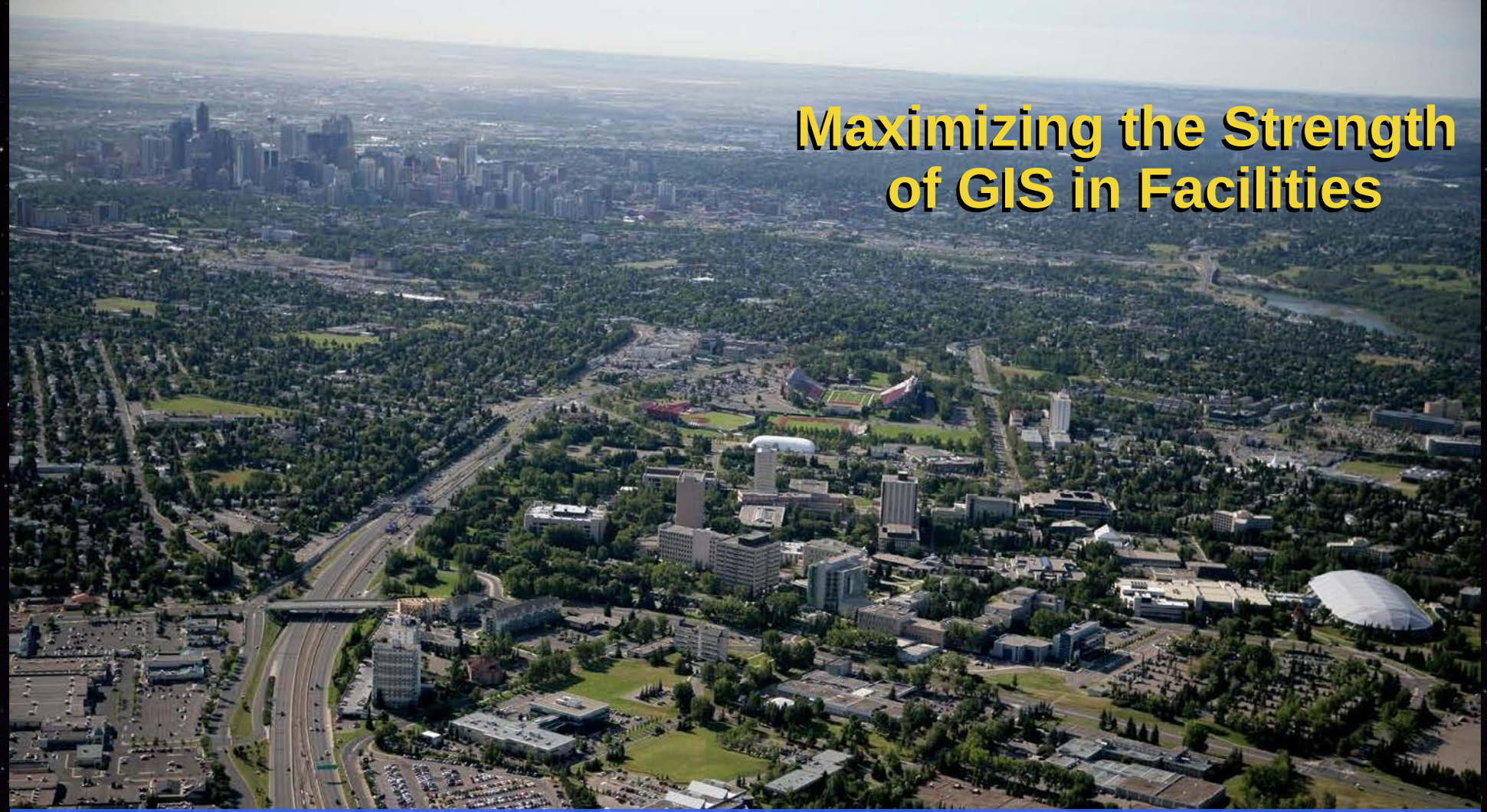
Maximizing the Strength of GIS in Facilities



University of CALGARY

Presented by: **Tom McCaffrey** *Director of* ***UCMAPS***

(University Centralized MAP Services)

Agenda

Agenda

- About the University of Calgary

Agenda

- About the University of Calgary
- **Growing Data Sets**

Agenda

- About the University of Calgary
- Growing Data Sets
- **Using the Data**

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- **Building Data Systems**

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- **Quality Control**

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- **Future Plans**

Agenda

- About the University of Calgary
- Growing Data Sets
- Using the Data
- Building Data Systems
- Quality Control
- Future Plans
- Questions

University of Calgary

Located in Western Canada


Alberta
Calgary
CANADA
Great Bear Lake
Gulf of Alaska
Beaufort Sea
Gulf of Boothia
Nuuk
Hudson Bay
Washington
Montana
North Dakota
Minnesota
Oregon
Idaho
Wyoming
South Dakota
Nebraska
Nevada
Utah
Colorado
California
United States
Arizona
New Mexico
Oklahoma
Texas
Missouri
Arkansas
Tennessee
Iowa
Illinois
Indiana
Ohio
Michigan
Wisconsin
Lake Michigan
Lake Erie
Lake Ontario
Lake Huron
Georgian Bay
Ottawa
Washington


Downtown Campus
Football Stadium
Medical Campus
MAIN Campus
Image Landsat
Google earth

Fast Facts:

- **31,000 students**

Fast Facts:

- **31,000** students
- **2,900** administrative staff

Fast Facts:

- **31,000** students
- **2,900** administrative staff
- **1,800** faculty staff

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- **416** acres

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- **110+** buildings

Fast Facts:

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- **2,900** administrative staff
- **1,800** faculty staff
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- **416** acres
- **110+** buildings
- **10 million ft^2** of interior space

Fast Facts:

- **31,000** students
- **2,900** administrative staff
- **1,800** faculty staff
- **14** faculties

- **416** acres
- **110+** buildings
- **10 million ft^2** of interior space

- **Home to the 1988 Winter Olympics**

UCMAPS (University Centralized MAP Services)

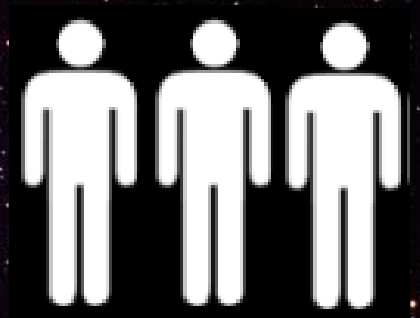
Information Technologies

12 years

UCMAPS (University Centralized MAP Services)

Information Technologies

Facilities



Production Back-up Development

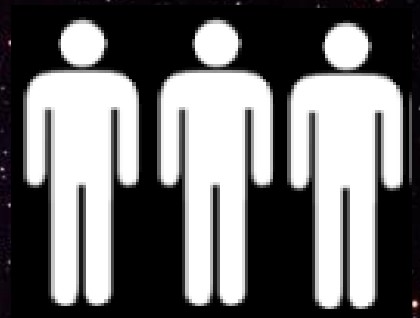
3 years

UCMAPS (University Centralized MAP Services)

Building Management System

Geographical Information System

Facilities



Production Back-up Development

3 years

ArcNEWS winter 2012 – article

Building a University of the Future

Highlights

- ArcGIS for Server provides the foundation for GeoDesign of university facilities.
- Integrating lidar data provided 3D modeling for new building sites.
- An integrated approach to design has saved thousands of dollars.

The University of Calgary in Alberta is considered one of the top research universities in Canada. It has more than 29,000 students and more than 4,000 academic and support staff. The university began using GIS for academic research 20 years ago and has now standardized the management of its geographic information with Esri technology. Realizing the value of geographic analysis for informed decision making, it has expanded the use of GIS to manage not only academic data but also institutional and administrative data.

Running a Smart Campus

The main campus has more than 20 academic buildings occupying more than 200 hectares, which is larger than Calgary's entire downtown core. In 2008, the university embarked on a $1.5 billion campus expansion, the largest capital expansion project in its history. Knowing that implementing a project of this size and continuing to maintain so many buildings would require a comprehensive understanding of every aspect of the campus—its landscape, people, buildings, and infrastructure—university planners relied heavily on ArcGIS and GeoDesign principles to help analyze and evaluate the impacts of design alternatives early in the development process.

The university maintains institutional data used for facilities management in a central data warehouse. Esri's ArcGIS for Server serves as the front-end technology that pulls data from ARCHIBUS, Esri Partner (Boston, Massachusetts) and creator of a solution used to manage spatial data and real estate, infrastructure, and facilities information. These recently integrated systems enable users to visualize and analyze both interior and exterior building data that's important to understanding how the campus currently works. Defining how the landscape works and evaluating whether it is working well are key tenets of the GeoDesign framework for landscape change. Evaluation of current processes allows proper "baselining" and the identification of key metrics against which design alternatives can be measured. The result is improved site planning and facilities design optimized for cost-efficient management and sustainability well after the initial project work is complete.

Understanding the physical constraints of a property is equally important. During site assessments, planners and landscape architects alike need to know how water flows across a property. This question came up early in the design phase, before construction, when the facilities management team approached the university's GIS team to create a campus drainage basin model. While there are no drastic slopes on the campus, there are low spots. Coupled with Calgary's high water tables, understanding these environmental issues was an important design constraint. If a basement is built in a particular location, the probability of flooding may be higher. Knowing where rainwater would drain allowed the team to see where flash floods might occur and then mitigate any potential dangers.

Understanding the terrain—the physical lay of the land—and how it affects drainage across this particular landscape has proved to be invaluable. The drainage basin model has been leveraged in planning new building sites and the expansion of the storm sewer system, including an innovative research project for filtering surface water before it enters the sewer system.

3D Data to the Rescue

The team combined light detection and ranging (lidar) data with high-resolution, orthorectified aerial photographs to create the drainage model data. ArcScene allowed decision makers to view and process the data in 3D while analyzing the effects of new construction sites on the existing grounds.

The University of Calgary uses ArcGIS to manage a $1.5 billion expansion and maintain the facilities on its 200-hectare campus.

Using lidar to map the campus allowed the team members to look not only on the ground but in the trees, as well. They recorded and processed the height of every tree on campus to provide even more information necessary for relandscaping after the expansion project, as well as to understand the position of shadows on potential buildings. Armed with this information, the team was able to optimize the planting of five trees for every tree removed during construction, along with native, low-water vegetation, helping the team achieve greenhouse gas and water use reduction goals.

Once the surface models were completed, the team generated 3D building models to use for shadow simulations during the next construction phases. Traditionally the models have been leveraged to ensure that new buildings do not obstruct the views of existing buildings. In this case, the shadow models were used to track the antic effect on a glass exterior compared to a solid wall structure. This method of optimizing the heating mechanics of buildings is an important consideration in an area as far north as Calgary, where sun angles change drastically depending on the season. In the summer, the sun is high, creating narrower shadows; in the winter, the reverse is true. Simulating 3D shadow effects based on sun angle allowed team members to calculate just how long a building would sit in shade at any time of year, enabling decisions to be made on the heating needs and estimated costs to maintain the comfort level of that specific building.

As with many GIS projects, the development of one application often generates additional benefits. With the surface models in place and the building sites located, there was an urgent need to model the campus irrigation system. An application was developed to help map the changes caused by the construction. The irrigation model also provided the ability to monitor water usage and maintain asset inventories. This innovative application created a model for managing 8,800 sprinkler heads across campus and has helped grounds personnel better understand and manage the system. Knowing the flow rate and tilt angle of each sprinkler, the university is now able to calculate the volume of water it sprays, as well as the areas it covers. The application can be used for the life of the campus and allows it to conserve water by reducing overlap and avoiding spraying water on roads and pedestrian walkways.

The interactive room finder provides the ability to determine the user's current location and find the best path to a new destination.

Coordinating Solutions

The GeoDesign process opened many new avenues to explore to increase efficiency around campus, even in areas where it wasn't expected. In a synergistic move with the new construction, the information technologies (IT) department also used ArcGIS to consolidate several computer centers where remote computer systems were once maintained. The consolidation freed up new space for faculty to use and has led to better communication and system coordination across campus. It also allowed a reduction in utilities costs for electrical and cooling systems.

"Using GIS as a decision-making tool is a smart way of gathering all the things you already know and placing them in a single spot so you can see the entire picture," says Tom McCaffrey, GIS coordinator, University of Calgary. "Understanding each layer of data as a separate entity is one thing; combining several layers together to get a coordinated solution to a complex problem is a completely different scenario. It's the difference between thinking in two dimensions versus thinking in three or four."

This understanding of how ArcGIS can be applied to different problems led the IT telecom group to reach out to the GIS team for help creating an application that would track telecom network lines, utility corridors, wiring closets, and utility shafts throughout the campus. While general maintenance for utilities and computer networking systems can be overwhelming if left unchecked, the ArcGIS for Server web-based application, when completed, will serve up 3D diagrams of the networks that administrators can edit and analyze at any time. Service technicians will also be able to trace, track, and repair faulty wires and equipment as those tasks are necessary. The system will enable them to monitor real-time data, plan networks, and prevent costly technical problems.

Improving Asset Management and Reducing Risk

The university currently needs to renew and maintain the exterior roofs of more than 90 buildings on several different campus sites. To make this process more efficient, the GIS team created a web mapping application that allows editing, updating, measuring, and reporting on government funding spent on reroofing the campus. Using ArcGIS, the team is now able to more effectively track life cycles and warranties of the roofing materials, which can potentially lead to thousands of dollars in savings on roofing jobs. Data on structures reported to the government is now documented using an accurate spatial and temporal method that provides strong accountability for how government money is spent. GIS has virtually eliminated the need for manual roof measurements that cost both time and money, as well as pose a potential safety risk.

From a risk management perspective, the university has also used ArcGIS to enhance public safety. Using a current model of the campus and incorporating up-to-date floor plans, emergency preparedness and evacuation plans were developed. Models and processes were discussed with local authorities and emergency responders to generate a map standard that was distributed to these stakeholders. The safety team created different scenarios and determined several possible routes for building evacuations. These plans were posted on a central website to help fire wardens understand the proper evacuation protocols. Future plans to integrate fire security camera feeds into a secure campus web dashboard would allow the creation of a mobile command and control center.

ArcGIS was even used to design external lighting models for the university's safety walk programs. These models estimated ground illumination based on the type of light fixtures and any interference caused by vegetation or building shadows. Maps were then generated and given to grounds personnel to take corrective measures in illuminating unsafe areas.

Zoomed view in the room finder.

Enhancing the Campus Experience

To help students and visitors easily find their way around campus, the university developed an interactive room-finder application using institutional data. Users can input the building name and room number they wish to find, and the application generates a detailed map showing the floor plan with the desired room highlighted. Visitors can look up their destination using the online tool and determine the nearest parking area before arriving on campus. This enhances visitors' experience and helps them save time.

The interactive room finder will soon become available on mobile devices. Users will be able to take a picture of a wall marker to determine their current location and then enter their new destination. The map will show several route options—shortest path, indoor or outdoor routing, elevator access for the handicapped, or stair access for those who want more exercise.

Another future project will use administrative data to help students select classes based on spatial proximity. An application is being developed that will allow students to enter their ID numbers and generate maps that show their classroom locations, as well as the proximity to the next class, based on a specific time and day. This will help students familiarize themselves with the campus and select a schedule that offers reasonable travel times between classes.

"GIS technology offers endless opportunities for our processes to grow," says McCaffrey. "Processes that used to take weeks can now be done in minutes. Being able to see the entire picture at once is an option we've never had before. GIS allows us to plan at a much higher level than we could have ever imagined. Now, we look for new ways to view scenarios and come up with better ideas to manage them."

With all the efficiencies gained in their research, institutional, and administrative processes using Esri technology, the University of Calgary earns an AEC GeoDesign and is well on its way to becoming a university of the future.

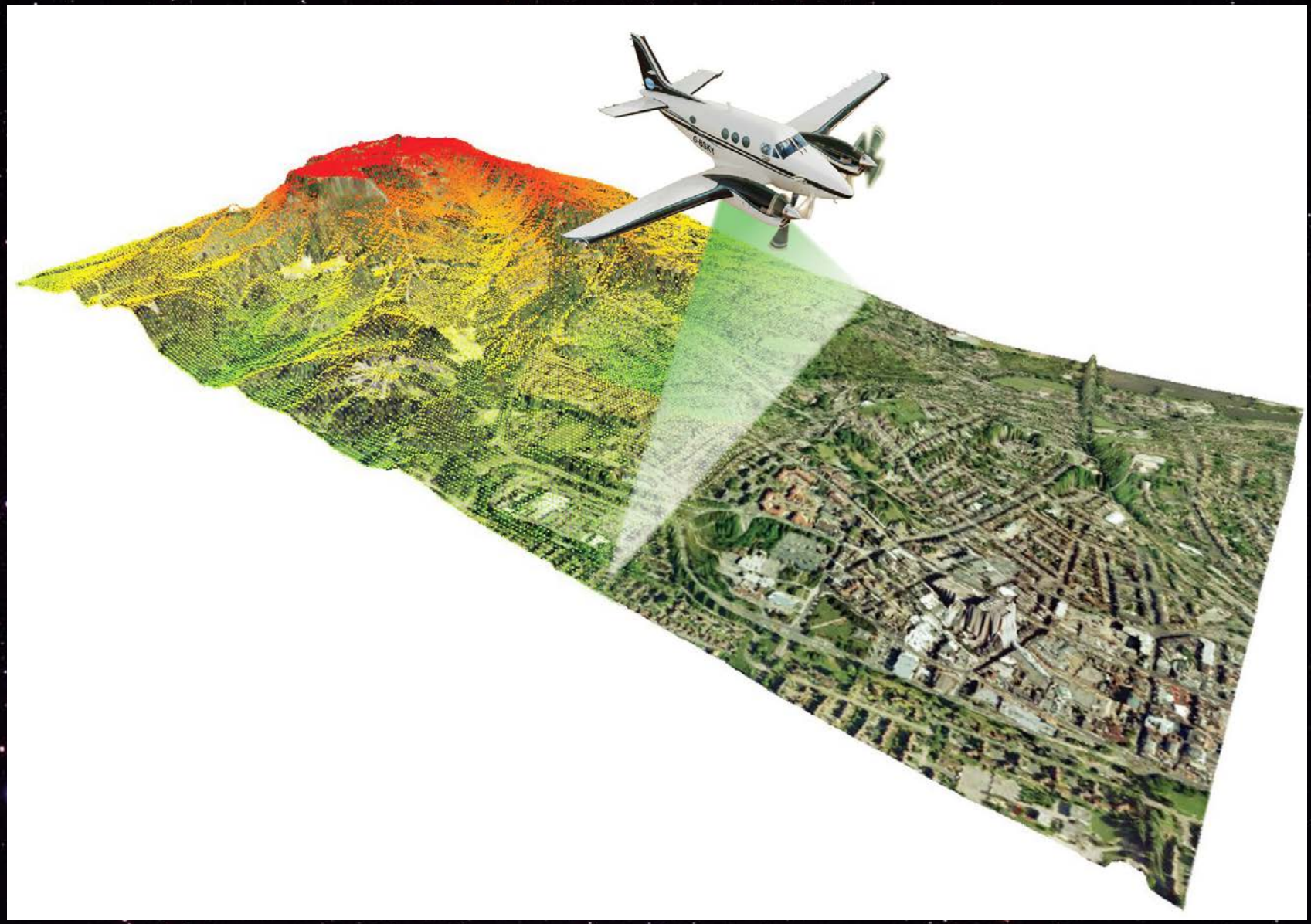
For more information, contact Tom McCaffrey, GIS coordinator, University of Calgary (e-mail: tmmccaff@ucalgary.ca).

For more information on how you can put GeoDesign into practice, contact Mr. Shannon McElhaney Esri (e-mail: smcelhaney@esri.com), or visit esri.ca/geodesign.


Growing Data Sets

Growing Data Sets

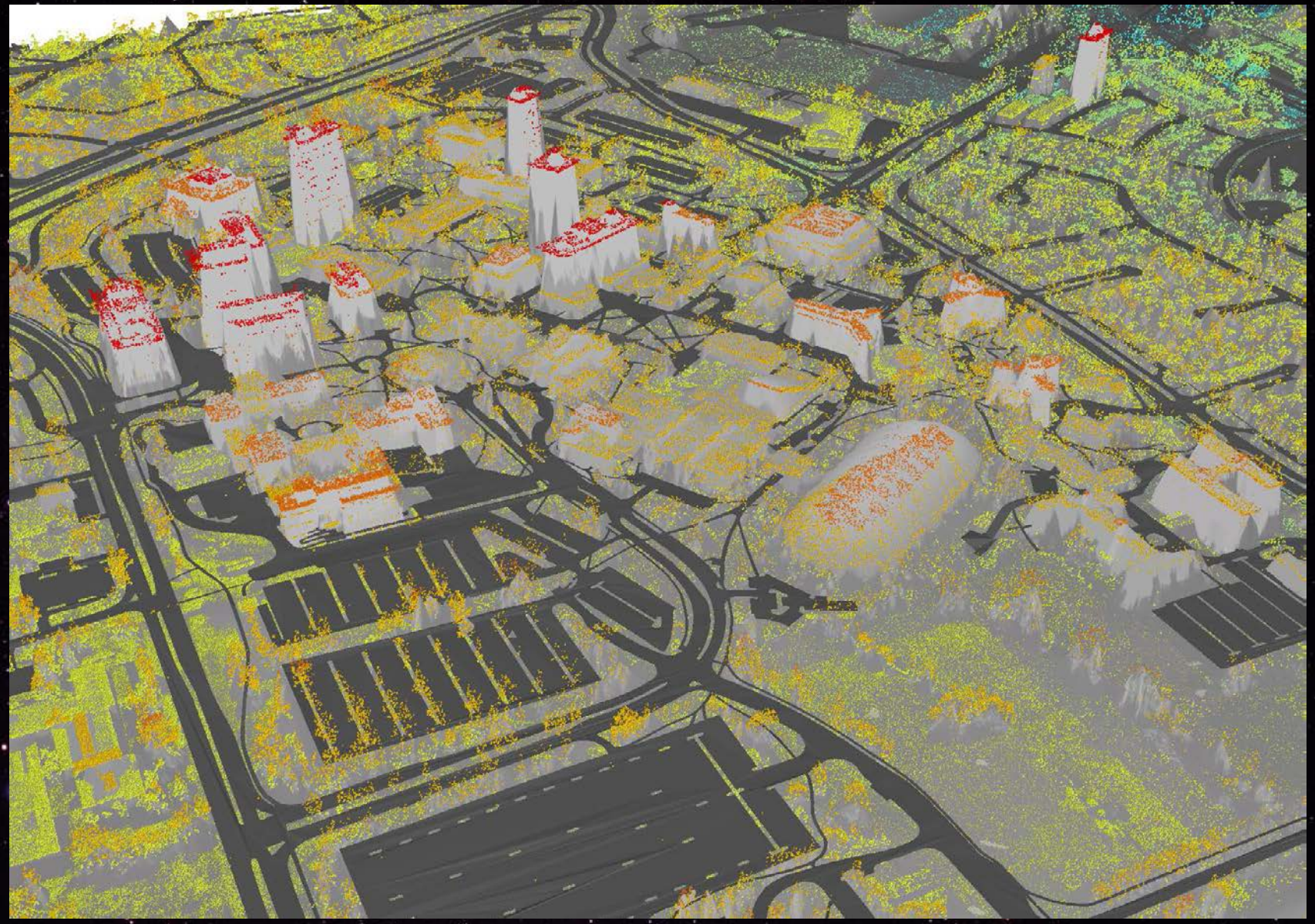
LiDAR



Growing Data Sets

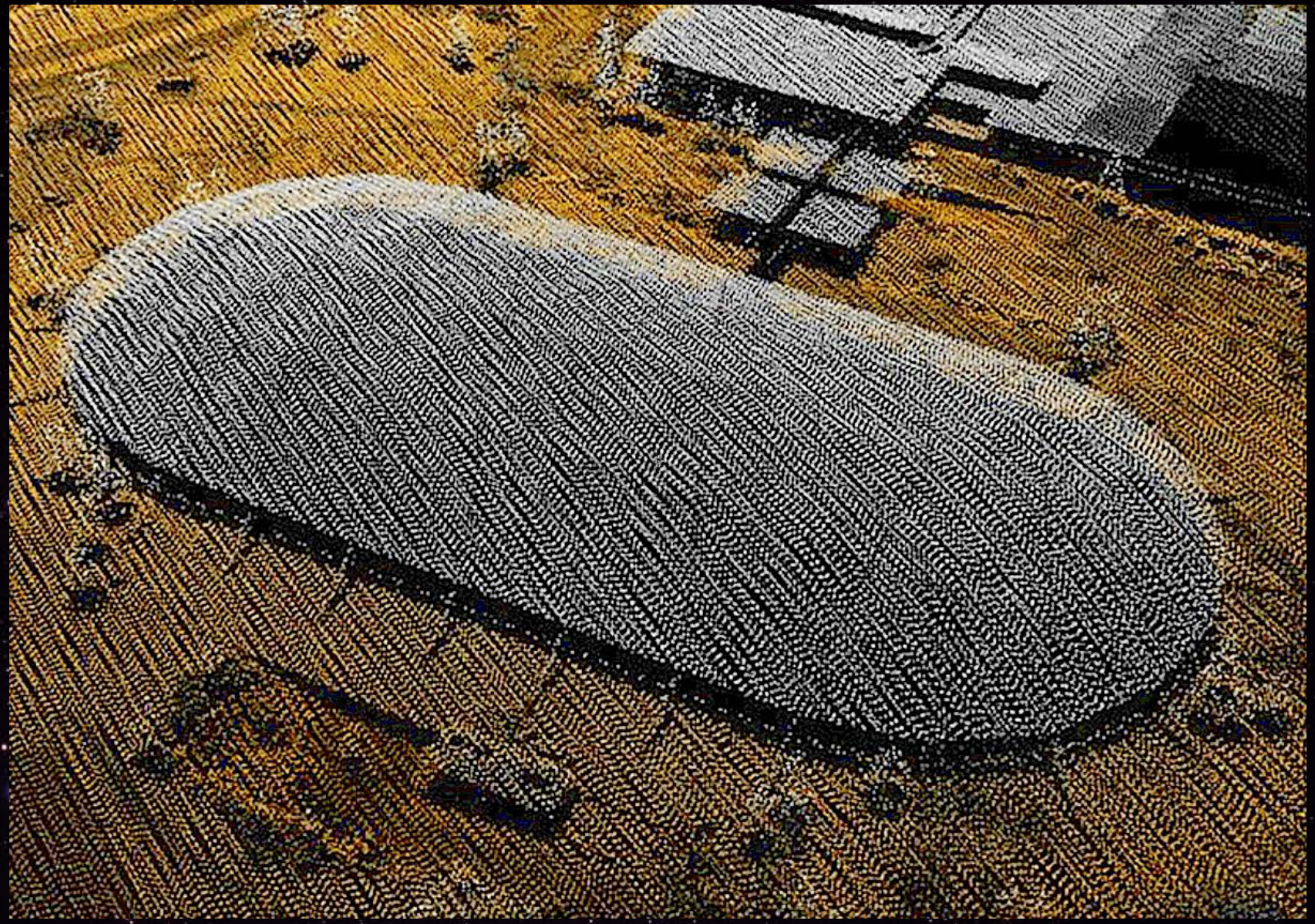
LiDAR

> 3 million pts



Growing Data Sets

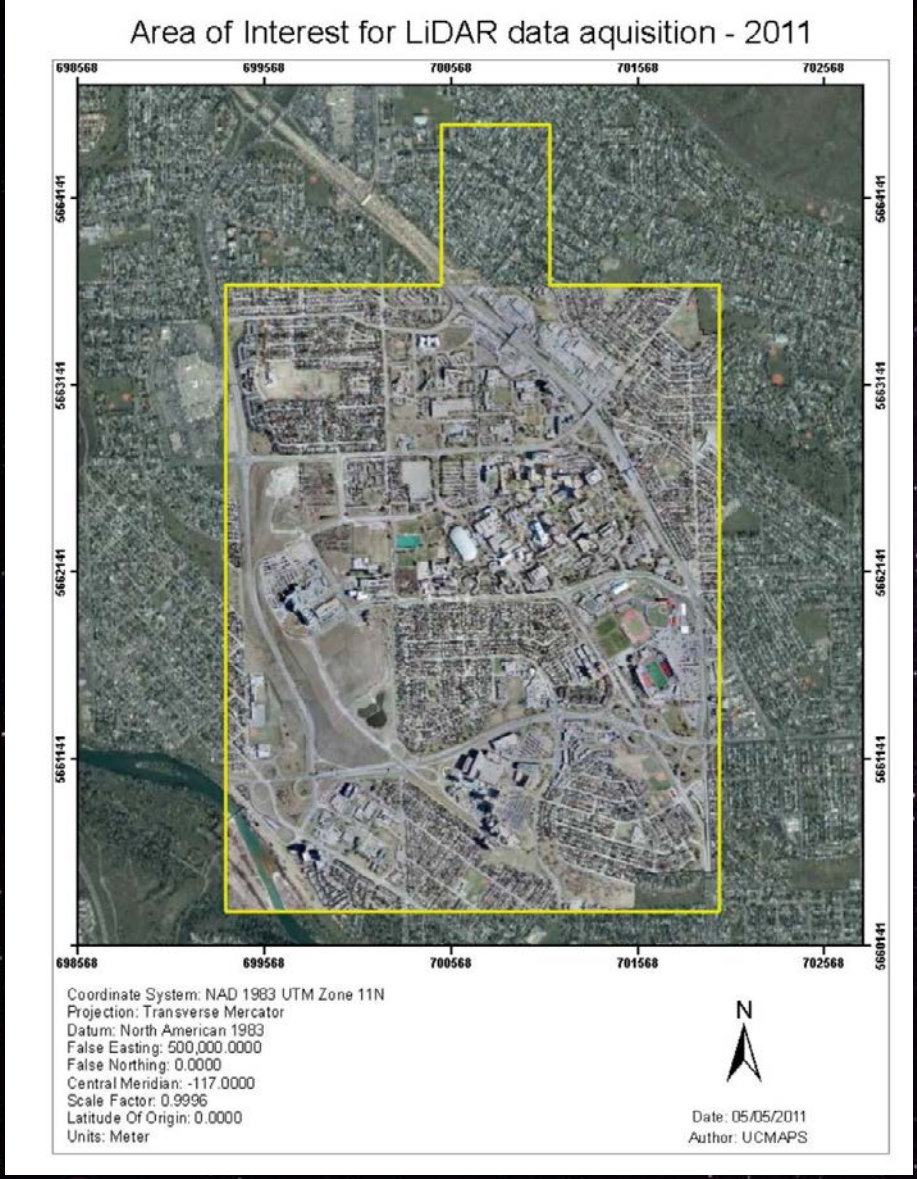
LiDAR



.75m point spread
with 50% overlap

Growing Data Sets

LiDAR + Aerial Data



Growing Data Sets

LiDAR + Aerial Data

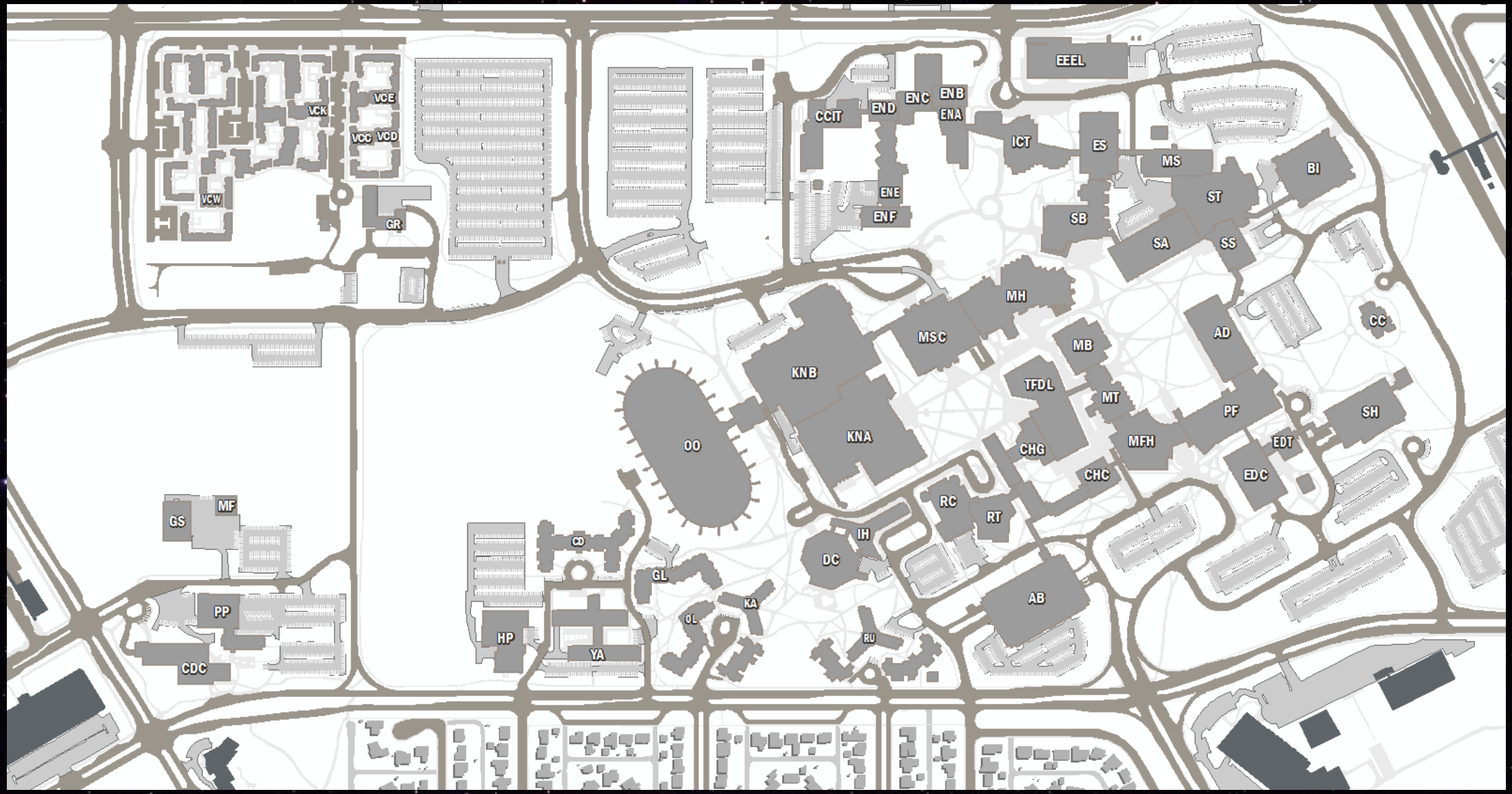
High resolution 1:5000 Aerial photographs

