# ITS As A Data Resource Study

## Technical Memorandum No. 2
## Regional ITS Data Exchange System Architecture Analysis

Prepared for:

**Metropolitan Washington Council of Governments**

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# SECTION 1
# INTRODUCTION

## 1.1 STUDY BACKGROUND

Intelligent Transportation System (ITS) devices generate large amounts of operational data that are primarily in real-time to effect traffic control/management strategies. However, data from ITS field devices offer great promise for uses beyond the execution of ITS control strategies. ITS data from field devices and installations aggregated to the proper level can be used for transportation planning, engineering, policy, safety, operations and research. There is considerable interest around the country in planning and developing systems that can effectively use ITS-generated data for "traditional" transportation planning and engineering purposes. The fact that the National ITS Architecture now includes Archived Data as a User Service (ADUS) is symbolic of this interest.

In the Washington, D.C. Metropolitan Area, the Metropolitan Washington Council of Governments (MWCOG) and its member agencies decided to conduct a feasibility study and an implementation plan for using existing and planned ITS equipment. The study was sponsored by MWCOG's ITS as a Data Resource Working Group.

The Working Group was formed in early 1997 to examine opportunities for using ITS equipment as data sources for transportation planning. Members of the Working Group include interested members of the MWCOG Technical Task Force such as representatives from each of the Departments of Transportation (DOTs), local governments, transit agencies, and members of the private sector. The objective of the Group is to determine what ITS related data can be gathered and compiled using ITS equipment. The Working Group's efforts have culminated in the preparation of this study, which will ultimately lead to the design of a data sharing system, now referred to as the future "Regional ITS Data Exchange System (RIDES)."

MWCOG is the lead agency in this effort and has selected TransCore and VRPA Technologies to conduct the study. However, Phase 2 of this study as described below was completed solely by TransCore.

## 1.2 STUDY PURPOSE

As part of the study, an accurate inventory of the data and processes used by participating agencies for ITS data collection, storage and analysis was needed. It is important for studies of this nature to gather information on current and planned ITS data management operations (inclusive of data and processes) within the context of a common *data architecture* and *data management infrastructure*. This inventory was completed in Phase 1 of the study and was used to identify elements of the respective agencies' ITS data management operations. Information from all agencies was then reviewed to identify a common data architecture and data management infrastructure.

The purpose of Phase 2 of this study is to develop four alternative system architecture ideas along with their respective pros and cons in order to assist MWCOG with selecting a preferred concept for the RIDES. Upon selection of a preferred concept, a detailed design will be completed. Phase 2 study objectives included the following:

- provide a technical perspective on the existing ITS data environment and potential RIDES architecture;
- facilitate an informed decision making process regarding the selection of a preferred RIDES system design.

Potential benefits of developing a decision-making methodology regarding system design include:

- reduced financial and manpower risk;
- ability to utilize a low level solution and build on for more complex functionality
- ability to better address multiple agency data needs in a short timeframe (6-12 months)

## 1.3 STUDY APPROACH

The Phase 2 study approach relies on a balanced perspective of technology, people and process. This portion of the study was focused on:

- establishing the "As-Is" environment (completed in Phase I of the study);
- **defining the "To-Be" environment**; and
- developing an implementation plan that will illustrate how to migrate from the "As-Is" to the "To-Be" environment.

The first phase of this study examined current and planned ITS data management operations among participating agencies resulting in the establishment of a baseline inventory of processes and data. This was followed by the definition of a concept design (based on the pragmatic analysis of what is feasible). The last phase will include a high-level implementation strategy for "getting there from here". To develop a successful study, the Project Team is implementing this multi-phase approach, but focused primarily on Phase 2 for this technical memorandum.

- *Phase 1 - Inventory & Assessment* includes tasks necessary to develop and complete an inventory as well as assess the existing and planned ITS data management infrastructure;
- ***Phase 2 – Concept Design*** **includes tasks necessary to define a future or "target" data management environment; and**

- *Phase 3 - Implementation Planning* includes tasks necessary to develop a migration strategy that will include a high-level definition of the steps necessary to implement the "target" environment.

## 1.4 ORGANIZATION OF THE TECHNICAL MEMORANDUM

The purpose of this technical memorandum is to provide the Metropolitan Washington Council of Governments (MWCOG) with a documented analysis of four (4) alternative designs along with the pros and cons to each design in order to facilitate an informed decision making process regarding the Regional ITS Data Exchange System (RIDES) design.

This Regional ITS Data Exchange System Architecture Analysis Technical Memorandum documents the processes and findings of Phase 2 of the *ITS as a Data Resource* study. Specifically, this Technical Memorandum provides an overview of the Phase 2 process and is detailed in the following Sections of this document:

### Section 2

*Phase 2 Concept Design Approach* – defines the approach applied by the Project Team to develop four alternative architecture designs in order to facilitate an informed decision making process regarding the RIDES design. The task technical team was requested by the ITS as a Data Resource Working Group to define four design alternatives including:

- Low Cost, Centralized
- Low Cost, Decentralized
- Moderate Cost, Centralized
- Moderate Cost, Decentralized

In addition, it describes the methodology used to gather information from the affected agencies as well as provides a detailed explanation of how the alternative designs were decided upon.

### Section 3

*Design Options* – the identification of the design alternatives produced as part of this phase of the project and pros and cons of each alternative focusing on primary functional areas including: cost, security, communications infrastructure, analysis functionality, complexity, scalability, storage, maintenance and institutional issues.

### Section 4

*Preferred Design* – documents the selected design, along with its pros and cons and a brief description of why MWCOG selected this option.

## Section 5

*Detailed Design* – documents the RIDES process design and data flow for the preferred alternative that is initially focused on the development of a regionally shared ITS data archiving system for traffic data collected using inductive loop detectors.

## Appendices

This memorandum includes sixteen technical appendices that provide more detailed data and information that support the main report. The list of acronyms used in this memorandum is presented in Appendix A.

# SECTION 2
# PHASE 2 – CONCEPT DESIGN APPROACH

## 2.1 INTRODUCTION

This section of the report documents the approach applied by the Project Team to develop four design alternatives and their respective pros and cons. This section also provides a description of how the development process was undertaken and provides a list of MWCOG member agencies that were surveyed in the form of Technical Workshops. It also documents the associated findings and interpretations along with Information Technology (IT) trends and observations, as well as potential ITS Data Architecture components.

## 2.2 PHASE 2 STUDY PROCESS

The following sections describe the specific tasks or approach applied by the Project Team to complete the Phase 2 Regional ITS Data Exchange System Architecture Analysis process.

### 2.2.1 TECHNICAL WORKSHOPS

Once the initial interviews had been completed in Phase 1 of the ITS as a Data Resource Study, follow-up interviews were conducted in the form of agency workshops. The agencies chosen to participate were done so jointly among TransCore, MWCOG and the ITS as a Data Resource Working Group. These agencies included:

- Virginia Department of Transportation (VDOT)
- Maryland State Highway Administration (MdSHA)
- Washington Metro Area Transit Authority (WMATA)
- Metropolitan Washington Council of Governments (MWCOG)
- Montgomery County/Maryland-National Capital Park and Planning Commission (M-NCPPC)

These agencies were selected due to their organizational size, type and volume of data elements collected, and their initial interview responses and the need for further clarification. The general idea for holding these technical workshops was to generate user, technical and management feedback regarding data, data processes and relationships, known policies and standards as well as business requirements and other issues of relevance for designing the four design alternatives.

The Technical Workshops were held over April and May, 2001 and were designed to capture additional information in three primary focus areas:

**TABLE 1**

| *Focus Area* | *Details* |
|---|---|
| Business Focus | ▪ Mission, Strategy & Customers<br>▪ ITS Vision & Outcome Expectations<br>▪ Planning Horizon & Priorities<br>▪ Policies & Standards<br>▪ Methods & Operations |
| Technical Focus | ▪ Tools & Technologies<br>▪ Bandwidth & Communications<br>▪ Service Levels & Capacities<br>▪ Data Services Skills & Staffing |
| Data Services Architecture | ▪ Partitioning of Services…N Tiered Model<br>▪ Structured vs. Unstructured Content<br>▪ Centralization vs. Distribution<br>▪ Views on: RIDES and Data Clearinghouse |

## 2.2.2 WORKSHOP FINDINGS AND INTERPRETATIONS

The findings that resulted from the TECHNICAL WORKSHOPS were measured in terms of Data Service Architecture layers and workflow functionality. The Project Team analyzed the findings and began assembling the alternative concept designs.

Data Service Architecture Layers – The ability to share and exchange files of ITS data is a service provided to transportation planners by a regional file sharing system. The scope of this service for ITS data extends from the initial act of collecting the data through to an end result of analyzing the data. This scope defines the workflow of value adding services that constitute the data service architecture. At the highest level, the data service architecture consists of: the acquisition of the data, the management of the data, and the analysis of the data.

## 2.2.3 DATA ACQUISITION

Data Acquisition is the set of workflow service tasks that accomplish the collection of data content, and then transmit the individual records of data content to a designation where the records are consolidated into a file of homogeneous records. Data Acquisition is a necessary cost to the enterprise.

Data Acquisition – Our findings revealed the following key points:

- The focus of ITS spending by member agencies of MWCOG is on data collection devices and real-time operations.
- However, the primary constraint to preserving the data collected by these devices is the cost of data transmission and storage.
- Acquiring the data also involves the consolidation of the data and the data elements and collection parameters may be unique to the type of data collection device.

### 2.2.4 DATA MANAGEMENT

Data Management is the set of workflow tasks that produce the wide spectrum of services that add quality, integrity, usability and security into the value of the data content that has been acquired. Data Management services include data validation, data transformation, data aggregation, data access security, data archival, data integration, data reusability, data about data, and data sharing. Data Management is an investment for the enterprise.

Data Management – Managing enterprise level data can be a complex undertaking. The Project Team's analysis resulted in the following findings:

- The Project Team determined via interviews and technical workshops that the standard traffic count aggregation is at 15 minute intervals, except at M-NCPPC where aggregation is at one hour intervals;
- The majority of nonstandard formats (e.g., proprietary data) are end-user requirements driven;
- Data validation (data hygiene) is being performed but the validation rules and data quality expectations are generally not published;
- The archive process utilized by MWCOG and its member agencies is occurring on a selective basis
- The integration of the same type of data content that is collected across different types of collection mechanisms is virtually nonexistent;
- Data Security is a common theme, with emphasis on network firewall;
- Metadata about the ITS data file is also generally not published;
- Cross application re-use of ITS data is virtually nonexistent; and
- Sharing of data typically occurs within the agency on the local area network via file sharing.

### 2.2.5 DATA ANALYSIS

Data Analysis is the set of workflow tasks that produce information from the data. While data are inalienable facts, information is the interpretation of those facts within some context. For example, it is a fact that the annual average daily traffic count for a bridge is 10,000 vehicles. It is information when that AADT is viewed within the context of being twice the designed capacity of the designated bridge. Data Analysis services include forecasting, query and reporting, video and geo-spatial representation, multi-dimensional analysis, data mining, and data visualization. The improved information for transportation planning that results from Data Analysis is a fundamental benefit derived from the cost of collecting data and the investment of managing data.

Data Analysis – Analysis functions were found mainly to be composed of Forecasting, Multimedia and Query & Reporting processes and resulted in the following findings:

- Forecasting and planning are based on transportation models;
- Video focuses on real-time usage;
- Forecasting and planning reports are common, but queries to a database of ITS data are not;
- Geo-spatial integration is not regional;
- Multi-dimensional analysis is initially being used by the transit authority; and
- The use of advanced analytical capabilities is nonexistent.

### 2.2.6 INTERPRETATION OF FINDINGS

In an effort to obtain appropriate and relevant data to support the development of a "To-Be" architecture, a series of Technical Workshops were held at each of the five follow-up agencies. The Project Team facilitated these workshops and informally documented the findings in the format of "meeting minutes" for internal analysis.

The following bullet points are highlights of the Project Team's interpretation of the actual Technical Workshop findings:

- Transportation professionals are missing out on Commercial-Off-The-Shelf (COTS) data analysis tools (used more specifically for query and reporting, data mining and data visualization);

- Transportation professionals share files, but have not evolved towards a shared base of integrated data;

- Data Validation is compensating for lost data rather than content quality;

- Proprietary formats are more prominent than standardized data formats; and
- Bandwidth of communications is often lagging the growth in ITS data collected.

Technical workshop meeting notes for each organization interviewed can be found in Appendix B of this document.

### 2.2.7 IT TRENDS AND OBSERVATIONS

Much of the information discussed in both interviews and technical workshops was analyzed in conjunction with IT industry development of data management, analysis, validation and integration standards. The Project Team made the following observations based upon current and near future IT industry trends:

- Web based computing is a reality and is readily becoming an industry corporate standard.
- Data analytics is a strategic advantage to organizations that gather details on specific types of data.
- The universal standard for database access is via Structured Query Language (SQL). SQL provides a mechanism to query the data utilizing industry standard command formats.
- Security must be inherent to all layers of the computing technology infrastructure to protect the organizations greatest asset – its data.
- Integration of data and workflow is a business best practice
- Ad Hoc query's answer spontaneous questions, which allow for greater end-user flexibility regarding data manipulation.
- Multi-dimensional analysis is ultimately the executive's scoreboard. It allows them to view aggregations and optionally drill down for details to explain anomalies.
- Data Mining is the process of detecting latent patterns of correlated influence.
- Data Visualization uses high-resolution graphics that accentuate variances.
- Physical storage and management of collected data is a major issue.

## 2.2.8 POTENTIAL ITS DATA ARCHITECTURE

The proposed ITS Data Architecture was presented to MWCOG's ITS as a Data Resource Working Group and representatives of its member agencies on June 28, 2001 and can be found in Appendix C. The objective of this meeting was to review the four alternative architecture designs developed by the Project Team and for MWCOG and its representative member agencies to select a preferred architecture for the Project Team to develop a Detailed Design.

The proposed architecture illustrates a star schema, which is defined as a fact that is surrounded by its dimensions. The facts associated with this architecture are elements such as traffic counts, ridership counts, travel time, speed, person trips and length and incident or accident data and typically answer the questions to What?, Where? and When?. The dimensions associated with these facts are typically special events such as weather, public holiday, type of vehicle, speed zone, etc. The three primary functional areas were addressed as well as how they may provide value added features to the RIDES system:

1. **Potential Data Acquisition**
    - *Exploit ITS investments in data collection* – it was suggested to MWCOG and its member agencies to utilize ITS and transportation technology to not only collect data, but also use that data across multiple agencies and jurisdictions for planning, querying and reporting functionality.
    - *Plan data transmission capacities to accommodate growth in data collected* --- plan through architecture and design activities to "size" or include scalability features when analyzing and evaluating necessary or desired data.
    - *Consolidate data based on ITS subject matter, rather than type of collection device*—a desire was expressed by MWCOG and its member agencies to maintain all metadata in order to support how data was originally derived.
2. **Potential Data Management**
    - *Document data validation guidelines* – define the unique process that all data entered into the RIDES system will go through for validation and quality control.
    - *Mitigate data transformation costs by utilizing a standard SQL data format* – utilizing a single format for all of the data will reduce the cost, resources and effort associated with transforming the data from multiple platforms and provide the value-added benefit of data reusability.
    - *Document data aggregation guidelines* – MWCOG and its member agencies voiced a desire to include and implement transportation related business partners industry best practices.
    - *Establish data retention guidelines and implement with data archival processes* – In order to build an inventory of what data participating organizations generate, data archive practices should be implemented to manage the data.

- *Set data integration as a common goal* – Stove-piped data can only be used in the short term and only by the organization that collected it; however, integrated data can be utilized by multiple organizations, in various capacities (data can be manipulated) over the long term.
- *Define a security architecture as a set of services across the technical architecture*—this architecture is positioned and promoted as the preferred access security framework to be used by all users accessing the RIDES system.
- *Publish documented guidelines and data definitions as a metadata website*—to establish a business tool for all users to leverage as a centralized point of reference information about data management expectations, the RIDES system and its archive of content.
- *Leverage SQL to achieve data re-use*
- *Leverage internet protocol based access to achieve wide area content sharing* – all MWCOG employees and their member agencies have access to the internet and could utilize this medium to both share and access multi -organizational and –jurisdictional data.

**3. Potential Data Analysis**

- *Enhance validation and development of traffic forecasting models* – availability of archived traffic volume data from ITS devices provides planners with a rich source of historical or time-series databases that are very useful for model validation and development of time-of-day traffic forecasting models
- *Exploit video data for imaging analysis* – incorporating the use of high technology solutions, the RIDES system can take advantage of video data for future planning and analysis activities.
- *Leverage SQL for query and reporting analysis*
- *Seek a regional geo-spatial guideline* – it was discovered during interviews and technical workshops that various GIS software packages were used by MWCOG and its member agencies. Due to the variety of packages used, a single set of guidelines or standards must be established at a regional level in order to accommodate this type of data. It has been suggested that the location of deployed ITS devices be specified in terms of longitude/latitude coordinates.
- *Expand the ability to interpret ITS data with multi-dimensional analysis tools*
- *Position ITS data to exploit data visualization and data mining tools* – Data Visualization and Data Mining Tools are effectively used in planning activities and can be used to seek details regarding specific pieces of data.

# SECTION 3
# DESIGN OPTIONS

## 3.1 INTRODUCTION

After the completion of Phase 1 --- Inventory and Assessment, the MWCOG Project Team was tasked with generating a Preliminary RIDES Design Concept. This concept design can be found in Appendix D of this document. A meeting to discuss this design was held February 1, 2001 and resulted in the Project Team developing a series of design options that incorporated a matrix approach of four alternatives consisting of: D1 – Low Cost Centralized, D2 – Low Cost Distributed, D3 – Moderate Cost Centralized, and D4 – Moderate Cost Distributed. The following alternative design options depict specific functions that the Project Team feels are relevant to the implementation of the RIDES system. Each alternatives' pros and cons follow each design alternative illustration.

## 3.2 ALTERNATIVE D1: LOW COST, CENTRALIZED

The Existing Data Acquisition portion of the Alternative D1 diagram in Exhibit 1 represents data collection, data transmission and data consolidation services. The aforementioned services are defined by the following terms:

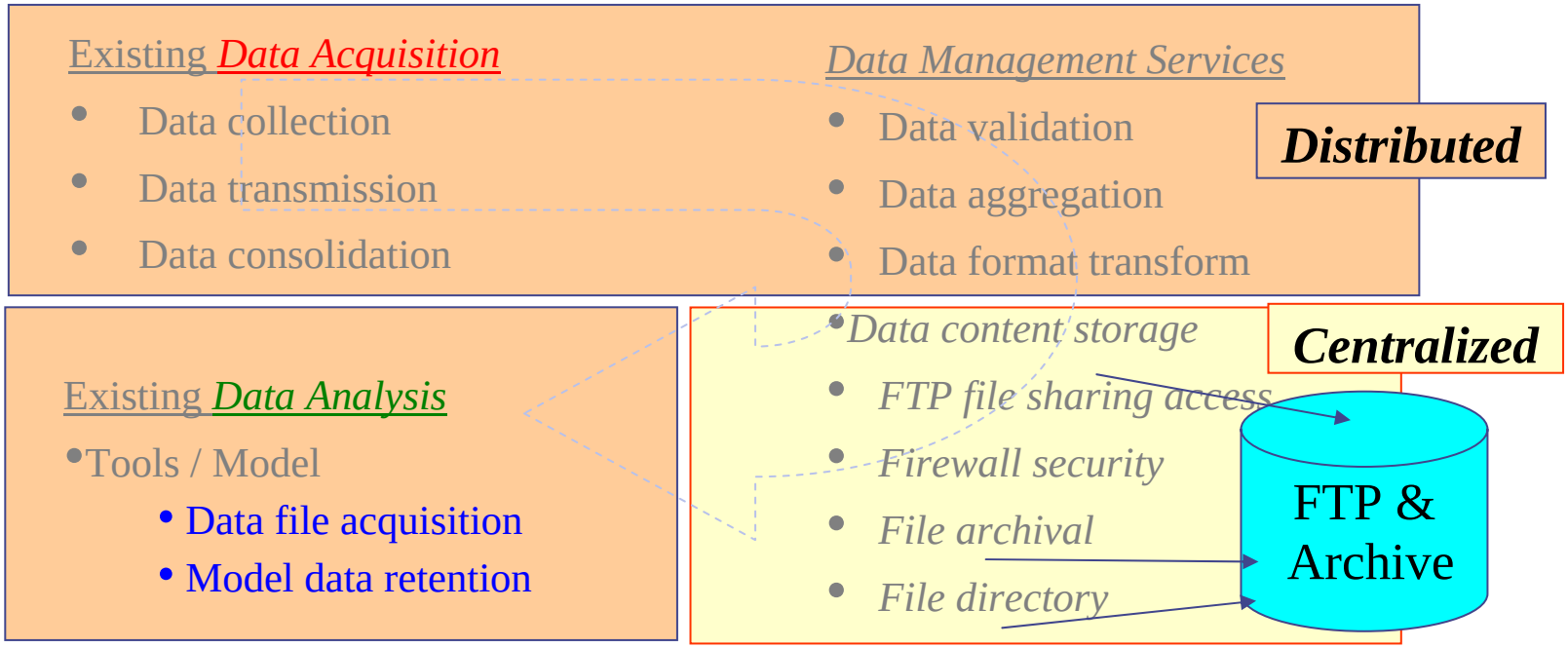
- Data Collection is defined as those pieces or data elements that are collected from either systems or actual ITS devices that are necessary for analysis and planning purposes;
- Data Transmission is the actual movement of data from a system or a device; and
- Data Consolidation is the actual merging or combining of data into a specific location.

The Data Management Services illustrated for this alternative consist of Data Validation, Data Aggregation and Data Format Transformation. Validation and Aggregation of the data is critical to ensuring quality data has been both collected and integrated prior to transforming it into the standard data format. The outcome of not validating and aggregating data results in disparate data, lack of quality control and subsequent erroneous data.

The Existing Data Analysis portion of Alternative D1 reflects those tools and/or models utilized in analyzing the data files and data models initially designed to hold the data for the systems. All of the aforementioned Services (Data Acquisition, Data Management and Existing Data Analysis) are conducted in a distributed environment.

**EXHIBIT 1**

**ALTERNATIVE D1: LOW COST, CENTRALIZED**



The centralized portion of this design relies primarily on Data Content Storage, FTP File Sharing Access, Firewall Security, File Archival and File Directory Services. Data Content Storage, File Archival and File Directory services operate out of an FTP and Archive data store/database located at a centralized location. Alternative D1 is the lowest cost and least complex of the four alternatives. It incorporates basic level file sharing capabilities with data access from a centralized (single) location, but *does not* incorporate data sharing integration capabilities. Table 2 illustrates additional pros and cons for this design option:

**TABLE 2**

| Alternative D1: Low Cost, Centralized | | |
|---|---|---|
| **Evaluation Criteria** | **PROS** | **CONS** |
| ➢ *COST* | ➢ Low Cost | |
| ➢ *SECURITY* | ➢ Needed only at central location | |
| ➢ *COMMUNICATIONS INFRASTRUCTURE* | ➢ Less infrastructure needed | |
| ➢ *ANALYSIS FUNCTIONALITY* | ➢ Limited functionality | ➢ File Sharing capabilities, not integrated |
| ➢ *COMPLEXITY* | ➢ Low degree of complexity | |
| ➢ *SCALABILITY* | ➢ Low | |
| ➢ *STORAGE* | ➢ Central Location | |
| ➢ *MAINTENANCE* | ➢ Central Location. Data Management simple compared to other alternatives | ➢ Data aggregation and transformation activities are performed by the authoritative agency of RIDES |
| ➢ *INSTITUTIONAL ISSUES* | ➢ Less complex | |

## 3.3 ALTERNATIVE D2: LOW COST, DISTRIBUTED

Alternative D2, shown in Exhibit 2, maintains all of the same services that alternative D1 has, except that the centralized portion of the design is smaller and the Data Content Storage service requires a separate FTP function. There are only two pieces that maintain a centralized operation: File Archival and File Directory. The remaining data management services maintain their place in a distributed environment.

