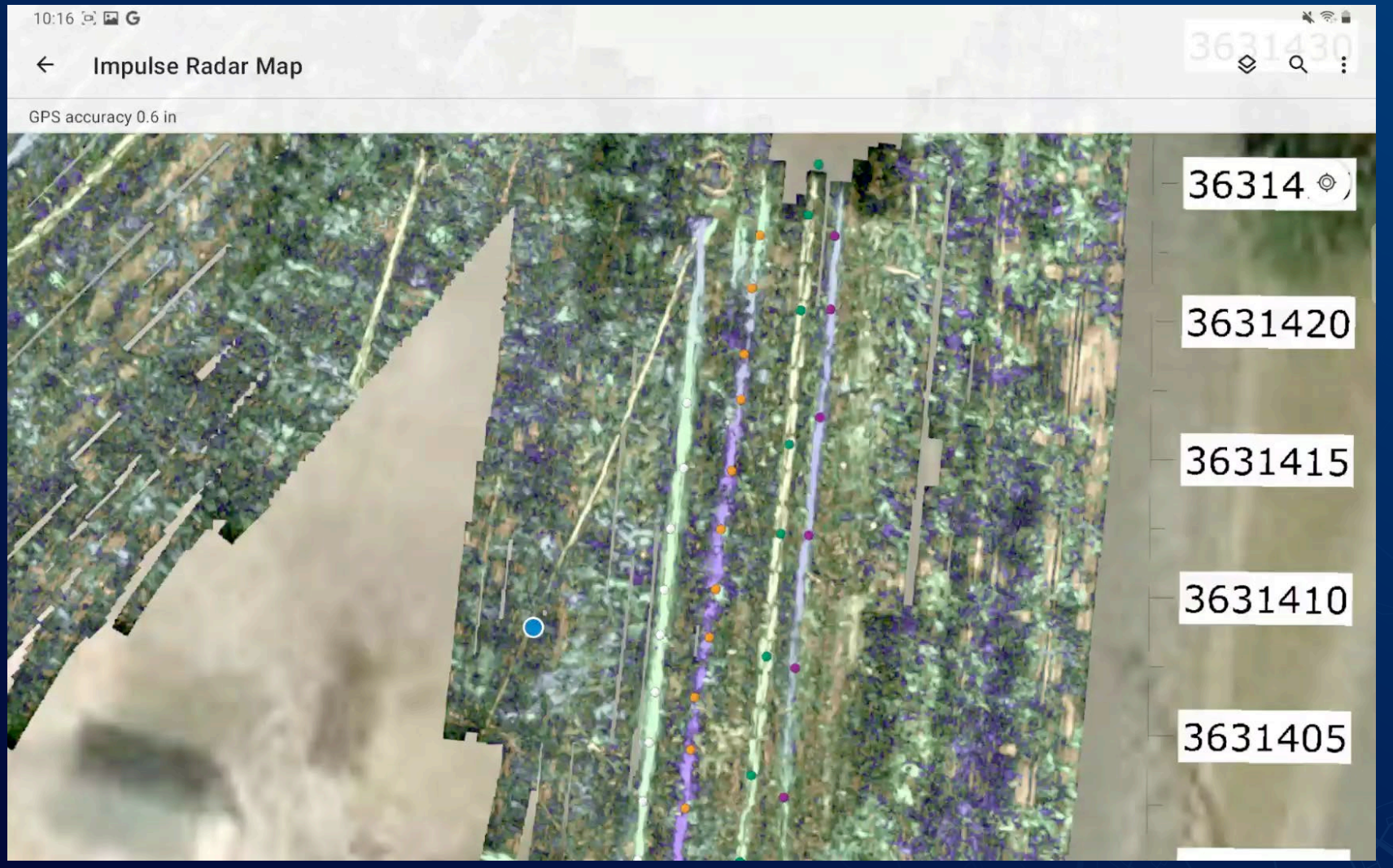
Innovative Approaches - GPR

Use Ground Penetrating Radar data to improve underground utility locates.

