

MINNESOTA DEPARTMENT OF TRANSPORTATION

MINNESOTA DISTANCE BASED USER FEE DEMONSTRATION

Test Plan

VERSION 1.0

MARCH 2020



REVISIONS

VERSION	DATE	CHANGES
1.0	03/05/2020	Initial Test Plan development

TABLE OF CONTENTS

	REVISIONS	I
	ACRONYMS	V
1	SCOPE	6
2	ROLES & RESPONSIBILITIES	9
3	STRATEGY	10
3.1	Test Phases.....	10
3.2	Punchlists	11
3.3	Traceability.....	11
4	TESTING SCENARIOS.....	12
4.1	System Needs	12
4.2	Data Collection	12
4.3	Data Processing	13
4.4	Reporting.....	14
5	TEST PROCEDURES.....	15
5.1	Unit Testing.....	15
5.2	Integration Testing	17
5.3	Dry Run.....	18

ACRONYMS

C/AV	Connected/Automated Vehicle
CSV	Comma Separated Values
DBUF	Distance-Based User Fee
MnDOT	Minnesota Department of Transportation
PII	Personally Identifiable Information
RACI	Responsible, Accountable, Consulted, Informed
Revenue	Minnesota Department of Revenue
SM	Shared Mobility
VCRI	Verification Cross Reference Index
VSI	Vision Systems Intelligence
XLS	Microsoft Excel file extension (1997-2003)

1 SCOPE

The Minnesota Department of Transportation (MnDOT), in partnership with the Minnesota Department of Revenue (Revenue) and its Research Partners, the University of Minnesota, Humphrey School of Public Affairs (Humphrey School) and WSP USA, will conduct a 12-month Distance-Based User Fee (DBUF) demonstration to confirm the ability to accurately and securely collect travel data from Shared Mobility (SM) providers' vehicle fleets and Connected and Automated Vehicles (C/AV) to assess a simulated DBUF tied to road use.

The demonstration will be conducted in three stages, each stage progressively building upon the previous. Testing will be conducted for each stage of the demonstration, focusing on the requirements for that specific stage.

The following describes how each of the 3 stages of the demonstration will operate:

- Demonstration Stage 1 – No Formal Reporting (~4 months):** Monthly, SM providers will sanitize and aggregate travel data and transmit the datasets to the shared demonstration data repository. The C/AV Researcher may generate datasets for use in analyses and simulated reporting. MnDOT's research partners, the Humphrey School and WSP USA will conduct simulated financial reporting to the State, using information provided by the SM providers. The research partners will work with the State and SM providers to develop the Revenue Report template to be used in subsequent stages. The State may conduct initial mock audit inquiries with SM Providers, based on aggregated data transmitted. The Research Partners will conduct analyses on transmitted data.

Minnesota Distance-Based User Fee Demonstration – Stage 1

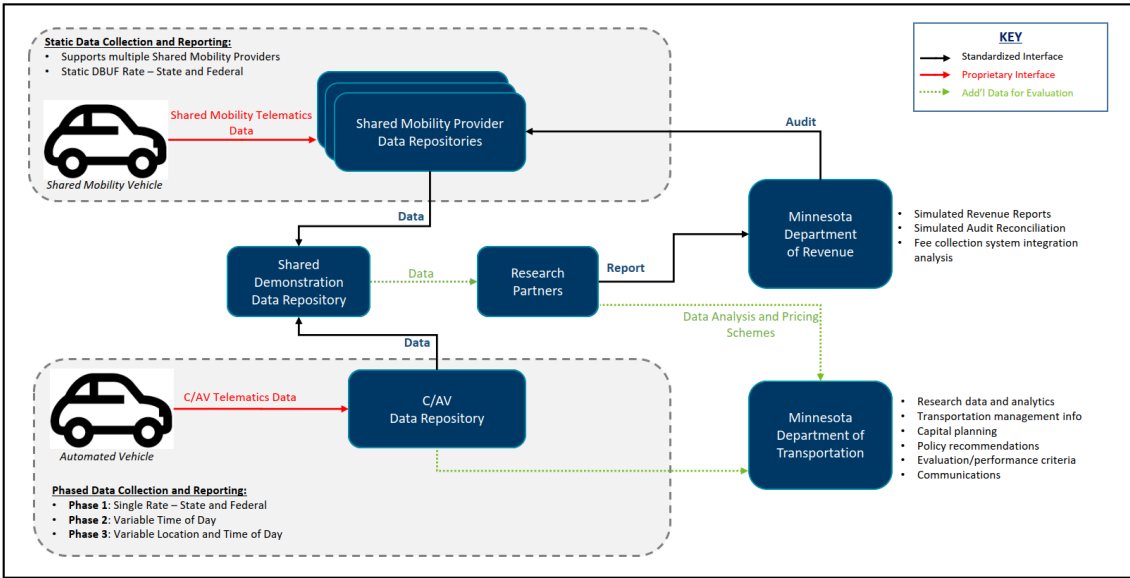


Figure 1: Minnesota DBUF Demonstration Architecture – Stage 1 No Formal Reporting