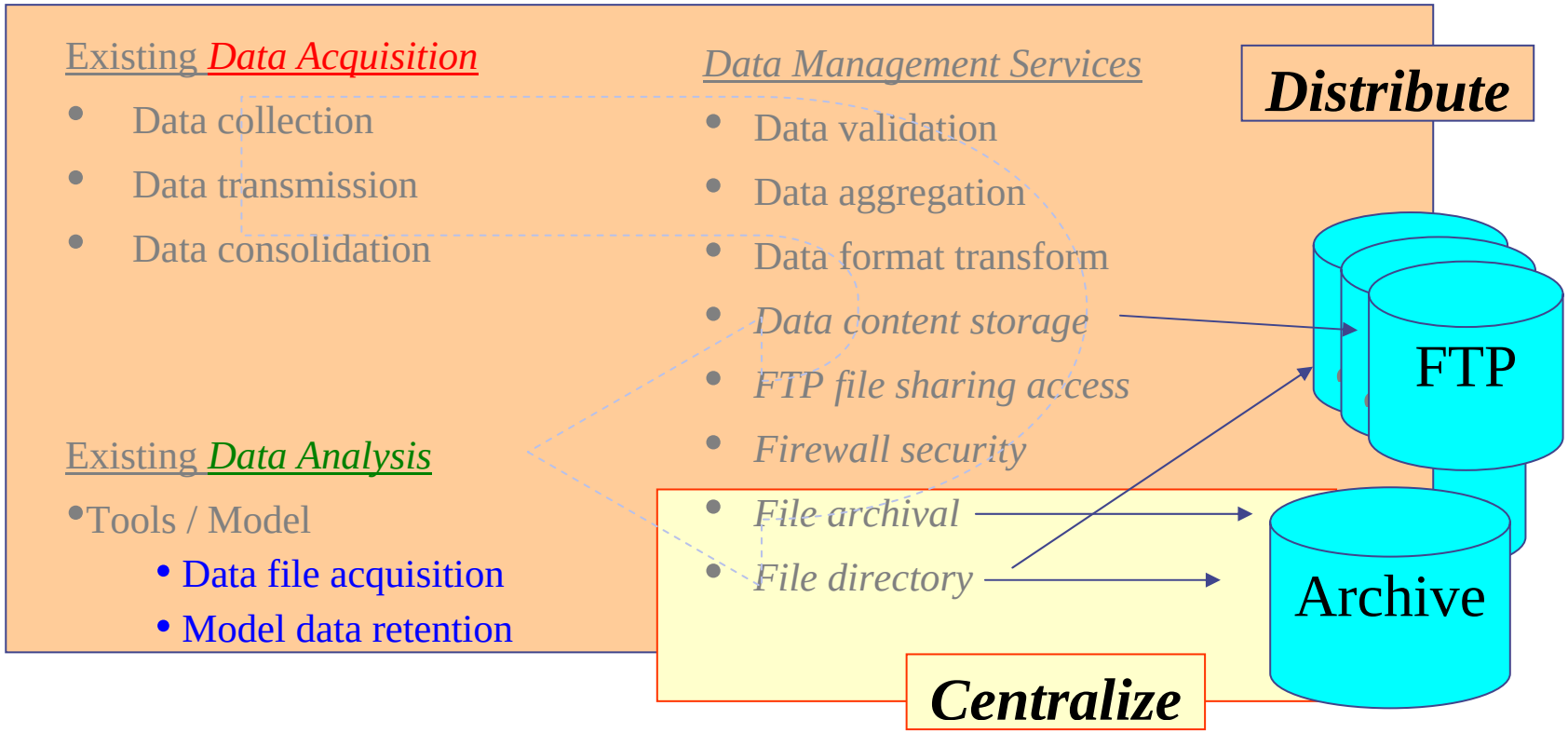
Alternative D2 is still a low cost alternative, but incorporates basic level file sharing capabilities with data access from a distributed architecture perspective (data is stored at multiple locations and requires enhanced access privileges and security). Table 3 illustrates additional pros and cons for this alternative:

**TABLE 3**

| Alternative D2: Low Cost, Distributed | | |
|---|---|---|
| **Evaluation Criteria** | **PROS** | **CONS** |
| ➢ ***COST*** | ➢ **Lower cost than alternatives D3 and D4** | ➢ **Higher cost than D1 alternative** |
| ➢ ***SECURITY*** | | ➢ **Two separate servers needed for FTP and Archive functions – increased transaction load; increased security needs** |
| ➢ ***COMMUNICATIONS INFRASTRUCTURE*** | | ➢ **Dealing with multiple formats – must have common interface** |
| ➢ ***ANALYSIS FUNCTIONALITY*** | | ➢ **File Sharing capabilities, not integrated** |
| ➢ ***COMPLEXITY*** | | ➢ **May have to consider going to the universities to get the data (since they collect it already)** |
| ➢ ***SCALABILITY*** | ➢ **More than alternative D1, but less than alternatives D3 & D4** | |
| ➢ ***STORAGE*** | | ➢ **Data files are stored at multiple locations** |
| ➢ ***MAINTENANCE*** | ➢ **Responsibilities are shared by all participating agencies** | |
| ➢ ***INSTITUTIONAL ISSUES*** | ➢ **Responsibilities are shared by all participating agencies** | ➢ **More complex solution – need uniform business rules an policies across all agencies** |

**EXHIBIT 2**

**ALTERNATIVE D2: LOW COST, DISTRIBUTED**



## 3.4 ALTERNATIVE D3: MODERATE COST, CENTRALIZED

The distributed services for this alternative change considerably to more of a web/warehouse focus with regard to the data management services. Data Acquisition services remain constant, but Data Analysis Services incorporate ad hoc querying, multi-dimensional analysis and geo-spatial integration. Firewall Security becomes a centralized operation in comparison to that of alternative D2 and Data and File Archival, Data Integration and Data Sharing Access are all new centralized services obtained through alternative D3, shown in Exhibit 3. The centralized component of this design alternative also makes use of a Web service, File service and Regional Data Warehouse for access and data sharing activities.

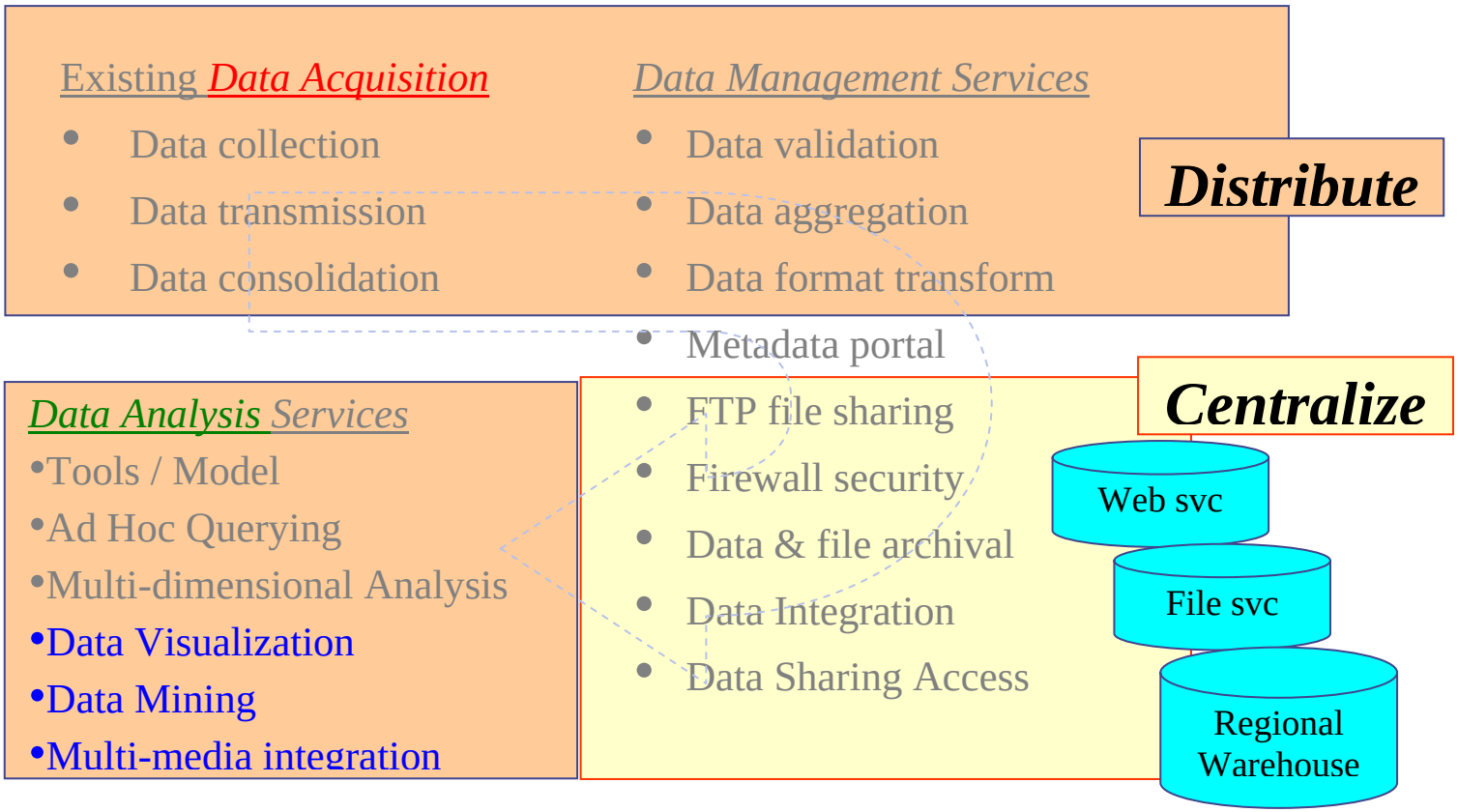
Design Option D3 is higher in cost, but like alternative D1 still stores and accesses data from a centralized location. Unlike Alternatives D1 and D2, this option incorporates integrated data sharing features. Table 4 illustrates additional pros and cons for this design option:

**TABLE 4**

| Alternative D3: Moderate Cost, Centralized | | |
|---|---|---|
| **Evaluation Criteria** | **PROS** | **CONS** |
| ➢ ***COST*** | | ➢ **Increased costs due to greater access at a single location** |
| ➢ ***SECURITY*** | ➢ **Only needed at Central Location** | |
| ➢ ***COMMUNICATIONS INFRASTRUCTURE*** | ➢ **Less infrastructure required than alternative D4** | |
| ➢ ***ANALYSIS FUNCTIONALITY*** | ➢ **Integrated Data Sharing capabilities; Ability to collect specific details due to increased data granularity** | |
| ➢ ***COMPLEXITY*** | ➢ **Responsibilities are shared by all participating agencies** | |
| ➢ ***SCALABILITY*** | ➢ **Increased analysis and data mining functionality as compared to alternatives D1 and D2** | |
| ➢ ***STORAGE*** | ➢ **All data content is stored at a single location** | |
| ➢ ***MAINTENANCE*** | ➢ **Data and System Maintenance and Administration activities are needed at central location** | ➢ **Increased implementation and maintenance Costs – both data and labor resources issues** |
| ➢ ***INSTITUTIONAL ISSUES*** | ➢ **Responsibilities are shared by all participating agencies** | ➢ **Ownership issues – who will be authoritative source?** |

**EXHIBIT 3**

**ALTERNATIVE D3: MODERATE COST, CENTRALIZED**



## 3.5 ALTERNATIVE D4: MODERATE COST, DISTRIBUTED

The Existing Data Acquisition services for alternative D4, shown in Exhibit 4, remain the same as in Alternatives D1, D2 and D3, but the Data Management Services migrate to a more decentralized environment in which the Metadata Portal and Firewall Security services offered as decentralized alternative D3, now find themselves in a centralized environment; whereas, the Data Archival and Data Sharing Access now become decentralized features. In addition, design alternative D4 utilizes a virtual data warehouse feature, which allows for all users to tap into a single source across the web for data searching, analysis and planning activities. The relative cost realized by implementing this alternative is the highest of all four alternatives, however, the ability to reuse data is also at its greatest of all four design alternatives.

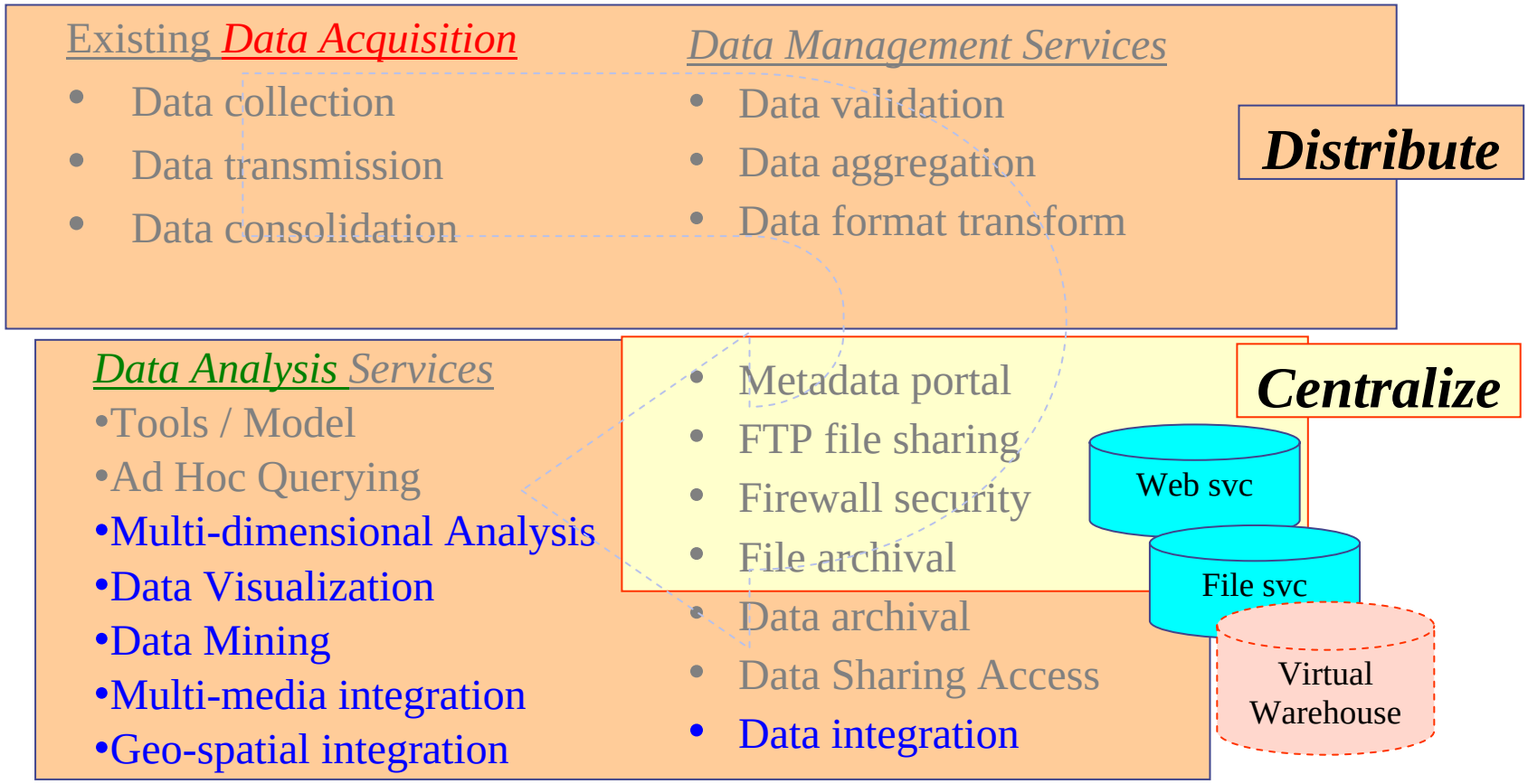
Design Alternative D4 is the most expensive and most complex of the four design alternatives. This is due in large part to the optimum level of functionality combined with a medium level of scalability, a high degree of complexity and a low level of manageability. This design option would provide the end user with comparable benefits to that of a data warehouse, but will also require agreed upon access protocols by all member agencies. Table 5 provides additional pros and cons for this design alternative:

Table 5

| D4: Moderate Cost, Distributed | | |
|---|---|---|
| Evaluation Criteria | PROS | CONS |
| ➢ *COST* | | ➢ Highest cost amongst alternatives |
| ➢ *SECURITY* | | ➢ Necessary at ALL locations |
| ➢ *COMMUNICATIONS INFRASTRUCTURE* | ➢ Most robust infrastructure amongst alternatives | ➢ More robust, therefore increased cost to implement |
| ➢ *ANALYSIS FUNCTIONALITY* | ➢ Optimum integrated data sharing capabilities, including data mining, visualization & multidimensional analysis capability | |
| ➢ *COMPLEXITY* | ➢ Responsibilities are shared by all participating agencies | ➢ Data Management activities is most complex of all 4 options; administration responsibilities are shared by all agencies |
| ➢ *SCALABILITY* | ➢ Optimal of suggested alternatives | ➢ Data Acquisition activities are also the most complex – more sources to access |
| ➢ *STORAGE* | ➢ Responsibilities are shared by all participating agencies | ➢ Data files are stored at multiple locations – Distributed |
| ➢ *MAINTENANCE* | ➢ Responsibilities are shared by all participating agencies | ➢ Implementation and Maintenance costs increase due to the number of source locations |
| ➢ *INSTITUTIONAL ISSUES* | ➢ Responsibilities are shared by all participating agencies | ➢ More complex – need uniform business rules and policies across participating agencies |

**EXHIBIT 4**

**ALTERNATIVE D4: MODERATE COST, DISTRIBUTED**



# SECTION 4
# PREFERRED DESIGN

The principal design objective of the Metropolitan Washington Regional ITS Data Exchange System is to provide a shareable archive of ITS data content collected throughout the region by participating agencies. Design alternatives ranged from the tactical option of sharing ITS data files to a more strategic notion of ITS data integration. Design alternatives were expressed as four service architectures. The services portrayed were data acquisition services, data management services, and data analysis services. The merits of a centralized solution as compared to a distributed solution were contrasted in relative terms of where each data service would reside. The element of costs was addressed as a relative increment from low cost to moderate cost.

Fundamentally as best practice, the wider the scope of data accessibility and data sharing, the more centralized is the placement of the data to be accessed and shared. In a consistent manner and for purposes of access security control, the more frequently a collection of data is updated the more centralized its placement should be. For example, the master copy of the enterprise e-mail directory is generally located in one central location accepting a constant stream of changes being pushed towards it, while users of e-mail directory may access it from any point within the enterprise and typically keep highly used subsets of it in their personal address book. The collection of ITS data envisioned to be shared throughout the Metropolitan Washington region is expected to be absorbing the on-going stream of new content being pushed in its direction. From the perspective of costs, economies of scale are frequently realized through centralization of data management services via a reduction in the duplication of data management services experienced in distributed data archiving solutions.

The transportation planning community has relied upon forecasting models that reside on personal computers and accept only proprietary data formatted inputs, and it is anticipated that they will continue to rely on forecasting models in a regional ITS data exchange system setting. However, the wealth of decision support tools, relational database technologies, and web enabled solutions have typically not been leveraged by transportation planning professionals to the degree that financial analysis and marketing analysis professionals have employed them. The recommendation of data integration and data analysis capabilities, as a means to extend the value of archived ITS content to the transportation planning community, is predicated upon the ability to integrate ITS data from across the region and upon the ability to institutionalize a workable infrastructure of data management practices across participating agencies.

The business prospects of viewing large volumes of ITS data from a number of transportation planning perspectives and correlating ITS data across a spatial reference system, transportation system and temporal dimensions is strategically enticing, but as of yet not compelling.

Tactically, the convincing solution is strictly to satisfy the principal design objective; namely providing a shareable archive of ITS data. This file sharing design solution has the effect of initiating the institutionalization of the workable infrastructure of data management practices and data management services that are absolutely essential to a successful migration from file sharing based RIDES solution to data integration based RIDES solution should MWCOG business objectives dictate and funding conditions allow. The file sharing solution (D1) would facilitate a future pursuit of a data integration - data analysis oriented solution (D3).

MWCOG and representative member agencies met with the Project Team on June 28, 2001 to discuss the four design alternatives and select a preferred design. The Project Team's design recommendation was to establish an internal goal to implement D3 – Moderate Cost, Centralized, but begin with initiating steps directly in line with D1 – Low Cost, Centralized and simultaneously determine what approach MWCOG will use to implement the solution, either buy, build or outsource. After completing the Project Team's presentation, it was voiced by MWCOG that the design preference was Alternative D1.

This D1 option was the preferred design so that while the details were being defined in Detailed Design, the non-technical infrastructure would be initiated to address:

- Data management guidelines;
- Metadata documentation guidelines;
- Staffing and skills assessment; and
- Service level agreement,

Simultaneously, MWCOG and its member agencies could resolve three issues that surfaced during the Project Team's presentation:

- Metadata Issues/Standards;
- Data Validation Issues; and
- Data Format Issues.

The implementation of Alternative D1 will provide MWCOG and its member agencies with the benefit to integrate both its "low hanging fruit" AND "its higher level harvest." The "Low Hanging Fruit" was identified as the following:

- Consolidating ITS files
- Sharing ITS files
- Archiving ITS files
- Forecasting models
- Metadata web page

The "Higher Level Harvest" was defined as the following:

- ITS data integration
- Query based data access
- Historical ITS content
- Advanced analytics
- Web portal navigation

Alternative D1, Low Cost Centralized, was selected as the preferred design alternative due to its relatively low cost commitment, but it was also acknowledged that with this in mind the planning and idea over the long term was to build alternative D3, Moderate Cost Centralized to allow for maximum flexibility and data usage across multiple jurisdictions at a regional level.

Based upon the Project Team's analysis and findings, it has been recommended to MWCOG and its member agencies to set their goal to implement D3 – Moderate Cost, Centralized design alternative. In addition, the Project Team has recommended to MWCOG to start this initiative with implementing Alternative D1 and building on as both time and funding permits. At the same time, this will allow MWCOG and its member agencies to resolve open issues such as: metadata standards, data validation and data format issues.

The Project Team felt that it was in the best interest of MWCOG and its member agencies to start small and as the concept was proven and details expressed, to expand and enhance the RIDES system.

# SECTION 5
# RIDES Process Design and Data Flow

## 5.1 INTRODUCTION

In specifying the detailed design for the Low Cost-Centralized Alternative (designated D1), the Project Team decided to focus on the development of a regionally shared ITS data archiving system for traffic data collected using inductive loop detectors. The current level of deployment of this type of device is pervasive enough to generate a significant amount of data that would be very useful for transportation planning and operations.

Inductive loop detectors are the most widely used type of device for traffic surveillance and control systems. This device is used to detect vehicle presence, count traffic volume, estimate travel speed, and determine lane occupancy. These data are primarily used to control operations at individual signalized intersections, arterial corridor systems, area-wide or network traffic control systems, and freeway systems. Other similar devices that are gaining popularity are non-pavement invasive detectors such as radar/microwave detectors and video image processing systems.

While the primary purpose of inductive loop detectors is to collect real-time surveillance data for optimizing the parameters of traffic signal systems for roadway intersection and freeway operations, the possibility to archive real-time traffic data to a level of temporal and geographical aggregation that is useful for transportation planning purposes presents an enormous potential for having a cost-effective system of collecting traffic volume data and other information that can augment and supplement traditional sources of transportation planning data. Other purposes for which loop detectors are deployed include collection of data for monitoring growth and measuring temporal (e.g., hourly, daily, or weekly) variability and seasonal trends in traffic volume, and evaluating operational performance of highways and arterial roads.

Archiving of traffic volume data from inductive loop detectors yields significant benefits in terms of extending the applications of traffic surveillance data beyond their typical usage in traffic operations. Archived traffic volume data can provide valuable information not only for day-to-day operations but also for short-term and long-term transportation management and planning applications. Examples of such applications include: (a) Monitoring of arterial and freeway systems; (b) Validation of travel forecasting models; (c) Validation of macroscopic and microscopic traffic simulation models; (d) Preparation of traffic operations, incident and emergency management plans; (e) Assessment of traffic impacts; and (f) Evaluation of travel demand management strategies and congestion management programs.

Another significant benefit of archived traffic volume data is in its ability to provide historical traffic trends and information on the variability of hourly, daily, monthly and seasonal traffic volumes. Having information on traffic trends and variability over a wide geographical area greatly enhances the ability of transportation planners and decision makers to develop short- term and long-term transportation plans and make wise transport investment decisions. Traffic volume data archives will significantly expand the geographical coverage of currently established traffic counting programs of State and local agencies.

However, there are a number of critical issues that need to be addressed when developing archival systems of traffic data from ITS devices in general and inductive loop detectors in particular. These include: (a) defining appropriate levels of temporal and geographic aggregation; (b) establishing data quality control checks from point of collection to point of use; (c) proper handling of incomplete or missing data; (d) developing effective data management operating procedures; and, (c) creating a sustainable system for financing the development and operations of the data archive.

## 5.2 DESIGN PARAMETERS

### 5.2.1 Agency and ITS Device Type

The Project Team defined the scope of the design to include inductive loop detectors that are currently deployed and managed by five agencies, namely: (a) Virginia Department of Transportation's Smart Traffic Center and Smart Traffic Signal System in Northern Virginia; (b) Maryland State Highway Administration's Traffic Management System and Office of Traffic Safety; (c) Maryland-National Capital Park and Planning Commission/Montgomery County Department of Public Works and Transportation; (d) Arlington County; and (e) City of Fairfax. These agencies were selected based on a screening of nine device types, ten agencies, and four data types that formed the scope of interest of Alternative D1. Please refer to Appendix E for further details. In making the decision to focus on loop detectors, the Project Team also considered the various transit ITS devices that WMATA has implemented or are planning to implement.

Beginning late August up to early November 2001, the Project Team conducted interviews with several key personnel from the above-listed agencies to collect data and document existing workflow and data flow related to traffic data from inductive loop detectors. The list of contacted persons is shown in Appendix F. The information collected included: (a) number of deployed inductive loop detectors devices; (b) data dictionary metadata describing the data produced and its geographical location; (c) metadata describing the processing workflow; (d) clarification as to whether or not the loop detector data is currently being archived; etc.