Growing Data Sets

LiDAR + Aerial Data = True Ortho Rectified Imagery

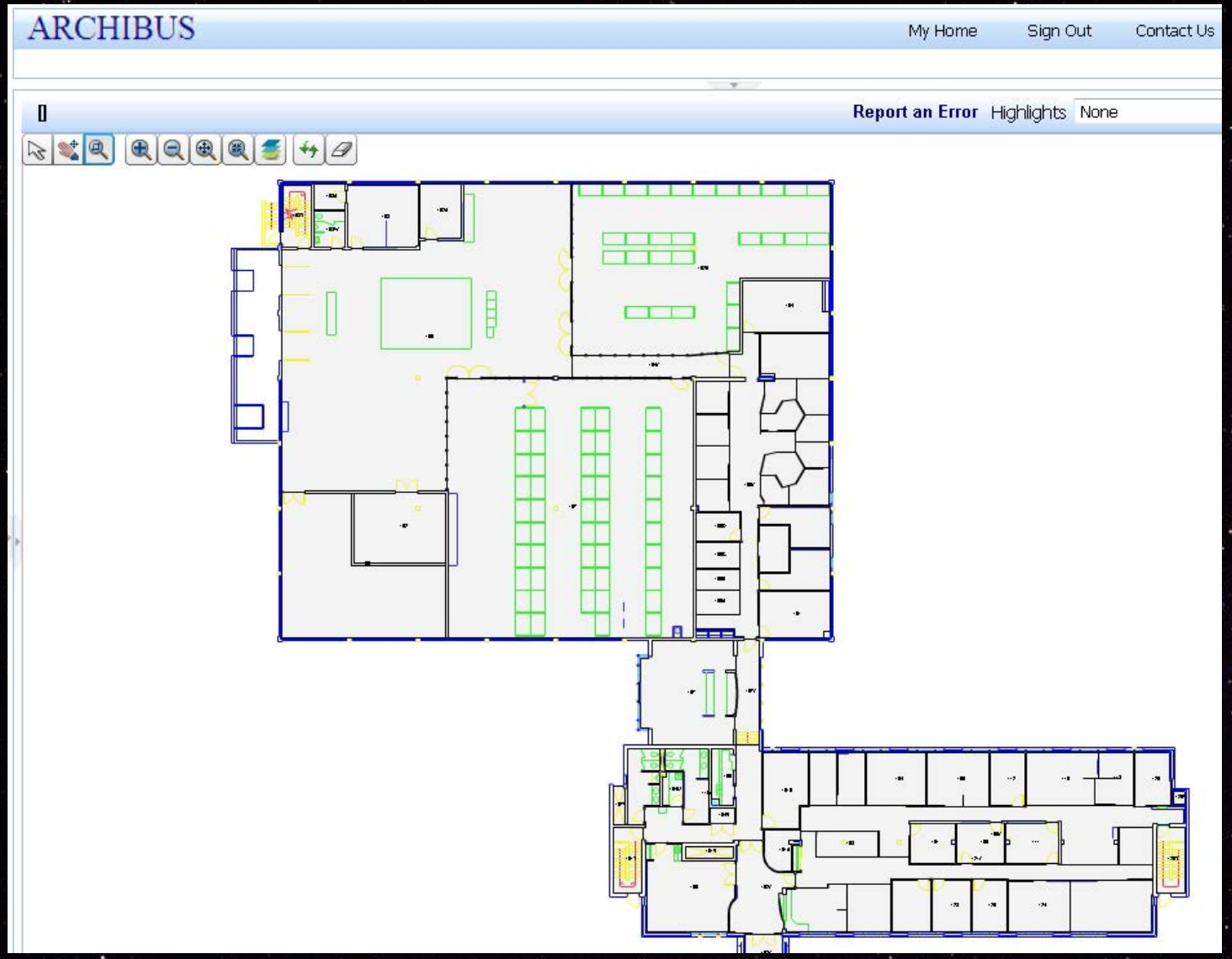
Growing Data Sets

Orthophotos + GIS = Basemap



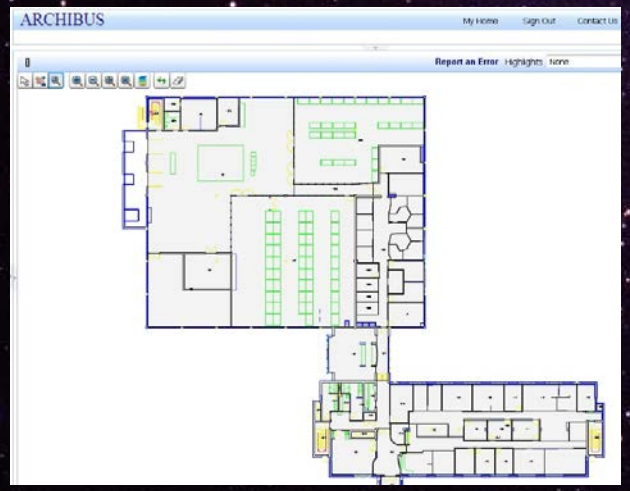
Growing Data Sets

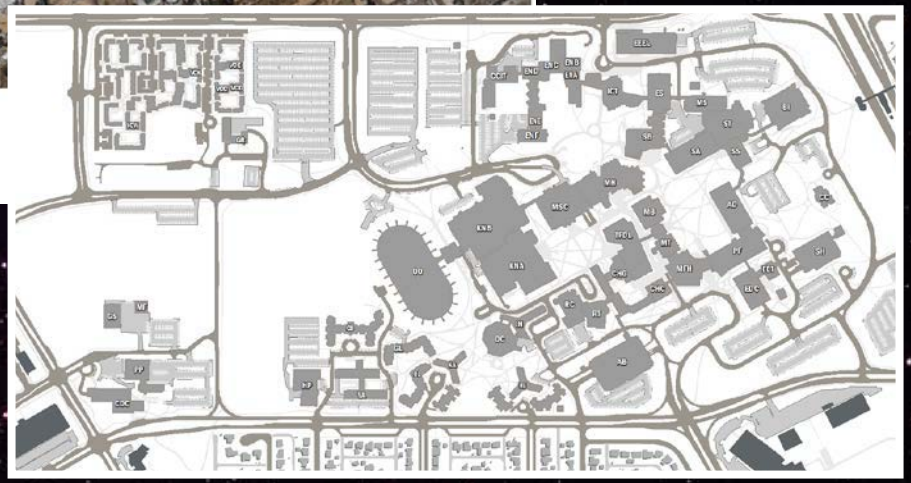
Include CAD drawings



Growing Data Sets

Combining 4 data sets will generate numerous new data sets

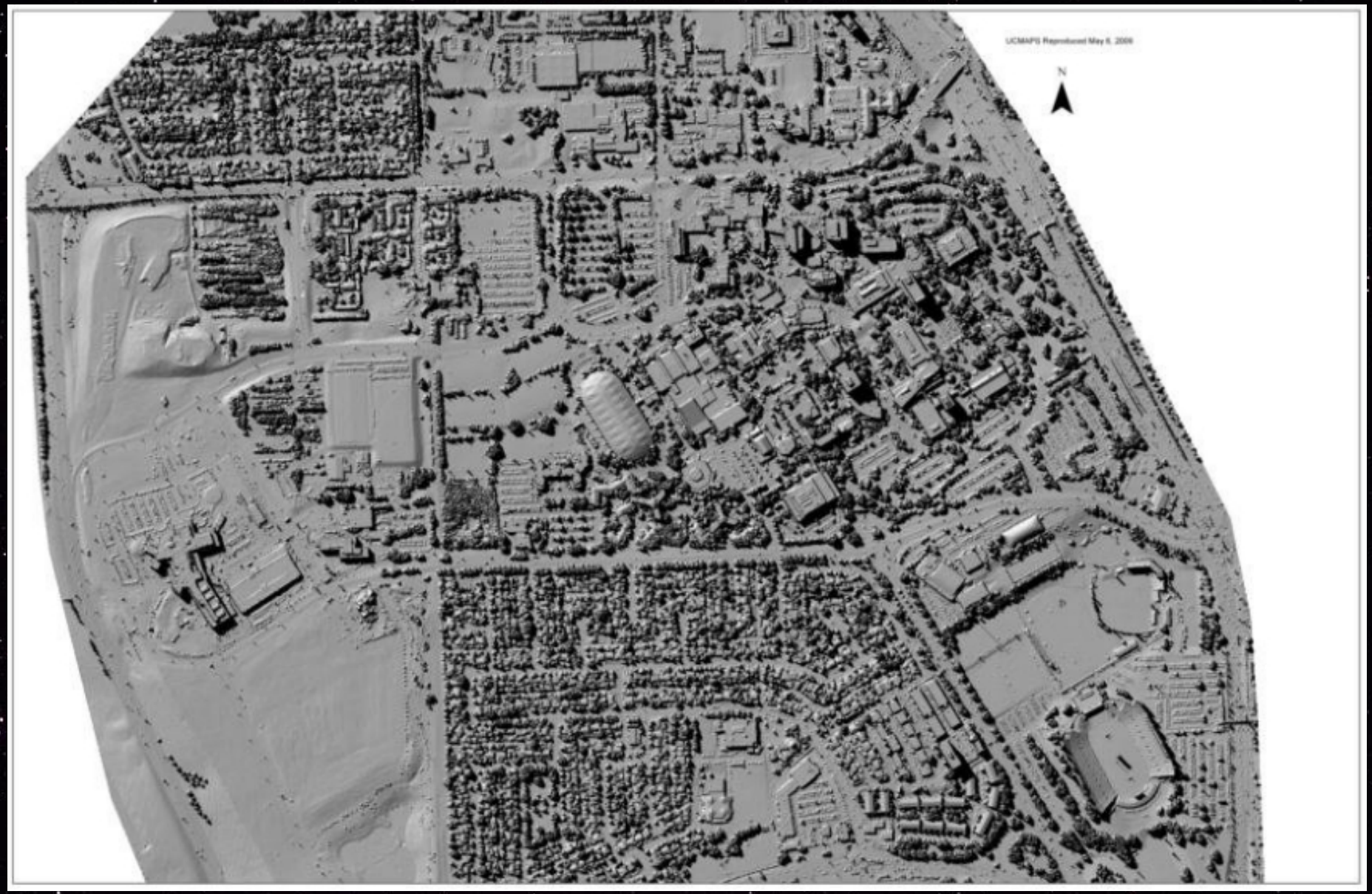




Create 3D Models

Growing Data Sets

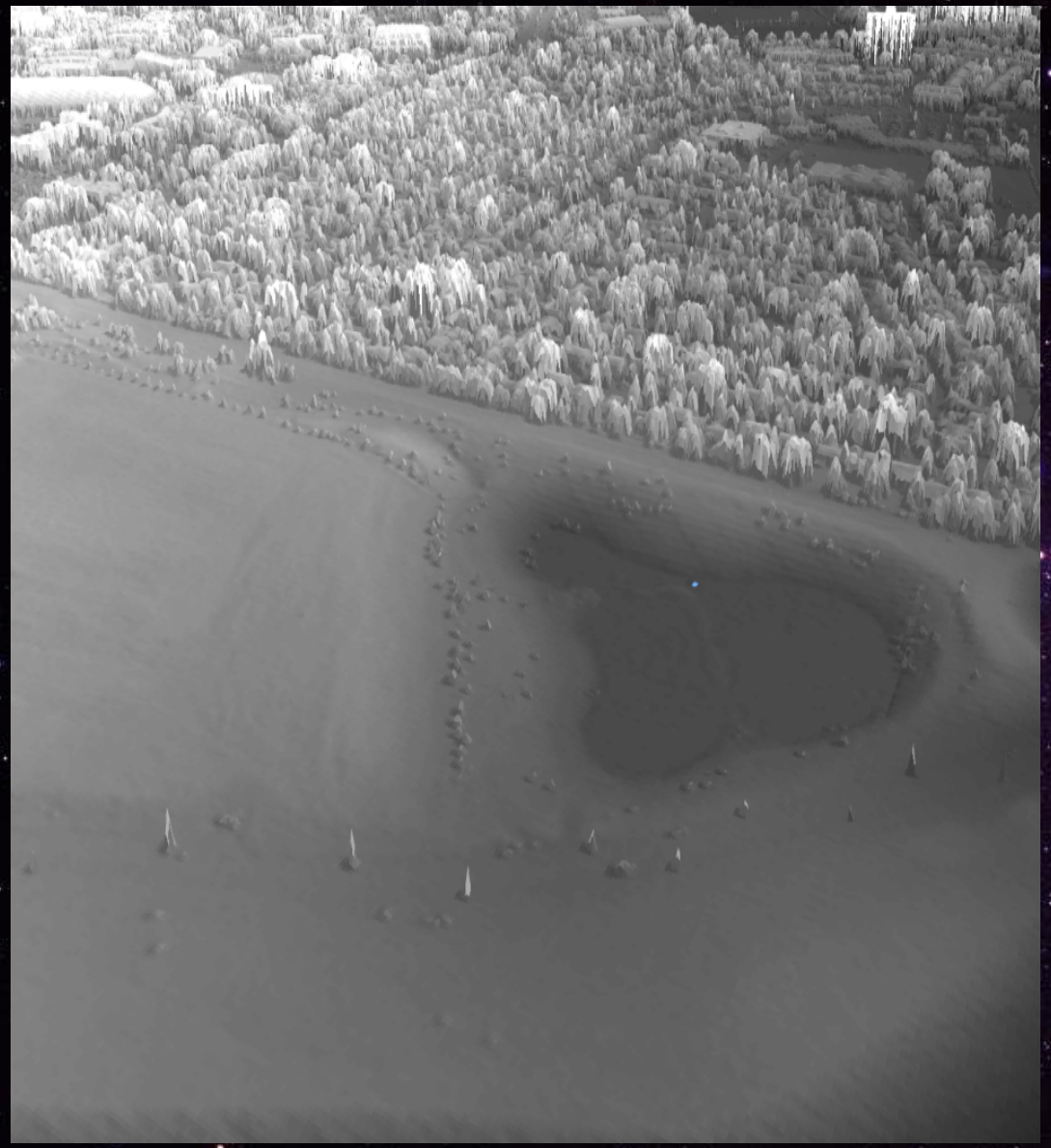
Hill Shade Models

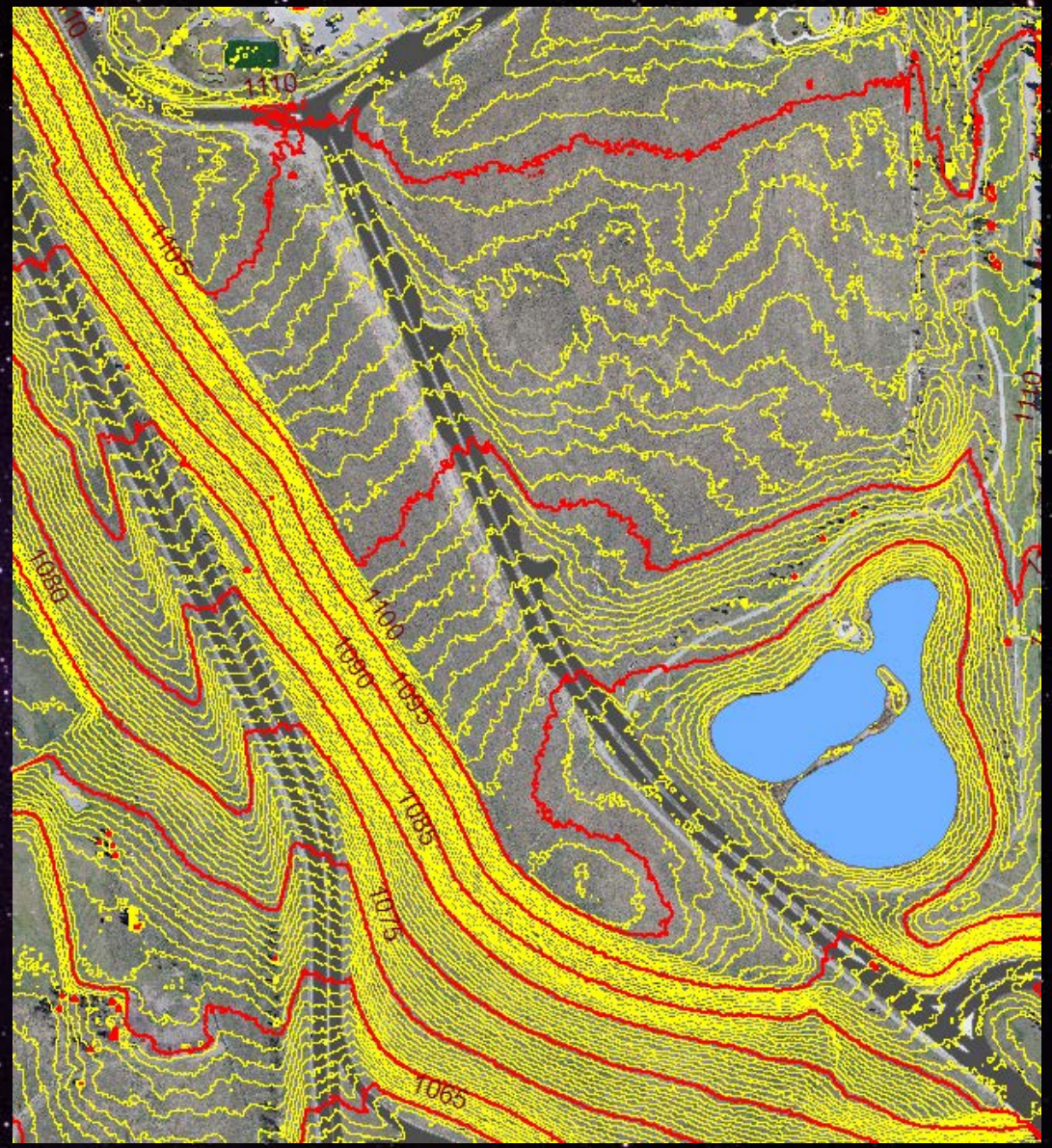


- Used to calculate elevations & building heights

Growing Data Sets

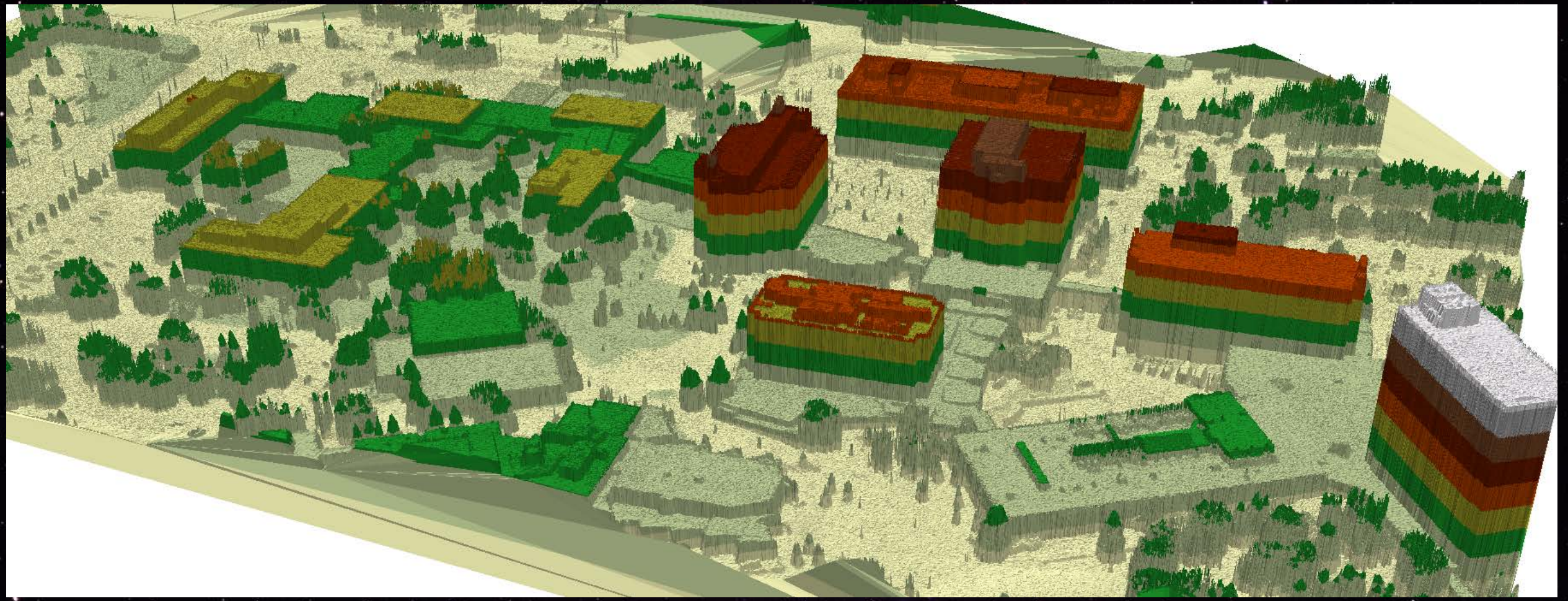
Generate Contours from LiDAR





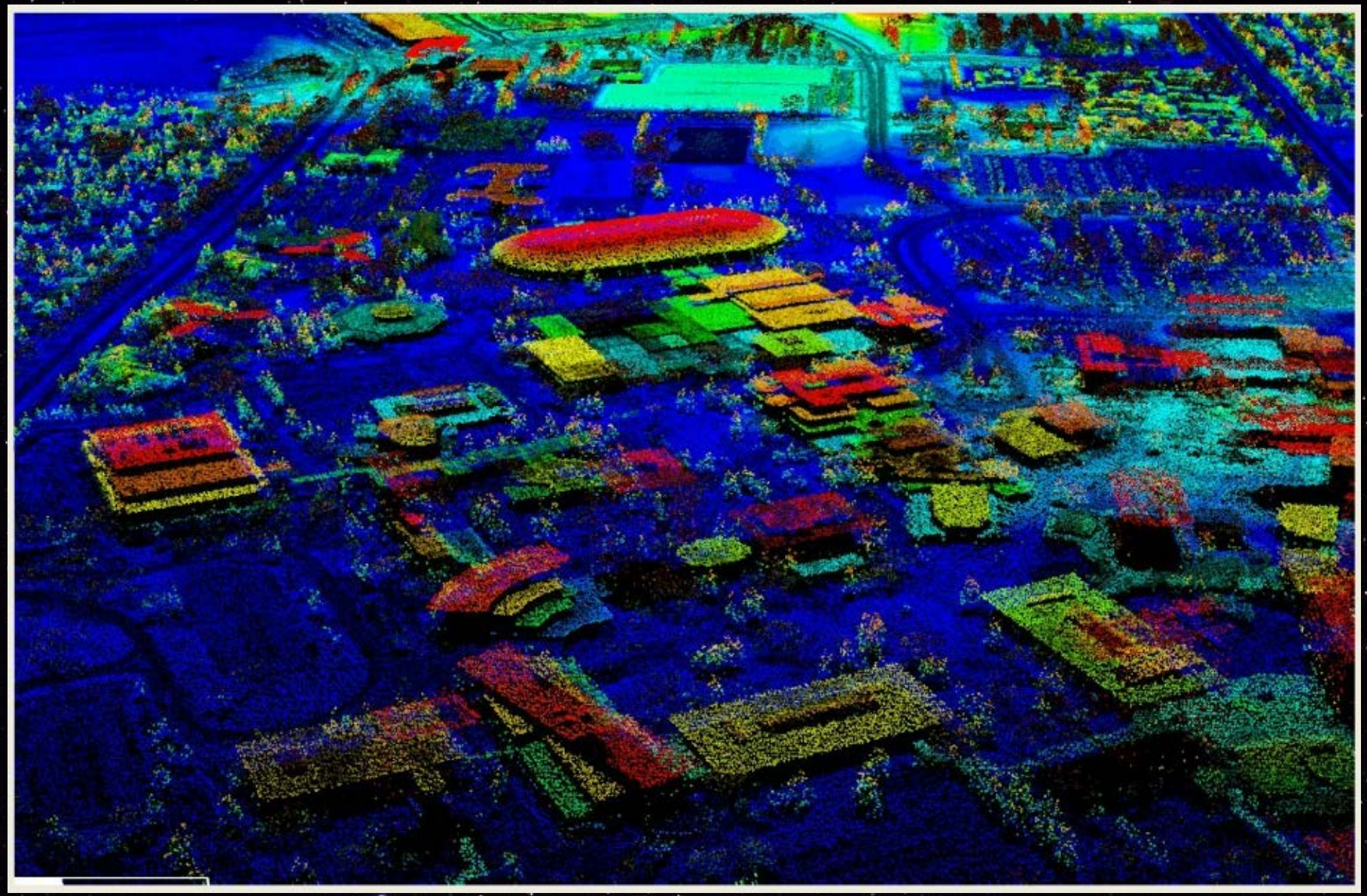
Growing Data Sets

Generate Digital Surface Models (DSM) from LiDAR



Growing Data Sets

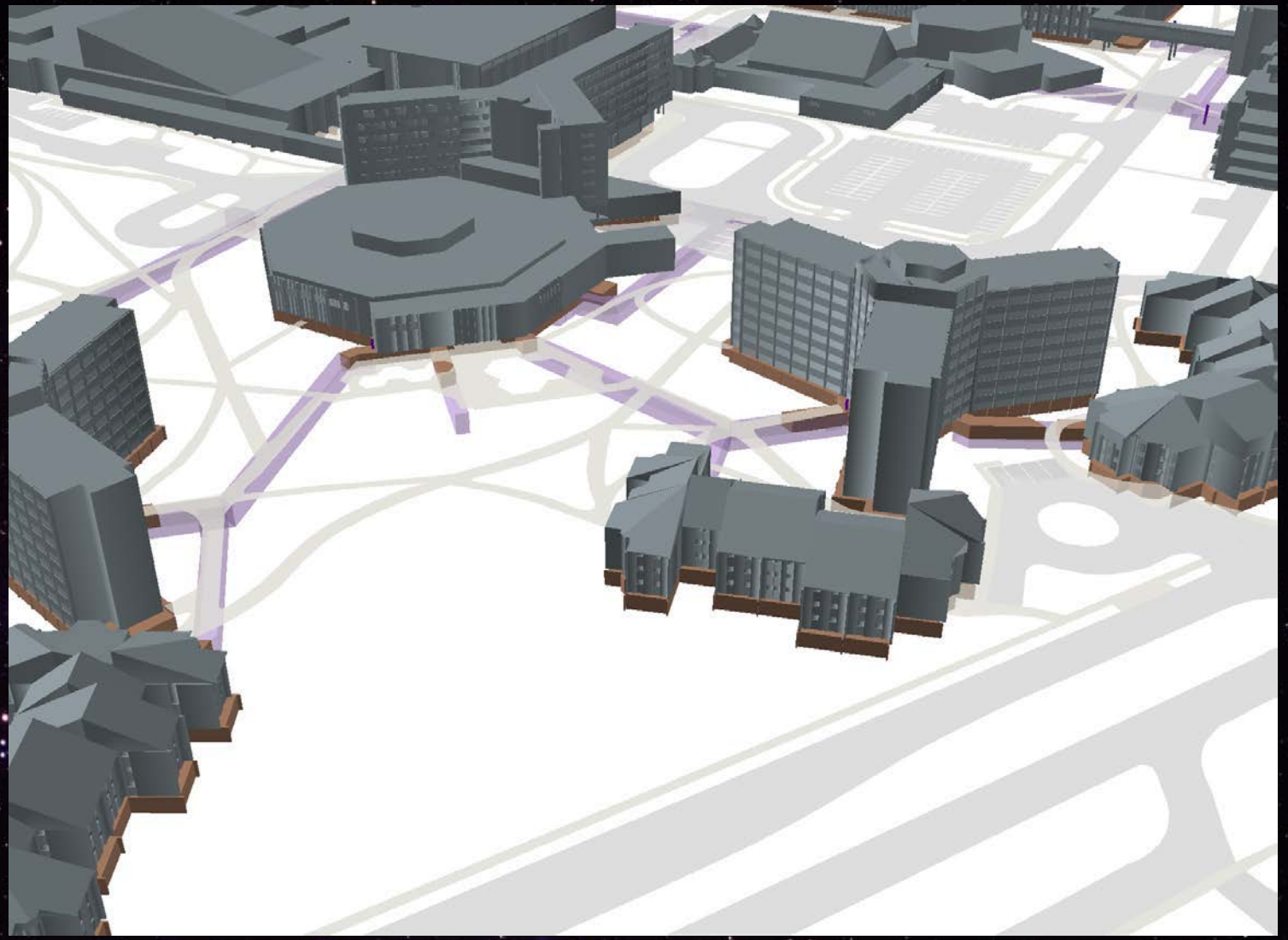
Calculated Building Heights



Growing Data Sets

Buildings
Basements
Tunnels

Created Sub-Surface Models



Growing Data Sets

LiDAR + Aerial Data + CAD = 3D ArcScene Models

Used to promote
the campus and
for Campus Planning

Create Catch Basin Models

Growing Data Sets

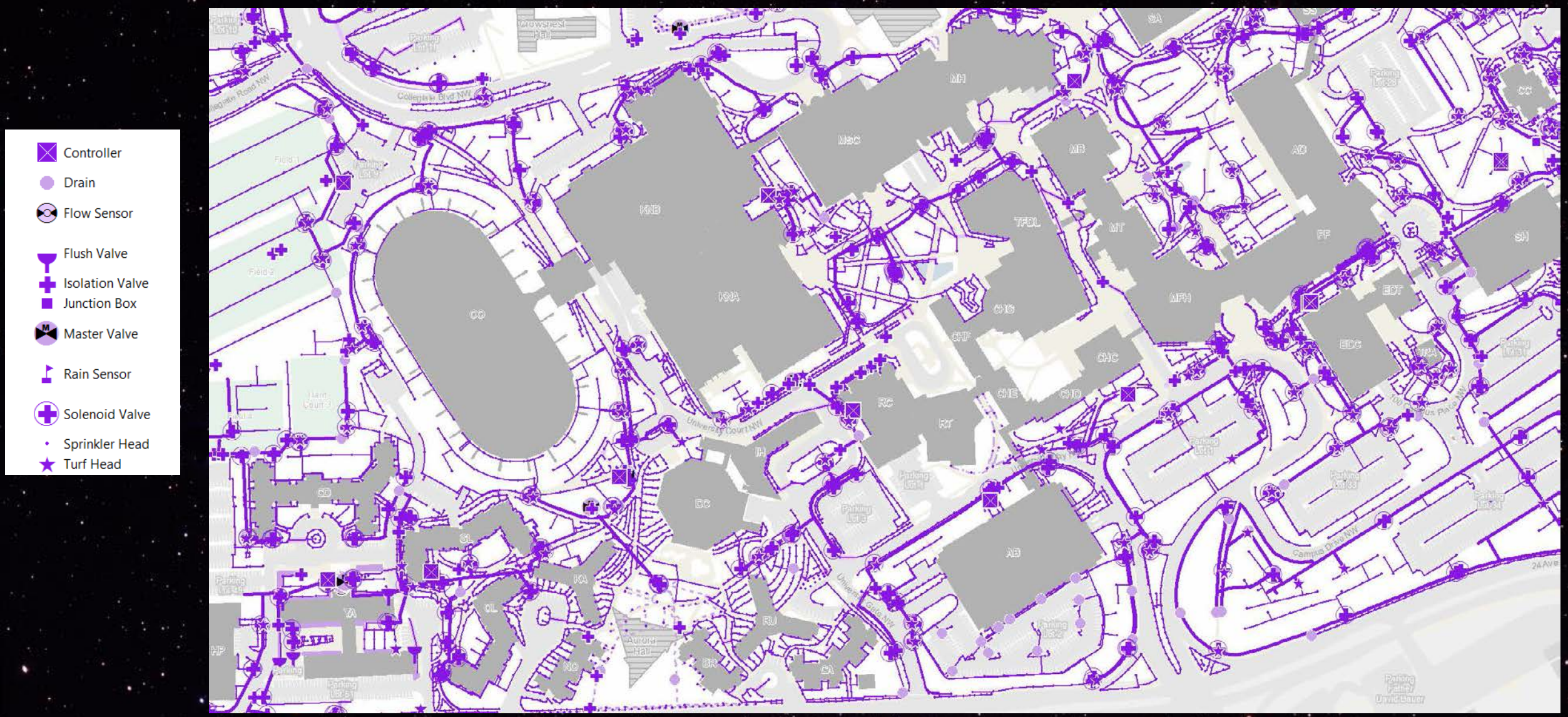
Map Catch Basins

- CB Manhole
- Catchbasin
- Inlet
- Manhole
- Outlet
- Outlet MH
- Unknown

Create Irrigation Models

Growing Data Sets

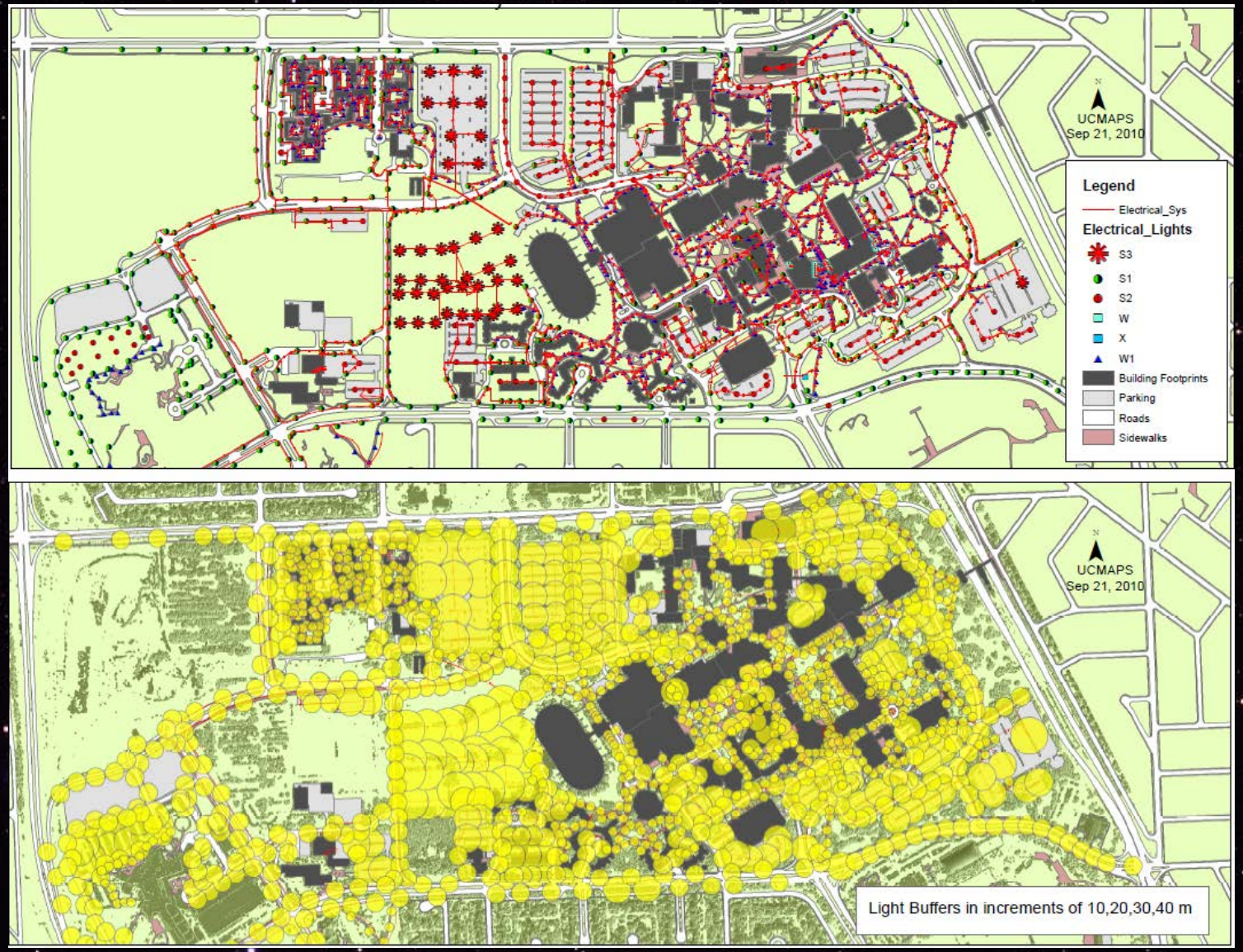
Map Irrigation Zones



Create Electrical Models

Growing Data Sets

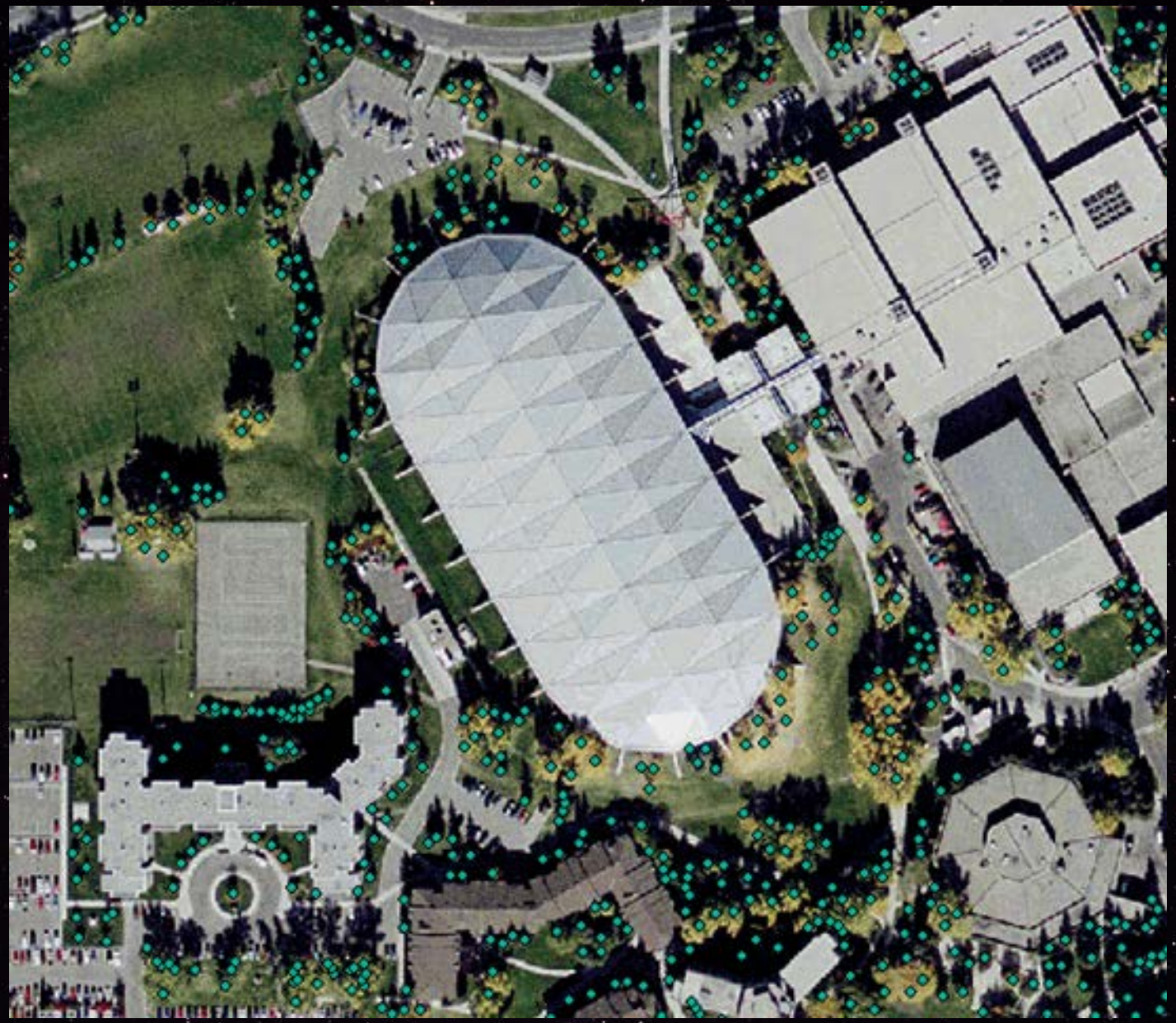
Map Light Standards against base maps



Create Vegetation Models

Growing Data Sets

Locate trees during leaf-off seasons