- Demonstration Stage 2 – Initial Revenue Reporting** (~4 months): Monthly, SM providers will sanitize and aggregate travel data and transmit the datasets to the data repository. SM providers will also assess DBUF and fuels tax rates on the aggregated data, generate a Revenue Report (using the template designed in Stage 1) and transmit the report to the data repository for validation by the research partners. The C/AV Researcher may generate datasets for use in analyses and simulated reporting. The State may conduct mock audits with SM Providers, based on aggregated data. The research partners will conduct analyses on transmitted data.

Minnesota Distance-Based User Fee Demonstration – Stage 2

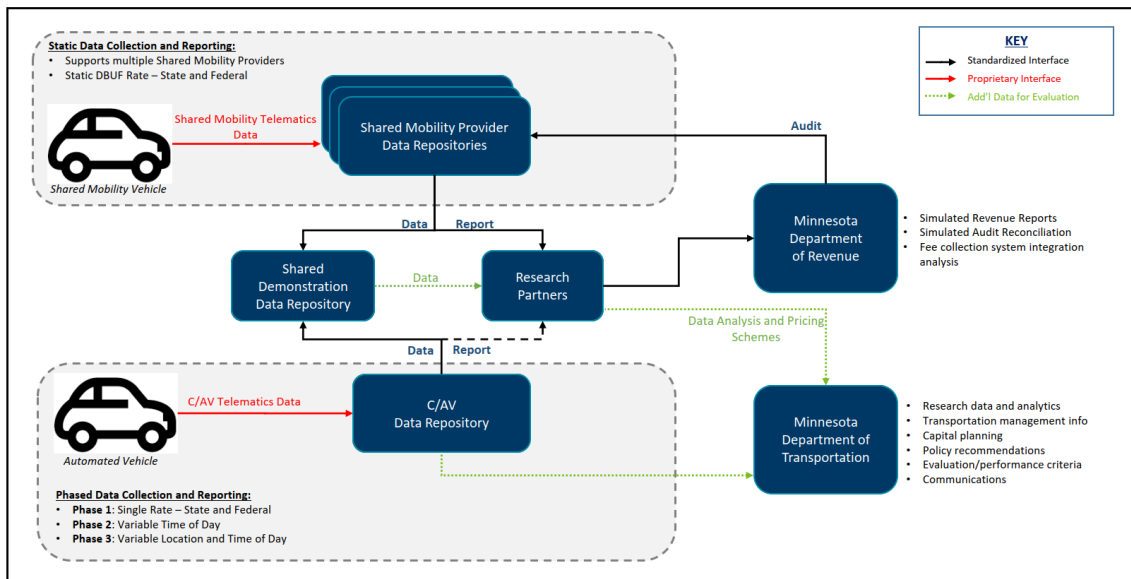


Figure 2: Minnesota DBUF Demonstration Architecture – Stage 2 Initial Revenue Reporting

- Stage 3 – Final Revenue Reporting** (~4 months): Monthly, SM Providers will sanitize and aggregate travel data and transmit the datasets to the shared demonstration data repository. SM Providers will also assess DBUF and fuels tax rates on the travel data, generate a Revenue Report and transmit the report to Revenue directly for simulated tax reporting, mock auditing, and demonstration evaluation purposes. The C/AV Researcher may generate datasets for use in analyses and simulated reporting. The Research Partners will conduct analyses on transmitted data.

