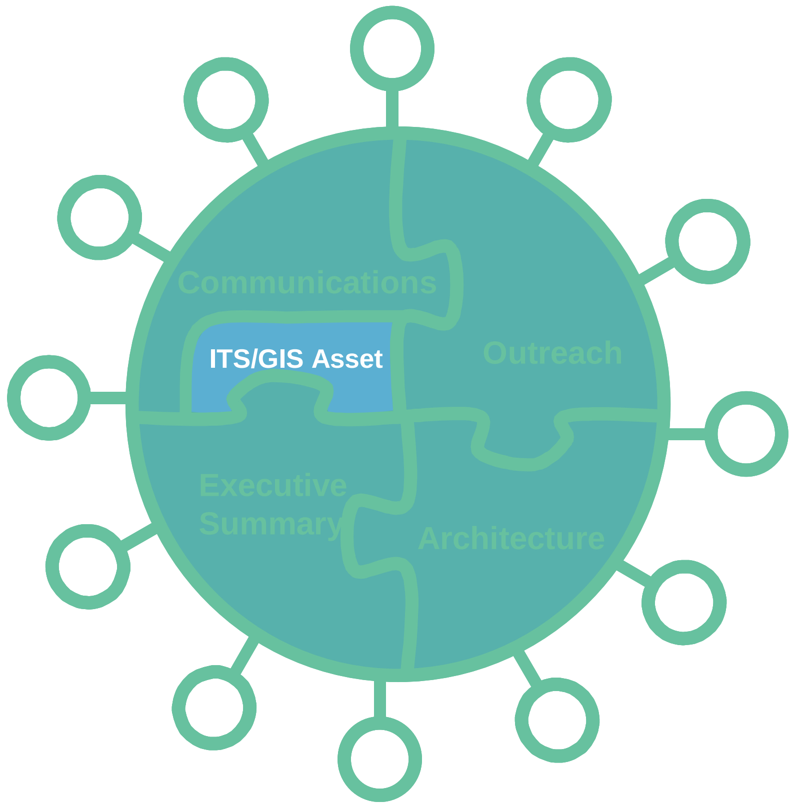
VDOT NOVA – Centric ITS Architecture

ITS/GIS ASSET BASELINE 1.0



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1 INTRODUCTION

The Virginia Department of Transportation (VDOT) Northern Virginia (NOVA) District embarked on a rather aggressive program to define a VDOT NOVA-Centric Intelligent Transportation System (ITS) Architecture. This program required a substantial stakeholder outreach process and included the development of a Communications Plan to directly support the stakeholder requirements and the VDOT NOVA-centric ITS Architecture. For additional information about the NOVA ITS architecture and the communications plan, refer to the project web site at www.vdot-itsarch.com.

The purpose of the Communications Plan is to provide guidance and recommendations to VDOT NOVA District and the regional stakeholders on investing in and deploying communications infrastructure and/or establishing services that will provide direct benefit to the NOVA ITS System Architecture. The Communications Plan is intended to serve as a reference document on communications technologies as they relate to ITS. Communications technologies and networks are widely recognized as a vital aspect of any ITS initiative. This is especially true for the NOVA ITS program because of the functions and services VDOT provides to the District and also due to the unique responsibility VDOT has regionally, given the physical proximity of the NOVA District to Washington, D.C. and the State of Maryland.

A major component of the Communications Plan is to address infrastructure and services that were (are) currently available or needed within Northern Virginia. Due to the importance of linking location to data acquired during the NOVA ITS Architecture project, GIS was a useful tool in aiding in an inventory/data gathering phase, as well as in the communications and architecture analyses. NOVA ITS project team desired a low budget solution that allows for spatial representation of its assets, facilities, and any known communication infrastructure; and the team did just that.

1.1 HOW GIS IS USED

GIS was used to assemble, store, manipulate, analyze, and display information about relevant NOVA ITS assets, facilities, and communication infrastructure and how they are spatially related in Northern Virginia. Initially, master lists were created of relevant assets/infrastructure, and the attributes that would be beneficial to have in that asset's database or layer. Data was gathered by email, phone interviews, and in-person interviews with relevant stakeholders, and a master database was created. These spreadsheets were then imported into the GIS tool and brought to life in customized display maps for use in documents or analysis involving any variety of scenarios desired by the project team. The GIS development process is shown in Figure 1.

For both the database and display maps, the GIS technology was very effective in creating and organizing a comprehensive ITS asset inventory, along with the existing and planned communications infrastructure (see Figure 2). Within the constraints of the project, the team was able to build an efficient inventory, in a relatively short period of time. The GIS aids the decision making process of locating potential connection points for the sharing of ITS data, now and in the future. Due to the very dynamic nature of ITS and the communications industry, GIS can be used over time to help grow and make even more useful the initial inventory and analysis effort.

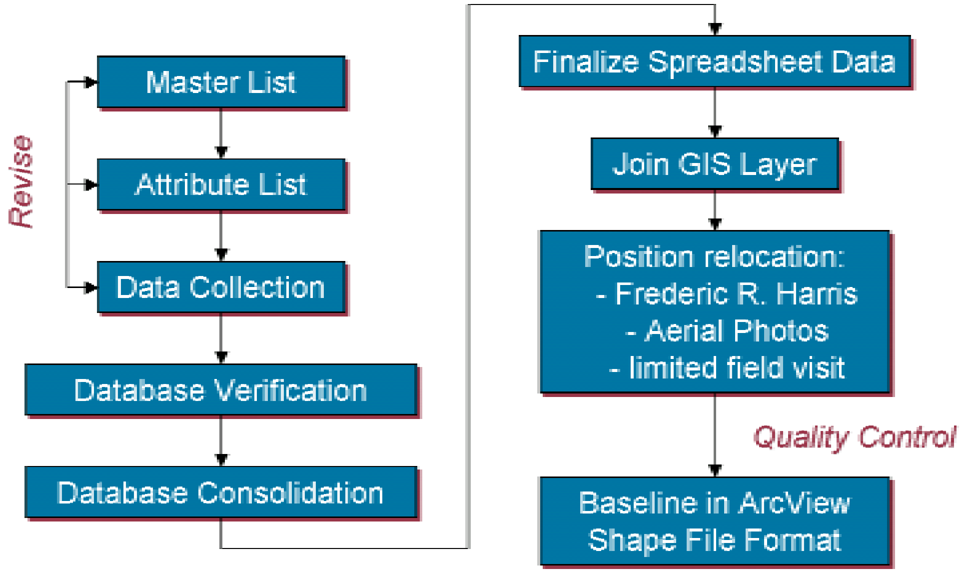

Figure 1 – GIS Development Process

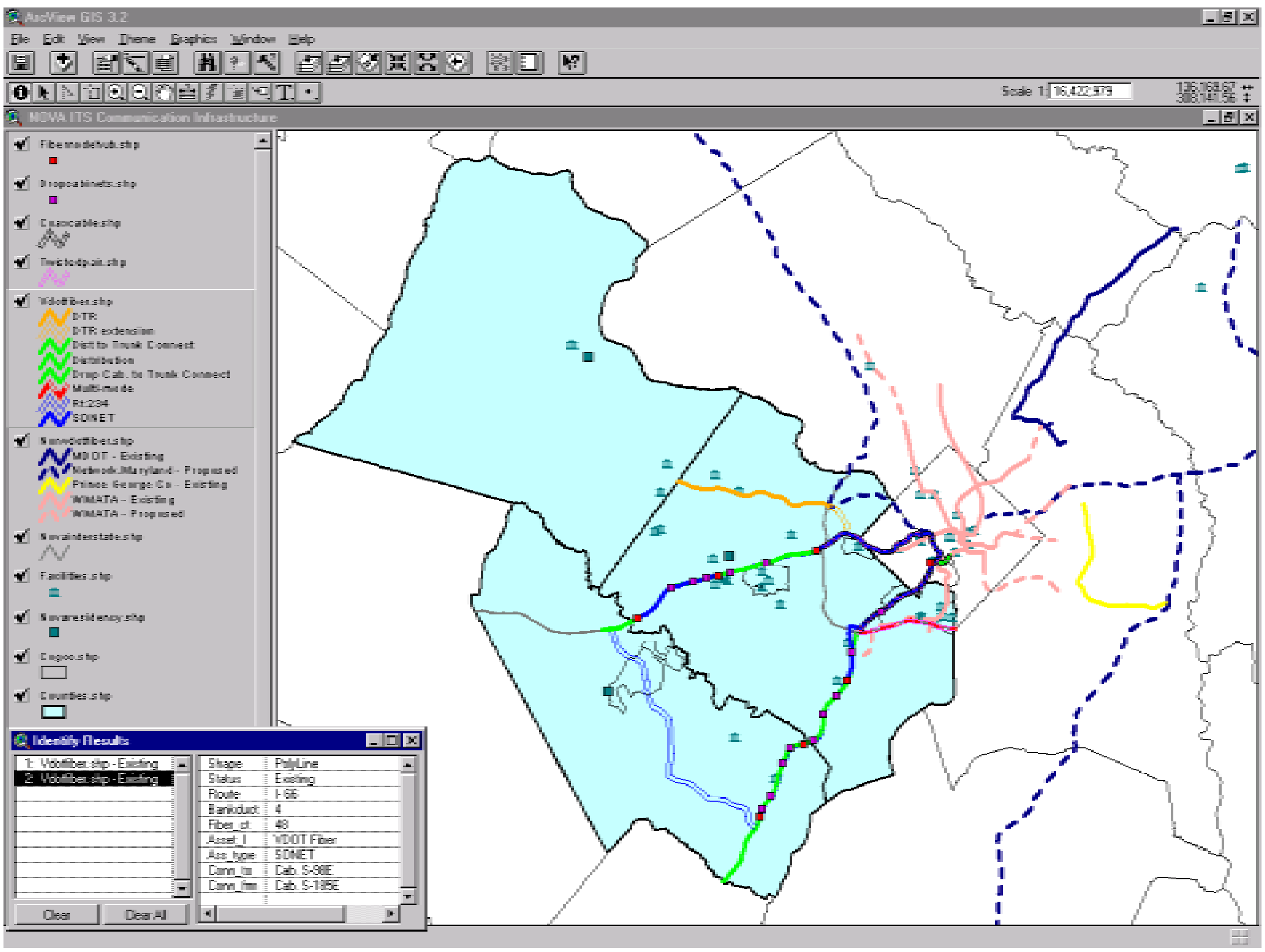

Figure 2 – NOVA ITS Asset & Communications Infrastructure GIS

Using ESRI's suite of core GIS products, ArcInfo 8.1 and ArcView 3.2, the team was able to comply not only with the local VDOT NOVA GIS tools and standard, but also with the VDOT central office in Richmond, VA. This is important as it enables a future integration with a statewide repository of data for VDOT's central office. A pilot project for a statewide effort has recently concluded and the same ESRI tools and technology was used, again allowing for a smoother future integration. Locally, it aids the VDOT NOVA GIS team in achieving one of the project's goals, for their team to assume responsibility for data and other GIS administration and maintenance internally. Another currently deployed tool by VDOT is an Internet/Intranet Mapping Server made available from ESRI called, ArcIMS.

There are plans to deploy the NOVA ITS Architecture GIS project online using the GIS Integrator technology that's based on the ArcIMS product line. This allows GIS experts as well as any VDOT onlookers to either just view the data, or even make redline suggestions or additions, so that the NOVA GIS team may make appropriate updates. This increases the accessibility of the tool from local desktop installations, to the entire VDOT network by means of the existing GIS infrastructure already utilized and in place for both VDOT NOVA and VDOT Central Office. The NOVA ITS GIS data includes metadata in compliance with the Federal Geographic Data Committee (FGDC) standards adopted by Northern Virginia jurisdictions that allows VDOT to convert to a statewide metadata standard, when such a standard is adopted. In summary, the development of the NOVA ITS asset baseline GIS serves as an example for other VDOT GIS projects.

2 NOVA ITS ASSET BASELINE 1.0

Through interviews with appropriate VDOT personnel, Master Asset and Facility lists were developed along with an extensive number of potential attributes to be assigned to any of the facilities and/or assets researched. Section 2.1 shows the Asset and Facility Master lists while Appendix A, the Data Dictionary, displays those attributes that were used for each corresponding asset/facility or "theme". It was the purpose of the GIS to remain as flexible as possible as far as including any important or discoverable data, so any potential or known attribute for any theme was included in the GIS to optimize its usefulness.

2.1 ASSET AND FACILITY MASTER LIST

There are a total of twenty-four ITS assets included in the NOVA ITS baseline. Although roadway lighting is maintained by the NOVA Smart Traffic Center, it is not considered to be an "ITS" asset and therefore is not included in the baseline. Appendix B, Metadata, describes how the data was collected for each ITS asset and points of contacts for the source of the data. It is planned to reach a consensus with other Districts on a list of important ITS assets through the ITS Coordinating Committee (ITSCC); and the ITSCC would recommend to VDOT Central Office GIS the key ITS assets for inventory that shall be maintained from a statewide viewpoint.

In addition to ITS assets, the NOVA ITS baseline also included thirty-one facility locations and the current locations of 91 NOVA ITS architecture stakeholders as of the release of the baseline GIS.

1	Blankout Signs
2	Call Box
3	CCTV
4	Coaxial Cable
5	Count Station
6	Detector
7	Drop Cabinets
8	Fiber Node/Hub
9	VDOT Fiber
10	Non-VDOT Fiber
11	HAR Transmitter
12	HAR Sign
13	HOV Gate Group
14	Lane Control Signals
15	Ramp Meter Signals
16	Resource Sharing Cell Tower
17	Roadway Weather Station
18	Service Panels
19	Smart Tag
20	Traffic Signals
21	Truck Rollover
22	Twisted Wire Pair
23	Vehicle Classification System
24	VMS

1	VDOT District Office
2	VDOT Residency Office
3	VDOT Area Headquarters
4	VDOT Equipment Shop
5	VDOT Central Office, Annex Bldg., 1401 East Broad St.
6	VDOT Central Office, Highway Bldg., 1221 East Broad St.
7	VDOT Central Office, Old Hospital Bldg., 1201 East Broad St.
8	VDOT Central Office, James Monroe Bldg., 19th Floor
9	VDOT Central Office, Biotech Bldg., 800 East Leigh St.
10	VDOT Fulton Complex, 508 Bickerstaff Rd
11	VDOT Materials Lab, Elko Tract Road, Sandston
12	Transportation Emergency Operations Center
13	Virginia Emergency Operations Center
14	Virginia Transportation Research Council
15	Smart Travel Lab
16	VTTI & Smartroad
17	Smart Traffic Center
18	NOVA Traffic Field Operations
19	Rest Areas
20	Weigh Station
21	Weigh in Motion Turnout
22	Toll Administration Bldg.
23	Mainline Toll Plaza
24	Ramp Toll Plaza
25	Highway Tunnel
26	Tunnel Administration Bldg.
27	Park & Ride Lot
28	State Police Administrative Headquarters
29	State Police Division Headquarters
30	DMV Headquarters
31	Other VDOT Facilities

Due to the project resource constrain, only some ITS assets include accurate position data through GPS effort, but some don't. For most of assets that do not include GPS location data, efforts in verifying locations through other means were involved. To summarize the position accuracy of collected ITS assets; Table 1 provides a synopsis:

Table 1 – ITS Asset Position Accuracy Summary

Asset	GPS	Note
Basedata	No	All basedata is taken from the VDOT County Map Series.
Blankout Sign	No	Verified based on the Vargis aerial photo.
Call Box	Yes	
CCTV	Yes	
Coaxial Cable	No	Verified from program knowledgeable personnel (Dave Smallwood)
Count Station	No	Locations gathered from milepost data using 3rd party COTS mapping software
Detector	No	Estimated locations from NOVA STC's system.
Drop Cabinets	No	Verified from program knowledgeable VDOT personnel.
Facilities	No	Locations gathered from address data using 3rd party COTS mapping software.
Fiber Node/Hub	No	Verified from program knowledgeable VDOT personnel.
HAR Sign	No	Verified from program knowledgeable VDOT personnel.
HAR Transmitter	Yes	
HOV (Gate Group)	No	Verified based on the Vargis aerial photo.
Lane Control Signal	No	Estimated locations from NOVA STC's system.
NonVDOT Fiber	No	Data obtained from source maps (MWCOG, WMATA, etc)
Ramp Meter Signal	No	Verified based on the Vargis aerial photo.
Resource Sharing Cell Tower	Yes	
RWIS	No	Locations gathered from milepost data using 3rd party COTS mapping software
Service Panel	Yes	
Smart Tag	Yes	
Traffic Signal	Yes	
Truck Rollover	No	Verified from program knowledgeable VDOT personnel.
Twisted Pair	No	Verified from program knowledgeable VDOT personnel.
VDOT Fiber	No	Verified from program knowledgeable VDOT personnel.
Vehicle Classification System	No	Estimated locations from NOVA STC's system.
VMS	Yes	

2.2 DATA DICTIONARY

Each theme has eight "base" attributes that were deemed pertinent enough to associate with all assets/facilities. These "base" attributes include: GIS Tag, Asset Name, Asset ID, District, Latitude, Longitude, Owner, and Remarks.