Based on the information gathered, the above list of five agencies was shortened to exclude Arlington County and the City of Fairfax because these agencies currently do not electronically transmit traffic volume data from loop detectors to a central traffic signal control office. Hence, the detailed design was further focused to include three agencies only, namely: VDOT-NOVA, MdSHA within the Metropolitan Washington Region, and M-NCPPC/Montgomery County.

VDOT's Smart Traffic Center (STC) and Smart Traffic Signal System (STSS) cover freeways and arterial intersections, respectively, in Fairfax County, Prince William County and Loudoun County. The STC manages approximately 1,561 inductive loop detectors and 161 controllers deployed along I-95, I-395, and I-66. Plans are underway to deploy detectors along I-495. The STSS manages approximately 10,000 inductive loop detectors deployed in approximately 1,000 arterial intersections. Data from STC and STSS are sent to the Smart Travel Laboratory (STL) for archiving (Please see discussion in Section 5.3.1).

MdSHA manages approximately 312 detectors deployed in freeways and arterial intersections within Montgomery County, 259 detectors deployed in Prince George's County, and 284 detectors deployed in Frederick County. Currently, MdSHA maintains a website that provides archived traffic volume data.

M-NCPPC/Montgomery County and Department of Public Works and Transportation (DPWT) collect and manage traffic data from loop detectors in approximately 700 intersections. The DPWT directly manages the traffic signals and sends data to M-NCPPC/Montgomery County for archiving and other purposes.

### 5.2.2 ITS Data and Planning Application

*Focus on traffic volume data*

In-depth interviews were undertaken and more detailed data were collected from VDOT-NOVA, MdSHA and M-NCPPC in order to gain an understanding of the existing conditions and processes related to the collection of traffic data from inductive loop detectors up to the point where data is stored for archival purposes.

Loop detectors typically collect traffic volume, speed and occupancy data. However, for this initial design, the Project Team decided to focus on traffic volume since it is the most useful data element for planning applications and it is obtainable from loop detectors at acceptable levels of accuracy. While the initial effort focused on traffic volume data, the design for the RIDES data architecture does not preclude the inclusion of other traffic data elements in future RIDES enhancements.

*Enhancement to the MWCOG Regional Transportation Data Clearinghouse Highway Network*

The initial RIDES design was also developed to address the need of MWCOG for more detailed traffic volume data for travel demand model development, calibration and forecasting. The MWCOG maintains a regional transportation database that includes traffic volumes and other data for highway links that comprise its modeled regional highway network. The metadata for this database is shown in Appendix G.

Currently, the database provides Average Annual Daily Traffic (AADT) for the years starting 1986 through 1997. Since the RIDES archive will be designed to store traffic volume data at very fine temporal granularities (e.g., traffic volume at fifteen-minute intervals), its implementation will significantly enhance the ability of planners to validate existing traffic forecasting models and enable them to develop new models (e.g., time-of-day models, peak-hour traffic models, etc.).

However, it will be necessary to define and implement a process for mapping the loop detector stations onto the links in the MWCOG regional transportation data clearinghouse highway network. A loop detector station is a collection of loop detectors deployed across a set of highway lanes that comprises a link in the highway network. Hence, the traffic volume aggregated at the station level gets assigned to a link in the highway network. However, in cases where there are several stations deployed along a single link, it will be necessary to investigate on a case-to-case basis which station or stations would provide a more accurate representation of the traffic volume on the link. This work may involve field checks to gain familiarity of the specific location of the loop detectors in relation to the characteristics of the highway link.

The initial task leading to the development of this mapping process was undertaken in this project covering loop detector data currently deployed along portions of Northern Virginia freeways (i.e., I-66, I-95, and I-395). The result of this initial effort is shown in Appendix H. The tables in said appendix indicate the set of loop detector stations that corresponds to a set of highway links. The next step would be to examine each highway link and determine which among the loop detector stations (if multiple) would provide the best estimate of traffic volume on the link.

This mapping process needs to be applied to the entire inventory of deployed loop detectors that are within the geographical coverage of the MWCOG regional highway network. Information on the deployment location of the loop detectors is typically obtained from traffic management system plans. The geographical reference systems vary across plans and so the process may be tedious but it can be done manually. In cases where the inventory of loop detectors provides a GIS-based reference system, then it may be possible to overlay the files with MWCOG's regional highway network.

It will be necessary to coordinate with relevant agencies on the availability and nature of the files that contain the inventory and location information of loop detectors in the region. The same effort may be necessary in the future when data from other ITS devices are incorporated in the RIDES archive.

## 5.3 DATA FLOW DESIGN

This section addresses the data flow design for volume count data collected by loop detector devices. A data flow diagram is provided in Exhibits 5, 10 and 14 to serve as an aid in visualizing the process workflow, data stores, and data attributes that flow between processes. The accompanying narrative strives to add clarity and detail to the process flow image envisioned.

Three entities would provide loop detector data to the RIDES data archive. The three entities are: the Northern Virginia District of the Virginia Department of Transportation in collaboration with the Smart Travel Lab residing at the University of Virginia, the Maryland-National Capital Park and Planning Commission, and the Maryland State Highway Administration. The data flows from these three data providers to the Metropolitan Washington Council of Governments are addressed in the process flow design as individual data flows that, collectively, form the general work flow solution for regional archival of loop detector data.

Processes within each data flow are discussed in the sequence of their workflow execution, and data stores are discussed in the sequence in which they are accessed by associated processes. Processes 1.0 thru 5.0 are common workflow processes independent of RIDES data contributors. Processes particular to RIDES data contributors are presented as rectangular boxes that include agency offices that collect and handle data such as STSS, STC, STL, M-NCPPC, and Md-SHA.

### 5.3.1 Virginia Department of Transportation - Northern Virginia District

*General*

Virginia Department of Transportation for northern Virginia (VDOT-NOVA) out-sources archive services and data validation services for loop detector volume count data to the Smart Travel Lab (STL) located at the University of Virginia (UVA). The Virginia Department of Transportation organization for northern Virginia consists of two agency offices: the Smart Traffic Center (STC) and the Smart Traffic Signal System (STSS).

From January to October 2000, the STSS provided the STL with volume count data acquired from loop detectors located at sites on arterial highways. The site count data has been aggregated into fifteen-minute intervals and archived at the STL in the data store represented as D1a – arterial site counts archive in Exhibit 5. The database schema associated with the STL's archive of STSS arterial data is presented in Appendix I. The STL is currently not receiving data from the STSS, as there is no connection established for transmission of the data. The database schema and data flow as depicted in Appendices I and M are subject to change once connection is re-established.

Since late Fall 2001, the Smart Traffic Center has been providing the STL with volume count data acquired from loop detectors stationed on freeways. The data is being aggregated at the STL from 10-second intervals to 1-minute intervals and is planned for archival as depicted in data store D2a – freeway station counts archive in Exhibit 5. Aggregation of one-minute-interval volume data (data store D2a) into fifteen-minute intervals will necessarily be performed. The aggregation process is preferably implemented as a database executable, and would occur at STL in order to reduce the amount of data being transmitted. Refer to Appendices J and K for the work-in-progress database schemas associated with STL's archive of STC freeway data. It is important to note that the work flow depicted in Appendix L and database schemas associated with STL's archiving of freeway data are not fully established as they were still under development when this memorandum was finalized in December 2001.

a. The contact persons for VDOT-NOVA and the UVA-STL are as follows:
   i. For the STC the contact person is Amy Tang, the ITS Engineer for VDOT-NOVA. Her telephone number is 703.383.2240.
   ii. For the STSS the contact person is Mark Hagan, VDOT Northern Virginia District's engineer for signal systems. His telephone number is 703.383.2872.
   iii. For the STL the contact person is Dave Lewis, staff technical administrator for the lab. His telephone number is 804.924.4548.

b. The VDOT policy for accessing Intelligent Transportation System (ITS) data is as follows:
   i. STL is viewed as a functional extension of VDOT.
   ii. Achieved data (defined as device acquired data) is archived at STL.
   iii. Access to archived data occurs at STL rather than STC or STSS.
   iv. VDOT defines data validation rules for achieved data.
   v. STL performs data hygiene upon achieved data in accordance with stated data validation rules.

vi. STC and STSS have an operational level business objective and therefore only real-time operational data may be accessed directly from STC data stores or STSS data stores.

c. Data at the STL is validated for feasibility in its archive database. A status column in the database record is set to a value of one (1) for feasible data and to a value of zero (0) for data that is not validated as feasible. The criteria developed by VDOT to validate the feasibility of loop detector data are:
   i. Collection length too short – Test if Collection Length is greater than or equal to 60
   ii. General maximum volume threshold –Test if volume is greater than 3000 vehicles per hour per lane
   iii. Maximum occupancy threshold -Test if occupancy > 95
   iv. Positive volume with zero speed:
   If velocity is zero there can be no flow.
   Then if speed = 0, Test if Volume > 0

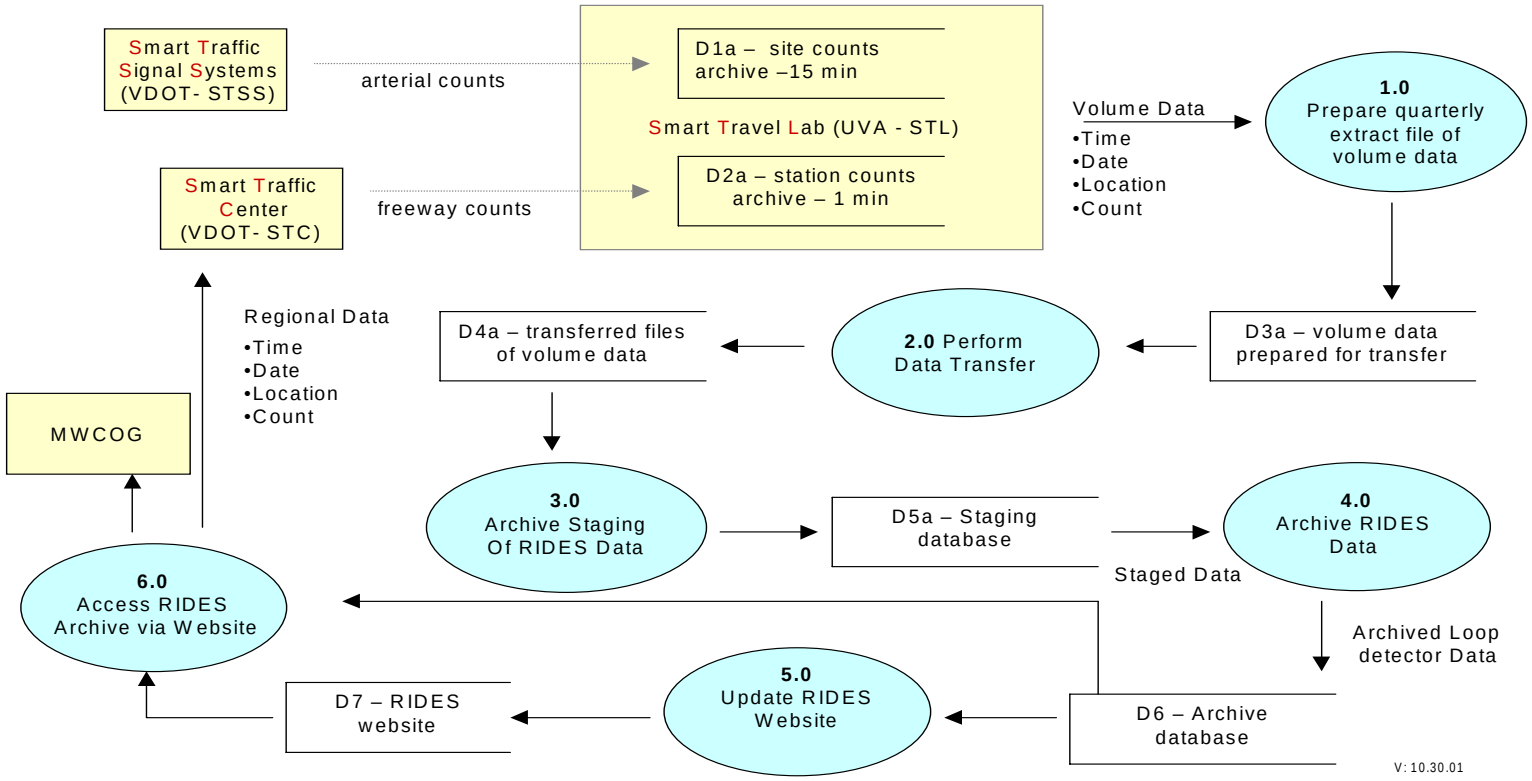
Maximum allowable volume with a reported occupancy of zero. Flow at occupancy of zero cannot be over reasonable flow for 0.4 percent occupancy. Average effective vehicle length infeasible. AEVL is the average vehicle length plus the length between the dual loop detectors.

d. A tentative description of the work flow of the freeway data from the point where the data is collected at the STC to the points where the data is transmitted and processed at the STL is presented in Appendix L.

e. The work flow of the data from the point where the data is collected at the STSS to the points where the data is transmitted and processed at the STL is presented in Appendix M.

**EXHIBIT 5**

# VDOT- NOVA Loop Detector Data Flow



*Process Flow Chart for VDOT Sourced Loop Detector Data*

PROCESS 1.0 - Prepare Quarterly Extract File of Volume Data:

1. The Smart Travel Lab, at the beginning of each quarter of the year, initiates a stored query that contains selection criteria specified by the MWCOG. The stored query executes upon the database table containing the prior 3-month time period of fifteen-minute interval VDOT Northern Virginia District traffic count records. The query results are saved as a comma delimited text file result that contains date, time, station, site and link, direction, location description, and associated count summarized into fifteen-minute intervals. This text file (data store D3a) is then written to a compact disk (or disks), and notification is provided to the RIDES administrator at MWCOG that data files are prepared for shipment.

PROCESS 2.0 – Perform Data Transfer:

2. The Smart Travel Lab mails the compact disk(s) to the RIDES Administrator at the following address:
   Metropolitan Washington Council of Governments
   777 North Capitol Street, NE, Suite 300
   Washington DC. 20002-4239
   Attention: Bob Griffiths

3. Upon inspection of the mailed CDs, the RIDES Administrator acknowledges successful (or damaged) receipt to Dave Lewis via electronic mail addressed to dlewis@virginia.edu

4. The RIDES Administrator places the recently received CDs (data store D4a) into the designated storage area for subsequent use in loading the RIDES staging area.

PROCESS 3.0 – RIDES Archive Staging:

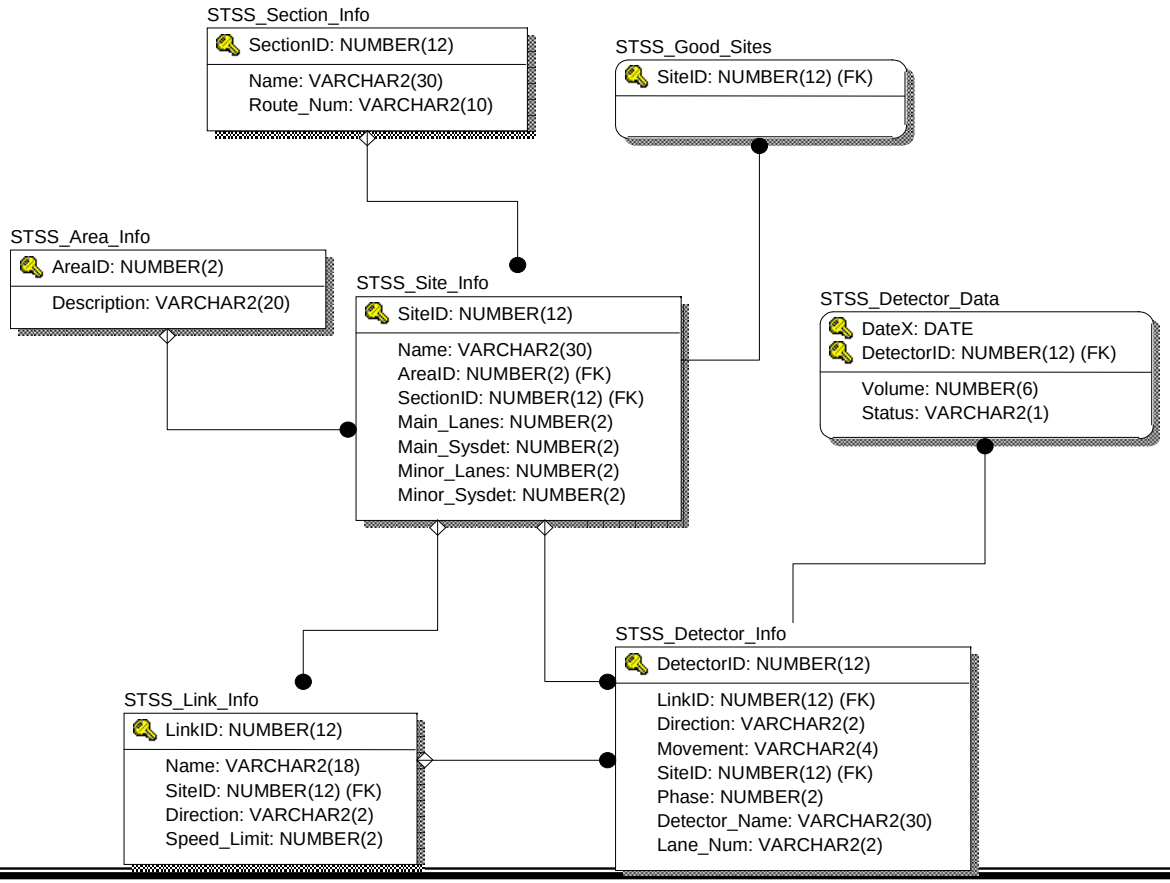
5. The archive staging process begins by clearing tables in RIDES Staging database- D5a.

6. The archive staging process proceeds to load text file contents of data store D4a, stored on one or more compact disks, into the archive staging relational database which consolidates the new set of data into the empty staging tables. The purpose of data archive staging processes is the consolidation of comma-delimited text files (data store D4a) into relational database records (data store D5a) that are accessible through a standard language, SQL. Key data relationships are established within the data archive staging relational database.

Data integrity constraints ensure that incomplete or duplicate records do not exist in the data archive. Archive staging processes organize location descriptive metadata (link and site, station, direction) to be directly associated and accessible with corresponding site codes, link codes, station codes, and area codes.

7. The design for the staging database tables containing arterial highway volume counts collected by VDOT – STSS is shown in Exhibit 6. Appendix I shows the database schema being used at the Smart Travel Lab for organizing arterial loop detector data content collected by VDOT

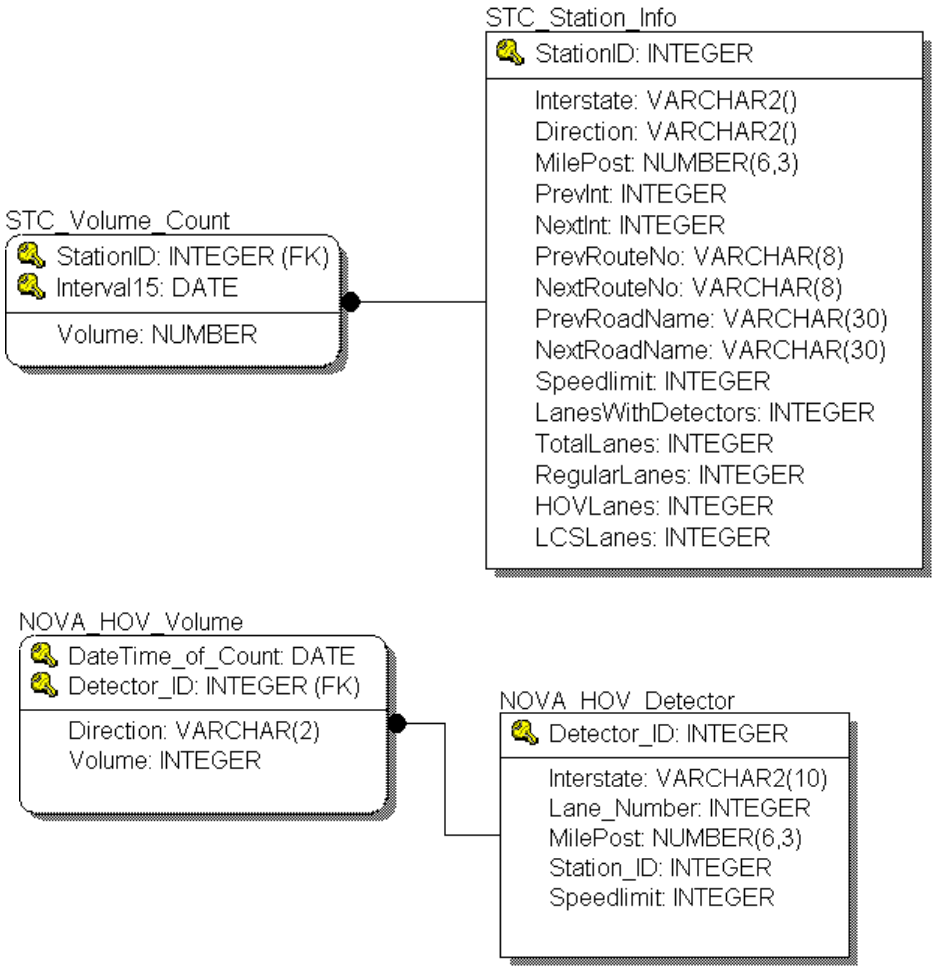
**EXHIBIT 6**



8. The design for the staging database tables containing freeway volume counts collected by VDOT – STC is shown in Exhibit 7.

   Appendix J shows the database schema being used at the Smart Travel Lab for organizing freeway loop detector data content collected by VDOT. Appendix K illustrates the metadata that describes each station of loop detectors along Northern Virginia freeways.

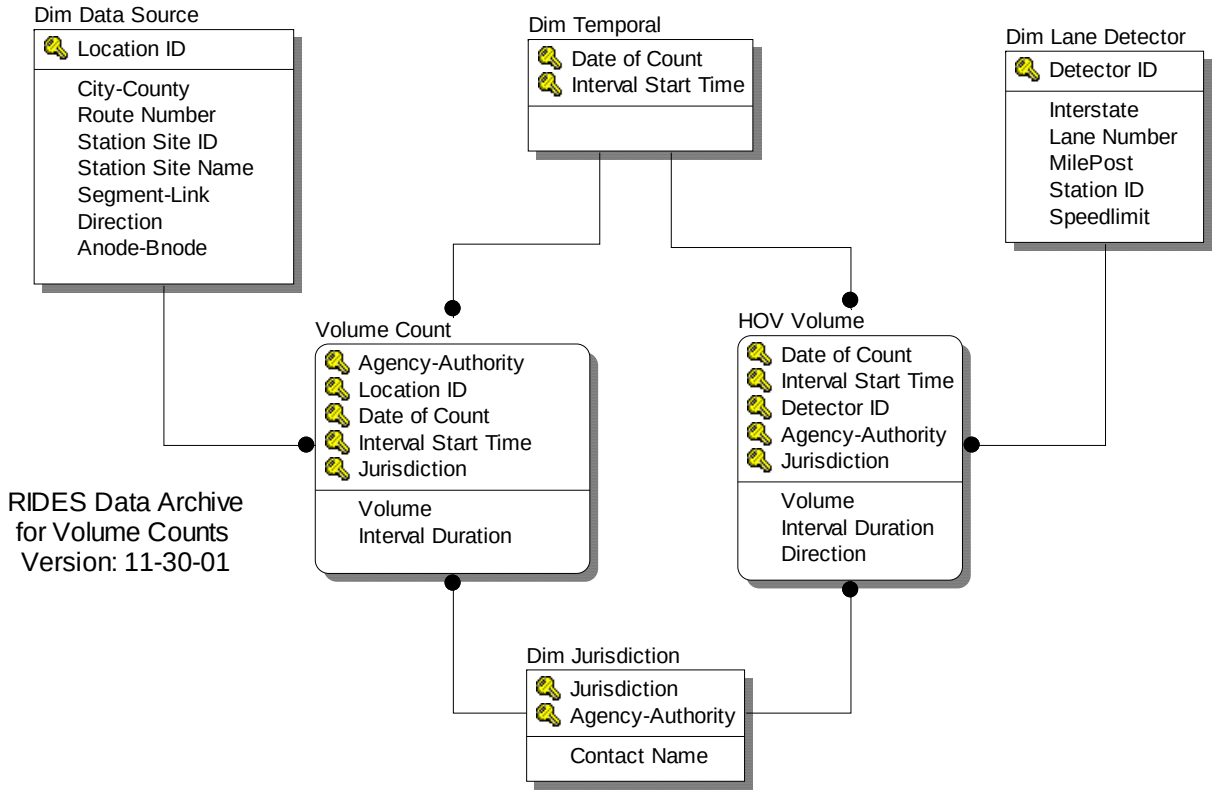
**EXHIBIT 7**


STC_Station_Info
StationID: INTEGER
Interstate: VARCHAR2()
Direction: VARCHAR2()
MilePost: NUMBER(6,3)
PrevInt: INTEGER
NextInt: INTEGER
PrevRouteNo: VARCHAR(8)
NextRouteNo: VARCHAR(8)
PrevRoadName: VARCHAR(30)
NextRoadName: VARCHAR(30)
Speedlimit: INTEGER
LanesWithDetectors: INTEGER
TotalLanes: INTEGER
RegularLanes: INTEGER
HOVLanes: INTEGER
LCSLanes: INTEGER
STC_Volume_Count
StationID: INTEGER (FK)
Interval15: DATE
Volume: NUMBER
NOVA_HOV_Volume
DateTime_of_Count: DATE
Detector_ID: INTEGER (FK)
Direction: VARCHAR(2)
Volume: INTEGER
NOVA_HOV_Detector
Detector_ID: INTEGER
Interstate: VARCHAR2(10)
Lane_Number: INTEGER
MilePost: NUMBER(6,3)
Station_ID: INTEGER
Speedlimit: INTEGER

PROCESS 4.0 – RIDES Data Archiving:

9. The data archiving process begins by integrating the archive staging contents of data store D5a, into a relational database of archive data (D6), shown in Exhibit 8. Dim is the abbreviation for Dimension and it indicates the descriptive attributes of a recorded business event. Typically a business event would at the very least be described by temporal and spatial attributes.