Minnesota Distance-Based User Fee Demonstration – Stage 3

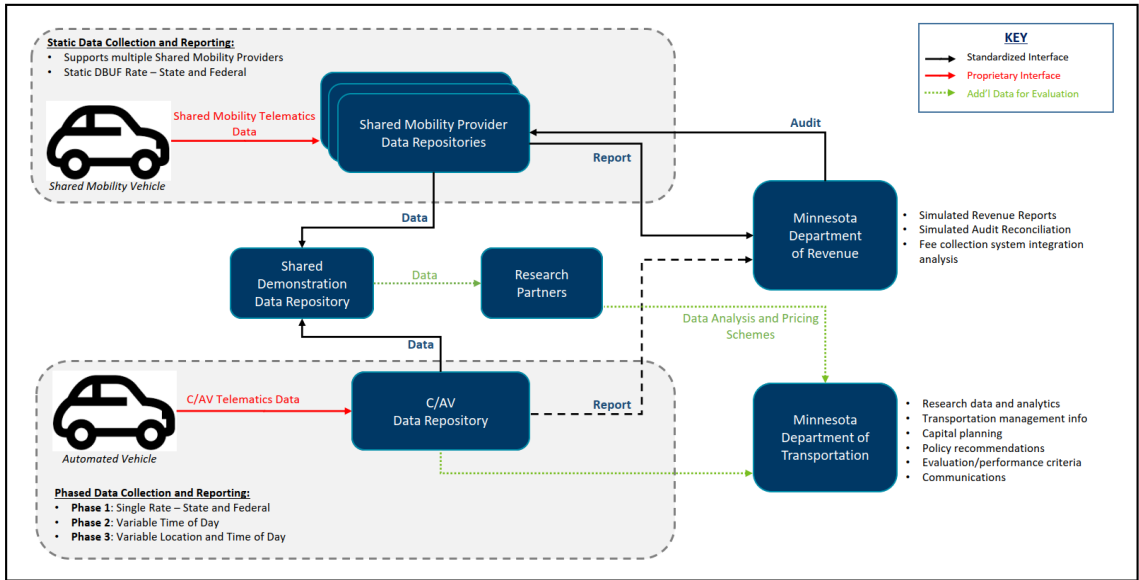


Figure 3: Minnesota DBUF Demonstration Architecture – Stage 3 Formal Revenue Reporting

2 ROLES & RESPONSIBILITIES

There are several entities involved in demonstration testing:

- **Minnesota Department of Transportation (MnDOT):** Demonstration testing oversight and approval of results for all testing phases.
- **Minnesota Department of Revenue (Revenue):** Review of simulated revenue reports and conducting mock audits on submitted reports.
- **University of Minnesota, Hubert H. Humphrey School of Public Affairs (Humphrey School):** Support test case development and validation to confirm the demonstration is designed in a way to address evaluation criteria, and support data analyses activities.
- **WSP USA:** “Technical Team” – Establish and manage test plan, strategy, cases, environment and exit criteria. Review test results from SM Providers and C/AV Research Partner through all phases of testing. Coordinate Dry Run with all participating entities.
- **SM Providers (Zipcar & HOURCAR)** – Execute test cases to complete unit, integration, and acceptance testing, report results and resolve issues to confirm compliance with all SM Provider requirements.
- **C/AV Research Partner (Vision Systems Intelligence (VSI))** – Execute test cases to complete unit, integration, and acceptance testing, report results and resolve issues to confirm compliance with all C/AV requirements. VSI will also be responsible for standing up and maintaining the shared demonstration data repository, and supporting the repository during integration testing.

The following RACI table describes the responsibility of each entity during testing.

TESTING ACTIVITY	SM Providers (Zipcar & HOURCAR)	C/AV Research Partner (VSI)	WSP USA	Humphrey School	MnDOT	Revenue
Conduct Unit Testing	R	R	A			
Validate Unit Testing Results			R	I	A	I
Conduct Integration Testing	R	R	A			
Validate Integration Testing Results			R	I	A	
Conduct Dry Run (Acceptance Testing)	R	R	R	C	R	C
Validate Dry Run Results			R	C	A	C
Create Punchlists	C	C	R	I	A	I
Final Testing Approval and Go/No-Go to Launch Demonstration	C	C	R	I	A	I

Table 1: Demonstration Testing Roles & Responsibilities RACI Chart

3 STRATEGY

3.1 TEST PHASES

The technical team, in concert with the SM providers and C/AV research partner, will conduct testing on all systems, processes, and components to ensure each demonstration requirement is met (“Unit Testing”). The technical team will then test the overall systems integration, validating that data can be seamlessly and securely transmitted from the SM providers and C/AV research partner to the shared demonstration data repository and the State (“Integration Testing”). The overall project team will then conduct an acceptance test (“Dry Run”) to test end-to-end demonstration functionality. Each testing phase is described in more detail below.