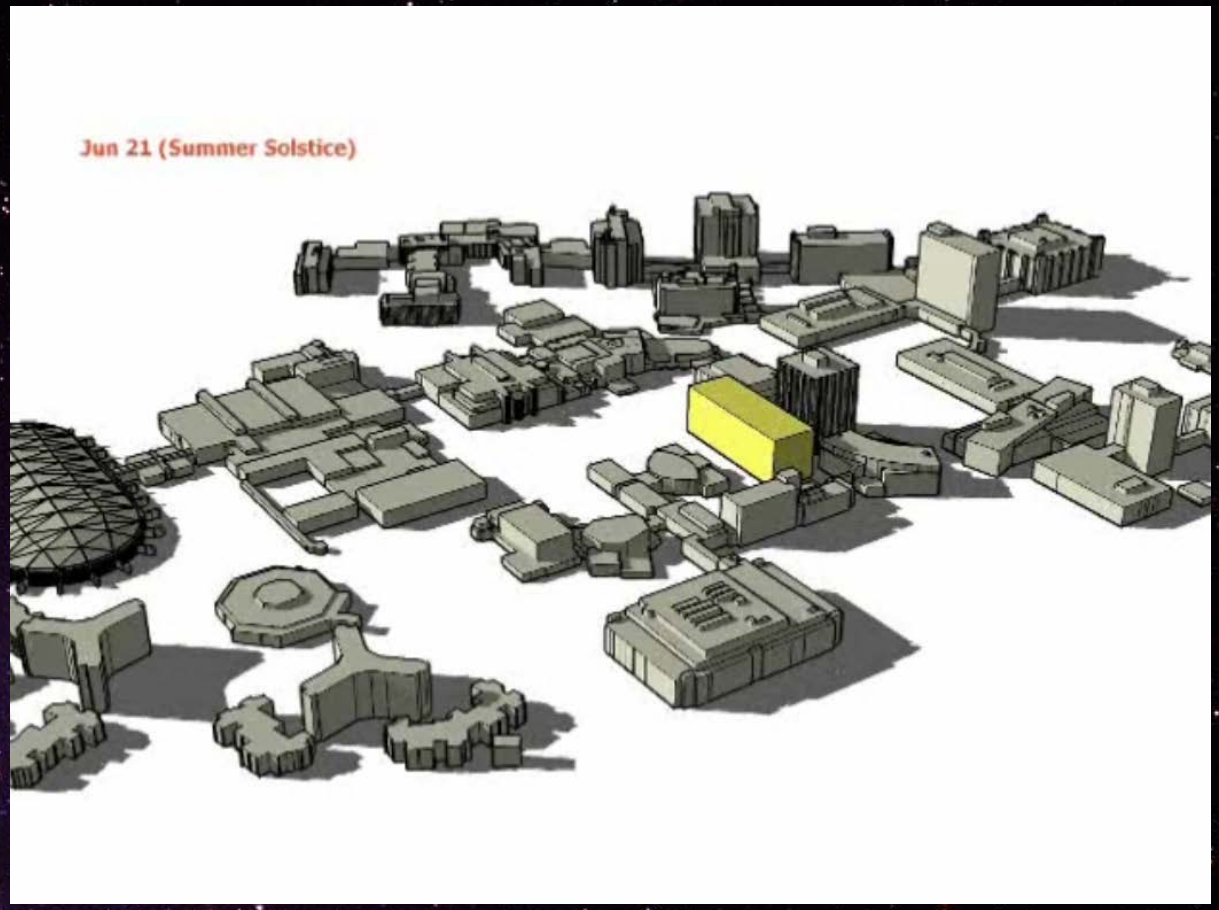


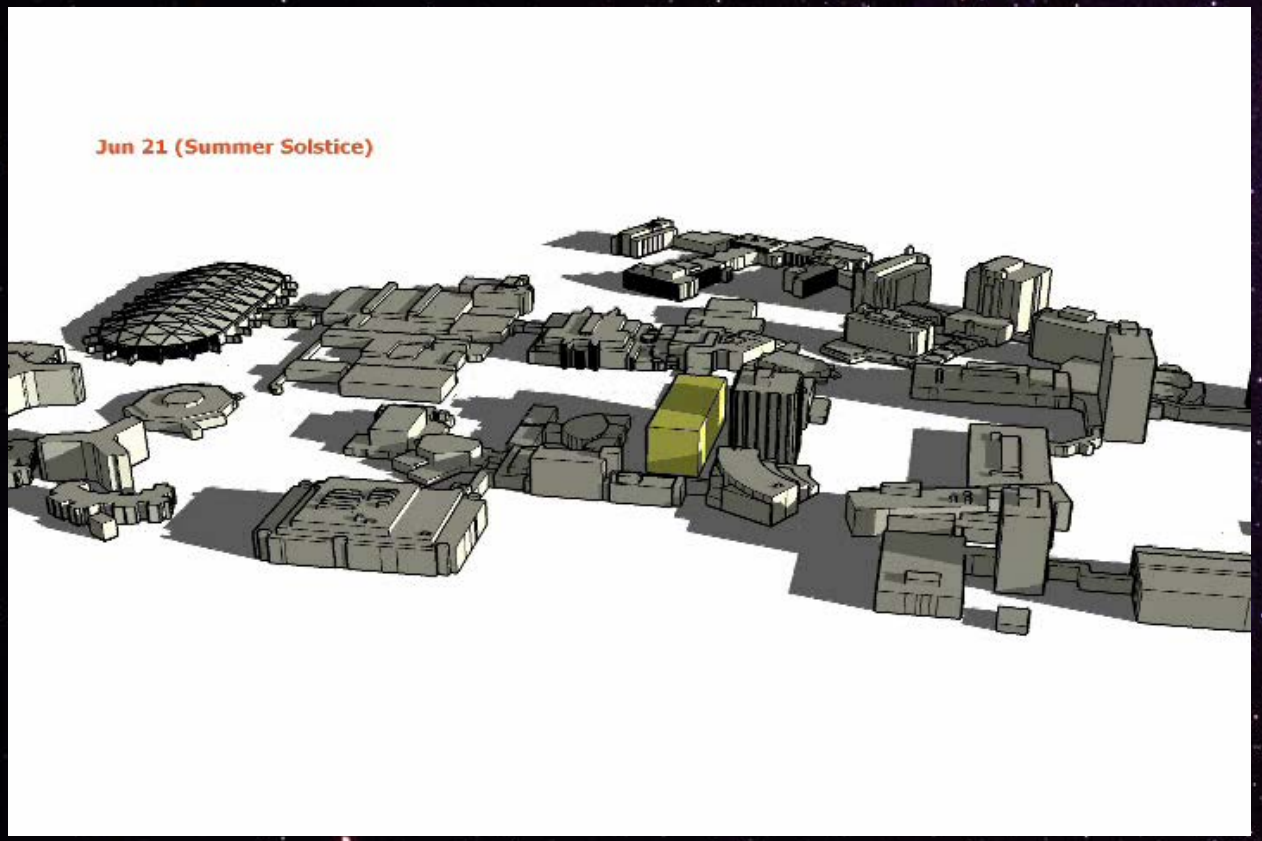
Using the data

3D Models

Using the data

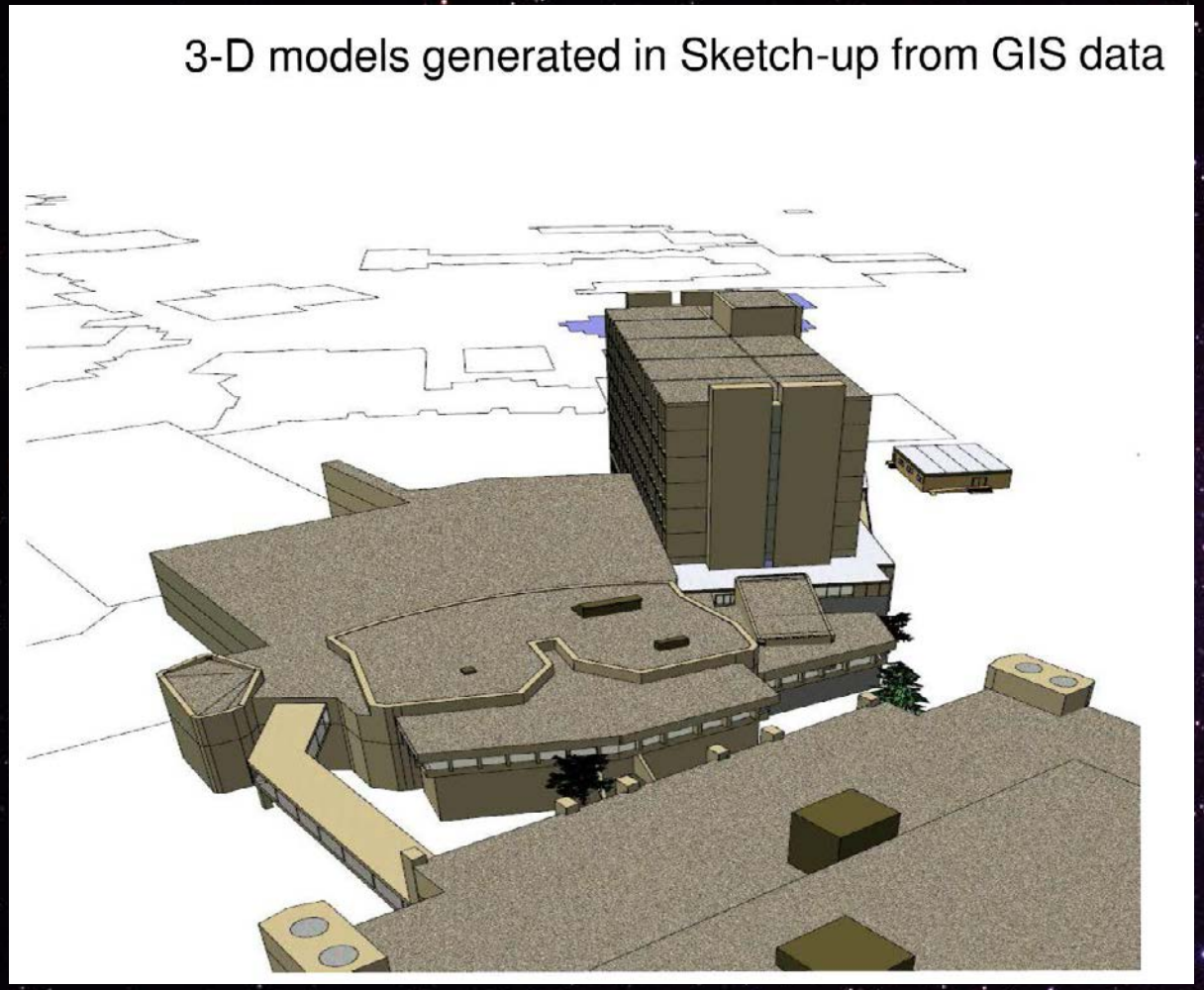
Generate 3D Shadow models

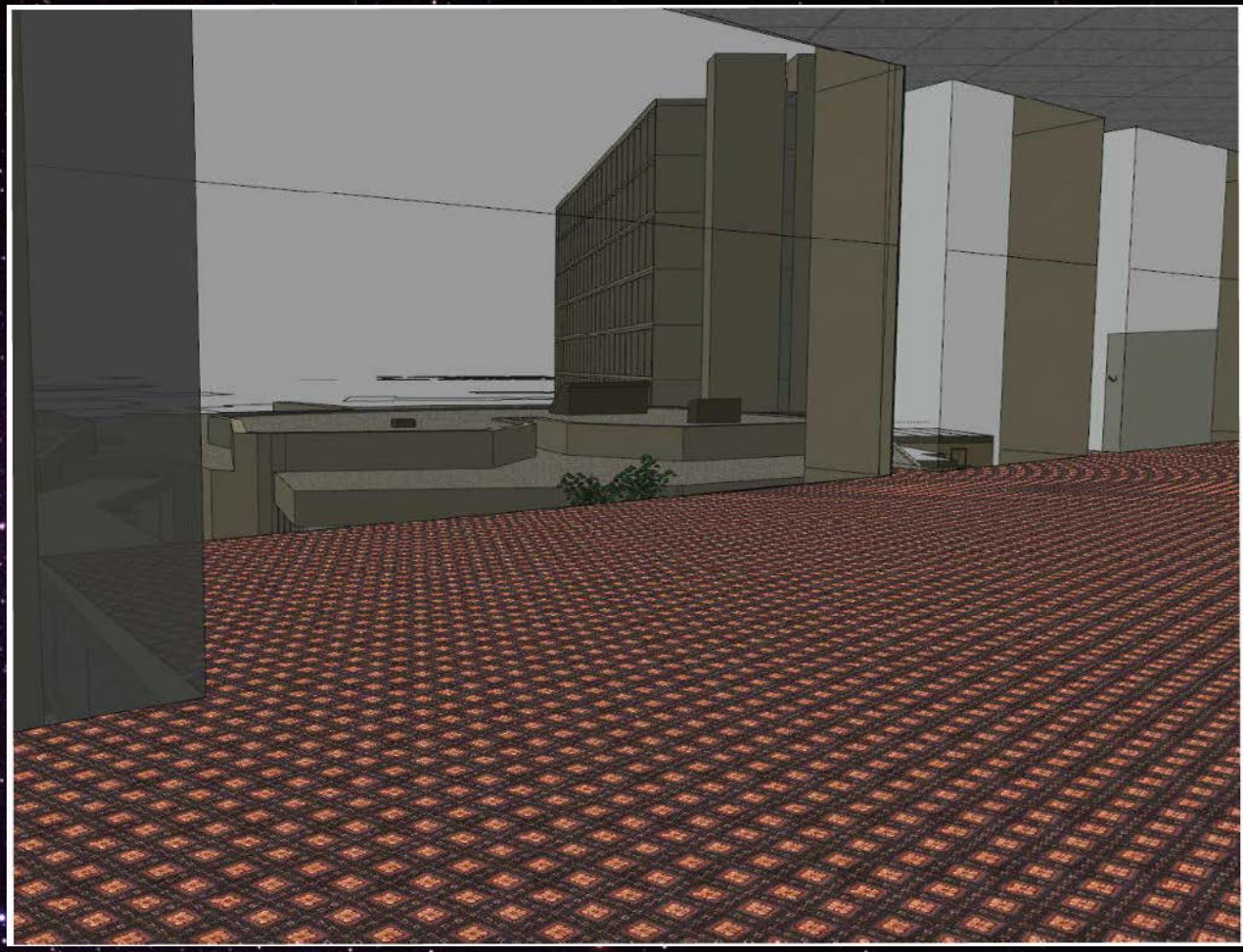




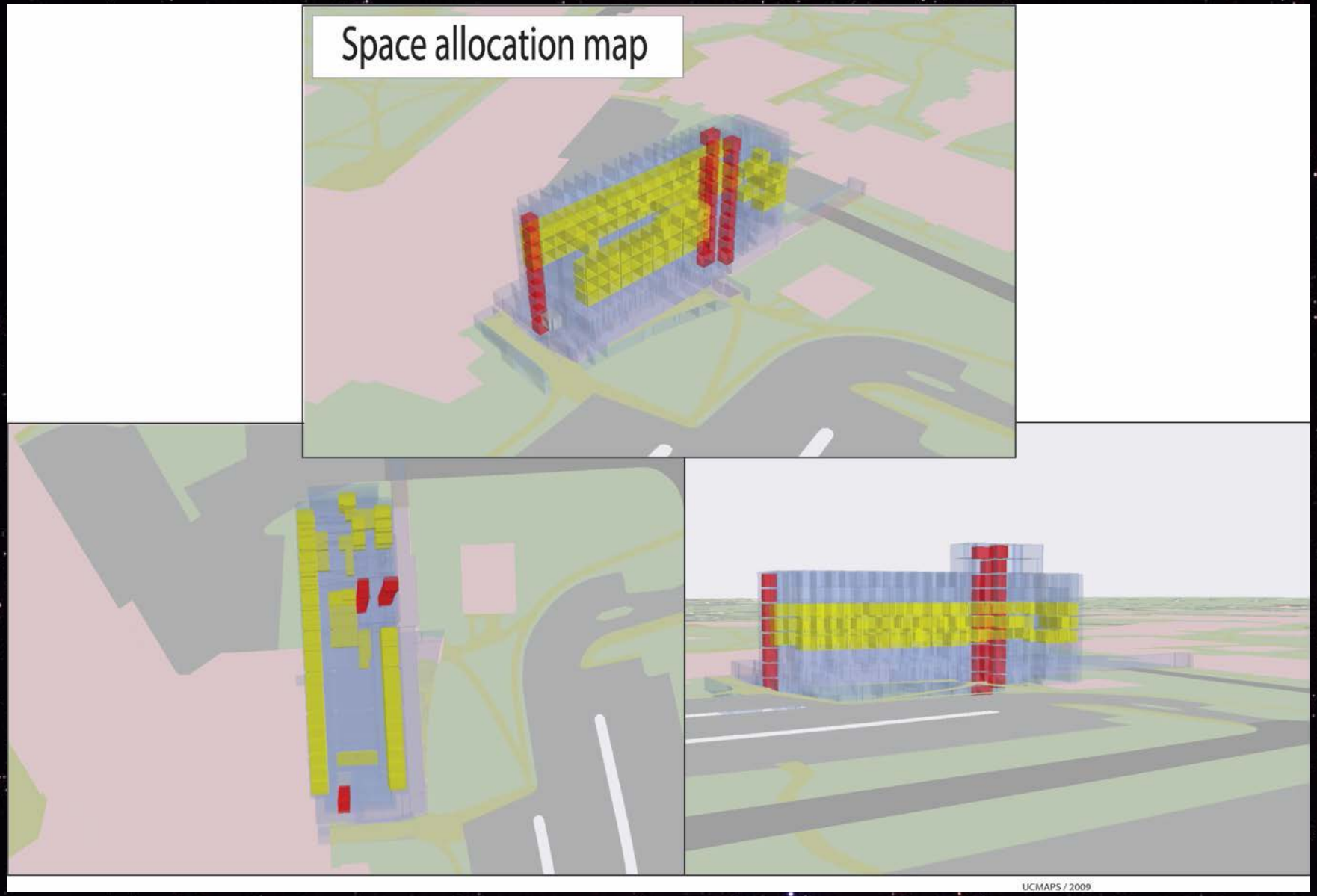
Video

Growing Data Sets





Using the data



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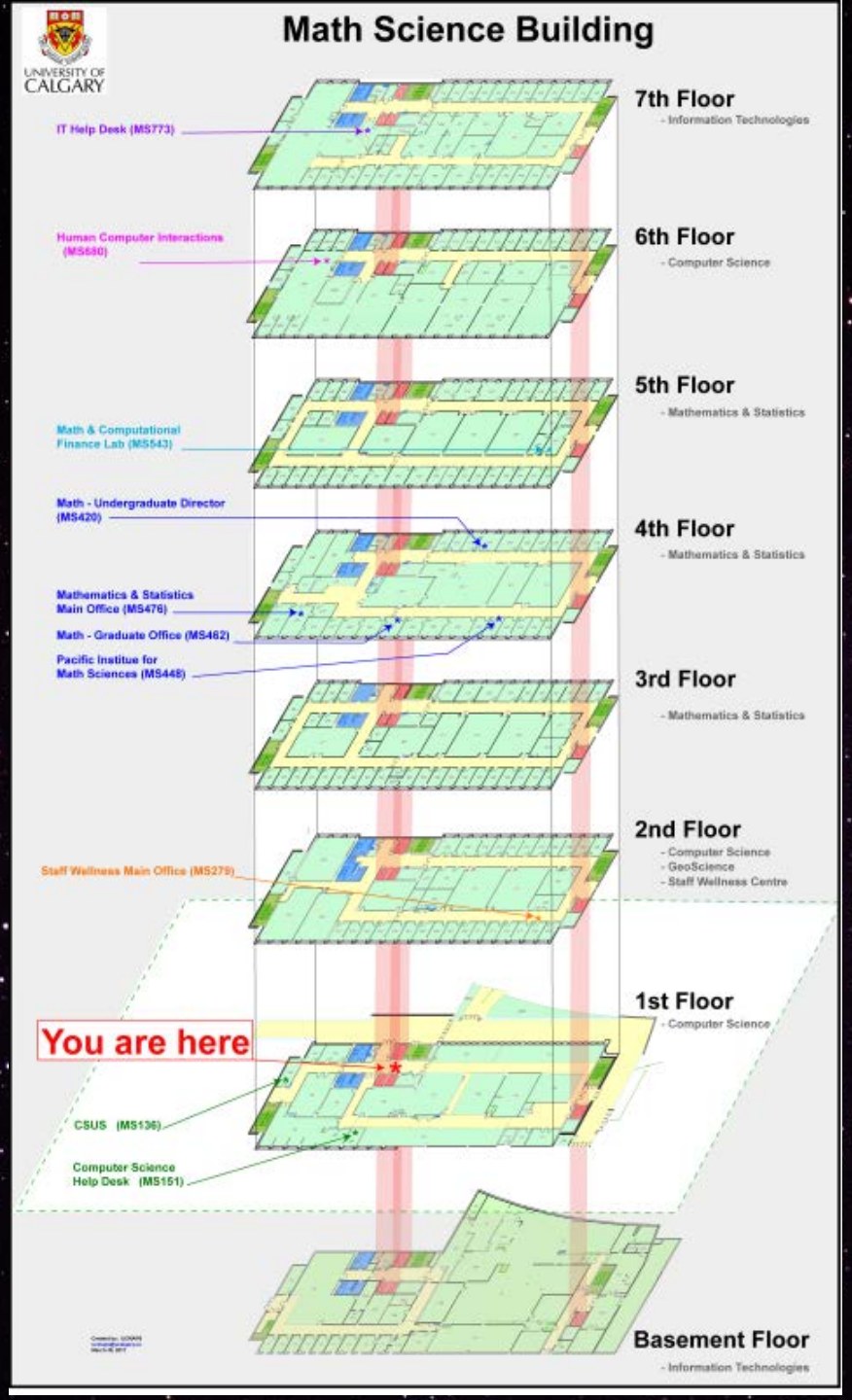


Using the data

3D fly through videos
used in student recruitment
and campus planning

Using the data

VIDEO

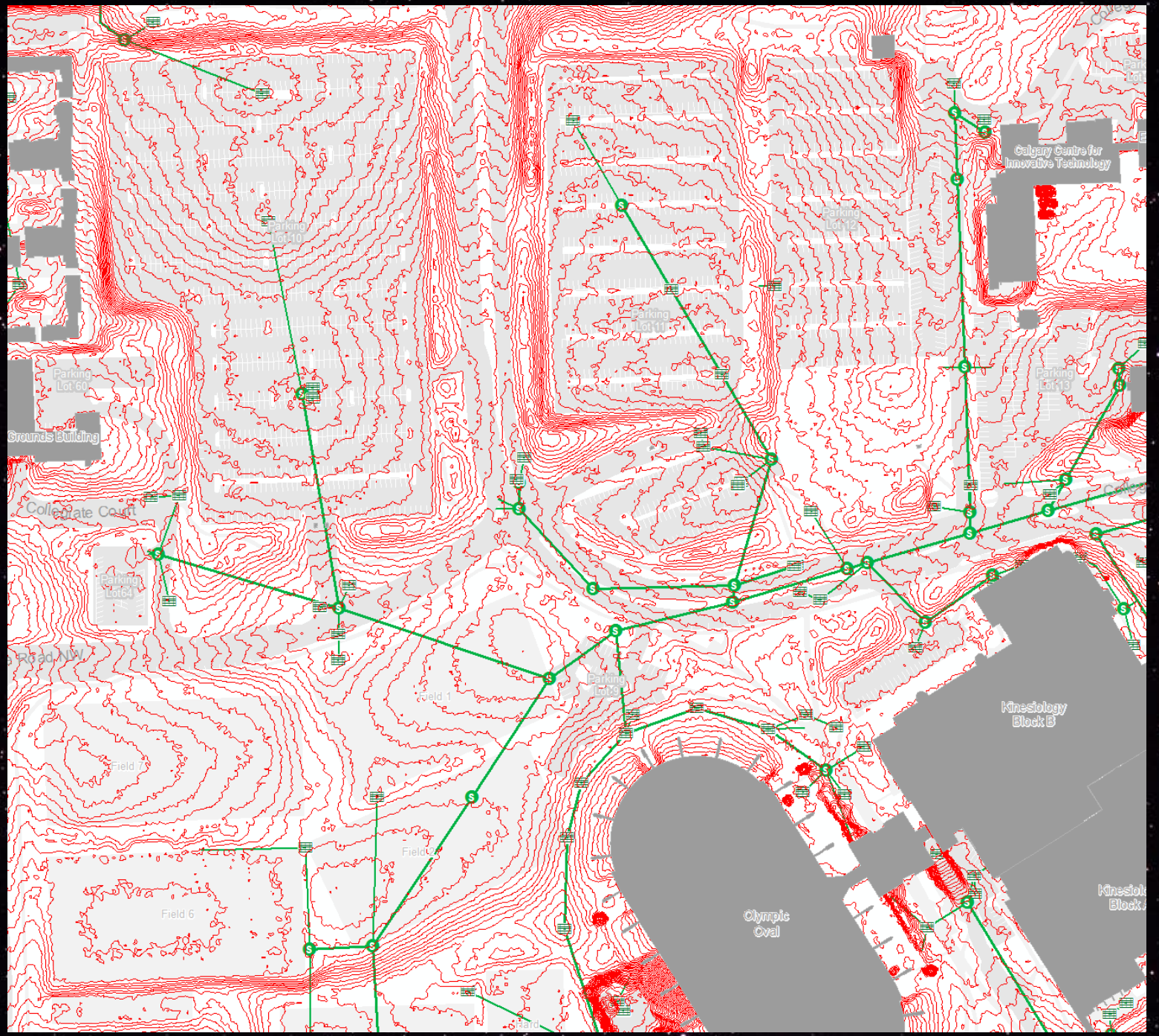
Create Catch Basin Models

Using the data

Drainage
Catch Basin Models

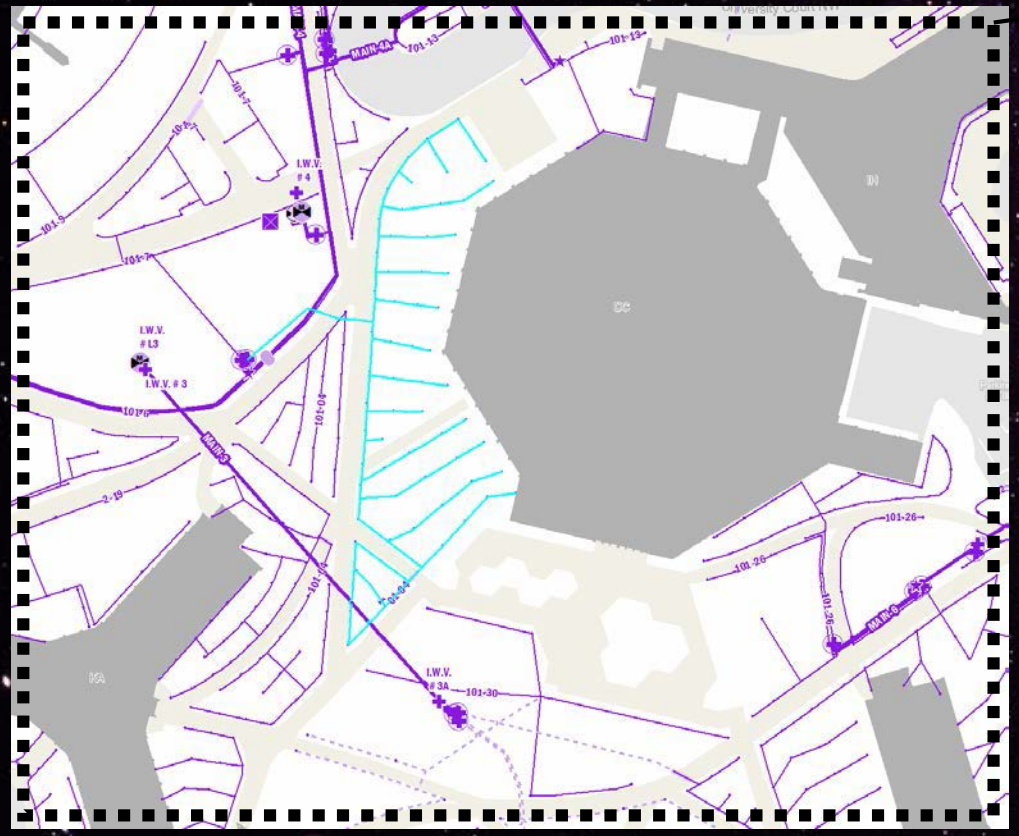
Using the data

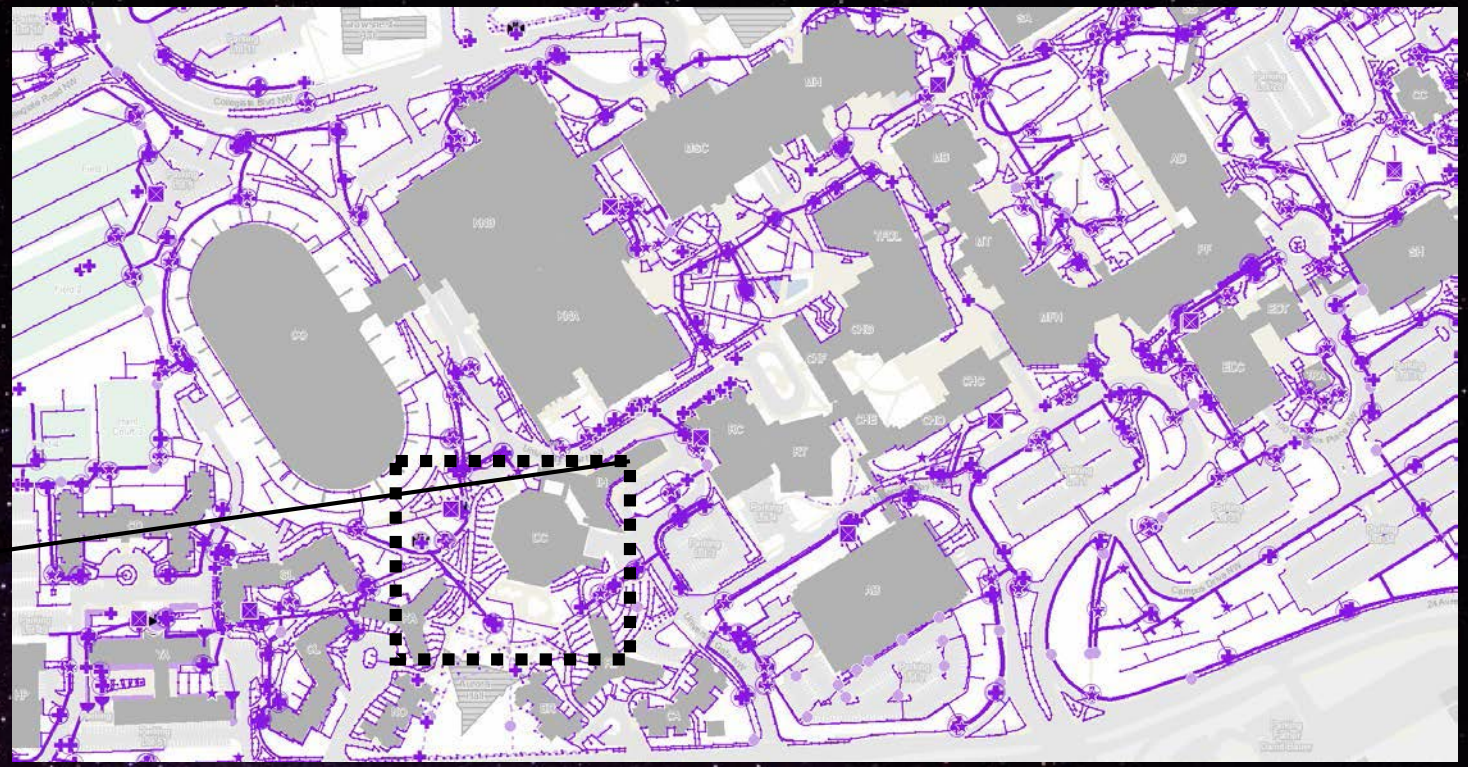
Drainage
Sewer Models



Create Irrigation Models

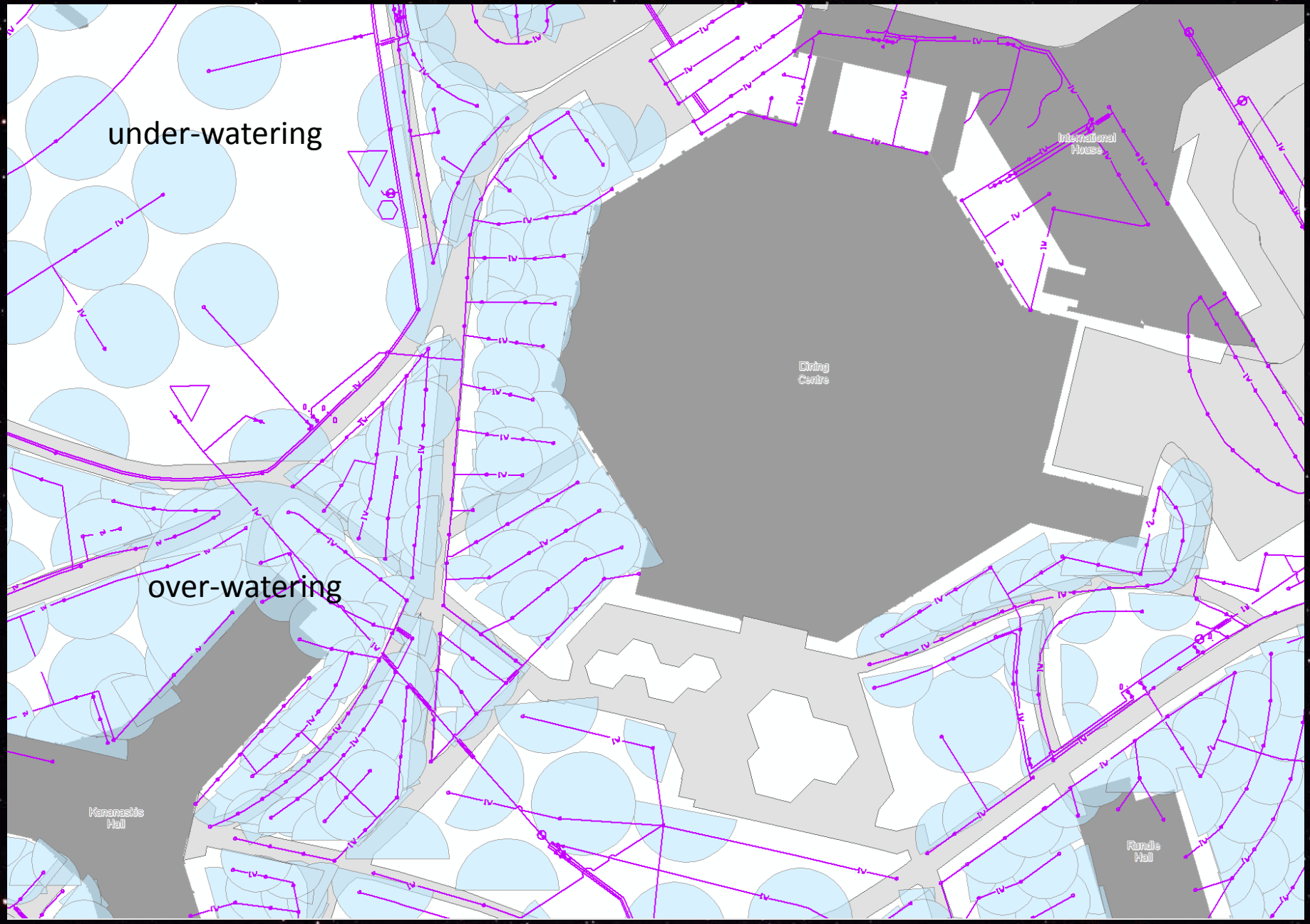
Using the data





Controller
Drain
Flow Sensor
Flush Valve
Isolation Valve
Junction Box
Master Valve
Rain Sensor
Solenoid Valve
Sprinkler Head
Turf Head

Using the data



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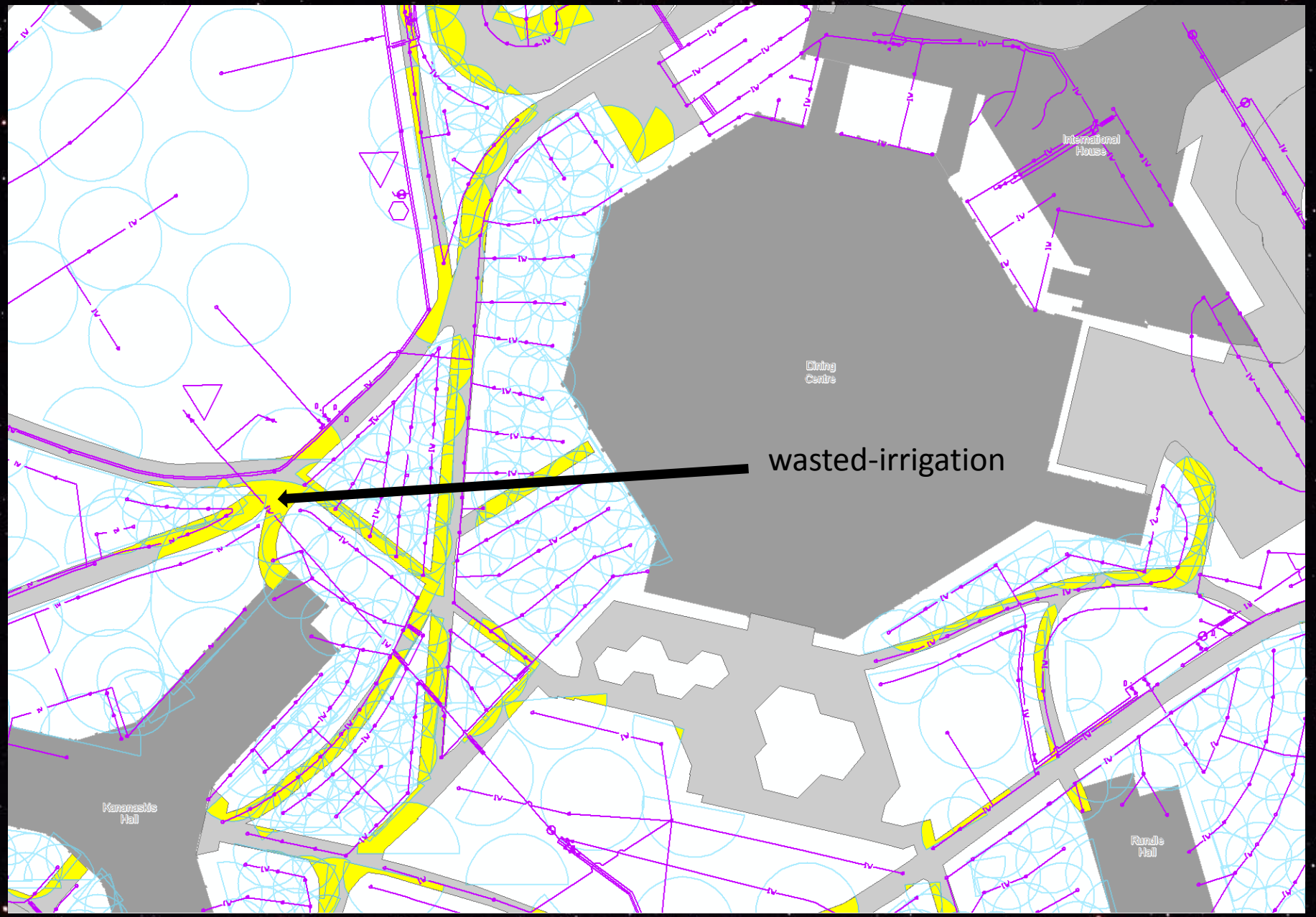
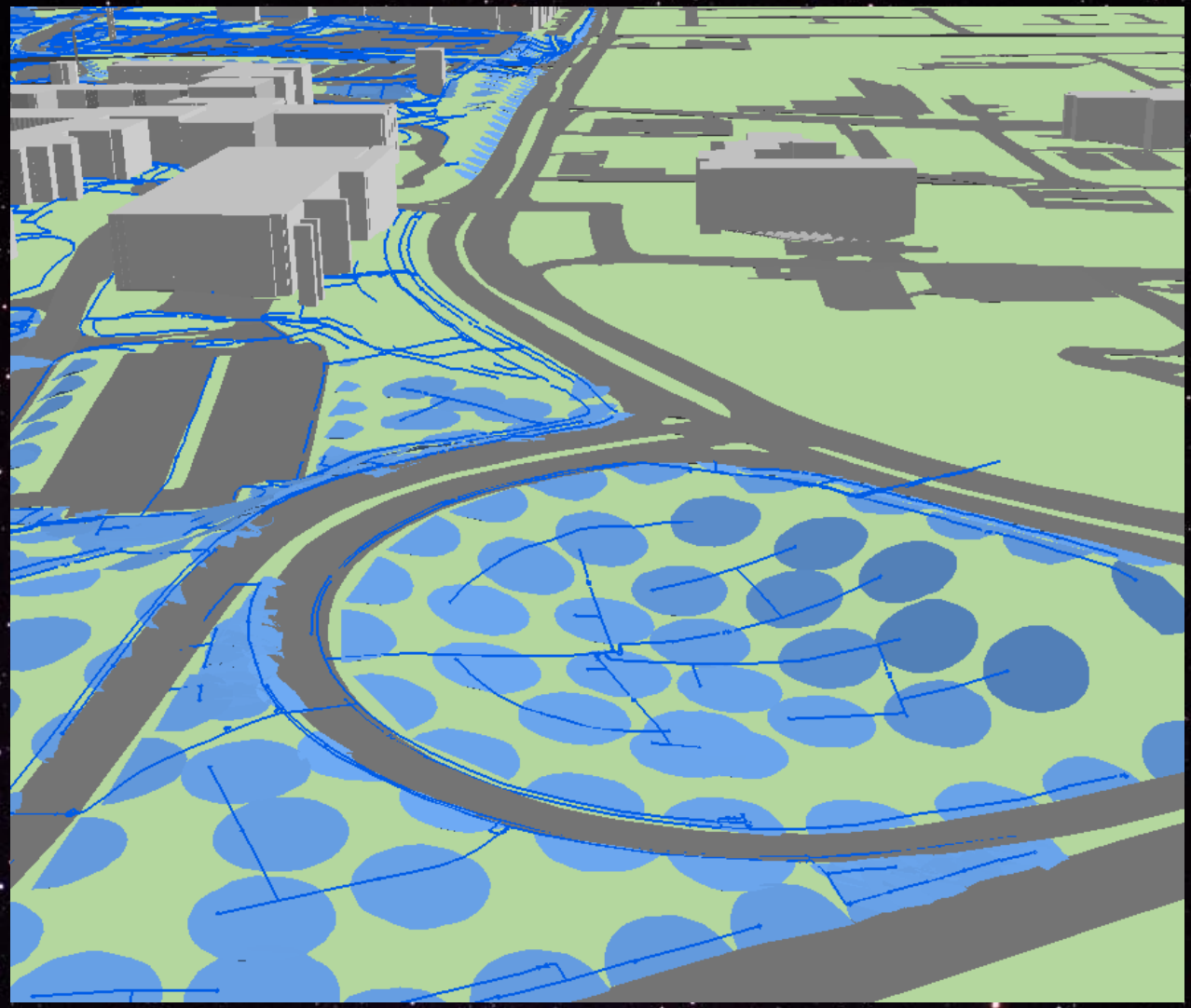


Using the data



Create Electrical Models

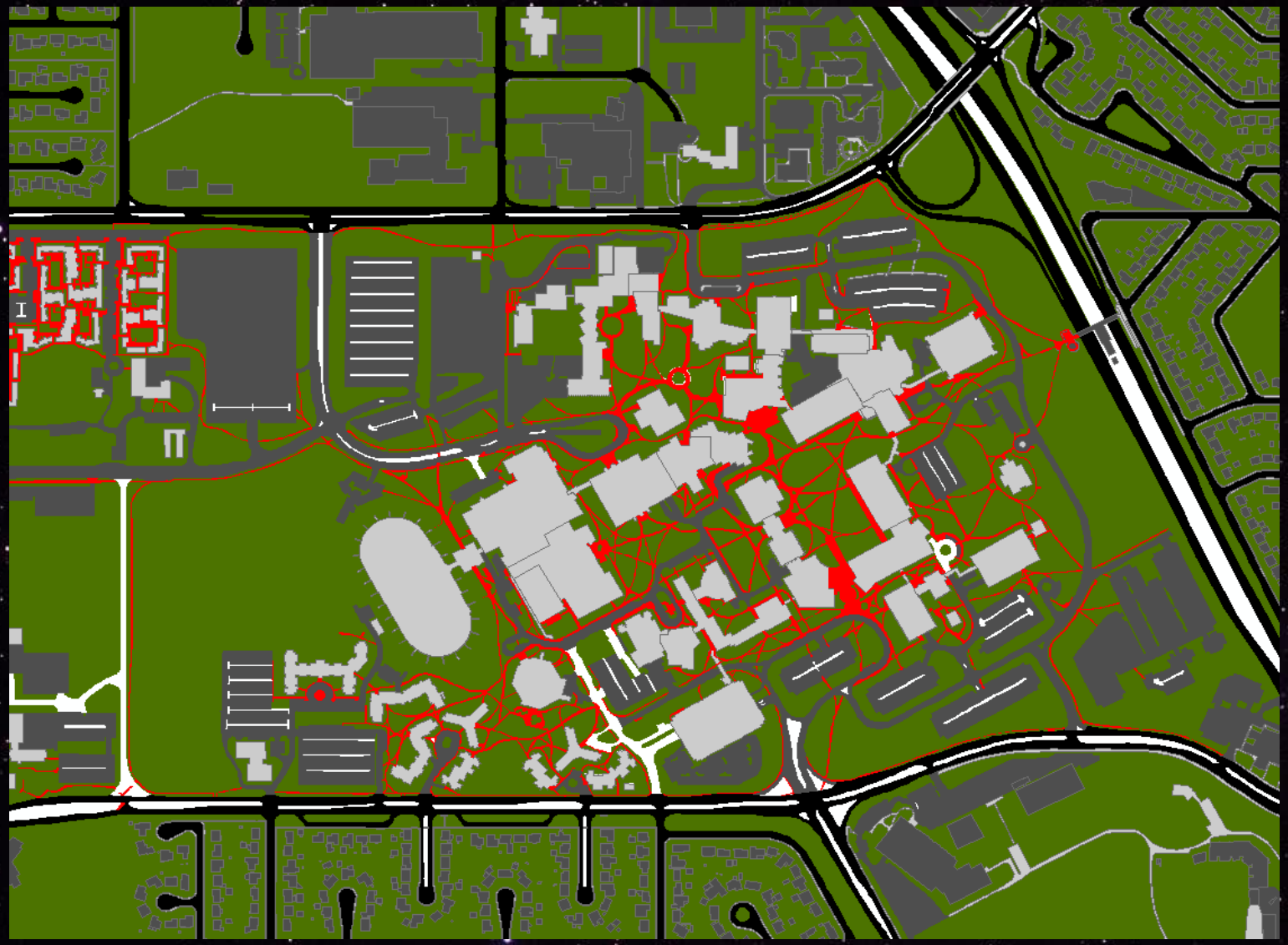
Using the data

Using the data

Using the data

Benefits: safe and worry free environment with potentially lower personal risk to students and staff
Potential savings in insurance pay outs

Safety Walk Program
LED Conversion Program



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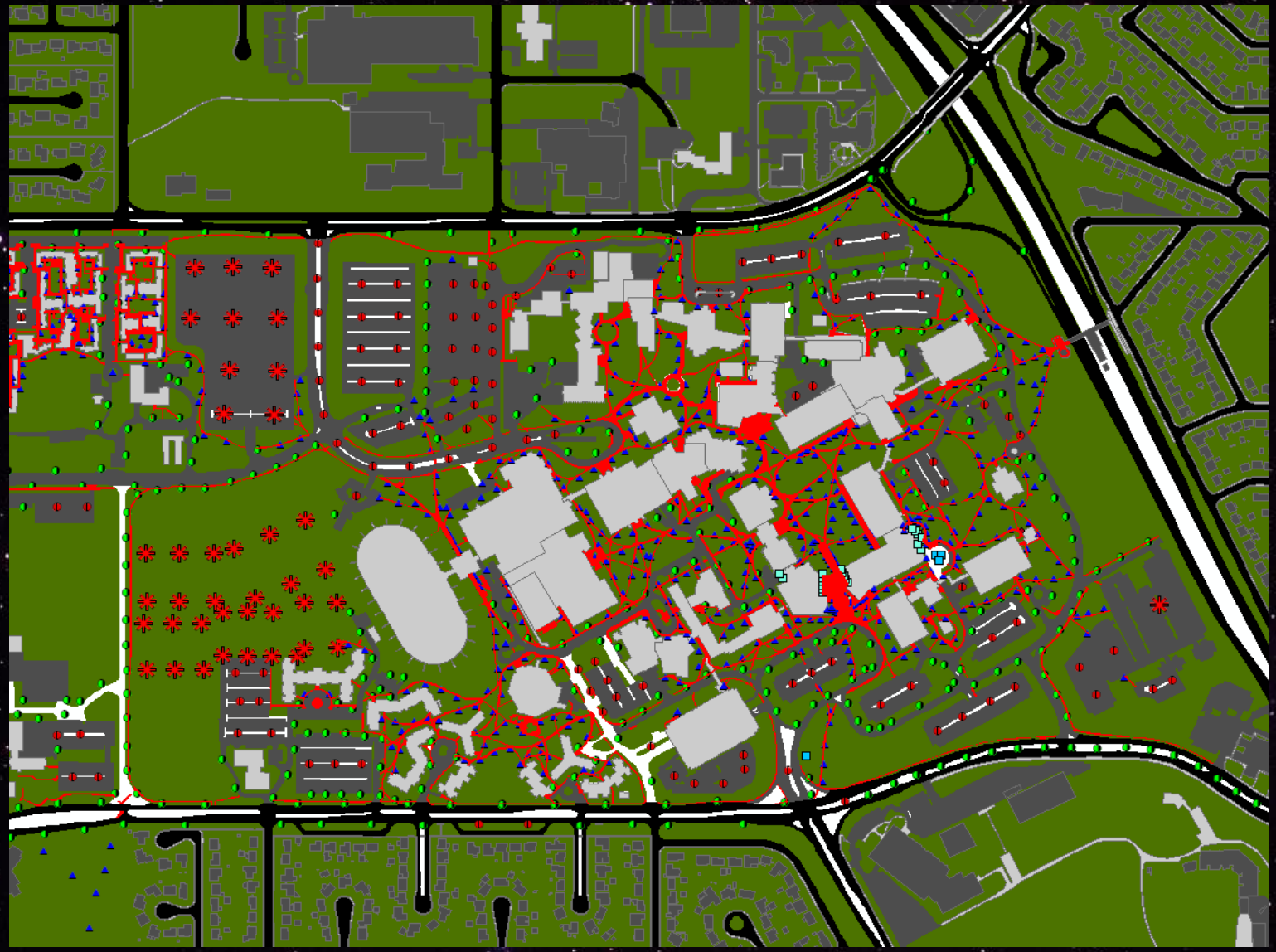