**EXHIBIT 8**




10. The design of the RIDES Data Archive (data store D6) is a fact and dimension style of design used to organize quantitative facts and qualitative artifacts of a discrete transaction event for the purpose of multi-dimensional analysis. The discrete event being transacted is the detection and incremental count of a vehicle through the electromagnetic field of an inductive loop. The quantitative fact is the count. The qualitative artifacts of the event are the location of the event, the date and time of the event, and the agency or authority responsible for transacting the volume count event. The type and amount of facts of the volume count event vary dependent upon the level of

sophistication for the equipment being employed. Surface moisture level and surface heat levels, occupancy, and speed (derived from time traveling a known distance between two devices) are examples of additional facts that are typically collected.

11. The data entities involved are:
    a. Volume Count – contains records of volume count information achieved or aggregated over a time interval duration expressed in minutes at the station or site specified by the agency or authority on the date and start time noted.
    b. Dim Temporal – contains time and date of each volume count event.

c. Dim Jurisdiction – contains information about the agency or authority initiating the volume count, jurisdiction represented by agency, and the name of the contact person for the data contributed to RIDES.
d. Dim Data Source – contains the station or site identifier and associated description for the location where the volume counts were collected, the route number, direction of traffic flow as designated by the jurisdiction, city or county, segment-link identifier, and the associated ANODE-BNODE link identifier from MWCOG's Regional Network Database.
e. HOV Volume – contains records of volume count information achieved or aggregated over a time interval duration expressed in minutes for the applicable direction at the HOV detector specified by the agency or authority on the date and start time noted.
f. Dim Lane Detector – contains the identifier of the HOV detector, the HOV lane for which the detector is collecting counts, the associated interstate, the milepost location of the detector along the interstate, the associated station, and the posted speed limit for that HOV lane.

12. The data contained in data store D5a is queried and inserted into the archive data store D6 by SQL procedures stored within the database. Once the new records have been incorporated into the database, a new set of statistics is generated, and a full backup is accomplished.

PROCESS 5.0 – Update RIDES Web Page:

13. The RIDES web page (data store D7), accessed via a link on the MWCOG web site, is updated with a brief description of the new quarterly data that has been added to the RIDES Archive.

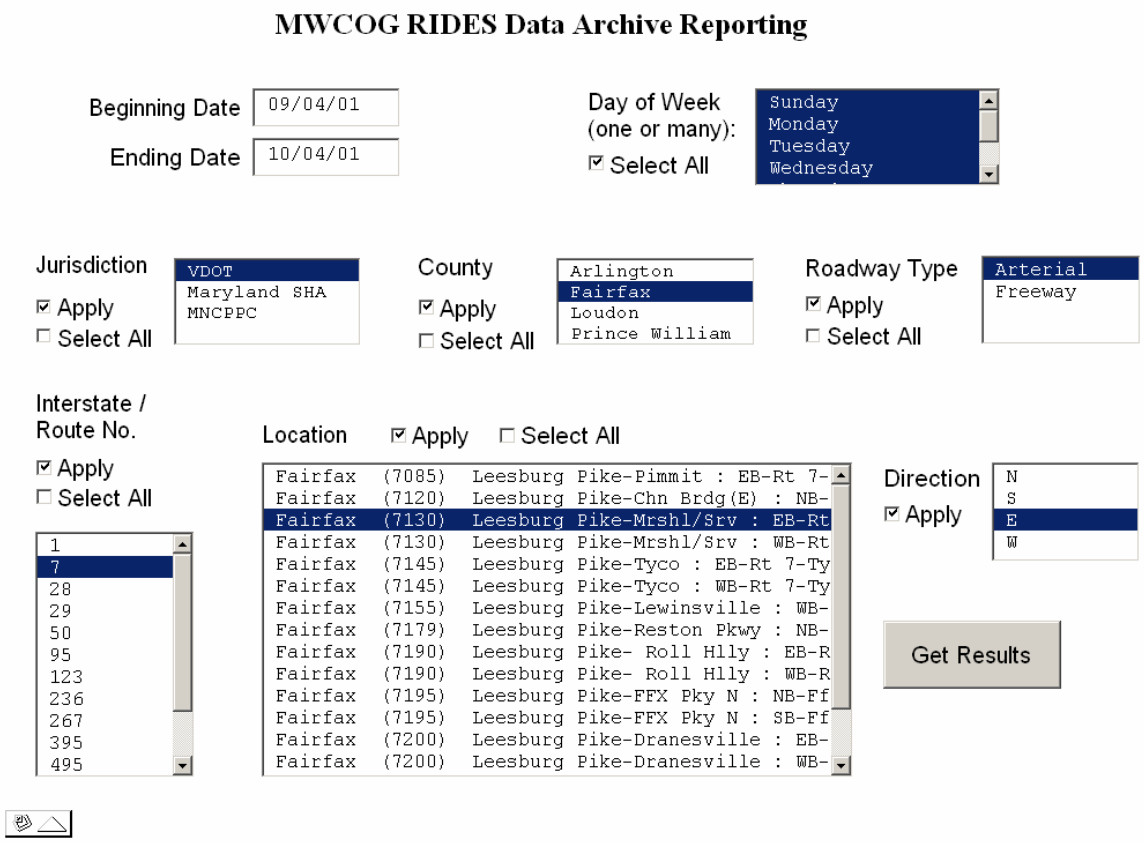
14. News of an updated RIDES database is broadcast via e-mail to the community of RIDES users for their awareness of the availability of new data content.

PROCESS 6.0 – Access RIDES web page and Data Archive:

15. The RIDES web page is accessed via a link on the MWCOG web site. From there, the RIDES Data Archive user clicks on the link to the data archive reporting web page.

16. The data archive reporting web page will look similar to the Report Criteria web page of the Maryland State Highway Administration's web site. Exhibit 9 is a prototype of user interface and data fields that present the principal functionality anticipated for the web page solution applicable to regional data access needs.

## EXHIBIT 9




a. Beginning Date Text Box – contains the start date of the time period for which traffic counts are desired. The format of the date is MM/DD/YYYY. The default value is the current date of MWCOG's RIDES server. The date may be changed by typing in the desired date in the correct format.

b. Ending Date Text Box – contains the end date of the time period for which traffic counts are desired. The format of the date is MM/DD/YYYY. The default value is the current date of MWCOG's RIDES server. The date may be changed by typing in the desired date in the correct format.
c. Day of Week List Box – contains a list of the named days of the week for which traffic counts are desired. One or many days are selected or deselected by clicking on the names. If no days are selected, then all days are included for selection by default.

d. Day of Week "Select All" Check Box – selects all the days of the week if checked.
e. Jurisdiction List Box – contains a list of the jurisdictions (e.g., VDOT, M-NCPPC, MdSHA) that provide traffic counts to RIDES. Clicking on a jurisdiction toggles its selection.
f. Jurisdiction's "Apply" Check Box – indicates whether the user has completed his selection of jurisdictions. Checking the box updates the County list box.
g. Jurisdiction's "Select All" Check Box – selects all jurisdictions in the Jurisdiction list box if checked.
h. County List Box – contains a list of the counties within the chosen jurisdictions from which data is collected in the Metropolitan Washington region. Clicking on a county name toggles its selection.
i. County's "Apply" Check Box – indicates whether the user has completed his selection of counties. Checking the box updates the roadway type list box.
j. County's "Select All" Check Box – selects all counties in the County list box if checked.
k. Roadway Type List Box – contains a list of the types of roadway (e.g., freeway, arterial, on ramp, off ramp, etc.) for which traffic counts are desired. One or many types are selected by clicking on the types.
l. Roadway Type "Apply" Check Box – indicates whether the user has completed his selection of roadway types. Checking the box updates the Route Number list box.
m. Roadway Type "Select All" Check Box – selects all roadway types if checked.
n. Interstate / Route Number List Box – contains a list of the interstates/routes that are located within the selected counties and for which traffic counts are collected. One or many interstates/routes are selected by clicking on the numbers.
o. Interstate / Route Number "Apply" Check Box – indicates whether the user has completed his selection of interstate/route numbers. Checking the box updates the location list box.
p. Interstate / Route Number "Select All" Check Box – selects all interstate/route numbers if checked.
q. Location List Box – contains a list of location descriptions for the sites/stations collecting data at the selected routes. One or many locations are selected by clicking on the location descriptions.
r. Location "Apply" Check Box – indicates whether the user has completed his selection of locations. Checking the box updates the direction list box.
s. Location "Select All" Check Box – selects all locations if checked.
t. Direction List Box – contains a list of the directions of traffic flow associated with the chosen locations. One or many directions are selected by clicking on the directions.
u. Direction "Apply" Check Box – indicates whether the user has completed his selection of directions.

**v. "Get Results" Command Button – when clicked, processes and returns the results associated with the reporting selections made.**

### 5.3.2 Maryland-National Capital Park and Planning Commission:

*General*

The Maryland-National Capital Park and Planning Commission (M-NCPPC) is located in Silver Spring, Maryland.

a. The contact person for the M-NCPPC is Rich Roisman, Senior Planner for the Transportation Modeling Group and GIS-T. His telephone number is 301.495.4547.

b. Montgomery County has approximately 1515 loop detectors collecting counts in one-minute intervals over 24-hour periods at 245 intersections. The one-minute interval data is subsequently aggregated to five-minute intervals per device over 24-hour periods in the Automated Traffic Management System's Informix database (data store D1b) located in Rockville Maryland. The device level five-minute counts are forwarded to the Planning Commission's Oracle 8.0.5 database (data store D2b) where they are staged to be aggregated into fifteen-minute intervals. Simultaneously device level counts are aggregated into link level counts. The five-minute interval device level counts are not retained. Subsequent aggregations of the fifteen-minutes interval counts produce 1-hour link intervals, 1-hour intersection intervals, and peak-hour counts. These higher-level aggregations are stored in data store D1b.

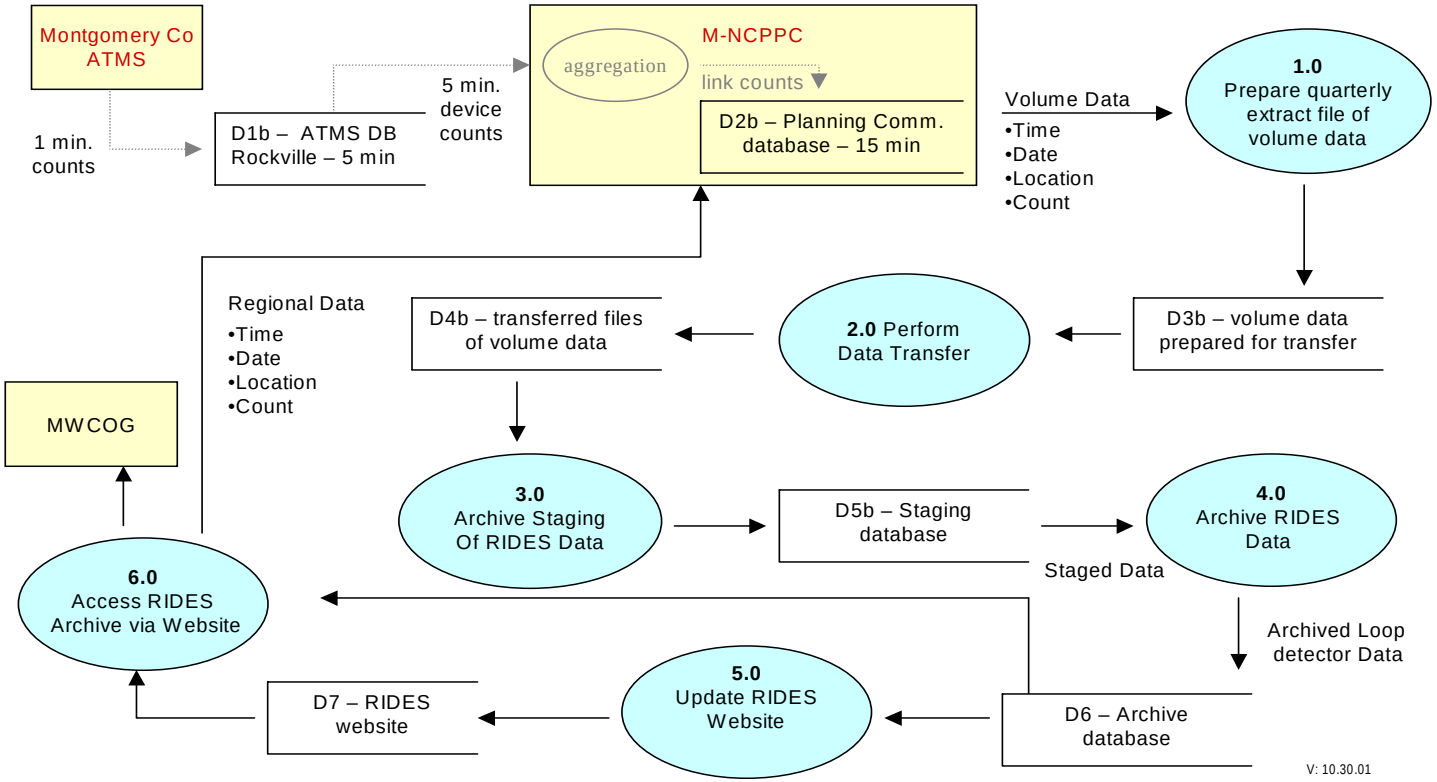
c. Feasibility tests on loop detector data are conducted by M-NCPPC on an ad hoc basis and are performed by manual inspection of the proportionally small number of records that represent the higher-level aggregations, particularly the peak-hour counts. Morning peak-hour is defined as the peak hour within the 3-hour period between 6am and 9am. Similarly, afternoon peak-hour is defined as the peak hour within the 3-hour period from 3:30pm until 6:30pm. An error log of the device polling process records the state of the loop detector device, the content of which is preserved in an offline database and is provided as a report distributed internally within M-NCPPC via e-mail.

d. Refer to Appendix N for the data flow diagram depicting the work flow of the data from the point where the data is collected from the device to the points where the data is processed and approved for sharing with MWCOG.

e. The process flow for M-NCPPC data is shown in Exhibit 10.

**EXHIBIT 10**

# M-NCPPC Loop Detector Data Flow



*Process Flow for M-NCPPC Sourced Loop Detector Data*

PROCESS 1.0 - Prepare Quarterly Extract File of Volume Data:

17. M-NCPPC, at the beginning of each quarter of the year, initiates a stored query that contains selection criteria specified by the MWCOG. The stored query executes upon the database table containing the prior 3-month time period of fifteen-minute interval Montgomery County intersection traffic count records. The query results are saved as a comma delimited text file result that contains date, time, station, site and link, direction, location description, and associated count summarized into fifteen-minute intervals. This text file (data store D3b) is then written to a compact disk (or disks), and notification is provided to the RIDES administrator at MWCOG that data files are prepared for shipment.

PROCESS 2.0 – Perform Data Transfer:

18. M-NCPPC mails the compact disk(s) to the RIDES Administrator at the following address:
    Metropolitan Washington Council of Governments
    777 North Capitol Street, NE, Suite 300
    Washington DC. 20002-4239
    Attention: Bob Griffiths

19. Upon inspection of the mailed CDs, the RIDES Administrator acknowledges successful (or damaged) receipt to Richard Roisman via electronic mail addressed to the following address: richard.roisman@mncppc-mc.org

20. The RIDES Administrator places the recently received CDs (data store D4b) into the designated storage area for subsequent use in loading the RIDES staging area.

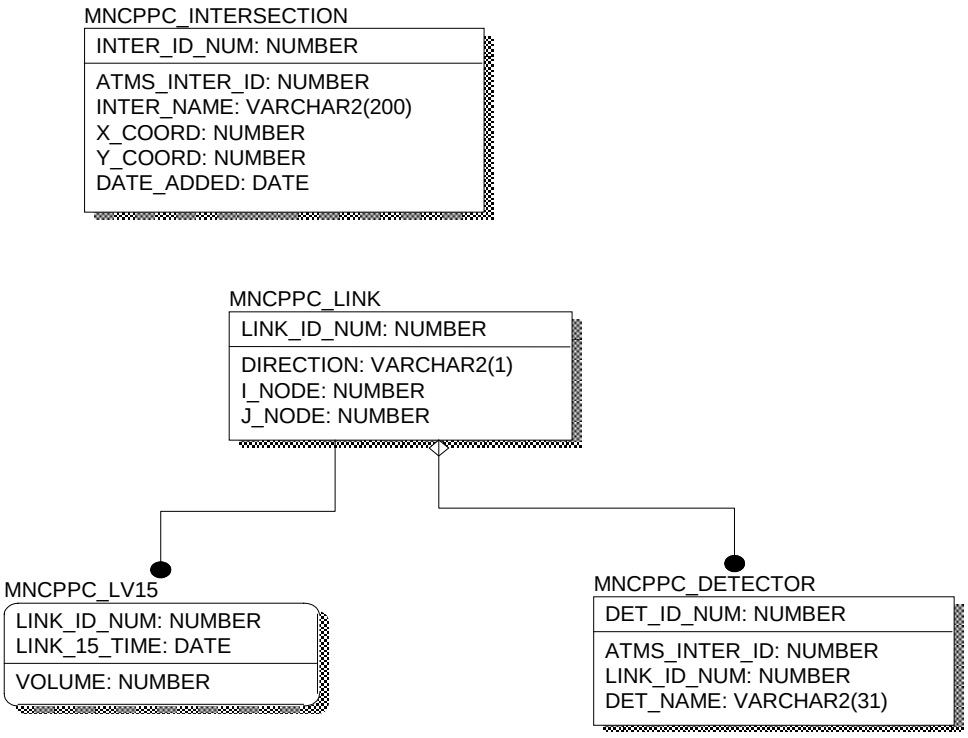
PROCESS 3.0 – RIDES Archive Staging:

21. The archive staging process begins by clearing tables in RIDES Staging database- D5b.

22. The archive staging process proceeds to load text file contents of data store D4b, stored on one or more compact disks, into the archive staging relational database which consolidates the new set of data into the empty staging tables. The purpose of data archive staging processes is the consolidation of comma-delimited text files (data store D4b) into relational database records (data store D5b) that are accessible through a standard language, SQL. Key data relationships are established within the data archive staging relational database. Data integrity constraints ensure that incomplete or duplicate records do not exist in the data archive. Archive staging processes organize location descriptive metadata (link and direction) to be directly associated and accessible with corresponding device codes, link codes, and intersection codes.

23. The design for the staging database tables containing intersection volume counts collected by Montgomery County, Maryland is shown in Exhibit 11.

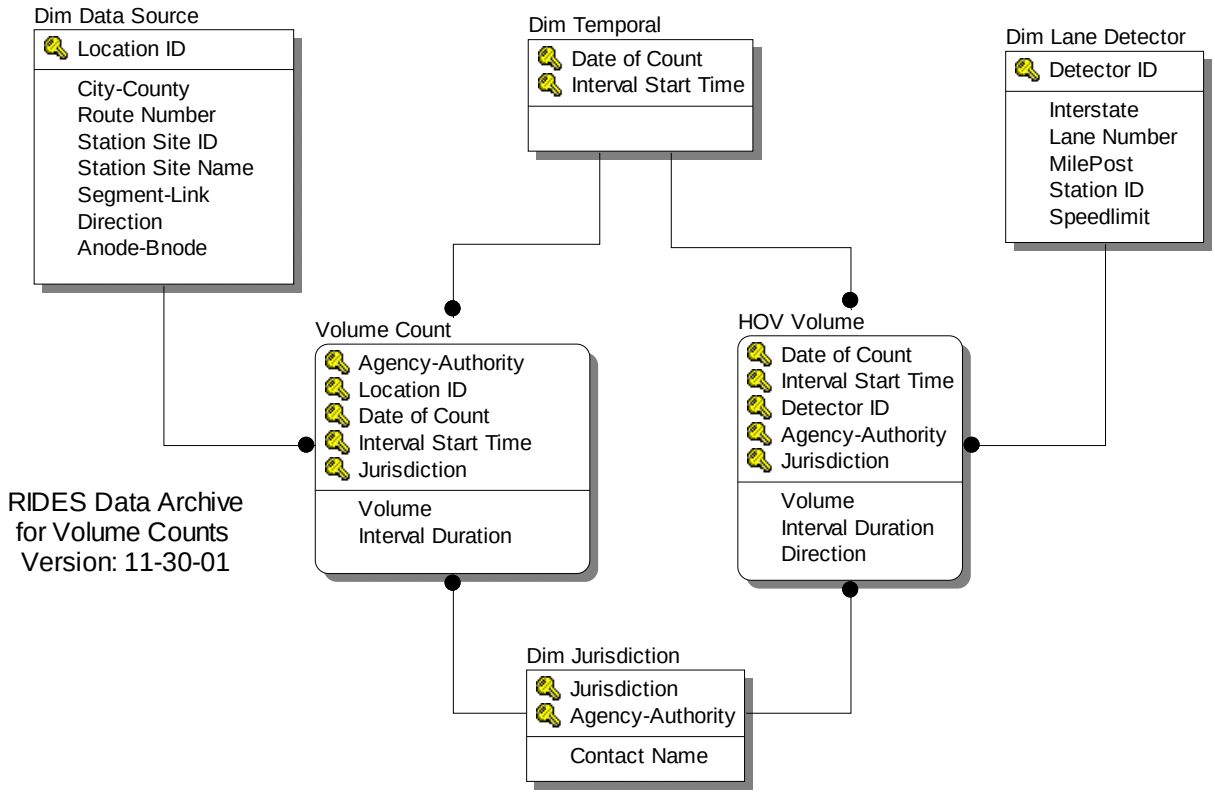
**EXHIBIT 11**



PROCESS 4.0 – RIDES Data Archiving:

24. The data archiving process begins by integrating the archive staging contents of data store D5b, into a relational database of archive data (D6), shown in Exhibit 12.

**EXHIBIT 12**




25. The design of the RIDES Data Archive (data store D6) is a fact and dimension style of design used to organize quantitative facts and qualitative artifacts of a discrete transaction event for the purpose of multi-dimensional analysis. The discrete event being transacted is the detection and incremental count of a vehicle through the electromagnetic field of an inductive loop. The quantitative fact is the count. The qualitative artifacts of the event are the location of the event, the date and time of the event, and the agency or authority responsible for transacting the volume count event. The type and amount of facts of the volume count event vary dependent upon the level of sophistication for the equipment being employed. Surface moisture level and surface heat levels, occupancy, and speed (derived from time traveling a known distance between two devices) are examples of additional facts that are typically collected.

26. The data entities involved are:
    a. Volume Count – contains records of volume count information achieved or aggregated over a time interval duration expressed in minutes at the station or site specified by the agency or authority on the date and start time noted.
    b. Dim Temporal – contains time and date of each volume count event.
    c. Dim Jurisdiction – contains information about the agency or authority initiating the volume count, jurisdiction represented by agency, and the name of the contact person for the data contributed to RIDES.
    d. Dim Data Source – contains the station or site identifier and associated description for the location where the volume counts were collected, the route number, direction of traffic flow as designated by the jurisdiction, city or county, segment-link identifier, and the associated ANODE-BNODE link identifier from MWCOG's Regional Network Database.
    e. HOV Volume – contains records of volume count information achieved or aggregated over a time interval duration expressed in minutes for the applicable direction at the HOV detector specified by the agency or authority on the date and start time noted.
    f. Dim Lane Detector – contains the identifier of the HOV detector, the HOV lane for which the detector is collecting counts, the associated interstate, the milepost location of the detector along the interstate, the associated station, and the posted speed limit for that HOV lane.

27. The data contained in data store D5b is queried and inserted into the archive data store D6 by SQL procedures stored within the database. Once the new records have been incorporated into the database, a new set of statistics is generated, and a full backup is accomplished.