All other possible attributes are also listed in Appendix A, Data Dictionary. Additionally, the NOVA Smart Travel manager plans to work with the Statewide ITS Coordinating Committee (ITSCC) in further establishing a list of core attributes that should be included for all ITS asset database across all of the VDOT Districts. Building consensus would help VDOT in acquiring construction contractors to turn in the new field asset's location and attribute information that is consistent with VDOT's baseline database.

2.3 DATA COLLECTION

The data collection effort was found to be more of an exercise than the team anticipated (see Section 5.1, Lessons Learned). There was a process developed; however, that proved efficient in gathering and incorporating into the GIS, accurate and extensive data. Data was initially gathered through an interview process with stakeholders or VDOT personnel whose specific jobs deal frequently with the asset or communication infrastructure that was being researched. From the interview notes, and follow up information (hard copy documents, emailed soft copy documents or spreadsheets) from these points of contact, the team was able to compile spreadsheets for each of the layers in Microsoft Excel format.

A conversion process was done to make the spreadsheet ArcView compatible (as discussed in detail in Section 4.1, Load Data Tables For GIS Layer Creation). In brief, it involves saving each theme's Excel spreadsheet as a .DBF IV format file, then "adding" the .DBF table as an Event Theme. This newly created Event Theme can then be saved as a shape file and named and filed appropriately.

The dynamic nature of ITS that is discussed throughout this document makes it very important to maintain a continual data collection effort over time. A "snapshot" view of data would limit the value of the data, and since the GIS is data-driven, the entire tool would lose value over time. In Section 5.2, Recommendations, this topic is discussed further as to its importance to a NOVA ITS Asset and Communication GIS.

2.4 NOVA ITS ASSET BASELINE 1.0 RELEASE

The release of the NOVA ITS Asset and Communication GIS Baseline will be delivered on CD media containing an executable for download (ArcExplorer 2.0) that allows you to view the GIS files, as well as view this document, metadata for the GIS themes, as well as the Master Lists and Data Dictionary. There will also be available ArcView shape files for download for those parties that have the ArcView software. ArcExplorer is a freeware that will allow users to spatially view the GIS themes as well as query the data behind the layers. After the baseline release on CD the GIS will be turned over to VDOT's NOVA GIS who will work directly with other NOVA organizations (i.e. STC, STSS, DTR) for all maintenance and updates. This document merely provides recommendations to NOVA GIS for their maintenance and updating practices.

NOTE: Due to security concerns, the CD will only be available for VDOT personnel and other government entities. One may, however, contact VDOT to obtain a copy of the CD and VDOT will evaluate whether to make the CD available or not.

3 FILE MANAGEMENT RECOMMENDATIONS

The purpose of the File Management section is to foster better electronic data management practices for the NOVA ITS Asset and Communications GIS by providing guidance on the management of electronic GIS files. These guidelines are intended to aid any person such as records managers, archivists, information resource managers, data administrators and other information technology professionals within VDOT that work with the GIS data. The guidelines should be applied in support of VDOT's policies on information management and record keeping.

Some of the general benefits for adhering file management practices include:

- standardizing naming conventions project-wide promotes for easier of maintenance and updating
- documented file hierarchy allows for accessing and retrieving documents rapidly and efficiently
- avoiding the loss or inadvertent destruction of data
- naming documents quickly and easily, therefore facilitating identification and retrieval
- providing a framework in which individuals can understand their responsibilities for using and maintaining information systems
- consistent practices and procedures will facilitate the use of information resources and systems by new staff.

3.1 DIRECTORY AND PATH RECOMMENDATIONS

The NOVA ITS Asset and communications GIS has been allotted VDOT network space on the <G:> drive otherwise known as the <501NVGIS> drive internally to VDOT. The subdirectories have already been created for the GIS Baseline product. The location of files will be in the directory:

<501NVGIS/sections/ITSAssets>

From this subdirectory, three additional paths have been created, one for the projection used by the NOVA GIS team called <StatePlane>, and another folder <CentralOffice> that represents the projection used by VDOT's Central Office GIS, Lambert Conformal Conic. The last folder will be the <GISgeneral> folder that will be home to any project wide documents, the icons folder, spreadsheets such as the baseline GIS Master Lists and Attribute Data Dictionary, and the .APR project file for the GIS application. This folder will also be the home directory for the Geographic folder, the location where each asset has a folder and these folders store the original creation of an Event Theme as they all are created in the Geographic projection (to be discussed in Maintenance Strategies).

Within the <StatePlane> and <CentralOffice> folders, the only difference in the data will be the projections in which the data will be viewed. This way both local data administrators as well as central office data administrators have access to the GIS in their native projections. At this point we have home directories as follows:

<501NVGIS/sections/ITSAssets/CentralOffice> (Lambert Conformal Conic data)
<501NVGIS/sections/ITSAssets/StatePlane> (Stateplane data; NOVA)
<501NVGIS/sections/ITSAssets/GISgeneral> (General NOVA ITS GIS data)

Each of these subdirectories will be home to folders named after each of the assets included in the NOVA ITS Asset and Communication GIS Master List. Within both CentralOffice and Stateplane directories will be the same exact folders and files with only projection being a difference. The 24 assets folders will be home to both the ArcView shapefiles, excel and, DBFIV spreadsheets, and metadata. There will also be a <facilities> folder where all facility data will be located. The written path for asset and facility layer level data is as follows:

<501NVGIS/sections/ITSAssets/CentralOffice/Asset name here…>
<501NVGIS/sections/ITSAssets/StatePlane/Asset name here…>
<501NVGIS/sections/ITSAssets/GISgeneral/Geographic/Asset name here…>

Figure 3 shows a graphic layout of the file directory scheme recommended for the NOVA ITS Asset and Communication GIS Baseline on the VDOT server.

3.2 NAMING CONVENTIONS

It is important to update a layer once more current or accurate layers are received from stakeholders. This data may vary in terms of frequency of updates, it is logical to know that some more dynamic and widespread resources such as CCTV and traffic signals whose data is well tracked and positions well known, to have more updates than other assets. For this reason, a date stamp on the file name will help the administrators to track the most current versions of layers, documents, and spreadsheets. This allows administrator's to mark in metadata the dates and details of changes, as well as, removal of any data not current to maintain reasonable levels of server space utilized over time.

The Maintenance Strategy to follow will discuss how to update and maintain the data, but it's important to recommend naming practices for when data is saved or imported during the life of the GIS. Once a new file, spreadsheet, document, or GIS layer has been produced/updated, it can be "saved as…" a new version incorporating a date suffix at the end of the file name. In the case where the baseline version CCTV layer has been updated by a stakeholder, and it is necessary to update the layer, the new version shall continue using the asset name, but a prefix showing the current date shall be used as such: CCTV05-31-02. The structure is Asset name/Current Month/Current Day/Current Year. At this point in time, the older versions of spreadsheets, documents, or layers can be removed from the server and archived.

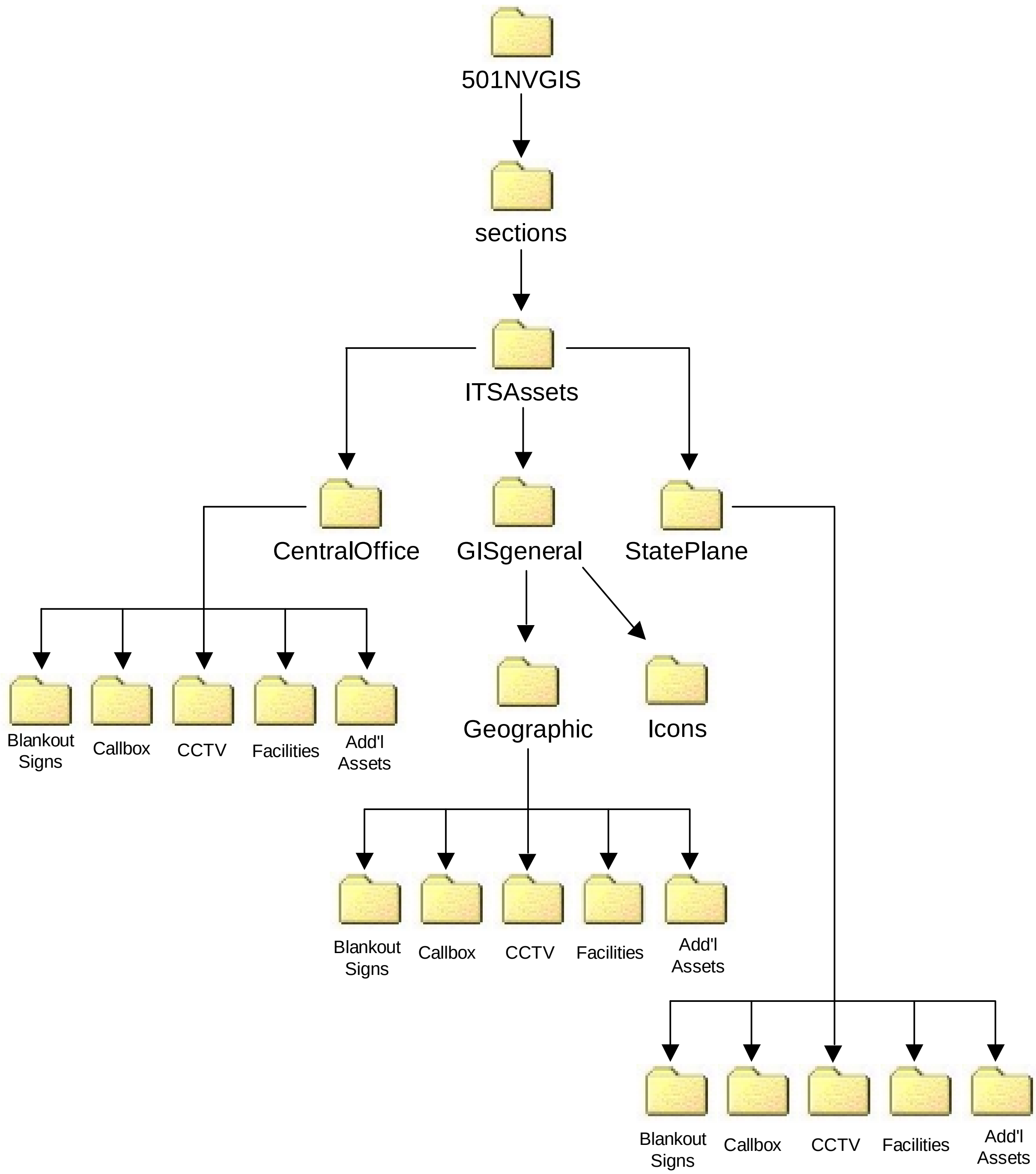

Figure 3 – NOVA VDOT ITS Asset and Communications GIS Recommended File Structure

4 MAINTENANCE AND UPDATING STRATEGIES

There are two aspects to the maintenance and updating for the NOVA ITS Asset and Communications GIS. First, a VDOT division or section, or another government department, that is responsible for an asset, provides updates of data for that particular asset. For this document's purpose we will call this a "responsible party" of the ITS asset. Updating of an Excel spreadsheet can be done by either having that particular "responsible party" to directly update the spreadsheet and sending back to the GIS administrator, or by sending pieces of data for the administrator to use in updating the spreadsheet and then the GIS. VDOT NOVA GIS is prepared to work with the responsible parties that will be providing updates and data about any field asset in the inventory. NOVA GIS may wish to place the GIS on the Intranet for those responsible parties to comment or redline the database or the map online. Another possibility may be to furnish all the baseline files to any responsible parties that may view the files using GIS software, and either documenting updates for the administrator to make or actually make the updates on their own (Only if the GIS administrator and the responsible party come to an agreement and process for which the responsible party may acceptably update the file themselves). For example the NOVA Smart Traffic Center closely observes several ITS assets including CCTV, VMS, Lane Control Signals, etc. NOVA GIS may agree to have the STC update certain attributes on their own, in turn having the STC send updates back to the NOVA GIS after a determined amount of time (quarterly, annually, etc.). Another method may be that the STC may only wish to export for the NOVA GIS, a current and updated database and map for any asset. The success will depend on the relationship developed between the GIS administrators and the "responsible parties" and defining processes to most effectively update the NOVA ITS Asset and Communications GIS. There is a need for the NOVA GIS administrators to define all the steps and responsibilities involved in providing an efficient process in acquiring the updated data for each ITS asset.

The second aspect for the GIS maintenance is the process in which the NOVA GIS administrators actually update each ITS asset or facility layer, once the updated data has been sent to them by any responsible party. The rest of this chapter will focus on detailing the methods of updating the GIS for the NOVA GIS administrators (or any responsible party with the GIS software that's in agreement with NOVA GIS that they will update the GIS layers themselves) once an excel spreadsheet has been supplied. Since the native projection for NOVA GIS is State Plane, it is the intent for the GIS administrators to update in that particular projection, while providing updates in Lambert Conformal Conic projection in the CentralOffice folders at a given frequency. Due to many of the restraints listed in the first section of this document, maintenance and updating recommendations were restricted as far as creating a process that was relatively user independent and automated. First, a maintenance process will be recommended explaining the "How?" in which the GIS is updated. Then the general project specific maintenance strategies will be discussed. The NOVA ITS Asset and Communication GIS baseline was created with basic "parts" and it is the sequence of updating and creating the parts that makes maintenance slightly more involved than in more elaborate GIS's. The GIS software ArcView 3.2 from ESRI was used as it is widely utilized tool by both NOVA VDOT GIS as well as the VDOT Central Office when this document is prepared.

