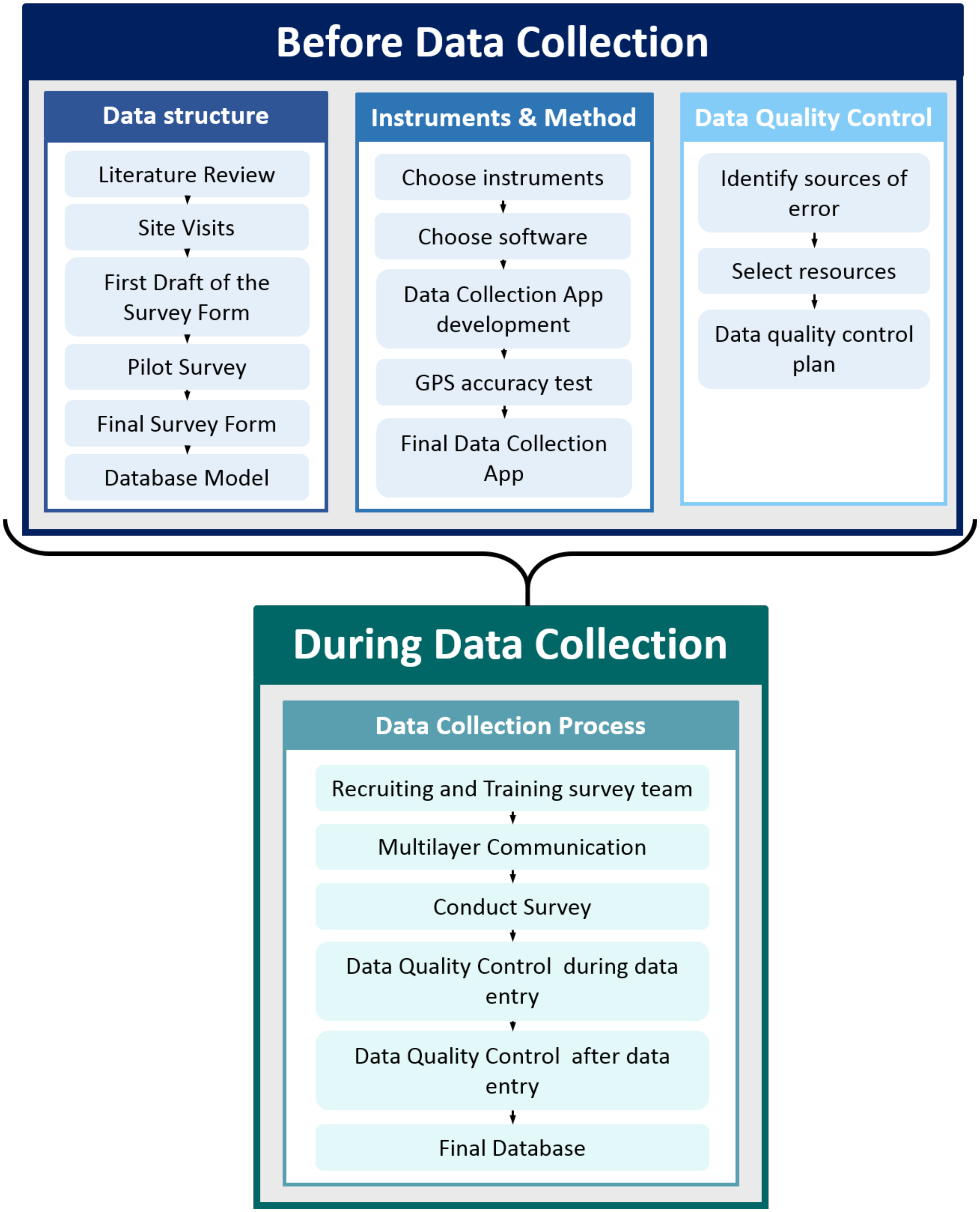
3. METHOD OVERVIEW AND STEP-BY-STEP PROCESS TO CONDUCT A PRIVATE INVENTORY SURVEY



Step 1: Determine study parameters

Based on project scope and budget, determine at the outset the:

- Scope/size of desired study area.
- Number of private infrastructure to inventory. Use pre-existing GIS databases, like transportation network. If no database or no private infrastructure is in database, estimate using the number of city blocks in the study area.
- Data-collection hours. Daylight hours only are recommended for security reasons. Low-activity periods (e.g. weekends) are acceptable.