The successful completion of each progressive test stage will serve as the entry criteria for the next stage. Only when all tests are successfully executed and MnDOT has signed off on test results will the systems, technologies, and processes for the demonstration be considered ready for launch.

3.1.1 UNIT TESTING

The technical team, SM providers and C/AV research partner will conduct unit testing of all systems and processes to be used during the demonstration, necessary to prove compliance with all demonstration system and business requirements. Unit testing will include data collection, data processing, and simulated revenue reporting.

SM providers and the C/AV research partner will provide a suite of documentation (manuals, procedure documents, data sheets, etc.) as well as conduct a series of test cases to simulate demonstration operations functionality, in order to successfully prove compliance with each of the business and system requirements defined for the demonstration.

Unit testing will occur for each of the 3 demonstration stages, to validate the requirements developed specifically for the respective stage.

3.1.2 INTEGRATION TESTING

The technical team, SM providers and C/AV research partner will conduct integration testing of all demonstration interfaces. Integration testing will include verifying connectivity of each participating entity to the shared demonstration data repository, successful upload of datasets and simulated revenue reports, and validating data and reports are correctly formatted and include all required data/fields, per the interface specifications. The technical team will coordinate integration testing activities with each provider to verify interface connectivity and compliance with interface requirements.

Integration testing will occur for each of the 3 demonstration stages, validating interfaces/reports designed for the respective stage.

3.1.3 DRY RUN

Following successful completion of unit and integration testing for each demonstration stage, the technical team, SM providers and C/AV researcher will conduct an end-to-end Dry Run test of the demonstration. MnDOT, Revenue, and the Humphrey School will also witness testing during the Dry Run and review Dry Run results. The Dry Run will validate demonstration stage 1 functionality, including data collection, data processing and aggregation, and reporting to the shared demonstration data repository. The technical team will coordinate with each provider to launch and operate the Dry Run. At the end of the Dry Run, the technical team will compile the results and conduct a “hot wash” with all entities that operated or contributed to the Dry Run to discuss outstanding issues, proposed changes and updates to meet the needs of the demonstration, and the potential impacts of any changes. The Dry Run is the final step to validate the system is ready to launch into demonstration operations.

For demonstration stages 2 and 3, unit testing results for those respective stages will be used to generate appropriate Dry Run testing and results.

3.2 PUNCLISTS

In the event a test is not successfully executed, or a requirement is not fully met through one or more tests, the item’s level of criticality to the remainder of testing and ultimately demonstration operations launch will be evaluated. If an item is not critical to overall operation of the system, the item will be “punchlisted”, allowing the progression of testing without fully completing the testing phase the item was punchlisted in. All punchlisted items will be reviewed with MnDOT at time of assignment to the punchlist, and will be reviewed at regular check-ins with MnDOT and the providers to evaluate the progress of further testing to move the item into compliance.

3.3 TRACEABILITY

Test cases will be defined for each requirement, serving as a guideline for how each requirement is expected to be met (with either documentation or test results). The test cases are defined in a verification cross reference index (VCRI), which lists the requirement and the associated test case, and provides a mechanism to track the status of compliance for each requirement during testing.

4 TESTING SCENARIOS

The demonstration is divided into three main operational processes: Data collection, data processing, and reporting. The demonstration also includes overarching system needs that drive system security, privacy protection, and other systemwide specifications. Testing will leverage these concepts to organize testing scenarios into logical test groups and cases.

4.1 SYSTEM NEEDS

The overarching demonstration system includes all subsystems, operational processes, activities, components and functions of SM and C/AV Providers, Research Partners and the State needed to successfully operate the demonstration. The overarching demonstration system will be tested to confirm it is secure, reliable, auditable, protects privacy and promotes safe and reliable operations.

- **Security:** Verify the system applies controls and safeguards to protect the system from malicious activity and protects information and operations.
 - **Data Privacy and Protection:** Validate demonstration data is protected from unauthorized access, and correctly classifies and protects personally-identifiable information (PII).
 - **Reliability and Availability:** Verify the system consistently functional and that any downtime does not negatively impact to demonstration data collection, processing and retention.
 - **Auditability:** Verify data retention and destruction policies to support demonstration needs, and confirm alignment with industry standards to support auditing and traceability.
 - **Safe and Reliable Operations:** Confirm that systems and technologies used to operate the demonstration do not compromise the safety of participating vehicles, vehicle users, or a provider's normal business operations.
-

4.2 DATA COLLECTION

The Data Collection operational process leverages the SM Provider's and C/AV Researcher's existing systems and technologies to collect relevant travel data from participating vehicles and transmit the data to the SM Provider's and C/AV Researcher's internal data repository for further processing. Testing of Data Collection includes several key activities:

- **Prepare Vehicle:** Verify that participating vehicles are uniquely identified and prepared to accurately collect the required demonstration data.
- **Collect Trip Data:** Verify that trip/travel data is collected from participating vehicles in a way that supports the accurate calculation and reporting of a DBUF.