The following sections describe how the administrator may create ArcView GIS compatible .DBF tables exported from the updated .XLS databases and load them into the ArcView GIS software (Section 4.1); how to create actual theme layers from the .DBF spreadsheets in

ArcView (Section 4.2); how to re-project the layers into VDOT Central Office GIS's native projection of Lambert Conformal Conic (Section 4.3); and lastly how to re-project the layers into VDOT NOVA GIS's native projection of State Plane (Section 4.4)

4.1 LOAD DATA TABLES FOR GIS LAYER CREATION

It is important to repeat that this section is intended only for the NOVA GIS administrators of the NOVA ITS Asset and Communications GIS and any responsible party (such as potentially the NOVA STC or STSS) who has the GIS software and permission to update the spreadsheets or GIS files from NOVA GIS. The first component is the spreadsheet that was created for each asset, and in this project, Microsoft Excel software was used to create the initial spreadsheets. Once filled or updated to a determined completeness, the .XLS workbook is then "saved as…" a .DBFIV formatted spreadsheet, our now second component. This puts the data into an ArcView compatible format for importing into a layer. Start the ArcView session and once the NOVA ITS Asset and Communication project has been initialized, click on the "Tables" Icon on the main project menu, and click the "Add" button to import your new .dbf spreadsheet. (depicted in Figure 4 below)

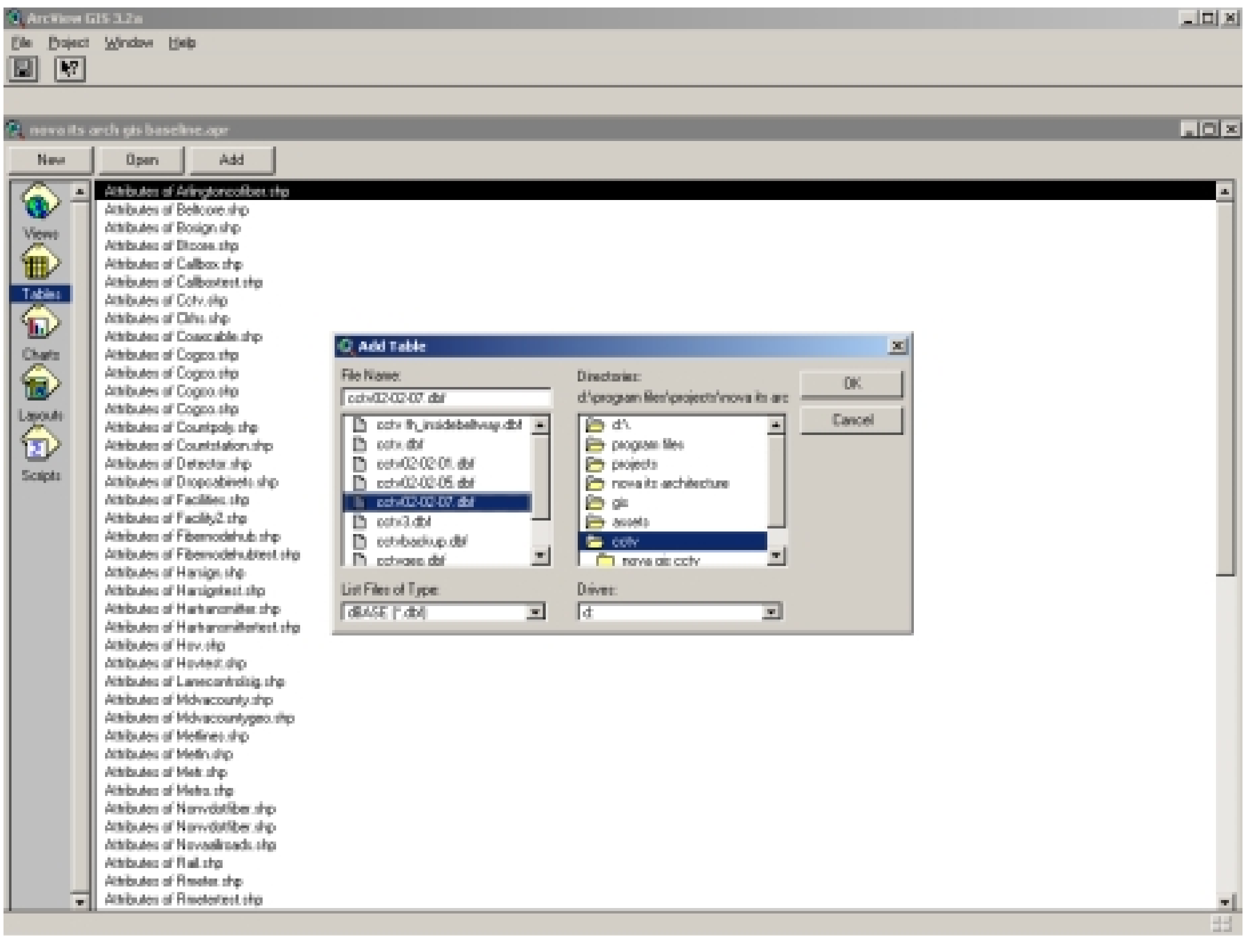

Figure 4 – Load a .dbf Table Into the Project

4.2 CREATE AN EVENT THEME AND NEW SHAPEFILE

After the .dbf file has been added to your tables for the project, click the “View” icon on the same main project menu, and click on the view “NOVA ITS Asset and Communications GIS - Lambert” (We’ll use the Lambert projection View in this example, for Stateplane projections use the “NOVA ITS Asset and Communications GIS – Stateplane” view). Once the view is initialized go to the “View” pull down menu option, and select “Add Event Theme” as seen in Figure 5 below.

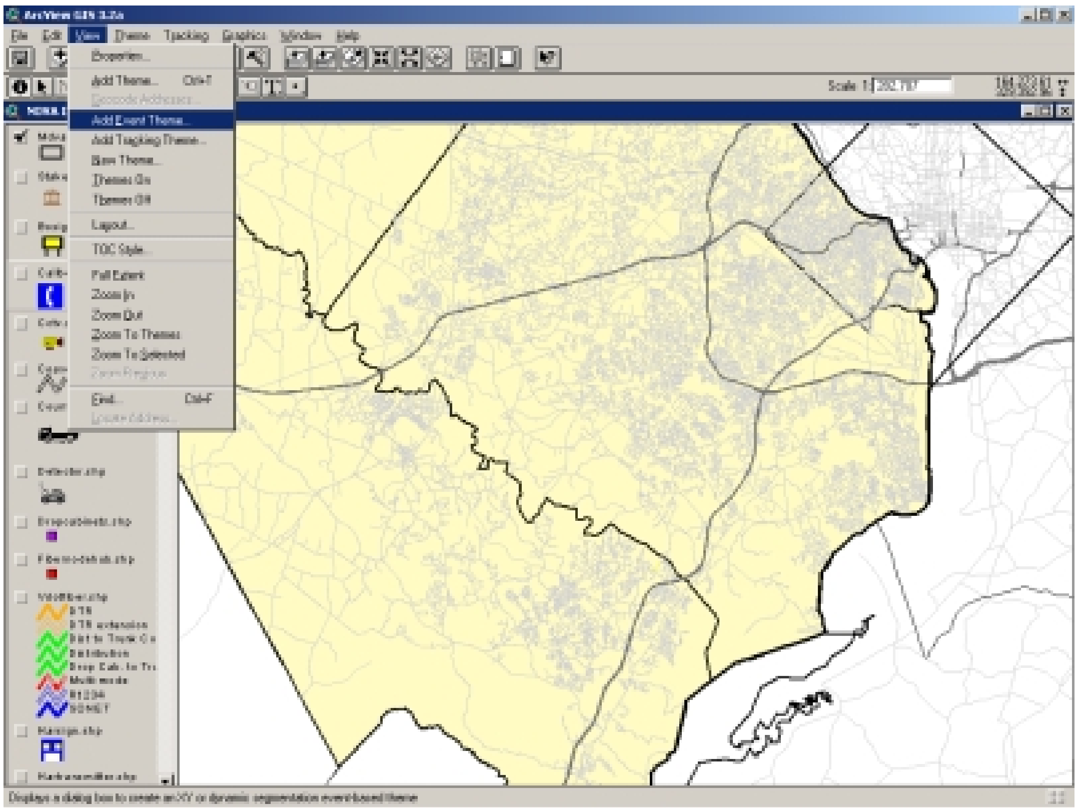

Figure 5 – Add an Event Theme

This will direct you to add a new theme using one of your tables you’ve imported into the project. Navigate at this point, to the .dbf file you recently added to your project’s tables, and select it from the pull down option bar next to Table. Once selected the software automatically detects the Longitude and Latitude, simply click OK. This will add a new event theme in the geographic projection (no need to save at this point).

The next step involves removing or deleting the theme that you are about to update, not only from the view, but also any attribute table associated with said theme from the Table section of the project (may not be present in the tables section, but will appear as “Attributes of ‘Assetname’.shp”). This will allow for the new theme to save over the old theme avoiding duplicate shapefiles. After deleting, be sure to save the project entirely (this will update the .APR project file to remove any trace of the old version of the theme, otherwise, the project will not let you save over it because it’s considered “in use”).

Before creating appropriate layers in separate projections, you must first make the event theme a theme. Make sure the newly created event theme has been made active (click on the theme's box, not just the check box but the entire box so that it appears outset) and go to the "Theme" pull down menu and select "Convert to shapefile…" (see Figure 6).

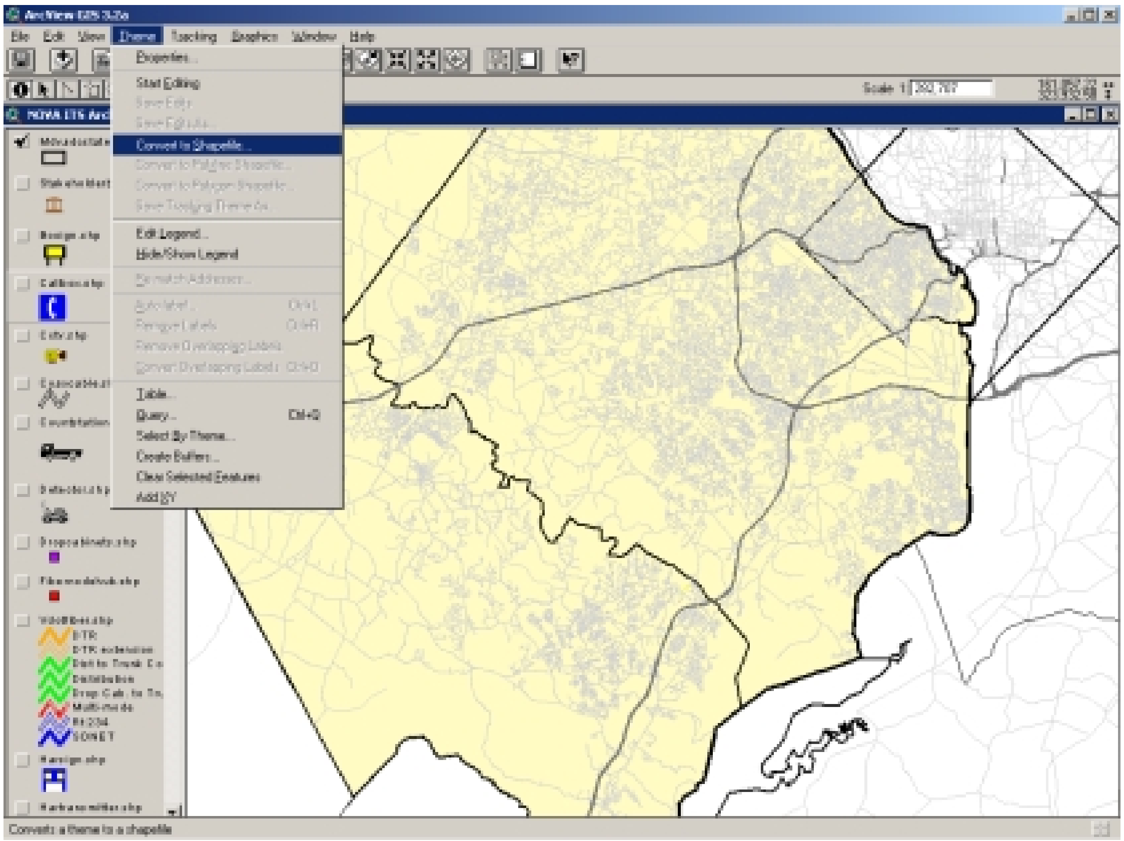

Figure 6 – Convert an Event Theme to a Shapefile

Navigate to <501NVGIS/sections/ITSAssets/GISgeneral/Geographic/"Assetname"> and save the file as "Assetname-date" as discussed in the naming convention recommendation in the preceding section. Select "YES" to add theme to view. Select/activate the Event Theme (with the extension .DBF in your table of contents) used to create the new shapefile just saved, and go to the "Edit" pull down menu and click "Delete Themes" to remove the temporary Event Theme.

4.3 RE-PROJECT A NEW THEME INTO LAMBERT CONFORMAL CONIC

At this point, it is time to utilize the ArcView Projection Wizard in order to re-project the layer into the appropriate projection. To activate (and make default) the ArcView Projection Wizard, go to the "File" pull down menu option and select "Extensions…". Once the dialog box appears select with a check, the Projection Utility Wizard and also select the make default button to the right on the dialog box so that in the future this extension is activated.

The recently saved Theme you just created is currently in a geographic projection and the Projection Utility Wizard will create output layers in each the Stateplane projection (discussed in Section 4.4) as well as the Lambert Conformal Conic projection. Initiate the ArcView Projection Utility Wizard by selecting the “File” pull down menu and selecting “ArcView Projection Utility…”. After a short wait for the utility to initialize (this may take several minutes; make sure you are not running any other applications and it may help to disable any anti-virus software while you run this utility for speed purposes), the Projection Utility Step 1 Dialog box will appear. This will be the first dialog box for user input in a series to first give the geographic projection to the original theme, and secondly to create a new theme that’s re-projected into either Lambert Conformal Conic or Stateplane.

The steps for re-projecting the theme are as follows: (with illustrations and using CCTV re-projecting to Lambert Conformal Conic as the example)

Step 1 – “Select which shapefile(s) you would like to re-project…”
Use the “Browse…” option and navigate to the theme(s) you wish to re-project. (i.e. <501NVGIS/sections/ITSAssets/GISGeneral/Geographic/CCTV/CCTV02-05-31>). Highlight the newly added theme and click on the “Next>” button. (Figure 7)

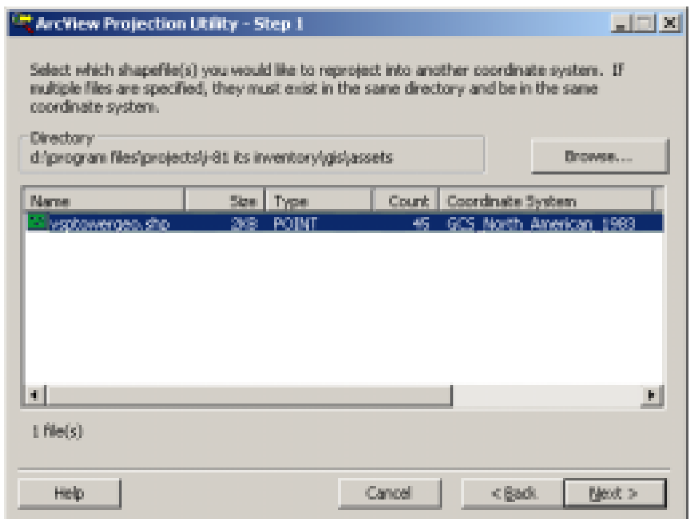

Figure 7 – Step 1: Re-project into Lambert Projection

Step 2 – “What is the current coordinate system of your shapefile(s)?”
First select the “Show Advanced Options” option, and follow these Step 2 directions: (make sure that the fixed variables on each dialog box in the following Figures, included in Step 2, match the same in your wizard on the screen, if they are different an error may have occurred in selecting an option under one of the tabs.)