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Safety Walk Program
LED Conversion Program

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Safety Walk Program
LED Conversion Program

Using the data

Benefits: safe and worry free environment with potentially lower personal risk to students and staff
Potential savings in insurance pay outs

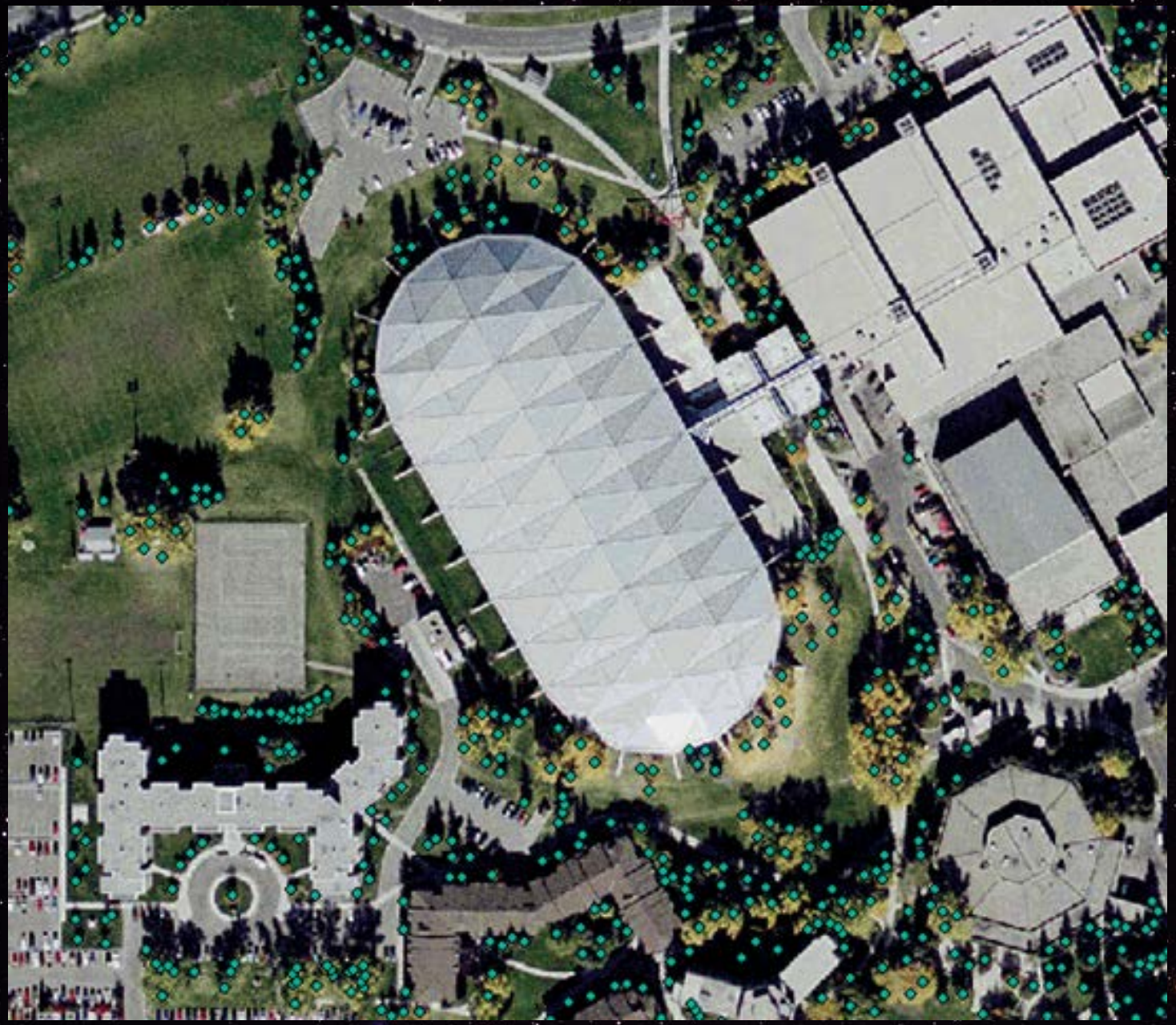
Safety Walk Program
LED Conversion Program

Vegetation Models

Using the data

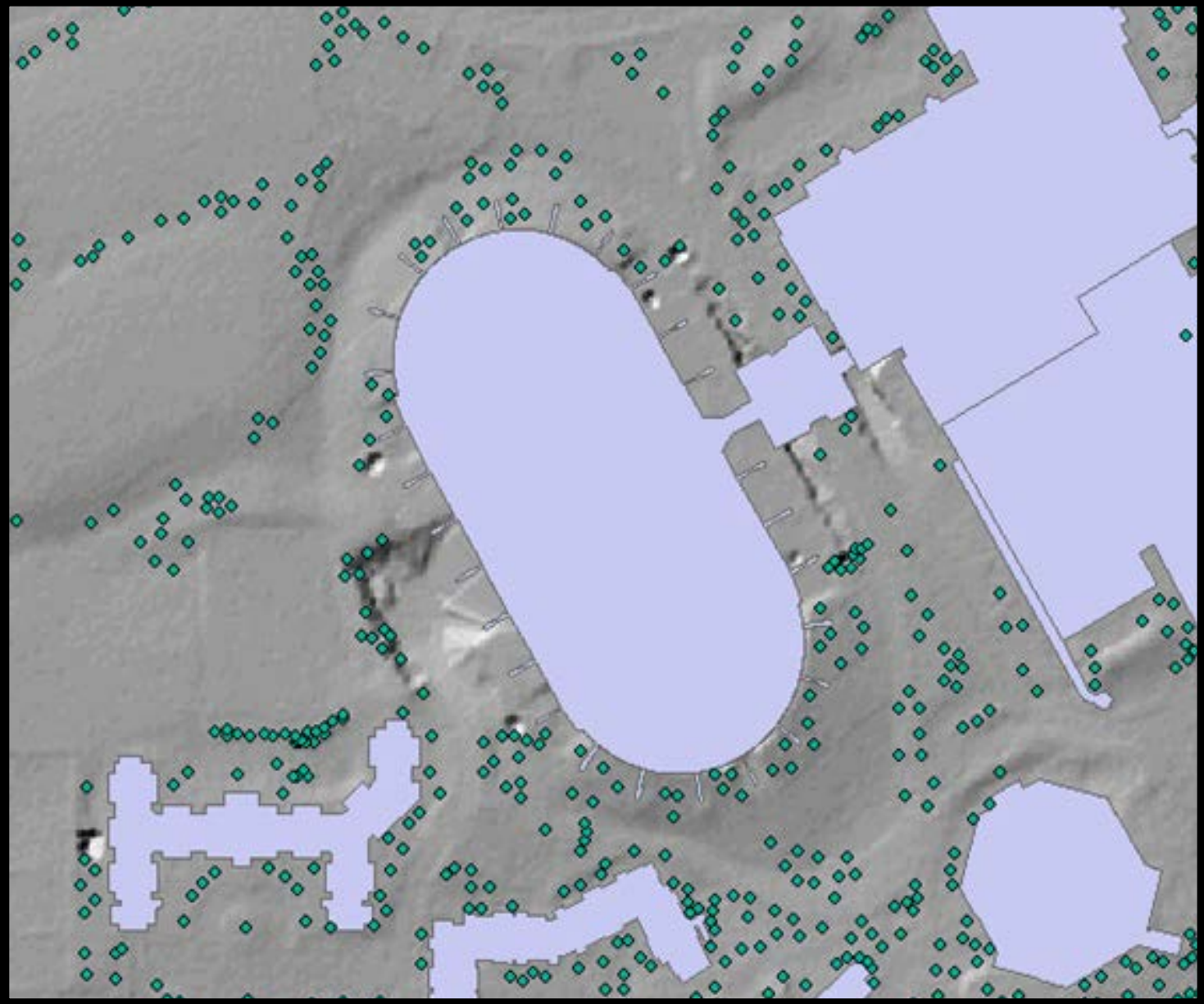
Tree modeling for inventory and heights

1. High Res photos



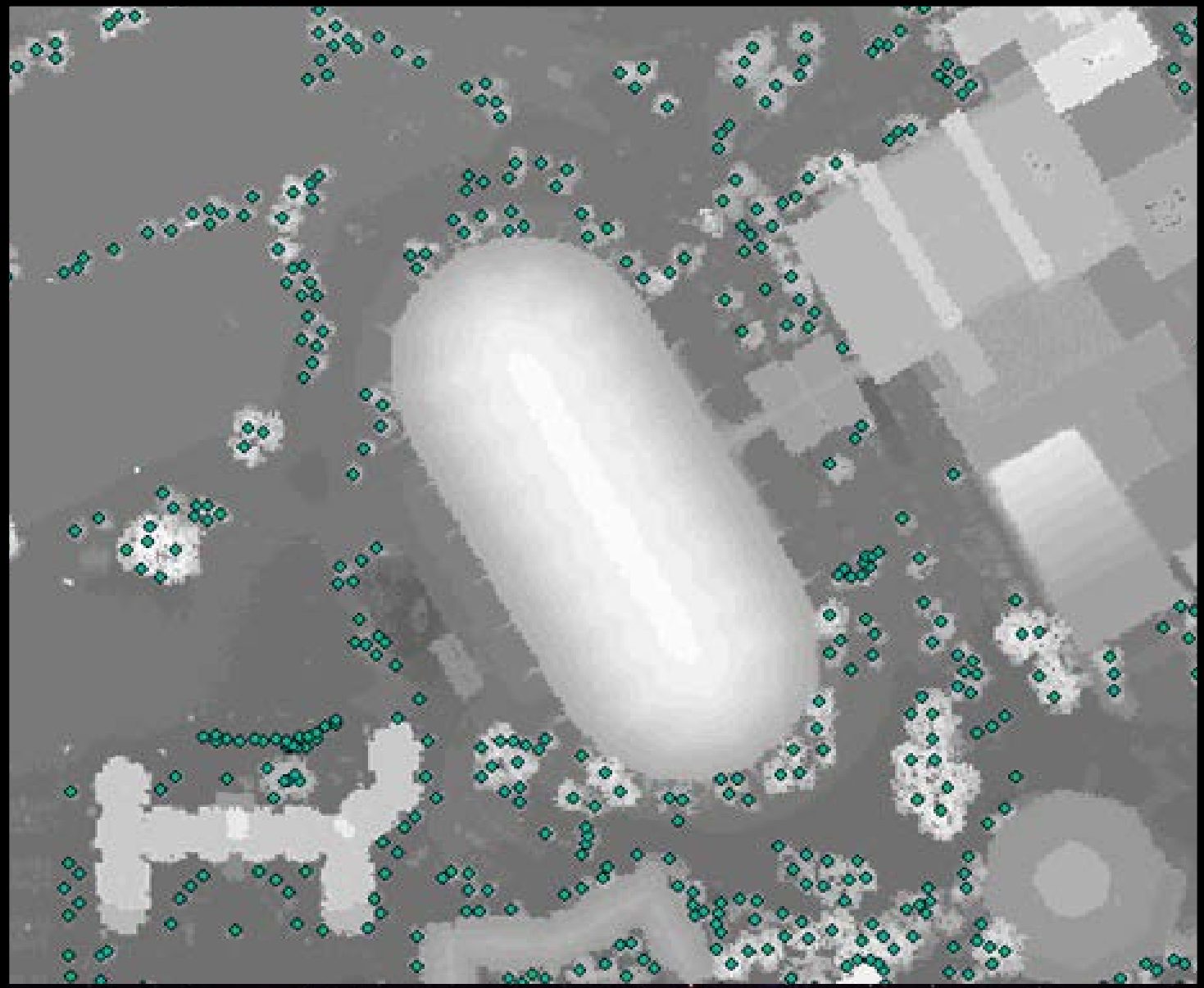
Using the data

2. Surface model base heights from LiDAR bare earth features



Using the data

3. Crown heights from LiDAR Full Feature elevations



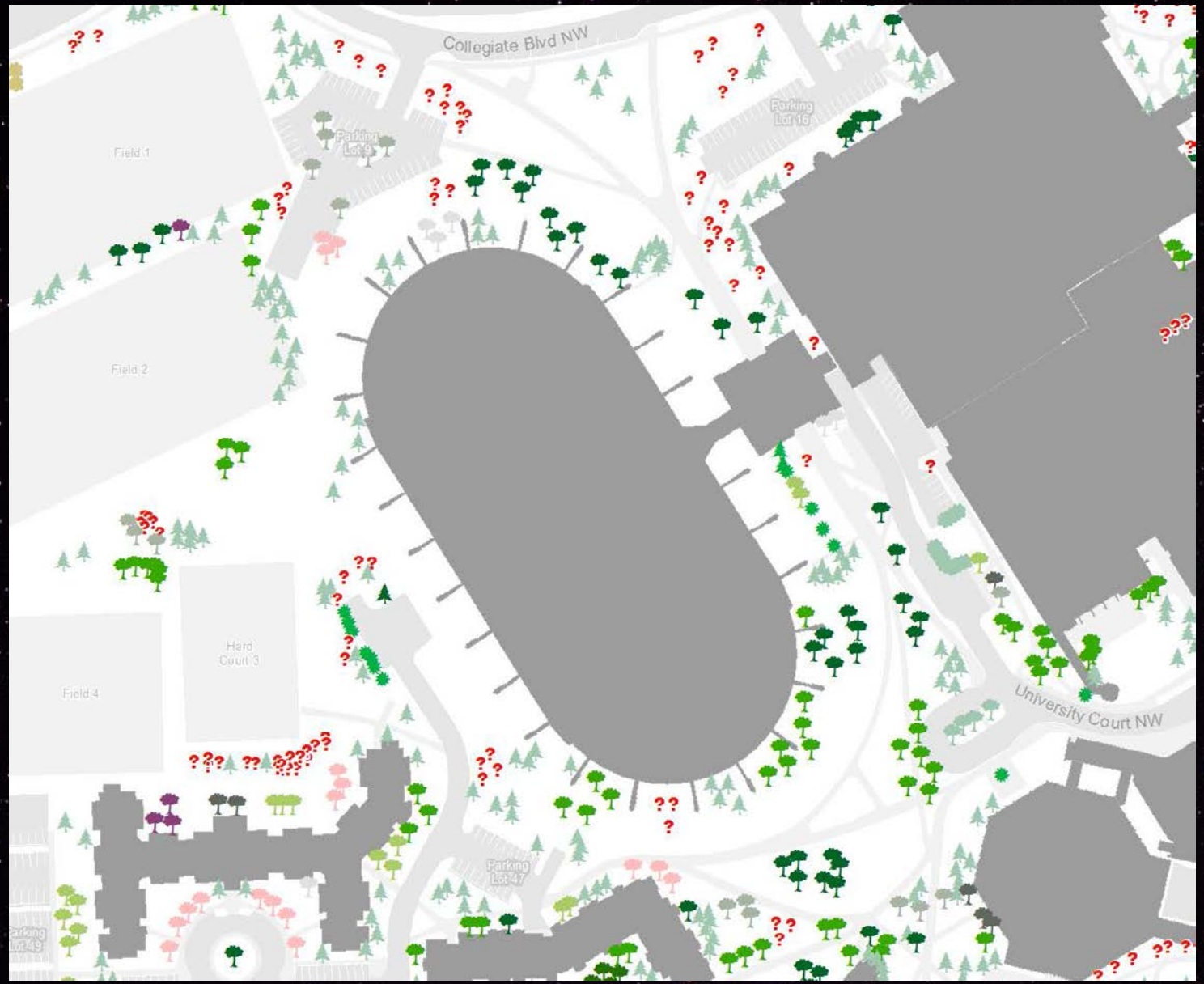
Using the data

4. Crown – Base = Tree heights

Using the data

5. Species Attribute

- Unknown
- American Elm
- Amur Cherry
- Amur Maple
- Apricot
- Aspen
- Birch
- Black Ash
- Blue Spruce
- Bristlecone Pine
- Buckthorn
- Bur Oak
- Caragana
- Crab Apple
- Cranberry
- Dogwood



Using the data

High resolution generated map book - 112 pages with master index reflecting FM database

Benefit: use summer workers to ground truth the data during the winter months
employees stay busy during slow times and are retained, skilled, and experienced for the next summer season
field crews remain constant and training costs decline

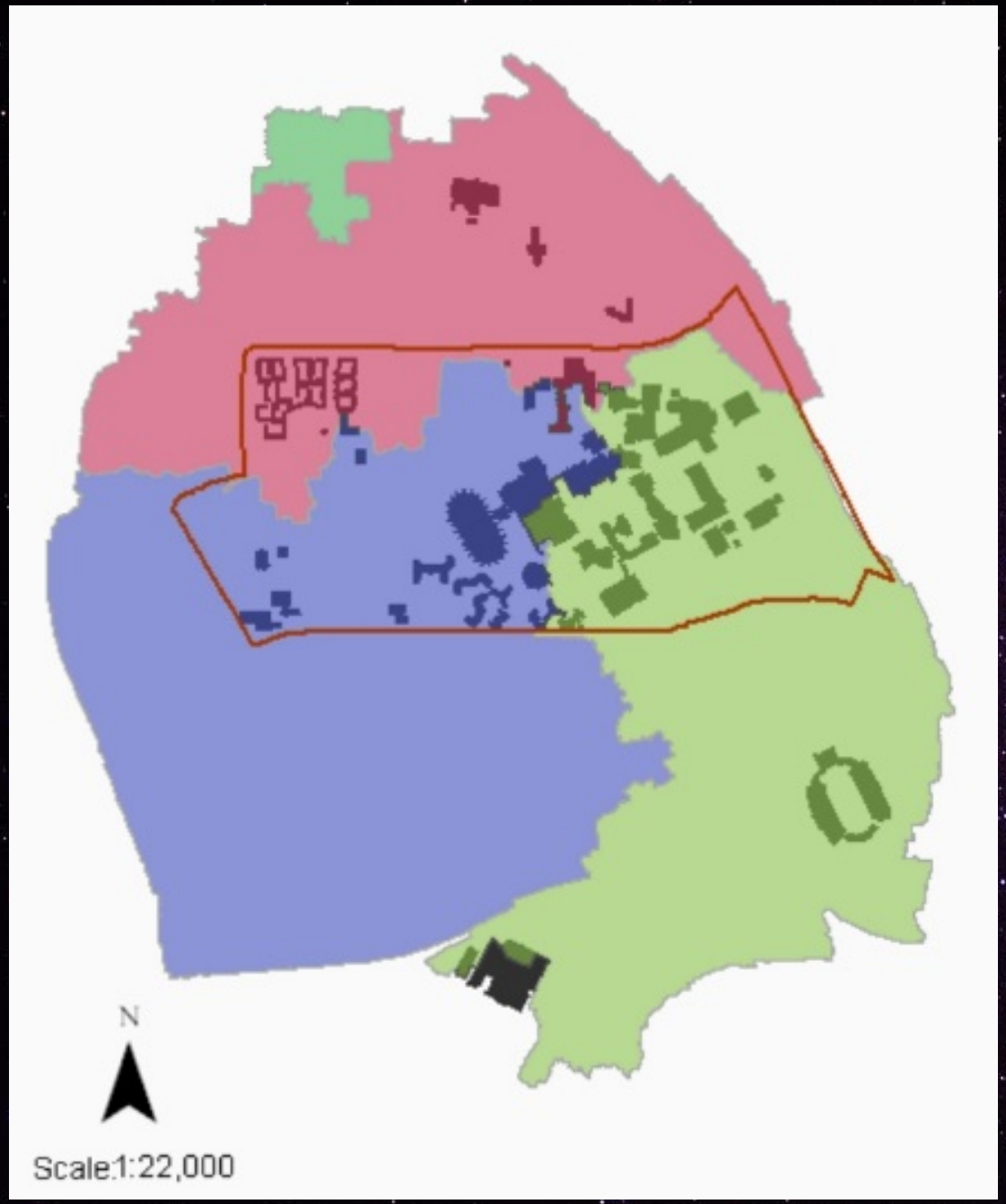
Using the data

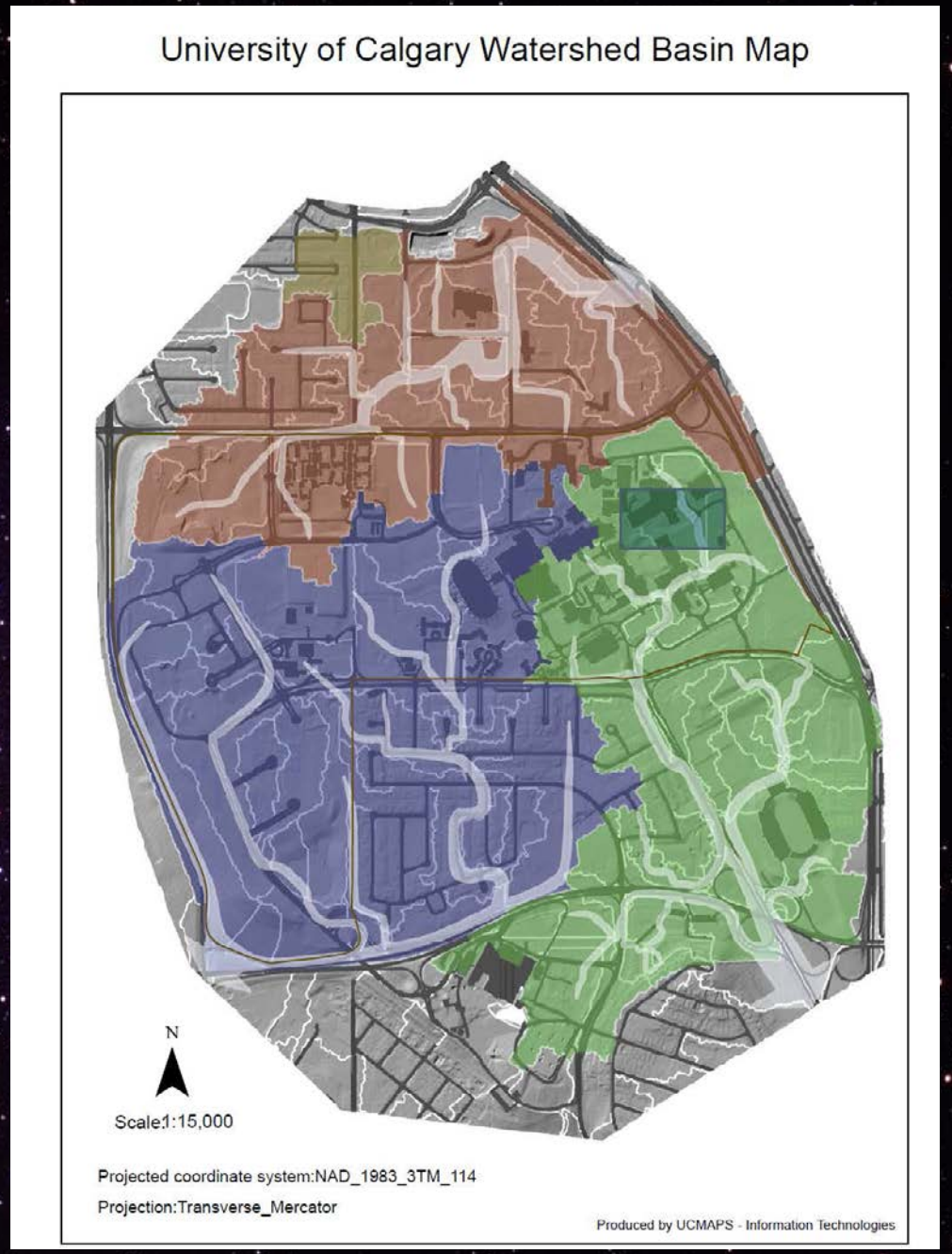
6. Accurate 3D Vegetation Model

Drainage Basin Models

Using the data

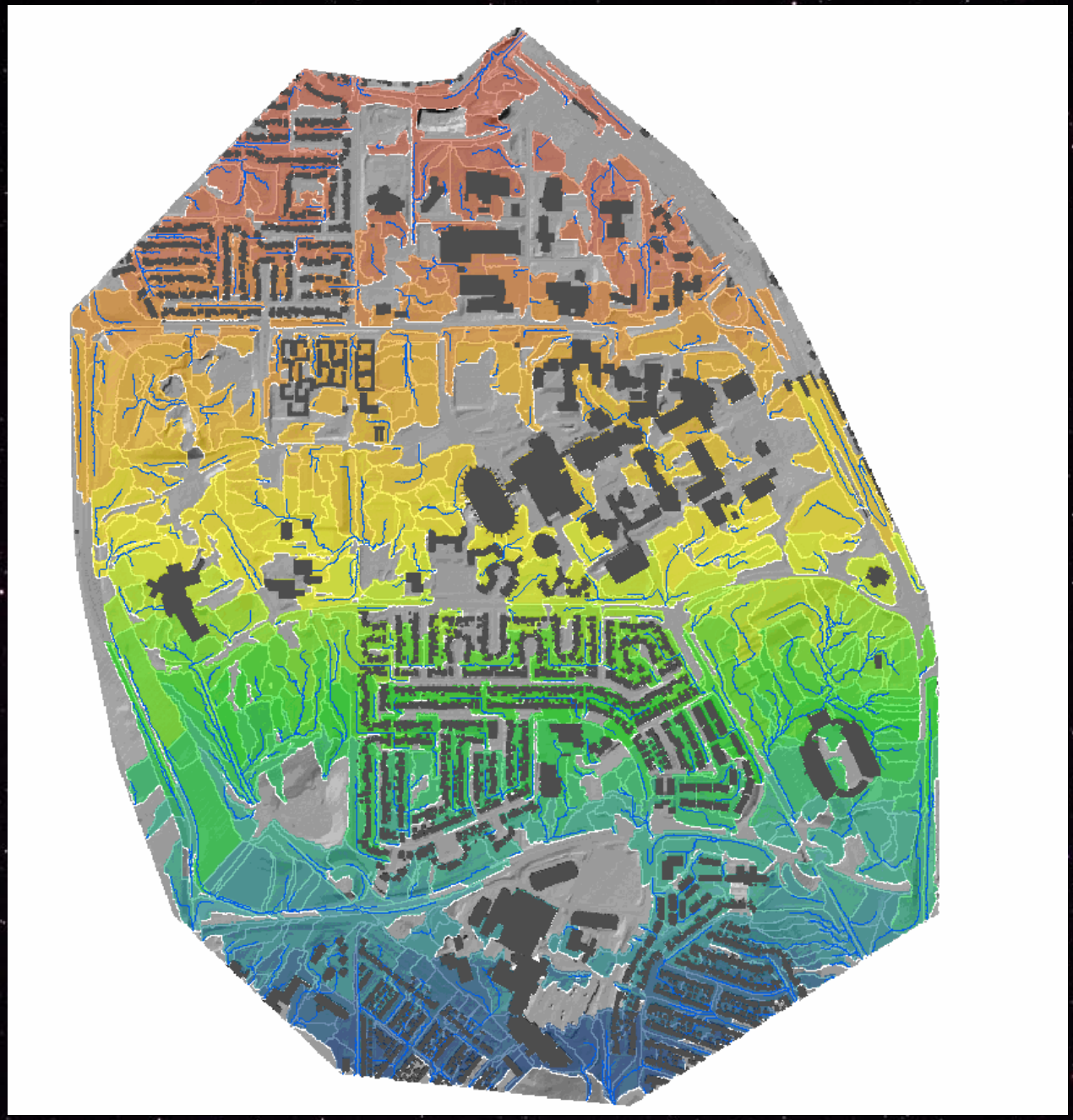
Watershed Model





Using the data

Micro Water Flow Accumulations

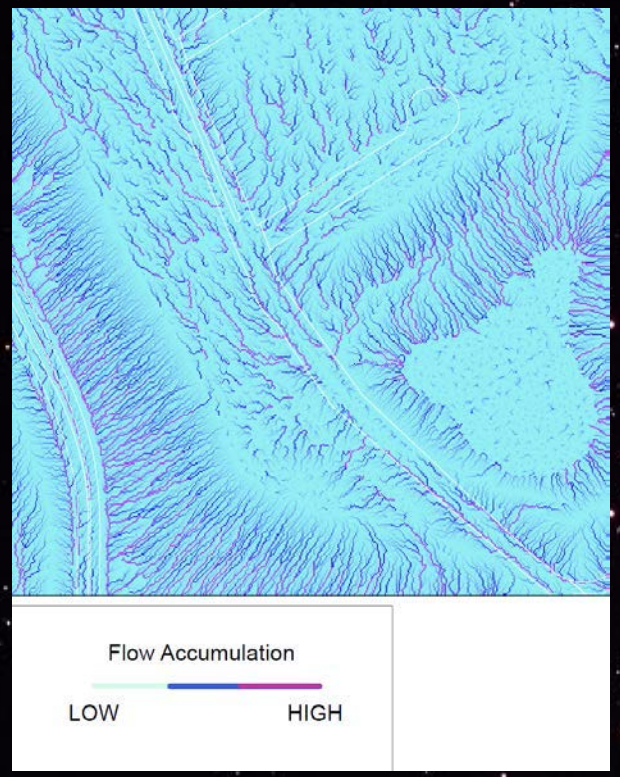


Concentrated water flows

Used to depict flow direction during hazardous goods spill

Using the data

Micro Water Flow Accumulations



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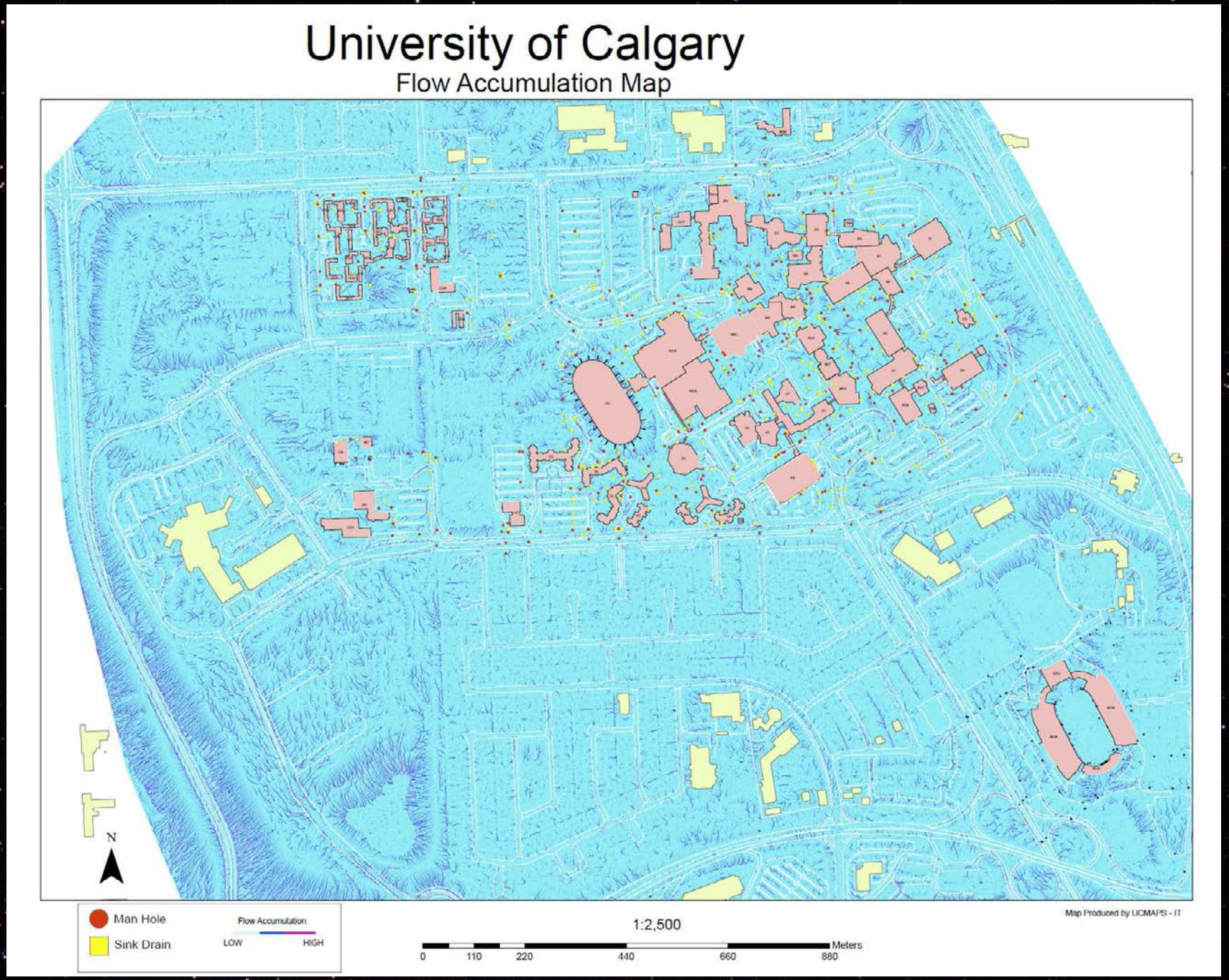
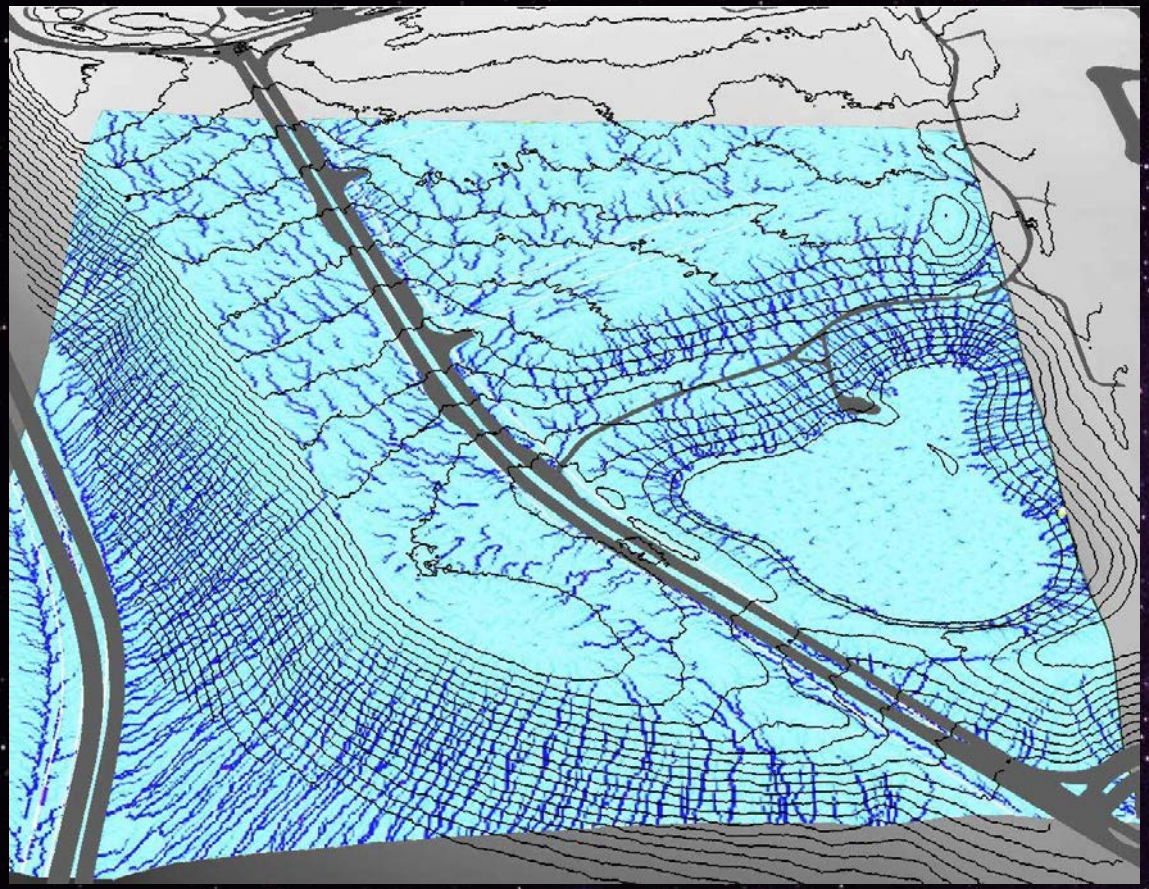
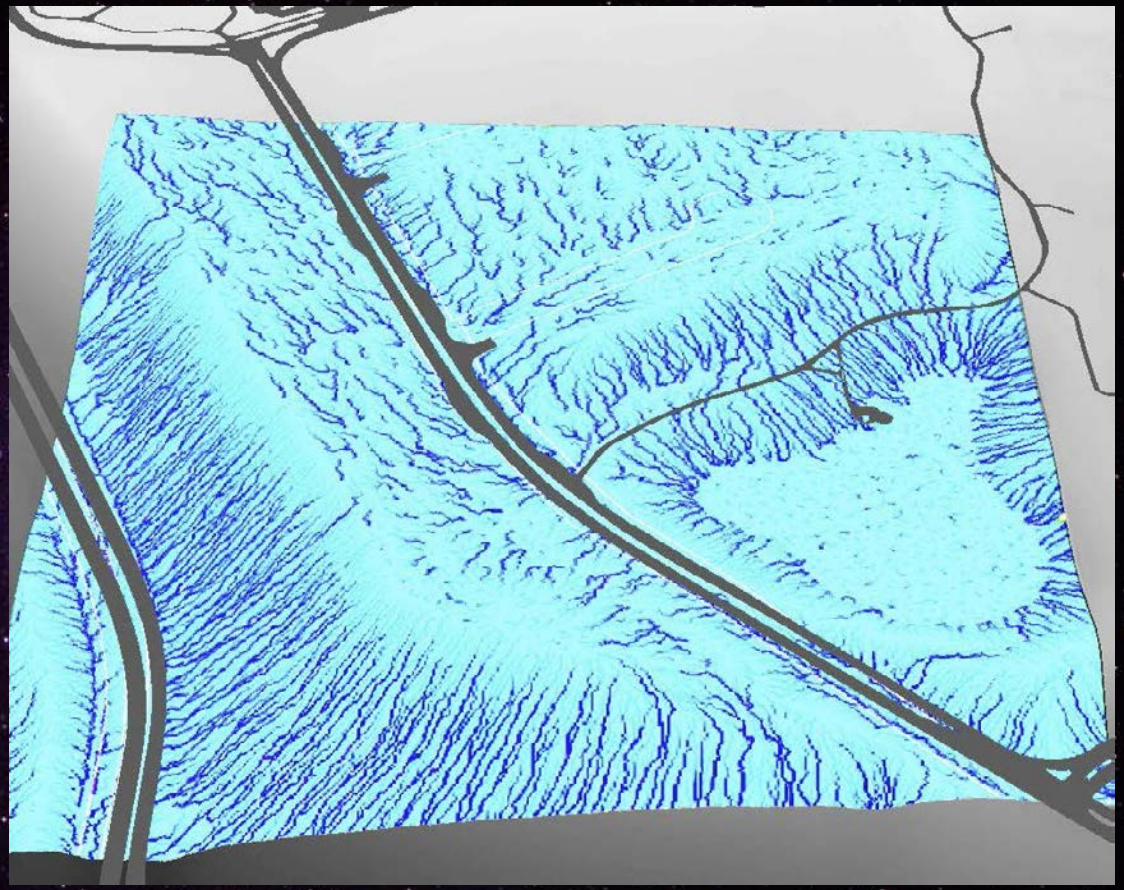