- **Collect Location Data:** Verify that SM Providers collect, at a minimum, vehicle origin and destination data for participating vehicles; Verify that the C/AV researcher collects detailed location differentiation data using geographic waypoints.
- **Collect Fuel Purchase Data:** Verify that fuel purchase data is collected from participating vehicles in a way that supports the accurate calculation and reporting of state and federal motor fuel taxes.
- **Transmit Collected Data:** Verify that the data collected from participating vehicles (miles, fuel purchase, and location) is transmitted to the respective provider's data repository / backend systems for further processing, at a frequency that supports demonstration reporting requirements.
- **Report Errors and Events:** Identify potential errors and events that may occur during the data collection process and how those errors/events are reported.

4.3 DATA PROCESSING

The Data Processing operational process leverages SM Provider's and C/AV Researcher's existing processes to receive data from vehicles, validate and process the data into transactions, and use the transactions to sanitize and aggregate the data for transmission to the DBUF demonstration third-party repository for simulated revenue reporting and analyses. The testing of Data Processing includes the following key activities:

- **Receive Transmitted Data:** Verify that data transmitted from the Data Collection mechanism(s) is received securely and is complete.
- **Assign Data to Vehicle:** Verify that the data received from the Data Collection mechanism(s) is assigned to the correct vehicle in the SM Provider's systems.
- **Process into Transactions:** Confirm that the received data is processed into logical, transaction records that are aligned with the correct vehicle and associated trips. Transactions may be grouped by trip, by reservation, by day, or another other logical grouping that is unique, traceable, and does not illogically split trips (for auditability).
- **Validate Data:** Verify that reasonableness/sanity checks are performed on transactions to confirm the validity and accuracy of the data.
- **Sanitize Data of PII:** Confirm that processed data aggregated for the demonstration do not include any personally-identifiable information (PII), including customer identity and customer billing/payment information.
- **Transmit Data to Repository:** Verify that sanitized, aggregated data is correctly transmitted to the shared demonstration data repository, in the format and frequency as defined in the requirements and interface specifications.

4.4 REPORTING

TEST SCENARIOS IN THIS SECTION WILL BE DEFINED DURING STAGE 1 OF THE DEMONSTRATION.

5 TEST PROCEDURES

The following section details procedures that serve as guidelines for successful execution and completion of each testing phase and the associated requirements.

5.1 UNIT TESTING

To successfully complete unit testing, both documentation and test results are expected to be used to verify compliance, based on the requirement being met.

Documentation will be used to verify process or policy based requirements, such as third-party compliance verification of an industry standard. Test results will be used to demonstrate how a component operates and complies with a requirement based on functionality.

Providers will submit a suite of documentation and a series of test results during the unit testing phase, clearly indicating in the VCRI which document or test case aligns with each requirement to prove compliance. See the VCRI/Test Cases document for information on the anticipated methods for compliance verification for each requirement.

WSP USA will coordinate unit testing with each provider, reviewing submitted documentation and test results to verify compliance status of all requirements. WSP USA will witness testing with each provider to verify compliance.

5.1.1 UNIT TESTING – DOCUMENTATION

SM Providers will provide copies of, or live access to (if company policies restrict providing copies), documentation appropriate to prove compliance with certain requirements.

Documentation may include, but is not limited to:

- Operations Manuals
 - Operations Process Documents
 - Operations Procedure Documents
 - Plans and Guides (e.g. Disaster Recovery Guide or Information Systems Plan)
 - Specifications / Data Sheets for systems or technologies
 - Production Manuals and/or Release Notes for systems or technologies
 - Statements of Attestation (Provider assumes liability through contractual statement)
-

5.1.2 UNIT TESTING – TEST RESULTS

The following procedures serve as a guideline for providers to simulate demonstration operations scenarios, for Stage 1 of the demonstration, to generate test results appropriate to validate unit test-level compliance requirements. During each step of these unit test procedures, one or more requirements will be validated using the test results to verify compliance.