Under the Name tab (Figure 8):

- Select the “Geographic” option under the “Coordinate System Type” section
- Select the “GCS_NorthAmerican_1983 [4269]” option under the “Name” section
- Select the “Degree [9102]” option under the “Units” section

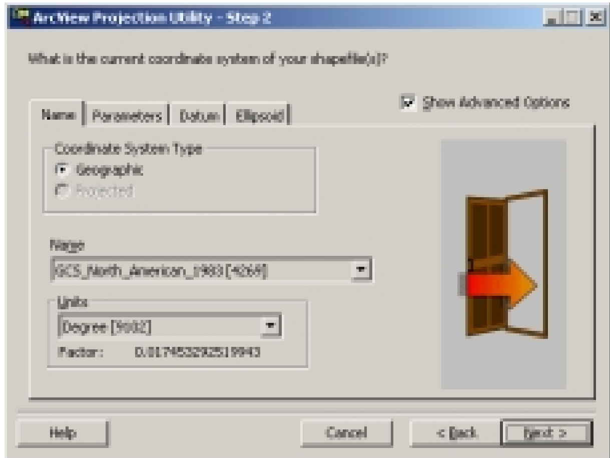

Figure 8 – Step 2: Configure the “Name” Tab

Under the Parameters tab (Figure 9):

- Select the “Greenwich [8901]” option under the “Prime Meridian” section

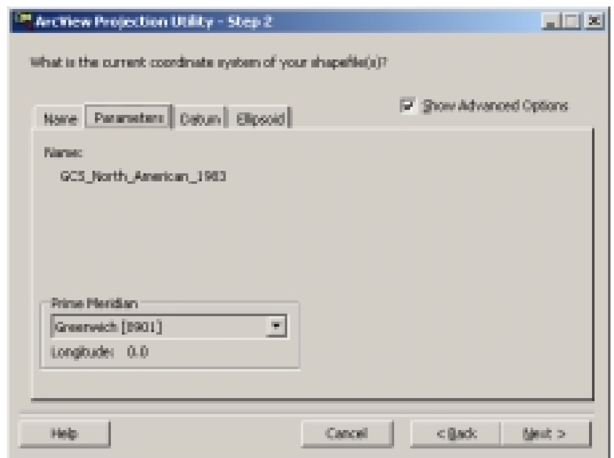

Figure 9 – Step 2: Configure the “Parameters” Tab

Under the Datum tab (Figure 10):

- Select the “GEOTRANSFORMATION_UNSET” under the “Geographic Transformation:” section.

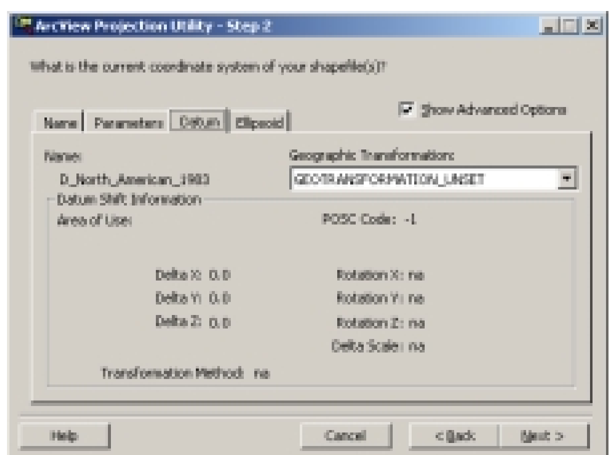

Figure 10 – Step 2: Configure the “Datum” Tab

Under the Ellipsoid tab (Figure 11):

- No input or selecting is needed. Verify that values are correct.

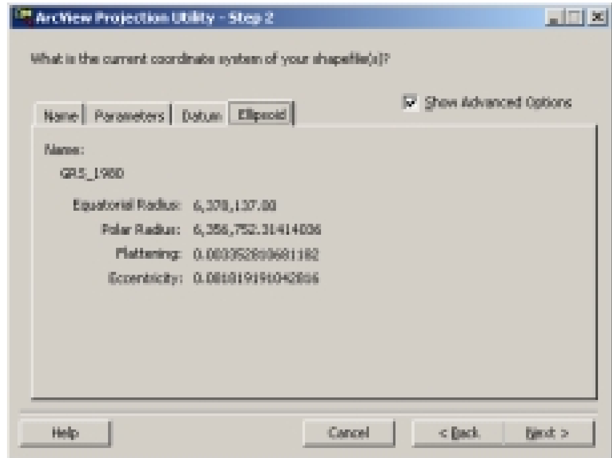

Figure 11 – Step 2: View the "Ellipsoid" Tab

After configuring all of the Step 2 options as described, click the "Next>" button to continue to Step 3. At this point, you may be asked if you would like to save your newly specified coordinate system for your shapefile, if so, select "YES".

Step 3 – "Select the new coordinate system for your new shapefile(s)."

Under the Name tab (Figure 12):

- Select the "Projected" option under the "Coordinate System Type" section.
- Select the "Custom" option under the "Name" section.
- Select the "Meter [9001]" option under the "Units" section.

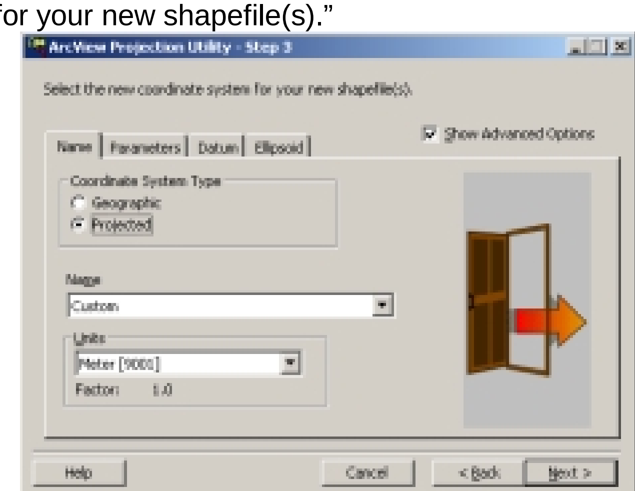

Figure 12 – Step 3: Configure the "Name" Tab

Under the Parameters tab (Figure 13):

- Select the "GCS_North_American_1983 [4269]" option under the "Geographic Coordinate System:" section.
- Input "0" (zero) for the "False Easting" and "False Northing" values.
- Select "Greenwich [8901]" option for the "Prime Meridian" section.
- Select "Lambert_Conformal_Conic [43020]" option for the "Base Projection" section.
- Input "-79.5" for the "Central_Meridian" value.
- Input "36.0" for the Central_Parallel" value.
- Input "37.0 for the "Standard_Parallel_1" value.
- Input "39.5" for the "Standard_Parallel_2" value.

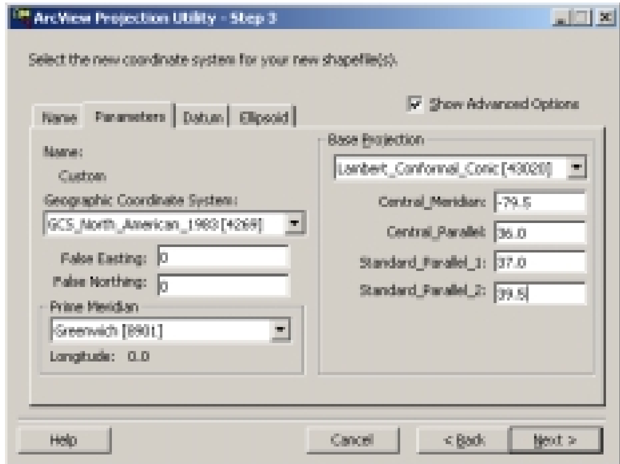

Figure 13 – Step 3: Configure the “Parameters” Tab

Under the Datum tab (Figure 14):

- Select “GEOTRANSFORMATION_UNSET” from the “Geographic Transformation” section.

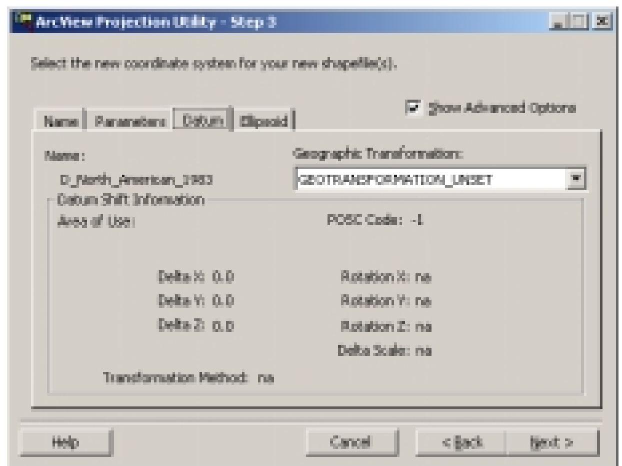

Figure 14 – Step 3: Configure the “Datum” Tab

Under the Ellipsoid tab (Figure 15):

- No input or selecting is needed. Verify that values are correct.

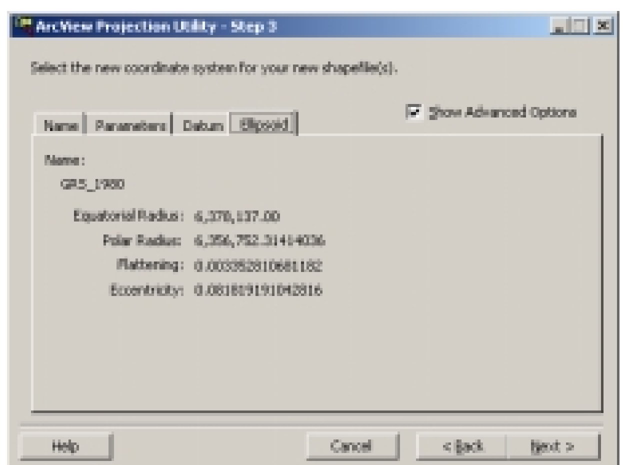

Figure 15 – Step 3: Viewing the “Ellipsoid” Tab

After configuring all of the Step 3 options as described, click the “Next>” button to continue to Step 4.

Step 4 – “Where do you want to save your new shapefile(s)?…”

- Use the “Browse…” option and navigate to the directory you wish to save your new theme.
- Rename the file using the naming conventions recommended in the earlier section (i.e.: <501NVGIS/sections/ITSAssets/CentralOffice/CCTV/CCTV02-05-31>) and click the “Save” button.
- Click on the “Next>” button to continue to the Summary.

Step 5 – Summary
Verify that the summary details match the following two illustrations (Figure 16 and Figure 17) for your input and output coordinate systems and projections:

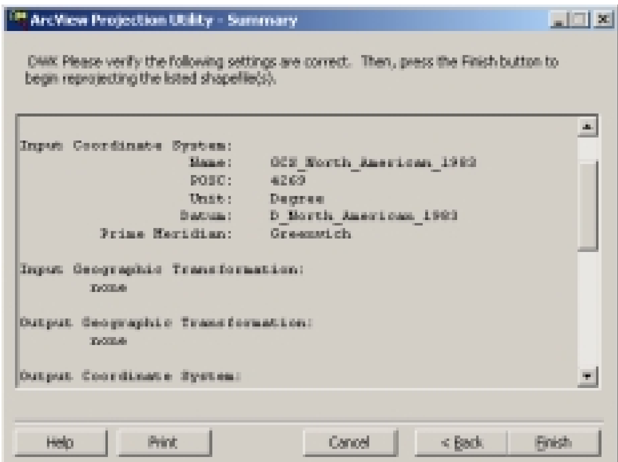

Figure 16 – Step 5: Summary Dialog Box I

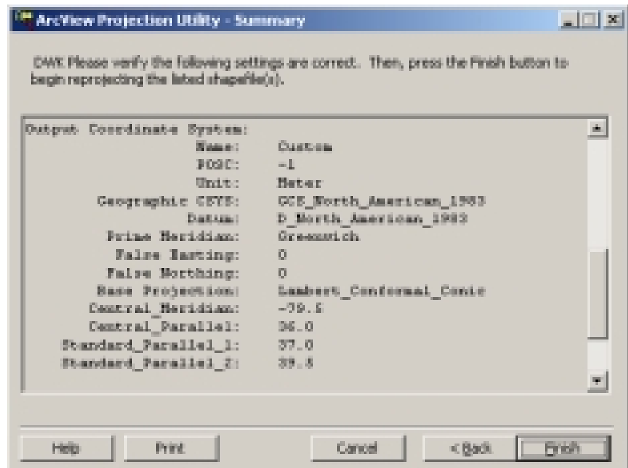

Figure 17 – Step 5: Summary Dialog Box II

Once you’ve verified the values, continue by clicking the “Finish” button. After a short wait, a progress box will appear showing the conversion to the new shapefile/theme.

The last dialog box will soon appear advising that the Projection Utility wizard has finished processing the shapefiles (Figure 18).

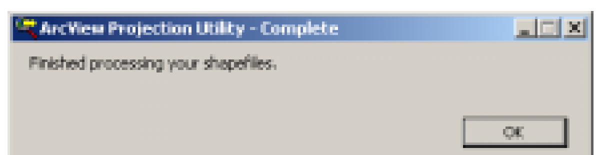

Figure 18 – Re-projection Process Complete Dialog Box

After processing the Projection Utility, you will be asked if you want to add the projected data (Figure 19).

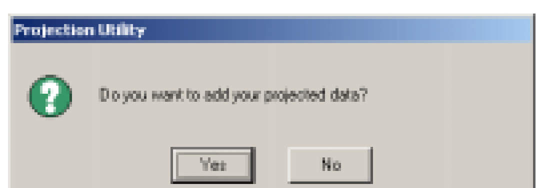

Figure 19 – Add Re-projected Data to Your View Dialog Box

Select the newly projected theme, and click the “OK” button. The new shapefile now is ready to be added to the appropriate view, depending on the projection. Another dialog box will appear and you will be asked to choose which view to add the projected theme. In the case of the new CCTV theme in the Lambert Conformal Conic projection, make sure to select the “NOVA ITS Asset and Communication GIS – Lambert” view and click “OK” to add the projected data to the view.

To complete the process, select/make active the Geographically project “Assetname” theme, and go to “Edit” on the top menu, select “Delete Theme…” and that will remove the geographically projected shapefile. Lastly, add the appropriate icon to the theme, and verify that the positioning is accurate by turning on the new theme and eyeballing the locations to see if they appear correct. At this point, “Save” your project and the process is complete.

4.4 RE-PROJECT A NEW THEME INTO STATEPLANE

When adding any updated data into the StatePlane folder, data must be converted to the State Plane coordinate system. The following details the conversion of a Geographic theme (in the appropriate 501NVGIS\sections\ITSAssets\GISGeneral\Geographic\”asset” folders) into State Plane. Begin by initializing your ArcView Utility Projection Wizard as discussed in section 4.3 and follow these steps:

Step 1 – “Select which shapefile(s) you would like to re-project…”
Use the “Browse…” option and navigate to the theme(s) you wish to re-project.
(i.e. <501NVGIS/sections/ITSAssets/GISGeneral/Geographic/CCTV/CCTV02-05-31>).
Highlight the newly added theme and click on the “Next>” button. (Figure 20)

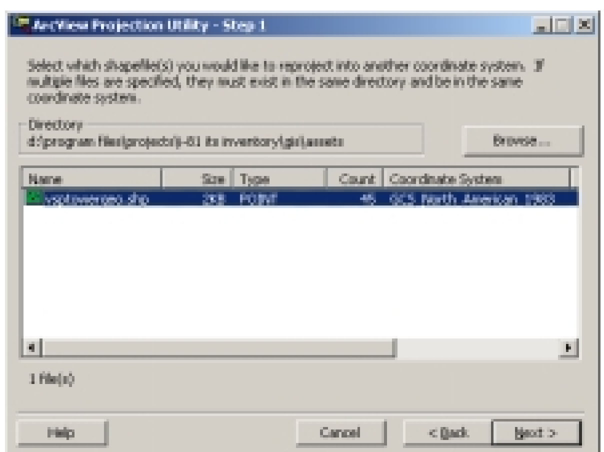

Figure 20 – Step 1: Re-project into State Plane

Step 2 – “What is the current coordinate system of your shapefile(s)?”
First check the “Show Advanced Options” option, and follow these Step 2 directions: (make sure that the fixed variables on each dialog box included in the figures in Step 2 match the same in your wizard, if they are different an error may have occurred in selecting an option under one of the tabs.) If you’ve already defined the Geographic projection in your “input” shapefile, then you may not need to input rather than just verify your variables, and continue to Step 3 by clicking “Next >”.