Seattle private infrastructure project at a glance:

Data-collection period: Four weeks in July and August 2017

Study area: 421 city blocks covered by four data collectors

Total person-hours to examine and collect data on the 96 private freight loading/unloading infrastructures: 230

Step 2: Define private infrastructure features of interest or use Urban Freight Lab-identified features

Myriad design standards, city reports and research papers were reviewed to include in the survey the features below that impact private infrastructure operations.

Location features (apart from geolocation) including:

- Road type used to access the private infrastructure (e.g. alley, street)
- Traffic flow direction of the access road above
- Infrastructure inside or outside the building
- Needed clearance to access the private infrastructure

Design features including:

- Access point dimensions (e.g. width and height for vehicle doorway and dock doorway)
- Ground clearance: shortest distance between vehicle tire and infrastructure's upper level
- Specifics on how vehicles access the infrastructure, including:
  - Access angle to the infrastructure: angle between vehicle access and traffic flow
  - Whether the vehicle needs to back-in
  - Security access measures (e.g. physical barriers, access code, any personal interaction needed to gain access.)

Capacity features related to parking spaces and mechanical devices, such as:

- Number of parking spaces
- Apron: space for parking and maneuverability
- Presence of a dock platform and dock-levelers

Step 3: Draft and pilot field survey

Pilot-testing the draft survey in a six-block area gave the research team critical information about what features data collectors could not capture in the field from the public right of way (e.g. sidewalks and alleys.) This led to elimination from the survey features such as turning radius, maximum truck size, and centerline distance.

Other projects may require adaptation of the final UFL survey form, which should be pilot tested to enable cities to:

- Estimate the time needed to survey each infrastructure, including walking time between survey locations;
- Identify potential problems with the survey logic, and;
- Test data-collection methods and instruments.

Vis a vis survey logic, data collectors created a record for each loading bay entrance/exit to record individual features of each loading bay.

Having collectors stand on public sidewalks and in alleys can help avoid the time and effort involved in having to secure prior permission requests.

Step 4: Select data-collection tools

It is recommended that the chosen tools of the data-collection method be:

- Able to measure metrics with sufficient accuracy
- Easy to transport
- Reasonably priced
- Available as off-the-shelf technology

The UFL research team created what is thought to be a first-of-its-kind mobile-app-based private infrastructure inventory data-collection instrument. This allows manual input of the infrastructure location, supported by offline basemaps, enabling the research team to avoid the cost of having a wireless Internet plan for the tablets to support data collection. Once collected, data can be uploaded using the Wi-Fi option.

Additional tools in the UFL project and their unit price are below:

INSTRUMENT	UNIT PRICE ($)
Laser measuring device	80
iPad mini 2 with 32 GB and Wi-Fi and cellular option*	300
Portable power bank	11
iPad Case	90
Security Vest	17.9
Clipboard	2

*This instrument may not be required if the survey instrument is paper-based.

Step 5: Choose software and program data-collection app

Select database management software that allows for:

- Controlled submission or input of data
- Data storage in different formats, including databases with relationships, geodatabases and cloud storage
- Multiuser data editing
- Set data rules and relationships
- Secure data
- Data-collection app

These criteria enable effective data management, data quality control and scale-up of data collection with multiple staff.

Using ESRI GIS software Survey123, ArcView and ArcGIS Online for the survey form and data-collection process on tablets allows for seamless visualization of collected data and its editing. Survey123 allows selection of the most appropriate basemap to assist the geolocation input. An appropriate basemap can be created incorporating various elements as needed/available in a given city.

In Seattle, researchers chose the World Street basemap (from ArcGis.com viewer last updated July 2017) preloaded within ArcGIS software. Existing GIS data of the location and key names of loading bays in Seattle's Center City area were added from government databases and others.