Using the data



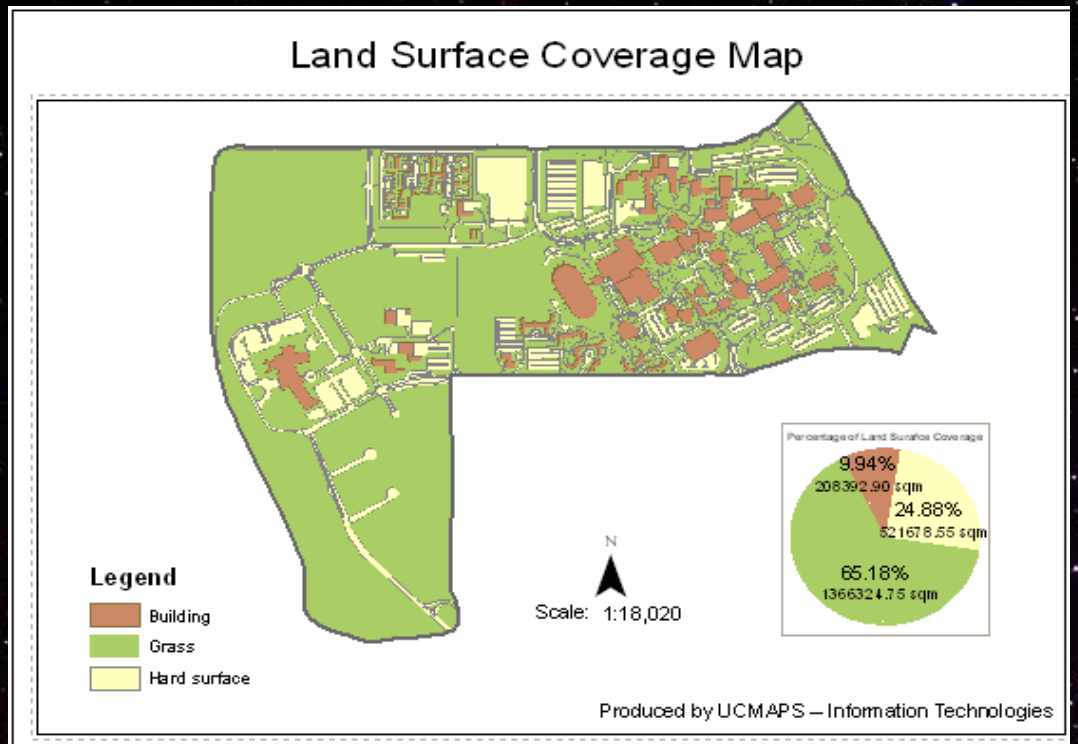


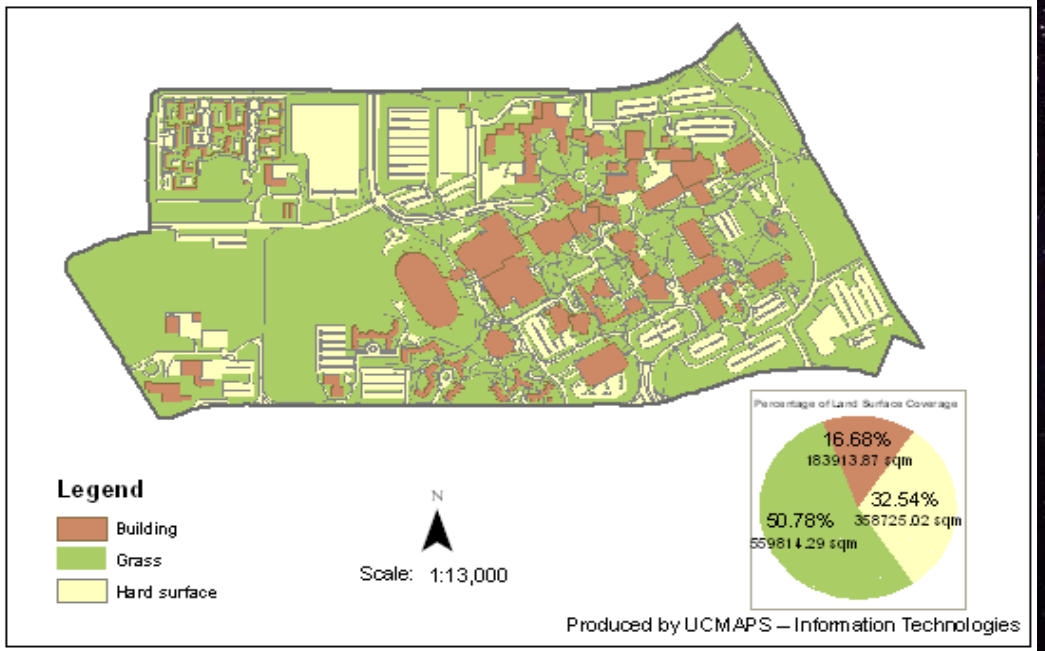
Planning, Costing and Estimations

Using the data

Using the data

Grounds
Cost / Surface type report

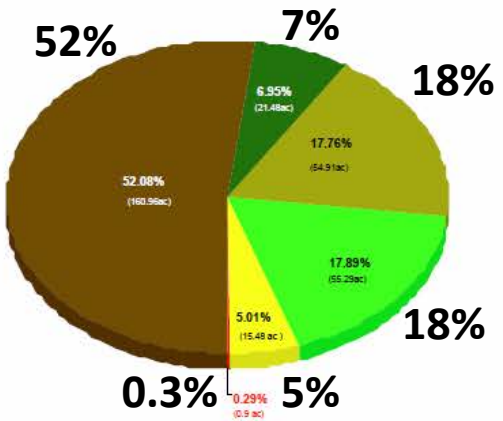




Using the data

UNIVERSITY OF CALGARY

Exterior Service Levels



Legend

- Roads
- Building Footprints

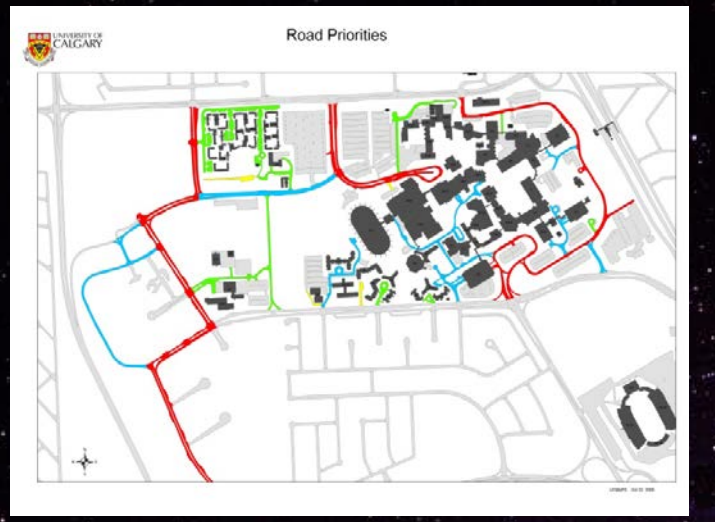
Service Levels

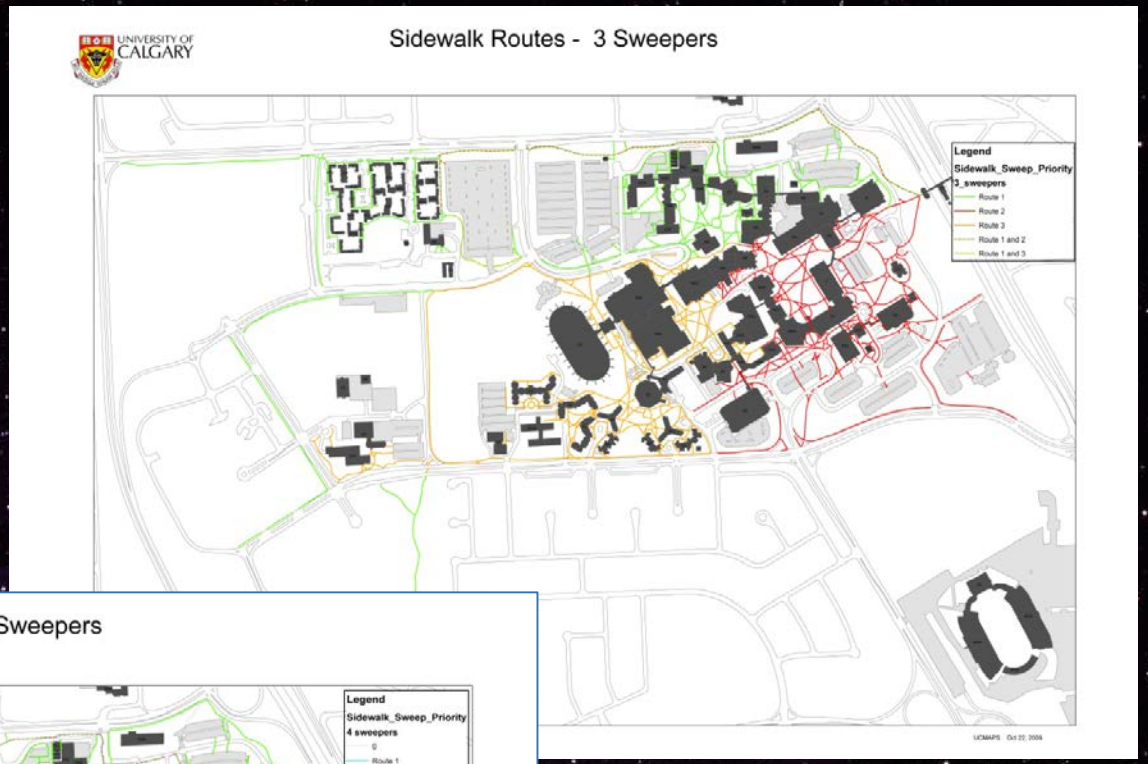
- Level 1
- Level 2
- Level 3
- Level 4
- Level 5
- Level 6

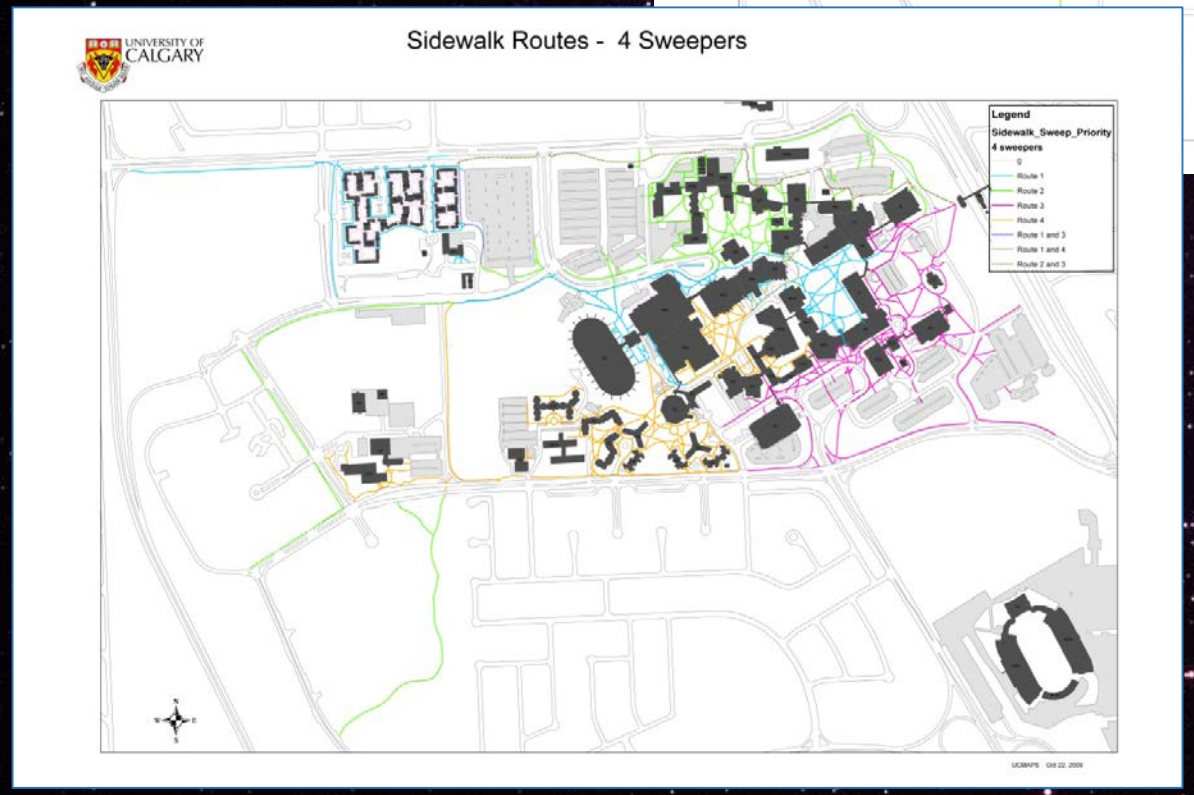
Benefit: dollar cost savings by changing service level areas or by reducing the number of serviced levels
reporting is now possible due the generation external data (previously funds were blended in with other shared service)

Using the data

Snow Removal





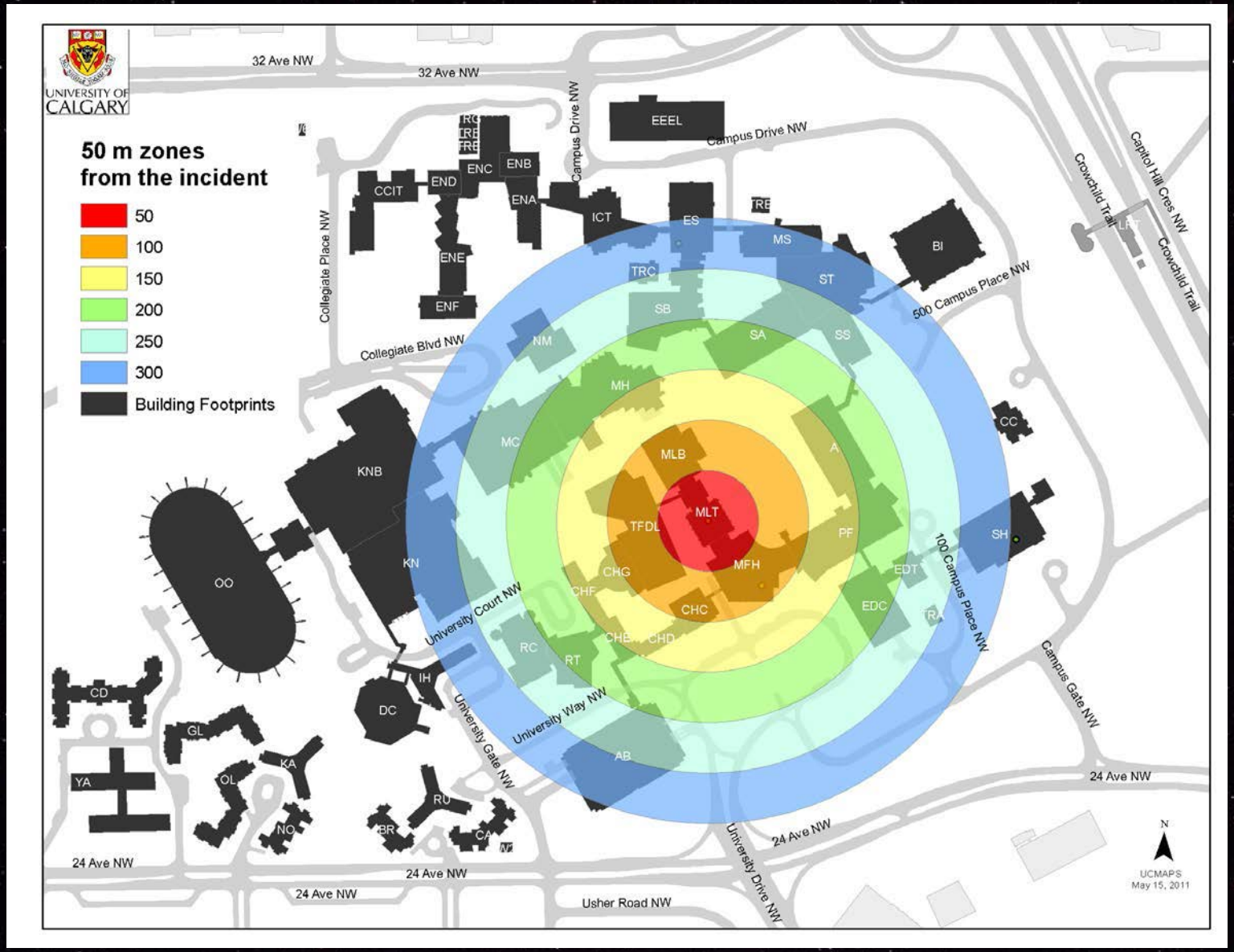


Benefit: better financial costing models with multiple modeling scenarios (3 or 4 sweeper trucks)

Health & Safety Support

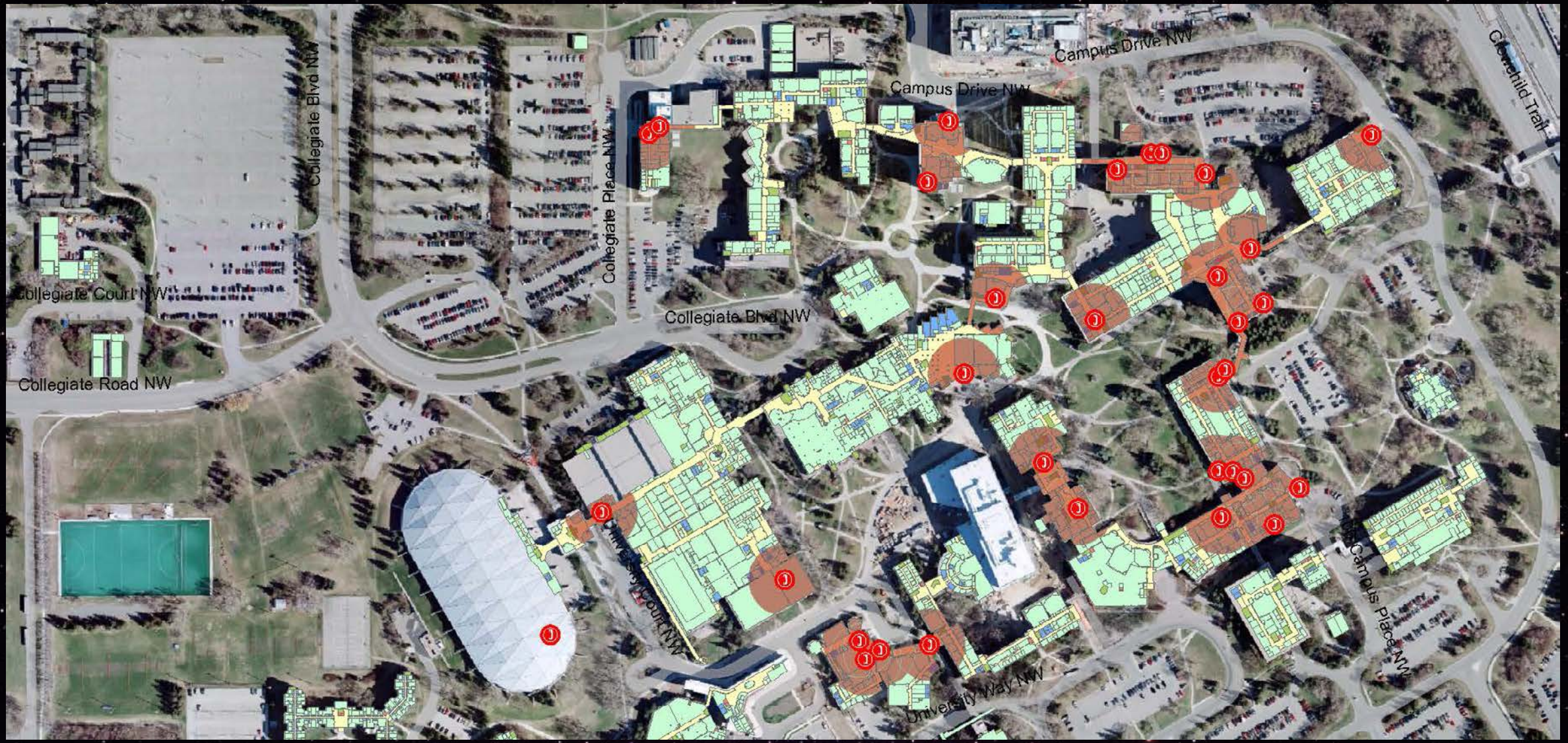
Using the data

Evacuation boundary map



Using the data

Emergency Management

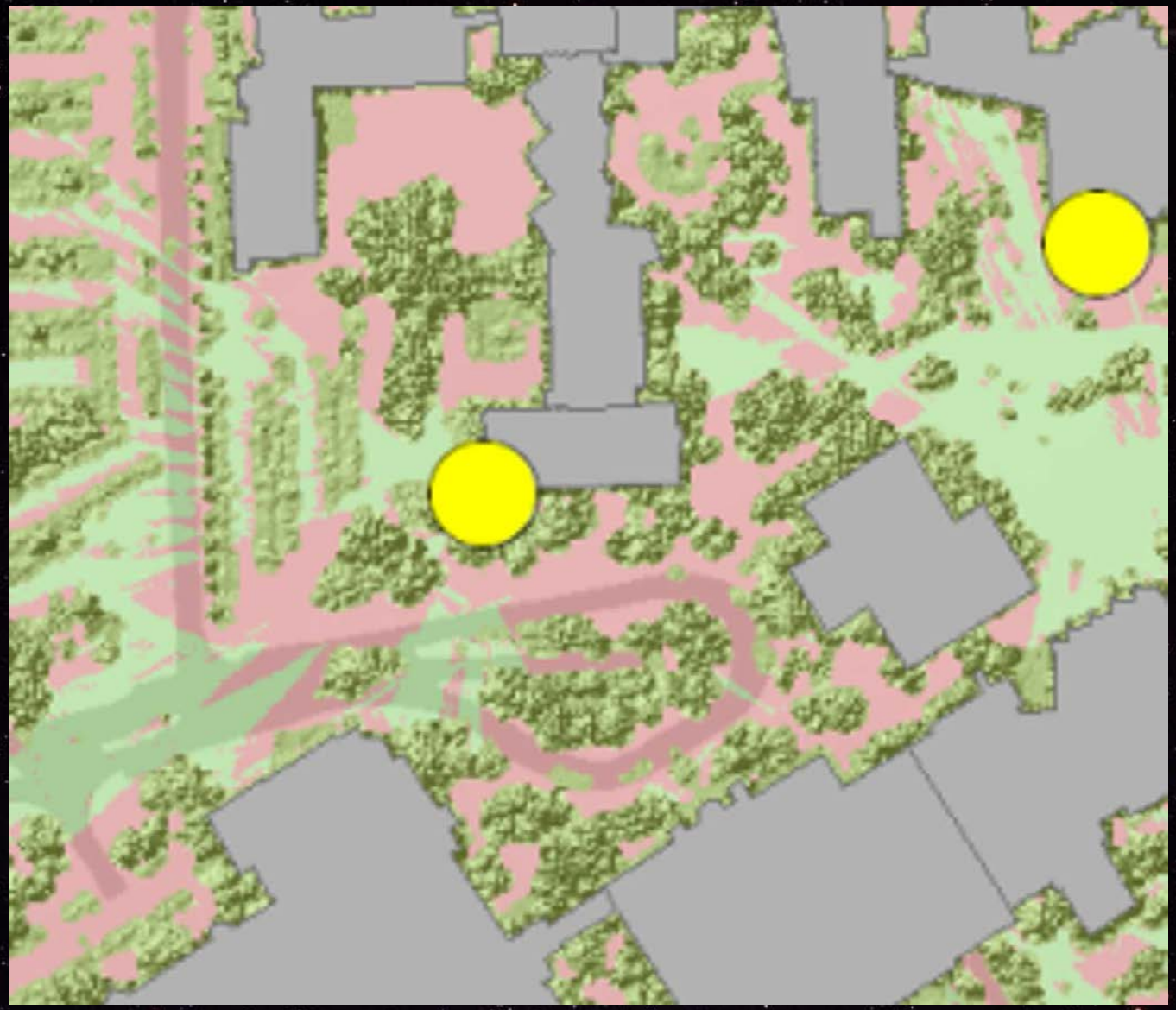


Do the locations of dangerous goods coincide with the help phones?

- could also map : fire hydrants, fire stand pipes, hose lengths, alarm panels, defibrillators, etc…
- these can be monitored live and updated upon mobile inspection

Using the data

Security Camera View Shed Model



Telecom Support

Using the data

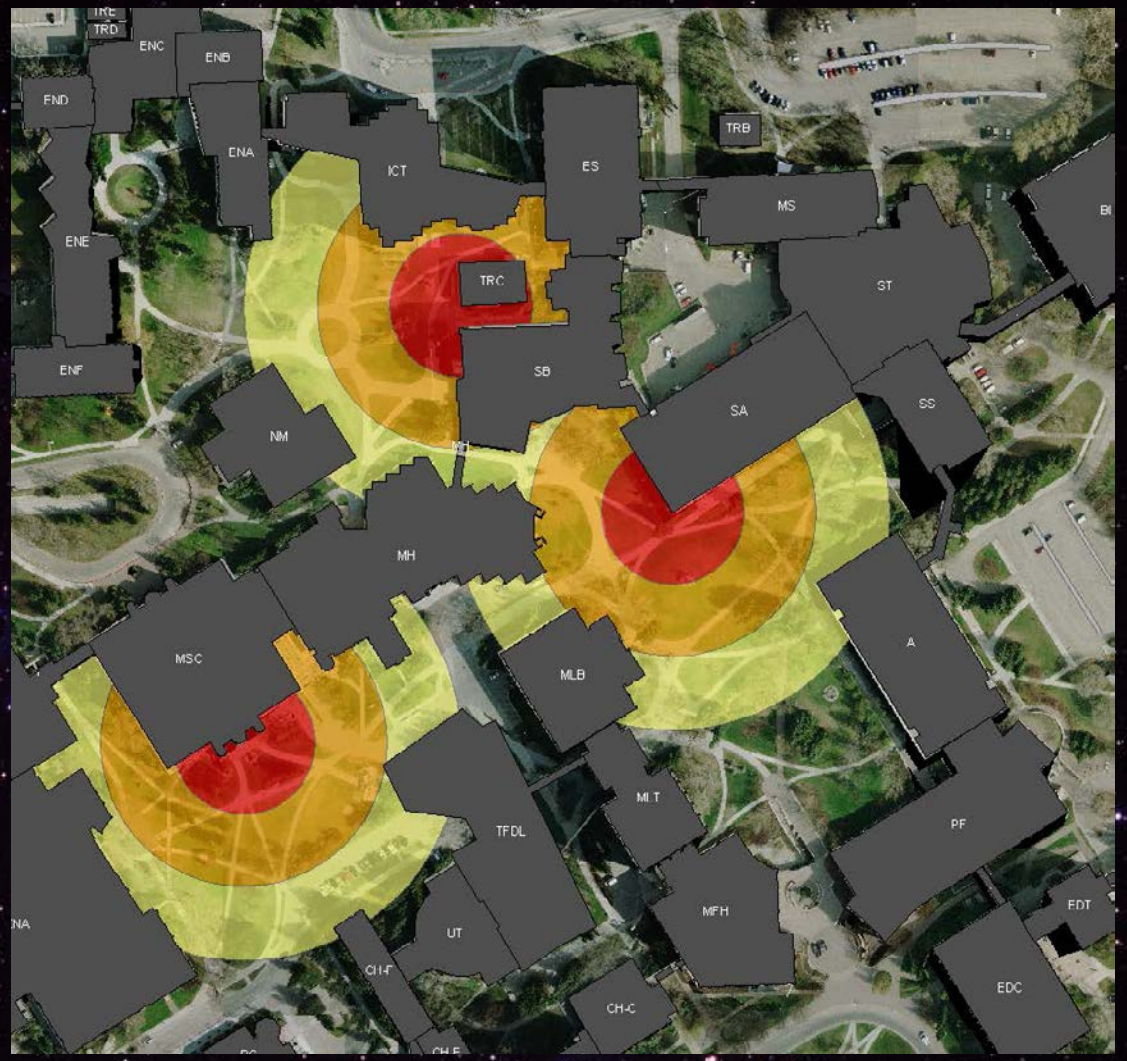
Schematic drawing of I.T. Fiber Model

built-in redundancy

Using the data

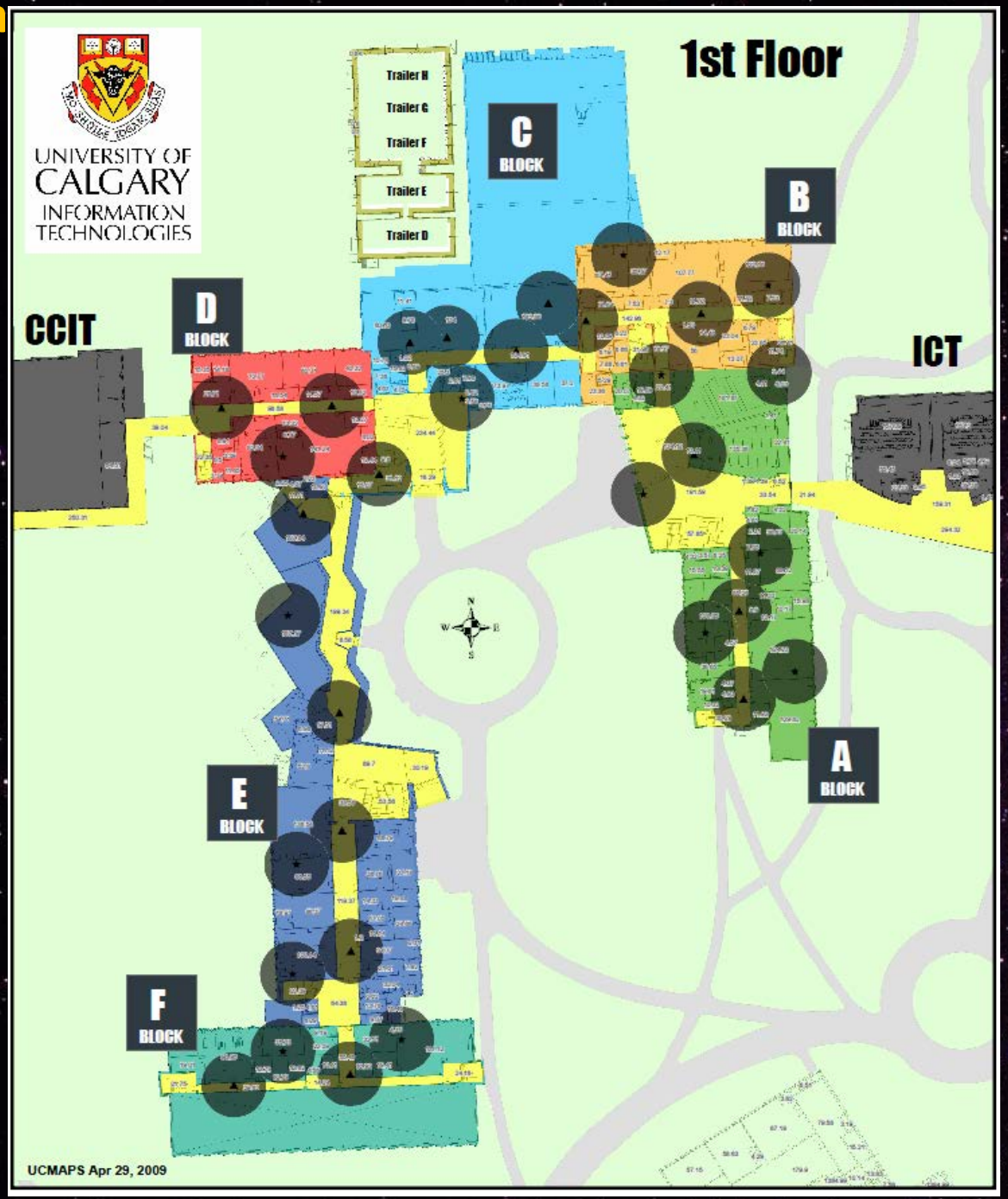
Benefit: cost savings in infrastructure
Better student experience in the summer months
In house solution without external contracting costs

External Wireless maps



Wireless zonal maps
frequency strength

Using the data

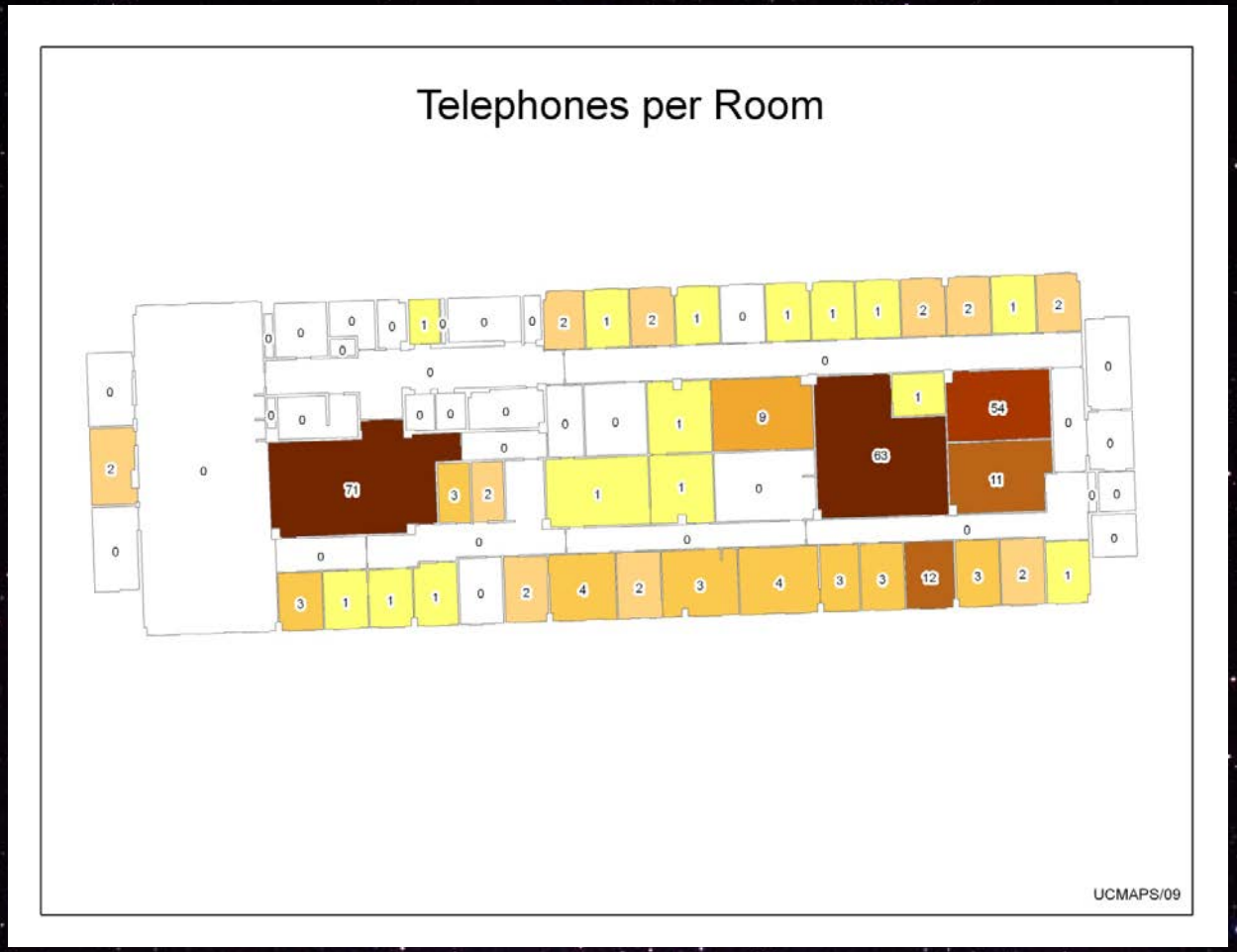


Engineering building
Internal wireless antenna proposal

Benefit: see the coverage
before time and money is spent
determining reception holes

Estimate costs more accurately

Using the data

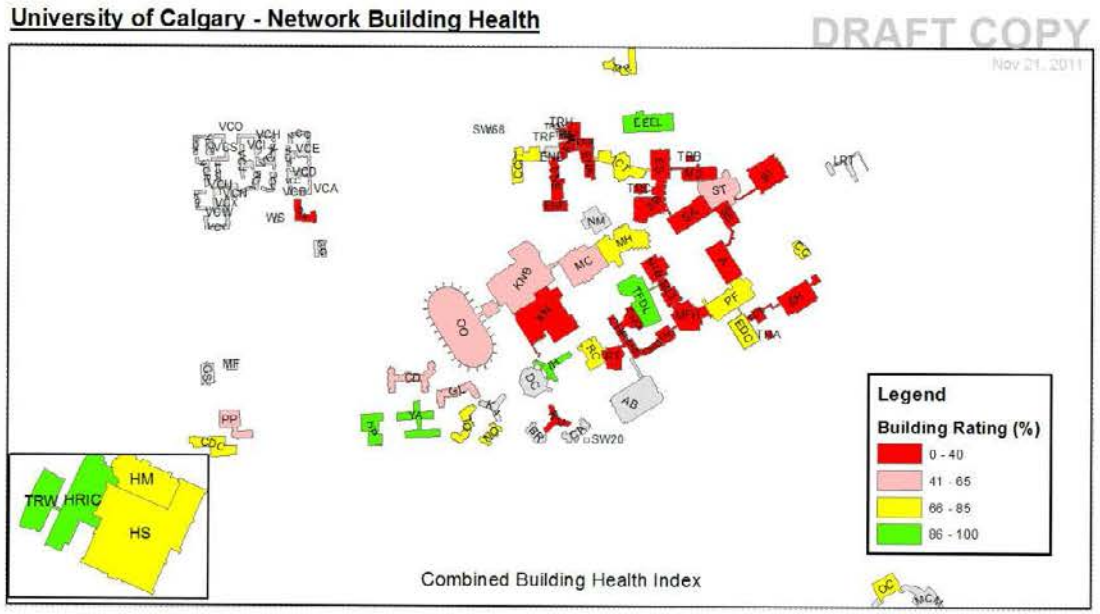


Benefit: Locate orphaned telephone lines and reduce costs
update the data base
improve security risks if 911 needs to locate a caller

Administrative Support

Using the data

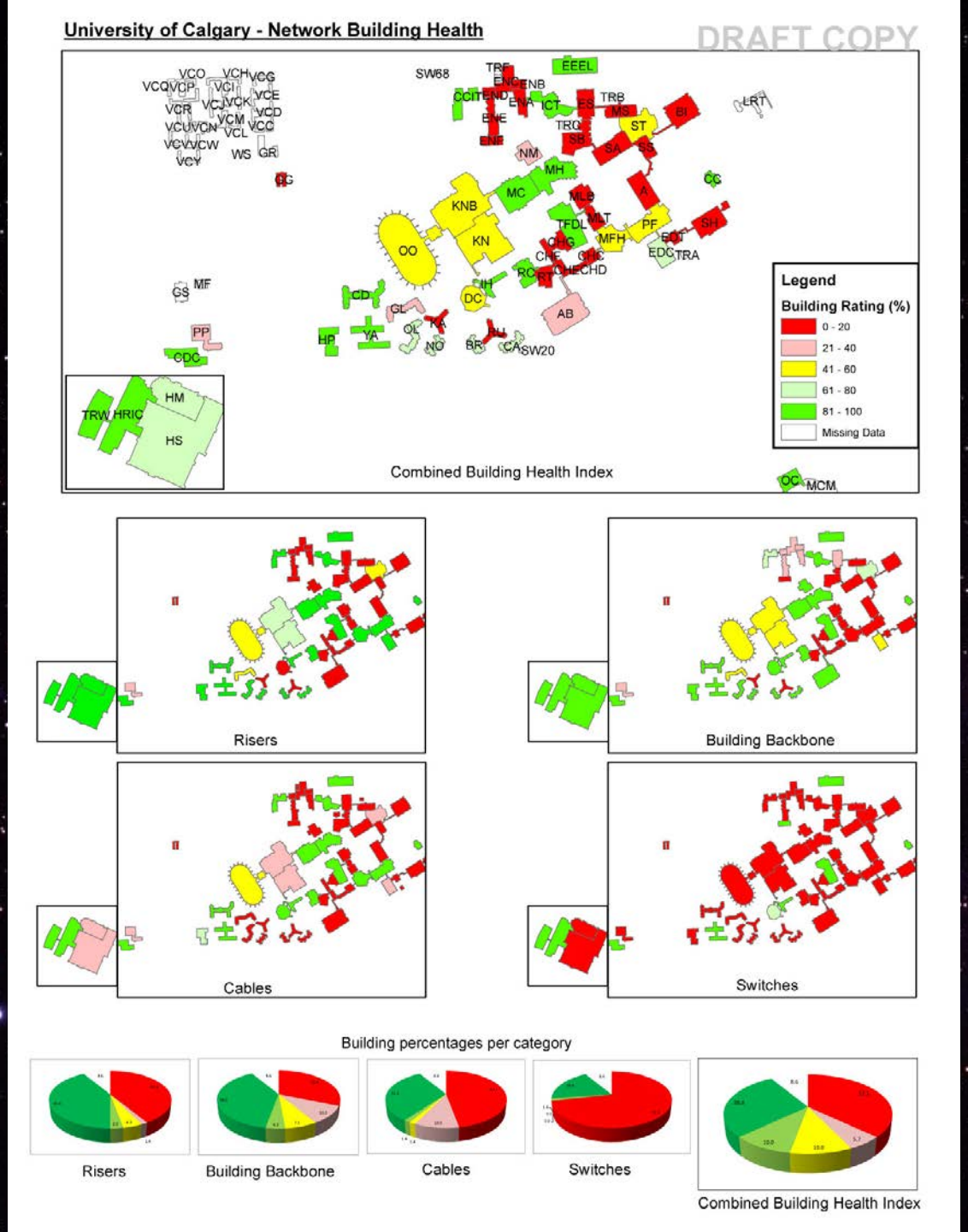
- create new data from mutiple data sets