Under the Name tab (Figure 21):

- Select the "Geographic" option under the "Coordinate System Type" section
- Select the "GCS_NorthAmerican_1983 [4269]" option under the "Name" section
- Select the "Degree [9102]" option under the "Units" section

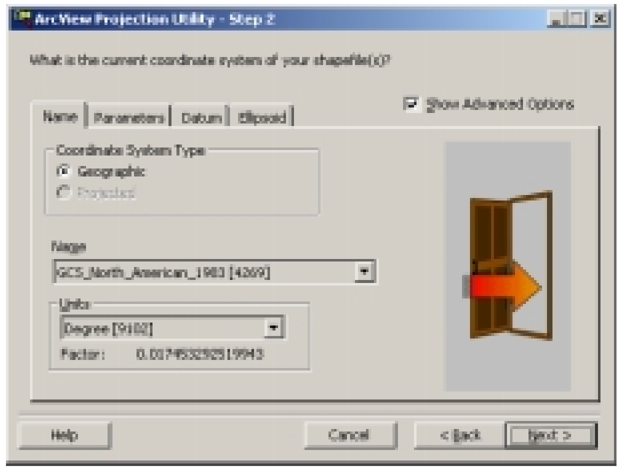

Figure 21 – Step 2: Configure the "Name" Tab

Under the Parameters tab (Figure 22):

- Select the "Greenwich [8901]" option under the "Prime Meridian" section

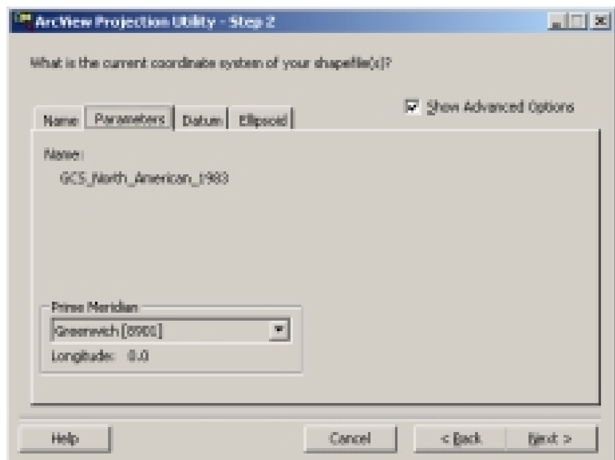

Figure 22 – Step 2: Configure the "Parameters" Tab

Under the Datum tab (Figure 23):

- Select the "GEOTRANSFORMATION_UNSET" under the "Geographic Transformation:" section

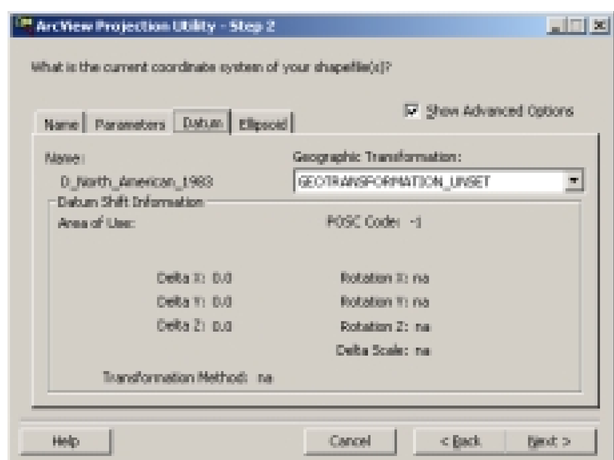

Figure 23 – Step 2: Configure the "Datum" Tab

Under the Ellipsoid tab (Figure 24):

- No input or selecting is needed. Verify that values are correct.

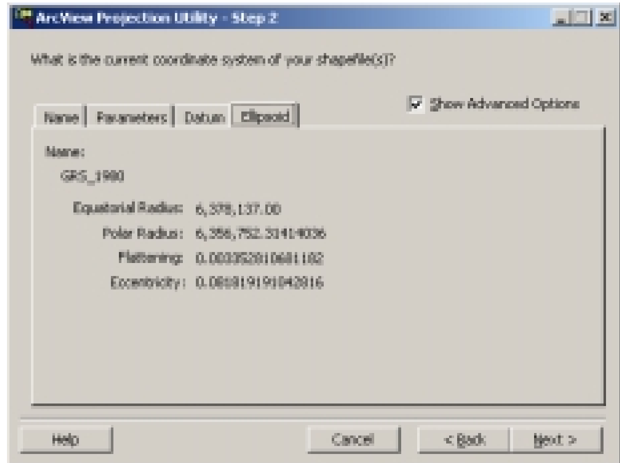

Figure 24 – Step 2: View the “Ellipsoid” Tab

After configuring all of the Step 2 options as described, click the “Next>” button to continue to Step 3.

Step 3 – “Select the new coordinate system for your new shapefile(s).”

Under the Name tab (Figure 25):

- Select the “Projected” option under the “Coordinate System Type” section.
- Select the “NAD_83_Virginia_North [32146]” option under the “Name” section.
- Select the “Foot [9002]” option under the “Units” section.

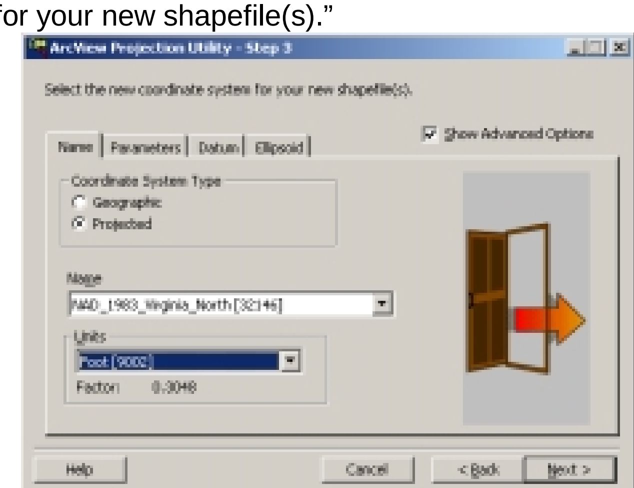

Figure 25 – Step 3: Configure the “Name” Tab

Under the Parameters tab (Figure 26):

- Confirm the “False Easting:” value under the “Geographic Coordinate System:” section as “11482939.6325459”.
- Confirm the False Northing value under the same “Geographic Coordinate System” section as “6561679.79002625”.
- Confirm the “Greenwich [8901]” option for the “Prime Meridian” section.
- Confirm the “Central_Meridian” value under the “Base Projection” section as “-78.5”.
- Confirm the “Central_Parallel” value under the “Base Projection section as “37,.666666666”.
- Confirm the “Standard_Parallel_1” value under the “Base Projection” section as “38.033333333”.
- Confirm the “Standard_Parallel_2” value under the “Base Projection” section as “39.2”.

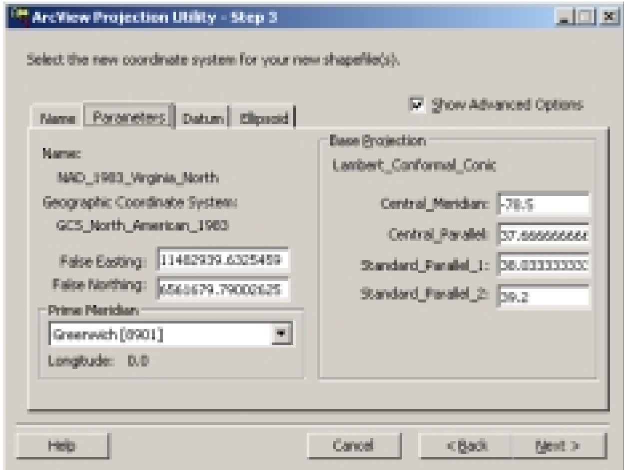

Figure 26 – Step 3: Configuring the “Parameters” Tab

Under the Datum tab (Figure 27):

- Select “GEOTRANSFORMATION_UNSET” from the “Geographic Transformation” section.

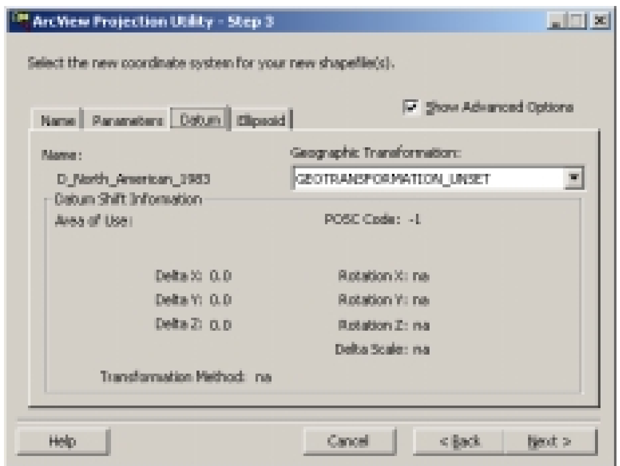

Figure 27 – Step 3: Configure the “Datum” Tab

Under the Ellipsoid tab (Figure 28):

- No input or selecting is needed. Verify that values are correct.

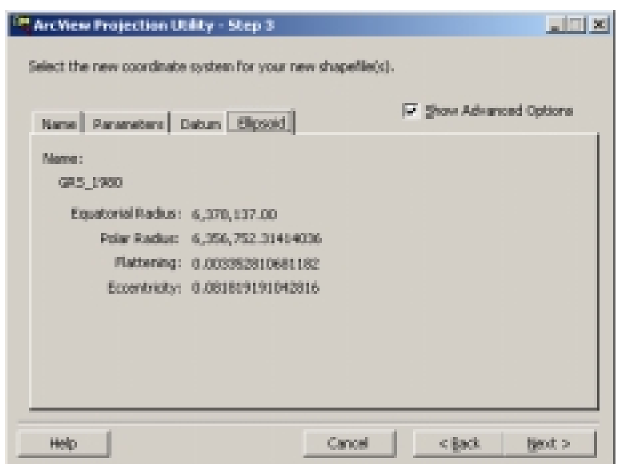

Figure 28 – Step 3: Configure the “Ellpsoid” Tab

After configuring all of the Step 3 options as described, click the “Next>” button to continue to Step 4.

Step 4 – “Where do you want to save your new shapefile(s)?…”

- Use the “Browse…” option and navigate to the directory you wish to save your new theme.
- Rename the file using the naming conventions recommended in the earlier section (i.e.: <501NVGIS/sections/ITSAssets/StatePlane/CCTV/CCTV02-05-31>) and click the “Save” button.
- Click on the “Next>” button to continue to the Summary.

Step 5 – Summary
Verify that the summary details match the following two illustrations (Figure 29 and Figure 30) for your input and output coordinate systems and projections:

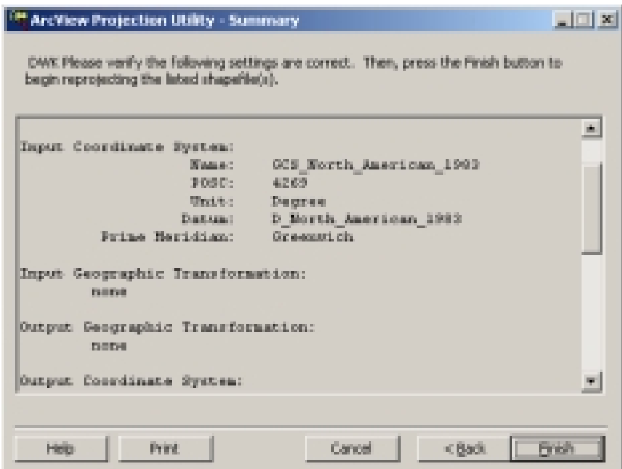

Figure 29 – Step 5: Summary Dialog Box I

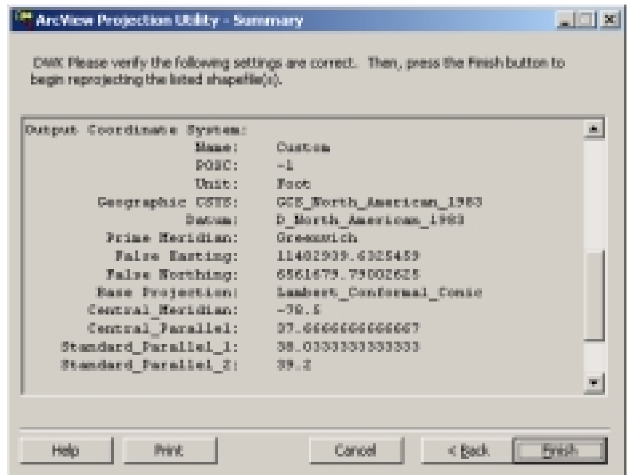

Figure 30 – Step 5: Summary Dialog Box II

Once you’ve verified the values continue by clicking the “Finish” button. After a short wait, a progress box will appear showing the conversion to the new shapefile/theme.

The last dialog box will soon appear advising that the Projection Utility wizard has finished processing the shapefiles (Figure 31).

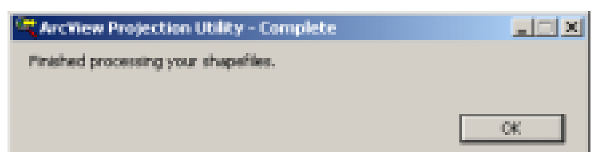

Figure 31 – Re-projection Process Complete Dialog Box

After processing the Projection Utility, you will be asked if you want to add the projected data (Figure 32). Click the “Yes” button at this point. The new shapefile now is ready to be added to the appropriate view, depending on the projection.

Figure 32 – Add Re-projected Data to Your View Dialog Box

Another dialog box will appear asking you to choose which view to add the projected theme. In the case of the new CCTV theme in the State Plane projection, make sure to select the "NOVA ITS Asset and Communication GIS – StatePlane" view and click "OK" to add the projected data to the view.

5 LESSONS LEARNED AND RECOMMENDATIONS

5.1 LESSONS LEARNED

The development of a communications plan is a unique and often overlooked (or not funded) aspect of an ITS architecture project. Many state agencies do not or are unable to follow-up the system architecture development with such a plan. However, VDOT recognized the importance of and natural relationship between system architecture and communications. Communications infrastructure is critical to the realization of the system architecture. The Department took this relationship even further by including the development of an ITS asset baseline using GIS to support architecture and communications maintenance aspects. The development of the ITS asset and communications GIS yielded significant lessons learned.

Time & Budget Consuming – The original limited scope and budget were based on the fact that a statewide ICAS effort was underway to collect location information (via GPS) of all VDOT assets. The assumed limited effort required was also based on an over-estimated availability of ITS asset databases from NOVA GIS and other VDOT staff. With the limited availability of data and direct involvement by NOVA GIS, the NOVA ITS Architecture Team (VDOT and consultants) had to re-allocate resources to perform the whole tasks.

Increasing Scope & Opportunity – It was difficult to predict with great certainty the amount of data collection required and GIS application development involved when data collection mainly depended on feedback from stakeholders rather than actual field research. Also, once the baseline GIS was established, the inherent capability of the GIS to serve more VDOT functions (e.g., statewide applications) became evident and it was financially more cost effective to increase the scope of the GIS.

Cooperation from VDOT – The GIS is completely data-driven, when there are issues with the data collection that are relying on others almost completely within VDOT, whom may not find that it's a high priority or in some way cannot turn in or research the data. Finding it difficult enough to find the best point of contact (POC) for each asset, communications infrastructure/facility, it can take a while to just find the "right" person from whom data should be collected. On top of the normal duties, it can be a lot to ask for the VDOT associate to aid in, at times, in depth and lengthy research. As such, the VDOT project manger assumed daily coordination with various VDOT staff for in-depth and lengthily research on accurate ITS asset databases. This could severely infringe into the budget and period of performance (POP), and makes it hard to proceed with other aspects of the GIS and any analysis.

Data Accuracy Standards – It was recognized that there was a relationship between the project budget and POP, and the ability to establish and maintain very rigid standards that apply to both the database as well as the positional accuracy of assets. In general, the smaller the budget and the shorter the POP the less standards can be applied. However, a properly developed long-term GIS maintenance strategy can overcome this initial shortfall.