- Capture GPR data
- Publish data as a web service
- Use as reference layer in web map (online/offline)
- Visualize GPR data with RTK GPS
- Locate and mark underground assets

impulse RADAR

Innovative Approaches - GPR



Some Hot Topics

Hot Topics and Industry Insights

- Artificial Intelligence (AI)
- NSRS Modernization
- Digital Submission / Digital Construction As-Builts

Artificial Intelligence (AI)

Plotting Land Descriptions Automatically

All that portion of the North one-half of Section 23, Township 8 North, Range 5 East, Mount Diablo Base and Meridian, described as follows:

Beginning at a one and one-half inch iron pipe monument tagged "L. S. 2651", marking the northwest corner of that certain tract of land designated "Jerome K. Aubin 1.000 Acre", as shown on the Record of Survey entitled "Portion of the North one-half of Section 23, T. 8 N., R. 5 E. M. D. B. & M.", recorded in the office of the Recorder of Sacramento County on December 12, 1960 in Book 17 of Surveys at Page 8, from which a three-quarter inch iron pipe monument tagged "L. S. 2651" marking the southeast corner of the Northeast one-quarter of said Section 23, bears the following (2) courses and distances: (1) North 88°56'10" East 208.70 feet and (2) South 00°39'20" East 908.70 feet; thence from said point of beginning along the boundary of said Aubin parcel of land the following 2 courses and distances: (1) South 00°39'20" East 208.70 feet to a one and one-half inch pipe monument tagged "L. S. 2651", as shown on said Record of Survey and (2) North 88°56'10" East 208.70 feet to the east line of said Section 23; thence southerly along the east line of said Section 23, South 00°39'20" East 190.00 feet; thence South 88°56'10" West 285.00 feet; thence South 00°39'20" East 510.00 feet to the south line of the Northeast one-quarter of said Section 23; thence westerly along the south line of the northeast one-quarter of said Section 23, South 88°56'10" West 1611.14 feet; thence North 01°03'50" West 1609.97 feet to a point on the northerly line of that certain 45.786 acre parcel of land designated "Safeway Stores, Inc 45.786 Acres", as shown on said Record of Survey; thence Easterly along the northerly line of said 45.786 acre parcel of land, North 88°56'10" East 1907.18 feet to the east line of said Section 23; thence southerly along the east line of said Section 23, South 00°39'20" East 701.32 feet to the northeast corner of said "Aubin" parcel of land; thence westerly along the northerly line of said "Aubin" parcel of land; South 88°56'10" West 208.70 feet to the point of beginning.

The route of said right of way shall be within a strip of land 60 feet in width the centerline of which is described as follows: Beginning at a point in said Section 23 located South 88°56'10" West 285 feet and North 00°39'20" West 65.06 feet from the southeast corner of that certain 42.338-acre tract of land designated "B. J. Ukropina, T. P. Polich and Steve Kral", as shown on the Record of Survey entitled "Portion of the North One-Half of Section 23 T. 8 N., R. 5 E., M.D.B. & M." recorded in the office of the Recorder of Sacramento County on December 12, 1960 in Book 17 of Surveys at Page 8; thence from said point of beginning South 88°56'10" West 1611.60 feet to a point on the east line of Parcel 3 as shown on the Parcel Map entitled "Portion of the North one-half of Section 23 T.10 N., R.6 E., M.D.B. & M.", recorded in the office of the Recorder of Sacramento County on May 11, 1972, in Book 5 of Parcel Maps at Page 10 located North 01°03'50" West 65.06 feet from the southeast corner of said Parcel 3.

Title	Grant of Right of Way
File Number	R/W - 107/24
Address	1485 Nelson Road
City	Citrus Heights
County	Sacramento
Asset	Distribution
Book & Page	775-278
Width (feet)	15
Year	1966
Grantor	Walter and Renate Winkler

whitestar
An esg Company

Artificial Intelligence (AI)