- help create educated decisions based on facts

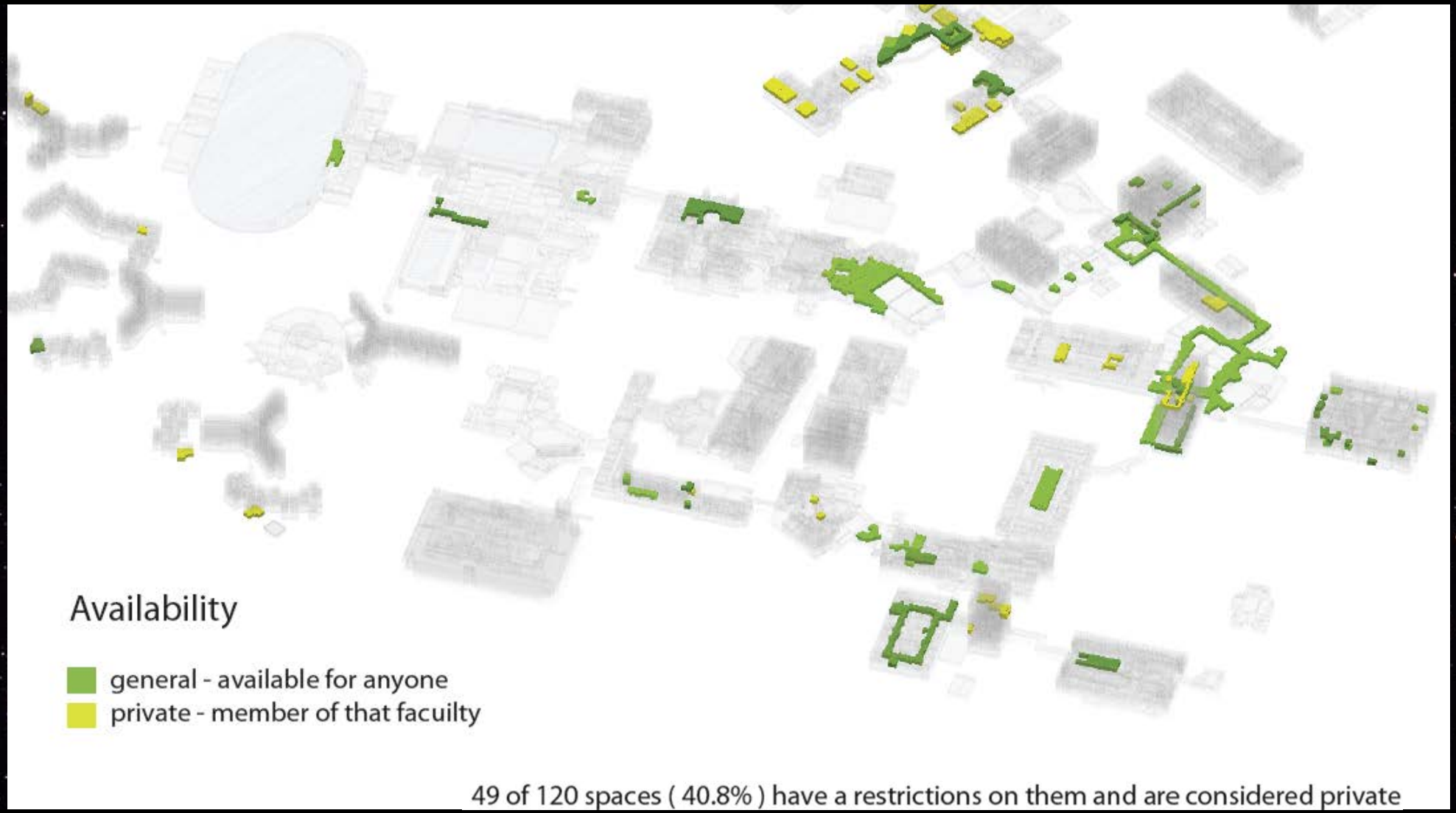
Using the data

Cost Benefit Analysis
and
Priority Analysis



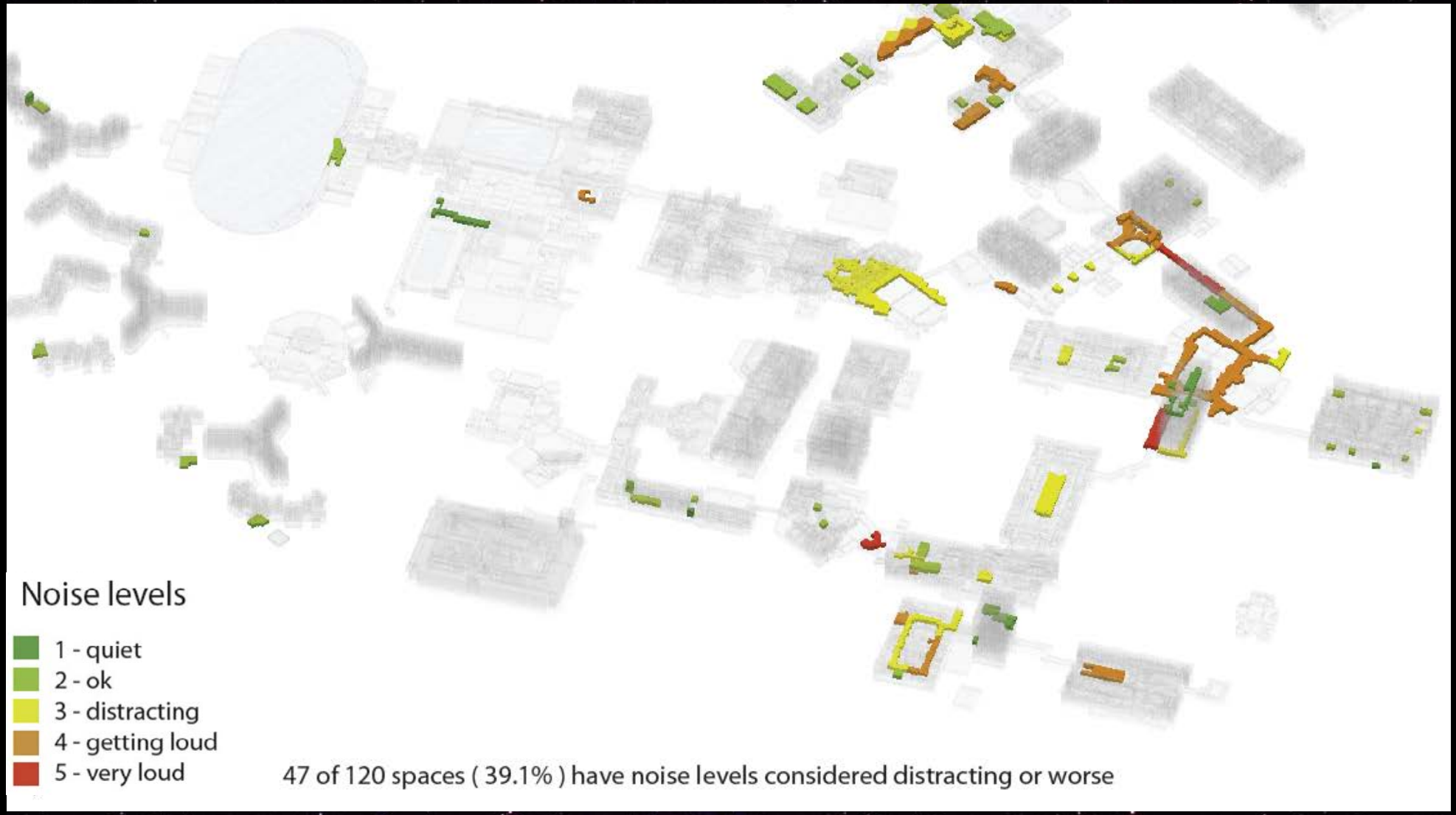
Using the data

Understanding Study Spaces



Using the data

Understanding Study Spaces

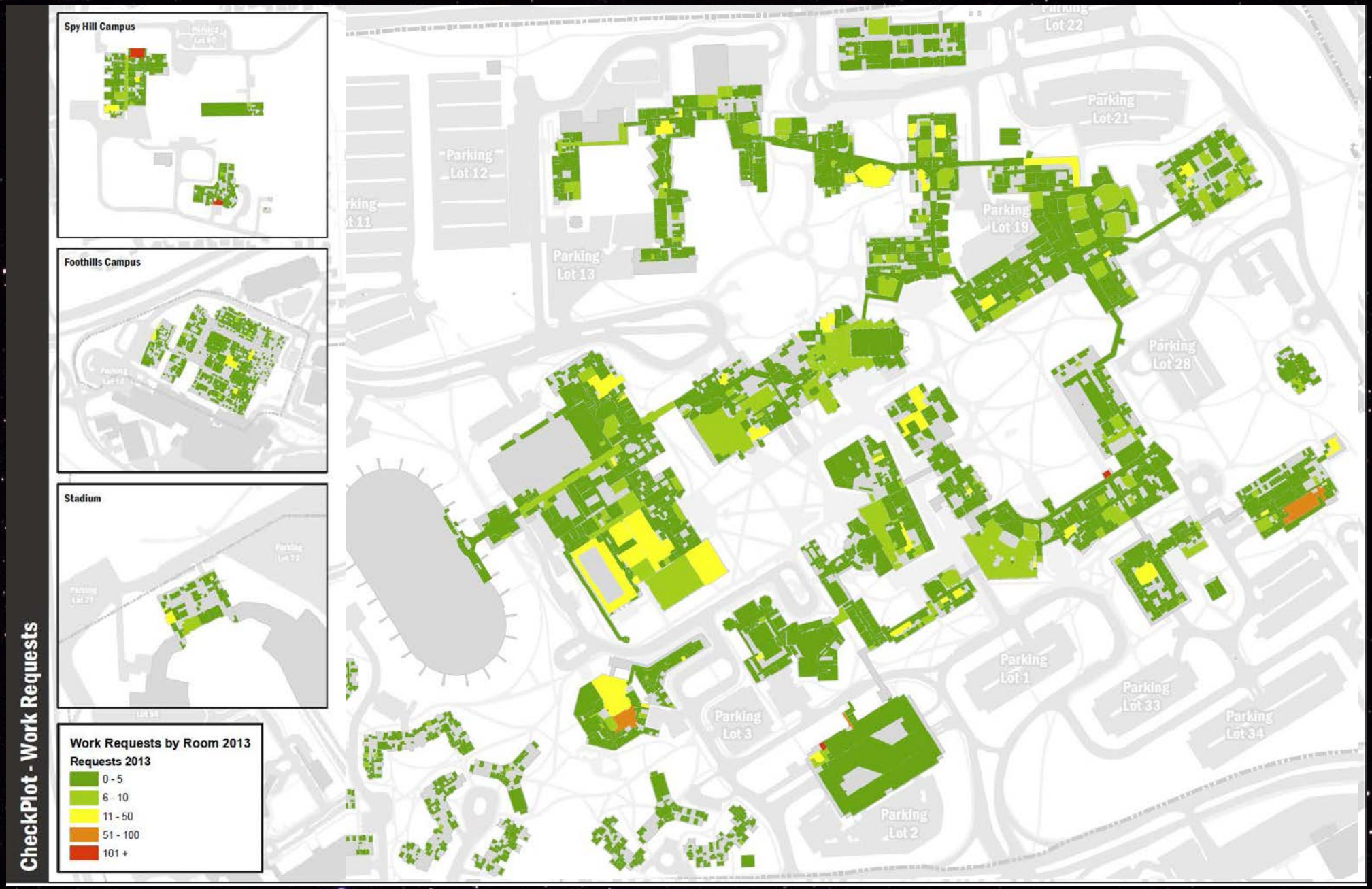


Using the data

Understanding Work Request Costs and Spatial Distributions by Buildings

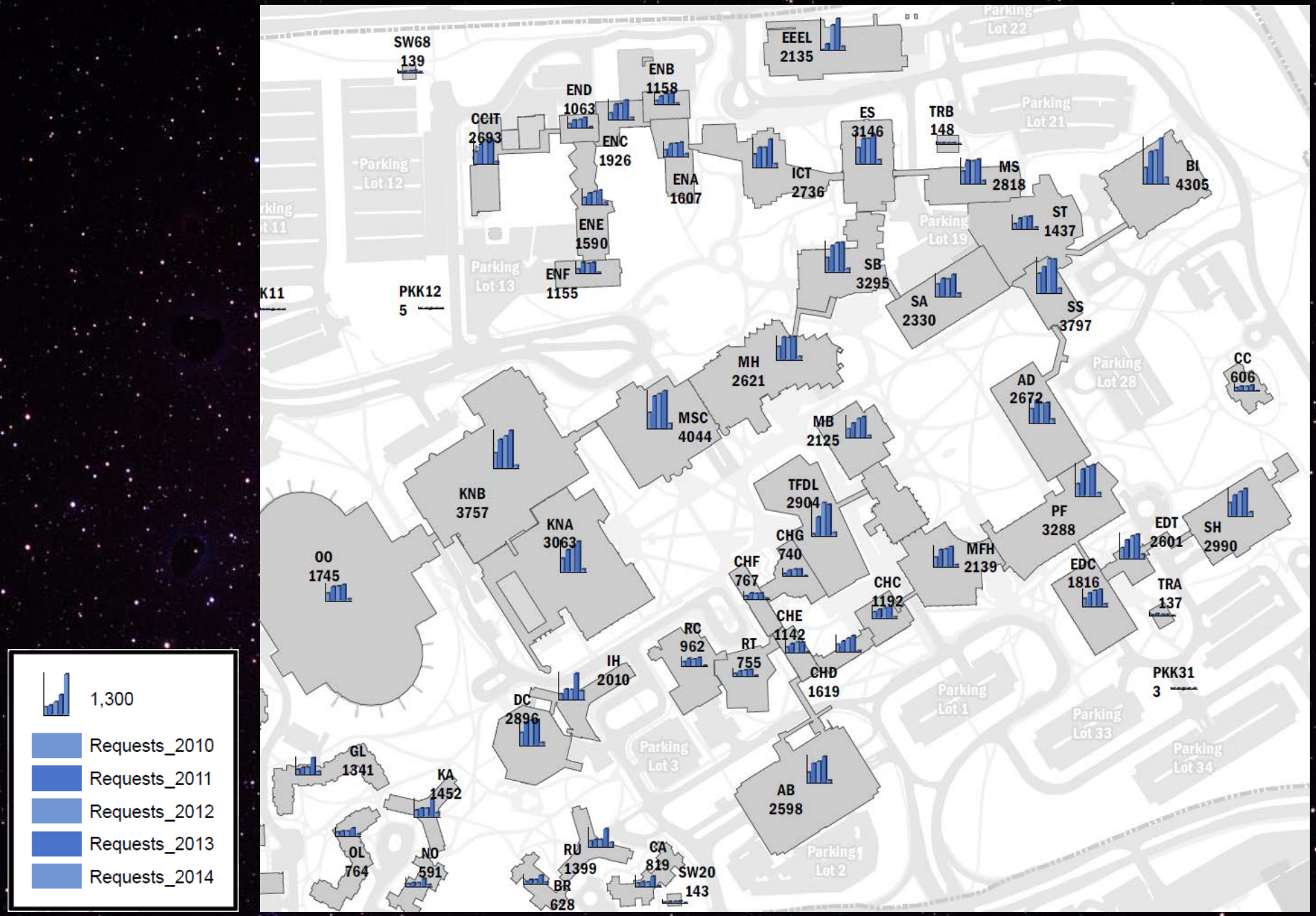
Using the data

Understanding Work Request Costs and Spatial Distributions by Rooms



Using the data

Understanding Work Request Costs and Spatial Distributions by Year




Building Data Systems

Roofing Asset Management System

Building Data Systems

Roofing Asset System

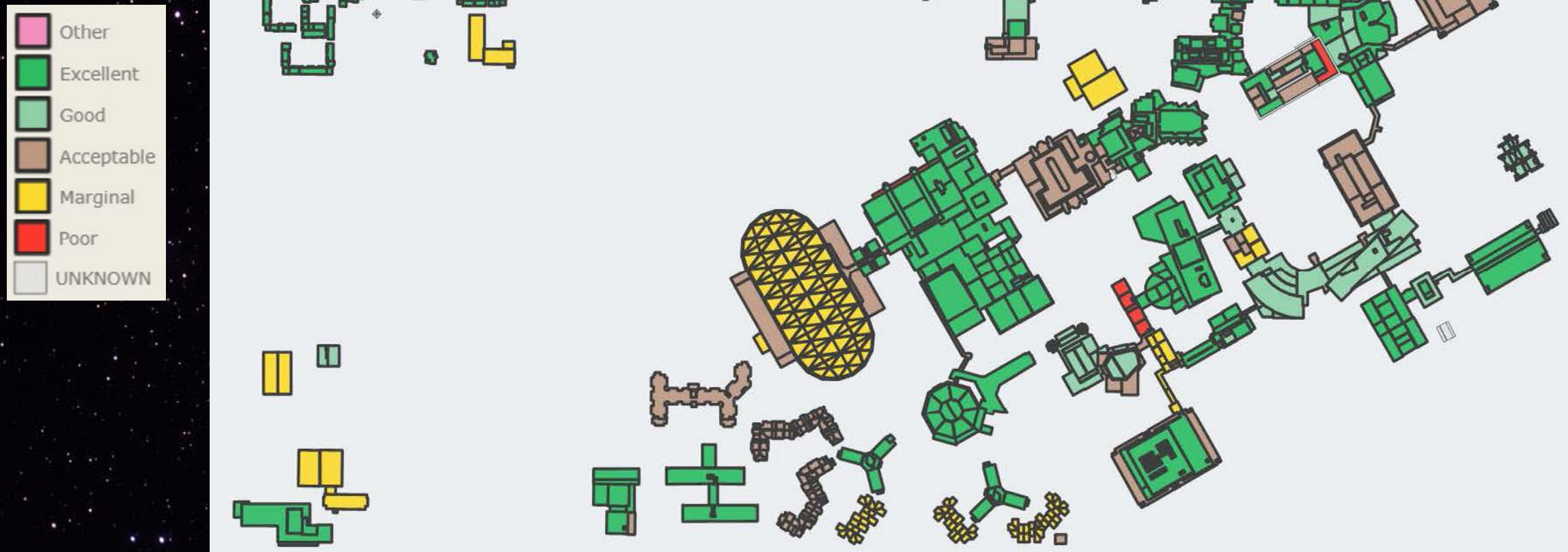
Building Data Systems

Building Data Systems

Life cycle for roofing materials (~40 yrs)

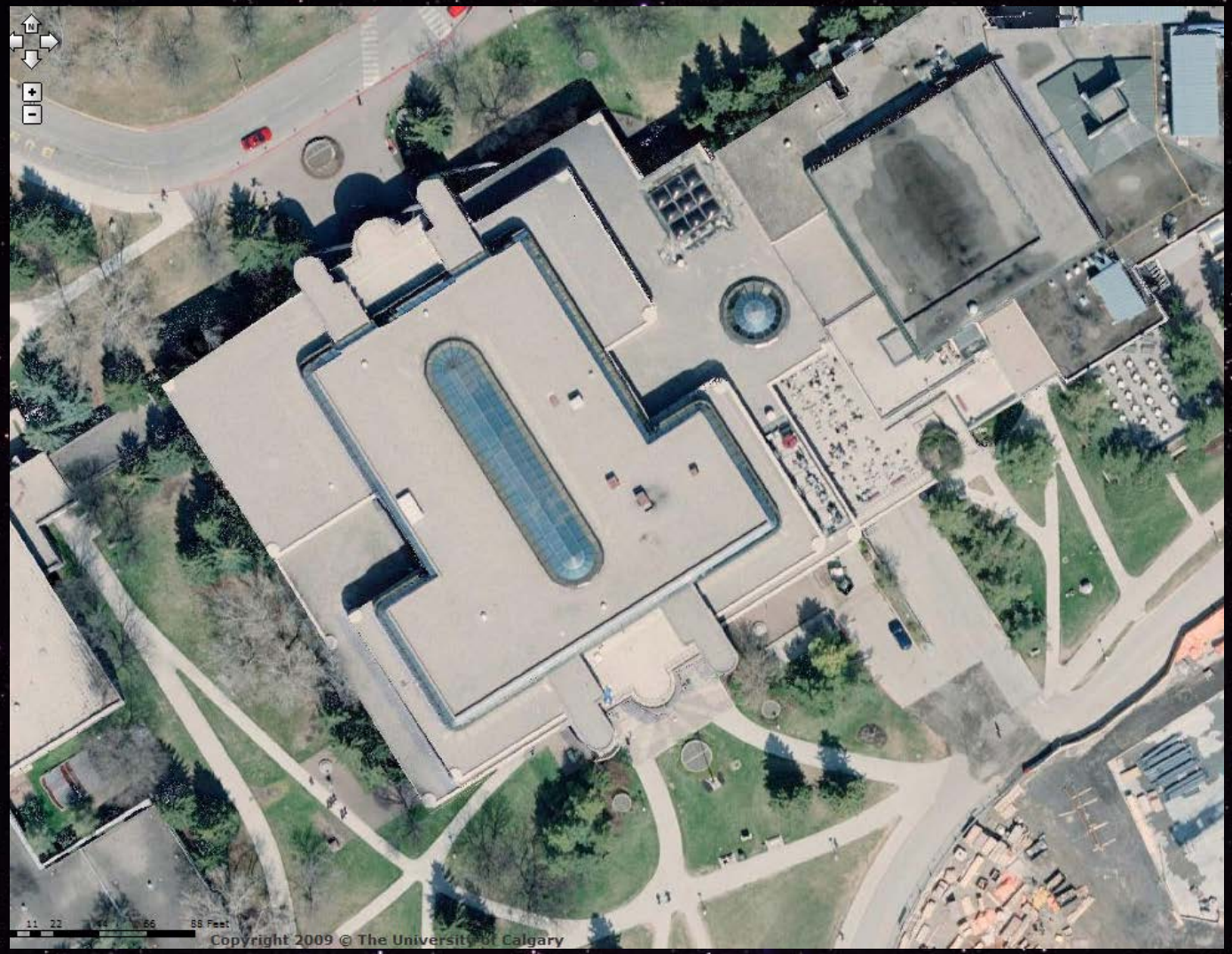
Building Data Systems

State of Roof Conditions



Building Data Systems

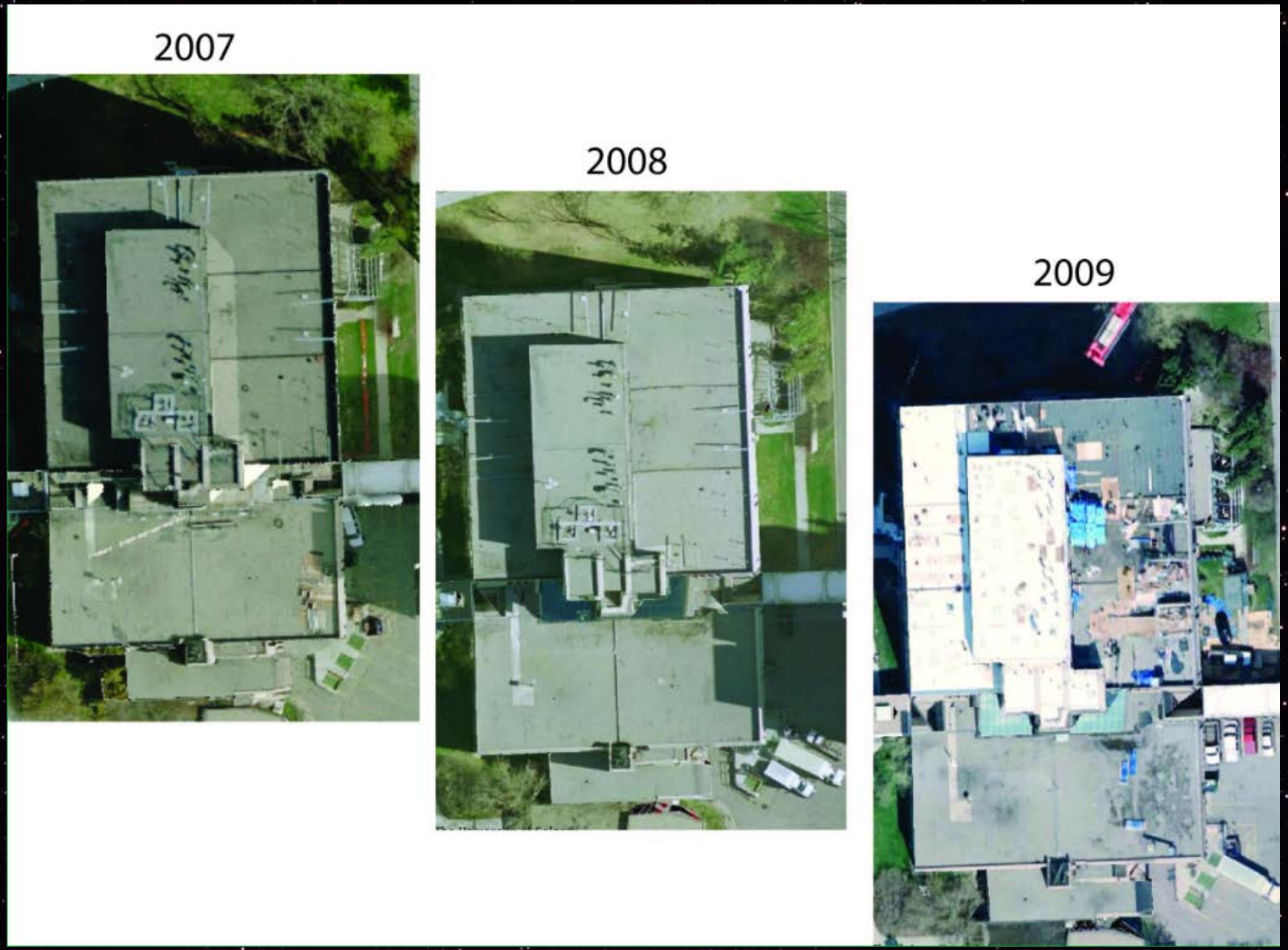
Asset tracking of roofing equipment (AC units, safety tie-downs, venting units)



Benefit: cost savings in man-hours and reporting processes
Asset tracking capabilities

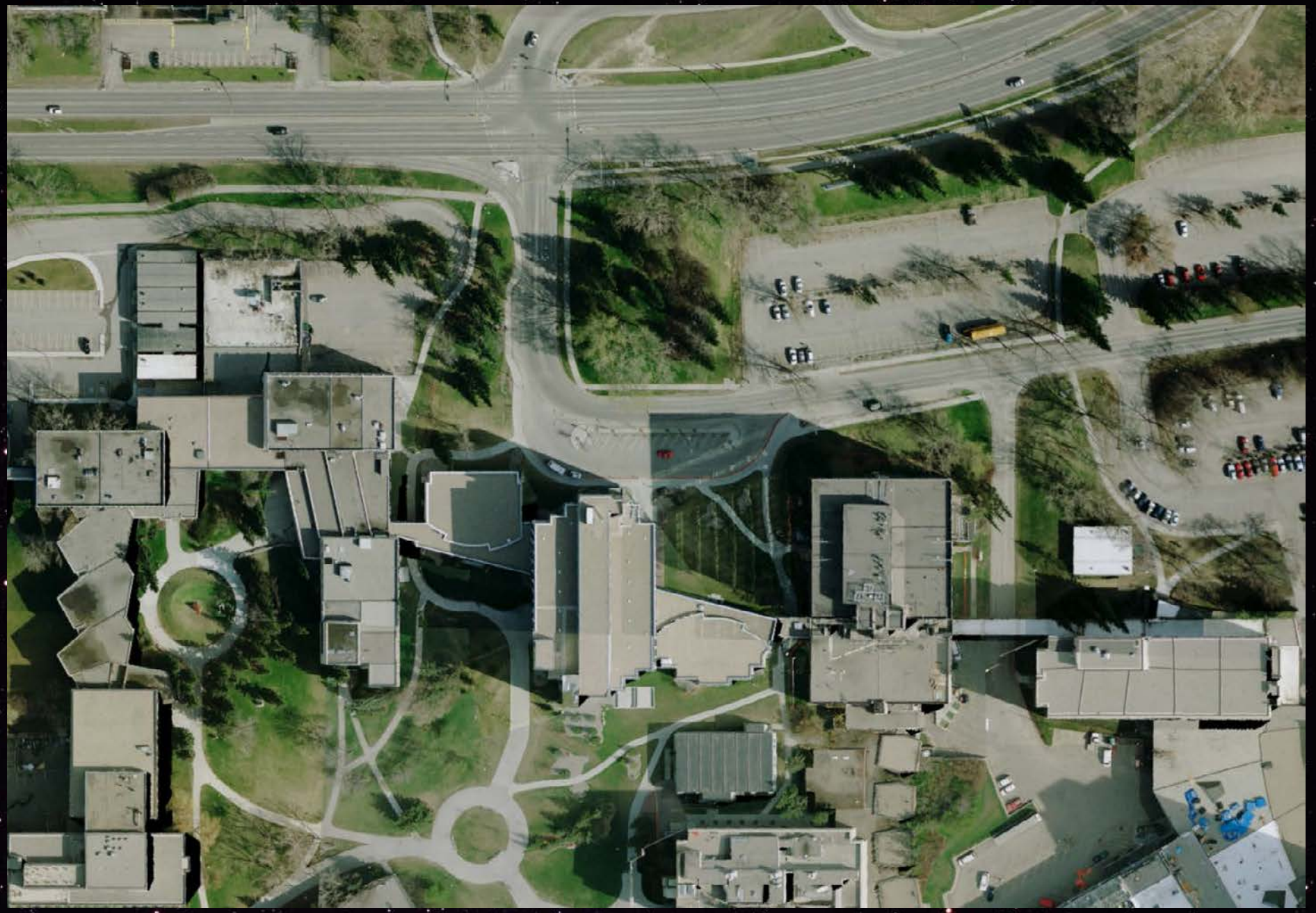
Building Data Systems

Temporal Asset Tracking
and construction progress



Building Data Systems

Annual Snap Shot



2007

Building Data Systems

2008

Building Data Systems

2009

Building Data Systems

2010

Building Data Systems

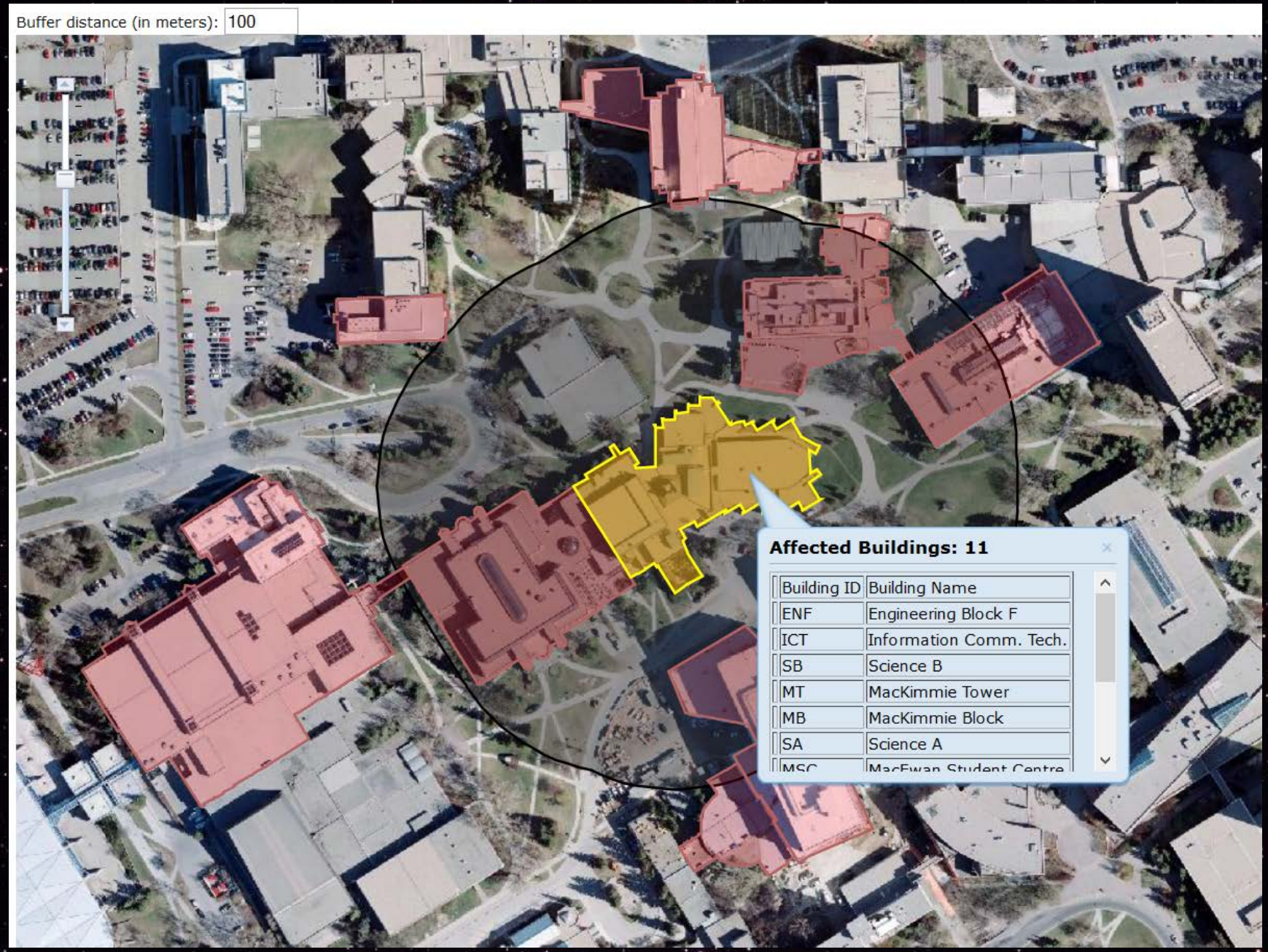
2011

Evacuation Range Finder

Building Data Systems

Evacuation Range Finder

(what buildings are with in 100 m of the containment area)



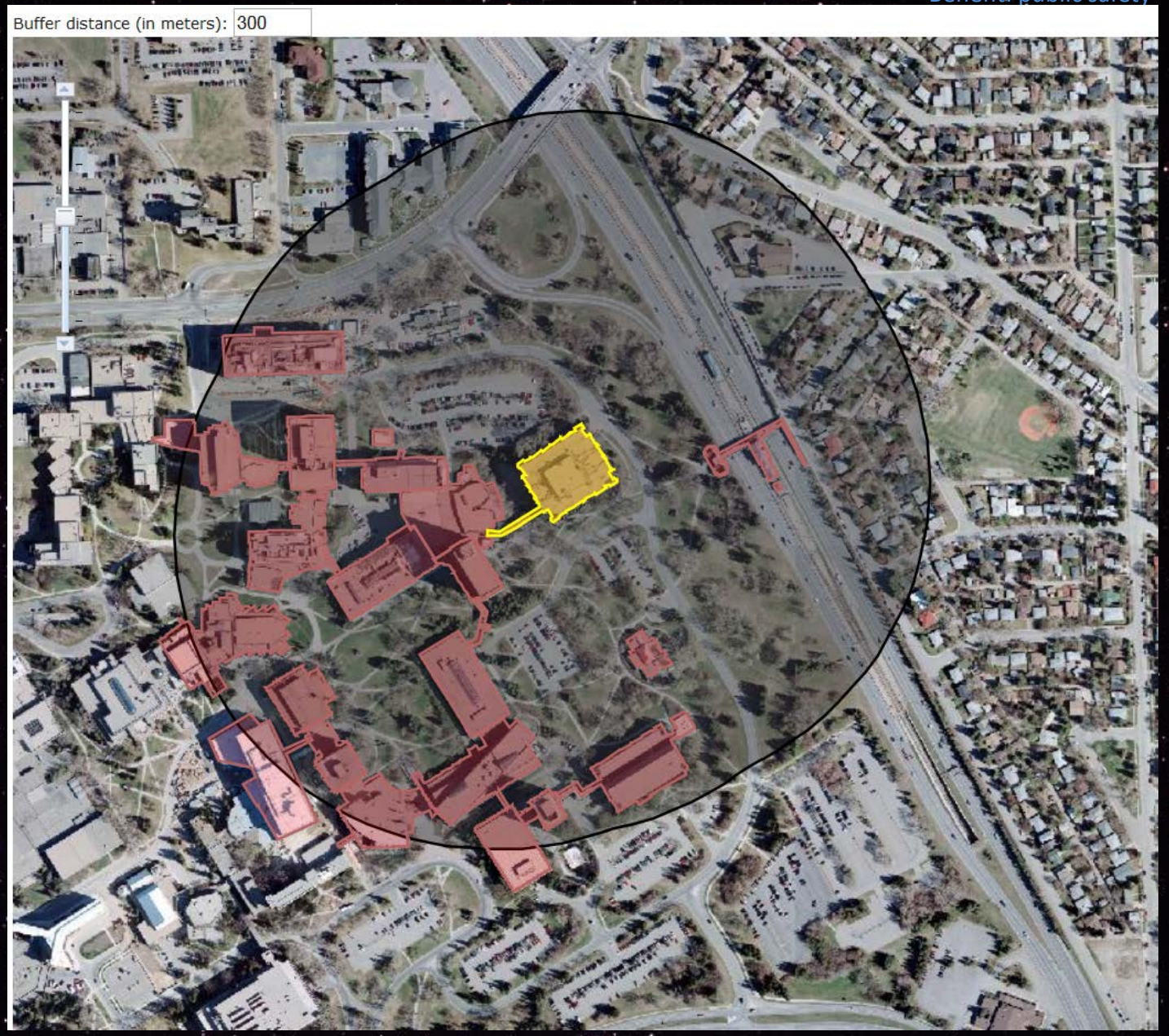
Benefit: web access for instant updates and multiple scenarios

Building Data Systems

Evacuation Range Finder

(quick visuals to see scenarios that may be have been overlooked)

Benefit: public safety



Building Buffers

DEMO

Interactive Room Finder

Building Data Systems

Interactive Room Finder – 32,000 rooms

Building Data Systems

Interactive Room Finder Map

Building: PP - Physical Plant Room: 61 Search

Floors:
- P2
- P1
- 15
- 14
- 13
- 12
- 11
- 10
- 09
- 08
- 07
- 06
- 05
- *04A*
- 04
- *03A*
- 03
- *02A*
- 02
- *01A*
- 01
- M1
- *G1A*
- G1
- *B1A*
- **B1**
- B2
- B3

Click on any table results to visualize on the map.