Growing Pains – The structure and development of the GIS required coordination and compliance with the NOVA GIS team, the Central VDOT Data Management Program, as well as the NOVA and Central ITS Offices. This proved to be a series of compromises - from which base data to use, to what projection, all the way to what attributes to use for each ITS asset.

Since the scope of the GIS was enhanced to allow VDOT to address statewide applications, this was seen as normal growing pains. It is fully expected that this additional coordinating with other VDOT interests (outside the NOVA District) will yield increased benefit to the Department.

Working Relationship – It took time for the consultant to prepare the GIS and customize it to a clients needs. At times, client reviews facilitated large-scale changes in structure and appearance of some to all of the GIS. It was important to maintain a working relationship between the GIS development team and the user (VDOT) in order to avoid a misdirection of effort to prevent a situation where the entire GIS process had to be amended or, more significantly, repeated.

All in all, the NOVA ITS System Architecture project, and in particular the NOVA ITS asset and communications GIS, was a valuable experienced for those involved.

5.2 RECOMMENDATIONS

There is great value in the NOVA ITS Asset and Communication Baseline GIS, but due to the very dynamic nature of ITS, there will need to be implemented certain practices and processes in which to maintain, update, and improve the product. If the spatial or database information is left as a snapshot in time, the tremendous potential of this product will be unrealized. Therefore, it is recommended that this document not only be adhered to as closely as possible, but also updated over time with effective alternatives to what has been proposed.

Update the Baseline – As mentioned in previous sections, it is imperative for the NOVA GIS administrators to work in close cooperation with the NOVA parties responsible for their respective ITS assets or GIS layer. Perhaps the most difficult step is to determine a willing and correct point of contact for each of the GIS layers/assets, and defining what process will be used in providing updates to NOVA GIS. Whether it’s a database only update or a fully updated ArcView shapefile that is delivered to the administrator, this process must be defined on a per asset basis. The following table illustrates the probable points of contact during the research phase for the GIS baseline for NOVA GIS administrators’ use.

Table 2 – Summary of ITS Asset Points of Contact

Asset	Point of Contact	Note
Basedata	Darlette Meekins Tom Phillips	Central Office NOVA GIS
Blankout Sign	Shawn Ball and Matt Miller Alan McCormick for I-495/Rt.236	NOVA Consultant NOVA GIS
Call Box	Tom Phillips (original data: Alan McCormick)	NOVA GIS NOVA STC
CCTV	NOVA STC System Integrator	NOVA STC
Coaxial Cable	Dave Smallwood	NOVA Technical Construction
Count Station	Gene Martin	Central Office ITS
Detector	NOVA STC System Integrator	NOVA STC

Table 2 – Summary of ITS Asset Points of Contact

Asset	Point of Contact	Note
	(detectors on the beltway: Alan McCormick)	
Drop Cabinets	Dave Smallwood	NOVA Technical Construction
Facilities	Omar Necko (architecture stakeholders: Amy McElwain)	Central Office ITS NOVA ITS
Fiber Node/Hub	Dave Smallwood	NOVA Technical Construction
HAR Sign	Alan McCormick	NOVA STC
HAR Transmitter	Alan McCormick	NOVA STC
HOV (Gate)	NOVA STC System Integrator	NOVA STC
Lane Control Signal	Dave Smallwood	NOVA Technical Construction
NonVDOT Fiber	Amy McElwain	NOVA ITS
Ramp Meter Signal	NOVA STC System Integrator	NOVA STC
Resource Sharing Cell Tower	Alan McCormick and Matt Miller	NOVA STC and NOVA Consultant
RWIS	Sue Maddox-Toth	Central Office
Service Panel	Tom Phillips (original data: NOVA STC)	VDOT NOVA GIS NOVA STC
Smart Tag	Amy McElwain (future contact: Dulles Toll Road)	NOVA ITS NOVA DTR
Traffic Signal	Tom Phillips (original data: Nhan Vu)	NOVA GIS NOVA STSS
Truck Rollover	Shawn Ball Alan McCormick for I-495/Rt.236	NOVA Consultant NOVA STC
Twisted Pair	Dave Smallwood	NOVA Technical Construction
VDOT Fiber	Dave Smallwood	NOVA Technical Construction
Vehicle Classification System	NOVA STC System Integrator	NOVA STC
VMS	Tom Phillips (original data: NOVA STC System Integrator and Matt Miller)	NOVA GIS NOVA STC and NOVA Consultant

Add New Data to the Baseline – There are other ways to ensure the success of the GIS product. In the initial stage, VDOT could add a construction addendum to construction contract that would require VDOT contractors to report location as well as some data concerning ITS or ITS-related product that they install or work with in the field. When ITS field equipment is removed or replaced by VDOT personnel, VDOT personnel would report the changes to GIS administrator. Efforts like these reduce the expenses involved in revisiting assets or locations in the field, and with the dynamic nature of ITS, and the moving of some assets frequently, this type of requirement could prove invaluable.

Practice Configuration and File Management – Maintenance and updating the NOVA ITS Asset and Communications GIS by practicing the recommended configuration management concepts (see Appendix C) will ensure the integrity of the data, and clearly control version release and changing to the product in any way, by any administrator. Configuration Management (CM) is a formal engineering discipline that provides software developers and users with the methods and tools to identify, establish, and maintain the reliability of work products. These work products consist of the software-developed baselines, control changes to those baselines, record and track status, and audit the products. CM is the means through which the integrity and continuity of the software, hardware, and documentation products are recorded, communicated, and controlled throughout the life of the project.

Improve Position Accuracy – The baseline was created as a work in progress where accuracy and data detail can and should be improved over time. With the use of the GPS units and ArcPad products available in the NOVA GIS department, location accuracy for most assets can be greatly improved.

Statewide Success – It is extremely important for VDOT departments to come to a consensus on what ITS assets, stakeholder (facilities), and attributes for both, are important to maintain from a statewide point of view. Entities, such as ITSCC, need to make recommendations to the Central Office GIS so that they will define what assets and attributes each VDOT district's GIS personnel or other designated personnel will need to update and send to the Central Office GIS administrators. It is the vision, that ultimately the Central Office GIS will add this Statewide ITS Asset and Communications GIS to it's intranet-capable GIS software, the GIS Integrator, for all VDOT personnel to have access to view, query, and make comments.

Other Applications – Potentially, the GIS and its database could be used for other purposes other than ITS asset and communication management. GASB-34, an accounting standard issued by the Government Accounting Standards Board, requires the state and local governments such as VDOT to recognize the cost of fixed assets through depreciation over the life of the assets, i.e. plant, property and equipment, all of which apply to most or all of ITS deployments. This GIS product would be an ideal application for this purpose. When the NOVA ITS asset baseline was completed in May 2002, NOVA Smart Traffic Center (STC) was in the process of documenting its traffic management software, hardware, and field asset baseline. This NOVA ITS asset baseline provides STC tremendous input that could save STC time and financial need. The NOVA ITS Asset and Communication GIS will be useful in an ATIS web application as well. Other applications that other DOT's already use asset management related GIS's for preventative maintenance, presentations to management or public, planning tool, and many other graphical or database uses

Lastly, it is extremely important to reemphasize the need to keep the themes in the NOVA ITS Asset and Communications GIS as current as possible. **The data drives the value, and if the data is outdated, the value of this product diminishes**. Without value, the effect the GIS has and potential for all of the aforementioned applications will not be realized.

APPENDIX A – DATA DICTIONARY

NOVA ITS Architecture Asset – Baseline Data Dictionary (release 5.0)
Bold & Highlighted - Base Attributes

Item	Attribute Name	Short Name	Data Type	Length / Format	Units	Dictionary Notes
0	Item					Arbitrary item no. for this category of asset
1	**GIS Tag**	**GISTAG**	**Alpha**	**Decimal**		**Unique identifier for GIS inventory purposes**
2	**Asset Name**	**ASSET_L**	**Alpha**			**Ordinary asset name in standard nomenclature**
3	Asset Short Name	ASSET_S	Alpha			Special short name as assigned
4	**Asset ID**	**ID**	**Alpha**			**VDOT designation or identifier, or blank**
5	**District**	**DIST**	**Alpha**			**Standard District Name**
6	Residency	RESID	Alpha			Standard Residency Name
7	County	COUNTY	Alpha			County Name or Code
8	Route	ROUTE	Alpha			Conventional use; e.g. I-81, Rt.20
9	Route Direction	RT_DIR	Alpha	5 char.		East, West, North or South
10	Side of Centerline	SIDE_CL	Alpha		Right, Left	
11	**Latitude Decimal Degrees**	**LATITUDE**	**Decimal**	**xx.12345678**	**Degrees**	**Eight decimal places needed**
12	Latitude DMS	LAT_DMS	Integer	dd.mm.ss	DMS	dd=Degrees, mm=Minutes, ss=Seconds
13	**Longitude Decimal Degrees**	**LONGITUDE**	**Decimal**	**xx.12345678**	**Degrees**	**Eight decimal places needed**
14	Longitude DMS	LONG_DMS	Integer	dd.mm.ss	DMS	dd=Degree, mm=Minutes, ss=Seconds
15	Status	STATUS	Alpha			Existing or Proposed
16	Date Installed	DATE_INST	Date			
17	Planned Installation Year	PLAN_YR	Integer	4 char.	Year	Year in four digits, If asset is planned
18	Planned Project (Program)	PROJ	Alpha			Project Name or Number, if available
19	Milepost	MILEPOST	Decimal	xxx.x	Tenths of Mile	Mile Post designation, if known
20	Location Description	LOCATION	Alpha			Ordinary location as street address or intersection of ..
21	Data Rate Requirement	DATA_RATE	Decimal	xx.xxx	Mb/sec	Voice circuit is 64 Kb/s or 0.064 Mb/s
22	Protocol	PROTCL	Alpha			Voice for Call Box
23	Device Interface	I/F	Alpha			2-Wire, 4-Wire, RS-232, Ethernet, or other
24	Criticality Requirement	CRIT	Alpha			Requires redundancy or backup route
25	Latency Requirement	LATEN	Decimal		Sec.	Must be real time
26	End User(s)	USER	Alpha		Short Name	Choose 'Short Name' from schedule of VDOT Facilities List
27	**Owner**	**OWNER**	**Alpha**			**If not VDOT, indicate VSP, BAM etc.**
28	Data Source	SOURCE	Alpha			Cited source of this information

NOVA ITS Architecture Asset – Baseline Data Dictionary (release 5.0) **Bold & Highlighted - Base Attributes**						
Item	Attribute Name	Short Name	Data Type	Length / Format	Units	Dictionary Notes
29	Device Power Requirement	POWER_REQ	Alpha		Free Form	Indicate Volts AC or DC; e.g., 120 VAC
30	Power Available (Y/N)	PWR_AVAIL	Alpha	1 char.		Y or N, or blank if not known
31	Service Panel No.	SP_NUM	Integer	SPnnn		
32	Radio Channel Designation	RAD_CHAN	Alpha		Free Form	Frequency or Channel Name, or blank if not a radio transmitter/receiver
33	Elevation	ELEV	Integer	Feet	Feet AMSL	Ground elevation above mean sea level (AMSL)
34	Structure Height	HEIGHT	Integer	Feet	Feet AGL	Structure height above ground level (AGL)
35	**Remarks**	**REMARKS**	**Alpha**		**Free Form**	**Comments particular to record**
36	Text Height	TXT_HT	Decimal		feet	
37	Text Width	TXT_WTH	Decimal		feet	
38	Face Height	FACE_HT	Decimal		feet	
39	Face Width	FACE_WTH	Decimal		feet	
40	Voltage	VOLTAGE	Decimal		Volts	
41	Wattage	WATTAGE	Decimal		Watts	
42	List of Terminated Cables	TERM_CAB	Alpha			
43	List of Cables Carried	CAB_CARRY	Alpha			
44	Comm Channel Data	COM_CHAN	Alpha			
45	Comm Address Data	COM_ADDR	Alpha			
46	Comm Channel Video	COM_VIDEO	Alpha			
47	Housing Type	HSE_TYPE	Alpha			
48	Lowering Device (Y/N)	LOW_DEV	Alpha		Yes, No	
49	Maintenance Access (Y/N)	MAINT_ACC	Alpha		Yes, No	
50	End1	END1	Alpha			Manhole/Junction Box ID
51	End2	END2	Alpha			Manhole/Junction Box ID
52	Total No. 30mm Ducts	TOT_30_D	Integer			
53	No. 30mm Ducts Occupied	OCC_30_D	Integer			
54	Total No. 50mm Ducts	TOT_50_D	Integer			
55	No. 50mm Ducts Occupied	OCC_50_D	Integer			
56	Total No. 75mm Ducts	TOT_75_D	Integer			
57	No. 75mm Ducts Occupied	OCC_75_D	Integer			
58	Total No. 100mm Ducts	TOT_100_D	Integer			

NOVA ITS Architecture Asset – Baseline Data Dictionary (release 5.0) **Bold & Highlighted - Base Attributes**						
Item	Attribute Name	Short Name	Data Type	Length / Format	Units	Dictionary Notes
59	No. 100mm Ducts Occupied	OCC_100_D	Integer			
60	Total No. Other Ducts	TOT_OTH_D	Integer			
61	No. Other Ducts Occupied	OCC_OTH_D	Integer			
62	Size of Other Ducts	SIZE_OTH	Decimal		inches	
63	Direct Buried (Y/N)	DIR_BURY	Alpha		Yes, No	
64	Milepost To	MP_TO	Decimal		Tenths of Mile	Mile Post designation, if known
65	Milepost From	MP_FROM	Decimal		Tenths of Mile	Mile Post designation, if known
66	Category	CATEGORY	Text			
67	Breaker Amps	BREAK_AMP	Decimal		Amps	
68	Breaker Volts	BREAK_VOLT	Decimal		Volts	
69	Breaker Poles	BREAK_POLE	Integer			
70	Cables Terminated on Breaker	CAB_TERM	Alpha			List of cables terminated on the breaker
71	Transformer KVA	TRAN_KVA	Decimal			
72	Device Width	DEV_WIDTH	Decimal		feet	
73	Device Depth	DEV_DEPTH	Decimal		feet	
74	Foundation Width	FND_WIDTH	Decimal		feet	
75	Foundation Depth	FND_DEPTH	Decimal		feet	
76	Number of Front Doors	FRT_DOOR	Integer			
77	Number of Back Doors	BK_DOOR	Integer			
78	Rack Units Provided	RACK_PROV	Integer			
79	Rack Units Used	RACK_USED	Integer			
80	Swing or Semaphore	SWG_SEM	Alpha		Swing, Semaphore	
81	Arm Length	ARM_LGTH	Decimal		feet	
82	Inbound or Outbound	INBD_OUTBD	Alpha		Inbound, Outbound	
83	Three Phase (Y/N)	THREE_PH	Alpha		Yes, No	
84	Number of Fixtures	NUM_FIXT	Integer			
85	Fixture Type	FIXT_TYPE	Alpha			
86	Ballast	BALLAST	Alpha			
87	Ballast Type	BALL_TYPE	Alpha			
88	Function	FUNCTION	Alpha			
89	Operational	OPERAT	Alpha			

NOVA ITS Architecture Asset – Baseline Data Dictionary (release 5.0)
Bold & Highlighted - Base Attributes