PROCESS 5.0 – Update RIDES Web Page:

28. The RIDES web page (data store D7), accessed via a link on the MWCOG web site, is updated with a brief description of the new quarterly data that has been added to the RIDES Archive.

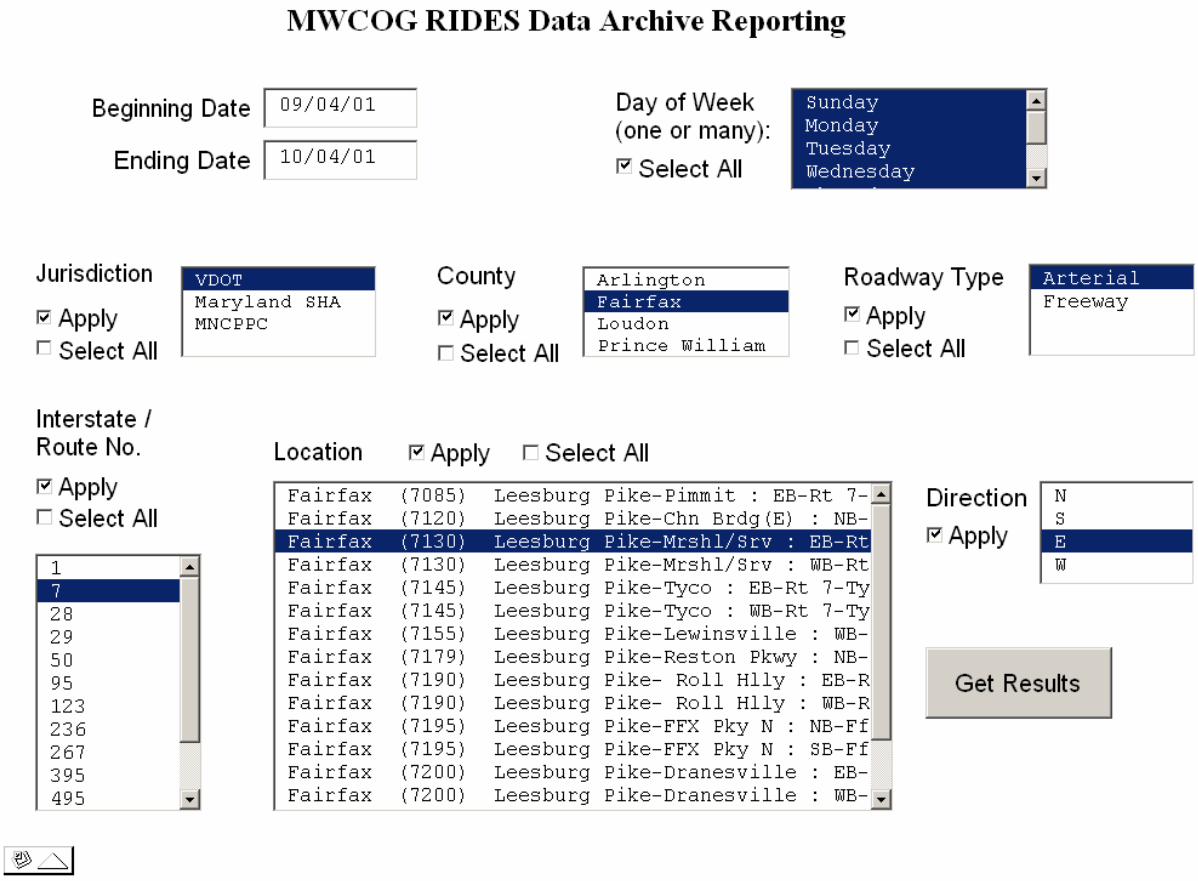
29. News of an updated RIDES database is broadcast via e-mail to the community of RIDES users for their awareness of the availability of new data content.

PROCESS 6.0 – Access RIDES web page and Data Archive:

30. The RIDES web page is accessed via a link on the MWCOG web site. From there, the RIDES Data Archive user clicks on the link to the data archive reporting web page.

31. The data archive reporting web page will look similar to the Report Criteria web page of the Maryland State Highway Administration's web site. Exhibit 13 is a prototype of user interface and data fields that present the principal functionality anticipated for the web page solution applicable to regional data access needs.

## EXHIBIT 13




a. Beginning Date Text Box – contains the start date of the time period for which traffic counts are desired. The format of the date is MM/DD/YYYY. The default value is the current date of MWCOG's RIDES server. The date may be changed by typing in the desired date in the correct format.
b. Ending Date Text Box – contains the end date of the time period for which traffic counts are desired. The format of the date is MM/DD/YYYY. The default value is the current date of MWCOG's RIDES server. The date may be changed by typing in the desired date in the correct format.
c. Day of Week List Box – contains a list of the named days of the week for which traffic counts are desired. One or many days are selected or deselected by clicking on the names. If no days are selected, then all days are included for selection by default.
d. Day of Week "Select All" Check Box – selects all the days of the week if checked.

e. Jurisdiction List Box – contains a list of the jurisdictions (e.g., VDOT, M-NCPPC, MdSHA) that provide traffic counts to RIDES. Clicking on a jurisdiction toggles its selection.
f. Jurisdiction's "Apply" Check Box – indicates whether the user has completed his selection of jurisdictions. Checking the box updates the County list box.
g. Jurisdiction's "Select All" Check Box – selects all jurisdictions in the Jurisdiction list box if checked.
h. County List Box – contains a list of the counties within the chosen jurisdictions from which data is collected in the Metropolitan Washington region. Clicking on a county name toggles its selection.
i. County's "Apply" Check Box – indicates whether the user has completed his selection of counties. Checking the box updates the roadway type list box.
j. County's "Select All" Check Box – selects all counties in the County list box if checked.
k. Roadway Type List Box – contains a list of the types of roadway (e.g., freeway, arterial, on ramp, off ramp, etc.) for which traffic counts are desired. One or many types are selected by clicking on the types.
l. Roadway Type "Apply" Check Box – indicates whether the user has completed his selection of roadway types. Checking the box updates the Route Number list box.
m. Roadway Type "Select All" Check Box – selects all roadway types if checked.
n. Interstate / Route Number List Box – contains a list of the interstates/routes that are located within the selected counties and for which traffic counts are collected. One or many interstates/routes are selected by clicking on the numbers.
o. Interstate / Route Number "Apply" Check Box – indicates whether the user has completed his selection of interstate/route numbers. Checking the box updates the location list box.
p. Interstate / Route Number "Select All" Check Box – selects all interstate/route numbers if checked.
q. Location List Box – contains a list of location descriptions for the sites/stations collecting data at the selected routes. One or many locations are selected by clicking on the location descriptions.
r. Location "Apply" Check Box – indicates whether the user has completed his selection of locations. Checking the box updates the direction list box.
s. Location "Select All" Check Box – selects all locations if checked.
t. Direction List Box – contains a list of the directions of traffic flow associated with the chosen locations. One or many directions are selected by clicking on the directions.
u. Direction "Apply" Check Box – indicates whether the user has completed his selection of directions.
v. "Get Results" Command Button – when clicked, processes and returns the results associated with the reporting selections made.

### 5.3.3 Maryland State Highway Administration

*General*

Maryland State Highway Administration (MdSHA) Office of Traffic and Safety (OOTS) is located in Hanover, Maryland, and the MdSHA Highway Information Services Division (HISD) is located in Baltimore, Maryland.

a. The contact persons are as follows:
   i. For the MdSHA HISD the contact person is Michael Baxter, Manager of Traffic Data Collection Operations. His telephone number is 410.545.5511.
   ii. For the MdSHA OOTS the contact person is Jean Yves Point-du-Jour, Transportation Planner. His telephone number is 410.787.5866.

b. Maryland has 312 stationary count stations deployed in Montgomery County and 259 deployed in Prince Georges County. These count stations collect vehicle counts and classifications on fifteen-minute intervals over 24-hour periods, and store the count data in Traffic Monitoring System data files (data store D1c).

c. The Highway Information Services Division of the MdSHA daily accesses data store D1c, retrieves the fifteen-minute interval traffic count data and performs basic checks for reasonableness.

d. HISD next aggregates the 15-minute intervals to 60-minute intervals. The one hour interval station level data is incorporated into the Oracle based Traffic Monitoring System database (data store D2c).

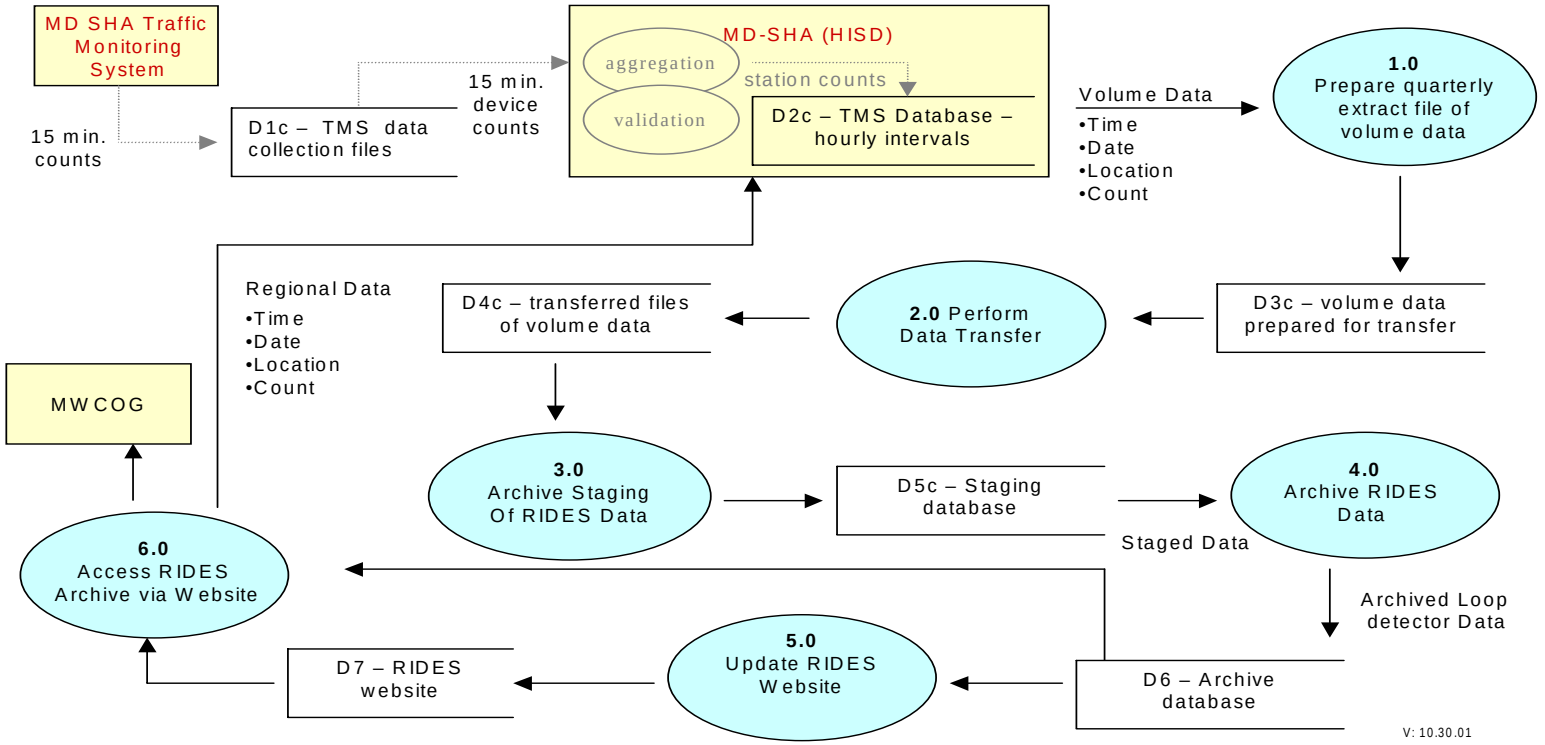
e. The Traffic Monitoring database is accessible to the general public via the Traffic Monitoring System web page is http://www.marylandroads.com/oppe/tms/tms.htm.

f. Refer to Appendix O for the data flow diagram depicting the work flow of the data from the point where the data is collected from the device to the points where the data is processed and approved for sharing with MWCOG.

g. The process flow design for MdSHA data is shown in Exhibit 14.

**EXHIBIT 14**

# MD-SHA Loop Detector Data Flow



*Process Flow for MdSHA Sourced Loop Detector Data*

PROCESS 1.0 - Prepare Quarterly Extract File of Volume Data:

32. MdSHA, at the beginning of each quarter of the year, initiates a stored query that contains selection criteria specified by the MWCOG. The stored query executes upon the database table containing the prior 3-month time period of fifteen-minute interval traffic count records. The query results are saved as a comma delimited text file result that contains date, time, station, site and link, direction, location description, and associated count summarized into fifteen-minute intervals. This text file (data store D3c) is then written to a compact disk (or disks), and notification is provided to the RIDES administrator at MWCOG that data files are prepared for shipment.

PROCESS 2.0 – Perform Data Transfer:

33. MdSHA mails the compact disk(s) to the RIDES Administrator at the following address:
    Metropolitan Washington Council of Governments
    777 North Capitol Street, NE, Suite 300
    Washington DC. 20002-4239
    Attention: Bob Griffiths

34. Upon inspection of the mailed CDs, the RIDES Administrator acknowledges successful (or damaged) receipt to Michael Baxter via electronic mail addressed to the following address: mbaxter@sha.state.md.us

35. The RIDES Administrator places the recently received CDs (data store D4c) into designated storage area for subsequent use in loading the RIDES staging area.

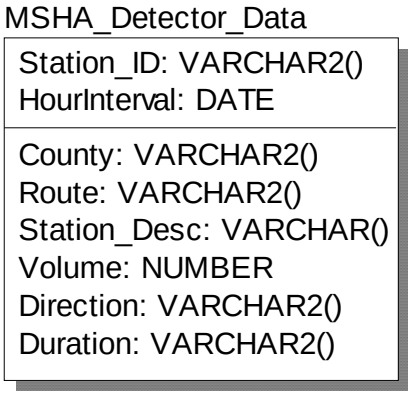
PROCESS 3.0 – RIDES Archive Staging:

36. The archive staging process begins by clearing tables in RIDES Staging database - data store D5c.

37. The archive staging process proceeds to load text file contents of data store D4c, stored on one or more compact disks, into the archive staging relational database which consolidates the new set of data into the empty staging tables. The purpose of data archive staging processes is the consolidation of comma-delimited text files (data store D4c) into relational database records (data store D5c) that are accessible through a standard language, SQL. Key data relationships are established within the data archive staging relational database. Data integrity constraints ensure that incomplete or duplicate records do not exist in the data archive. Archive staging processes organize location descriptive metadata (station and direction) to be directly associated and accessible with corresponding station codes and interstate highway codes.

38. The design for the staging database tables containing intersection volume counts collected by Md SHA is shown in Exhibit 15.

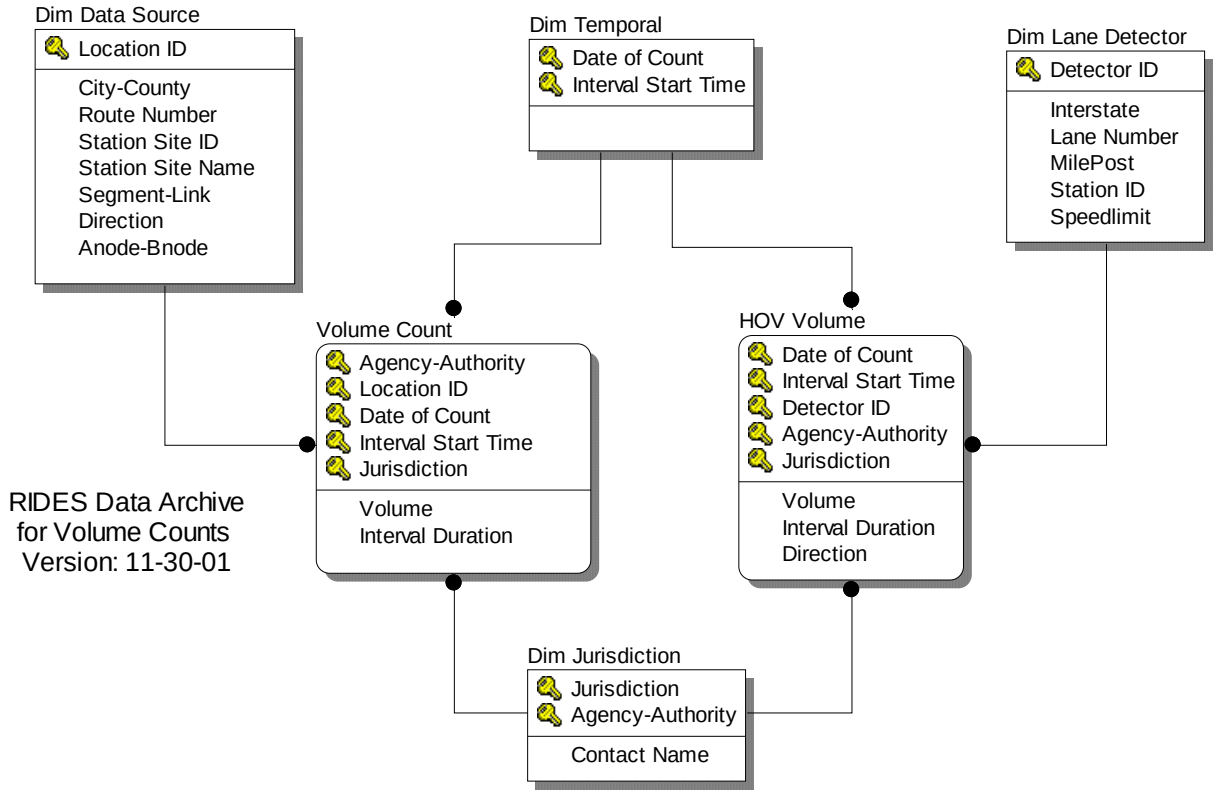
**EXHIBIT 15**




PROCESS 4.0 – RIDES Data Archiving:

39. The data archiving process begins by integrating the archive staging contents of data store D5c, into a relational database of archive data (D6), shown in Exhibit 16.

**EXHIBIT 16**




40. The design of the RIDES Data Archive (data store D6) is a fact and dimension style of design used to organize quantitative facts and qualitative artifacts of a discrete transaction event for the purpose of multi-dimensional analysis. The discrete event being transacted is the detection and incremental count of a vehicle through the electromagnetic field of an inductive loop. The quantitative fact is the count. The qualitative artifacts of the event are the location of the event, the date and time of the event, and the agency or authority responsible for transacting the volume count event. The type and amount of facts of the volume count event vary dependent upon the level of sophistication for the equipment being employed. Surface moisture level and surface heat levels, occupancy, and speed (derived from time traveling a known distance between two devices) are examples of additional facts that are typically collected.

41. The data entities involved are:
    a. Volume Count – contains records of volume count information achieved or aggregated over a time interval duration expressed in minutes at the station or site specified by the agency or authority on the date and start time noted.
    b. Dim Temporal – contains time and date of each volume count event.
    c. Dim Jurisdiction – contains information about the agency or authority initiating the volume count, jurisdiction represented by agency, and the name of the contact person for the data contributed to RIDES.

d. Dim Data Source – contains the station or site identifier and associated description for the location where the volume counts were collected, the route number, direction of traffic flow as designated by the jurisdiction, city or county, segment-link identifier, and the associated ANODE-BNODE link identifier from MWCOG's Regional Network Database.
e. HOV Volume – contains records of volume count information achieved or aggregated over a time interval duration expressed in minutes for the applicable direction at the HOV detector specified by the agency or authority on the date and start time noted.
f. Dim Lane Detector – contains the identifier of the HOV detector, the HOV lane for which the detector is collecting counts, the associated interstate, the milepost location of the detector along the interstate, the associated station, and the posted speed limit for that HOV lane.

42. The data contained in data store D5c is queried and inserted into the archive data store D6 by SQL procedures stored within the database. Once the new records have been incorporated into the database, a new set of statistics is generated, and a full backup is accomplished.

PROCESS 5.0 – Update RIDES Web Page:

43. The RIDES web page (data store D7), accessed via a link on the MWCOG web site, is updated with a brief description of the new quarterly data that has been added to the RIDES Archive.

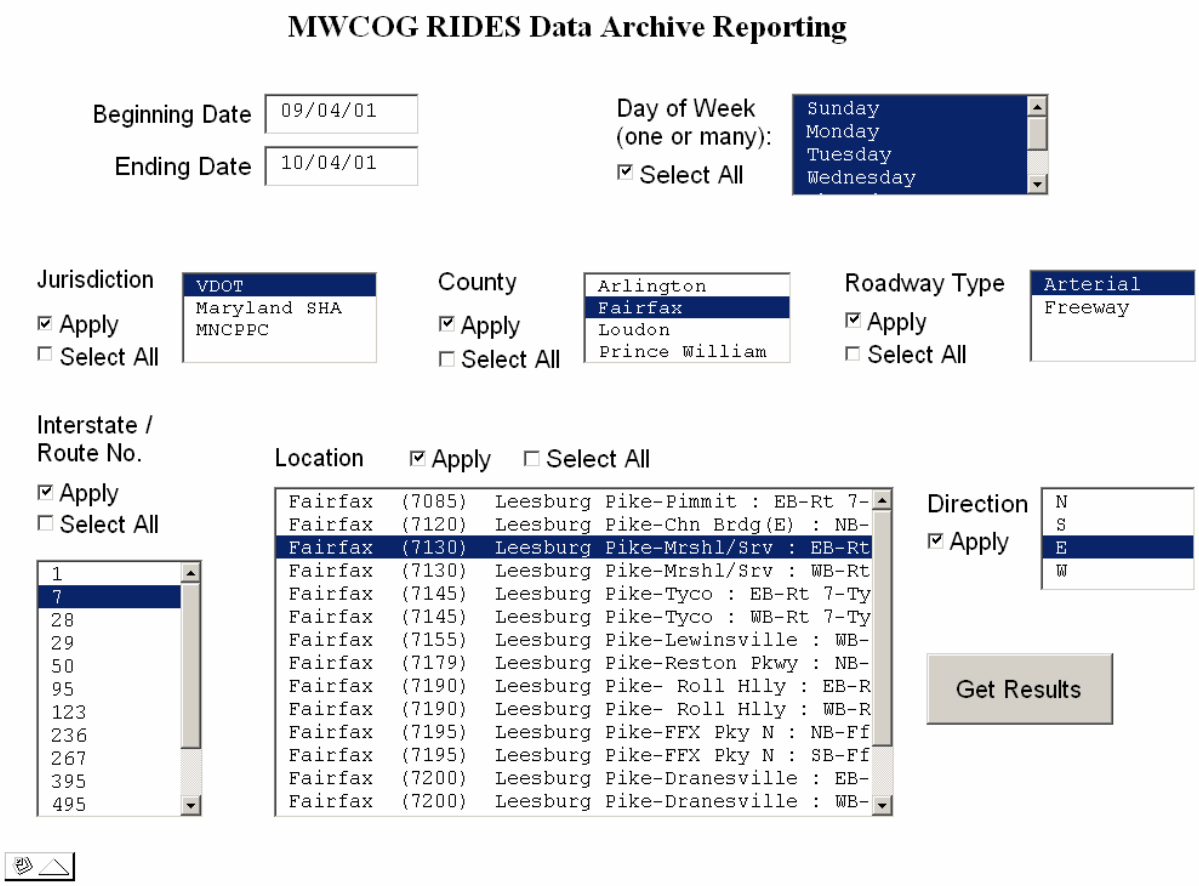
44. News of an updated RIDES database is broadcast via e-mail to the community of RIDES users for their awareness of the availability of new data content.

PROCESS 6.0 – Access RIDES web page and Data Archive:

45. The RIDES web page is accessed via a link on the MWCOG web site. From there, the RIDES Data Archive user clicks on the link to the data archive reporting web page.

46. The data archive reporting web page will look similar to the Report Criteria web page of the Maryland State Highway Administration's web site. Exhibit 17 is a prototype of user interface and data fields that present the principal functionality anticipated for the web page solution applicable to regional data access needs.