Imagery Analysis and Change Detection

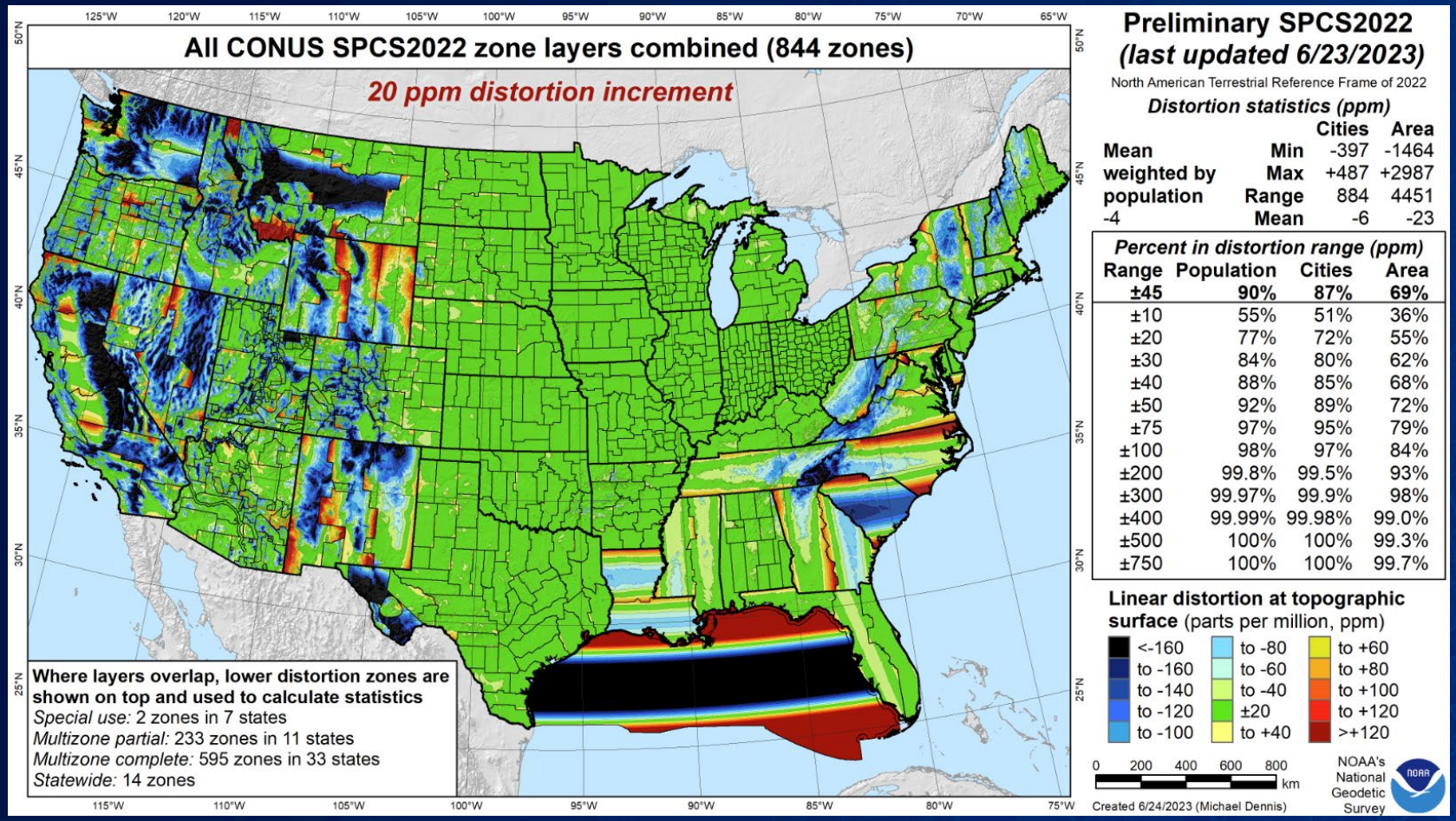
Robust desktop Review

Swimming Pool Detection

Rooftop Solar Panels

NGS – NSRS Modernization

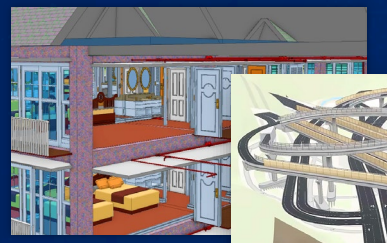
Testing and Preparation is Underway



Digital Submission / As-Builts

The Race is on!