Item	Attribute Name	Short Name	Data Type	Length / Format	Units	Dictionary Notes
90	Lead-In Cable ID	LEAD_CAB	Alpha			
91	Lane	LANE	Integer			
92	Circuit No.	CIR_NUM	Integer			
93	Phase A Used (Y/N)	PHASE_A	Alpha		Yes, No	
94	Phase B Used (Y/N)	PHASE_B	Alpha		Yes, No	
95	Phase C Used (Y/N)	PHASE_C	Alpha		Yes, No	
96	Contactor Type	CONT_TYPE	Alpha			
97	Old Panel No.	OLD_PANEL	Alpha			
98	ADC Map No.	ADC_MAP	Alpha			
99	Service Pole No.	POLE_NUM	Alpha			
100	Meter No.	METER_NUM	Alpha			
101	Account No.	ACCT_NUM	Alpha			
102	Company Name	CO_NAME	Alpha			
103	Utility Pole Location	UP_LOC	Alpha			
104	Directions to Asset	DIR_ASSET	Alpha			
105	Panel Type	PAN_TYPE	Alpha			
106	Line Voltage	LINE_VOLT	Decimal		Volts	
107	Feed Voltage	FEED_VOLT	Decimal		Volts	
108	Circuits Powered from Cabinet	CIRC_CAB	Integer			
109	Main Breaker Type	BREAK_TYPE	Alpha			
110	Base Type	BASE_TYPE	Alpha			
111	Pole Type	POLE_TYPE	Alpha			
112	Lamp Type	LAMP_TYPE	Alpha			
113	Breakaway Fuse	BREAK_FUSE	Alpha			
114	Fuse Amperage	FUSE_AMPS	Decimal		Amps	
115	Fuse Holder Type	FUSE_HOLD	Alpha			
116	Voltage Type	VOLT_TYPE	Decimal			
117	Maker	MAKER	Alpha			
118	Display Technology	DISP_TECH	Alpha			
119	Display Matrix	DISP_MAT	Alpha			
120	Walk In (Y/N)	WALK_IN	Alpha		Yes, No	

NOVA ITS Architecture Asset – Baseline Data Dictionary (release 5.0)
Bold & Highlighted - Base Attributes

Item	Attribute Name	Short Name	Data Type	Length / Format	Units	Dictionary Notes
121	Mounted On	MOUNT_ON	Alpha			
122	Number of Lines	NUM_LINES	Integer			
123	Linked to Gates (Y/N)	LINK_GATE	Alpha		Yes, No	
124	Direction Facing	DIR_FACE	Alpha	5 char.	North, South, East, or West	
125	Construction ID	CONS_ID	Alpha			
126	Connection	CONNECT	Alpha			
127	Controller ID	CONTR_ID	Alpha			
128	Controller Type	CONTR_TP	Alpha			
129	Controller Address	CONTR_AD	Alpha			
130	Cabinet Type	CAB_TYPE	Alpha			
131	Preemption (Signal Priority)	PREEMPT	Alpha			
132	Closest Intersection Road Name	CLST_INT	Alpha			
133	Closest Route Number	CLST_RT	Alpha			
134	Closest Exit	CLST_EXT	Alpha			
135	Previous Intersection Road Name	PREV_INT	Alpha			
136	Previous Route Number	PREV_RT	Alpha			
137	Previous Exit	PREV_EXT	Alpha			
138	Next Intersection Road Name	NXT_INT	Alpha			
139	Next Route Number	NXT_RT	Alpha			
140	Next Exit	NXT_EXIT	Alpha			
141	Sign Message	SIGN_MES	Alpha			
142	Main Usage/Purpose	USAGE	Alpha			
143	Main Usage/Purpose ID	USAGE_ID	Alpha			
144	Other Usage/Purpose	USAGE_2	Alpha			
145	Other Usage/Purpose ID	USAGE_ID2	Alpha			
146	Smart Tag Reader	READER	Decimal			
147	ID-1	ID-1	Alpha		Special STC ID Attributes	
148	ID-2	ID-2	Alpha		Special STC ID Attributes	
149	Number of Gates	GATE_NUM	Decimal			

NOVA ITS Architecture Asset – Baseline Data Dictionary (release 5.0) **Bold & Highlighted - Base Attributes**						
Item	Attribute Name	Short Name	Data Type	Length / Format	Units	Dictionary Notes
150	Ramp ID	RAMP_ID	Alpha			
151	Manufacturer	MANUFAC	Alpha			
152	Collocated	COLLOCAT	Alpha		Yes, No	
153	Collocated Asset (ID)	COLL_ASS	Alpha			
154	Collocated Asset (ID) Other	COL_ASS2	Alpha			
155	Other Collocated Asset	COLL_OTH	Alpha			
156	Support System of Collocated Asset	COLL_SUP	Alpha			
157	RCU Number	RCU_NUM	Alpha			
158	Asset Address	ADDR	Alpha			
159	Old ID	OLD_ID	Alpha			
160	Video Switch ID	VID_SWCH	Alpha			
161	Condition of Asset	CONDITN	Alpha			
162	Asset Subsystem	SUBSYS	Alpha			
163	Link ID	LINK_ID	Decimal			
164	Node or Hub ID	NODE_HUB	Alpha			
165	Signalhead ID	SIGNHEAD	Alpha			
166	Signalhead status	SH_STAT	Alpha			
167	Location in Plans	LOC_PLAN	Alpha			
168	Connected to	CONN_TO	Alpha		to a device, asset or location	
169	Connected from	CONN_FRM	Alpha		from a device, asset or location	
170	Conduit Ducts in Duct Bank	BANKDUCT	Alpha			
171	Removal Date	REMOVE	Alpha			
172	Metro Line	LINE	Alpha			
173	Owner and Status Combined	OWN_STAT	Alpha			
174	Wire Count	WIRE_CT	Alpha			
175	Type of Asset	ASS_TYPE	Alpha			
176	Structure ID	STRUCTURE	Alpha			
177	Structure Type	STR_TYPE	Alpha			
178	Structure Construction Date	STR_DATE	Alpha			

NOVA ITS Architecture Asset – Baseline Data Dictionary (release 5.0) **Bold & Highlighted - Base Attributes**						
Item	Attribute Name	Short Name	Data Type	Length / Format	Units	Dictionary Notes
179	Structure Removal Date	STR_REM	Alpha			
180	Other VDOT ID	OTHER_ID	Alpha			
181	Carrier Signed Lease Date	LEASE_DT	Alpha			
182	Carrier Signed Lease Exception	LEASE_EX	Alpha			
183	Carrier Lease Number	LEASE_NO	Alpha			
184	Second Carrier	CARR_2	Alpha			
185	Carrier Two Signed Lease Date	LSE_DT_2	Alpha			
186	Carrier Two Signed Lease Exception	LSE_EX_2	Alpha			
187	Carrier Two Lease Number	LSE_NO_2	Alpha			
188	Carrier Three	CARR_3	Alpha			
189	Carrier Three Signed Lease Date	LSE_DT_3	Alpha			
190	Carrier Three Signed Lease Exception	LSE_EX_3	Alpha			
191	Carrier Three Lease Number	LSE_NO_3	Alpha			
192	Number of Loops	LOOP_NUM	Alpha			
193	Cabinet ID	CAB_ID	Alpha			
194	Detector Loop ID's	DET_LOOP	Alpha			
195	Detector Station ID's	DET_STAT	Alpha			
196	Lane Type	LANE_TYP	Alpha			
197	Speed Limit	SPEED	Decimal	MPH		
198	Lanes With Detector	LANE_DET	Decimal			
199	Total Lanes	TOT_LANE	Decimal			
200	Regular Lanes	REG_LANE	Decimal			
201	HOV Lanes	HOV_LANE	Decimal			
202	Lane Control Signal Lanes	LSC_LANE	Decimal			
203	SAS Number	SAS_NO	Alpha			
204	SAS Type	SAS_TYPE	Alpha			
205	System Network Number	SYS_NETW	Alpha			
206	Central Drop Address	CENT_DRP	Alpha			
207	Associated Image/Photo Link	IMAGE	Alpha			
208	Av. Status	AV_STATUS	Alpha			

NOVA ITS Architecture Asset – Baseline Data Dictionary (release 5.0)
Bold & Highlighted - Base Attributes

Item	Attribute Name	Short Name	Data Type	Length / Format	Units	Dictionary Notes
209	Jurisdiction	JURISDIC	Alpha			
210	Number of Counters	COUNT_NUM	Decimal			
211	Transmitter	TRANSMIT	Alpha			
212	FCC Call Sign	FCC_SIGN	Alpha			
213	Sign One Controlled by Transmitter	SIGN_ID1	Alpha			
214	Sign Two Controlled by Transmitter	SIGN_ID2	Alpha			
215	O.H. Location	OH_LOCAT	Alpha			
216	VDOT Type	VDOT_TYPE	Alpha			
217	Connection type/description	CONN_TYPE	Alpha			
218	Port Name	PORT_NAME	Alpha			
219	Contact Telephone Number	CONTACT#	Alpha			
220	Contact Person	CONTACT	Alpha			
221	Contact Address	CONT_ADDR	Alpha			
222	Contact Address Continued	CONT_ADDR 2	Alpha			
223	Contact Organization	CONT_ORG	Alpha			
224	Contact Organization Continued	CONT_ORG2	Alpha			
225	Contact Email	CONT_EML	Alpha			
226	Relationship to Gate	GATE_REL	Alpha		Yes, No	
227	Website link	WEB_LINK	Alpha			
228	Other Website link	WEB_LNK2	Alpha			
229	Study ID	STUDY	Alpha			

APPENDIX B – METADATA

METADATA

The official Federal Geographic Data Committee (FGDC) standard metadata (data about the data) is in .XML format included in each of the subfolders for each individual theme, and can be read using standard text editors or ESRI's ArcGIS ArcCatalog. The FGDC is responsible for the "policies, standards, and procedures for organizations to cooperatively produce and share geographic data."[1] This committee is the accepted standard for metadata in VDOT's GIS community and has been adhered to for this project.

Above and beyond what is expected in terms of metadata, the NOVA ITS Architecture team decided that it would be equally important to provide a quick and easy reference to how the data was collected at what point in the data collection process, as well as any points of contacts used. Below is the abbreviated description of each layer.

Basedata - Any basedata used for this GIS tool was either given by NOVA VDOT GIS personnel (COG and Metro rail data) or brought in off of the VDOT County Map Series CD distributed out of the Cartography department of VDOT published in 2000. Darlette Meekins, VDOT, is the suggested point of contact.

Blank Out Sign – Data gathering was completed by January, 2002 in MS Excel spreadsheet. Data was gathered from several VDOT personnel. The original positional and database for the blank out sign layer originated from the STC Traffic Management System. The database was modified with attributes added by Amy McElwain, the NOVA Smart Travel Manager. Matt Miller, a VDOT consultant, provided the sign message information. The blank out sign's usage information came from Matt Miller and Shawn Ball of VDOT consultant. They were re-positioned by matching with the Vargis aerial photo and further confirmed by consulting Shawn Ball. Alan McCormick verified the locations of the signs for the truck rollover system at the interchange of I-495 and Rt. 236. Positional accuracy not field verified but accurate to general intersection location.

Call Box – Data gathering was complete in June of 1999, and NOVA GIS delivered the theme for this task. The point of contact is Tom Phillips of NOVA GIS department. The call box project contact is Alan McCormick. Positional accuracy is very good as GPS units were used to record location.

CCTV – Original positional and database information was gathered from the NOVA STC traffic management system (System Integrator, point of contact). Amy McElwain made the following changes to the database: added 2 new CCTVs to be installed via the Truck Rollover project at the interchange of I-495 and Rt. 236 (Alan McCormick, point of contact); verified the currency of the data with the STC System Integrator; verified the cabinet numbers for CCTVs outside the beltway from the NOVA Fiber Block Diagram (Dave Smallwood, point of contact); confirmed the rest of cabinet numbers with the maintenance data provided by STC (Marlowe Dixon, point of contact); added all the resource sharing CCTVs with accurate GPS data (Alan McCormick & Matt Miller, points of contact); and added several attributes related to communications and resource sharing information. Positions of all CCTVs inside the beltway were verified from accurate GPS data provided by Frederick R. Harris (Tom Phillips, point of contact). As a result, the positions of CCTVs inside the beltway and on the resource sharing towers present accurate

[1] Statement quoted from the home page of the Federal Geographic Data Committee; www.fgdc.gov.

locations and the rest of CCTVs were merely estimated location from STC's traffic management system. VDOT NOVA GIS conducted field verification by using GPS units to collect accurate GPS data for the CCTVs whose positions were estimated (Tom Phillips, point of contact). The latest version with all accurate GPS data was completed in May of 2002.

Coax Cable – Data gathering was completed in February 2002 through interviews with Dave Smallwood of VDOT Technical Construction. Mr. Smallwood described location as roadside and the cable was electronically copied over these described roads (due to the fact that it wasn't productive to follow the many time the cable changes from side to side on each road, and to do so accurately) in the GIS. Mr. Smallwood provided all the information in the database as well for this theme.

Count Station – Data was gathered from a Microsoft Access spreadsheet that was the most recent provided by VDOT in November of 2001. Gene Martin of VDOT was the author of the spreadsheet. Latitude and Longitude were found by using third party software that was used to identify intersections, and measure the given distance on a road where the asset was located (provided by the spreadsheet).

Detector – Original detector locations and data was gathered from the NOVA STC (System Integrator, point of contact). Detector stations are comprised of individual detectors, single-loop or double-loop, that are located in the same geographic area. Each detector station may be comprised of one or more detectors. Detector controllers are the units that process detector data and it's this detector controller database and location data that the STC traffic management system uses. Therefore, an individual detector point in the detector layer represents a detector controller. Typically, there are multiple detectors that send data to each controller and every detector in a station connects to the same controller, and additionally some controllers take data from multiple stations (Brian Smith & Matt Green of Smart Travel Lab, points of contact). Amy McElwain used the detector controller database as the starting point and added several attributes by manually entering the content from the detector loop and station databases so that the detector controller layer database would also contain the aggregated information for the loops and stations. Additional detector records were added in December, 2001 for the new detectors installed on the Beltway from American Legion Bridge to Dulles Toll Road (Alan McCormick & Matt Miller, points of contact). Positions of the beltway detectors are accurate as these detector controllers are located on the resource sharing towers that do contain accurate GPS data. Positional accuracy is variable as the STC has the capability to maneuver its icons for each theme, and therefore the intersection data available in the detector database was used to verify each detector's location using the third party mapping software.

Drop Cabinet - Data gathering was completed in February 2002 through interviews with Dave Smallwood of VDOT. Amy McElwain used the NOVA Fiber Block Diagram to create the drop cabinet database and verified the cabinet ids with the CCTV and VMS databases. The positions of the drop cabinets were calculated based on the relational distance with STC and known locations of Fiber Nodes/Hubs shown on the Fiber Block Diagram. The cabinet ids were sometimes conflicted with those shown in the CCTV and VMS databases due to the difference on the database currency; the ids were then further verified by Marlowe Dixon of NOVA STC.

Facilities – Data gathering for the VDOT residencies, central offices, and district headquarters was done in a previous VDOT project, the Fiber Optic Resource Sharing (FORS) project (Omar Necko, point of contact) completed in December of 2000. Using VDOT provided street addresses, a third party addressing software was able to provide latitude and longitude coordinates for each facility. VDOT personnel in the FORS project provided all database information. The stakeholder theme (Amy McElwain, point of contact) was created from the stakeholders' interviews conducted by the NOVA ITS Architecture team in an earlier phase as part of the Outreach task. Address data was collected and again third party software was used to find positional data for input into the GIS. Excel spreadsheets with stakeholder information were completed by the team in March, 2002.

Fiber Node/Hub - Data gathering was completed in February 2002 through interviews with Dave Smallwood of VDOT. Mr. Smallwood described the position of the nodes/hubs by pointing out each on a large map that was produced for the purpose of allowing Mr. Smallwood to identify where certain communication infrastructure were located in the NOVA district. Mr. Smallwood provided all the information in the database as well for this theme.

HAR Sign and HAR Transmitter – Data gathering for HAR Signs and Transmitters was completed in December, 2001. HAR transmitter information provided by Alan McCormick contains accurate GPS positional data. Alan McCormick illustrated approximate positions where the HAR signs are located on a map and provided mile marker information. Using milepost and intersection information combined with third party mapping software, latitude and longitude points were produced for each HAR sign asset.