**EXHIBIT 17**




a. Beginning Date Text Box – contains the start date of the time period for which traffic counts are desired. The format of the date is MM/DD/YYYY. The default value is the current date of MWCOG's RIDES server. The date may be changed by typing in the desired date in the correct format.
b. Ending Date Text Box – contains the end date of the time period for which traffic counts are desired. The format of the date is MM/DD/YYYY. The default value is the current

date of MWCOG's RIDES server. The date may be changed by typing in the desired date in the correct format.

c. Day of Week List Box – contains a list of the named days of the week for which traffic counts are desired. One or many days are selected or deselected by clicking on the names. If no days are selected, then all days are included for selection by default.
d. Day of Week "Select All" Check Box – selects all the days of the week if checked.
e. Jurisdiction List Box – contains a list of the jurisdictions (e.g., VDOT, M-NCPPC, MdSHA) that provide traffic counts to RIDES. Clicking on a jurisdiction toggles its selection.
f. Jurisdiction's "Apply" Check Box – indicates whether the user has completed his selection of jurisdictions. Checking the box updates the County list box.
g. Jurisdiction's "Select All" Check Box – selects all jurisdictions in the Jurisdiction list box if checked.
h. County List Box – contains a list of the counties within the chosen jurisdictions from which data is collected in the Metropolitan Washington region. Clicking on a county name toggles its selection.
i. County's "Apply" Check Box – indicates whether the user has completed his selection of counties. Checking the box updates the roadway type list box.
j. County's "Select All" Check Box – selects all counties in the County list box if checked.
k. Roadway Type List Box – contains a list of the types of roadway (e.g., freeway, arterial, on ramp, off ramp, etc.) for which traffic counts are desired. One or many types are selected by clicking on the types.
l. Roadway Type "Apply" Check Box – indicates whether the user has completed his selection of roadway types. Checking the box updates the Route Number list box.
m. Roadway Type "Select All" Check Box – selects all roadway types if checked.
n. Interstate / Route Number List Box – contains a list of the interstates/routes that are located within the selected counties and for which traffic counts are collected. One or many interstates/routes are selected by clicking on the numbers.
o. Interstate / Route Number "Apply" Check Box – indicates whether the user has completed his selection of interstate/route numbers. Checking the box updates the location list box.
p. Interstate / Route Number "Select All" Check Box – selects all interstate/route numbers if checked.
q. Location List Box – contains a list of location descriptions for the sites/stations collecting data at the selected routes. One or many locations are selected by clicking on the location descriptions.
r. Location "Apply" Check Box – indicates whether the user has completed his selection of locations. Checking the box updates the direction list box.
s. Location "Select All" Check Box – selects all locations if checked.
t. Direction List Box – contains a list of the directions of traffic flow associated with the chosen locations. One or many directions are selected by clicking on the directions.
u. Direction "Apply" Check Box – indicates whether the user has completed his selection of directions.
v. "Get Results" Command Button – when clicked, processes and returns the results associated with the reporting selections made.

# SECTION 6
# SUMMARY AND RECOMMENDATIONS

## 6.1 BACKGROUND

This Intelligent Transportation System (ITS) as a Data Resource Study was sponsored by the Metropolitan Washington Council of Governments' ITS As A Data Resource Working Group. The Working Group was formed in early 1997 to examine opportunities for using ITS equipment as data sources for transportation planning. ITS devices generate large amounts of operational data that are used primarily in real-time to effect traffic control/management strategies. However, data from ITS field devices offer great promise for uses beyond the execution of ITS control strategies. A system for collecting, processing, archiving, retrieval, and sharing of data from ITS field devices needs to be put in place so that planners can benefit from these data sources. This study is a first step in achieving the Working Group's long-term vision for the design and implementation of a data sharing system referred to as the future "Regional ITS Data Exchange System (RIDES)." Potential benefits of developing such a system include increased efficiency, reduced duplication, enhanced consistency, and improved ability to fulfill multiple agency data needs.

The ITS as a Data Resource Study is a three-phase feasibility analysis, conceptual design and implementation planning study for the use of existing and planned ITS installations at MWCOG member organizations as resources for sharing transportation systems data. The study sought to determine the practicality of developing and deploying in a cost effective manner a regional ITS data sharing and data archiving solution using a common architectural framework. More specifically, the study objectives include the following:

- Identify opportunities and issues relevant to archiving, analyzing and sharing data collected by ITS equipment by agencies in the region;
- Develop an accurate inventory of the existing data management environment in the member organizations;
- Develop a high-level functional design and conceptual plan for a regional system that would draw data from ITS field devices; and
- Develop a high-level implementation plan.

During Phase 1, an inventory of the data and processes used by participating agencies for ITS data collection, storage and analysis was prepared. A survey on current and planned ITS data management operations was undertaken. The results of the survey were used to identify a common data architecture and data management infrastructure. The outcome of Phase 1 was documented in the ***Inventory and Assessment Technical Memorandum*** that was completed in November 2000.

Under Phase 2, the study solicited inputs from key stakeholders on technical, operational, and policy constraints within their organization that might affect the design of the RIDES; developed four alternative design options that address varying levels of system architecture and cost; identified their respective pros and cons; assisted MWCOG with the selection of a preferred concept for the RIDES; and, prepared a detailed design for the preferred concept. The main objectives of Phase 2 were to provide a technical perspective on the existing ITS data environment and potential RIDES architecture; and, to facilitate an

informed decision making process regarding the selection of a preferred RIDES system design. The results of Phase 2 are documented in this ***Regional ITS Data Exchange System Architecture Analysis Technical Memorandum***.

Phase 3 involves implementation planning. However, based on the Phase 2 findings regarding the current status of data management and operations and level of readiness of the data infrastructure in the MWCOG member organizations, it was decided that the study would culminate in the preparation of study recommendations in lieu of an implementation plan. The recommendations are presented in this technical memorandum.

## 6.2 KEY FINDINGS AND CONCLUSIONS

Based upon the Phase 1 Survey findings and Phase 2 Technical Workshops, four alternatives for the conceptual design for a Regional ITS Data Exchange System (RIDES) were developed, namely:

- Low Cost-Centralized
- Low Cost-Distributed
- Moderate Cost-Centralized
- Moderate Cost-Distributed

After a thorough evaluation of these alternatives the ITS as a Data Resource Working Group selected Low Cost-Centralized as the preferred option. The Project Team then sought to identify the ITS data that would become the focus of the detailed design effort. With the exception of ramp meter data, the Project Team found that the ITS data of interest to transportation planners within the Metropolitan Washington include:

- Automated Vehicle Locator data
- Inductive loop detector data
- Interconnected Traffic Signal Control Systems data
- Radar detection data
- Traffic Management Center data
- Vehicle probe (cellular, transponder) data
- Video detection (counts, occupancy) data
- Weather detection data

Furthermore, the ITS device types and the corresponding agencies where ITS data are collected and prepared for planning purposes were investigated. The results are summarized in Appendix E.

In specifying the detailed design for the Low Cost-Centralized Alternative (designated D1), the Project Team decided to focus on the development of a regionally shared ITS data archiving system for traffic data collected using inductive loop detectors. The current level of deployment of this type of device is pervasive enough to generate a significant amount of data that would be very useful for transportation planning and operations.

For the purpose of developing the detailed design, field data gathering and interviews of key personnel were undertaken at the following agencies that collect traffic data on freeways and arterial highways:

- Virginia Department of Transportation
- Maryland State Highway Administration
- Maryland-National Capital Park and Planning Commission
- City of Fairfax
- Arlington County

The individuals from the above-mentioned agencies who were interviewed and provided data for the preparation of the detailed design are listed in Appendix F. The following information on inductive loop detector data in their respective agencies were gathered from said individuals:

- The number of deployed inductive loop detectors that produce the ITS data content candidate to be shared regionally
- The data dictionary metadata (or at minimum, the data format) describing the ITS data produced and geographic information describing and/or referencing the location of the loop detectors
- Metadata describing the processing workflow of the ITS data from collection to that point within the workflow when the ITS data is ready to be shared regionally
- A descriptive clarification as to whether or not the ITS data to be shared regionally is being archived by the producing agency; if so, for how long and in which manner

The findings from these interviews and data gathering effort are presented in Section 5 and Appendices I through M of this technical memorandum. The data flow diagrams presented in said appendices describe the detailed work flow of the loop detector data from the point in the process where the devices collect the data to the point where the data is fully processed and approved for transmission to MWCOG for regional data sharing. Other findings that pertain to inductive loop detector data are as follows:

- Inductive loop detector data appears to be a sufficiently prevalent device category of ITS data that provides transportation planners with cost effective volume count information representative of a significant portion of the metropolitan area.
- Inductive loop detector data is being validated before being used for planning purposes, but the methods of data validation vary across agencies.
- Inductive loop detector data is being retained, and typically it is an aggregation of the data collected that is being archived.
- Inductive loop detector data made available by individual agencies to public access is being organized primarily for query and reporting purposes and not explicitly for regional data sharing purposes.
- Data terminology issues may affect the accurate interpretation of inductive loop detector data that has been integrated across jurisdictional areas.
- Individual agencies are very willing to support a regional data sharing initiative, but are constrained by funding resources.

## 6.3 RECOMMENDATIONS

The recommendations toward the realization of a Regional ITS Data Exchange System (RIDES) cover implementation strategies, data quality, technical aspects, and organizational aspects. It also includes a list of the "future steps" necessary to move the project forward to the detailed implementation of the RIDES archive.

### 6.3.1 General

A. Implementation Strategies

- Commence with inductive loop detector data
- Proceed on an agency-by-agency basis using representative data samples
- Prepare an in-depth analysis of the state of readiness of data infrastructure within and among the participating agencies
- Undertake comprehensive inventory and location survey of currently deployed loop detectors and identify those that provide traffic volume data

B. Data Quality

- Investigate the accuracy of traffic volume data obtained from loop detectors in order to identify possible causes of failures in data collection, determine potential sources of errors in data processing, and examine the magnitude of measurement errors.
- Establish centralized and standardized procedures for checking the accuracy of traffic volume data based on the results of the investigation described in the preceding recommendation
- Define and automate data validation rules for filtering or flagging erroneous data that need to undergo a more rigorous data hygiene procedure
- Assign the application of validation rules and data hygiene procedures among the data providers and the central archive site to achieve the desired level of accuracy for data collected from different sites
- Establish data quality indicators or indices that can guide users in making judgments on the applicability of the data to their planning and analysis tasks
- Define policies, procedures and analytical methods for imputing values to fill data gaps

C. Technical Aspects

- Analyze the compatibility of data structures supporting RIDES and current and planned data structures at participating agencies
- Consider the evolving ITS data architecture standards in finalizing the RIDES data structures
- Use longitude/latitude coordinates to describe the deployment location of inductive loop detectors and other ITS devices that provide archival data
- Establish data management procedures for using GIS data supporting the RIDES archive

- Map the loop detector stations onto the links of the MWCOG Clearinghouse Regional Network by undertaking the following: (a) prepare a comprehensive inventory of inductive loop detectors deployed in freeways and arterial roads in the region; (b) identify loop detector stations that collect traffic volume data; and, (c) determine the loop detector station that corresponds to each link in the MWCOG network. In cases where there are multiple loop detector stations that map onto a single link, determine the loop detector station that provides the best representation of the traffic volume for the link.
- Ensure that traffic volume data collected is classified into general-purpose lane and high-occupancy vehicle (HOV) lane traffic
- Assess the reliability and capacity of communications network needed to support data transmission to the RIDES archive
- Establish appropriate level of data granularity that can support intended applications
- Resolve with MdSHA the issues related to the availability of fifteen-minute traffic volume data. Currently, MdSHA provides traffic volume data aggregated at the hourly level
- Coordinate across agencies the database definitions related to the different road classification systems

D. Organizational Aspects

- Coordinate with relevant agencies the design and implementation of database schemas
- Formalize the multi-jurisdictional setup and responsibilities for data management
- Recognize the need for a flexible design for RIDES given the varying state of readiness of data infrastructure among the participating agencies
- Have the data "pushed" to the RIDES archive at MWCOG by the participating data providers
- Determine funding source

### 6.3.2 Future Steps

A. Data Validation - Analyze representative data samples in order to validate RIDES Staging Area data structures for correctness as to:
- Data relationships
- Data record uniqueness
- Data content completeness
- Data content granularity

B. Technology Specification and Deployment - Allocate the MWCOG technologies necessary to support the RIDES solution:
- File server
- Database server
- Database instance

C. Database Setup and Implementation
- Construct the data structures for the RIDES Archive Staging Area
- Construct the data inflow and database load processes
- Validate data inflow and database load processes for RIDES Archive Staging Area data structures
- Design and develop process to incorporate MWCOG specific (Anode-Bnode) data into Staging Area content
- Construct the data structures for the RIDES Archive
- Construct the database load process to move data from RIDES Archive Staging Area to the read-only RIDES Archive

D. Data Retrieval System Implementation
- Develop the RIDES Archive data access mechanism

E. System Documentation and User Training
- Design and develop RIDES Archive User's Guide
- Develop RIDES Archive Operations and Technical Support Instructions
- Develop RIDES Archive Training Program and perform training as needed

F. System Enhancement
- Plan and budget expansion of RIDES Archive to accommodate other ITS data types of interest

# APPENDIX A
# ACRONYMS LIST

| Acronym | Acronym Description |
|---|---|
| ATM | Asynchronous Transfer Mode |
| ATMS | Advanced Traffic Management System |
| AVL | Automatic Vehicle Location |
| CHART | Coordinated Highways Action Response Team |
| COTS | Commercial Off The Shelf |
| DBA | Data Base Administrator |
| DOT | Department of Transportation |
| DPWT | Department of Public Works and Transportation |
| FGDC | Federal Geographic Data Committee |
| FHWA | Federal Highway Administration |
| FOIA | Freedom Of Information Act |
| GIS | Geographic Information Systems |
| GPS | Global Positioning System |
| HTML | HyperText Markup Language |
| ISTEA | Intermodal Surface Transportation Efficiency Act of 1991 |
| IT | Information Technology |
| ITS | Intelligent Transportation System |
| JAD | Joint Application Design |
| LAN | Local Area Network |
| LRS | Linear Referencing System |
| M-NCPPC | Maryland-National Capital Park and Planning Commission |
| MOU | Memorandum of Understanding |
| MPO | Metropolitan Planning Organization |
| MdSHA | Maryland State Highway Administration |
| MWCOG | Metropolitan Washington Council of Governments |
| NDA | Non-Disclosure Agreement |
| OOTS | Office of Traffic and Safety |
| PIM | Partners In Motion |
| QA/QC | Quality Assurance/Quality Control |
| RIDES | Regional ITS Data Exchange System |
| SQL | Structured Query Language |
| STL | Smart Travel Lab |
| TMC | Traffic Management Center |
| VDOT | Virginia Department of Transportation |
| VPN | Virtual Private Network |
| WAN | Wide Area Network |
| WMATA | Washington Metropolitan Area Transit Authority |
| XML | Extensible Markup Language |

# APPENDIX B
# TECHNICAL WORKSHOP CONSULTANT NOTES

| *Agency Workshop* | *Participants* | *Finding Highlight* |
|---|---|---|
| **VDOT/NOVA STC** | Amy Tang<br>Stephen Read<br>Melanie Wright<br>Jimmy Chu<br>Tom Phillips<br>Andy Meese<br>Oneill Brooke | ▪ No formal Archive or Data Sharing Policy, but currently working on one for the entire state<br>▪ Archived data will be stored at the Smart Travel Lab<br>▪ Want consolidated policy on data and centralize/distribute as information is requested<br>▪ Overwhelming preference to "Push" data<br>▪ Currently has no formal Security policy (data or facility)<br>▪ All traffic data is public knowledge via FOIA – no sensitivity issues<br>▪ Currently attempting to parse/filter data to make it more meaningful<br>▪ Currently working with PIM and MdSHA to determine what data is realistic to share – decided this is not beneficial or constructive – only needed if major incident on adjoining roadways<br>▪ Primary incident data is collected and archived, but not sure how to use it – currently no data model<br>▪ Current archive timeframe is approx. 1 years worth of data<br>▪ 3 areas of concern: Signals, Freeways and Permanent Counts<br>▪ No QA/QC or cleansing process – this function is performed primarily by Smart Travel Lab<br>▪ Plan to utilize VDOT Data Warehouse to take over archive functions for ITS data<br>▪ VDOT Central Office has primary control over web operations<br>▪ Standard data formats for VDOT regarding GIS are done thru MOU's and/or NDA's among participating agencies<br>▪ No current protocol for database format/structure<br>▪ Congestion problems cannot be solved by county, they must be done at the regional level.<br>▪ VDOT currently has "unstructured" data<br>▪ Planners are only people that want/need "archived" ITS data. |

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| **MdSHA** | Woody Hood<br>Patrick Zilliacus<br>Jim Yarskey<br>Jean Yves Point-du-jour<br>Loui Stratokos<br>Doug Simmons<br>Dennis Simpson<br>Bill Walsek | ▪ MdSHA currently shares TMC data with MPO's<br>▪ TMC has ability to store 8 years of data although this practice has only been in use for 2 years<br>▪ Do not currently have data standards<br>▪ Does have data collection standards – makes traffic counters sign-off on counts to ensure accountability<br>▪ Currently there are no plans for data archiving services.<br>▪ Signal System data is left on the street – only bring data back to MdSHA if they need it.<br>▪ Communication and cost issues prohibit ability to bring more data back to the office<br>▪ Rely on manual models and traffic counters for analysis and plans<br>▪ Data Management is planned to be covered only by CHART, although it is not currently in place – 4-5 year planning horizon<br>▪ Traffic, Speed, Volume, Vehicle Classification and Video Images are currently being collected<br>▪ Telephone lines are currently the communication technology used to bring data in.<br>▪ Signal responsibility is solely that of OOTS; CHART is currently expanding their fiber lines<br>▪ MdSHA uses Oracle for data that spreads across OOTS, but for internal databases, MS Access is prominent database software.<br>▪ CHART uses Sonet ATM Backbone with Dial-up lines<br>▪ MdSHA would be happy just to get data back to MdSHA offices; prefers to maintain data management, collection and cleansing activities to be done by MdSHA.<br>▪ CHART and OOTS are responsible for IT connections<br>▪ MdSHA is currently sharing data with FHWA<br>▪ Currently do not share with Counties<br>▪ Get count data from monitoring and through HPMS<br>▪ Currently document incidents on paper format only<br>▪ Maryland State Police have their own database – 5 years behind in database development<br>▪ CHART is looking into pilot program to develop in the field<br>▪ Voice Communications – fiber sharing effort among VA, DC and MD<br>▪ Content still desired – travel speeds and cell phone probe data – would love to have access to AVL data via GPS from buses to help derive travel times and access to data that can help determine trip |

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| | | duration and trip duration variability due to incidents.<br>▪ LRS used is county/route/milepost.<br>▪ Follow e-Gov initiative; have ~ 300 inventory items/100 already in place; pushing for HTML links or back end database solutions |
| **M-NCPPC, Montgomery County and DPWT** | Scott Myers<br>Eric Graye<br>Andrew Meese<br>Rich Roisman<br>Patrick Zilliacus | ▪ DPWT has years of data and is currently trying to translate this data into useable information. Present constraint is that resources are NOT available for integration activities.<br>▪ Montgomery County eliminated traffic counts being done on a continual basis, so M-NCPPC and DPWT began utilizing ATMS data<br>▪ DASH system is currently not operational<br>▪ M-NCPPC and DPWT want to collect center to center – from one jurisdiction to another in a cooperative effort and coordination with other counties.<br>▪ M-NCPPC IT implementations throughout the county are behind their compatriots by approximately 5 years<br>▪ Bandwidth issues continue to be weak link in the chain<br>▪ Must use NTCIP standards or will forfeit federal funding<br>▪ Utilizing XML now and in the future to accommodate disparate data and formats<br>▪ Currently get ridership data for Montgomery County from WMATA, but M-NCPPC resource is retiring and will lose this connection<br>▪ No formal policy on Data Security<br>▪ Looking into linking up CHART to update Master Plan and Growth Policy Analysis to validate data<br>▪ Use EMME/2 modeling package<br>▪ DASH gives Montgomery County data only; RIDES would provide a regional perspective<br>▪ No error checking algorithm – validate within the context of the data<br>▪ Data Cleansing for DASH is done at M-NCPPC<br>▪ No business rules, entirely ad hoc – DASH<br>▪ Planning Documents are all hardcopy – no electronic copies<br>▪ Analysis is for sale – cost recovery only, not for profit<br>▪ ATMS is funded by CIP funds on 20 year bonds<br>▪ Most data is coming from loops in the ground – most reliable<br>▪ Bus and transit data are the best collectors of data – put out across the radio, cable TV and over the |

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| | | county website<br>▪ 250 buses collecting AVL data – currently being archived, but not being put out via radio or web<br>▪ GIS base map work – parcel and street level mapping data done by M-NCPPC; GPS is automated without operator involvement – DPWT<br>▪ Archived data is stuffed into an Informix database<br>▪ DPWT has DBA; M-NCPPC doesn't have any administration resources<br>▪ DPWT prefers "push" solution<br>▪ Bandwidth is M-NCPPC's biggest problem; DPWT has plenty of bandwidth<br>▪ Informix is utilized strictly for ATMS<br>▪ DPWT has web kiosk at Tasty Diner down the street from M-NCPPC offices which provides access to the Internet regarding Transportation related issues<br>▪ Approx. 700 intersections that DPWT has detectors on times 4 times the number of lanes<br>▪ In RIDES, M-NCPPC and DPWT would like to see: metadata, FGDC Standard for GIS data, when last update made?, original data source, data definitions, drill down abilities, 15 minute aggregates, M-NCPPC uses State Plane, not Lat/Lon<br>▪ Clone of Montgomery County ATMS is in the not too distant future for Prince George's County |
| **MWCOG** | Ron Milone<br>Bob Griffiths<br>Malaika Abernathy<br>Andrew Meese<br>Patrick Zilliacus<br>Raymon Murchison | ▪ No centralized DBA; No central Data Dictionary for the organization<br>▪ Need to focus on yesterday and today versus annual average data<br>▪ MWCOG planning horizon – present to 2025<br>▪ Deal primarily with long range forecasts<br>▪ Scale needs to be addressed – not necessarily at the "block" level; use regional data<br>▪ Traffic data collection is usually taken Tuesday thru Thursday<br>▪ More structured data is necessary for decision making<br>▪ Major obstacle – collecting data from multiple jurisdictions (DC, MD and VA)<br>▪ Utilize ISTEA and TEA21 standards for data collection protocol<br>▪ Erroneous and Duplicative data is major concern<br>▪ If MWCOG falls within 3% of HPMS data, models are considered accurate<br>▪ Traffic counts are taken from ATMS and pushed to M-NCPPC<br>▪ Not connected with ITS data systems<br>▪ "Push" solution should be considered |

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| | | ▪ MWCOG Data Clearinghouse would fill in the gaps if the RIDES data is included<br>▪ Data Clearinghouse has a 2 year lag in adding new data<br>▪ Data Clearinghouse is not web-based<br>▪ Measure data through events…volume, speed, direction, location, incidents, and measure variability by season, weather, day of the week, time, etc.<br>▪ Currently use decentralized databases…NT, AIX for GIS, SAS<br>▪ No plans to migrate to NT2000<br>▪ Website is hosted by off-site contractor<br>▪ No VPN capabilities as of yet<br>▪ 2 networks: 1 for internal MWCOG and 1 for Commuter Connections Ridership Program<br>▪ Oracle 8i – used by accounting department users only, not by Transportation Planning<br>▪ Not currently sharing data<br>▪ Have a lot of bottlenecks at the hub<br>▪ Visual Basic for ArcView and ArcInfo – Long term implementation<br>▪ Main concern with RIDES implementation is Security<br>▪ Funding at MWCOG is by project, not out of an overhead pool<br>▪ Moving toward IP; currently outsourced<br>▪ Don't want to assume MWCOG will be the "authority" to maintain and own RIDES – funding issue<br>▪ Archive ability – up and coming mandate to receive federal funding – probably within 5 years |
| **WMATA** | Andy Meese<br>Patrick Zilliacus<br>Don McCanless<br>Greg Garback<br>William Raine<br>Mike Saunders<br>Kathleen Donodeo | ▪ Budget planning for IT is 5 years out, with year to year adjustments<br>▪ Strategic Plan is a business plan for WMATA<br>▪ Customers – riding public, WMATA staff, elected officials, FTA/FHWA<br>▪ WMATA board comprises 16 member jurisdictions. Elected officials from jurisdictions sit on the board.<br>▪ WMATA web site geared towards riders and procurement, not jurisdictional support.<br>▪ IT department does not have direct contact with customers. IT supports employees, they support external customers<br>▪ Privacy concerns about SmartCard data. Current board policy is not to release any SmartCard data outside WMATA. Using SmartCard data for RIDES would require board approval. WMATA |

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| | | stores all data related to SmartCard transactions to the lowest level of granularity – even data regarding when the SmartCard reader fails to read a card.<br>▪ Overall ridership data can be released.<br>▪ Don McCanless – cost is the most critical component. How much is the RIDES system going to cost? More specifically what will WMATA's share be?<br>▪ Andy Meese – This is not an unfunded mandate<br>▪ Don McCanless – what kind of data elements would the system provide or contain?<br>▪ Need to convincingly answer the question – "What's in it for me?" What kind of benefits would WMATA derive from contributing to such a system (RIDES)<br>▪ AVL is being planned for implementation on buses. Metrorail has AVL/GPS<br>▪ Real-time bus data is not available yet<br>▪ IT Provides DBA, data management and tech support functions<br>▪ All SmartCard transactions are stored to the lowest level of granularity<br>▪ ORACLE is the database standard<br>▪ Tool sets available to extract data<br>▪ Developing data warehouse (ORACLE Express) WebDB; Ridership data with focus on SmartCards; Enterprise wide data<br>▪ Customizing front-ends<br>▪ Cross-platform environment – IBM Mainframe, Novell, Sun<br>▪ None of the WMATA jurisdictions share data – do not have access inside WMATA firewall<br>▪ Operate leased lines<br>▪ Web site is outside firewall<br>▪ 24 by 7 operation. Overnight production processing<br>▪ Would be a strong proponent of push technology<br>▪ Data hygiene would be a major concern. WMATA would be very cautious about the data they push out to a regional system. Data hygiene would be performed at WMATA<br>▪ Need to qualify quality of data<br>▪ When pulling data from RIDES – query RIDES, pull data back<br>▪ Authority may not want a distributed system – added cost of maintaining WMATA's portion of the system; WMATA will push data to a central location<br>▪ Privacy Policy |