Room	Floor	Building	Area m²
61	B1	PP	69.36


Interactive Room Finder
DEMO

Building Data Systems

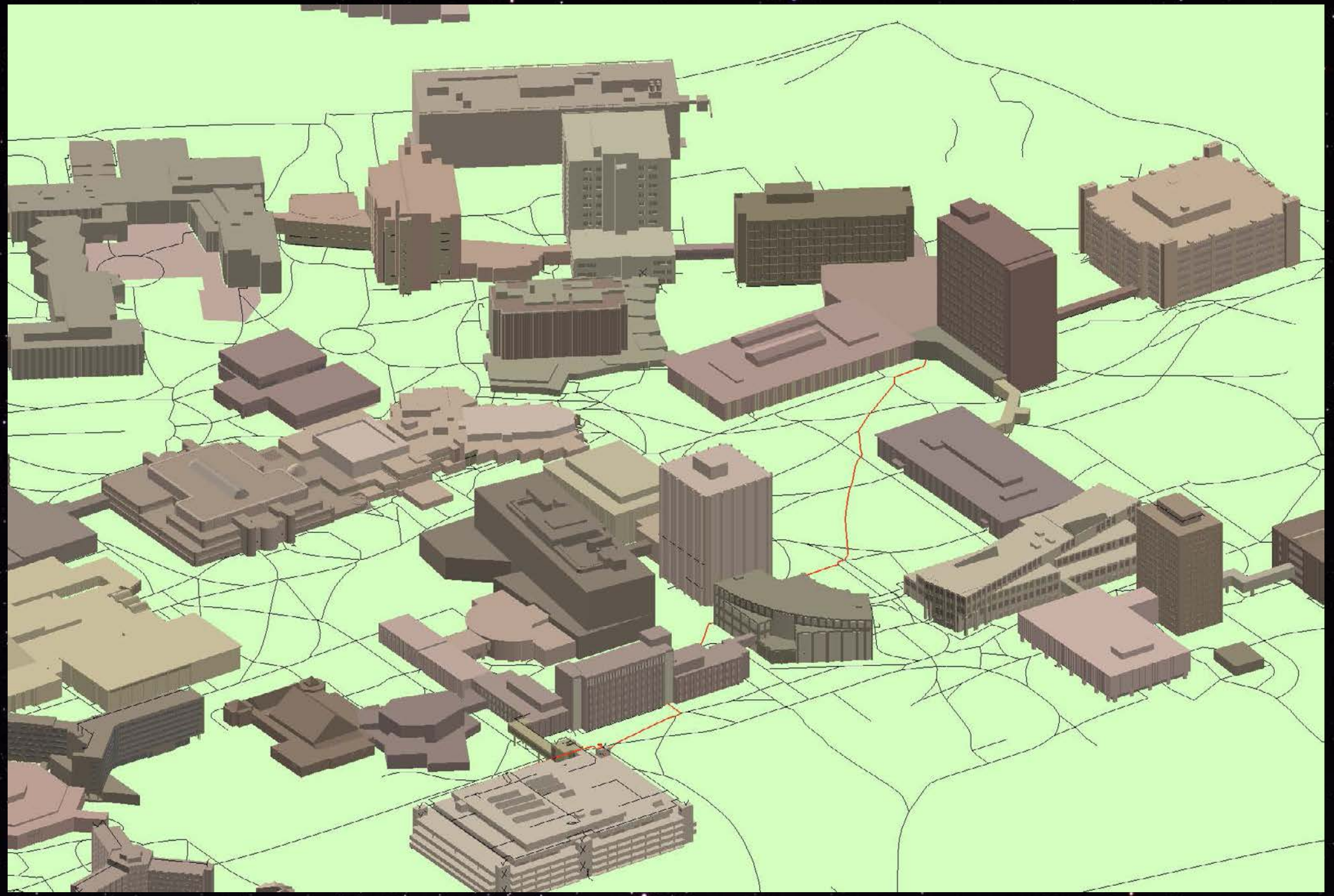
Tracking Room Finder Users

Pageviews
2,604,654

1.	Canada	
2.	United States	
3.	India	
4.	(not set)	Local Wireless
5.	United Kingdom	
6.	Iran	
7.	China	
8.	Germany	
9.	Pakistan	
10.	Brazil	
11.	France	
12.	Australia	
13.	Japan	
14.	Mexico	
15.	Nigeria	
16.	South Korea	
17.	Bangladesh	
18.	Hong Kong	
19.	Saudi Arabia	
20.	Netherlands	
21.	Colombia	
22.	Spain	
23.	Italy	
24.	Malaysia	
25.	United Arab Emirates	
26.	Russia	
27.	Singapore	
28.	Turkey	
29.	Qatar	
30.	Philippines	
31.	Egypt	
32.	Taiwan	
33.	Switzerland	
34.	Venezuela	
35.	Sweden	