HOV (Gate) – Original positional and database information was gathered from the NOVA STC (System Integrator, point of contact). Additional data gathering was completed in January, 2002. Cabinet numbers were gathered from the NOVA Fiber Block Diagram and verified with Marlowe Dixon of NOVA STC. Amy McElwain re-positioned all HOV Gate groups by verifying against the Vargis aerial photos. This HOV gate layer represents gate groups, rather individual gates. The database contains information on number of gates for each gate group. Positional accuracy not field verified but accurate to general intersection location.

Lane Control Signal - Original lane control signal data was gathered from the NOVA STC (System Integrator, point of contact). Additional research was completed in February 2002 with interviews from Dave Smallwood. The NOVA STC traffic management system uses 11 LCS groups in its database. Each controller controlled multiple lane control signal heads and there were a total of 31 signal heads. During this data collection effort, there was a project to assign each signal head with an individual controller. Therefore, this database reflects the new changes and contains 31 records. Positional accuracy is variable as the STC has the capability to maneuver its icons for each theme, and therefore the intersection data available in the lane control signal database was used to verify each location using the third party mapping software.

Non-VDOT Fiber – Data was gathered from non-GIS maps (Amy McElwain, point of contact) originally produced in January, 2000 by PB Farradyne and Computer Sciences Corporation as an effort of conducting a multi-jurisdictional transportation telecommunications study for Maryland SHA and WMCOG. Nora Salinas of NOVA Smart Travel compared the regional fiber map with the roadway map and the WMATA Metrorail map and labeled the non-VDOT fiber with roadway information and/or Metro Rail lines that ran alongside or near the fiber. (WMATA fiber is consistent with its Metrorail line.) They are accurate to road/rail level, but do not show where roads or rail are crossed or where drop cabinets or nodes are located. As more fiber is being buried, it will be important to discover reliable resources to continue maintaining the Non-VDOT Fiber theme.

Ramp Meter Signal – Original positional and database information was gathered from the NOVA STC (System Integrator, point of contact). Additional data gathering for Ramp Meter

Signals was completed in January, 2002. Amy McElwain repositioned the ramp meter signal locations by comparing against the Vargis aerial photos and further verified locations with Shawn Ball. Positional accuracy not field verified but accurate to general intersection location.

Resource Sharing Cell Tower – Data gathering was completed in January, 2002 in MS Excel spreadsheet format. Database and positional information was gathered from Alan McCormick and Matt Miller (points of contact). Several resource sharing cell towers have multiple cell carriers' transmitters co-located on the same towers. Amy McElwain consolidated the cell tower and cell carrier databases and created a data layer that represents cell towers with carriers' information. Locations of the towers were collected by GPS units and are accurate.

RWIS – Data gathering was completed in February, 2002 through research done on the RWIS sites on the VDOT intranet. Sue Maddox-Toth of VDOT recommended that our team find any data on the site <<SCAN Web 3.0.htm>> as the most recent data and positional information were to be found there. The intersection data available from the web site was used to verify each location using the third party mapping software.

Service Panel - Data gathering is ongoing with the first service panel publication beginning in July, 1998. NOVA GIS delivered the theme for this task. The point of contact is Tom Phillips of VDOT NOVA GIS. The source of information came from NOVA STC maintenance personnel. Positional accuracy is very good as GPS units were used to record location.

Smart Tag – Data gathering was complete by the NOVA ITS Architecture team (Amy McElwain, point of contact) in April, 2002 by driving the Dulles Toll Road and taking GPS readings and gathering database information for each location where smart tag readers were present. No VDOT contact was used in data research for this theme, and very accurate positional data was acquired through the use of a GPS unit.

Traffic Signal – Data gathering is ongoing with the latest traffic signal publication being in May, 2002. NOVA GIS delivered the theme for this task. The point of contact is Tom Phillips of VDOT NOVA GIS, the original data is continuousely being updated by Nhan Vu of NOVA Smart Traffic Signal System. Positional accuracy is very good as GPS units were used to record location.

Truck Rollover – Data gathering was completed in February, 2002 through interviews with Alan McCormick and Shawn Ball (points of contact). This data theme represents the truck rollover detectors while the truck rollover signs are included in the blank out sign layer. Alan McCormick provided the information on the truck rollover system at the interchange of I-495 and Rt. 236 and pointed on the map the truck rollover detectors' location. Information on two other truck rollover detectors was gathered from the NOVA Smart Travel Program Plan (Amy McElwain, point of contact) and Shawn Ball verified the locations. The intersection data available in the Truck Rollover database was used to verify each location using the third party mapping software.

Twisted Wire Pair – Data gathering was completed in February, 2002 through interviews with Dave Smallwood of VDOT (point of contact). Mr. Smallwood described the position of the twisted wire pair by pointing out the wire on a large map that was produced for the purpose of allowing Mr. Smallwood to identify where certain communication infrastructure were located in the NOVA district. Mr. Smallwood provided all the information in the database as well for this theme.

VDOT Fiber - Data gathering was completed in February, 2002 through interviews with Dave Smallwood of VDOT (point of contact). Mr. Smallwood described the position of the VDOT-owned fiber by pointing out the fiber on a large map that was produced for the purpose of allowing Mr. Smallwood to identify where certain communication infrastructure were located in the NOVA district. Mr. Smallwood provided all the information in the database as well for this theme.

Vehicle Classification System – Original positional and database information was gathered from the NOVA STC (System Integrator, point of contact). Additional data gathering from the NOVA Fiber Block Diagram (Dave Smallwood, point of contact) was completed in February, 2002. Positional accuracy is variable as the STC has the capability to maneuver its icons for each theme, and since no intersection data was made available no positional verification has been achieved to this layer.

VMS – Original positional and database information was gathered from the NOVA STC (System Integrator, point of contact). The data was further updated by the STC system integrator between December 2001 and February 2002. Some VMSs are not included in the STC traffic management system database due to contractual reasons. A separate VMS database was collected from the NOVA STC system integrator; unfortunately, not all of the VMS's in the database were installed in the field. Matt Miller provided a list of VMSs that are actually out in the field. As result of this verification, some VMSs were removed from the database and others were added. Amy McElwain compared and consolidated several VMS databases into the most accurate list of VMSs that matched what were in the field as of February, 2002 for the baseline. She further filled the sign usage information by researching the NOVA Fiber Block Diagram and confirming the accuracy with Matt Miller. There has been positional verification inside the beltway from accurate GPS data provided by Frederick R. Harris. The latest database additions were completed in May of 2002. Field verification began in March 2002 and is ongoing as VDOT NOVA GIS has GPS units in the field (Tom Phillips, point of contact). The NOVA ITS Architecture team holds the baseline release till this effort is completed in July 2002 and therefore the latest/released version would have the accurate GPS data.

APPENDIX C – CONFIGURATION MANAGEMENT

CONFIGURATION MANAGEMENT

Resources and Organization
The resources needed for this product is the ESRI GIS software ArcView 3.2. However, other ESRI tools may be used in working with this data. ESRI's ArcGIS suite of products can be used for re-projection and other editing to the GIS by capable technicians.

Software Configuration Item Identification
Configuration identification for software is applied to the CSCIs, CSCs, CSUs, and all associated documentation and media. CM will assign the identification and record the assignment in the CM folder. There will be unique configuration identification numbers for software and non-software items.

The CM organization will assign a version number for all subsequent software releases. The software version number will be identified as follows:

1) Major release number: numerical field (1-n) that identifies each major release of the software, initially set to 1 then incremented by one for each minor release.
2) Minor release number: numerical field (1-n) that identifies each minor release of the software, initially set to 0 then incremented by one for each minor release of the major release.
3) Internal increment (internal release): numerical field (1-n) that identifies each internal release of the software, initially set to 1 then incremented by one for each internal build. This number is not included in the version number for external releases.

For example, the version of the first release of the software would be 1.1. The version of the first internal release of the software after 1.1.0 would be 1.1.1.

Software Documentation Configuration Identification
Documentation for CM baselines represents products that fully define aspects of the project. These documents are generally of interest to organizations outside of the engineering team. For the purposes of configuration control, all project planning documents and technical documents are generated for release. All baseline documents will be generated and formally reviewed prior to sign-off and release. For document revisions, these documents will follow the change control process. The document sign-off list for these documents will include, at a minimum, the following (or their designated representatives):

- Document Author
- Program Manager/Project Leader
- Software Quality Assurance Manager
- QA Manager

The CM organization will assign a unique publication number for all documentation. The publication number will consist of the following:

1) Six-digit project number: Six digit unique identifier that relates to a single project.
2) CML number: Integer that identifies each item with a unique number, incremented by one for each item.

3) Internal revision: Two-digit numerical field (00-99) that identifies each development baseline of the document, initially set to 00 then incremented by one for each internal revision.
4) External release: Two-digit alpha field (A-ZZ) that identifies each external release of the publication, initially set to blank and incremented by one for each release after each release of the item.
5) Each part of the publication number will be separated by a "-"

For example, the identification number for the first document delivered would be 000001-1-00. The next delivery of this document would be 000001-1-00-A.

The project number and CM number together comprise the Document Identifier.

Software Baseline Configuration Management

Baselines are used as milestones or logical transition points during the development of a project. Each baseline consists of the products that compose a project at a particular point of time. One of the principal functions of CM is to track the changes to each established baseline.

Configuration Management Library

The CML consists of the physical repository consisting of all documentation and software media for this project as well as COTS software. CM will maintain historical and current copies of deliverable code and documentation within the CML. All items in the CML will be assigned unique identification numbers and maintained by CM. The electronic CML is set up on a network drive in a directory under control of CM who has both read/write access. Team members are granted read-only access.

CM will checkout the documentation and source files from the CM repository and forward them to be updated. Once updated the new version of documentation and source will be checked into the CM repository.

Configuration Control Board (CCB)

The CCB is established to manage configuration control of customer-released and delivered software products. In addition, all software change requests (SCRs) and baselines will be assessed and approved by the CCB. This includes any changes to software tools supporting the GIS. The CCB membership is listed in Table C1.

Table C1 – CCB Membership

Functional Discipline	SCCB Participation
Project Leader/Chairperson	Mandatory
Customer	Mandatory
Developer	Mandatory
Tester	As Required
CM	Mandatory
Software Quality Assurance (SQA)	Mandatory

Operation of the CCB is at the discretion of the CCB chairperson. Routing SDRs to the appropriate CCB members for review and impact assessment will conduct normal operation of the CCB. The CCB will convene when there are significant changes being considered or there is a significant volume of defects to consider. The CCB will discuss the impacts of proposed software changes.

Software Change Request Processing

Software Deficiency Report (SDR) is used to identify problems in documentation and software behavior as well as proposed changes to software products. SDRs will be entered and tracked in a CM tool repository and assigned a unique identifier. The SDR is assigned for resolution to a responsible party at the CCB. To ensure that the SDR is resolved without introducing additional problems, regression test is performed on the next release of the software using test cases identified as failed in the previous release. Regression test also includes exercising additional test cases on related and unmodified software components. The amount of regression test and the test cases to be exercised will be determined by the tester and included in the impact assessment for the SDR for internal review.

All SDRs will be documented on an SDR form (Figure C1). The following process (see Figure C2) will be followed for SDRs:

- Customer submits SDR
- CM will enter the SDR
- CCB will assign a SDR to a Release

A complete diagram of the SDR process and a sample SDR form can be found in Figure 35.

Storage, Handling, and Delivery of Project Media

CM shall maintain all software items that are either configuration managed or managed and controlled in a CM tool or in the CML. CM controls access to the CML. CM performs backups on all software items maintained in the CM repository. All deliverable items will be labeled according to the configuration identification procedure.

Configuration Status Accounting (CSA)

Configuration Status Accounting ensures the accurate identification of each configured item. The following process is identified:

1)	*Determine Status of Software CIs*	CM identifies the software CIs and verifies their identification numbers. CM verifies that the current status and history of changes to the software CIs are correct. CM verifies checkout logs are consistent with the state of the software baselines.
2)	*Verify Procedures Followed*	CM verifies that development and modification procedures defined in the SDP were followed by the SW Development Team prior to checking items into the CML. CM verifies that all CM activities are being performed in accordance with the SDP.
3)	*Document Results*	CM documents and reports the results in accordance with the SDP.

Contractor and Vendor Control

If source code is necessary for subcontractor tasking, CM will checkout the source files from the CM repository and forwards them to the subcontractor. Updated source received from the subcontractor will be checked into the CM repository and tested.

Customer to Complete

Date Initiated: ___________________ **Date Sent to** : ____________

Reported by: ______________ **Reporter's Phone #:** _______________

SDR_ **Reporter's Email:**

This task is submitted as maintenance:

SW VERSION NUMBER: ____________________________

Date and Time Problem First Identified: _________________________________
Trace/Other data available? **Y**__________ **N** ____________
Description of Software Deficiency (attach supporting material as applicable):

Impact

Complete

SDR #__________ **Date Received:** _______________

Reviewed by:_______________ **Reviewer's Phone #:** ______________
Reviewer's Email: _______________

Classification

______Defect
______Enhancement
______Clarification Only

Estimate to Complete

Hours: ___________________
Schedule: _________________
Travel: ___________________

Reviewer Comments (attach detailed information as appropriate)

Figure C1 - Software Deficiency Report – SDR

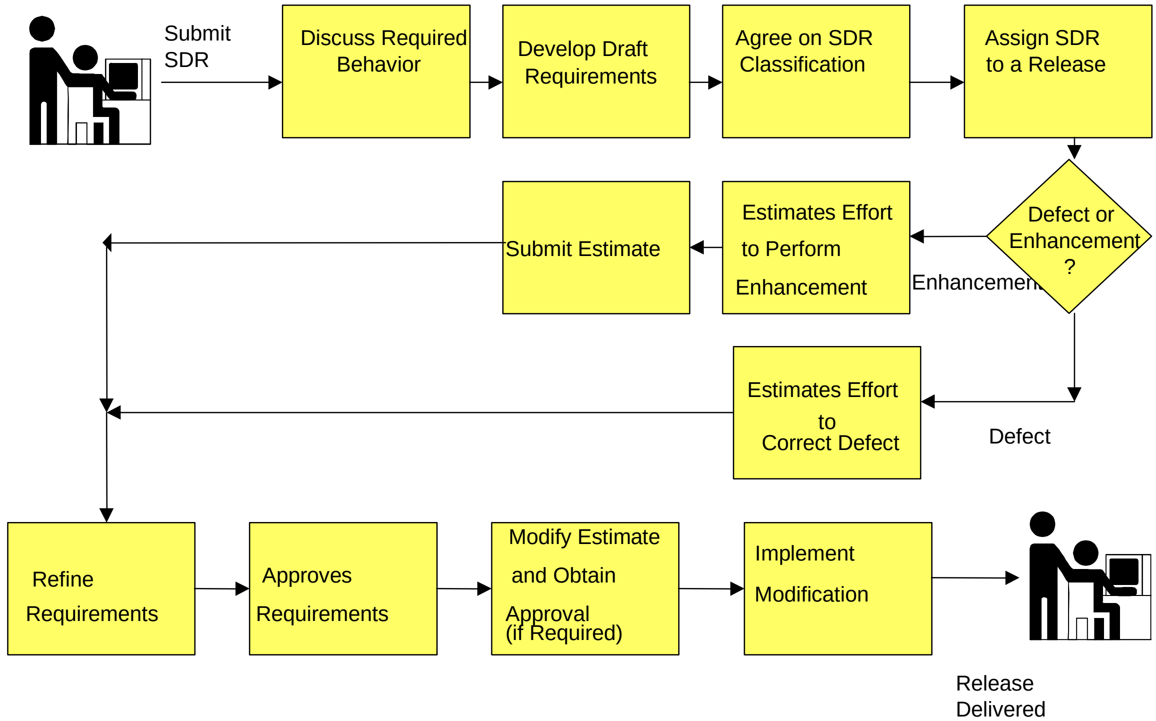

Figure C2 – SDR Flow of Activities