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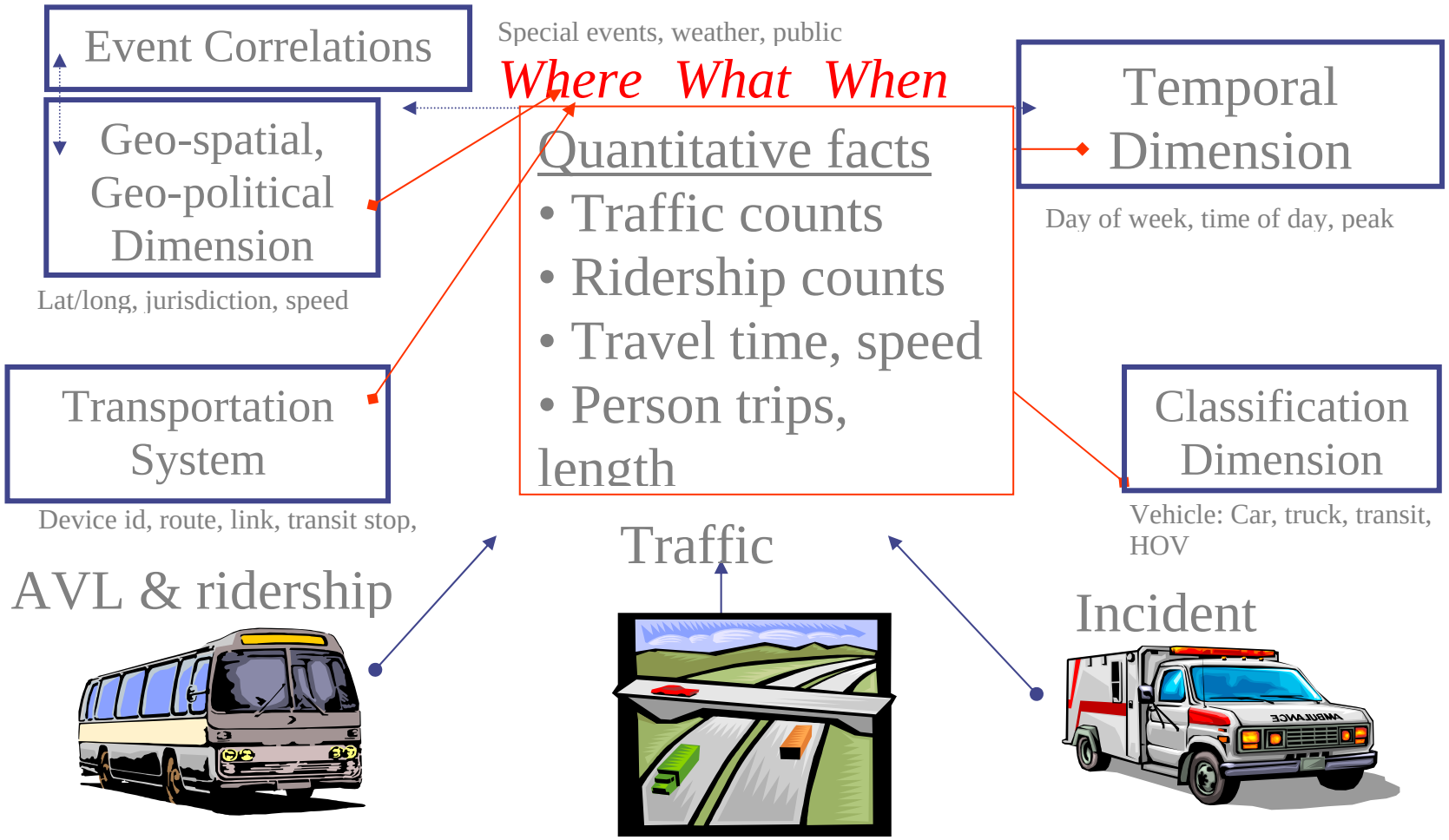
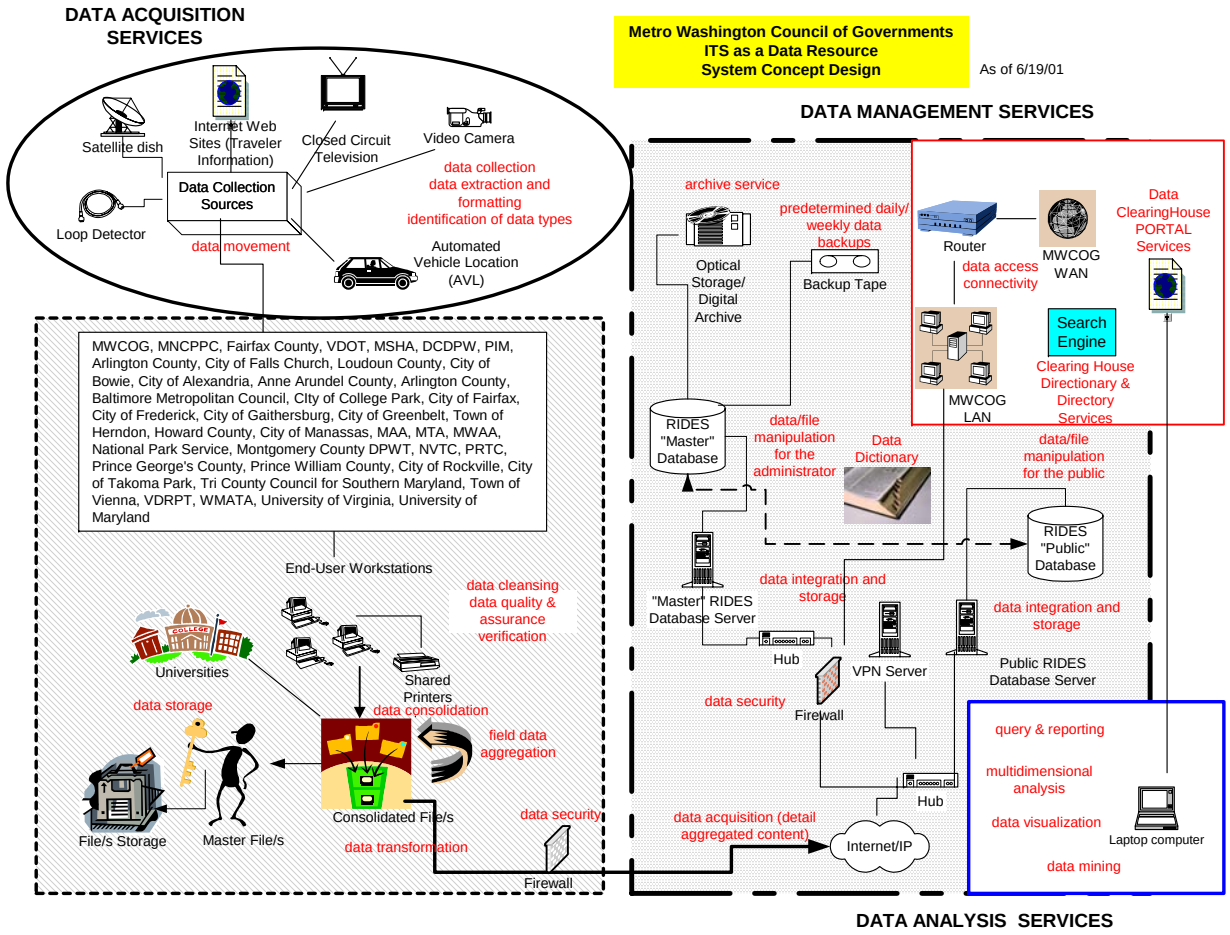
| | | ▪ Clearinghouse<br>▪ Agency Cost – O&M (data cleansing)<br>▪ Need to sell the system. For example, WMATA provides transit route information to MWCOG on a regular (Yearly) basis. This information is used by MWCOG for coding transit network. This is a time-intensive process. If RIDES could eliminate the need for this process, it would be a major selling point.<br>▪ Not in support of un-funded mandate. Need to identify funding source for the effort such as the Federal ITS earmark. |

# APPENDIX C
# PROPOSED ITS DATA ARCHITECTURE



# APPENDIX D
# PRELIMINARY RIDES DESIGN CONCEPT



# APPENDIX E
# ITS DEVICES BY AGENCY

| ITS Device by Agency | Virginia DOT STC | Virginia DOT STSS | WMATA | City of Fairfax | Arlington County | Montgomery County | Partners In Motion | District of Columbia | Maryland SHA | City of Alexandria | Prince Georges DPWT |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Automated vehicle locator (AVL) | | | EXISTING (MetroAccess only) | *Planned* | *Planned* | | | | *Planned* | | *Planned (2003)* |
| Inductive loop detectors | EXISTING | EXISTING | | EXISTING | EXISTING | | | EXISTING | EXISTING | EXISTING | EXISTING |
| Interconnected traffic signal control systems | *Planned* | *planned* | | EXISTING | | | | EXISTING | | EXISTING | EXISTING |
| Ramp meters | | | | | | | | | | | |
| Radar detection (Side-fire, Overhead) | *Planned* | *planned* | | *Planned* | | | | | EXISTING | | |
| Traffic Management Center (TMC) | EXISTING | EXISTING | | *Planned* | EXISTING | EXISTING (MCDPWT) | EXISTING | | EXISTING | EXISTING | *Planned (2001)* |
| Vehicle probes (cellular, transponder) | | | EXISTING (rail only) | | | | EXISTING | | *Planned* | | |
| Video detection (counts, occupancy) | *Planned 2001-2002* | *planned* | | *Planned, but not funded* | *Planned* | | | EXISTING | | EXISTING | *Planned (2001)* |
| Weather detection | | | | | | | | EXISTING | EXISTING | EXISTING | EXISTING |

# APPENDIX F
# INDIVIDUALS CONTACTED FOR THE DETAILED DESIGN WORK

| Name | Organization | Contribution Area |
|---|---|---|
| Andre Conerly | Arlington County | Traffic data collection in Arlington County |
| Doug Simmons | Maryland SHA | Transportation planning at MdSHA |
| Bill Walsek | Maryland SHA | Highway Information Services Division |
| Michael Baxter | Maryland SHA | Traffic data collection at MdSHA |
| James Burney | City of Fairfax | Traffic data collection in Fairfax city |
| Richard Roisman | M-NCPPC | Transportation planning at M-NCPPC |
| Amy Tang | Virginia DOT | VDOT NOVA district ITS policy |
| Mark Hagan | Virginia DOT - STSS | VDOT - Smart Traffic Signal Systems |
| O'Neil Brooke | Virginia DOT - STC | VDOT - Smart Traffic Center |
| Brian Smith | Smart Travel Lab (UVA) | Smart Travel Lab Director |
| Dave Lewis | Smart Travel Lab (UVA) | STL database schema and documents |
| Ryan Hammond | Smart Travel Lab (UVA) | Student; NOVA freeway volume counts |
| Matt Grimes | Smart Travel Lab (UVA) | Student; NOVA arterial volume counts |
| Paul Hill | PB Farradyne | Real-time data archive at VDOT - STSS |

# APPENDIX G
# MWCOG Regional Network

## MWCOG Regional Transportation Data Clearinghouse Highway Network – 2191

(Source: This document was provided by the Metropolitan Washington Council of Governments)

| | |
|---|---|
| Topology: | Polygon |
| Scale: | 1:100,000 |
| Coordinate System: | Maryland State Plane |
| Zone: | 4126 NAD83 |
| Units: | Feet |
| Extent: | COG/TPB 2191 Modeled area including: COG Member Jurisdictions plus Jefferson, Clarke, Fauquier, Stafford, Spotsylvania, Anne Arundel, Charles, Saint Mary's, Calvert, King George, Howard, and Carroll Counties, and the City of Fredericksburg. |

### Description

Spatial Data

The Regional Transportation Data Clearinghouse Network is based upon the 2191 Highway Network. This Network was rubber-sheeted in ARC/INFO to match the TIGER file street base. The unique identifier for each arc in the network is the item LINK_ID, which is derived from the ANODE-BNODE pair. The theme is titled **CH2191**.

Attribute Data

For the past several years, COG staff members have been building a comprehensive Regional Transportation Data Clearinghouse that includes traffic volumes and other data for highway links in the 2191 modeled region network. Sources of information for this database included state DOT roadway inventories, traffic trend books, traffic volume maps and other information obtained from state and local transportation planners. Regional clearinghouse coverage now contains 1986 through 1997 AADT volumes for most freeways and principal arterials and for a substantial number of minor arterials in the region. Route numbers, facility names and from and to street names are also included in the database. This makes it easy for users to identify specific links. The Clearinghouse Network is derived from the COG master any-year highway network. The Clearinghouse database is designed to be used with a desktop GIS such as ArcView. The data files included are all spatially referenced, but the presence of the facility names and logical sequence numbers makes the Clearinghouse network file useable with spreadsheet or database software as well.

### Arc Attribute Fields for CH2191.DBF

| Field Name | Type | *DESCRIPTION* |
|---|---|---|
| LINK_ID | 11,11,C | Anode – Bnode Pair |
| JUR | 8,11,F | Jurisdiction Number<br>0 - District of Columbia<br>1 - Montgomery County, Rockville, Gaithersburg & Takoma Park |

| | | |
|---|---|---|
| | | 2 - Prince George's County, College Park, Greenbelt & Bowie<br>3 - Arlington County<br>4 - Alexandria<br>5 - Fairfax County, City of Fairfax, Falls Church, Herndon, & Vienna<br>6 - Loudoun County, Leesburg, Round Hill<br>7 - Prince William County, Manassas, Manassas Park<br>9 - Frederick County<br>10 - Howard County<br>11 - Anne Arundel County<br>12 - Charles County<br>14 - Carroll County<br>15 - Calvert County<br>16 - St Mary's County<br>17 - King George County<br>18 - Fredericksburg<br>19 - Stafford County<br>20 - Spotsylvania County<br>21 - Fauquier County, Warrenton<br>22 - Clarke County<br>23 - Jefferson County |
| NHS | 1,1,C | National Highway System flag [1]<br>Y - Part of the National Highway System |
| ROUTE_ID | 10,10,C | Type of Route and Route Number<br>ALX – Alexandria Classification System<br>CO - Maryland County Route<br>DC - DC Highway<br>I - Interstate Highway<br>US - US Highway<br>VA - Virginia State Highway<br>MD – Maryland State Highway<br>WV - West Virginia Route |
| NAME | 35,35,C | Facility Name |
| FROM | 35,35,C | From Facility Name (at ANODE) |
| TO | 35,35,C | To Facility Name (at BNODE) |
| COUNTY | 20,20,C | County or City Name |
| AADT1986 | 5,5,C | 1986 Average Annual Daily Traffic [2] |
| CT86 | 2,2,C | 1986 Type of Traffic Count<br>a – Arlington Count from Arlington County Traffic Count book by Arlington Department of Public Works<br>5a- Arlington Count that has been averaged between two or more links<br>b – Virginia secondary road count that has been intentionally left blank<br>0 – No Traffic Count or Count Carried Down from Previous or Next Link<br>50- Average of two counts that have been carried down |

| | | |
|---|---|---|
| | | 1 – Traffic Count(s) Contained within Link<br>2 – Link Not Yet Built<br>3 – Statistic from County Traffic Count Source, Traffic Count(s) Contained within Link<br>4 – Statistic from County Traffic Count Source, Traffic Count Carried Down from Previous or Next Link<br>5 - Volume Averaged Between Two Links<br>mh – Volume taken from a HPMS section<br>ave – Volume is an average of the nearest years' volumes |
| AADT1987 | 8,20,F | 1987 Average Annual Daily Traffic [2] |
| CT87 | 2,2,C | 1987 Type of Traffic Count, See CT86 for codes |
| AADT1988 | 8,20,F | 1988 Average Annual Daily Traffic [2] |
| CT88 | 2,2,C | 1988 Type of Traffic Count, See CT86 for codes |
| AADT1989 | 8,20,C | 1989 Average Annual Daily Traffic [2] |
| CT89 | 2,2,C | 1989 Type of Traffic Count, See CT86 for codes |
| AADT1990 | 8,20,C | 1990 Average Annual Daily Traffic [2] |
| CT90 | 2,2,C | 1990 Type of Traffic Count, See CT86 for codes |
| AADT1991 | 8,20,F | 1991 Average Annual Daily Traffic [2] |
| CT91 | 2,2,C | 1991 Type of Traffic Count, See CT86 for codes |
| AADT1992 | 8,20,F | 1992 Average Annual Daily Traffic [2] |
| CT92 | 2,2,C | 1992 Type of Traffic Count, See CT86 for codes |
| AADT1993 | 8,20,F | 1993 Average Annual Daily Traffic [2] |
| CT93 | 2,2,C | 1993 Type of Traffic Count, See CT86 for codes |
| AADT1994 | 8,20,F | 1994 Average Annual Daily Traffic [2] |
| CT94 | 2,2,C | 1994 Type of Traffic Count, See CT86 for codes |
| AADT1995 | 8,20,F | 1995 Average Annual Daily Traffic [2] |
| CT95 | 2,2,C | 1995 Type of Traffic Count, See CT86 for codes |
| AADT1996 | 8,20,F | 1996 Average Annual Daily Traffic [2] |
| CT96 | 2,2,C | 1996 Type of Traffic Count, See CT86 for codes |
| AADT1997 | 8,20,F | 1997 Average Annual Daily Traffic [2] |
| CT97 | 2,2,C | 1997 Type of Traffic Count, See CT86 for codes |
| REMARKS | 40,40,C | Remark Field |
| FTYPE | 8,11,F | Facility Type<br>1 – Freeway<br>2 – Major Arterial<br>3 – Minor Arterial<br>4 – Collector<br>5 – Expressway |
| SEQUENCE | 8,11,F | Sequence Number within Route Segment |
| SEGMENT | 8,11,F | Segment of Route with Unique Name |
| STATE | 5,5,C | Link State<br>DC – District of Columbia<br>MD – Maryland<br>VA – Virginia<br>WV – West Virginia |

| | | |
|---|---|---|
| LOG_SEQ | 8,8,F,2 | Logical Sequence Number for Entire Route, the Whole Number Represents the Segment Number, and the Decimal Number Represents the Sequence within the Segment |
| URB_AREA | 3,3,C | Flag Indicating Link within an Urbanized Area<br>Y – Link within an Urbanized Area |
| PERMCOUNT | 16,16,C | Permanent Counting Location Identifier – for future data collection |
| TRAVTIME | 10,10,I | Indicates the Arterial Travel Time Section Identifier – used to like to the Dbase file ARTERIALTRAVTIME.dbf |

Attribute Data Sources:

1. The source for this data item was taken from the NHS coverage provided by the U.S. Department of Transportation, Federal Highway Administration.

2. The Average Annual Daily Traffic statistics were taken from state and county traffic agencies, as follows:

   a) All years for Virginia interstates, freeways, and primary arterials were taken from: *Average Daily Traffic Volumes on Interstate, Arterial and Primary Routes* (by year), Commonwealth of Virginia, Department of Transportation, Traffic Engineering Division

   b) All years for Virginia, except for Arlington County, minor arterials and below were taken from: *Secondary Traffic Tabulation* (by year and county), Commonwealth of Virginia, Department of Transportation, Traffic Engineering Division

   c) All years for Virginia, urban routes were taken from: *Urban Traffic Tabulation* (by year and city/town), Commonwealth of Virginia, Department of Transportation, Transportation Planning Division

   d) Arlington County's minor arterials and below were taken from: *Arlington County Traffic Counts*, Arlington County, Department of Public Works, Traffic Engineering Division. Some counts for Virginia Cities were taken from *24 Hour Traffic Volumes – Urban Traffic Count*, VDOT Transportation Planning Division

   e) All years for Maryland interstates, US highways, and state highways were taken from:

      *Highway Location Reference* (by year), Maryland Department of Transportation, State Highway Administration, with additions in 1996 from *Maryland County Traffic Volume Maps 1996* where data was not reported in the *Highway Location Reference*

Traffic volumes for the District of Columbia are reported as Average Annual Weekday Traffic (AAWT). AAWT for the District of Columbia (1986- 1993) was taken from printed volume maps by year, linked to the Street Inventory System (SIS) centerline file, averaged by HPMS section and linked to the Clearinghouse Highway Network. AAWT for the District of Columbia (1995 - 1997) was reported by the Traffic Services Branch for each HPMS section. Traffic volumes on links other than HPMS sections were reported by individual SIS link where available.

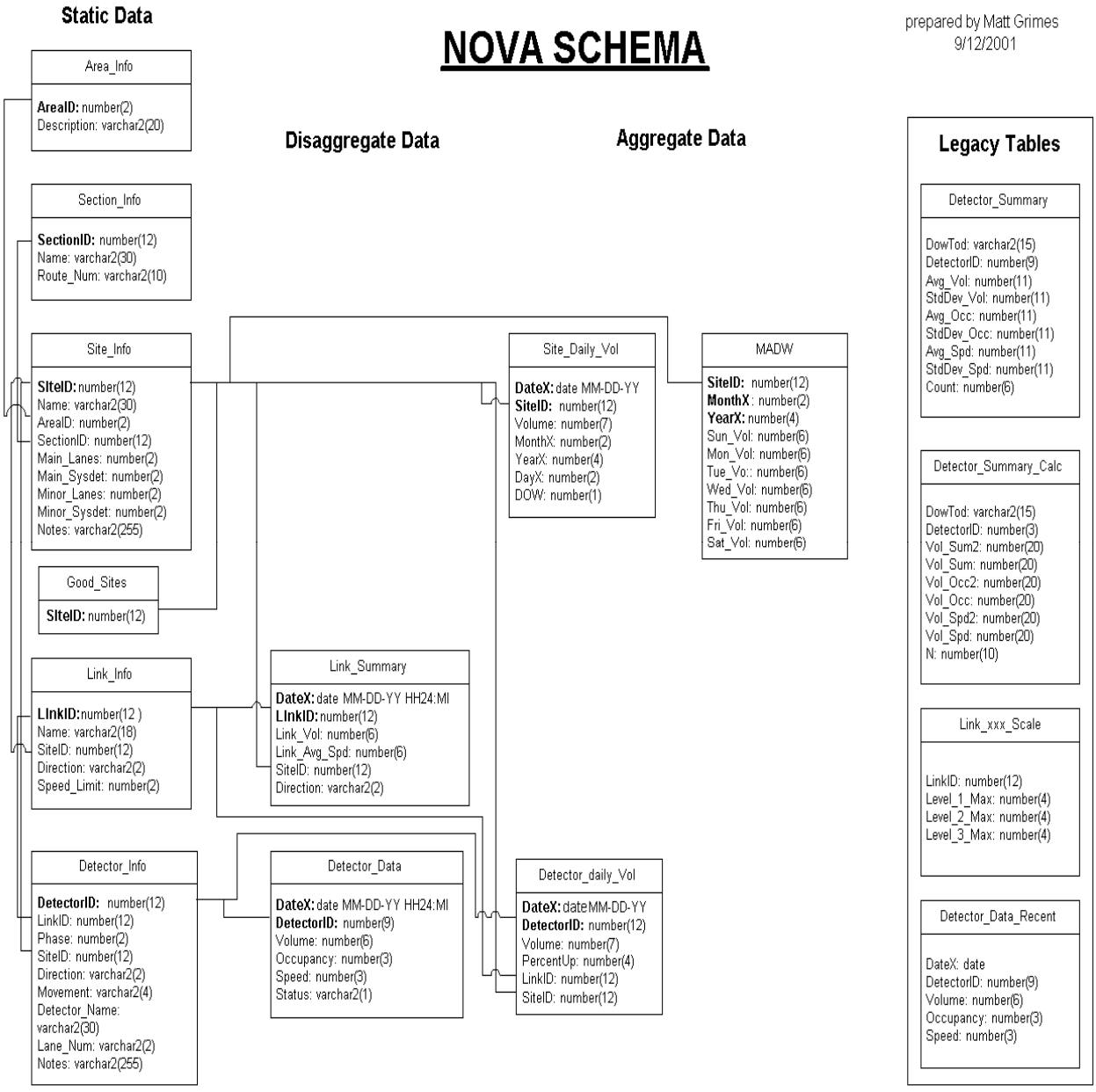
# APPENDIX H
# MAPPING OF VDOT NOVA FREEWAY LOOP DETECTOR STATIONS TO THE MWCOG REGIONAL NETWORK