Step 6: Use pilot learning to create final survey, data structure, metadata and data quality-control plan

Final survey should include the key private infrastructure attributes identified in Step 2 and vetted via pilot testing.

Identify and create plan to prevent three common error types in this project type:

1. **Positional error**: inaccuracies in GPS coordinate readings due to device issues (e.g. low satellite signal in urban canyons) and human error in manually collecting data on tablets
2. **Attribute error**: associated with non-spatial data collected (e.g. incorrect data entry due to wrong measurements or mistyped data; lack of access to needed data due to obstructions or safety issues)
3. **Conceptual error**: around identification/classification of alley attributes or related information.

Follow quality-control protocols before data collection, during data entry, and after data entry that involve supervisors, data collectors in field, and related technologies and inventory survey app (programmed to limit data-entry inaccuracies.)

Define roles and respective quality-control responsibilities.

Supervisor(s) define/enforce data-collection standards and methodology; train data collectors; monitor/maintain database and handle data-control measures before data collection/after data entry.

Collectors enter data in field and run same-day data quality-control checks after data entry.

Survey app digital and online tool creates entry constraints/eases digitization as data are collected.

Carrier refers to the private company (United Parcel Service, UPS, an Urban Freight Lab member) that collaborated with the research team to review survey locations when it was unclear if the locations were used for freight operations, such as when locations had a closed door during the survey. The carrier-check happens after collectors finish their same-day checks.

Step 7: Recruit and train data collectors

Recruiting: Project budget; timeline; survey length/complexity; security concerns; time needed for in-field collection, including commute time to/within study area, and in-office quality-control determine number of data collectors and supervisors needed. Deploying collectors in teams of two improves security and enables efficient operation of data-collection instruments (e.g. laser measurement device, measuring wheel, iPad, etc.)

Training: At least three distinct data-collector training sessions are suggested, with first and third done in classroom-type setting and second done in field.

1. **First session**: Covers alley concepts, attributes, project overview, shift information and security/safety.
2. **Second session**: Covers practical aspects of data collection such as how to: use questionnaire in tablet app; take accurate measurements with the laser and wheel devices; effectively divide collection work between the two collectors; use hard-copy maps that divide study area into sectors; follow safety/security protocol.
3. **Third session**: Covers how to access survey data results and properly clean data after each field shift.

Step 8: Collect data

Ensure territory assignments formed, hard-copy maps printed for each team/shift.

Develop check-out/check-in process for collectors' needed shift materials.

Form work shifts around geographic area depending on collectors' schedules and shift lengths.

Instruct collectors to work in teams of 2 so one can input survey and measurements via app/tablet while the other takes measurements, updates hard-copy inventory sheet, and maps each location.

Collect GPS coordinates (geopoints) manually by dropping a pin on the map at the infrastructure location. Then use Survey123 to average multiple GPS readings. This process yielded better precision/reliability in field testing than automatic geopoint collection alone.

Establish comprehensive security protocol and multilayer communications plan for all interested parties to avoid unsafe situations in field, including instructing data collectors to:

- Not enter loading areas if uncomfortable, including due to vehicles obstructing loading area access
- Exit loading areas at any point if uncomfortable while collecting features
- Carry official documents from sponsoring agency (including agency official contact information) explaining project and granting data-collection authorization.

Recruit and inform police and other relevant agencies to help communicate with all building managers in the survey area.

- In Seattle, police notified all survey area building managers in real time where/when collectors were working via pre-existing information exchange for building operators and the police.
- Seattle Department of Transportation webpage communicated to public and stakeholders where and when data collectors were working.

Step 9: Clean, assemble and summarize data

Conduct comprehensive data clean. In Seattle, collaborating with UPS drivers who regularly serve the study area to identify whether locations with closed doors during the survey collection were/were not used for loading/unloading enabled the UFL team to reduce inventory uncertainty from 33% to ≤ 1%.

Assemble data in final format that best meets city and/or researcher needs.

Seattle format included these features:

- Geodatabase with private infrastructure represented as point feature layer on GIS map
- Corresponding attribute table stored most private infrastructure information
- JPEG files with a naming convention allowed stored photos of private loading/unloading infrastructure features to easily link to the corresponding infrastructure