UNIT TESTING PROCEDURES – STAGE 1 “NO FORMAL REPORTING”

Step	Procedure
1	Conduct normal carshare operations
2	Collect SM vehicle trip and location data <ul style="list-style-type: none"> • At least 4 vehicles • At least 3 trips per vehicle
3	Collect SM vehicle fuel purchase data <ul style="list-style-type: none"> • At least 4 vehicles • At least 2 fuelings per vehicle
4	Process and aggregate the data, per “Data Processing” requirements and interface specifications for Stage 1 datasets. Sanitize aggregated data of all Personally Identifiable Information (PII).
5	Compile aggregated datasets (mileage and fuel purchases) in a CSV or XLS format.
6	Identify and report any errors or events that occurred during data collection, processing or transmission. <i>Error and event reporting interface specifications to be designed collaboratively between providers and WSP USA during the unit testing phase.</i>

NOTE: Requirements and test cases for Stage 2 will be developed during Stage 1.

UNIT TESTING PROCEDURES – STAGE 2 “INITIAL REVENUE REPORTING”

Step	Procedure
1	Obtain a copy of a demonstration aggregated and sanitized dataset (as generated by the 10 th of the month following the reporting period).
2	Using the data from the dataset obtained in step 1, generate a simulated revenue report per the stage 2 interface specifications.
3	Access the shared demonstration data repository, using current credentials.
4	Access the appropriate repository folder for your organization.
5	Select the option to upload one or more files. Browse to and select the simulated revenue report generated during Step 2.
6	Verify the selected file was successfully uploaded to the appropriate repository folder.

NOTE: Requirements and test cases for Stage 3 will be developed during Stage 1 and 2.

UNIT TESTING PROCEDURES – STAGE 3 “FORMAL REVENUE REPORTING”

Step	Procedure
1	Obtain a copy of a demonstration operations simulated revenue report (as generated by the 10 th of the month following the reporting period).
2	Follow instructions provided in stage 3 interface specifications to transmit the simulated revenue report to the Minnesota Department of Revenue.

5.2 INTEGRATION TESTING

The following procedures serve as a guideline for providers to simulate demonstration operations interface connectivity and transmissions, for Stage 1 of the demonstration, to generate test results appropriate to validate interface requirements and specifications.

NOTE: Integration testing procedures for demonstration stages 2 and 3 are addressed as part of the unit testing procedures for those respective phases.

Step	Procedure
1	Compile aggregated datasets (mileage and fuel purchases) in a CSV or XLS format, per the interface specifications. <i>Compiled datasets created during Unit Testing may be used for this step.</i>
2	Access the shared demonstration data repository by clicking the weblink below: https://dbuf.vsi-labs.com/html/login.html
3	Log in to the data repository using your username and password. <i>You should have received instructions prior to this step to setup a new user account using your email address. If you have not received these instructions and/or have not setup a user account to access the data repository, please contact Markell Moffett (WSP USA) at markell.moffett@wsp.com</i>
4	Access the appropriate repository folder for your organization.
5	Select the option to upload one or more files. Browse to and select the compiled dataset generated during Step 1.
6	Verify the selected file was successfully uploaded to the appropriate repository folder.

5.3 DRY RUN

For the Demonstration Stage 1 Dry Run, the test procedures executed for unit and integration testing will be used or repeated to simulate the collection of SM vehicle data (trip, fuel purchase and location), processing and sanitizing the data, aggregating and compiling the data into the appropriate reporting format, and transmitting the data to the shared demonstration data repository. The Dry Run will contain no less than one week of vehicle data (trips, fuel purchases, and location).

MnDOT and its partners may choose to witness Dry Run testing and activities. This would include reserving a provider's carshare vehicle and taking one or more trips, then following those trips through the data processing, aggregation and reporting process. The technical team will work with MnDOT, its partners, and the providers to coordinate any test witnessing and evaluation during the Dry Run.

The technical team, in conjunction with providers, will compile Dry Run test results and a final Dry Run report to indicate whether the system is prepared and certified for demonstration launch.

Following successful completion of the Dry Run, and confirmation the system is approved for demonstration launch, the technical team and providers will purge systems of Dry Run data and prepare systems for demonstration launch into operations.

For demonstration stages 2 and 3, unit testing results for those respective stages will be used to generate appropriate Dry Run testing and results, to verify compliance with functionality added for stages 2 and 3, prior to launching that functionality into demonstration operations.