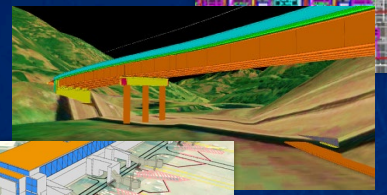
ArcGIS Pro



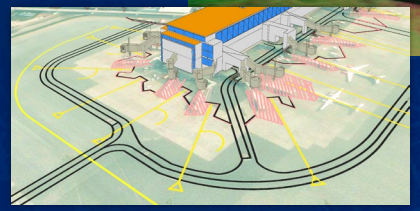
Revit®

IFC

DWG



DGN



Civil 3D®

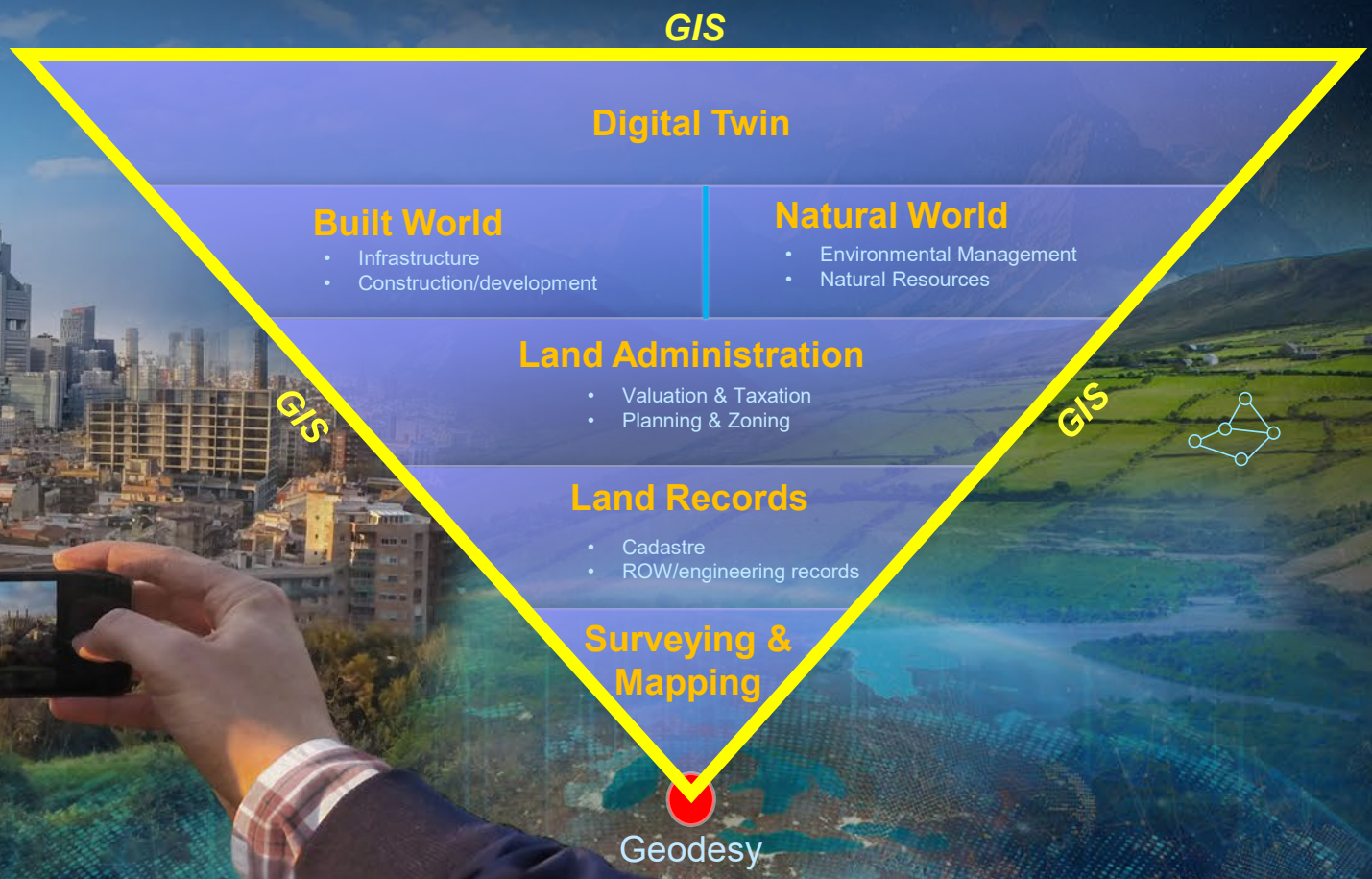
ArcGIS Enterprise

ArcGIS Online

Autodesk Construction Cloud®

How does it all stack up?

Finding some order in the chaos…



Demand for high accuracy data . . .

THANK YOU – QUESTIONS?

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