Path Finder

Building Data Systems



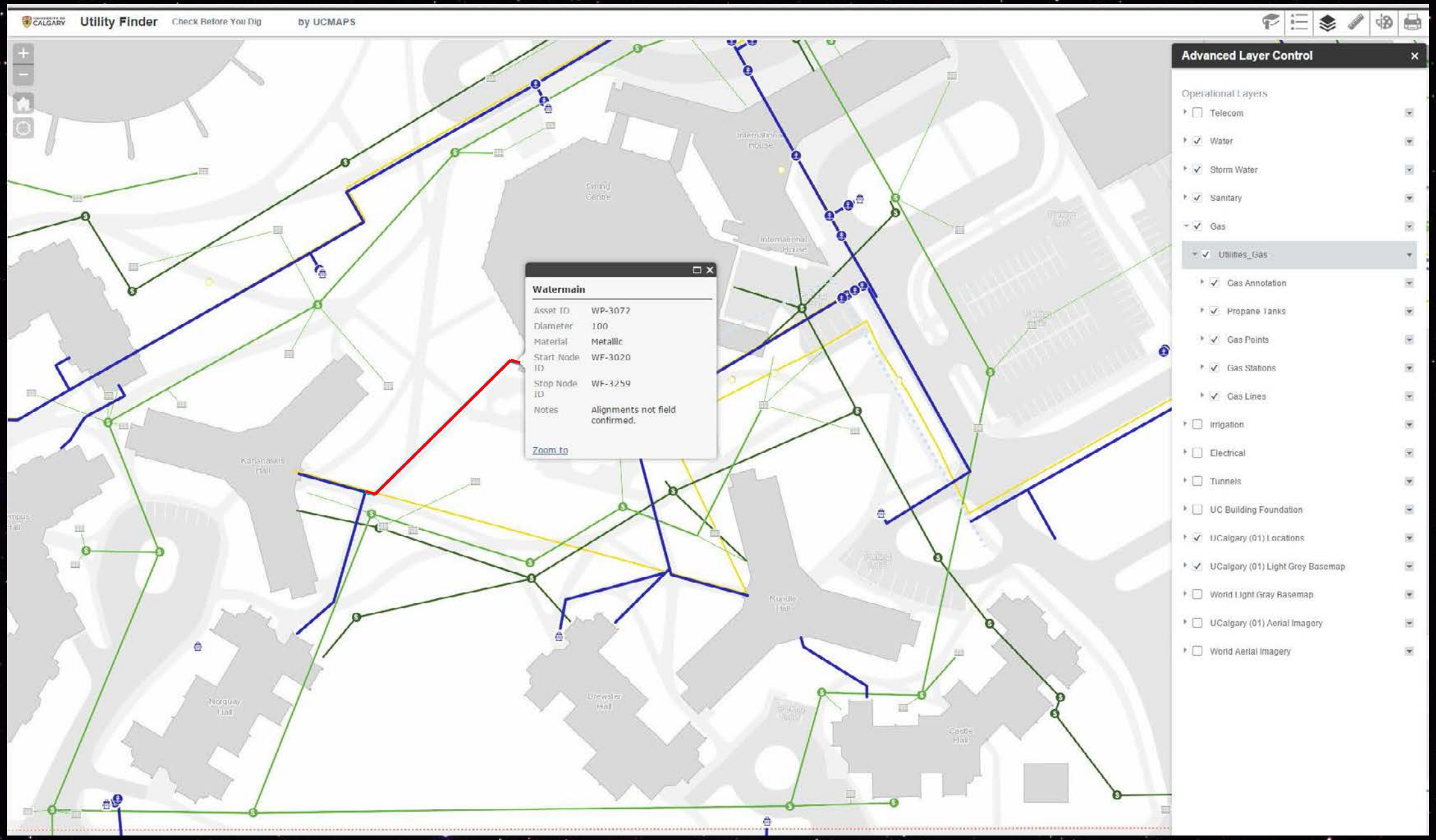
Building Data Systems

Building Data Systems

Utility Finder

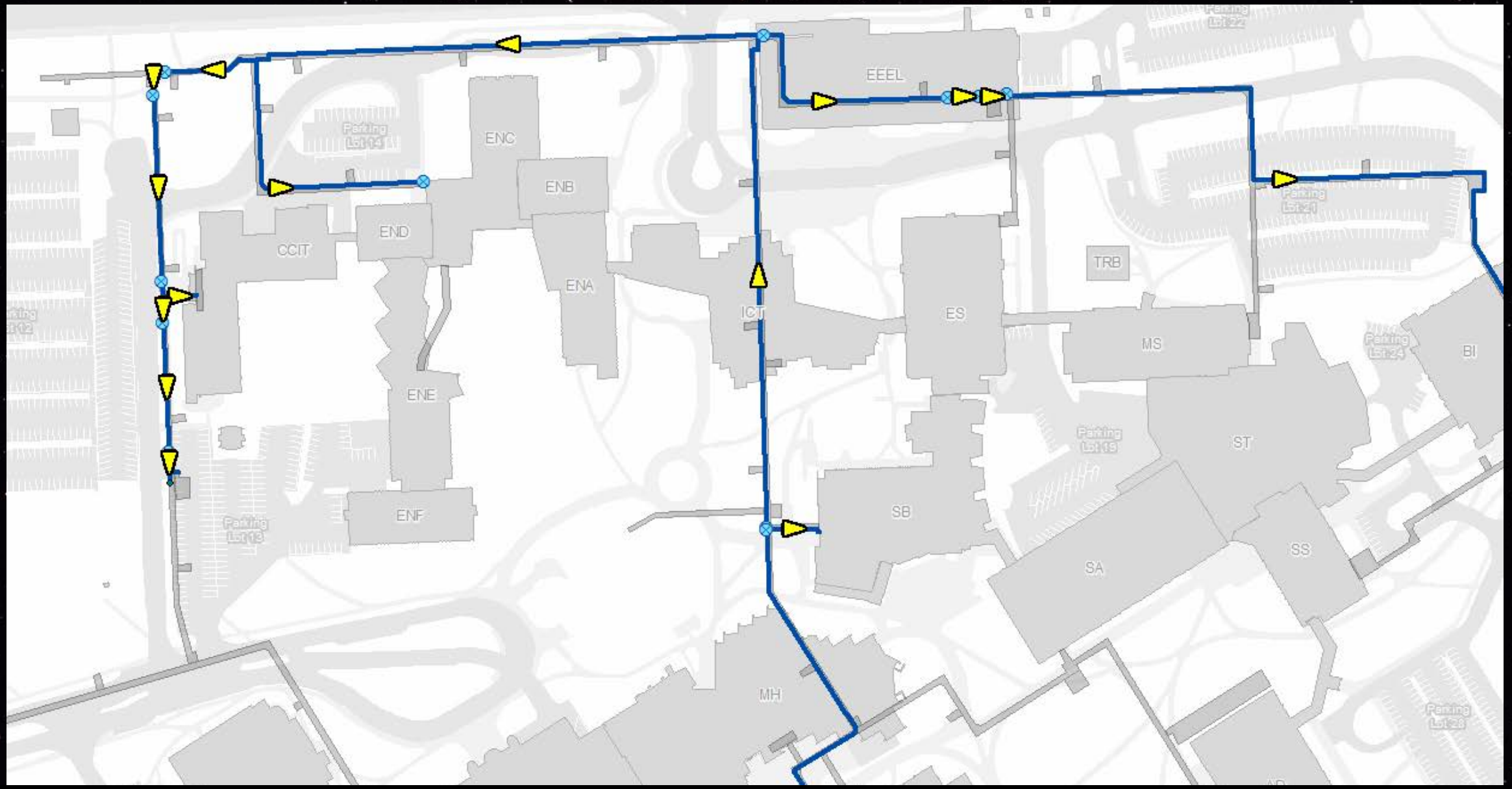
Building Data Systems

Web Interface for Utilities



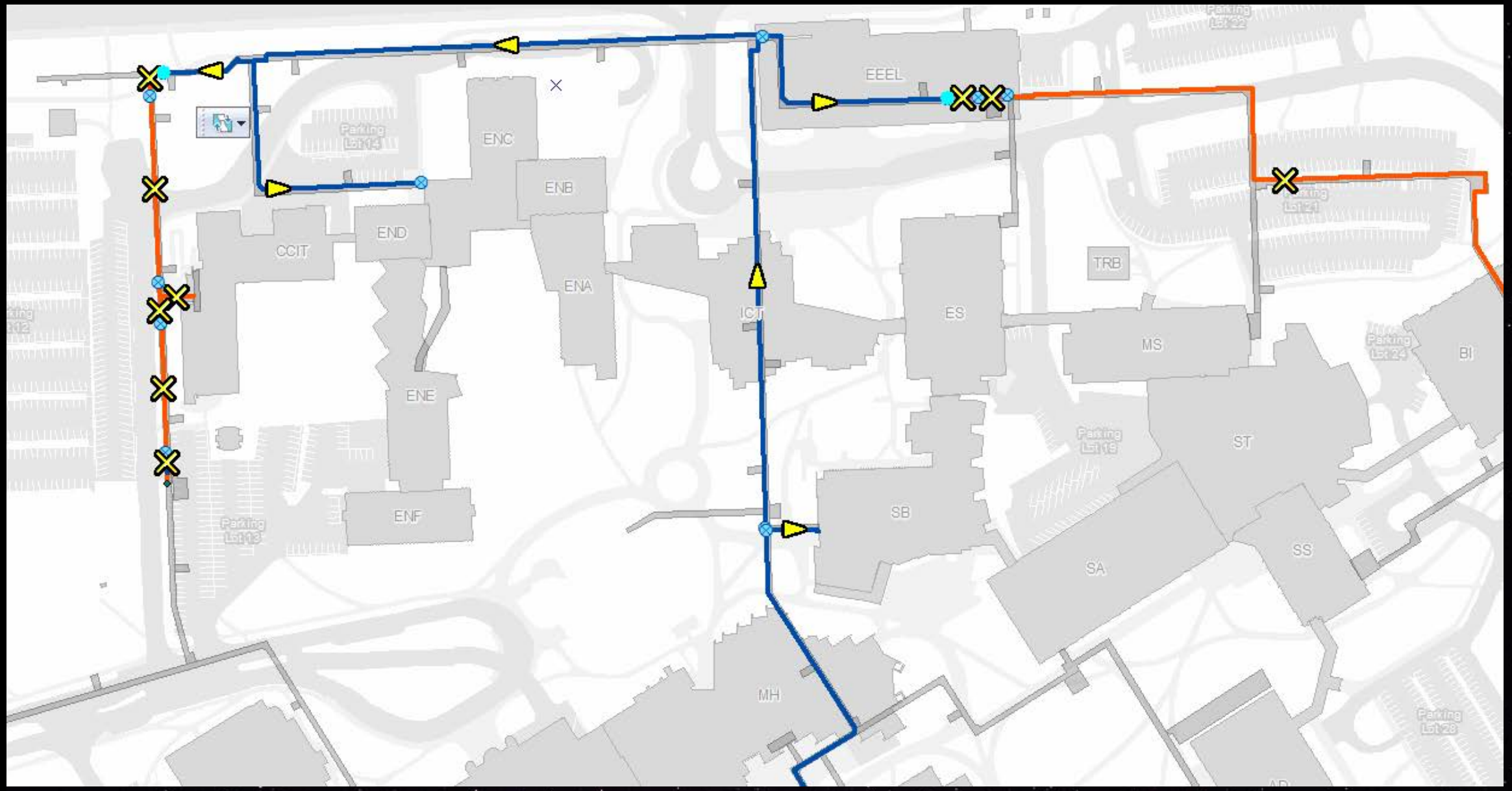
Building Data Systems

Example for Chilled Water Network – all valves open



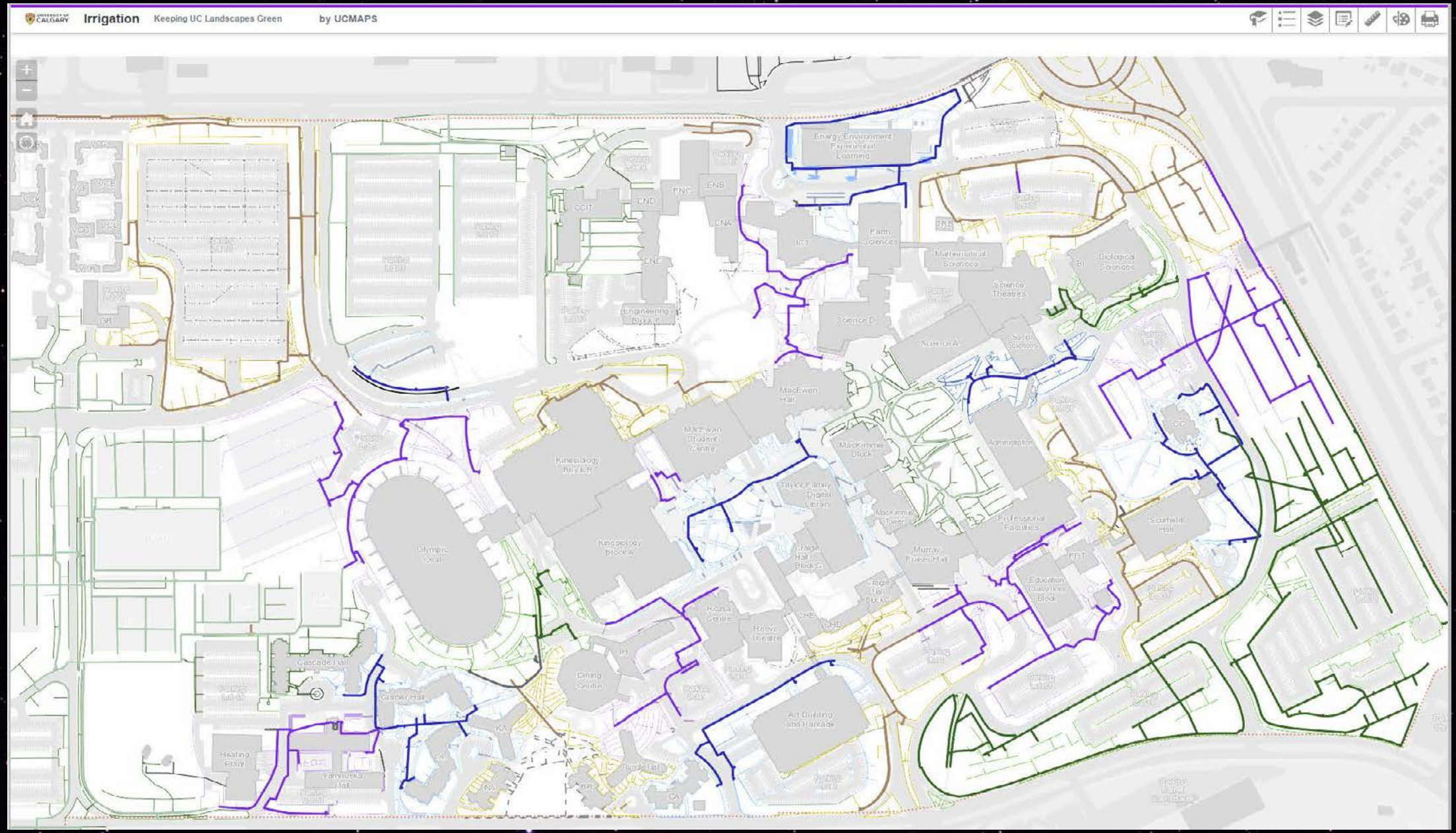
Building Data Systems

Example for Chilled Water Network – 2 valves closed

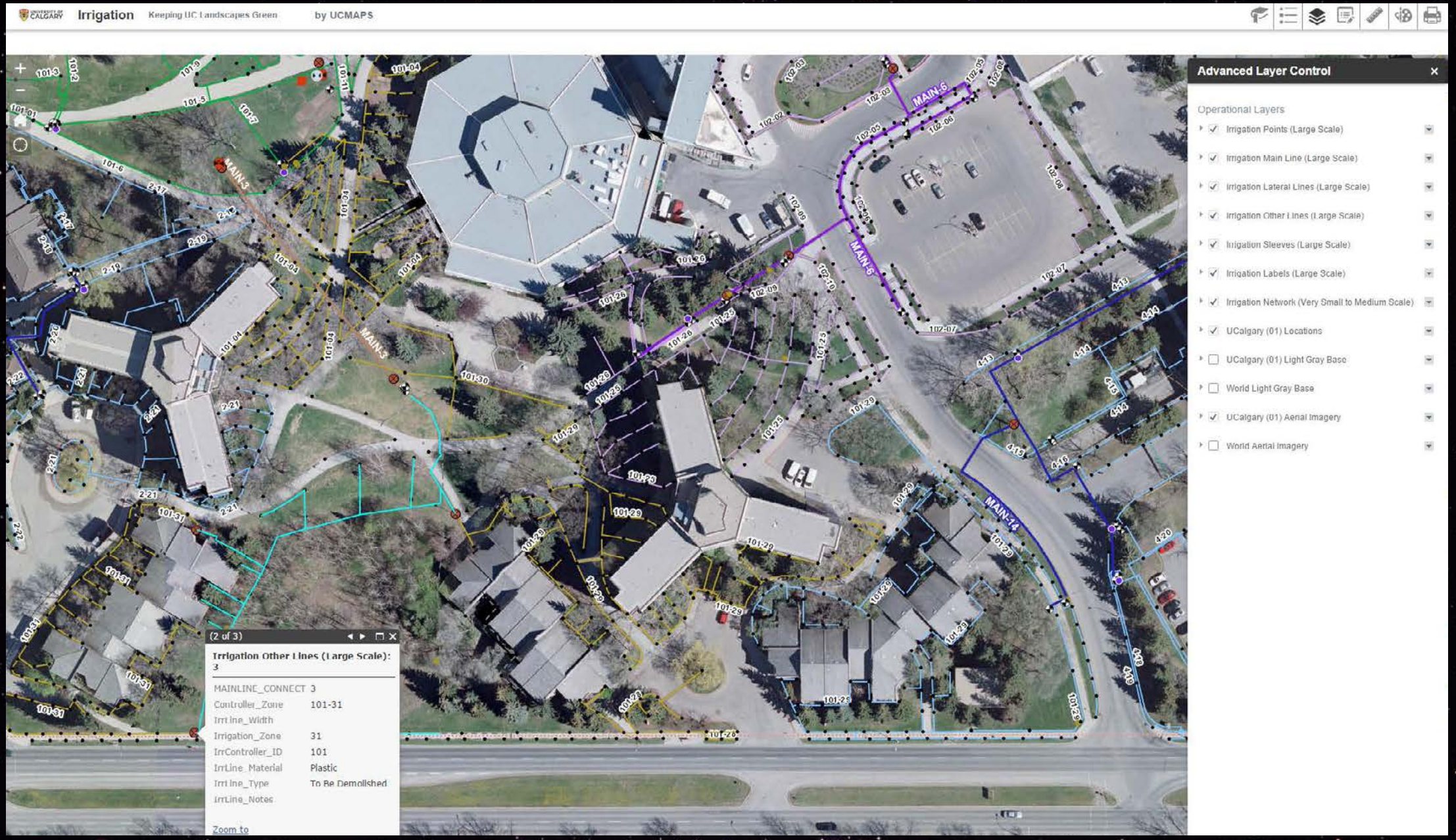


Irrigation System

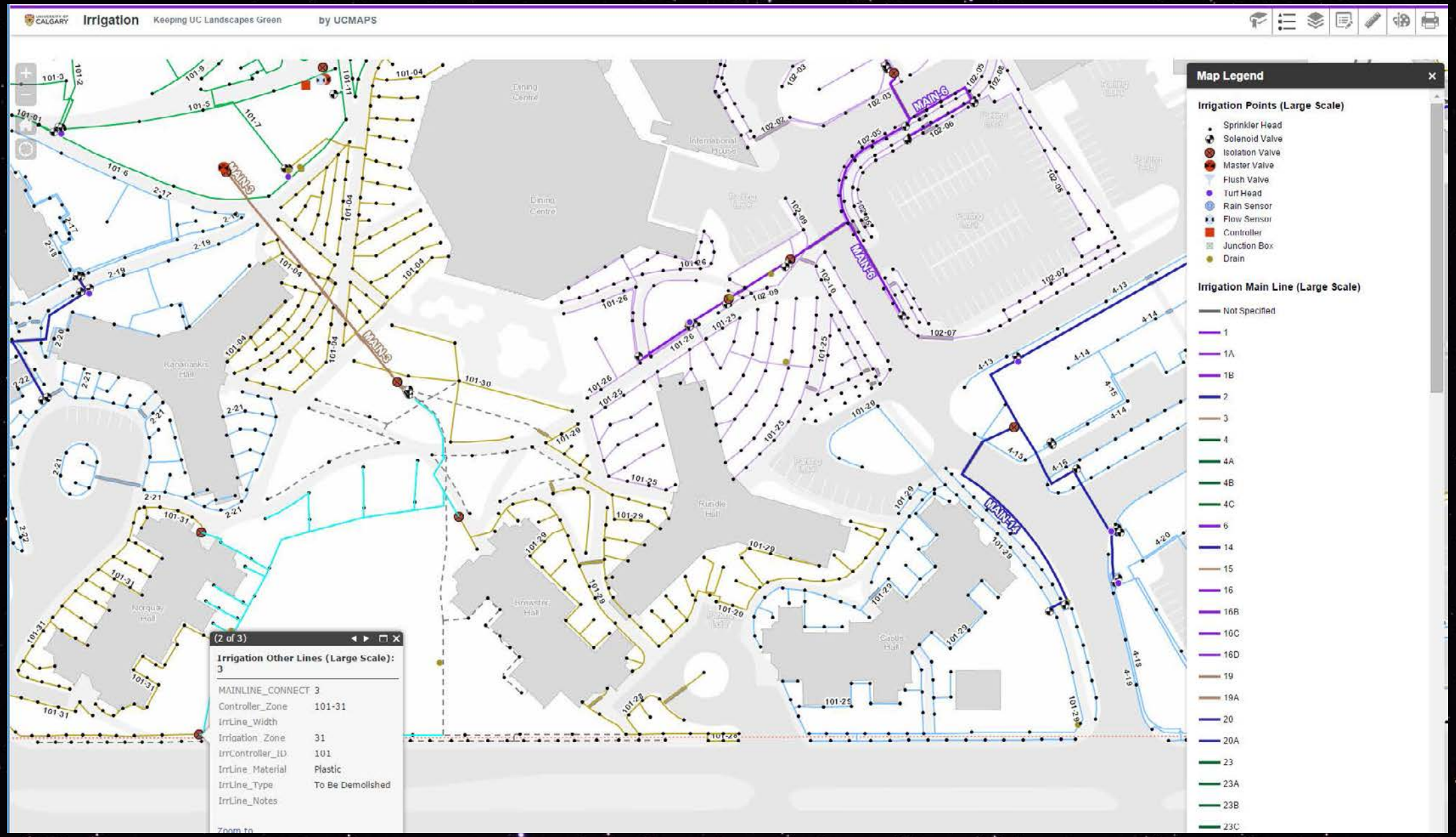
Building Data Systems



Building Data Systems

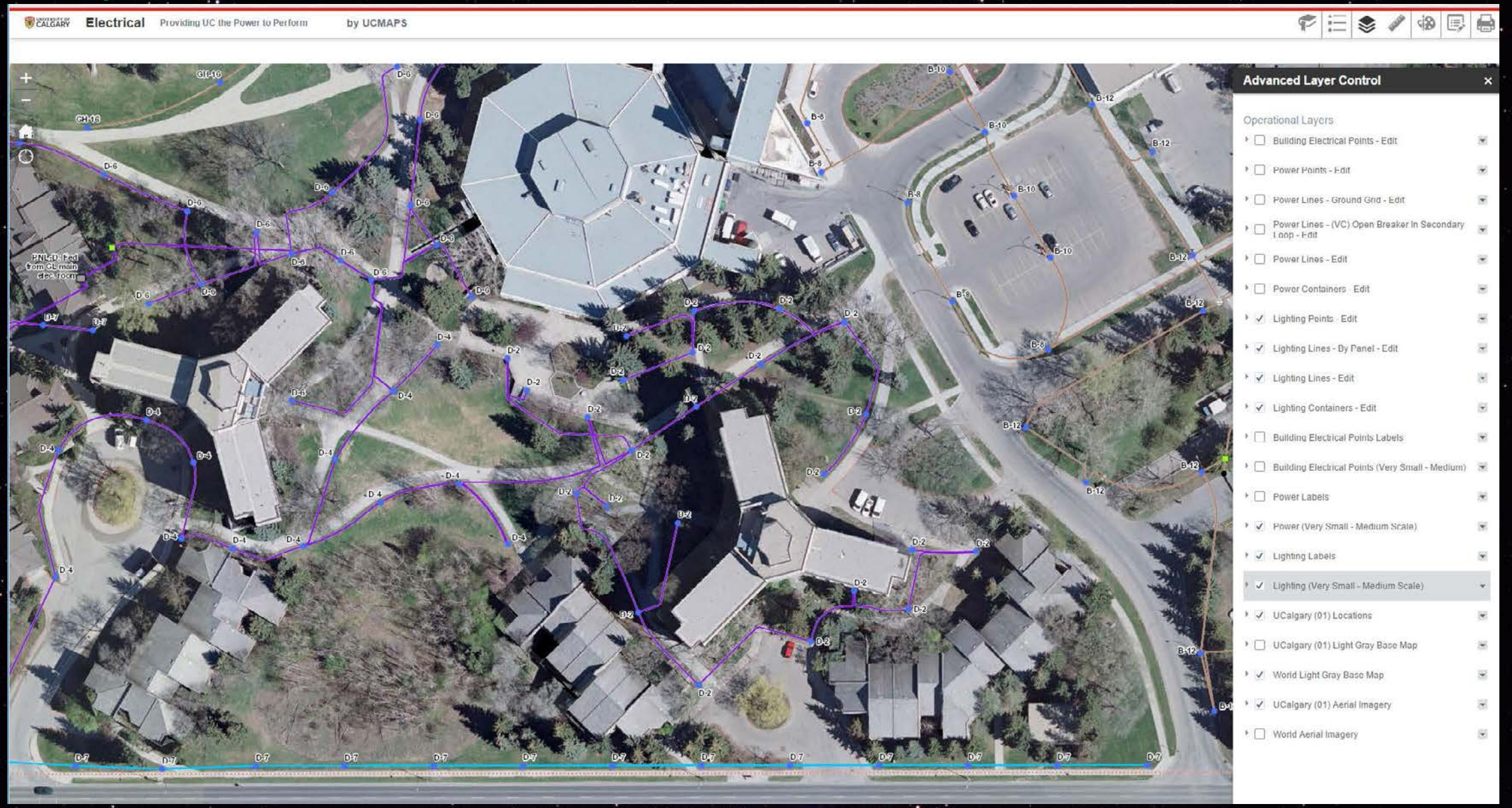


Building Data Systems

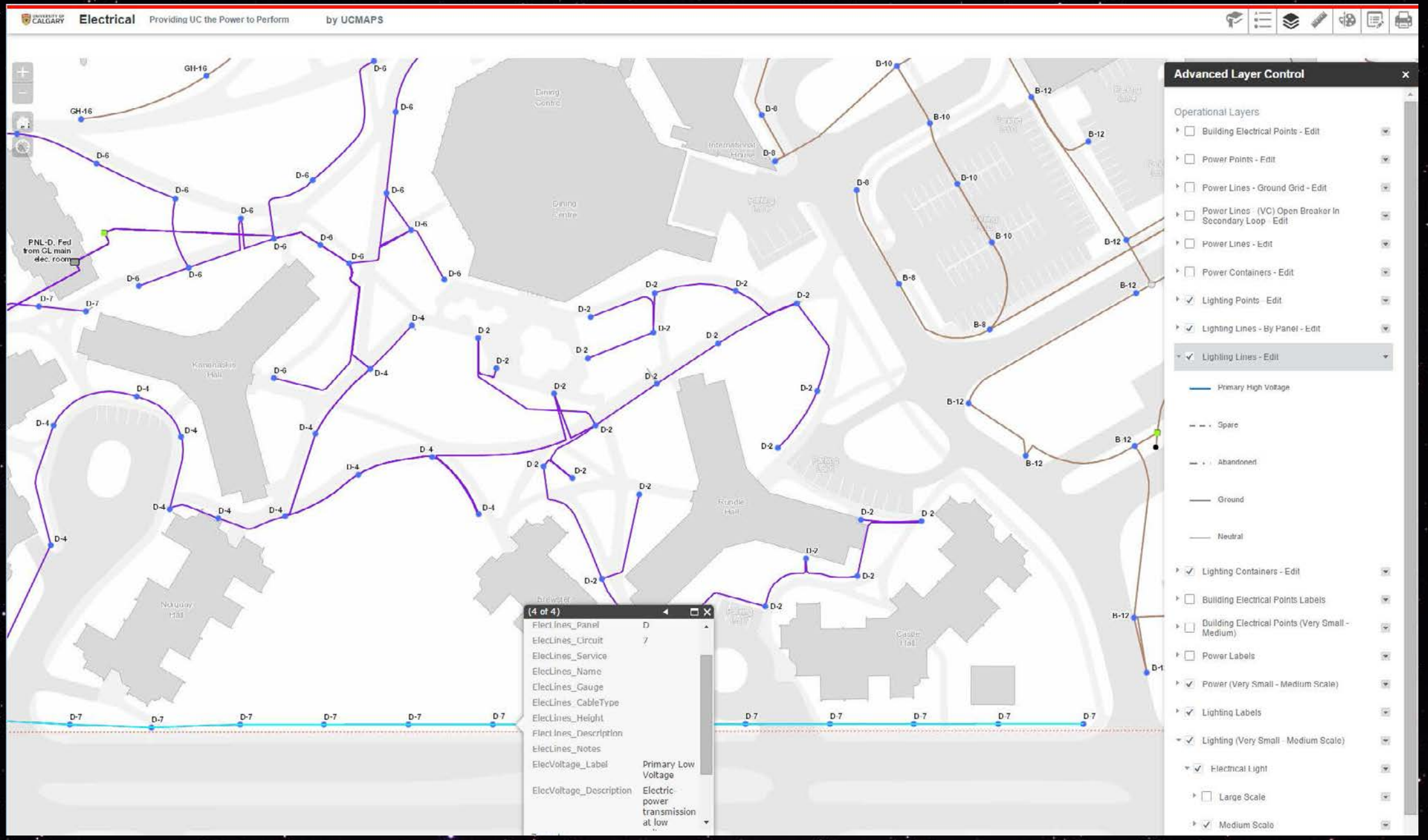


Electrical Network

Building Data Systems

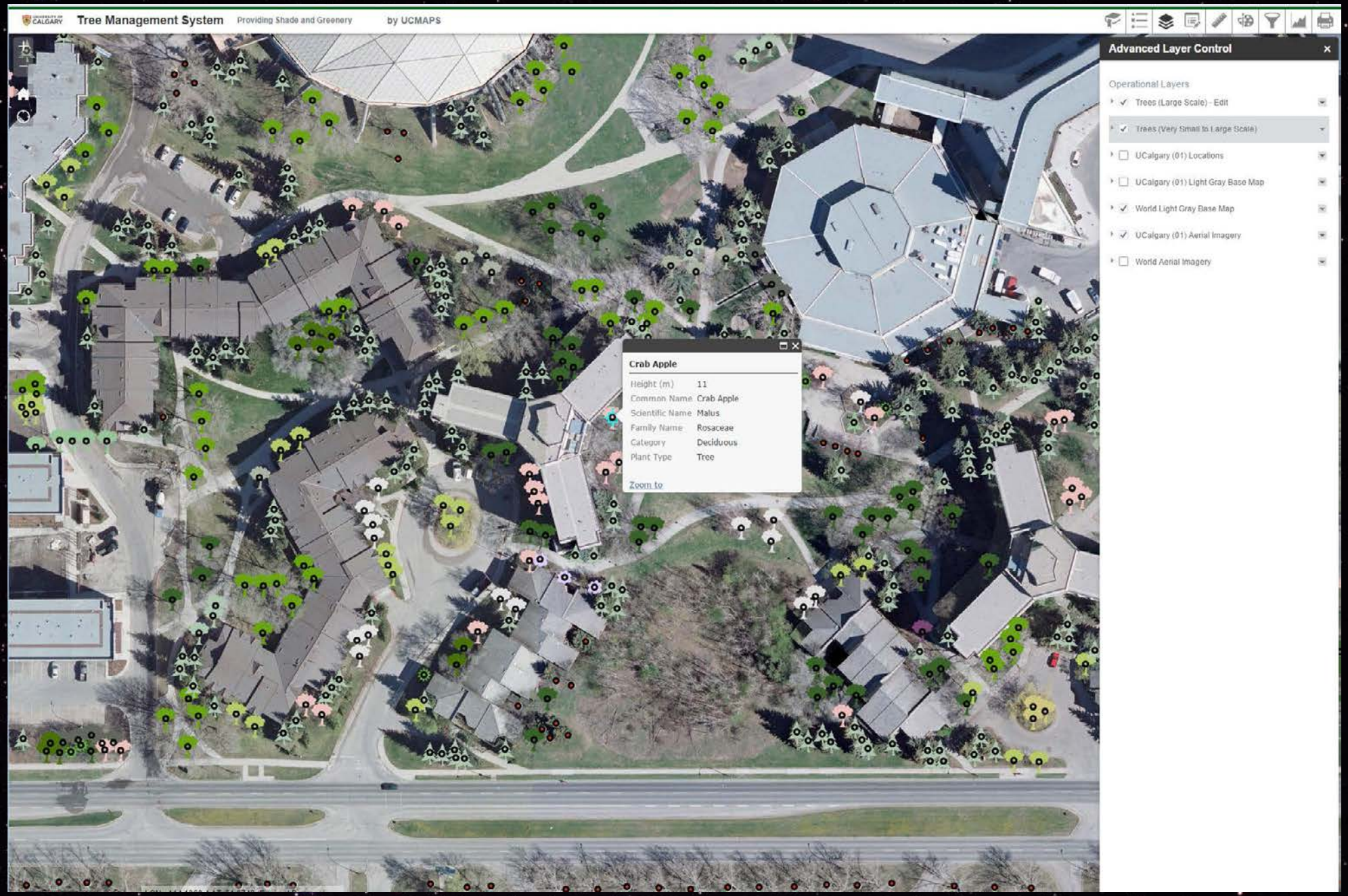


Building Data Systems

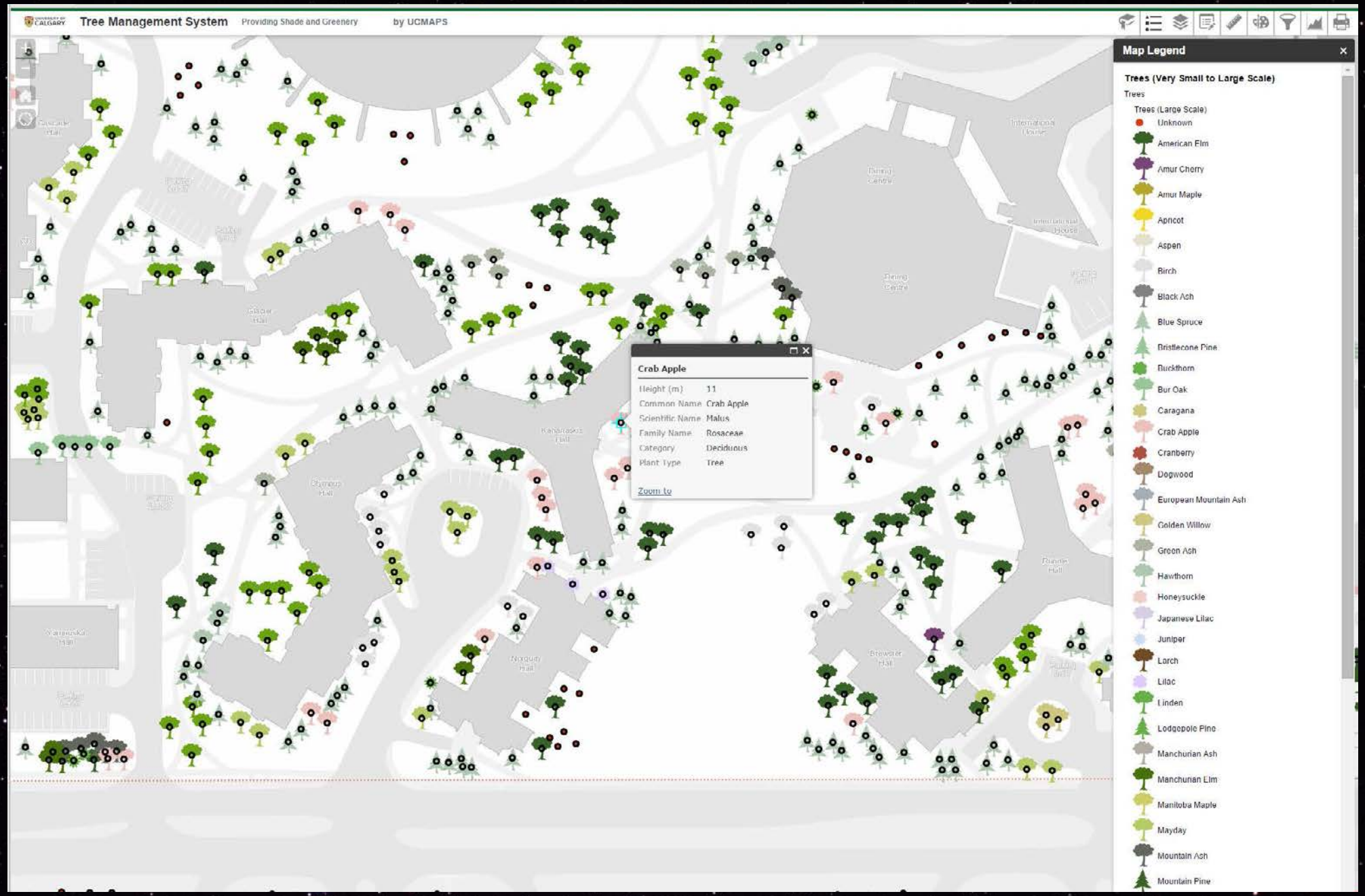


Tree Management System

Building Data Systems

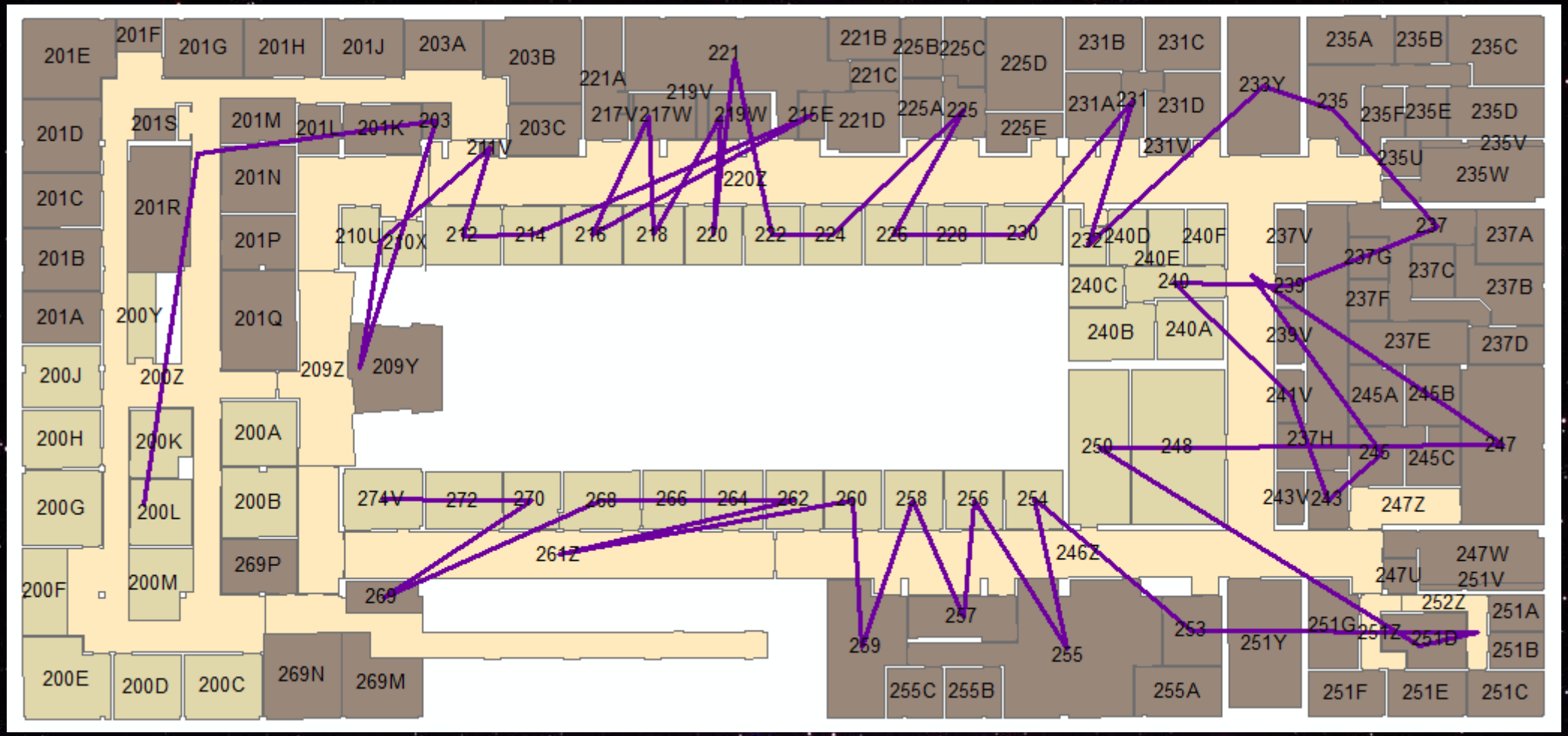


Building Data Systems



Quality Control

Correcting Room Numbering Issues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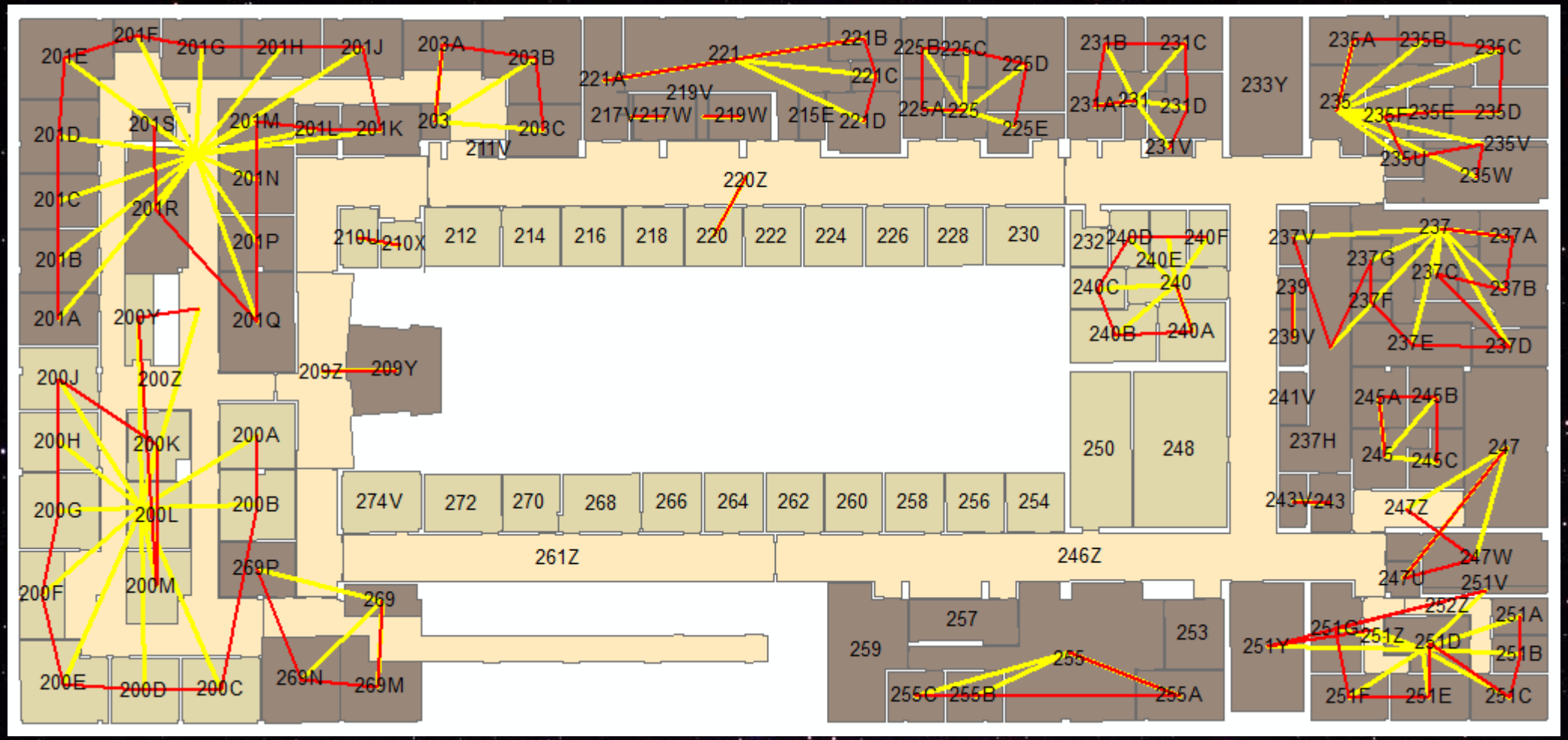
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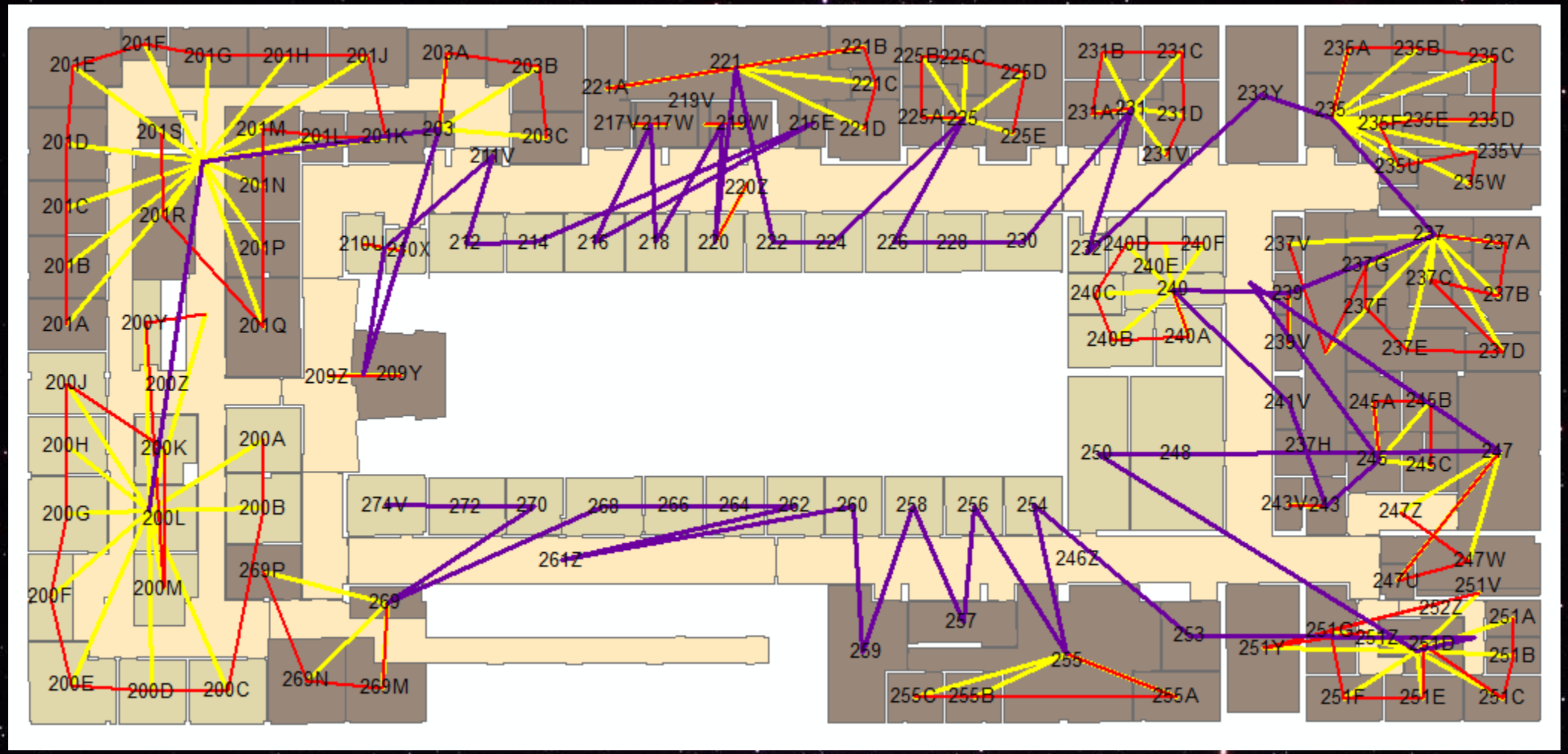
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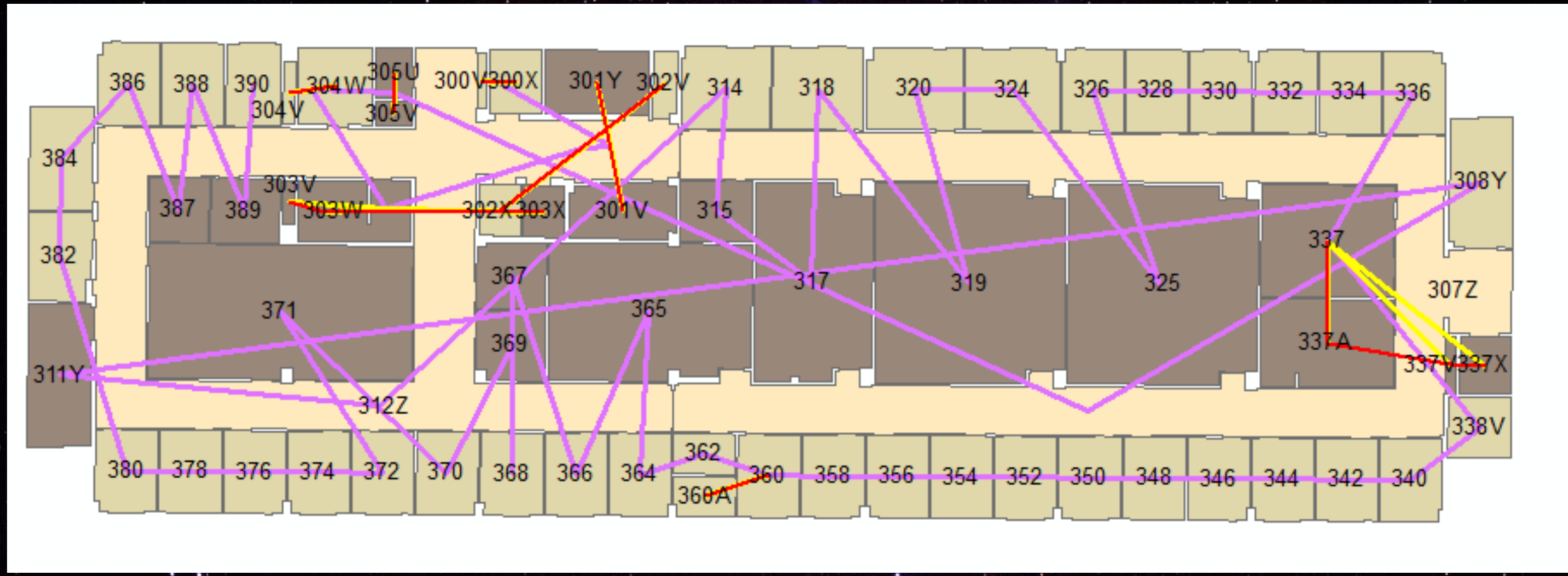
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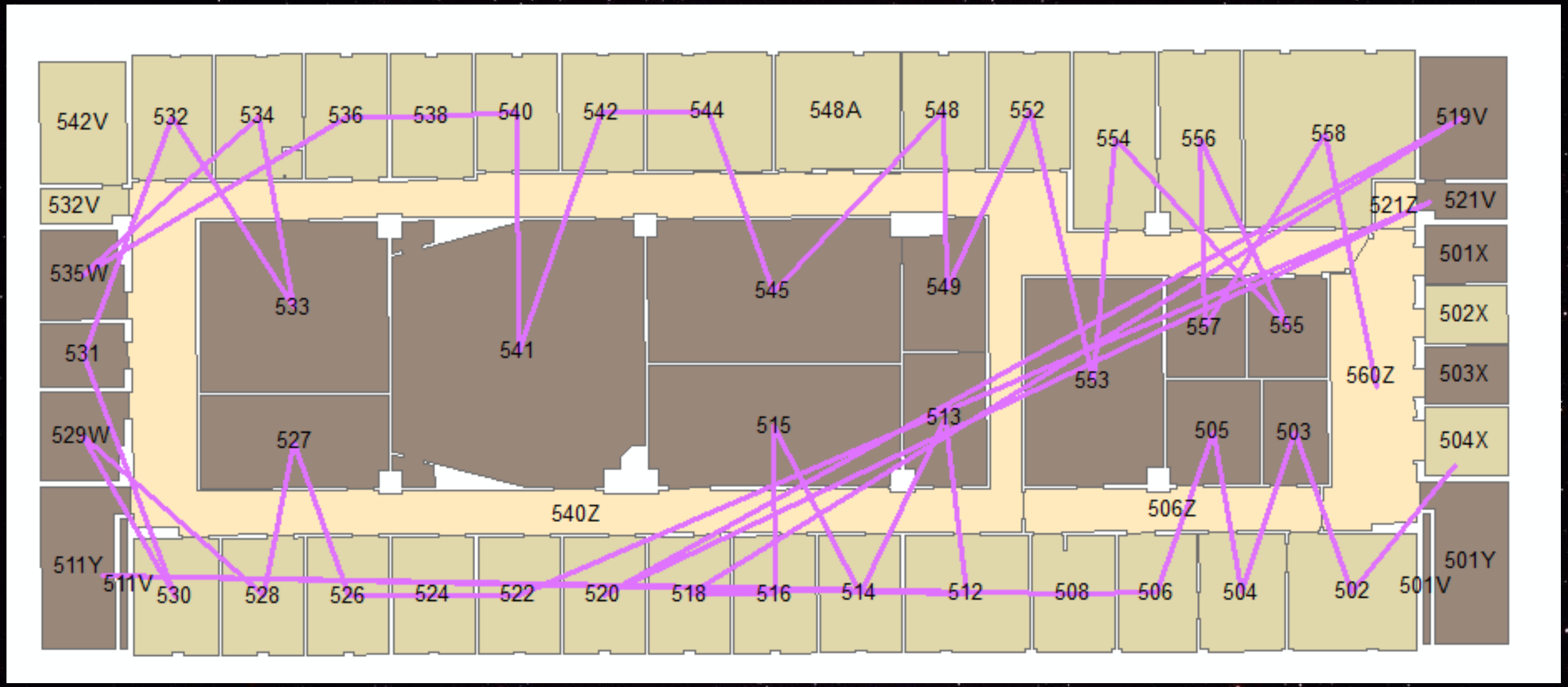
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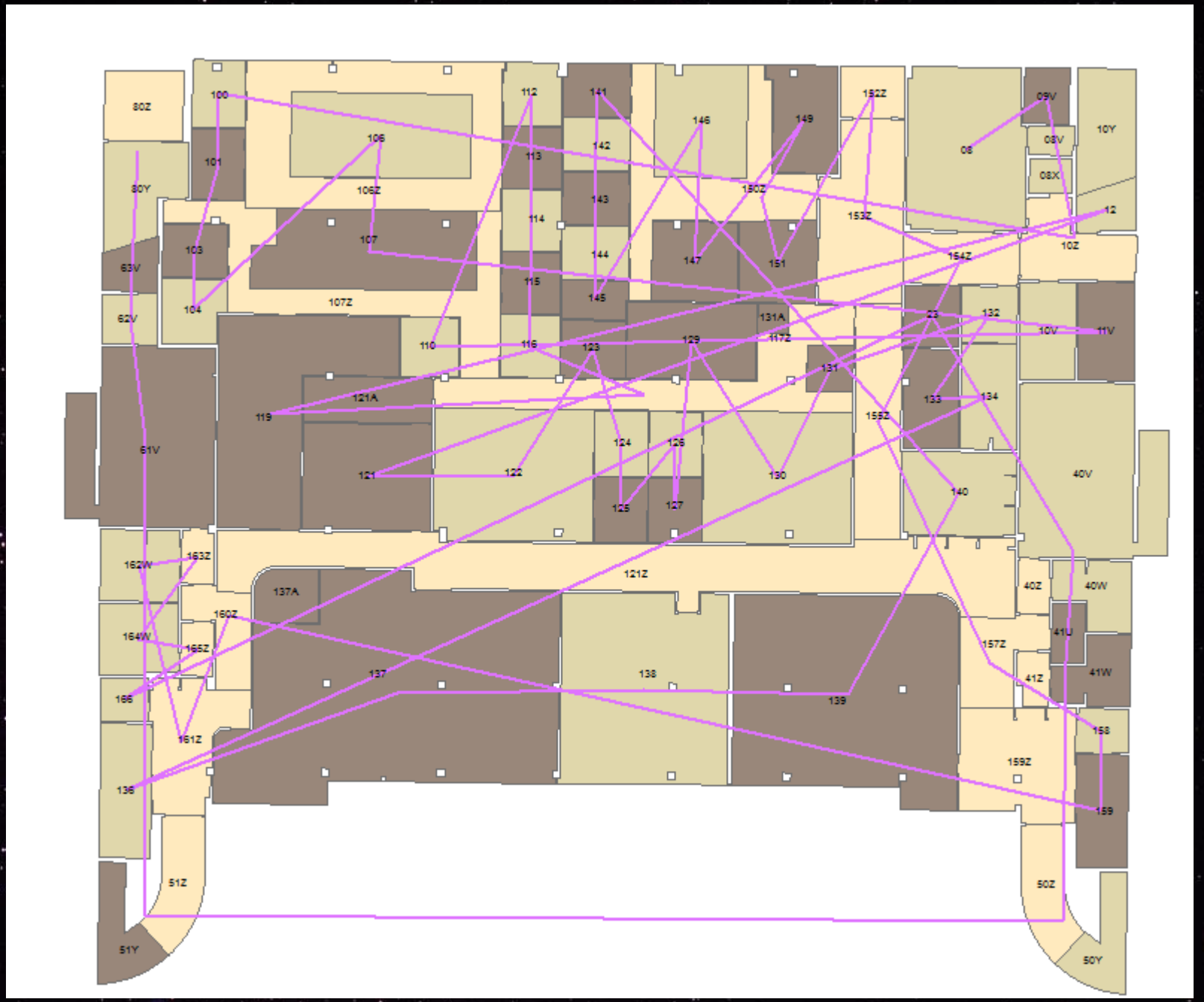
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Monitoring Change

Python scripts used to detect change during monthly updates

AFM Room Changes in Ops

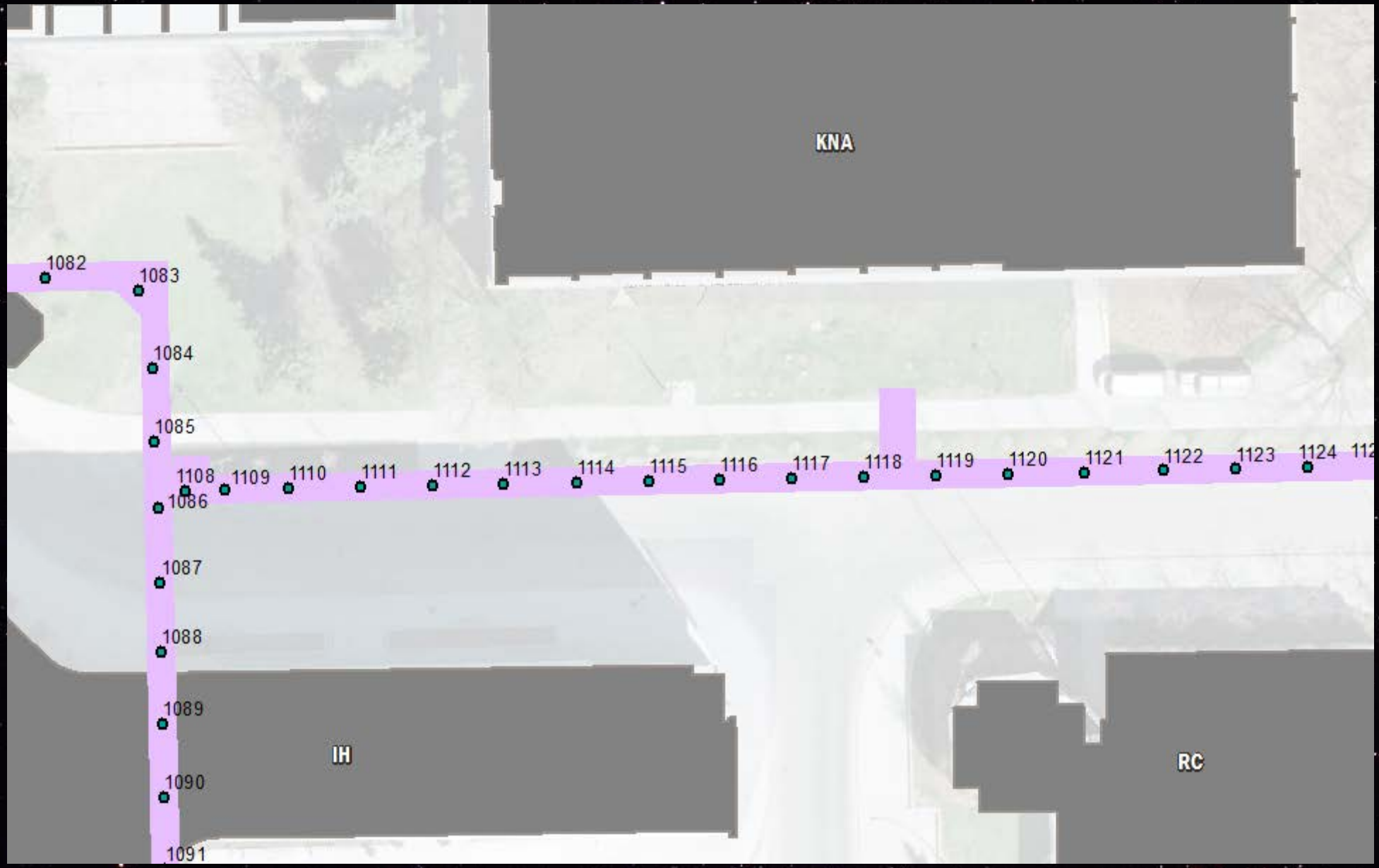
These are the room changes (adds and deletes) between \\UC
\UCMAPS\Apps\AFM\Resources\RoomArchive.gdb\Rooms_20
\UCMAPS\Apps\AFM\Resources\RoomArchive.gdb\Rooms_20

Total Adds: 141.
Total Deletes: 118

BLD_FLR_RM_ID	EHANDLE	Operation
BI_01_199C	E0	Delete
BI_05_59OH	310D9	Delete
CHF_01_113	1AD	Add
CHF_01_113A	1AE	Add
CHF_01_114	1AF	Add
CHF_01_115U	2EE	Add
CHF_01_116	1B8	Add
CHF_01_117	1BD	Add
CHF_01_118	1B0	Add
CHF_01_119	1BE	Add
CHF_01_120	1B7	Add
CHF_01_121	1BF	Add
CHF_01_122	1B1	Add
CHF_01_123	1C0	Add
CHF_01_124	1B6	Add
CHF_01_125	1C1	Add
CHF_01_126	1B2	Add
CHF_01_127	1C8	Add
CHF_01_128	1B5	Add
CHF_01_129	1C5	Add
CHF_01_130	1B3	Add
CHF_01_132	1B4	Add
CHF_01_134	1C6	Add
CHF_01_136	1C3	Add
CHF_01_F113	1AD	Delete
CHF_01_F113A	1AE	Delete
CHF_01_F114	1AF	Delete

Verify the data

Map out tunnel utilities

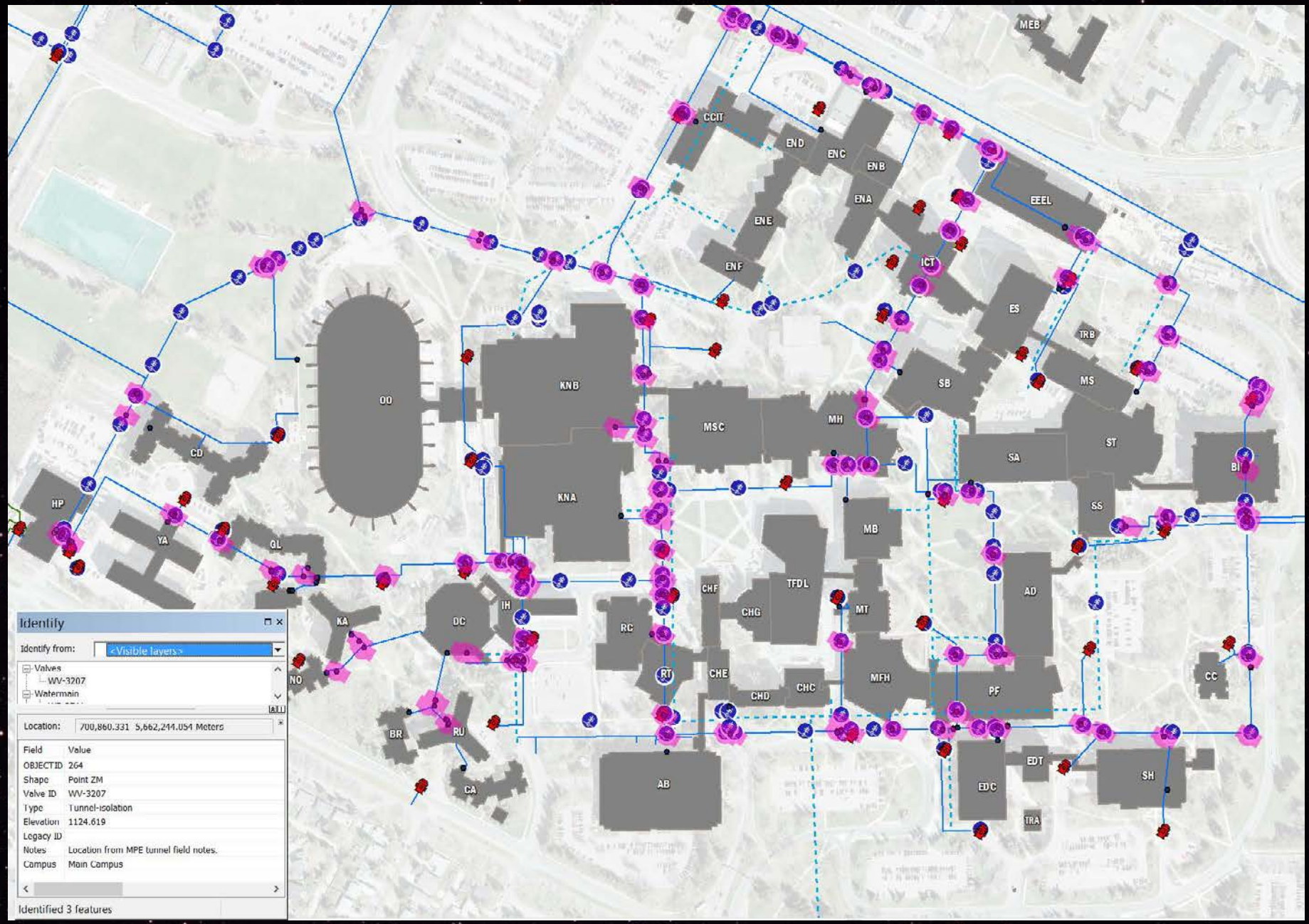


Overlay existing CAD drawings

Verify accuracies

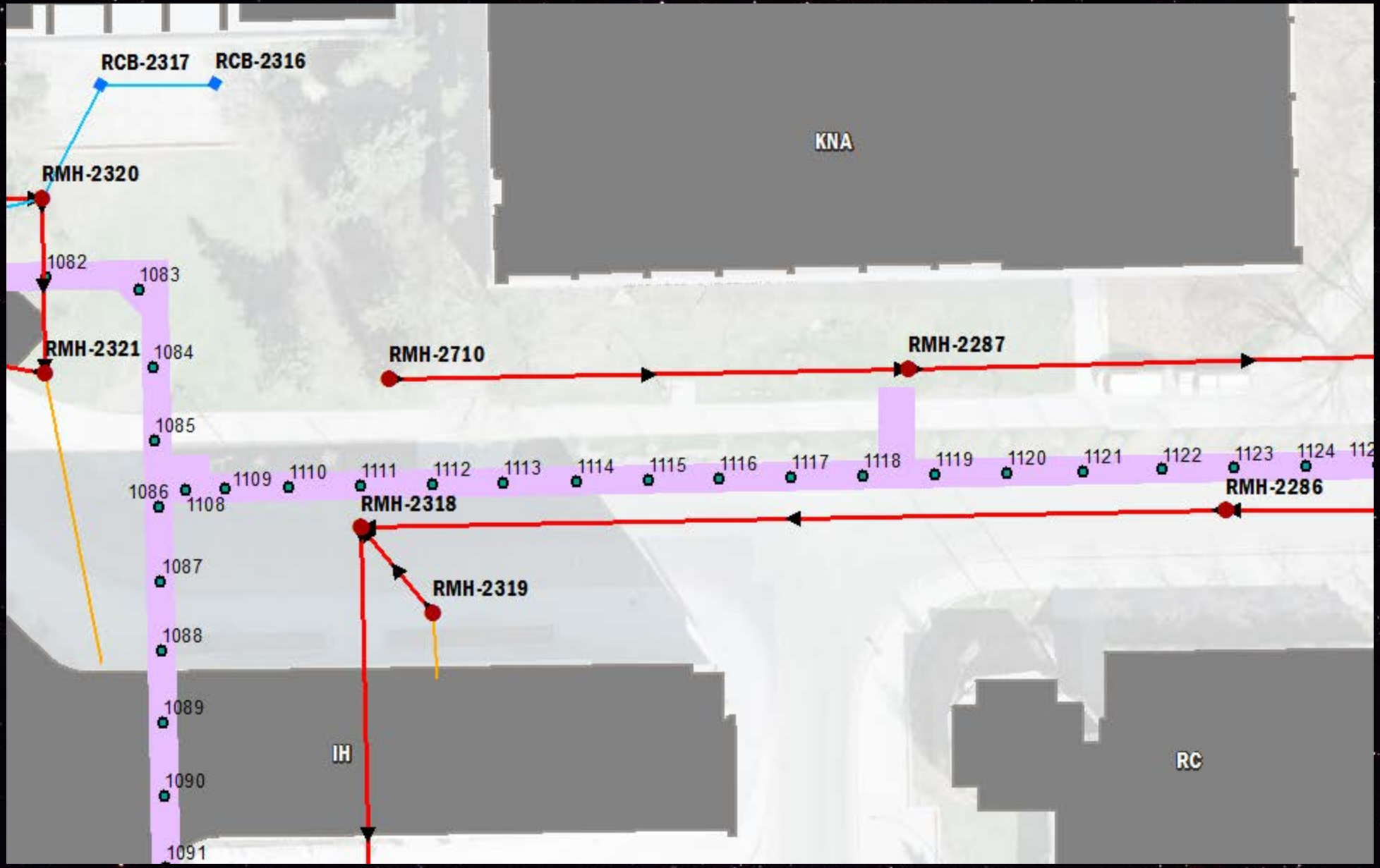
Tunnel Video

Map out differences

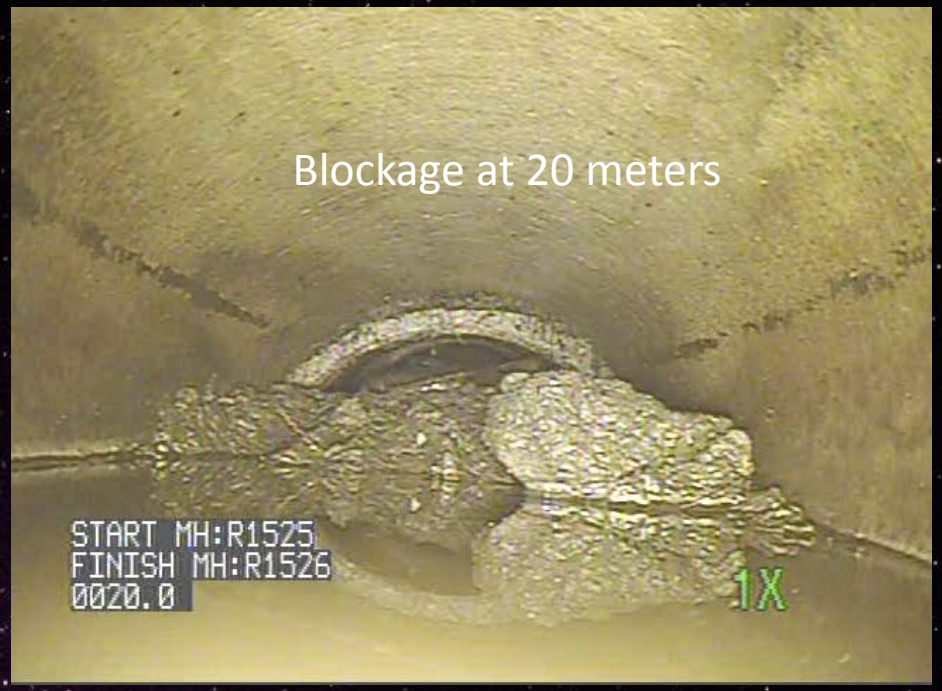


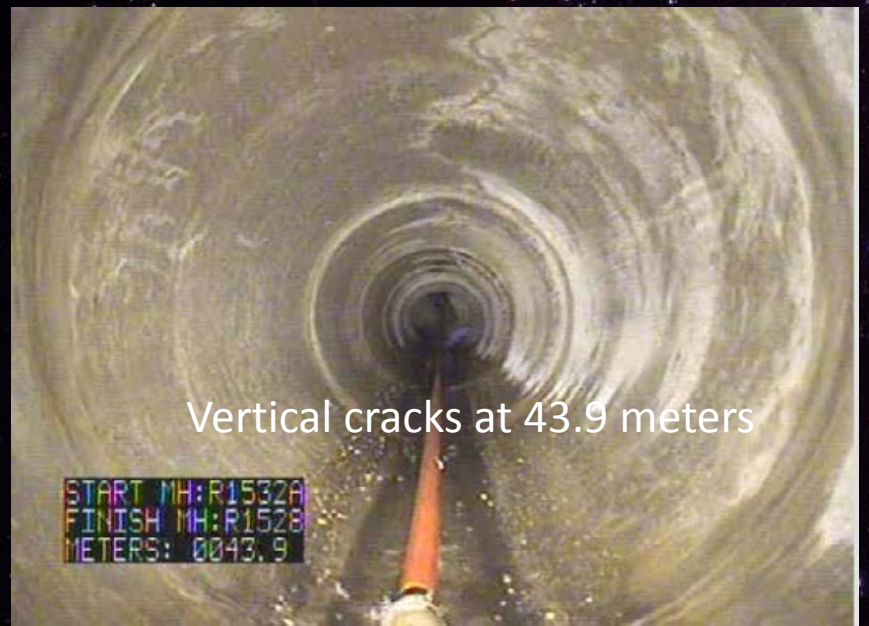
Linking Surveys to Websites

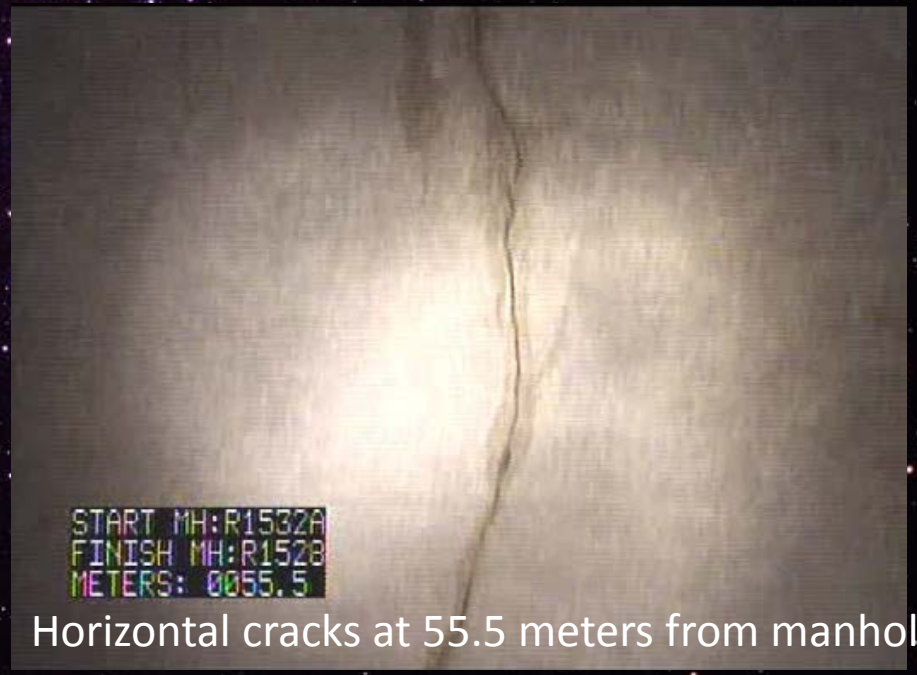
Input external data sets



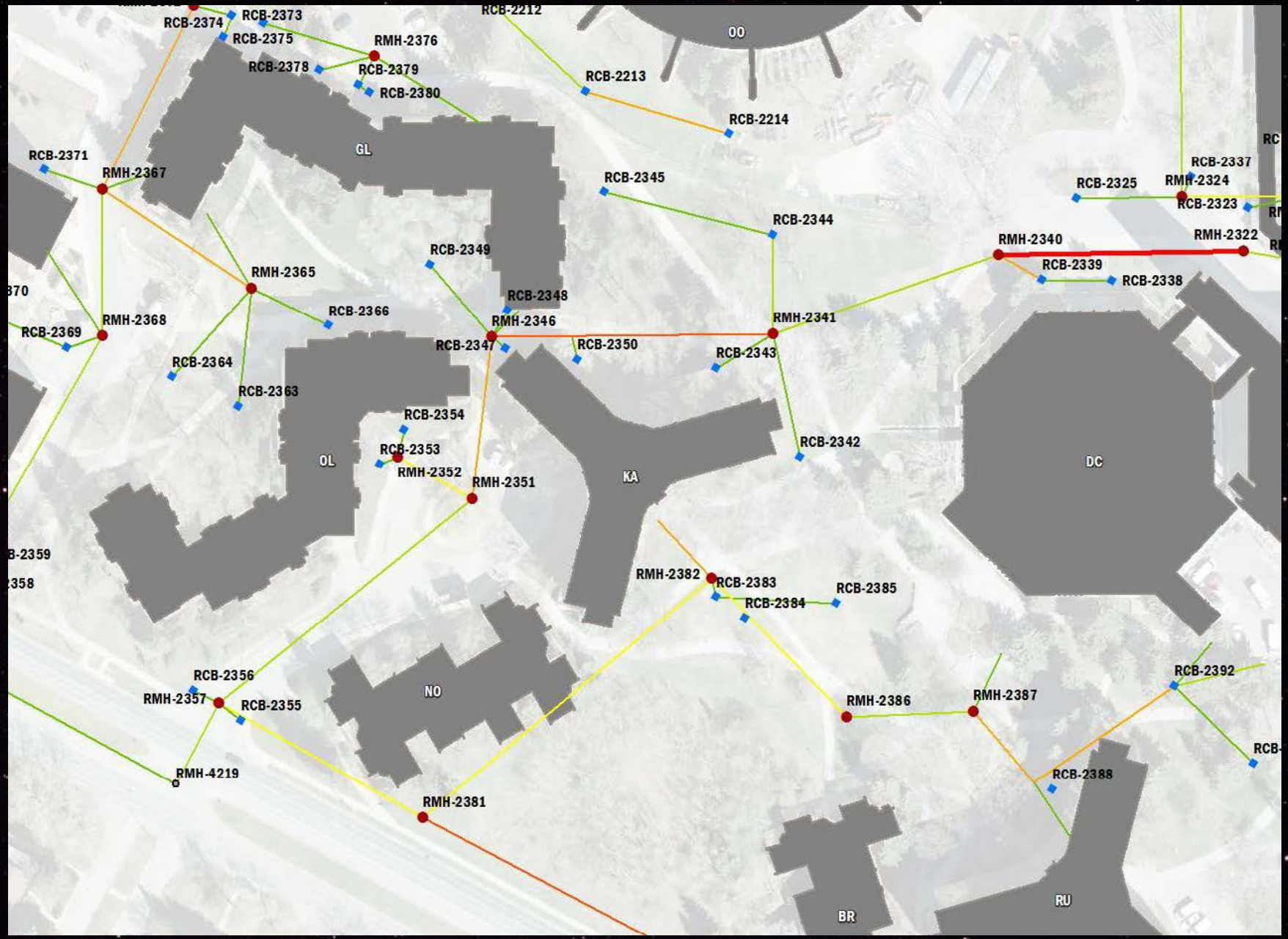
Contract Utility Assessment







Generate RISK assessment maps



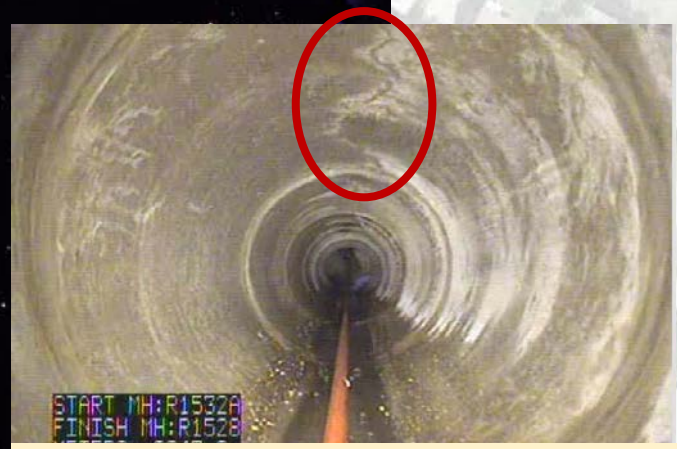
Risk of Failure

- 1
- 2
- 3
- 4
- 5

Link data/videos to GIS to generate business plans

Pipe Separation @ 41.7 meters from manhole

Horizontal cracks at 55.5 meters from manhole



Vertical cracks at 43.9 meters from manhole

Future Plans

Fully Automated Network systems

- edit both attribute & vector data
- mobile based
- remotely sensed data collection
- dash board interface for utility usage

Fully Automated Network systems

- edit both attribute & vector data
- mobile based
- remotely sensed data collection
- dash board interface for utility usage

Integrated Records systems

- record document retrieval system
- spatial record layer overlays
- project management / GIS phase projections

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