## Loop Detector Station Data (Right side of spreadsheets)

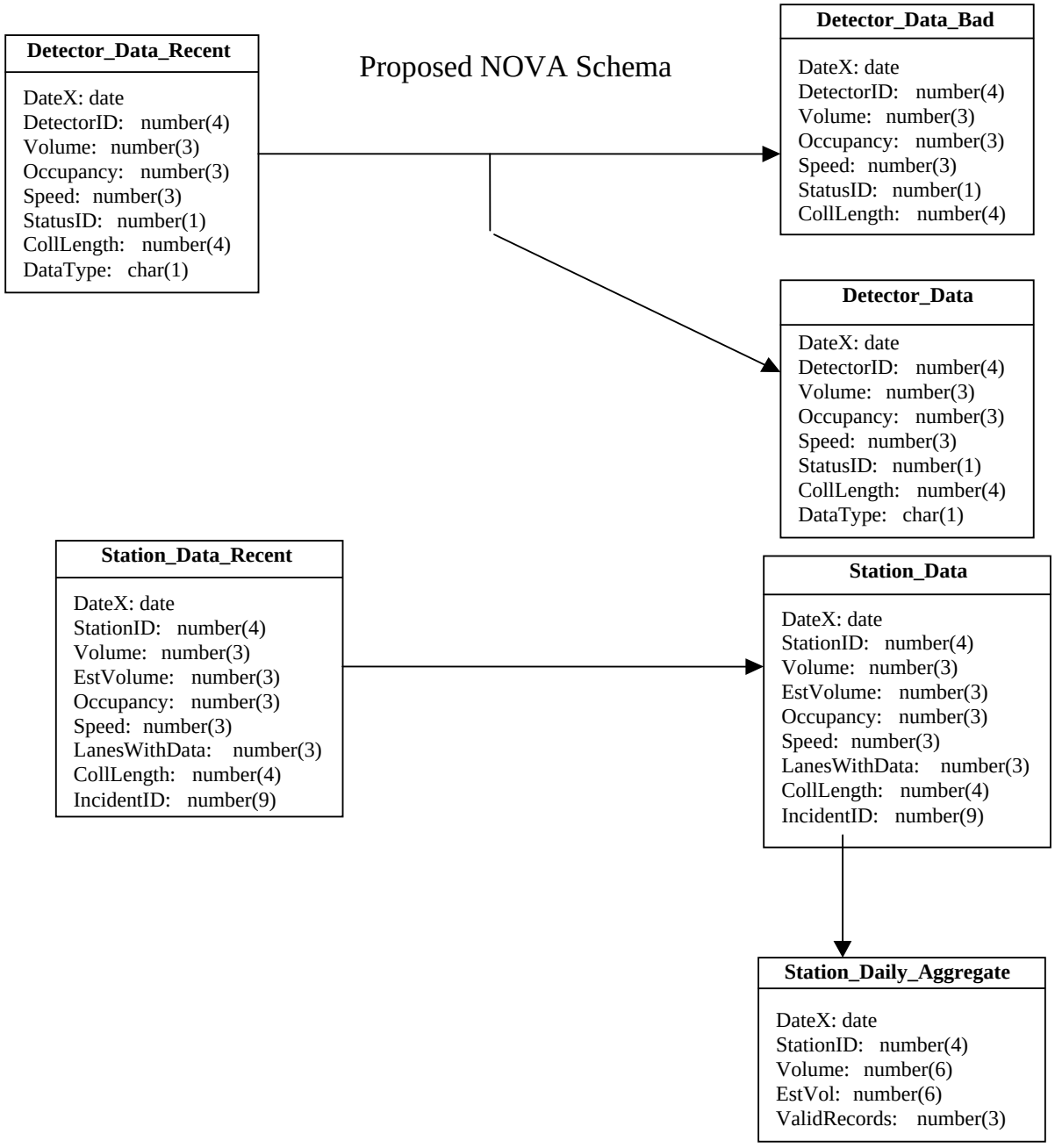
| Field | Descriprion |
|---|---|
| StationID | Station ID number |
| ControllerID | Controller ID number |
| Cabinet | Cabinet number |
| Interstate | Interstate on which station is located |
| Direction | Direction of road (NB, SB, EB, WB) |
| Lane_Type | Type of lane (Normal, On Ramp, Off Ramp, etc) |
| Mile | Location of station along roadway (currently the mileage reflects the location on the plan sheets measured in stati |
| Detector_Type | Type of detector setup (S - single loop, T - speed trap (double loop)) |
| UpStation | Number of station upstream (-1 if there is no station upstream) |
| DownStation | Number of station downstream (-1 if there is no station downstream) |
| DBL | Distance (in feet) between loops in a speed trap (-1 if a single loop) |
| PrevInt | Interchange number upstream of station |
| NextInt | Interchange number downstream of station (PrevInt and NextInt are same if detector is located in an interchange) |
| PrevRouteNo | Route number upstream of station (route numbers of roads in interchanges) |
| NextRouteNo | Route number downstream of station (route numbers of roads in interchanges) |
| PrevRoadName | Road name upstream of station (road names of roads in interchanges) |
| NextRoadName | Road name downstream of station (road names of roads in interchanges) |
| SpeedLimit | Speed limit at station |
| LanesWithDetectors | Number of lanes with detectors at station |
| TotalLanes | Number of lanes at station |
| RegularLanes | Number of regular lanes at station |
| HOVLanes | Number of HOV lanes at station |
| LCSLanes | Number of LCS lanes at station |

**MWCOG Clearinghouse Regional Network Data (Left side of spreadsheets);** Please refer to Appendix G for field attributes

# APPENDIX I
# VDOT NOVA ARTERIAL DETECTOR DATA SCHEMA AT SMART TRAVEL LAB



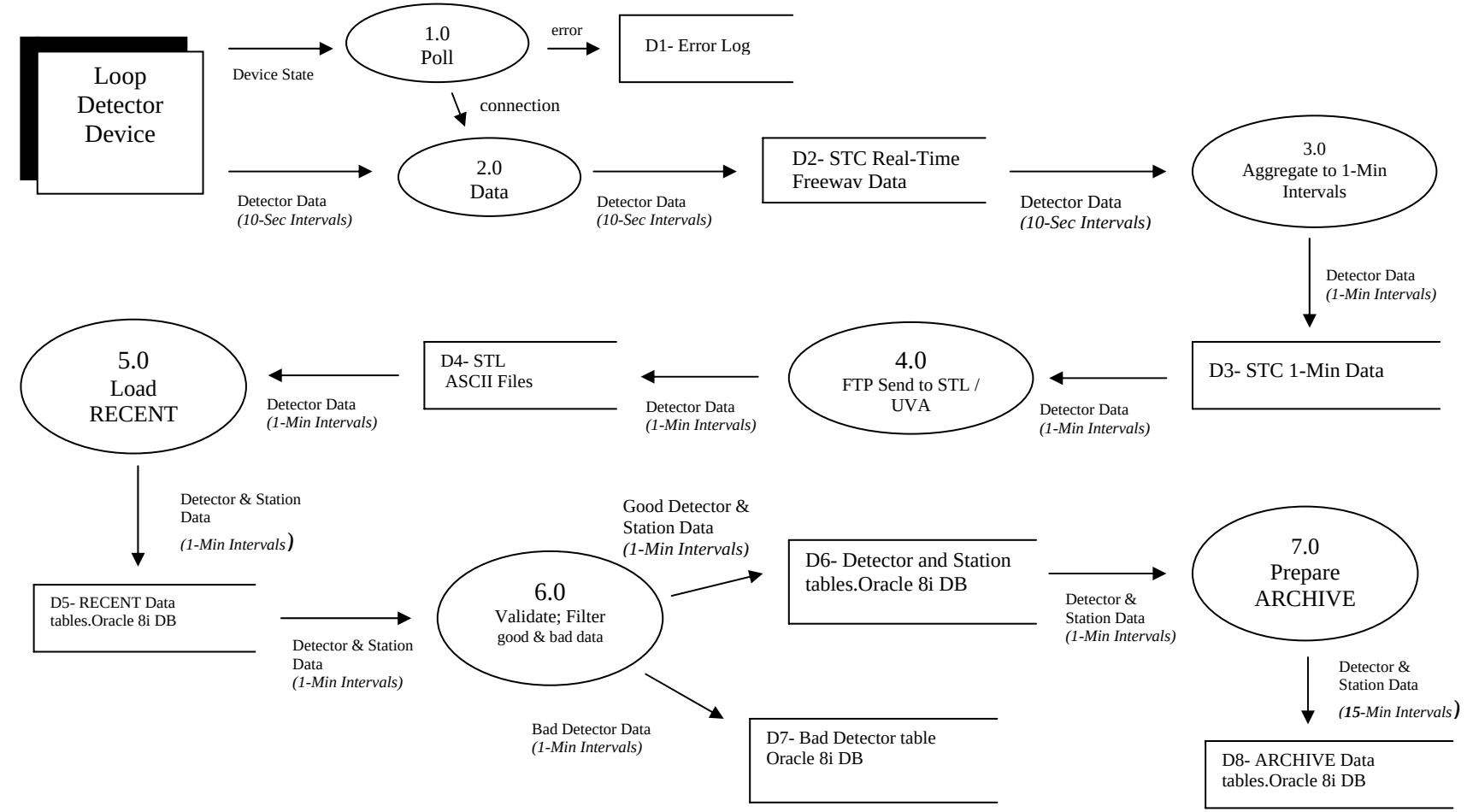
# APPENDIX J
# VDOT NOVA FREEWAY DETECTOR DATA SCHEMA AT SMART TRAVEL LAB



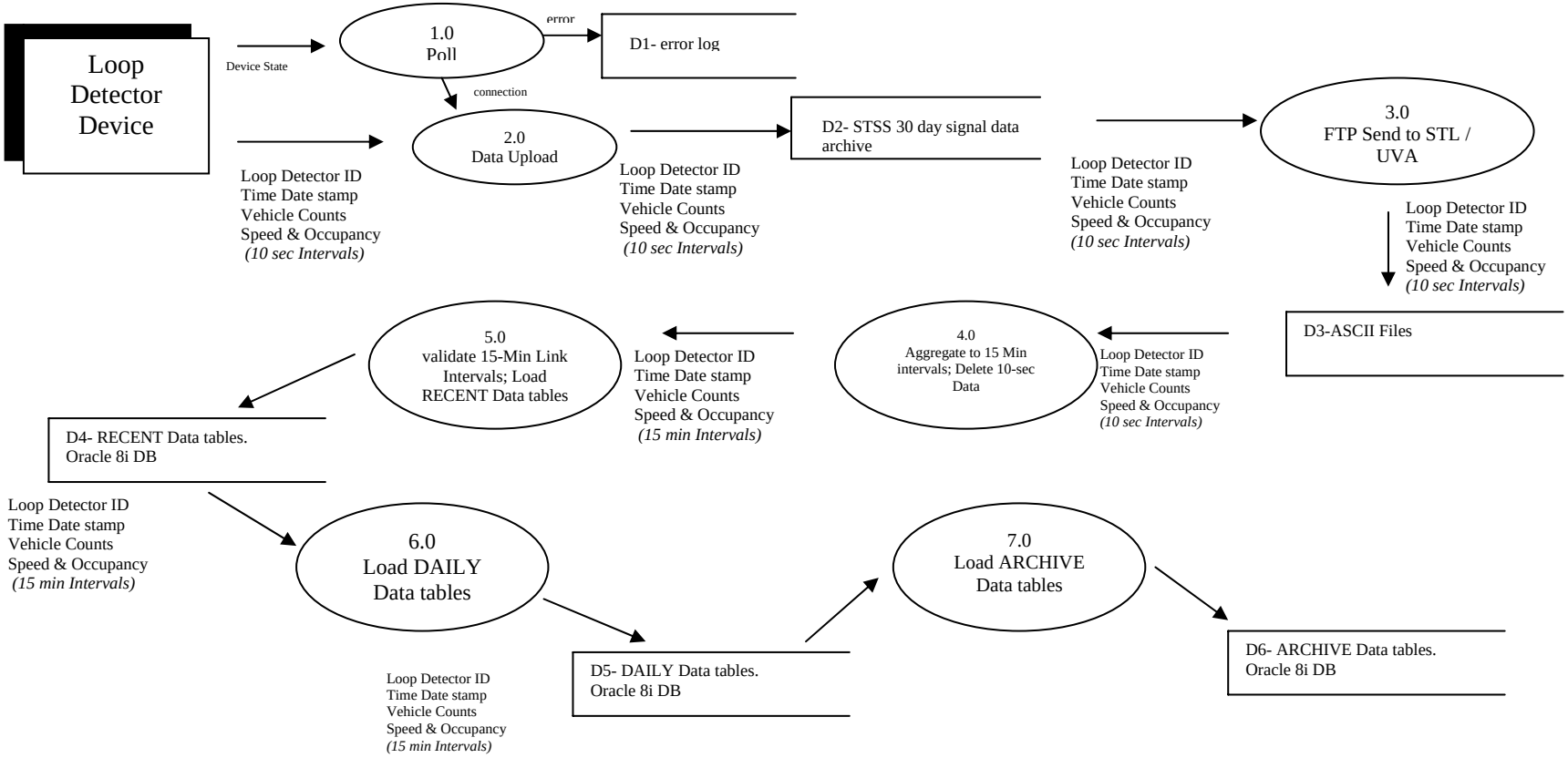
# APPENDIX K
# VDOT NOVA FREEWAY LOOP DETECTOR STATION INFORMATION

| | |
|---|---|
| StationID | Station ID number |
| ControllerID | Controller ID number |
| Cabinet | Cabinet number |
| Interstate | Interstate on which station is located |
| Direction | Direction of road (NB, SB, EB, WB) |
| Lane_Type | Type of lane (Normal, On Ramp, Off Ramp, etc) |
| Mile | Location of station along roadway (currently the mileage reflects the location on the plan sheets measured in stations) |
| Detector_Type | Type of detector setup (S - single loop, T - speed trap (double loop)) |
| UpStation | Number of station upstream (-1 if there is no station upstream) |
| DownStation | Number of station downstream (-1 if there is no station downstream) |
| DBL | Distance (in feet) between loops in a speed trap (-1 if a single loop) |
| PrevInt | Interchange number upstream of station |
| NextInt | Interchange number downstream of station (PrevInt and NextInt are same if detector is located in an interchange) |
| PrevRouteNo | Route number upstream of station (route numbers of roads in interchanges) |
| NextRouteNo | Route number downstream of station (route numbers of roads in interchanges) |
| PrevRoadName | Road name upstream of station (road names of roads in interchanges) |
| NextRoadName | Road name downstream of station (road names of roads in interchanges) |
| SpeedLimit | Speed limit at station |
| LanesWithDetectors | Number of lanes with detectors at station |
| TotalLanes | Number of lanes at station |
| RegularLanes | Number of regular lanes at station |
| HOVLanes | Number of HOV lanes at station |
| LCSLanes | Number of LCS lanes at station |

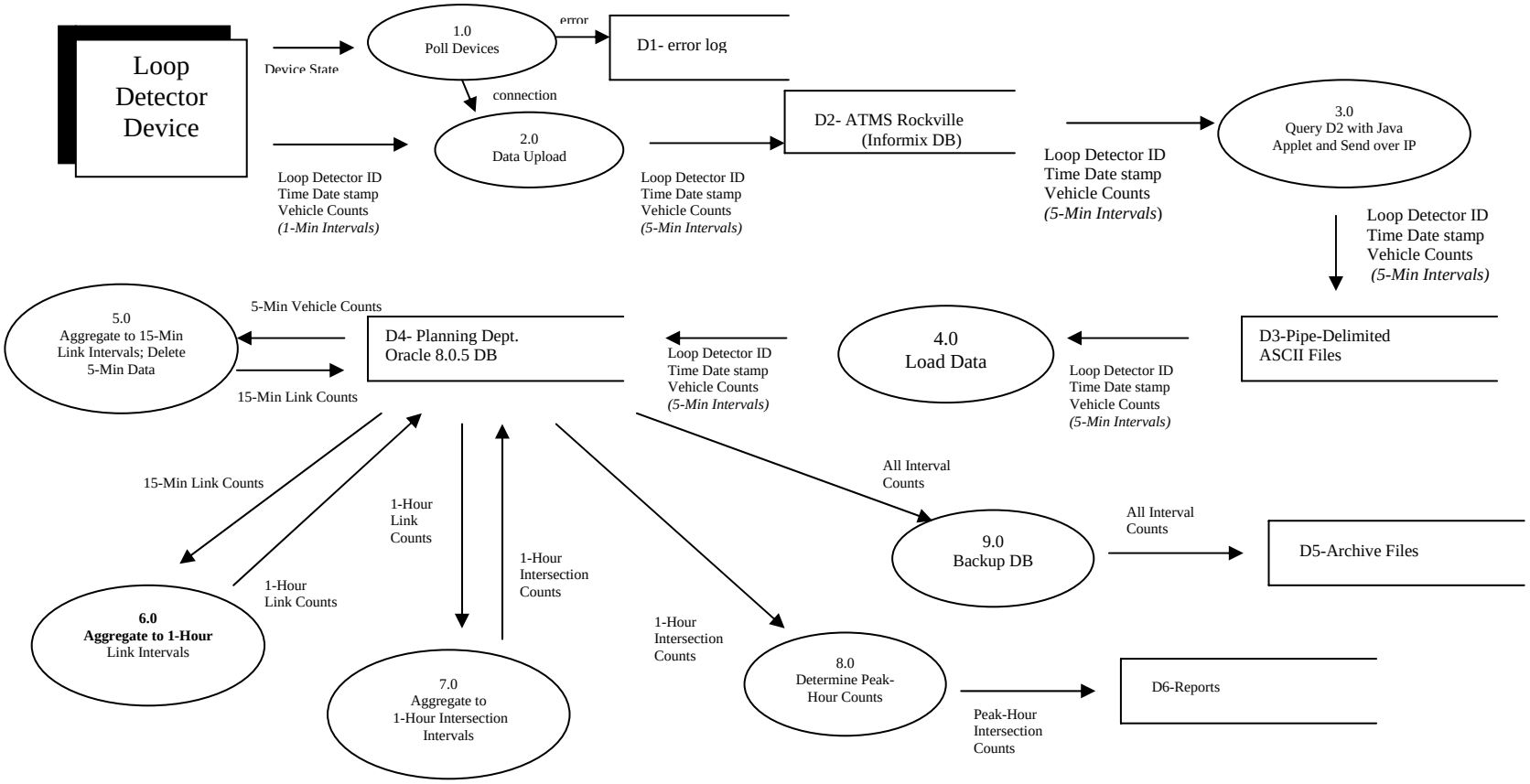
# APPENDIX L
# LOOP DETECTOR DATA FLOW
# VDOT NOVA SMART TRAFFIC CENTER TO SMART TRAVEL LAB



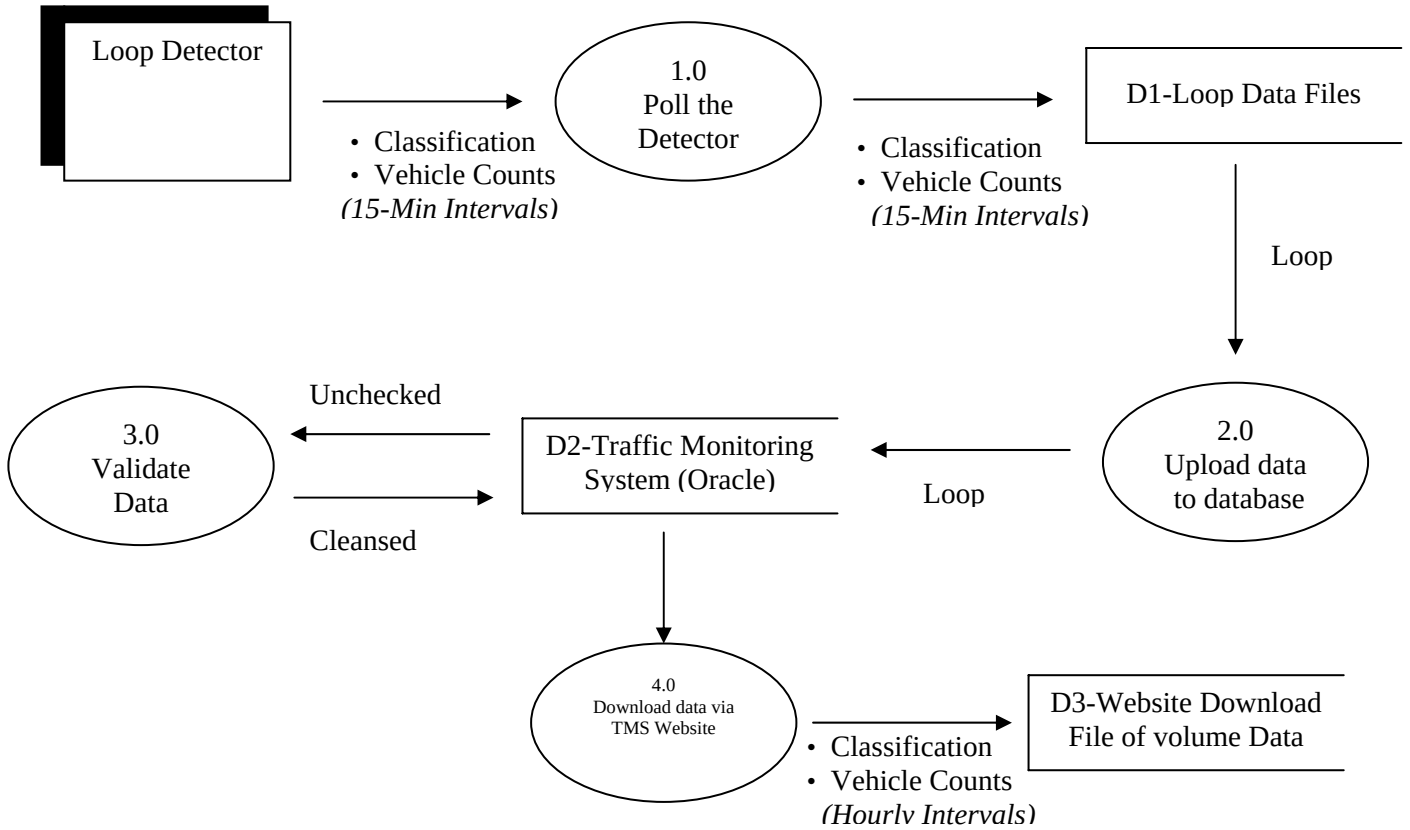
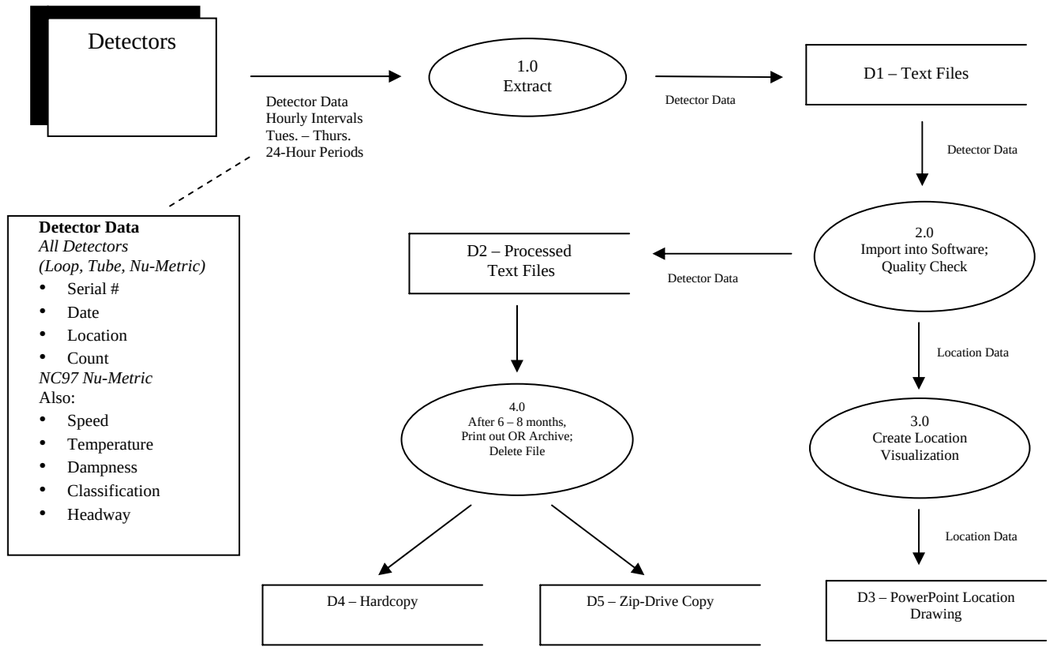
# APPENDIX M
# LOOP DETECTOR DATA FLOW
# VDOT NOVA SMART TRAFFIC SIGNAL SYSTEM TO SMART TRAVEL LAB



# APPENDIX N
# LOOP DETECTOR DATA FLOW
# MARYLAND–NATIONAL CAPITAL PARK & PLANNING COMMISSION
# MONTGOMERY COUNTY



# APPENDIX O
# LOOP DETECTOR DATA FLOW
# Maryland State Highway Administration



# APPENDIX P
# LOOP DETECTOR DATA FLOW
# FAIRFAX CITY